DOCKETED	
Docket Number:	19-ERDD-01
Project Title:	Research Idea Exchange
TN #:	237242
Document Title:	Rachel Clemesha Comments - Attenuation of solar energy by wildfire smoke
Description:	N/A
Filer:	System
Organization:	Rachel Clemesha
Submitter Role:	Public
Submission Date:	3/19/2021 3:09:59 PM
Docketed Date:	3/19/2021

Comment Received From: Rachel Clemesha
Submitted On: 3/19/2021
Docket Number: 19-ERDD-01

Attenuation of solar energy by wildfire smoke

Additional submitted attachment is included below.

Attenuation of solar energy by wildfire smoke

There is a need for fine-scale, aerosol-capable modeling to elucidate structure and predict smoke effects on solar irradiance. A quantitative bound on the amount of dimming by wildfires for CA is a needed area of research.

It may be interesting as a first step to simply understand how much attenuation, on a percentage basis, occurred in big wildfire years like 2007, 2018, 2020, etc. and were these extreme outliers? Can a historical trend be established? Certainly compelling trends in number acres burned have been shown, do these same trends show up in attenuation by wildfire smoke?

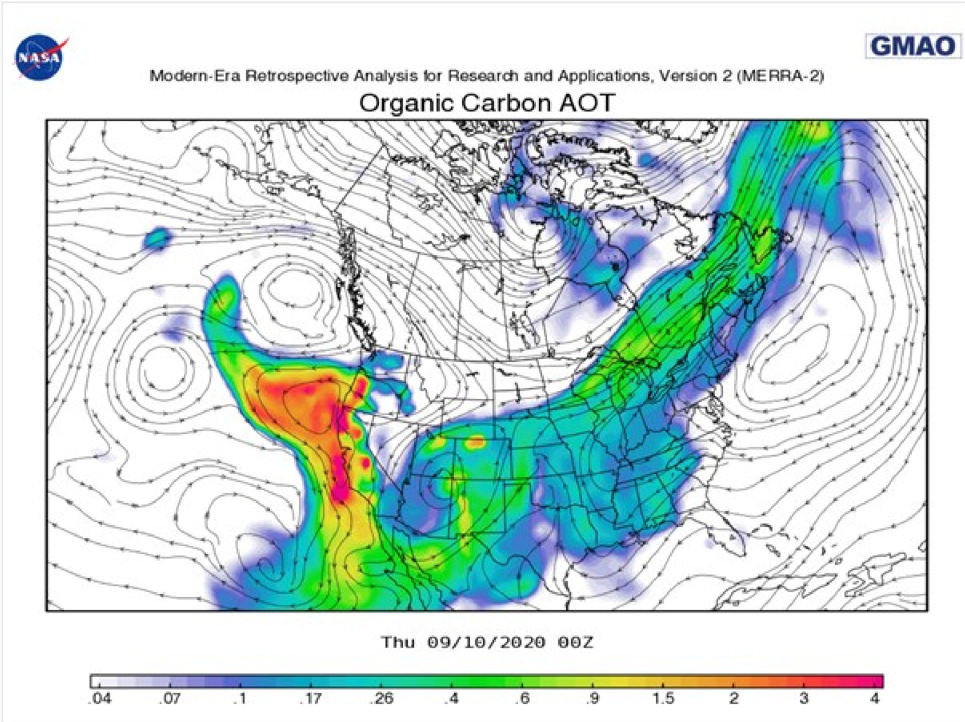
For practical matters, some good data resources exist. There is ground-based radiometer network that could be leveraged. There is a more detailed (in terms of aerosol properties) AERONET network with several long-ish term sites in CA too. And there are the satellite smoke products with good data back to at least ~ 2000. There is also an interesting opportunity in the model world. MERRA-2 includes some atmospheric aerosol analyses, including some related to wildfire smoke.

As an example, see attached: the "organic carbon" aerosol optical thickness analysis from MERRA-2 for 00Z on Sept. 10, 2020. This is a few days after the huge labor day outbreak of mega-fires on the West Coast. The model analysis shows large, widespread plumes of solar attenuating organic carbon aerosols over the West Coast from NW Oregon to Central CA . A couple translating points here: 1) "organic carbon" is an atmospheric aerosol modeling catch-all that includes primarily aerosols resulting from the burning of biomass, so mostly smoke. 2) Aerosol optical thickness (AOT) should be related to the total attenuation of solar radiation in the atmosphere. Crudely, the relationship goes attenuation = exp(-AOT). Where you see values > 3 in the figure, that corresponds to roughly 95% attenuation of the solar energy by the time light reaches the surface (a rough by illustrative calculation).

The presence of a wildfire-emitted aerosol variable in the reanalysis record would allow longer term trends (~40 years) to be studied, without the complicating factor of changes in satellite sensor technology. It also would support experimental efforts to pursue a high-resolution dynamical downscaling of smoke using WRF/CHEM or a similar tool.

Also, the CA utilities sector may be interested to understand what to expect in the future for *dimming of solar PV* by wildfire activity, but wildfire *mitigation of extreme heat days* is likely another interesting application.

As a specific example, the week following Labor Day, 2020, was forecast for near-record heat in Portland. High temperatures possibly reaching 100 F. After the fires and the terrible thick smoke settled into the valley, high temperatures did not exceed 70 degrees. This like an accidental model sensitivity experiment. The weather forecast models predicting 100 degree temperature were unaware of the looming smoke plumes, but probably captured the rest of the atmospheric conditions more or less correctly. By adding just solar attenuation by the smoke, the outcome was cooling by ~ 30 degrees F for an entire week! Another way to think of that is half a dozen or so extreme heat days mitigated. One could study how geographically widespread and large in magnitude that effect was for recent active fire years.


GMAO
Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2)
Organic Carbon AOT
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