

Mapping Modeled Exposure of Wildland Fire Smoke for Human Health Studies in California

Introduction

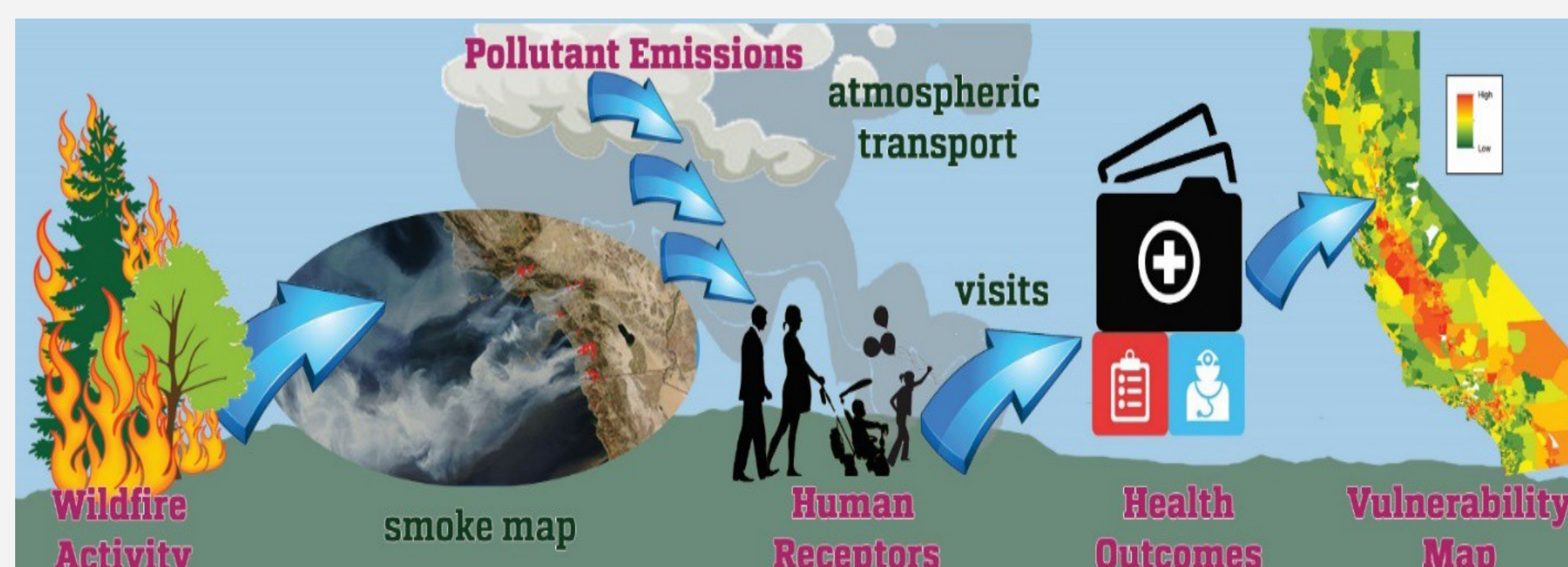
Smoke from wildland fire has been associated with a variety of human respiratory, cardiovascular, and reproductive health effects. Investigations to address the role of fine particulate (PM_{2.5}) pollution from wildfire smoke related to human health is complicated by several spatial data and modeling challenges:

- Geospatial environmental modeling can be challenging to estimate air pollution exposure, including relevant scale, available air quality measurements, source attribution, and identification of confounders;
- Mapping wildland fire emissions and air quality for exposure assessment using chemistry transport models is computationally challenging and requires specialized expertise;
- Wildland fires have increased rapidly over the past three decades and account for 40% of PM emissions inventories in the U.S.

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Long-term Research Questions:

1. To what extent is regional wildland fire-specific air pollution associated with cardio-vascular risk in adults and among pregnant women?



2. To what extent are peak exposures to wildland fire smoke associated with increased risk of cardiovascular disease and maternal outcomes?

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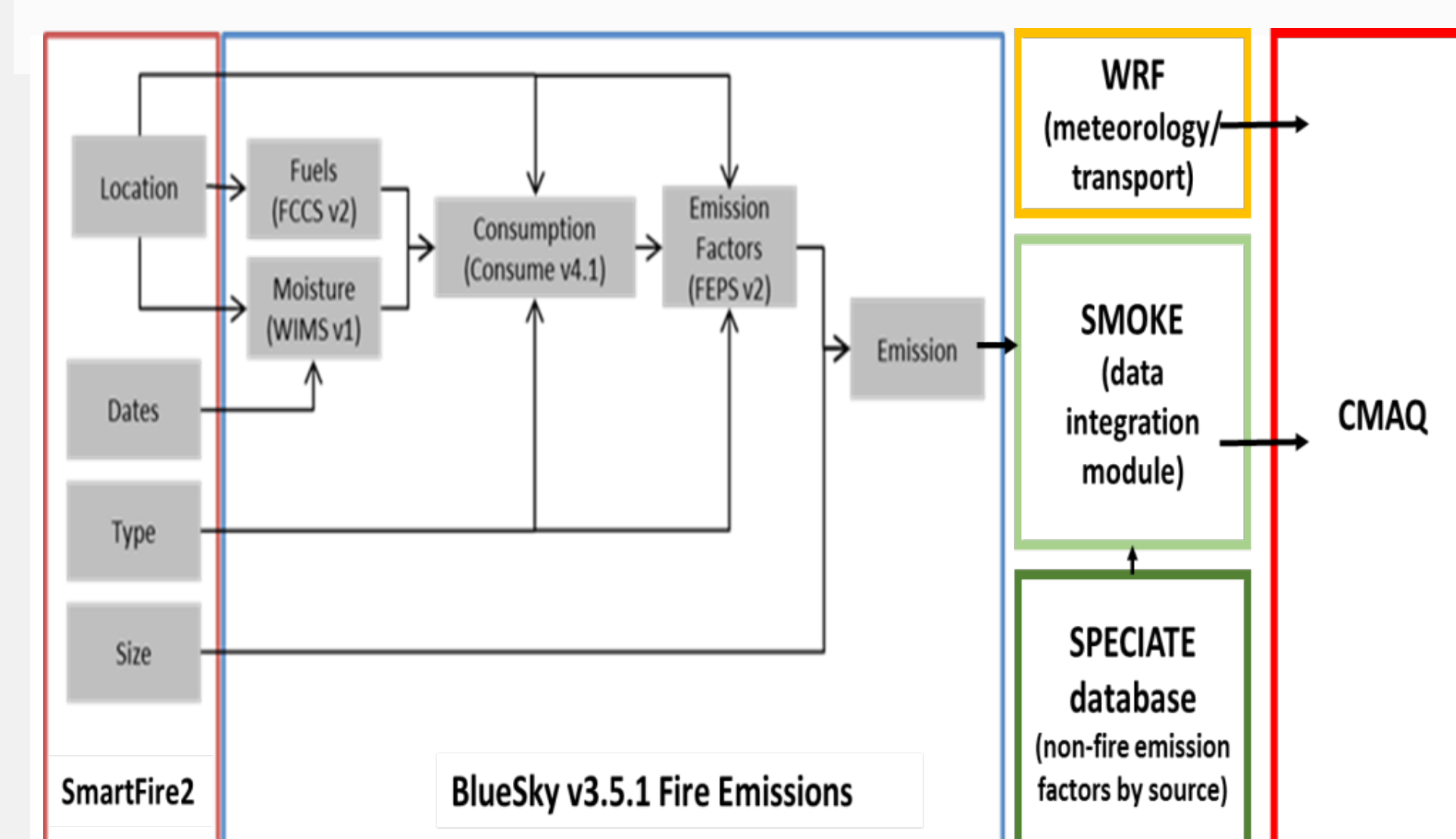
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Methods: Modeling Wildland Fire Smoke PM_{2.5} Concentrations with CMAQ

Using atmospheric chemical transport modeling (CMAQ), we examined 24-hour PM_{2.5} concentrations in California (2007 - 2013) with and without fire sources.

- Provided information on the source of the pollutants
- Allowed separation of sources (e.g., wildfire source) from other contributors (e.g., transportation, utilities)
- Provided PM_{2.5} estimates in areas where air quality monitoring stations are sparse
- Compared CMAQ predictions to daily average PM_{2.5} carbon (organic and elemental) from rural monitors

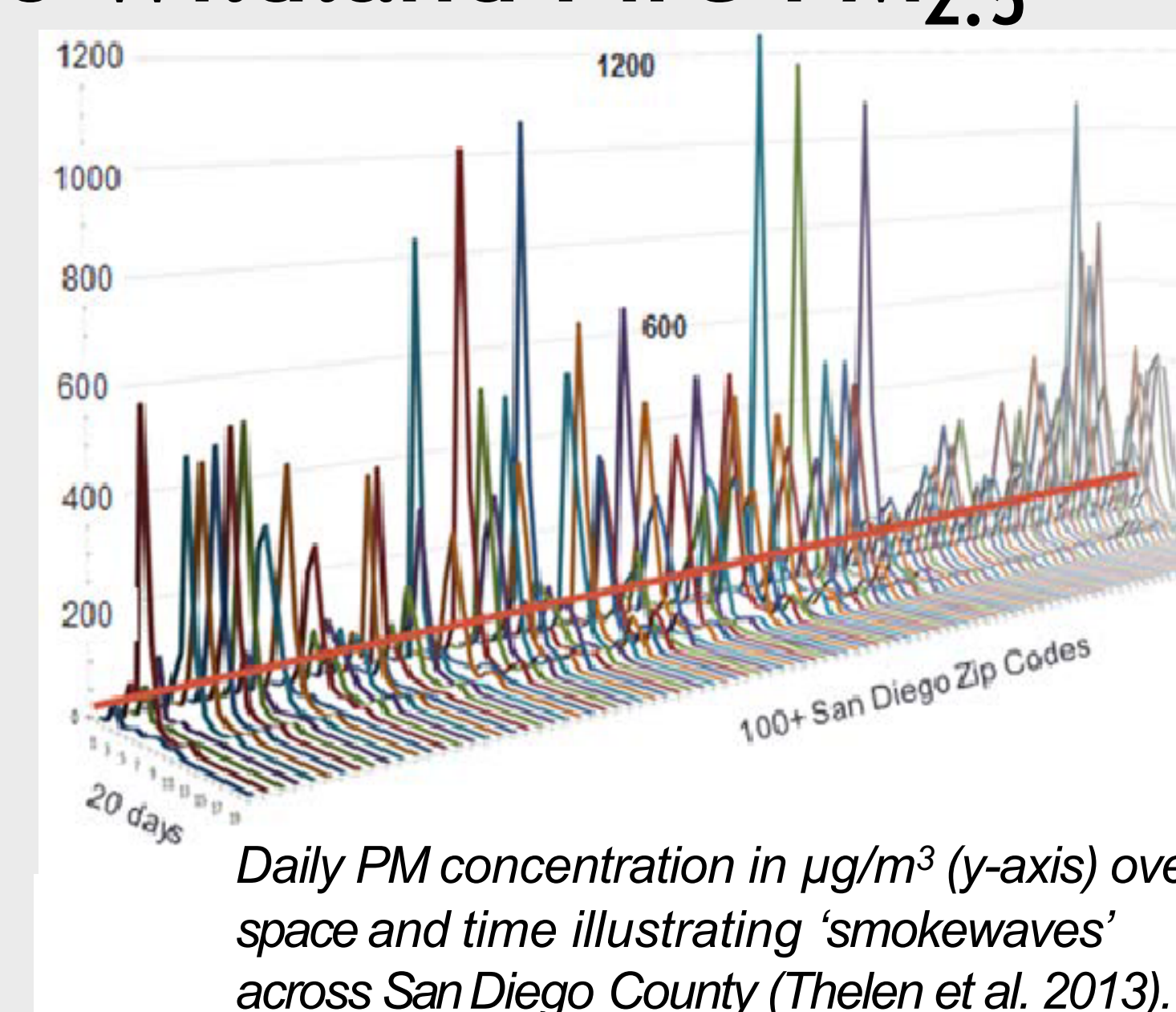


The Community Multiscale Air Quality Model (CMAQ) 12-km grid modeling uses fire-related emissions (SmartFire2, BlueSky), other emissions sources (SMOKE), and meteorology (WRF) inputs. www.epa.gov/cmaq

Quantifying Exposure to Wildland Fire PM_{2.5}

Wildfire smoke exposures occur in peaks with long periods of near zero levels that vary over fine scales. We are exploring metrics for quantifying associations between smoke with health such as

- Temporal lag of several days
- Aggregating data into smokewaves (akin to heat waves; Liu et al. 2015)

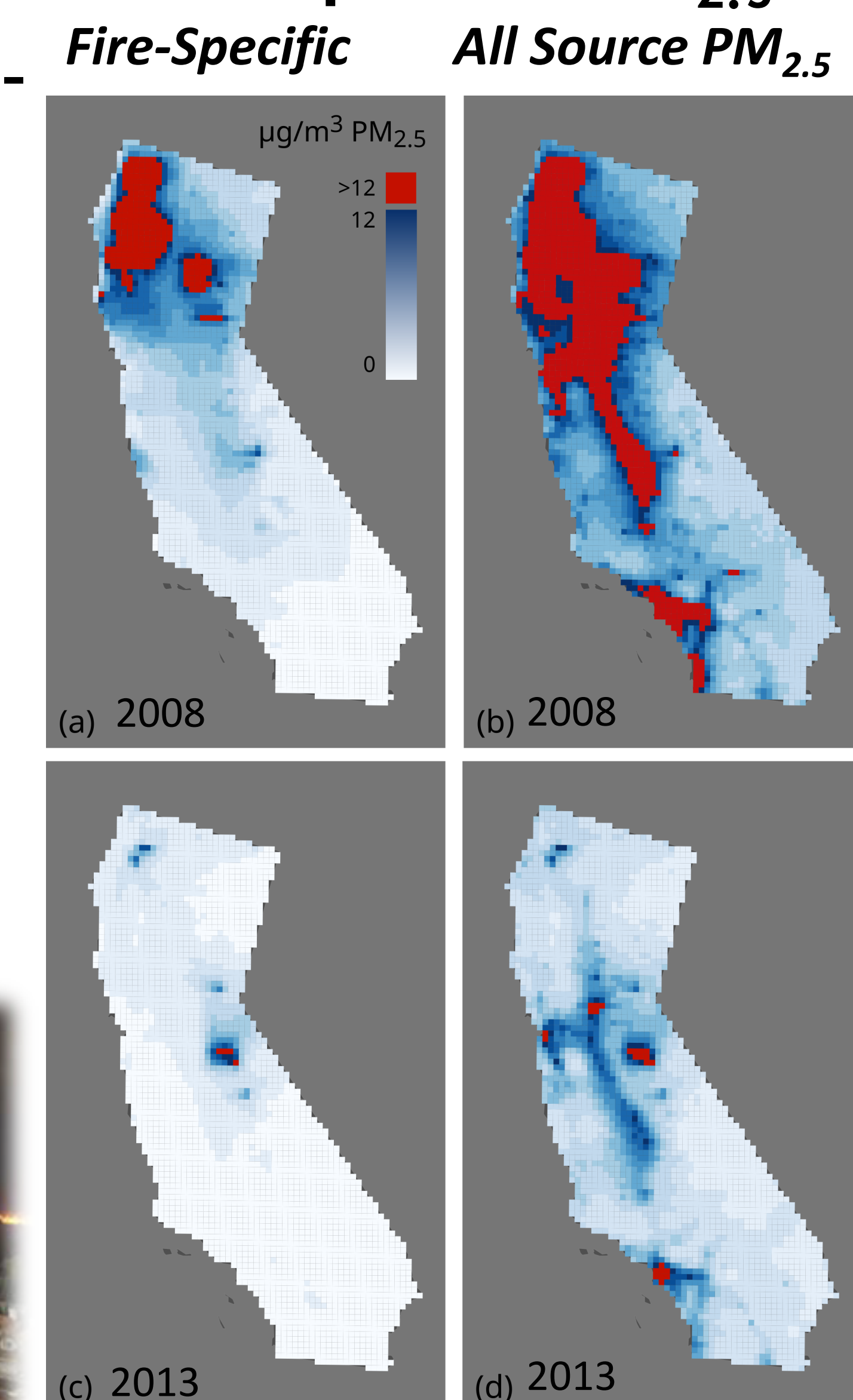


Results: Annual Mean Fire-Specific PM_{2.5}

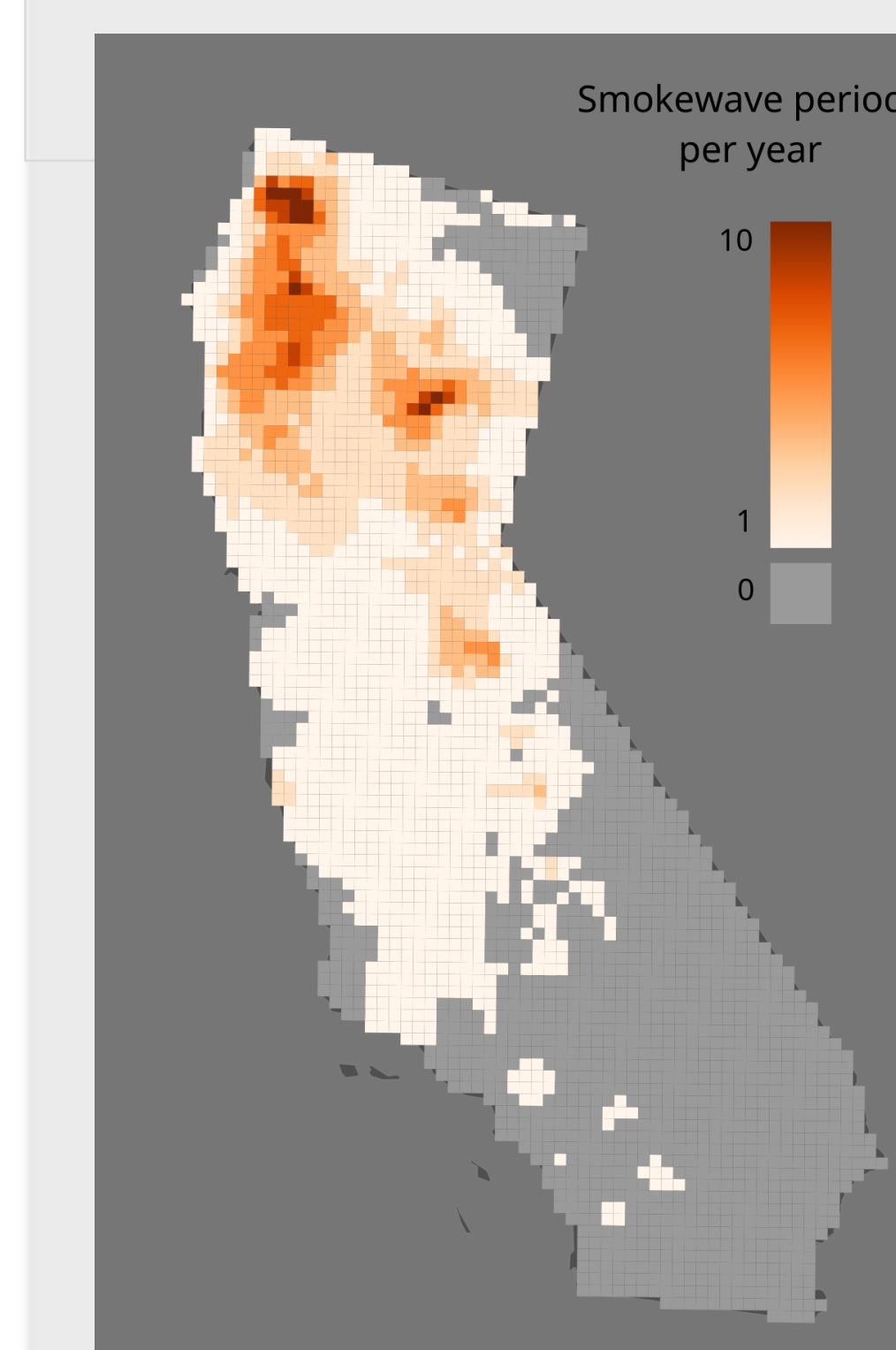
The average modeled fire-specific PM_{2.5} concentration in California by year was 1.22 µg/m³ – about 25% of total all-source PM_{2.5}.

The annual fire-specific PM_{2.5}

- 4.40 µg/m³ in a high fire year ((a) 2008)
- 1.16 µg/m³ in a low fire year ((c) 2013).



Results: PM_{2.5} Smokewave Periods per Year (2007-2013)



Smokewaves are defined as when modeled fire-specific PM_{2.5} > 35 µg/m³ for more than 2 consecutive days.

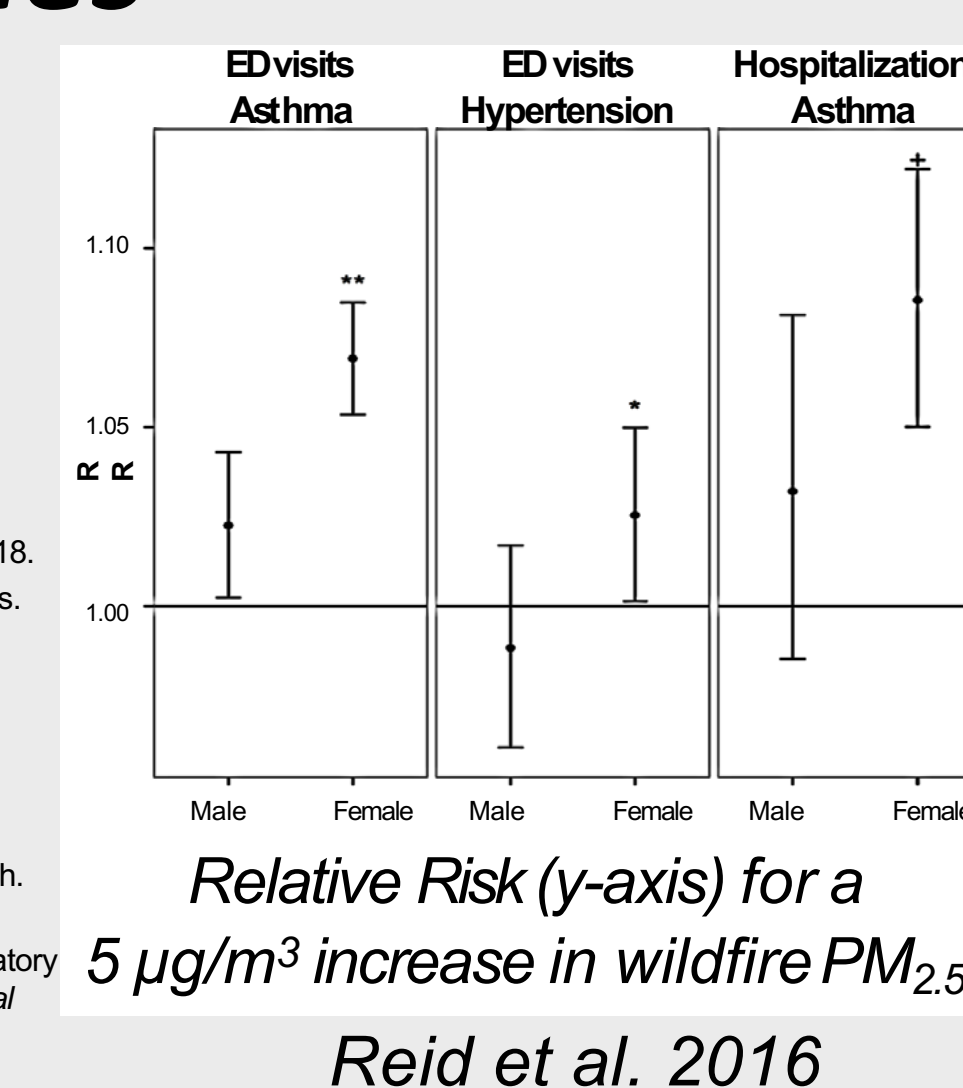
97% of the population in California lived in a county that experienced at least one smoke wave (2007-2013).

Next Steps: Epidemiology Studies

- Additional years of CMAQ modeling
- Combine measurements with modeling
- Perform epidemiologic studies

References and Acknowledgements

French, N.H.F. et al., 2014. Modeling regional-scale fire emissions with the wildland fire emissions information system. *Earth Interactions*, 18. doi:10.1029/2013JG002012.
 Hoshiko, S., et al., 2010. A simple method for estimating excess mortality due to heat waves, as applied to the 2006 California heat wave. *Int J Public Health*, 55, 133-137. doi:10.1007/s00038-009-0060-8.
 Liu, J.C., and Coauthors, 2017. Wildfire-specific Fine Particulate Matter and Risk of Hospital Admissions in Urban and Rural Counties. *Epidemiology* 28(1): 77-85.
 Reid CE and Coauthors 2016. Differential respiratory health effects from the 2008 northern California wildfires: a spatiotemporal approach. *Environmental Research* 150:227-235. doi: 10.1016/j.envres.2016.06.012.
 Thelen, B., French, N.H.F., Kozal, B.W., Billmire, M., Owen, R.C., Johnson, J., Griesberg, M., Loboda, T. & Wu, S., 2013. Modeling acute respiratory illness during the 2007 San Diego wildland fires using a coupled emissions-transport system and general additive modeling. *Environmental Health*, 12, 94.



Reid et al. 2016

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