



# Aerosol and climate interactions in CESM1

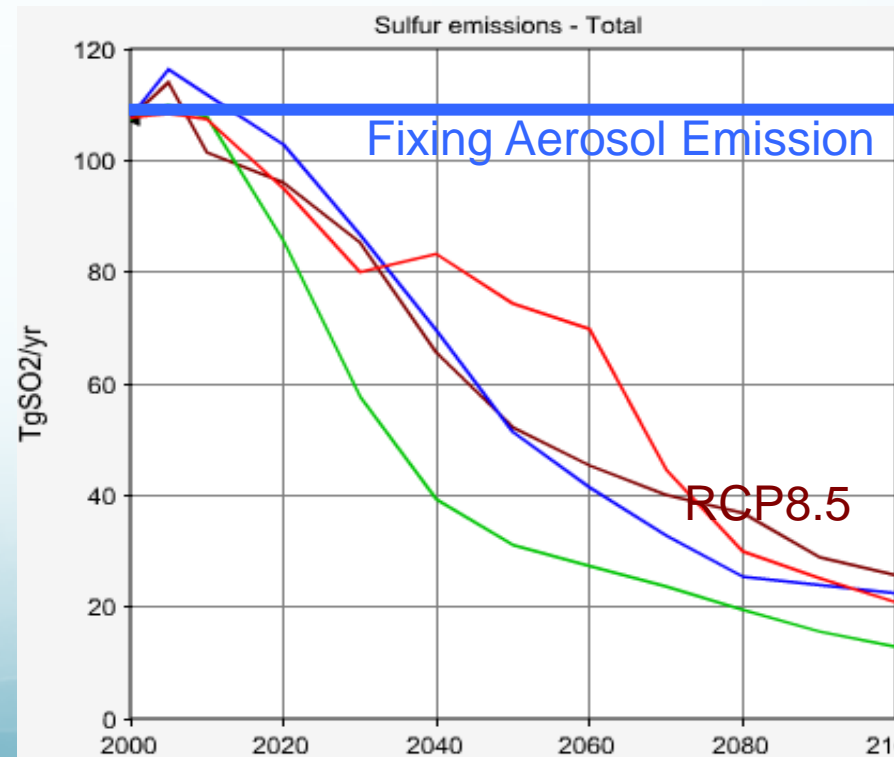
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National Center for Atmospheric Research

CESM Breckenridge workshop, Jun 23, 2016

# “Interaction”

- 1. Aerosol => Climate Change (e.g. Heat extreme, mid-latitude circulation, mountain snowpack, etc.)

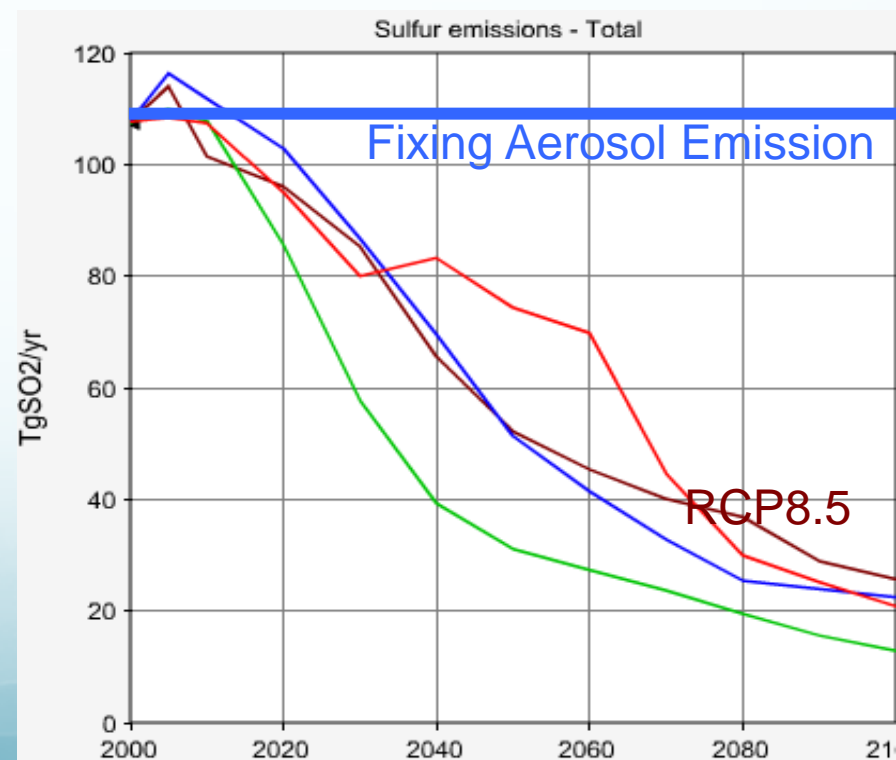


# “Interaction”

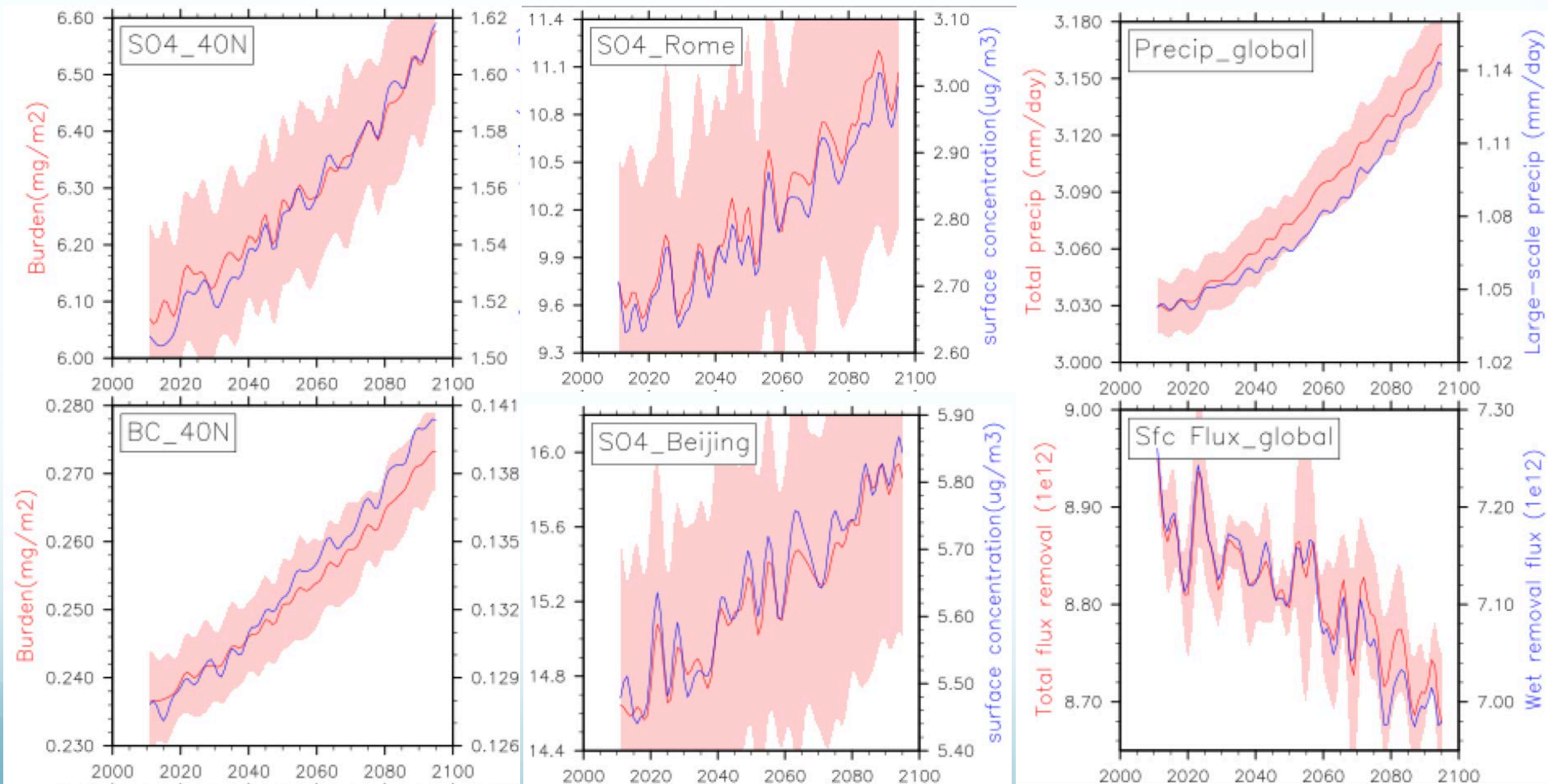
- 1. Aerosol => Climate Change (e.g. Heat extreme, mid-latitude circulation, mountain snowpack, etc.)
- 2. Climate Change => Aerosol Pollution (mean and extreme)

Effects NOT addressed in this study:

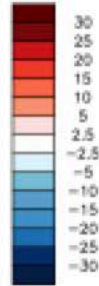
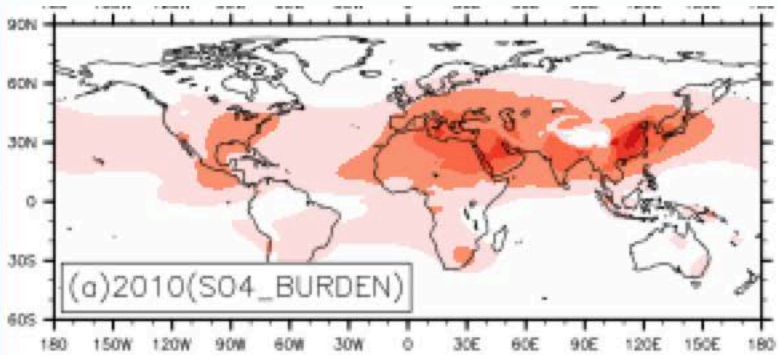
- Gas-to-particle production due to T, RH, UV changes
- Natural aerosols (sea salt, dust, biogenic, wildfire)



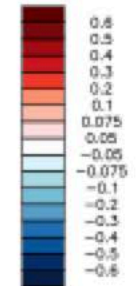
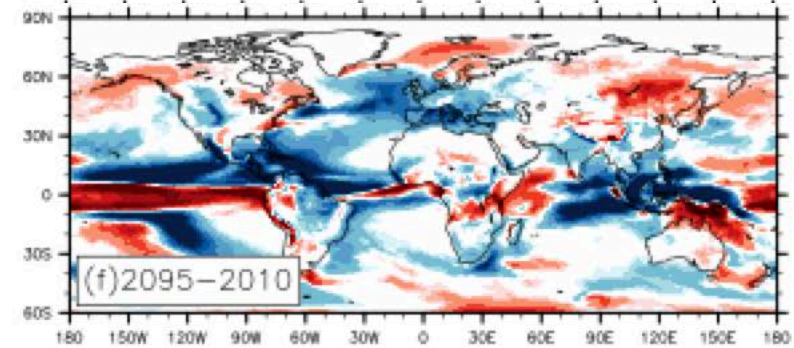
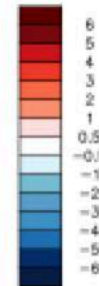
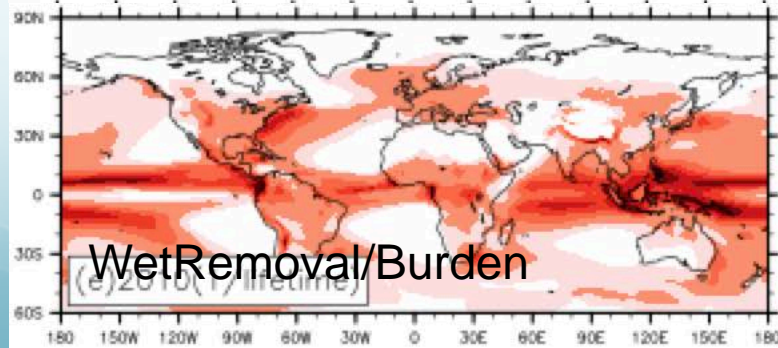
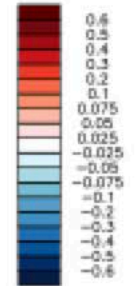
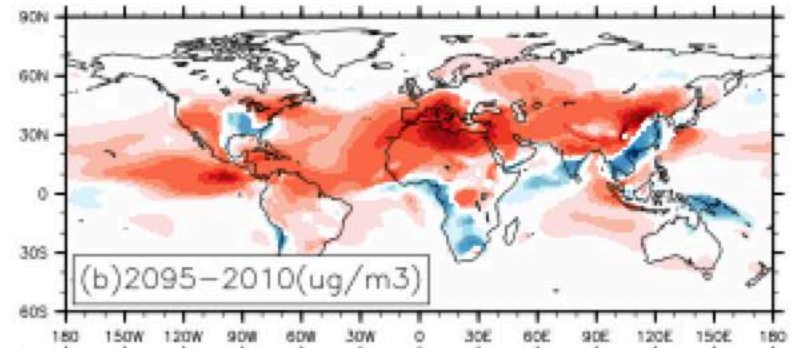
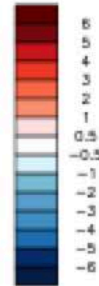
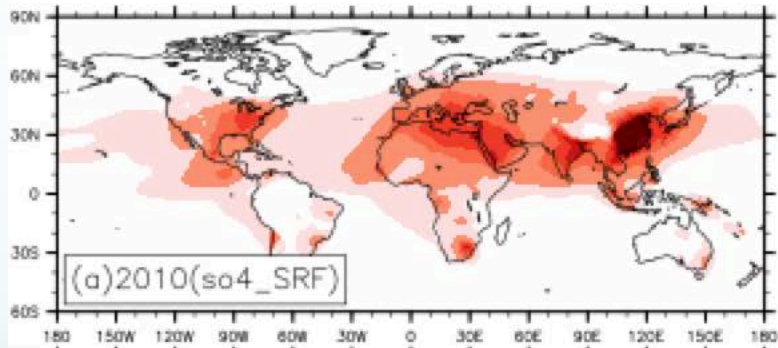
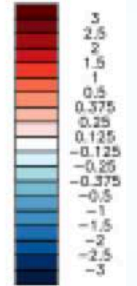
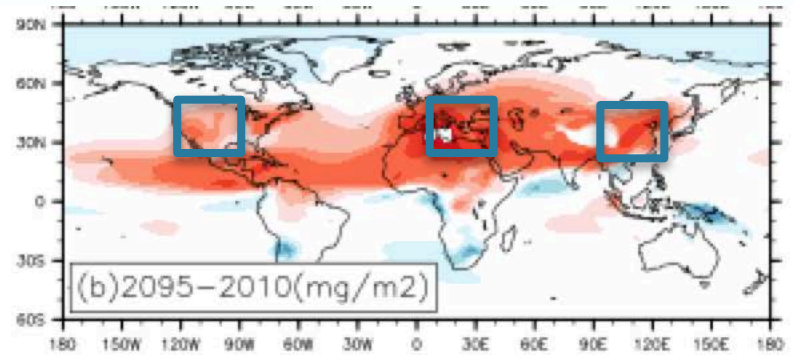
# The 21<sup>st</sup> century pollution levels go up despite fixed emission at present-day level?



# Climatology

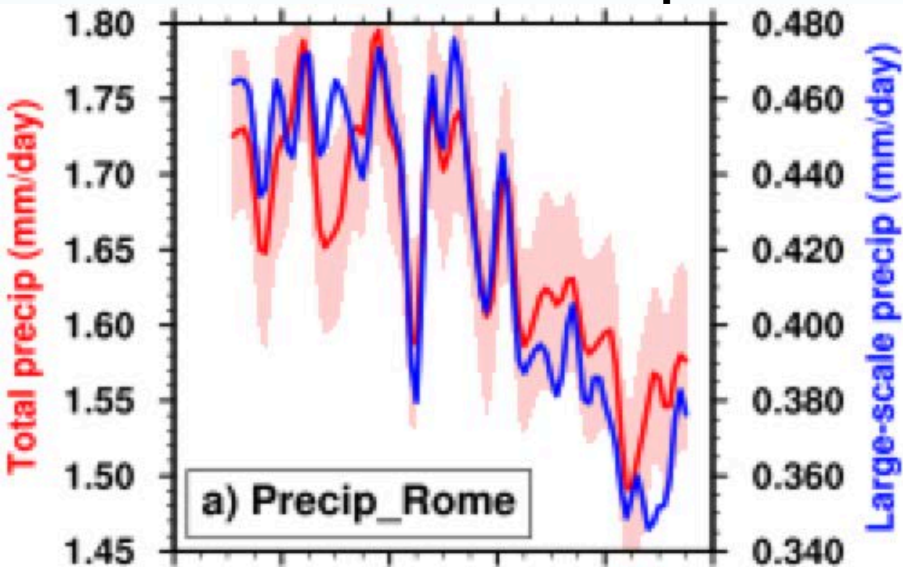


# End-of-Century Changes

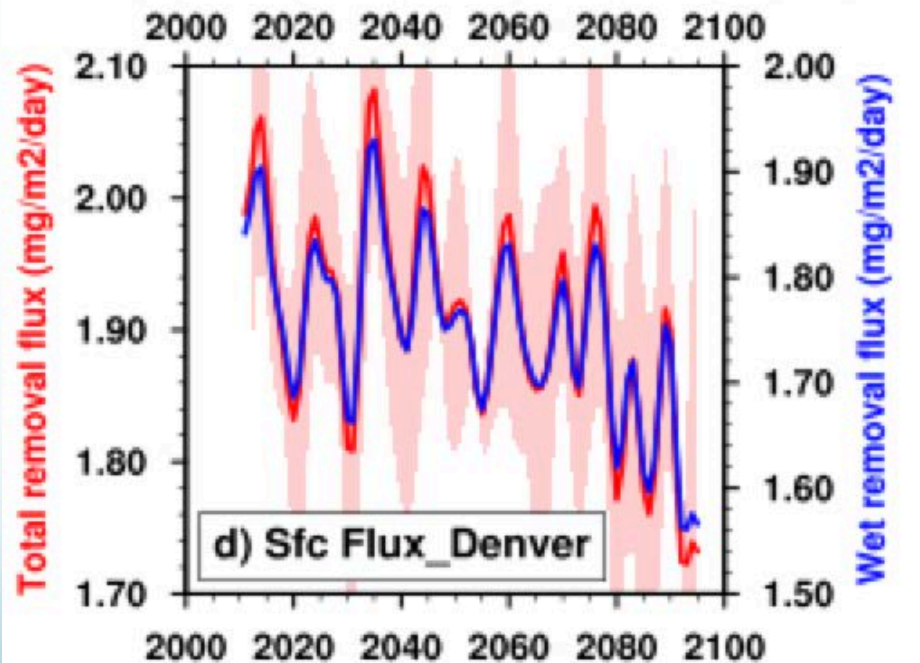
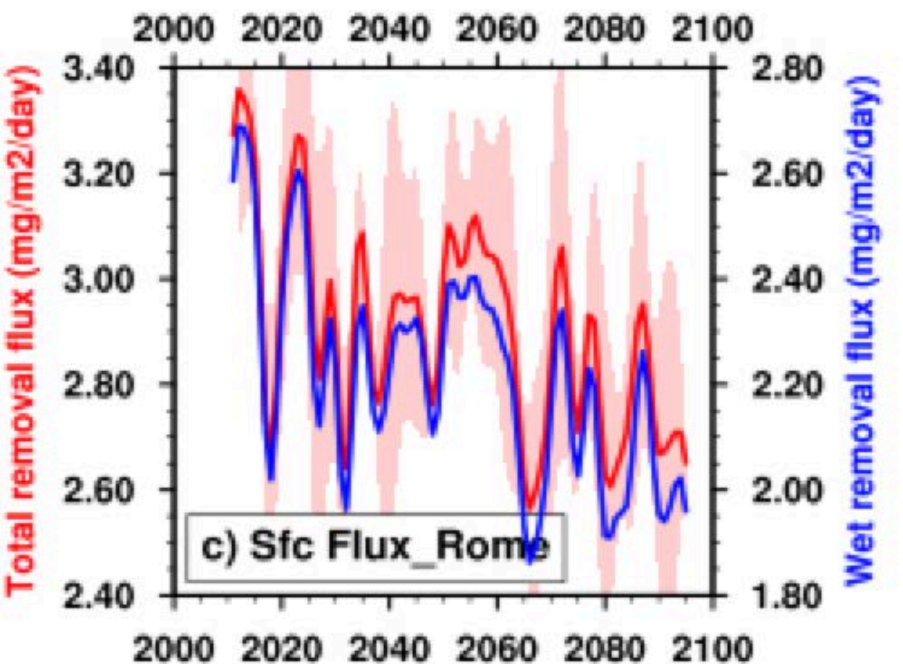
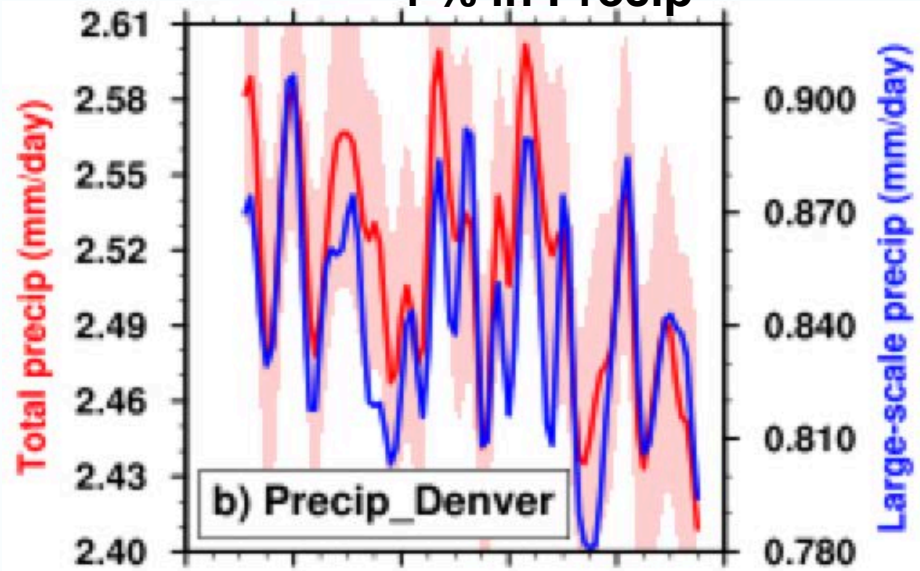


WetRemoval/Burden

- 15% in Precip

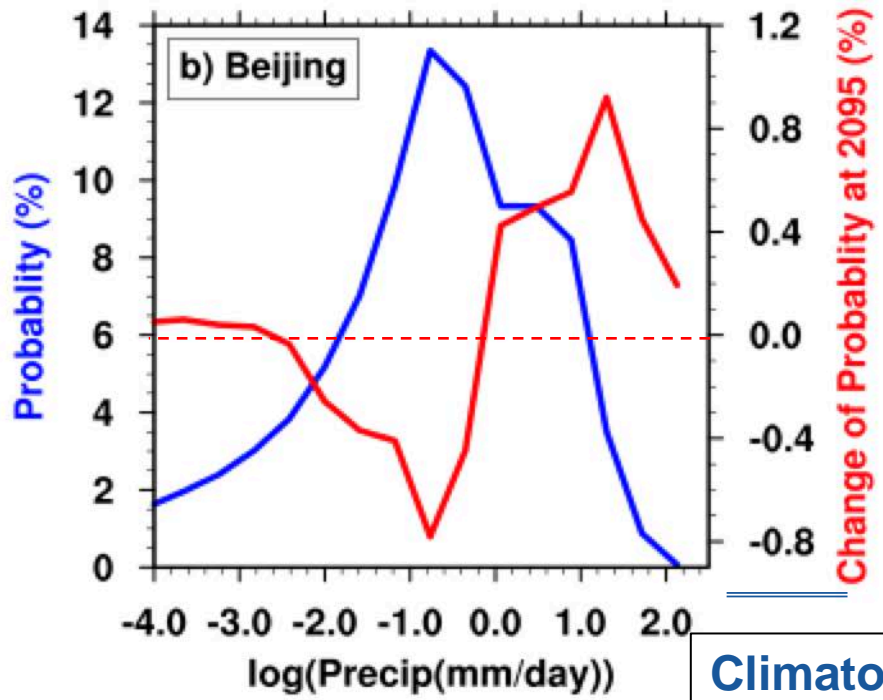
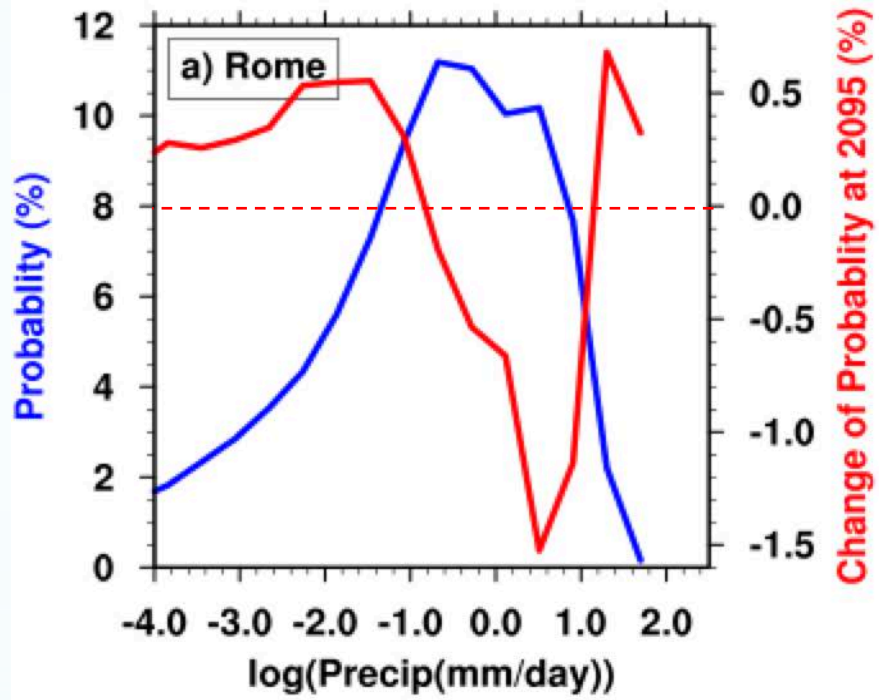


- 4 % in Precip

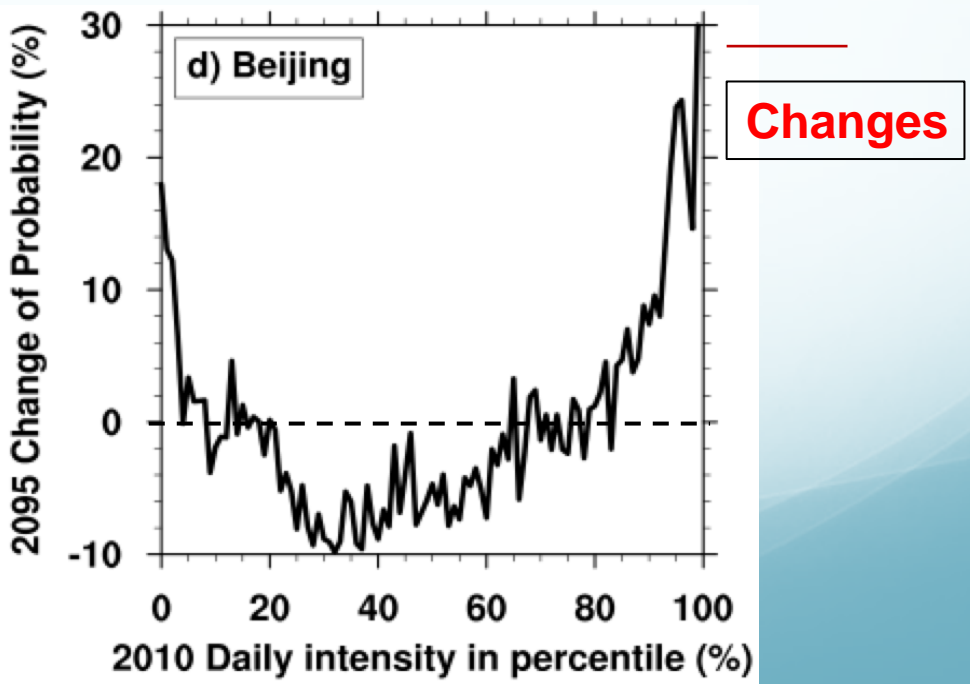
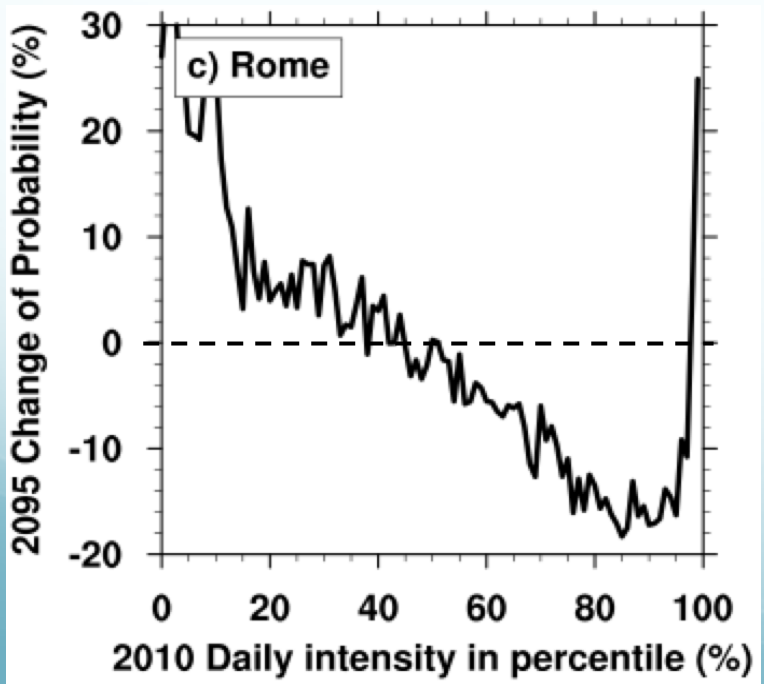


- 25%

- 20%

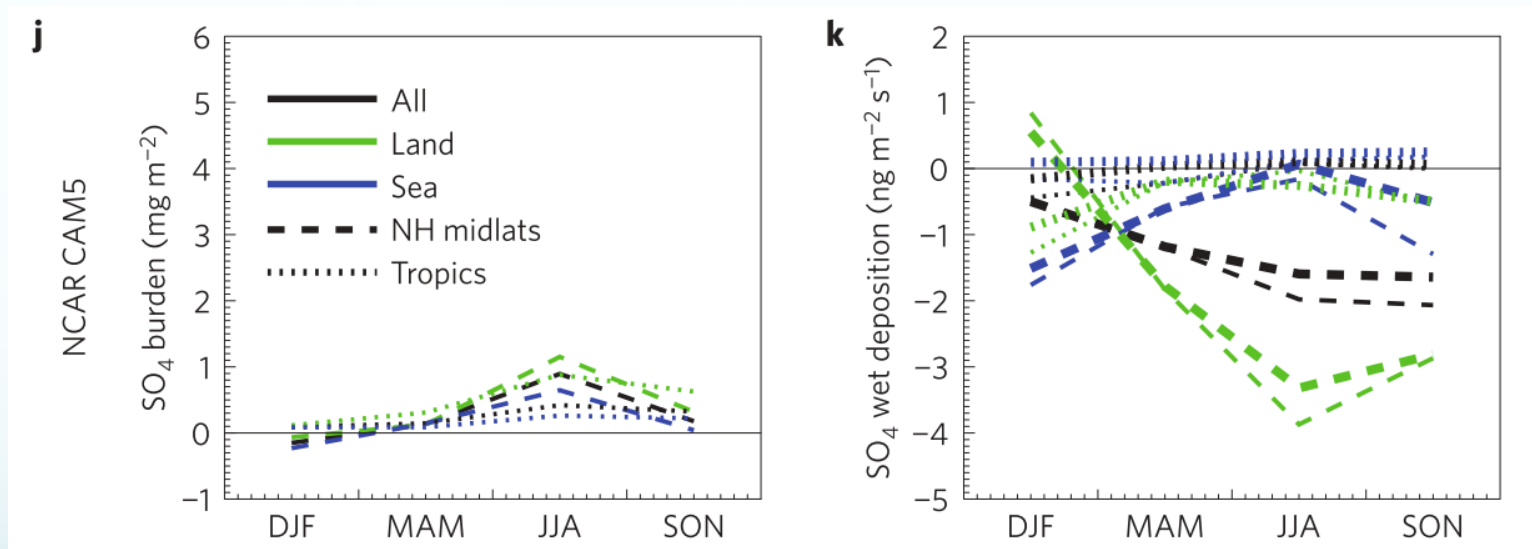


Climatology



# Summary (part 1)

- Aerosol pollution increase in response to GHG warming



Allen et al. (2015), using ACCMIP (2100 minus 2000)

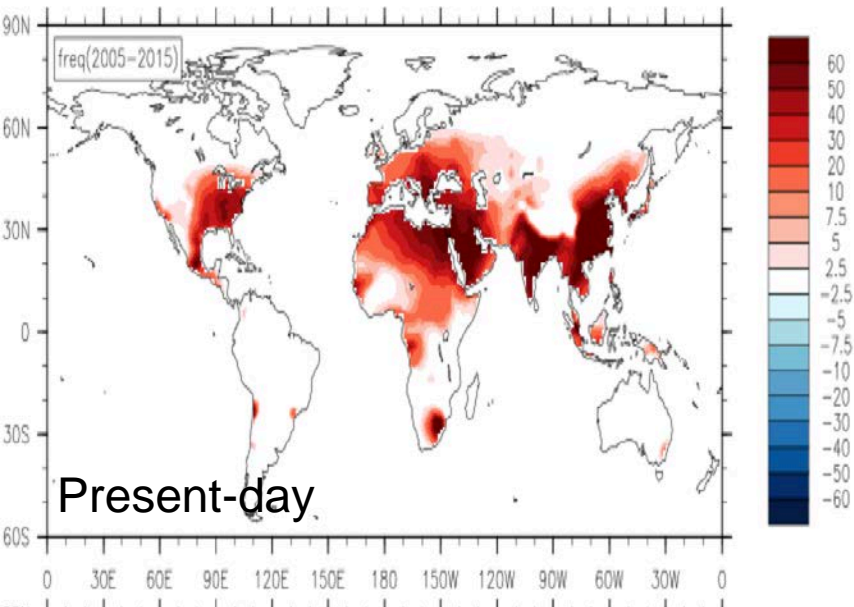
- Rainfall shift in the daily intensity spectrum as a cause of wet removal flux reduction



# Extreme pollutions

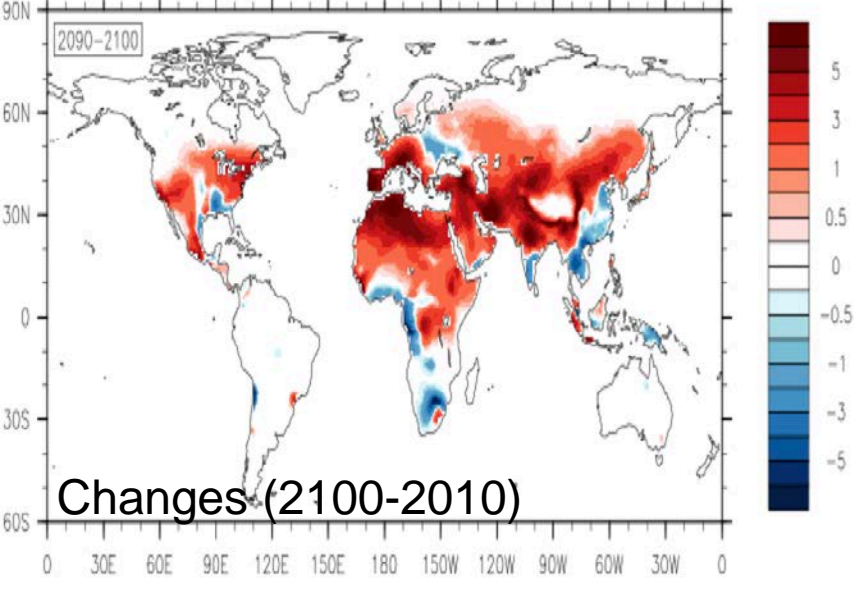
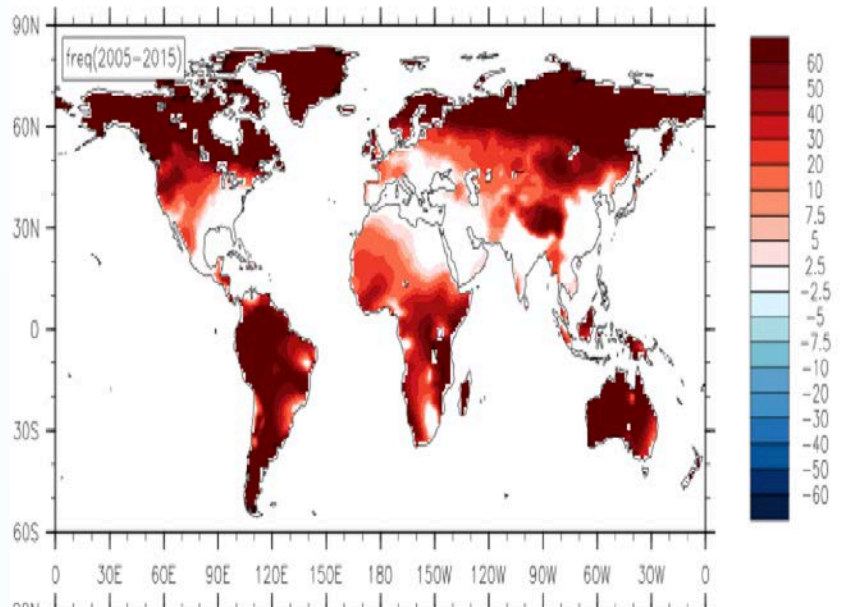
Daily PM2.5 extremes exceeding 2.5 microgram/m3 as the WHO threshold

Freq of Extreme PM2.5 events (%)

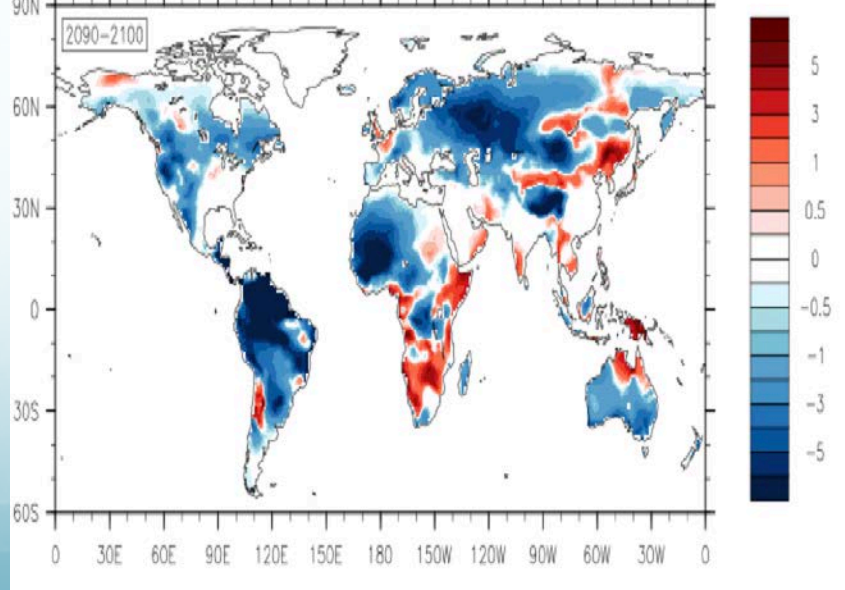


Present-day

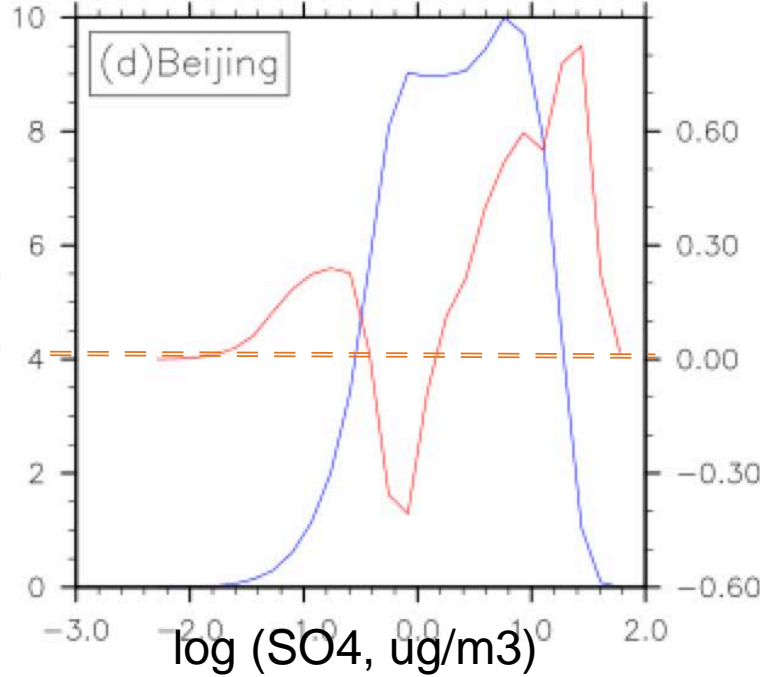
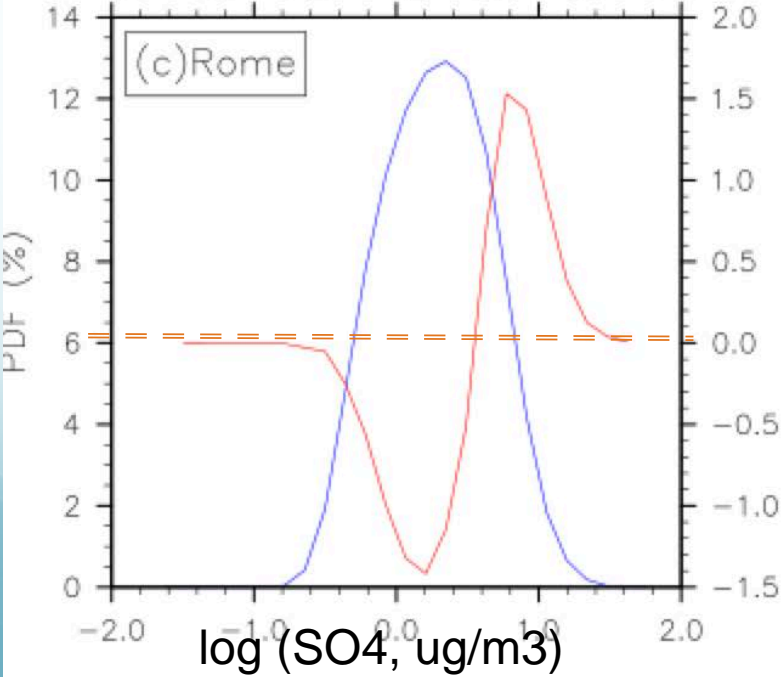
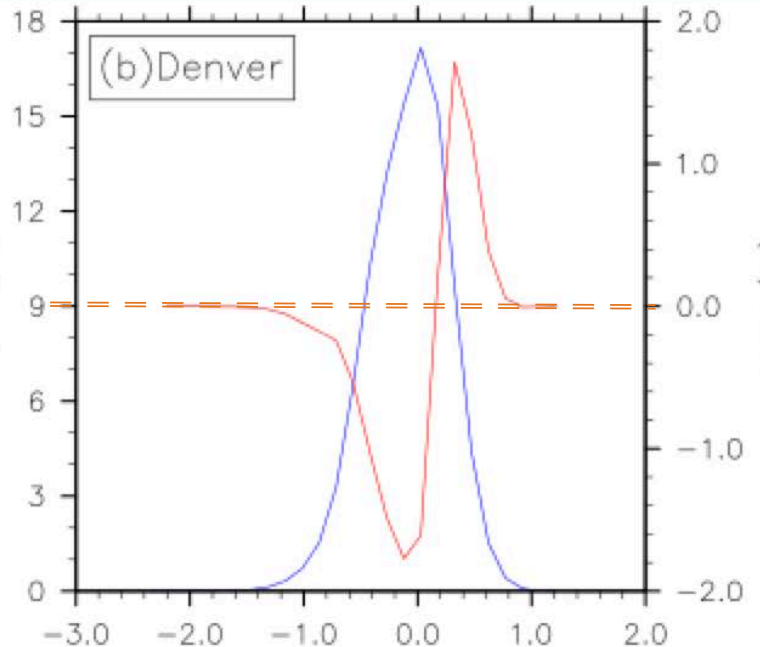
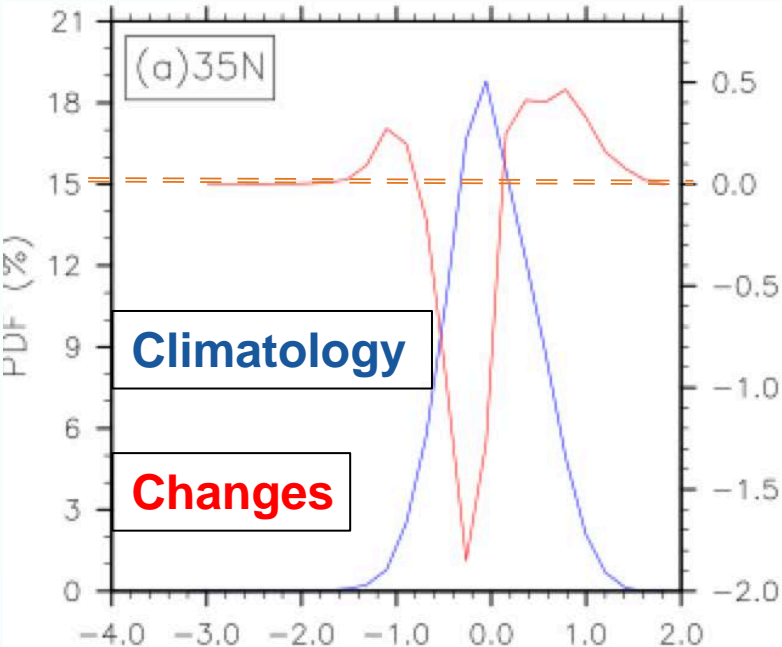
Freq of "clean" days (%)



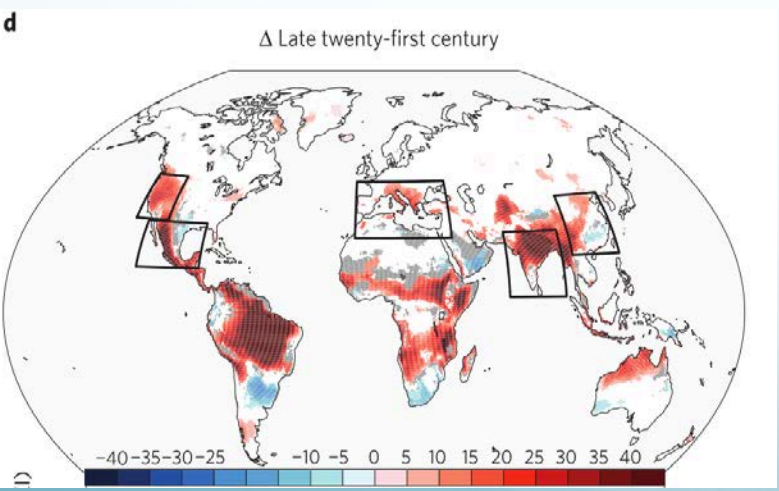
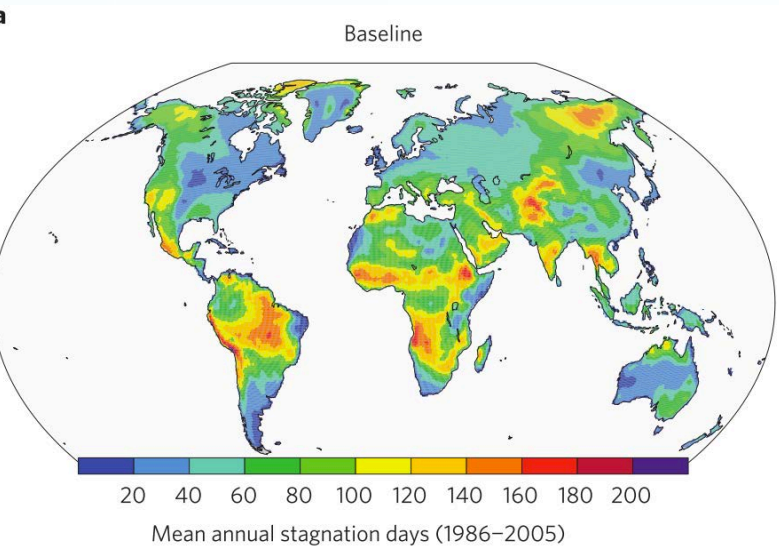
Changes (2100-2110)



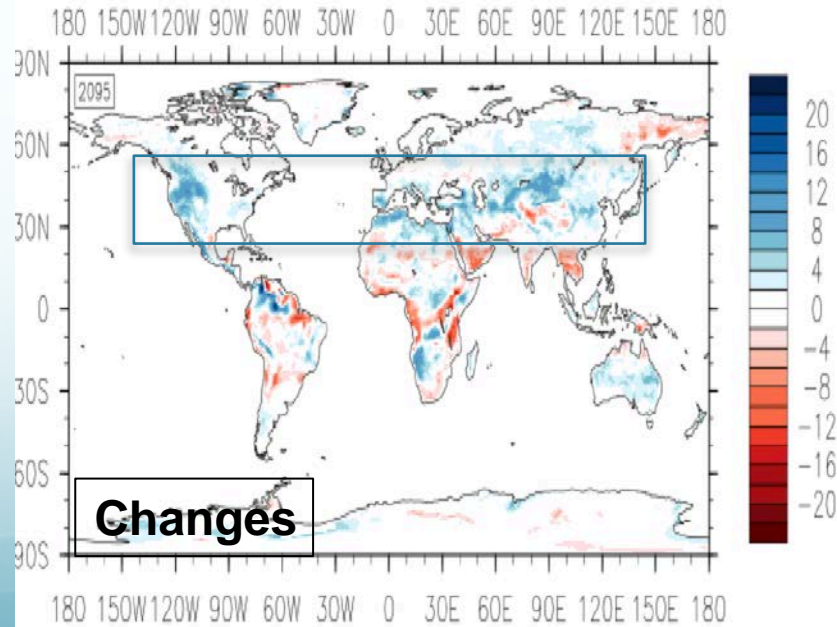
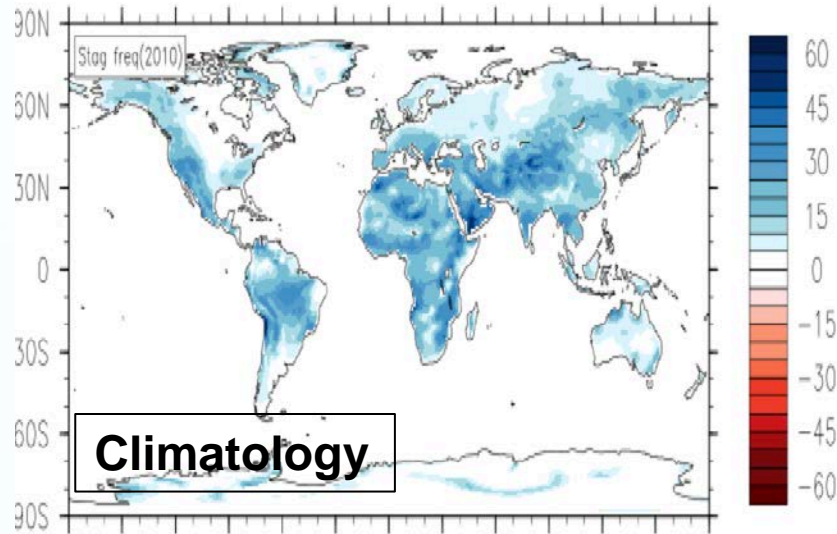
# Probability density function of daily SO4 surface concentration



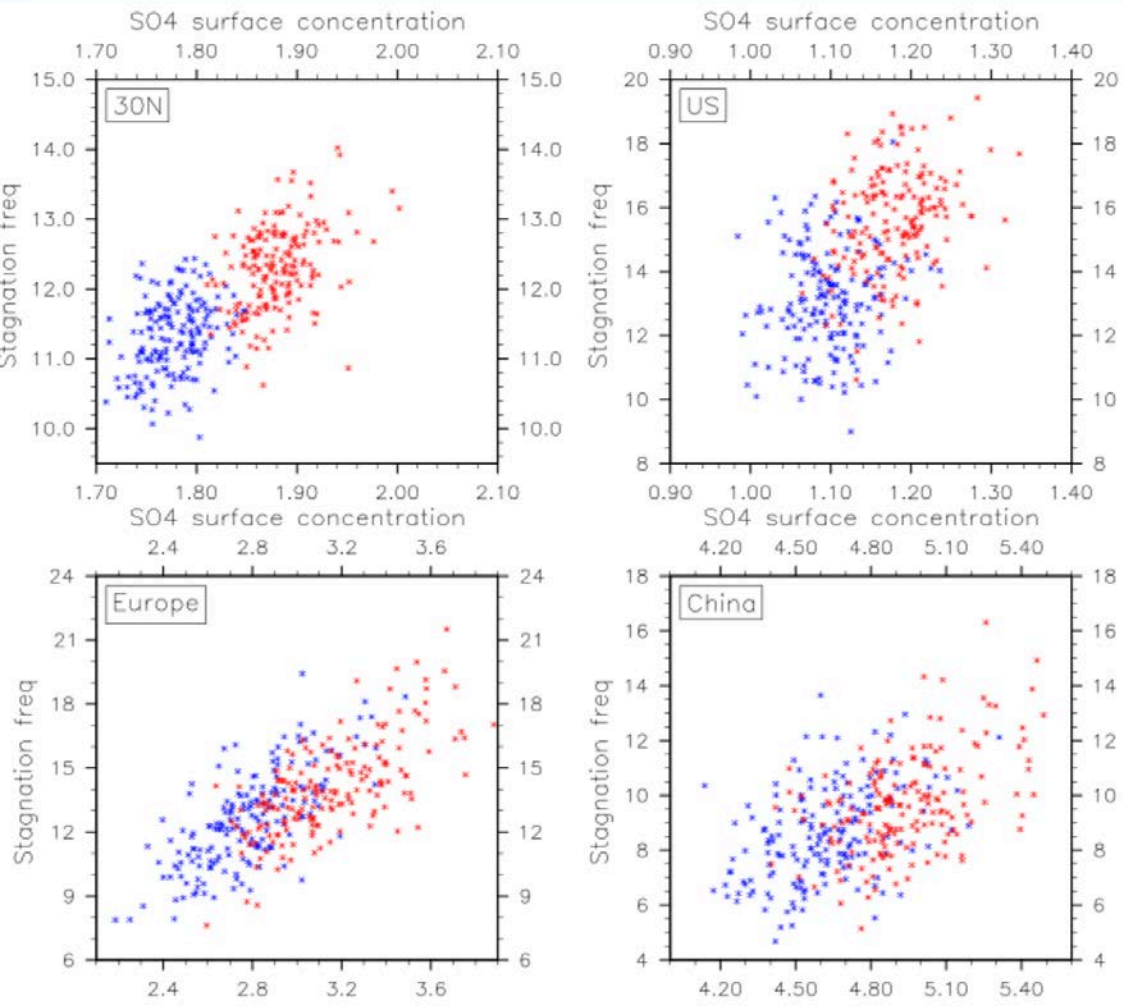
# Metrological drivers of the extreme pollution ?



Stagnation freq (%)

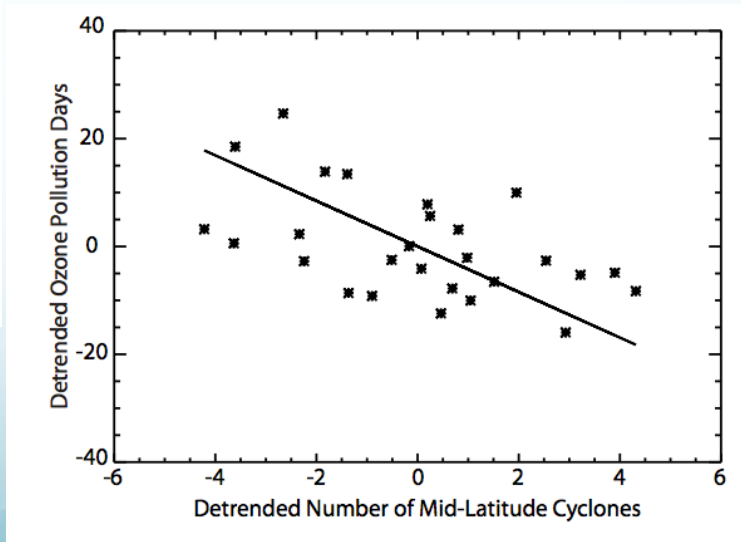


# Mid-latitude stagnation frequency => PM pollution



Present-day

End of Century



# Summary (part 2)

- Extreme pollution events become more frequent across NH mid-latitude regions under global warming conditions
- Occurrences of stagnation (cyclone) increase (decrease) as an additional contributor to the worsened pollution extremes

# Future Research

- Air pollution  $\Rightarrow$  Climate change
- Climate change  $\Rightarrow$  Air pollution
- Climate variability  $\Rightarrow$  Air pollution ?  
(Monsoon, ENSO, PDO)
- Utilizing CAM-CHEM as the modeling tool ?