Top-down ammonia (NH3) emissions estimation, 2008 to 2018

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NH3 Background

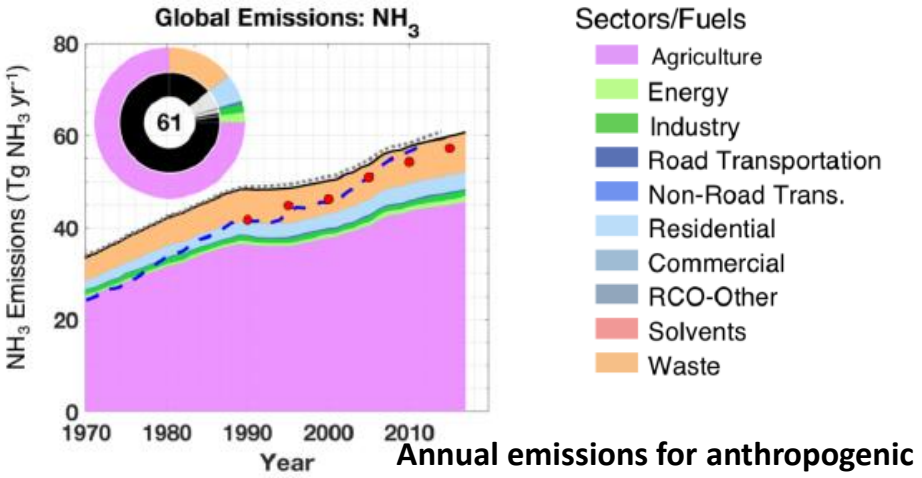
- Implications
  - **Air quality: formation of particulate** matter
    - mortality
  - Ecosystem
    - acidification
    - eutrophication
  - Climate change: aerosol indirect effects
    - cooling

Air pollution linked mortality
(Lelieveld et al., 2015, Nature)

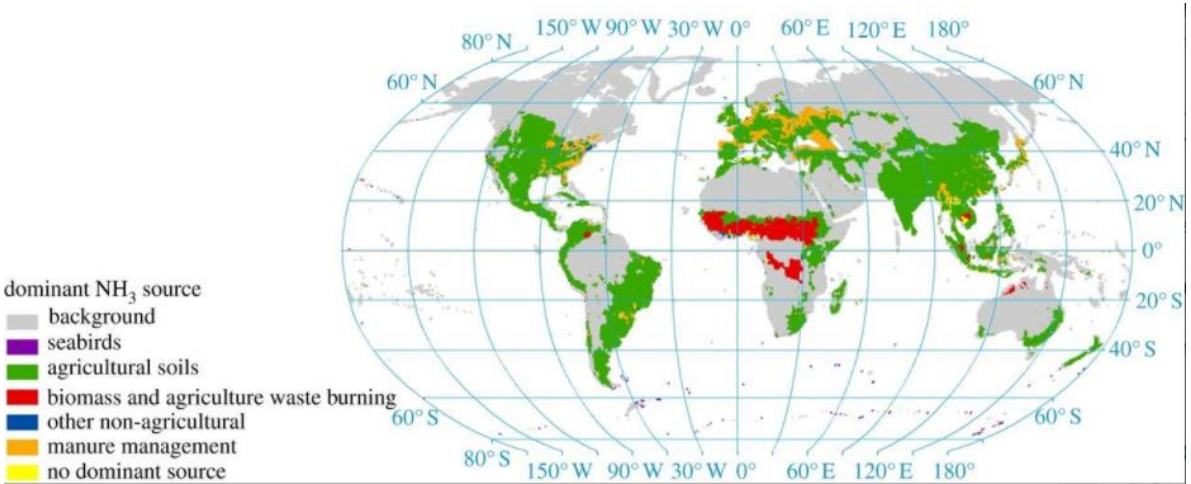
Radiative forcing
(Shindell et al., 2009, Science)

NH3 Background

- Emission sources
  - Anthropogenic
    - agriculture: majority (86%, 49 Tg, EDGARv5.0)
    - waste
    - residential
  - Natural
    - biomass burning (9%, 5 Tg, GFEDv4.1)
    - oceans and soils
    - wild animals



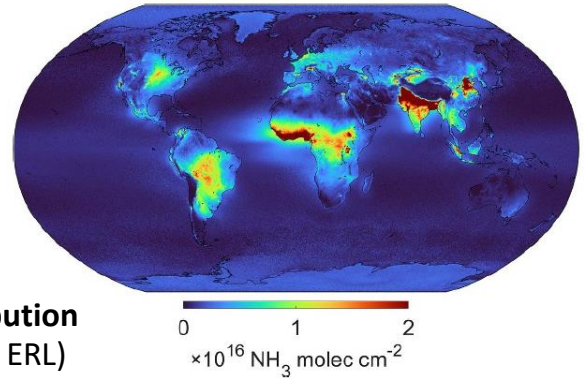
Annual emissions for anthropogenic
(McDuffie et al., 2020, ESSD)



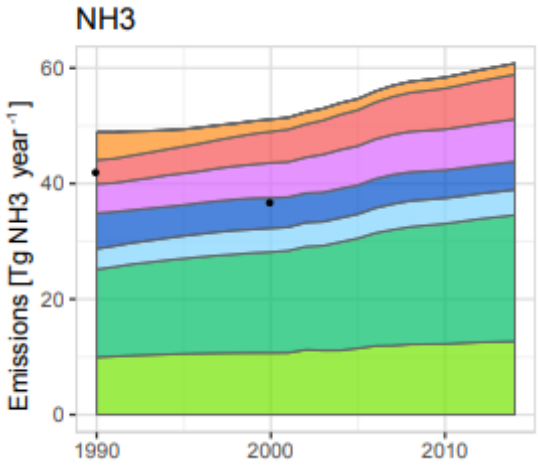
Global spatial variability
(Sutton et al., 2013, PTRSB)

NH3 Background

- Satellite products
  - Infrared Atmospheric Sounding Interferometer (IASI)
  - Atmospheric Infrared Sounder (AIRS)
  - Cross-track Infrared Sounder (CrIS)
  - Tropospheric Emission Spectrometer (TES)
  - Greenhouse Gases Observing Satellite
- Bottom-up inventory
  - CEDS+GFED+regioal…
- Chemistry transport model
  - GEOS-Chem



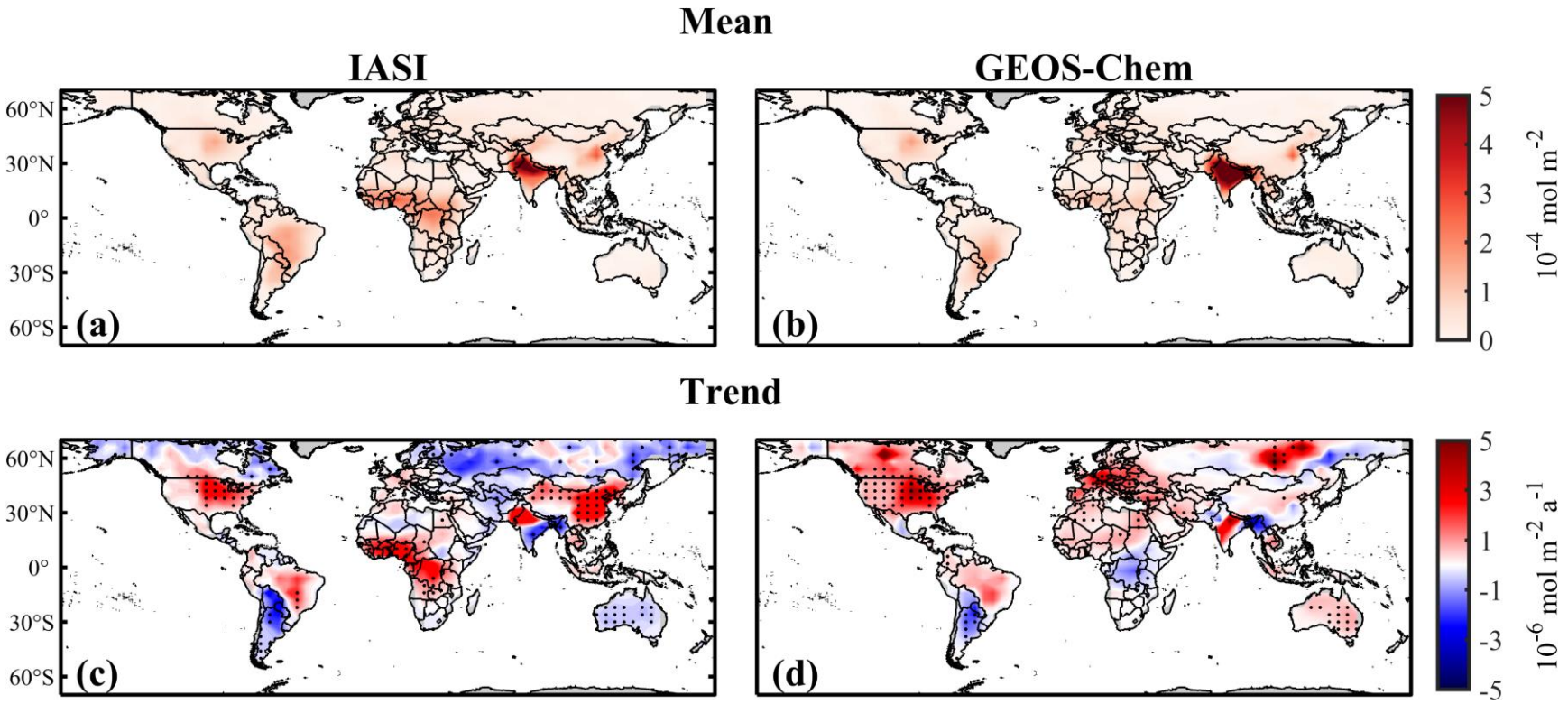
IASI total columns distribution
(Van Damme et al., 2021, ERL)



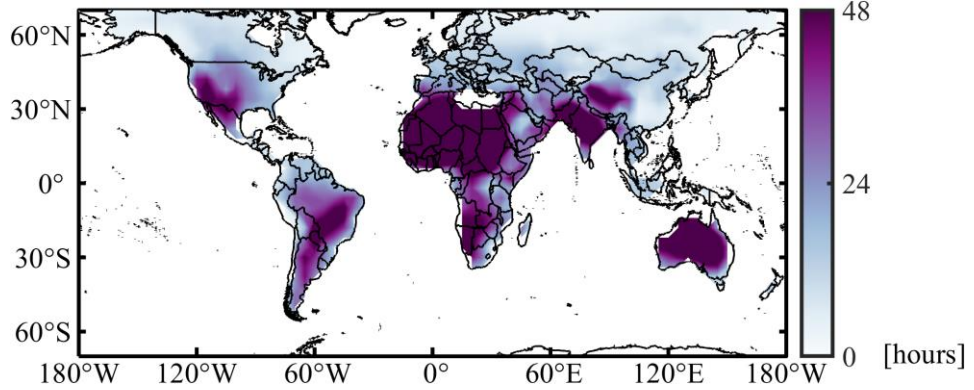
CEDS emission estimates
(Hoesly et al., 2018, GMD)

NH3 concentrations

- Observation: IASI
- Simulation: GEOS-Chem



NHx lifetime



Emission fluxes: $\hat{E}_{NH_3}$

$$\hat{E}_{NH_3} = E_{NH_3,mod} + \frac{C_{NH_3,obs} - C_{NH_3,mod}}{\tau_{NH_x,mod}}$$

$E_{NH_3,mod}$: GEOS-Chem model emission fluxes
$C_{NH_3,obs}$: observed total column densities
$C_{NH_3,mod}$: simulated total column densities
$\tau_{NH_x,mod}$: the lifetime of the total reduced nitrogen ($NH_x = NH_3 + NH_4^+$)

Lifetime: $\tau_{NH_x,mod}$

$$\tau_{NH_x,mod} = \frac{C_{NH_3,mod}}{D_{NH_3,mod} + D_{NH_4^+,mod}}$$

$D_{NH_3,mod}$: simulated NH_3 deposition fluxes
$D_{NH_4^+,mod}$: simulated NH_4^+ depositions fluxes

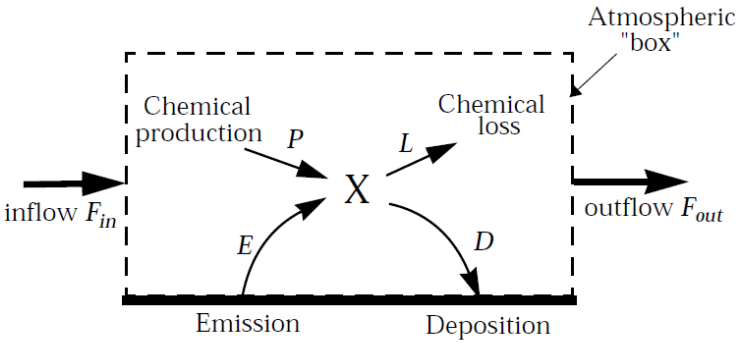
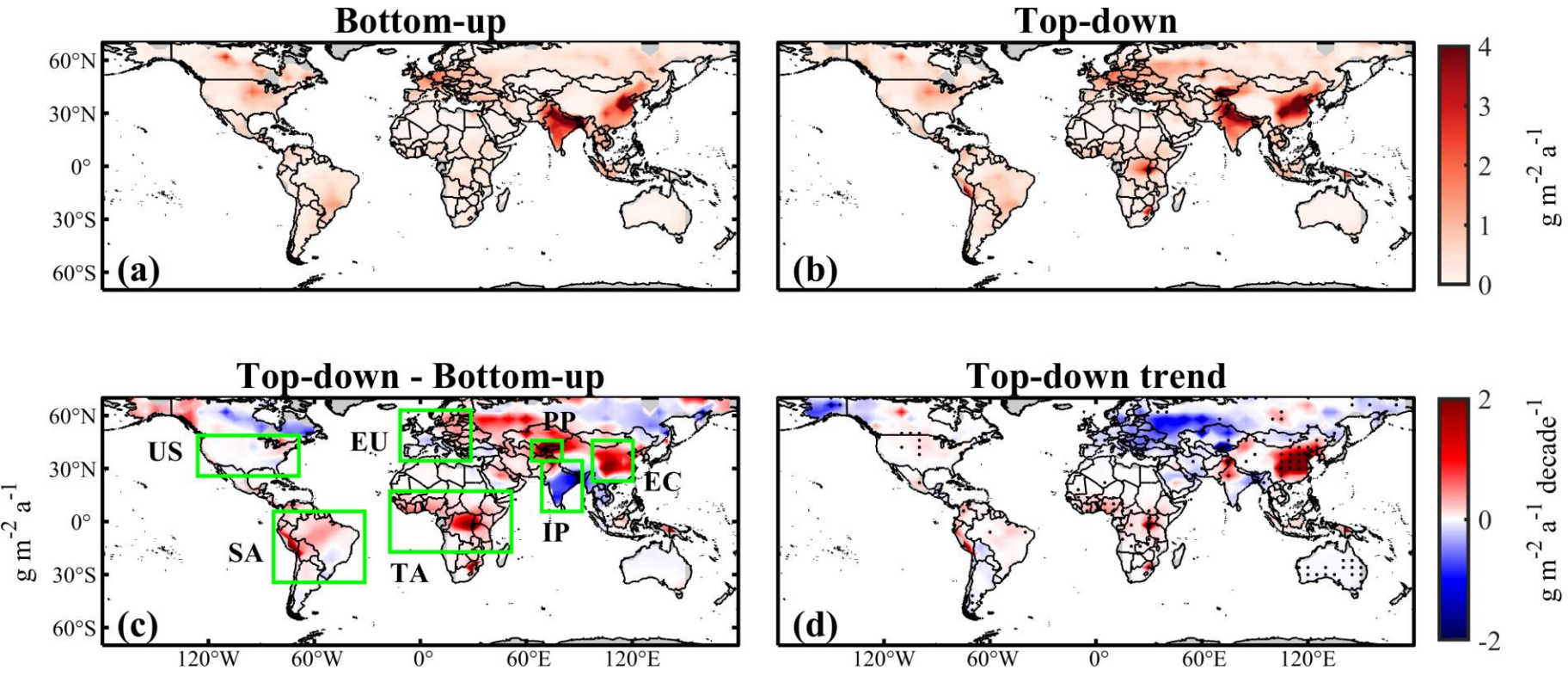
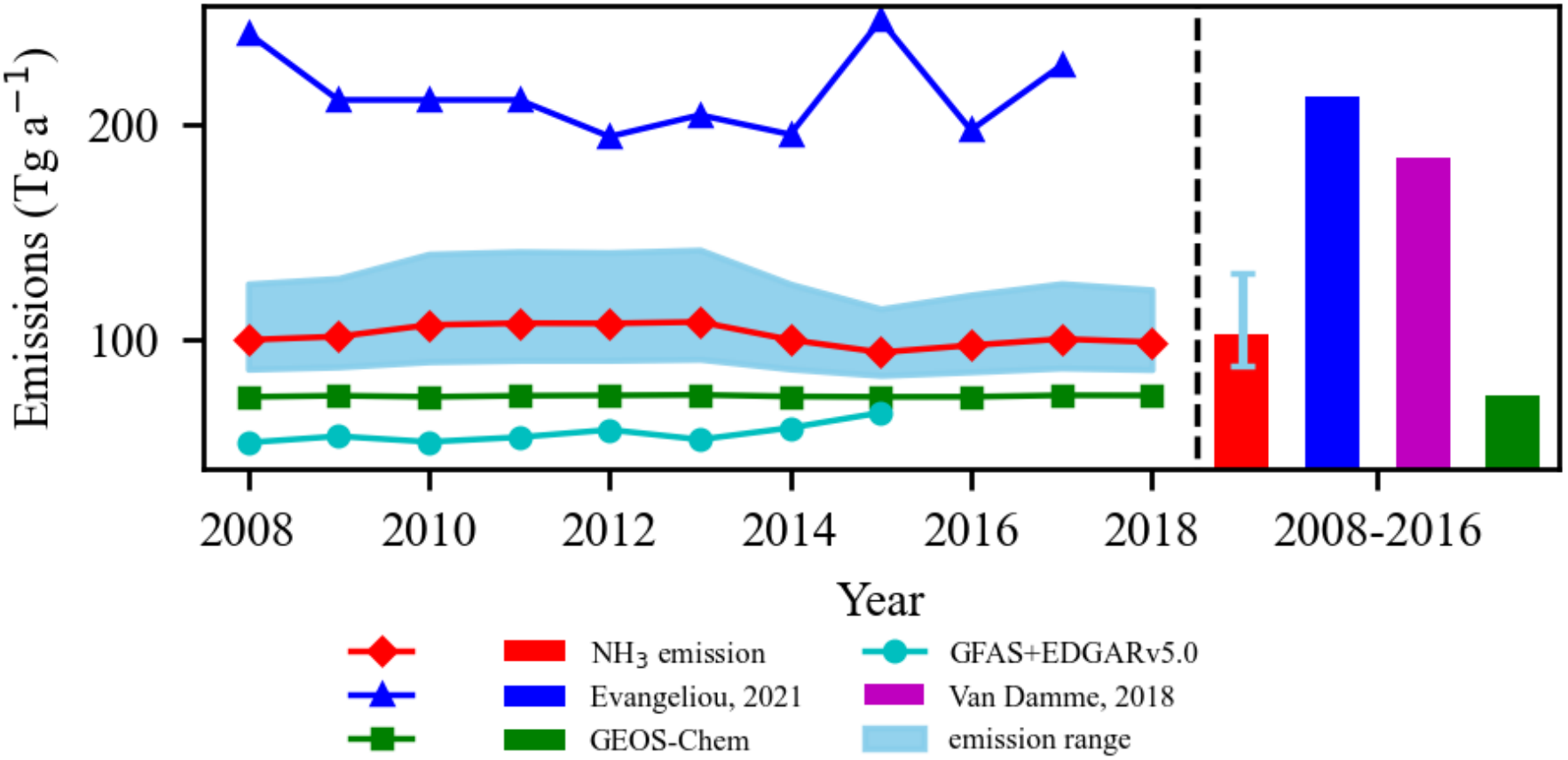


Figure 3-1 One-box model for an atmospheric species X

Top-down emission fluxes



Compared with others



Questions?