AGU PUBLICATIONS

GeoHealth

Supporting Information for

Spatial and Temporal Estimates of Population Exposure to Wildfire Smoke during the Washington State 2012 Wildfire Season Using Blended Model, Satellite, and In-Situ Data

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Text S1: Summary of satellite post-processing procedure

When pixels were missing from our MODIS AOD retrieval in a region of smoke, the following procedure was used to interpolate a value and reduce the number of missing pixels.

If a missing pixel has three of eight adjacent pixels that are not missing, then the pixel is given the average of all adjacent non-missing pixels. This process is repeated until gaps that appear to be in the smoke plume are filled, which was 8 times for this dataset. This procedure accounts for approximately 50% of the missing values from the MODIS AOD dataset over Washington, making it nearly continuous in regions of high-AOD where we believe dense smoke is located. However, pixels missing due to the presence of real clouds, or other filtering by the algorithm (i.e. not surrounded by high AOD measurements) are not filled in because they usually do not have three neighbors that are elevated.

To test the robustness of our satellite gap-filling procedure, we tested the approach on simulated AOD fields output from our WRF-Chem simulation. First, we regridded the WRF-Chem output to the MODIS Level 2 lat/lon grid.

We then masked pixels in our WRF-Chem AOD dataset that were missing in the original MODIS AOD dataset and applied our pixel-filling algorithm. We compared the entire WRF-Chem AOD dataset with the result from our pixel removing and refilling approach. We found that this procedure produced two AOD fields with MAE of 0.0024, and MB of -0.0006. If we only consider pixels that were missing in the original MODIS field, we have an MAE of 0.0076, and a MB of -0.002.

We do not expect our pixel-filling procedure to exactly reproduce the original AOD values. The presence of a negative bias is expected because pixels that are flagged by the MODIS AOD retrieval algorithm represent thicker smoke that is erroneously interpreted as clouds. The surrounding pixels that are used to fill these gaps are likely lower AOD because they were not flagged. What we show here is that the bias is small, and on average, we introduce very little error into our analysis with this approach. However, we are able to salvage almost 80% of the missing data with this approach, making this step worthwhile in our analysis.

Additionally, in our comparisons, we use a composite of Terra and Aqua overpasses to represent AOD for the 24-hour period. This will introduce some bias, as Terra and Aqua overpasses occur during the daytime, so our composited image does not include any information about plume location at night. However, the surface observations we compare AOD to are 24-hour averages. To investigate this, we compared 24-hour average WRF-Chem simulated AOD to average between 10am and 2pm local time from the same day. The result introduces a positive bias (MB = 0.0066) which accounts for all of the error (MAE = 0.0068), meaning that this approach unilaterally introduces a small positive bias into the AOD fields. However, due to the small size of this bias, we do not believe that we are compromising the usefulness of MODIS AOD with this approach.

It is important to note that both of these of the sensitivity analyses of AOD to the preprocessing strategies we employ were conducted using WRF-Chem simulated AOD, while we input MODIS AOD into our model. These calculations are the best we can do to estimate the order-of-magnitude of bias and error introduced by these procedures, but may not reflect the actual changes introduced by this approach.

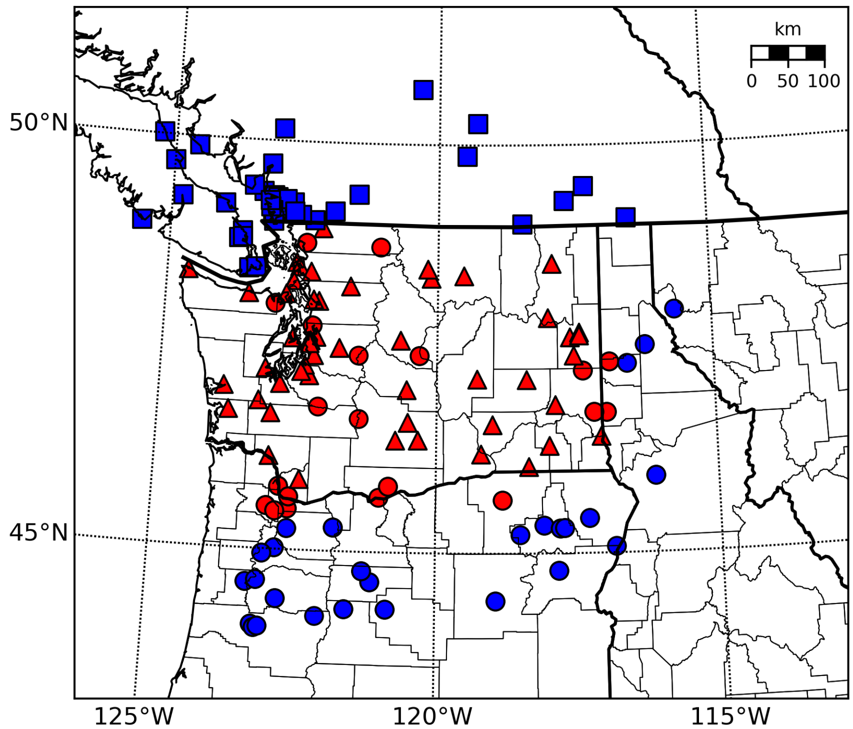

Figure S1. Measurement locations for the study period (July 1st-October…. 31st). Red denotes evaluation sites, blue denotes boundary sites for interpolation, circle denotes EPA AQS monitor location, triangle denotes supplementary monitor, square denotes Canadian monitor.

Simulation Parameter Name	Parameter/Setting Used
Meteorlology Initia/Boundary Conditions	GFS Analysis
Model Resolution	15x15 km
Ref Lat/Lon (Domain Center)	44N, 112W (Lambert Projection)
Boundary Layer Parameterization	YSU[1]
Microphysics Scheme	Morrison[2]
Chemical Initial/Boundary Conditions	MOZART-4[3]
Chemical Mechanism	MOZCART[4] (MOZART-4 gas-phase, GOCART aerosols)
Biomass Burning Emissions	FINNv1.5[5]
Anthropogenic Emissions	NEI 2011[6]

1[Hu et al., 2013b]
2[Morrison and Gettelman, 2008]
3[Emmons et al., 2010]
4[Chin et al., 2000]
5[Wiedinmyer et al., 2011]
6(https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data)

Table S1. Simulation parameters, settings, and inputs for WRF-Chem simulations.