Work in progress:

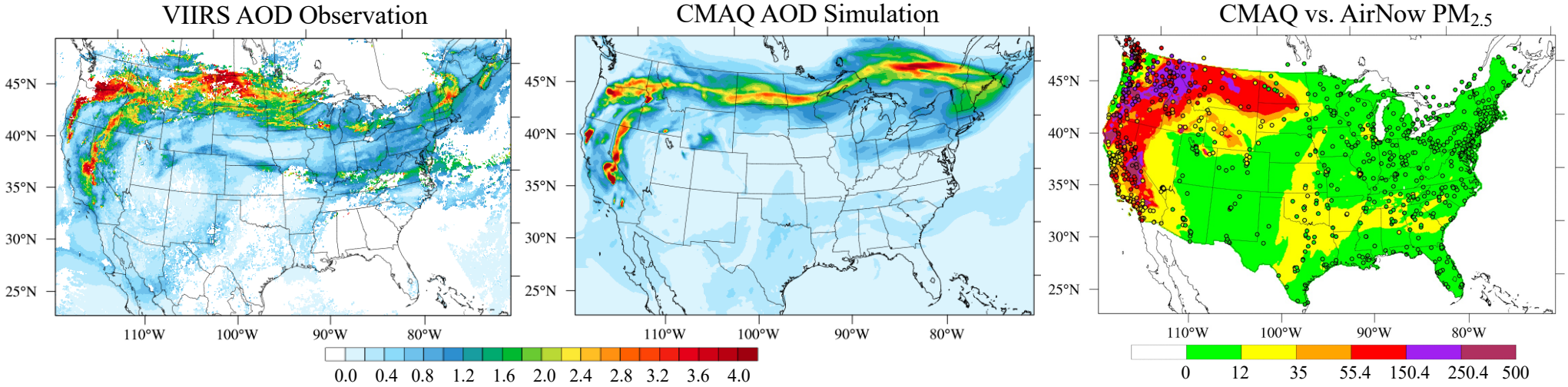
Wildfire Effects on $PM_{2.5}$ Exceedances

Daniel Tong, Yunyao Li & Air Quality group
George Mason University

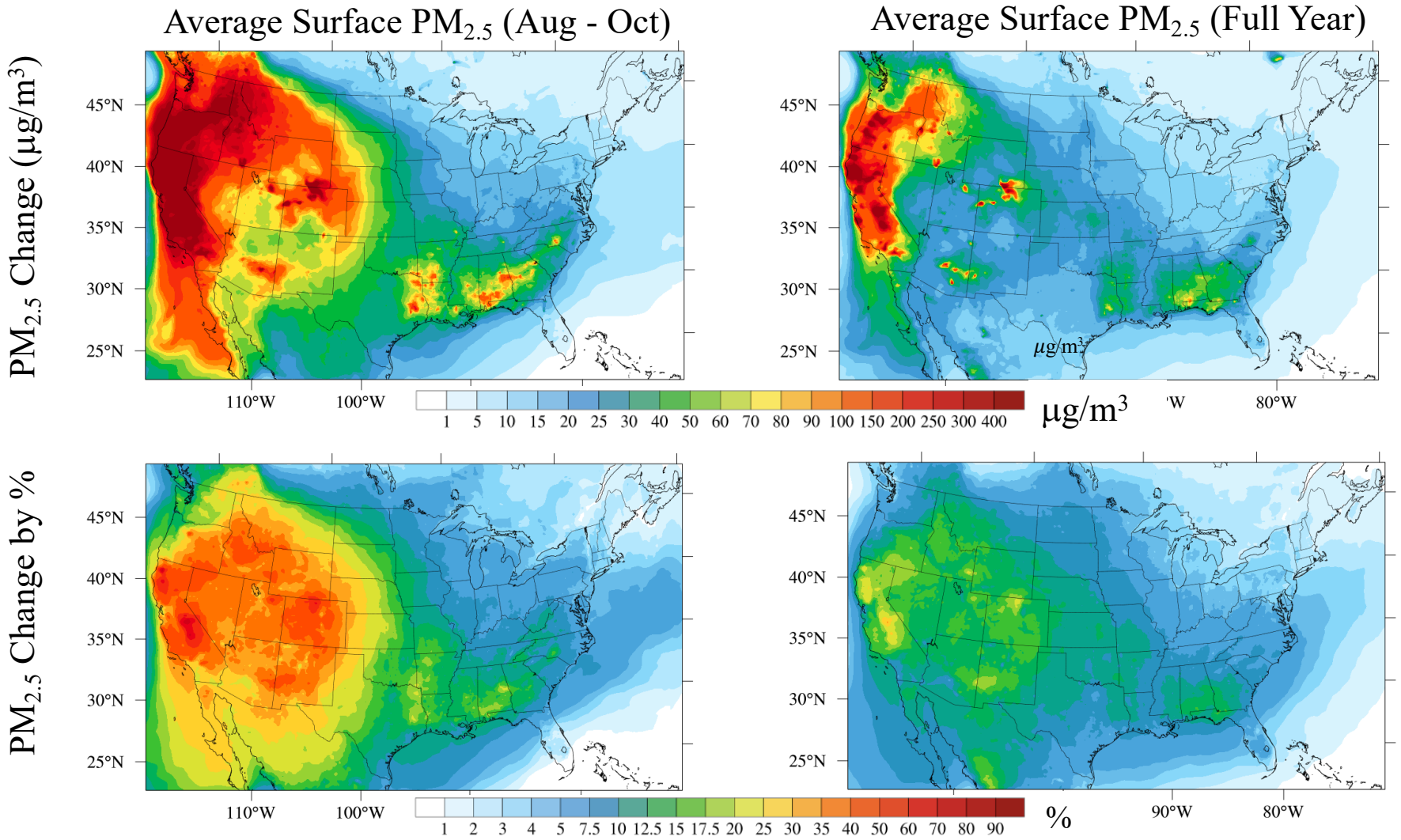
Email: qtong@gmu.edu

Quantifying Air Quality Effects of Wildfire Emissions

- Wildfire emissions: blended MODIS and VIIRS fire detection with NASA QFED emission algorithm (Zhang et al., 2015);
- Two runs using the Community Multiscale Air Quality (CMAQ) model: **With** and **Without fire** emissions;
- Study period (August – October, 2020);
- Full chemistry with detailed anthropogenic and natural emissions;



Wildfire Effects on Surface $PM_{2.5}$



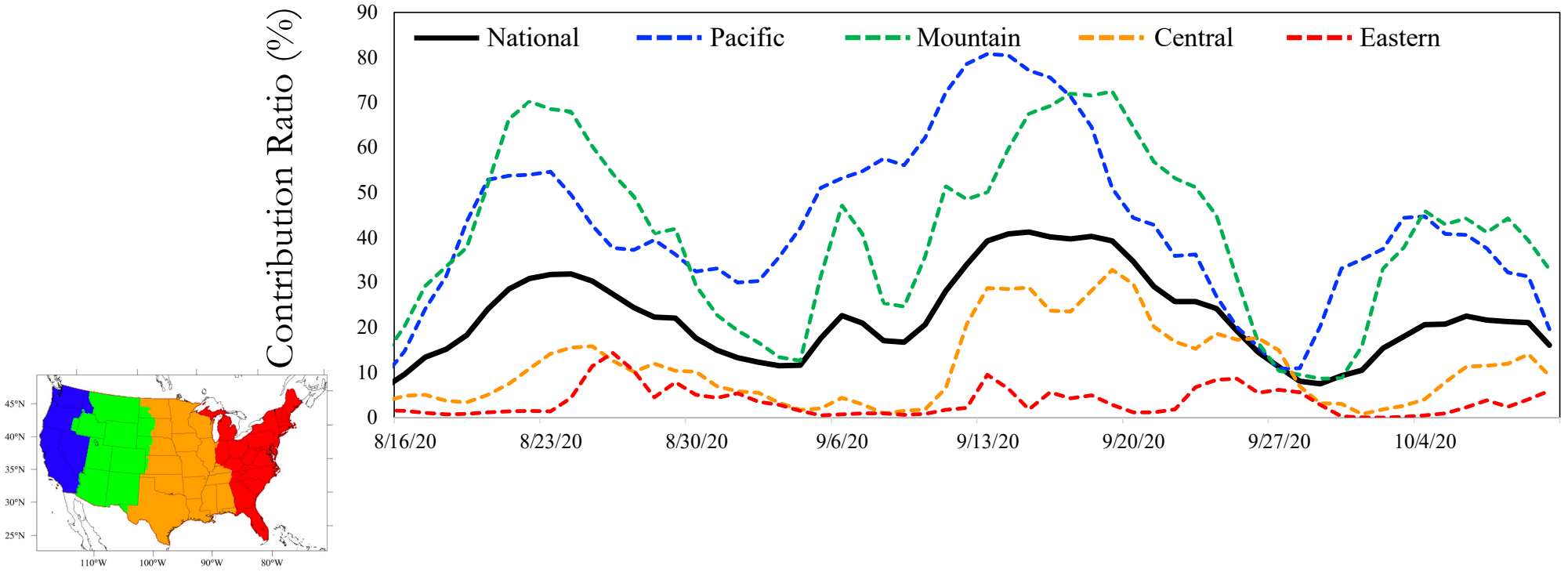
Wildfire Contribution to Surface $PM_{2.5}$

- The Contribution Ratio (CR) to assess wildfire contribution to $PM_{2.5}$

$$CR = \frac{M_{WDF} - M_{NOF}}{M_{WDF}} \times 100\%$$

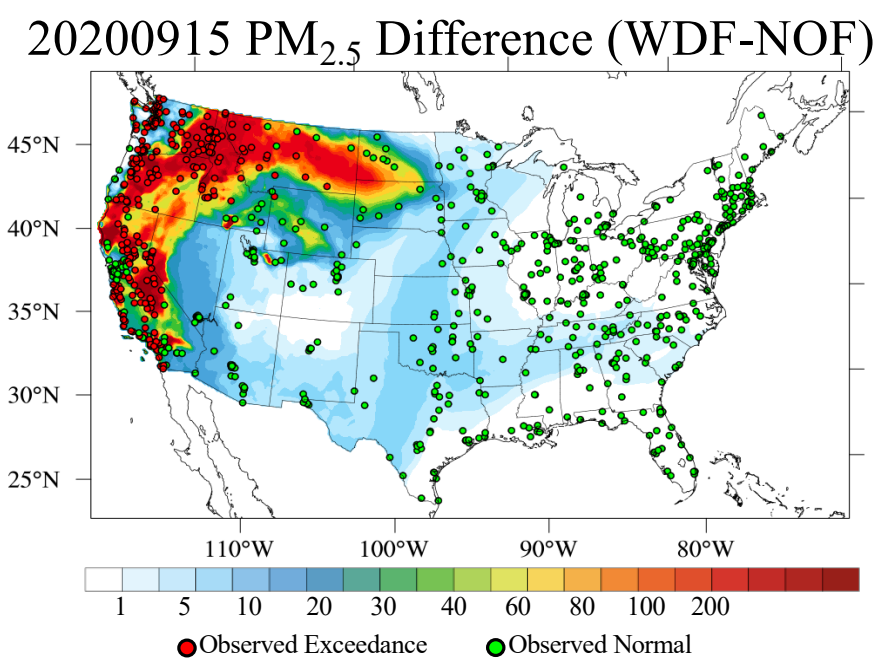
M_{WDF} – Model prediction with wildland fire;

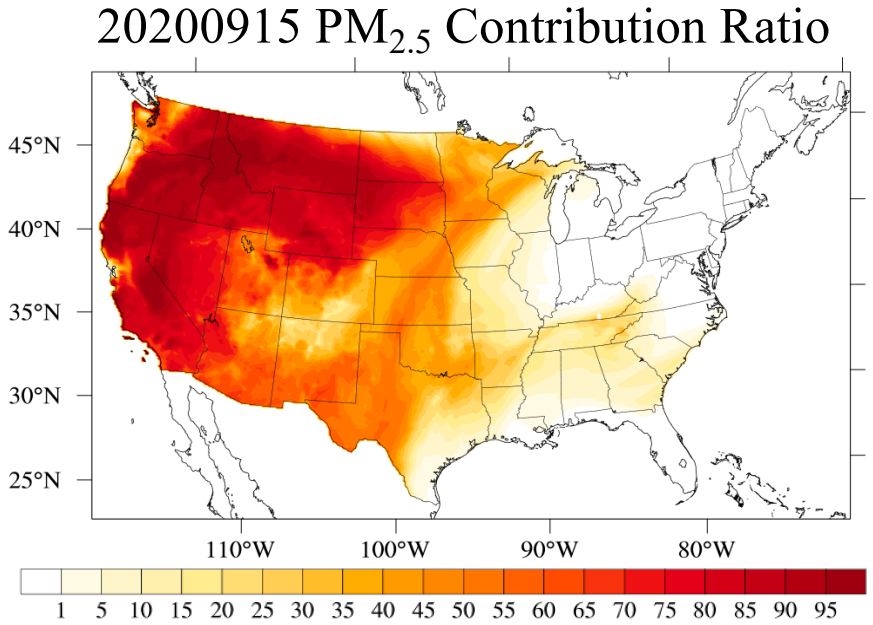
M_{NOF} – Model prediction with no fire;



Wildfire Effect on $PM_{2.5}$ Exceedances

- USA EPA National Ambient Air Quality Standards (NAAQS): 35 μg/m^3 for 24h average; 12 μg/m^3 annual average.
- Wildfires were major contributor to 3,720 $PM_{2.5}$ exceedances during Aug-Sep 2020.

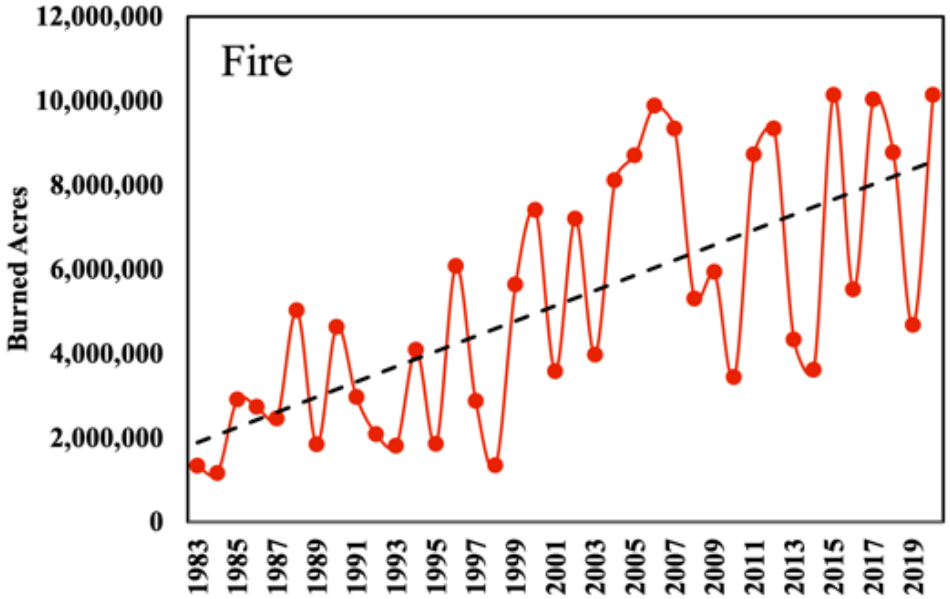




>4.6M people exposed to smoke $PM_{2.5}$ levels exceeding annual NAAQS in 2020.

Fires in the Past

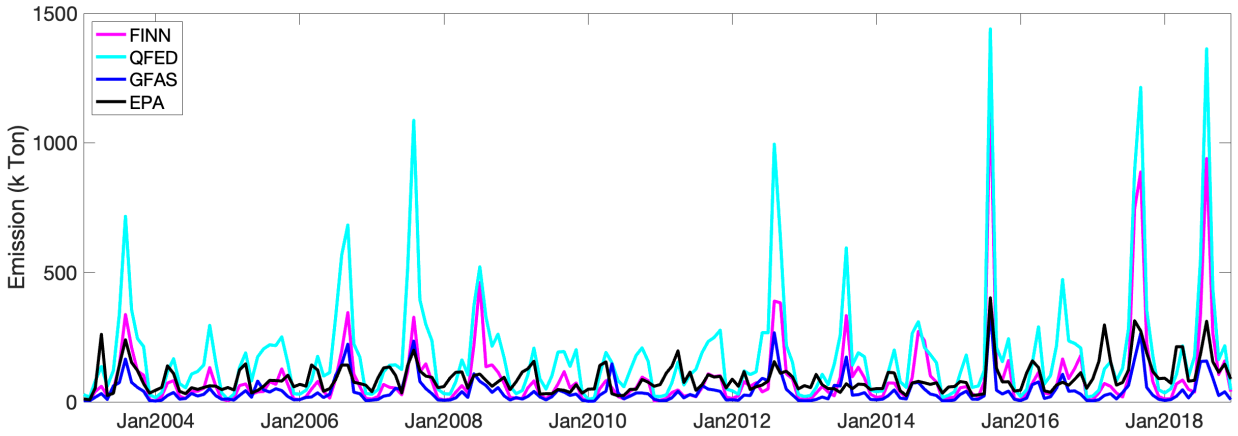
- As the Earth warms and the risk of droughts increases, extreme weather events have increased in the past decades



North America Chemical Reanalysis (NACR)

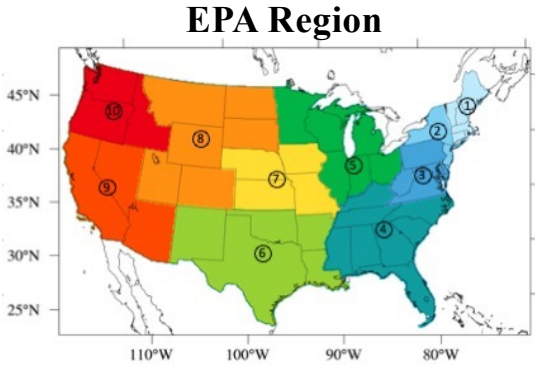
- Period: 2002-2019
- Resolution & Domain: 12 km CONUS
- Meteorology model: WRF V4.2, BC/IC: ERA5, Analysis nudging
- Emission: EPA EQUATES (2002-2017), NEI (2018 and after)
- Chemical transport model: CMAQ V5.3

Compare EPA Fire $PM_{2.5}$ Emission with Other Fire Emission Products

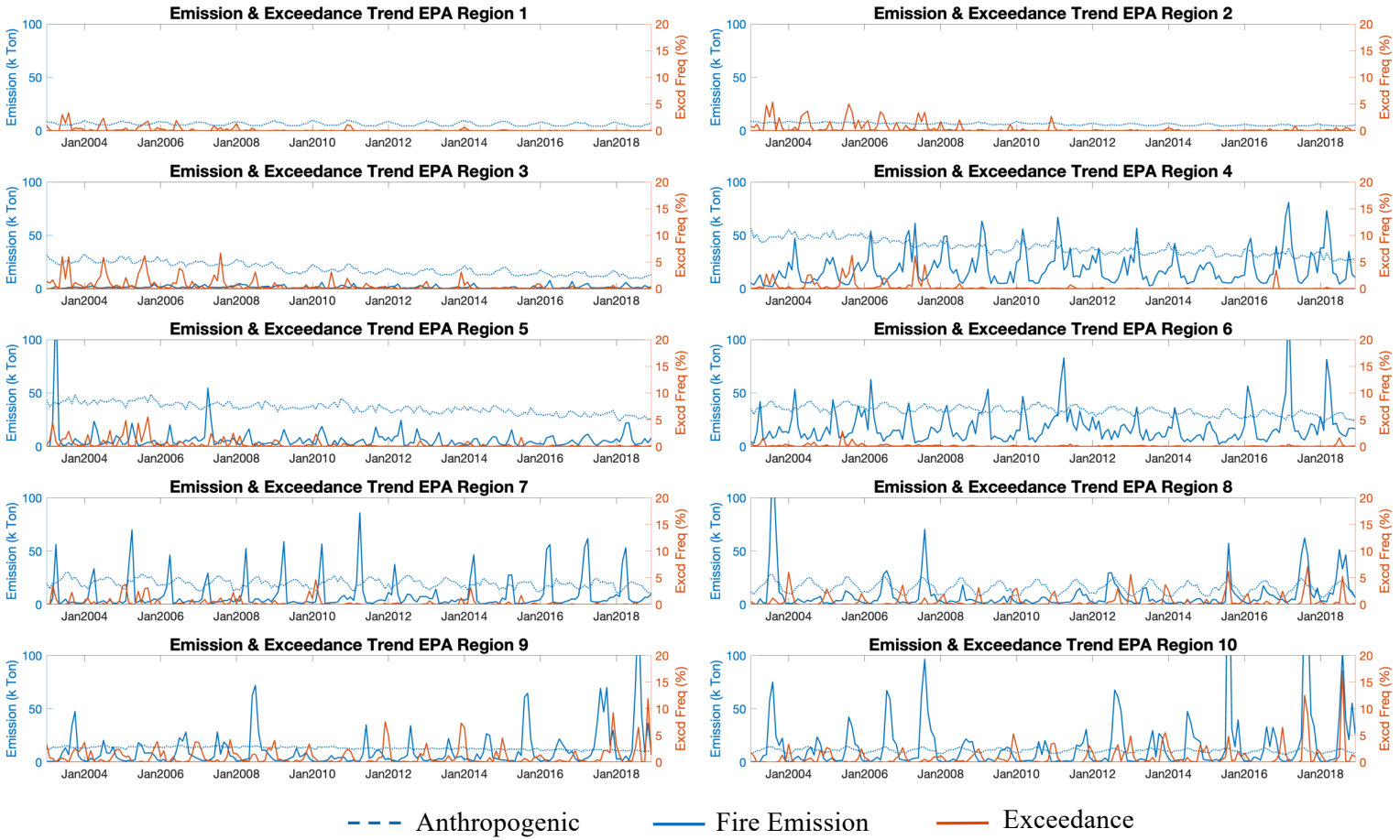


	Total Emis (k Ton)
FINN	1.8e+04
QFED	3.6e+04
GFAS	0.8e+04
EPA	1.7e+04

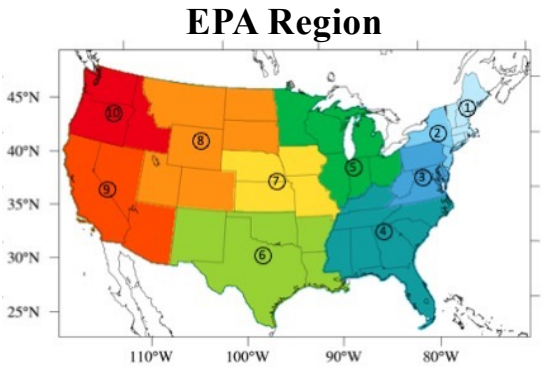
Fire vs. Anthropogenic $PM_{2.5}$ Emission



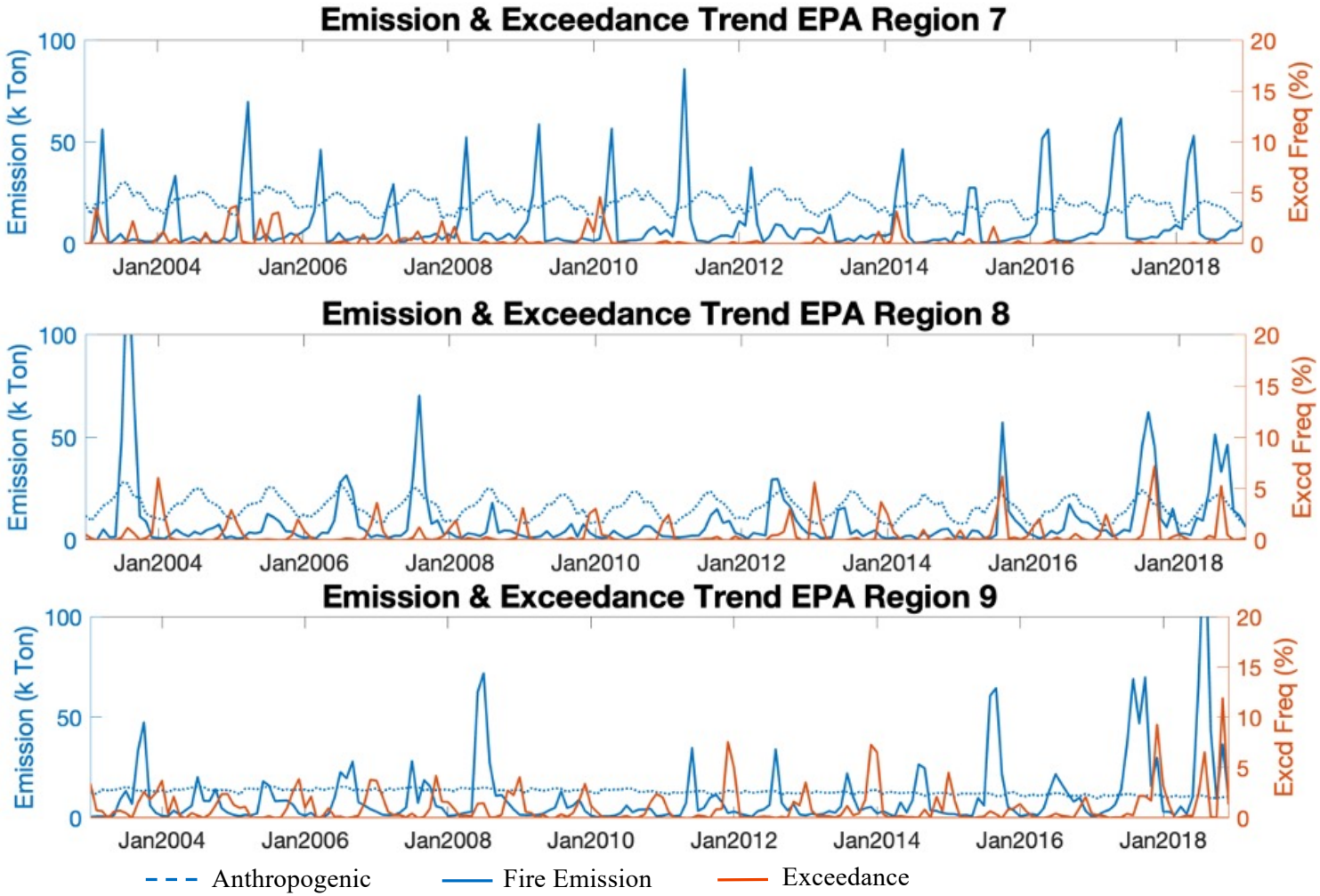
- In Region 7, most of the exceedances are caused by fire.
- In Regions 8 and 9 the exceedance peaks do not match the fire peak.



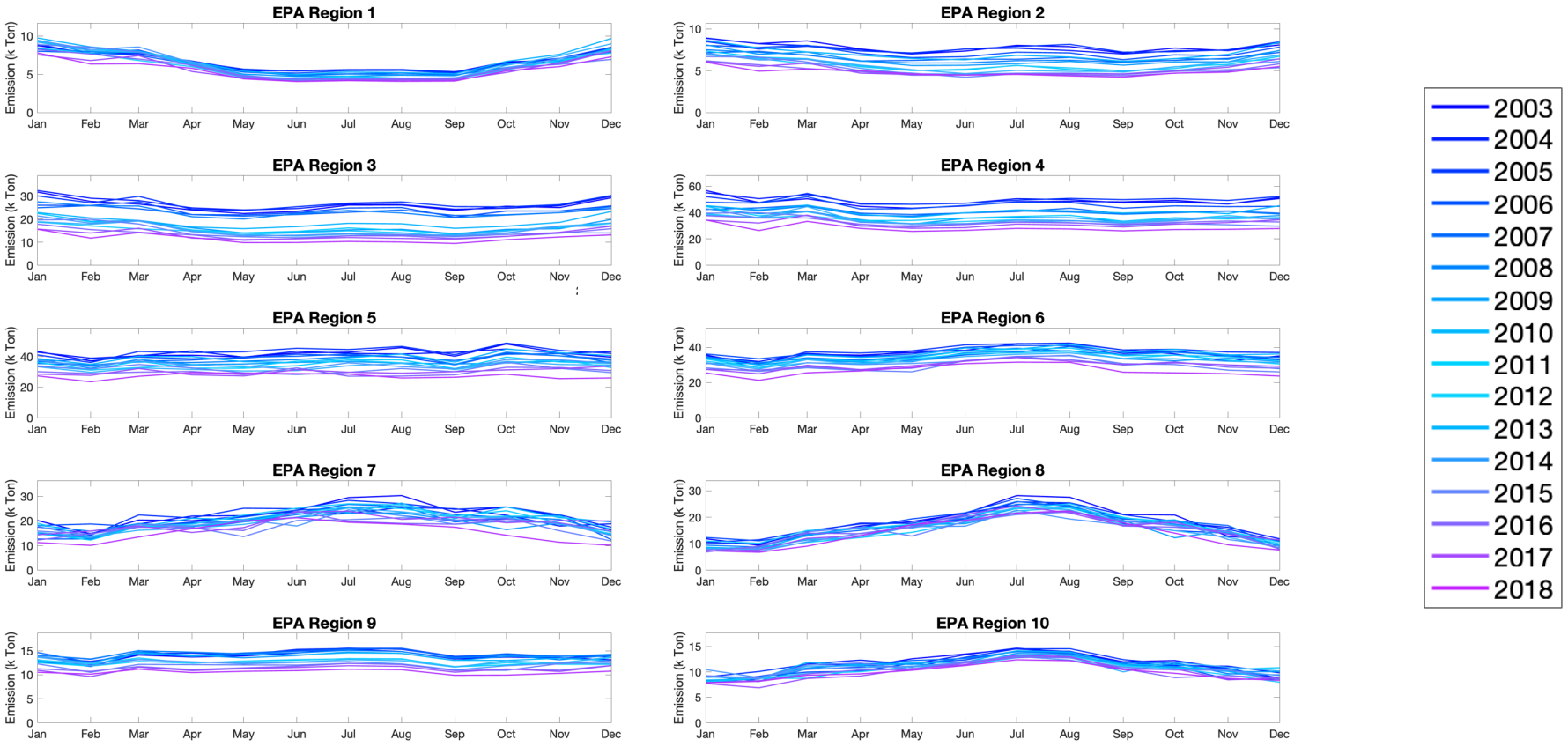
Fire vs. Anthropogenic $PM_{2.5}$ Emission



- In Region 7, most of the exceedances are caused by fire.
- In Regions 8 and 9 the exceedance peaks do not match the fire peak.

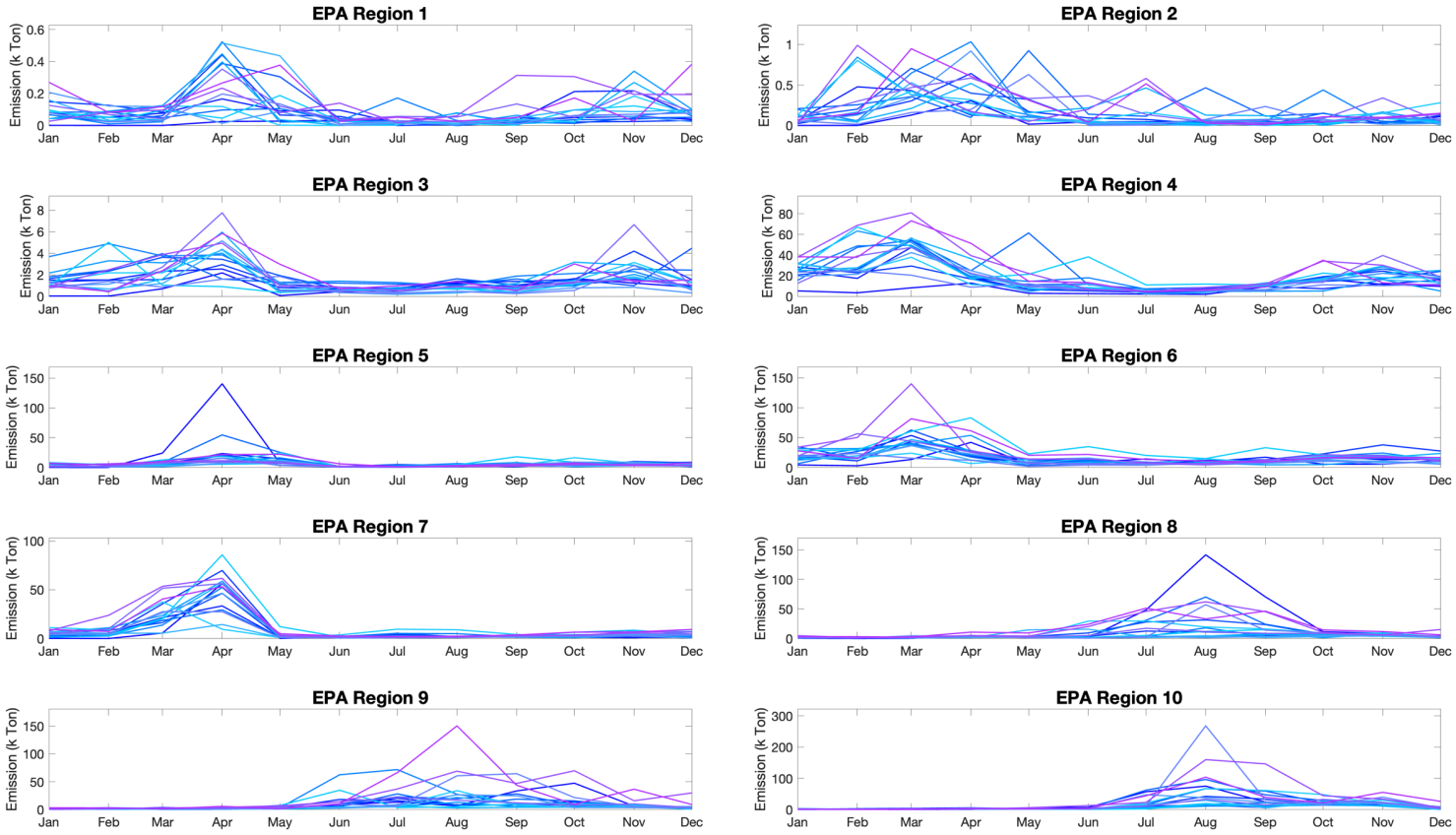


Seasonal Change of Anthropogenic Emission

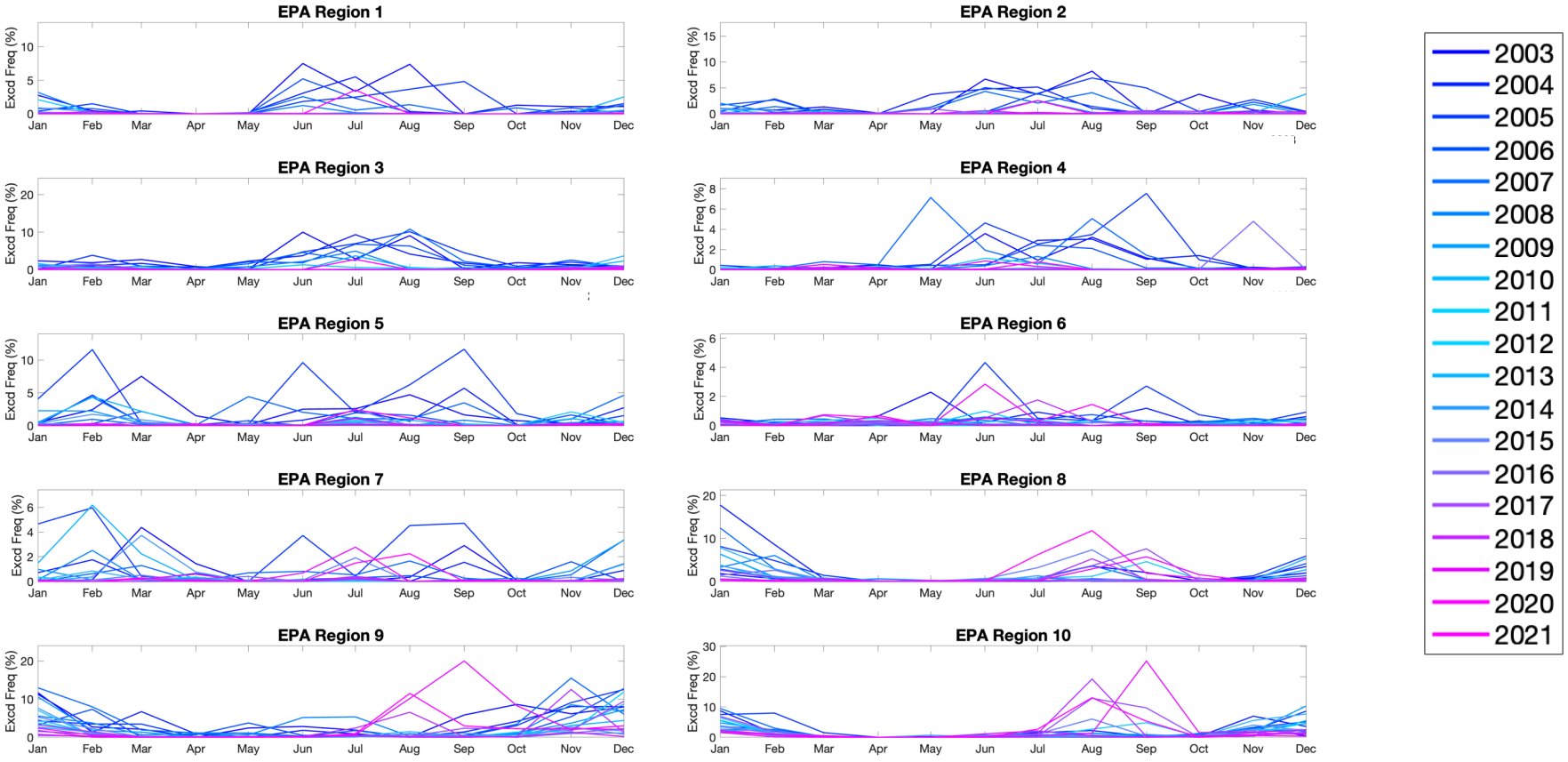


- The decreasing trend in the Eastern US anthropogenic emission.
- Emission Peak: Eastern US in Winter; Western US in Summer.

Seasonal Change of Fire Emission



Seasonal Change of $PM_{2.5}$ Exceedance (AQS)



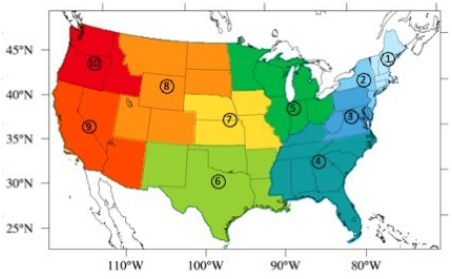
- The decreasing trend in the Eastern US PM2.5 exceedance.
- Exceedance Peak: Eastern US in summer; Western US one peak in summer, one peak in winter.

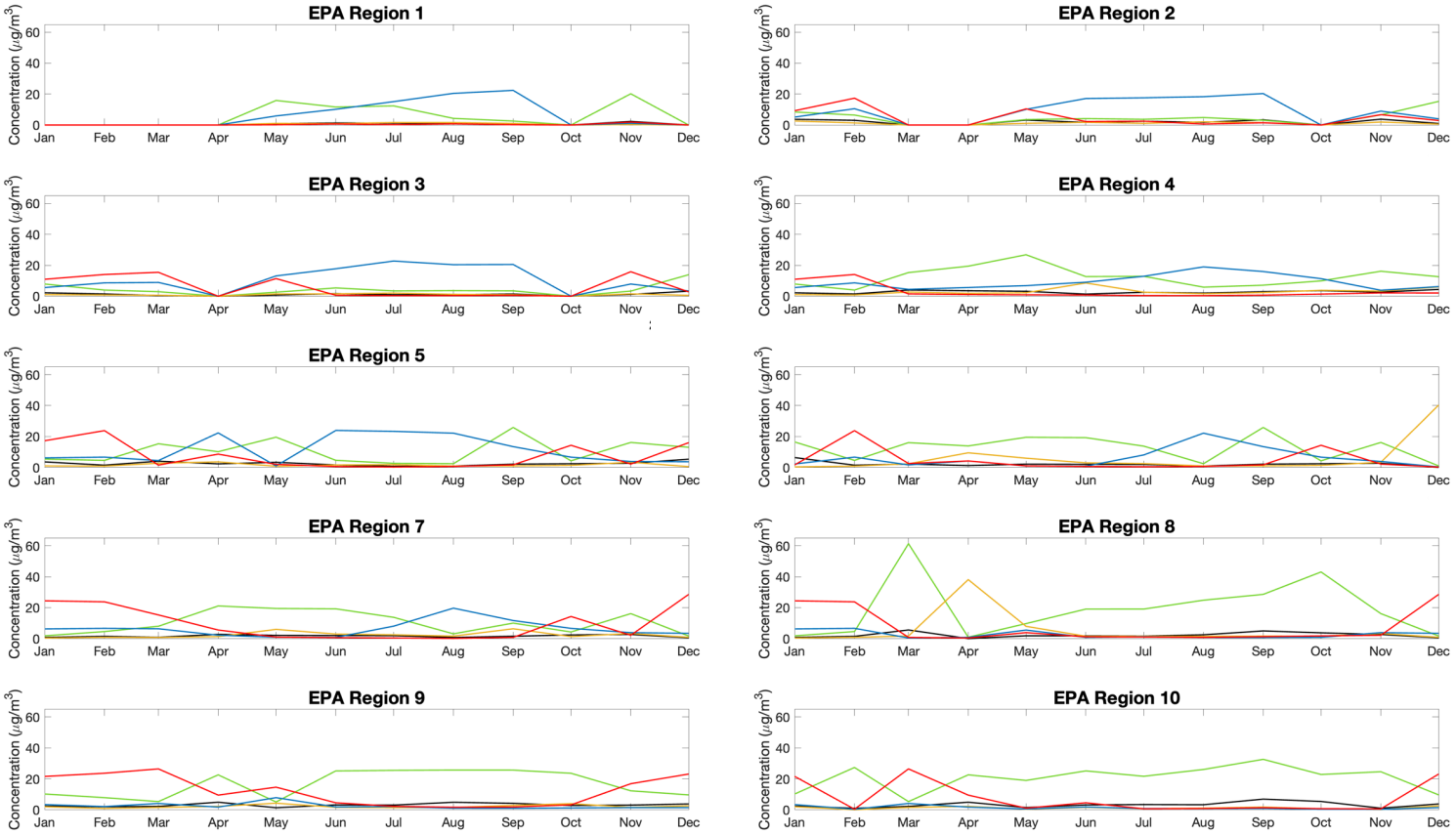
Seasonal Change of $PM_{2.5}$ Composition during Exceedance Events (IMPROVE)

PM2.5 Chemical Composition

- Elemental Carbon
- Organic Carbon
- Soil
- Sulfate
- Ammonium Nitrate

EPA Region



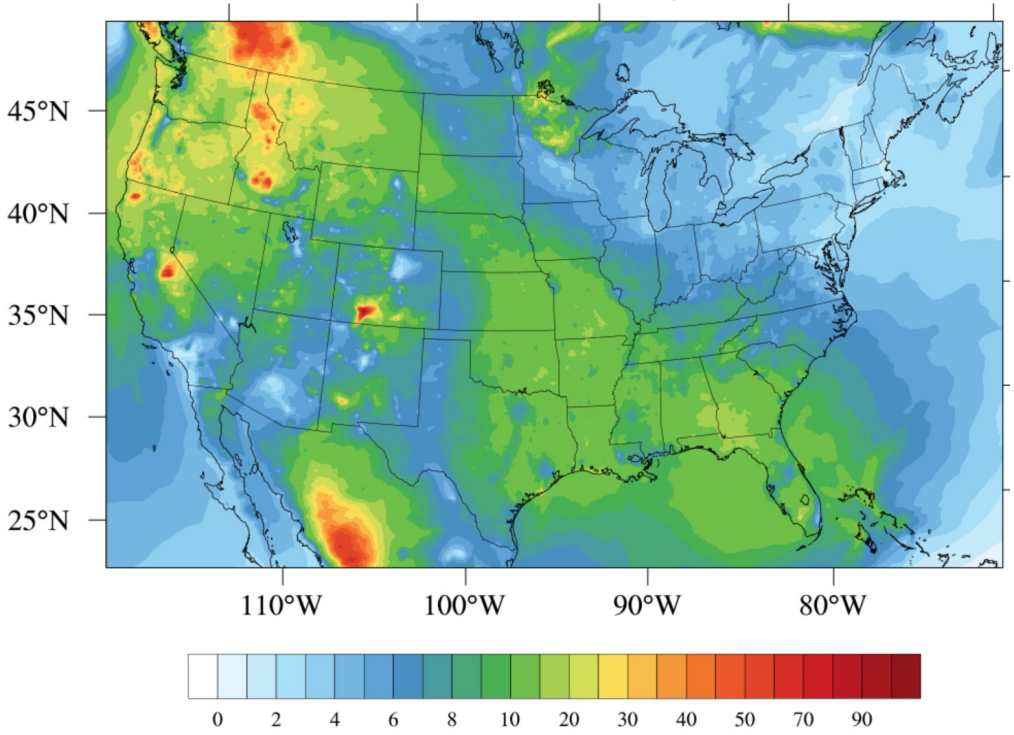


- Wintertime exceedance's major contributor is Ammonium.
- Summertime exceedance's major contributor is SO_4 for the Eastern US, and OC for the Western US.

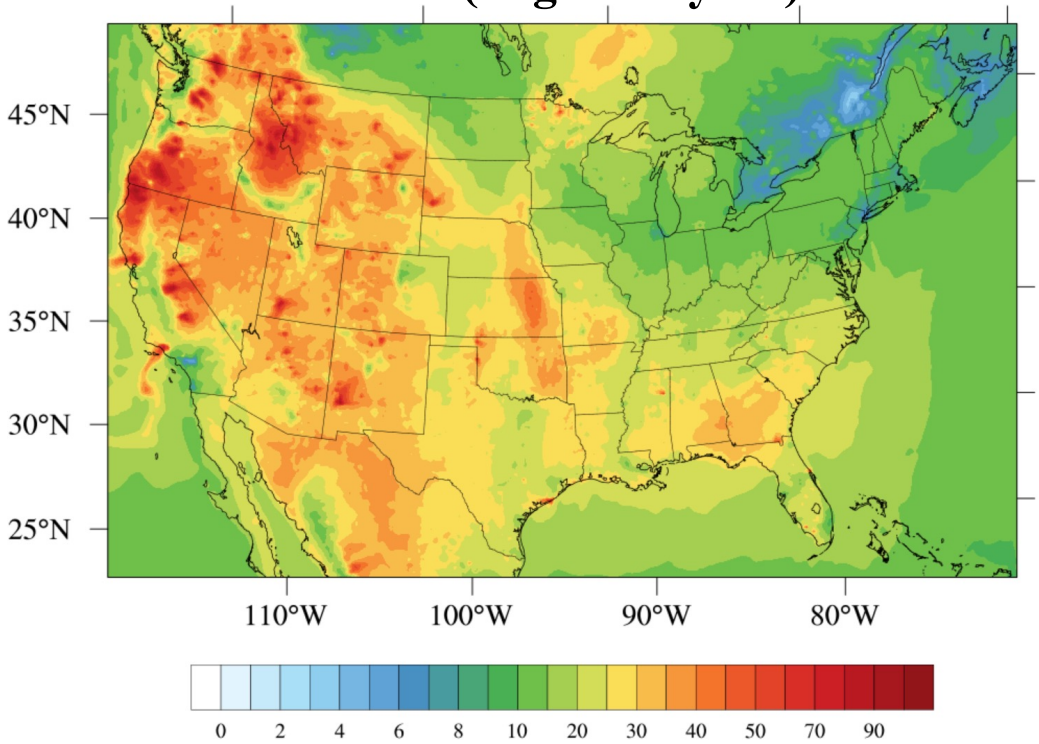
Fire Contribution to $PM_{2.5}$ (%)

- Wildfire emissions: EPA EQUATES;
- Two runs using GMU WRF-CMAQ: **With** and **Without fire** emissions

2013 (Low fire year)



2017 (High fire year)



Long-term Fire Contribution to $PM_{2.5}$ (%)