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Appendix 5.1F
Dispersion Modeling Protocol

APPENDIX 5.1F

Dispersion Modeling Protocols

This appendix contains the air dispersion modeling protocols used to assess air quality impacts at Class II and Class I areas near the Alamitos Energy Center. The files contained within this appendix are as follows:

Protocol	Dispersion Modeling Protocol for the Alamitos Energy Center
Protocol	Dispersion Modeling Protocol for Air Quality Related Values at Class I Areas Near the Alamitos Energy Center
Response to Comments	Alamitos Energy Center – Response to USFS FLM Comments on the AQRV Protocol
Correspondence	Forest Service Approval of Class I Modeling Protocol

Modeling Protocol

Dispersion Modeling Protocol for the Alamitos Energy Center

Prepared for

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Submitted to

South Coast Air Quality Management District and the California Energy Commission

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Acronyms and Abbreviations

°F	degrees Fahrenheit
ΔE	color difference
µg/m^3	microgram(s) per cubic meter
AEC	Alamitos Energy Center
AES-SLD	AES Southland Development, LLC
AFC	Application for Certification
AQRV	air quality-related values
ARB	California Air Resources Board
ARM	Ambient Ratio Method
BACT	Best Available Control Technology
CAAQS	California Ambient Air Quality Standards
CalEEMod	California Emissions Estimator Model
CAPCOA	California Air Pollution Control Officers Association
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CTG	combustion turbine generator
DPM	diesel particulate matter
EPA	U.S. Environmental Protection Agency
FLM	Federal Land Managers
GHG	greenhouse gas
GRP	General Reporting Protocol
H_2S	hydrogen sulfide
H_2SO_4	sulfuric acid
HARP	Hotspots Analysis Reporting Program
HBEP	Huntington Beach Energy Project
HFC	hydrofluorocarbons
HI	hazard index
HRA	health risk assessment
HRSG	heat recovery steam generator
IMPROVE	Interagency Monitoring of Protected Visual Environments
ISC	Industrial Source Complex

K	degrees Kelvin
km	kilometer
L/kg/day	liters per kilogram per day
lb	pound(s)
LBWD	City of Long Beach Water Department
MEIR	maximally exposed individual resident
MICR	maximum individual cancer risk
MPRM	Meteorological Processor for Regulatory Modeling Applications
MPSA	Mitsubishi Power Systems Americas
MT	metric ton(s)
MW	megawatt(s)
N_2O	nitrous oxide
N/A	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAD 83	North American Datum 1983
NO_2	nitrogen dioxide
NO_x	oxides of nitrogen
NSR	New Source Review
OEHHA	Office of Environmental Health Hazard Assessment
PFC	perfluorocarbons
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
ppm	parts per million
ppmv	parts per million by volume
PSD	Prevention of Significant Deterioration
PTE	potential to emit
PVMRM	plume volume molar ratio method
Q/D	emissions/distance
RECLAIM	Regional Clean Air Incentives Market
REL	Reference Exposure Level
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SF_6	sulfur hexafluoride
SIL	significant impact levels
SO_2	sulfur dioxide
STG	steam turbine generator
T-BACT	Best Available Control Technology for Toxics
TAC	toxic air contaminants
TCR	The Climate Registry

tpy	ton(s) per year
UTM	Universal Transverse Mercator
VOC	volatile organic compounds

SECTION 1.0

Introduction

AES Southland Development, LLC (AES-SLD) proposes to construct, own, and operate the Alamitos Energy Center (AEC)—a natural-gas-fired, air-cooled, combined-cycle, electrical generating facility in Long Beach, Los Angeles County, California. The proposed AEC will have a net generating capacity of 1,936 megawatts (MW) and gross generating capacity of 1,995 MW.[1] The AEC will replace and be constructed on the site of the existing Alamitos Generating Station located at 690 N. Studebaker Road, Long Beach, California 90803 (see Figure 1-1).

AEC will consist of four 3-on-1 combined-cycle gas turbine power blocks with twelve Mitsubishi Power Systems Americas (MPSA) 501DA combustion turbine generators (CTG), twelve heat recovery steam generators (HRSG), four steam turbine generators (STG), four air-cooled condensers, and related ancillary equipment. The CTGs will use dry low oxides of nitrogen (NO_x) burners and selective catalytic reduction to limit NO_x emissions to 2 parts per million by volume (ppmv). Emissions of carbon monoxide (CO) will be limited to 2 ppmv and volatile organic compounds (VOC) to 1 ppmv through the use of an oxidation catalyst. Best combustion practices and burning pipeline-quality natural gas will minimize emissions of the remaining pollutants.

The AEC will use air-cooled condensers for cooling, completely eliminating the existing ocean water once-through-cooling system. The AEC will use potable water provided by the City of Long Beach Water Department (LBWD) for construction, operational process, and sanitary uses but at substantially lower volumes than the existing Alamitos Generating Station has historically used. This water will be supplied through existing onsite potable water lines.

The AEC will interconnect to the existing Southern California Edison 230-kilovolt switchyard adjacent to the north side of the property. Natural gas will be supplied to the AEC via the existing offsite 30-inch-diameter pipeline owned and operated by Southern California Gas Company that currently serves the Alamitos Generating Station. Existing water treatment facilities, emergency services, and administration and maintenance buildings will be reused for the AEC. The AEC will require relocation of the natural gas metering facilities and construction of a new natural gas compressor building within the existing Alamitos Generating Station site footprint. Stormwater will be discharged to two retention basins and then ultimately to the San Gabriel River via existing stormwater outfalls.

The AEC will include a new 1,000-foot process/sanitary wastewater pipeline to the first point of interconnection with the existing LBWD sewer system and will eliminate the current practice of treatment and discharge of process/sanitary wastewater to the San Gabriel River. The project may also require upgrading approximately 4,000 feet of the existing offsite LBWD sewer line downstream of the first point of interconnection; therefore, this possible offsite improvement to the LBWD system is also analyzed in this Application for Certification (AFC). The total length of the new pipeline (1,000 feet) and the upgraded pipeline (4,000 feet) is approximately 5,000 feet.

The existing Alamitos Generating Station, constructed in the 1950s and 1960s, currently has six operating generating units (Units 1–6) and one retired generating unit (Unit 7). The operating units, the retired unit, and other ancillary structures will be demolished as part of the project. Because the existing Alamitos Generating Station units will be retired and removed as part of the project, the maximum 2-year historical past actual emissions from these units between calendar years 2008 and 2012 will be subtracted from the potential to emit (PTE) for the AEC.

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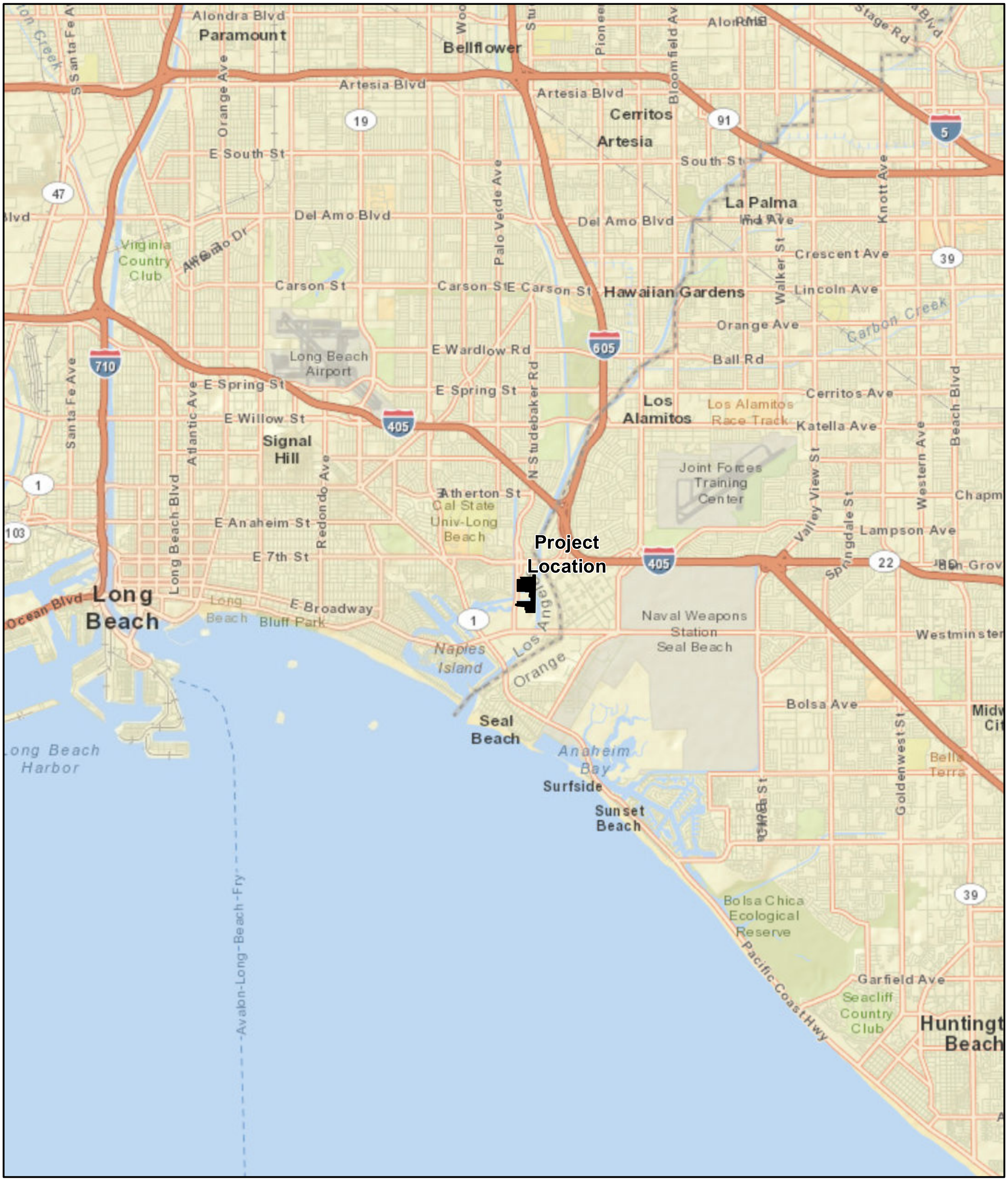
[1] Referenced to site ambient average temperature conditions of 65.3 degrees Fahrenheit (°F) dry bulb and 62.7°F wet bulb temperature without evaporative cooler operation.

The AEC will be permitted through the California Energy Commission (CEC) AFC licensing process and the South Coast Air Quality Management District (SCAQMD) New Source Review (NSR) permitting process. Because the AEC is also categorized as one of the 28 Prevention of Significant Deterioration (PSD) major source categories (40 Code of Federal Regulations [CFR] 52.21(b)(1)(i)), the project is subject to PSD permitting requirements if the net emission increase from the project exceeds 100 tons per year (tpy) for any regulated pollutant, with the exception of greenhouse gases (GHG). The threshold for GHGs is a net increase of 100,000 tpy.

Despite the netting analysis, the resulting PTE is still expected to exceed both the 100 and 100,000 tpy thresholds for criteria pollutants and GHGs, respectively (see Section 3.3, Operation). Therefore, the AEC will be considered a major stationary source in accordance with PSD review. SCAQMD has also been delegated PSD-permitting authority. Therefore, the PSD modeling results will be submitted to SCAQMD as part of the permitting process.

Dispersion modeling will be conducted to demonstrate that the AEC will neither cause a new violation of a state or federal ambient air quality standard nor make an existing violation significantly worse for nitrogen dioxide (NO_2), CO, particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and sulfur dioxide (SO_2). AES-SLD intends to submit an air quality impact analysis to both SCAQMD and CEC that evaluates the impacts from AEC commissioning, startup/shutdown, and normal facility operations. AES-SLD will also evaluate the demolition and construction-based air quality impacts per CEC regulations. In addition, an assessment of the cumulative air quality impacts analysis and the potential human health risks associated with operation of the AEC will be performed. Although VOC and GHG emissions are included in the following discussion, modeling VOC or GHG emissions is not required.

The following discussion presents the methodology proposed for evaluating the potential air quality and public health impacts associated with AEC demolition, construction, commissioning, and operation activities.



Legend

Project Boundary

0 1 2 Miles

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FIGURE 1-1
Regional Location Map
Alamitos Energy Center
Long Beach, California

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SECTION 2.0

Existing Setting

2.1 Area Classifications

The AEC will be located in Long Beach, Los Angeles County, California. The county is in attainment for all federal National Ambient Air Quality Standards (NAAQS) with the exception of ozone, $PM_{2.5}$, and lead. The county is in attainment for all California Ambient Air Quality Standards (CAAQS) with the exception of ozone, NO_2, PM_{10}, $PM_{2.5}$, and lead. The area classifications for each of the pollutants are included in Table 2-1.

TABLE 2-1

State and Federal Air Quality Designations for Los Angeles County (South Coast Air Basin), California

Pollutant	State Designation	Federal Designation
Ozone	1-Hour: Non-attainment (Extreme) 8-Hour: Non-attainment	1-Hour: N/A 8-Hour: Non-attainment (Extreme)
CO	1-Hour: Attainment 8-Hour: Attainment	1-Hour: Attainment 8-Hour: Attainment
NO_2	1-Hour: Non-attainment Annual: Non-attainment	1-Hour: Attainment Annual: Attainment
SO_2	1-Hour: Attainment 24-Hour: Attainment	1-Hour: Attainment 24-Hour: N/A
PM_{10}	24-Hour: Non-attainment Annual: Non-attainment	24-Hour: Attainment* Annual: N/A
$PM_{2.5}$	24-Hour: N/A Annual: Non-attainment	24-Hour: Non-attainment Annual: Non-attainment
Lead	Non-attainment	Non-attainment
H_2S, Sulfates	Unclassified, Attainment	N/A, N/A

*Effective July 26, 2013, Los Angeles County was reclassified by the U.S. Environmental Protection Agency (EPA) from non-attainment to attainment for PM_{10} (78 Federal Register 38223; EPA-R09-OAR-2013-0007-0021).

N/A = Not Applicable (i.e., no standard)
H_2S = hydrogen sulfide

Sources: California Air Resources Board (ARB), 2013c; EPA, 2013b

2.2 Background Concentrations

Several monitoring stations are located near the AEC site, including monitoring stations in the cities of Long Beach, Anaheim, and Compton. The four closest California Air Resources Board (ARB)-certified monitoring stations relative to the AEC site with three or more years of data available are located approximately 4.6 miles northwest of the project site in South Long Beach (South Coastal Los Angeles County 2), 6.4 miles northwest of the project site in North Long Beach (South Coastal Los Angeles County 1), 7.2 miles to the northwest of the project site in Long Beach (South Coastal Los Angeles County 3, U.S. Environmental Protection Agency [EPA] ID 06-037-4006), and 10.1 miles to the east-northeast of the project site in Anaheim (Central Orange County). One other ARB-certified monitoring station was identified near the project site: the South Central Los Angeles County monitoring station in Compton. However, this monitoring station was relocated from the Lynwood location in 2008 and is approximately 10.9 miles to the north-

northwest of the project site, which is farther from the project site than the other monitoring stations identified.

Table 2-2 lists the pollutants monitored at each of the monitoring stations.

TABLE 2-2
Summary of the Nearest Monitoring Stations and the Pollutants Monitored at Each Station

Monitoring Location	Ozone	NO_2	CO	SO_2	PM_{10}	$PM_{2.5}$	Lead
South Coastal Los Angeles County 1 (North Long Beach)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
South Coastal Los Angeles County 2 (South Long Beach)	N/A	N/A	N/A	N/A	Yes	Yes	Yes
Central Orange County (Anaheim)	Yes	Yes	Yes	N/A	Yes	Yes	N/A
South Central Los Angeles County (Compton) [a]	Yes	Yes	Yes	N/A	N/A	Yes	Yes
South Coastal Los Angeles County 3, EPA ID 06-037-4006 (Long Beach) [b]	Yes	Yes	Yes	Yes	N/A	N/A	N/A

[a] Station is near the AEC, but not one of the three closest stations. The station has been presented for informational purposes.
[b] Station, referred to as the Hudson site by the SCAQMD, was commissioned in 2010 and, at the request of the SCAQMD, is used to represent NO_2 background because EPA Region 9 believes that it captures the large NO_x sources in the Ports area that are upwind of the AEC.

Yes = Pollutant monitored at this location
N/A = Not Applicable (i.e., pollutant was not monitored at this location)

As outlined in 40 CFR 51, Appendix W, Section 9.2, the background data used to evaluate the potential air quality impacts need not be collected on a project site, as long as the data are representative of the air quality in the subject area. The following three criteria were used for determining whether the background data are representative of the project site: (1) location, (2) data quality, and (3) data currentness. These criteria are defined and apply to the project as follows:

- **Location:** The measured data must be representative of the areas where the maximum concentration occurs for the proposed stationary source, existing sources, and a combination of the proposed and existing sources.

  The nearest monitoring station relative to the project site is the South Long Beach monitoring station (South Coastal Los Angeles County 2). This monitoring station is located approximately 4.6 miles northwest of the project site. The proximity to the ocean is similar at both locations, and no significant terrain features are in the vicinity of either the project site or monitoring station that would significantly affect the representativeness of the winds or monitored background concentrations. For the reasons noted previously, the South Long Beach monitoring station is considered the most representative location. However, because the South Long Beach monitoring station only measures PM_{10}, $PM_{2.5}$, and lead, the nearest representative location for the remaining pollutants was selected based on the surrounding features, as discussed below.

  The North Long Beach monitoring station (South Coastal Los Angeles County 1) is close to the AEC site (approximately 6.4 miles to the northwest), is located in an urban area near two large industrial sources (the Port of Long Beach and the Long Beach airport), and collects monitored background concentrations comparable to the other monitoring station options located in Long Beach. In addition, the North Long Beach monitoring station measures each of the pollutants required in the air quality impact analysis. The Anaheim monitoring station (Central Orange County) is directly downwind from the project site, but is farther away (approximately 10.1 miles to the east-northeast), farther inland than the project site, and collects monitored background concentrations lower than those collected at the North Long Beach monitoring station (i.e., the North Long Beach monitoring station represents a more conservative analysis).

Based on the information above, the ambient data collected at the North Long Beach monitoring station are considered representative of the project site for the pollutants not monitored at the South Long Beach monitoring station, unless otherwise noted below. Additionally, a meteorological dataset has also been collected at the North Long Beach monitoring station and is considered representative of the project site using the criteria above (see Section 4.0, Topography and Meteorology).

At the request of SCAQMD, NO_2 data collected at the Long Beach monitoring station (South Coastal Los Angeles County 3, EPA ID 06-037-4006) are considered representative of the project site. This monitoring station is located approximately 7.2 miles to the northwest of the project site and is considered representative because it captures the large NO_x-emitting sources in the Ports area that are upwind of the proposed project.

- **Data quality:** Data must be collected and equipment must be operated in accordance with the requirements of 40 CFR 58, Appendices A and B, and PSD monitoring guidance.

  The SCAQMD, ARB, and EPA ambient air quality data summaries will be used as the primary sources of data. Therefore, the data at each of the monitoring stations listed in Table 2-2 meet the data quality requirements of 40 CFR 58, Appendices A and B, and PSD monitoring guidance.

- **Data currentness:** The data are current if they have been collected within the preceding three years and are representative of existing conditions.

  The maximum ambient background concentrations from the three most recent years will be combined with the modeled concentrations and used for comparison to the ambient air quality standards. Therefore, the data at each of the monitoring stations listed in Table 2-2 represent the three most recent years of data available.[2]

Based on the criteria presented previously, the three most recent years of background hourly NO_2 data from the Long Beach monitoring station, the three most recent years of background CO, SO_2, ozone, and annual NO_2 data from the North Long Beach monitoring station, and the three most recent years of background PM_{10}, $PM_{2.5}$, and lead data from the South Long Beach monitoring station will be combined with the modeled concentrations and used for comparison to the ambient air quality standards. A summary of the background concentrations for 2008 through 2012 is presented in Table 2-3. In a few instances, 2011 or 2012 data were unavailable and, therefore, 2008 or 2009 data were used to maintain the three most recent years of data.

[2] It should be noted that the recently established site in Long Beach (South Coastal Los Angeles County 3, EPA ID 06-037-4006) does not have three complete years of data available. In 2012, NO_2 was only monitored during peak conditions; therefore, the collected data do not meet the completeness criteria for an annual averaging time.

TABLE 2-3
Background Air Concentrations (2008–2012)

		2008 [a]		2009 [a]		2010		2011		2012		Maximum
Pollutant	**Averaging Time**	**ppm**	**µg/m³**	**ppm**	**µg/m³**	**ppm**	**µg/m³**	**ppm**	**µg/m³**	**ppm**	**µg/m³**	**µg/m³**
NO_2	1-hour (Max.)	—	—	—	—	0.118	222	0.090	169	0.091	170	222
	1-hour (98th Percentile)	—	—	—	—	0.071	134	0.074	139	0.077	146	139 [d]
	Annual [b]	—	—	—	—	0.020	37.3	0.018	33.3	0.021	39.1	39.1
Ozone	1-hour (Max.)	—	—	—	—	0.101	198	0.073	143	0.084	165	198
	8-hour (Max.)	—	—	—	—	0.084	165	0.061	120	0.067	132	165
SO_2	1-hour (Max.)	—	—	—	—	0.040	105	0.015	38.7	0.022	58.1	105
	1-hour (99th Percentile)	—	—	—	—	0.016	41.9	0.011	28.0	0.014	37.4	35.8 [d]
	3-hour [c]	0.038	98.4	0.011	29.6	0.025	64.4	N/A	N/A	N/A	N/A	98.4
	24-hour (Max.)	—	—	—	—	0.006	15.7	0.004	10.5	0.003	7.85	15.7
CO	1-hour (Max.)	—	—	—	—	3.00	3,436	3.20	3,665	2.60	2,978	3,665
	8-hour (Max.)	—	—	—	—	2.10	2,405	2.60	2,978	2.20	2,519	2,978
PM_{10}	24-hour (Max.)	—	—	—	—	—	76.0	—	50.0	—	54.0	76.0
	Annual [b]	—	—	—	—	—	27.3	—	28.7	—	25.5	28.7
$PM_{2.5}$	24-hour (98th Percentile)	—	—	—	—	—	26.5	—	26.6	—	25.1	26.1 [d]
	Annual [b]	—	—	—	—	—	10.4	—	10.7	—	10.6	10.7
Lead	Monthly (Max.)	—	—	—	0.010	—	0.010	—	0.013	—	N/A	0.013
	Quarterly (Max.)	—	—	—	0.010	—	0.010	—	0.009	—	N/A	0.010

[a] 2008 and 2009 data were used when 2011 and 2012 data were unavailable for certain pollutants.
[b] Annual Arithmetic Mean.
[c] EPA Secondary Standard.
[d] 3-year average rather than the maximum.

µg/m³ = micrograms per cubic meter
N/A = Not Applicable (i.e., data not available from SCAQMD, ARB, or EPA sources)
ppm = parts per million

Sources: SCAQMD, 2013; ARB, 2013a; EPA, 2013a

SECTION 3.0

Methodology for Estimating Project-Related Emissions

3.1 Construction

Onsite construction activities will consist of the installation of twelve new CTGs, twelve new HRSGs, four new STGs, four new air-cooled condensers, and various auxiliary equipment. AEC construction is anticipated to take approximately 139 months, starting in January 2016 and finishing in July 2027. The AEC will reuse existing onsite potable water, natural gas, and stormwater pipelines as well as electrical transmission facilities to the maximum extent possible; however, some modification and interconnection of the AEC facility into these systems will require construction activity. Additionally, the project will include construction of a new 1,000-foot offsite wastewater pipeline and the potential need to upgrade up to 4,000 feet of an existing offsite sanitary pipeline.

The project will commence in the first quarter of 2016 with demolition of the retired Alamitos Generating Station Unit 7, the Unit 7 fuel tank, and the northeast warehouse, which is anticipated to take approximately 8 months. Demolition of the retired Alamitos Generating Station Unit 7, the Unit 7 fuel tank, and the northeast warehouse will make space for construction of AEC Blocks 1 and 2. Construction of AEC Block 1 is scheduled to commence in the third quarter of 2016, and construction of AEC Block 2 is scheduled to commence in the fourth quarter of 2016; construction of AEC Blocks 1 and 2 is anticipated to take approximately 33 months. Demolition of Alamitos Generating Station Units 5 and 6 will commence in the fourth quarter of 2018 and continue for approximately 24 months. Demolition of Units 5 and 6 will make space for construction of AEC Block 3, which is scheduled to commence in the first quarter of 2020 and continue for approximately 30 months. Demolition of Alamitos Generating Station Units 3 and 4 will commence in the first quarter of 2022 and continue for approximately 24 months. Demolition of Units 3 and 4 will make space for construction of AEC Block 4, which is scheduled to commence in the second quarter of 2023 and continue for approximately 30 months. Demolition of Alamitos Generating Station Units 1 and 2 is scheduled to commence in the third quarter of 2025 and continue for approximately 24 months. Demolition of the existing units will include an organized, top-down dismantling of the existing boiler units, generators, and stacks. The existing foundations will remain largely intact at the conclusion of the demolition activities, and most of the demolition debris will be transported to an offsite location for recycling. In addition to the planned construction and demolition activities, construction of the new offsite wastewater pipeline and upgrades to the existing offsite sanitary pipeline will commence in the third quarter of 2016 and continue for approximately 4 months. All project-related construction/demolition activities are expected to be complete by July 2027. Throughout this duration, there will be periods of up to 8 months of overlap between construction and demolition activities.

Construction of the AEC will require the use of onsite laydown areas (approximately 8 acres dispersed throughout the existing site) and a 10-acre laydown area located adjacent to the existing site. At all times, more laydown space will be available due to the sequential nature of the project. The adjacent 10-acre laydown area will be shared with another project (Huntington Beach Energy Project [HBEP] – 12-AFC-02) being developed by AES-SLD. Due to the timing for commencement of construction for these two projects, the 10-acre laydown area will already be in use for equipment storage before AEC construction begins. Because emissions associated with preparing this area for equipment storage will occur prior to commencement of AEC construction, and offsite truck travel associated with the use of this laydown area for HBEP were included in HBEP’s AFC (12-AFC-02). Air emissions attributed to the AEC project, unrelated to site preparation, will be minimal emissions from construction equipment used to move AEC items into and out of the laydown area for construction of AEC Block 3. Exhaust emissions associated with the use of the

10-acre laydown area are included in the Block 3 construction and demolition estimates. During AEC construction, all construction equipment and supplies will be trucked directly to the project site.

Onsite and offsite project emissions from construction and demolition will be divided into three categories: (1) vehicle and construction/demolition equipment exhaust; (2) fugitive dust from vehicle and construction/demolition equipment, including grading and bulldozing during AEC construction; and (3) fugitive dust from demolition activities such as the top-down removal of the boilers and stacks, and loading of waste haul trucks with the recyclable materials and generated debris.

The following criteria pollutant emissions will be calculated: NO_x, SO_2, VOC, CO, PM_{10}, and $PM_{2.5}$. Fugitive dust and construction equipment exhaust emissions will be estimated using methodology and emission factors consistent with the California Emissions Estimator Model (CalEEMod; Version 2013.2.2 or newer), which incorporates portions of EPA's *AP-42* (ENVIRON, 2013; EPA, 2006; SCAQMD, et al., 2011). Vehicle exhaust emissions for both paved and unpaved roads will be estimated using EMFAC2011 emission factors,[3] as consistent with the CalEEMod methodology.[4] As appropriate, fugitive dust emissions will be mitigated by watering; the control efficiency for each mitigation measure applied will be determined per the SCAQMD *California Environmental Quality Act (CEQA) Handbook* (SCAQMD, 2007). It is not expected that large stockpiles of earthen materials will be present during project construction; therefore, wind-blown fugitive dust emissions from earthen stockpiles will be assumed to be negligible.

Construction and demolition equipment GHG emissions will be estimated using emission factors from The Climate Registry (TCR) General Reporting Protocol (GRP, Version 2.0) (TCR, 2013) and fuel consumption rates from OFFROAD2007. Vehicle emissions (from vehicles used in commuting and from trucks) will be estimated using emission factors from TCR GRP (Version 2.0) (TCR, 2013) and fuel economy values from the EMFAC2011 Web Based Database.[5] No significant emissions of hydrofluorocarbons (HFC), perfluorocarbons (PFC), or sulfur hexafluoride (SF_6) are expected during construction and demolition.

SCAQMD staff has recommended a GHG significance threshold that would apply to stationary source/industrial projects and would include direct and indirect emissions during construction and operation. Following the Tier 3 screening level approach, construction emissions would be amortized over the life of the project (defined as 30 years) and would be added to the operational emissions for comparison to the significance threshold of 10,000 metric tons (MT) of carbon dioxide equivalent (CO_2e).[6] Because the GHG PTE emissions from the operation of the AEC are expected to exceed 1,000,000 MT of CO_2e, the AEC would exceed the 10,000 MT of CO_2e limit. However, the AEC has been designed to incorporate energy-efficient technologies for reducing GHG PTE emissions from the power generation equipment; additionally, SCAQMD will define the Best Available Control Technology (BACT) for reducing GHG emissions as part of the PSD permitting process. Therefore, for purposes of evaluating the potential GHG impacts associated with AEC construction and demolition activities, the construction GHG emissions will be compared to the 10,000 MT of CO_2e threshold.

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[3] The EMFAC2011-PL (project-level assessment) module will be used for vehicle emission factors. EMFAC2011 consists of three modules: EMFAC-LDV, which estimates passenger vehicle emissions; EMFAC-HD, which estimates emissions from diesel trucks and buses over 14,000 pounds (lb); and a third module called EMFAC-SG, which integrates the output of EMFAC-LDV and EMFAC-HD and the ability to conduct scenario assessments for air quality and transportation planning (ARB, 2013b). In order to aid in obtaining emission rates for project- level assessments, ARB has released a new tool, EMFAC2011-PL, which can be used for most assessments using EMFAC default information to obtain standard emission rates for the desired vehicle category scheme (ARB, 2013b).

[4] CalEEMod is a statewide computer model created by ENVIRON and SCAQMD to quantify criteria pollutant and GHG emissions associated with the construction activities from a variety of land use projects (ENVIRON, 2013). Developed in cooperation with air districts throughout the state, CalEEMod is intended to standardize air quality analyses while allowing air districts to provide specific defaults reflecting regional conditions, regulations, and policies (SCAQMD, et al., 2011).

[5] Fuel economy was determined using EMFAC2007 vehicle categories. The database is available online at http://www.arb.ca.gov/emfac/.

[6] Information on thresholds is available online at http://www.aqmd.gov/hb/2008/December/081231a.htm.

3.2 Commissioning

During commissioning, each turbine will be initially operated at various load rates without the benefit of the emission control systems while these systems are being commissioned and tested. The total duration of a power block commissioning period is expected to be up to 180 days. During the commissioning period, each turbine will be operated for up to 455 hours without, or with partial, emission control systems in operation. Several possible scenarios during commissioning are expected to result in NO_x, VOC, and CO emissions that are greater than during normal operations. During commissioning, PM_{10}, $PM_{2.5}$, and SO_2 emissions are expected to be no greater than full-load operations. Therefore, short-term emission calculations for commissioning activities will be limited to NO_x, CO, and VOC. The NO_x, CO, and VOC emissions will be estimated based on turbine performance data provided by the vendor, estimated durations and control efficiencies of each commissioning event, and turbine operating rates.

Although commissioning is expected to be completed within 180 days, annual impacts for the combined commissioning of one power block and operation of four power blocks for a rolling 12-month period will also be evaluated because annual emissions during the commissioning year could be higher than those during a non-commissioning year. The annual average emission rates associated with commissioning and operation will be estimated based on the total commissioning period emissions and the maximum operation emission rates for an annual operating scenario, respectively.

3.3 Operation

Emissions of NO_x, SO_2, CO, VOC, PM_{10}, and $PM_{2.5}$ to the atmosphere from the AEC will occur from combustion of natural gas in each of the identical CTGs. Emission rates will be calculated based on vendor data and additional conservative assumptions of turbine performance. Turbine emissions and stack parameters, such as flow rate and exit temperature, will exhibit some variation with ambient temperature and operating load. Therefore, to evaluate the worst-case air quality impacts during normal operation, dispersion modeling will be conducted at 70, 80, 90, and 100 percent load at 28, 65.3, and 107 °F. In addition to the normal operating load/temperature scenarios, emission estimates and an air quality impact analysis will also be conducted for startup and shutdown events. As previously noted, the proposed project will include the use of two existing electrically driven fire pumps. Therefore, no direct emissions will be emitted from the emergency fire pumps.

An estimate of the annual AEC PTE criteria pollutant emissions and past actual emissions from 2008 through 2012 are presented in Table 3-1. The PTE estimates are based on preliminary engineering data, 3,320 hours of base load operation per turbine per year, and 495 startups and shutdowns per turbine per year. The net increase presented in Table 3-1 will be used to define PSD applicability but will not be used in the dispersion modeling to determine air quality impacts.

TABLE 3-1
Annual Facility Emission Estimates

	Estimates Facility Emission Totals (tons per year)					
Facility	**NO_x**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**
Existing Units (Past Actual)	65.8	6.84	16.3	16.3	25.7	1,180
AEC (PTE)*	272	20.8	99.5	99.5	188	372
Net Increase	206	13.9	83.2	83.2	163	-808

*Assumes twelve MPSA 501DA gas turbines operating 3,320 hours per turbine per year at base load and 495 startups and shutdowns per turbine per year.

Combustion of natural gas in the turbines will also result in emissions of the following GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Therefore, GHG emissions for normal facility operations will be calculated based on the maximum fuel usage predicted for AEC and emission factors contained in the TCR GRP (Version 2.0) (TCR, 2013). GHG emissions will be calculated for comparison to the PSD significance thresholds but will not be included in the dispersion modeling impact analysis.

Criteria pollutant and GHG emissions from AEC operational worker commutes and material deliveries will also be calculated. Criteria pollutant emissions will be estimated using emission factors from EMFAC2011. GHG emissions will be estimated using emission factors from TCR GRP (Version 2.0) (TCR, 2013) and fuel economy values from the EMFAC2011 Web Tool Database, based on EMFAC2007 vehicle categories. Criteria pollutant and GHG emissions from AEC operational worker commutes and material deliveries will be calculated for CEC informational purposes but will not be included in the dispersion modeling impact analysis.

SECTION 4.0

Topography and Meteorology

4.1 Topography

The AEC site is located near sea level approximately 2 miles from the California coast and is bounded to the north by a switchyard; to the east by the San Gabriel River and, beyond that, a power generating facility; to the south by a petroleum storage facility and undeveloped property; and to the west by the Los Cerritos Channel, Alamitos Generating Station inlets, and city of Long Beach residences. The site is also partially bisected by a single parcel that was the former fuel oil tank farm for the Alamitos Generating Station, which is now owned by a third party.

The AEC site is located on a gently sloping coastal terrace above the Alamitos Bay marina, and the topography of the site ranges from approximately 7 to 20 feet above mean sea level. The nearest complex terrain (terrain exceeding stack height) in relation to the AEC is located in the city of Signal Hill, approximately 3.5 miles northwest of the AEC site. Although Signal Hill is the highest area within 6 miles of the AEC site, it is not a significant terrain feature, with gradual rising terrain less than 0.5 mile in width. The nearest Class I area is the San Gabriel Wilderness, which is approximately 33 miles (approximately 53 kilometers [km]) northeast of the AEC site.

4.2 Meteorology

4.2.1 Meteorology for Dispersion Modeling

According to EPA's *Guideline on Air Quality Models* (EPA, 2005), representativeness of meteorological data used in dispersion modeling depends on (1) the proximity of the meteorological monitoring site to the area under consideration; (2) the complexity of the terrain; (3) the exposure of the meteorological monitoring site; and (4) the period of time during which data are collected.

Two SCAQMD meteorological data collection sites were identified in proximity to the proposed project: North Long Beach and Anaheim. Of the two locations, the North Long Beach site was selected as the most representative based on the following factors:

- The monitoring site is the closer of the two to the proposed project (approximately 6.4 miles to the northwest of the AEC site, versus 10.1 miles to the east-northeast for the Anaheim monitoring station).
- There are no complex terrain features between the two locations.
- The land uses surrounding the monitoring site and the AEC site are similar (both are surrounded by a blend of low-, medium-, and high-intensity land uses with open water less than 10 miles to the south-southwest).

Therefore, the North Long Beach monitoring station is considered representative of the AEC site, and the meteorological data collected at the North Long Beach monitoring station will be used to model the ambient air quality impacts. The meteorological data used for this analysis have been compiled by SCAQMD specifically for use in dispersion modeling analyses and include the periods of January 1, 2006, through December 31, 2009, and January 1, 2011, through December 31, 2011.[7] A wind rose for the North Long Beach monitoring station is presented in Figure 4-1.

[7] At the direction of the SCAQMD, 2010 meteorological data were not recommended for use because the data do not meet the 90 percent completeness requirements. Similarly, 2012 meteorological data were not recommended for use because the collected wind speeds are suspect.

4.2.2 Upper Air Data

Twice-daily National Climatic Data Center soundings from the San Diego Miramar National Weather Service station (Station #03190) were coupled with the North Long Beach surface data by SCAQMD to create the AERMET meteorological dataset.

4.2.3 AERMET Preprocessing

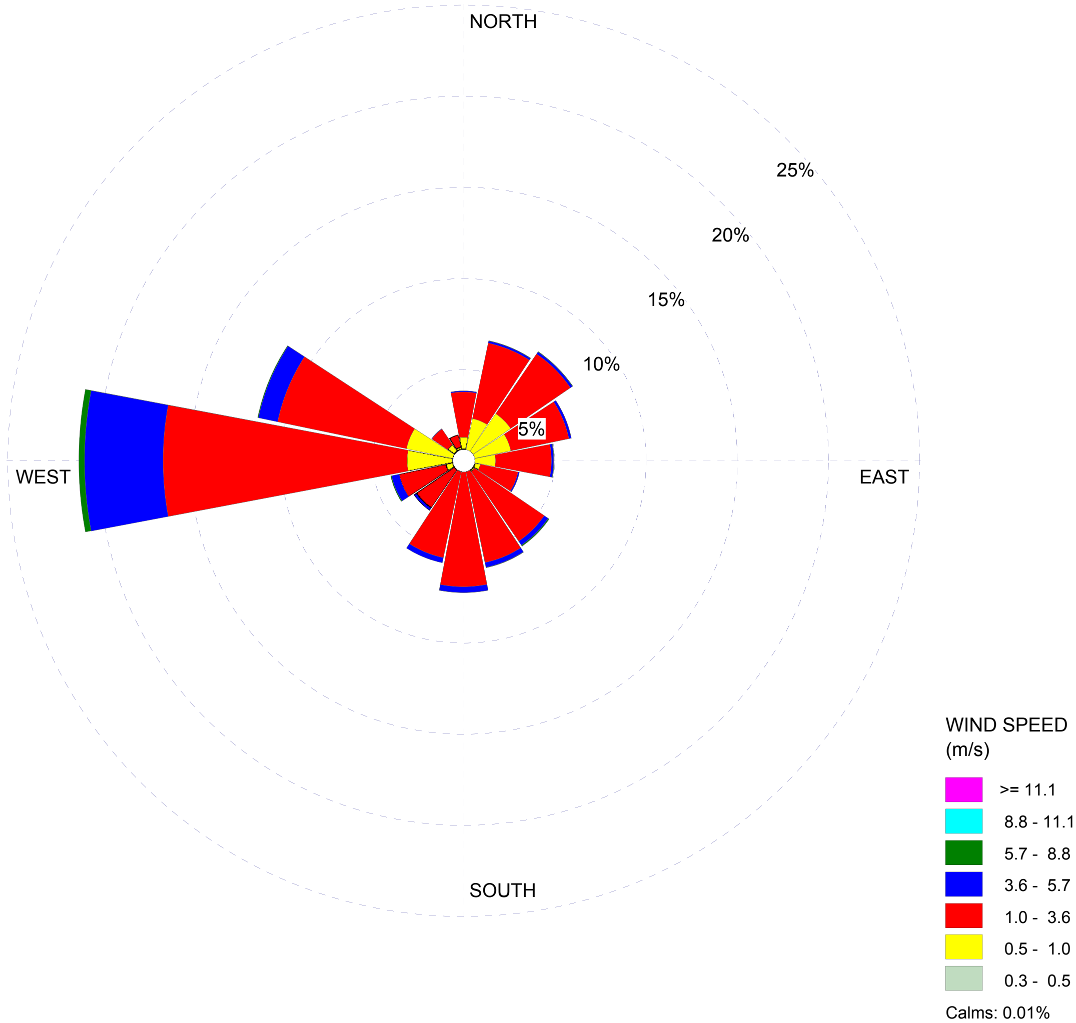
SCAQMD preprocessed the meteorological data with the AERMET preprocessor. The processed data files for 2006 through 2009 and 2011 were provided via e-mail by SCAQMD.

WIND ROSE PLOT:

AERMET Meteorological Data
SCAQMD Long Beach Station

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:	DATA PERIOD:	COMPANY NAME:	
	Start Date: 1/1/2006 - 00:00 **End Date: 12/31/2011 - 23:00**		
		MODELER:	
	CALM WINDS: **0.01%**	TOTAL COUNT: **43378 hrs.**	
	AVG. WIND SPEED: **1.88 m/s**	DATE: **12/6/2013**	PROJECT NO.:

WRPLOT View - Lakes Environmental Software

FIGURE 4-1
SCAQMD Long Beach Meteorological Station Wind Rose
Alamitos Energy Center
Long Beach, California

IS061013112817SAC Figure_4-1.ai tdaus 12.11.2013

CH2MHILL.

SECTION 5.0
Dispersion Modeling Approach

5.1 Model Selection

The EPA-approved AERMOD (Version 12345 or most recent version) dispersion model will be used to evaluate the air quality emissions from the AEC. The AERMOD model is the latest generation of EPA's short-term model recommended for predicting impacts from industrial-point sources, as well as area and volume sources.

5.2 Model Input Defaults/Options

The AERMOD model will be used with regulatory default options as recommended in the EPA *Guideline on Air Quality Models* (EPA, 2005). The following supporting preprocessing programs for AERMOD will also be used:

- BPIP-Prime (Version 04274)
- AERMAP (Version 11103)

The technical options to be selected for the AERMOD model include the following:

- Regulatory default control options
- Receptor elevations and controlling hill heights obtained from AERMAP output

SCAQMD modeling guidance recommends running AERMOD with the non-default FLAT option (which assumes that all receptors and emission sources have the same elevation) for receptors with elevations below the stack base (SCAQMD, 2012). However, recent correspondence with SCAQMD staff further clarified that the FLAT option is intended for locations with drainage or gravity flows that would typically occur in mountain valley settings. Based on the additional guidance and the proposed location of the AEC on a coastal plain where onshore and offshore wind flows occur, it is concluded that the FLAT option is not required for this analysis.

Initially, a complete conversion of NO_x emissions to NO_2 will be assumed. If this assumption leads to predicted exceedances of the NAAQS, CAAQS, or significance criteria for NO_2 identified in Section 6.0, Air Quality Impacts Analysis, the default ambient ratio of 0.75 NO_2/NO_x (i.e., 75 percent of NO_x emissions are converted to NO_2) will be applied to annual predicted impacts, and the default ratio of 0.80 will be applied to 1-hour predicted impacts to determine NO_2 concentrations (EPA, 2005; EPA, 2011). If 1-hour predicted NO_2 impacts still exceed the NAAQS after application of the ambient ratio, the predicted impact will instead be estimated by pairing the maximum modeled concentration with the 98th percentile seasonal, hour-of-day background NO_2 concentrations. The 98th percentile seasonal, hour-of-day background NO_2 concentrations for 2009 through 2011 were provided via e-mail by the SCAQMD.

If predicted NO_2 impacts require further refinement, the plume volume molar ratio method (PVMRM) will be used. PVMRM options will assume an initial in-stack NO_2/NO_x ratio of 0.5 and an out-of-stack NO_2/NO_x ratio of 0.9 (EPA, 2011; California Air Pollution Control Officers Association [CAPCOA], 2011). Corresponding hourly ozone data from the North Long Beach monitoring station were provided via e-mail by SCAQMD.

5.3 Land Use / Classification

AERMOD will be run in urban dispersion mode because land use within 3 km of the AEC site is primarily classified as urban, based on the Auer Method. A population of 9,862,049 will be used in AERMOD, as recommended by SCAQMD for projects in Los Angeles County (SCAQMD, 2012).

5.4 Receptor Network

The base modeling receptor grid for the AERMOD modeling will consist of receptors that are placed at the ambient air boundary and Cartesian-grid receptors that are placed beyond the project's site boundary at spacing that increases with distance from the origin. The project's property boundary will be used as the ambient air boundary. Property boundary receptors will be placed at 30-meter intervals. Beyond the project's property boundary, receptor spacing will be as follows:

- 50-meter spacing from the property boundary to 500 meters from the origin
- 100-meter spacing from beyond 500 meters to 3 km from the origin
- 500-meter spacing from beyond 3 km to 10 km from the origin
- 1,000-meter spacing from beyond 10 km to 25 km from the origin
- 5,000-meter spacing from beyond 25 km to 50 km from the origin

All receptors and source locations will be expressed in the Universal Transverse Mercator (UTM) North American Datum 1983 (NAD 83), Zone 11 coordinate system.

The base modeling receptor grid will be extended if predicted concentration gradients are increasing at the edge of the grid. Similarly, the base (coarse) receptor grid will be supplemented with receptors at closer (tighter) receptor spacing, where appropriate, so that the maximum points of impact can be identified.

AERMAP (Version 11103) will be used to calculate the receptor elevations and the controlling hill heights. Terrain in the vicinity of the project will be accounted for by assigning base elevations to each receptor. National Elevation Dataset files from the United States Geological Survey will be obtained in one-third arc-second resolution for the 50-km grid. The AERMAP domain will be large enough to encompass the 10 percent slope factor required for calculating the controlling hill height.

5.5 Source Characterization

5.5.1 Construction

The AEC construction site will be represented as a set of point sources and area sources in the modeling analysis. The exhaust emissions will be modeled as a set of point sources spaced approximately 25 meters apart over the construction areas with a horizontal stack release. The horizontal release type is an AERMOD beta option (i.e., non-regulatory default option), which negates mechanical plume rise. This conservative approach is proposed because it is unknown whether the construction equipment will have vertically oriented exhaust stacks. Stack release parameters will consist of a stack release temperature of 533 degrees Kelvin (K; 500°F), a stack diameter of 0.127 meters (5 inches), and a release height of 4.6 meters (15 feet) based on data for typical construction equipment. The wind-blown and fugitive dust emissions will be modeled as area sources assuming a ground-level release height with an initial vertical dimension of 1 meter.

As discussed in Section 6.0, Air Quality Impacts Analysis, predicted concentrations of NO_x, CO, PM_{10}, $PM_{2.5}$, and SO_2 from onsite construction-related activities will be combined with the ambient background concentrations and compared to the ambient air quality standards. Note that if the predicted concentrations initially exceed the ambient air quality standards, the model will be refined to limit the hours in which concentrations are predicted to align with the expected hours of construction activities. In an effort to limit noise impacts to nearby residents and businesses, AES-SLD will limit construction activities to occur between the hours of 7:00 a.m. and 7:00 p.m. on weekdays and 9:00 a.m. and 6:00 p.m. on Saturdays.

5.5.2 Commissioning

The CTG exhaust stacks will be modeled as point sources within AERMOD. Exhaust parameters will be based on information provided by the vendor for each commissioning phase. For short-term averaging periods, only maximum hourly impacts for NO_x and CO will be modeled for each commissioning phase. Emission rates of PM_{10}, $PM_{2.5}$, and SO_2 are expected to be equal to or lower than normal operating rates due to reduced loads during commissioning.

Although commissioning is expected to be completed within 180 days, annual impacts for the combined commissioning of one power block and operation of four power blocks for a rolling 12-month period will also be evaluated because annual emissions during the commissioning year could be higher than those during a non-commissioning year. As a result, annual NO_x, PM_{10}, and $PM_{2.5}$ impacts from commissioning with operation will also be modeled.

5.5.3 Operation

The proposed CTGs will be modeled as point sources within AERMOD. Exhaust parameters will be based on information provided by the vendor. The modeling analysis will include a load analysis to determine which operating conditions expected for the CTGs will yield the highest ground-level concentrations.

5.6 Building Wake Downwash and Good Engineering Practice

AERMOD can account for building downwash and cavity zone effects. The proposed AEC stack locations, heights, building locations, and dimensions will be input to BPIP-PRIME. The first step of BPIP-PRIME determines and reports on whether or not a stack follows good engineering practice or is being subjected to wake effects from a structure or structures. The second step calculates direction-dependent equivalent building dimensions if a stack is being influenced by structure wake effects. The BPIP-PRIME output will be used in the AERMOD modeling.

A screening BPIP-PRIME analysis will also be conducted to evaluate if the existing Alamitos Generating Station structures influence the AEC sources prior to demolition. If it is determined that the existing structures influence downwash, the existing structures will also be included in the commissioning and operational air quality impact assessment.

SECTION 6.0

Air Quality Impacts Analysis

As previously described, the AEC will require an ambient air quality analysis for pollutants for which there would be an increase in emissions. The following sections summarize the approach to address the requirements applicable to each reviewing agency and highlight the criteria required for each analysis.

6.1 SCAQMD New Source Review

6.1.1 Rule 1303 and Rule 1304

SCAQMD Rule 1303 requires an ambient air quality analysis for each new emission source to demonstrate that a proposed project will not cause a violation or make significantly worse an existing violation of the CAAQS or NAAQS. However, under SCAQMD Rule 1304(a)(2), the AEC will be exempt from this rule because the AEC is a replacement of existing electric utility steam boilers with combined-cycle gas turbines with no increase in energy output rating. Therefore, a comparison of potential impacts to the significant change in air quality thresholds of SCAQMD Rule 1303, Table A-2, is not required as part of this air quality impacts analysis.

Per SCAQMD Rule 1303(b)(5)(C), a modeling analysis is required to evaluate impacts on plume visibility if the net emission increase from the new or modified source exceeds 15 tpy of PM_{10} or 40 tpy of NO_x; and the location of the source, relative to the closest boundary of a specified Federal Class I area, is within 28 km. Net emissions of NO_x will exceed the emissions threshold, but the distance to the nearest Class I area is approximately 53 km, as presented in Figure 6-1. Therefore, a visibility analysis is not required for Class I areas under SCAQMD Rule 1303.

Although not required by its Rules, SCAQMD requested an analysis of a project's impacts on visibility for nearby State Parks and National Wilderness Areas designated as Class II areas. As such, a visibility analysis for Class II areas will be performed using the EPA-recommended VISCREEN model. The general procedures to determine visibility impacts will follow the approach outlined in the *Workbook for Plume Visual Impact Screening and Analysis (Revised)* (EPA, 1992), with clarification of the following particular inputs:

- Background visual ranges for the Class II areas will be determined using maps supplied by the Interagency Monitoring of Protected Visual Environments (IMPROVE). The average of the annual upper and lower bounds will be used.
- If a Tier 1 approach exceeds the Class I criterion for color difference (ΔE) and contrast, a Tier II assessment will be conducted. The Tier II assessment will use the North Long Beach AERMET meteorological dataset provided by SCAQMD staff for the years 2006 through 2009 and 2011. These data will be pre-processed with the EPA Meteorological Processor for Regulatory Modeling Applications (MPRM, Version 99349) for the Industrial Source Complex (ISC) modeling system.[8]

Based on a survey of State Parks and National Wilderness Areas designated as Class II areas within 50 km of the AEC, AES-SLD proposes to include the following Class II areas in the visibility assessment, as presented in Figure 6-2:

- Crystal Cove State Park
- Water Canyon National Park
- Chino Hills State Park
- Kenneth Hahn State Park

[8] ISC-ready data, preprocessed with MPRM, contain the wind speed, wind direction, and stability class for each hour of the year. These data are required to create the Joint Frequency Distribution tables used to calculate the Tier II wind speed and stability class for each area analyzed.

6.1.2 Rule 1401

SCAQMD Rule 1401 specifies limits for maximum individual cancer risk (MICR), cancer burden, and noncancer acute and chronic hazard index (HI) from new permit units, relocations, or modifications to existing permit units that emit toxic air contaminants (TAC) listed in SCAQMD Rule 1401, Table I. The AEC will be subject to SCAQMD Rule 1401 NSR requirements. Therefore, a health risk assessment (HRA) will be completed as part of the air quality impacts analysis for the AEC. The procedure for evaluating the potential impacts is discussed in Section 7.0, Human Health Risk Assessment.

6.1.3 Rule 2005

SCAQMD Rule 2005 sets forth preconstruction review requirements for new facilities subject to the requirements of the Regional Clean Air Incentives Market (RECLAIM) program, for modifications to RECLAIM facilities, and for facilities that increase their allocation to a level greater than their starting allocation plus non-tradable credits. The existing Alamitos Generating Station is currently subject to the RECLAIM requirements and, as shown in Table 6-1, the proposed project will also exceed the major NO_2 modification threshold of 1 pound (lb) per day. Therefore, an ambient air quality analysis is required to demonstrate that the AEC will not cause a significant increase in the air quality concentration of NO_2, as specified in SCAQMD Rule 2005, Appendix A.

TABLE 6-1
Rule 2005 Emissions Levels That Trigger Dispersion Modeling Requirement

Pollutant	Estimated PTE – Past Actual	Major Source Threshold	Major Modification Threshold	Exceeds Threshold? (Yes/No)
NO_x	206 tpy	10 tpy	1 lb per day	Yes
SO_2	13.9 tpy	100 tpy	40 tpy	No

The significance thresholds and the most stringent air quality standards for NO_2 are presented in Table 6-2. The maximum modeled NO_2 concentrations from the refined dispersion modeling analysis for each turbine will be compared to the significance values identified in Table 6-2. The maximum modeled NO_2 concentrations will also be added to representative background concentrations, and the results compared to the state and federal ambient air quality standards for NO_2. The highest ambient concentration from the most recent three years of ambient monitoring data will be used as the background concentration.

TABLE 6-2
Rule 2005 Air Quality Thresholds and Standards Applicable to the Project (per Emission Unit)

Averaging Period/ Pollutant	Significant Change in Air Quality Concentration [a] (µg/m^3)	National Ambient Air Quality Standard (µg/m^3)	California Ambient Air Quality Standards (µg/m^3)
NO_2 (1-hour)	20	188 [b]	339
NO_2 (Annual)	1	100	57

[a] Allowable change in air quality concentration per emission unit per SCAQMD Rule 2005, Appendix A.
[b] National 1-hour standard represents the 3-year average of the 98th percentile of the daily maximum 1-hour average.

6.2 Prevention of Significant Deterioration

SCAQMD Regulation XVII sets forth preconstruction review requirements for stationary sources to ensure that air quality in clean air areas does not significantly deteriorate, while maintaining a margin for future industrial growth, and applies to preconstruction review of new or modified stationary sources that emit more than 100 tpy of federal attainment air contaminants. As discussed in Section 2.0, Existing Setting, CO,

NO_2, PM_{10}, and SO_2 are classified as federal attainment pollutants. Therefore, the estimated AEC emissions were compared to the major source thresholds of 100 tpy and the significant emissions increase thresholds, shown in Table 6-3, to determine which pollutants are subject to dispersion modeling requirements as outlined in SCAQMD Rule 1703. Note that although the AEC is not expected to emit more than 100 tpy of PM_{10}, PM_{10} impacts were also evaluated against the significant emissions increase thresholds due to Los Angeles County's new designation as an attainment area for PM_{10}. Based on the estimated emissions and attainment designations, NO_x and PM_{10} are the only attainment pollutants from the AEC that will exceed the significant emissions increase thresholds and be subject to dispersion modeling requirements.

Low sulfur natural gas will be the only fuel allowed for the AEC. Therefore, emissions of asbestos, beryllium, mercury, sulfur compounds, vinyl chloride, fluoride, and lead would be negligible.

TABLE 6-3
PSD Emissions Levels That Trigger Dispersion Modeling Requirements

Pollutant	Estimated PTE – Past Actual (tpy)	Significant Emission Increase Threshold* (tpy)	Exceeds Threshold? (Yes/No)
CO	-808	100	No
NO_x	206	40	Yes
PM_{10}	83.2	15	Yes
SO_2	13.9	40	No
Asbestos	Negligible	0.007	No
Beryllium	Negligible	0.0004	No
Mercury	Negligible	0.1	No
Vinyl Chloride	Negligible	1.0	No
Fluorides	Negligible	3	No
Lead	Negligible	0.6	No
Sulfuric Acid Mist	Negligible	7	No
H_2S	Negligible	10	No
Total Reduced Sulfur (including H_2S)	Negligible	10	No
Reduced Sulfur Compounds (including H_2S)	Negligible	10	No

*The PSD significance level is listed here for reference.

6.3 Class II Area Analysis

Based on the emissions presented in Table 6-3, a dispersion modeling analysis will be conducted to demonstrate that AEC will not cause or contribute to a violation of the NAAQS or CAAQS and will not exceed the federal PSD Class II Increment Standards for NO_2 and PM_{10}. To demonstrate compliance with the standards, the AEC will be modeled in two tiers. A description of each tier is presented below. Modeling for either tier will be performed per the methodology described in Section 5.0, Dispersion Modeling Approach, unless otherwise noted below.

6.3.1 Tier 1 Analysis

Using the worst-case load identified as part of the operations modeling, the preliminary Tier 1 analysis for each pollutant will be conducted as follows:

- If the predicted impacts are less than the significant impact levels (SIL) presented in Table 6-4 for each criteria pollutant, the modeling is complete for that pollutant and averaging period.
- If the predicted impacts are significant, a Tier 2 refined analysis will be conducted.

Table 6-4 summarizes the Class II SILs, PSD Class II Increment Standards, and the significant monitoring concentration levels. Currently, no ambient air quality data are collected at the existing Alamitos Generating Station. If modeling results for the AEC are greater than the significant monitoring concentrations listed in Table 6-4, onsite ambient air quality data collection may be required. If such monitoring is required, AES-SLD requests that the monitoring be conducted in parallel with AEC construction and that alternate background levels listed in Table 2-3 be used for permit modeling.

TABLE 6-4
PSD Air Quality Impact Standards Applicable to the Project

Averaging Period/ Pollutant	Significant Impact Level ($\mu g/m^3$)	PSD Class II Increment Standard ($\mu g/m^3$)	Significant Monitoring Concentrations ($\mu g/m^3$)
NO_2 (1-hour)	7.52*	N/A	N/A
NO_2 (Annual)	1.0	25	14
PM_{10} (24-hour)	5.0	30	10
PM_{10} (Annual)	1.0	17	N/A

*The SIL for 1-hour NO_2 is based on SCAQMD correspondence.

N/A = Not Applicable (i.e., no standard)

6.3.2 Tier 2 Analysis

The refined Tier 2 analysis will include a comparison to the ambient air quality standards and PSD Class II Increment Standards as follows:

- For pollutants with concentrations greater than the respective SIL, a significant impact radius will be defined. Preliminary modeling indicates that the project may be significant for 1-hour NO_2 with a significant impact radius of 5.3 km from the project site.
- The maximum modeled concentrations will be determined and compared to the NAAQS, CAAQS, and PSD Class II Increment Standards, as appropriate. These concentrations will include contributions from the facility, competing nearby sources, and ambient background concentrations.
- SCAQMD will be consulted to identify competing nearby sources and exhaust characteristics, if available, for inclusion in the refined analysis. Section 6.3.2.1, Competing Source Inventory, summarizes the approach to develop the competing source inventory.
- Only receptors identified above the SIL in the Tier 1 analysis will be included in the Tier 2 analysis.
- Background concentrations described in Section 6.3.2.2, 1-hour NO_2 Refined Analysis, will be included in the Tier 2 analysis.

6.3.2.1 Competing Source Inventory

As previously mentioned, preliminary modeling indicates that the 1-hour NO_2 SIL may be exceeded with a significant impact radius extending approximately 5.3 km from the project site, with maximum impacts located on the project fence line. Figure 6-3 shows the anticipated significant impact radius and the project's proximity to the background monitor location. At the request of SCAQMD, the Long Beach monitoring station (South Coastal Los Angeles County 3, EPA ID 06-037-4006) will be used as the ambient monitor because it captures the large NO_x-emitting sources in the Ports area that are upwind of the proposed project. Based on this significant impact radius, the location of maximum impacts within the significant impact radius, and the location of the representative ambient monitor, AES-SLD proposes to include competing sources within a distance of 10 km from the maximum impact locations in the analysis. The competing source inventory for NO_x-emitting sources within 10 km from AEC's maximum impact locations approved for use in the competing source analysis was provided via e-mail by SCAQMD.

6.3.2.2 1-hour NO_2 Refined Analysis

Emergency equipment will not be included in the 1-hour NO_2 competing source analysis. Consistent with recent EPA guidance addressing intermittent emissions for the 1-hour NO_2 analysis (EPA, 2011), exclusion of emergency equipment is appropriate. Startup emissions from the AEC turbines will be included in the 1-hour NO_2 competing source analysis because startups of the units are expected to occur frequently.

Further refinements of the 1-hour NO_2 modeling include the incorporation of seasonal, hour-of-day NO_2 background concentrations and the use of an ambient NO_2 equilibrium ratio and PVMRM in AERMOD, if necessary, described as follows:

- Seasonal, hour-of-day background NO_2 concentrations will be determined by following the most recent EPA NO_2 modeling guidance (EPA, 2011). This includes using the third-highest concentration for each hour-of-day, by season, at the NO_2 monitor. AERMOD will automatically combine the modeled NO_2 concentration to the appropriate background concentration for each hour to determine the model design concentration for comparison to the NAAQS. The 98th percentile seasonal, hour-of-day background NO_2 concentrations for 2009 through 2011 were provided via e-mail by SCAQMD for the Long Beach monitoring station.
- The Ambient Ratio Method (ARM) uses 0.80 as a default ambient ratio for the 1-hour NO_2 standard.
- PVMRM options, if needed, will initially conservatively assume an in-stack NO_2/NO_x ratio of 0.5 and an ambient NO_2 ratio of 0.9 (EPA, 2011). If additional analysis is required, AES-SLD will consult with SCAQMD to define alternative appropriate in-stack and ambient NO_2 ratios consistent with EPA guidance. Corresponding hourly ozone data from the North Long Beach monitoring station were provided via e-mail by SCAQMD.

To complete the refined 1-hour NO_2 competing source analysis, hourly emissions from the competing sources identified on SCAQMD's final inventory will be modeled by apportioning each source's permitted emissions (tpy) evenly throughout the year, unless otherwise noted. The model design concentration of the 5-year average of the 98th percentile hourly impact at each receptor will be compared to the NAAQS of 188 micrograms per cubic meter ($\mu g/m^3$).

If the model design concentration at any receptor exceeds the NAAQS, the project's impacts during the NAAQS exceedances will be evaluated and compared to the SIL. If the project's impacts are below the SIL during all modeled exceedances of the NAAQS, then the project will be assumed to not significantly contribute to the modeled exceedances.

6.4 Class I Area Increment Analysis

In addition to addressing the AEC's impacts within the near field (i.e., Class II impacts), a Class I impact analysis will be conducted to demonstrate that the AEC will not cause or contribute to an exceedance of the Class I SIL or PSD Class I Increment Standards (Table 6-5) and will not adversely affect air quality-related values (AQRV).[9] To evaluate the potential impacts on Class I areas near the AEC site, all Class I areas within

[9] A separate protocol is being submitted to address AQRVs at the nearby Class I areas.

300 km of the AEC were identified. Based on this survey, the San Gabriel Wilderness, which is approximately 53 km from the AEC site, was identified as the nearest Class I area. Figure 6-1 shows the locations and distances to the Class I areas within 300 km of AEC.

Federal Class I area air quality guidance (Federal Land Managers [FLM], 2010) allows an emissions/distance (Q/D) factor of 10 to be used as a screening criterion for sources located more than 50 km from a Class I area. This screening criterion includes all AQRVs. Emissions are calculated as the total SO_2, NO_x, PM_{10}, and sulfuric acid (H_2SO_4) annual emissions (in tpy, based on 24-hour maximum allowable emissions). These emissions are divided by the distance (in km) from the Class I area.

Based on the combined annual emissions of NO_x, SO_2, H_2SO_4, and PM_{10}, calculated using the 24-hour maximum allowable emissions, the maximum Q/D for the project will be greater than the FLM Q/D ratio of 10. Since the project exceeds the screening criterion for Q/D for the nearest Class I area, an additional protocol will be submitted to address AQRVs for all Class I areas that exceed the screening criterion and any additional Class I areas requested by the FLM.

To address PSD Class I Increment Standards, AERMOD will be used with a receptor ring at 50 km from the facility. The ring will be spaced in 5-degree increments centered on the AEC site. AERMOD maximum modeled impacts of NO_x and PM_{10} will be compared to the applicable SILs. If modeled impacts are below the SILs, then the project would be considered to have negligible impact at the more distant Class I areas. If impacts are above the SILs in the direction of the Class I areas, SCAQMD would be contacted to determine a refined approach to quantify criteria pollutant impacts at the Class I areas.

TABLE 6-5
Class I SIL and PSD Class I Increment Standards Applicable to the Project

Averaging Period/ Pollutant	Significant Impact Level (µg/m³)	PSD Class I Increment Standard (µg/m³)
NO_2 (Annual)	0.1	2.5
PM_{10} (24-hour)	0.3	2.0
PM_{10} (Annual)	0.2	1.0

6.5 California Energy Commission Air Dispersion Analysis

The following sections summarize the requirements and modeling assessment to be submitted to the CEC.

6.5.1 Construction Emissions Impact Assessment

The AEC construction site will be represented as a set of point sources and area sources in the modeling analysis. The exhaust emissions will be modeled as a set of point sources spaced approximately 25 meters apart over the construction areas with a horizontal stack release. Stack release parameters will consist of a stack release temperature of 533 K (500°F), a stack diameter of 0.127 meters (5 inches), and a release height of 4.6 meters (15 feet) based on data for typical construction equipment. The wind-blown and fugitive dust emissions will be modeled as area sources assuming a ground-level release height with an initial vertical dimension of 1 meter. Modeled concentrations of NO_x, CO, PM_{10}, $PM_{2.5}$, and SO_2 from construction activities related to the AEC will be combined with the ambient background concentrations and compared to the ambient air quality standards.

6.5.2 Commissioning Emissions Impact Assessment

The short-term concentrations of NO_2 and CO (i.e., the 1- and 8-hour impacts) from AEC commissioning activities will be combined with the ambient background concentrations and compared to the short-term ambient air quality standards. Although commissioning is expected to be completed within 180 days, annual impacts for the combined commissioning of one power block and operation of four power blocks for a rolling 12-month period will also be evaluated because annual emissions during the commissioning year could be higher than those during a non-commissioning year. As a result, annual concentrations of NO_x, PM_{10}, and $PM_{2.5}$ from commissioning with operation will be combined with the ambient background concentrations and compared to the annual ambient air quality standards. Furthermore, because commissioning activities only occur once in the life of the project and are expected to be less than one year in duration, the impacts will not be compared to the 1-hour federal NO_2 NAAQS, which is a 3-year average of a 98th percentile daily maxima concentration standard.

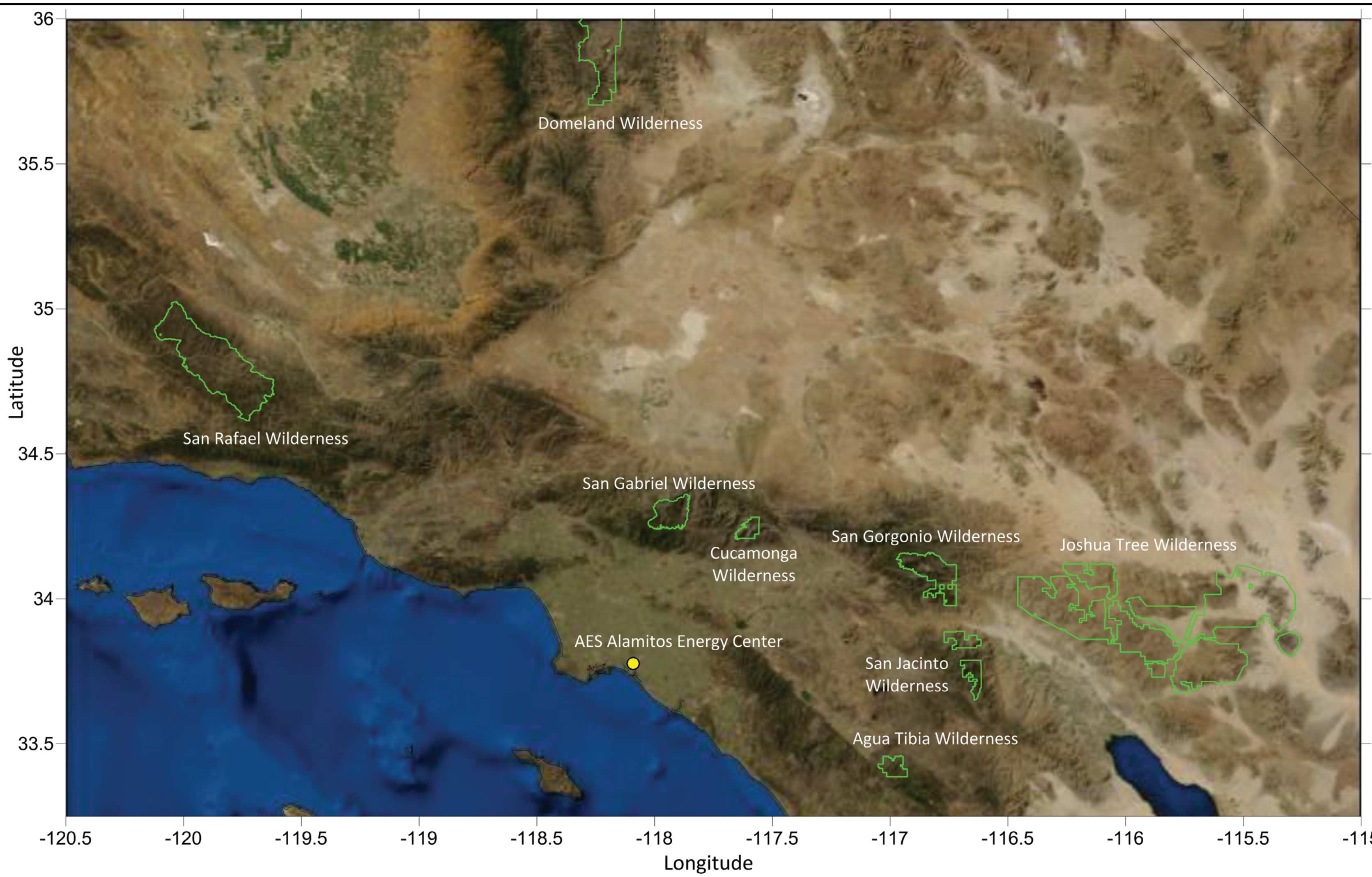
6.5.3 Operational Emissions Impact Assessment

The maximum modeled concentrations from the refined analysis will be added to representative background concentrations and the results compared to the state and federal ambient air quality standards for SO_2, NO_2, CO, PM_{10}, and $PM_{2.5}$. The ambient concentrations from the most recent three years of ambient monitoring data identified in Section 2.0, Existing Setting, will be used as the background concentration.

6.5.4 Fumigation Impact Assessment

A meteorological condition that can produce high concentrations of ground-level pollutants is referred to as shoreline or inversion breakup fumigation and can occur during the breakup of the nocturnal radiation inversion by solar warming of the ground surface. Inversion breakup fumigation occurs when a plume is emitted into a stable layer of air and that layer is then mixed to the ground in a short period of time through convective heating and microscale turbulence. Shoreline fumigation occurs when a plume is emitted into a stable layer of air and is then mixed to the surface as a result of advection of the air mass to less stable surroundings. Under both conditions, an exhaust plume may be drawn to the ground with little diffusion, causing high ground-level pollutant concentrations, although typically for periods less than 1 hour.

SCREEN3 will be used to determine the predicted impacts associated with these fumigation scenarios. The maximum modeled concentrations from the fumigation impact assessment will then be added to representative background concentrations, and the results compared to the state and federal ambient air quality standards. The condition would be short-lived; therefore, impacts will only be compared to the 1-hour standard.

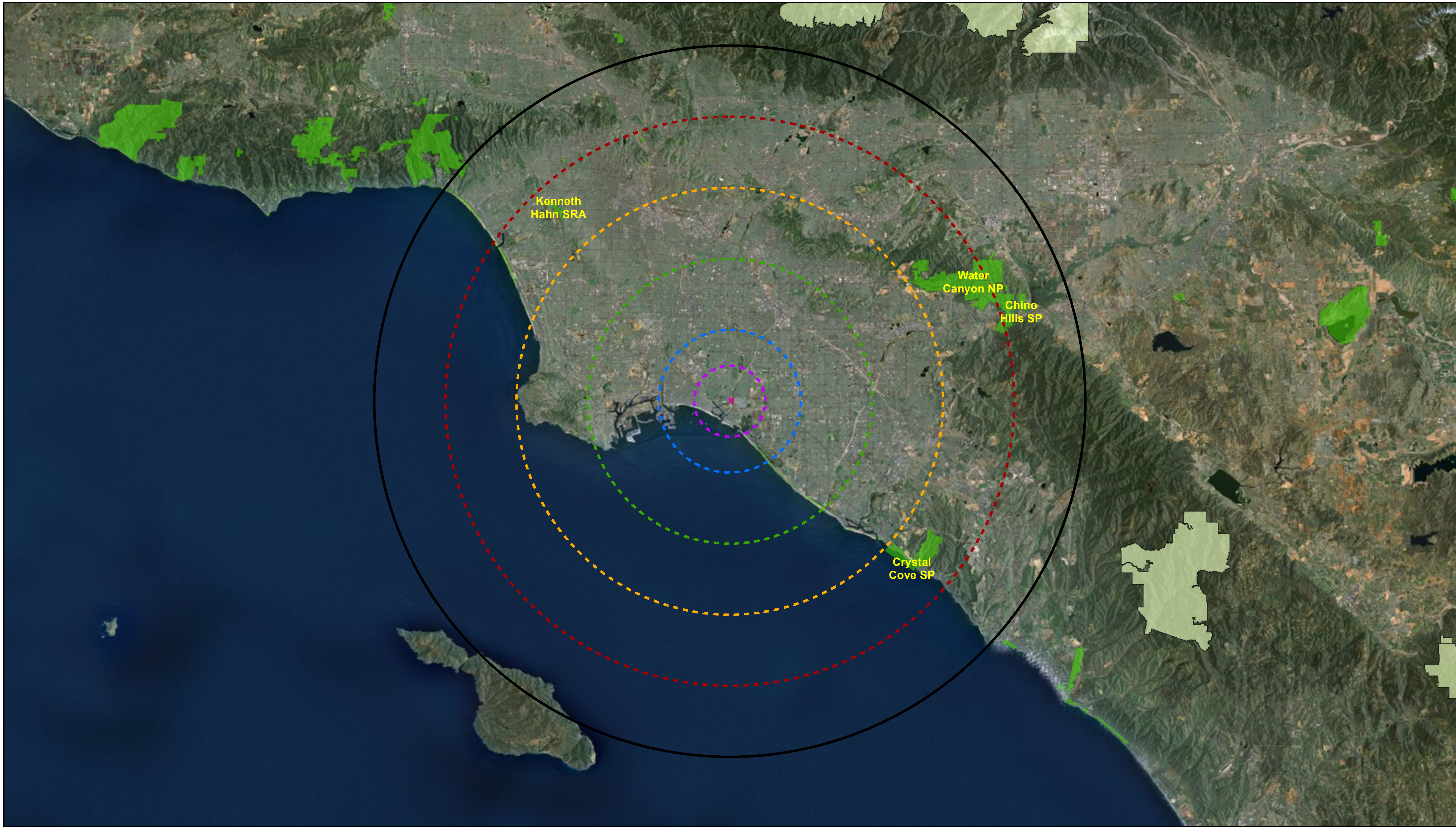


Distance to Nearby Class I Areas (km)

Agua Tibia Wilderness	Cucamonga Wilderness	Domeland Wilderness	Joshua Tree Wilderness	San Gabriel Wilderness	San Gorgonio Wilderness	San Jacinto Wilderness	San Rafael Wilderness
104.5	63.6	214.8	153.7	53.5	111.8	123.5	175.1

FIGURE 6-1
Distance to Nearby Class I Areas
Alamitos Energy Center
Long Beach, California

CH2MHILL.



Legend

- Alamitos Energy Center
- 50-km Buffer
- NLCS Wilderness [1]
- California State Parks [2]

Project Buffers

- 5 km
- 10 km
- 20 km
- 30 km
- 40 km

Sources:
1. Bureau of Land Management (http://www.blm.gov/ca/gis/)
2. Cal-Atlas Geospatial Clearninghouse (https://projects.atlas.ca.gov/)

0 8 16 Miles

0 25 Kilometers

N

FIGURE 6-2
Class II Areas within 50 km of AEC
Alamitos Energy Center
Long Beach, California

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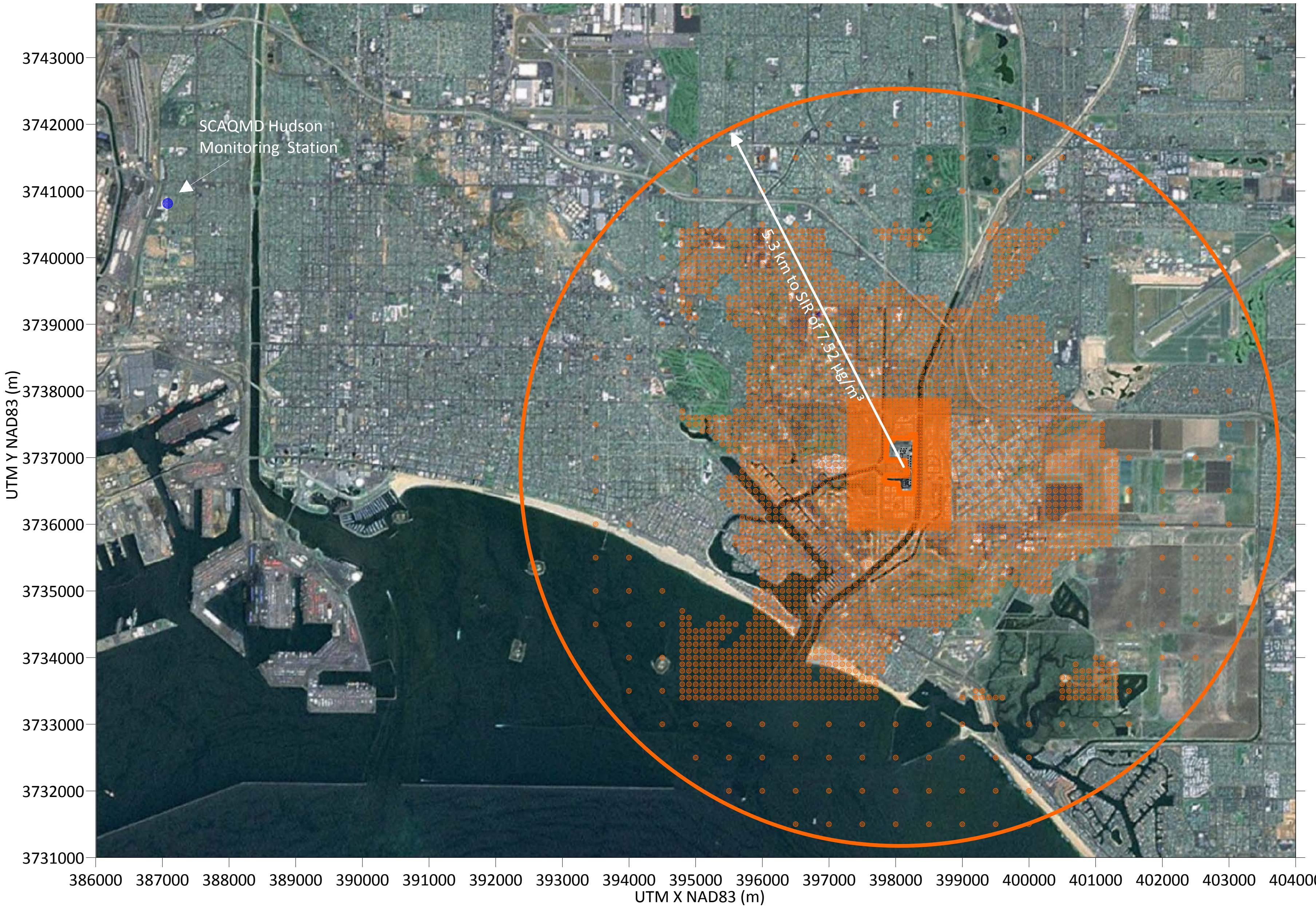

FIGURE 6-3
AEC 1-hr NO2 Distance to Significant Impact Level
Alamitos Energy Center
Long Beach, California

CH2MHILL

SECTION 7.0

Human Health Risk Assessment

A human HRA will be performed to evaluate the potential cancer, chronic, and acute health impacts related to the AEC. The HRA will follow the latest version of the *Air Toxics Hot Spots Program Risk Assessment Guidelines* (Office of Environmental Health Hazard Assessment [OEHHA], 2003), SCAQMD guidance documents (SCAQMD, 2011), and the EPA *Guideline on Air Quality Models* (EPA, 2005). In addition, for predicted cancer risks for residential receptors where the inhalation pathway is the dominant exposure pathway for cancer risks, the Derived (Adjusted) Method outlined in the ARB *Recommended Interim Risk Management Policy for Inhalation-based Residential Cancer Risk* (ARB, 2003) will be used for the cancer risk evaluation.

TAC from normal operation of the turbines will be included in the HRA. Turbine emissions will be estimated assuming that all twelve turbines operate simultaneously under normal load conditions. For maximum hourly emissions, the maximum natural gas consumption rate per turbine will be used. For annual emissions, the annual average natural gas consumption rate per turbine will be used, assuming that the turbines will operate 3,320 hours of base load operation and 495 startups and shutdowns per turbine per year. Ammonia emissions associated with potential ammonia slip from the selective catalytic reduction system will be calculated based on a permit limit maximum of 5 ppmv, dry at 15 percent oxygen. An offsite consequence analysis for ammonia will be conducted for the AEC as part of a separate analysis.

Due to the length of the proposed construction and demolition period, TAC associated with construction of the AEC and demolition of the existing Alamitos Generating Station units, which consist of combustion byproducts generated during movement of onsite construction/demolition equipment and onsite and offsite movement of vehicles, will also be included in the HRA. The primary exhaust TAC associated with construction and demolition activities is diesel particulate matter (DPM). Total DPM exhaust emissions from construction and demolition activities will be averaged over the 11.5-year construction period and spatially distributed over the areas in which activities are expected to occur.

7.1 Model Selection

The HRA modeling for the normal AEC operations and the construction and demolition activities will be conducted using the ARB Hotspots Analysis Reporting Program (HARP, Version 1.4f), along with the ARB HARP file converter (HARP On-ramp, Version 1.0), and AERMOD. HARP On-ramp converts the AERMOD output files to files compatible with the HARP modeling system. The AERMOD modeling approach, such as default options, source parameters, meteorological data, receptor spacing, and terrain data, will be similar to the criteria pollutant modeling analysis. The receptor grid will also include sensitive receptors as defined by SCAQMD and CEC regulations (Appendix B (g)(9)(E)(i)). The sensitive receptors included in the analysis will be based on a search conducted by Environmental Data Resources. Additionally, census block receptors will be included in the analysis in order to calculate the increased cancer burden. For normal AEC operations, a unit emission rate (1 gram per second) will be used to model each source, as outlined in the HARP converter program manual. For construction and demolition activities, the modeling will also use a unit emission rate, but emission sources will be distributed spatially over the areas in which activities are expected to occur.

7.2 Evaluation of Impacts

For normal AEC operation, cancer risks will be evaluated for each source and the AEC based on the annual TAC ground-level concentrations, inhalation cancer potency, oral slope factor, frequency and duration of exposure at the receptor, and breathing rate of the exposed persons. Cancer risks will be estimated using a conservative assumption of 70-year continuous exposure duration for residential receptors and a 40-year, 5-days-per-week, 8-hours-per-day exposure duration for commercial/industrial receptors. In addition, for predicted cancer risks for residential receptors where the inhalation pathway is the dominant pathway of cancer risks, the Derived (Adjusted) Method in HARP will be used for the cancer risk evaluation, based on the *Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk* (ARB, 2003). To assess chronic and acute non-cancer exposures, annual and 1-hour TAC ground-level concentrations will be compared with the Reference Exposure Levels (REL) developed by OEHHA to obtain a chronic or acute hazard index.

The HRA for construction of the AEC and demolition of the existing Alamitos Generating Station will be performed for a shorter exposure duration. The HARP model limits short-term, continuous residential exposure to 9 years. Therefore, for conservative results, the average annual emissions, calculated as previously described, will be assumed to occur for each year for 9 years of continuous exposure. Because the primary TAC for construction and demolition activities is DPM, the cancer risks will be evaluated based on annual TAC ground-level concentrations and inhalation cancer potency. To account for variations in breathing rates, the cancer risks will be conservatively estimated using a 9-year continuous residential and sensitive receptor exposure breathing rate, the average of which is equal to 452 liters per kilogram per day (L/kg/day) and higher than the average breathing rate of 271 L/kg/day (OEHHA, 2003).[10] The OEHHA Derived Method in HARP will be used to determine the cancer risk at residential and sensitive receptors. An adjusted 9-year, 5-days-per-week, 10-hours-per-day exposure duration will be used to determine the cancer risk at commercial/industrial receptors. Chronic toxicity will also be considered using the average annual emissions, calculated as previously described.

In addition to inhalation exposure, the HRA will assess potential health impacts related to exposure from homegrown produce, dermal absorption, soil ingestion, and mother's milk, as applicable and required by OEHHA guidelines (OEHHA, 2003). The inhalation cancer potency, oral slope factor values, and RELs used to characterize health risks associated with the modeled impacts will be obtained from the most recent version of the *Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values* (OEHHA, 2011).

Consistent with SCAQMD Rule 1401, the modeled health risk values for each permitted unit and construction and demolition activities will be compared to the following *de minimis* thresholds:

- Incremental increase in cancer risk of 10 in 1 million individuals (for construction and demolition activities and if the permitted unit is constructed with Best Available Control Technology for Toxics [T-BACT])
- Incremental increase in cancer risk of 1 in 1 million individuals (if the permitted unit is constructed without T-BACT)
- Cancer burden greater than 0.5
- Chronic hazard index of 1.0
- Acute hazard index of 1.0

Predicted cancer risk and hazard indices less than the thresholds will be considered an acceptable increase in risk associated with AEC.

[10] Note that using the child breathing rate may be overly conservative for many receptor locations because the 9-year cancer risk for a child assumes continuous exposure (i.e., 24-hours-per-day, 7-days-per-week) during the first 9 years of life, which would not be representative of non-Maximally Exposed Individual Resident (MEIR) or sensitive receptor locations.

SECTION 8.0

Cumulative Impacts Analysis

Per CEC requirements, a cumulative air quality impacts analysis for the AEC's typical operating mode will be conducted as part of the AFC process. Impacts from the project will be combined with other stationary emission sources within a 6-mile radius that have received construction permits but are not yet operational or are in the permitting process (such as the NSR or CEQA permitting process). The stationary emission sources included in the cumulative impacts assessment will be limited to new or modified sources that would cause a net increase of 5 tons or more per modeled criteria pollutant. Therefore, VOC sources, equipment shutdowns, permit-exempt equipment registrations, rule compliance, permit renewals, or replacement/upgrading of existing systems will not be included in the cumulative impacts analysis. TAC emissions will also be excluded from the cumulative impacts analysis.

The sources to be included in the cumulative air quality impacts analysis will be determined through consultation with SCAQMD and CEC. The applicant will work with SCAQMD and CEC staffs to identify those new air pollution sources within the 6-mile radius surrounding the AEC, which is centered approximately at 398,180 meters (East), 3,736,940 meters (North) (UTM, NAD 83, Zone 11).

The cumulative air quality impacts analysis will be performed using the model settings and refined receptor grid outlined in Section 4.0, Topography and Meteorology, and Section 5.0, Dispersion Modeling Approach. The fence line for the cumulative sources will not be included in the modeling analysis.

The maximum predicted cumulative impacts will represent the impact at the receptor location identified as the maximum receptor for each pollutant in the ambient air quality impact assessment. The maximum modeled concentrations from the refined analysis will then be added to representative background concentrations and the results compared to the state and federal ambient air quality standards for SO_2, NO_2, CO, PM_{10}, and $PM_{2.5}$. The highest ambient concentration from the most recent three years of ambient monitoring data will be used as the background concentration.

SECTION 9.0

Presentation of Results

The results of the air dispersion modeling analyses for the AEC will be presented to each reviewing agency, as follows:

- A description of modeling methodologies and input data will be provided.
- A summary of the results in tabular form will be provided.
- Modeling files used by AERMOD and other models will be provided with the application on compact disc.
- Any significant deviations from the methodology proposed in this protocol will be presented.

SECTION 10.0

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Dispersion Modeling Protocol for Air Quality Related Values at Class I Areas Near the Alamitos Energy Center

Prepared for

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690 N. Studebaker Road
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September 3, 2013

Submitted to

South Coast Air Quality Management District

Prepared by

CH2MHILL®

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Contents

Abbreviations and Acronyms

$\mu g/m^3$	microgram per cubic meter
AEC	Alamitos Energy Center
AES-SLD	AES Southland Development, LLC
AQRV	Air Quality Related Values
BPIP	Building Profile Input Program
CT	cooling tower
CTG	combustion turbine generator
DAT	Deposition Analysis Threshold
EPA	U.S. Environmental Protection Agency
f(RH)	relative humidity adjustment factor
FLM	Federal Land Manager
GHG	greenhouse gas
H_2SO_4	sulfuric acid
HNO_3	nitric acid
HRSG	heat recovery steam generator
IWAQM	Interagency Workgroup on Air Quality Modeling
kg/ha-yr	kilogram(s) per hectare per year
km	kilometer(s)
lb/day	pound(s) per day
Mm^{-1}	Inverse megameters
MPSA	Mitsubishi Power Systems Americas
MW	megawatt(s)
NO_3	nitrate
NOx	nitrogen oxides
NPS	National Park Service
NSA	National Scenic Area
NSR	New Source Review
O_3	ozone
Pb	lead
PM	particulate matter
PM_{10}	particulate matter with a diameter less than 10 microns
$PM_{2.5}$	particulate matter with a diameter less than 2.5 microns
ppb	parts per billion

Q/D	emissions/distance factor
SCAQMD	South Coast Air Quality Management District
STG	steam turbine generator
SO_2	sulfur dioxide
SOx	sulfur oxides
tpy	ton(s) per year
ULSD	ultra-low sulfur distillate
USGS	U.S. Geological Survey

SECTION 1

Introduction

1.1 Project Background

AES Alamitos, LLC (AES) proposes to construct the Alamitos Energy Center (AEC or project) at the existing AES Alamitos Generating Station site at 690 N. Studebaker Road, Long Beach, California 90803. The existing Alamitos Generating Station, constructed in the 1950s and 1960s, currently has six operating generating units (Units 1–6) and one retired generating unit (Unit 7). The operating units, the retired unit, the Unit 7 fuel tank, and the northeast warehouse will be demolished as part of the project. Once constructed, AEC will consist of four, three-on-one natural gas-fired combined-cycle power blocks with a net generating capacity of 1,936 megawatts (MW)[1]. The power blocks will utilize twelve Mitsubishi Power Systems Americas (MPSA) 501DA combustion turbine generators (CTGs), four steam turbine generators (STG), and four air-cooled condensers. Each CTG will be equipped with a heat recovery steam generator (HRSG).

AEC will be located in the City of Long Beach, Los Angeles County, California. Los Angeles County is in attainment for all federal National Ambient Air Quality Standards (NAAQS) with the exception of ozone, particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead. Effective July 26, 2013, Los Angeles County was reclassified by the U.S. Environmental Protection Agency (EPA) from non-attainment to maintenance for particulate matter less than 10 microns in diameter (PM_{10}) (78 Federal Register 38223).

AEC will be permitted through the South Coast Air Quality Management District (SCAQMD) New Source Review (NSR) permitting process. Because AEC is also categorized as one of the 28 Prevention of Significant Deterioration (PSD) major source categories (40 Code of Federal Regulations [CFR] 52.21(b)(1)(i)), the project is subject to PSD permitting requirements if the net emission increase from the project exceeds 100 tons per year (tpy) for any regulated pollutant for which the area is designated as attainment, maintenance, or unclassified, with the exception of greenhouse gases (GHG). The threshold for GHGs is a net increase of 100,000 tpy.

Preliminary emission estimates indicate that the project will exceed PSD significant emission increases for nitrogen oxides (NO_x), which is an attainment pollutant, volatile organic compounds (VOC), and PM_{10}, for which the area is designated as maintenance. Therefore, the project will be required to conduct an analysis at Class I areas for which NO_x and PM_{10} could affect Air Quality Related Values (AQRV) (40 CFR 51.166(p)(2)).[2] Class I AQRVs affected by significant increases in NO_x and PM_{10} are visibility and total nitrogen deposition.

This air dispersion modeling protocol summarizes the modeling methodology which will be used to evaluate the project's impacts to air quality with respect to AQRVs at the federally-designated Class I areas within 300 kilometers (km) of the project site. This protocol has been prepared based on the U.S. Environmental Protection Agency (EPA) *Guideline on Air Quality Models* (EPA, 2005), Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 report (EPA, 1998), and the Federal Land Managers' (FLM) Air Quality Related Values Work Group (FLAG) guidance document (FLM, 2010). These guidance documents provide modeling approaches suggested by EPA and the FLMs.

A separate protocol was previously submitted to the SCAQMD for the criteria pollutant air quality analysis for NAAQS and PSD Increment Standards.

[1] Referenced to site ambient average temperature (SAAT) conditions of 65.3 degrees Fahrenheit (°F) dry bulb and 62.7°F wet bulb temperature without evaporative cooler operation.

[2] No air dispersion modeling demonstration is required for VOC.

1.2 Project Description

AEC will have a net generating capacity of 1,936 MW. The project location is presented in Figure 1-1.

An estimate of the annual AEC potential to emit (PTE) criteria pollutant emissions and past actual emissions from 2008 through 2012 are presented in Table 1-1. The PTE estimates are based on preliminary engineering data, 3,320 hours of base load operation per turbine per year, and 495 startups and shutdowns per turbine per year.

TABLE 1-1
Annual Facility Emission Estimates

	Facility Emission Totals – Tons Per Year (Estimate)						
Facility	**NO_2**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**H_2SO_4**
Existing Units (Past Actual)	65.8	6.9	16.3	16.3	27.0	1,180	—
AEC (PTE)*	272	20.8	99.5	99.5	188	372	0.9
Net Increase	206	13.9	83.2	83.2	161	-808	0.9

*Assumes twelve MPSA 501DA gas turbines operating 3,320 hours per year per turbine and 495 startups/shutdowns per turbine per year.
NO_2 = nitrogen dioxide
SO_2 = sulfur dioxide
VOC = volatile organic compounds
CO = carbon monoxide
H_2SO_4 = sulfuric acid

In order to evaluate the potential impacts on Class I areas near the AEC site, all Class I areas within 300 km of AEC were identified. The identified Class I areas are summarized in Table 1-2 and presented, relative to the project site, in Figure 1-2. Based on this survey, the San Gabriel Wilderness, which is approximately 53 km from the AEC site, was identified as the nearest Class I area.

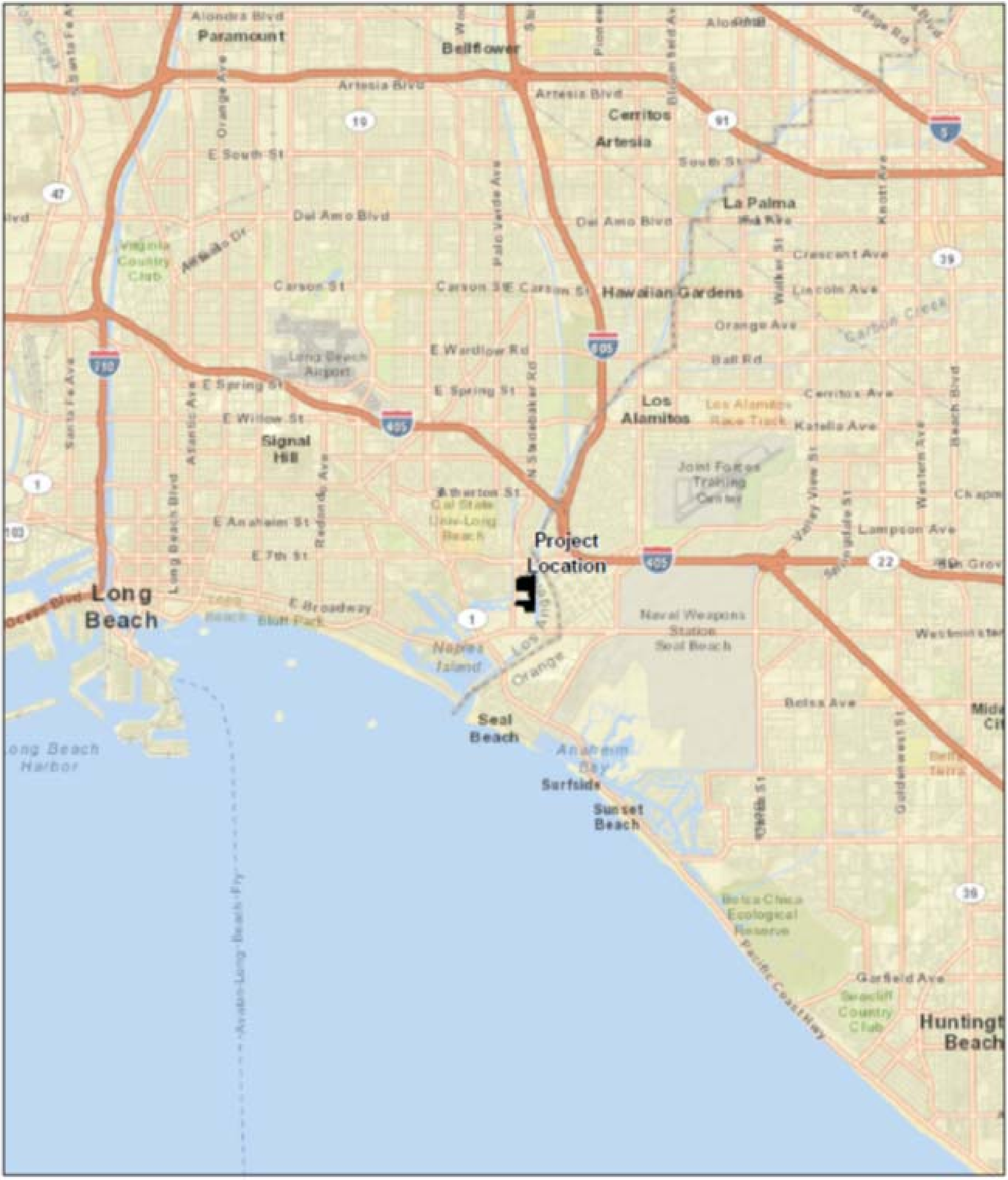
TABLE 1-2
Nearest Class I Areas

Class I Area	Distance (km)
San Gabriel Wilderness	53.5
Cucamonga Wilderness	63.6
Agua Tibia Wilderness	104.5
San Gorgonio Wilderness	111.8
San Jacinto Wilderness	123.5
Joshua Tree Wilderness	153.7
San Rafael Wilderness	175.1
Domeland Wilderness	214.8

1.3 AQRV Analysis Requirements

As described above, the AEC will be a federal major source subject to major PSD NSR requirements for NO_x and PM_{10}. As such, AES must perform an AQRV modeling analysis evaluating the project's impacts of the visibility impairing pollutants (PM_{10}, NO_x, sulfuric acid [H_2SO_4], and sulfur dioxide [SO_2]). AES will conduct an

AQRV analysis at each of the Class I areas within 300 km of the project site. This analysis consists of an initial screening step to identify Class I areas subject to further evaluation (discussed in Section 2.1). For those Class I areas which exceed the screening criterion, a far-field AQRV analysis will be performed. The far-field AQRV analysis will address the potential project impacts on visibility. In addition to visibility, total nitrogen deposition will be assessed at each Class I area which exceeds the screening criterion. A total sulfur deposition analysis is not required because the project's increases in SO_2 emissions would not trigger PSD review.



Legend

Project Boundary

0 1 2 Miles

N

FIGURE 1-1
Project Location
Alamitos Energy Center
Long Beach, California

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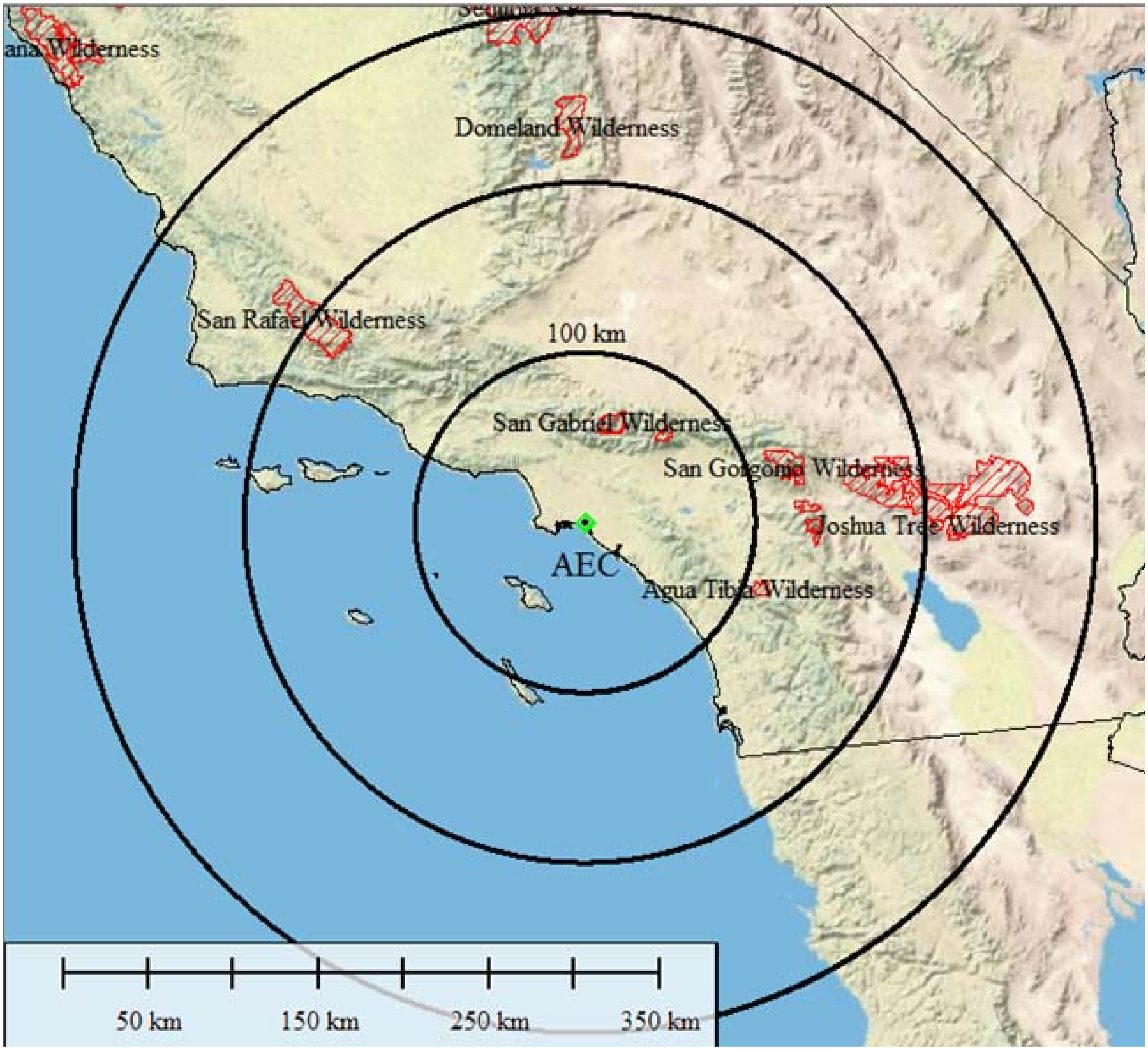

FIGURE 1-2
Class I Area Map
Alamitos Energy Center
Long Beach, California

CH2MHILL.

SECTION 2

Modeling Methodology

2.1 Screening Methodology for AQRVs

The FLM guidance document allows an emissions/distance (Q/D) factor of 10 to be used to screen sources, located greater than 50 km from a Class I area, out of conducting a far-field AQRV analysis (FLM, 2010). This screening criterion applies to all AQRVs such that, where Q/D is 10 or less for a given Class I area, no further AQRV review is required for that area. For purposes of applying the Q/D screening criterion, emissions are conservatively calculated as the total SO_2, NO_x, PM_{10}, and H_2SO_4 annual emissions (in tpy, based on the 24-hour maximum allowable emissions). These emissions are divided by the distance (in km) from the Class I area. The emission rates used for screening are extremely conservative and exceed the annual emission limits being requested in the permit application. This is because the FLM guidance document specifies that the emission rates used in the screening analysis must reflect the annual emissions if the 24-hour maximum emission rate were to occur every day, regardless of whether the applicant is seeking to operate in that manner (FLM, 2010).

Table 2-1 summarizes the potential maximum allowable emissions of each of the pollutants used to calculate Q.

TABLE 2-1
Maximum Facility Calculated Q*

	Pollutant				
Units	**NO_x**	**SO_2**	**PM_{10}**	**H_2SO_4**	**Total**
Maximum lb/hr (Each)	10.7	3.1	4.5	0.1	
lb/hr (Facility, 12 Turbines)	128.2	37.1	54.0	1.6	
lb/day (Facility)	3,076	890	1,296	37	
lb/yr (Facility)	1,122,766	324,774	473,040	13,677	
Facility Total tpy (Q)	561	162	237	7	**967**

*Q is a theoretical value based on the maximum daily 24-hour emission rate assuming all 12 proposed turbines at the AEC would be operating at maximum capacity every day of the year.

lb/hr = pound(s) per hour
lb/day = pound(s) per day
lb/yr = pound(s) per year

Using the emissions in Table 2-1, the Q/D for each Class I area is presented in Table 2-2.

TABLE 2-2
Screening for Class I Areas within 300 km of AEC

Class I Areas	Distance to AEC (km)	Class I AQRV Q/D (24-hour Max)*
San Gabriel Wilderness	53.5	**18.1**
Cucamonga Wilderness	63.6	**15.2**
Agua Tibia Wilderness	104.5	9.3
San Gorgonio Wilderness	111.8	8.7
San Jacinto Wilderness	123.5	7.8
Joshua Tree Wilderness	153.7	6.3
San Rafael Wilderness	175.1	5.5
Domeland Wilderness	214.8	4.5

*Class I AQRV Q/D calculated as total tpy identified in Table 2-1, divided by the distance to the nearest Class I area.

Bold values indicate an exceedance of the screening criterion (10).

Based on the screening analysis above, a far-field AQRV analysis is required for the San Gabriel and Cucamonga Wilderness areas. All other Class I areas are below the FLM screening criterion; therefore, the project will not adversely affect AQRVs at these areas.

2.2 AQRV Far-Field Dispersion Modeling

The FLM guidance document recommends that a far-field AQRV analysis be performed using the CALPUFF modeling system (FLM, 2010). As described above, a far-field AQRV analysis is required to assess a project's effect on AQRVs if the project is located more than 50 km from Class I areas that do not screen out in the Q/D calculation. The CALPUFF modeling system includes a Gaussian puff dispersion model (CALPUFF) with algorithms for chemical transformation and deposition, and a post-processor (CALPOST) capable of calculating concentrations, visibility impacts, and total deposition.

SECTION 3

Meteorological Data Processing

3.1 Computational Grid

CALMET will generate a three-dimensional wind field and boundary layer parameters suitable for use by the CALPUFF model. A modeling domain will be established to encompass the project site and the Class I areas of concern. The selected domain will allow for coverage of each of the Class I areas of concern, with a 50-km buffer to the west of the project site, a 50-km buffer beyond the farthest boundary of the most distant Class I areas in all other directions, and a grid resolution of 4 km. Figure 3-1 shows the CALMET/CALPUFF modeling domain.

The default options listed in Appendix A of the IWAQM Phase 2 report (EPA, 2009) will be used for CALMET. The CALMET program receives geophysical and meteorological data as described below and defines gridded, multilevel wind fields that are subsequently used in the CALPUFF program for dispersion modeling. Wind fields will be examined graphically for appropriate response to terrain. A sampling of wind fields from different times of year and under different stability conditions will be evaluated.

3.1.1 CALMET Processing

In accordance with the IWAQM Phase 2 report, CALMET, the CALPUFF meteorological pre-processor, will be used to simulate three years (2006, 2007, and 2008) of meteorological conditions. For the hourly wind field initialization, CALMET will use gridded prognostic MM5 data. The MM5 data used is available every 36 km within the modeling domain for the years 2006 through 2008.

These predictive meteorological data sets will be combined with gridded terrain data derived from U.S. Geological Survey (USGS) 1:250,000 (3 arc second or 90-meter grid spacing) Digital Elevation Model (DEM) files and gridded land use data derived from USGS 1:250,000 Composite Theme Grid (CTG) land use files.

Following wind field initialization, a secondary wind field will be produced with the input hourly surface data from all available National Weather Service (NWS) surface stations within and just outside the modeling domain and twice daily upper air sounding data from the San Diego Miramar NWS station (Station #03190). Hourly surface data from both first-order (i.e., NWS surface stations) and second-order stations will be considered in this analysis. Other sources of meteorological data, such as CASTNET, may be used to supplement areas lacking NWS or second-order data. Hourly precipitation data from stations within and just outside of the modeling domain will be taken from a National Climatic Data Center (NCDC) data set for purposes of wet scavenging of the plume and wet deposition calculations. Each of the stations contributing to the CALMET data set is shown in Figure 3-1.

The criteria used in the CALMET processing are summarized in an appendix to this report.

3.1.2 Validation of CALMET Wind Field

The CalVIEW data display and analysis system included in the CALPRO GUI system, developed by the CALPUFF software developer (TRC), will be used to view plots of wind vectors and other meteorological parameters to evaluate the CALMET wind fields. Observed weather conditions, as depicted in surface and upper-air weather maps from the National Oceanic and Atmospheric Administration (NOAA) Central Library U.S. Daily Weather Maps Project[3], will be used to compare to the CalVIEW vector displays.

[3] Observed weather conditions available at http://docs.lib.noaa.gov/rescue/dwm/ data_rescue_daily_weather_maps.html.

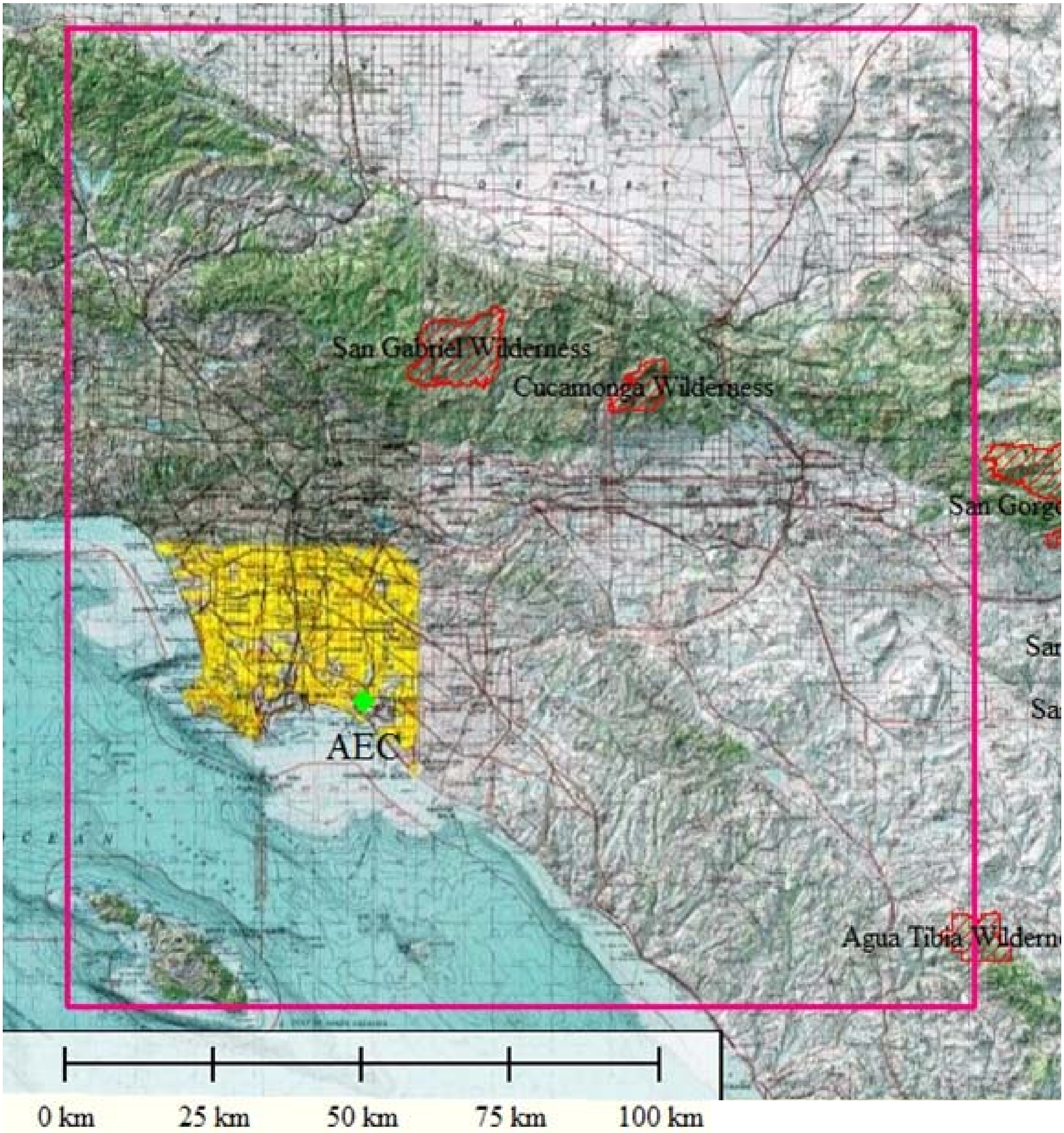

FIGURE 3-1
CALMET/CALPUFF Modeling Domain
Alamitos Energy Center
Long Beach, California

SECTION 4

Modeling Steps

The most recent EPA-approved version of CALPOST will be used to process CALPUFF binary output data files and produce summary results files. These results will then be used to analyze total nitrogen deposition and visibility impacts.

4.1 CALPUFF Modeling

The following subsections provide a summary of the CALPUFF modeling procedures that will be used to model Class I AQRVs.

4.1.1 Model Version

The most recent EPA-approved version of the CALPUFF modeling system (Version 5.8) will be used in a full, refined mode using MM5 meteorological data. The following CALPUFF pre- and post-processors will be used:

- SMERGE: Version 5.57, Level 070627
- PMERGE: Version 5.32, Level 070627
- MAKEGEO: Version 2.29, Level 070327
- CALMET: Version 5.8, Level 070623
- CALPUFF: Version 5.8, Level 070623
- CALPOST: Version 6.221, Level 080724 (for Method 8, mode 5[4] processing option)

4.1.2 Technical Options for Modeling

FLM and EPA guidance on the CALPUFF model technical options, inputs, and processing steps will be followed.

The CALPUFF model will be run with EPA-recommended technical option values, including the selection of the MESOPUFF II chemical transformation. The sections below summarize the source characterization, building downwash, receptor grids for each Class I area modeled, and background ozone and ammonia concentrations used for the CALPUFF modeling.

4.1.3 Source Characterization

All sources will be modeled in CALPUFF as point sources. Particulate matter (PM) emissions will be speciated into filterable PM (PM_{10}, $PM_{2.5}$, and elemental carbon) and condensable PM (organic carbon and sulfates). Guidance on the FLM Web site[5] will be used to speciate the emissions from the project's emission sources.

4.1.4 Building Downwash

Building influences on stacks are calculated by incorporating the updated EPA Building Profile Input Program (BPIP). Output from the BPIP program will be included in the CALPUFF modeling file.

4.1.5 Receptors

The TRC COORDS program will be used to convert the latitude/longitude coordinates to Lambert Conformal Conic (LCC) coordinates for the meteorological stations and source locations. The USGS conversion program, PROJ (Version 4.4.6), will be used to convert the National Park Service (NPS) receptor location data from

[4] Method 8 allows for the use of different relative humidity adjustment factor (f[RH]) values for large hydroscopic particles, small hydroscopic particles, and sea salt.

[5] Speciation information is available at http://www.nature.nps.gov/air/permits/ect/index.cfm.

latitude/longitude to LCC. Discrete receptors within the Class I areas that exceeded the screening criterion were taken from the NPS database for Class I area modeling receptors.

4.1.6 Ozone and Ammonia

The CALPUFF modeling will be conducted with hourly background ozone data from the closest monitors and monthly average ammonia background values. In the absence of hourly ozone data for a particular hour, the monthly average of all hourly data from all stations will be used. The background ammonia concentration will initially be taken from the IWAQM Phase 2 report, which suggests values based on the predominant land use throughout the modeling domain. Refinements will be made to the IWAQM ammonia background concentration based on observed seasonal variations in the background ammonia levels.

4.1.6.1 Ozone

The transformation rates of gaseous SO_2 and NO_x are dependent on the ambient concentrations of ozone. Temporally varying ozone values from a number of monitoring stations within the domain can be used within the model to estimate the transformation rates of SO_2 and NO_x.

Southern California has many ozone monitors which collect hourly concentrations. Monitoring stations within the modeling domain will be included in the CALPUFF modeling analysis. A final list of the stations utilized will be included in the permit application.

4.1.6.2 Ammonia

Ammonia is not simulated by CALPUFF, but a background value is required to characterize the conversion of NO_x and SO_2 to ammonium nitrate and ammonium sulfate, respectively.

There is little (if any) monitored ammonia concentration data in the South Coast Air Basin and Los Angeles region. The IWAQM Phase 2 report (EPA, 1998) recommends background concentrations of ammonia of 10 part(s) per billion (ppb) for grasslands, 1 ppb for arid lands at 20 degrees Celsius (°C), and 0.5 ppb for forested land. The California Regional Haze Rule modeling analysis conservatively utilized a 10 ppb statewide ambient ammonia background concentration. The 10 ppb background ammonia concentration used for the California Regional Haze Rule modeling would be appropriate for many sources and Class I areas in California due to the amount of agriculture in the central San Joaquin and Sacramento Valleys. However, since the proposed AEC is located in the Los Angeles area and the surrounding land use is neither predominantly agriculture nor grassland, a conservative year-round background ammonia concentration of 2 ppb is proposed for the project. This is consistent with the land-use types surrounding the source and sources of ammonia near the project area.

If better ammonia data are available for the South Coast Air Basin and Los Angeles region, the South Coast Air Quality Management District (SCAQMD) and FLMs will be contacted to determine the appropriateness of such data. If the background ammonia concentration differs from the initially proposed 2 ppb, an analysis of the updated ammonia data will be supplied in the permit application.

4.2 Total Nitrogen Deposition

CALPUFF and CALPOST will be applied to obtain upper limit estimates of annual wet and dry deposition of nitrogen compounds associated with emissions from the project. Specifically, CALPUFF will be used to model both wet and dry deposition of ammonia and nitric acid, as well as dry deposition of NO_x, to estimate the maximum annual wet and dry deposition of nitrogen at the Class I areas. The deposition results will be documented for evaluation.

POSTUTIL (Version 1.56) will be used to calculate total nitrogen deposition for each receptor. POSTUTIL will also be used to reapportion nitrate concentrations using monthly ambient ammonia data, if available.

The U.S. Department of Agriculture Forest Service Web site[6] indicates that the minimum detectable level for measuring an increase in wet deposition of nitrates is 0.5 kilograms per hectare per year (kg/ha/yr). For conservatism, the U.S. Department of Agriculture Forest Service recommends a significance level of one tenth of this minimum detectable level, or 0.05 kg/ha/yr. The FLMs have also developed a Deposition Analysis Threshold (DAT) of 0.005 kg/ha/yr (FLM, 2008) to be used as a threshold for Class I areas in the western U.S., classified as west of the Mississippi River. Since all Class I areas to be assessed in this analysis are west of the Mississippi River, the selected DAT for total nitrogen deposition is 0.005 kg/ha/yr (FLM, 2008).

4.3 Regional Haze

CALPUFF and CALPOST processing will be used for the regional haze analysis to compute the maximum 24-hour average light extinction due to NO_x, PM_{10}, SO_2, and H_2SO_4 emissions from the project. As mentioned above, all emissions which could contribute to visibility impacts are modeled. For both ambient background and emissions, the relative humidity adjustment factor (f[RH]) will calculate the sulfate and nitrate components of the visibility extinction coefficient. For this factor, monthly average f(RH) values for large hygroscopic particles, small hygroscopic particles, and sea salt will be used (Method 8).

Ambient background concentrations of light attenuating pollutants are based on the 20 percent best day visibility conditions for the Class I areas included in this analysis. The proposed background values, taken from Table 5 of the FLM guidance document (FLM, 2010), are presented in Table 4-1. Table 4-2 presents the f(RH) values used for each Class I area modeled.

Visibility impacts estimated with the CALPUFF model will be reported for each Class I area analyzed. Modeled potential visibility impacts will then be compared to the applicable background concentrations. For each Class I area, the 3-year average of the 98th percentile change in background light extinction, along with the total number of days exceeding a change greater than 5 and 10 percent, if any, will be reported. If the 3-year average of the 98th percentile change in background light extinction exceeds the recommended screening value of 5 percent in one or more Class I areas, alternative analytical options will be investigated in conjunction with the FLMs and SCAQMD.

TABLE 4-1
20 Percent Best Natural Conditions

Aerosol Component	San Gabriel Wilderness	Cucamonga Wilderness
Ammonium Sulfate ($\mu g/m^3$)	0.03	0.03
Ammonium Nitrate ($\mu g/m^3$)	0.03	0.03
Organic Matter ($\mu g/m^3$)	0.15	0.15
Elemental Carbon ($\mu g/m^3$)	0.01	0.01
Soil ($\mu g/m^3$)	0.14	0.14
Coarse Mass ($\mu g/m^3$)	0.67	0.67
Sea Salt ($\mu g/m^3$)	0.01	0.01
Rayleigh (Mm^{-1})	9	9

*Data taken from Table 5 of the FLM guidance document (FLM, 2010).

$\mu g/m^3$ = microgram(s) per cubic meter
Mm^{-1} = inverse megameters

[6] U.S. Department of Agriculture Forest Service information is available at http://www.fs.fed.us/r6/ aq/natarm/document.htm.

TABLE 4-2
CALPOST Method 8 f(RH) Values

	f(RH) by Month											
f(RH) Fraction	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
San Gabriel Wilderness												
f(RH) Small	2.94	2.78	2.72	2.41	2.37	2.29	2.32	2.39	2.44	2.44	2.36	2.58
f(RH) Large	2.25	2.17	2.14	1.96	1.95	1.90	1.91	1.95	1.98	1.97	1.91	2.04
f(RH) Sea Salt	3.12	3.04	3.04	2.77	2.78	2.69	2.69	2.77	2.79	2.74	2.59	2.79
Cucamonga Wilderness												
f(RH) Small	2.87	2.73	2.68	2.40	2.37	2.29	2.31	2.38	2.43	2.42	2.34	2.54
f(RH) Large	2.21	2.14	2.13	1.96	1.95	1.90	1.91	1.96	1.98	1.96	1.90	2.02
f(RH) Sea Salt	3.07	3.01	3.03	2.79	2.80	2.72	2.72	2.80	2.81	2.76	2.58	2.77

SECTION 5

Output / Presentation of Results

The results of the air dispersion modeling analysis will be presented as follows:

- A description of modeling methodologies and input data
- A summary of the results in tabular and, where appropriate, graphical and narrative form
- Modeling files used for analysis will be provided with the application on an external hard drive
- Any significant deviations from the methodology proposed in this protocol will be presented in the application

SECTION 6

References

Federal Land Managers (FLM). 2008. Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report (Revised 2008). June.

Federal Land Managers (FLM). 2010. Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report (Revised 2010). November.

U.S. Environmental Protection Agency (EPA). 1998. Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts. December.

U.S. Environmental Protection Agency (EPA). 2005. *Guideline On Air Quality Models*, 40 CFR 51, Appendix W. November.

U.S. Environmental Protection Agency (EPA). 2009. Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations. May.

Appendix
CALMET Settings

CALMET Parameters

Input Group	Variable	Version 5 Default	Input
2	PMAP	UTM	LCC
2	FEAST	0.0	0.0
2	FNORTH	0.0	0.0
2	IUTMZN	No Default	11
2	UTMHEM	N	N
2	RLAT0	No Default	34.06179
2	RLON0	No Default	-117.8192
2	XLAT1	No Default	33
2	XLAT2	No Default	35
2	DATUM	WGS-84	WGS-84
2	NX	No Default	39
2	NY	No Default	42
2	DGRIDKM	No Default	4
2	XORIGKM	No Default	-78
2	YORIGKM	No Default	-84
2	NZ	No Default	10
2	ZFACE	No Default	0.,20.,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00
3	LSAVE	T	T
3	IFORMO	1	1
3	LPRINT	F	F
3	IPRINF	1	1
3	IUVOUT	NZ*0	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0
3	IWOUT	NZ*0	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0
3	ITOUT	NZ*0	0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0 , 0
3	STABILITY	0	0
3	USTAR	0	0
3	MONIN	0	0
3	MIXHT	0	0
3	WSTAR	0	0
3	PRECIP	0	0
3	SENSHEAT	0	0
3	CONVZI	0	0
3	LDB	F	F
3	NN1	1	1
3	NN2	1	1
3	LDBCST	F	F
3	IOUTD	0	0
3	NZPRN2	1	0
3	IPR0	0	0
3	IPR1	0	0
3	IPR2	0	0
3	IPR3	0	0
3	IPR4	0	0
3	IPR5	0	0
3	IPR6	0	0
3	IPR7	0	0
3	IPR8	0	0
4	NOOBS	0	0
4	NSSTA	No default	TBD
4	NPSTA	No default	TBD
4	ICLOUD	0	0
4	IFORMS	2	2

CALMET Parameters

Input Group	Variable	Version 5 Default	Input
4	IFORMP	2	2
4	IFORMC	2	2
5	IWFCOD	1	1
5	IFRADJ	1	1
5	IKINE	0	0
5	IOBR	0	0
5	ISLOPE	1	1
5	IEXTRP	-4	-4
5	ICALM	0	0
5	BIAS	NZ*0	10*0
5	RMIN2	4.	-1
5	IPROG	0	14
5	ISTEPPG	1	1
5	IGFMET	0	1
5	LVARY	F	F
5	RMAX1	No default	10
5	RMAX2	No default	100
5	RMAX3	No default	200
5	RMIN	0.1	0.1
5	TERRAD	No default	15
5	R1	No default	5
5	R2	No default	50
5	RPROG	No default	0
5	DIVLIM	5.E-6	5.0E-06
5	NITER	50	50
5	NSMTH	2,(mxnz-1)*4	2, 9*4
5	NINTR2	99.	10*99
5	CRITFN	1.0	1
5	ALPHA	0.1	0.1
5	FEXTR2	NZ*0.0	10*0
5	NBAR	0	0
5	KBAR	NZ	10
5	XBBAR	No defaults	0
5	YBBAR	No defaults	0
5	XEBAR	No defaults	0
5	YEBAR	No defaults	0
5	IDIOPT1	0	0
5	ISURFT	-1	TBD
5	IDIOPT2	0	0
5	IUPT	-1	3
5	ZUPT	200.	200
5	IDIOPT3	0	0
5	IUPWND	-1	-1
5	ZUPWND	1., 1000	1., 1000
5	IDIOPT4	0	0
5	IDIOPT5	0	0
5	LLBREZE	F	F
5	NBOX	User Defined	0
5	XG1	User Defined	0
5	XG2	User Defined	0
5	YG1	User Defined	0
5	YG2	User Defined	0
5	XBCST	None	0

CALMET Parameters

Input Group	Variable	Version 5 Default	Input
5	YBCST	None	0
5	XECST	None	0
5	YECST	None	0
5	NLB	None	0
5	METBXID	User Defined	0
6	CONSTB	1.41	1.41
6	CONSTE	0.15	0.15
6	CONSTN	2400.	2400
6	CONSTW	0.16	0.16
6	FCORIOL	1.E-4	1.0E-04
6	IAVEZI	1	1
6	MNMDAV	1	1
6	HAFANG	30.	30
6	ILEVZI	1	1
6	IMIXH	1	-1
6	THRESHL	0.0	0.0
6	THRESHW	0.05	0.05
6	ITWPROG	0	0
6	ILUOC3D	16	16
6	DPTMIN	0.001	0.001
6	DZZI	200.	200
6	ZIMIN	50.	50
6	ZIMAX	3000.	3000
6	ZIMINW	50.	50
6	ZIMAXW	3000.	3000
6	ICOARE	10	0
6	DSHELF	0.	0
6	IWARM	0	0
6	ICOOL	0	0
6	ITPROG	0	0
6	IRAD	1	1
6	TRADKM	500.	500
6	NUMTS	5	5
6	IAVET	1	1
6	TGDEFB	-.0098	-0.0098
6	TGDEFA	-.0045	-0.0045
6	JWAT1	User Defined	55
6	JWAT2	User Defined	55
6	NFLAGP	2	2
6	SIGMAP	100.0	100
6	CUTP	0.01	0.01
7	SS#	User Defined	TBD
8	US#	User Defined	TBD
9	PS#	User Defined	TBD

Alamitos Energy Center - Response to USFS FLM Comments on the AQRV Protocol

PREPARED FOR: USFS Federal Land Managers

COPY TO: Tom Chico/SCAQMD
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Cleveland Holladay/EPA
Stephen O'Kane/AES
CH2M HILL/Project Folder

PREPARED BY: CH2M HILL

DATE: November 11, 2013

AES Alamitos, LLC (AES) proposes to construct the Alamitos Energy Center (AEC or project) at the existing AES Alamitos Generating Station site in Los Angeles County. Emission estimates indicate that the project will exceed Prevention of Significant Deterioration (PSD) significant emission increases for nitrogen oxides (NOx), which is an attainment pollutant, volatile organic compounds (VOC), and particulate matter with a diameter of 10 microns or less (PM_{10}), for which the area is designated as maintenance. Therefore, the project will be required to conduct an analysis at Class I areas for which NOx and PM_{10} could affect Air Quality Related Values (AQRVs) (40 Code of Federal Regulations [CFR] 51.166(p)(2)).[1] Class I AQRVs affected by significant increases in NOx and PM_{10} are visibility and total nitrogen deposition.

An AQRV modeling protocol[2] was submitted to the U.S. Forest Service (USFS) on September 4, 2013. The USFS supplied comments to the modeling protocol on September 27, 2013. Subsequently, a conference call to discuss the USFS comments was conducted on November 1, 2013. The purpose of the meeting was to receive further input and clarification from the USFS regarding comments on the AQRV modeling protocol.

This technical memorandum summarizes the USFS comments on the AQRV modeling protocol and each comment is followed by a detailed response. Supporting documentation for the responses is attached to this memorandum.

In addition to the written comments below, during the November 1, 2013 conference call, the Federal Land Managers (FLMs) identified two additional Class I areas to include in the visibility and total nitrogen deposition analysis, even though the Q/d screening analysis was below the threshold of 10 for each of these areas. These two additional Class I areas are Agua Tibia Wilderness Area and San Gorgonio Wilderness Area. The two additional areas will be included in the visibility and total nitrogen deposition analysis for the Class I area analysis.

Comment 1: [Please provide] MM5 data documentation [including]: source of data, horizontal/vertical resolution, physics options, and performance evaluation.

Response: As described in the AQRV modeling protocol, MM5 data for years 2006, 2007, and 2008 are proposed for this analysis. The MM5 data is of 36-kilometer (km) horizontal resolution and developed by Alpine Geophysics, LLC.

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[1] No air dispersion modeling demonstration is required for VOC.

[2] CH2M HILL, 2013. *Dispersion Modeling Protocol for Air Quality Related Values at Class I Areas Near the Alamitos Energy Center*. Sacramento, CA. September.

Alpine Geophysics, LLC has provided a performance evaluation of the year 2006 for the continental and western United States, which is included in Attachment A. Model performance is evaluated based on state-wide statistics of temperature bias, temperature error, mixing ratio bias, mixing ratio error, and wind speed index agreement (refer to Tables 3-1, 3-4, 3-7, 3-10, and 3-14, respectively, of Attachment A) as well as numerous snapshots of MM5 predicted parameters with comparisons to contemporaneous observations.

For the 12-km and 36-km domains, the statistical values were compared with similar model performance evaluation statistics from MM5 simulations performed in previous studies upon the same or very similar grid domains. Based on this comparison, the current simulation has performance characteristics that are similar to prior studies. Of the simulations examined, no one simulation exhibits consistently superior performance. Therefore, the current MM5 simulation is performing at par with other simulations that are currently being used for air quality planning so the overall performance of the model is judged to be adequate (Alpine Geophysics, LLC, 2008. *Evaluation of 36/12/4 km MM5 for Calendar Year 2006 over the Continental and Western United States with Emphasis in Southwestern Wyoming*. December).

Comment 2: [Please provide the] procedures for filling in missing meteorological data [and a] list of surface and upper air meteorological stations.

Response: Missing meteorological data will be filled in using different approaches depending on whether it is surface station data or Miramar upper air station data.

If required, surface station data will be filled in following the procedures outlined in the *Meteorological Monitoring Guidance for Regulatory Modeling Applications*[3] guidance document.

Upper air sounding data will be filled in using the TRC UAMAKE pre-processor. If sounding data are missing, the UAMAKE pre-processor will extract sounding data from the prognostic data set for substitution for the missing sounding period. These data will be compared to upper air weather maps from the National Oceanic and Atmospheric Administration (NOAA) Central Library U.S. Daily Weather Maps Project[4] for accuracy and appropriateness.

Attachment B contains a list of the surface and upper air monitoring stations to be included in the CALMET processing.

Comment 3: [Please supply the] list of proposed CALPUFF control options.

Response: As described in the modeling protocol, the MESOPUFF II chemistry scheme will be used for the analysis. A sample CALPUFF input file is supplied in Attachment C, which contains the model triggers required to accurately characterize the emissions from the proposed source to evaluate potential impacts to visibility and total nitrogen deposition at the Class I areas analyzed.

Comment 4: [Please supply the] list of POSTUTIL and CALPOST [control] options.

Response: As recommended by the FLMs' AQRV Work Group (FLAG) guidance document[5], the method 8, mode 5 option in CALPOST will be used to determine the change in background light extinction for each Class I area being evaluated. Attachment D contains the sample CALPOST output file, which identifies the control options utilized for the analysis. As agreed upon during the November 1, 2013 conference call, the Agua Tibia and San Gorgonio Wilderness areas will also be evaluated in the AQRV analysis for project

[3] U.S. Environmental Protection Agency (EPA), 2000. *Meteorological Monitoring Guidance for Regulatory Modeling Applications.* Office of Air Quality Planning and Standards. Research Triangle Park, NC. February. EPA-454/R-99-005.

[4] http://docs.lib.noaa.gov/rescue/dwm/ data_rescue_daily_weather_maps.html

[5] U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service, 2010. *Federal Land Managers' Air Quality Related Values Work group (FLAG) Phase I Report (Revised 2010)*. Natural Resource Report NPS/NRPC/NRR—2010/232. National Park Service. Denver, Colorado. November.

impacts on visibility and total nitrogen deposition. Ambient background concentrations of light attenuating pollutants are based on the 20 percent best day visibility conditions for these Class I areas. To augment the 20 percent best natural conditions presented in Table 4-1 of the modeling protocol, the proposed background values (taken from Table 5 of the FLAG guidance document) for Agua Tibia and San Gorgonio Wilderness Areas are presented in Table 1. Table 2 presents the f(RH) values used for these additional Class I areas modeled to augment the modeling protocol Table 4-2.

TABLE 1

20 Percent Best Natural Conditions

Aerosol Component	Agua Tibia Wilderness Area	San Gorgonio Wilderness Area
Ammonium Sulfate (μg/m^3)	0.03	0.03
Ammonium Nitrate (μg/m^3)	0.04	0.02
Organic Matter (μg/m^3)	0.26	0.15
Elemental Carbon (μg/m^3)	0.01	0.01
Soil (μg/m^3)	0.26	0.10
Coarse Mass (μg/m^3)	1.20	0.62
Sea Salt (μg/m^3)	0.04	0.02
Rayleigh (Mm^{-1})	11	10

*Data taken from Table 5 of the FLAG guidance document.
μg/m^3 = microgram per cubic meter
Mm^{-1} = inverse megameters

TABLE 2

CALPOST Method 8 f(RH) values

f(RH) Fraction	f(RH) by Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agua Tibia Wilderness Area												
f(RH) Small	2.68	2.61	2.63	2.42	2.40	2.33	2.33	2.45	2.49	2.46	2.29	2.42
f(RH) Large	2.10	2.08	2.11	1.98	1.98	1.93	1.93	2.01	2.02	1.99	1.87	1.95
f(RH) Sea Salt	2.94	2.95	3.02	2.85	2.88	2.81	2.78	2.90	2.90	2.83	2.56	2.69
San Gorgonio Wilderness Area												
f(RH) Small	2.94	2.94	2.74	2.36	2.34	2.00	1.88	2.02	2.05	2.04	2.10	2.43
f(RH) Large	2.21	2.23	2.13	1.90	1.90	1.69	1.62	1.71	1.72	1.70	1.73	1.92
f(RH) Sea Salt	2.97	3.06	2.93	2.60	2.63	2.28	2.13	2.30	2.31	2.24	2.25	2.55

As described in the protocol, POSTUTIL will be used to reapportion the nitrate concentrations using monthly ambient ammonia data. Attachment D contains a sample POSTUTIL input file which details the control options.

Comment 5: Discussion on CALMET control options as proposal does not comport with August 31, 2009 EPA Model Clearinghouse memorandum.

Response: Based on the USFS comment and the November 1, 2013 conference call, the control options for CALMET have been updated to reflect the recommendations in the August 31, 2009 clarification memorandum[6]. The revised sample CALMET input file for the proposed project is included in Attachment E.

[6] EPA, 2009. *Clarification on EPA FLM Recommended Settings for CALMET.* Research Triangle Park, NC. August 31.

Attachment A

MM5 Performance Evaluation Support Documentation

Evaluation of 36/12/4 km MM5 for Calendar Year 2006 over the Continental and Western United States with Emphasis in Southwestern Wyoming

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5 December 2008

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1 INTRODUCTION

Over the past decade, emergent requirements for direct numerical simulation of urban and regional scale photochemical and secondary aerosol air quality—spawned largely by the new particulate matter ($PM_{2.5}$) and regional haze regulations—have led to intensified efforts to construct high-resolution emissions, meteorological and air quality data sets. The concomitant increase in computational throughput of low-cost modern scientific workstations has ushered in a new era of regional air quality modeling. It is now possible, for example, to exercise sophisticated mesoscale prognostic meteorological models and Eulerian and Lagrangian photochemical/aerosol models for the full annual period, simulating ozone, sulfate and nitrate deposition, and secondary organic aerosols (SOA) across the entire United States (U.S.) or over discrete subregions.

One such model is the Pennsylvania State University/National Center for Atmospheric Research (PSU/NCAR) Mesoscale Model (MM5) (Dudhia, 1993; Grell et al., 1994: www.mmm.ucar.edu/mm5). MM5 is a limited-area, non-hydrostatic, terrain-following model designed to simulate mesoscale atmospheric circulation. The model is supported by several pre- and post-processing programs which are referred to collectively as the MM5 modeling system.

This report describes an application and performance evaluation of MM5 for an atmospheric simulation for calendar 2006 over a modeling domain that covers the continental United States at 36km grid spacing, much of the Intermountain Western United States at 12km grid spacing and a 4km grid over western Wyoming, Northern Utah and Eastern Idaho.

2 METHODOLOGY

The methodology for this approach is very straightforward. The basic methodology was to apply the MM5 model for the 2006 annual period, and the model results (e.g., wind speeds, wind directions, temperatures) were compared with available surface meteorological observations.

2.1 Model Selection and Application

A brief summary of the MM5 input data preparation procedure used for this annual modeling exercise is provided in the following text.

Model Selection: The publicly available non-hydrostatic version of MM5 (version 3.7.4) was used for this modeling study. Preprocessor programs of the MM5 modeling system including TERRAIN, REGRID, LITTLE_R, and INTERPF (UCAR, 2003b) were used to develop model inputs.

Horizontal Domain Definition: The computational grid is presented in Figure 2-1. The outer 36km domain (D01) has 165 x 129 grid cells, selected to maximize the coverage of the National Center for Environmental Prediction (NCEP) ETA analysis region. The projection is Lambert Conformal with the "national RPO" grid projection pole of 40^o, -97^o with true latitudes of 33^o and 45^o. The 12km domain (D02) has 103 x 100 grid cells with offsets from the 36km grid of 41 columns and 58 rows. The 04km domain (D03) has 163x166 grid cells with offsets from the 12km grid of 13 columns and 30 rows.

Vertical Domain Definition: The MM5 modeling is based on 34 vertical layers with an approximately 38 meter deep surface layer. The MM5 vertical domain is presented in both sigma and height coordinates in Table 2-1.

Topographic Inputs: Topographic information for the MM5 was developed using the NCAR and the United States Geological Survey (USGS) terrain databases (UCAR, 2002). The 36km grid was based on the 5 min (~9 km) Geophysical Data Center global data. The 12km grid was based on the 2 min (~4 km) Geophysical Data Center Global data and the 4km grid on the 30 sec (~1 km) data. Terrain data was interpolated to the model grid using a Cressman-type objective analysis scheme (Cressman, 1959). To avoid interpolating elevated terrain over water bodies, after the terrain databases were interpolated onto the MM5 grid, the NCAR graphic water body database was used to correct elevations over water bodies.

Vegetation Type and Land Use Inputs: Vegetation type and land use information were developed using the most recently released PSU/NCAR databases provided with the MM5 distribution (UCAR, 2002). Standard MM5 surface characteristics that correspond to each land use category were employed.

Atmospheric Data Inputs: The first guess fields were taken from the NCAR ETA archives (UCAR, 2008a). Available surface and upper-air observations were used in the objective analyses. These data were incorporated into the analyses datasets following the procedures outlined by Stauffer and Seaman (1990) and were quality-inspected by MM5 pre-processors using automated gross-error checks and "buddy" checks. In addition, radiosonde soundings were subjected to vertical consistency checks. The synoptic-scale data used for the initialization (and in the analysis nudging discussed later) were obtained from the conventional National Weather Service (NWS) twice-daily radiosondes (UCAR, 2008a) and 3-hr NWS surface observations (UCAR, 2008b).

Water Temperature Inputs: The ETA database contains a “skin temperature” field. This can be and was used as the water temperature input to these MM5 simulations. Past studies have shown that these skin temperatures, the water temperature surrogates, can lead to temperature errors along coastlines. However, for this analysis which focuses on bulk continental scale transport with more resolved flows the intermountain west, this issue is likely not important and the skin temperatures were used.

FDDA Data Assimilation: This simulation used a combination of analysis observation based nudging. Analysis nudging coefficients of 2.5×10^{-4} on the 36km grid domain and 1.0×10^{-4} on the 12km grid domain were used for winds and temperature. For mixing ratio, analysis nudging coefficients of 1.0×10^{-5} were used for both the 36km and 12km grids. On the 36km and 12km grids, nudging was done at both the surface and aloft layers though nudging of temperatures and mixing ratios were excluded in the boundary layer. For the 4km grid, observation nudging to NOAA Techniques Development Lab (TDL) surface observation database (NCAR DS472.0) was used for winds with a nudging coefficient of 4×10^{-4}

Physics Options: The MM5 physics options employed in this analysis were as follows:

- Betts-Miller Cumulus Parameterization;
- Pleim-Xiu PBL and Land Surface Schemes;
- Reisner 1 Mixed Phase Moisture Scheme; and
- RRTM Atmospheric Radiation Scheme.

Application Methodology: The MM5 model was executed in 5-day blocks initialized at 12Z every 5 days with a 90 second time step. Model results were output every 60 minutes and output files were split at 24 hour intervals. Twelve (12) hours of spin-up was included in each 5-day block before the data were used in the subsequent evaluation. The model was run for all of calendar year 2006.

2.2 Evaluation Approach

The model evaluation approach was based on a combination of qualitative and quantitative analyses. The qualitative approach was to compare the model estimated monthly total precipitation with the monthly Center for Prediction of Climate (CPC) precipitation analysis using graphical outputs (CPC, 2008; Higgins et al., 1996). For the quantitative model performance evaluation, tabulations of (1) the model bias and error for temperature and mixing ratio and (2) the index of agreement for the wind fields were analyzed for each of the grid domains (i.e., 36km, 12km, and 4km). The observed database for winds, temperature, and water mixing ratio used in this analysis was the NOAA Technique Development Lab (TDL) DS472 dataset (UCAR, 2008b; Vincent et al., 2007). Further, the 36km and 12km statistical results were compared to similar 36km and 12km simulations performed in other studies.

Interpretation of bulk statistics over a continental or regional scale domain is problematic. To detect if the model is missing important sub-regional features is difficult. For this analysis, the statistics were performed on a state-by-state basis, a Regional Planning Organization (RPO) basis, and on a domain-wide for the continental 36km domain and the regional 12km domain.

Table 2-1. MM5 vertical domain specification.				
k (MM5)	**sigma level**	**pressure (Pa)**	**height (m)**	**depth (m)**
34	0.000	10000	15674	2004
33	0.050	14500	13670	1585
32	0.100	19000	12085	1321
31	0.150	23500	10764	1139
30	0.200	28000	9625	1004
29	0.250	32500	8621	900
28	0.300	37000	7720	817
27	0.350	41500	6903	750
26	0.400	46000	6153	693
25	0.450	50500	5461	645
24	0.500	55000	4816	604
23	0.550	59500	4212	568
22	0.600	64000	3644	536
21	0.650	68500	3108	508
20	0.700	73000	2600	388
19	0.740	76600	2212	282
18	0.770	79300	1930	274
17	0.800	82000	1657	178
16	0.820	83800	1478	175
15	0.840	85600	1303	172
14	0.860	87400	1130	169
13	0.880	89200	961	167
12	0.900	91000	794	82
11	0.910	91900	712	82
10	0.920	92800	631	81
9	0.930	93700	550	80
8	0.940	94600	469	80
7	0.950	95500	389	79
6	0.960	96400	310	78
5	0.970	97300	232	78
4	0.980	98200	154	39
3	0.985	98650	115	39
2	0.990	99100	77	38
1	0.995	99550	38	38
0	1.000	100000	0	0

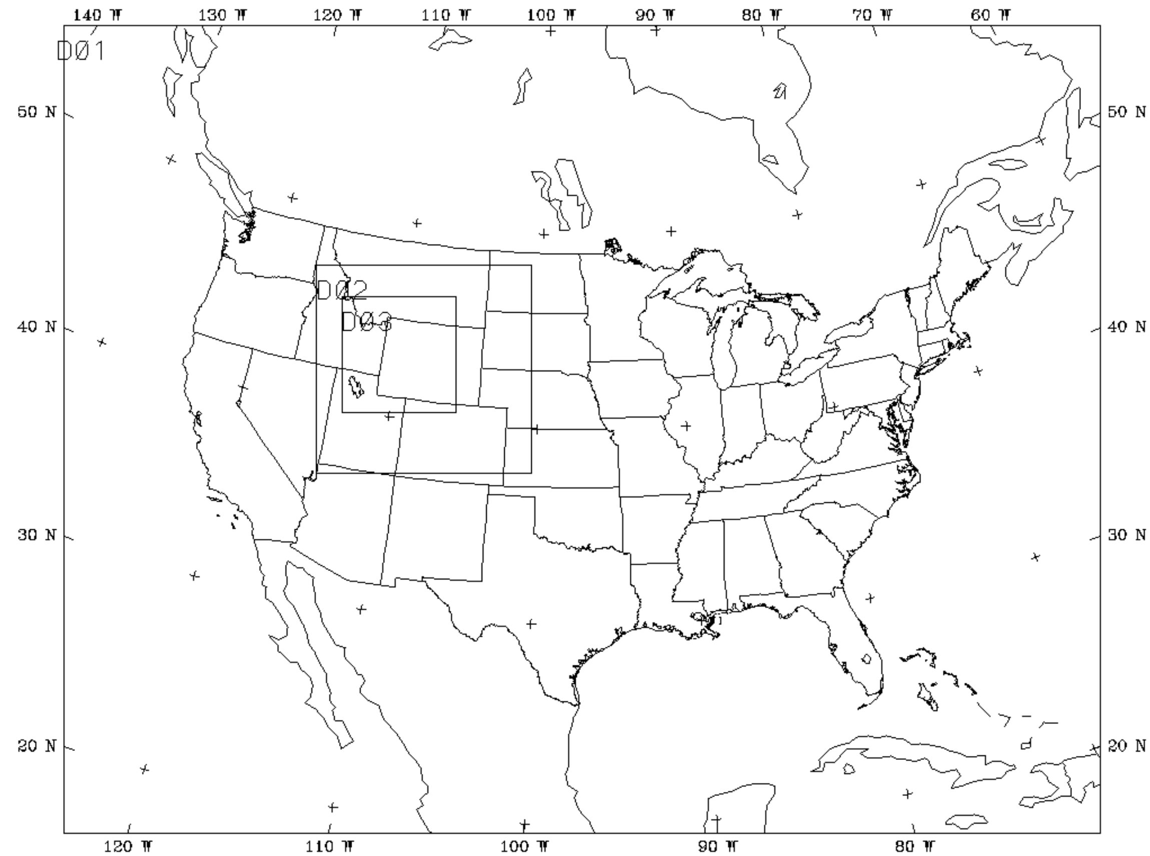

Figure 2-1. 36km (D01), 12km (D02) and 4km (D03) MM5 Domain.

3 MM5 PERFORMANCE EVALUATION RESULTS

3.1 Introduction

Quantitative and qualitative model performance evaluation results for surface winds, temperature, mixing ratio and episode total precipitation are presented and discussed. A full annual model evaluation is very difficult to summarize in a single document. With this in mind, this section presents results so potential users of the MM5 predictions can independently judge the adequacy of the model simulation. Overall comparisons are offered herein to judge the model efficacy, but this review does not necessarily cover all potential user needs and applications.

The statistics that were estimated include the mean bias (or simply bias) and mean absolute gross error (or simply error) for temperature and mixing ratio as well as the wind speed index of agreement (Willmott, 1982; Willmott et al., 1985). Bias quantifies the difference between the average of a predicted value and the average of an observed value. If the bias is negative, the model is said to underpredict the mean observed value. Error quantifies the average of the absolute differences between the predictions and observations. Thus, even if a simulation exhibits no bias, it can still exhibit large error as the simulation results have offsetting under- and overpredictions. Index of agreement quantifies the relative average error between the predictions and observations. <u>***Please note***</u> that in the comparisons, vertical level one model estimates that are predicted at approximately nineteen meters are compared directly with the nominal, observed temperatures and moistures that are measured at about two meters and wind speeds and directions that are measured at about ten meters. As such, model performance must be judged with this caveat taken into context.

Quantitative meteorological model performance benchmarks have been developed to help assess the ability of a model to reproduce observed conditions (Emery et al., 2001). The benchmarks are based upon the evaluation of about thirty MM5 and RAMS meteorological simulations of <u>*multi-day episodes*</u> in support of air quality modeling study applications performed over several years. In turn, these benchmarks have been adopted for use in <u>*annual*</u> meteorological modeling studies. The purpose of these benchmarks is not to give a pass or fail grade to any one particular meteorological model application, but rather to put the model results into the proper context of other model simulations and meteorological data sets. That is, the benchmarks provide a contextual understanding as to how the model results compare to other model applications run over portions of the continental United States. Therefore, the benchmarks must be viewed as being *guideline* and not *bright-line* numbers. These benchmarks include bias and error in temperature and mixing ratio as well as the wind speed index of agreement (IA) between the model predictions and observational data bases. The benchmarks for each variable to judge whether predictions from a meteorological model are on par with previous meteorological modeling studies are as follows:

- Temperature bias: less than or equal to $\pm$0.5 K;

- Temperature error: less than or equal to 2.0 K
- Mixing ratio bias: less than or equal to ±1.0 g/kg
- Mixing ratio error: less than or equal to 2.0 g/kg
- Wind speed index of agreement: 0 = worst, 1 = best, 0.6 = acceptable

3.2 Quantitative Model Evaluation Results

Tables 3-1 through 3-15 summarize the statistical metrics by month, season, and year for each state and Regional Planning Organization (RPO). The statistical metrics are presented in individual tables for the 36km, 12km, and 4km modeling domains. Model performance results of the MM5 simulation are presented for the metrics temporally by year, season, and month and spatially by the domain as a whole, by RPO subdomain, and by state. For reference, a graphic of the RPO boundaries is presented in Figure 3-1.

3.2.1 Temperature Bias and Error

Temperature bias statistics are presented in Tables 3-1, 3-2, and 3-3 for the 36km, 12km and 04km domains, respectively. When the temperature biases are averaged over the entire 2006 period for the entire modeling domain (ALL), the model has a bias of 0.46 K for the 36km domain, 0.27 K for the 12km domain, and 0.97 K for the 04km domain. That is, MM5 overestimates mean annual observed temperatures in all three modeling domains, with the model falling within the ±0.5 K benchmark for the 36km and 12km domains.

Over the 36km domain, in general, MM5 tends to overpredict temperatures both seasonally and monthly with the exception of the WRAP states in spring and summer where there is a mix of positive and negative biases. Over the 12km domain, there is a general positive temperature bias seasonally and monthly with the exception of the spring months. And over the 04km domain, MM5 tends to overpredict temperatures, though March and April have distinct underpredictions.

Tables 3-4, 3-5, and 3-6 show the temperature error statistics for the 36km, 12km and 04km modeling domains, respectively. When the temperature errors are averaged over the entire 2006 period for the entire modeling domain (ALL), the model has a temperature error of 2.23 K for the 36km domain, 2.92 K for the 12km domain, and 2.89 K for the 04km domain all which miss the 2.0 K benchmark for temperature error.

Over the 36km domain on a month and seasonal basis by state and RPO subdomain, MM5 generally does not meet the 2.0 K benchmark for temperature error with the exception of the summer months for all but the WRAP states. Over the 12km and 04km domains, MM5 does not meet the benchmark for any period.

3.2.2 Mixing Ratio Bias and Error

Mixing ratio bias statistics are presented in Tables 3-7, 3-8, and 3-9 for the 36km, 12km, and 04km modeling domains, respectively. When the mixing ratio biases are averaged over the entire 2006 period for the entire modeling domain (ALL), the model has a bias of 0.20 g/kg for the 36km domain, -0.04 g/kg for the 12km domain, and -0.51 g/kg for the 04km domain with all within the mixing ratio bias benchmark of $\pm$1.0 g/kg.

Over the 36km domain, in general, MM5 tends to overpredict mixing ratio both seasonally and monthly with the exception of the summer months most notably in the VISTAS, CENRAP and WRAP states. Over the 12km domain, there is a general negative mixing ratio bias seasonally and monthly with the exception of the winter months. And over the 04km domain, MM5 tends to underpredict mixing ratio with the exception, again, of the winter months.

Tables 3-10, 3-11, and 3-12 show the mixing ratio error statistics for the 36km, 12km and 04km modeling domains, respectively. When the mixing ratio errors are averaged over the entire 2006 period for the entire modeling domain (ALL), the model has a mixing ratio error of 1.04 g/kg for the 36km domain, 0.81 g/kg for the 12km domain, and 0.94 g/kg for the 04km domain all which meet the 2.0 g/kg benchmark for mixing ratio error.

Over the 36km domain on a month and seasonal basis by state and RPO subdomain, MM5 almost exclusively meets the 2.0 g/kg benchmark for mixing ratio error with the exceptions of Oklahoma in July and Arizona in May. Over the 12km and 04km domains, MM5 meets the benchmark for all periods.

3.2.3 Wind Speed Index of Agreement

The wind speed index of agreement (IA) model performance results are presented in Tables 3-13, 3-14, and 3-15 for the 36km, 12km, and 04km domains, respectively. The 36 km domain-wide 2006 annual average IA is 0.87, which is well above the benchmark of 0.6. Seasonal and month-to-month IA values for the entire domain are also well above the 0.6 benchmark with IA values no less than 0.85. Over the entire 12km and 04km domains, the IA is 0.84 and 0.80, respectively, which are well above the benchmark. Further for the 12km and 04km domains, MM5 meets the IA benchmark for all areas both monthly and seasonally.

3.3 Qualitative Monthly Precipitation Analysis

This section presents qualitative comparisons of MM5 estimated precipitation with the CPC retrospective analysis data. When comparing the CPC and MM5 precipitation data, note should be taken that the CPC analysis covers only the Continental U.S. and does not extend offshore or into Canada or Mexico. The MM5 fields, on the other hand, cover the entire 36km domain. Also note that the CPC analysis is based on a 0.25 x 0.25 degree (~40 x 40 km) grid and the MM5 is based on a 36 x 36 km grid. Neither grid will effectively capture small precipitation features.

Monthly total precipitation comparisons for the 36km domain are presented in Figures 3-2 through 3-13. For each month, the first plot (e.g., Figure 3-2a) represents the CPC analyzed precipitation data, and the second plot (e.g., Figure 3-2b) represents the MM5 total precipitation for the month (e.g., Figure 3-2 is for January 2006 over the 36km domain). If the CPC analysis data are considered to be the observational standard for precipitation, MM5 provides an overall, reasonable representation of the spatial distribution and rate of precipitation over the contiguous U.S. for all months of 2006.

Over the 36km domain during the winter months (i.e., December, January, and February [Figures 3-13, 3-2, and 3-3]), MM5 does reasonably well at predicting the spatial extent of rainfall and the magnitude of the precipitation rates, though there is a noticeable overprediction of the rate over the Ohio River Valley and underprediction over northern Florida in February. During the spring months (i.e., March, April, and May [Figures 3-4 through 3-6]), MM5 tends to predict a greater spatial extent of rainfall with slightly higher rates over much of the domain. During the summer months (i.e., June, July, and August [Figures 3-7 through 3-9]), MM5 generally has good spatially agreement with noted additional rainfall over southern Oregon, parts of Nevada and Arizona, and much of New Mexico in June and misses precipitation over Oregon, Washington, and parts of Idaho, Nevada, Montana, and Wyoming in August. Further, MM5 has relatively high overpredictions of the precipitation rates during the summer months. During the autumn months (i.e., September, October, and November [Figures 3-10 through 3-12]), MM5 has relatively good spatial agreement though it does miss some rainfall in various parts of the 36km domain. Also, MM5 does reasonably well at predicting the rate of rainfall with various slight over- and underpredictions throughout the domain.

Over the 12km domain during the winter months (Figures 3-25, 3-14, and 3-15), MM5 does reasonably well at predicting the spatial extent of rainfall and the magnitude of the precipitation rates. During the spring months (Figures 3-16 through 3-18), MM5 tends to predict a greater spatial extent of rainfall with slightly higher rates over localized portions of the domain. During the summer months (Figures 3-19 through 3-21), MM5 generally has fair spatial agreement though misses rainfall throughout small parts of the domain and has slight overpredictions of precipitation rates. During the autumn months (Figures 3-22 through 3-24), MM5 has relatively good spatial agreement though it does miss some rainfall in the Colorado, Nebraska, Wyoming border area in September and has slight overpredictions of precipitation rates over the mountains.

Over the 04km domain during the winter months (Figures 3-37, 3-26, and 3-27), MM5 has fair spatial representation though in January, MM5 predicts rain over much of the north-south extent just east of the central portion of the domain where the CPC data indicate no rainfall. Also during the winter, MM5 has large overpredictions of rainfall rates over the mountains. During the spring months (Figures 3-28 through 3-30), MM5 tends to predict a greater spatial extent of rainfall with slightly higher rates over localized portions of the domain, especially the mountains. During the summer months (Figures 3-31 through 3-33), MM5 generally has fair spatial agreement though misses rainfall throughout small parts of the domain and has generally good agreement with precipitation rates though the peak rate tends to be displaced. During the autumn months (Figures 3-34 through 3-36), MM5 has relatively good spatial agreement and predicts reasonably well the precipitation rates with some slight displacement of the peak rate.

Of note, over mountainous terrain during some months, MM5 modeling tends to intensify precipitation and have higher amounts with less spatial coverage. This appears to be a function of the difference in grid spacing as the CPC data tends to smear precipitation over the larger 40km grid cells than the 12km or 04km grid cells used in the current MM5 simulation. Through the use of the coarse resolution CPC data, it is not possible to determine if this is a real feature or an artifact of the resolution.

3.4 Summary of Model Performance Evaluation

Temperature bias and error statistics, mixing ratio bias and error statistics, and wind speed index of agreement statistics were estimated for the model predictions for the 36km, 12km and 4km modeling grids. Further, a qualitative examination of model predicted rainfall versus observed precipitation was performed.

Temperature bias performance for all three domains indicated that MM5 consistently had difficulty reproducing temperature (i.e., the $\pm$0.5 K benchmark was not consistently met at the spatial levels and time scales examined). This was further confirmed by the temperature error statistic with, again, MM5 failing to consistently meet the 2.0 K benchmark.

Though this may appear to be problematic, it is not outside the realm of MM5 performance as demonstrated in other studies. This is issue is covered in more detail in Section 4 of this report.

Mixing ratio bias performance is good at all spatial levels and time scales that were examined over all three domains. Indeed, the model predicted mixing ratios so well that the benchmark of $\pm$1.0 g/kg was met in virtually all instances.

As with mixing ratio bias performance, mixing ratio error performance is good at all levels that were examined over the three domains. The model was unable to meet the benchmark of 2.0 g/kg in only two instances both of which occurred over the 36km domain.

The model also did well in regards to the wind speed index of agreement performance over the three domains. In only a handful of instances did MM5 fail to meet the benchmark of 0.6 most of which occurred over the 36km domain.

Finally, from a qualitative perspective, the model does a reasonable job of replicating rainfall. Though as noted previously, the model does tend to overpredict the magnitude of the rainfall, especially in the summer months, and overpredict the spatial extent where rainfall occurs.

Table 3-1. Temperature bias (K) for 2006 MM5 by month, state and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Mid-Atlantic/Northeast Visibility Union (MANE-VU)																	
CT	0.32	-0.12	-0.38	-0.06	-0.31	0.42	0.63	0.25	0.65	0.56	0.68	0.63	0.76	0.48	0.61	0.62	0.36
DE	1.01	-0.43	-0.40	0.06	-0.50	0.00	-0.09	-0.20	0.26	0.15	0.02	0.14	0.30	0.52	0.48	0.43	0.11
MA	0.31	-0.35	-0.33	-0.12	-0.15	0.41	0.44	0.23	0.47	0.07	0.58	0.37	0.78	0.47	0.57	0.61	0.27
MD	0.96	0.65	0.30	0.64	0.58	0.83	0.41	0.61	0.48	0.70	0.32	0.50	0.67	0.57	0.69	0.64	0.60
ME	0.63	0.10	-0.27	0.15	-1.37	0.29	1.15	0.02	0.94	0.44	0.93	0.77	0.80	0.72	0.79	0.77	0.43
NH	0.76	0.11	-0.09	0.26	-0.37	0.70	1.30	0.54	1.34	0.86	1.15	1.12	1.16	0.89	0.94	1.00	0.73
NJ	0.29	0.14	-0.30	0.04	-0.08	0.29	0.34	0.18	0.47	0.58	0.42	0.49	0.74	0.48	0.26	0.49	0.30
NY	0.11	-0.31	-0.56	-0.25	-0.75	0.11	0.48	-0.05	0.39	0.05	0.32	0.25	0.53	0.38	0.47	0.46	0.10
PA	0.34	0.20	-0.21	0.11	0.21	0.67	0.85	0.58	0.89	0.73	0.42	0.68	0.95	0.64	0.43	0.67	0.51
RI	0.17	-0.29	-0.43	-0.18	0.04	0.55	0.50	0.36	0.53	0.33	1.15	0.67	0.63	0.40	0.52	0.52	0.34
VT	-0.06	-0.94	-1.34	-0.78	-1.57	-0.46	0.63	-0.47	0.90	0.19	0.41	0.50	0.39	0.38	0.36	0.38	-0.09
MANE_VU	0.37	-0.07	-0.34	-0.01	-0.36	0.38	0.66	0.23	0.67	0.41	0.55	0.54	0.74	0.54	0.54	0.61	0.34
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)																	
AL	1.39	0.66	1.14	1.06	0.62	0.73	1.11	0.82	0.81	0.64	0.31	0.59	0.35	1.24	1.07	0.89	0.84
FL	0.53	0.62	1.02	0.72	-0.03	-0.38	0.02	-0.13	0.01	0.14	0.43	0.19	0.49	0.56	0.82	0.62	0.35
GA	1.66	0.89	1.23	1.26	0.79	0.72	1.12	0.88	0.71	0.55	0.39	0.55	0.57	1.08	0.98	0.88	0.89
KY	0.65	-0.01	0.11	0.25	0.86	1.05	1.28	1.06	1.18	1.01	0.71	0.97	1.07	0.83	0.92	0.94	0.81
MS	1.34	1.16	1.55	1.35	0.95	0.83	1.15	0.98	1.07	1.19	0.68	0.98	0.66	1.32	1.55	1.18	1.12
NC	1.68	0.84	1.17	1.23	0.92	1.08	1.39	1.13	1.04	0.60	0.37	0.67	0.43	0.78	0.73	0.65	0.92
SC	1.93	1.04	1.45	1.47	0.88	0.51	1.13	0.84	0.59	0.42	0.36	0.46	0.46	0.91	1.00	0.79	0.89
TN	1.33	0.31	0.54	0.73	0.52	0.88	1.45	0.95	1.02	0.98	0.56	0.85	0.49	0.93	1.24	0.89	0.85
VA	1.14	0.22	0.13	0.50	0.41	0.79	0.63	0.61	0.57	0.68	0.19	0.48	0.52	0.50	0.64	0.55	0.53
WV	0.35	-0.38	-1.14	-0.39	0.34	0.47	1.16	0.66	1.11	0.91	0.45	0.82	0.85	0.59	0.59	0.68	0.44
VISTAS	1.22	0.61	0.85	0.89	0.57	0.59	0.91	0.69	0.69	0.59	0.39	0.56	0.53	0.80	0.87	0.73	0.72
Midwest Regional Planning Organization (MRPO)																	
IL	0.49	-0.02	-0.05	0.14	1.12	1.45	1.48	1.35	1.20	1.04	1.05	1.10	0.96	0.58	0.85	0.80	0.85
IN	0.22	0.14	0.16	0.17	1.14	1.47	1.41	1.34	1.15	0.90	1.13	1.06	1.05	0.58	0.92	0.85	0.86
MI	0.25	0.17	-0.09	0.11	-0.14	0.84	0.88	0.53	0.68	0.44	0.91	0.68	1.17	0.94	0.54	0.88	0.55
OH	0.23	0.03	-0.14	0.04	0.97	1.20	1.30	1.16	0.93	0.85	0.84	0.87	0.85	0.54	0.68	0.69	0.69
WI	-0.19	-0.85	-1.67	-0.90	-1.33	0.84	1.31	0.27	1.27	0.80	1.07	1.05	0.89	0.39	0.09	0.46	0.22
MRPO	0.21	-0.13	-0.42	-0.11	0.19	1.10	1.24	0.84	1.03	0.77	0.99	0.93	1.00	0.64	0.57	0.74	0.60

Table 3-1. Temperature bias (K) for 2006 MM5 by month, state and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Central States Regional Air Partnership (CENRAP)																	
AR	0.68	0.56	1.22	0.82	0.83	0.79	1.25	0.96	1.20	0.70	0.75	0.88	1.21	1.13	0.89	1.08	0.93
IA	0.76	0.08	-0.28	0.19	0.54	1.63	1.58	1.25	1.52	1.35	1.33	1.40	1.10	0.82	0.88	0.93	0.94
KS	1.09	0.64	0.98	0.90	0.92	0.75	1.06	0.91	0.63	0.68	0.67	0.66	1.17	0.98	1.13	1.09	0.89
LA	1.17	0.54	1.27	0.99	0.32	0.17	0.46	0.32	0.83	0.82	0.44	0.70	0.58	1.31	1.25	1.05	0.76
MN	0.28	-0.54	-0.94	-0.40	-2.00	0.54	1.32	-0.05	1.61	0.97	1.33	1.30	0.96	0.60	0.68	0.75	0.40
MO	0.11	0.13	0.46	0.23	1.00	0.94	1.25	1.06	0.91	0.51	0.27	0.56	1.02	0.65	0.49	0.72	0.65
NE	1.88	0.73	0.97	1.19	0.39	1.10	1.06	0.85	0.66	0.74	0.81	0.74	1.30	1.48	2.10	1.63	1.10
OK	0.22	0.53	0.90	0.55	0.66	0.27	0.89	0.61	1.01	0.71	0.79	0.84	0.96	0.72	0.32	0.67	0.67
TX	0.83	0.85	1.46	1.05	0.61	0.26	0.22	0.36	0.30	0.14	0.06	0.17	0.55	0.68	0.61	0.61	0.55
CENRAP	0.73	0.35	0.55	0.54	0.09	0.64	0.91	0.55	0.94	0.67	0.71	0.77	0.91	0.83	0.83	0.86	0.68
Western Regional Air Partnership (WRAP)																	
AZ	1.74	0.80	0.60	1.05	-0.25	-1.14	-1.77	-1.05	-1.38	-0.69	-0.86	-0.98	-0.27	0.05	1.06	0.28	-0.18
CA	2.01	0.82	1.11	1.31	-0.25	-0.92	-1.41	-0.86	-1.47	-1.12	-0.74	-1.11	0.06	0.31	0.96	0.44	-0.05
CO	0.96	-0.56	-0.35	0.02	-1.54	-1.57	-0.78	-1.30	-0.77	0.02	0.08	-0.22	0.16	0.01	-0.04	0.04	-0.37
ID	1.07	-0.27	-0.49	0.10	-1.55	-0.98	0.25	-0.76	0.29	0.42	0.60	0.44	1.44	1.02	-0.02	0.81	0.15
MT	0.72	-0.77	-0.95	-0.33	-1.28	-0.94	0.20	-0.67	0.09	-0.37	-0.09	-0.12	0.46	0.47	-0.25	0.23	-0.23
ND	1.32	0.41	0.27	0.67	-0.62	1.10	1.73	0.74	1.54	1.48	1.50	1.51	1.21	1.17	1.67	1.35	1.07
NM	1.03	0.20	0.59	0.61	-0.27	-0.65	-0.84	-0.59	-0.52	-0.06	0.06	-0.17	0.46	0.61	1.10	0.72	0.14
NV	1.65	-0.98	-0.90	-0.08	-1.87	-2.06	-1.70	-1.88	-2.07	-1.90	-2.18	-2.05	-0.69	-0.25	0.94	0.00	-1.00
OR	1.03	-0.26	-0.06	0.24	-1.05	-0.83	-0.54	-0.81	-0.97	-1.13	-0.81	-0.97	0.44	1.04	0.17	0.55	-0.25
SD	1.69	0.44	0.26	0.80	-0.25	1.41	1.71	0.96	1.30	1.18	1.35	1.28	1.66	1.59	1.90	1.72	1.19
UT	2.41	0.82	-0.04	1.06	-1.03	-1.69	-0.77	-1.16	-0.82	-0.83	-0.57	-0.74	0.65	0.99	1.62	1.09	0.06
WA	0.68	0.03	-0.06	0.22	-0.20	0.04	0.40	0.08	-0.13	-0.16	0.07	-0.07	1.02	0.98	0.31	0.77	0.25
WY	0.85	-1.30	-1.03	-0.49	-1.81	-2.04	-0.56	-1.47	-0.92	-0.71	-0.41	-0.68	0.19	-0.15	-0.73	-0.23	-0.72
WRAP	1.36	0.17	0.23	0.59	-0.69	-0.77	-0.55	-0.67	-0.66	-0.43	-0.19	-0.43	0.45	0.57	0.62	0.55	0.01
ALL	0.87	0.23	0.28	0.46	-0.06	0.31	0.56	0.27	0.46	0.35	0.42	0.41	0.70	0.69	0.72	0.70	0.46

(a) ALL in this case refers to those states within the area covered by the 36km modeling domain.

Table 3-2. Temperature bias (K) for 2006 MM5 by month and state in the 12km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
CO	1.19	0.26	0.24	0.56	-1.20	-1.38	-0.43	-1.00	-0.26	0.52	0.53	0.26	0.44	0.00	0.13	0.19	0.00
UT	2.28	0.89	0.06	1.08	-0.99	-1.32	-0.54	-0.95	-0.42	-0.44	-0.18	-0.35	0.85	0.94	1.68	1.16	0.23
WY	1.76	0.07	-0.05	0.59	-1.01	-1.09	0.17	-0.64	-0.07	0.18	0.42	0.18	0.84	0.30	0.05	0.40	0.13
ALL	1.55	0.36	0.12	0.68	-1.06	-0.88	0.10	-0.61	0.05	0.36	0.47	0.29	0.89	0.63	0.59	0.70	0.27

(a) ALL in this case refers to those states within the area covered by the 12km modeling domain.

Table 3-3. Temperature Bias (K) for 2006 MM5 by Month in the 4km Domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
ALL	2.24	1.04	0.68	1.32	-0.94	-1.52	0.96	-0.50	1.60	1.89	1.97	1.82	2.11	1.17	0.47	1.25	0.97

Table 3-4. Temperature error (K) for 2006 MM5 by month, state and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Mid-Atlantic/Northeast Visibility Union (MANE-VU)																	
CT	1.75	1.87	1.97	1.86	1.88	1.98	1.73	1.86	1.61	1.62	1.81	1.68	1.87	1.90	2.02	1.93	1.83
DE	2.18	2.08	2.19	2.15	2.36	2.25	1.84	2.15	1.61	1.75	1.73	1.70	1.59	1.60	1.55	1.58	1.89
MA	1.71	1.96	2.03	1.90	2.03	2.05	1.94	2.01	1.84	1.63	2.00	1.82	1.97	1.87	1.98	1.94	1.92
MD	2.58	1.85	2.04	2.16	2.11	2.15	1.90	2.05	1.67	1.68	1.85	1.73	1.80	2.11	2.26	2.06	2.00
ME	1.75	2.42	1.93	2.03	2.50	2.29	1.97	2.25	1.67	1.73	1.87	1.76	1.92	1.94	1.85	1.90	1.99
NH	2.48	2.56	2.74	2.59	3.04	2.96	2.60	2.87	2.40	2.57	2.70	2.56	2.60	2.65	2.56	2.60	2.65
NJ	1.89	1.74	1.93	1.85	1.84	2.10	1.63	1.86	1.51	1.68	1.81	1.67	1.80	1.95	1.89	1.88	1.81
NY	1.67	1.86	2.00	1.84	2.11	2.06	1.89	2.02	1.72	1.66	1.87	1.75	1.81	1.94	1.90	1.88	1.87
PA	1.75	1.70	1.67	1.71	1.77	1.94	1.84	1.85	1.72	1.58	1.70	1.67	1.71	1.78	1.87	1.79	1.75
RI	1.54	1.63	1.79	1.65	1.58	1.83	1.83	1.75	1.78	1.74	2.29	1.94	1.79	1.62	1.58	1.66	1.75
VT	1.79	2.28	2.31	2.13	2.60	2.38	2.00	2.33	1.92	1.92	2.00	1.95	1.99	2.11	2.18	2.09	2.12
MANE_VU	1.85	1.95	1.99	1.93	2.11	2.13	1.91	2.05	1.76	1.73	1.92	1.80	1.88	1.94	1.96	1.93	1.93
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)																	
AL	2.47	2.09	2.22	2.26	2.14	2.14	2.13	2.14	2.25	2.05	1.90	2.07	1.95	2.39	2.38	2.24	2.18
FL	1.86	1.98	2.33	2.06	2.08	1.92	1.90	1.97	1.82	1.76	1.85	1.81	1.88	2.09	2.10	2.02	1.96
GA	2.74	2.18	2.39	2.44	2.23	2.23	2.31	2.26	2.25	2.01	1.80	2.02	1.88	2.41	2.40	2.23	2.24
KY	1.70	1.77	1.62	1.70	1.86	2.03	1.83	1.91	1.86	1.65	1.51	1.67	1.78	1.95	2.07	1.93	1.80
MS	2.27	2.28	2.38	2.31	2.21	2.05	2.09	2.12	2.39	2.15	2.09	2.21	2.07	2.37	2.67	2.37	2.25
NC	3.07	2.18	2.31	2.52	2.22	2.32	2.27	2.27	2.10	1.84	1.81	1.92	1.75	2.33	2.50	2.19	2.22
SC	2.94	2.23	2.30	2.49	2.20	2.14	2.17	2.17	1.87	1.66	1.66	1.73	1.62	2.18	2.40	2.07	2.11
TN	2.28	1.96	1.92	2.05	2.02	2.09	2.06	2.06	2.07	1.98	1.80	1.95	1.86	2.14	2.43	2.14	2.05
VA	2.83	1.93	2.15	2.30	2.14	2.32	2.10	2.19	1.92	1.77	1.83	1.84	1.86	2.20	2.40	2.15	2.12
WV	2.34	2.07	2.34	2.25	2.05	2.11	2.14	2.10	2.05	1.85	1.80	1.90	1.82	2.03	2.24	2.03	2.07
VISTAS	2.53	2.08	2.25	2.29	2.14	2.16	2.12	2.14	2.04	1.86	1.82	1.91	1.84	2.23	2.35	2.14	2.12
Midwest Regional Planning Organization (MRPO)																	
IL	1.65	1.68	1.70	1.68	1.84	2.18	2.02	2.01	1.95	1.86	1.84	1.88	2.00	1.94	1.84	1.93	1.88
IN	1.49	1.48	1.45	1.47	1.76	2.14	1.95	1.95	1.89	1.64	1.74	1.76	1.80	1.82	1.84	1.82	1.75
MI	1.31	1.33	1.55	1.40	1.98	2.20	2.06	2.08	2.15	2.01	2.04	2.07	2.00	1.86	1.67	1.84	1.85
OH	1.60	1.44	1.53	1.52	1.78	1.94	1.97	1.90	1.94	1.78	1.76	1.83	1.63	1.78	1.98	1.80	1.76
WI	1.57	1.88	2.35	1.93	2.35	2.33	2.19	2.29	2.27	2.23	2.11	2.20	2.01	1.94	1.69	1.88	2.08
MRPO	1.52	1.57	1.76	1.62	1.98	2.18	2.06	2.07	2.07	1.96	1.94	1.99	1.93	1.89	1.78	1.87	1.89

Table 3-4. Temperature error (K) for 2006 MM5 by month, state and region in the 36km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
Central States Regional Air Partnership (CENRAP)																	
AR	1.94	2.12	2.24	2.10	1.98	1.98	1.87	1.94	2.07	1.94	1.87	1.96	2.13	2.16	2.23	2.17	2.04
IA	2.02	1.73	1.95	1.90	2.14	2.40	2.22	2.25	2.33	2.00	1.91	2.08	2.16	2.07	2.12	2.12	2.09
KS	2.40	2.36	2.41	2.39	2.16	2.19	2.19	2.18	1.92	1.86	1.81	1.86	2.15	2.18	2.39	2.24	2.17
LA	2.37	2.40	2.53	2.43	2.18	1.94	1.97	2.03	2.20	2.06	2.05	2.10	2.14	2.40	2.60	2.38	2.24
MN	1.74	2.00	2.57	2.10	2.78	2.51	2.21	2.50	2.36	2.17	2.15	2.23	2.10	2.04	2.00	2.05	2.22
MO	1.96	1.93	1.82	1.90	2.03	2.02	1.86	1.97	1.88	1.76	1.73	1.79	2.01	1.98	1.97	1.99	1.91
NE	2.82	2.39	2.42	2.54	2.53	2.38	2.52	2.48	2.16	2.03	1.94	2.04	2.32	2.57	3.07	2.65	2.43
OK	2.50	2.55	2.41	2.49	2.05	2.04	1.97	2.02	1.97	1.82	1.90	1.90	2.20	2.14	2.14	2.16	2.14
TX	2.18	2.53	2.67	2.46	1.96	1.74	1.77	1.82	1.65	1.51	1.68	1.61	1.93	1.92	2.16	2.00	1.98
CENRAP	2.15	2.24	2.43	2.27	2.23	2.12	2.04	2.13	2.03	1.86	1.88	1.92	2.09	2.09	2.22	2.13	2.12
Western Regional Air Partnership (WRAP)																	
AZ	3.16	2.94	2.83	2.98	2.34	2.70	3.29	2.78	3.00	2.69	2.70	2.80	2.71	2.77	3.27	2.92	2.87
CA	3.47	2.60	3.08	3.05	2.18	2.37	2.84	2.46	2.98	3.10	2.77	2.95	2.96	2.92	2.78	2.89	2.84
CO	3.37	3.65	3.71	3.58	3.47	3.84	3.27	3.53	3.22	2.91	2.75	2.96	2.80	2.76	3.32	2.96	3.26
ID	2.68	2.44	3.06	2.73	2.93	3.16	3.10	3.06	2.80	3.35	3.31	3.15	3.25	2.89	2.56	2.90	2.96
MT	3.52	3.14	3.41	3.36	2.85	3.34	2.84	3.01	2.57	3.09	2.91	2.86	2.75	2.63	3.34	2.91	3.03
ND	2.34	1.96	2.49	2.26	2.01	2.65	2.54	2.40	2.35	2.57	2.48	2.47	2.18	2.12	2.68	2.33	2.36
NM	2.98	2.84	2.93	2.92	2.40	2.48	2.59	2.49	2.42	2.23	1.99	2.21	2.31	2.54	3.09	2.65	2.57
NV	3.71	2.74	3.10	3.18	2.96	3.15	3.52	3.21	3.74	3.69	4.24	3.89	3.92	3.48	3.47	3.62	3.48
OR	2.78	2.00	2.61	2.46	2.25	2.27	2.49	2.34	2.56	2.96	2.95	2.82	3.08	2.96	2.33	2.79	2.60
SD	2.64	1.93	2.09	2.22	2.35	2.60	2.64	2.53	2.50	2.48	2.32	2.43	2.31	2.48	2.71	2.50	2.42
UT	3.54	2.64	3.07	3.08	2.63	3.21	2.96	2.93	3.17	3.04	3.01	3.07	3.01	2.63	3.07	2.90	3.00
WA	1.99	1.49	2.11	1.86	1.85	1.93	2.25	2.01	2.18	2.58	2.56	2.44	2.66	2.42	1.76	2.28	2.15
WY	3.78	3.39	3.69	3.62	3.15	3.46	3.06	3.22	2.99	3.23	3.03	3.08	2.73	2.58	3.10	2.80	3.18
WRAP	3.06	2.58	2.93	2.86	2.45	2.69	2.80	2.65	2.76	2.87	2.69	2.77	2.76	2.70	2.77	2.74	2.76
ALL	2.33	2.16	2.37	2.29	2.22	2.28	2.24	2.25	2.20	2.12	2.10	2.14	2.18	2.23	2.30	2.24	2.23

(a) ALL in this case refers to those states within the area covered by the 36km modeling domain.

Table 3-5. Temperature error (K) for 2006 MM5 by month and state in the 12km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
CO	3.44	3.49	3.47	3.47	3.04	3.60	3.04	3.23	2.94	2.67	2.56	2.72	2.75	2.79	3.44	2.99	3.10
UT	3.39	2.72	3.22	3.11	2.56	3.08	3.01	2.88	3.25	3.02	3.10	3.12	3.14	2.76	3.22	3.04	3.04
WY	3.82	3.02	3.14	3.33	2.69	2.88	2.77	2.78	2.68	2.92	2.75	2.78	2.62	2.42	2.91	2.65	2.89
ALL	3.36	2.89	3.11	3.12	2.75	3.11	2.90	2.92	2.77	2.84	2.72	2.78	2.78	2.67	3.11	2.85	2.92

(a) ALL in this case refers to those states within the area covered by the 12km modeling domain.

Table 3-6. Temperature error (K) for 2006 MM5 by month in the 4km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
ALL	3.47	2.75	3.14	3.12	2.55	3.05	2.64	2.75	2.71	2.97	2.98	2.89	2.96	2.69	2.81	2.82	2.89

Table 3-7. Mixing ratio bias (g/kg) for 2006 MM5 by month, state, and region in the 36km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
Mid-Atlantic/Northeast Visibility Union (MANE-VU)																	
CT	0.85	0.62	0.49	0.65	0.98	0.58	0.67	0.74	0.68	0.26	0.53	0.49	0.48	0.72	0.93	0.71	0.65
DE	0.40	0.49	0.18	0.36	0.17	0.36	0.23	0.25	-0.10	-0.39	0.10	-0.13	0.28	0.22	0.57	0.36	0.21
MA	0.81	0.43	0.41	0.55	0.88	0.55	0.65	0.69	0.75	0.49	0.88	0.71	0.63	0.75	0.87	0.75	0.68
MD	0.38	0.73	0.24	0.45	0.35	0.33	0.11	0.26	-0.10	-0.72	-0.34	-0.39	0.23	-0.09	0.64	0.26	0.15
ME	0.65	0.36	0.31	0.44	0.56	0.82	0.64	0.67	0.80	0.54	0.71	0.68	0.58	0.62	0.70	0.63	0.61
NH	0.83	0.44	0.43	0.57	0.85	0.82	0.78	0.82	0.93	0.59	0.75	0.76	0.45	0.69	0.87	0.67	0.70
NJ	0.87	0.88	0.43	0.73	0.69	0.64	0.52	0.62	0.61	0.36	0.93	0.63	0.79	0.70	1.04	0.84	0.70
NY	0.75	0.58	0.36	0.56	0.65	0.53	0.43	0.54	0.55	0.39	0.62	0.52	0.51	0.69	0.84	0.68	0.57
PA	0.69	0.91	0.38	0.66	0.63	0.58	0.51	0.57	0.57	0.14	0.63	0.45	0.42	0.48	0.85	0.58	0.57
RI	0.69	0.56	0.39	0.55	0.81	0.60	0.74	0.72	0.73	0.45	0.95	0.71	0.46	0.58	0.71	0.58	0.64
VT	0.74	0.31	0.31	0.45	0.63	0.88	0.53	0.68	0.84	0.48	0.55	0.62	0.43	0.62	0.84	0.63	0.60
MANE_VU	0.72	0.61	0.37	0.57	0.67	0.60	0.53	0.60	0.60	0.28	0.62	0.50	0.50	0.58	0.83	0.64	0.58
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)																	
AL	0.82	1.19	0.86	0.96	0.88	0.92	0.43	0.74	0.53	0.20	0.40	0.38	0.18	-0.02	0.30	0.15	0.56
FL	0.80	1.15	1.02	0.99	1.02	0.70	0.52	0.75	0.36	-0.31	-0.27	-0.07	0.07	0.53	0.59	0.40	0.52
GA	0.77	1.03	0.63	0.81	0.78	1.04	0.58	0.80	0.53	-0.07	0.16	0.21	0.23	0.06	0.37	0.22	0.51
KY	0.72	0.67	0.23	0.54	0.42	0.97	0.32	0.57	0.15	-0.60	-0.40	-0.28	0.21	0.20	0.61	0.34	0.29
MS	0.50	1.09	1.00	0.86	1.02	0.89	0.39	0.77	0.51	-0.34	0.34	0.17	0.12	0.15	0.26	0.18	0.49
NC	0.88	1.05	0.41	0.78	0.64	1.23	0.87	0.91	0.69	0.15	0.37	0.40	0.26	0.16	0.71	0.38	0.62
SC	1.04	1.19	0.60	0.94	0.98	1.58	1.24	1.27	0.85	0.41	0.59	0.62	0.34	0.24	0.59	0.39	0.80
TN	0.72	0.92	0.41	0.68	0.61	1.04	0.64	0.76	0.32	-0.20	-0.21	-0.03	0.32	0.01	0.46	0.26	0.42
VA	0.43	0.72	0.19	0.45	0.38	0.64	0.05	0.36	-0.23	-0.82	-0.50	-0.52	-0.11	-0.15	0.52	0.09	0.09
WV	0.49	0.84	0.25	0.53	0.58	1.06	0.52	0.72	0.28	-0.36	-0.01	-0.03	0.31	0.15	0.51	0.32	0.38
VISTAS	0.74	1.01	0.58	0.78	0.74	0.96	0.55	0.75	0.40	-0.20	0.02	0.07	0.16	0.16	0.53	0.28	0.47
Midwest Regional Planning Organization (MRPO)																	
IL	0.47	0.29	0.10	0.29	0.38	0.40	0.04	0.27	0.17	-0.19	-0.25	-0.09	0.11	0.06	0.23	0.13	0.15
IN	0.66	0.44	0.15	0.42	0.47	0.45	-0.03	0.30	0.10	-0.24	-0.25	-0.13	0.23	0.29	0.50	0.34	0.23
MI	0.41	0.37	0.26	0.35	0.46	0.35	0.29	0.37	0.36	0.44	0.40	0.40	0.39	0.33	0.30	0.34	0.36
OH	0.60	0.64	0.19	0.48	0.42	0.33	0.18	0.31	0.31	-0.08	-0.09	0.05	0.36	0.40	0.50	0.42	0.31
WI	0.34	0.23	0.15	0.24	0.36	0.43	0.21	0.33	0.55	0.62	0.26	0.48	0.38	0.06	0.17	0.20	0.31
MRPO	0.45	0.36	0.18	0.33	0.41	0.39	0.16	0.32	0.32	0.19	0.08	0.20	0.30	0.20	0.30	0.27	0.28

Table 3-7. Mixing ratio bias (g/kg) for 2006 MM5 by month, state, and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Central States Regional Air Partnership (CENRAP)																	
AR	0.49	0.59	0.16	0.41	0.74	0.92	0.50	0.72	-0.15	-0.23	-0.13	-0.17	-0.01	0.00	0.17	0.05	0.25
IA	0.06	0.33	0.06	0.15	0.33	0.03	-0.58	-0.07	-0.01	-0.69	-0.37	-0.36	0.35	-0.18	-0.24	-0.02	-0.08
KS	0.14	0.23	0.15	0.17	0.28	0.68	0.53	0.50	0.29	-0.47	-0.09	-0.09	-0.07	-0.14	-0.06	-0.09	0.12
LA	0.43	0.99	1.14	0.85	1.03	1.11	0.68	0.94	0.47	0.03	0.57	0.36	0.18	0.55	0.28	0.34	0.62
MN	0.13	0.21	0.12	0.15	0.13	0.41	-0.23	0.10	-0.16	-0.14	-0.13	-0.14	0.20	-0.10	-0.09	0.00	0.03
MO	0.40	0.47	0.11	0.33	0.50	0.93	0.58	0.67	0.24	0.11	0.47	0.27	0.06	0.10	0.11	0.09	0.34
NE	0.30	0.28	0.14	0.24	0.09	0.24	0.29	0.21	0.66	-0.19	0.04	0.17	0.27	-0.07	-0.02	0.06	0.17
OK	-0.06	0.09	-0.07	-0.01	0.10	-0.07	-0.45	-0.14	-1.16	-1.73	-1.08	-1.32	-1.01	-0.55	-0.39	-0.65	-0.53
TX	-0.15	0.37	0.55	0.26	0.29	-0.12	0.06	0.08	-0.39	-0.79	-0.61	-0.60	-0.51	-0.44	-0.21	-0.39	-0.16
CENRAP	0.09	0.34	0.26	0.23	0.30	0.26	0.01	0.19	-0.16	-0.54	-0.30	-0.33	-0.12	-0.19	-0.12	-0.14	-0.01
Western Regional Air Partnership (WRAP)																	
AZ	0.20	0.38	0.51	0.36	0.47	1.09	1.93	1.16	1.49	0.14	0.09	0.57	-0.36	0.31	0.64	0.20	0.57
CA	0.10	0.01	-0.30	-0.06	0.19	0.00	-0.17	0.01	-0.33	-0.58	-0.83	-0.58	-0.82	-0.48	-0.14	-0.48	-0.28
CO	0.19	0.15	0.23	0.19	0.17	0.18	-0.12	0.08	0.00	-0.79	-0.90	-0.56	-0.76	-0.42	-0.11	-0.43	-0.18
ID	0.29	0.30	0.17	0.25	0.12	-0.03	-0.12	-0.01	-0.29	-0.15	-0.32	-0.25	-0.44	-0.33	0.19	-0.19	-0.05
MT	0.49	0.58	0.37	0.48	0.20	-0.19	-0.18	-0.06	-0.40	0.12	-0.10	-0.13	-0.15	-0.06	0.49	0.09	0.10
ND	0.28	0.42	0.28	0.33	0.20	0.10	-0.21	0.03	-0.14	-0.16	-0.12	-0.14	0.04	-0.11	0.24	0.06	0.07
NM	0.00	0.24	0.31	0.18	0.56	0.62	0.62	0.60	0.43	-0.64	-1.02	-0.41	-0.88	-0.59	0.00	-0.49	-0.03
NV	0.55	0.30	0.23	0.36	0.20	0.31	0.38	0.30	0.74	-0.08	0.62	0.43	0.44	0.16	0.73	0.44	0.38
OR	0.33	0.45	0.33	0.37	0.33	0.09	-0.09	0.11	0.08	0.61	0.18	0.29	-0.04	-0.01	0.47	0.14	0.23
SD	0.35	0.34	0.28	0.32	0.31	0.13	-0.16	0.09	0.68	0.02	-0.12	0.19	0.12	-0.09	0.06	0.03	0.16
UT	0.27	0.11	0.05	0.14	-0.01	-0.09	-0.05	-0.05	0.20	0.12	-0.49	-0.06	-0.16	-0.38	0.00	-0.18	-0.04
WA	0.18	0.43	0.23	0.28	0.19	-0.04	-0.10	0.02	-0.16	0.46	0.12	0.14	-0.08	-0.16	0.48	0.08	0.13
WY	0.40	0.30	0.24	0.31	0.07	-0.17	-0.55	-0.22	-0.30	0.20	-0.50	-0.20	-0.27	-0.04	0.17	-0.05	-0.04
WRAP	0.21	0.25	0.12	0.19	0.23	0.14	0.05	0.14	0.03	-0.15	-0.41	-0.18	-0.43	-0.25	0.15	-0.18	-0.01
ALL	0.38	0.48	0.29	0.38	0.43	0.43	0.21	0.36	0.17	-0.18	-0.09	-0.03	0.00	0.01	0.25	0.09	0.20

(a) ALL in this case refers to those states within the area covered by the 36km modeling domain.

Table 3-8. Mixing ratio bias (g/kg) for 2006 MM5 by month and state in the 12km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
CO	0.14	0.13	0.18	0.15	0.09	0.18	-0.15	0.04	0.10	-0.84	-0.94	-0.56	-0.65	-0.38	-0.09	-0.37	-0.19
UT	0.17	0.01	-0.03	0.05	-0.05	-0.02	0.07	0.00	0.29	-0.07	-0.42	-0.07	-0.14	-0.27	0.02	-0.13	-0.04
WY	0.31	0.19	0.16	0.22	-0.01	-0.16	-0.45	-0.21	-0.12	0.15	-0.44	-0.14	-0.17	0.00	0.11	-0.02	-0.04
ALL	0.27	0.20	0.17	0.21	0.05	0.02	-0.14	-0.02	0.03	-0.21	-0.51	-0.23	-0.30	-0.21	0.09	-0.14	-0.04

(a) ALL in this case refers to those states within the area covered by the 12km modeling domain.

Table 3-9. Mixing ratio bias (g/kg) for 2006 MM5 by month in the 4km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
ALL	0.24	0.14	0.12	0.17	-0.18	-0.5	-0.99	-0.56	-1.23	-1.16	-1.14	-1.18	-0.82	-0.47	-0.12	-0.47	-0.51

Table 3-10. Mixing ratio error (g/kg) for 2006 MM5 by month, state, and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Mid-Atlantic/Northeast Visibility Union (MANE-VU)																	
CT	0.89	0.73	0.61	0.74	1.00	0.80	0.94	0.91	1.05	1.26	1.26	1.19	0.97	0.90	1.01	0.96	0.95
DE	0.63	0.66	0.41	0.57	0.62	0.84	0.87	0.78	0.95	1.31	1.12	1.13	0.82	0.73	0.71	0.75	0.81
MA	0.87	0.61	0.55	0.68	0.92	0.78	0.95	0.88	1.12	1.14	1.30	1.19	1.00	0.92	0.97	0.96	0.93
MD	0.70	0.84	0.51	0.68	0.73	1.00	1.00	0.91	1.08	1.63	1.54	1.42	1.03	0.92	0.90	0.95	0.99
ME	0.71	0.56	0.43	0.57	0.67	0.95	0.93	0.85	1.19	1.15	1.05	1.13	0.86	0.77	0.80	0.81	0.84
NH	0.91	0.62	0.52	0.68	0.91	0.99	1.03	0.98	1.29	1.27	1.16	1.24	0.88	0.86	0.95	0.90	0.95
NJ	0.96	0.92	0.56	0.81	0.78	0.88	0.99	0.88	1.15	1.37	1.50	1.34	1.22	0.99	1.12	1.11	1.04
NY	0.79	0.67	0.48	0.65	0.73	0.80	0.92	0.82	1.04	1.19	1.19	1.14	0.90	0.87	0.90	0.89	0.87
PA	0.81	0.96	0.51	0.76	0.75	0.99	1.02	0.92	1.16	1.35	1.35	1.29	0.94	0.84	0.98	0.92	0.97
RI	0.77	0.66	0.54	0.66	0.85	0.88	1.10	0.94	1.10	1.25	1.46	1.27	0.98	0.89	0.86	0.91	0.94
VT	0.78	0.51	0.44	0.58	0.76	1.04	0.96	0.92	1.29	1.29	1.07	1.22	0.84	0.81	0.89	0.85	0.89
MANE_VU	0.81	0.73	0.51	0.68	0.79	0.89	0.97	0.88	1.13	1.28	1.28	1.23	0.95	0.87	0.94	0.92	0.93
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)																	
AL	1.11	1.32	1.01	1.15	1.19	1.43	1.33	1.32	1.41	1.59	1.42	1.47	1.17	1.12	0.82	1.04	1.24
FL	1.21	1.45	1.31	1.32	1.39	1.47	1.50	1.45	1.58	1.57	1.46	1.54	1.41	1.35	1.16	1.31	1.41
GA	1.19	1.27	0.99	1.15	1.26	1.67	1.62	1.52	1.84	1.79	1.64	1.76	1.44	1.26	0.94	1.21	1.41
KY	0.85	0.85	0.45	0.72	0.80	1.49	1.15	1.15	1.34	1.47	1.44	1.42	0.96	0.98	0.92	0.95	1.06
MS	0.92	1.31	1.21	1.15	1.32	1.43	1.45	1.40	1.54	1.72	1.54	1.60	1.16	1.20	0.94	1.10	1.31
NC	1.10	1.17	0.73	1.00	1.06	1.68	1.44	1.39	1.53	1.52	1.60	1.55	1.09	1.03	1.05	1.06	1.25
SC	1.31	1.30	0.86	1.16	1.23	1.78	1.57	1.53	1.53	1.31	1.43	1.42	1.02	1.02	0.92	0.99	1.27
TN	0.91	1.06	0.63	0.87	0.90	1.45	1.27	1.21	1.32	1.40	1.39	1.37	0.99	1.03	0.88	0.97	1.10
VA	0.82	0.88	0.52	0.74	0.83	1.31	1.17	1.10	1.38	1.77	1.69	1.61	1.12	1.05	0.98	1.05	1.13
WV	0.69	0.92	0.46	0.69	0.81	1.41	1.14	1.12	1.09	1.24	1.21	1.18	0.93	0.95	0.91	0.93	0.98
VISTAS	1.06	1.19	0.87	1.04	1.12	1.52	1.40	1.35	1.51	1.59	1.53	1.54	1.19	1.13	1.00	1.11	1.26
Midwest Regional Planning Organization (MRPO)																	
IL	0.63	0.55	0.42	0.53	0.71	1.22	1.15	1.03	1.31	1.54	1.40	1.42	1.03	0.92	0.70	0.88	0.96
IN	0.76	0.59	0.42	0.59	0.73	1.24	1.09	1.02	1.24	1.33	1.33	1.30	0.98	0.85	0.77	0.87	0.94
MI	0.49	0.45	0.36	0.43	0.56	0.80	0.99	0.78	1.06	1.25	1.30	1.20	0.92	0.64	0.55	0.70	0.78
OH	0.69	0.70	0.40	0.60	0.69	1.07	1.05	0.94	1.12	1.24	1.24	1.20	0.93	0.83	0.76	0.84	0.89
WI	0.45	0.42	0.31	0.39	0.52	0.96	1.01	0.83	1.25	1.47	1.22	1.31	0.92	0.65	0.46	0.68	0.80
MRPO	0.57	0.52	0.37	0.49	0.62	1.02	1.05	0.90	1.19	1.38	1.30	1.29	0.96	0.76	0.62	0.78	0.86

Table 3-10. Mixing ratio error (g/kg) for 2006 MM5 by month, state, and region in the 36km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
Central States Regional Air Partnership (CENRAP)																	
AR	0.80	0.85	0.69	0.78	1.10	1.36	1.37	1.28	1.38	1.68	1.63	1.56	1.11	1.17	0.90	1.06	1.17
IA	0.56	0.51	0.36	0.48	0.72	1.15	1.43	1.10	1.54	1.91	1.57	1.67	1.10	0.94	0.64	0.89	1.04
KS	0.49	0.51	0.39	0.46	0.74	1.13	1.28	1.05	1.34	1.57	1.46	1.46	0.90	0.80	0.70	0.80	0.94
LA	0.92	1.25	1.33	1.17	1.31	1.52	1.47	1.43	1.64	1.58	1.51	1.58	1.12	1.28	0.98	1.13	1.33
MN	0.36	0.40	0.28	0.35	0.43	1.10	1.19	0.91	1.36	1.72	1.41	1.50	0.99	0.77	0.45	0.74	0.87
MO	0.64	0.61	0.40	0.55	0.85	1.36	1.29	1.17	1.32	1.46	1.35	1.38	0.86	0.91	0.73	0.83	0.98
NE	0.53	0.52	0.46	0.50	0.72	1.00	1.32	1.01	1.52	1.48	1.46	1.49	0.98	0.82	0.55	0.78	0.95
OK	0.64	0.58	0.52	0.58	0.95	1.17	1.42	1.18	1.85	2.16	1.81	1.94	1.39	1.06	0.91	1.12	1.21
TX	0.91	0.91	1.02	0.95	1.30	1.51	1.54	1.45	1.58	1.67	1.66	1.64	1.41	1.38	1.04	1.28	1.33
CENRAP	0.65	0.66	0.62	0.64	0.90	1.27	1.38	1.18	1.51	1.72	1.56	1.60	1.16	1.05	0.77	0.99	1.10
Western Regional Air Partnership (WRAP)																	
AZ	0.66	0.67	0.74	0.69	1.05	1.26	2.04	1.45	1.96	1.66	1.90	1.84	1.40	1.33	0.86	1.20	1.29
CA	0.95	0.95	1.12	1.01	0.78	0.82	1.03	0.88	1.32	1.64	1.61	1.52	1.52	1.22	1.12	1.29	1.17
CO	0.49	0.49	0.47	0.48	0.70	0.78	0.99	0.82	1.28	1.54	1.51	1.44	1.18	0.88	0.58	0.88	0.91
ID	0.54	0.53	0.46	0.51	0.56	0.82	1.01	0.80	1.18	1.47	1.05	1.23	0.96	0.82	0.69	0.82	0.84
MT	0.59	0.68	0.50	0.59	0.46	0.80	1.05	0.77	1.16	1.20	0.97	1.11	0.78	0.66	0.66	0.70	0.79
ND	0.41	0.52	0.38	0.44	0.38	0.89	1.14	0.80	1.25	1.38	1.27	1.30	0.85	0.62	0.53	0.67	0.80
NM	0.54	0.54	0.61	0.56	0.92	1.07	1.23	1.07	1.46	1.51	1.66	1.54	1.43	1.17	0.59	1.06	1.06
NV	0.70	0.62	0.52	0.61	0.65	0.91	1.25	0.94	1.30	1.42	1.30	1.34	0.95	0.84	0.90	0.90	0.95
OR	0.62	0.62	0.58	0.61	0.61	0.68	0.88	0.72	0.97	1.29	1.09	1.12	0.97	0.87	0.74	0.86	0.83
SD	0.47	0.48	0.39	0.45	0.57	0.99	1.26	0.94	1.47	1.43	1.44	1.45	0.91	0.76	0.45	0.71	0.88
UT	0.47	0.49	0.44	0.47	0.62	0.74	1.05	0.80	1.25	1.47	1.33	1.35	0.93	0.97	0.56	0.82	0.86
WA	0.63	0.57	0.53	0.58	0.59	0.66	0.86	0.70	0.96	1.20	0.97	1.04	1.02	0.77	0.72	0.84	0.79
WY	0.54	0.47	0.43	0.48	0.47	0.73	1.05	0.75	1.10	1.27	1.13	1.17	0.90	0.69	0.50	0.70	0.77
WRAP	0.66	0.66	0.68	0.67	0.69	0.83	1.10	0.87	1.27	1.45	1.39	1.37	1.18	0.97	0.76	0.97	0.97
ALL	0.74	0.75	0.63	0.71	0.84	1.13	1.22	1.06	1.36	1.53	1.44	1.44	1.11	0.98	0.81	0.97	1.04

(a) ALL in this case refers to those states within the area covered by the 36km modeling domain.

Table 3-11. Mixing ratio error (g/kg) for 2006 MM5 by month and state in the 12km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
CO	0.47	0.46	0.43	0.45	0.62	0.73	0.96	0.77	1.17	1.46	1.49	1.37	1.08	0.82	0.55	0.82	0.85
UT	0.42	0.45	0.43	0.43	0.6	0.74	1.04	0.79	1.26	1.41	1.33	1.33	0.88	0.92	0.57	0.79	0.84
WY	0.47	0.42	0.36	0.42	0.44	0.69	0.98	0.70	1.07	1.19	1.07	1.11	0.83	0.65	0.47	0.65	0.72
ALL	0.48	0.47	0.42	0.46	0.53	0.76	1.03	0.77	1.19	1.34	1.29	1.27	0.91	0.74	0.53	0.73	0.81

(a) ALL in this case refers to those states within the area covered by the 12km modeling domain.

Table 3-12. Mixing ratio error (g/kg) for 2006 MM5 by month in the 4km domain.																	
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
ALL	0.45	0.47	0.42	0.45	0.52	0.85	1.32	0.90	1.61	1.63	1.48	1.57	1.1	0.89	0.56	0.85	0.94

Table 3-13. Wind speed index of agreement for 2006 MM5 by month, state, and region in the 36km domain.																
Region	**Dec**	**Jan**	**Feb**	**Win**	**Mar**	**Apr**	**May**	**Spr**	**Jun**	**Jul**	**Aug**	**Sum**	**Sep**	**Oct**	**Nov**	**Aut**	**Mean**
Mid-Atlantic/Northeast Visibility Union (MANE-VU)																	
CT	0.53	0.52	0.55	0.53	0.53	0.53	0.52	0.53	0.57	0.53	0.55	0.55	0.56	0.56	0.51	0.54	0.54
DE	0.72	0.69	0.75	0.72	0.73	0.77	0.80	0.77	0.79	0.74	0.81	0.78	0.74	0.71	0.72	0.72	0.75
MA	0.55	0.61	0.58	0.58	0.59	0.64	0.65	0.63	0.57	0.64	0.57	0.59	0.63	0.59	0.57	0.60	0.60
MD	0.51	0.57	0.57	0.55	0.57	0.61	0.60	0.59	0.50	0.55	0.60	0.55	0.53	0.54	0.55	0.54	0.56
ME	0.52	0.56	0.56	0.55	0.55	0.58	0.54	0.56	0.54	0.51	0.59	0.55	0.55	0.59	0.51	0.55	0.55
NH	0.27	0.41	0.43	0.37	0.39	0.44	0.33	0.39	0.45	0.35	0.32	0.37	0.24	0.36	0.33	0.31	0.36
NJ	0.48	0.56	0.58	0.54	0.55	0.59	0.53	0.56	0.59	0.52	0.52	0.54	0.60	0.54	0.53	0.56	0.55
NY	0.68	0.71	0.68	0.69	0.71	0.68	0.71	0.70	0.71	0.72	0.67	0.70	0.72	0.68	0.66	0.69	0.69
PA	0.61	0.63	0.64	0.63	0.64	0.63	0.66	0.64	0.65	0.69	0.64	0.66	0.65	0.67	0.63	0.65	0.65
RI	0.68	0.66	0.67	0.67	0.69	0.71	0.70	0.70	0.72	0.72	0.72	0.72	0.76	0.72	0.72	0.73	0.71
VT	0.52	0.50	0.50	0.51	0.49	0.49	0.51	0.50	0.50	0.54	0.51	0.52	0.51	0.48	0.50	0.50	0.50
MANE_VU	0.64	0.70	0.68	0.67	0.69	0.72	0.69	0.70	0.73	0.69	0.72	0.71	0.65	0.70	0.65	0.67	0.69
Visibility Improvement State and Tribal Association of the Southeast (VISTAS)																	
AL	0.66	0.65	0.68	0.66	0.65	0.64	0.65	0.65	0.65	0.64	0.61	0.63	0.65	0.69	0.63	0.66	0.65
FL	0.68	0.74	0.68	0.70	0.73	0.75	0.73	0.74	0.73	0.73	0.74	0.73	0.71	0.65	0.70	0.69	0.71
GA	0.56	0.65	0.65	0.62	0.60	0.65	0.58	0.61	0.55	0.60	0.58	0.58	0.55	0.60	0.59	0.58	0.60
KY	0.56	0.56	0.58	0.57	0.53	0.55	0.55	0.54	0.57	0.54	0.58	0.56	0.59	0.57	0.59	0.58	0.56
MS	0.61	0.61	0.63	0.62	0.62	0.61	0.61	0.61	0.61	0.57	0.62	0.60	0.59	0.61	0.62	0.61	0.61
NC	0.57	0.60	0.58	0.58	0.64	0.60	0.53	0.59	0.56	0.62	0.56	0.58	0.63	0.57	0.59	0.60	0.59
SC	0.59	0.64	0.61	0.61	0.66	0.55	0.66	0.62	0.56	0.57	0.59	0.57	0.59	0.55	0.60	0.58	0.60
TN	0.62	0.59	0.60	0.60	0.56	0.67	0.60	0.61	0.64	0.63	0.64	0.64	0.63	0.64	0.66	0.64	0.62
VA	0.63	0.63	0.62	0.63	0.61	0.64	0.59	0.61	0.64	0.62	0.61	0.62	0.66	0.61	0.66	0.64	0.63
WV	0.55	0.54	0.57	0.55	0.55	0.54	0.55	0.55	0.56	0.59	0.53	0.56	0.53	0.60	0.56	0.56	0.56
VISTAS	0.76	0.76	0.78	0.77	0.76	0.73	0.76	0.75	0.75	0.76	0.78	0.76	0.74	0.77	0.76	0.76	0.76
Midwest Regional Planning Organization (MRPO)																	
IL	0.67	0.65	0.67	0.66	0.66	0.62	0.66	0.65	0.64	0.64	0.66	0.65	0.68	0.65	0.70	0.68	0.66
IN	0.61	0.60	0.61	0.61	0.62	0.58	0.58	0.59	0.61	0.58	0.62	0.60	0.62	0.63	0.62	0.62	0.61
MI	0.64	0.64	0.66	0.65	0.65	0.62	0.63	0.63	0.66	0.63	0.63	0.64	0.66	0.65	0.64	0.65	0.64
OH	0.64	0.62	0.63	0.63	0.62	0.65	0.62	0.63	0.64	0.65	0.65	0.65	0.62	0.65	0.64	0.64	0.64
WI	0.62	0.63	0.63	0.63	0.61	0.58	0.61	0.60	0.62	0.59	0.59	0.60	0.60	0.59	0.62	0.60	0.61
MRPO	0.73	0.72	0.71	0.72	0.73	0.69	0.75	0.72	0.73	0.76	0.72	0.74	0.76	0.74	0.77	0.76	0.73

Table 3-13. Wind speed index of agreement for 2006 MM5 by month, state, and region in the 36km domain.

Central States Regional Air Partnership (CENRAP)																	
AR	0.72	0.69	0.68	0.70	0.66	0.66	0.71	0.68	0.71	0.66	0.71	0.69	0.70	0.70	0.71	0.70	0.69
IA	0.68	0.63	0.65	0.65	0.69	0.64	0.70	0.68	0.65	0.66	0.66	0.66	0.69	0.67	0.71	0.69	0.67
KS	0.75	0.74	0.74	0.74	0.73	0.73	0.72	0.73	0.75	0.74	0.71	0.73	0.73	0.69	0.78	0.73	0.73
LA	0.65	0.68	0.67	0.67	0.62	0.68	0.66	0.65	0.65	0.68	0.65	0.66	0.65	0.65	0.67	0.66	0.66
MN	0.64	0.67	0.67	0.66	0.66	0.67	0.68	0.67	0.69	0.70	0.68	0.69	0.70	0.70	0.65	0.68	0.68
MO	0.68	0.69	0.70	0.69	0.68	0.64	0.67	0.66	0.69	0.67	0.66	0.67	0.66	0.72	0.66	0.68	0.68
NE	0.77	0.78	0.76	0.77	0.78	0.78	0.75	0.77	0.73	0.73	0.72	0.73	0.76	0.72	0.80	0.76	0.76
OK	0.71	0.68	0.70	0.70	0.70	0.66	0.70	0.69	0.68	0.69	0.68	0.68	0.67	0.64	0.69	0.67	0.68
TX	0.77	0.76	0.77	0.77	0.75	0.77	0.77	0.76	0.75	0.73	0.78	0.75	0.74	0.75	0.78	0.76	0.76
CENRAP	0.85	0.83	0.83	0.84	0.82	0.82	0.85	0.83	0.86	0.85	0.84	0.85	0.88	0.85	0.83	0.85	0.84
Western Regional Air Partnership (WRAP)																	
AZ	0.74	0.75	0.72	0.74	0.65	0.72	0.75	0.71	0.71	0.69	0.73	0.71	0.72	0.71	0.75	0.73	0.72
CA	0.79	0.73	0.74	0.75	0.74	0.74	0.74	0.74	0.75	0.75	0.76	0.75	0.78	0.78	0.78	0.78	0.76
CO	0.72	0.79	0.79	0.77	0.78	0.76	0.77	0.77	0.78	0.75	0.76	0.76	0.76	0.72	0.74	0.74	0.76
ID	0.72	0.77	0.77	0.75	0.74	0.73	0.71	0.73	0.77	0.75	0.69	0.74	0.74	0.74	0.69	0.72	0.73
MT	0.68	0.78	0.78	0.75	0.76	0.78	0.77	0.77	0.76	0.76	0.78	0.77	0.73	0.73	0.74	0.73	0.75
ND	0.71	0.74	0.73	0.73	0.68	0.73	0.73	0.71	0.76	0.72	0.69	0.72	0.77	0.74	0.69	0.73	0.72
NM	0.73	0.77	0.77	0.76	0.78	0.80	0.79	0.79	0.79	0.77	0.77	0.78	0.78	0.77	0.75	0.77	0.77
NV	0.76	0.74	0.74	0.75	0.73	0.75	0.74	0.74	0.72	0.73	0.76	0.74	0.75	0.74	0.74	0.74	0.74
OR	0.72	0.72	0.73	0.72	0.76	0.72	0.75	0.74	0.76	0.77	0.76	0.76	0.74	0.73	0.72	0.73	0.74
SD	0.80	0.79	0.80	0.80	0.79	0.78	0.72	0.76	0.74	0.77	0.80	0.77	0.74	0.72	0.75	0.74	0.77
UT	0.72	0.68	0.72	0.71	0.71	0.73	0.72	0.72	0.72	0.72	0.75	0.73	0.74	0.74	0.71	0.73	0.72
WA	0.72	0.77	0.74	0.74	0.81	0.78	0.81	0.80	0.71	0.76	0.77	0.75	0.75	0.71	0.71	0.72	0.75
WY	0.65	0.76	0.78	0.73	0.76	0.76	0.74	0.75	0.68	0.69	0.73	0.70	0.67	0.66	0.73	0.69	0.72
WRAP	0.86	0.86	0.86	0.86	0.85	0.84	0.87	0.85	0.84	0.84	0.84	0.84	0.83	0.86	0.85	0.85	0.85
ALL	0.87	0.86	0.88	0.87	0.87	0.85	0.85	0.86	0.90	0.88	0.87	0.88	0.87	0.89	0.88	0.88	0.87

(a) ALL in this case refers to those states within the area covered by the 36km modeling domain.

Table 3-14. Wind speed index of agreement for 2006 MM5 by month and state in the 12km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
CO	0.75	0.80	0.80	0.78	0.81	0.77	0.79	0.79	0.78	0.80	0.78	0.79	0.79	0.76	0.77	0.77	0.78
UT	0.75	0.70	0.74	0.73	0.72	0.76	0.74	0.74	0.74	0.72	0.77	0.74	0.76	0.76	0.73	0.75	0.74
WY	0.81	0.79	0.80	0.80	0.79	0.81	0.78	0.79	0.80	0.78	0.81	0.80	0.79	0.80	0.79	0.79	0.80
ALL	0.83	0.85	0.85	0.84	0.86	0.85	0.84	0.85	0.83	0.83	0.82	0.83	0.83	0.83	0.80	0.82	0.84

(a) ALL in this case refers to those states within the area covered by the 12km modeling domain.

Table 3-15. Wind speed index of agreement for 2006 MM5 by month in the 4km domain.

Region	Dec	Jan	Feb	Win	Mar	Apr	May	Spr	Jun	Jul	Aug	Sum	Sep	Oct	Nov	Aut	Mean
ALL	0.76	0.80	0.81	0.79	0.81	0.81	0.81	0.81	0.81	0.77	0.78	0.79	0.80	0.79	0.81	0.80	0.80

Figure 3-1. Regional Planning Organization (RPO) Boundaries.

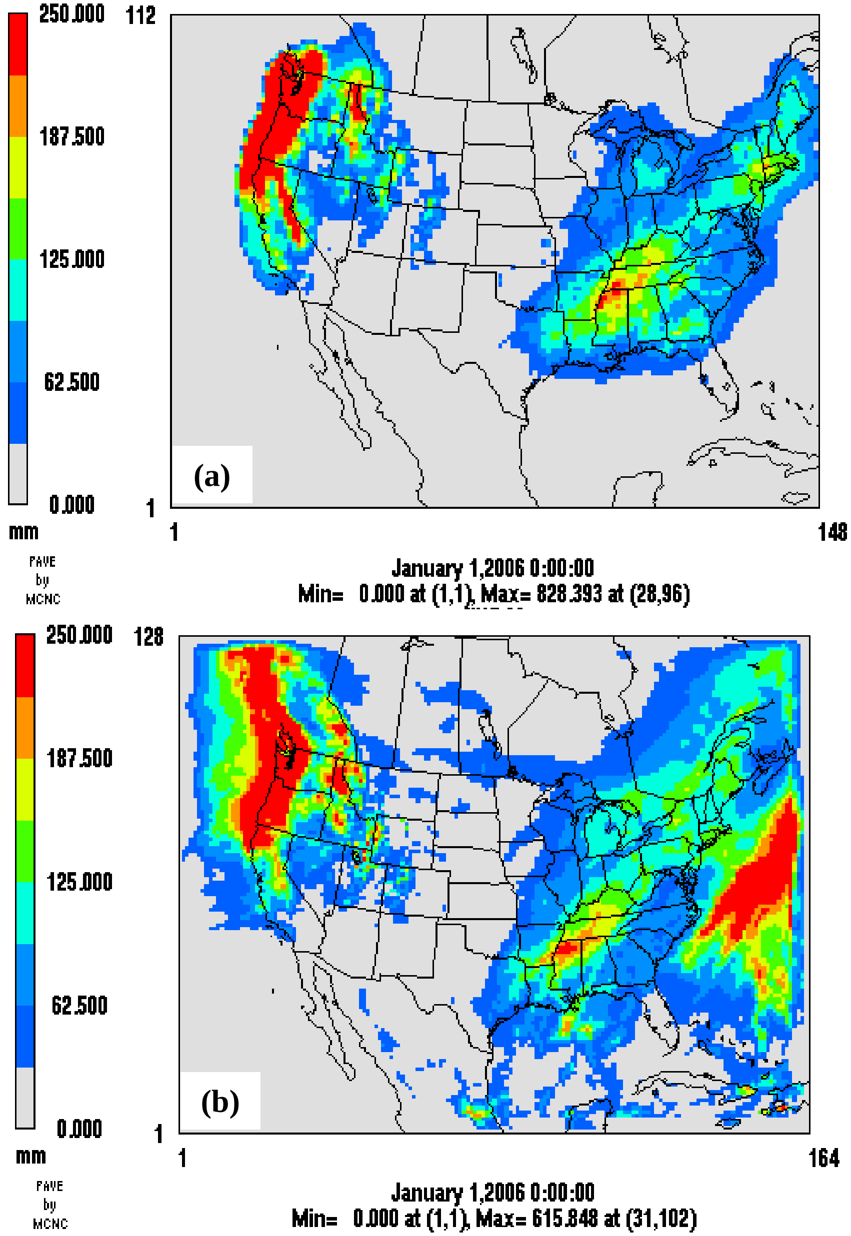

Figure 3-2. Precipitation for January 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

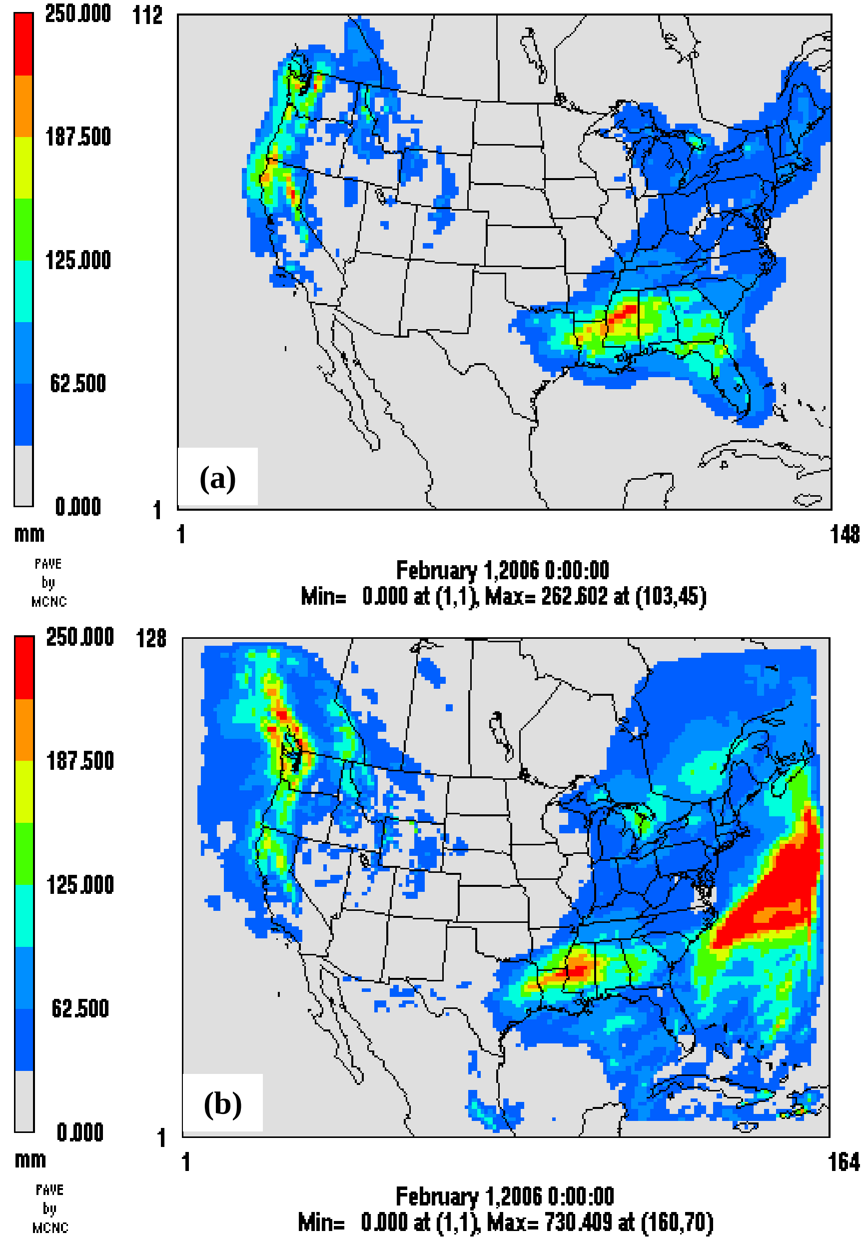

Figure 3-3. Precipitation for February 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

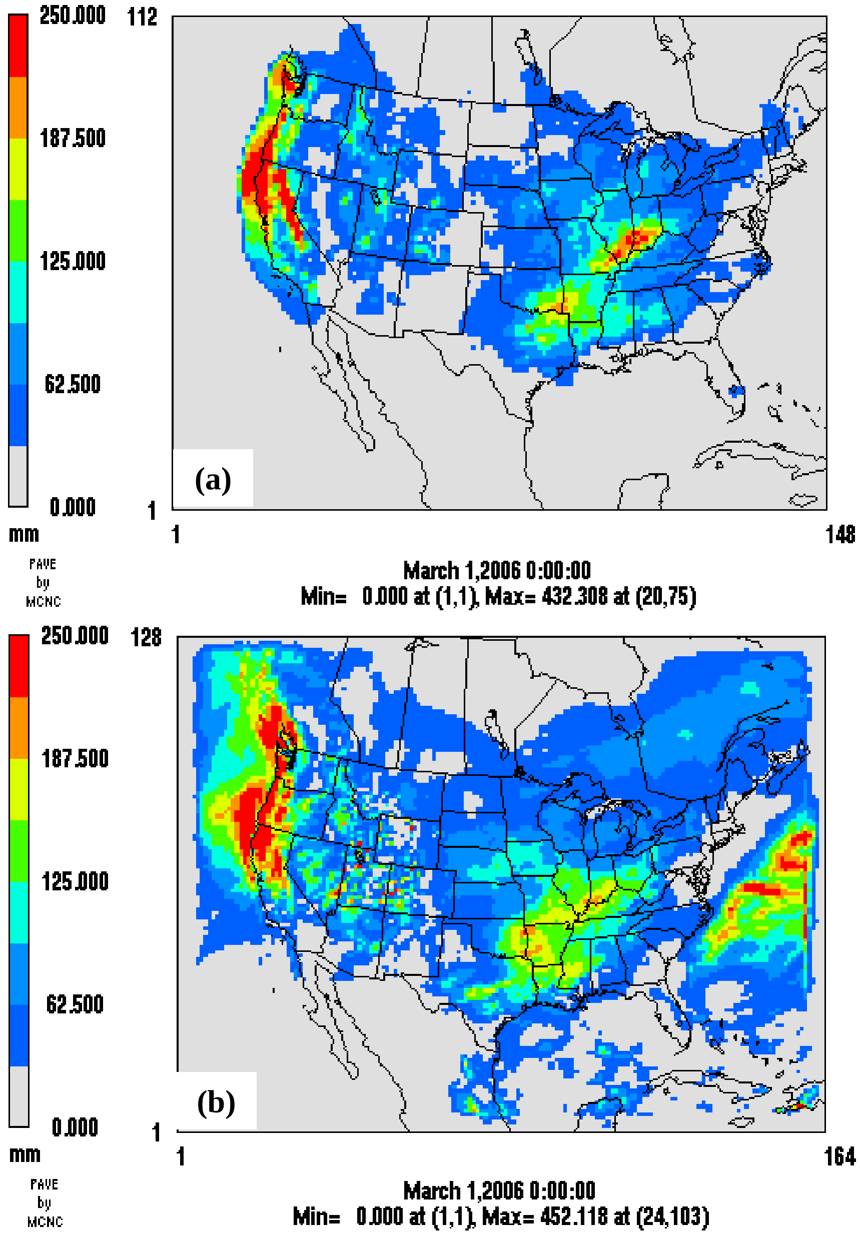

Figure 3-4. Precipitation for March 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

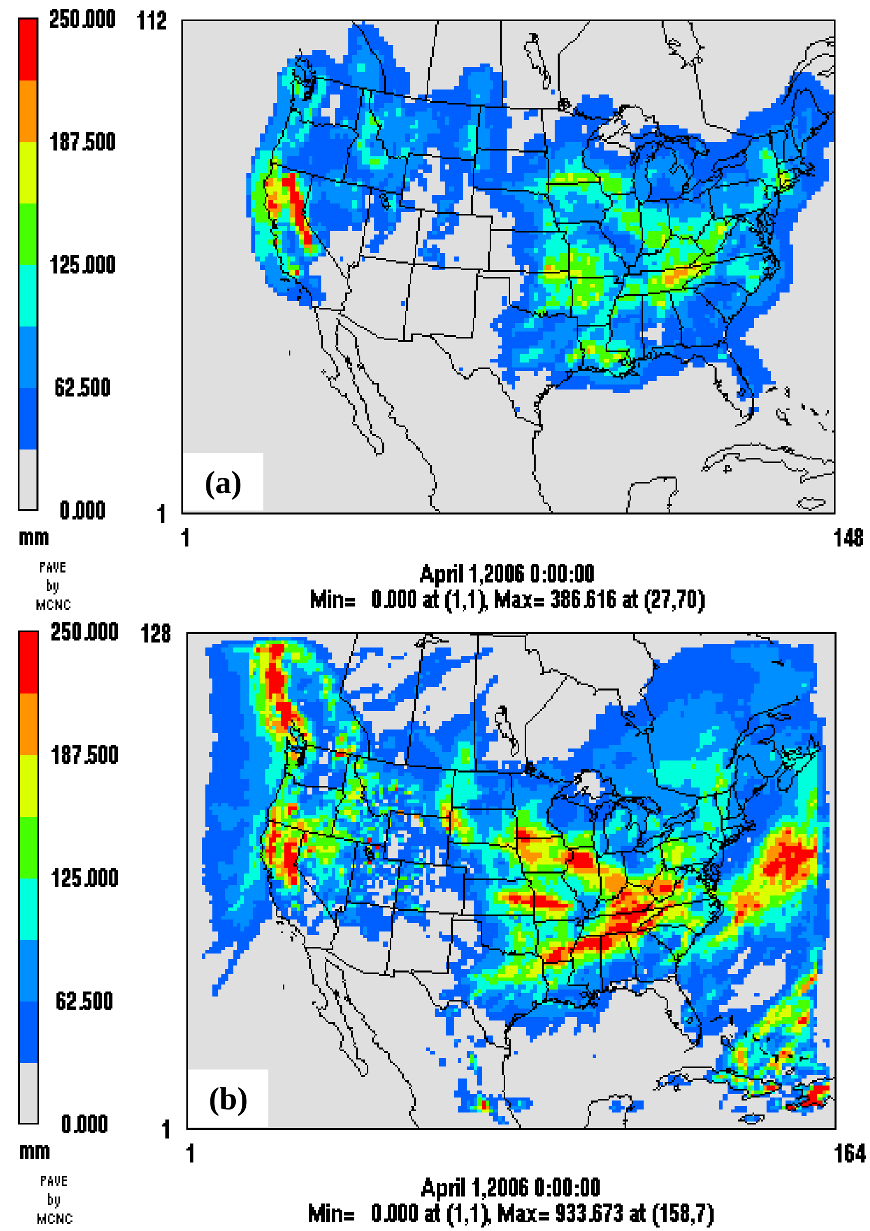

Figure 3-5. Precipitation for April 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

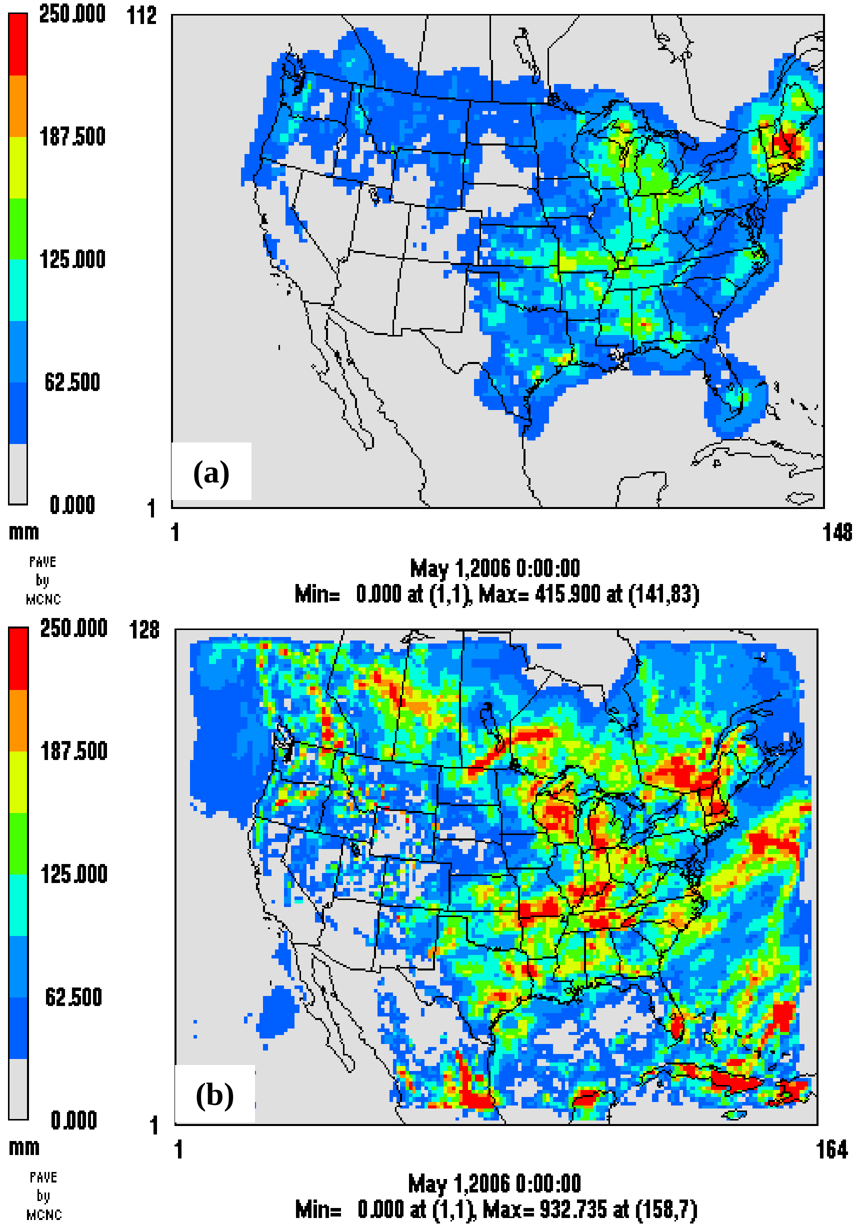

Figure 3-6. Precipitation for May 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

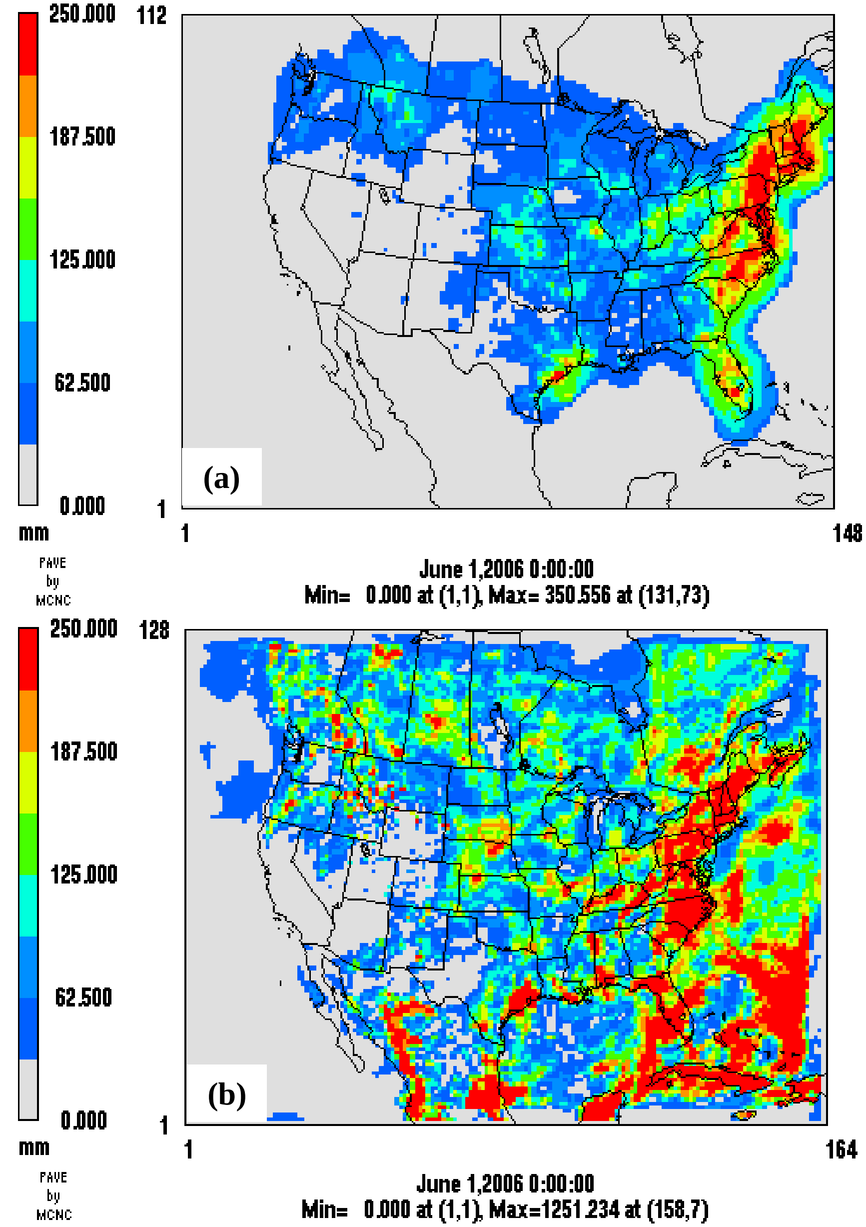

Figure 3-7. Precipitation for June 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

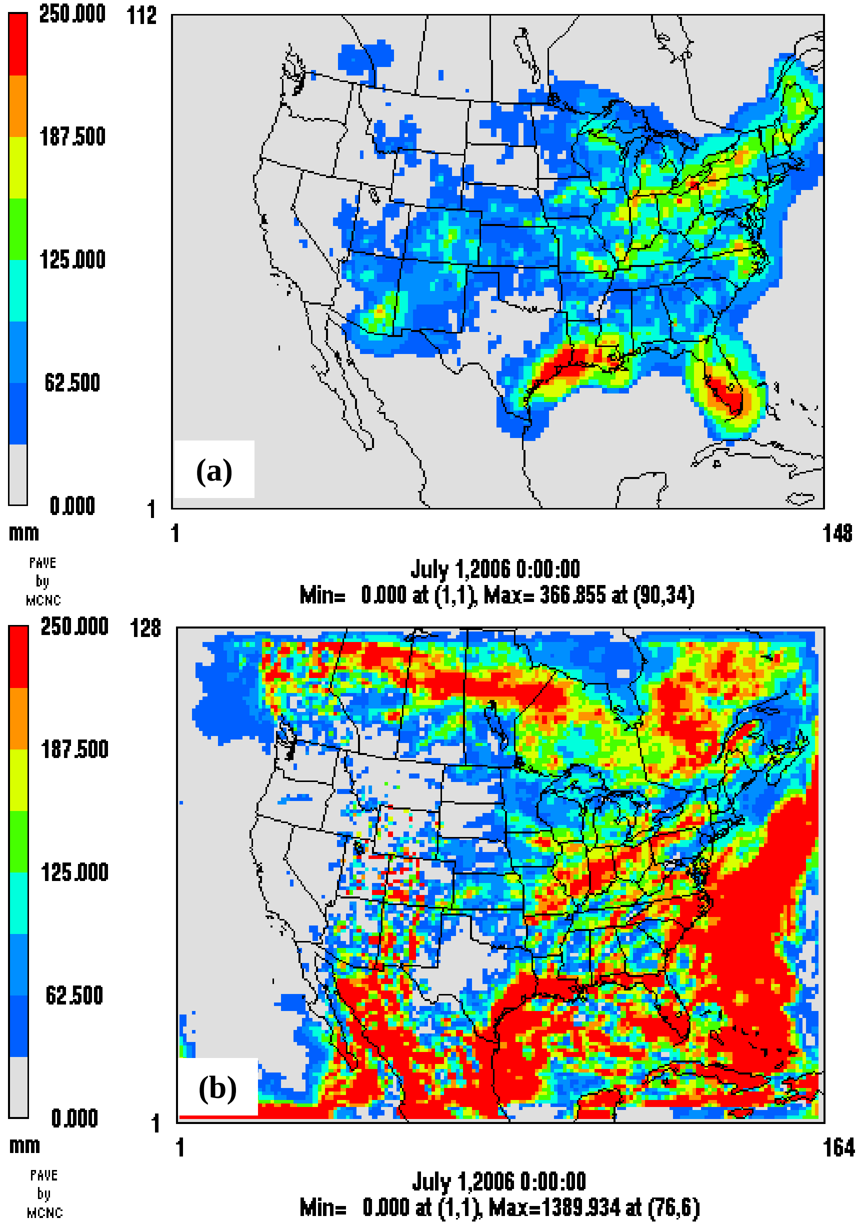

Figure 3-8. Precipitation for July 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

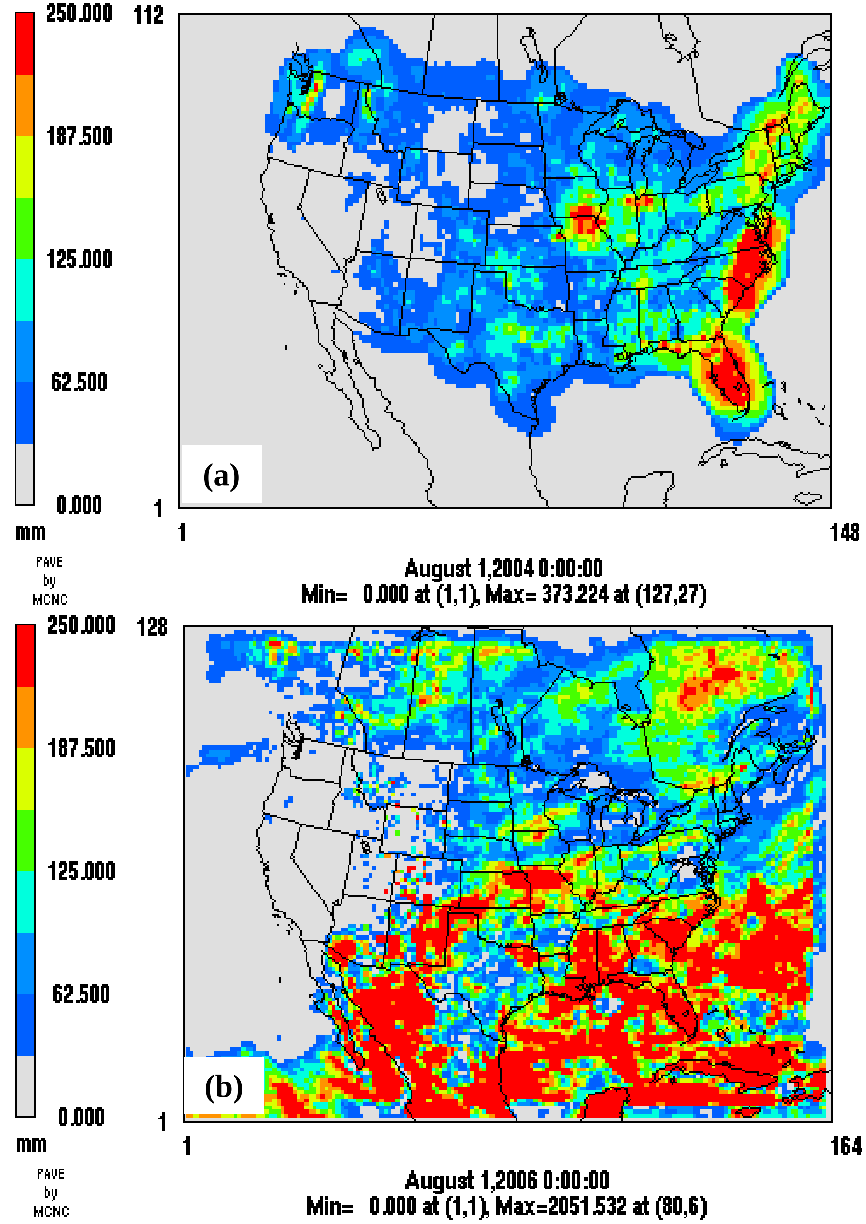

Figure 3-9. Precipitation for August 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

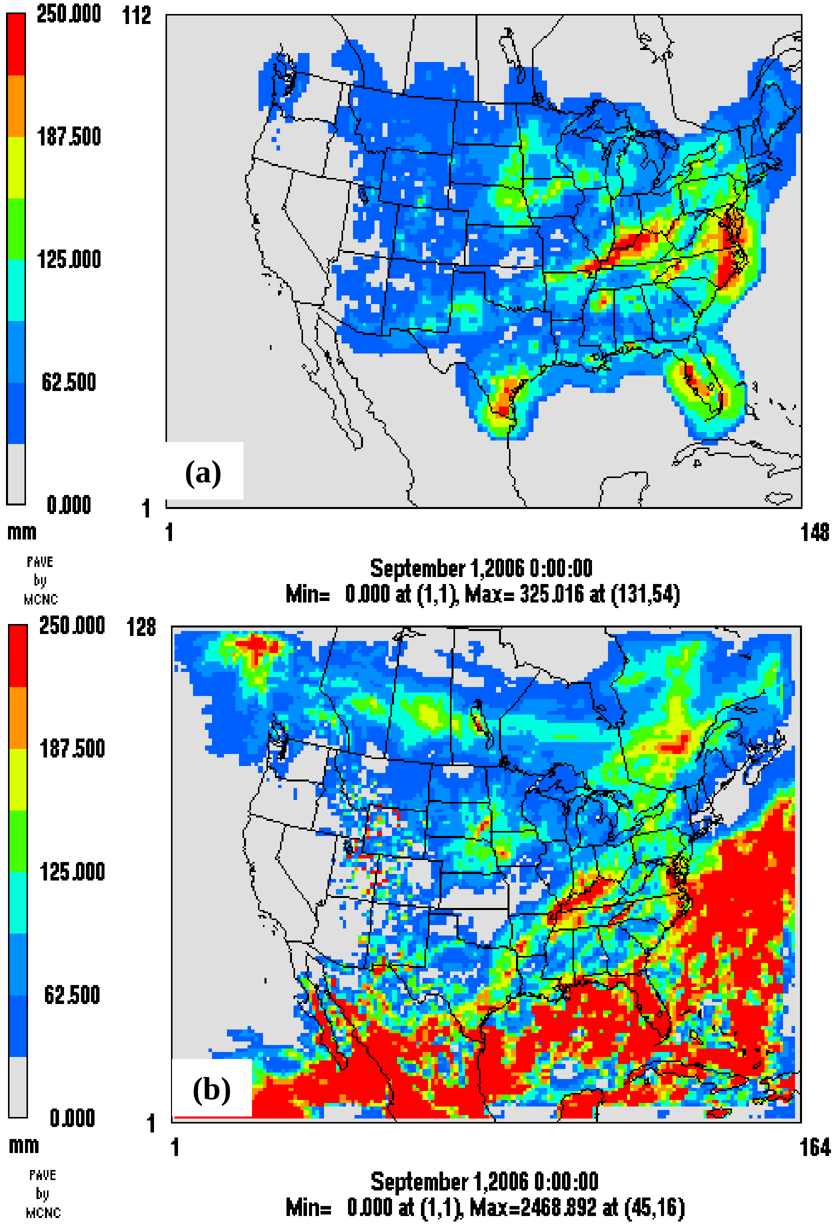

Figure 3-10. Precipitation for September 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

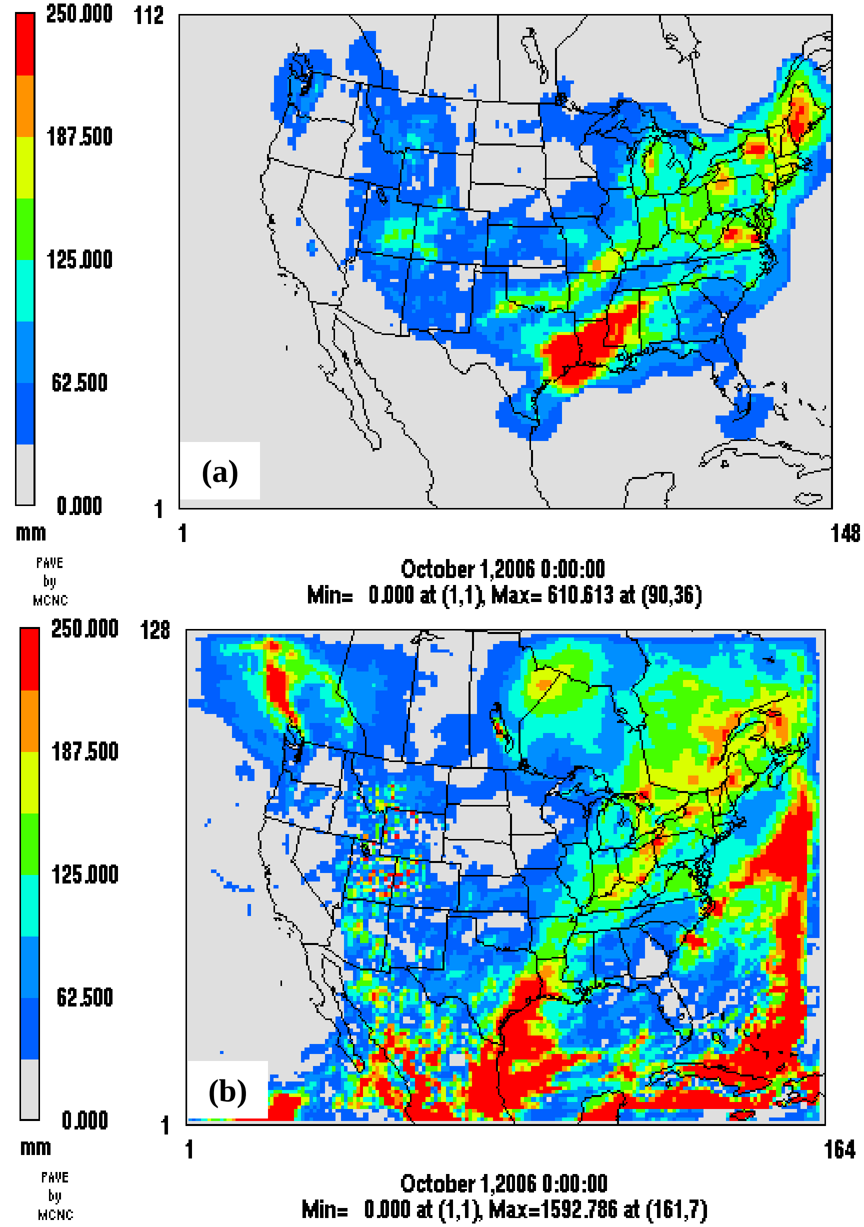

Figure 3-11. Precipitation for October 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

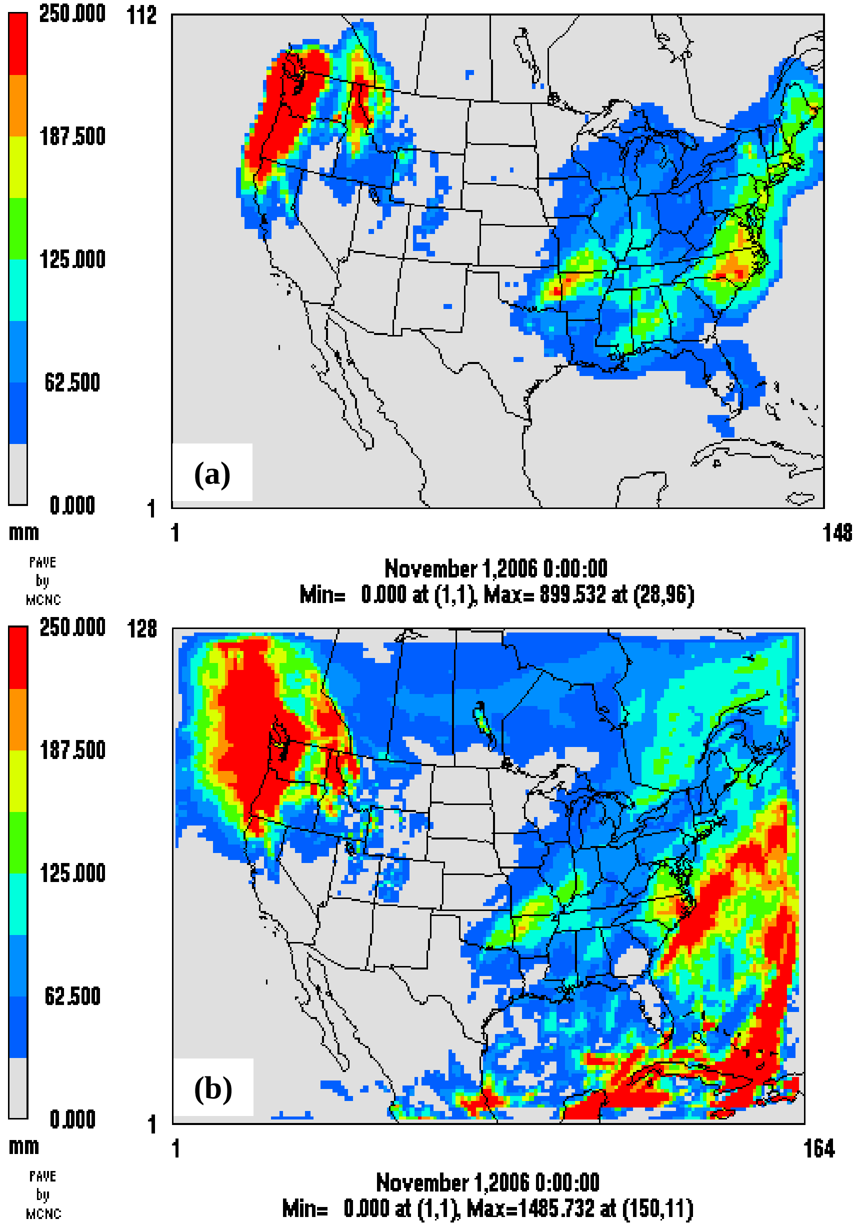

Figure 3-12. Precipitation for November 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

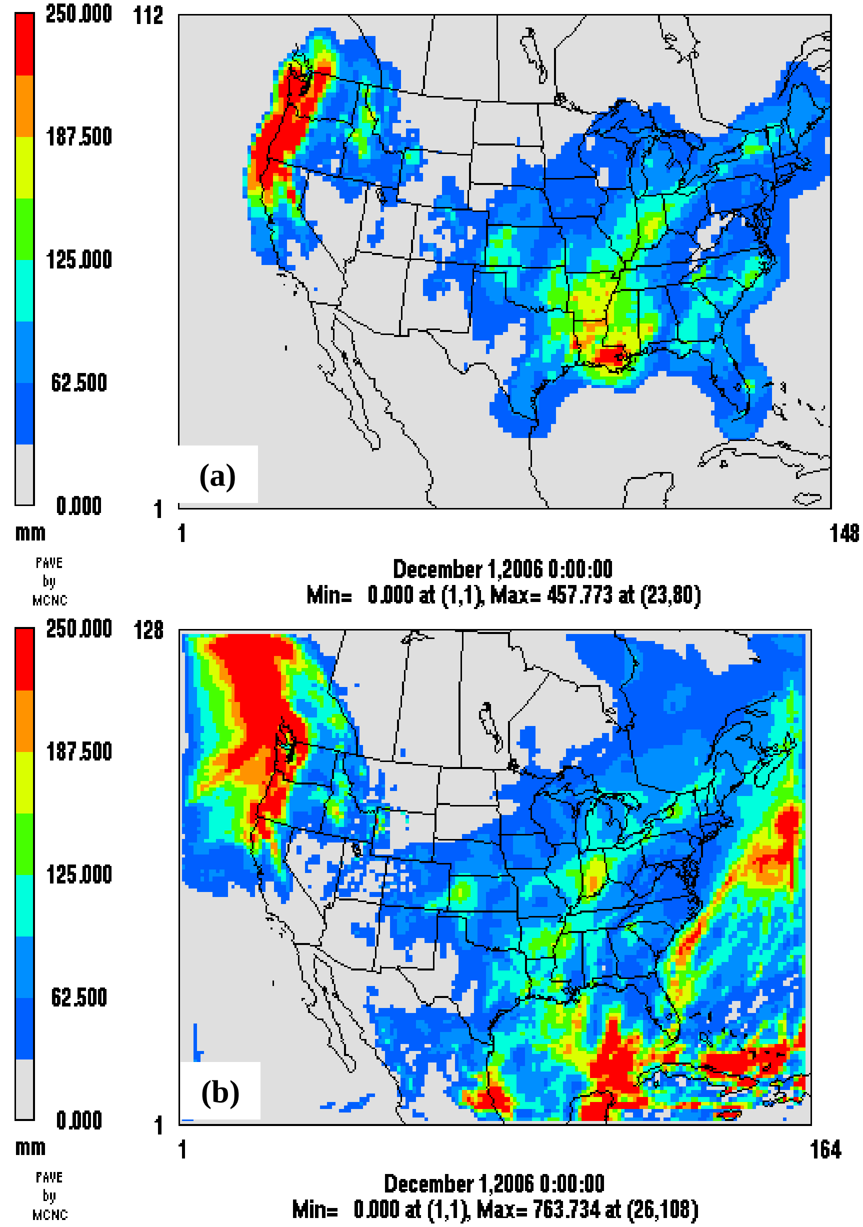

Figure 3-13. Precipitation for December 2006 over the 36km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

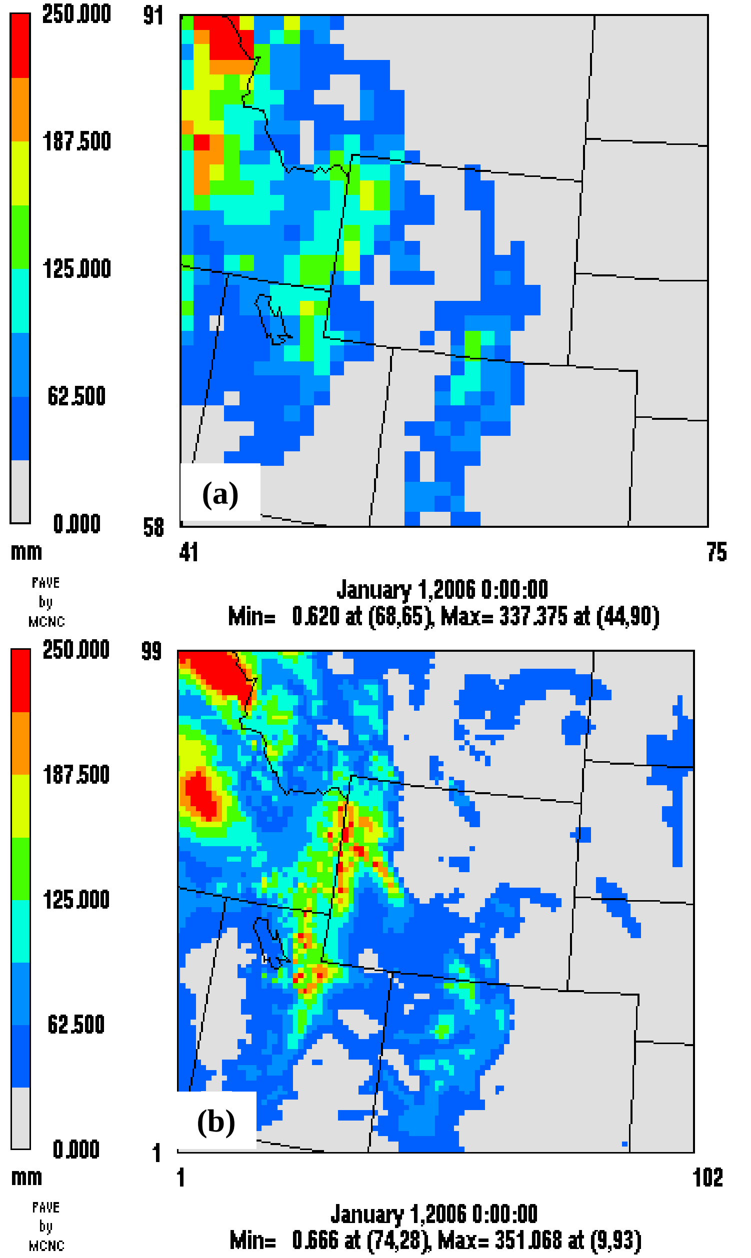

Figure 3-14. Precipitation for January 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

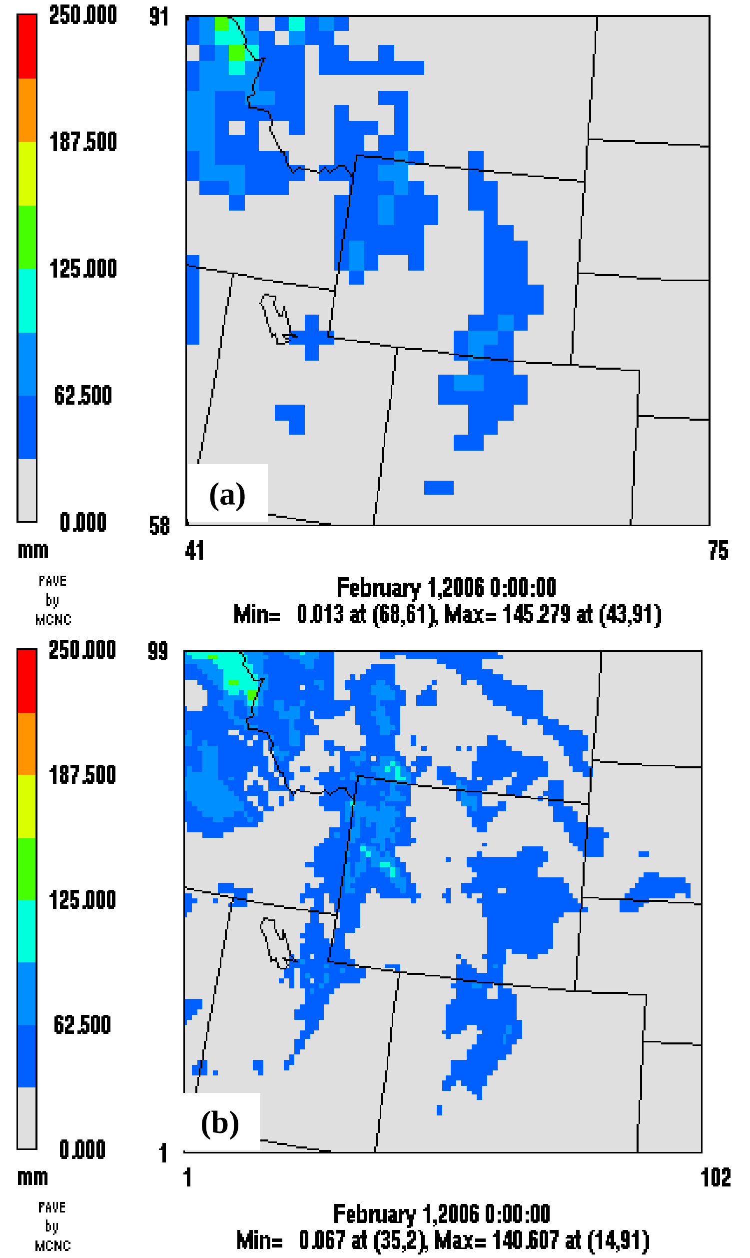

Figure 3-15. Precipitation for February 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

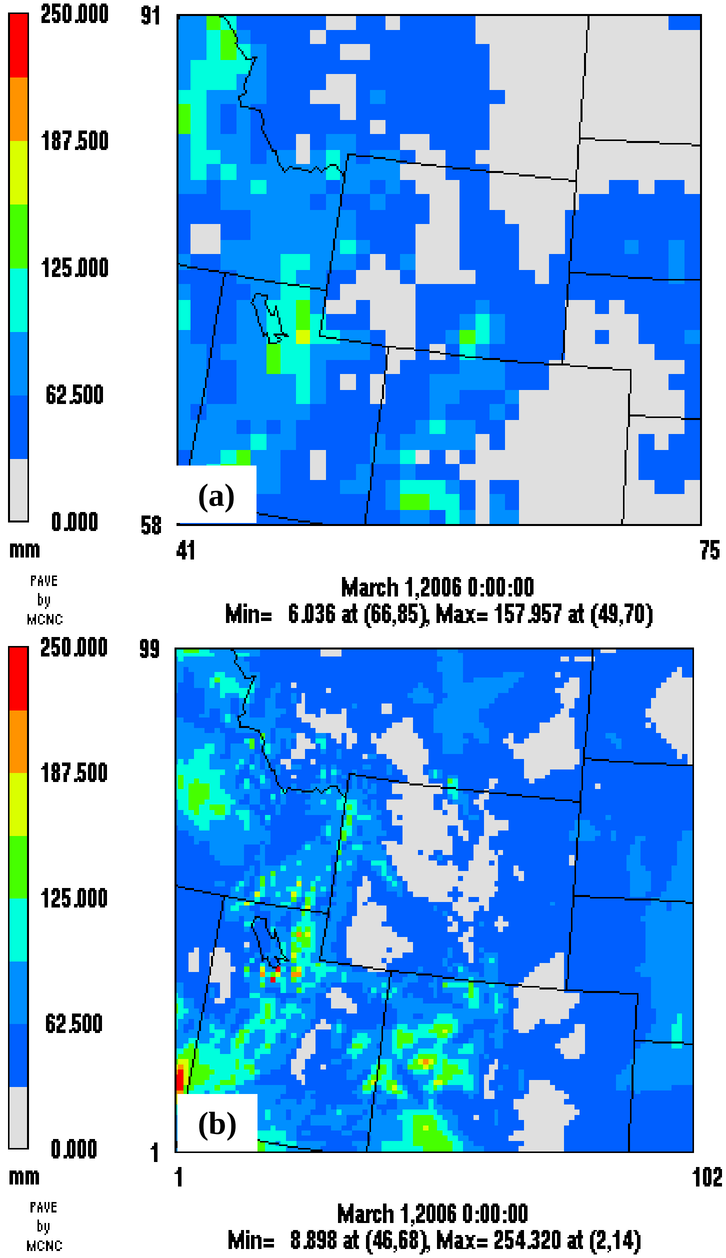

Figure 3-16. Precipitation for March 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

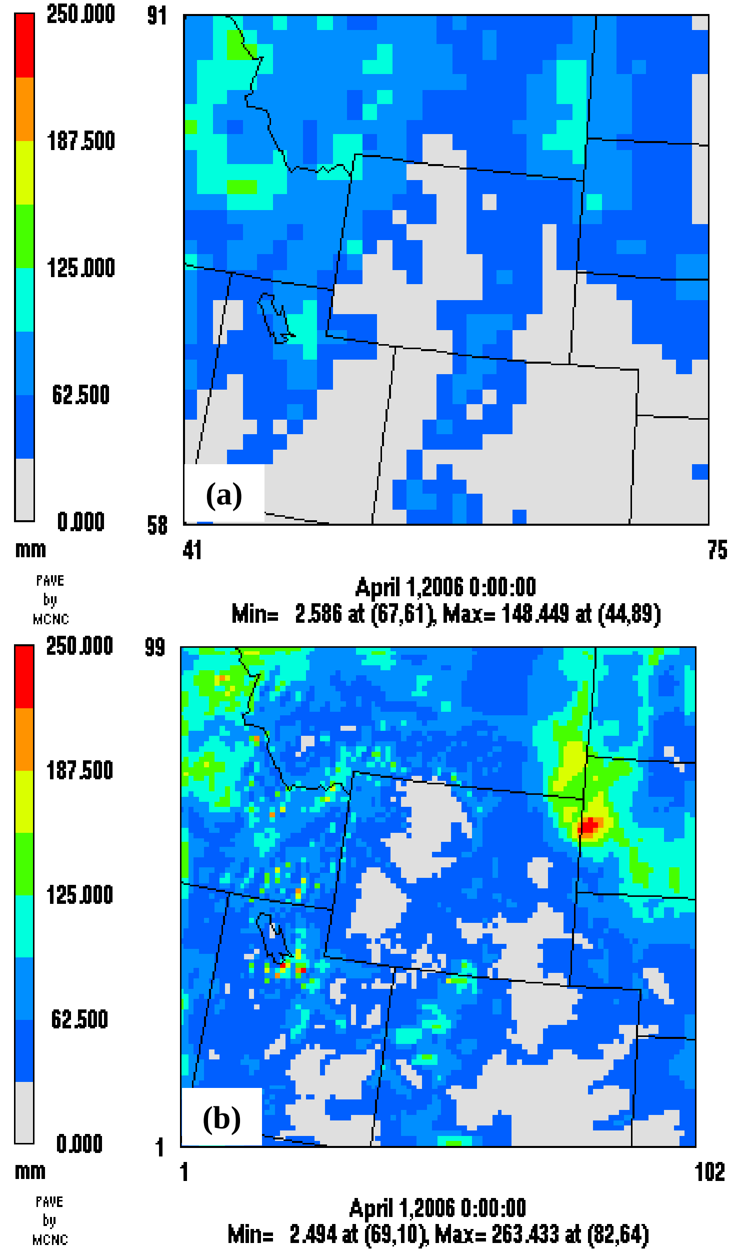

Figure 3-17. Precipitation for April 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

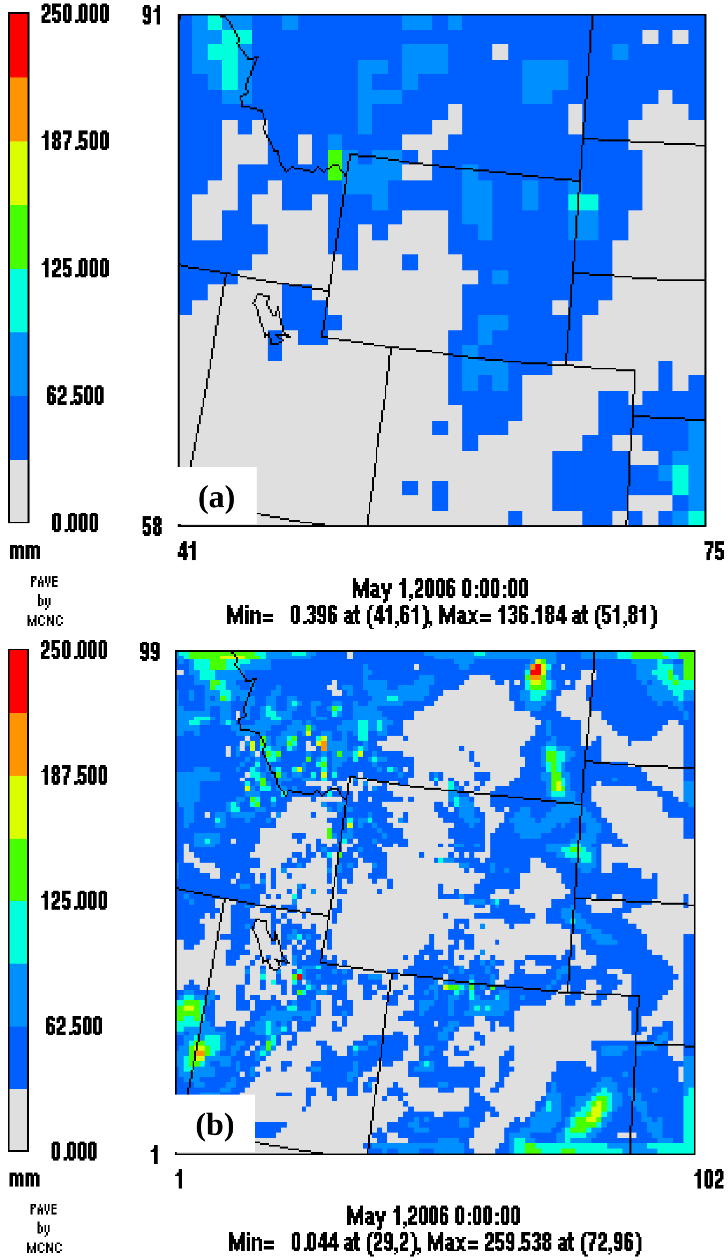

Figure 3-18. Precipitation for May 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

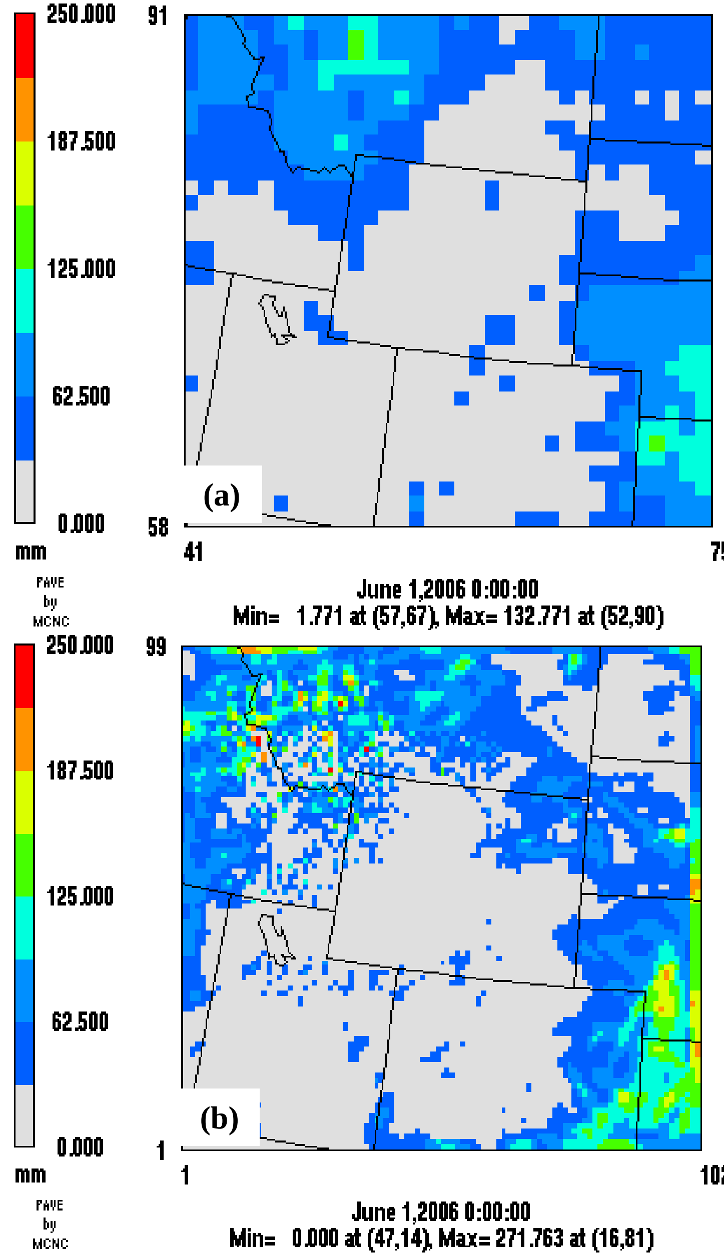

Figure 3-19. Precipitation for June 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

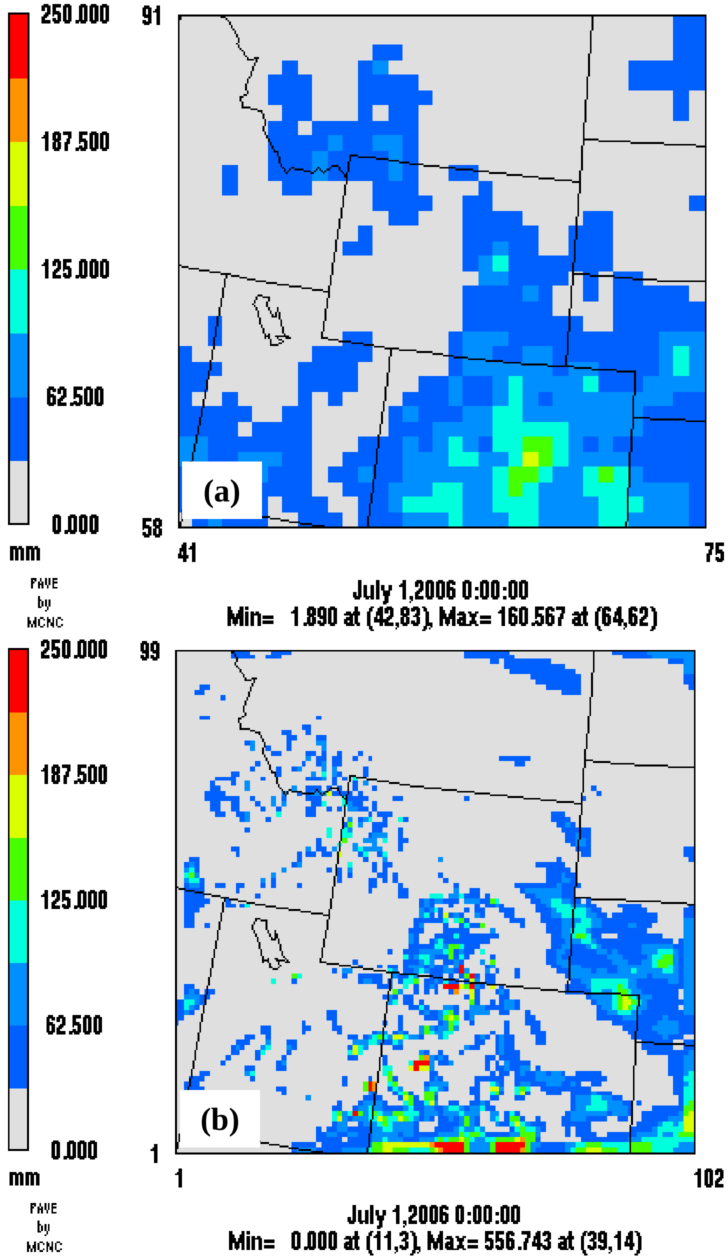

Figure 3-20. Precipitation for July 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

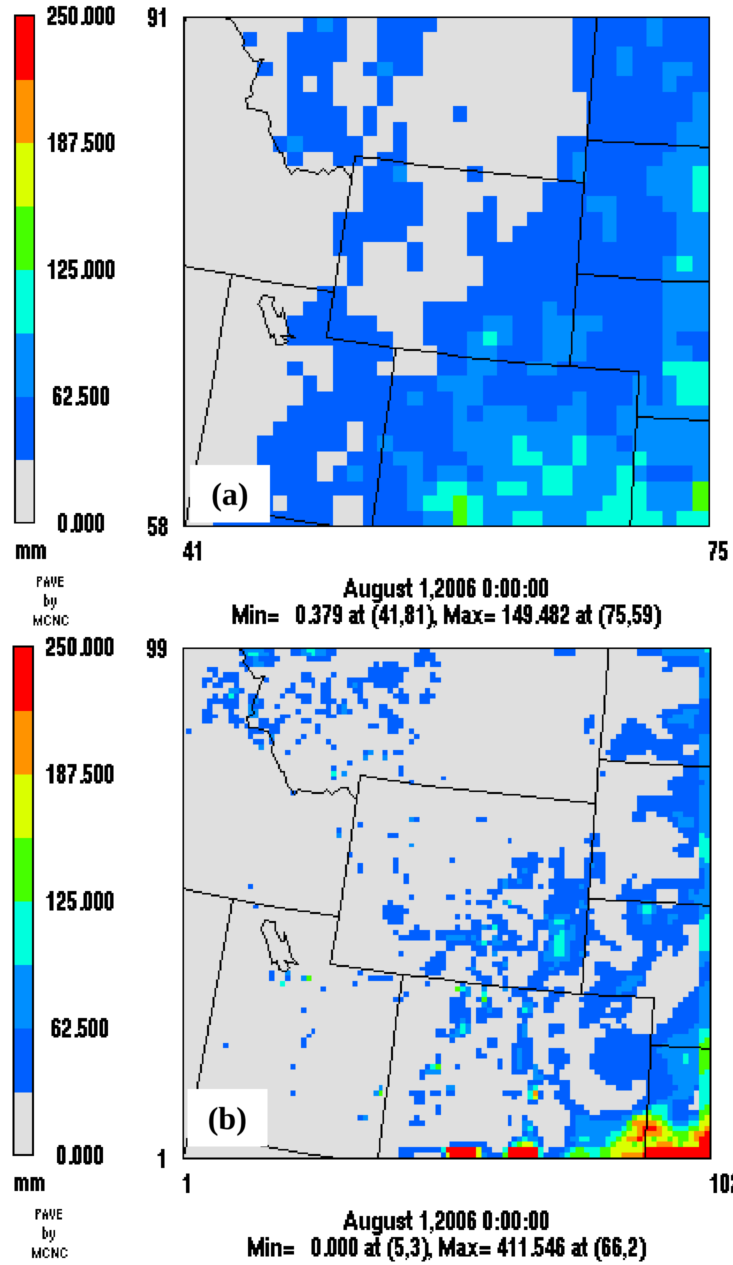

Figure 3-21. Precipitation for August 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

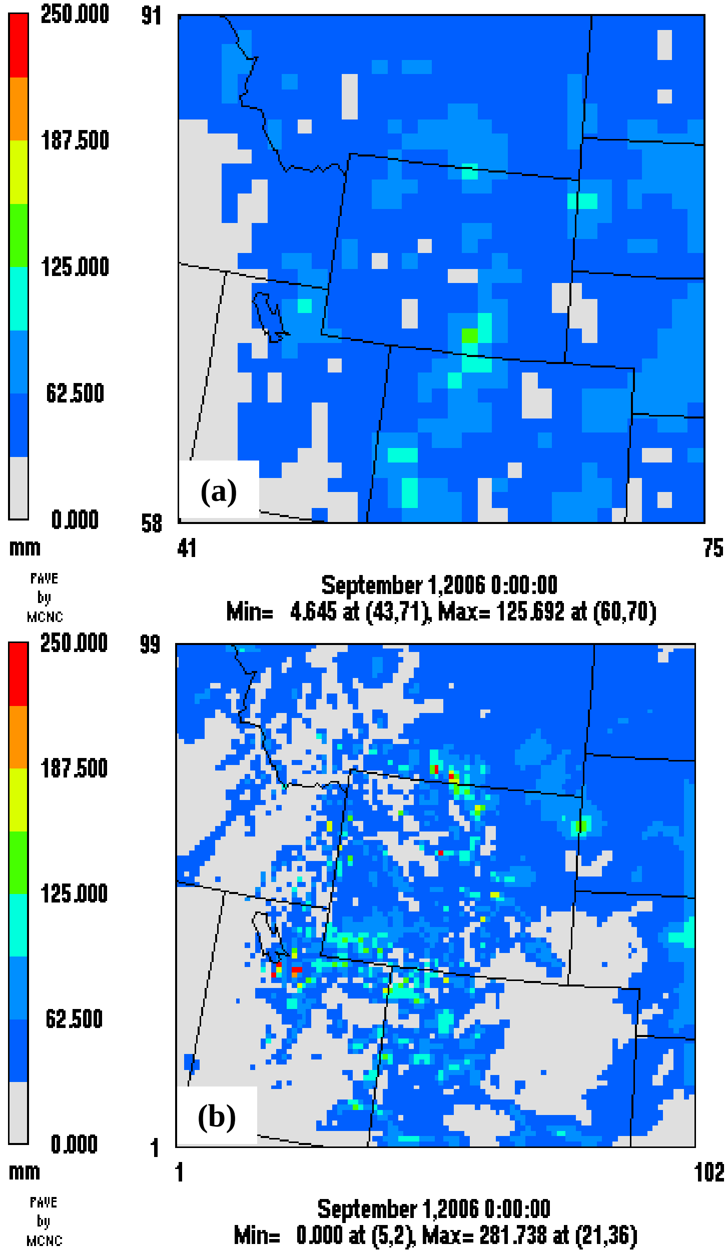

Figure 3-22. Precipitation for September 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

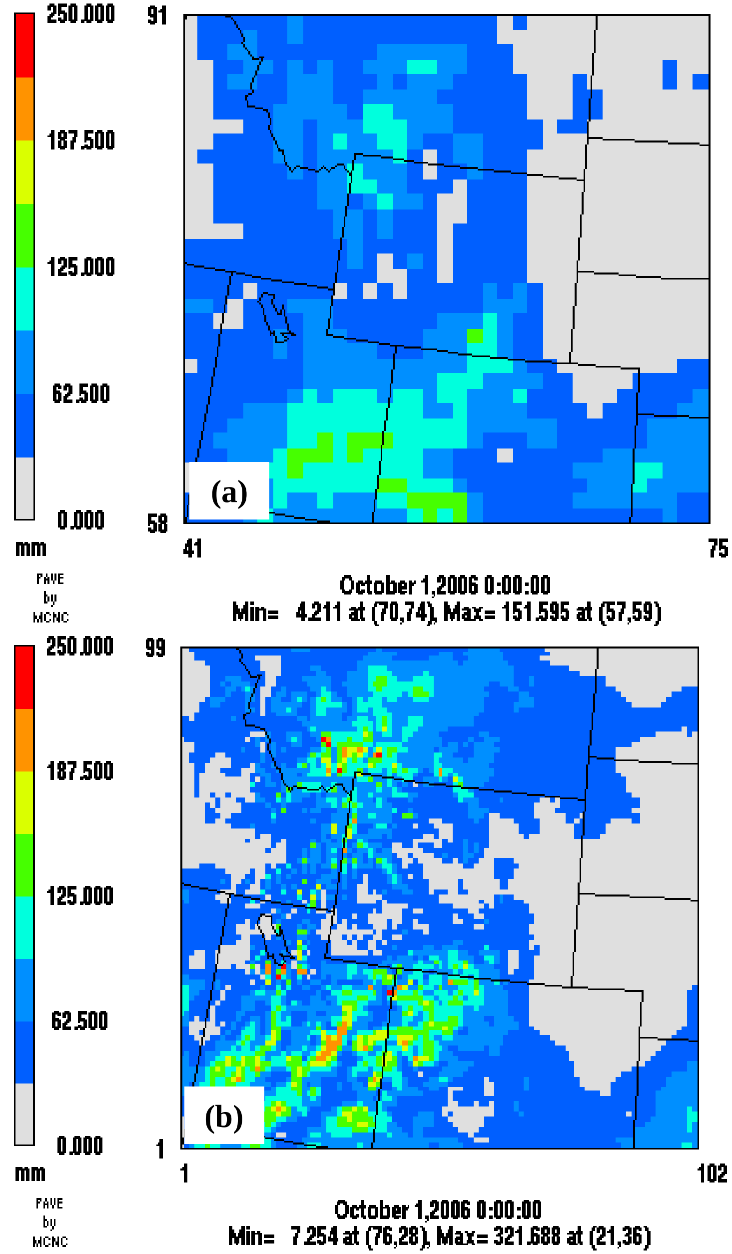

Figure 3-23. Precipitation for October 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

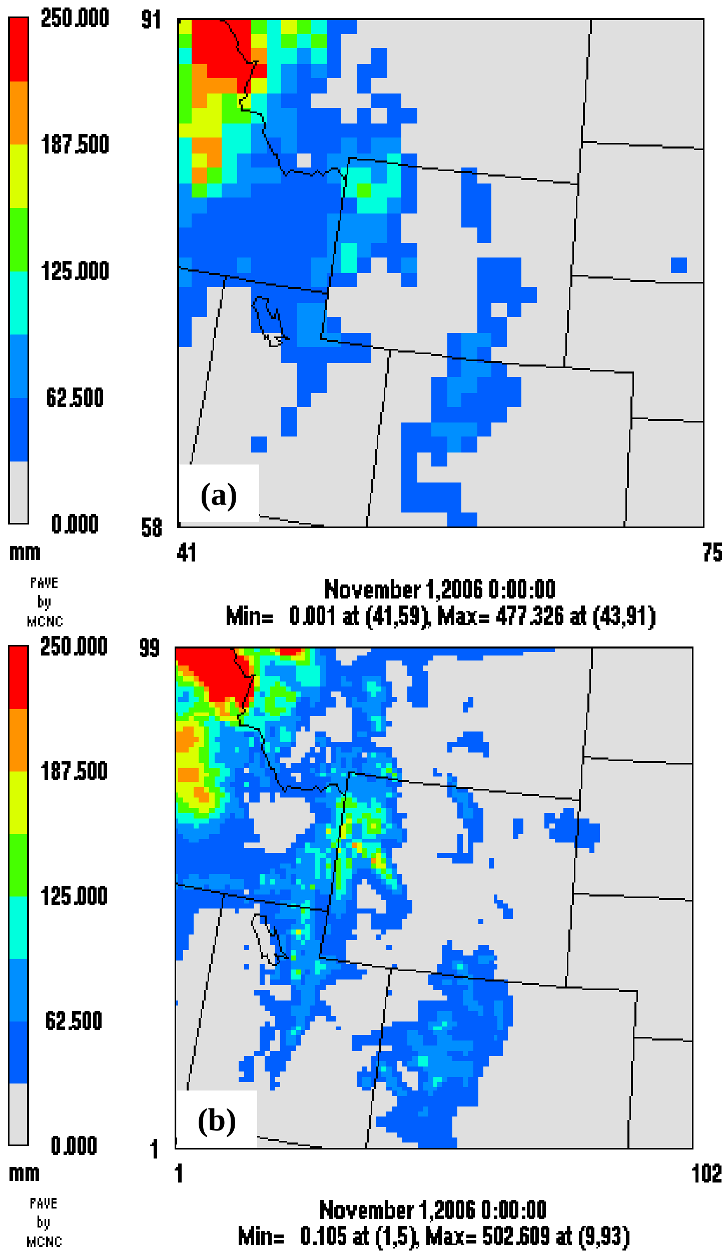

Figure 3-24. Precipitation for November 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

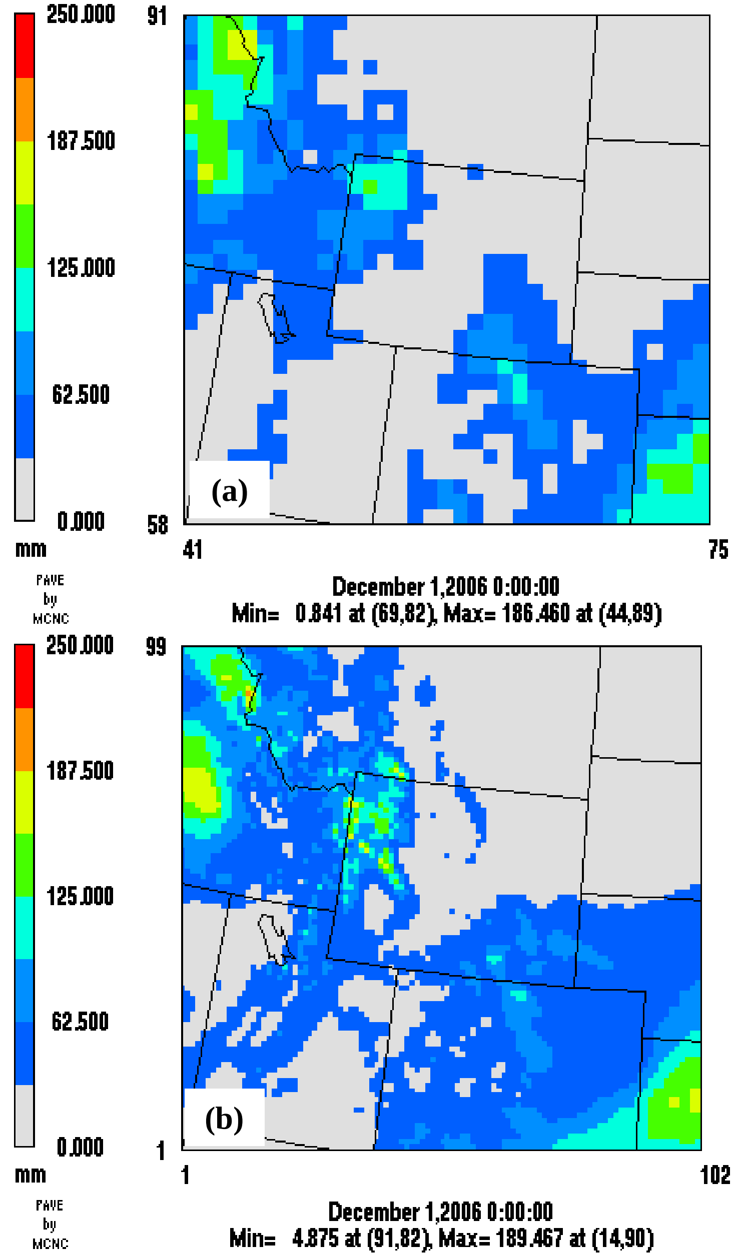

Figure 3-25. Precipitation for December 2006 over the 12km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

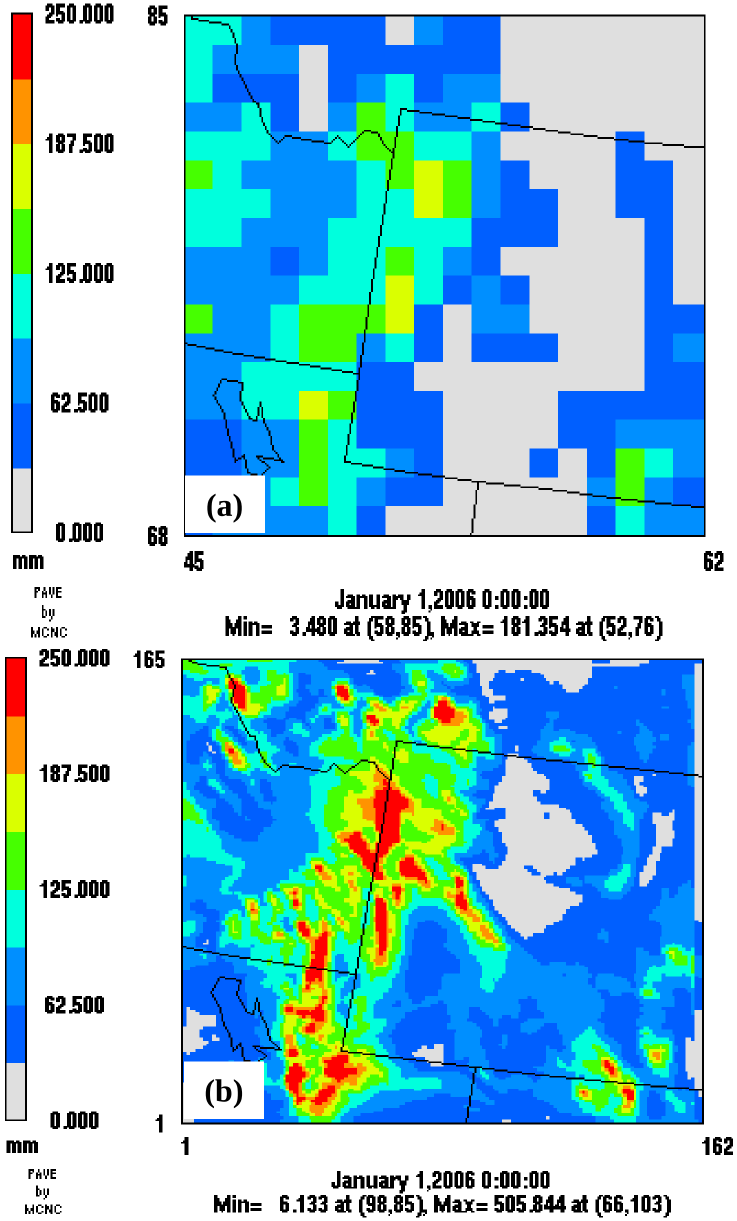

Figure 3-26. Precipitation for January 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

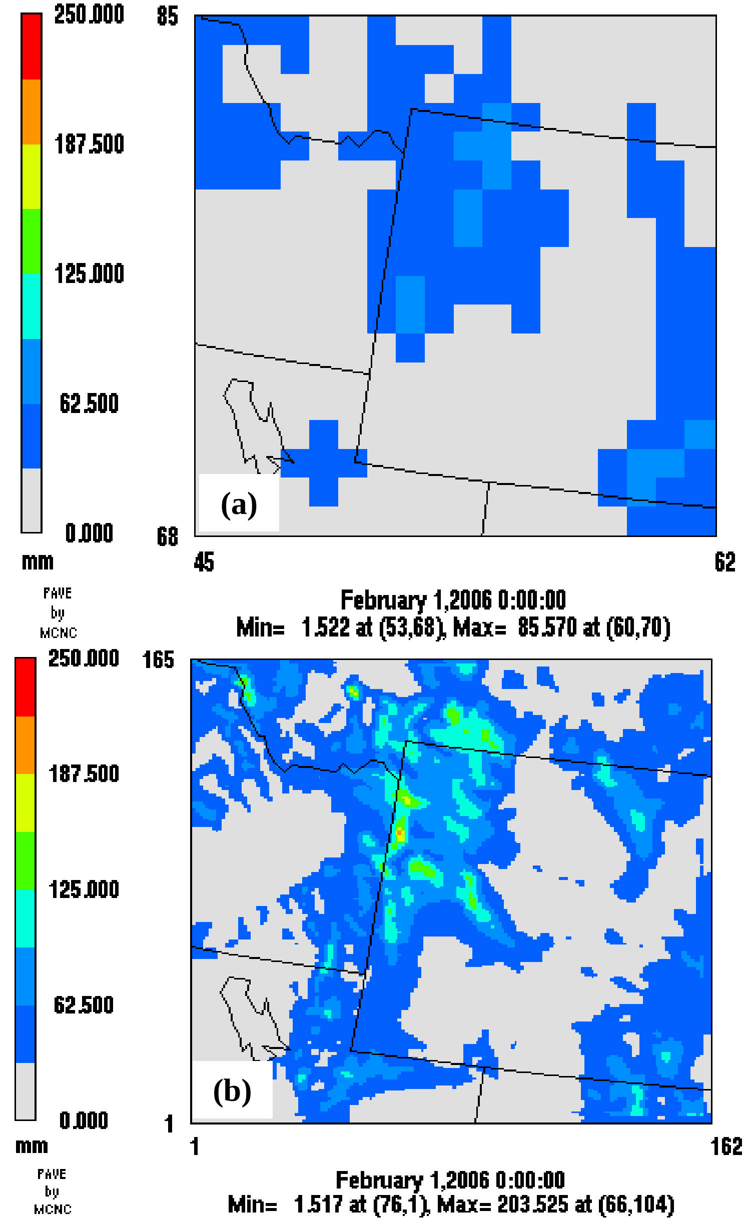

Figure 3-27. Precipitation for February 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

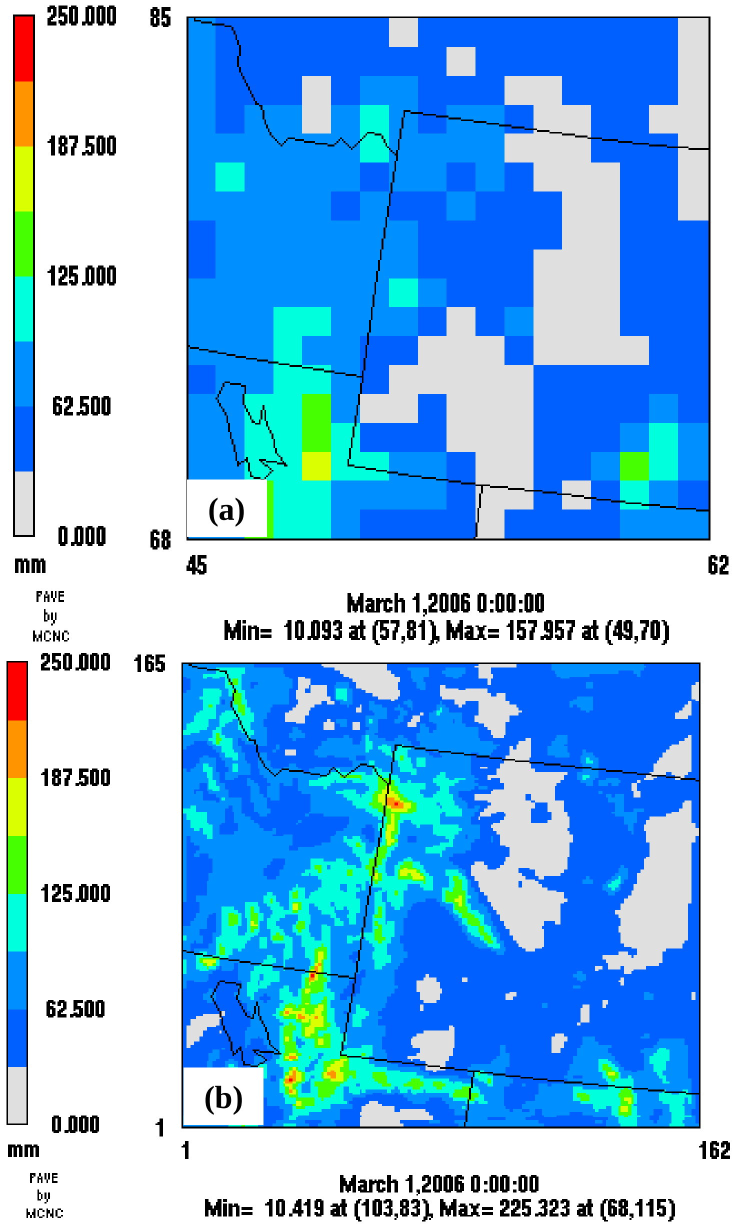

Figure 3-28. Precipitation for March 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

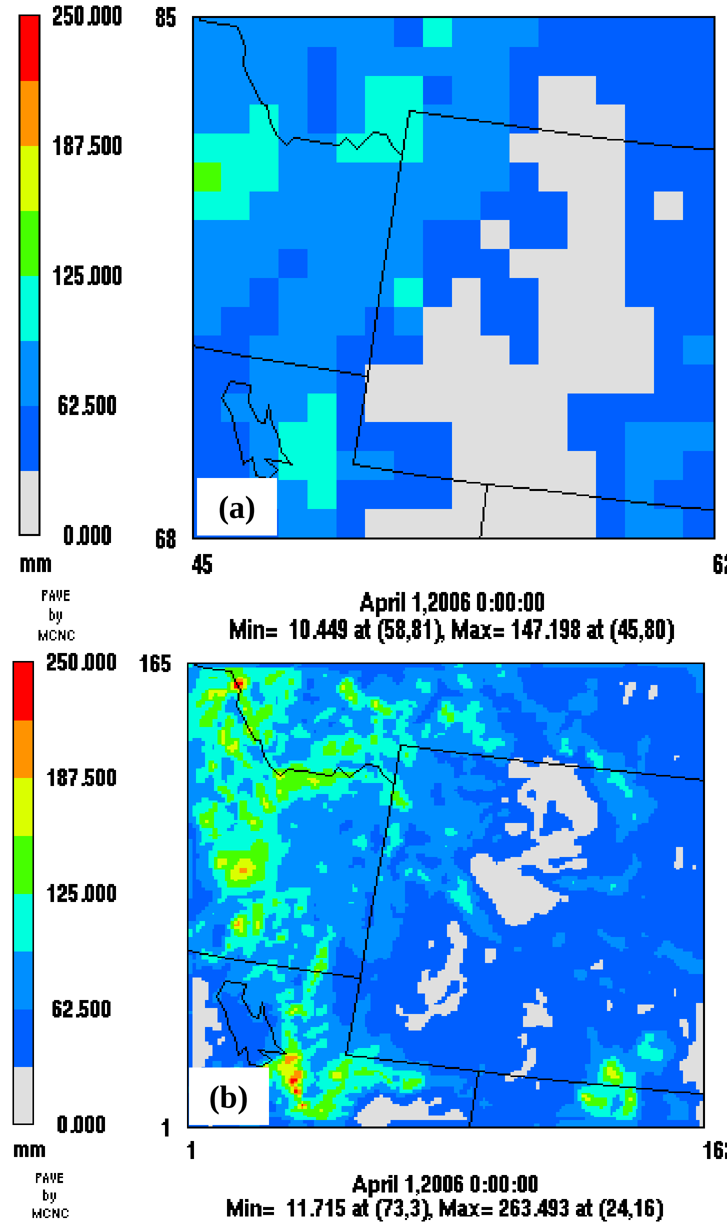

Figure 3-29. Precipitation for April 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

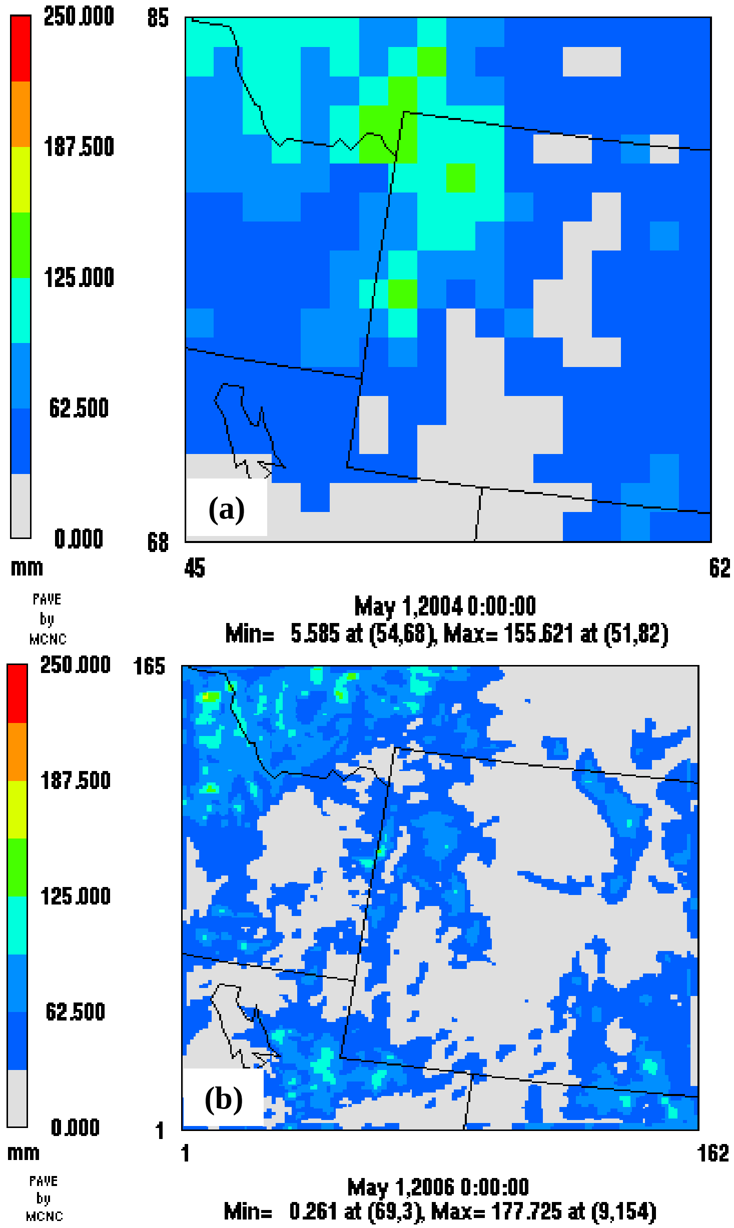

Figure 3-30. Precipitation for May 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

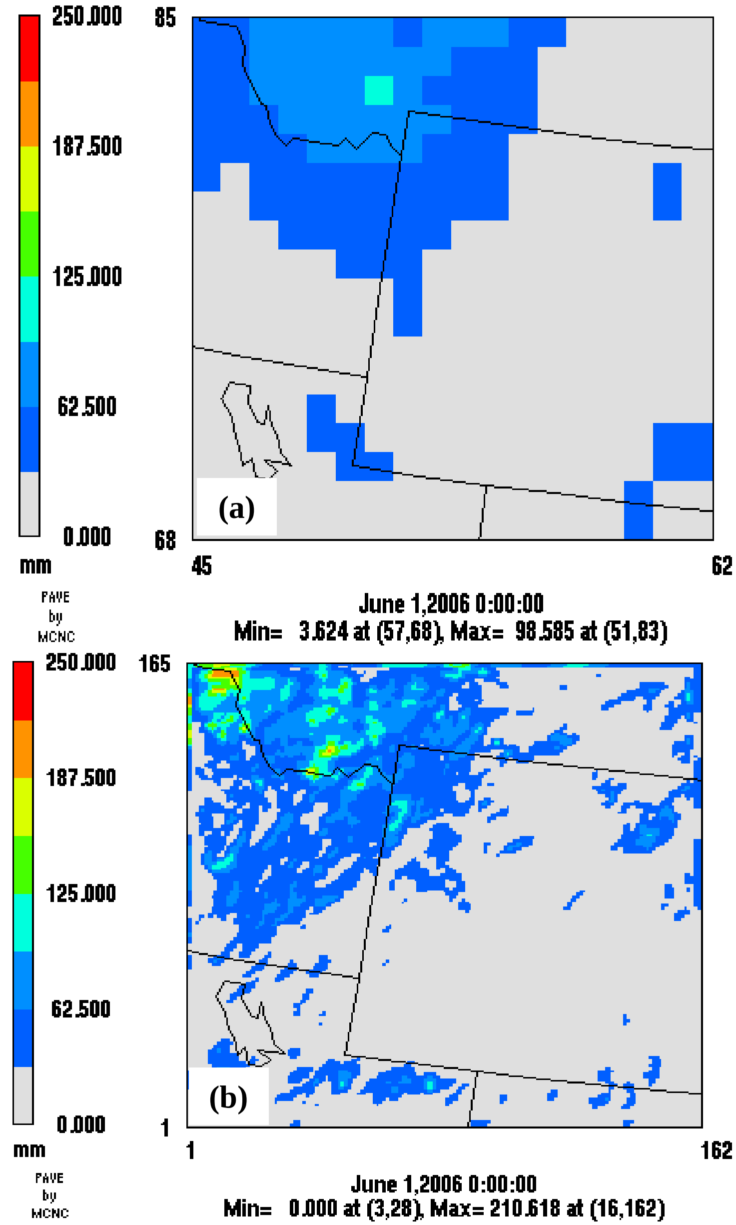

Figure 3-31. Precipitation for June 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

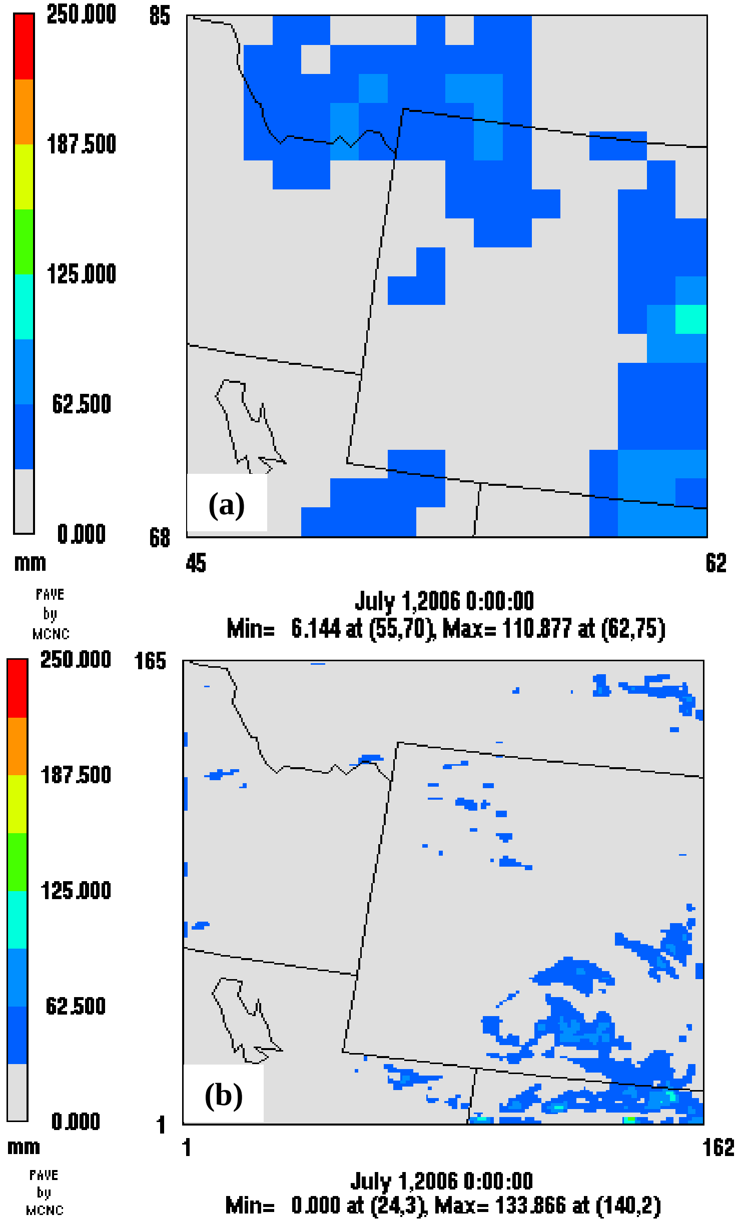

Figure 3-32. Precipitation for July 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

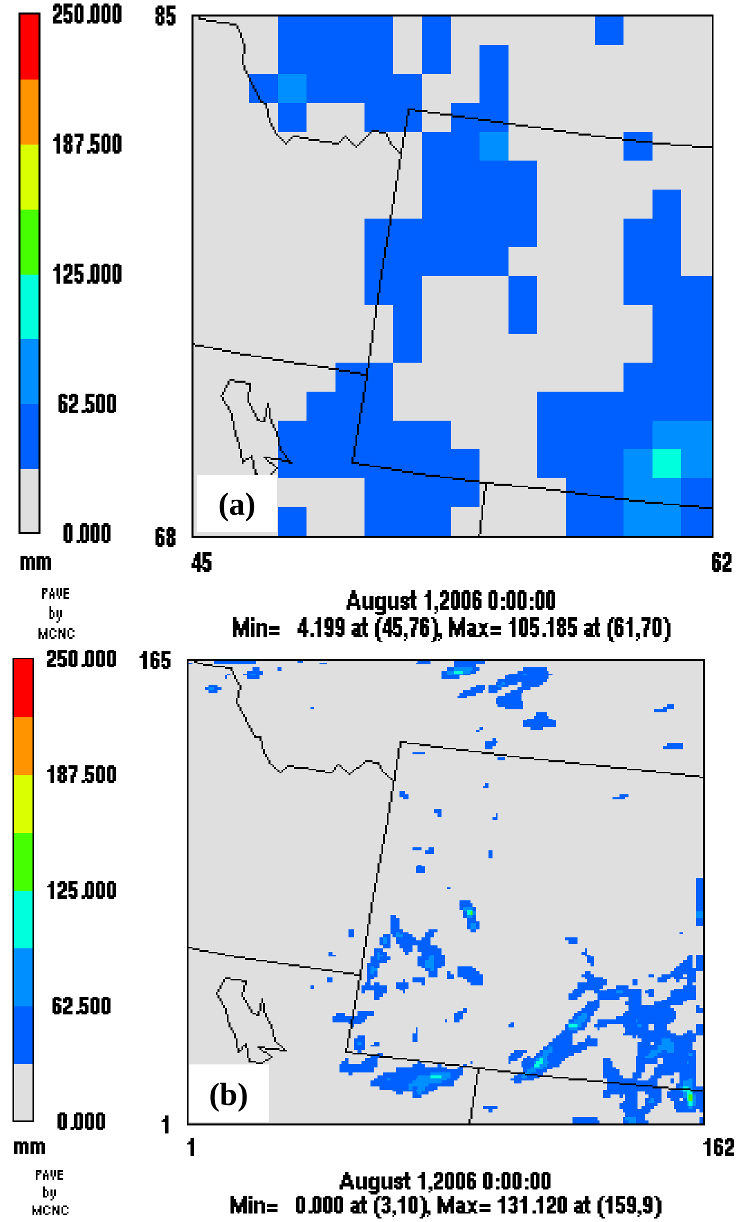

Figure 3-33. Precipitation for August 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

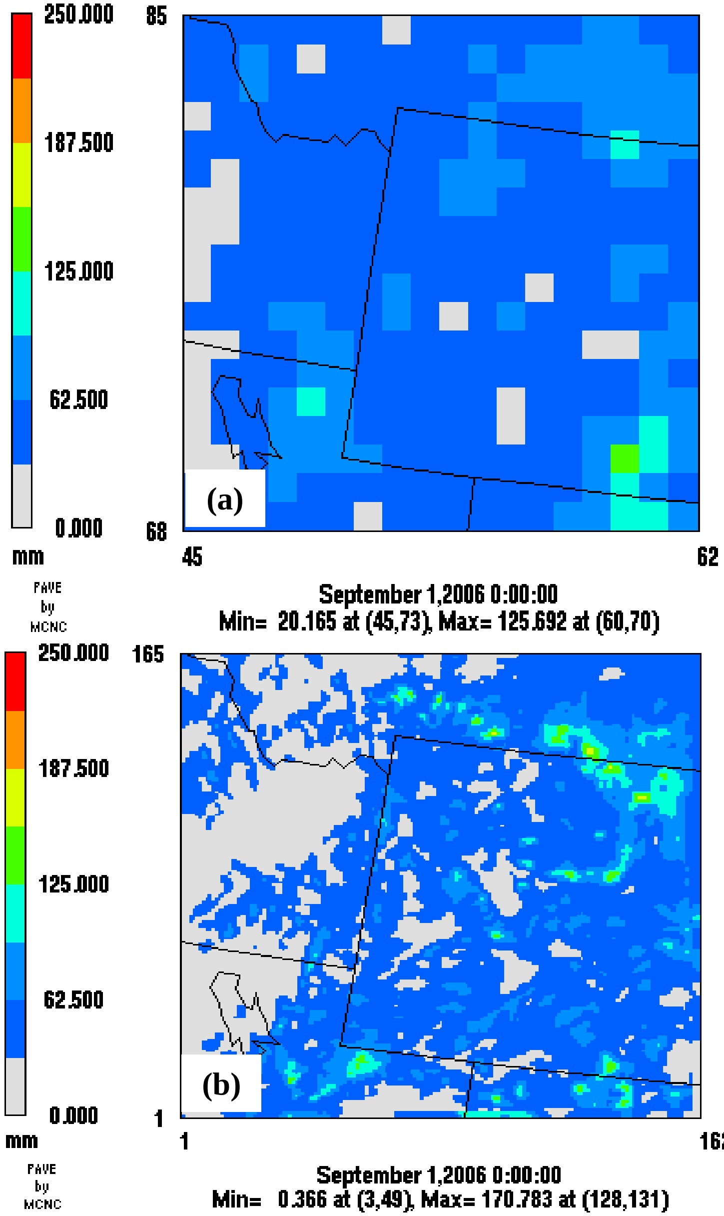

Figure 3-34. Precipitation for September 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

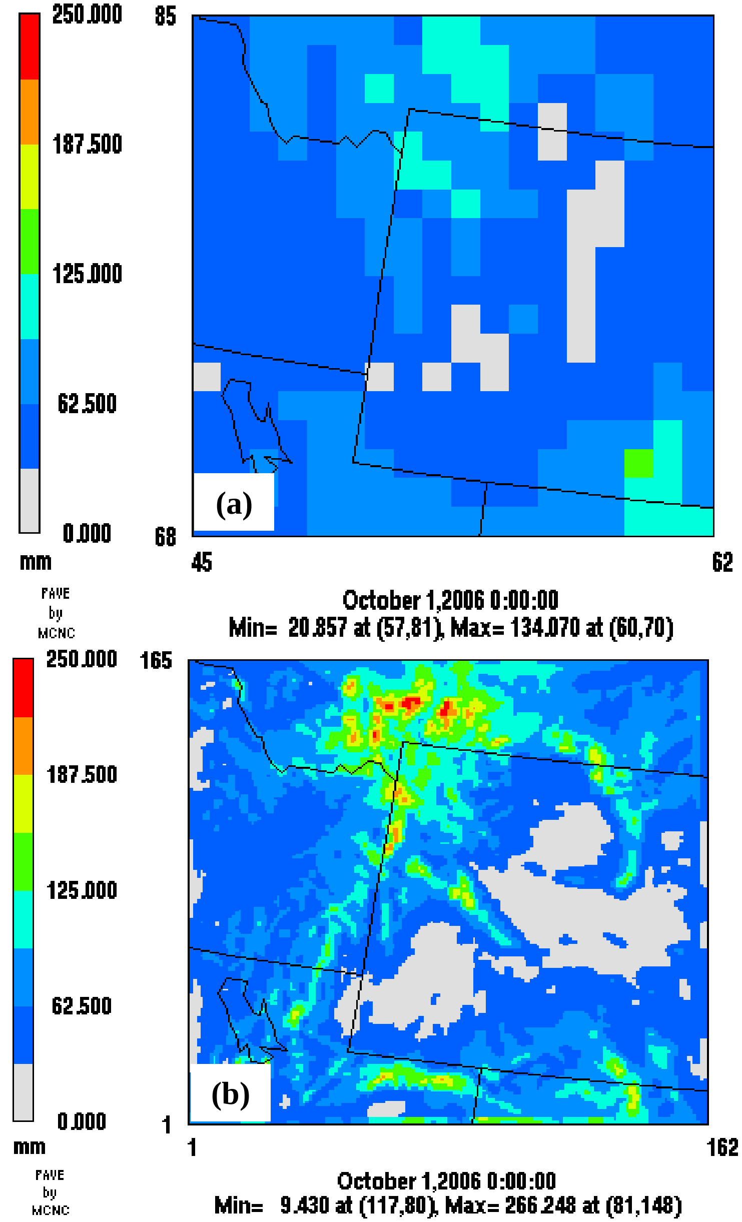

Figure 3-35. Precipitation for October 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

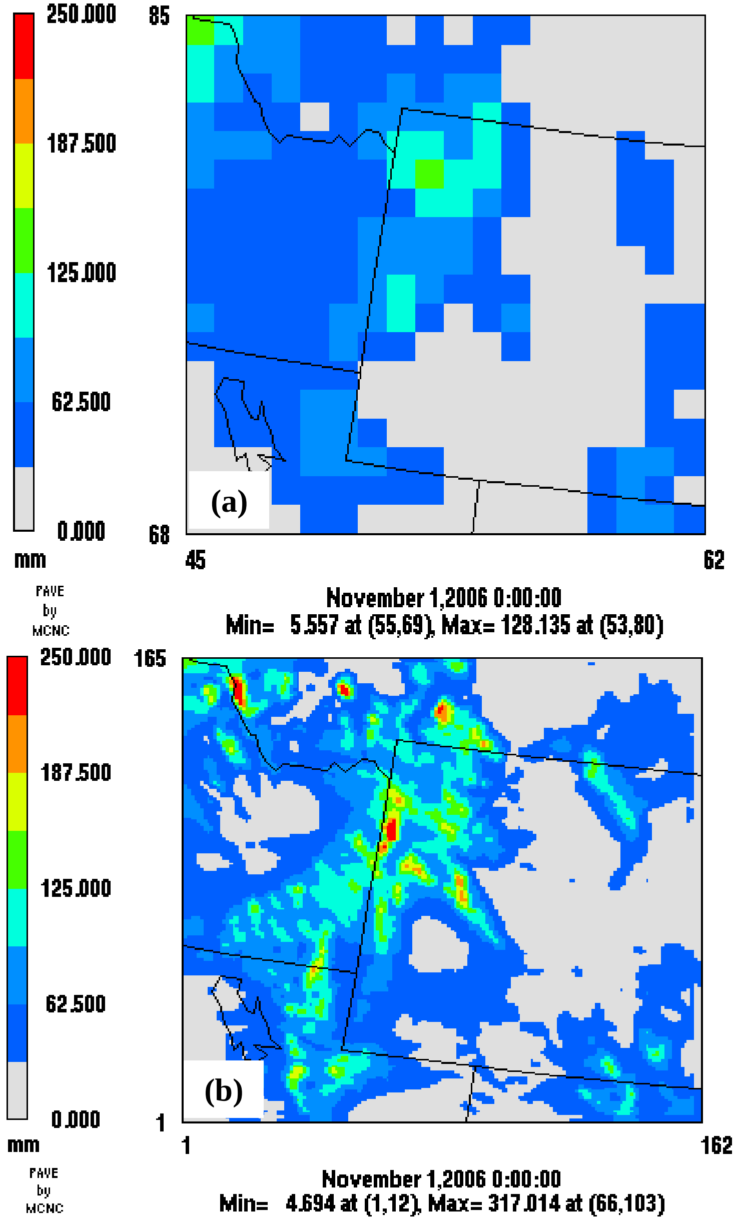

Figure 3-36. Precipitation for November 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

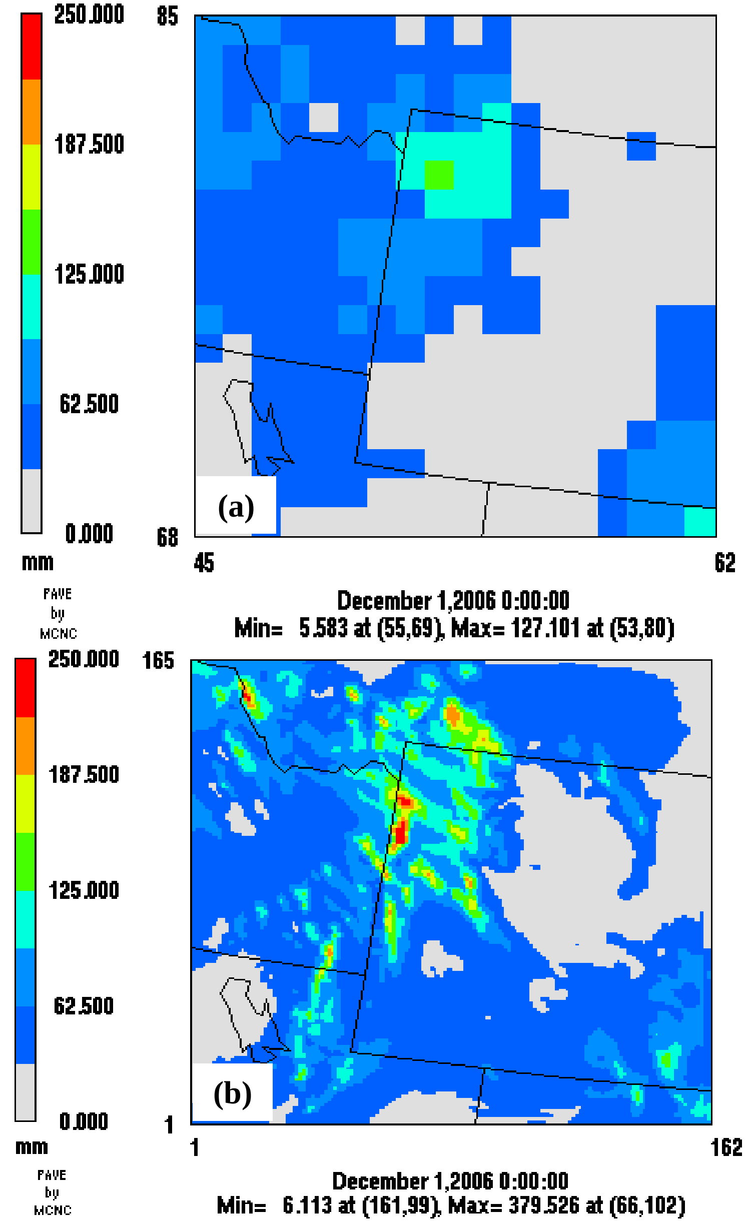

Figure 3-37. Precipitation for December 2006 over the 4km domain. (a) CPC analyzed precipitation. (b) MM5 predicted precipitation.

4 COMPARISON WITH OTHER ANNUAL MM5 SIMULATIONS

This section presents a comparison of the current 36km and 12km MM5 simulations with past 36km and 12km annual meteorological simulations that have been completed during the past several years by Alpine Geophysics and other researchers. Tables 4-1 through 4-5 present the temperature bias, temperature error, mixing ratio bias, mixing ratio error, and wind speed index of agreement comparisons, respectively, for the 36km simulations. Tables 4-6 through 4-10 present the temperature bias, temperature error, mixing ratio bias, mixing ratio error, and wind speed index of agreement comparisons, respectively, for the 12km simulations.

4.1 Comparison to Other Annual 36km Simulations

Comparisons between the performance of the current 2006 MM5 36km simulation and the performance of those atmospheric simulations of contemporaneous researchers were conducted. All Alpine MM5 simulations as well as those of the other researchers were performed at a 36km grid resolution using the same horizontal and vertical grid definitions as the 36km grid simulations presented in this report. The simulations that were compared include the following:

- EPA 2001 (McNally and Tesche, 2003);
- WRAP 2002 (Kemball-Cook, Jia, et. al., 2005);
- VISTAS 2002 (Olerud and Sims, 2004);
- MRPO 2003 (Baker and Johnson, 2005);
- NMED 2003, NMED 2004, and NMED 2005 (McNally, 2006);
- ENSR 2006 (McNally and Schewe, 2007);
- MOG 2005 (McNally and Schewe, 2007);
- RAQC 2006 (McNally and Schewe, 2008);
- EPA 2005 (McNally and Wilkinson, 2008a; Wilkinson and McNally, 2008);
- ARWY 2005, ARWY 2004 (McNally and Wilkinson, 2008b,c); and
- ARCO 2006, ARCO 2005, and ARCO 2004 (McNally and Wilkinson, 2008d,e,f).

For purposes of model comparisons, the current study will be referred herein as the ARWY 2006. The analysis of these simulations was subdivided by region (CENRAP, MANE_VU, MRPO, VISTAS, and WRAP) and used the Alpine Geophysics MAPS analysis package (McNally and Tesche, 1994).

The performance benchmarks for typical meteorological model performance that were used in this comparison were based on the same measures as in Section 3 of this report. As stated before, the purpose of these benchmarks was not to give a passing or failing grade to any one particular meteorological model application, but rather to put its results into the proper context of other derived meteorological data sets. As a reference, the performance benchmarks are repeated here:

- Temperature bias - +/- 0.5 K

- Temperature error - 2.0 K
- Mixing ratio bias - +/- 1.0 g/kg
- Mixing ratio error - 2.0 g/kg
- Wind Speed Index of Agreement – 0 = worst, 0.6=acceptable, 1 = best

Temperature bias model performance statistics for the entire domain and each RPO for the sixteen studies and for the current study (i.e., ARWY 2006) are presented in Table 4-1. The ARWY 2006 MM5 application is within the temperature bias benchmark of +/- 0.5 K with a 0.46 K average over the whole U.S. (ALL in Table 4-1). When comparing ARWY 2006 performance across the RPOs, the simulation has a slightly high temperature bias for the CENRAP, MRPO, and VISTAS subdomains (0.68 K, 0.60 K and 0.72 K respectively) while the MANE-VU and WRAP regions (0.34 K and 0.01 K, respectively) are well within the benchmark range. The ARWY 2006 simulation performs similarly to other researchers' simulations in terms of the temperature bias.

Temperature error is presented in Table 4-2. For the ARWY 2006 application of MM5, the temperature error is comparable to annual simulations conducted by other researchers. As with the other simulations, the MM5 results for ARWY 2006 is somewhat greater than the benchmark of 2.0 K over the entire U.S (i.e., 2.23 K for ALL). On a RPO subdomain basis, only the MANE-VU (1.93 K) and MRPO (1.89 K) subdomains meet the benchmark. The temperature error in the ARWY 2006 study is consistent across all regions with those as derived from other simulations.

Mixing ratio bias is presented in Table 4-3. The domain-wide bias for the ARWY 2006 MM5 simulation is 0.20 g/kg (ALL in Table 4-3) which is well within the benchmark of +/- 1.0 g/kg. Further, the ARWY 2006 simulation meets the performance benchmark in all subdomains. The ARWY 2006 mixing ratio bias is comparable to the overall performance of the other studies and other years across each RPO.

Table 4-4 presents the mixing ratio error comparisons between the sixteen studies and the ARWY 2006 simulation across the U.S. and the five RPO regions. The domain-wide mixing ratio error of 1.04 g/kg and the range of mixing ratio errors across the RPOs from 0.86 g/kg to 1.26 g/kg for the ARWY 2006 simulation are well under the benchmark error of 2.0 g/kg. The ARWY 2006 MM5 simulation has mixing ratio errors that are comparable with the other annual MM5 applications by other researchers.

Wind speed index of agreement (IA) is presented in Table 4-5. The domain-wide Wind IA for the ARWY 2006 simulation is 0.87 (ALL in Table 4-5) which exceeds the benchmark of 0.6 and is close to the best performing IA statistic of 1.0. Indeed, the IA benchmark for the ARWY 2006 simulation is exceeded in each of the RPO subdomains. The ARWY 2006 simulation is comparable to all other annual simulations.

4.2 Comparison to Other 12km Annual Simulations

Over the past several years, Alpine Geophysics has been involved with a number of 12km Western United States MM5 applications. These studies have simulated 2003 through 2006 for a 12km grid that is comparable to the 12km grid that was used in the current study with the notable exception of EPA 2005, which was a much larger 12km grid. However, these studies have evaluated the MM5 12km simulations on a state-by-state basis for states that were wholly contained in the modeling domain. Thus, a direct comparison between the current study and the previous studies can be performed for the states of Colorado, Utah and Wyoming.

These studies used the most recent versions of MM5 at the time of the study, starting with version 3.7.2. While changes to the MM5 model have occurred since v.3.7.2, these have been only minor model changes.

Tables 4-6 through 4-10 present the model performance evaluation results at 12km from previous studies and the current study. The entries in the "State/Simulation" columns of Tables 4-6 through 4-10 are coded as "SS-Simulation" where "SS" is CO (Colorado), UT (Utah), or WY (Wyoming) and "Simulation" is as follows:

- 2003-NM, 2004-NM, and 2005-NM – 2003, 2004, and 2005 MM5 simulations sponsored by New Mexico Environment Department (McNally, 2006);
- 2006-CO – 2006 RAQC MM5 simulation sponsored by the State of Colorado (McNally and Schewe, 2008);
- 2005-EPA – 2005 MM5 simulation sponsored by the U.S. EPA (McNally and Wilkinson, 2008a; Wilkinson and McNally, 2008);
- 2004-ARWY, 2005-ARWY – 2004 and 2005 MM5 simulations sponsored by Arcadis Environmental (McNally and Wilkinson, 2008b,c); and
- 2004-ARCO, 2005-ARCO, and 2006-ARCO – 2004, 2005, and 2006 MM5 simulations sponsored by Arcadis Environmental (McNally and Wilkinson, 2008d,e,f).

Table 4-6 shows the temperature bias model performance evaluation results for the 12km grid. Examination of Table 4-6 reveals the current simulation has temperature bias performance characteristics that are similar to previous simulations. The current simulation compared to previous simulations appear to have equal mixes of positive and negative biases, and the simulations appear to perform similarly on an annual basis, seasonal basis, and month-by-month basis.

Table 4-7 shows the temperature error model performance evaluation results for the 12km grid. Examination of Table 4-7 reveals that all model simulations had difficulty replicating observed temperatures. No single simulation routinely meets the temperature error benchmark of 2.0 K. Further, the temperature error model performance results are similar across the simulations.

Table 4-8 shows the mixing ratio bias model performance evaluation results for the 12km grid. Examination of Table 4-8 reveals the current simulation has mixing ratio bias performance characteristics that are similar to previous. Monthly, seasonally and annually, all simulations perform similarly.

Table 4-9 shows the mixing ratio error model performance evaluation results for the 12km grid. Examination of Table 4-9 reveals the current simulation has mixing ratio error performance characteristics that are similar to previous simulations. Monthly, seasonally and annually, all simulations perform similarly.

Table 4-10 shows the wind speed index of agreement model performance evaluation results for the 12km grid. Examination of Table 4-10 reveals that all simulations perform similarly. All simulations meet the 0.6 benchmark for this statistic. No single simulation has superior index of agreement performance characteristics.

4.3 Summary of Intercomparison of Model Performance Evaluation Results

Temperature bias and error statistics, mixing ratio bias and error statistics, and wind speed index of agreement statistics were estimated for the model predictions on 04km, 12km and 36km modeling grids for the current simulation. For the 12km and 36km domains, the statistical values were compared with similar model performance evaluation statistics from previous MM5 simulations performed in previous studies upon the same or very similar grid domains.

In regards to the 12km and 36km domains, the current simulation has performance characteristics that are similar to prior studies. Of the simulations examined, no one simulation exhibits consistently superior performance. Therefore, the current MM5 simulation is performing at par with other simulations that are currently being used for air quality planning so the overall performance of the model is judged to be adequate.

Table 4-1. Temperature Bias (K) for 36km Annual MM5 Simulations. Current simulation results are highlighted in blue.

Simulation	ALL	CENRAP	MANE_VU	MRPO	VISTAS	WRAP
EPA 2001	-0.51	-0.26	-0.40	-0.31	-0.25	-1.10
WRAP 2002	-0.12	0.14	-0.15	-0.11	0.05	-0.49
VISTAS 2002	-0.05	0.14	0.00	0.05	0.24	-0.55
MRPO 2003	-0.15	0.11	-0.17	-0.10	0.18	-0.67
NMED 2005	0.52	0.86	0.15	0.58	0.75	0.13
NMED 2004	0.49	0.79	0.27	0.55	0.73	0.07
NMED 2003	0.27	0.54	0.21	0.28	0.65	-0.26
MOG 2005	0.38	0.75	0.05	0.49	0.61	-0.12
ENSR 2006	0.44	0.68	0.37	0.59	0.72	-0.10
RAQC 2006	0.51	0.72	0.40	0.63	0.75	0.04
EPA 2005	-0.33	-0.05	-0.82	-0.44	-0.09	-0.52
ARWY 2005	0.49	0.81	0.11	0.51	0.76	0.11
ARWY 2004	0.45	0.76	0.24	0.51	0.70	-0.03
ARCO 2006	0.46	0.68	0.33	0.60	0.73	0.00
ARCO 2005	0.50	0.81	0.11	0.51	0.76	0.12
ARCO 2004	0.45	0.76	0.24	0.52	0.70	-0.02
ARWY 2006	0.46	0.68	0.34	0.60	0.72	0.01

Table 4-2. Temperature Error (K) for 36km Annual MM5 Simulations. Current simulation results are highlighted in blue.

Simulation	ALL	CENRAP	MANE_VU	MRPO	VISTAS	WRAP
EPA 2001	2.04	1.77	1.85	1.63	1.92	2.70
WRAP 2002	2.10	1.85	1.80	1.74	1.93	2.79
VISTAS 2002	2.02	1.76	1.80	1.72	1.84	2.67
MRPO 2003	2.17	1.94	1.86	1.92	1.98	2.82
NMED 2005	2.28	2.20	2.05	2.05	2.10	2.74
NMED 2004	2.26	2.13	1.99	2.01	2.11	2.75
NMED 2003	2.23	2.07	1.97	1.97	2.06	2.73
MOG 2005	2.26	2.16	2.05	2.03	2.07	2.74
ENSR 2006	2.24	2.15	1.95	1.90	2.13	2.75
RAQC 2006	2.25	2.16	1.96	1.92	2.15	2.76
EPA 2005	2.22	2.08	2.11	1.98	2.01	2.72
ARWY 2005	2.28	2.21	2.04	2.01	2.10	2.74
ARWY 2004	2.24	2.12	1.98	1.99	2.08	2.73
ARCO 2006	2.24	2.12	1.94	1.89	2.13	2.77
ARCO 2005	2.28	2.21	2.04	2.01	2.10	2.75
ARCO 2004	2.24	2.11	1.98	1.99	2.09	2.74
ARWY 2006	2.23	2.12	1.93	1.89	2.12	2.76

Table 4-3. Mixing Ratio Bias (g/kg) for 36km Annual MM5 Simulations. Current simulation results are highlighted in blue.

Simulation	ALL	CENRAP	MANE_VU	MRPO	VISTAS	WRAP
EPA 2001	-0.11	-0.24	-0.06	-0.22	0.06	-0.08
WRAP 2002	-0.09	-0.34	0.08	-0.11	0.20	-0.09
VISTAS 2002	0.01	-0.07	0.19	0.13	0.02	-0.04
MRPO 2003	0.22	0.11	0.30	0.29	0.49	0.05
NMED 2005	0.17	-0.02	0.54	0.24	0.47	-0.08
NMED 2004	0.07	-0.09	0.36	0.19	0.38	-0.20
NMED 2003	0.05	-0.18	0.35	0.17	0.35	-0.13
MOG 2005	0.29	0.11	0.59	0.30	0.67	0.03
ENSR 2006	0.17	-0.04	0.57	0.27	0.46	-0.05
RAQC 2006	0.13	-0.07	0.53	0.23	0.42	-0.09
EPA 2005	0.33	0.13	0.54	0.31	0.75	0.15
ARWY 2005	0.19	-0.01	0.53	0.24	0.48	-0.03
ARWY 2004	0.08	-0.09	0.35	0.18	0.38	-0.17
ARCO 2006	0.20	-0.01	0.59	0.29	0.49	-0.02
ARCO 2005	0.18	-0.01	0.53	0.24	0.48	-0.04
ARCO 2004	0.08	-0.09	0.36	0.19	0.38	-0.18
ARWY 2006	0.20	-0.01	0.58	0.28	0.47	-0.01

Table 4-4. Mixing Ratio Error (g/kg) for 36km Annual MM5 Simulations. Current simulation results are highlighted in blue.

Simulation	ALL	CENRAP	MANE_VU	MRPO	VISTAS	WRAP
EPA 2001	1.02	1.09	0.80	0.85	1.13	1.04
WRAP 2002	1.03	1.17	0.82	0.93	1.16	0.94
VISTAS 2002	0.94	0.98	0.78	0.82	1.13	0.90
MRPO 2003	0.96	0.98	0.78	0.82	1.14	0.97
NMED 2005	1.12	1.20	0.96	0.97	1.32	1.03
NMED 2004	1.05	1.11	0.89	0.85	1.29	0.99
NMED 2003	1.03	1.09	0.86	0.85	1.22	1.00
MOG 2005	1.16	1.23	0.98	1.00	1.38	1.07
ENSR 2006	1.04	1.10	0.92	0.86	1.24	0.97
RAQC 2006	1.03	1.10	0.91	0.85	1.23	0.97
EPA 2005	1.04	1.10	0.86	0.89	1.31	0.93
ARWY 2005	1.08	1.14	0.92	0.92	1.28	1.00
ARWY 2004	1.06	1.11	0.88	0.85	1.29	1.00
ARCO 2006	1.05	1.11	0.93	0.86	1.26	0.97
ARCO 2005	1.08	1.14	0.92	0.92	1.28	1.00
ARCO 2004	1.06	1.11	0.89	0.86	1.30	0.99
ARWY 2006	1.04	1.10	0.93	0.86	1.26	0.97

Table 4-5. Wind Index of Agreement for 36km Annual MM5 Simulation. Current simulation results are highlighted in blue.

Simulation	ALL	CENRAP	MANE_VU	MRPO	VISTAS	WRAP
EPA 2001	0.88	0.85	0.69	0.75	0.77	0.86
WRAP 2002	0.93	0.92	0.81	0.84	0.84	0.92
VISTAS 2002	0.90	0.88	0.71	0.78	0.79	0.89
MRPO 2003	0.90	0.88	0.72	0.78	0.80	0.88
NMED 2005	0.87	0.84	0.71	0.73	0.75	0.86
NMED 2004	0.90	0.88	0.76	0.77	0.79	0.88
NMED 2003	0.90	0.88	0.76	0.77	0.79	0.88
MOG 2005	0.87	0.84	0.71	0.73	0.75	0.86
ENSR 2006	0.87	0.85	0.69	0.73	0.75	0.85
RAQC 2006	0.89	0.87	0.74	0.76	0.78	0.87
EPA 2005	0.88	0.85	0.72	0.75	0.77	0.87
ARWY 2005	0.87	0.84	0.71	0.73	0.75	0.85
ARWY 2004	0.88	0.85	0.70	0.74	0.76	0.86
ARCO 2006	0.87	0.84	0.69	0.73	0.76	0.85
ARCO 2005	0.87	0.84	0.71	0.73	0.75	0.85
ARCO 2004	0.88	0.85	0.70	0.74	0.76	0.85
ARWY 2006	0.87	0.84	0.69	0.73	0.76	0.85

Table 4-6. Temperature bias (K) model performance evaluation (MPE) results by state for 12km annual MM5 simulations. MPE results from prior studies that are within the benchmark of ±0.5 K are shaded yellow. Current study MPE results are shaded blue with those MPE results shaded green that are within the benchmark.

State/Simulation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
CO-2003-NM	0.55	-0.68	-2.11	-2.20	-0.75	-0.59	-0.75	-0.63	0.33	0.80	-0.14	0.99	-0.43
CO-2004-NM	1.47	-0.04	-1.04	-1.08	-0.17	0.00	0.25	0.22	0.07	-0.17	0.26	0.58	0.03
CO-2005-NM	0.68	-0.06	-1.42	-0.94	-0.30	-0.01	-0.14	0.45	0.38	0.32	0.46		-0.05
CO-2006-CO	-0.46	-0.24	-1.34	-1.39	-0.43	-0.33	0.47	0.56	0.32	-0.04	0.06	0.85	-0.16
CO-2005-EPA	0.27	-0.31	-1.16	-0.99	-0.41	-0.16	-0.39	0.27	0.24	0.12	0.02	0.11	-0.20
CO-2005-ARWY	0.69	0.08	-1.40	-0.97	-0.26	0.00	-0.07	0.53	0.41	0.40	0.44	0.43	0.02
CO-2004-ARWY	1.42	-0.13	-1.20	-1.25	-0.33	-0.11	0.22	0.15	0.05	-0.21	0.20	0.56	-0.05
CO-2006-ARCO	0.57	0.62	-1.01	-1.08	-0.33	-0.22	0.52	0.50	0.55	0.36	0.72	1.76	0.25
CO-2005-ARCO	1.15	0.37	-1.11	-0.71	-0.18	0.08	0.03	0.55	0.49	0.57	0.93	0.98	0.26
CO-2004-ARCO	2.03	0.04	-0.71	-0.96	-0.16	0.09	0.31	0.28	0.14	-0.01	0.66	1.20	0.27
CO-2006-ARWY	0.26	0.24	-1.20	-1.38	-0.43	-0.26	0.52	0.53	0.44	0.00	0.13	1.19	0.00
UT-2003-NM	0.91	-1.04	-1.78	-1.35	-0.61	-1.20	-1.27	-0.70	0.54	1.51	-0.02	0.93	-0.34
UT-2004-NM	1.90	0.14	-0.72	-0.45	-0.53	-0.45	-0.44	-0.16	0.18	0.33	1.03	1.09	0.16
UT-2005-NM	0.76	0.34	-0.63	-0.97	-0.25	-0.32	0.07	0.45	0.87	1.00	1.40		0.25
UT-2006-CO	0.59	-0.14	-1.03	-1.46	-0.37	-0.50	-0.31	-0.11	0.70	0.83	1.57	2.06	0.15
UT-2005-EPA	0.64	0.37	-0.57	-0.92	-0.36	-0.43	-0.32	0.28	0.56	0.74	1.06	0.89	0.16
UT-2005-ARWY	0.97	0.56	-0.58	-0.92	-0.28	-0.37	0.06	0.46	0.78	1.02	1.44	1.29	0.37
UT-2004-ARWY	2.22	0.48	-0.55	-0.52	-0.65	-0.50	-0.48	-0.18	0.07	0.27	1.09	1.27	0.21
UT-2006-ARCO	0.86	0.29	-0.90	-1.22	-0.46	-0.36	-0.38	-0.11	0.93	1.08	1.85	2.56	0.35
UT-2005-ARCO	1.15	0.73	-0.44	-0.83	-0.21	-0.31	0.11	0.47	0.89	1.19	1.63	1.54	0.49
UT-2004-ARCO	2.53	0.62	-0.39	-0.45	-0.57	-0.44	-0.44	-0.17	0.20	0.36	1.28	1.55	0.34
UT-2006-ARWY	0.89	0.06	-0.99	-1.32	-0.54	-0.42	-0.44	-0.18	0.85	0.94	1.68	2.28	0.23
WY-2003-NM	-0.01	-0.08	-1.38	-1.62	-0.64	-0.43	-0.51	-0.61	0.26	0.57	-0.08	0.95	-0.30
WY-2004-NM	1.43	0.56	-0.63	-0.26	-0.34	-0.25	0.20	-0.01	0.14	0.64	1.00	-0.68	0.15
WY-2005-NM	0.73	1.56	-0.80	-0.93	0.09	0.45	0.17	1.05	0.68	0.78	0.20		0.36
WY-2006-CO	-0.49	-0.40	-1.18	-1.35	0.12	-0.14	0.14	0.34	0.61	0.02	-0.22	1.28	-0.11
WY-2005-EPA	0.50	1.42	-0.68	-0.86	-0.05	0.28	-0.12	0.83	0.62	0.54	-0.22	-0.14	0.18
WY-2005-ARWY	1.18	1.98	-0.58	-0.73	0.20	0.55	0.22	1.12	0.84	0.98	0.54	0.62	0.58
WY-2004-ARWY	1.97	1.07	-0.35	-0.17	-0.28	-0.19	0.25	0.06	0.25	0.76	1.33	-0.18	0.38
WY-2006-ARCO	-0.93	-0.66	-1.49	-1.46	-0.01	-0.37	-0.10	0.13	0.59	0.02	-0.34	1.16	-0.29
WY-2005-ARCO	0.83	1.31	-0.96	0.98	0.01	0.35	-0.09	0.90	0.49	0.65	-0.03	0.00	0.21
WY-2004-ARCO	1.42	0.42	-0.76	-0.33	-0.30	-0.42	-0.07	-0.30	-0.04	0.48	0.84	-0.81	0.01
WY-2006-ARWY	0.07	-0.05	-1.01	-1.09	0.17	-0.07	0.18	0.42	0.84	0.30	0.05	1.76	0.13

Table 4-7. Temperature error (K) MPE results by state for 12km annual MM5 simulations. MPE results from prior studies that meet the benchmark of 2.0 K are shaded yellow. Current study MPE results are shaded blue with those MPE results shaded green that meet the benchmark.

State/Simulation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
CO-2003-NM	3.69	2.79	3.50	3.64	2.82	2.73	3.23	2.62	2.86	3.50	2.94	3.53	3.15
CO-2004-NM	3.71	2.92	3.33	2.91	3.04	2.88	2.85	2.78	2.75	2.82	2.73	3.48	3.02
CO-2005-NM	3.26	3.06	3.29	3.17	2.93	2.80	3.11	2.69	2.93	2.90	3.32		3.04
CO-2006-CO	3.19	3.49	3.11	3.56	3.02	2.97	2.66	2.61	2.75	2.77	3.33	3.30	3.06
CO-2005-EPA	2.98	3.00	3.09	3.06	2.79	2.70	3.00	2.56	2.76	2.67	3.09	3.08	2.90
CO-2005-ARWY	3.28	3.09	3.29	3.22	2.95	2.78	3.13	2.72	2.99	2.90	3.23	3.29	3.07
CO-2004-ARWY	3.78	2.88	3.38	2.99	3.02	2.82	2.84	2.80	2.75	2.81	2.75	3.44	3.02
CO-2006-ARCO	3.75	3.60	3.02	3.56	3.07	3.02	2.69	2.56	2.76	2.77	3.44	3.58	3.15
CO-2005-ARCO	3.39	3.13	3.23	3.16	2.96	2.83	3.18	2.75	3.00	2.98	3.42	3.49	3.13
CO-2004-ARCO	3.88	2.92	3.27	2.89	3.04	2.92	2.90	2.82	2.78	2.80	2.77	3.61	3.05
CO-2006-ARWY	3.49	3.47	3.04	3.60	3.04	2.94	2.67	2.56	2.75	2.79	3.44	3.44	3.10
UT-2003-NM	2.93	2.46	2.87	2.85	2.81	3.06	3.52	2.85	3.31	3.62	2.17	2.79	2.94
UT-2004-NM	3.67	2.58	3.42	2.42	2.78	3.02	3.05	2.95	3.04	2.55	2.53	3.04	2.92
UT-2005-NM	2.74	2.70	2.88	2.75	2.46	2.68	3.15	2.90	3.19	2.96	3.11		2.87
UT-2006-CO	2.59	3.21	2.59	3.16	3.03	3.13	2.96	2.95	2.96	2.66	3.15	3.29	2.97
UT-2005-EPA	2.55	2.58	2.63	2.54	2.30	2.61	2.94	2.80	2.96	2.73	2.92	2.81	2.70
UT-2005-ARWY	2.84	2.84	2.99	2.80	2.55	2.82	3.28	3.05	3.34	3.12	3.23	3.13	3.00
UT-2004-ARWY	3.86	2.72	3.48	2.50	2.91	3.11	3.16	3.04	3.17	2.61	2.68	3.14	3.03
UT-2006-ARCO	2.90	3.22	2.52	3.02	2.96	3.22	2.99	3.05	3.12	2.78	3.30	3.54	3.05
UT-2005-ARCO	2.88	2.86	2.96	2.79	2.52	2.77	3.29	3.00	3.33	3.14	3.30	3.23	3.01
UT-2004-ARCO	3.95	2.68	3.46	2.48	2.86	3.10	3.11	3.07	3.14	2.60	2.69	3.23	3.03
UT-2006-ARWY	2.72	3.22	2.56	3.08	3.01	3.25	3.02	3.10	3.14	2.76	3.22	3.39	3.04
WY-2003-NM	3.37	2.87	2.92	3.00	2.50	2.38	3.09	2.74	2.65	3.33	3.07	3.26	2.93
WY-2004-NM	4.36	3.00	3.22	2.53	2.54	2.45	2.70	2.61	2.60	2.46	2.95	3.02	2.87
WY-2005-NM	3.30	3.57	2.81	2.75	2.17	2.36	2.86	2.92	2.90	2.72	2.72		2.83
WY-2006-CO	2.90	3.14	2.73	2.99	2.90	2.78	3.03	2.87	2.66	2.49	2.94	3.65	2.92
WY-2005-EPA	3.04	3.41	2.66	2.58	2.05	2.22	2.71	2.75	2.74	2.56	2.64	3.16	2.71
WY-2005-ARWY	3.34	3.74	2.74	2.70	2.13	2.34	2.89	2.93	2.90	2.78	2.80	3.46	2.90
WY-2004-ARWY	4.48	3.15	3.17	2.51	2.47	2.39	2.66	2.58	2.55	2.46	3.04	2.97	2.87
WY-2006-ARCO	3.23	3.20	2.82	3.13	2.79	2.66	2.91	2.73	2.58	2.47	3.07	3.66	2.94
WY-2005-ARCO	3.36	3.52	2.86	2.85	2.20	2.37	2.82	2.83	2.86	2.69	2.72	3.41	2.87
WY-2004-ARCO	4.34	2.95	3.26	2.57	2.51	2.44	2.64	2.58	2.57	2.40	2.92	3.00	2.85
WY-2006-ARWY	3.02	3.14	2.69	2.88	2.77	2.68	2.92	2.75	2.62	2.42	2.91	3.82	2.92

Table 4-8. Mixing ratio bias (g/kg) MPE results by state for 12km annual MM5 simulations. MPE results from prior studies that meet the benchmark of ±1.0 g/kg are shaded yellow. Current study MPE results are shaded blue with those MPE results shaded green that meet the benchmark.

State/Simulation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
CO-2003-NM	0.26	0.04	0.10	0.15	-0.09	-0.14	0.63	-0.05	-0.36	0.04	-0.15	0.01	0.04
CO-2004-NM	-0.09	-0.09	0.26	-0.05	-0.42	-0.13	-0.54	-0.76	-0.60	-0.20	-0.10	0.01	-0.23
CO-2005-NM	0.15	0.08	0.10	0.23	-0.12	-0.46	0.24	-0.57	-0.10	-0.37	-0.08		-0.08
CO-2006-CO	0.14	0.21	0.15	0.27	-0.01	0.22	-0.65	-0.82	-0.54	-0.36	-0.06	0.12	-0.11
CO-2005-EPA	0.21	0.08	0.12	0.34	0.16	0.05	1.08	0.17	0.32	-0.14	0.01	0.15	0.21
CO-2005-ARWY	0.13	0.09	0.06	0.18	-0.21	-0.54	0.14	-0.68	-0.23	-0.41	-0.13	0.12	-0.12
CO-2004-ARWY	-0.10	-0.13	0.19	-0.07	-0.48	-0.17	-0.67	-0.88	-0.67	-0.25	-0.13	0.02	-0.28
CO-2006-ARCO	0.09	0.14	0.07	0.16	-0.15	0.02	-0.89	-0.98	-0.68	-0.43	-0.14	0.10	-0.22
CO-2005-ARCO	0.09	0.00	0.00	0.09	-0.27	-0.71	-0.03	-0.83	-0.37	-0.44	-0.15	0.10	-0.21
CO-2004-ARCO	-0.14	-0.14	0.10	-0.13	-0.55	-0.32	-0.77	-0.99	-0.73	-0.30	-0.17	-0.05	-0.35
CO-2006-ARWY	0.13	0.18	0.09	0.18	-0.15	0.10	-0.84	-0.94	-0.65	-0.38	-0.09	0.14	-0.19
UT-2003-NM	0.15	0.04	0.27	0.25	0.06	0.47	1.24	0.46	0.46	0.42	-0.06	0.13	0.32
UT-2004-NM	0.24	0.10	0.77	0.27	-0.05	0.48	0.84	0.50	0.47	0.26	-0.13	0.08	0.32
UT-2005-NM	0.10	0.04	0.37	0.11	-0.35	-0.13	0.68	0.25	0.22	-0.07	-0.14		0.10
UT-2006-CO	0.02	-0.03	-0.03	0.01	0.11	0.47	0.09	-0.13	0.03	-0.22	0.02	0.16	0.04
UT-2005-EPA	0.27	0.13	0.41	0.27	-0.12	0.21	1.30	0.96	0.55	0.15	0.04	0.23	0.37
UT-2005-ARWY	0.06	-0.04	0.28	0.05	-0.45	-0.21	0.44	-0.07	0.14	-0.11	-0.15	0.09	0.00
UT-2004-ARWY	0.21	0.07	0.60	0.17	-0.14	0.33	0.58	0.27	0.39	0.20	-0.16	0.05	0.21
UT-2006-ARCO	-0.02	-0.04	-0.04	-0.03	0.07	0.30	-0.01	-0.39	-0.11	-0.29	-0.01	0.15	-0.03
UT-2005-ARCO	0.04	-0.04	0.27	0.04	-0.43	-0.23	0.54	0.08	0.11	-0.09	-0.17	0.10	0.02
UT-2004-ARCO	0.20	0.06	0.57	0.18	-0.16	0.34	0.65	0.32	0.36	0.19	-0.17	0.03	0.21
UT-2006-ARWY	0.01	-0.03	-0.05	-0.02	0.07	0.29	-0.07	-0.42	-0.14	-0.27	0.02	0.17	-0.04
WY-2003-NM	0.33	0.09	0.23	0.37	-0.01	-0.33	0.23	0.29	-0.31	0.29	0.11	0.17	0.12
WY-2004-NM	0.22	0.12	0.40	0.16	-0.28	-0.35	-0.41	-0.25	-0.25	-0.08	0.04	0.13	-0.05
WY-2005-NM	0.23	0.22	0.19	0.13	-0.59	-0.89	-0.10	0.00	0.11	-0.23	0.06		-0.08
WY-2006-CO	0.20	0.18	0.00	-0.11	-0.33	-0.06	0.31	-0.21	-0.10	0.05	0.13	0.31	0.03
WY-2005-EPA	0.27	0.28	0.16	0.27	-0.34	-0.42	0.46	0.61	0.35	-0.02	0.09	0.22	0.16
WY-2005-ARWY	0.19	0.16	0.10	0.04	-0.67	-1.04	-0.29	-0.15	-0.07	-0.29	-0.01	0.22	-0.15
WY-2004-ARWY	0.19	0.09	0.23	0.08	-0.37	-0.46	-0.54	-0.37	-0.39	-0.14	-0.03	0.07	-0.14
WY-2006-ARCO	0.19	0.17	-0.01	-0.14	-0.51	-0.11	0.20	-0.41	-0.20	0.02	0.17	0.35	-0.02
WY-2005-ARCO	0.22	0.20	0.13	0.07	-0.64	-1.13	-0.25	-0.15	-0.07	-0.30	0.02	0.25	-0.14
WY-2004-ARCO	0.21	0.11	0.29	0.07	-0.40	-0.37	-0.51	-0.36	-0.36	-0.15	-0.01	0.10	-0.12
WY-2006-ARWY	0.19	0.16	-0.01	-0.16	-0.45	-0.12	0.15	-0.44	-0.17	0.00	0.11	0.31	-0.04

Table 4-9. Mixing ratio error (g/kg) MPE results by state for 12km annual MM5 simulations. MPE results from prior studies that meet the benchmark of 2.0 g/kg are shaded yellow. Current study MPE results are shaded blue with those MPE results shaded green that meet the benchmark.

State/Simulation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
CO-2003-NM	0.55	0.47	0.61	0.85	1.14	1.23	1.73	1.46	1.05	0.79	0.56	0.46	0.91
CO-2004-NM	0.46	0.48	0.77	0.78	1.05	1.27	1.64	1.47	1.15	0.79	0.56	0.45	0.91
CO-2005-NM	0.51	0.58	0.56	0.80	0.95	1.39	1.57	1.46	1.19	0.88	0.62		0.96
CO-2006-CO	0.47	0.45	0.64	0.77	0.99	1.29	1.48	1.46	1.05	0.81	0.55	0.46	0.87
CO-2005-EPA	0.55	0.60	0.59	0.82	1.01	1.47	2.02	1.56	1.27	0.79	0.61	0.43	0.98
CO-2005-ARWY	0.51	0.56	0.54	0.80	0.97	1.43	1.52	1.45	1.19	0.90	0.64	0.43	0.91
CO-2004-ARWY	0.47	0.49	0.76	0.79	1.09	1.26	1.63	1.48	1.21	0.82	0.56	0.44	0.92
CO-2006-ARCO	0.47	0.42	0.63	0.74	0.97	1.20	1.47	1.44	1.06	0.84	0.56	0.45	0.85
CO-2005-ARCO	0.50	0.57	0.54	0.77	0.97	1.46	1.53	1.52	1.20	0.91	0.62	0.41	0.92
CO-2004-ARCO	0.47	0.49	0.72	0.78	1.07	1.27	1.67	1.54	1.20	0.81	0.56	0.45	0.92
CO-2006-ARWY	0.46	0.43	0.62	0.73	0.96	1.17	1.46	1.49	1.08	0.82	0.55	0.47	0.85
UT-2003-NM	0.57	0.51	0.62	0.66	0.99	1.25	2.13	1.64	1.16	0.93	0.61	0.50	0.96
UT-2004-NM	0.45	0.40	1.11	0.78	0.92	1.44	1.74	1.42	1.20	0.77	0.59	0.46	0.94
UT-2005-NM	0.55	0.52	0.71	0.72	1.12	1.38	1.74	1.54	1.16	0.87	0.69		1.00
UT-2006-CO	0.43	0.43	0.60	0.74	1.02	1.29	1.43	1.25	0.91	0.94	0.58	0.43	0.84
UT-2005-EPA	0.60	0.58	0.75	0.78	1.11	1.44	2.12	1.87	1.27	0.86	0.65	0.53	1.05
UT-2005-ARWY	0.55	0.52	0.68	0.71	1.16	1.41	1.63	1.48	1.12	0.86	0.69	0.47	0.94
UT-2004-ARWY	0.45	0.40	0.99	0.75	0.90	1.41	1.63	1.35	1.17	0.78	0.59	0.46	0.91
UT-2006-ARCO	0.47	0.43	0.59	0.74	1.02	1.24	1.39	1.30	0.88	0.92	0.57	0.42	0.83
UT-2005-ARCO	0.54	0.52	0.66	0.69	1.11	1.37	1.66	1.46	1.13	0.85	0.70	0.47	0.93
UT-2004-ARCO	0.44	0.40	0.97	0.75	0.89	1.42	1.65	1.40	1.16	0.77	0.59	0.45	0.91
UT-2006-ARWY	0.45	0.43	0.60	0.74	1.04	1.26	1.41	1.33	0.88	0.92	0.57	0.42	0.84
WY-2003-NM	0.52	0.37	0.50	0.76	0.90	1.20	1.61	1.41	1.01	0.77	0.43	0.43	0.83
WY-2004-NM	0.47	0.43	0.72	0.71	0.90	1.06	1.46	1.08	0.97	0.75	0.53	0.40	0.79
WY-2005-NM	0.46	0.51	0.55	0.73	1.01	1.52	1.39	1.28	1.03	0.75	0.55		0.89
WY-2006-CO	0.43	0.38	0.44	0.69	0.98	1.11	1.25	1.07	0.85	0.67	0.48	0.48	0.74
WY-2005-EPA	0.47	0.53	0.54	0.74	0.86	1.44	1.60	1.57	1.14	0.68	0.51	0.42	0.88
WY-2005-ARWY	0.45	0.47	0.51	0.68	1.03	1.58	1.37	1.24	0.97	0.74	0.54	0.41	0.83
WY-2004-ARWY	0.45	0.42	0.63	0.69	0.90	1.05	1.43	1.09	0.97	0.75	0.52	0.38	0.77
WY-2006-ARCO	0.45	0.38	0.46	0.72	1.02	1.10	1.24	1.09	0.86	0.68	0.49	0.49	0.75
WY-2005-ARCO	0.49	0.50	0.54	0.72	1.06	1.67	1.41	1.27	1.01	0.77	0.57	0.44	0.87
WY-2004-ARCO	0.46	0.42	0.66	0.73	0.94	1.07	1.50	1.13	1.00	0.78	0.52	0.39	0.80
WY-2006-ARWY	0.42	0.36	0.44	0.69	0.98	1.07	1.19	1.07	0.83	0.65	0.47	0.47	0.72

Table 4-10. Wind speed Index of Agreement MPE results by state for 12km annual MM5 simulations. All areas meet the 0.6 benchmark for the statistic monthly and annually. Current study MPE results are shaded blue.

State/Simulation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
CO-2003-NM	0.84	0.83	0.83	0.80	0.83	0.84	0.85	0.84	0.85	0.87	0.84	0.85	0.84
CO-2004-NM	0.84	0.84	0.82	0.8	0.84	0.85	0.83	0.82	0.82	0.82	0.84	0.85	0.83
CO-2005-NM	0.82	0.81	0.79	0.79	0.80	0.81	0.83	0.83	0.81	0.81	0.79		0.81
CO-2006-CO	0.80	0.82	0.81	0.78	0.81	0.83	0.83	0.83	0.83	0.83	0.82	0.82	0.82
CO-2005-EPA	0.82	0.82	0.81	0.82	0.81	0.81	0.80	0.81	0.80	0.80	0.80	0.80	0.81
CO-2005-ARWY	0.82	0.79	0.78	0.82	0.80	0.80	0.79	0.80	0.80	0.78	0.78	0.79	0.80
CO-2004-ARWY	0.81	0.80	0.81	0.80	0.79	0.80	0.79	0.82	0.77	0.78	0.81	0.77	0.80
CO-2006-ARCO	0.81	0.81	0.81	0.77	0.80	0.81	0.77	0.79	0.77	0.75	0.78	0.76	0.79
CO-2005-ARCO	0.83	0.82	0.81	0.83	0.81	0.80	0.77	0.81	0.81	0.79	0.78	0.80	0.81
CO-2004-ARCO	0.81	0.80	0.80	0.80	0.81	0.81	0.80	0.82	0.80	0.78	0.78	0.82	0.80
CO-2006-ARWY	0.80	0.80	0.81	0.77	0.79	0.78	0.80	0.78	0.79	0.76	0.77	0.75	0.78
UT-2003-NM	0.79	0.76	0.77	0.80	0.79	0.81	0.78	0.80	0.81	0.81	0.78	0.80	0.79
UT-2004-NM	0.72	0.78	0.78	0.81	0.81	0.79	0.77	0.79	0.79	0.79	0.78	0.77	0.78
UT-2005-NM	0.72	0.71	0.74	0.76	0.76	0.78	0.77	0.74	0.78	0.77	0.76		0.75
UT-2006-CO	0.77	0.75	0.76	0.77	0.78	0.78	0.76	0.79	0.78	0.77	0.76	0.73	0.77
UT-2005-EPA	0.70	0.74	0.71	0.77	0.76	0.73	0.75	0.78	0.75	0.74	0.76	0.78	0.75
UT-2005-ARWY	0.70	0.72	0.69	0.76	0.76	0.75	0.73	0.78	0.76	0.73	0.75	0.78	0.74
UT-2004-ARWY	0.67	0.74	0.72	0.72	0.75	0.76	0.77	0.75	0.78	0.76	0.78	0.78	0.75
UT-2006-ARCO	0.71	0.74	0.76	0.72	0.75	0.73	0.73	0.76	0.75	0.75	0.74	0.75	0.74
UT-2005-ARCO	0.71	0.73	0.70	0.77	0.76	0.73	0.74	0.77	0.75	0.74	0.76	0.78	0.75
UT-2004-ARCO	0.67	0.74	0.74	0.73	0.76	0.75	0.76	0.76	0.76	0.76	0.77	0.78	0.75
UT-2006-ARWY	0.70	0.74	0.72	0.76	0.74	0.74	0.72	0.77	0.76	0.76	0.73	0.75	0.74
WY-2003-NM	0.82	0.82	0.80	0.82	0.82	0.82	0.84	0.83	0.82	0.81	0.82	0.84	0.82
WY-2004-NM	0.82	0.84	0.81	0.82	0.82	0.81	0.81	0.81	0.82	0.83	0.84	0.82	0.82
WY-2005-NM	0.78	0.79	0.75	0.77	0.80	0.78	0.79	0.78	0.78	0.79	0.80		0.78
WY-2006-CO	0.84	0.84	0.82	0.81	0.80	0.82	0.82	0.84	0.83	0.83	0.82	0.83	0.83
WY-2005-EPA	0.79	0.80	0.78	0.78	0.81	0.80	0.80	0.78	0.81	0.79	0.79	0.81	0.80
WY-2005-ARWY	0.79	0.80	0.79	0.78	0.81	0.80	0.80	0.79	0.80	0.78	0.79	0.81	0.80
WY-2004-ARWY	0.79	0.78	0.81	0.81	0.79	0.81	0.80	0.79	0.80	0.79	0.80	0.78	0.80
WY-2006-ARCO	0.78	0.79	0.77	0.78	0.76	0.77	0.75	0.78	0.75	0.76	0.76	0.76	0.77
WY-2005-ARCO	0.77	0.76	0.78	0.76	0.77	0.77	0.78	0.78	0.75	0.76	0.77	0.78	0.77
WY-2004-ARCO	0.77	0.76	0.78	0.78	0.77	0.78	0.77	0.75	0.78	0.78	0.75	0.76	0.77
WY-2006-ARWY	0.79	0.80	0.79	0.81	0.78	0.80	0.78	0.81	0.79	0.80	0.79	0.81	0.80

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Attachment B

List of Surface and Upper Air Monitoring Stations used for CALMET

Table B-1. List of Surface Meteorological Stations in CALPUFF Domain

Station Name	USAF (ISH/NWS) or AIRS (SCAQMD)	WBAN (ISH/NWS) or ARB (SCAQMD)	Latitude	Longitude	Station ID (USAF-WBAN for ISH/NWS and AIRS-ARB for SCAQMD data)	Data Source	Years Available
TWENTYNINE PALMS	690150	93121	34.3	-116.167	690150-93121	ISH/NWS	2006-2008
NEWHALL	720046	99999	34.367	-118.567	720046-99999	ISH/NWS	2006-2008
BIG BEAR CITY	720165	99999	34.264	-116.854	720165-99999	ISH/NWS	2007-2008
CORONA MUNI	720333	99999	33.9	-117.6	720333-99999	ISH/NWS	2006-2008
PALM SPRINGS INTL	722868	93138	33.833	-116.5	722868-93138	ISH/NWS	2006- 2008
RIVERSIDE MUNI	722869	99999	33.95	-117.433	722869-99999	ISH/NWS	2006-2008
LA USC DOWNTOWN CAM	722874	99999	34.024	-118.291	722874-99999	ISH/NWS	2006-2008
BURBANK/GLENDALE	722880	03171	34.201	-118.358	722880-03171	ISH/NWS	2006-2008
SANTA MONICA MUNI	722885	93134	34.017	-118.45	722885-93134	ISH/NWS	2006-2008
VAN NUYS	722886	23152	34.21	-118.489	722886-23152	ISH/NWS	2006-2008
BRACKETT FLD	722887	93197	34.083	-117.783	722887-93197	ISH/NWS	2006-2008
MOUNT WILSON	722890	99999	34.226	118.066	722890-99999	ISH/NWS	2006
CHINO	722899	23130	33.967	-117.633	722899-23130	ISH/NWS	2006-2008
BROWN FLD MUNI	722904	99999	32.567	-116.967	722904-99999	ISH/NWS	2006-2008
NORTH ISLAND NAS	722906	03180	32.7	-117.2	722906-03180	ISH/NWS	2006-2008
GILLESPIE FLD	722907	93136	32.833	-116.967	722907-93136	ISH/NWS	2006-2008
AVALON/CATALINA	722920	99999	33.405	-118.416	722920-99999	ISH/NWS	2006-2008
SAN CLEMENTE ISLAND	722925	03179	33.023	-118.588	722925-03179	ISH/NWS	2006-2008
CAMP PENDLETON MCAS	722926	99999	33.3	-117.35	722926-99999	ISH/NWS	2006, 2007
MC CLELLAN PALOMAR	722927	93112	33.128	-117.28	722927-93112	ISH/NWS	2006-2008
OCEANSIDE MUNI	722934	53143	33.217	-117.35	722934-53143	ISH/NWS	2006-2008
LOS ANGELES INTL	722950	99999	33.938	-118.389	722950-99999	ISH/NWS	2006-2008
ZAMPERINI FLD	722955	23191	33.8	-118.333	722955-23191	ISH/NWS	2006-2008
JACK NORTHROP FLD H	722956	93117	33.917	-118.333	722956-93117	ISH/NWS	2006-2008
LONG BEACH/LB AIRP.	722970	03154	33.812	-118.146	722970-03154	ISH/NWS	2006-2008
LOS ALAMITOS AAF	722975	99999	33.783	-118.05	722975-99999	ISH/NWS	2006-2008
FULLERTON MUNICIPAL	722976	03177	33.867	117.983	722976-03177	ISH/NWS	2006-2008

Station Name	USAF (ISH/NWS) or AIRS (SCAQMD)	WBAN (ISH/NWS) or ARB (SCAQMD)	Latitude	Longitude	Station ID (USAF-WBAN for ISH/NWS and AIRS-ARB for SCAQMD data)	Data Source	Years Available
JOHN WAYNE ARPT ORA	722977	99999	33.68	-117.866	722977-99999	ISH/NWS	2006-2008
EDWARDS AF AUX NORTH	723171	99999	34.983	-117.867	723171-99999	ISH/NWS	2006-2008
PALMDALE PRODUCTION	723820	03174	34.629	-118.084	723820-03174	ISH/NWS	2006-2008
SANDBURG (AUT)	723830	99999	34.744	-118.724	723830-99999	ISH/NWS	2006-2008
SANTA BARBARA MUNI	723925	03167	34.426	119.843	723925-03167	ISH/NWS	2006-2008
OXNARD AIRPORT	723927	23129	34.201	119.206	723927-23129	ISH/NWS	2006-2008
RAMONA	745056	99999	33.038	-116.916	745056-99999	ISH/NWS	2008
RAMONA	745056	53141	33.039	-116.915	745056-53141	ISH/NWS	2006-2007
WHITEMAN	745057	99999	34.267	-118.417	745057-99999	ISH/NWS	2006-2008
EL MONTE	747043	93184	34.086	-118.035	747043-93184	ISH/NWS	2006-2008
CAMPO	747186	99999	32.633	-116.467	747186-99999	ISH/NWS	2006-2008
SAN DIEGO	994027	53144	32.717	-117.167	994027-53144	ISH/NWS	2006-2008
SANTA MONICA	994028	99999	34.008	-118.5	994028-99999	ISH/NWS	2006-2008
LOS ANGELES	994035	03159	33.717	-118.267	994035-03159	ISH/NWS	2006-2008
TIJUANA RIVER RESERV	998013	23182	32.573	-117.127	998013-23182	ISH/NWS	2008
ANAHEIM	60590007	30178	33.829	-117.939	60590007-30178	SCAQMD	2006-2008
AZUSA	60370002	70060	34.135	-117.924	60370002-70060	SCAQMD	2008
BANNING AIRPORT	60650012	33164	33.919	-116.858	60650012-33164	SCAQMD	2008
BURBANK	60371002	70069	34.174	-118.317	60371002-70069	SCAQMD	2008
CENTRAL LA	60710025	70087	34.065	-118.227	60710025-70087	SCAQMD	2006-2007
COSTA MESA	60591003	30195	33.672	-117.926	60591003-30195	SCAQMD	2007-2008
CRESTLINE	60710005	36181	34.240	-117.276	60710005-36181	SCAQMD	2006-2008
FONTANA	60712002	36197	34.099	-117.492	60712002-36197	SCAQMD	2008
INDIO	60652002	33157	33.707	-116.216	60652002-33157	SCAQMD	2007-2008
LA HABRA	60595001	30177	33.923	-117.952	60595001-30177	SCAQMD	2008
LAKE ELSINORE	60659001	33158	33.675	-117.331	60659001-33158	SCAQMD	2008
LAX	60375005	70111	33.952	-118.430	60375005-70111	SCAQMD	2007-2008
LONG BEACH	60374002	70072	33.822	-118.189	60374002-70072	SCAQMD	2007-2008
MISSION VIEJO	60592022	30002	33.628	-117.675	60592022-30002	SCAQMD	2007-2008

Station Name	USAF (ISH/NWS) or AIRS (SCAQMD)	WBAN (ISH/NWS) or ARB (SCAQMD)	Latitude	Longitude	Station ID (USAF-WBAN for ISH/NWS and AIRS-ARB for SCAQMD data)	Data Source	Years Available
PALM SPRINGS	60655001	33137	33.851	-116.541	60655001-33137	SCAQMD	2008
PERRIS	60656001	33149	33.787	-117.228	60656001-33149	SCAQMD	2007-2008
PICO RIVERA	60371602	70185	34.008	-118.069	60371602-70185	SCAQMD	2008
POMONA	60371701	70075	34.065	-117.750	60371701-70075	SCAQMD	2008
REDLANDS	60714003	36204	34.057	-117.148	60714003-36204	SCAQMD	2007-2008
RESEDA	60371201	70074	34.197	-118.533	60371201-70074	SCAQMD	2008
RIVERSIDE	60658001	33144	33.999	-117.415	60658001-33144	SCAQMD	2007-2008
SAB BERNADINO	60719004	36203	34.105	-117.274	60719004-36203	SCAQMD	2007-2008
SANTA CLARA	60376012	70090	34.382	-118.528	60376012-70090	SCAQMD	2006-2008
UPLAND	60711004	36175	34.102	-117.629	60711004-36175	SCAQMD	2008
WEST LA	60370113	70091	34.049	-118.457	60370113-70091	SCAQMD	2006, 2008

Table B-2. Upper Air Meteorological Station in CALPUFF Domain

Station Name	USAF	WBAN	Lat	Long	Station ID (USAF-WBAN)	Data Source	Years Available
MIRMAR	722930	03190	32.87	117.15	722930-03190	**NOAA/ESRL**	2005-2008

Attachment C

Sample CALPUFF Input File

CALPUFF Demonstration Run

```
---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT =CMET.DAT   !
    or
ISCMET.DAT    input    * ISCDAT =             *
    or
PLMMET.DAT    input    * PLMDAT =             *
    or
PROFILE.DAT   input    * PRFDAT =             *
SURFACE.DAT   input    * SFCDAT =             *
RESTARTB.DAT  input    ! RSTARTB=CPUF.out!
--------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST =CPUF.LST  !
CONC.DAT      output   ! CONDAT =CPUF.CON     !
DFLX.DAT      output   ! DFDAT  =CPUF.DRY     !
WFLX.DAT      output   ! WFDAT  =CPUF.WET     !

VISB.DAT      output   ! VISDAT =CPUF.VIS     !
TK2D.DAT      output   * T2DDAT =             *
RHO2D.DAT     output   * RHODAT =             *
RESTARTE.DAT  output  ! RSTARTE= CPUF.rst    !
--------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =             *
VOLEMARB.DAT  input    * VOLDAT =             *
BAEMARB.DAT   input    * ARDAT  =             *
LNEMARB.DAT   input    * LNDAT  =             *
--------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    ! OZDAT  =OZONE.DAT    !
VD.DAT        input    * VDDAT  =             *
CHEM.DAT      input    * CHEMDAT=             *
H2O2.DAT      input    * H2O2DAT=             *
HILL.DAT      input    * HILDAT=             *
HILLRCT.DAT   input    * RCTDAT=             *
COASTLN.DAT   input    * CSTDAT=             *
FLUXBDY.DAT   input    * BDYDAT=             *
BCON.DAT      input    * BCNDAT=             *
DEBUG.DAT     output   * DEBUG =             *
MASSFLX.DAT   output   * FLXDAT=             *
MASSBAL.DAT   output   * BALDAT=             *
FOG.DAT       output   * FOGDAT=             *
--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length
```

```
Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                     Default: 1       ! NMETDAT =   12   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                     Default: 0       ! NPTDAT =  0  !

     Number of BAEMARB.DAT files for run (NARDAT)
                                     Default: 0       ! NARDAT =  0  !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                     Default: 0       ! NVOLDAT =  0  !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if NMETDAT>1

Default Name  Type          File Name
------------  ----          ---------
 none         input    ! METDAT=   ~\CALMET\calpuff_jan08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_feb08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_mar08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_apr08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_may08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_jun08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_jul08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_aug08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_sep08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_oct08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_nov08.met  !   !END!
 none         input    ! METDAT=   ~\CALMET\calpuff_dec08.met  !   !END!


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0       ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:   Year (IBYR) -- No default       ! IBYR =  2008  !
     (used only if   Month (IBMO) -- No default       ! IBMO =  1  !
      METRUN = 0)      Day (IBDY) -- No default       ! IBDY =  1  !
                      Hour (IBHR) -- No default       ! IBHR =  0  !

     Note: IBHR is the time at the END of the first hour of the simulation
           (IBHR=1, the first hour of a day, runs from 00:00 to 01:00)

     Base time zone        (XBTZ) -- No default       ! XBTZ = 8.0  !
     The zone is the number of hours that must be
     ADDED to the time to obtain UTC (or GMT)
```

```
Examples: PST = 8., MST = 7.
          CST = 6., EST = 5.

Length of run (hours) (IRLG) -- No default       ! IRLG =  8784  !

Number of chemical species (NSPEC)
                                Default: 5       ! NSPEC =  9   !

Number of chemical species
to be emitted  (NSE)            Default: 3       ! NSE =  7   !

Flag to stop run after
SETUP phase (ITEST)             Default: 2       ! ITEST =  2   !
(Used to allow checking
of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of program
                  after SETUP

Restart Configuration:

   Control flag (MRESTART)      Default: 0       ! MRESTART =  0   !

      0 = Do not read or write a restart file
      1 = Read a restart file at the beginning of
          the run
      2 = Write a restart file during run
      3 = Read a restart file at beginning of run
          and write a restart file during run

   Number of periods in Restart
   output cycle (NRESPD)        Default: 0       ! NRESPD =  0   !

      0 = File written only at last period
     >0 = File updated every NRESPD periods

Meteorological Data Format (METFM)
                                Default: 1       ! METFM =  1   !

      METFM = 1 - CALMET binary file (CALMET.MET)
      METFM = 2 - ISC ASCII file (ISCMET.MET)
      METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
      METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                  surface parameters file (SURFACE.DAT)
      METFM = 5 - AERMET tower file (PROFILE.DAT) and
                  surface parameters file (SURFACE.DAT)

Meteorological Profile Data Format (MPRFFM)
       (used only for METFM = 1, 2, 3)
                                Default: 1       ! MPRFFM =  1   !

      MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
      MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
Averaging Time (minutes) (AVET)
                                Default: 60.0    ! AVET = 60. !
PG Averaging Time (minutes) (PGTIME)
                                Default: 60.0    ! PGTIME = 60. !


!END!
```

```
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     ! MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     ! MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     ! MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     ! MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     ! MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)

     Stack tip downwash? (MTIP)            Default: 1     ! MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     ! MBDW =   1  !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top? (MSHEAR)                   Default: 0     ! MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     ! MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     ! MCHEM =  1   !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
```

```
        computed (MESOPUFF II scheme for OH)

Aqueous phase transformation flag (MAQCHEM)
(Used only if MCHEM = 1, or 3)        Default: 0     ! MAQCHEM =  0   !
   0 = aqueous phase transformation
        not modeled
   1 = transformation rates adjusted
        for aqueous phase reactions

Wet removal modeled ? (MWET)          Default: 1     ! MWET =  1   !
   0 = no
   1 = yes

Dry deposition modeled ? (MDRY)       Default: 1     ! MDRY =  1   !
   0 = no
   1 = yes
   (dry deposition method specified
    for each species in Input Group 3)


Gravitational settling (plume tilt)
modeled ? (MTILT)                     Default: 0     ! MTILT =  0   !
   0 = no
   1 = yes
   (puff center falls at the gravitational
    settling velocity for 1 particle species)

Restrictions:
    - MDRY  = 1
    - NSPEC = 1  (must be particle species as well)
    - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8 is
                 set to zero for a single particle diameter

Method used to compute dispersion
coefficients (MDISP)                  Default: 3     ! MDISP =  3   !

   1 = dispersion coefficients computed from measured values
        of turbulence, sigma v, sigma w
   2 = dispersion coefficients from internally calculated
        sigma v, sigma w using micrometeorological variables
        (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
        the ISCST multi-segment approximation) and MP coefficients in
        urban areas
   4 = same as 3 except PG coefficients computed using
        the MESOPUFF II eqns.
   5 = CTDM sigmas used for stable and neutral conditions.
        For unstable conditions, sigmas are computed as in
        MDISP = 3, described above.  MDISP = 5 assumes that
        measured values are read

Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
(Used only if MDISP = 1 or 5)         Default: 3     ! MTURBVW =  3  !
   1 = use sigma-v or sigma-theta measurements
        from PROFILE.DAT to compute sigma-y
        (valid for METFM = 1, 2, 3, 4, 5)
   2 = use sigma-w measurements
        from PROFILE.DAT to compute sigma-z
        (valid for METFM = 1, 2, 3, 4, 5)
   3 = use both sigma-(v/theta) and sigma-w
        from PROFILE.DAT to compute sigma-y and sigma-z
        (valid for METFM = 1, 2, 3, 4, 5)
   4 = use sigma-theta measurements
```

```
        from PLMMET.DAT to compute sigma-y
        (valid only if METFM = 3)

Back-up method used to compute dispersion
when measured turbulence data are
missing (MDISP2)                      Default: 3     ! MDISP2 =  3  !
(used only if MDISP = 1 or 5)
   2 = dispersion coefficients from internally calculated
       sigma v, sigma w using micrometeorological variables
       (u*, w*, L, etc.)
   3 = PG dispersion coefficients for RURAL areas (computed using
       the ISCST multi-segment approximation) and MP coefficients in
       urban areas
   4 = same as 3 except PG coefficients computed using
       the MESOPUFF II eqns.

[DIAGNOSTIC FEATURE]
Method used for Lagrangian timescale for Sigma-y
(used only if MDISP=1,2 or MDISP2=1,2)
(MTAULY)                              Default: 0     ! MTAULY =  0  !
   0 = Draxler default 617.284 (s)
   1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
  10 < Direct user input (s)             -- e.g., 306.9


[DIAGNOSTIC FEATURE]
Method used for Advective-Decay timescale for Turbulence
(used only if MDISP=2 or MDISP2=2)
(MTAUADV)                             Default: 0     ! MTAUADV =  0  !
   0 = No turbulence advection
   1 = Computed (OPTION NOT IMPLEMENTED)
  10 < Direct user input (s)   -- e.g., 300


Method used to compute turbulence sigma-v &
sigma-w using micrometeorological variables
(Used only if MDISP = 2 or MDISP2 = 2)
(MCTURB)                              Default: 1     ! MCTURB =  1  !
   1 = Standard CALPUFF subroutines
   2 = AERMOD subroutines

PG sigma-y,z adj. for roughness?      Default: 0     ! MROUGH =  0  !
(MROUGH)
   0 = no
   1 = yes

Partial plume penetration of          Default: 1     ! MPARTL =  1  !
elevated inversion?
(MPARTL)
   0 = no
   1 = yes

Strength of temperature inversion     Default: 0     ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0     ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes
```

```
Sub-Grid TIBL module used for shore line?
                                      Default: 0     ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0     ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.

Individual source contributions saved?
                                      Default: 0     ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0     ! MFOG =  0   !
(MFOG)
   0 = no
   1 = yes  - report results in PLUME Mode format
   2 = yes  - report results in RECEPTOR Mode format


Test options specified to see if
they conform to regulatory
values? (MREG)                        Default: 1     ! MREG =  1   !

   0 = NO checks are made
   1 = Technical options must conform to USEPA
       Long Range Transport (LRT) guidance
                  METFM    1 or 2
                  AVET     60. (min)
                  PGTIME   60. (min)
                  MGAUSS   1
                  MCTADJ   3
                  MTRANS   1
                  MTIP     1
                  MCHEM    1 or 3 (if modeling SOx, NOx)
                  MWET     1
```

```
MDRY      1
MDISP     2 or 3
MPDF      0 if MDISP=3
          1 if MDISP=2
MROUGH    0
MPARTL    1
SYTDEP    550. (m)
MHFTSZ    0
SVMIN     0.5 (m/s)
```

```
!END!


-------------------------------------------------------------------------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          SO2 !         !END!
! CSPEC =          SO4 !         !END!
! CSPEC =          NOX !         !END!
! CSPEC =          HNO3!         !END!
! CSPEC =          NO3 !         !END!
! CSPEC =          PMC !         !END!
! CSPEC =          SOA !         !END!
! CSPEC =          PMF !         !END!
! CSPEC =          EC  !         !END!
                                                              Dry                 OUTPUT
GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED                NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)    (0=NO,                  (0=NONE,
   (Limit: 12                                        1=COMPUTED-GAS          1=1st
CGRUP,
    Characters                                       2=COMPUTED-PARTICLE     2=2nd
CGRUP,
    in length)                                       3=USER-SPECIFIED)       3= etc.)

!          SO2  =         1,               1,           1,                 0   !
!          SO4  =         1,               1,           2,                 0   !
!          NOX  =         1,               1,           1,                 0   !
!          HNO3 =         1,               0,           1,                 0   !
!          NO3  =         1,               0,           2,                 0   !
!          PMC  =         1,               1,           2,                 0   !
!          SOA  =         1,               1,           2,                 0   !
!          PMF  =         1,               1,           2,                 0   !

!          EC   =         1,               1,           2,                 0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using the
         boundary condition option (MBCON > 0).  Species BCON should
         typically be modeled as inert (no chem transformation or
         removal).
```

```
-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



--------------------------------------------------------------------------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (PMAP)                     Default: UTM    ! PMAP = LCC !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
         PS  :  Polar Stereographic
         EM  :  Equatorial Mercator
         LAZA:  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN = 11 !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = N !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 34.06179N !
     (RLON0)                    No Default      ! RLON0 = 117.8192W !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
                RLAT0 identifies latitude of tangent-point of mapping plane

     Matching parallel(s) of latitude (decimal degrees) for projection
```

```
     (Used only if PMAP= LCC or PS)
     (RLAT1)                    No Default      ! RLAT1 = 33.0N !
     (RLAT2)                    No Default      ! RLAT2 = 35.0N !

         LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
         PS  :  Projection plane slices through Earth at RLAT1
                (RLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Output Datum-Region
     -------------------

     The Datum-Region for the output coordinates is identified by a character
     string.  Many mapping products currently available use the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in TERREL will make its output
     consistent with local mapping products.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     and Mapping Agency (NIMA).

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84 !



     Grid
     ----

     Reference coordinates X,Y (km) assigned to the southwest corner
     of grid cell (1,1)  (lower left corner of grid)
     (XREFKM)                   No Default      ! XREFKM = -78  !
     (YREFKM)                   No Default      ! YREFKM = -84 !

     Cartesian grid definition
     No. X grid cells (NX)      No default      ! NX =   39  !
     No. Y grid cells (NY)      No default      ! NY =   42  !
     Grid Spacing (DGRIDKM)     No default      ! DGRIDKM = 4 !
     in kilometers

!END!

-------------------------------------------------------------------------------

-------------------------------------------------------------------------------


INPUT GROUP: 5 -- Output Options
--------------
                                             *                          *
     FILE                       DEFAULT VALUE             VALUE THIS RUN
     ----                       -------------             --------------

   Concentrations (ICON)              1                   !  ICON =  1   !
   Dry Fluxes (IDRY)                  1                   !  IDRY =  1   !
   Wet Fluxes (IWET)                  1                   !  IWET =  1   !
```

```
2D Temperature (IT2D)             0                    !  IT2D =  0   !
2D Density (IRHO)                 0                    !  IRHO =  0   !
Relative Humidity (IVIS)          1                    !  IVIS =  1   !
 (relative humidity file is
  required for visibility
  analysis)
Use data compression option in output file?
(LCOMPRS)                          Default: T          ! LCOMPRS = T !

*
 0 = Do not create file, 1 = create file


 QA PLOT FILE OUTPUT OPTION:

    Create a standard series of output files (e.g.
    locations of sources, receptors, grids ...)
    suitable for plotting?
    (IQAPLOT)                      Default: 1          !  IQAPLOT =  1   !
      0 = no
      1 = yes

 DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

    Mass flux across specified boundaries
    for selected species reported?
    (IMFLX)                        Default: 0          ! IMFLX =  0  !
      0 = no
      1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
               are specified in Input Group 0)

    Mass balance for each species
    reported?
    (IMBAL)                        Default: 0          ! IMBAL =  0  !
      0 = no
      1 = yes (MASSBAL.DAT filename is
           specified in Input Group 0)


 LINE PRINTER OUTPUT OPTIONS:

    Print concentrations (ICPRT)   Default: 0          ! ICPRT =  1   !
    Print dry fluxes (IDPRT)       Default: 0          ! IDPRT =  0   !
    Print wet fluxes (IWPRT)       Default: 0          ! IWPRT =  0   !
    (0 = Do not print, 1 = Print)

    Concentration print interval
    (ICFRQ) in timesteps           Default: 1          ! ICFRQ =  1   !
    Dry flux print interval
    (IDFRQ) in timesteps           Default: 1          ! IDFRQ =  1   !
    Wet flux print interval
    (IWFRQ) in timesteps           Default: 1          ! IWFRQ =  1   !

    Units for Line Printer Output
    (IPRTU)                        Default: 1          ! IPRTU =  3   !
                for            for
           Concentration    Deposition
        1 =       g/m**3         g/m**2/s
        2 =      mg/m**3       mg/m**2/s
        3 =      ug/m**3       ug/m**2/s
        4 =      ng/m**3       ng/m**2/s
        5 =     Odour Units
```

```
       Messages tracking progress of run
       written to the screen ?
       (IMESG)                         Default: 2         ! IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

                 ---- CONCENTRATIONS ----   ------ DRY FLUXES ------   ------ WET
FLUXES ------   -- MASS FLUX --
   SPECIES
   /GROUP        PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON DISK?   PRINTED?
SAVED ON DISK?   SAVED ON DISK?
   -------       ------------------------   ------------------------
------------------------   ---------------
!          SO2 =     0,           1,           0,           1,           0,
 1,          0   !
!          SO4 =     0,           1,           0,           1,           0,
 1,          0   !
!          NOX =     0,           1,           0,           1,           0,
 1,          0   !
!          HNO3=     0,           1,           0,           1,           0,
 1,          0   !
!          NO3 =     0,           1,           0,           1,           0,
 1,          0   !
!          PMC =     0,           1,           0,           1,           0,
 1,          0   !
!          SOA =     0,           1,           0,           1,           0,
 1,          0   !
!          PMF  =    0,           1,           0,           1,           0,
 1,          0   !
!          EC   =    0,           1,           0,           1,           0,
 1,          0   !

  Note:  Species BCON (for MBCON > 0) does not need to be saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                 Default: F     ! LDEBUG = F !

       First puff to track
       (IPFDEB)                                 Default: 1     ! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                 Default: 1     ! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                    Default: 1     ! NN1 =  1   !

       Met. period to end output
       (NN2)                                    Default: 10    ! NN2 =  10  !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
```

```
------------------------

---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)       Default: 0     ! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                      Default: 0     ! NCTREC =  0   !

       Terrain and CTSG Receptor data for
       CTSG hills input in CTDM format ?
       (MHILL)                                  No Default     ! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0   ! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0   ! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default     ! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default     ! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                      1 **
     HILL information


HILL           XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO 2   SCALE
1    SCALE 2    AMAX1     AMAX2
 NO.          (km)      (km)      (deg.)   (m)     (m)      (m)       (m)       (m)
      (m)       (m)       (m)
----          ----      ----      ------  -----  ------    ------    ------
-------    -------    -----     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT        ZRCT          XHH
                      (km)         (km)         (m)
                     ------        -----      ------         ----


-------------------
1
     Description of Complex Terrain Variables:
```

```
        XC, YC  = Coordinates of center of hill
        THETAH  = Orientation of major axis of hill (clockwise from
                  North)
        ZGRID   = Height of the  0  of the grid above mean sea
                  level
        RELIEF  = Height of the crest of the hill above the grid elevation
        EXPO 1  = Hill-shape exponent for the major axis
        EXPO 2  = Hill-shape exponent for the major axis
        SCALE 1 = Horizontal length scale along the major axis
        SCALE 2 = Horizontal length scale along the minor axis
        AMAX    = Maximum allowed axis length for the major axis
        BMAX    = Maximum allowed axis length for the major axis

        XRCT, YRCT = Coordinates of the complex terrain receptors
        ZRCT    = Height of the ground (MSL) at the complex terrain
                  Receptor
        XHH     = Hill number associated with each complex terrain receptor
                  (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group terminator.

-------------------------------------------------------------------------------


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)                                             (s/cm)
         (dimensionless)
      -------     -----------      ----------      ----------
--------------------     -----------------------

!          SO2 =      .1509,        1000.0,           8.0,                 .0,
          .04 !
!           NO =      .1345,           1.0,           2.0,               25.0,
         18.0 !
!          NO2 =      .1656,           1.0,           8.0,                5.0,
          3.5 !
!         HNO3 =      .1628,           1.0,          18.0,                 .0,
      .0000001 !

!END!


-------------------------------------------------------------------------------


INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.
```

```
      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME             DIAMETER                   DEVIATION
                        (microns)                  (microns)
      -------      -------------------        ------------------
!          SO4 =          0.48,                      2.    !
!          NO3 =          0.48,                      2.    !
!          PMC  =         6.0 ,                      6.    !
!          SOA =          0.48,                      2.    !
!          PMF =          1.0 ,                      1.5   !
!          EC  =          1.0 ,                      1.5   !

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR = 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR = 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR = 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     !   NINT =  9  !

     Vegetation state in unirrigated areas
     (IVEG)                           Default: 1     !   IVEG =  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------


INPUT GROUP: 10 -- Wet Deposition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
!          SO2 =         3.0E-05,              0.0E00 !
!          SO4 =         1.0E-04,             3.0E-05 !
!         HNO3 =         6.0E-05,              0.0E00 !
!          NO3 =         1.0E-04,             3.0E-05 !
!         PMC  =         1.0E-04,             3.0E-05 !
!          SOA =         1.0E-04,             3.0E-05 !
!          PMF =         1.0E-04,             3.0E-05 !
!          EC   =         1.0E-04,             3.0E-05 !

!END!
```

```
--------------------------------------------------------------------------------


INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  1   !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.
     !  BCKO3 = 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00, 40.00,
40.00, 40.00, 40.00 !

     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.
     !  BCKNH3 = 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00, 2.00,
2.00 !

     Nighttime SO2 loss rate (RNITE1)
     in percent/hour                   Default: 0.2          ! RNITE1 = .2 !

     Nighttime NOx loss rate (RNITE2)
     in percent/hour                   Default: 2.0          ! RNITE2 = 2.0 !

     Nighttime HNO3 formation rate (RNITE3)
     in percent/hour                   Default: 2.0          ! RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)    Default: 1            ! MH2O2 =  1   !
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations
     (Used only if MQACHEM = 1 and
      MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
     (BCKH2O2) in ppb                  Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
```

```
   BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
   OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
   VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

Clean Marine (surface)
   BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
   OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
   VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

Urban - low biogenic (controls present)
   BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
   OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
   VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.

Urban - high biogenic (controls present)
   BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.  60.
   OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35  .35  .35  .25
   VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

Regional Plume
   BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.  20.
   OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30  .30  .30  .20
   VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.  15.

Urban - no controls present
   BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
   OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35  .35  .35  .30
   VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.   2.

Default: Clean Continental
!  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00 !
!  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.15 !
!  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00 !


!END!


-------------------------------------------------------------------------------


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                           Default: 550.   ! SYTDEP = 5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                   Default: 0      ! MHFTSZ =  0   !

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                               Default: 5      ! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)     Default: 0.01   ! CONK1 = .01 !
```

```
Vertical dispersion constant for neutral/
unstable conditions (k2 in Eqn. 2.7-4)
(CONK2)                                   Default: 0.1    ! CONK2 = .1 !

Factor for determining Transition-point from
Schulman-Scire to Huber-Snyder Building Downwash
scheme (SS used for Hs < Hb + TBD * HL)
(TBD)                                     Default: 0.5    ! TBD = .5 !
   TBD < 0   ==> always use Huber-Snyder
   TBD = 1.5 ==> always use Schulman-Scire
   TBD = 0.5 ==> ISC Transition-point

Range of land use categories for which
urban dispersion is assumed
(IURB1, IURB2)                            Default: 10     ! IURB1 =  10  !
                                                   19     ! IURB2 =  19  !

Site characterization parameters for single-point Met data files ---------
(needed for METFM = 2,3,4,5)

   Land use category for modeling domain
   (ILANDUIN)                             Default: 20     ! ILANDUIN =  20  !

   Roughness length (m) for modeling domain
   (Z0IN)                                 Default: 0.25   ! Z0IN = .25 !

   Leaf area index for modeling domain
   (XLAIIN)                               Default: 3.0    ! XLAIIN = 3.0 !

   Elevation above sea level (m)
   (ELEVIN)                               Default: 0.0    ! ELEVIN = .0 !

   Latitude (degrees) for met location
   (XLATIN)                               Default: -999.  ! XLATIN = .0 !

   Longitude (degrees) for met location
   (XLONIN)                               Default: -999.  ! XLONIN = .0 !

Specialized information for interpreting single-point Met data files -----

   Anemometer height (m) (Used only if METFM = 2,3)
   (ANEMHT)                               Default: 10.    ! ANEMHT = 10.0 !

   Form of lateral turbulance data in PROFILE.DAT file
   (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
   (ISIGMAV)                              Default: 1      ! ISIGMAV =  1  !
       0 = read sigma-theta
       1 = read sigma-v

   Choice of mixing heights (Used only if METFM = 4)
   (IMIXCTDM)                             Default: 0      ! IMIXCTDM =  0  !
       0 = read PREDICTED mixing heights
       1 = read OBSERVED mixing heights

Maximum length of a slug (met. grid units)
(XMXLEN)                                  Default: 1.0    ! XMXLEN = 1.0 !

Maximum travel distance of a puff/slug (in
grid units) during one sampling step
(XSAMLEN)                                 Default: 1.0    ! XSAMLEN = 1.0 !

Maximum Number of slugs/puffs release from
one source during one time step
```

```
     (MXNEW)                                   Default: 99     ! MXNEW =  99   !

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                   Default: 99     ! MXSAM =  99   !

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                  Default: 2      ! NCOUNT =  2   !

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                   Default: 1.0    ! SYMIN = 1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                   Default: 1.0    ! SZMIN = 1.0  !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                     ----------  LAND  ----------       ---------  WATER  ----------
        Stab Class :  A    B    C    D    E    F         A    B    C    D    E    F
                     ---  ---  ---  ---  ---  ---       ---  ---  ---  ---  ---  ---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37, .37, .37, .37, .37, .37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20, .12, .08, .06, .03,
.016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500, 0.500,
0.500, 0.500, 0.500 !
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016, 0.200, 0.120, 0.080,
0.060, 0.030, 0.016 !

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                 Default: 0.0,0.0  ! CDIV = .0, .0 !

     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                  Default: 0.5    ! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                  Default: 3000.  ! XMAXZI = 3000.0 !

     Minimum mixing height (m)
     (XMINZI)                                  Default: 50.    ! XMINZI = 50.0 !

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                      Default   :
                                     ISC RURAL : 1.54, 3.09, 5.14, 8.23, 10.8
(10.8+)

                              Wind Speed Class :  1     2     3     4     5
                                                 ---   ---   ---   ---   ---
                                       ! WSCAT = 1.54, 3.09, 5.14, 8.23, 10.80 !
```

```
     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                        Default   : ISC RURAL values
                                      ISC RURAL : .07, .07, .10, .15, .35, .55
                                      ISC URBAN : .15, .15, .20, .25, .30, .30

                                Stability Class :  A     B     C     D     E     F
                                                  ---   ---   ---   ---   ---   ---
                                         ! PLX0 = 0.07, 0.07, 0.10, 0.15, 0.35, 0.55
!

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                        Default: 0.020, 0.035
                                         ! PTG0 = 0.020,   0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                   Stability Class :  A     B     C     D     E     F
                                   Default  PPC : .50,  .50,  .50,  .50,  .35,  .35
                                                  ---   ---   ---   ---   ---   ---
                                         !  PPC = 0.50, 0.50, 0.50, 0.50, 0.35, 0.35
!

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                            Default: 10.        ! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                         Default:   3        ! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                   Default:  Hour 17 = 1
       !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                        Default: 100.       ! ZISPLIT = 100.0 !

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                        Default: 0.25       ! ROLDMAX = 0.25 !


       HORIZONTAL SPLIT
       ----------------
```

```
       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                          Default:   5        ! NSPLITH =  5  !

       Minimum sigma-y (Grid Cells Units) of puff
       before it may be split
       (SYSPLITH)                         Default:  1.0       ! SYSPLITH = 1.0 !

       Minimum puff elongation rate (SYSPLITH/hr) due to
       wind shear, before it may be split
       (SHSPLITH)                         Default:  2.        ! SHSPLITH = 2.0 !

       Minimum concentration (g/m^3) of each
       species in puff before it may be split
       Enter array of NSPEC values; if a single value is
       entered, it will be used for ALL species
       (CNSPLITH)                         Default:  1.0E-07   ! CNSPLITH = 1.0E-07
!

     Integration control variables ------------------------

       Fractional convergence criterion for numerical SLUG
       sampling integration
       (EPSSLUG)                          Default:   1.0e-04  ! EPSSLUG = 1.0E-04 !

       Fractional convergence criterion for numerical AREA
       source integration
       (EPSAREA)                          Default:   1.0e-06  ! EPSAREA = 1.0E-06 !

       Trajectory step-length (m) used for numerical rise
       integration
       (DSRISE)                           Default:   1.0      ! DSRISE = 1.0 !

       Boundary Condition (BC) Puff control variables ------------------------

       Minimum height (m) to which BC puffs are mixed as they are emitted
       (MBCON=2 ONLY).  Actual height is reset to the current mixing height
       at the release point if greater than this minimum.
       (HTMINBC)                          Default:   500.     ! HTMINBC = 500.0 !

       Search radius (km) about a receptor for sampling nearest BC puff.
       BC puffs are typically emitted with a spacing of one grid cell
       length, so the search radius should be greater than DGRIDKM.
       (RSAMPBC)                          Default:   10.      ! RSAMPBC = 10.0 !

       Near-Surface depletion adjustment to concentration profile used when
       sampling BC puffs?
       (MDEPBC)                           Default:   1        ! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------


INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
```

```
---------------

     Number of point sources with
     parameters provided below      (NPT1)  No default  !  NPT1 =  TBD  !

     Units used for point source
     emissions below                (IPTU)  Default: 1  !  IPTU =   1  !
           1 =       g/s
           2 =      kg/hr
           3 =      lb/hr
           4 =    tons/yr
           5 =    Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =    Odour Unit * m**3/min
           7 =    metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (13d)        (NSPT1) Default: 0  !  NSPT1 =  0  !

     Number of point sources with
     variable emission parameters
     provided in external file      (NPT2)  No default  !  NPT2 =  0  !

     (If NPT2 > 0, these point
     source emissions are read from
     the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                         a
          POINT SOURCE: CONSTANT DATA
          -----------------------------
                                                                                 b
    c
  Source       X          Y       Stack    Base     Stack    Exit  Exit    Bldg.
Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.   Dwash
Rates
              (km)      (km)       (m)      (m)       (m)  (m/s) (deg. K)
  ------   ---------- ---------- ------  ------   -------- ----- -------- -----
--------
   1 ! SRCNAM = TBD !
   1 ! X =    TBD !
   1 ! ZPLTFM  =       .0 !
   1 ! FMFAC  =      1.0 !   !END!

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

     SRCNAM  is a 12-character name for a source
             (No default)
     X       is an array holding the source data listed by the column headings
             (No default)
     SIGYZI  is an array holding the initial sigma-y and sigma-z (m)
             (Default: 0.,0.)
     FMFAC   is a vertical momentum flux factor (0. or 1.0) used to represent
```

```
          the effect of rain-caps or other physical configurations that
          reduce momentum rise associated with the actual exit velocity.
          (Default: 1.0  -- full momentum used)
  ZPLTFM  is the platform height (m) for sources influenced by an isolated
          structure that has a significant open area between the surface
          and the bulk of the structure, such as an offshore oil platform.
          The Base Elevation is that of the surface (ground or ocean),
          and the Stack Height is the release height above the Base (not
          above the platform).  Building heights entered in Subgroup 13c
          must be those of the buildings on the platform, measured from
          the platform deck.  ZPLTFM is used only with MBDW=1 (ISC
          downwash method) for sources with building downwash.
          (Default: 0.0)

    b
     0. = No building downwash modeled
     1. = Downwash modeled for buildings resting on the surface
     2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

           BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
           -------------------------------------------------------
Source                                                                  a
 No.       Effective building height, width, length and X/Y offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
           MBDW=2 (PRIME downwash option)
------     --------------------------------------------------------------------
1 ! SRCNAM =    TDB  !
1 ! HEIGHT =      TBD !
1 ! WIDTH =       TBD!
!END!

--------

    a
     Building height, width, length, and X/Y offset from the source are treated
     as a separate input subgroup for each source and therefore must end with
     an input group terminator.  The X/Y offset is the position, relative to the
     stack, of the center of the upwind face of the projected building, with the
     x-axis pointing along the flow direction.

---------------
Subgroup (13d)
---------------
                                                     a
          POINT SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.
```

```
     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below            (IARU)       Default: 1  !  IARU =   1  !
           1 =        g/m**2/s
           2 =       kg/m**2/hr
           3 =       lb/m**2/hr
           4 =     tons/m**2/yr
           5 =     Odour Unit * m/s  (vol. flux/m**2 of odour compound)
           6 =     Odour Unit * m/min
           7 =     metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !  NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
---------------
```

```
                                  a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                                 b
Source           Effect.    Base      Initial    Emission
 No.             Height   Elevation   Sigma z     Rates
                   (m)       (m)        (m)
-------          ------    ------     --------   ---------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).

---------------
Subgroup (14c)
---------------

           COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
           --------------------------------------------------------
Source                                                               a
 No.       Ordered list of X followed by list of Y, grouped by source
------     ------------------------------------------------------------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.


---------------
Subgroup (14d)
---------------
                                                    a
          AREA SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 14b.  Factors entered multiply the rates in 14b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                             Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
```

```
--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                               No default  !  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)         No default   ! NLINES =  0  !

     Units used for line source
     emissions below               (ILNU)            Default: 1  !  ILNU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (15c)       (NSLN1) Default: 0  !  NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                              Default: 7   ! MXNSEG =  7  !

     The following variables are required only if NLINES > 0.  They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                 Default: 6   ! NLRISE =  6  !
        transitional rise is computed

        Average building length (XL)                 No default   ! XL = .0 !
                                                     (in meters)

        Average building height (HBL)                No default   ! HBL = .0 !
                                                     (in meters)

        Average building width (WBL)                 No default   ! WBL = .0 !
                                                     (in meters)

        Average line source width (WML)              No default   ! WML = .0 !
                                                     (in meters)
```

```
        Average separation between buildings (DXL)  No default   ! DXL = .0 !
                                                    (in meters)

        Average buoyancy parameter (FPRIMEL)        No default   ! FPRIMEL = .0 !
                                                    (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

     a
Source     Beg. X      Beg. Y      End. X    End. Y     Release    Base
Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height    Elevation
Rates
            (km)        (km)        (km)      (km)       (m)       (m)
------   ----------  ----------  ---------  ----------  -------   ---------
---------

--------

    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.

    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by ILNTU
     (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                               a
          BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
          ----------------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 15b.  Factors entered multiply the rates in 15b.
     Skip sources here that have constant emissions.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)
```

```
--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------


INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 =  0   !

     Units used for volume source
     emissions below in 16b       (IVLU)     Default: 1  !  IVLU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)      (NSVL1)    Default: 0  !  NSVL1 =  0  !

     Number of volume sources with
     variable location and emission
     parameters                   (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                            a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------
                                                                               b
         X           Y        Effect.    Base     Initial    Initial    Emission
     Coordinate  Coordinate   Height   Elevation  Sigma y    Sigma z     Rates
        (km)        (km)        (m)       (m)       (m)        (m)
     ----------  ----------   ------    ------    --------   --------   --------


--------
    a
     Data for each source are treated as a separate input subgroup
     and therefore must end with an input group terminator.
```

```
    b
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IVLU
     (e.g. 1 for g/s).

---------------
Subgroup (16c)
---------------
                                                     a
          VOLUME SOURCE: VARIABLE EMISSIONS DATA
          ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 16b.  Factors entered multiply the rates in 16b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours 1-24)
           2 =       Monthly cycle (12 scaling factors: months 1-12)
           3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                    where first group is DEC-JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                    first group is Stability Class A,
                                    and the speed classes have upper
                                    bounds (m/s) defined in Group 12
           5 =       Temperature   (12 scaling factors, where temperature
                                    classes have upper bounds (C) of:
                                    0, 5, 10, 15, 20, 25, 30, 35, 40,
                                    45, 50, 50+)



--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.


-------------------------------------------------------------------------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC =  0   !

!END!

---------------
Subgroup (17b)
---------------
                                                     a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------
```

Receptor No.	X Coordinate (km)	Y Coordinate (km)	Ground Elevation (m)	Height [b] Above Ground (m)

```
1! X =  TDB,    TBD,    TBD,    TBD!    !END!   name
```

----

a Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

b Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

Attachment D

Sample CALPOST and POSTUTIL Input Files

CALPUFF Demonstration

```
---------------- Run title (3 lines) ------------------------------------------

                    CALPOST MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names
--------------

Input Files
-----------

File                       Default File Name
----                       -----------------
Conc/Dep Flux File         MODEL.DAT          ! MODDAT =CALPUFF.CON   !
Relative Humidity File     VISB.DAT           ! VISDAT =  ..\..CPUF.VIS! *
Background Data File       BACK.DAT           * BACKDAT =   *
Transmissometer or         VSRN.DAT           * VSRDAT =   *
Nephelometer Data File      or
DATSAV Weather Data File    or
Prognostic Weather  File

Single-point Met File      SURFACE.DAT        * MET1DAT =   *
 (Used ONLY to identify CALM hours for plume model
  output averaging when MCALMPRO option is used)


Output Files
------------

File                       Default File Name
----                       -----------------
List File                  CALPOST.LST        ! PSTLST =CALPOST.LST   !

Pathname for Timeseries Files   (blank)       * TSPATH =   *
(activate with exclamation points only if
providing NON-BLANK character string)

Pathname for Plot Files   (blank)             * PLPATH =   *
(activate with exclamation points only if
 providing NON-BLANK character string)

User Character String (U) to augment default filenames
(activate with exclamation points only if
 providing NON-BLANK character string)

Timeseries          TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT
Peak Value          PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT

                                              * TSUNAM =   *

Top Nth Rank Plot   RANK(ALL)_ASPEC_ttHR_CONC_TUNAM.DAT
                or  RANK(ii)_ASPEC_ttHR_CONC_TUNAM.GRD

                                              * TUNAM =   *

Exceedance Plot      EXCEED_ASPEC_ttHR_CONC_XUNAM.DAT
                 or  EXCEED_ASPEC_ttHR_CONC_XUNAM.GRD
```

```
                                               * XUNAM =   *

Echo Plot
(Specific Days)
           yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.DAT
     or    yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.GRD


Visibility Plot      DAILY_VISIB_VUNAM.DAT   ! VUNAM =VTEST   !
(Daily Peak Summary)


Auxiliary Output Files
----------------------

File                      Default File Name
----                      -----------------
Visibility Change         DELVIS.DAT         * DVISDAT =   *

--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case               ! LCFILES = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in length
NOTE: (2) Filenames for ALL PLOT and TIMESERIES FILES are constructed
          using a template that includes a pathname, user-supplied
          character(s), and context-specific strings, where
             ASPEC = Species Name
              CONC = CONC Or WFLX Or DFLX Or TFLX
                tt = Averaging Period (e.g. 03)
                ii = Rank (e.g. 02)
                hh = Hour(ending) in LST
             szzzz = LST time zone shift (EST is -0500)
              yyyy = Year(LST)
                mm = Month(LST)
                dd = day of month (LST)
          are determined internally based on selections made below.
          If a path or user-supplied character(s) are supplied, each
          must contain at least 1 non-blank character.

!END!
--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

     Option to run all periods found
     in the met. file(s)  (METRUN)       Default: 0   ! METRUN =   1  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in CALPUFF data file(s)

     Starting date:    Year   (ISYR)  --    No default   ! ISYR  =  2008  !
                       Month  (ISMO)  --    No default   ! ISMO  =  1  !
                       Day    (ISDY)  --    No default   ! ISDY  =  1  !
     Starting time:    Hour   (ISHR)  --    No default   ! ISHR  =  0  !
                       Minute (ISMIN) --    No default   ! ISMIN =  0  !
                       Second (ISSEC) --    No default   ! ISSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2008  !
                       Month  (IEMO)  --    No default   ! IEMO  =  12  !
                       Day    (IEDY)  --    No default   ! IEDY  =  31  !
```

```
      Ending time:       Hour   (IEHR)  --    No default   ! IEHR  =  23  !
                         Minute (IEMIN) --    No default   ! IEMIN =  0  !
                         Second (IESEC) --    No default   ! IESEC =  0  !

      (These are only used if METRUN = 0)

      All times are in the base time zone of the CALPUFF simulation.
      CALPUFF Dataset Version 2.1 contains the zone, but earlier versions
      do not, and the zone must be specified here.  The zone is the
      number of hours that must be ADDED to the time to obtain UTC (or GMT).
      Identify the Base Time Zone for the CALPUFF simulation
                               (BTZONE) -- No default   ! BTZONE = 8.0 !

      Process every period of data?
                                 (NREP) -- Default: 1   ! NREP  =  1  !
       (1 = every period processed,
        2 = every 2nd period processed,
        5 = every 5th period processed, etc.)

 Species & Concentration/Deposition Information
 ----------------------------------------------

       Species to process (ASPEC)       -- No default   ! ASPEC = VISIB  !
       (ASPEC = VISIB for visibility processing)

       Layer/deposition code (ILAYER)   -- Default: 1   ! ILAYER =  1  !
         '1'  for CALPUFF concentrations,
         '-1' for dry deposition fluxes,
         '-2' for wet deposition fluxes,
         '-3' for wet+dry deposition fluxes.

       Scaling factors of the form:     -- Defaults:    ! A =  0.0    !
             X(new) = X(old) * A + B         A = 0.0    ! B =  0.0    !
         (NOT applied if A = B = 0.0)        B = 0.0

       Add Hourly Background Concentrations/Fluxes?
                               (LBACK)  -- Default: F   ! LBACK =  F !


       Source of NO2 when ASPEC=NO2 (above) or LVNO2=T (Group 2) may be
       from CALPUFF NO2 concentrations OR from a fraction of CALPUFF NOx
       concentrations.  Specify the fraction of NOx that is treated as NO2
       either as a constant or as a table of fractions that depend on the
       magnitude of the NOx concentration:
                              (NO2CALC) -- Default: 1   ! NO2CALC =   1  !
          0 =  Use NO2 directly (NO2 must be in file)
          1 =  Specify a single NO2/NOx ratio (RNO2NOX)
          2 =  Specify a table NO2/NOx ratios (TNO2NOX)
               (NOTE: Scaling Factors must NOT be used with NO2CALC=2)

       Single NO2/NOx ratio (0.0 to 1.0) for treating some
       or all NOx as NO2, where [NO2] = [NOX] * RNO2NOX
       (used only if NO2CALC = 1)
                              (RNO2NOX) -- Default: 1.0 ! RNO2NOX = 1.0 !

       Table of NO2/NOx ratios that vary with NOx concentration.
       Provide 14 NOx concentrations (ug/m**3) and the corresponding
       NO2/NOx ratio, with NOx increasing in magnitude.  The ratio used
       for a particular NOx concentration is interpolated from the values
       provided in the table.  The ratio for the smallest tabulated NOx
       concentration (the first) is used for all NOx concentrations less
       than the smallest tabulated value, and the ratio for the largest
       tabulated NOx concentration (the last) is used for all NOx
```

```
      concentrations greater than the largest tabulated value.
      (used only if NO2CALC = 2)

       NOx concentration(ug / m3)
                           (CNOX)    -- No default
         ! CNOX = 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0,
                  8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0 !

       NO2/NOx ratio for each NOx concentration:
                           (TNO2NOX) -- No default
         ! TNO2NOX = 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
                     1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 !


Source information
------------------

  Option to process source contributions:
         0 =  Process only total reported contributions
         1 =  Sum all individual source contributions and process
         2 =  Run in TRACEBACK mode to identify source
              contributions at a SINGLE receptor
                           (MSOURCE) -- Default: 0   ! MSOURCE =  0  !


Plume Model Output Processing Options
-------------------------------------

  Output from models other than CALPUFF and CALGRID can be written in
  the CONC.DAT format and processed by CALPOST.  Plume models such as
  AERMOD typically do not treat CALM hours, and do not include such hours
  in multiple-hour averages, with specific rules about how many calm hours
  can be removed from an average.  This treatment is known as CALM
  PROCESSING.  Calm periods are identified from wind speeds in the
  meteorological data file for the application, which must be identified
  in Input Group 0 as the single-point meteorological data file MET1DAT.
         0 =  Option is not used for CALPUFF/CALGRID output files
         1 =  Apply CALM processing procedures to multiple-hour averages
                        (MCALMPRO) -- Default: 0   ! MCALMPRO =  0  !

  Format of Single-point Met File
         1 =  AERMOD/AERMET SURFACE file
                         (MET1FMT) -- Default: 1   ! MET1FMT =  1  !


Receptor information
--------------------

  Gridded receptors processed?    (LG) -- Default: F   ! LG  = F  !
  Discrete receptors processed?   (LD) -- Default: F   ! LD  = T  !
  CTSG Complex terrain receptors processed?
                                 (LCT) -- Default: F   ! LCT = F  !

--Report results by DISCRETE receptor RING?
  (only used when LD = T)     (LDRING) -- Default: F   ! LDRING = F  !

--Select range of DISCRETE receptors (only used when LD = T):

  Select ALL DISCRETE receptors by setting NDRECP flag to -1;
                               OR
  Select SPECIFIC DISCRETE receptors by entering a flag (0,1) for each
     0 = discrete receptor not processed
     1 = discrete receptor processed
```

```
  using repeated value notation to select blocks of receptors:
     23*1, 15*0, 12*1
  Flag for all receptors after the last one assigned is set to 0
  (NDRECP) -- Default: -1
                                                   ! NDRECP =  TBD  !


--Select range of GRIDDED receptors (only used when LG = T):

       X index of LL corner (IBGRID) -- Default: -1     ! IBGRID = -1  !
           (-1 OR 1 <= IBGRID <= NX)

       Y index of LL corner (JBGRID) -- Default: -1     ! JBGRID = -1  !
           (-1 OR 1 <= JBGRID <= NY)

       X index of UR corner (IEGRID) -- Default: -1     ! IEGRID = -1  !
           (-1 OR 1 <= IEGRID <= NX)

       Y index of UR corner (JEGRID) -- Default: -1     ! JEGRID = -1  !
           (-1 OR 1 <= JEGRID <= NY)

  Note: Entire grid is processed if IBGRID=JBGRID=IEGRID=JEGRID=-1


--Specific gridded receptors can also be excluded from CALPOST
  processing by filling a processing grid array with 0s and 1s.  If the
  processing flag for receptor index (i,j) is 1 (ON), that receptor
  will be processed if it lies within the range delineated by IBGRID,
  JBGRID,IEGRID,JEGRID and if LG=T. If it is 0 (OFF), it will not be
  processed in the run.  By default, all array values are set to 1 (ON).

  Number of gridded receptor rows provided in Subgroup (1a) to
  identify specific gridded receptors to process
                          (NGONOFF) -- Default: 0      ! NGONOFF =  0  !

!END!


--------------
Subgroup (1a) -- Specific gridded receptors included/excluded
--------------

    Specific gridded receptors are excluded from CALPOST processing
    by filling a processing grid array with 0s and 1s.  A total of
    NGONOFF lines are read here.  Each line corresponds to one 'row'
    in the sampling grid, starting with the NORTHERNMOST row that
    contains receptors that you wish to exclude, and finishing with
    row 1 to the SOUTH (no intervening rows may be skipped).  Within
    a row, each receptor position is assigned either a 0 or 1,
    starting with the westernmost receptor.
       0 = gridded receptor not processed
       1 = gridded receptor processed

    Repeated value notation may be used to select blocks of receptors:
       23*1, 15*0, 12*1

    Because all values are initially set to 1, any receptors north of
    the first row entered, or east of the last value provided in a row,
    remain ON.

    (NGXRECP) -- Default: 1
```

```
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Visibility Parameters (ASPEC = VISIB)
--------------

    Test visibility options specified to see
    if they conform to FLAG 2008 configuration?
                           (MVISCHECK) -- Default: 1   ! MVISCHECK =   1  !
         0 =  NO checks are made
         1 =  Technical options must conform to FLAG 2008 visibility guidance
                ASPEC = VISIB
                LVNO2 = T
                NO2CALC = 1
                RNO2NOX = 1.0
                MVISBK = 8
                M8_MODE = 5

    Some of the data entered for use with the FLAG 2008 configuration
    are specific to the Class I area being evaluated. These values can
    be checked within the CALPOST user interface when the name of the
    Class I area is provided.

    Name of Class I Area (used for QA purposes only)
                            (AREANAME) -- Default: User  ! AREANAME =  USER !

    Particle growth curve f(RH) for hygroscopic species
                                (MFRH) -- Default: 4   ! MFRH   =  4  !

         1 =  IWAQM (1998) f(RH) curve (originally used with MVISBK=1)
         2 =  FLAG (2000) f(RH) tabulation
         3 =  EPA (2003) f(RH) tabulation
         4 =  IMPROVE (2006) f(RH) tabulations for sea salt, and for small and
              large SULFATE and NITRATE particles;
              Used in Visibility Method 8 (MVISBK = 8 with M8_MODE = 1, 2, or 3)

    Maximum relative humidity (%) used in particle growth curve
                               (RHMAX) -- Default: 98  ! RHMAX  = 98 !

    Modeled species to be included in computing the light extinction
     Include SULFATE?          (LVSO4) -- Default: T   ! LVSO4  = T  !
     Include NITRATE?          (LVNO3) -- Default: T   ! LVNO3  = T  !
     Include ORGANIC CARBON?   (LVOC)  -- Default: T   ! LVOC   = T  !
     Include COARSE PARTICLES? (LVPMC) -- Default: T   ! LVPMC  = T  !
     Include FINE PARTICLES?   (LVPMF) -- Default: T   ! LVPMF  = T  !
     Include ELEMENTAL CARBON? (LVEC)  -- Default: T   ! LVEC   = T  !
     Include NO2 absorption?   (LVNO2) -- Default: F   ! LVNO2  = T  !
              With Visibility Method 8 -- Default: T
                                          FLAG (2008)

    And, when ranking for TOP-N, TOP-50, and Exceedance tables,
     Include BACKGROUND?       (LVBK)  -- Default: T   ! LVBK   = T  !

    Species name used for particulates in MODEL.DAT file
                   COARSE    (SPECPMC) -- Default: PMC ! SPECPMC = PMC !
                   FINE      (SPECPMF) -- Default: PMF ! SPECPMF = PMF !

Extinction Efficiency (1/Mm per ug/m**3)
----------------------------------------
    MODELED particulate species:
              PM  COARSE      (EEPMC) -- Default: 0.6   ! EEPMC  = 0.6 !
              PM  FINE        (EEPMF) -- Default: 1.0   ! EEPMF  = 1 !
    BACKGROUND particulate species:
              PM  COARSE    (EEPMCBK) -- Default: 0.6   ! EEPMCBK = 0.6 !
```

```
    Other species:
              AMMONIUM SULFATE (EESO4) -- Default: 3.0   ! EESO4  = 3 !
              AMMONIUM NITRATE (EENO3) -- Default: 3.0   ! EENO3  = 3 !
              ORGANIC CARBON   (EEOC)  -- Default: 4.0   ! EEOC   = 4 !
              SOIL             (EESOIL)-- Default: 1.0   ! EESOIL = 1 !
              ELEMENTAL CARBON (EEEC)  -- Default: 10.   ! EEEC   = 10 !
              NO2 GAS          (EENO2) -- Default: .1755 ! EENO2  = 0.17 !
    Visibility Method 8:
              AMMONIUM SULFATE (EESO4S)   Set Internally (small)
              AMMONIUM SULFATE (EESO4L)   Set Internally (large)
              AMMONIUM NITRATE (EENO3S)   Set Internally (small)
              AMMONIUM NITRATE (EENO3L)   Set Internally (large)
              ORGANIC CARBON   (EEOCS)    Set Internally (small)
              ORGANIC CARBON   (EEOCL)    Set Internally (large)
              SEA SALT         (EESALT)   Set Internally

Background Extinction Computation
---------------------------------

    Method used for the 24h-average of percent change of light extinction:
    Hourly ratio of source light extinction / background light extinction
    is averaged?               (LAVER) -- Default: F   ! LAVER = F  !


    Method used for background light extinction
                              (MVISBK) -- Default: 8   ! MVISBK =  8  !
                                          FLAG (2008)

         1 =  Supply single light extinction and hygroscopic fraction
              - Hourly F(RH) adjustment applied to hygroscopic background
                and modeled sulfate and nitrate
         2 =  Background extinction from speciated PM concentrations (A)
              - Hourly F(RH) adjustment applied to observed and modeled sulfate
                and nitrate
              - F(RH) factor is capped at F(RHMAX)
         3 =  Background extinction from speciated PM concentrations (B)
              - Hourly F(RH) adjustment applied to observed and modeled sulfate
                and nitrate
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         4 =  Read hourly transmissometer background extinction measurements
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - Hour excluded if measurement invalid (missing, interference,
                or large RH)
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         5 =  Read hourly nephelometer background extinction measurements
              - Rayleigh extinction value (BEXTRAY) added to measurement
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - Hour excluded if measurement invalid (missing, interference,
                or large RH)
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         6 =  Background extinction from speciated PM concentrations
              - FLAG (2000) monthly RH adjustment factor applied to observed and
                and modeled sulfate and nitrate
         7 =  Use observed weather or prognostic weather information for
              background extinction during weather events; otherwise, use Method 2
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - F(RH) factor is capped at F(RHMAX)
              - During observed weather events, compute Bext from visual range
                if using an observed weather data file, or
              - During prognostic weather events, use Bext from the prognostic
```

```
              weather file
            - Use Method 2 for hours without a weather event
       8 =  Background extinction from speciated PM concentrations using
            the IMPROVE (2006) variable extinction efficiency formulation
            (MFRH must be set to 4)
            - Split between small and large particle concentrations of
              SULFATES, NITRATES, and ORGANICS is a function of concentration
              and different extinction efficiencies are used for each
            - Source-induced change in visibility includes the increase in
              extinction of the background aerosol due to the change in the
              extinction efficiency that now depends on total concentration.
            - Fsmall(RH) and Flarge(RH) adjustments for small and large
              particles are applied to observed and modeled sulfate and
              nitrate concentrations
            - Fsalt(RH) adjustment for sea salt is applied to background
              sea salt concentrations
            - F(RH) factors are capped at F(RHMAX)
            - RH for Fsmall(RH), Flarge(RH), and Fsalt(RH) may be obtained
              from hourly data as in Method 2 or from the FLAG monthly RH
              adjustment factor used for Method 6 where EPA F(RH) tabulation
              is used to infer RH, or monthly Fsmall, Flarge, and Fsalt RH
              adjustment factors can be directly entered.
              Furthermore, a monthly RH factor may be applied to either hourly
              concentrations or daily concentrations to obtain the 24-hour
              extinction.
              These choices are made using the M8_MODE selection.

Additional inputs used for MVISBK = 1:
--------------------------------------
 Background light extinction (1/Mm)
                         (BEXTBK) -- No default   ! BEXTBK = 12 !
 Percentage of particles affected by relative humidity
                         (RHFRAC) -- No default   ! RHFRAC = 10 !

Additional inputs used for MVISBK = 6,8:
----------------------------------------
 Extinction coefficients for hygroscopic species (modeled and
 background) are computed using a monthly RH adjustment factor
 in place of an hourly RH factor (VISB.DAT file is NOT needed).
 Enter the 12 monthly factors here (RHFAC).  Month 1 is January.

 (RHFAC)  -- No default     ! RHFAC = 0, 0, 0, 0,
                                      0, 0, 0, 0,
                                      0, 0, 0, 0 !

Additional inputs used for MVISBK = 7:
--------------------------------------
 The weather data file (DATSAV abbreviated space-delimited) that
 is identified as VSRN.DAT may contain data for more than one
 station.  Identify the stations that are needed in the order in
 which they will be used to obtain valid weather and visual range.
 The first station that contains valid data for an hour will be
 used.  Enter up to MXWSTA (set in PARAMS file) integer station IDs
 of up to 6 digits each as variable IDWSTA, and enter the corresponding
 time zone for each, as variable TZONE (= UTC-LST).

 A prognostic weather data file with Bext for weather events may be used
 in place of the observed weather file.  Identify this as the VSRN.DAT
 file and use a station ID of IDWSTA = 999999, and TZONE = 0.

 NOTE:  TZONE identifies the time zone used in the dataset.  The
        DATSAV abbreviated space-delimited data usually are prepared
        with UTC time rather than local time, so TZONE is typically
```

```
       set to zero.

 (IDWSTA)   -- No default   * IDWSTA = 000000 *
 (TZONE)    -- No default   * TZONE =      0. *

Additional inputs used for MVISBK = 2,3,6,7,8:
----------------------------------------------
 Background extinction coefficients are computed from monthly
 CONCENTRATIONS of ammonium sulfate (BKSO4), ammonium nitrate (BKNO3),
 coarse particulates (BKPMC), organic carbon (BKOC), soil (BKSOIL), and
 elemental carbon (BKEC).  Month 1 is January.
 (ug/m**3)

 (BKSO4)  -- No default     ! BKSO4 = TBD !
 (BKNO3)  -- No default     ! BKNO3 = TBD !
 (BKPMC)  -- No default     ! BKPMC = TBD !
 (BKOC)   -- No default     ! BKOC  = TBD !
 (BKSOIL) -- No default     ! BKSOIL= TBD !
 (BKEC)   -- No default     ! BKEC  = TBD !
Additional inputs used for MVISBK = 8:
--------------------------------------
 Extinction coefficients for hygroscopic species (modeled and
 background) may be computed using hourly RH values and hourly
 modeled concentrations, or using monthly RH values inferred from
 the RHFAC adjustment factors and either hourly or daily modeled
 concentrations, or using monthly RHFSML, RHFLRG, and RHFSEA adjustment
 factors and either hourly or daily modeled concentrations.

 (M8_MODE) -- Default: 5     ! M8_MODE=  5   !
              FLAG (2008)

      1 = Use hourly RH values from VISB.DAT file with hourly
          modeled and monthly background concentrations.
      2 = Use monthly RH from monthly RHFAC and EPA (2003) f(RH) tabulation
          with hourly modeled and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      3 = Use monthly RH from monthly RHFAC with EPA (2003) f(RH) tabulation
          with daily modeled and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      4 = Use monthly RHFSML, RHFLRG, and RHFSEA with hourly modeled
          and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      5 = Use monthly RHFSML, RHFLRG, and RHFSEA with daily modeled
          and monthly background concentrations.
          (VISB.DAT file is NOT needed).

 Background extinction coefficients are computed from monthly
 CONCENTRATIONS of sea salt (BKSALT).  Month 1 is January.
 (ug/m**3)

 (BKSALT) -- No default     ! BKSALT= TBD !

 Extinction coefficients for hygroscopic species (modeled and
 background) can be computed using monthly RH adjustment factors
 in place of an hourly RH factor (VISB.DAT file is NOT needed).
 Enter the 12 monthly factors here (RHFSML,RHFLRG,RHFSEA).
 Month 1 is January.  (Used if M8_MODE = 4 or 5)

 Small ammonium sulfate and ammonium nitrate particle sizes
 (RHFSML) -- No default     ! RHFSML= TBD !

 Large ammonium sulfate and ammonium nitrate particle sizes
 (RHFLRG) -- No default     ! RHFLRG= TBD !
```

```
     Sea salt particles
     (RHFSEA) -- No default     ! RHFSEA= TBD !

    Additional inputs used for MVISBK = 2,3,5,6,7,8:
    ------------------------------------------------
     Extinction due to Rayleigh scattering is added (1/Mm)
                        (BEXTRAY) -- Default: 10.0 ! BEXTRAY = 10 !

!END!
-------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output options
--------------

Documentation
-------------

    Documentation records contained in the header of the
    CALPUFF output file may be written to the list file.
    Print documentation image?
                           (LDOC) -- Default: F   !  LDOC = F !

Output Units
------------
    Units for All Output       (IPRTU) -- Default: 1   ! IPRTU =  3   !
                     for             for
                Concentration    Deposition
       1 =         g/m**3         g/m**2/s
       2 =        mg/m**3        mg/m**2/s
       3 =        ug/m**3        ug/m**2/s
       4 =        ng/m**3        ng/m**2/s
       5 =      Odour Units

    Visibility: extinction expressed in 1/Mega-meters (IPRTU is ignored)


Averaging time(s) reported
--------------------------

    1-pd averages           (L1PD) -- Default: T   !   L1PD = F  !
    (pd = averaging period of model output)

    1-hr averages           (L1HR) -- Default: T   !   L1HR = F !

    3-hr averages           (L3HR) -- Default: T   !   L3HR = F  !

    24-hr averages         (L24HR) -- Default: T   !  L24HR = T  !

    Run-length averages    (LRUNL) -- Default: T   !  LRUNL = F  !

    User-specified averaging time in hours, minutes, seconds
    - results for this averaging time are reported if it is not zero

                           (NAVGH) -- Default: 0   !   NAVGH =  0  !
                           (NAVGM) -- Default: 0   !   NAVGM =  0  !
                           (NAVGS) -- Default: 0   !   NAVGS =  0  !


Types of tabulations reported
------------------------------

   1) Visibility: daily visibility tabulations are always reported
```

```
               for the selected receptors when ASPEC = VISIB.
               In addition, any of the other tabulations listed
               below may be chosen to characterize the light
               extinction coefficients.
               [List file or Plot/Analysis File]


2) Top 50 table for each averaging time selected
   [List file only]
                         (LT50) -- Default: T   !   LT50 = F  !

3) Top 'N' table for each averaging time selected
   [List file or Plot file]
                        (LTOPN) -- Default: F   !  LTOPN = T  !

     -- Number of 'Top-N' values at each receptor
        selected (NTOP must be <= 4)
                         (NTOP) -- Default: 4   ! NTOP =  1   !

     -- Specific ranks of 'Top-N' values reported
        (NTOP values must be entered)
                (ITOP(4) array) -- Default:     ! ITOP =  1   !
                                   1,2,3,4


4) Threshold exceedance counts for each receptor and each averaging
   time selected
   [List file or Plot file]
                        (LEXCD) -- Default: F   !  LEXCD = F  !

     -- Identify the threshold for each averaging time by assigning a
        non-negative value (output units).

                                -- Default: -1.0
         Threshold for  1-hr averages   (THRESH1) !  THRESH1 = -1.0 !
        Threshold for  3-hr averages   (THRESH3) !  THRESH3 = -1.0  !
        Threshold for 24-hr averages  (THRESH24) ! THRESH24 = -1.0  !
        Threshold for NAVG-hr averages (THRESHN) !  THRESHN = -1.0  !


     -- Counts for the shortest averaging period selected can be
        tallied daily, and receptors that experience more than NCOUNT
        counts over any NDAY period will be reported.  This type of
        exceedance violation output is triggered only if NDAY > 0.

        Accumulation period(Days)
                         (NDAY) -- Default: 0   !    NDAY =  0  !
        Number of exceedances allowed
                       (NCOUNT) -- Default: 1   !  NCOUNT =  1  !


5) Selected day table(s)

   Echo Option -- Many records are written each averaging period
   selected and output is grouped by day
   [List file or Plot file]
                        (LECHO) -- Default: F   !  LECHO = F  !

   Timeseries Option -- Averages at all selected receptors for
   each selected averaging period are written to timeseries files.
   Each file contains one averaging period, and all receptors are
   written to a single record each averaging time.
   [TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT files]
```

```
                         (LTIME) -- Default: F   !  LTIME = F  !

      Peak Value Option -- Averages at all selected receptors for
      each selected averaging period are screened and the peak value
      each period is written to timeseries files.
      Each file contains one averaging period.
      [PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT files]
                         (LPEAK) -- Default: F   !  LPEAK = F  !

        -- Days selected for output
                    (IECHO(366)) -- Default: 366*0
           ! IECHO  = 366*0  !
           (366 values must be entered)
```

Plot output options

```
     Plot files can be created for the Top-N, Exceedance, and Echo
     tables selected above.  Two formats for these files are available,
     DATA and GRID.  In the DATA format, results at all receptors are
     listed along with the receptor location [x,y,val1,val2,...].
     In the GRID format, results at only gridded receptors are written,
     using a compact representation.  The gridded values are written in
     rows (x varies), starting with the most southern row of the grid.
     The GRID format is given the .GRD extension, and includes headers
     compatible with the SURFER(R) plotting software.

     A plotting and analysis file can also be created for the daily
     peak visibility summary output, in DATA format only.

     Generate Plot file output in addition to writing tables
     to List file?
                               (LPLT) -- Default: F   ! LPLT  = F !

     Use GRID format rather than DATA format,
     when available?
                               (LGRD) -- Default: F   ! LGRD  = F !
```

Auxiliary Output Files (for subsequent analyses)

```
      Visibility

      A separate output file may be requested that contains the change
      in visibility at each selected receptor when ASPEC = VISIB.  This
      file can be processed to construct visibility measures that are
      not available in CALPOST.

      Output file with the visibility change at each receptor?
                              (MDVIS) -- Default: 0   ! MDVIS  =  0  !

           0 =  Do Not create file
           1 =  Create file of DAILY (24 hour) Delta-Deciview
           2 =  Create file of DAILY (24 hour) Extinction Change (%)
           3 =  Create file of HOURLY Delta-Deciview
           4 =  Create file of HOURLY Extinction Change (%)
```

Additional Debug Output

   Output selected information to List file

```
     for debugging?
                                    (LDEBUG) -- Default: F  ! LDEBUG  = F !

    Output hourly extinction information to REPORT.HRV?
     (Visibility Method 7)
                                   (LVEXTHR) -- Default: F  ! LVEXTHR = F !

!END!
```

```
CALPUFF Demonstration


--------------- Run title (3 lines) ------------------------------------------

                    CALPOST MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names
--------------

Input Files
-----------

File                       Default File Name
----                       -----------------
Conc/Dep Flux File         MODEL.DAT           ! MODDAT =CALPUFF.CON   !
Relative Humidity File     VISB.DAT            ! VISDAT =  ..\..CPUF.VIS! *
Background Data File       BACK.DAT            * BACKDAT =   *
Transmissometer or         VSRN.DAT            * VSRDAT =   *
Nephelometer Data File      or
DATSAV Weather Data File    or
Prognostic Weather  File

Single-point Met File      SURFACE.DAT         * MET1DAT =   *
 (Used ONLY to identify CALM hours for plume model
  output averaging when MCALMPRO option is used)


Output Files
------------

File                       Default File Name
----                       -----------------
List File                  CALPOST.LST         ! PSTLST =CALPOST.LST   !

Pathname for Timeseries Files   (blank)        * TSPATH =   *
(activate with exclamation points only if
providing NON-BLANK character string)

Pathname for Plot Files   (blank)              * PLPATH =   *
(activate with exclamation points only if
 providing NON-BLANK character string)

User Character String (U) to augment default filenames
(activate with exclamation points only if
 providing NON-BLANK character string)

Timeseries           TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT
Peak Value           PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT

                                               * TSUNAM =   *

Top Nth Rank Plot    RANK(ALL)_ASPEC_ttHR_CONC_TUNAM.DAT
                 or  RANK(ii)_ASPEC_ttHR_CONC_TUNAM.GRD

                                               * TUNAM =   *

Exceedance Plot       EXCEED_ASPEC_ttHR_CONC_XUNAM.DAT
                  or  EXCEED_ASPEC_ttHR_CONC_XUNAM.GRD
```

```
                                         * XUNAM =   *

Echo Plot
(Specific Days)
           yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.DAT
     or    yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.GRD


Visibility Plot      DAILY_VISIB_VUNAM.DAT   ! VUNAM =VTEST   !
(Daily Peak Summary)


Auxiliary Output Files
----------------------

File                      Default File Name
----                      -----------------
Visibility Change         DELVIS.DAT         * DVISDAT =   *

--------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case               ! LCFILES = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in length
NOTE: (2) Filenames for ALL PLOT and TIMESERIES FILES are constructed
          using a template that includes a pathname, user-supplied
          character(s), and context-specific strings, where
             ASPEC = Species Name
              CONC = CONC Or WFLX Or DFLX Or TFLX
                tt = Averaging Period (e.g. 03)
                ii = Rank (e.g. 02)
                hh = Hour(ending) in LST
             szzzz = LST time zone shift (EST is -0500)
              yyyy = Year(LST)
                mm = Month(LST)
                dd = day of month (LST)
          are determined internally based on selections made below.
          If a path or user-supplied character(s) are supplied, each
          must contain at least 1 non-blank character.

!END!
--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

     Option to run all periods found
     in the met. file(s)  (METRUN)       Default: 0   ! METRUN =   1  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in CALPUFF data file(s)

     Starting date:    Year   (ISYR)  --    No default   ! ISYR  =  2008  !
                       Month  (ISMO)  --    No default   ! ISMO  =  1  !
                       Day    (ISDY)  --    No default   ! ISDY  =  1  !
     Starting time:    Hour   (ISHR)  --    No default   ! ISHR  =  0  !
                       Minute (ISMIN) --    No default   ! ISMIN =  0  !
                       Second (ISSEC) --    No default   ! ISSEC =  0  !

     Ending date:      Year   (IEYR)  --    No default   ! IEYR  =  2008  !
                       Month  (IEMO)  --    No default   ! IEMO  =  12  !
                       Day    (IEDY)  --    No default   ! IEDY  =  31  !
```

```
      Ending time:       Hour   (IEHR)  --    No default   ! IEHR  =  23  !
                         Minute (IEMIN) --    No default   ! IEMIN =  0  !
                         Second (IESEC) --    No default   ! IESEC =  0  !

      (These are only used if METRUN = 0)

      All times are in the base time zone of the CALPUFF simulation.
      CALPUFF Dataset Version 2.1 contains the zone, but earlier versions
      do not, and the zone must be specified here.  The zone is the
      number of hours that must be ADDED to the time to obtain UTC (or GMT).
      Identify the Base Time Zone for the CALPUFF simulation
                               (BTZONE) -- No default   ! BTZONE = 8.0 !

      Process every period of data?
                                 (NREP) -- Default: 1   ! NREP  =  1  !
       (1 = every period processed,
        2 = every 2nd period processed,
        5 = every 5th period processed, etc.)

 Species & Concentration/Deposition Information
 ----------------------------------------------

       Species to process (ASPEC)       -- No default   ! ASPEC = N  !
       (ASPEC = VISIB for visibility processing)

       Layer/deposition code (ILAYER)   -- Default: 1   ! ILAYER =  -3  !
         '1'  for CALPUFF concentrations,
         '-1' for dry deposition fluxes,
         '-2' for wet deposition fluxes,
         '-3' for wet+dry deposition fluxes.

       Scaling factors of the form:     -- Defaults:    ! A =  0.0    !
             X(new) = X(old) * A + B         A = 0.0    ! B =  0.0    !
         (NOT applied if A = B = 0.0)        B = 0.0

       Add Hourly Background Concentrations/Fluxes?
                               (LBACK)  -- Default: F   ! LBACK =  F !


       Source of NO2 when ASPEC=NO2 (above) or LVNO2=T (Group 2) may be
       from CALPUFF NO2 concentrations OR from a fraction of CALPUFF NOx
       concentrations.  Specify the fraction of NOx that is treated as NO2
       either as a constant or as a table of fractions that depend on the
       magnitude of the NOx concentration:
                              (NO2CALC) -- Default: 1   ! NO2CALC =   1  !
          0 =  Use NO2 directly (NO2 must be in file)
          1 =  Specify a single NO2/NOx ratio (RNO2NOX)
          2 =  Specify a table NO2/NOx ratios (TNO2NOX)
               (NOTE: Scaling Factors must NOT be used with NO2CALC=2)

       Single NO2/NOx ratio (0.0 to 1.0) for treating some
       or all NOx as NO2, where [NO2] = [NOX] * RNO2NOX
       (used only if NO2CALC = 1)
                              (RNO2NOX) -- Default: 1.0 ! RNO2NOX = 0.8 !

       Table of NO2/NOx ratios that vary with NOx concentration.
       Provide 14 NOx concentrations (ug/m**3) and the corresponding
       NO2/NOx ratio, with NOx increasing in magnitude.  The ratio used
       for a particular NOx concentration is interpolated from the values
       provided in the table.  The ratio for the smallest tabulated NOx
       concentration (the first) is used for all NOx concentrations less
       than the smallest tabulated value, and the ratio for the largest
       tabulated NOx concentration (the last) is used for all NOx
```

```
      concentrations greater than the largest tabulated value.
      (used only if NO2CALC = 2)

       NOx concentration(ug / m3)
                             (CNOX)    -- No default
         ! CNOX = 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0,
                  8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0 !

       NO2/NOx ratio for each NOx concentration:
                             (TNO2NOX) -- No default
         ! TNO2NOX = 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
                     1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 !


Source information
------------------

  Option to process source contributions:
         0 =  Process only total reported contributions
         1 =  Sum all individual source contributions and process
         2 =  Run in TRACEBACK mode to identify source
              contributions at a SINGLE receptor
                             (MSOURCE) -- Default: 0   ! MSOURCE =  0  !


Plume Model Output Processing Options
-------------------------------------

  Output from models other than CALPUFF and CALGRID can be written in
  the CONC.DAT format and processed by CALPOST.  Plume models such as
  AERMOD typically do not treat CALM hours, and do not include such hours
  in multiple-hour averages, with specific rules about how many calm hours
  can be removed from an average.  This treatment is known as CALM
  PROCESSING.  Calm periods are identified from wind speeds in the
  meteorological data file for the application, which must be identified
  in Input Group 0 as the single-point meteorological data file MET1DAT.
         0 =  Option is not used for CALPUFF/CALGRID output files
         1 =  Apply CALM processing procedures to multiple-hour averages
                          (MCALMPRO) -- Default: 0   ! MCALMPRO =  0  !

  Format of Single-point Met File
         1 =  AERMOD/AERMET SURFACE file
                           (MET1FMT) -- Default: 1   ! MET1FMT =  1  !


Receptor information
--------------------

  Gridded receptors processed?    (LG) -- Default: F   ! LG  = F  !
  Discrete receptors processed?   (LD) -- Default: F   ! LD  = T  !
  CTSG Complex terrain receptors processed?
                                 (LCT) -- Default: F   ! LCT = F  !

--Report results by DISCRETE receptor RING?
  (only used when LD = T)     (LDRING) -- Default: F   ! LDRING = F  !

--Select range of DISCRETE receptors (only used when LD = T):

  Select ALL DISCRETE receptors by setting NDRECP flag to -1;
                               OR
  Select SPECIFIC DISCRETE receptors by entering a flag (0,1) for each
     0 = discrete receptor not processed
     1 = discrete receptor processed
```

```
  using repeated value notation to select blocks of receptors:
     23*1, 15*0, 12*1
  Flag for all receptors after the last one assigned is set to 0
  (NDRECP) -- Default: -1
                                                ! NDRECP =  TBD  !


--Select range of GRIDDED receptors (only used when LG = T):

       X index of LL corner (IBGRID) -- Default: -1     ! IBGRID = -1  !
           (-1 OR 1 <= IBGRID <= NX)

       Y index of LL corner (JBGRID) -- Default: -1     ! JBGRID = -1  !
           (-1 OR 1 <= JBGRID <= NY)

       X index of UR corner (IEGRID) -- Default: -1     ! IEGRID = -1  !
           (-1 OR 1 <= IEGRID <= NX)

       Y index of UR corner (JEGRID) -- Default: -1     ! JEGRID = -1  !
           (-1 OR 1 <= JEGRID <= NY)

  Note: Entire grid is processed if IBGRID=JBGRID=IEGRID=JEGRID=-1


--Specific gridded receptors can also be excluded from CALPOST
  processing by filling a processing grid array with 0s and 1s.  If the
  processing flag for receptor index (i,j) is 1 (ON), that receptor
  will be processed if it lies within the range delineated by IBGRID,
  JBGRID,IEGRID,JEGRID and if LG=T. If it is 0 (OFF), it will not be
  processed in the run.  By default, all array values are set to 1 (ON).

  Number of gridded receptor rows provided in Subgroup (1a) to
  identify specific gridded receptors to process
                         (NGONOFF) -- Default: 0      ! NGONOFF =  0  !

!END!


--------------
Subgroup (1a) -- Specific gridded receptors included/excluded
--------------

    Specific gridded receptors are excluded from CALPOST processing
    by filling a processing grid array with 0s and 1s.  A total of
    NGONOFF lines are read here.  Each line corresponds to one 'row'
    in the sampling grid, starting with the NORTHERNMOST row that
    contains receptors that you wish to exclude, and finishing with
    row 1 to the SOUTH (no intervening rows may be skipped).  Within
    a row, each receptor position is assigned either a 0 or 1,
    starting with the westernmost receptor.
       0 = gridded receptor not processed
       1 = gridded receptor processed

    Repeated value notation may be used to select blocks of receptors:
       23*1, 15*0, 12*1

    Because all values are initially set to 1, any receptors north of
    the first row entered, or east of the last value provided in a row,
    remain ON.

    (NGXRECP) -- Default: 1
```

```
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Visibility Parameters (ASPEC = VISIB)
--------------

    Test visibility options specified to see
    if they conform to FLAG 2008 configuration?
                           (MVISCHECK) -- Default: 1   ! MVISCHECK =   0  !
         0 =  NO checks are made
         1 =  Technical options must conform to FLAG 2008 visibility guidance
                ASPEC = VISIB
                LVNO2 = T
                NO2CALC = 1
                RNO2NOX = 1.0
                MVISBK = 8
                M8_MODE = 5

    Some of the data entered for use with the FLAG 2008 configuration
    are specific to the Class I area being evaluated. These values can
    be checked within the CALPOST user interface when the name of the
    Class I area is provided.

    Name of Class I Area (used for QA purposes only)
                            (AREANAME) -- Default: User  ! AREANAME =  USER !

    Particle growth curve f(RH) for hygroscopic species
                                (MFRH) -- Default: 4   ! MFRH   =  4  !

         1 =  IWAQM (1998) f(RH) curve (originally used with MVISBK=1)
         2 =  FLAG (2000) f(RH) tabulation
         3 =  EPA (2003) f(RH) tabulation
         4 =  IMPROVE (2006) f(RH) tabulations for sea salt, and for small and
              large SULFATE and NITRATE particles;
              Used in Visibility Method 8 (MVISBK = 8 with M8_MODE = 1, 2, or 3)

    Maximum relative humidity (%) used in particle growth curve
                               (RHMAX) -- Default: 98  ! RHMAX  = 98 !

    Modeled species to be included in computing the light extinction
     Include SULFATE?          (LVSO4) -- Default: T   ! LVSO4  = T  !
     Include NITRATE?          (LVNO3) -- Default: T   ! LVNO3  = T  !
     Include ORGANIC CARBON?   (LVOC)  -- Default: T   ! LVOC   = T  !
     Include COARSE PARTICLES? (LVPMC) -- Default: T   ! LVPMC  = T  !
     Include FINE PARTICLES?   (LVPMF) -- Default: T   ! LVPMF  = T  !
     Include ELEMENTAL CARBON? (LVEC)  -- Default: T   ! LVEC   = T  !
     Include NO2 absorption?   (LVNO2) -- Default: F   ! LVNO2  = T  !
              With Visibility Method 8 -- Default: T
                                          FLAG (2008)

    And, when ranking for TOP-N, TOP-50, and Exceedance tables,
     Include BACKGROUND?       (LVBK)  -- Default: T   ! LVBK   = T  !

    Species name used for particulates in MODEL.DAT file
                   COARSE    (SPECPMC) -- Default: PMC ! SPECPMC = PMC !
                   FINE      (SPECPMF) -- Default: PMF ! SPECPMF = PMF !

Extinction Efficiency (1/Mm per ug/m**3)
----------------------------------------
    MODELED particulate species:
               PM  COARSE      (EEPMC) -- Default: 0.6   ! EEPMC  = 0.6 !
               PM  FINE        (EEPMF) -- Default: 1.0   ! EEPMF  = 1 !
    BACKGROUND particulate species:
               PM  COARSE    (EEPMCBK) -- Default: 0.6   ! EEPMCBK = 0.6 !
```

```
    Other species:
              AMMONIUM SULFATE (EESO4) -- Default: 3.0   ! EESO4  = 3 !
              AMMONIUM NITRATE (EENO3) -- Default: 3.0   ! EENO3  = 3 !
              ORGANIC CARBON   (EEOC)  -- Default: 4.0   ! EEOC   = 4 !
              SOIL             (EESOIL)-- Default: 1.0   ! EESOIL = 1 !
              ELEMENTAL CARBON (EEEC)  -- Default: 10.   ! EEEC   = 10 !
              NO2 GAS          (EENO2) -- Default: .1755 ! EENO2  = 0.17 !
    Visibility Method 8:
              AMMONIUM SULFATE (EESO4S)   Set Internally (small)
              AMMONIUM SULFATE (EESO4L)   Set Internally (large)
              AMMONIUM NITRATE (EENO3S)   Set Internally (small)
              AMMONIUM NITRATE (EENO3L)   Set Internally (large)
              ORGANIC CARBON   (EEOCS)    Set Internally (small)
              ORGANIC CARBON   (EEOCL)    Set Internally (large)
              SEA SALT         (EESALT)   Set Internally

Background Extinction Computation
---------------------------------

    Method used for the 24h-average of percent change of light extinction:
    Hourly ratio of source light extinction / background light extinction
    is averaged?              (LAVER) -- Default: F   ! LAVER = F  !


    Method used for background light extinction
                             (MVISBK) -- Default: 8   ! MVISBK =  8  !
                                         FLAG (2008)

         1 =  Supply single light extinction and hygroscopic fraction
              - Hourly F(RH) adjustment applied to hygroscopic background
                and modeled sulfate and nitrate
         2 =  Background extinction from speciated PM concentrations (A)
              - Hourly F(RH) adjustment applied to observed and modeled sulfate
                and nitrate
              - F(RH) factor is capped at F(RHMAX)
         3 =  Background extinction from speciated PM concentrations (B)
              - Hourly F(RH) adjustment applied to observed and modeled sulfate
                and nitrate
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         4 =  Read hourly transmissometer background extinction measurements
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - Hour excluded if measurement invalid (missing, interference,
                or large RH)
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         5 =  Read hourly nephelometer background extinction measurements
              - Rayleigh extinction value (BEXTRAY) added to measurement
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - Hour excluded if measurement invalid (missing, interference,
                or large RH)
              - Receptor-hour excluded if RH>RHMAX
              - Receptor-day excluded if fewer than 6 valid receptor-hours
         6 =  Background extinction from speciated PM concentrations
              - FLAG (2000) monthly RH adjustment factor applied to observed and
                and modeled sulfate and nitrate
         7 =  Use observed weather or prognostic weather information for
              background extinction during weather events; otherwise, use Method 2
              - Hourly F(RH) adjustment applied to modeled sulfate and nitrate
              - F(RH) factor is capped at F(RHMAX)
              - During observed weather events, compute Bext from visual range
                if using an observed weather data file, or
              - During prognostic weather events, use Bext from the prognostic
```

```
            weather file
          - Use Method 2 for hours without a weather event
     8 =  Background extinction from speciated PM concentrations using
          the IMPROVE (2006) variable extinction efficiency formulation
          (MFRH must be set to 4)
          - Split between small and large particle concentrations of
            SULFATES, NITRATES, and ORGANICS is a function of concentration
            and different extinction efficiencies are used for each
          - Source-induced change in visibility includes the increase in
            extinction of the background aerosol due to the change in the
            extinction efficiency that now depends on total concentration.
          - Fsmall(RH) and Flarge(RH) adjustments for small and large
            particles are applied to observed and modeled sulfate and
            nitrate concentrations
          - Fsalt(RH) adjustment for sea salt is applied to background
            sea salt concentrations
          - F(RH) factors are capped at F(RHMAX)
          - RH for Fsmall(RH), Flarge(RH), and Fsalt(RH) may be obtained
            from hourly data as in Method 2 or from the FLAG monthly RH
            adjustment factor used for Method 6 where EPA F(RH) tabulation
            is used to infer RH, or monthly Fsmall, Flarge, and Fsalt RH
            adjustment factors can be directly entered.
            Furthermore, a monthly RH factor may be applied to either hourly
            concentrations or daily concentrations to obtain the 24-hour
            extinction.
            These choices are made using the M8_MODE selection.

Additional inputs used for MVISBK = 1:
--------------------------------------
 Background light extinction (1/Mm)
                         (BEXTBK) -- No default   ! BEXTBK = 12 !
 Percentage of particles affected by relative humidity
                         (RHFRAC) -- No default   ! RHFRAC = 10 !

Additional inputs used for MVISBK = 6,8:
----------------------------------------
 Extinction coefficients for hygroscopic species (modeled and
 background) are computed using a monthly RH adjustment factor
 in place of an hourly RH factor (VISB.DAT file is NOT needed).
 Enter the 12 monthly factors here (RHFAC).  Month 1 is January.

 (RHFAC)  -- No default     ! RHFAC = 0, 0, 0, 0,
                                      0, 0, 0, 0,
                                      0, 0, 0, 0 !

Additional inputs used for MVISBK = 7:
--------------------------------------
 The weather data file (DATSAV abbreviated space-delimited) that
 is identified as VSRN.DAT may contain data for more than one
 station.  Identify the stations that are needed in the order in
 which they will be used to obtain valid weather and visual range.
 The first station that contains valid data for an hour will be
 used.  Enter up to MXWSTA (set in PARAMS file) integer station IDs
 of up to 6 digits each as variable IDWSTA, and enter the corresponding
 time zone for each, as variable TZONE (= UTC-LST).

 A prognostic weather data file with Bext for weather events may be used
 in place of the observed weather file.  Identify this as the VSRN.DAT
 file and use a station ID of IDWSTA = 999999, and TZONE = 0.

 NOTE:  TZONE identifies the time zone used in the dataset.  The
        DATSAV abbreviated space-delimited data usually are prepared
        with UTC time rather than local time, so TZONE is typically
```

```
       set to zero.

 (IDWSTA)   -- No default   * IDWSTA = 000000 *
 (TZONE)    -- No default   * TZONE =      0. *

Additional inputs used for MVISBK = 2,3,6,7,8:
----------------------------------------------
 Background extinction coefficients are computed from monthly
 CONCENTRATIONS of ammonium sulfate (BKSO4), ammonium nitrate (BKNO3),
 coarse particulates (BKPMC), organic carbon (BKOC), soil (BKSOIL), and
 elemental carbon (BKEC).  Month 1 is January.
 (ug/m**3)

 (BKSO4)  -- No default     ! BKSO4 = 0.02,0.02,0.02,0.02,
                                      0.02,0.02,0.02,0.02,
                                      0.02,0.02,0.02,0.02 !
 (BKNO3)  -- No default     ! BKNO3 = 0.01,0.01,0.01,0.01,
                                      0.01,0.01,0.01,0.01,
                                      0.01,0.01,0.01,0.01 !
 (BKPMC)  -- No default     ! BKPMC = 0.21,0.21,0.21,0.21,
                                      0.21,0.21,0.21,0.21,
                                      0.21,0.21,0.21,0.21 !
 (BKOC)   -- No default     ! BKOC  = 0.06,0.06,0.06,0.06,
                                      0.06,0.06,0.06,0.06,
                                      0.06,0.06,0.06,0.06 !
 (BKSOIL) -- No default     ! BKSOIL= 0.04,0.04,0.04,0.04,
                                      0.04,0.04,0.04,0.04,
                                      0.04,0.04,0.04,0.04 !
 (BKEC)   -- No default     ! BKEC  = 0.00,0.00,0.00,0.00,
                                      0.00,0.00,0.00,0.00,
                                      0.00,0.00,0.00,0.00 !
Additional inputs used for MVISBK = 8:
--------------------------------------
 Extinction coefficients for hygroscopic species (modeled and
 background) may be computed using hourly RH values and hourly
 modeled concentrations, or using monthly RH values inferred from
 the RHFAC adjustment factors and either hourly or daily modeled
 concentrations, or using monthly RHFSML, RHFLRG, and RHFSEA adjustment
 factors and either hourly or daily modeled concentrations.

 (M8_MODE) -- Default: 5     ! M8_MODE=  5   !
              FLAG (2008)

      1 = Use hourly RH values from VISB.DAT file with hourly
          modeled and monthly background concentrations.
      2 = Use monthly RH from monthly RHFAC and EPA (2003) f(RH) tabulation
          with hourly modeled and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      3 = Use monthly RH from monthly RHFAC with EPA (2003) f(RH) tabulation
          with daily modeled and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      4 = Use monthly RHFSML, RHFLRG, and RHFSEA with hourly modeled
          and monthly background concentrations.
          (VISB.DAT file is NOT needed).
      5 = Use monthly RHFSML, RHFLRG, and RHFSEA with daily modeled
          and monthly background concentrations.
          (VISB.DAT file is NOT needed).

 Background extinction coefficients are computed from monthly
 CONCENTRATIONS of sea salt (BKSALT).  Month 1 is January.
 (ug/m**3)

 (BKSALT) -- No default     ! BKSALT= 0.01, 0.01, 0.01, 0.01,
```

```
                                            0.01, 0.01, 0.01, 0.01,
                                            0.01, 0.01, 0.01, 0.01 !

     Extinction coefficients for hygroscopic species (modeled and
     background) can be computed using monthly RH adjustment factors
     in place of an hourly RH factor (VISB.DAT file is NOT needed).
     Enter the 12 monthly factors here (RHFSML,RHFLRG,RHFSEA).
     Month 1 is January.  (Used if M8_MODE = 4 or 5)

     Small ammonium sulfate and ammonium nitrate particle sizes
     (RHFSML) -- No default     ! RHFSML= 5.71, 5.00, 4.46, 4.23,
                                          3.89, 3.55, 3.26, 3.41,
                                          4.02, 5.13, 5.89, 5.98 !

     Large ammonium sulfate and ammonium nitrate particle sizes
     (RHFLRG) -- No default     ! RHFLRG= 3.78, 3.40, 3.10, 2.98,
                                          2.78, 2.60, 2.43, 2.52,
                                          2.84, 3.45, 3.87, 3.92 !

     Sea salt particles
     (RHFSEA) -- No default     ! RHFSEA= 5.24, 4.74, 4.34, 4.18,
                                          3.91, 3.66, 3.41, 3.51,
                                          3.93, 4.78, 5.36, 5.44 !

    Additional inputs used for MVISBK = 2,3,5,6,7,8:
    ------------------------------------------------
     Extinction due to Rayleigh scattering is added (1/Mm)
                        (BEXTRAY) -- Default: 10.0 ! BEXTRAY = 10 !

!END!
-------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output options
--------------

Documentation
-------------

    Documentation records contained in the header of the
    CALPUFF output file may be written to the list file.
    Print documentation image?
                                (LDOC) -- Default: F   !  LDOC = F !

Output Units
------------
    Units for All Output       (IPRTU) -- Default: 1   ! IPRTU =  3   !
                     for             for
                Concentration    Deposition
       1 =         g/m**3         g/m**2/s
       2 =        mg/m**3        mg/m**2/s
       3 =        ug/m**3        ug/m**2/s
       4 =        ng/m**3        ng/m**2/s
       5 =      Odour Units

    Visibility: extinction expressed in 1/Mega-meters (IPRTU is ignored)


Averaging time(s) reported
--------------------------

    1-pd averages           (L1PD) -- Default: T   !   L1PD = F  !
    (pd = averaging period of model output)
```

```
    1-hr averages           (L1HR) -- Default: T   !   L1HR = F !

    3-hr averages           (L3HR) -- Default: T   !   L3HR = F  !

    24-hr averages         (L24HR) -- Default: T   !  L24HR = T  !

    Run-length averages    (LRUNL) -- Default: T   !  LRUNL = F  !

    User-specified averaging time in hours, minutes, seconds
    - results for this averaging time are reported if it is not zero

                           (NAVGH) -- Default: 0   !   NAVGH =  0  !
                           (NAVGM) -- Default: 0   !   NAVGM =  0  !
                           (NAVGS) -- Default: 0   !   NAVGS =  0  !


Types of tabulations reported
------------------------------

   1) Visibility: daily visibility tabulations are always reported
                  for the selected receptors when ASPEC = VISIB.
                  In addition, any of the other tabulations listed
                  below may be chosen to characterize the light
                  extinction coefficients.
                  [List file or Plot/Analysis File]


   2) Top 50 table for each averaging time selected
      [List file only]
                            (LT50) -- Default: T   !   LT50 = F  !

   3) Top 'N' table for each averaging time selected
      [List file or Plot file]
                           (LTOPN) -- Default: F   !  LTOPN = T  !

        -- Number of 'Top-N' values at each receptor
           selected (NTOP must be <= 4)
                            (NTOP) -- Default: 4   ! NTOP =  1   !

        -- Specific ranks of 'Top-N' values reported
           (NTOP values must be entered)
                   (ITOP(4) array) -- Default:     ! ITOP =  1   !
                                      1,2,3,4


   4) Threshold exceedance counts for each receptor and each averaging
      time selected
      [List file or Plot file]
                           (LEXCD) -- Default: F   !  LEXCD = F  !

        -- Identify the threshold for each averaging time by assigning a
           non-negative value (output units).

                                   -- Default: -1.0
            Threshold for  1-hr averages   (THRESH1) !  THRESH1 = -1.0 !
           Threshold for  3-hr averages   (THRESH3) !  THRESH3 = -1.0  !
           Threshold for 24-hr averages  (THRESH24) ! THRESH24 = -1.0  !
           Threshold for NAVG-hr averages (THRESHN) !  THRESHN = -1.0  !


        -- Counts for the shortest averaging period selected can be
           tallied daily, and receptors that experience more than NCOUNT
           counts over any NDAY period will be reported.  This type of
```

```
        exceedance violation output is triggered only if NDAY > 0.

        Accumulation period(Days)
                          (NDAY) -- Default: 0   !    NDAY =  0  !
        Number of exceedances allowed
                        (NCOUNT) -- Default: 1   !  NCOUNT =  1  !


   5) Selected day table(s)

      Echo Option -- Many records are written each averaging period
      selected and output is grouped by day
      [List file or Plot file]
                         (LECHO) -- Default: F   !  LECHO = F  !

      Timeseries Option -- Averages at all selected receptors for
      each selected averaging period are written to timeseries files.
      Each file contains one averaging period, and all receptors are
      written to a single record each averaging time.
      [TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT files]
                         (LTIME) -- Default: F   !  LTIME = F  !

      Peak Value Option -- Averages at all selected receptors for
      each selected averaging period are screened and the peak value
      each period is written to timeseries files.
      Each file contains one averaging period.
      [PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT files]
                         (LPEAK) -- Default: F   !  LPEAK = F  !

        -- Days selected for output
                    (IECHO(366)) -- Default: 366*0
           ! IECHO  = 366*0  !
           (366 values must be entered)

Plot output options
-------------------

     Plot files can be created for the Top-N, Exceedance, and Echo
     tables selected above.  Two formats for these files are available,
     DATA and GRID.  In the DATA format, results at all receptors are
     listed along with the receptor location [x,y,val1,val2,...].
     In the GRID format, results at only gridded receptors are written,
     using a compact representation.  The gridded values are written in
     rows (x varies), starting with the most southern row of the grid.
     The GRID format is given the .GRD extension, and includes headers
     compatible with the SURFER(R) plotting software.

     A plotting and analysis file can also be created for the daily
     peak visibility summary output, in DATA format only.

     Generate Plot file output in addition to writing tables
     to List file?
                               (LPLT) -- Default: F   ! LPLT  = F !

     Use GRID format rather than DATA format,
     when available?
                               (LGRD) -- Default: F   ! LGRD  = F !


Auxiliary Output Files (for subsequent analyses)
------------------------------------------------

      Visibility
```

```
      A separate output file may be requested that contains the change
      in visibility at each selected receptor when ASPEC = VISIB.  This
      file can be processed to construct visibility measures that are
      not available in CALPOST.

      Output file with the visibility change at each receptor?
                                 (MDVIS) -- Default: 0   ! MDVIS  =  0  !

           0 =  Do Not create file
           1 =  Create file of DAILY (24 hour) Delta-Deciview
           2 =  Create file of DAILY (24 hour) Extinction Change (%)
           3 =  Create file of HOURLY Delta-Deciview
           4 =  Create file of HOURLY Extinction Change (%)


Additional Debug Output
-----------------------

   Output selected information to List file
    for debugging?
                                (LDEBUG) -- Default: F  ! LDEBUG  = F !

   Output hourly extinction information to REPORT.HRV?
    (Visibility Method 7)
                               (LVEXTHR) -- Default: F  ! LVEXTHR = F !

!END!
```

```
POSTUTIL Run Deposition Analysis
---------------- Run title (3 lines) ------------------------------------------

                     POSTUTIL MODEL CONTROL FILE
                     ---------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names
--------------

-------------
Subgroup (0a)
-------------

Output Files
------------

 File             Default File Name
 ----             -----------------
 List File        POSTUTIL.LST       ! UTLLST =putildep.lst   !
 Data File        MODEL.DAT          ! UTLDAT =putildep.dat   !


Input Files
-----------

 A time-varying file of "background" concentrations can be included
 when the ammonia-limiting method (ALM) for setting the HNO3/NO3
 concentration partition is accomplished in 1 step.  This option
 is selected by setting MNITRATE=3 in Input Group 1.
 Species required in the "background" concentration file are:
 SO4, NO3, HNO3 and TNH3 (total NH3).

 File             Default File Name
 ----             -----------------
 BCKG File        BCKGALM.DAT         * BCKGALM =BCKGALM.DAT     *


 A number of CALPUFF data files may be processed in this application.
 The files may represent individual CALPUFF simulations that were made
 for a specific set of species and/or sources.  Specify the total number
 of CALPUFF runs you wish to combine, and provide the filename for each
 in subgroup 0b.

     Number of CALPUFF data files (NFILES)
                                     Default: 1       ! NFILES  = 2   !


 Meteorological data files are needed for the HNO3/NO3 partition option.
 Three types of meteorological data files can be used:
       METFM= 0 - CALMET.DAT
       METFM= 1 - 1-D file with RH, Temp and Rhoair timeseries
       METFM= 2 - 2-D files with either Rh, Temp or Rhoair in each
                  (3 2_D files are needed)
      The default is to use CALMET.DAT files.

                                     Default: 0       ! METFM   = 0   !


 Multiple meteorological data files may be used in sequence to span the
 processing period.  Specify the number of time-period files (NMET) that
```

```
 you need to use, and provide a filename for each in subgroup 0b.
 - NMET is 0 if no meteorological files are provided
 - NMET is 1 if METFM=1 (multiple file feature is not available)
 - NMET is 1 or more if METFM=0 or 2 (multiple CALMET files or 2DMET files)

     Number of meteorological data file time-periods (NMET)
                                    Default: 0       ! NMET    = 0   !


 All filenames will be converted to lower case if LCFILES = T
 Otherwise, if LCFILES = F, filenames will be converted to UPPER CASE

     Convert filenames to lower case?  Default: T     ! LCFILES = T !
         T = lower case
         F = UPPER CASE

!END!

-----------------------------------------------------------
 NOTE: file/path names can be up to 70 characters in length
-----------------------------------------------------------

-------------
Subgroup (0b)
-------------

NMET CALMET Data Files (METFM=0):

Input File      Default File Name
----------      -----------------
  1             MET.DAT    * UTLMET =~calpuff_jan08.met  *   *END*


NMET 1-D Data Files (METFM=1):

Input File      Default File Name
----------      -----------------
   1            MET_1D.DAT         * MET1D   = MET_1D.DAT * *END*


NMET 2-D Data Files of Each Type (METFM=2):

Input File      Default File Name
----------      -----------------
   1            RHUMD.DAT          * M2DRHU  = RELHUM.DAT * *END*
   1            TEMP.DAT           * M2DTMP  = TEMP.DAT   * *END*
   1            RHOAIR.DAT         * M2DRHO  = RHOAIR.DAT * *END*


NFILES CALPUFF Data Files:

Input File      Default File Name
----------      -----------------
   1            CALPUFF.DAT        ! MODDAT =cpuf08.dfx! !END!
   2            CALPUFF.DAT        ! MODDAT =cpuf08.wfx! !END!



-------------
Note:  provide NMET lines of the form   * UTLMET = name * *END*

                                   or   * MET1D  = name * *END*
```

```
                                    or    * M2DRHU = name * *END*
                                 (and)    * M2DTMP = name * *END*
                                 (and)    * M2DRHO = name * *END*

       and NFILES lines of the form       * MODDAT = name * *END*

       where the * should be replaced with an exclamation point,
       the special delimiter character.


--------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

     Starting date:    Year  (ISYR) --    No default   ! ISYR  =  2008 !
                       Month (ISMO) --    No default   ! ISMO  = 1   !
                       Day   (ISDY) --    No default   ! ISDY  = 1   !
                       Hour  (ISHR) --    No default   ! ISHR  = 1   !

     Number of periods to process
                                 (NPER) -- No default   ! NPER  = 8784   !

     Number of species to process from CALPUFF runs
                             (NSPECINP) -- No default   ! NSPECINP = 5 !

     Number of species to write to output file
                             (NSPECOUT) -- No default   ! NSPECOUT = 2 !

     Number of species to compute from those modeled
     (must be no greater than NSPECOUT)
                             (NSPECCMP) -- No default   ! NSPECCMP = 2 !


 When multiple files are used, a species name may appear in more than
 one file.  Data for this species will be summed (appropriate if the
 CALPUFF runs use different source groups).  If this summing is not
 appropriate, remove duplicate species from the file(s).

     Stop run if duplicate species names
     are found? (MDUPLCT)            Default: 0       ! MDUPLCT  =  0  !
        0 = no  (i.e., duplicate species are summed)
        1 = yes (i.e., run is halted)

 Data for each species in a CALPUFF data file may also be scaled as
 they are read.  This can be done to alter the emission rate of all
 sources that were modeled in a particular CALPUFF application.
 The scaling factor for each species is entered in Subgroup (2d), for
 each file for which scaling is requested.

     Number of CALPUFF data files that will be scaled
     (must be no greater than NFILES)
     (NSCALED)                       Default: 0       ! NSCALED = 0 !


 Ammonia-Limiting Method Option to recompute the HNO3/NO3 concentration
 partition prior to performing other actions is controlled by MNITRATE.
 This option will NOT alter any deposition fluxes contained in the CALPUFF
 file(s).  Three partition selections are provided.  The first two are
 typically used in sequence (POSTUTIL is run more than once).  The first
 selection (MNITRATE=1) computes the partition for the TOTAL (all sources)
 concentration fields (SO4, NO3, HNO3; NH3), and the second (MNITRATE=2)
```

```
uses this partition (from the previous application of POSTUTIL) to
compute the partition for individual source groups.  The third selection
(MNITRATE=3) can be used instead in a single POSTUTIL application if a
file of background concentrations is provided (BCKGALM in Input Group 0).

Required information for MNITRATE=1 includes:
         species NO3, HNO3, and SO4
         NH3 concentration(s)
         met. data file for RH and T

Required information for MNITRATE=2 includes:
         species NO3 and HNO3 for a source group
         species NO3ALL and HNO3ALL for all source groups, properly
         partitioned

Required information for MNITRATE=3 includes:
         species NO3, HNO3, and SO4 for a source group
         species NO3, HNO3, SO4 and TNH3 from the background BCKGALM file
         If TNH3 is not in the background BCKGALM file, monthly TNH3
         concentrations are used (BCKTNH3)

    Recompute the HNO3/NO3 partition for concentrations?
    (MNITRATE)                      Default: 0       ! MNITRATE  =  0  !
       0 = no
       1 = yes, for all sources combined
       2 = yes, for a source group
       3 = yes, ALM application in one step


SOURCE OF AMMONIA:

Ammonia may be available as a modeled species in the CALPUFF files,
and it may or may not be appropriate to use it for repartitioning NO3/HNO3
(in option MNITRATE=1 or MNITRATE=3).  Its use is contolled by NH3TYP.
When NH3 is listed as a processed species in Subgroup (2a), as one of
the NSPECINP ASPECI entries, and the right option is chosen for NH3TYP,
the NH3 modeled values from the CALPUFF concentration files will be used
in the chemical equilibrium calculation.

NH3TYP also controls when monthly background ammonia values are used.  Both
gaseous (NH3) and total (TNH3) ammonia can be provided monthly as
BCKNH3/BCKTNH3.

    What is the input source of Ammonia?
    (NH3TYP)                        No Default       ! NH3TYP = 3  !
       0 = No background will be used.
           ONLY NH3 from the concentration
           files listed in Subgroup (2a) as
           a processed species will be used.
           (Cannot be used with MNITRATE=3)

       1 = NH3 Monthly averaged background (BCKNH3)
           listed below will be added to NH3 from
           concentration files listed in Subgroup (2a)

       2 = NH3 from background concentration file BCKGALM
           will be added to NH3 from concentration files
           listed in Subgroup (2a)
           (ONLY possible for MNITRATE=3)

       3 = NH3 Monthly averaged background (BCKNH3)
           listed below will be used alone.
```

```
     4 = NH3 from background concentration file BCKGALM
         will be used alone
         (ONLY possible for MNITRATE=3)
```

NH3TYP	NH3 CONC	NH3 FROM BCKNH3	NH3 FROM BCKGALM
0	X	0	0
1	X	X	0
2	X	0	X
3	0	X	0
4	0	0	X

```
     Default monthly (12 values) background ammonia concentration (ppb)
     used for HNO3/NO3 partition:

      Gaseous NH3 (BCKNH3)            Default: -999
      *  BCKNH3 = 12*17 *

      Total TNH3  (BCKTNH3)           Default: -999
      * BCKTNH3 = 1., 1., 1., 1.1, 1.4, 1.3, 1.3, 1.2, 4*1. *

     If a single value is entered, this is used for all 12 months.
     Month 1 is JANUARY, Month 12 is DECEMBER.

!END!
-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Species Processing Information
--------------

-------------
Subgroup (2a)
-------------

  The following NSPECINP species will be processed:

! ASPECI =          SO2 !         !END!
! ASPECI =          SO4 !         !END!
! ASPECI =          NOX !         !END!
! ASPECI =          HNO3!         !END!
! ASPECI =          NO3 !         !END!


-------------
Subgroup (2b)
-------------

  The following NSPECOUT species will be written:

! ASPECO =          S !         !END!
! ASPECO =          N !         !END!

Subgroup (2c)
-------------

  The following NSPECCMP species will be computed by scaling and summing
  one or more of the processed input species.  Identify the name(s) of
```

```
  the computed species and provide the scaling factors for each of the
  NSPECINP input species (NSPECCMP groups of NSPECINP+1 lines each):

! CSPECCMP =        N !
!     SO2  =     0.0 !
!     SO4  =     0.291667 !
!     NOX  =     0.30435 !
!    HNO3  =     0.222222 !
!     NO3  =     0.451613 !
!END!

! CSPECCMP =        S !
!     SO2  =     0.500000 !
!     SO4  =     0.333333 !
!     NOX  =     0.0 !
!    HNO3  =     0.0 !
!     NO3  =     0.0 !
!END!

-------------
Subgroup (2d)
-------------

  Each species in NSCALED CALPUFF data files may be scaled before being
  processed (e.g., to change the emission rate for all sources modeled
  in the run that produced a data file).  For each file, identify the
  file name and then provide the name(s) of the scaled species and the
  corresponding scaling factors (A,B where x' = Ax+B).

               A(Default=1.0)      B(Default=0.0)
               --------------      --------------

* MODDAT =NOFILES.DAT    *
*     SO2  =      1.1,                 0.0   *
*     SO4  =      1.5,                 0.0   *
*    HNO3  =      0.8,                 0.0   *
*     NO3  =      0.1,                 0.0   *
*END*
```

Attachment E

Sample CALMET Input File

```
--------------- Run title (3 lines) ------------------------------------------

                    CALMET MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names


Subgroup (a)
------------
Default Name  Type          File Name
------------  ----          ---------
GEO.DAT       input    ! GEODAT=GEO4KM.DAT       !
SURF.DAT      input    ! SRFDAT=SURF.DAT      !
CLOUD.DAT     input    * CLDDAT=             *
PRECIP.DAT    input    ! PRCDAT=PRECIP.DAT    !
WT.DAT        input    * WTDAT=              *

CALMET.LST    output   ! METLST=CMET.LST     !
CALMET.DAT    output   ! METDAT=CMET.DAT    !
PACOUT.DAT    output   * PACDAT=             *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = T !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

    Number of upper air stations (NUSTA)  No default     ! NUSTA =  1  !
    Number of overwater met stations
                                 (NOWSTA) No default     ! NOWSTA =  1  !

NUMBER OF PROGNOSTIC and IGF-CALMET FILEs:

    Number of MM4/MM5/3D.DAT files
                                 (NM3D) No default       ! NM3D =  12  !

    Number of IGF-CALMET.DAT files
                                 (NIGF)   No default     ! NIGF =  0  !

                       !END!
--------------------------------------------------------------------------------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name  Type       File Name
------------  ----       ---------
UP1.DAT       input     1  ! UPDAT=UPPWM.DAT!    !END!

--------------------------------------------------------------------------------
Subgroup (c)
-----------------------------------------
Overwater station files (one per station)
-----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
SEA1.DAT       input     1  ! SEADAT=SEA.DAT!    !END!
--------------------------------------------------------------------------------
```

```
Subgroup (d)
------------------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
MM51.DAT       input     1  * M3DDAT=LSP2003.DAT *    *END*
--------------------------------------------------------------------------------
Subgroup (e)
-------------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
-------------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
IGFn.DAT       input     1  * IGFDAT=CALMET0.DAT *    *END*
--------------------------------------------------------------------------------
Subgroup (f)
----------------
Other file names
----------------

Default Name  Type       File Name
------------  ----       ---------
DIAG.DAT      input      * DIADAT=                  *
PROG.DAT      input      * PRGDAT=                  *

TEST.PRT      output     * TSTPRT=                  *
TEST.OUT      output     * TSTOUT=                  *
TEST.KIN      output     * TSTKIN=                  *
TEST.FRD      output     * TSTFRD=                  *
TEST.SLP      output     * TSTSLP=                  *
DCST.GRD      output     * DCSTGD=                  *

--------------------------------------------------------------------------------
NOTES: (1) File/path names can be up to 70 characters in length
       (2) Subgroups (a) and (f) must have ONE 'END' (surrounded by
           delimiters) at the end of the group
       (3) Subgroups (b) through (e) are included ONLY if the corresponding
           number of files (NUSTA, NOWSTA, NM3D, NIGF) is not 0, and each must have
           an 'END' (surround by delimiters) at the end of EACH LINE

                         !END!


-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------


     Starting date:   Year (IBYR) -- No default       ! IBYR=  2006  !
                     Month (IBMO) -- No default       ! IBMO=  1  !
                       Day (IBDY) -- No default       ! IBDY=  1  !
                      Hour (IBHR) -- No default       ! IBHR=  0  !

     Note: IBHR is the time at the END of the first hour of the simulation
           (IBHR=1, the first hour of a day, runs from 00:00 to 01:00)

     Base time zone        (IBTZ) -- No default       ! IBTZ=  8  !
        PST = 08, MST = 07
        CST = 06, EST = 05

     Length of run (hours) (IRLG) -- No default       ! IRLG=  8760  !
```

```
     Run type            (IRTYPE) -- Default: 1       ! IRTYPE=  1  !

        0 = Computes wind fields only
        1 = Computes wind fields and micrometeorological variables
            (u*, w*, L, zi, etc.)
        (IRTYPE must be 1 to run CALPUFF or CALGRID)

     Compute special data fields required
     by CALGRID (i.e., 3-D fields of W wind
     components and temperature)
     in additional to regular           Default: T    ! LCALGRD = T !
     fields ? (LCALGRD)
     (LCALGRD must be T to run CALGRID)

      Flag to stop run after
      SETUP phase (ITEST)            Default: 2       ! ITEST=  2   !
      (Used to allow checking
      of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of
                  COMPUTATIONAL phase after SETUP


     Test options specified to see if
     they conform to regulatory
     values? (MREG)                  No Default       ! MREG =  1   !

        0 = NO checks are made
        1 = Technical options must conform to USEPA guidance
                  IMIXH    -1       Maul-Carson convective mixing height
                                    over land; OCD mixing height overwater
                  ICOARE   0        OCD deltaT method for overwater fluxes
                  THRESHL  0.0      Threshold buoyancy flux over land needed
                                    to sustain convective mixing height growth

!END!

--------------------------------------------------------------------------------

INPUT GROUP: 2 -- Map Projection and Grid Information for Output
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (PMAP)                     Default: UTM    ! PMAP = LCC !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
         PS  :  Polar Stereographic
         EM  :  Equatorial Mercator
         LAZA:  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
```

```
(IUTMZN)                    No Default      ! IUTMZN = -999 !

Hemisphere for UTM projection?
(Used only if PMAP=UTM)
(UTMHEM)                    Default: N      ! UTMHEM = N !
    N   :  Northern hemisphere projection
    S   :  Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0)                     No Default      ! RLAT0 = 34.06179N !
(RLON0)                     No Default      ! RLON0 = 117.8192W !

    TTM :  RLON0 identifies central (true N/S) meridian of projection
           RLAT0 selected for convenience
    LCC :  RLON0 identifies central (true N/S) meridian of projection
           RLAT0 selected for convenience
    PS  :  RLON0 identifies central (grid N/S) meridian of projection
           RLAT0 selected for convenience
    EM  :  RLON0 identifies central meridian of projection
           RLAT0 is REPLACED by 0.0N (Equator)
    LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
           RLAT0 identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(RLAT1)                     No Default      ! RLAT1 = 33.0N !
(RLAT2)                     No Default      ! RLAT2 = 35.0N !

    LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
    PS  :  Projection plane slices through Earth at RLAT1
           (RLAT2 is not used)

----------
Note:  Latitudes and longitudes should be positive, and include a
       letter N,S,E, or W indicating north or south latitude, and
       east or west longitude.  For example,
       35.9  N Latitude  =  35.9N
       118.7 E Longitude = 118.7E


Output Datum-Region
-------------------

The Datum-Region for the output coordinates is identified by a character
string.  Many mapping products currently available use the model of the
Earth known as the World Geodetic System 1984 (WGS-84).  Other local
models may be in use, and their selection in TERREL will make its output
consistent with local mapping products.  The list of Datum-Regions with
official transformation parameters is provided by the National Imagery and
and Mapping Agency (NIMA).

Datum-region for output coordinates
     (DATUM)                     Default: WGS-84    ! DATUM = WGS-84  !


Horizontal grid definition:
---------------------------

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

       No. X grid cells (NX)      No default     ! NX =     !
```

```
        No. Y grid cells (NY)      No default     ! NY =     !

     Grid spacing (DGRIDKM)           No default     ! DGRIDKM = 4 !
                                      Units: km

     Reference grid coordinate of
     SOUTHWEST corner of grid cell (1,1)

        X coordinate (XORIGKM)        No default     ! XORIGKM =  !
        Y coordinate (YORIGKM)        No default     ! YORIGKM =  !
                                      Units: km


     Vertical grid definition:
     -------------------------

        No. of vertical layers (NZ)   No default     ! NZ =  10  !

        Cell face heights in arbitrary
        vertical grid (ZFACE(NZ+1))   No defaults
                                      Units: m
        ! ZFACE = 0.,20.,40.,80.,160.,320.,640.,1200.,2000.,3000, 4000. !

!END!


--------------------------------------------------------------------------------
INPUT GROUP: 3 -- Output Options
--------------


    DISK OUTPUT OPTION

       Save met. fields in an unformatted
       output file ?            (LSAVE)  Default: T     ! LSAVE = T !
       (F = Do not save, T = Save)

       Type of unformatted output file:
       (IFORMO)                          Default: 1    ! IFORMO =  1  !

            1 = CALPUFF/CALGRID type file (CALMET.DAT)
            2 = MESOPUFF-II type file     (PACOUT.DAT)


    LINE PRINTER OUTPUT OPTIONS:

       Print met. fields ?  (LPRINT)     Default: F     ! LPRINT = F !
       (F = Do not print, T = Print)
       (NOTE: parameters below control which
              met. variables are printed)

       Print interval
       (IPRINF) in hours                 Default: 1     ! IPRINF =  1  !
       (Meteorological fields are printed
        every  1  hours)


       Specify which layers of U, V wind component
       to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
       (0=Do not print, 1=Print)
       (used only if LPRINT=T)       Defaults: NZ*0
       ! IUVOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !
       -----------------------
```

```
Specify which levels of the W wind component to print
(NOTE: W defined at TOP cell face --  10  values)
(IWOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! IWOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !


Specify which levels of the 3-D temperature field to print
(ITOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! ITOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !

Specify which meteorological fields
to print
(used only if LPRINT=T)             Defaults: 0 (all variables)
-----------------------


  Variable            Print ?
                  (0 = do not print,
                   1 = print)
  --------        ------------------

!  STABILITY  =           0           ! - PGT stability class
!  USTAR      =           0           ! - Friction velocity
!  MONIN      =           0           ! - Monin-Obukhov length
!  MIXHT      =           0           ! - Mixing height
!  WSTAR      =           0           ! - Convective velocity scale
!  PRECIP     =           0           ! - Precipitation rate
!  SENSHEAT   =           0           ! - Sensible heat flux
!  CONVZI     =           0           ! - Convective mixing ht.


Testing and debug print options for micrometeorological module

   Print input meteorological data and
   internal variables (LDB)         Default: F       ! LDB = F !
   (F = Do not print, T = print)
   (NOTE: this option produces large amounts of output)

   First time step for which debug data
   are printed (NN1)                Default: 1       ! NN1 =  1  !

   Last time step for which debug data
   are printed (NN2)                Default: 1       ! NN2 =  1  !

   Print distance to land
   internal variables (LDBCST)      Default: F       ! LDBCST = F !
   (F = Do not print, T = print)
   (Output in .GRD file DCST.GRD, defined in input group 0)

Testing and debug print options for wind field module
(all of the following print options control output to
 wind field module's output files: TEST.PRT, TEST.OUT,
 TEST.KIN, TEST.FRD, and TEST.SLP)
```

```
         Control variable for writing the test/debug
         wind fields to disk files (IOUTD)
         (0=Do not write, 1=write)        Default: 0       ! IOUTD =  0  !

         Number of levels, starting at the surface,
         to print (NZPRN2)                Default: 1       ! NZPRN2 =  0  !

         Print the INTERPOLATED wind components ?
         (IPR0) (0=no, 1=yes)             Default: 0       !  IPR0 =  0  !

         Print the TERRAIN ADJUSTED surface wind
         components ?
         (IPR1) (0=no, 1=yes)             Default: 0       !  IPR1 =  0  !

         Print the SMOOTHED wind components and
         the INITIAL DIVERGENCE fields ?
         (IPR2) (0=no, 1=yes)             Default: 0       !  IPR2 =  0  !

         Print the FINAL wind speed and direction
         fields ?
         (IPR3) (0=no, 1=yes)             Default: 0       !  IPR3 =  0  !

         Print the FINAL DIVERGENCE fields ?
         (IPR4) (0=no, 1=yes)             Default: 0       !  IPR4 =  0  !

         Print the winds after KINEMATIC effects
         are added ?
         (IPR5) (0=no, 1=yes)             Default: 0       !  IPR5 =  0  !

         Print the winds after the FROUDE NUMBER
         adjustment is made ?
         (IPR6) (0=no, 1=yes)             Default: 0       !  IPR6 =  0  !

         Print the winds after SLOPE FLOWS
         are added ?
         (IPR7) (0=no, 1=yes)             Default: 0       !  IPR7 =  0  !

         Print the FINAL wind field components ?
         (IPR8) (0=no, 1=yes)             Default: 0       !  IPR8 =  0  !

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 4 -- Meteorological data options
--------------

    NO OBSERVATION MODE             (NOOBS)  Default: 0     ! NOOBS =  0   !
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air observations)
              Use MM4/MM5/3D for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM4/MM5/3D for surface, overwater, and upper air data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA =  TBD  !

       Number of precipitation stations
       (NPSTA=-1: flag for use of MM5/3D precip data)
                                    (NPSTA)  No default     ! NPSTA =  TBD  !
```

```
    CLOUD DATA OPTIONS
       Gridded cloud fields:
                                (ICLOUD)  Default: 0     ! ICLOUD =  0  !
       ICLOUD = 0 - Gridded clouds not used
       ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT
       ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT
       ICLOUD = 3 - Gridded cloud cover computed from prognostic fields

    FILE FORMATS

       Surface meteorological data file format
                                (IFORMS)  Default: 2     ! IFORMS =  2  !
       (1 = unformatted (e.g., SMERGE output))
       (2 = formatted   (free-formatted user input))

       Precipitation data file format
                                (IFORMP)  Default: 2     ! IFORMP =  2  !
       (1 = unformatted (e.g., PMERGE output))
       (2 = formatted   (free-formatted user input))

       Cloud data file format
                                (IFORMC)  Default: 2     ! IFORMC =  2  !
       (1 = unformatted - CALMET unformatted output)
       (2 = formatted   - free-formatted CALMET output or user input)

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------


    WIND FIELD MODEL OPTIONS
       Model selection variable (IWFCOD)     Default: 1      ! IWFCOD =  1  !
          0 = Objective analysis only
          1 = Diagnostic wind module

       Compute Froude number adjustment
       effects ? (IFRADJ)                    Default: 1      ! IFRADJ =  1  !
       (0 = NO, 1 = YES)

       Compute kinematic effects ? (IKINE)   Default: 0      ! IKINE  =  0  !
       (0 = NO, 1 = YES)

       Use O'Brien procedure for adjustment
       of the vertical velocity ? (IOBR)     Default: 0      ! IOBR =  0  !
       (0 = NO, 1 = YES)

       Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE  =  1  !
       (0 = NO, 1 = YES)

       Extrapolate surface wind observations
       to upper layers ? (IEXTRP)            Default: -4     ! IEXTRP = -4  !
       (1 = no extrapolation is done,
        2 = power law extrapolation used,
        3 = user input multiplicative factors
            for layers 2 - NZ used (see FEXTRP array)
        4 = similarity theory used
        -1, -2, -3, -4 = same as above except layer 1 data
            at upper air stations are ignored
```

```
     Extrapolate surface winds even
     if calm? (ICALM)                     Default: 0      ! ICALM  =  0  !
     (0 = NO, 1 = YES)

     Layer-dependent biases modifying the weights of
     surface and upper air stations (BIAS(NZ))
       -1<=BIAS<=1
     Negative BIAS reduces the weight of upper air stations
       (e.g. BIAS=-0.1 reduces the weight of upper air stations
     by 10%; BIAS= -1, reduces their weight by 100 %)
     Positive BIAS reduces the weight of surface stations
       (e.g. BIAS= 0.2 reduces the weight of surface stations
     by 20%; BIAS=1 reduces their weight by 100%)
     Zero BIAS leaves weights unchanged (1/R**2 interpolation)
     Default: NZ*0
                                 ! BIAS =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,
0  !

     Minimum distance from nearest upper air station
     to surface station for which extrapolation
     of surface winds at surface station will be allowed
     (RMIN2: Set to -1 for IEXTRP = 4 or other situations
      where all surface stations should be extrapolated)
                                          Default: 4.     ! RMIN2 = -1.0 !

     Use gridded prognostic wind field model
     output fields as input to the diagnostic
     wind field model (IPROG)             Default: 0      ! IPROG =  14  !
     (0 = No, [IWFCOD = 0 or 1]
      1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
      2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]
      3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]
      4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]
      5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]
      13 = Yes, use winds from MM5/3D.DAT file as Step 1 field [IWFCOD = 0]
      14 = Yes, use winds from MM5/3D.DAT file as initial guess field [IWFCOD = 1]
      15 = Yes, use winds from MM5/3D.DAT file as observations [IWFCOD = 1]

     Timestep (hours) of the prognostic
     model input data   (ISTEPPG)         Default: 1      ! ISTEPPG =  1   !

     Use coarse CALMET fields as initial guess fields (IGFMET)
     (overwrites IGF based on prognostic wind fields if any)
                                          Default: 0      ! IGFMET =  0  !

  RADIUS OF INFLUENCE PARAMETERS

     Use varying radius of influence      Default: F      ! LVARY =  F!
     (if no stations are found within RMAX1,RMAX2,
      or RMAX3, then the closest station will be used)

     Maximum radius of influence over land
     in the surface layer (RMAX1)         No default      ! RMAX1 = 100. !
                                          Units: km
     Maximum radius of influence over land
     aloft (RMAX2)                        No default      ! RMAX2 = 200. !
                                          Units: km
     Maximum radius of influence over water
     (RMAX3)                              No default      ! RMAX3 = 200. !
                                          Units: km
```

OTHER WIND FIELD INPUT PARAMETERS

```
   Minimum radius of influence used in
   the wind field interpolation (RMIN)   Default: 0.1    ! RMIN = 0.1 !
                                         Units: km
   Radius of influence of terrain
   features (TERRAD)                     No default      ! TERRAD = 15. !

                                         Units: km
   Relative weighting of the first
   guess field and observations in the
   SURFACE layer (R1)                    No default      ! R1 = 50. !
   (R1 is the distance from an           Units: km
   observational station at which the
   observation and first guess field are
   equally weighted)

   Relative weighting of the first
   guess field and observations in the
   layers ALOFT (R2)                     No default      ! R2 = 100. !
   (R2 is applied in the upper layers    Units: km
   in the same manner as R1 is used in
   the surface layer).

   Relative weighting parameter of the
   prognostic wind field data (RPROG)    No default      ! RPROG = 0. !
   (Used only if IPROG = 1)              Units: km
   ------------------------

   Maximum acceptable divergence in the
   divergence minimization procedure
   (DIVLIM)                              Default: 5.E-6  ! DIVLIM= 5.0E-06 !

   Maximum number of iterations in the
   divergence min. procedure (NITER)     Default: 50     ! NITER =  50  !

   Number of passes in the smoothing
   procedure (NSMTH(NZ))
   NOTE: NZ values must be entered
        Default: 2,(mxnz-1)*4 ! NSMTH =
2 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4  !

   Maximum number of stations used in
   each layer for the interpolation of
   data to a grid point (NINTR2(NZ))
   NOTE: NZ values must be entered       Default: 99.    ! NINTR2 =
99 ,  99,  99 ,  99 ,  99,  99 ,  99 ,  99 , 99 ,  99 !

   Critical Froude number (CRITFN)       Default: 1.0    ! CRITFN = 1. !

   Empirical factor controlling the
   influence of kinematic effects
   (ALPHA)                               Default: 0.1    ! ALPHA = 0.1 !

   Multiplicative scaling factor for
   extrapolation of surface observations
   to upper layers (FEXTR2(NZ))          Default: NZ*0.0
   ! FEXTR2 = 0., 0., 0., 0., 0., 0., 0., 0., 0., 0. !
   (Used only if IEXTRP = 3 or -3)
```

BARRIER INFORMATION

```
Number of barriers to interpolation
of the wind fields (NBAR)            Default: 0      ! NBAR =  0  !

Level (1 to NZ) up to which barriers
apply (KBAR)                         Default: NZ     ! KBAR =  10  !

THE FOLLOWING 4 VARIABLES ARE INCLUDED
ONLY IF NBAR > 0
NOTE: NBAR values must be entered    No defaults
      for each variable              Units: km

   X coordinate of BEGINNING
   of each barrier (XBBAR(NBAR))     ! XBBAR = 0. !
   Y coordinate of BEGINNING
   of each barrier (YBBAR(NBAR))     ! YBBAR = 0. !

   X coordinate of ENDING
   of each barrier (XEBAR(NBAR))     ! XEBAR = 0. !
   Y coordinate of ENDING
   of each barrier (YEBAR(NBAR))     ! YEBAR = 0. !


DIAGNOSTIC MODULE DATA INPUT OPTIONS

Surface temperature (IDIOPT1)        Default: 0      ! IDIOPT1 =  0  !
   0 = Compute internally from
       hourly surface observations
   1 = Read preprocessed values from
       a data file (DIAG.DAT)

   Surface met. station to use for
   the surface temperature (ISURFT)  No default     ! ISURFT =  TBD  !
   (Must be a value from 1 to NSSTA)
   (Used only if IDIOPT1 = 0)
   --------------------------

Domain-averaged temperature lapse
rate (IDIOPT2)                       Default: 0     ! IDIOPT2 =  0  !
   0 = Compute internally from
       twice-daily upper air observations
   1 = Read hourly preprocessed values
       from a data file (DIAG.DAT)

   Upper air station to use for
   the domain-scale lapse rate (IUPT) No default     ! IUPT   =  TBD  !
   (Must be a value from 1 to NUSTA)
   (Used only if IDIOPT2 = 0)
   --------------------------

   Depth through which the domain-scale
   lapse rate is computed (ZUPT)     Default: 200.  ! ZUPT = 200. !
   (Used only if IDIOPT2 = 0)        Units: meters
   --------------------------

Domain-averaged wind components
(IDIOPT3)                            Default: 0     ! IDIOPT3 =  0  !
   0 = Compute internally from
       twice-daily upper air observations
   1 = Read hourly preprocessed values
       a data file (DIAG.DAT)

   Upper air station to use for
   the domain-scale winds (IUPWND)   Default: -1    ! IUPWND = -1  !
```

```
    (Must be a value from -1 to NUSTA)
    (Used only if IDIOPT3 = 0)
    --------------------------

    Bottom and top of layer through
    which the domain-scale winds
    are computed
    (ZUPWND(1), ZUPWND(2))        Defaults: 1., 1000. ! ZUPWND= 1., 1000. !
    (Used only if IDIOPT3 = 0)    Units: meters
    --------------------------

 Observed surface wind components
 for wind field module (IDIOPT4)  Default: 0     ! IDIOPT4 =  0  !
    0 = Read WS, WD from a surface
        data file (SURF.DAT)
    1 = Read hourly preprocessed U, V from
        a data file (DIAG.DAT)

 Observed upper air wind components
 for wind field module (IDIOPT5)  Default: 0     ! IDIOPT5 =  0  !
    0 = Read WS, WD from an upper
        air data file (UP1.DAT, UP2.DAT, etc.)
    1 = Read hourly preprocessed U, V from
        a data file (DIAG.DAT)

 LAKE BREEZE INFORMATION

    Use Lake Breeze Module  (LLBREZE)
                                    Default: F      ! LLBREZE = F !

     Number of lake breeze regions (NBOX)           ! NBOX =  0  !

  X Grid line 1 defining the region of interest
                                                 ! XG1 = 0. !
  X Grid line 2 defining the region of interest
                                                 ! XG2 = 0. !
  Y Grid line 1 defining the region of interest
                                                 ! YG1 = 0. !
  Y Grid line 2 defining the region of interest
                                                 ! YG2 = 0. !

   X Point defining the coastline (Straight line)
             (XBCST)  (KM)   Default: none    ! XBCST = 0. !

   Y Point defining the coastline (Straight line)
             (YBCST)  (KM)   Default: none    ! YBCST = 0. !

   X Point defining the coastline (Straight line)
             (XECST)  (KM)   Default: none    ! XECST = 0. !

   Y Point defining the coastline (Straight line)
             (YECST)  (KM)   Default: none    ! YECST = 0. !


 Number of stations in the region     Default: none ! NLB =  0 !
 (Surface stations + upper air stations)

 Station ID's  in the region   (METBXID(NLB))
 (Surface stations first, then upper air stations)
   ! METBXID =  0 !

!END!
```

```
--------------------------------------------------------------------------------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters
--------------

    EMPIRICAL MIXING HEIGHT CONSTANTS

       Neutral, mechanical equation
       (CONSTB)                           Default: 1.41   ! CONSTB = 1.41 !
       Convective mixing ht. equation
       (CONSTE)                           Default: 0.15   ! CONSTE = 0.15 !
       Stable mixing ht. equation
       (CONSTN)                           Default: 2400.  ! CONSTN = 2400.!
       Overwater mixing ht. equation
       (CONSTW)                           Default: 0.16   ! CONSTW = 0.16 !
       Absolute value of Coriolis
       parameter (FCORIOL)                Default: 1.E-4  ! FCORIOL = 1.0E-04!
                                          Units: (1/s)

    SPATIAL AVERAGING OF MIXING HEIGHTS

       Conduct spatial averaging
       (IAVEZI)  (0=no, 1=yes)            Default: 1      ! IAVEZI =  1  !

       Max. search radius in averaging
       process (MNMDAV)                   Default: 1      ! MNMDAV =  1  !
                                          Units: Grid
                                                 cells
       Half-angle of upwind looking cone
       for averaging (HAFANG)             Default: 30.    ! HAFANG = 30. !
                                          Units: deg.
       Layer of winds used in upwind
       averaging (ILEVZI)                 Default: 1      ! ILEVZI =  1  !
       (must be between 1 and NZ)


    CONVECTIVE MIXING HEIGHT OPTIONS:
       Method to compute the convective
       mixing height(IMIHXH)              Default: 1      ! IMIXH =  -1  !
           1: Maul-Carson for land and water cells
          -1: Maul-Carson for land cells only -
              OCD mixing height overwater
           2: Batchvarova and Gryning for land and water cells
          -2: Batchvarova and Gryning for land cells only
              OCD mixing height overwater

       Threshold buoyancy flux required to
       sustain convective mixing height growth
       overland (THRESHL)                 Default: 0.05   ! THRESHL = 0.0 !
       (expressed as a heat flux          units: W/m3
        per meter of boundary layer)


       Threshold buoyancy flux required to
       sustain convective mixing height growth
       overwater (THRESHW)                Default: 0.05   ! THRESHW = 0.05 !
       (expressed as a heat flux          units: W/m3
        per meter of boundary layer)


       Option for overwater lapse rates used
       in convective mixing height growth
```

```
   (ITWPROG)                             Default: 0      ! ITWPROG =  0  !
   0 : use SEA.DAT lapse rates and deltaT (or assume neutral
       conditions if missing)
   1 : use prognostic lapse rates (only if IPROG>2)
       and SEA.DAT deltaT (or neutral if missing)
   2 : use prognostic lapse rates and prognostic delta T
       (only if iprog>12 and 3D.DAT version# 2.0 or higher)

   Land Use category ocean in 3D.DAT datasets
   (ILUOC3D)                             Default: 16     ! ILUOC3D =  16  !
   Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16
         if MM4.DAT,           typically iluoc3d = 7


OTHER MIXING HEIGHT VARIABLES

   Minimum potential temperature lapse
   rate in the stable layer above the
   current convective mixing ht.         Default: 0.001  ! DPTMIN = 0.001 !
   (DPTMIN)                              Units: deg. K/m
   Depth of layer above current conv.
   mixing height through which lapse     Default: 200.   ! DZZI = 200. !
   rate is computed (DZZI)               Units: meters

   Minimum overland mixing height        Default:  50.   ! ZIMIN = 50. !
   (ZIMIN)                               Units: meters
   Maximum overland mixing height        Default: 3000.  ! ZIMAX = 3000. !
   (ZIMAX)                               Units: meters
   Minimum overwater mixing height       Default:   50.  ! ZIMINW = 50. !
   (ZIMINW) -- (Not used if observed     Units: meters
   overwater mixing hts. are used)
   Maximum overwater mixing height       Default: 3000.  ! ZIMAXW = 3000. !
   (ZIMAXW) -- (Not used if observed     Units: meters
   overwater mixing hts. are used)


OVERWATER SURFACE FLUXES METHOD and PARAMETERS
      (ICOARE)                           Default: 10      ! ICOARE =  0   !
       0: original deltaT method (OCD)
      10: COARE with no wave parameterization (jwave=0, Charnock)
      11: COARE with wave option jwave=1 (Oost et al.)
          and default wave properties
     -11: COARE with wave option jwave=1 (Oost et al.)
          and observed wave properties (must be in SEA.DAT files)
      12: COARE with wave option 2 (Taylor and Yelland)
           and default wave properties
     -12: COARE with wave option 2 (Taylor and Yelland)
          and observed wave properties (must be in SEA.DAT files)

      Coastal/Shallow water length scale (DSHELF)
      (for modified z0 in shallow water)
      ( COARE fluxes only)
                                      Default : 0.        ! DSHELF = 0. !
                                      units: km

       COARE warm layer computation (IWARM)               ! IWARM =  0   !
       1: on - 0: off (must be off if SST measured with
       IR radiometer)                 Default: 0

       COARE cool skin layer computation (ICOOL)          ! ICOOL =  0   !
       1: on - 0: off (must be off if SST measured with
       IR radiometer)                 Default: 0
```

```
    TEMPERATURE PARAMETERS

       3D temperature from observations or
       from prognostic data? (ITPROG)       Default:0        ! ITPROG =  0   !

          0 = Use Surface and upper air stations
              (only if NOOBS = 0)
          1 = Use Surface stations (no upper air observations)
              Use MM5/3D for upper air data
              (only if NOOBS = 0,1)
          2 = No surface or upper air observations
              Use MM5/3D for surface and upper air data
              (only if NOOBS = 0,1,2)

       Interpolation type
       (1 = 1/R ; 2 = 1/R**2)               Default:1         ! IRAD =  1  !

       Radius of influence for temperature
       interpolation (TRADKM)               Default: 500.     ! TRADKM = 500. !
                                            Units: km

       Maximum Number of stations to include
       in temperature interpolation (NUMTS)  Default: 5       ! NUMTS = 5  !

       Conduct spatial averaging of temp-
       eratures (IAVET)  (0=no, 1=yes)      Default: 1        ! IAVET =  1  !
       (will use mixing ht MNMDAV,HAFANG
        so make sure they are correct)

       Default temperature gradient         Default: -.0098   ! TGDEFB = -0.0098 !
       below the mixing height over         Units: K/m
       water (TGDEFB)

       Default temperature gradient         Default: -.0045   ! TGDEFA = -0.0045 !
       above the mixing height over         Units: K/m
       water (TGDEFA)

       Beginning (JWAT1) and ending (JWAT2)
       land use categories for temperature                   ! JWAT1 =  55  !
       interpolation over water -- Make                      ! JWAT2 =  55  !
       bigger than largest land use to disable

   PRECIP INTERPOLATION PARAMETERS

       Method of interpolation (NFLAGP)     Default: 2       ! NFLAGP =  2  !
        (1=1/R,2=1/R**2,3=EXP/R**2)
       Radius of Influence  (SIGMAP)        Default: 100.0   ! SIGMAP = 100. !
        (0.0 => use half dist. btwn         Units: km
         nearest stns w & w/out
         precip when NFLAGP = 3)
       Minimum Precip. Rate Cutoff (CUTP)   Default: 0.01    ! CUTP = 0.01 !
        (values < CUTP = 0.0 mm/hr)         Units: mm/hr
!END!


-------------------------------------------------------------------------------

INPUT GROUP: 7 -- Surface meteorological station parameters
--------------

     SURFACE STATION VARIABLES
     (One record per station --  TBD  records in all)
```

```
              1     2
         Name   ID            X coord.   Y coord.   Time   Anem.
                               (km)       (km)      zone   Ht.(m)
       ----------------------------------------------------------
! SS1  =' '              !
! SS2  =' '              !
! SS3  =' '              !
! SS4  =' '             !
! SS5  =' '              !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Six digit integer for station ID

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

     UPPER AIR STATION VARIABLES
     (One record per station --  TBD  records in all)

              1     2
         Name    ID      X coord.   Y coord.  Time zone
                           (km)       (km)
        ---------------------------------------------
! US1  =''    !
! US2  =' '   !
! US3  =' '   !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

     PRECIPITATION STATION VARIABLES
     (One record per station --  TBD  records in all)
     (NOT INCLUDED IF NPSTA = 0)

             1          2
         Name   Station    X coord.  Y coord.
                  Code       (km)      (km)
         ------------------------------------

! PS1  =''       !
```

```
! PS2  =''        !
! PS3  =''        !
! PS4  =''        !
! PS5  =''        !
! PS6  =''        !
! PS7  =''        !
! PS8  =''        !
! PS9  =''        !
! PS10 =''        !
! PS11 =''        !
! PS12 =''        !
! PS13 =''        !
! PS14 =''        !
! PS15 =''        !
! PS16 =''        !
```

1
Four character string for station name
(MUST START IN COLUMN 9)

2
Six digit station code composed of state
code (first 2 digits) and station ID (last
4 digits)

!END!

From: Nick, Andrea -FS [anick@fs.fed.us]
Sent: Friday, December 06, 2013 7:59 AM
To: Salamy, Jerry/SAC
Cc: McCorison, Mike -FS; Anderson, Bret A -FS; Procter, Trent -FS; Uyehara, Julie C -FS; tchico@aqmd.gov; jbaker@aqmd.gov; stephen.okane@AES.com; Holladay.Cleveland@epamail.epa.gov; bohnenkamp.carol@epa.gov; Gbemis@energy.state.ca.us; JYee@aqmd.gov; Chris.Davis@energy.ca.gov
Subject: (Correction) AES Alamitos Energy Center PSD Application

Hello,

I apologize, the email below is in reference to the AES Alamitos Energy Center. The email should have read:

I am contacting you regarding the AES Alamitos Energy Center's Prevention of Significant Deterioration (PSD) permit. The U.S. Forest Service's Air Resources air quality modeling specialist along with other interested parties within the agency have reviewed the air dispersion modelling protocol which was submitted on November 11, 2013 entitled "AES_AEC_1_Protocol_Response_USFS_11-11-13.pdf". We are not anticipating further comment on the air dispersion modelling protocol for the AES Alamitos Energy Center project and you are free to proceed with the agreed protocol.

Andrea Nick, Air Resources Specialist
Forest Service Region 5
www.fs.fed.us/air

p: 626-574-5209 / c: 626-590-4451 / anick@fs.fed.us
701 N. Santa Anita Avenue, Arcadia, CA 91006-2725

From: Nick, Andrea -FS
Sent: Friday, December 06, 2013 7:49 AM
To: 'Jerry.Salamy@CH2M.com'
Cc: McCorison, Mike -FS; Anderson, Bret A -FS; Procter, Trent -FS; Uyehara, Julie C -FS; tchico@aqmd.gov; jbaker@aqmd.gov; stephen.okane@AES.com; Holladay.Cleveland@epamail.epa.gov; bohnenkamp.carol@epa.gov; Gbemis@energy.state.ca.us; JYee@aqmd.gov; Chris.Davis@energy.ca.gov
Subject: RE: AES Alamitos Energy Center PSD Application

Hello,

I am contacting you regarding the AES Huntington Beach Prevention of Significant Deterioration (PSD) permit. The U.S. Forest Service's Air Resources air quality modeling specialist along with other interested parties within the agency have reviewed the air dispersion modelling protocol which was submitted on November 11, 2013 entitled "AES_AEC_1_Protocol_Response_USFS_11-11-13.pdf". We are not anticipating further comment on the air dispersion modelling protocol for the AES Huntington Beach project and you are free to proceed with the agreed protocol.

Please contact me if you have further questions. Thank you.

Andrea Nick, Air Resources Specialist
Forest Service Region 5
www.fs.fed.us/air

p: 626-574-5209 / c: 626-590-4451 / anick@fs.fed.us
701 N. Santa Anita Avenue, Arcadia, CA 91006-2725

From: Jerry.Salamy@CH2M.com [mailto:Jerry.Salamy@CH2M.com]
Sent: Tuesday, November 12, 2013 9:29 AM
To: Nick, Andrea -FS
Cc: McCorison, Mike -FS; Anderson, Bret A -FS; Procter, Trent -FS; Uyehara, Julie C -FS; tchico@aqmd.gov; jbaker@aqmd.gov; stephen.okane@AES.com; Holladay.Cleveland@epamail.epa.gov; bohnenkamp.carol@epa.gov; Gbemis@energy.state.ca.us; JYee@aqmd.gov; Chris.Davis@energy.ca.gov
Subject: RE: AES Alamitos Energy Center PSD Application

Hi Andrea,

Based on your feedback during our November 1 conference call, we have prepared the attached responses to the United States Forest Service's comments on the Alamitos Energy Center's Class I air dispersion modeling protocol. Please let us know if you have any additional questions.

Thanks,

Jerry Salamy
Principal Project Manager
CH2M HILL/Sacramento
Phone 916-286-0207
Fax 916-614-3407
Cell Phone 916-769-8919

From: Nick, Andrea -FS [mailto:anick@fs.fed.us]
Sent: Wednesday, September 11, 2013 9:06 AM
To: Salamy, Jerry/SAC
Cc: McCorison, Mike -FS; Anderson, Bret A -FS; Procter, Trent -FS; Uyehara, Julie C -FS
Subject: AES Alamitos Energy Center PSD Application

Good Morning,

Our modeling specialist (Bret Anderson) has looked over the modeling protocols supplied for the AES Alamitos Energy Center PSD application. Additional information on the following subjects is requested:

1. MM5 Data documentation: source of data, horizontal/vertical resolution, physics options, performance evaluation, etc.

2. List of all surface and upper air meteorological stations.

3. Procedures for filling in missing meteorological data.

4. List of Proposed CALPUFF control options.

5. List of POSTUTIL and CALPOST options.

6. Discussion on CALMET control options as proposal does not comport with August 31, 2009 EPA Model Clearinghouse memorandum.

Our modeling specialist has recommended that we schedule a conference call to discuss these issues. Would any of the afternoons on Monday, Tuesday, or Thursday work for you?

****

Andrea Nick
Air Resources Specialist
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