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Advances in Climate Data and Analytical Approaches on Cal-Adapt: Relevance to Demand Forecasts

Cal-Adapt:
ANALYTICS
ENGINE

Owen Doherty, Ph.D.

Lead of Cal-Adapt, and Chief Research Scientist of Eagle Rock Analytics

EAGLE ROCK ANALYTICS

GEOSPATIAL INNOVATION FACILITY
Cutting-Edge Mapping Technology at UC Berkeley

BERKELEY LAB

Berkeley
UNIVERSITY OF CALIFORNIA

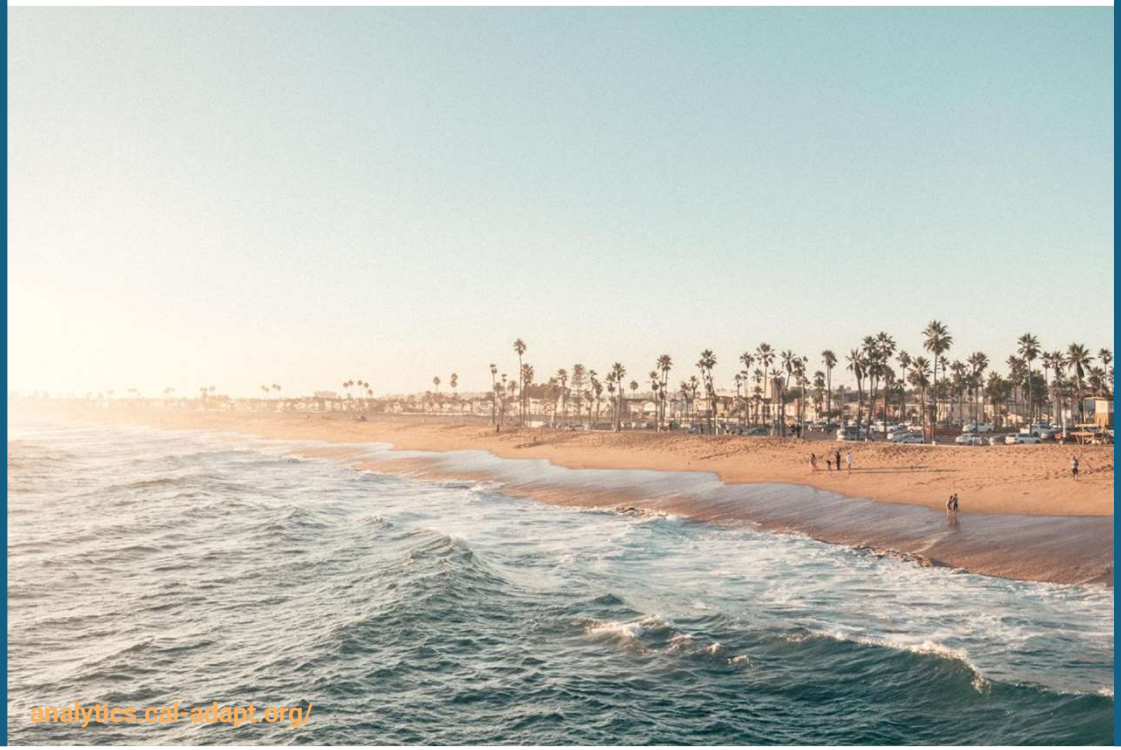
Spatial Informatics Group

Primary Funding Provided by: California Energy Commission – EPIC Program (EPC-20-007, EPC-23-024)

Managed by: Susan Wilhelm, Ph.D., M.S.E. (CEC) and Emily Field, MSc. (CEC)

Energy+Environmental Economics

Analytics Engine & IEPR



Cal-Adapt: ANALYTICS ENGINE

Multidisciplinary climate research team

Advancing demand forecasts through better climate information

- Open
- Transparent
- Reproducible
- Publicly accessible
- Publicly reviewable
- Peer reviewed

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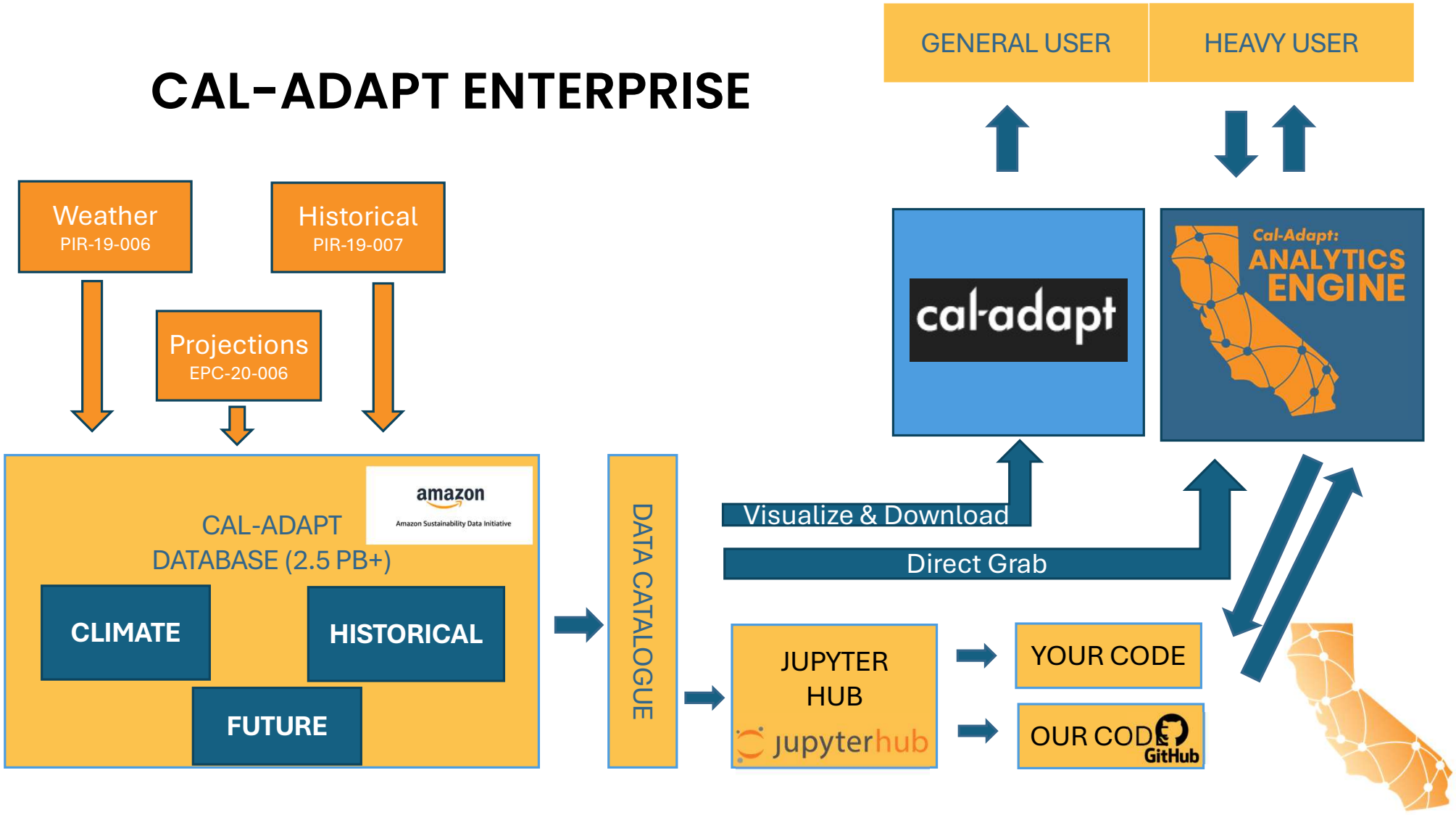
Guiding Research Principles for Analytics Engine Development

CAL-ADAPT ENTERPRISE



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California's 5th Climate Change Assessment

ipcc REPORTS SYNTHESIS REPORT WORKING GROUPS

The Intergovernmental Panel on Climate Change

Downscaling

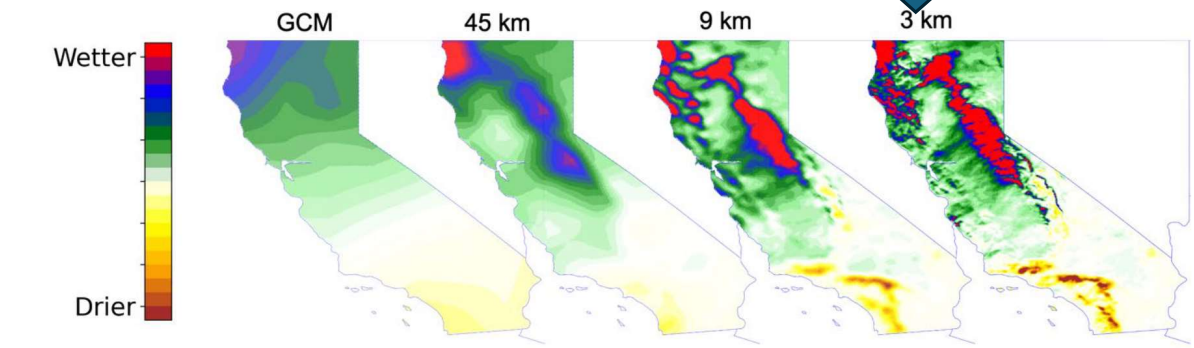

Image: Rahimi (2023), CEC Memo, Data Adoption Justification Memo: Dynamically Downscaled Dataset

Regulatory - Informed Analysis

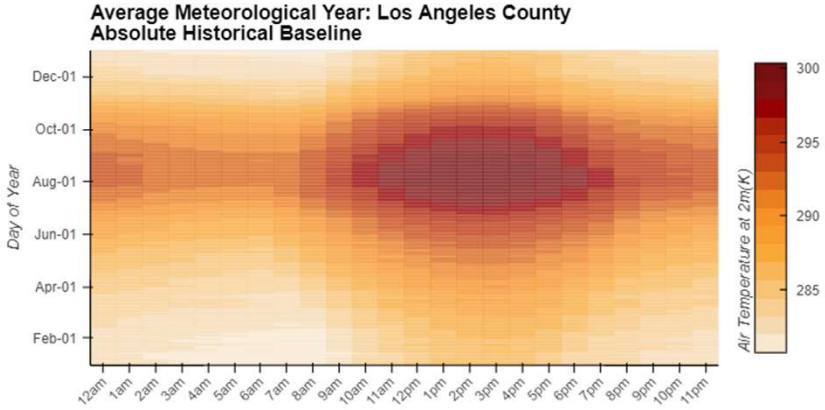

Image: Analytics Engine

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California's 5th Climate Change Assessment Data

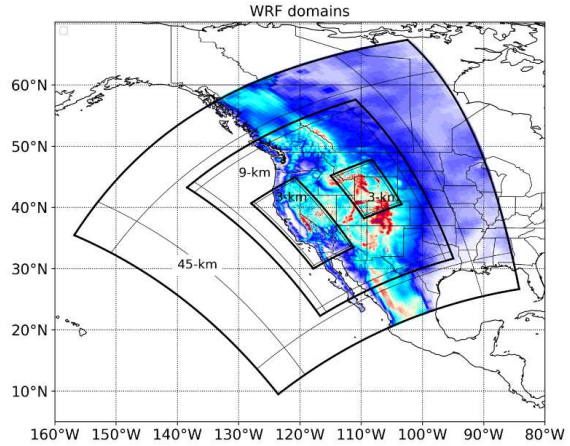
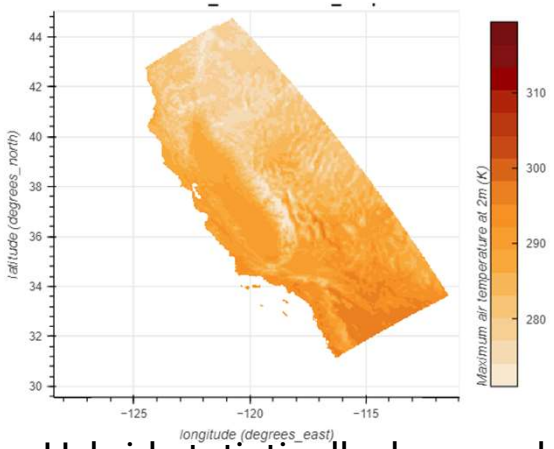


Figure 1: Domain setup of WRF simulations with a colorfill representing the complex topography across the region.

WRF
from UCLA

- Dynamically downscaled from **8** CMIP6 GCMs
- **Hourly,** daily, and monthly time resolution
- 3km, 9km, and 45km
- 20+ variables: (e.g. air temperature, precipitation, wind speed, humidity, solar radiation etc.)



LOCA2
from SIO

- Hybrid statistically downscaled from **15** CMIP6 GCMs
- Daily & monthly time resolution
- 3km
- 8 variables (e.g. air temperature, precipitation, wind, humidity, solar radiation)
- **199** realizations

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WRF

Partly bias adjusted: requires some care and thought in use

Suitable for applications that require **sub-daily observations** and focus on **individual events**

Compare across GCM and global emissions scenario

LOCA2

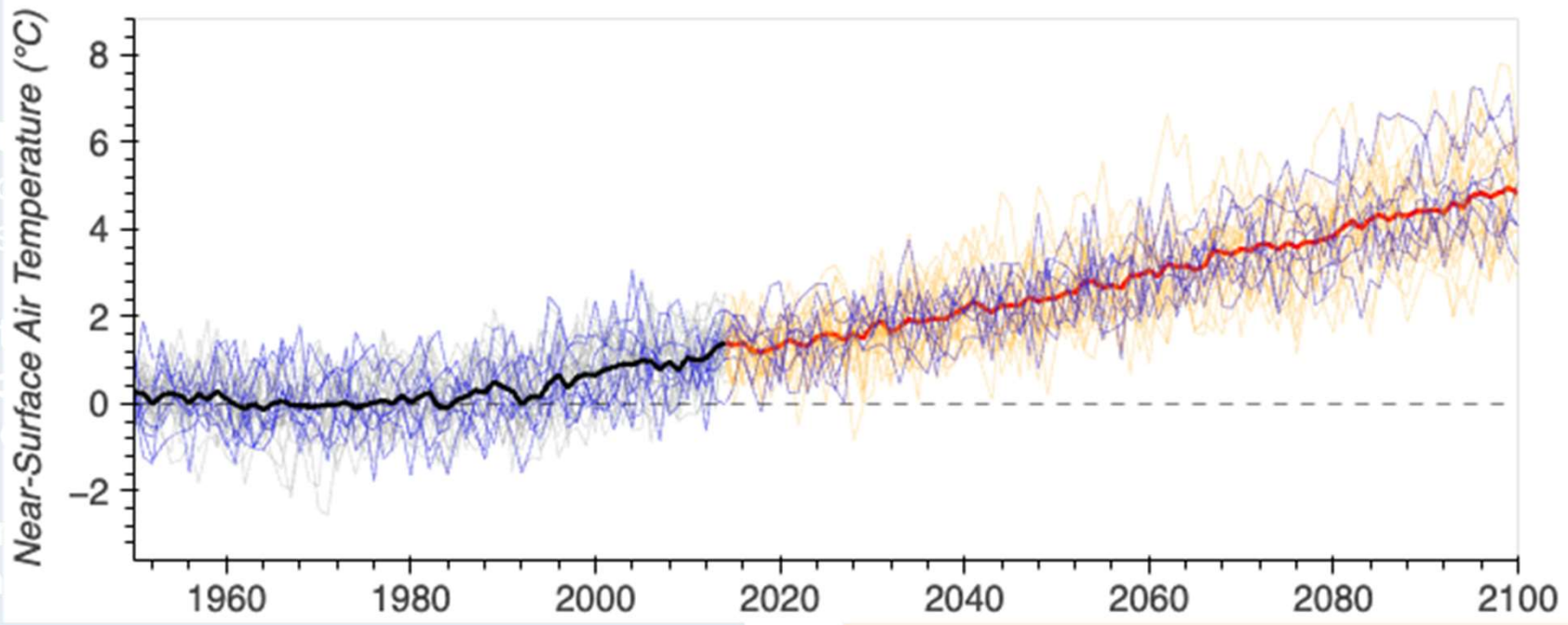
Bias adjusted: absolute values can be used as direct inputs into models

However, sub-monthly extremes may be distorted by this approach

Can characterize within-model variability in addition to across GCM and emissions scenario

WRF

LOCA2



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WRF

Not bias corrected: can be used as-is to examine relative change but not absolute values

Compare across GCM and global emissions scenario

LOCA2

Bias corrected: absolute values can be used as direct inputs into models

However, sub-monthly extremes may be distorted by this approach

Can characterize within-model variability in addition to across GCM and emissions scenario

Data selection depends on your question of interest

→ The Analytics Engine provides tools to help assess which model output is right for your application

https://analytics.cal-adapt.org/data/catalog/

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AE Data

- Data Overview
- About the Data
- Accessing Data
- Data Catalog
- Metadata Standards
- Data Updates

		Total precipitation (pr)	Max air temperature at 2m (tasmax)	Min air temperature at 2m (tasmin)	Specific humidity at 2m (huss)	Max relative humidity (hursmax)	Min relative humidity (hursmin)	Wind speed at 10m (wspeed)	West-east component of wind (uas)	North-south component of wind (vas)	Shortwave flux at the surface (rsds)
Historical	GCMs	15	15	15	13	13	13	11	11	11	14
	Ensembles	70	70	70	51	51	51	46	46	46	51
SSP2-4.5	GCMs	14	14	14	12	12	12	11	11	11	14
	Ensembles	33	33	33	25	25	25	24	24	24	30
SSP3-7.0	GCMs	14	14	14	12	12	12	10	10	10	13
	Ensembles	62	62	62	45	45	45	38	38	38	45
SSP5-8.0	GCMs	13	13	13	11	11	11	11	11	11	13
	Ensembles	34	34	34	25	25	25	26	26	26	29

Simulations				
Projections Simulations				
		Emissions Scenario	Temporal Resolution	
			Daily*	Hourly
Spatial Resolutions	3 km (CA)	Historical	4	8
		SSP2-4.5	0	0
		SSP3-7.0	4	8
		SSP5-8.5	0	0
	9 km (WECC)	Historical	4	8
		SSP2-4.5**	1	1
		SSP3-7.0	4	8
		SSP5-8.5	1	1
	45 km	Historical	4	5
		SSP2-4.5	1	1
		SSP3-7.0	4	5
		SSP5-8.5	1	1
Reanalysis Simulations				
Spatial Resolutions	3 km (CA)	Historical Reconstruction WRF_ERA5	1	1
	9 km (WECC)		1	1
	45 km		1	1
Variables: Air temperature, wind speed, total precipitation, relative humidity, solar radiation, + 19 others				

https://analytics.cal-adapt.org/guidance/about_climate_projections_and_models/

ANALYTICS ENGINE

About Guidance Analytics Data FAQ Sign In

AE Guidance

- Guidance Home
- About Climate Projections and Models
- Using Climate Data in Decision-Making
- Glossary
- References
- Guidance Updates

About Climate Projections and Models

The following sections provide an overview of climate projections and models, and how Analytics Engine tools have been developed to allow users to explore a variety of concepts. To learn more about the scientific methodology that underlies each of the following sections, please see the page titled References under the Guidance tab. To better understand how to apply these concepts to different adaptation and planning contexts, please see the Guidance on Using Climate Data in Decision Making page.

What are climate projections?

The data provided on the Analytics Engine are *projections*, or estimates, of potential future climates. Projections are not weather predictions and should not be treated as such. Weather is the short-term behavior of the atmosphere, and is characterized over time periods of days and weeks. Climate is the long-term behavior of the atmosphere, and it is characterized over multiple decades – it is the long-term statistics of weather conditions. The Analytics Engine provides users with the tools to characterize the long-term climate in new and novel ways,

Co-production: Understanding challenges in climate & demand forecasting

Cal-Adapt: ANALYTICS ENGINE

Narrowing the gap on:

- Gridded data vs. point-based work
- Daily timepoints vs. hourly timepoints
- Conceptual understanding of limitations of data and data quality

Use of Analytics Engine

- Who uses the Analytics Engine?
- What can users accomplish on the Analytics Engine
- Best science in a regulatory environment

Technical User

DEMOGRAPHIC

- Tool user, data user
- Analytical way of thinking
- Comfortable working in programming notebook environments (R Studio, Python Jupyter)
- Statistics, Econ, Engineering,

MOTIVATIONS

- Refining the information / data
  - Help shape information and data to suit technical and decision needs
- Answering specific questions defined by someone else
- Easy access to latest data and tools
- Build relationships with scientists and other decision makers
- Better understand uncertainty
- Seeks analysis outputs to further their goals

GOALS FOR CAL-ADAPT: ANALYTICS ENGINE

- User awareness of data available
- User awareness of use / utility to them

Advancing Towards A Climate-Informed IPER

- New Data + New Capabilities = Progress

- Progress toward:
  - Applicability of climate data
  - Energy system models approaches
  - Break barriers – to do work not previously possible
  - Less reliance upon statistical inferences than the past

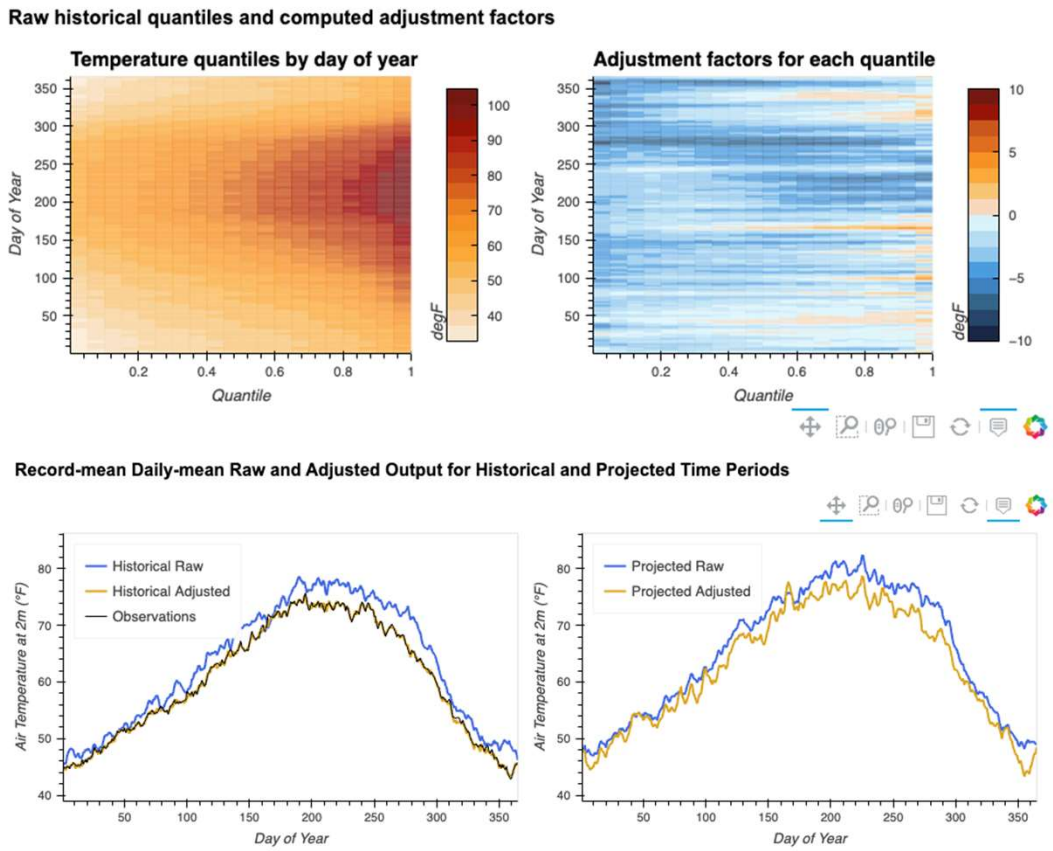
Climate & Weather Analyses Supported

Climate science research on IEPR use cases include:

- Localization of gridded data to points
- Climate information timed to consumer behavior
- Calculation of demand relevant metrics
- Removal of trends from climate data

Images: noaa.gov

Localization

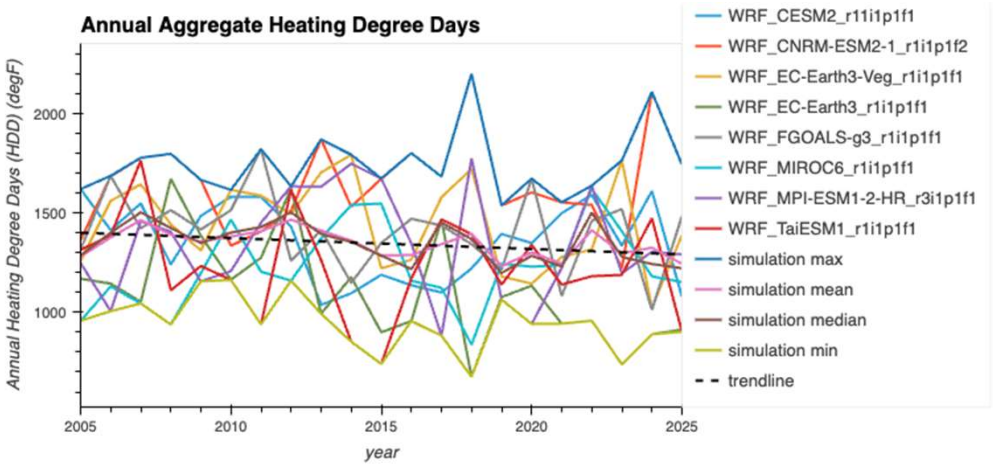


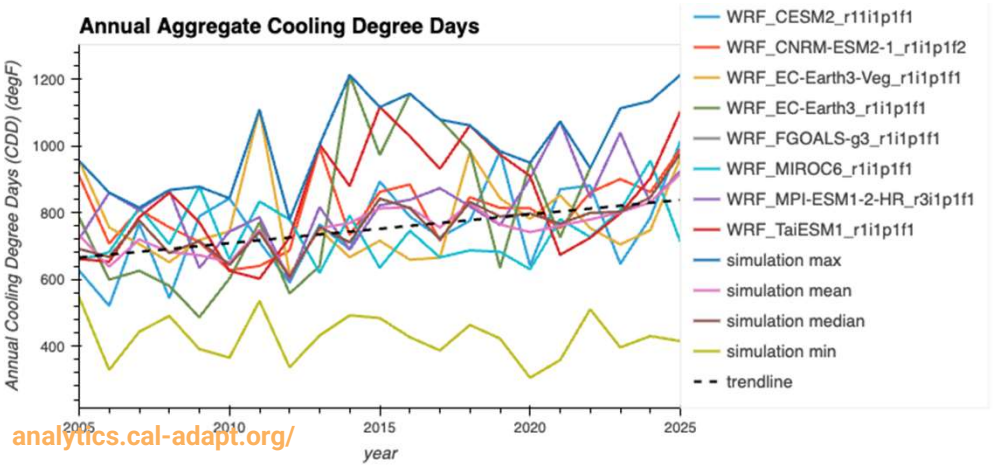
Addresses DFU need for localized model data appropriate for a station location

Quantile delta mapping adjusts for systematic biases in model projections by preserving individual quantiles

QDM **outperforms** simple bias adjustment procedures (e.g., mean, variance)

Cooling/Heating Degree Hours and Days





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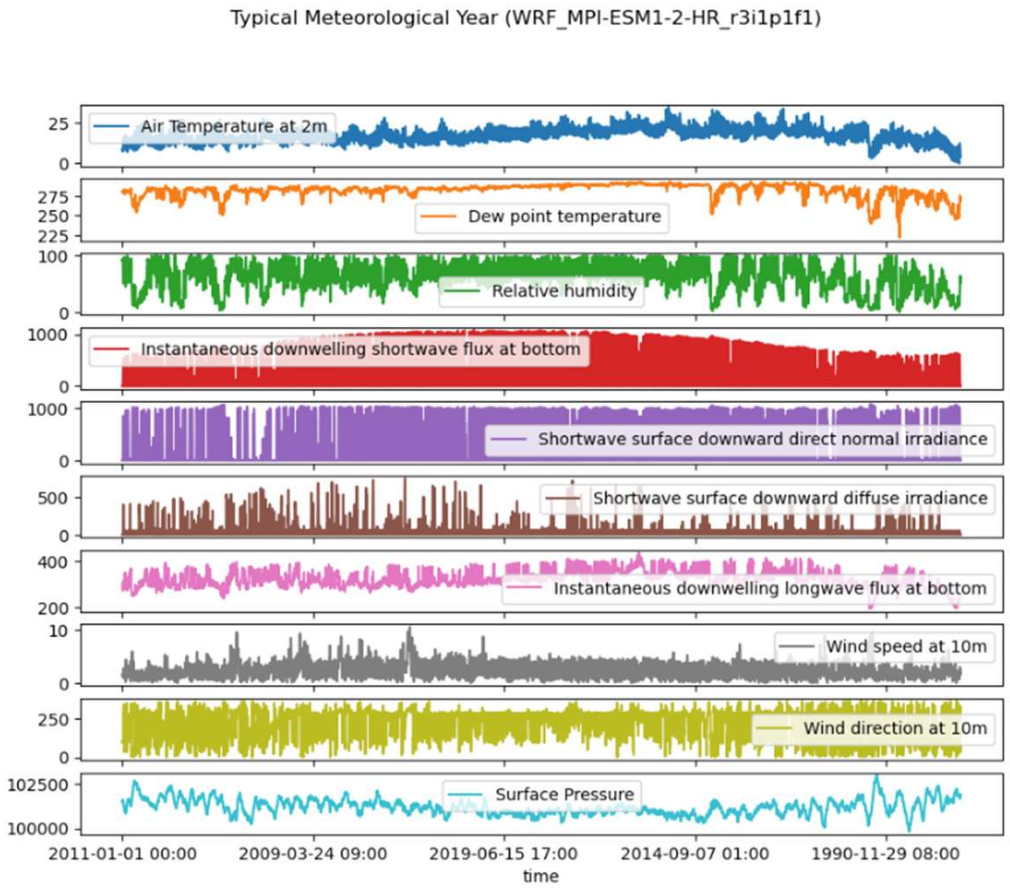
Benefits to demand forecasting:

- User can input custom and separate HDD / CDD thresholds
  - Example: HDD with 60°F and CDD with 70°F
- Can calculate HDD / CDD within demand forecast zone, or point location
- Aggregation across demand forecast zone after calculation includes extremes

Characterization of Typical Days



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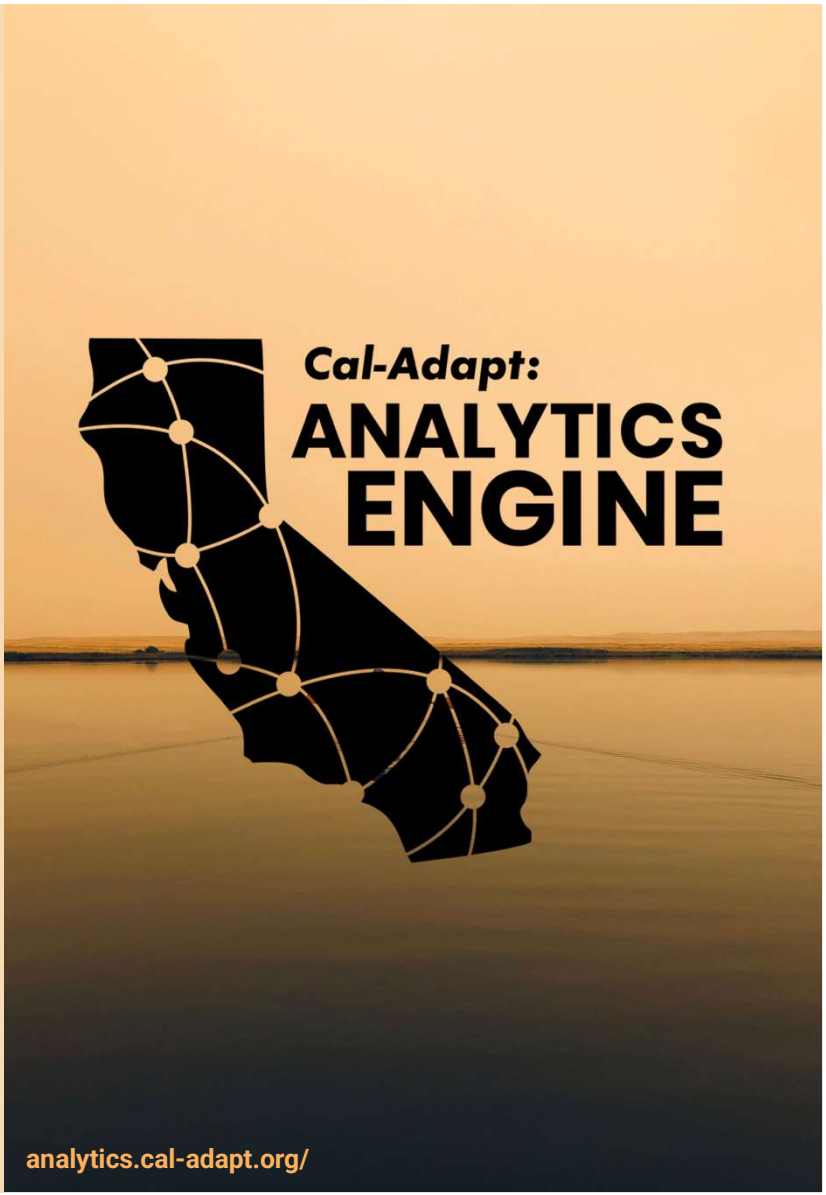
Addresses energy forecasting need for typical weather profiles

TMY methods adhere to national standards (Sandia/NREL), including solar radiation projections

Benefits to forecasting:

- Select any location
- Present or future



Climate-Informed IEPR Opportunities

1. Radiation vs cloud cover
2. IOU weather stations
3. Warming levels and year-glide-paths
4. New agreement with CEC calls out climate support for IEPR

Thank you for your time!

Please reach out to schedule a demo, talk data or contribute code:

analytics@cal-adapt.org

Learn more by visiting our websites!

Analytics Engine: analytics.cal-adapt.org

Cal-Adapt: cal-adapt.org