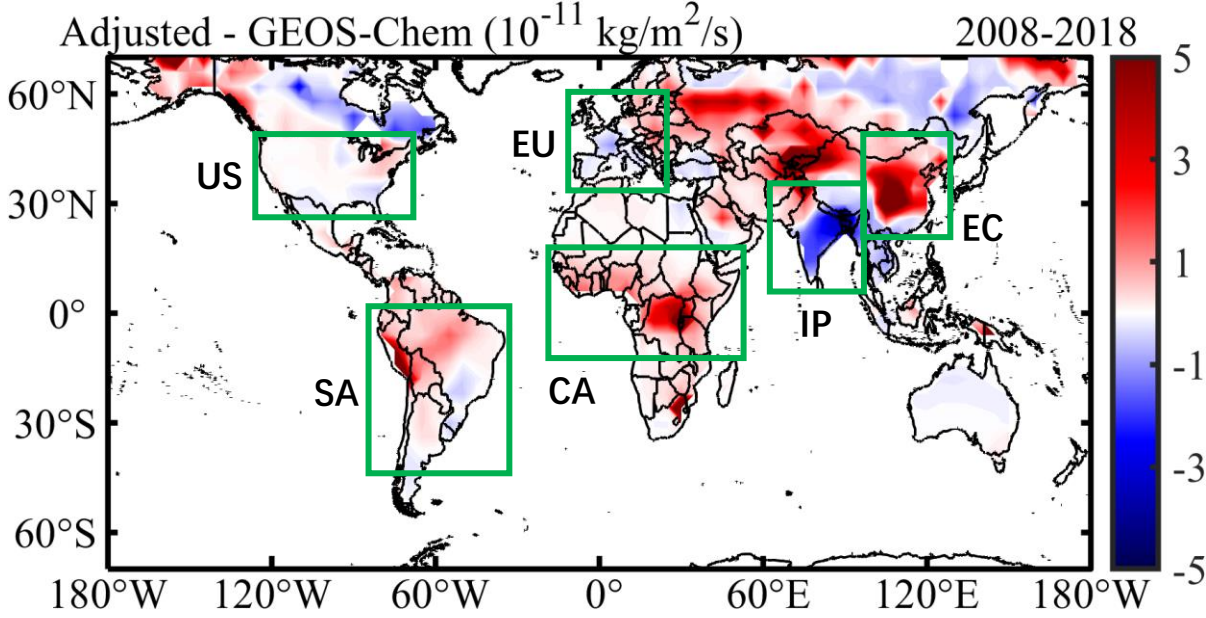
Ammonia emissions

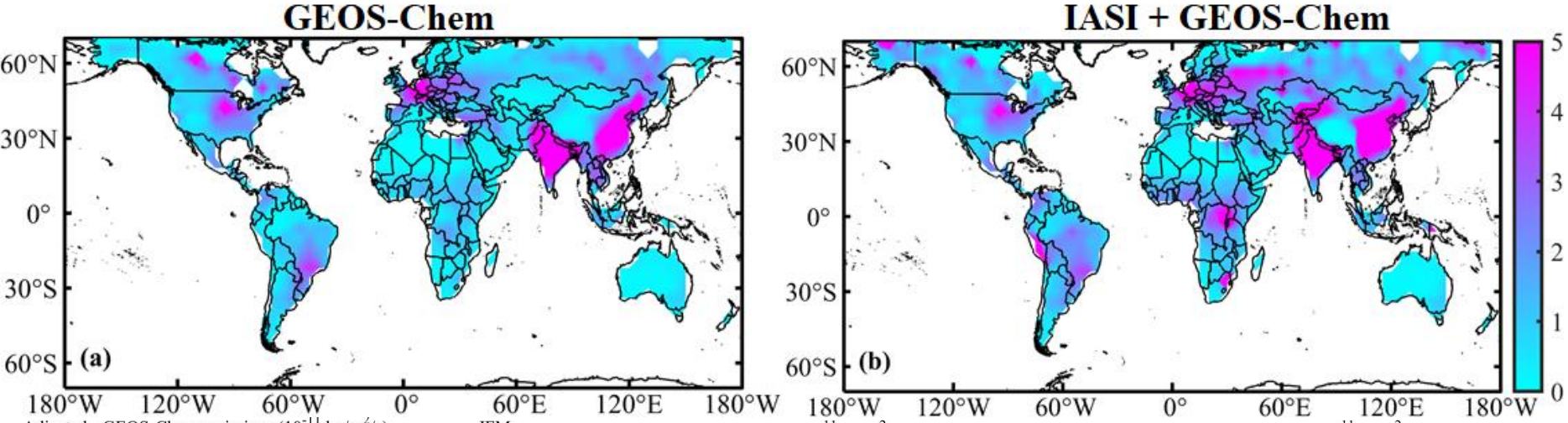
Zhenqi Luo 2021.3

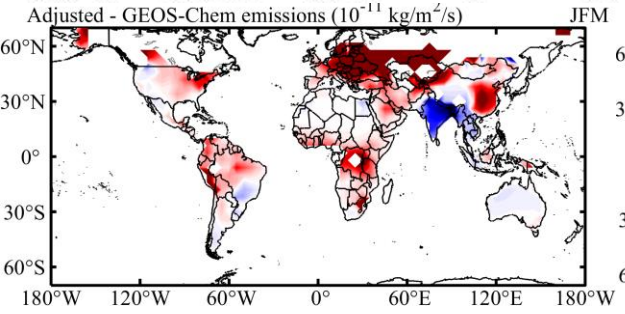
progress

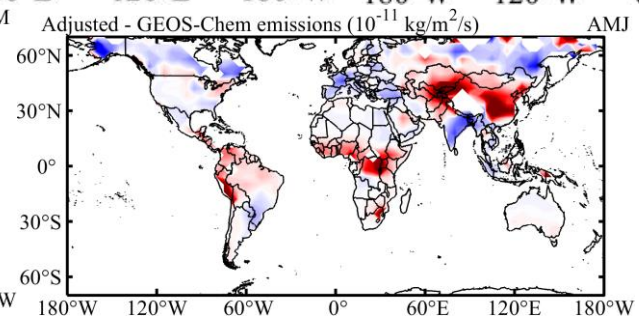
- 1. Difference of NH3 emissions——Adjusted vs GEOS-Chem
- 2. Regional details of NH3 emissions——fill the in adjusted by GEOS-Chem
  - Timeseries
  - Total

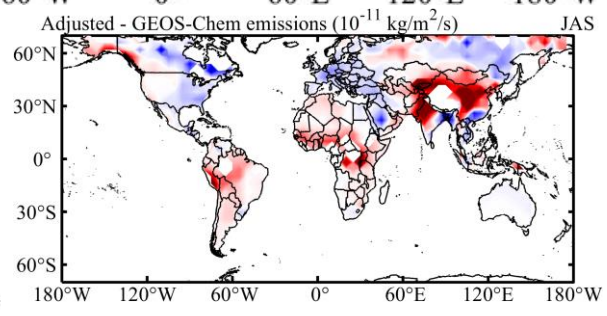
Difference of NH3 emission

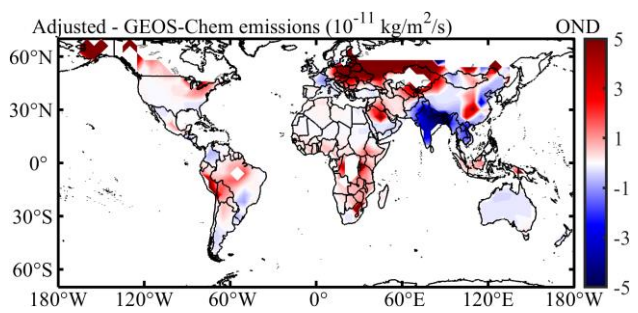




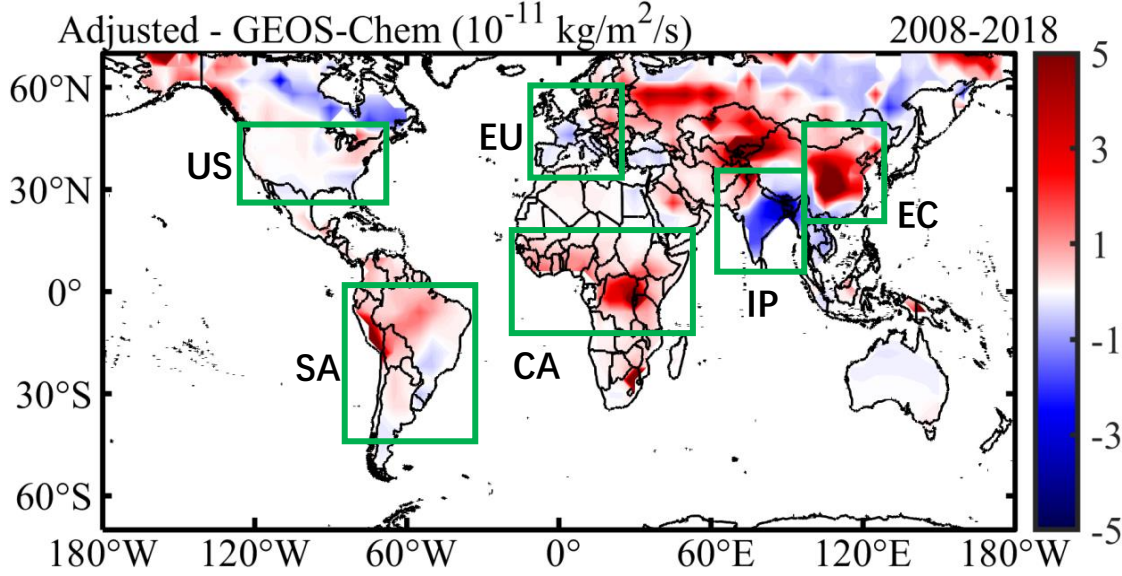


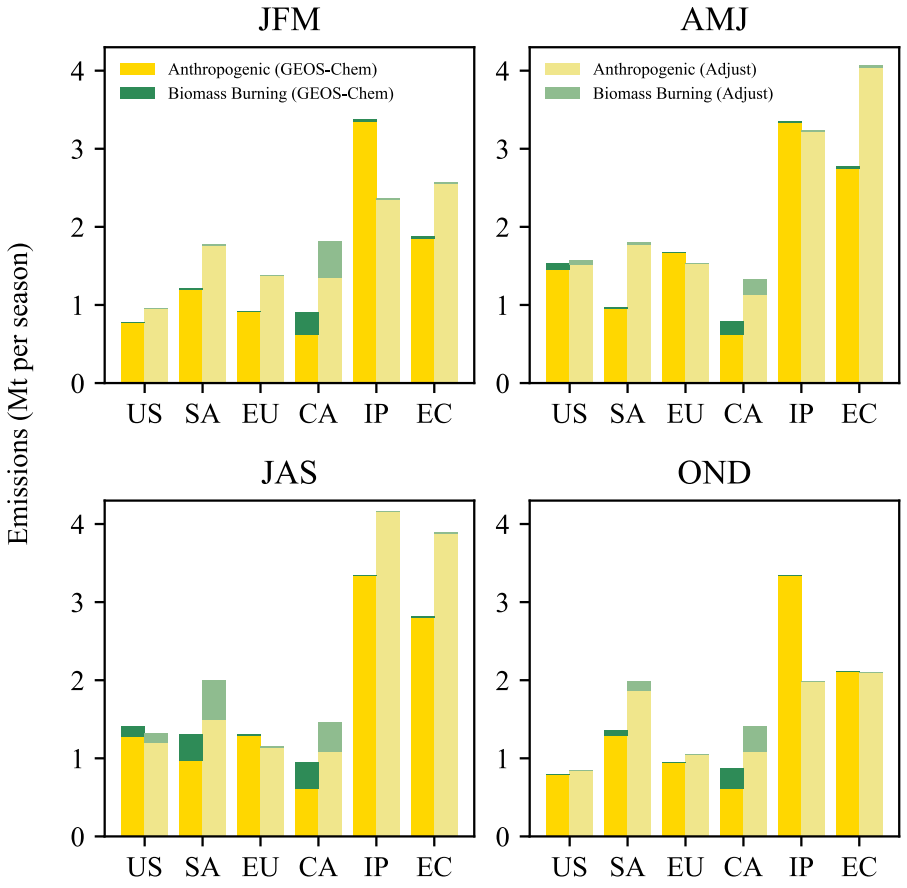


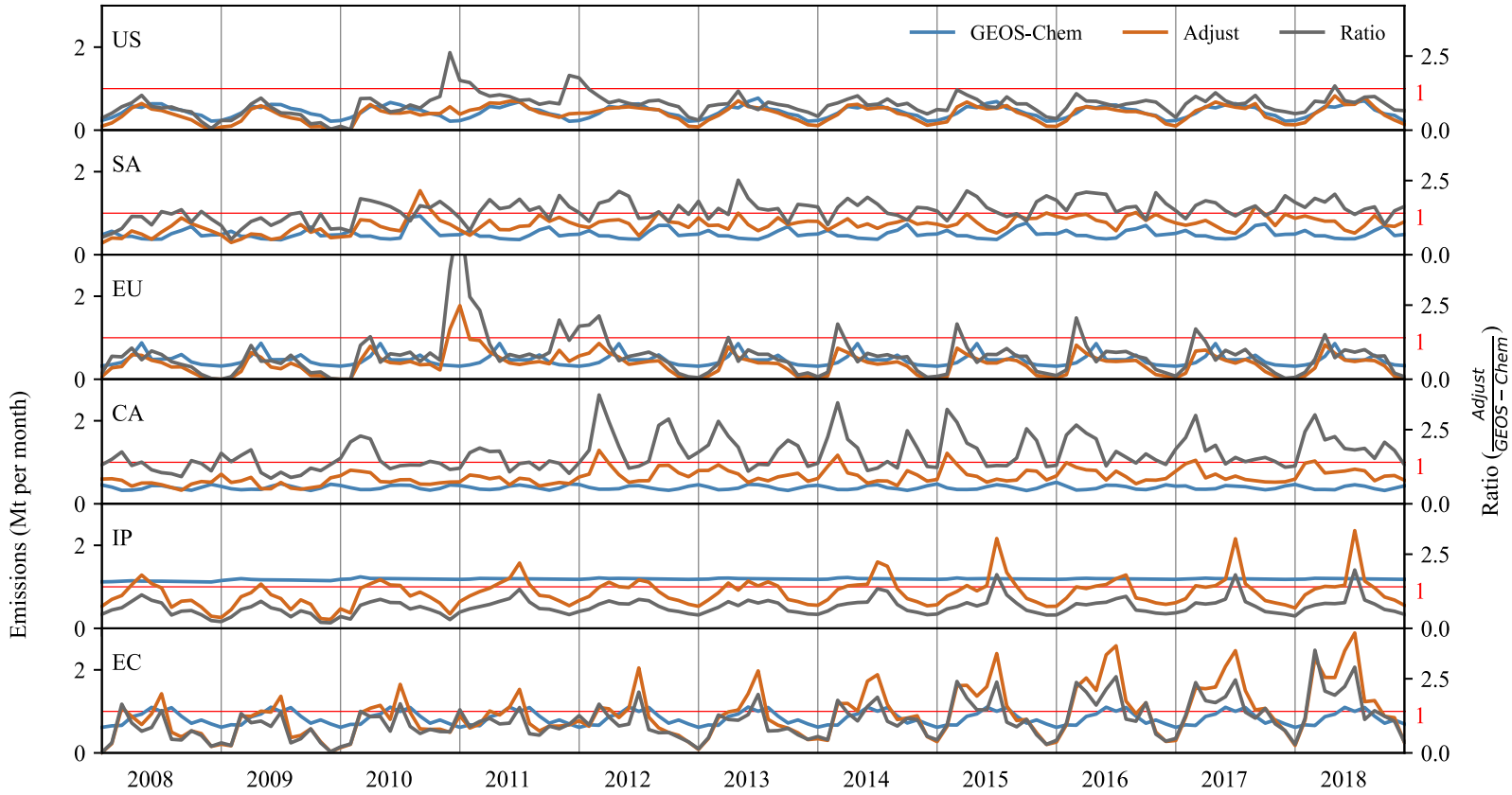




Regional NH3 emission







Analysis & Plan

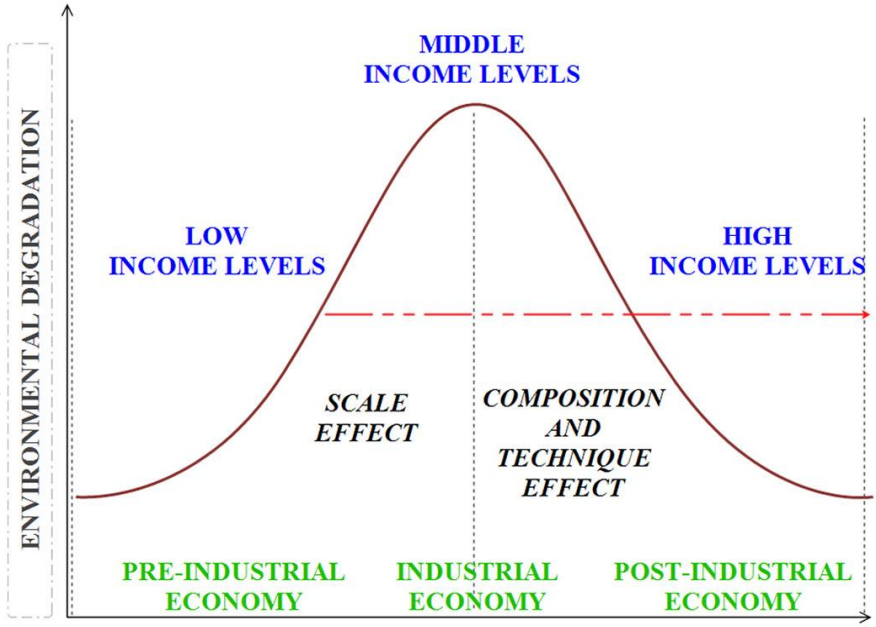
- Divide the anthropogenic emissions
  - Livestock
  - fertilizer
- Check the data quality
  - Ratio of grid amount
  - IASI data

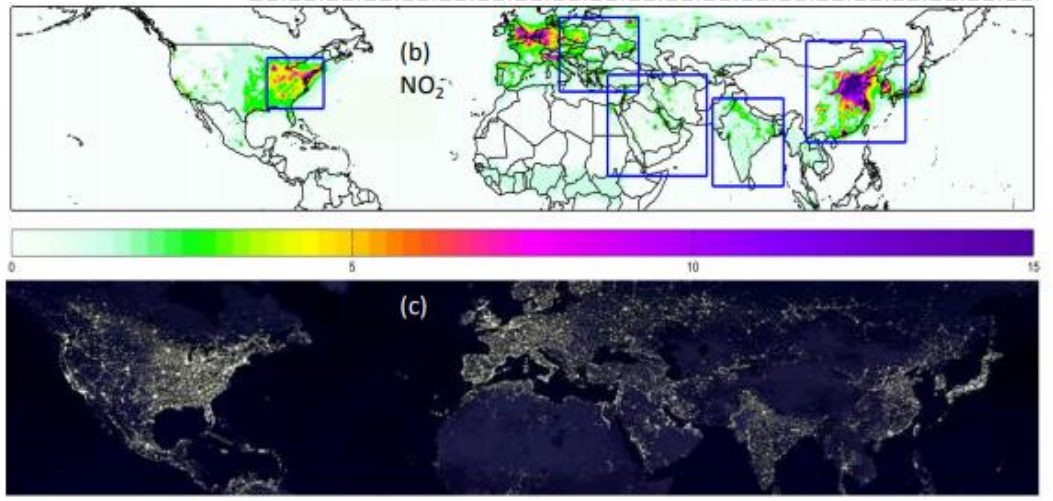
litreature

NO2 burden reductions over north equatorial Africa

- Socioeconomic development and population growth in low and middle-income countries
  - Increased environmental degradation——emissions
- NO2
  - Lifetime: < 1 day
    - total column densities and surface emissions are highly correlated
  - Toxic
    - premature mortality
    - asthma
  - Sources
    - fossil fuel combustion
    - anthropogenic alterations to soils
    - livestock management
- Africa
  - fossil fuel combustion (increase)
  - fire-prone savanna ecosystems——70% of the global (decline):
    - anthropogenic suppression

(Sarkodie et al., 2019)

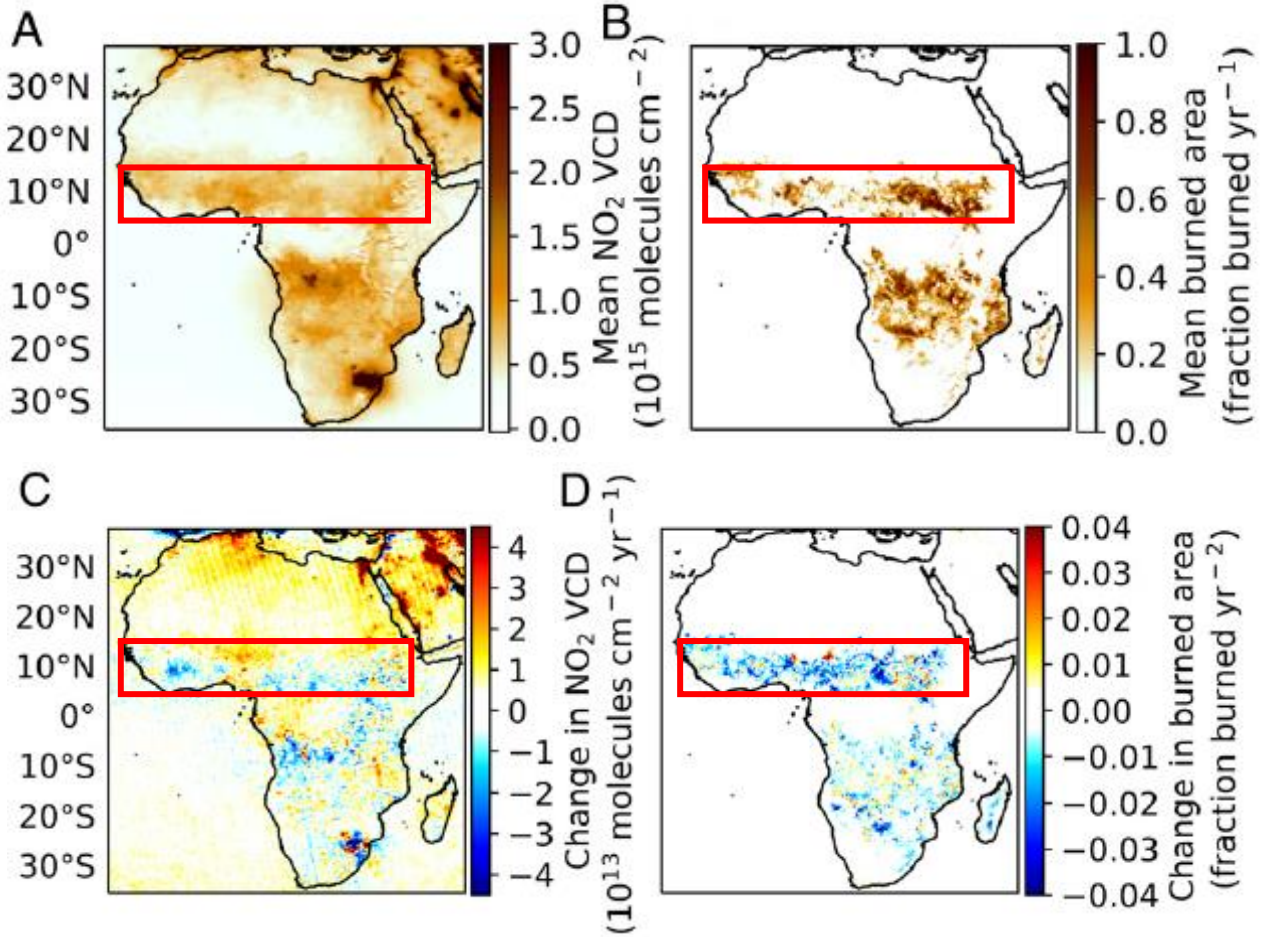




(Krotkov et al., 2016)

NO2 burden reductions over north equatorial Africa

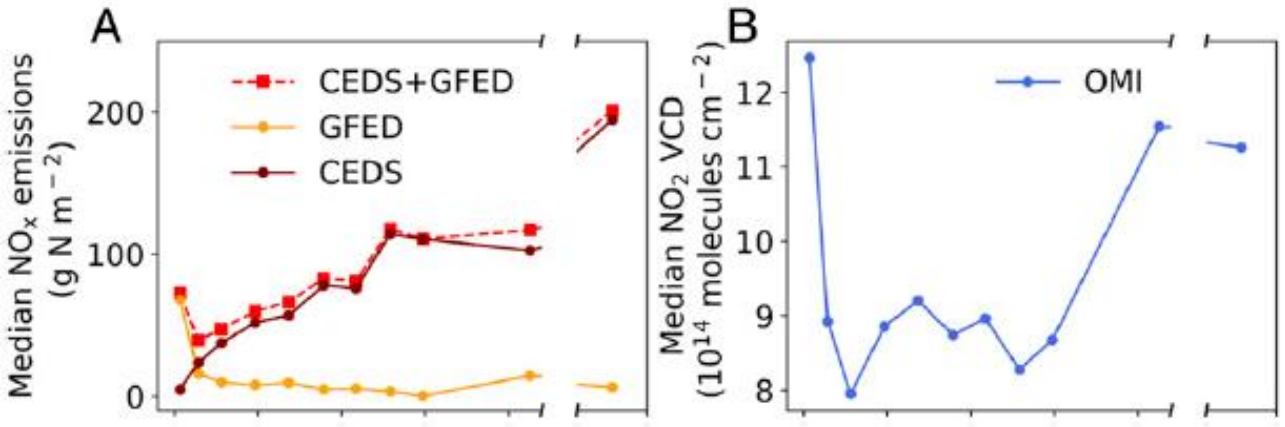
- Data
  - NO2: OMI
    - cloud cover < 30%
    - solar zenith angle < 80
    - terrain reflectivity < 0.3
    - free from error flags
    - include negative
  - CO: IASI (morning observation)
    - cloud cover < 10%
  - NH3: IASI (morning observation)
    - cloud cover < 25%
  - Burned area: MODIS
    - proportion: 1/3
  - Precipitation: TRMM
  - Emission:
    - biomass burning: GFED4s
    - Fossil fuel: CEDS
- Annual burned area and tropospheric NO2
  - mean: high level
  - trend: negative

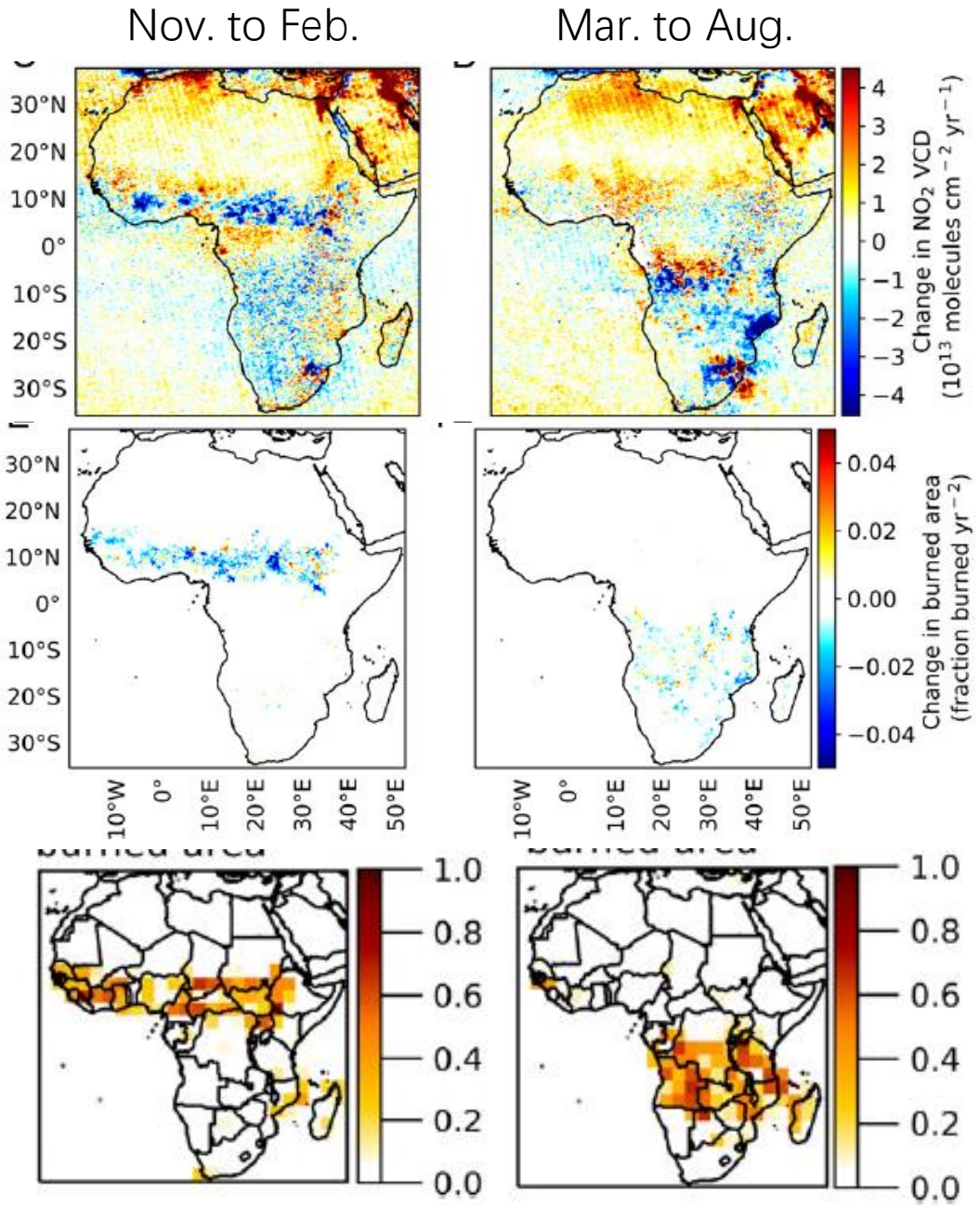


(E. Hickmane et al., 2021)

NO2 burden reductions over north equatorial Africa

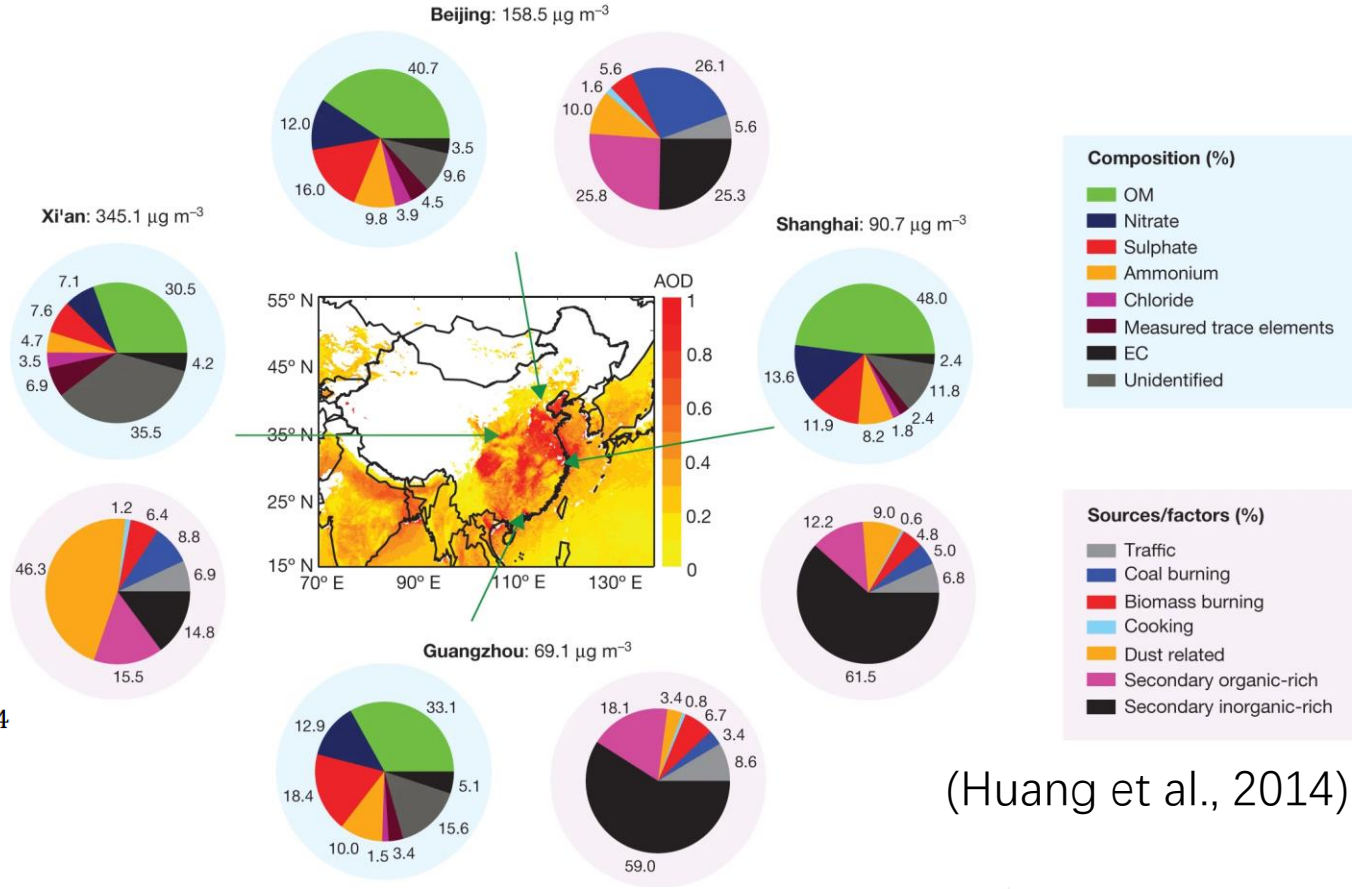
- Annual burned area and tropospheric NO2
  - decline: Nov. to Feb. (biomass burning season)
  - close spatiotemporal correspondence
- GDP density increase:
  - fossil fuel emissions: increase (E. Hickmane et al., 2021)
  - biomass burning emissions: decrease
    - play a more important role——inverted N



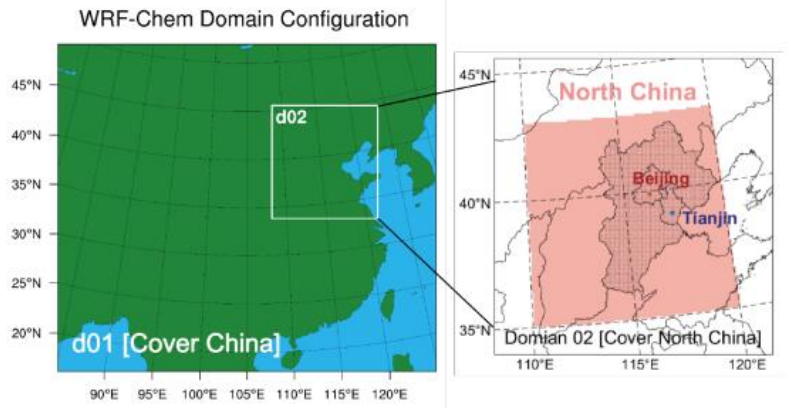


PM2.5 pollution to ammonia emission reductions in North China

- the North China Plain
  - severe PM2.5 air pollution
  - emission control measures——fuel combustion
    - SO2
    - NOx (NO + NO2)
    - primary aerosols
- Secondary inorgan
  - $2NH_3 + H_2SO_4 == (NH_4)_2SO_4$
  - $NH_3 + HNO_3 == NH_4NO_3$
- Model simulations
  - base: the 2015 emission conditions
  - S1RN (N = 20/40/60/100): reduce NH3 emissions
  - S2RN (N = 20/40/60/100): reduce NOX by 8% and SO2 by 40%
  - S3RN (N = 20/40/60/100): further reduce NOX by 20%



(Huang et al., 2014)

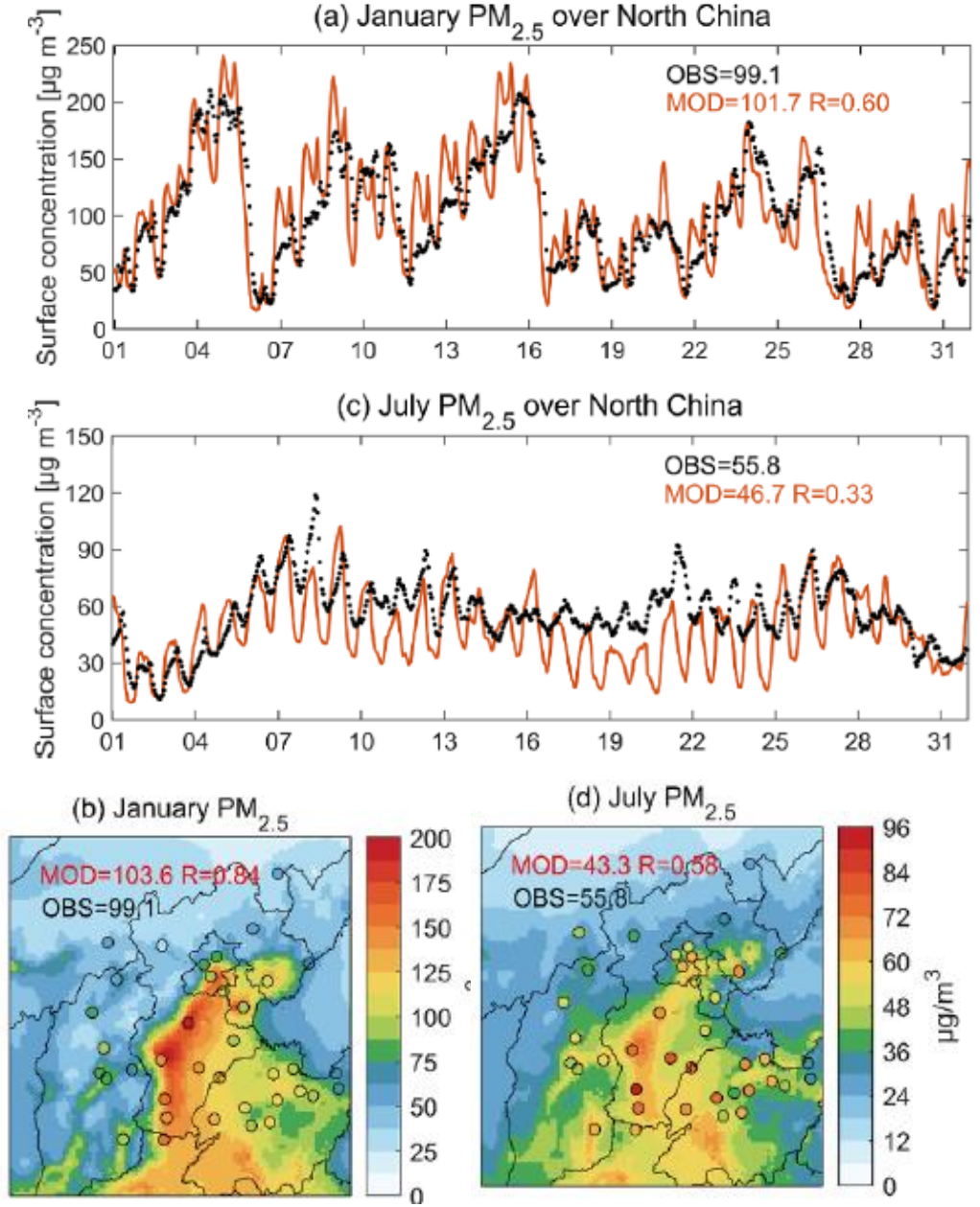


(Liu et al., 2021)

PM2.5 pollution to ammonia emission reductions in North China

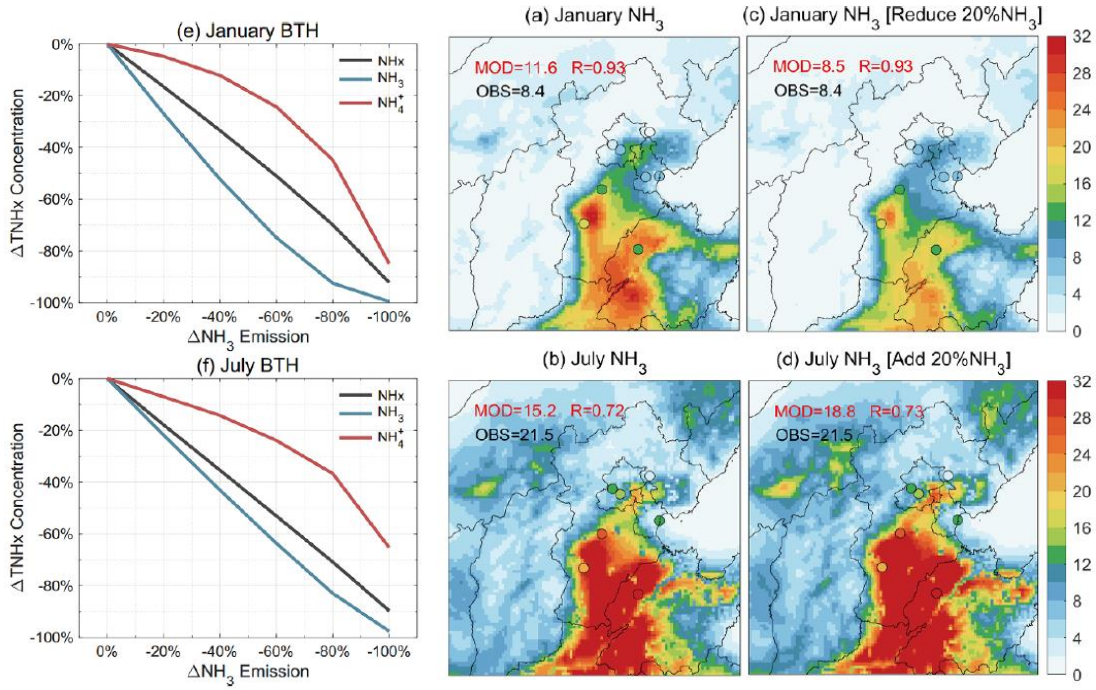
- The WRF-Chem model——WRF+Chemistry
  - mechanism: the gas-phase Carbon-Bond Mechanism Z
  - physical settings: Morrison double-moment microphysics scheme et al.
  - emissions:
    - anthropogenic: MEIC, agricultural NH3 from updated statistics for the year 2015
    - biogenic: Model of Emissions of Gases and Aerosols from Nature
    - biomass burning: Fire Inventory from the NCAR
- Meteorology:
  - 10 m wind direction
  - 10 m wind speed
  - 2 m air temperature
  - 2 m relative humidity
- Surface measurements
  - surface PM2.5
  - NH3 concentrations: Ammonia Monitoring Network in China
- Observed and simulated surface pollutant concentrations
  - PM2.5: in good agreement

(Liu et al., 2021)

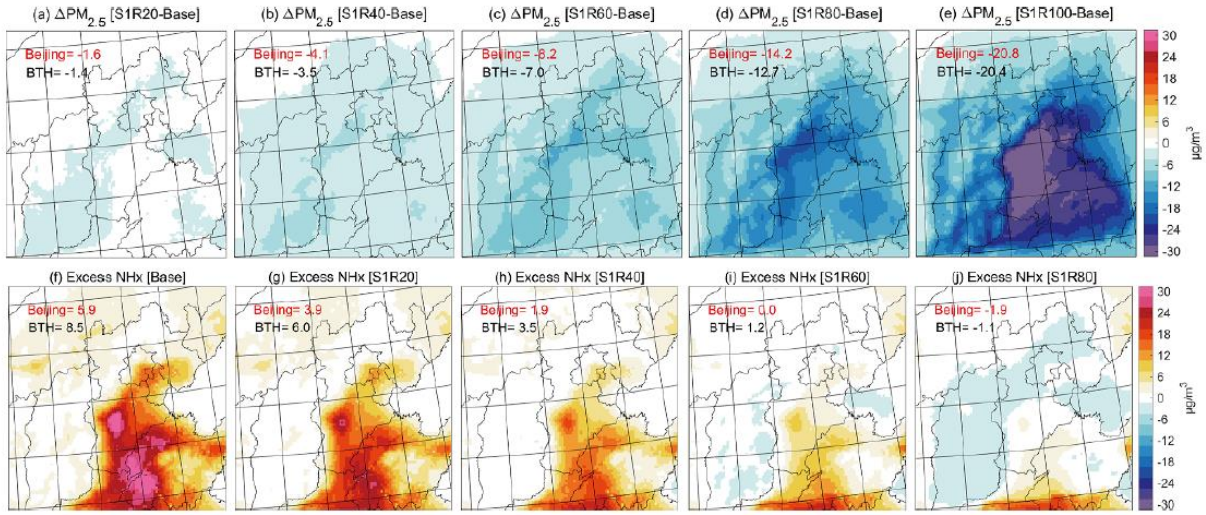


PM2.5 pollution to ammonia emission reductions in North China

- Observed and simulated surface pollutant concentrations
  - NH3 concentrations: biased high by 30%+
  - decrease/increase anthropogenic NH3 emissions by 20%
  - the effect of NH3 emission changes on surface concentrations: NHx = NH3 + NH4+
- Response of PM2.5 pollution to NH3 emission reductions
  - changes in surface PM2.5:
    - more distinct with stronger NH3 emission reductions
    - highly saturated in the southern Hebei province

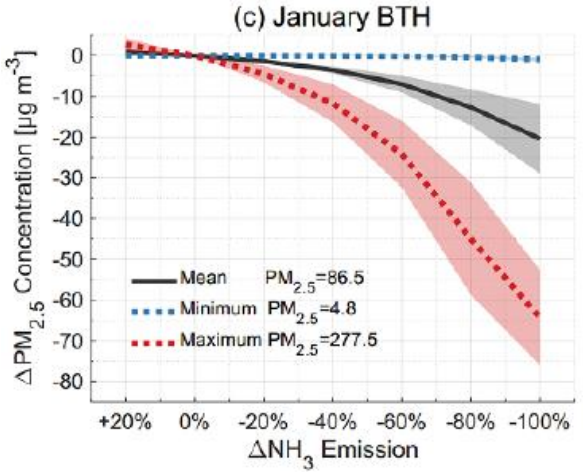


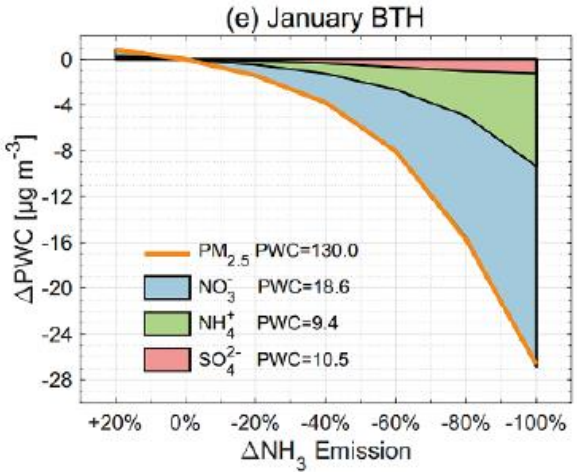
(Liu et al., 2021)

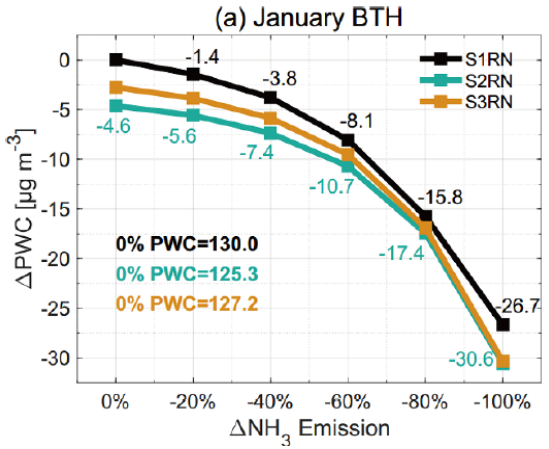


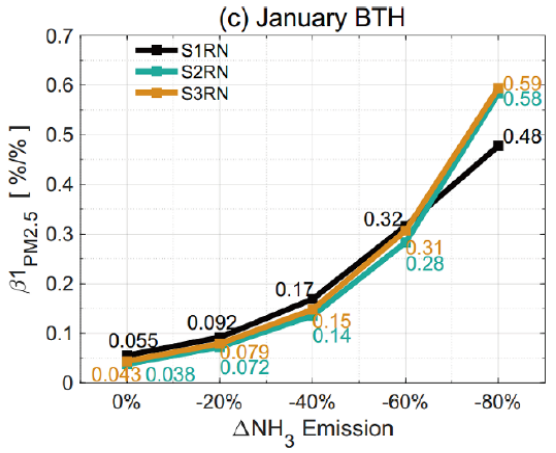
PM2.5 pollution to ammonia emission reductions in North China

- Response of PM2.5 pollution to NH3 emission reductions
  - changes in surface PM2.5:
    - a power exponential function
- Effects of NOx and SO2 emission changes
  - the changes in BTH PWC
  - the changes in BTH β1 efficiency
    - high NH3 emission: decrease
    - low NH3 emission: increase









$$\beta_1 = \frac{\Delta PWC}{PWC} / \frac{\Delta E}{E}$$

(Liu et al., 2021)

Questions?