Prescribed burns as a tool to mitigate future wildfire smoke exposure: Lessons for states and rural environmental justice communities

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AGU Fall Meeting 20221214

The West has always burned

1500s
-Pre-European
-Routine Indigenous land management

1940s:
Fire suppression

1970-90s:
-Environmental lobbying
-Shutdown of mills, logging

2018 fire season:
Camp fire (California)
Martin Fire in (Nevada)
Bridger-Teton (Wyoming)

2020 fire season:
Labor Day fire (Coast)
Colorado fires

Early 1930s:
Severe fire seasons

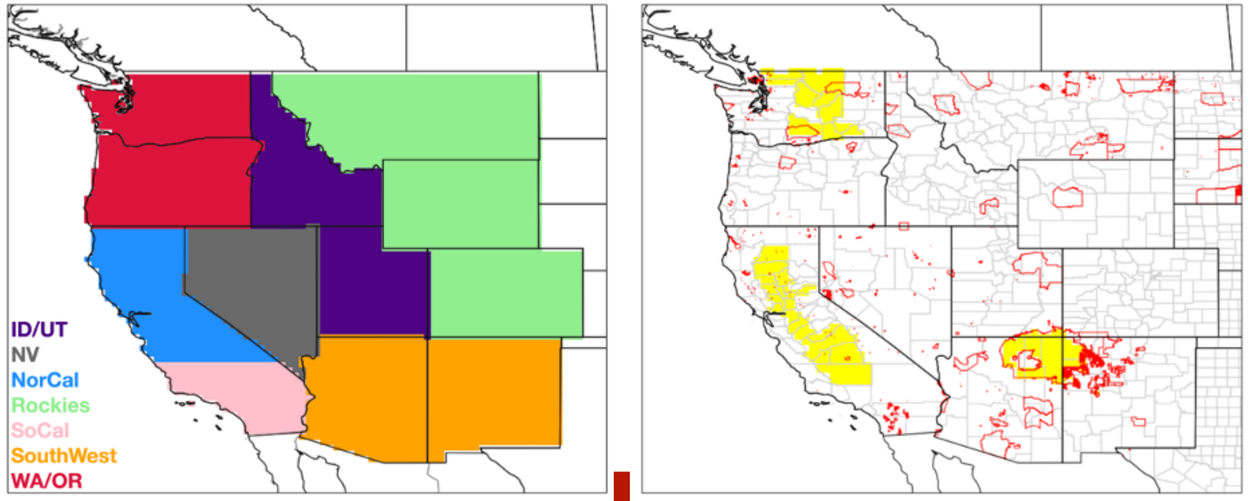
“Fire Deficit” today:
Current burning 10% of burned area pre-European

Stephens et al., 2007

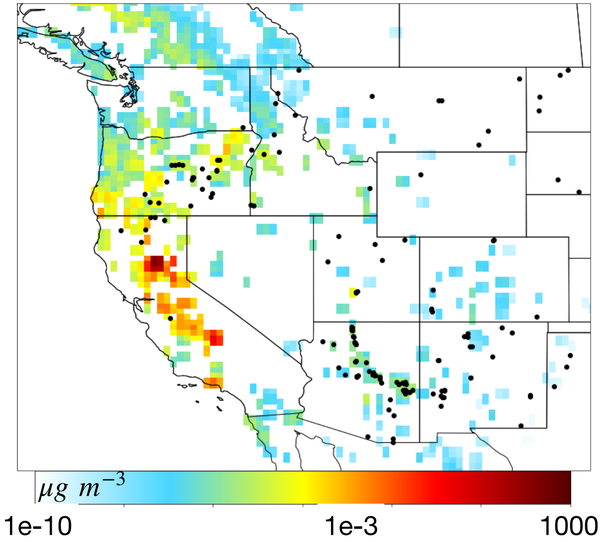
August 2022
-Inflation Reduction Act
-$2 billion for reduction of hazardous fuels

Using GEOS-Chem adjoint to compute population-weighted sensitivity of smoke concentrations in the Western US to fire emissions

1) Identify receptor region

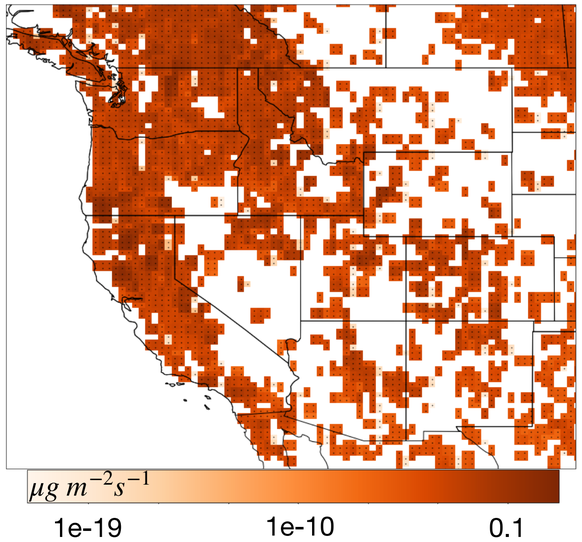


4) Population-weighted contribution to smoke



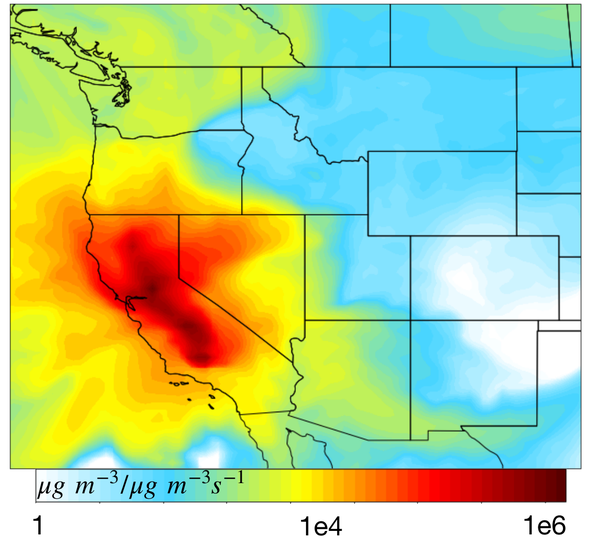
$$\int_{t_o}^{t} s(\mathbf{x},t,t')E(\mathbf{x},t')dt'$$

2) Emissions: monthly GFED 2018 + 2020



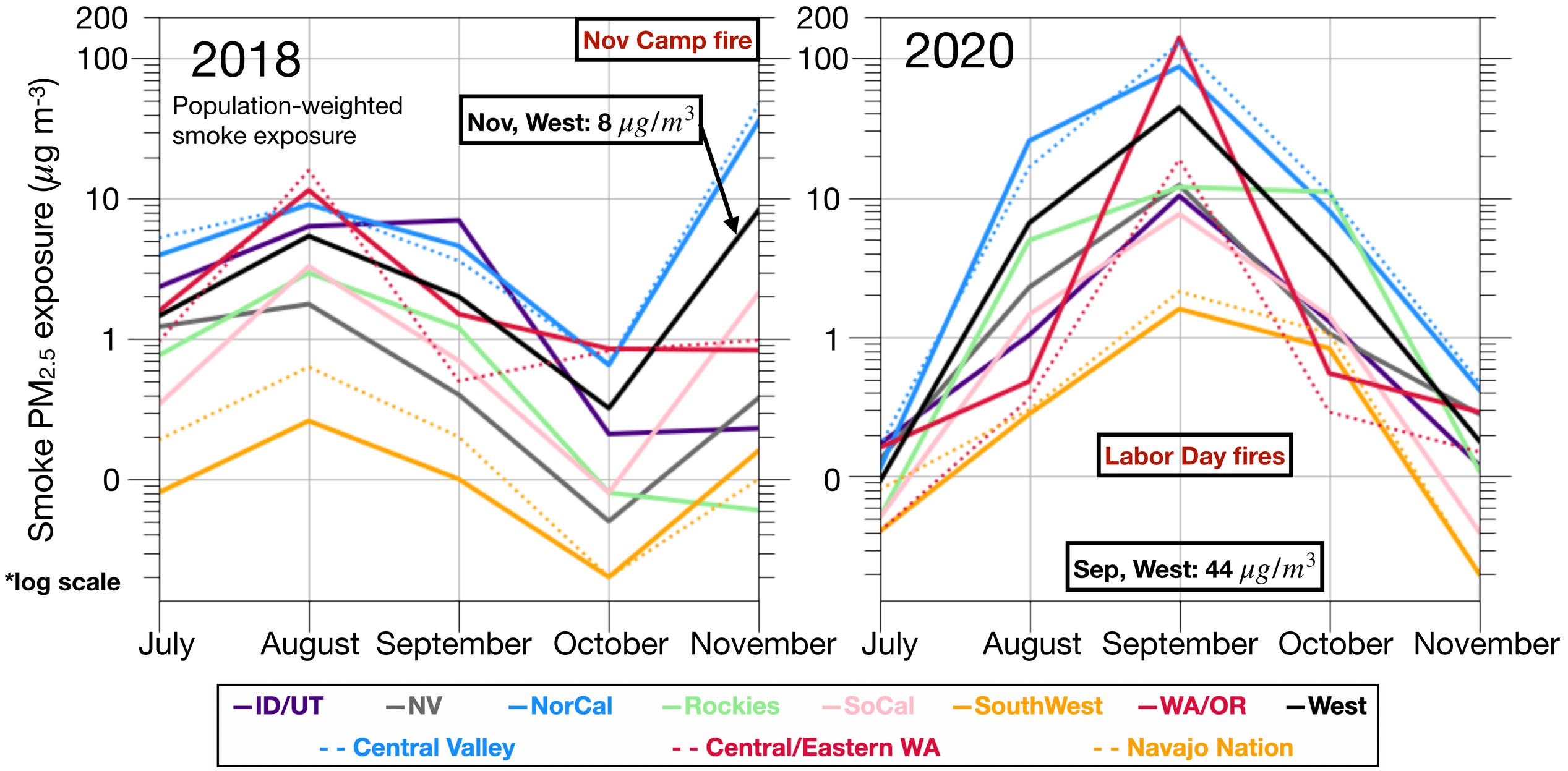
Emissions E(x, t) from bottom-up inventory

3) Sensitivities: monthly MERRA2 July-November

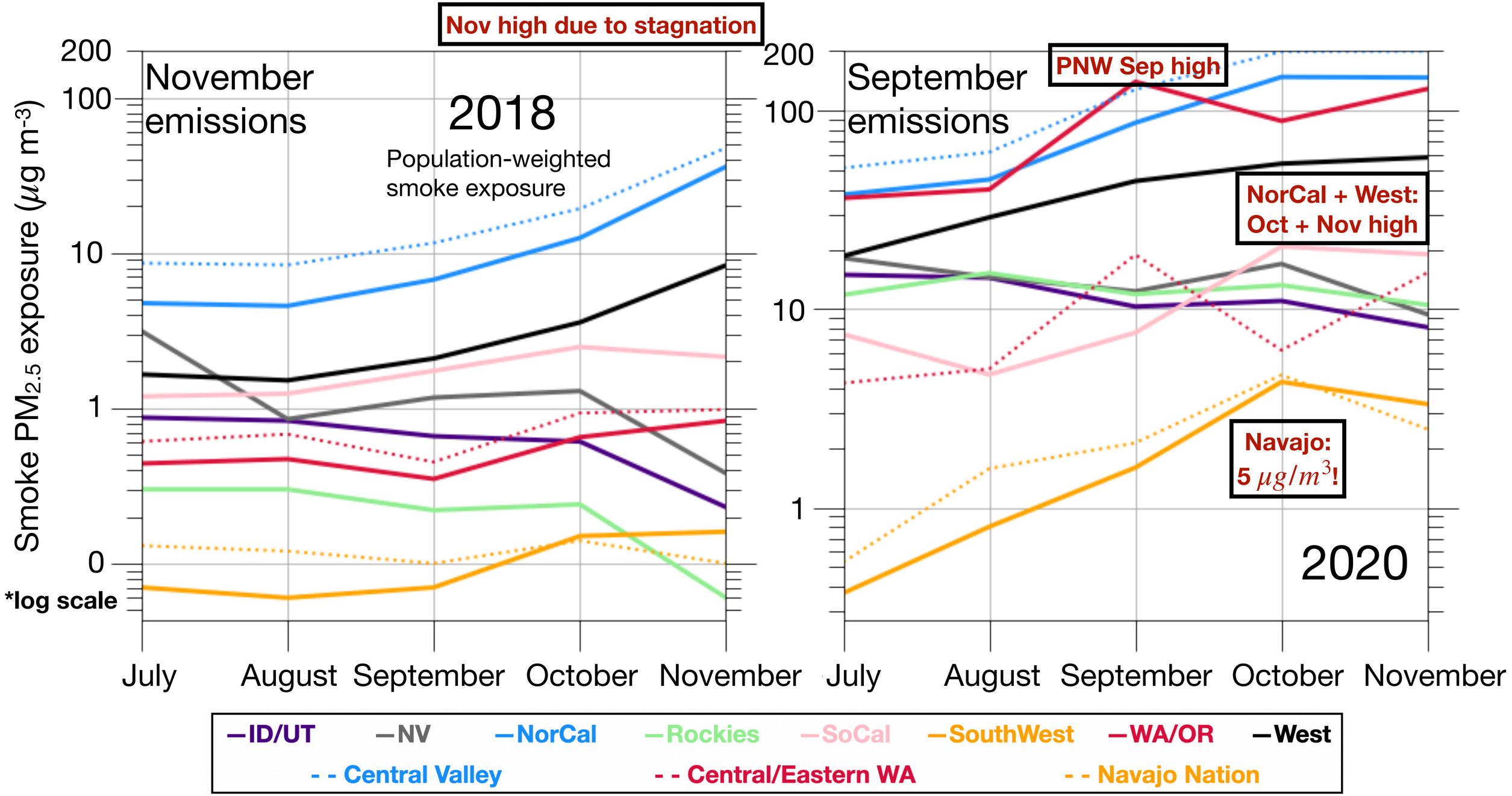


Sensitivities
$s(\mathbf{x}, t,t') = \delta \mathbf{y}_{\mathbf{West}}(t)/\delta E(\mathbf{x}, t')$
computed with GEOS-Chem adjoint (convection, advection, deposition)

“Historical smoke” simulations confirm the highs of 2018 and 2020 fire years



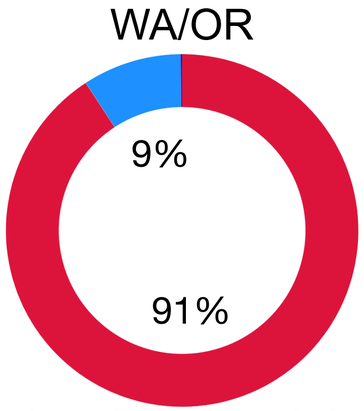
“Maximum smoke” simulations indicate greater exposure later in the fire season



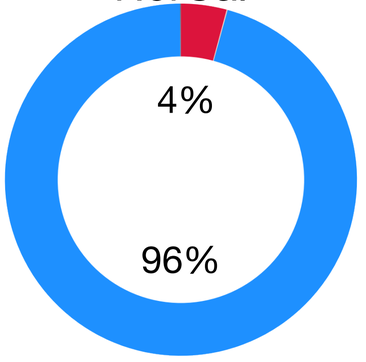
Applying prescribed burns on the coast yields large benefits for the West, while doing so in other states have relatively smaller impacts

We assume that prescribed burns reduce GFED emissions by 50%

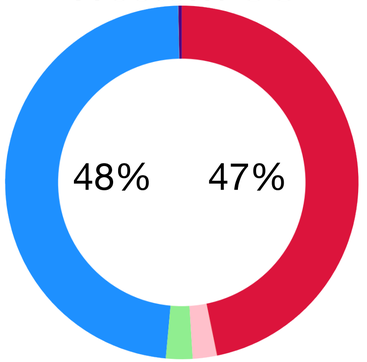
September 2020 fire season prescribed burn simulation



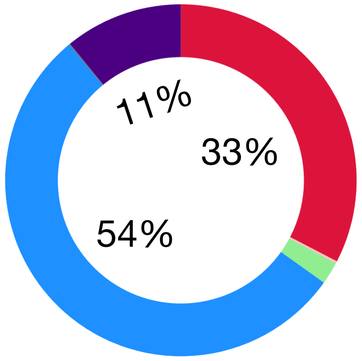
Prescribed Burns: -72.6 μg/m^3



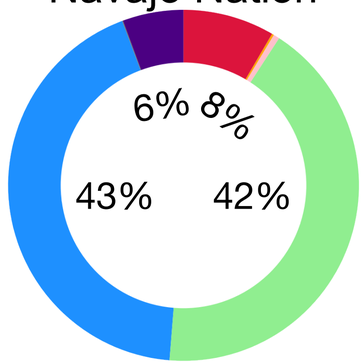
Prescribed Burns: -44.5 μg/m^3



Prescribed Burns: -22.6 μg/m^3



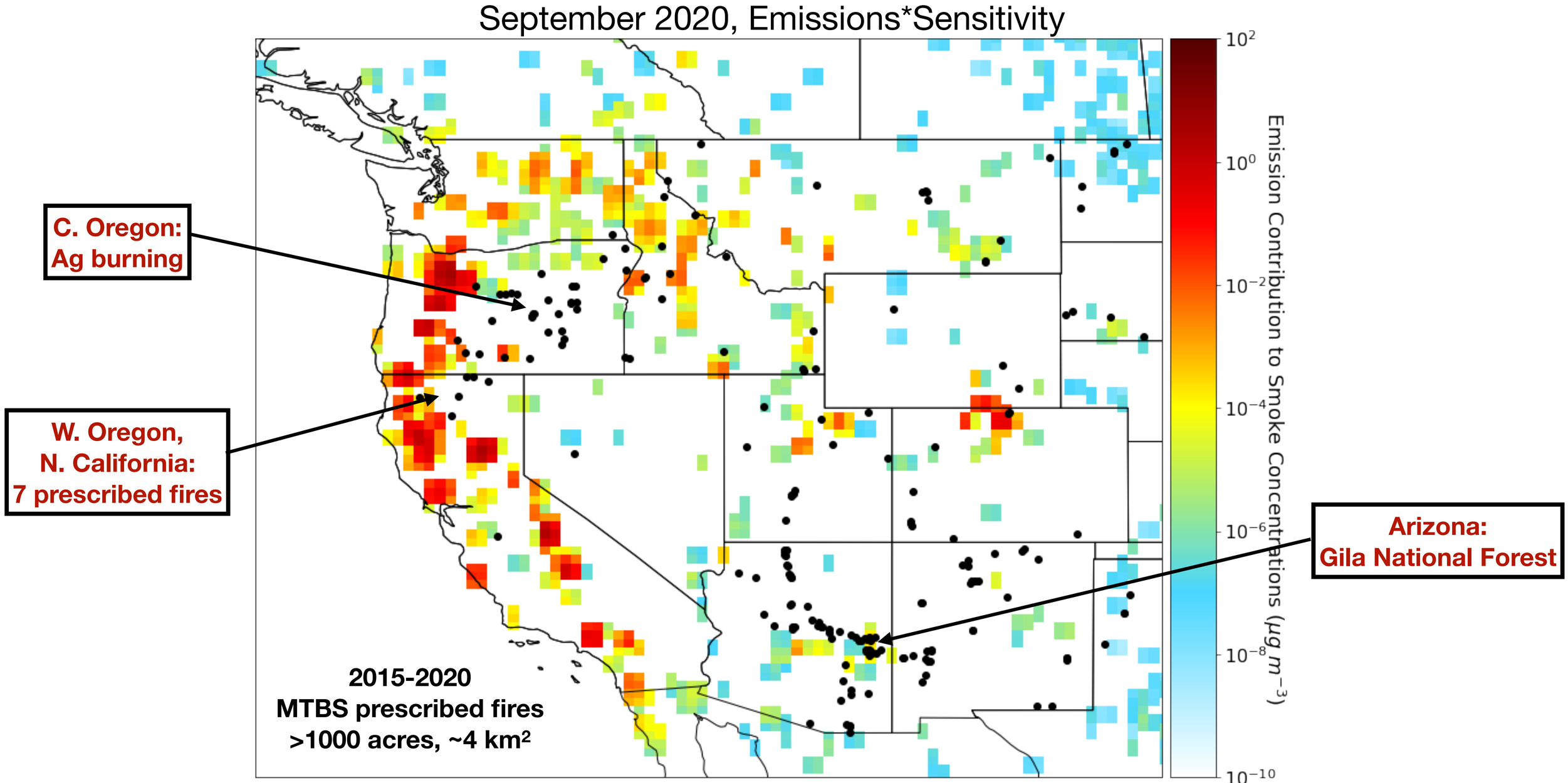
Prescribed Burns: -5.3 μg/m^3



Prescribed Burns: -1.1 μg/m^3

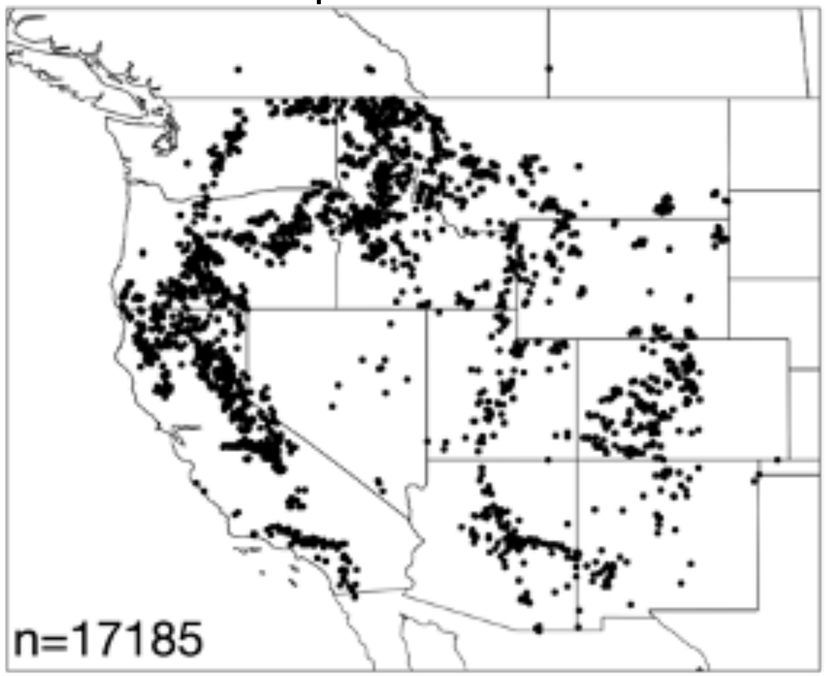
ID/UT
NV
NorCal
Rockies
SoCal
SouthWest
WA/OR

Larger prescribed burns may reduce smoke impacts from future large wildfires, but few such burns have occurred in key areas

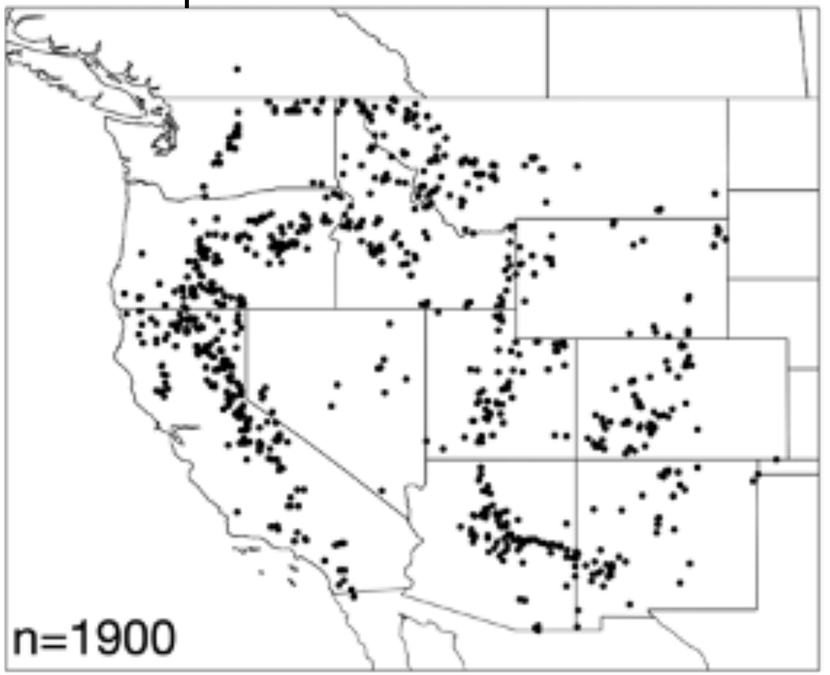


States in the West may benefit from applying a small number of large, prescribed burns instead of many small, prescribed burns.

2019 prescribed fires



2019 prescribed fires > 100 acres



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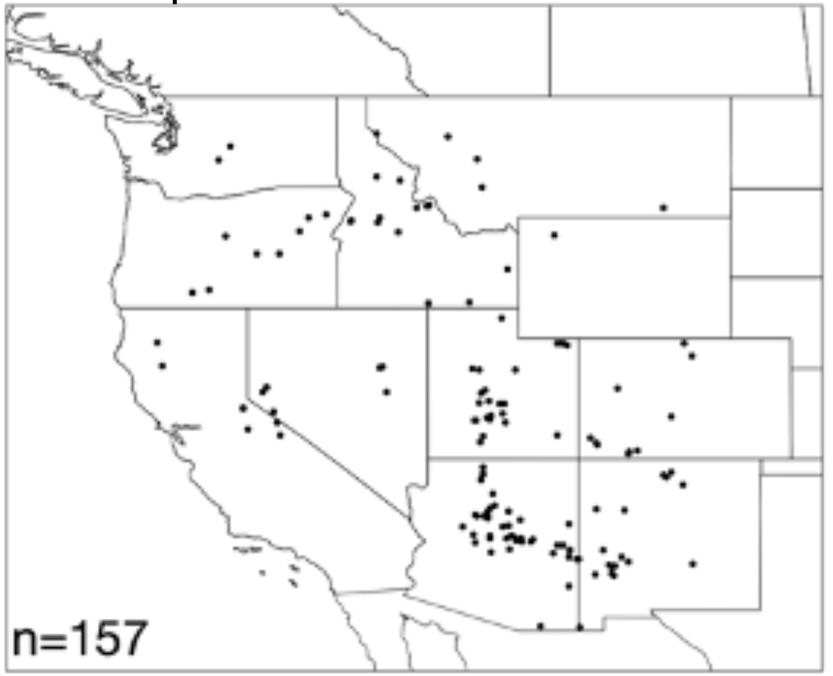

Black dots = prescribed fires

-Annual burned area from prescribed fires in N. California are **<11%** of fire burned area pre-European intervention.

-NFPORS indicates that N. California applied 9,590 prescribed burns over the course of 2018-2020, yet only **88 (0.9%)** of these burns were larger than 500 acres (~2 sq. km).

Takeaways

-Land managers do not consider the potential air quality impacts of wildfire smoke when planning prescribed burns.

-Applying prescribed burns on the coast yields large benefits for the West, while doing so in other states have relatively smaller impacts

- (1) prevailing westerly winds, (2) large population centers along the coast, and (3) denser fuel loads west of the Sierras/Cascades

-Larger prescribed burns may reduce smoke impacts from future large wildfires, but few such burns have occurred in key areas

-States in the West may benefit from applying a small number of large, prescribed burns instead of many small, prescribed burns.

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Preprint of this work may be found on my website