南京信息工程大学
Nanjing University of Information Science & Technology

Aerosol trends in China during 1980–2019

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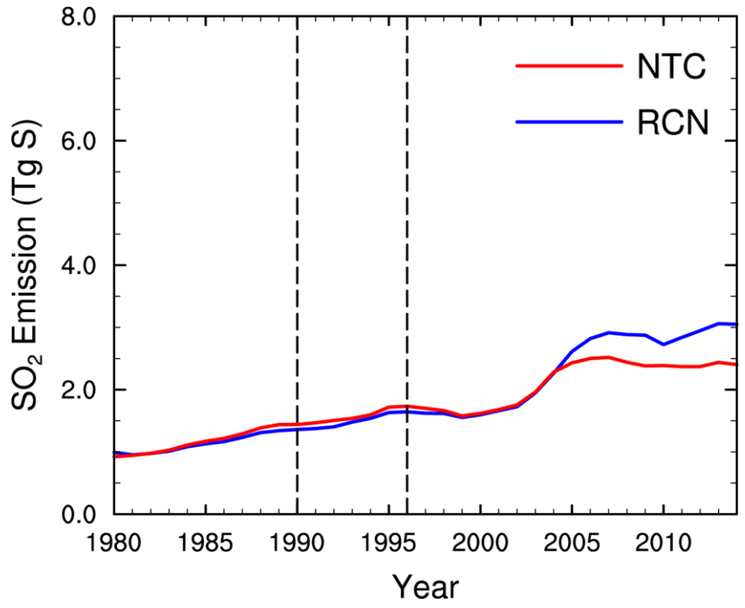
October 1, 2020

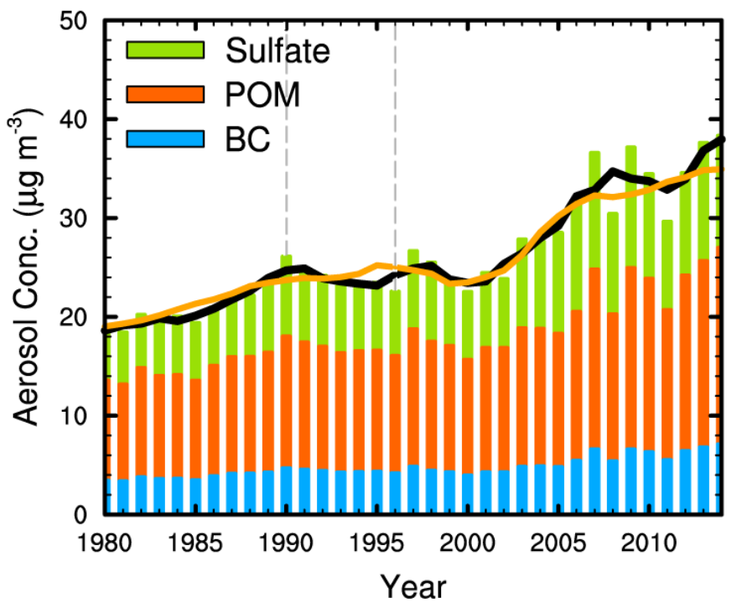
Modeled $PM_{2.5}$ variation in the North China Plain

SO_2 Emission in NCP



CMIP6 Emissions

Modeled $PM_{2.5}$ Conc.

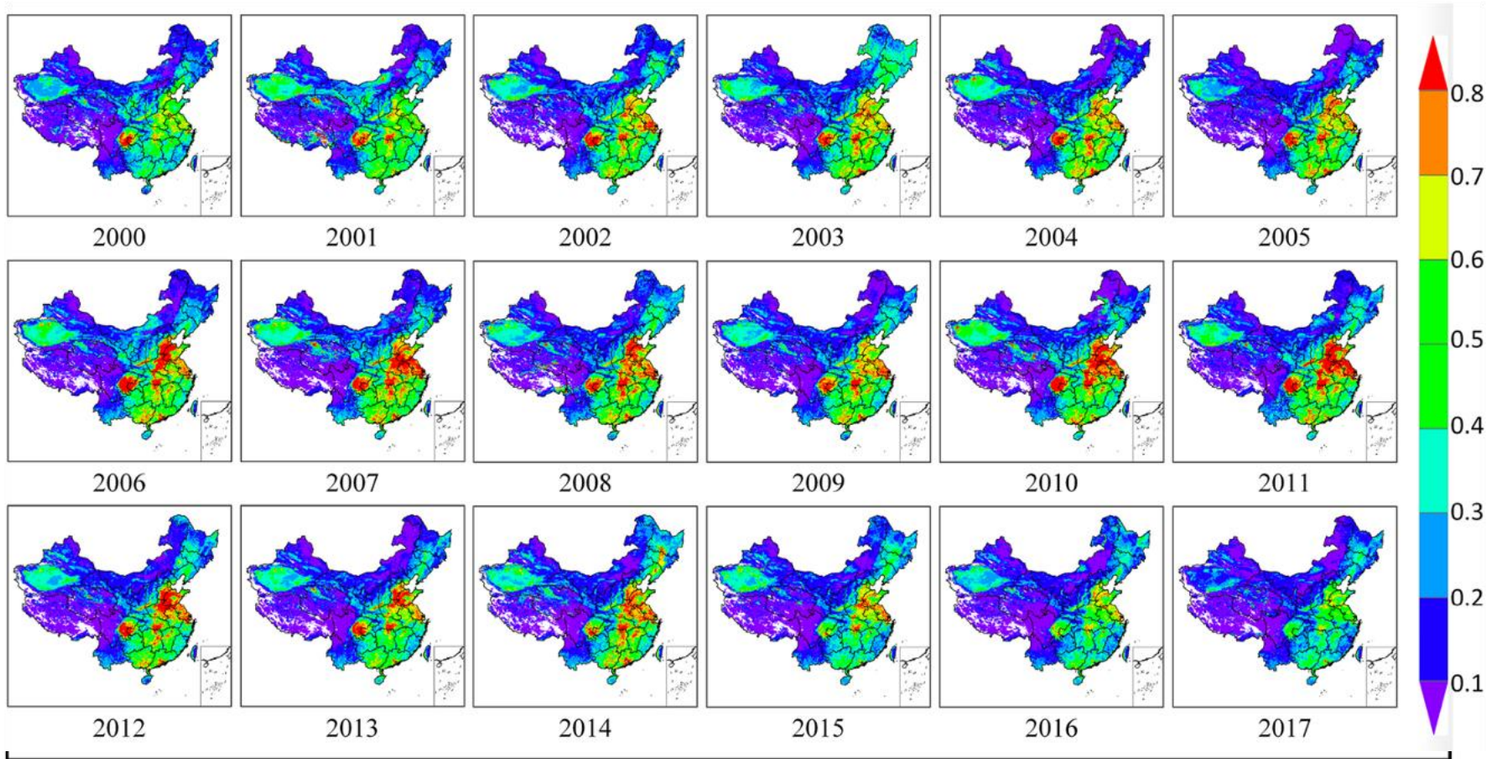


CAM5 Simulation

Yang, et al., SR (2018)

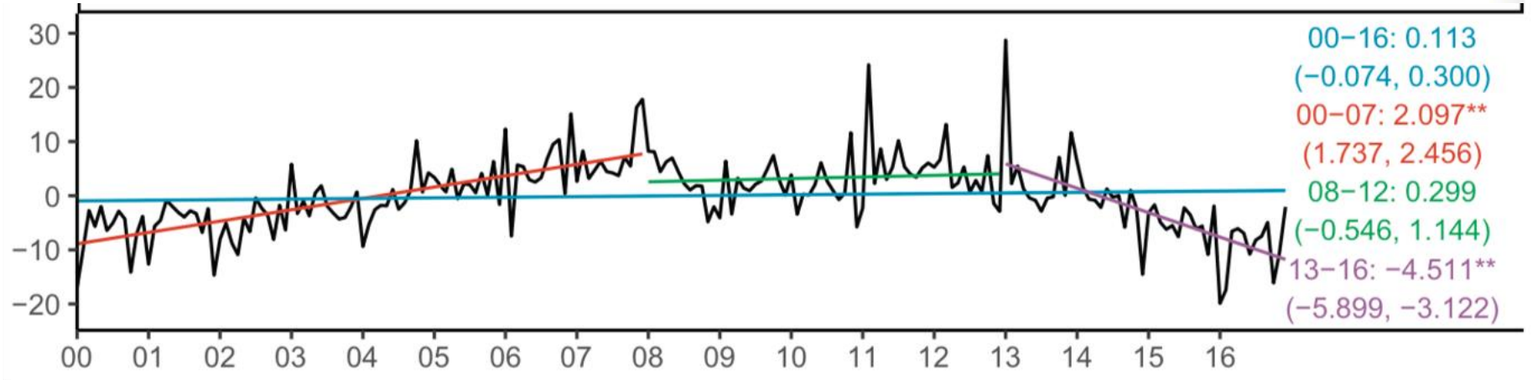
Variation in MODIS AOD in China during 2000–2017

MODIS AOD



Xie et al., AE (2019)

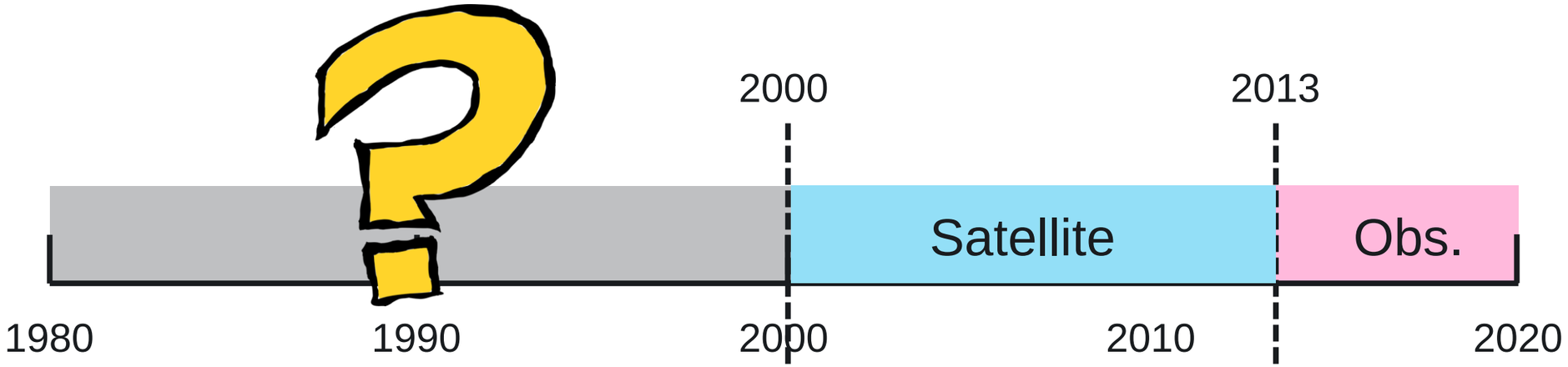
Estimated $PM_{2.5}$



Xue et al., EI (2019)

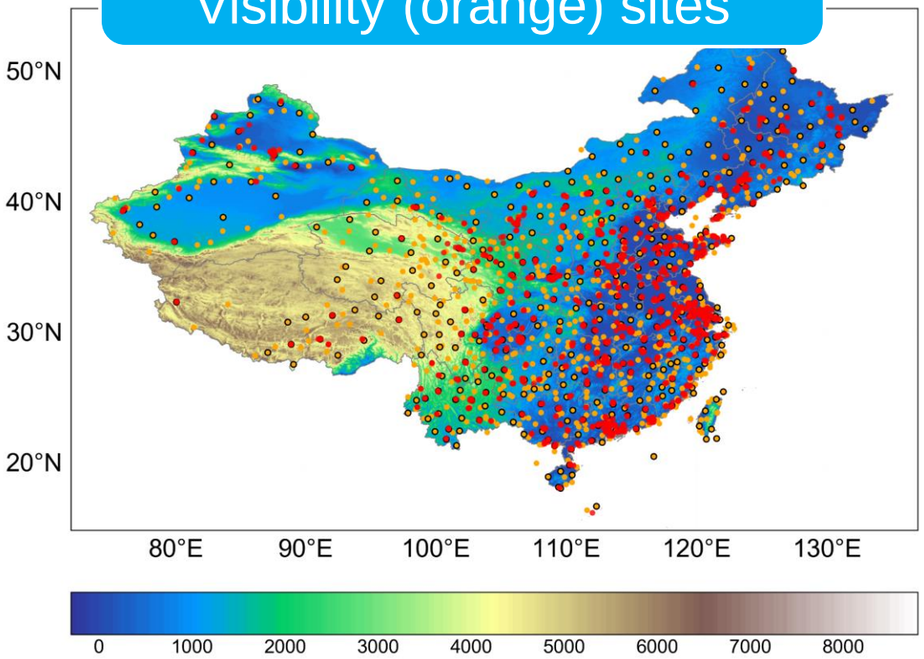
Lack of long-term $PM_{2.5}$ observation in China

- Model evaluation
- Interannual and decadal environmental and climate impacts related to aerosols

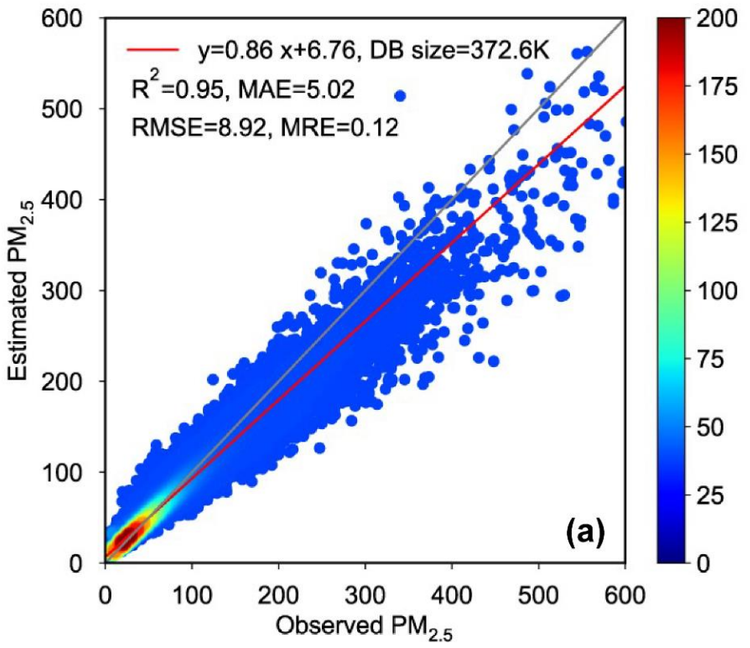


Constructing long-term $PM_{2.5}$ based on machine learning

$PM_{2.5}$ (red) and Visibility (orange) sites

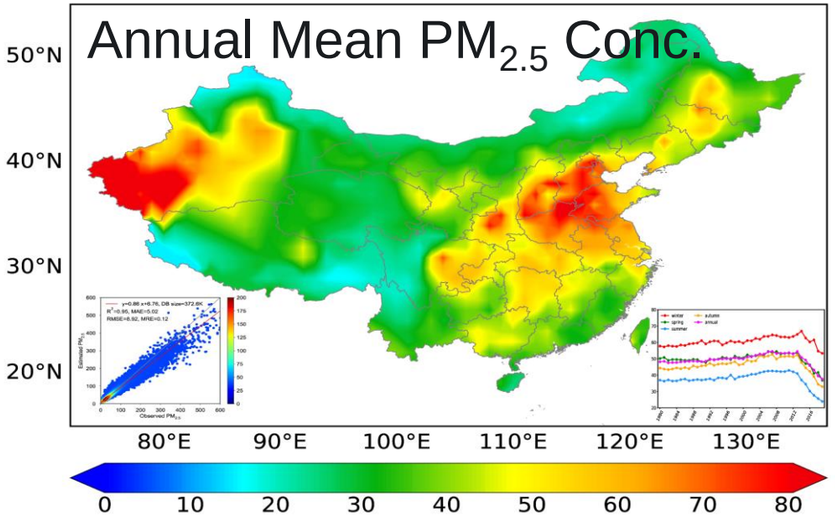


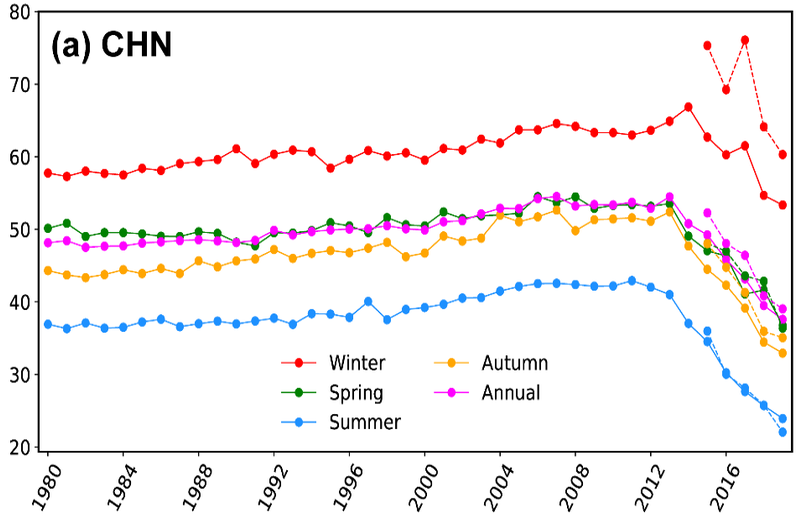
Model evaluation

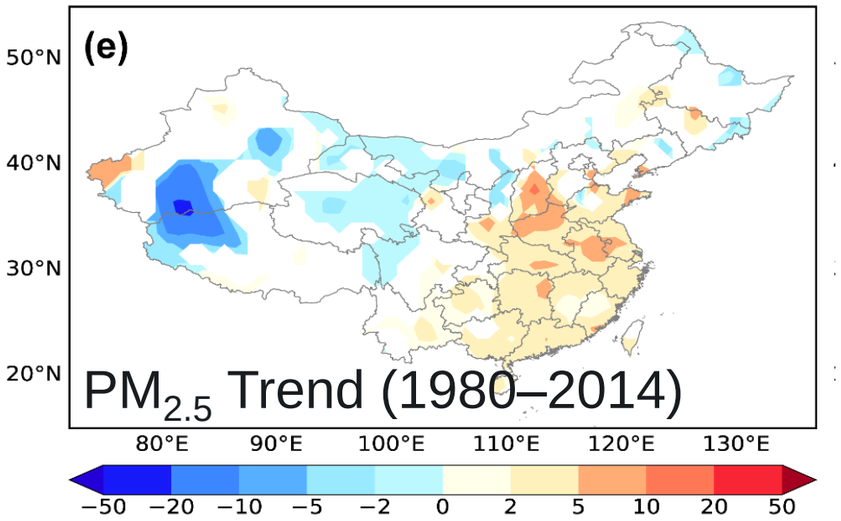


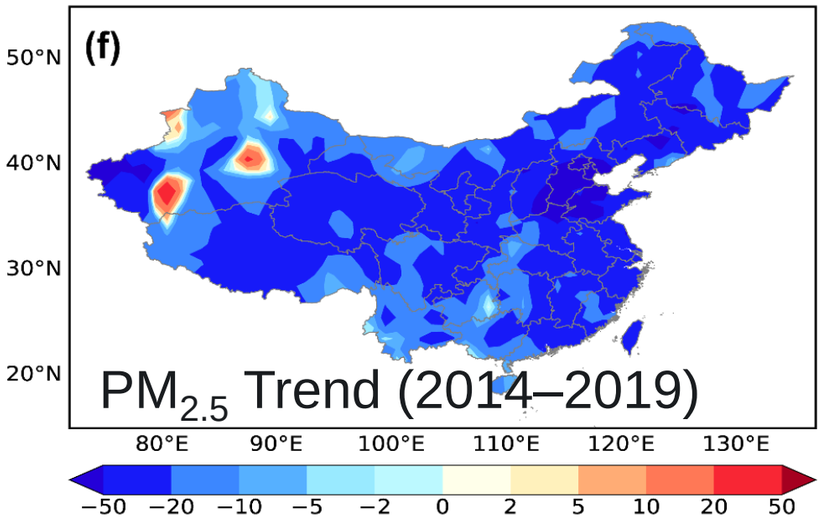
- ML Model: Space-time random forest model
- Datasets: $PM_{2.5}$ observation, atmospheric visibility, meteorology, land use, topography, anthropogenic emission, population

$PM_{2.5}$ decreased effectively after 2014 due to clean air actions









Li, Yang*, et al., ready to submit.

Thank You

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Impacts of domestic emissions and regional transport on aerosol concentration, radiative forcing and climate

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CAM5-EAST Model

NCAR CESM-CAM5

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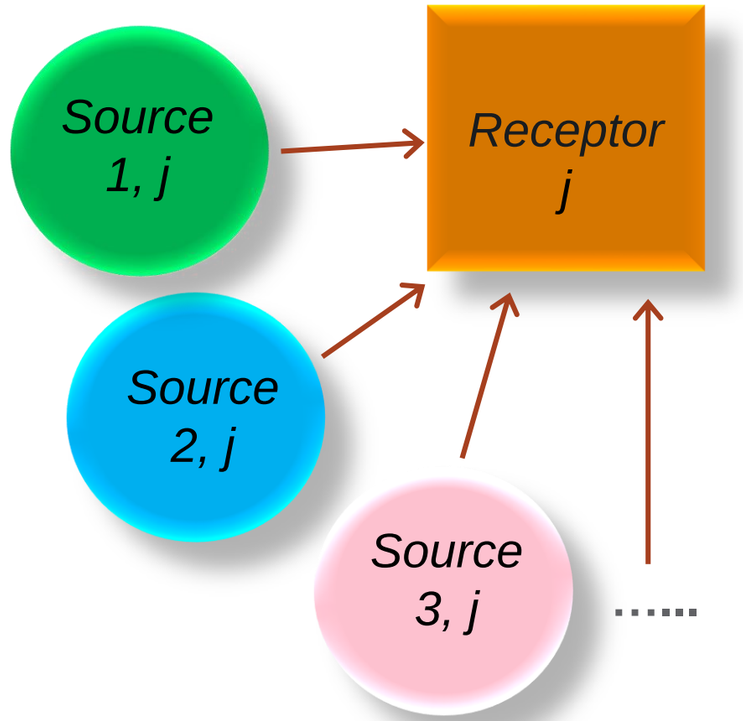
Explicit Aerosol Source Tagging:



Explicit Aerosol Source Tagging (EAST)

BC Tagging in CAM5.1

Wang et al. JGR (2014)

BC Tagging in CAM5.3

Yang et al. ACP (2017a)

Sulfate Tagging in CAM5.3

Yang et al. ACP (2017b) | Yang et al. JGR (2018)

CAM5-EAST (BC, POM, SOA, Sulfate) -> EAM-EAST / CAM6-EAST

Yang et al. Sci. Rep. (2018) | Yang et al. Earth's Future (2018) | Yang et al. ACP (2020) | Ren, Yang* et al. ACP (2020)

China **U.S.** **Europe** **Arctic**

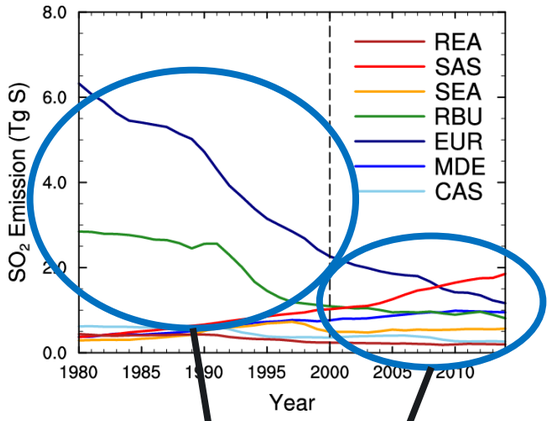
Slowdown of foreign emission reduction together with weakening winds intensify $PM_{2.5}$ by 25%

Δ: 2000-2014 vs. 1980-2000

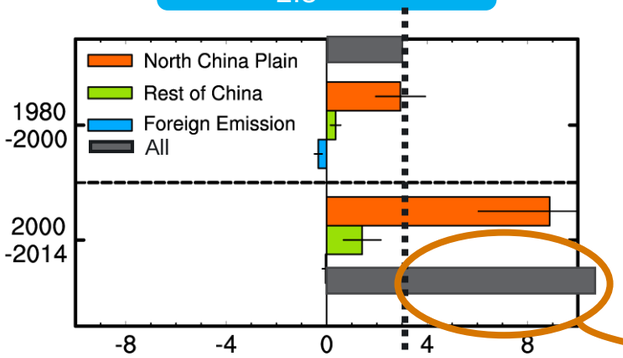
$$100\% = \frac{\Delta TR_{DOM}}{\Delta TR} + \frac{\Delta TR_{FOR}}{\Delta TR} + \frac{\Delta TR_{MET}}{\Delta TR}$$

75% 6% 19%

Foreign SO_2 Emission



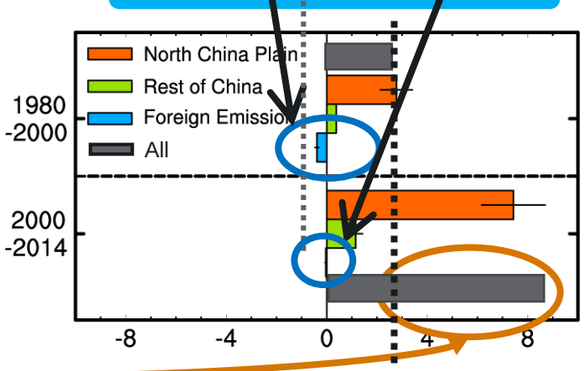
$PM_{2.5}$ Trend



$PM_{2.5}$ Contribution Trend
(μg m^{-3} $decade^{-1}$)

Remove meteorological influence

Normalized Trend



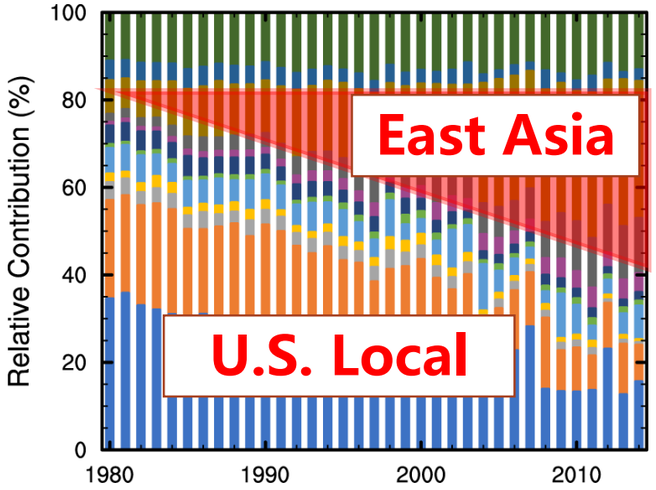
Trend of Normalized $PM_{2.5}$
(μg m^{-3} $decade^{-1}$)

China

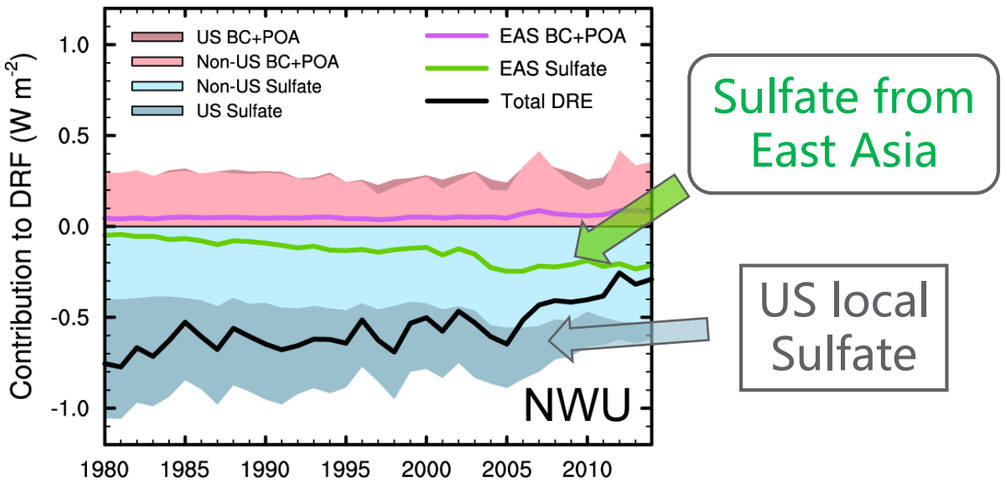
Yang, Y. et al., Sci. Rep. (2018)

Increases in emissions from E. Asia mitigated the warming effect induced by reductions in U.S. emissions by 25% in western US

Relative Contribution to $PM_{2.5}$ Column Burden in US (%)



Aerosol DRF in US

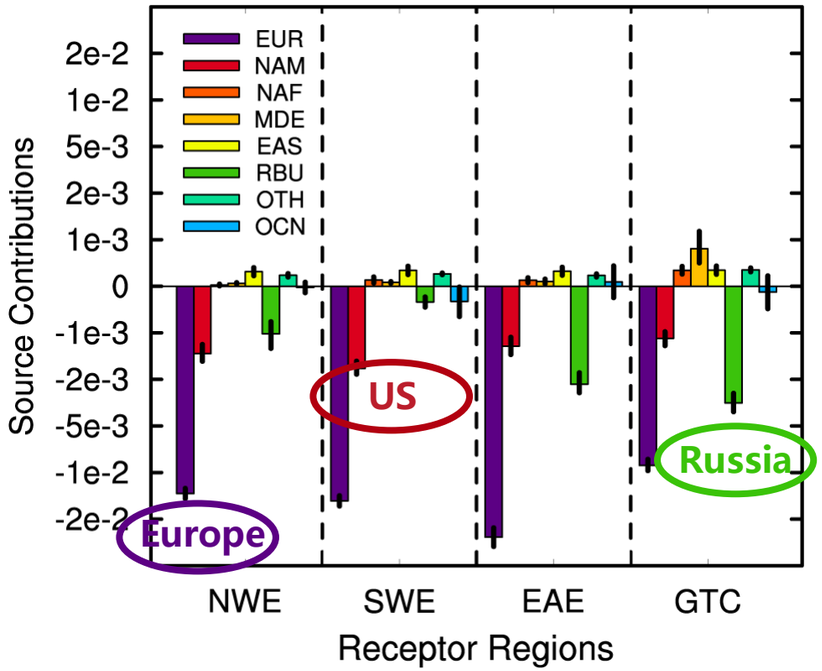


U.S.

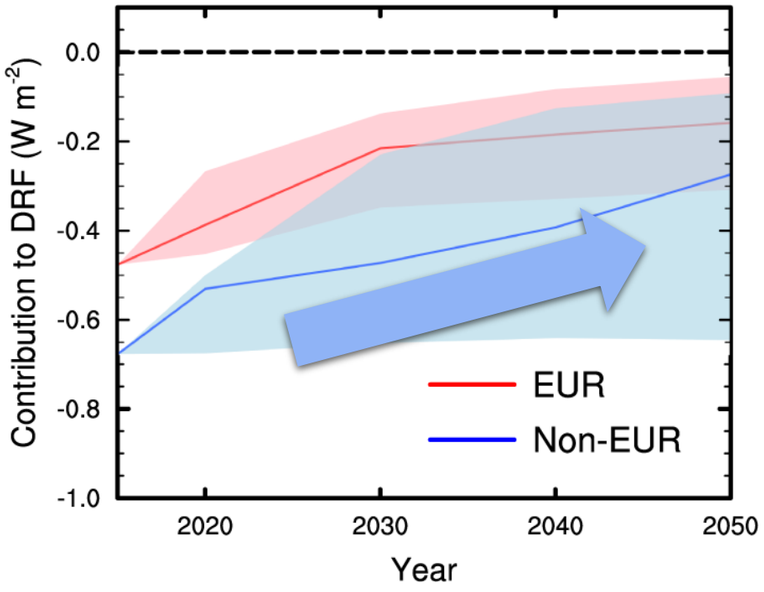
Yang, Y. et al., Earth's Future (2018)

Future changes in non-European emissions are as important as European emissions for causing possible regional climate change

AOD trends in Europe contributed by individual sources



Future sulfate DRF in Europe from local and non-local sources



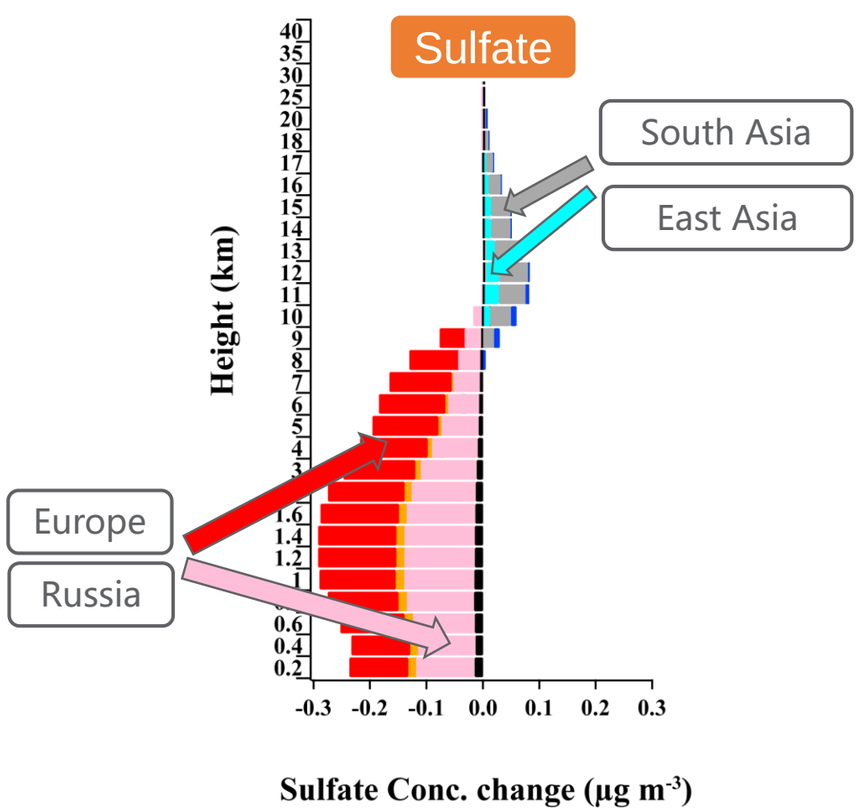
Non-EUR ≈ EUR

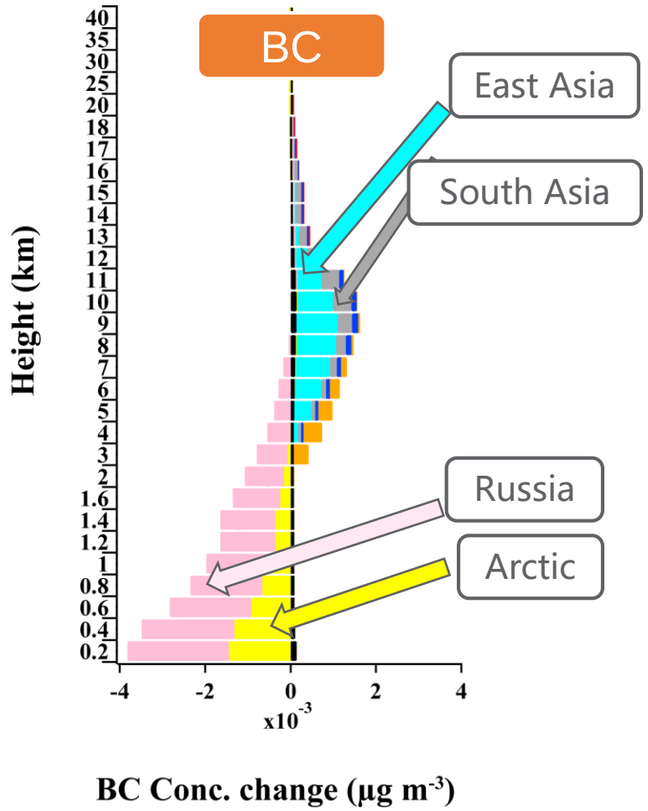
Europe

Yang, Y. et al., ACP (2020)

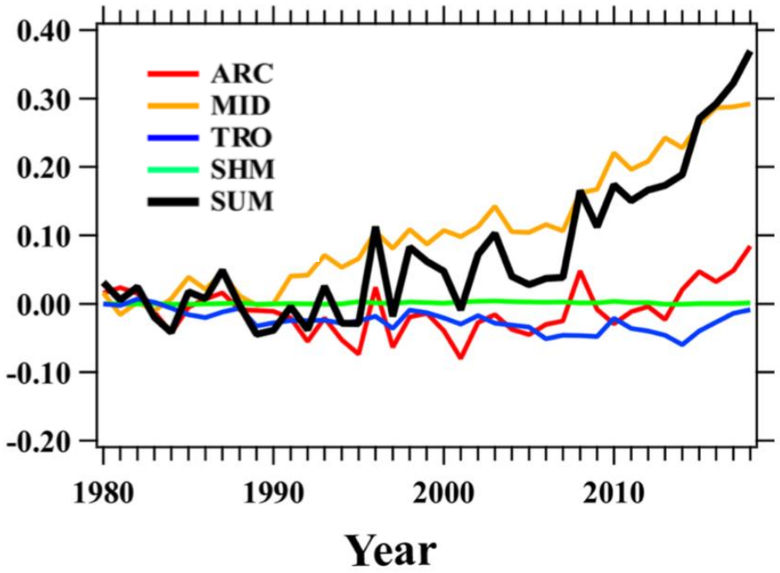
Sulfate and BC produced an Arctic surface warming of +0.30 K, explaining approximately 20 % of the observed Arctic warming since the early 1980s.

Aerosol vertical concentration change between 1980–1984 and 2014–2018 in the Arctic





Estimated response in surface temperatures to changes in sulfate and BC



Arctic

Ren, Yang*, et al., ACP (2020)