Future Global Changes on Air Quality in the United States

Maria Val Martin (CSU) and Colette L. Heald (MIT)

J-F Lamarque, S. Tilmes and L. Emmons (NCAR)

Massachusetts Institute of Technology

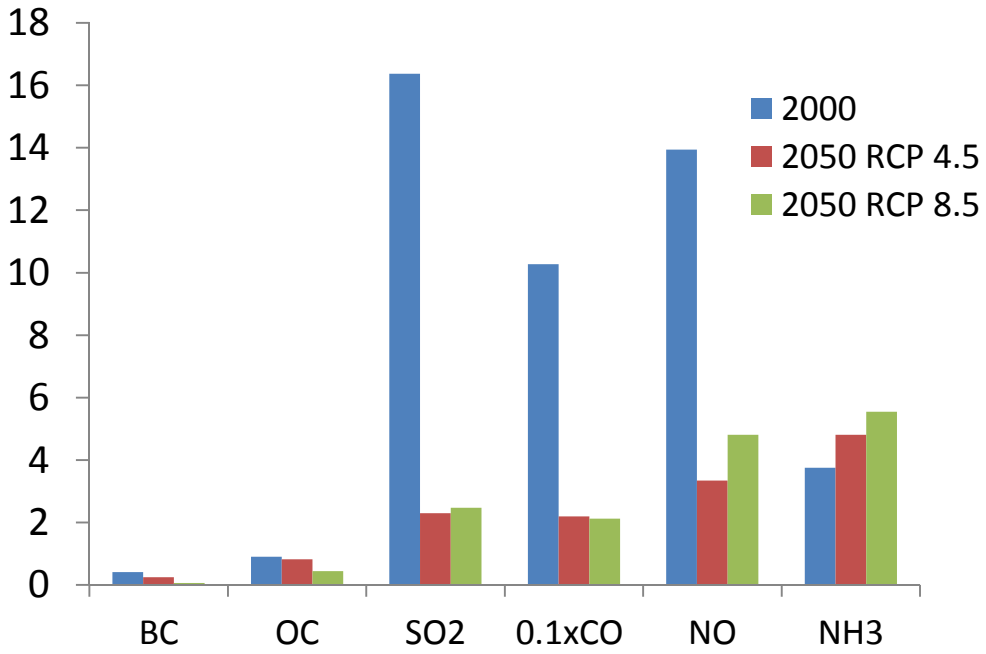
Colorado State University

NATIONAL PARK SERVICE

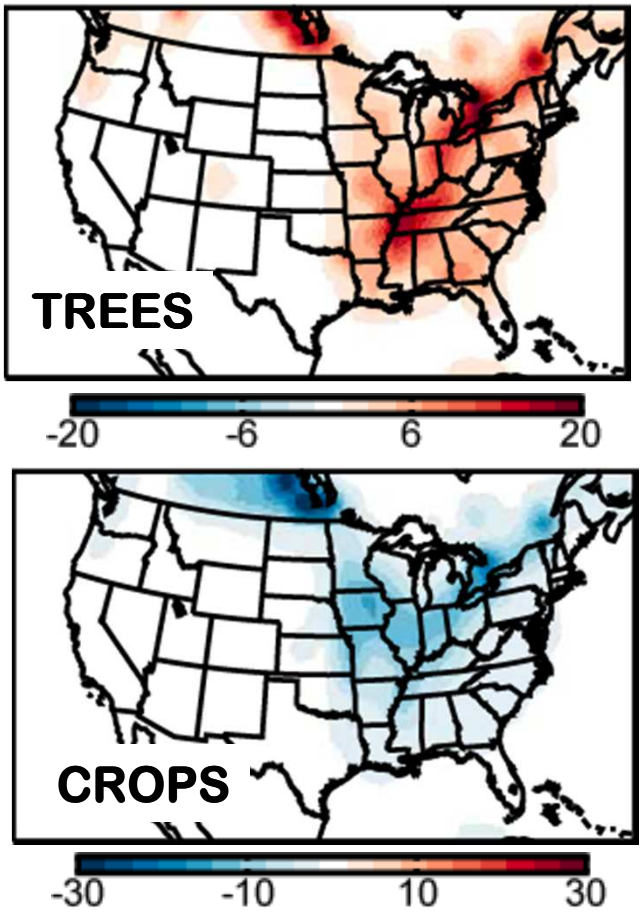
NCAR

New IPCC projects dramatic changes in anthropogenic emissions and land use over the US

U.S. Anthropogenic Emissions (Tg Species/year)



Changes in land cover projected for 2050 (RCP 4.5)



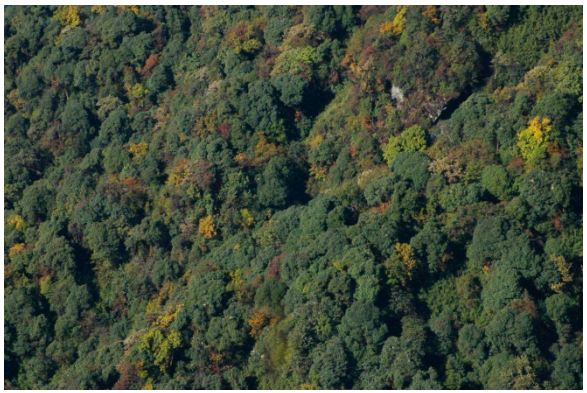
Short-lived anthropogenic emissions decrease in all IPCC scenarios, except NH_3

GHG emissions are projected to increase, in particular CH_4 in RCP8.5

EMISSIONS
(natural & anthropogenic)

AIR QUALITY
CESM 1.1

CLIMATE



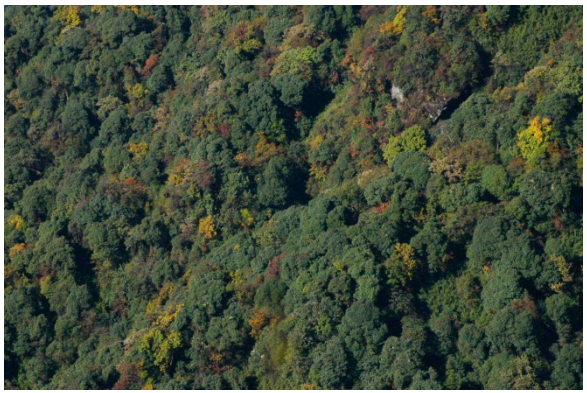
LAND USE CHANGE

Focus on O_3 , $PM_{2.5}$, and N deposition with the IPCC RCP4.5 and RCP8.5 scenarios

EMISSIONS
(natural & anthropogenic)

CLIMATE

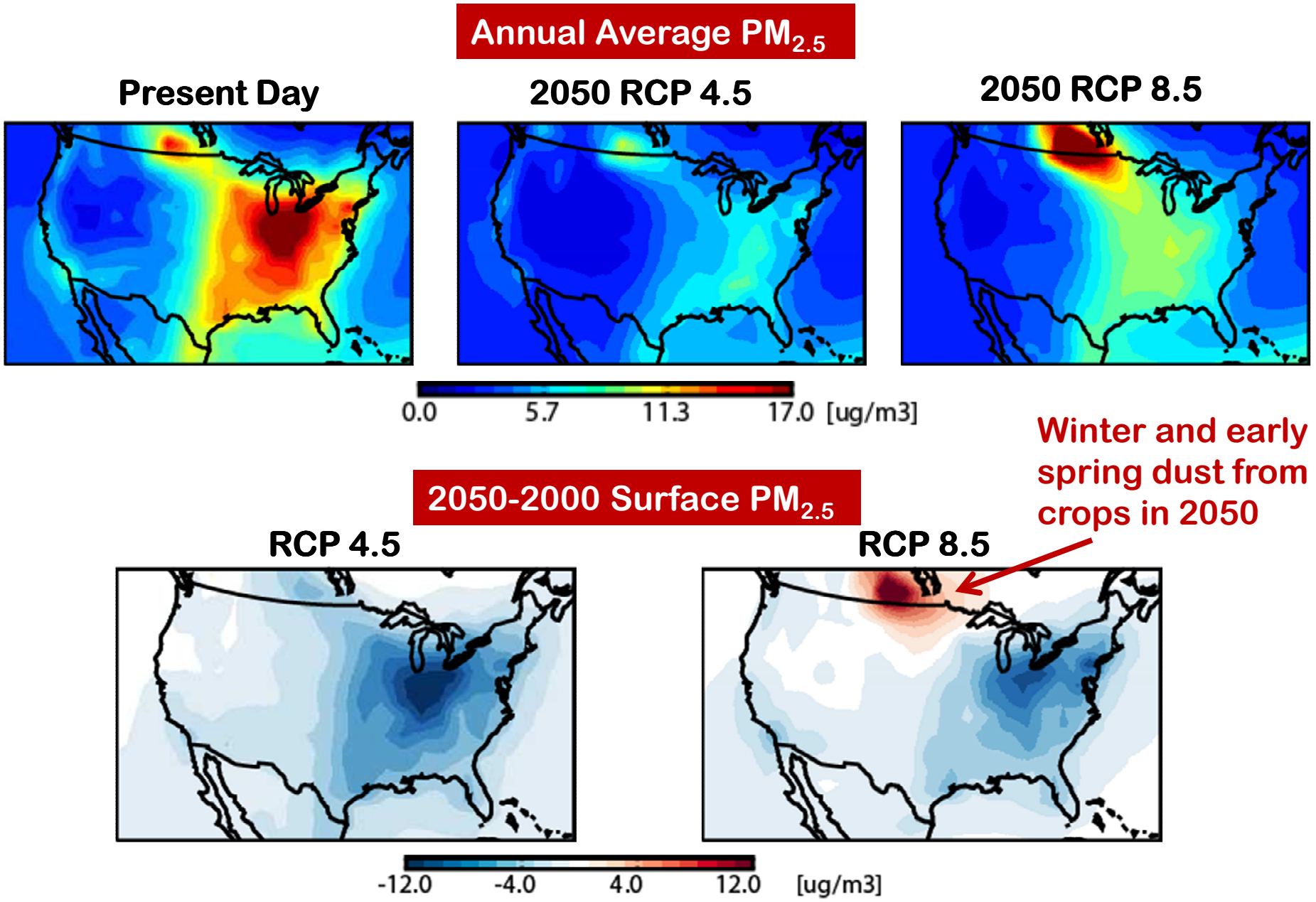
AIR QUALITY
CESM 1.1



LAND USE CHANGE

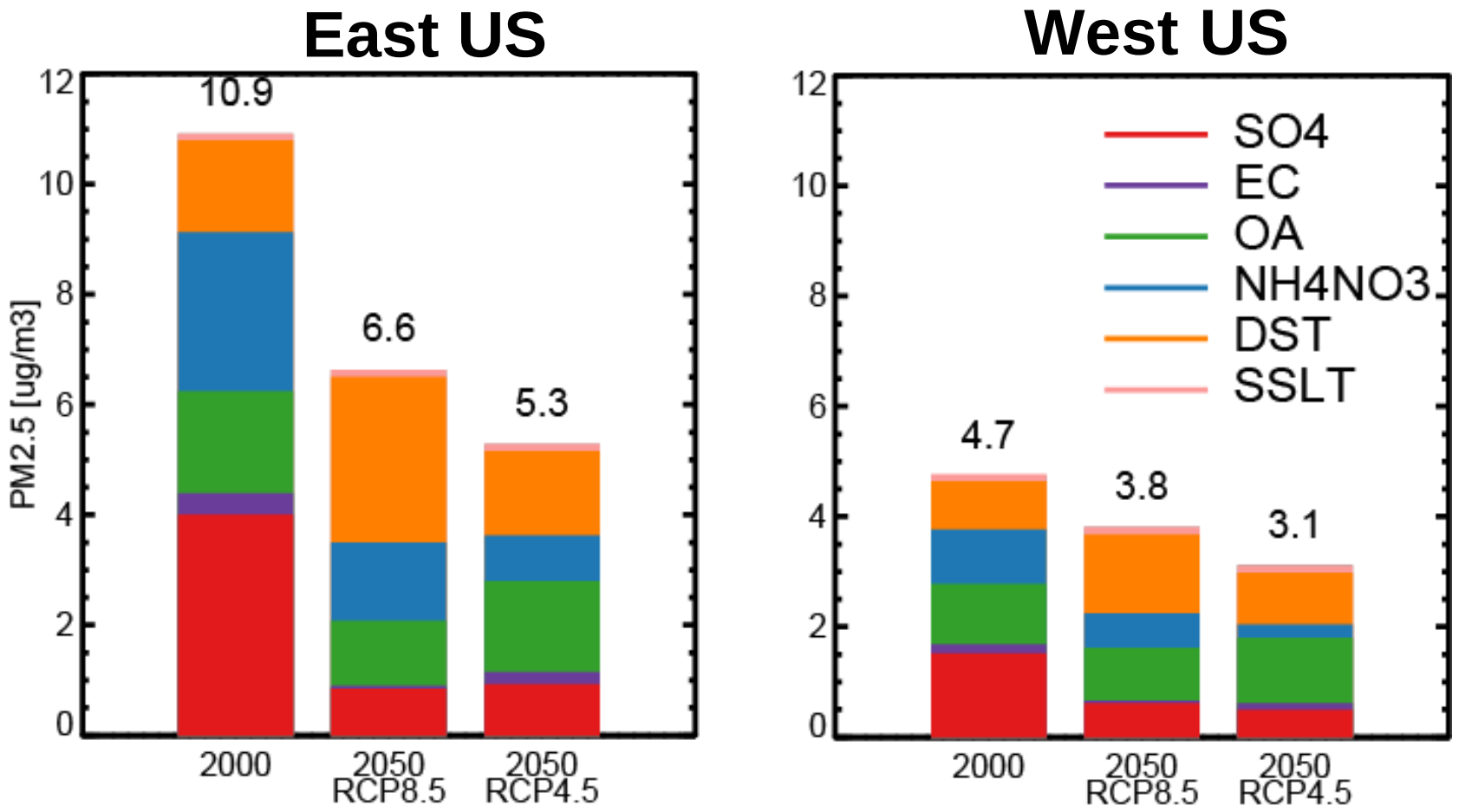
DISCLAIMER: Presented CESM results with wrong aircraft emissions!!!

Dramatic decreases in $PM_{2.5}$ over the US



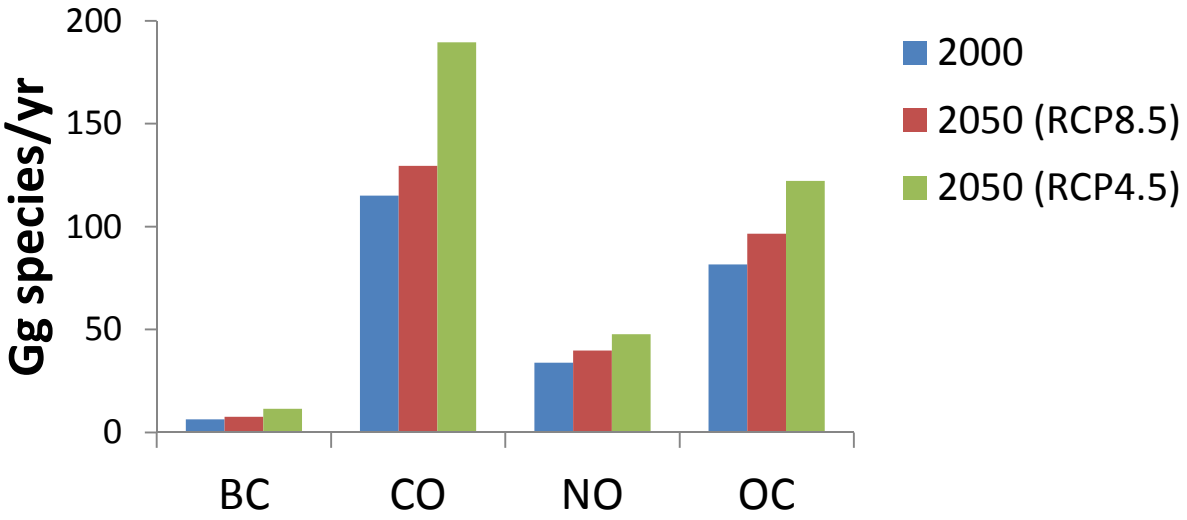
Predicted changes in $PM_{2.5}$ are mainly driven by SO_2 and NO_x emission reductions

Annual Changes in $PM_{2.5}$ Chemical Speciation



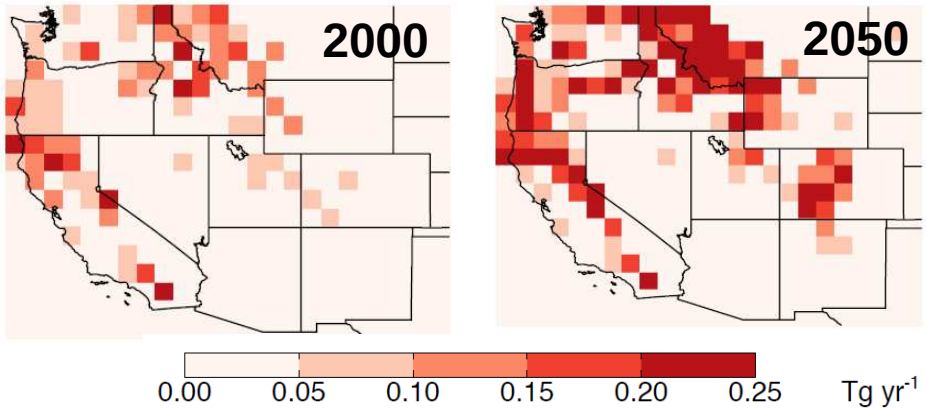
What about increases in $PM_{2.5}$ from fire activity?

IPCC US Fire Emissions (Gg Species/year)



IPCC projects an increased of ~60% (RCP4.5) and ~15% (RCP8.5) by 2050

Projected annual total biomass burned

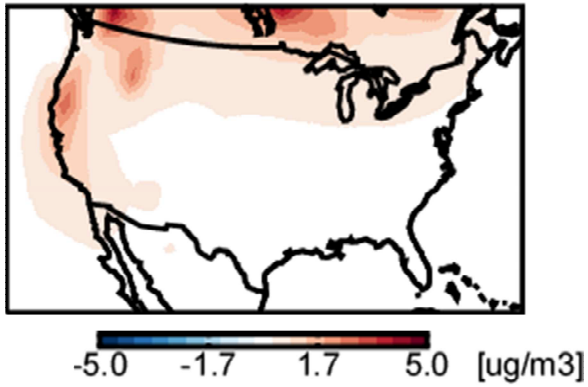


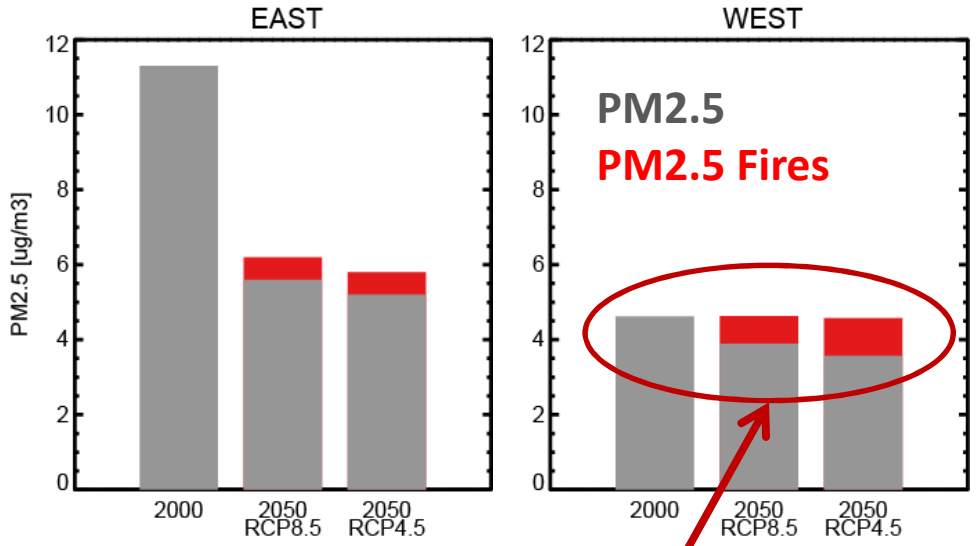
Yue et al, in review , Atm Env

Increased area burned results in ~150% increase in BC and OC fire emissions

Increased summer $PM_{2.5}$ due to predicted changes in fire emissions

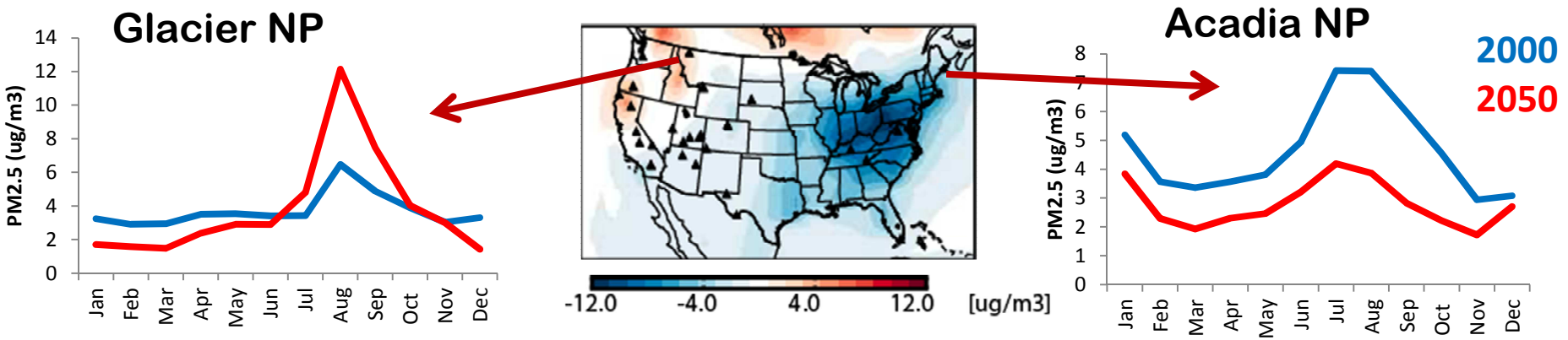
Changes in summer $PM_{2.5}$ from fires alone





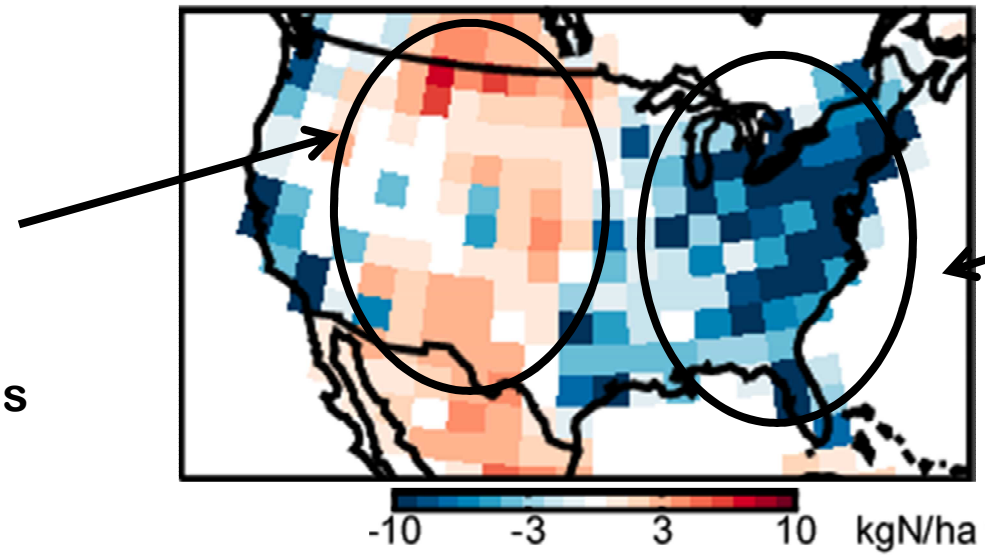
Future $PM_{2.5}$ may stay constant over western US due to increased fire activity!

Changes in $PM_{2.5}$ (RCP 4.5+Fires)

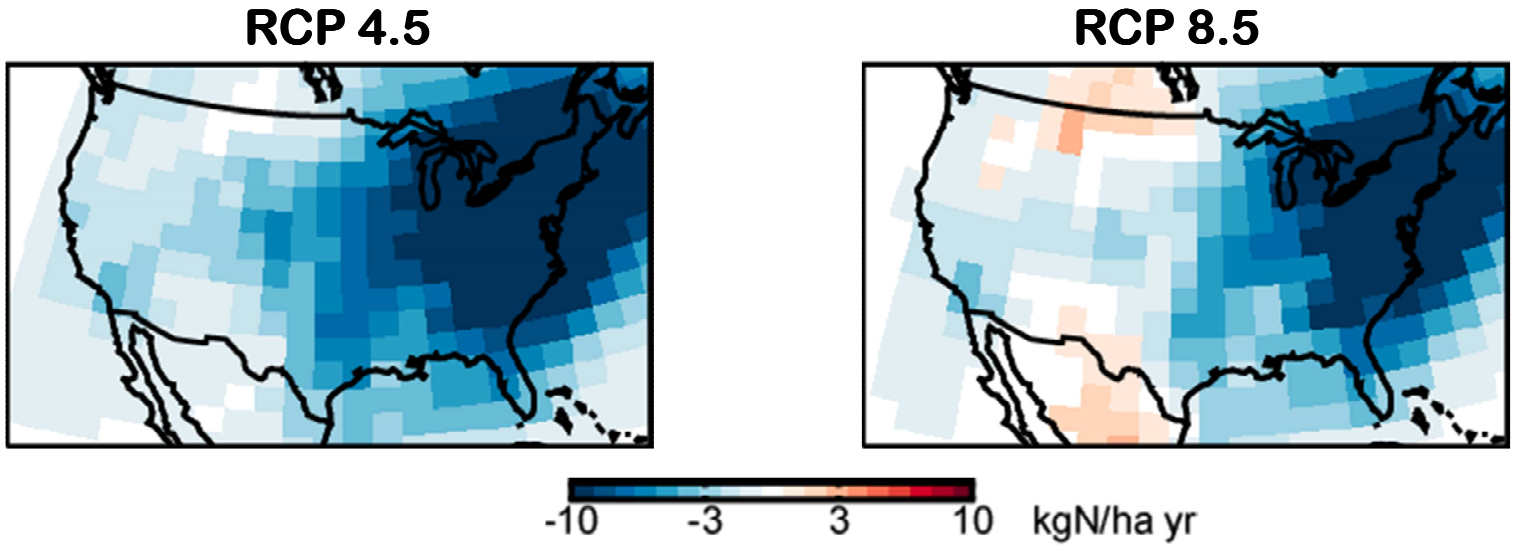


May 2050 NH_3 emissions affect N deposition?

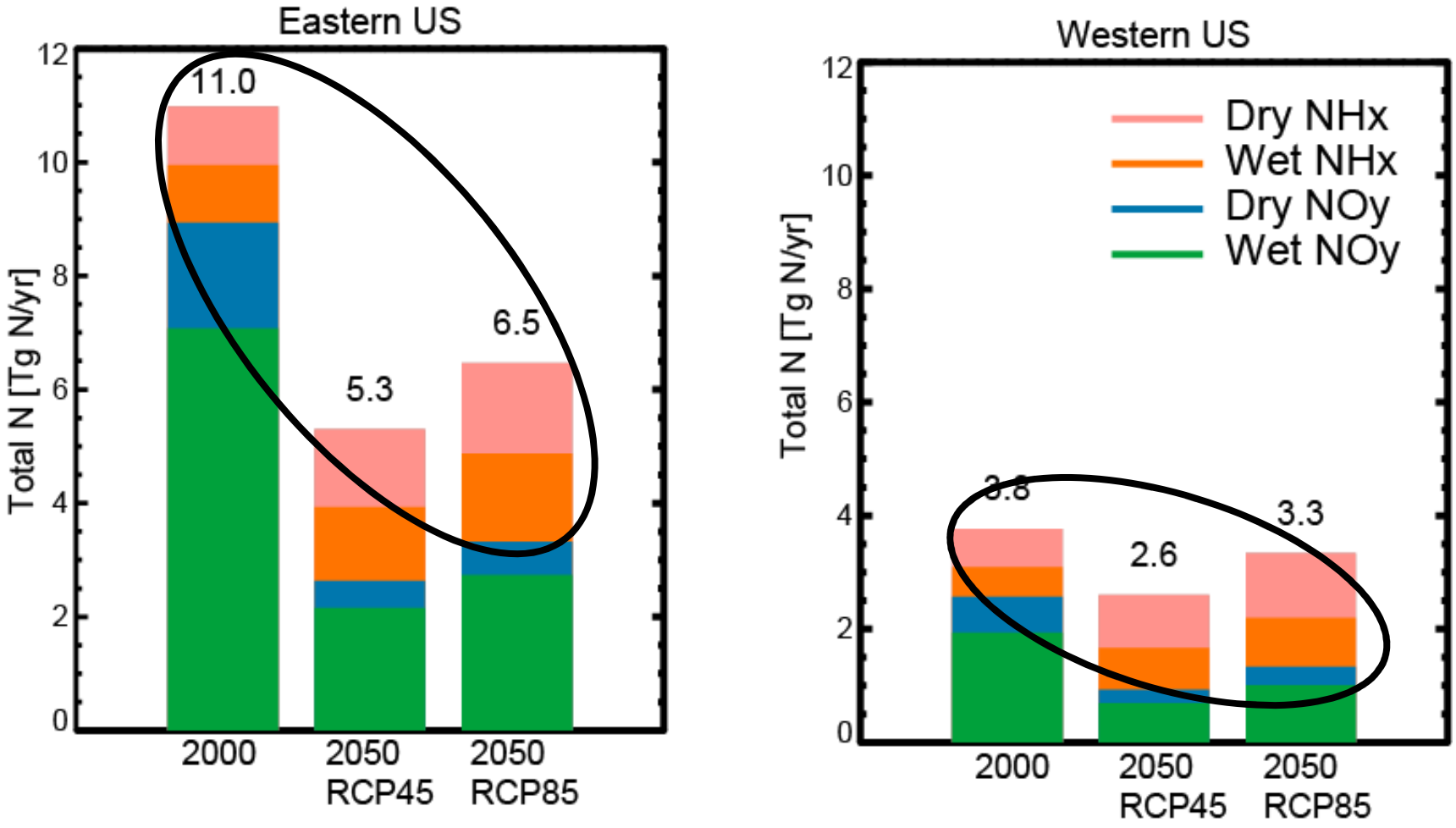
2050-2000 Nitrogen Emissions (RCP85)



2050-2000 Nitrogen deposition



Projected changes in N deposition are mainly due to lower HNO_3 deposition



*2050 NH_3 emissions will likely increase N deposition by about 60% (RCP85) and 30% (RCP45) in 2050

Summary

Air quality over the US is very likely to improve (both $PM_{2.5}$ and O_3) in 2050 based on new RCP scenarios (see Fiore et al., 2012; Kelly et al., 2012).

Wildfires may increase summer $PM_{2.5}$ over the US, although it is a difficult driver to predict.

N deposition is likely to decrease due to strong anthropogenic NO_x emission reductions, but agriculture NH_3 emissions may offset some of this benefit.