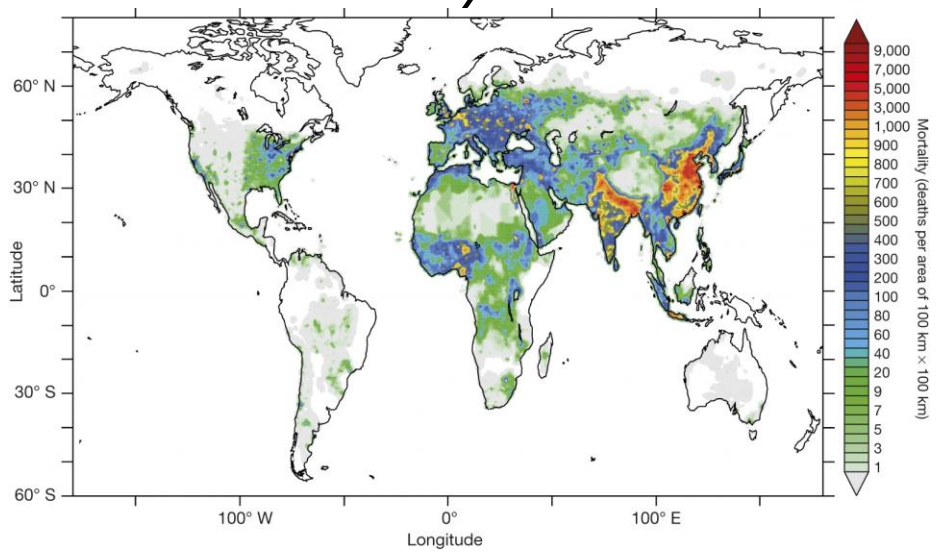
NH3 trend in Africa drove by biomass burning, wetlend extend or agriculture

Zhenqi Luo 2020.12

NH3 trend in Africa (2008-2017)

- Atmosphere NH3 implications
  - inorganic aerosols production
  - fine particulate matter constituent
  - health hazard
  - deposited to ecosystems:
    - Eutrophication
    - soil acidification
    - vegetation damage
    - productivity declines
    - reductions in biodiversity
    - indirect greenhouse gas emissions
- NH3 source
  - Agriculture: the global largest source
    - urea fertilizer: extremely low in sub-Saharan Africa
    - livestock excreta: very low in sub-Saharan Africa
    - soil: ammonium dissociation ($NH_4^+ + OH^- \leftrightarrow H_2O + NH_3$)
      - temperature-dependent
      - plant and soil physiological and physical factors
  - Biomass burning: 60-70% from Africa
    - Determinant: fuel moisture content
- Detailed Regions:
  - West Africa
  - the Lake Victoria Region
  - South Sudan



Mortality linked to outdoor **air pollution** in 2010
(Lelieveld et al., 2015, ***Nature***)

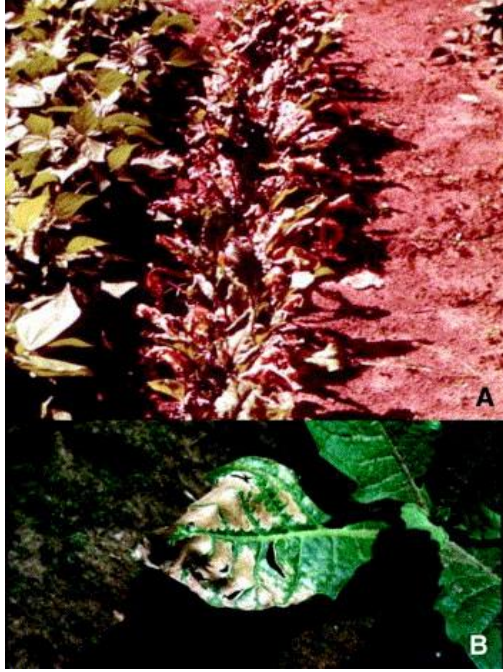
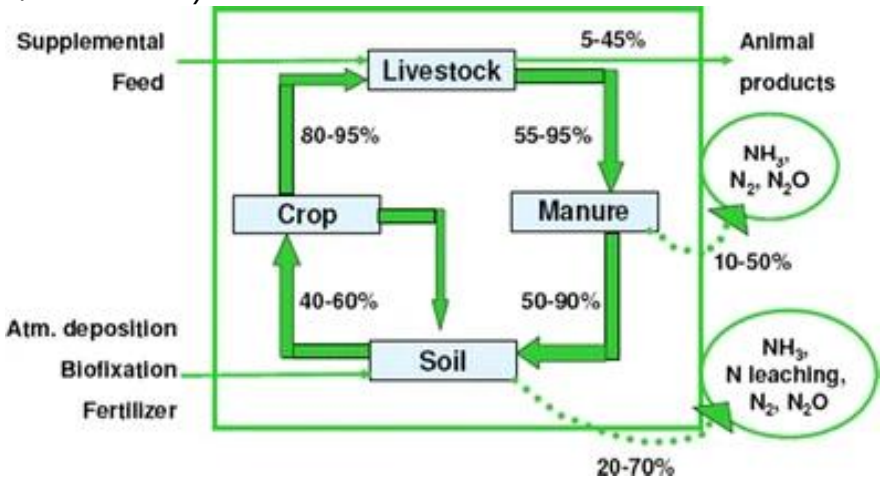


table beet exposed to **acute NH3 concentrations**
(Krupa 2015, ***Environ Pollut***)



(Behera et al., 2013)

N cycling and losses in a **livestock** farming system

NH3 trend in Africa (2008-2017)

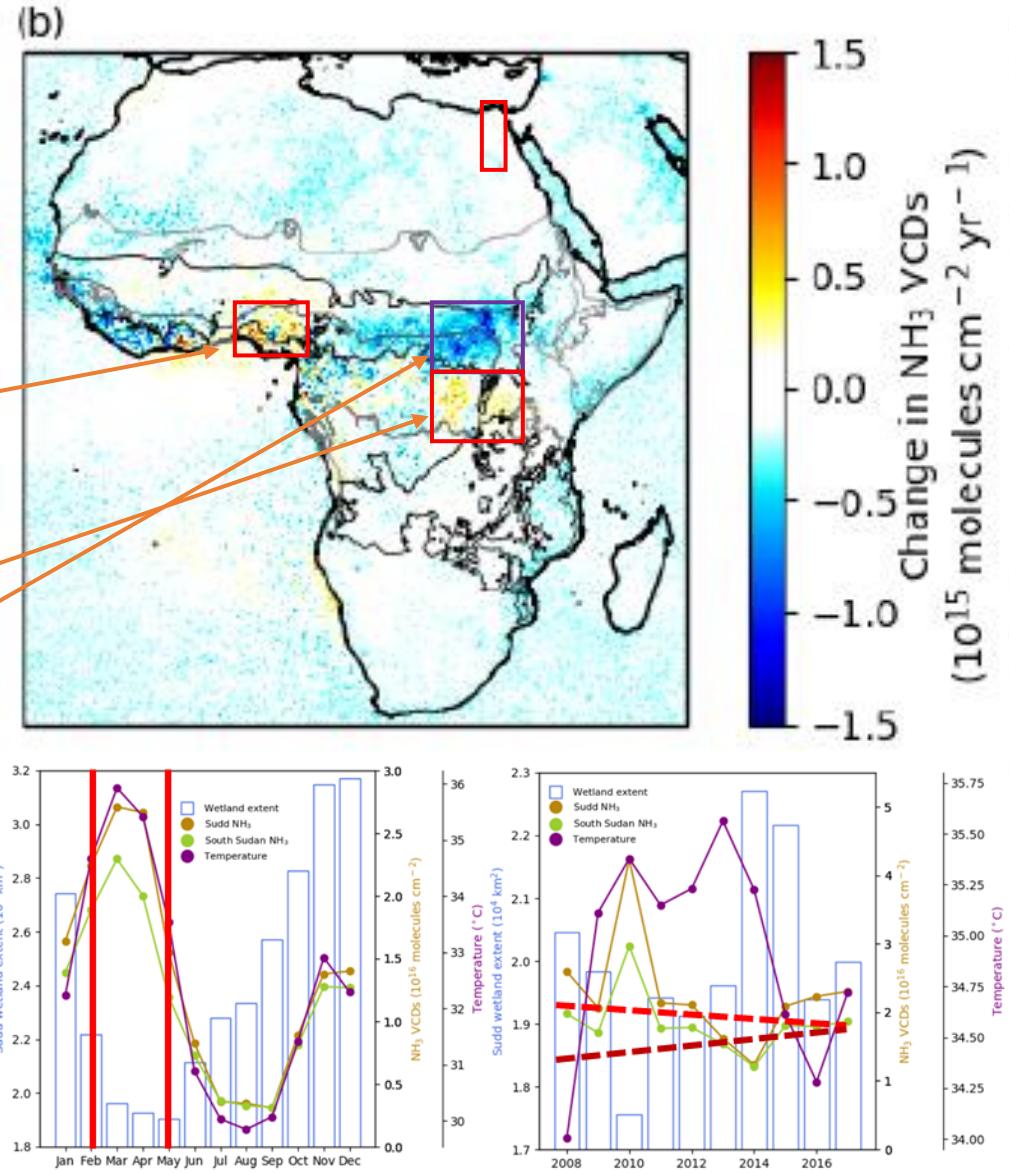
- Global data:
  - IASI-A: NH3, CO
    - regrid: 0.25° × 0.25°
    - Time: morning
    - cloud cover: < 20%
  - TRMM: daily precipitation
  - NOAA Global Surface Temperature Dataset: 0.5° gridded 2m monthly
  - MODIS MCD64A1: 0.25° gridded monthly burned area
  - MODIS MCD12C1: 0.25° gridded land cover product
  - ACLED: violent and non-violent conflict events
- Wetland extent: Sudd
  - MODIS MOD09A1: monthly flood maps (8-days)
    - First stage: distinguish
      - wetland vegetation classes
      - flooding regimes: seasonally flooded
    - Second stage:
      - compares seasonally flooded to non-flooded
      - identify the timing and duration of flooding
- Spatial relationships: (0.25°)
  - mean annual tropospheric NH3 concentration
  - independent variables
    - population density: USDEGL population dataset (2017 version)
    - livestock density: FAO (2007)
    - cropped area: MODIS MCD12C1
- National analyses: UN FAOSTAT (51 African countries)
  - livestock numbers
  - crop production
  - fertilizer N use

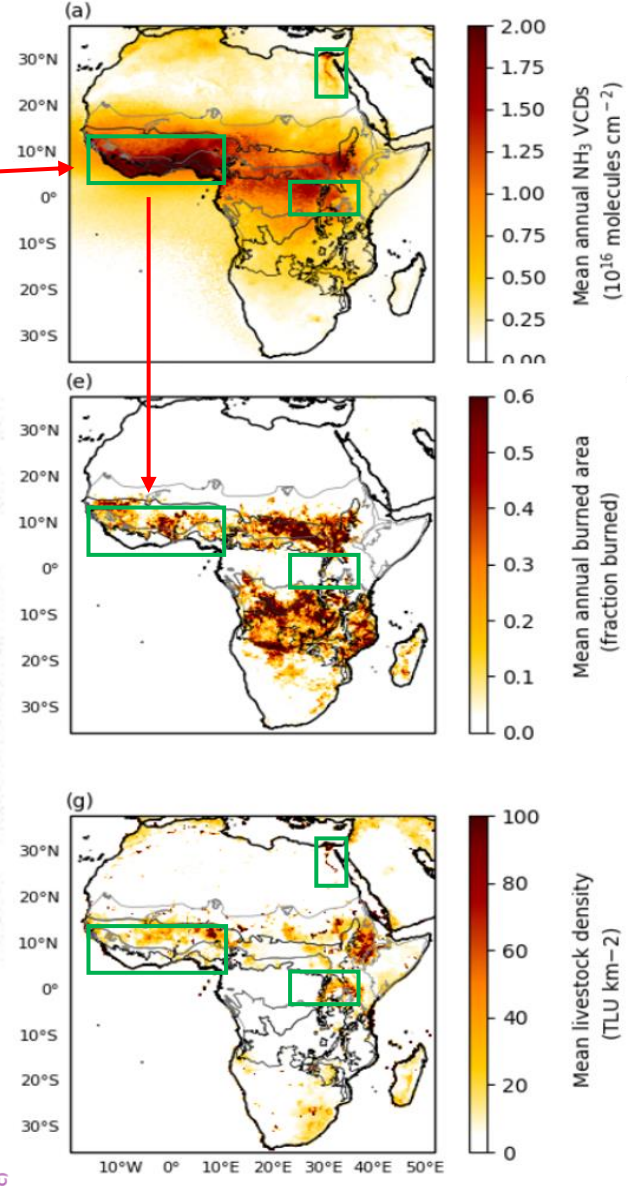
Low bin	Medium Bin	High Bin
Eswatini	Angola	Mauritania
South Africa	Western Sahara	Guinea-Bissau
Lesotho	Kenya	Burundi
Somalia	Central African Republic	Cameroon
Madagascar	Chad	Guinea
Djibouti	Zambia	Mali
Namibia	Tanzania	Rwanda
Libya	Malawi	Sierra Leone
Eritrea	Tunisia	Burkina Faso
Botswana	DRC	Nigeria
South Sudan	Niger	Benin
Egypt	Algeria	Togo
Mozambique	Uganda	Cote d'Ivoire
Sudan (former)	Senegal	Ghana
Sudan (former)	Gambia	Gabon
Zimbabwe	Morocco	Liberia
Ethiopia	Congo	Equatorial Guinea

Countries were sorted into three bins (Hickman et al., 2020)

Results——Africa (2008-2017)

- Continental distributions
  - Highest in West Africa: biomass burning
  - regional hotspots:
    - the Lake Victoria Basin
    - along the Nile delta and river
- Continental trends
  - Increases
    - the northern grasslands: during February and March
    - Nile region
    - the Lake Victoria Basin
  - Decline: South Sudan
    - Seasonal: increase as waters recede——from February to May
    - Interannual: an overall increase in the minimum flooded extent (r=-0.69)

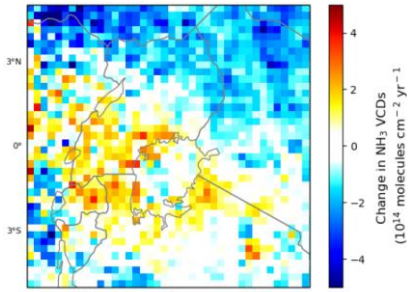


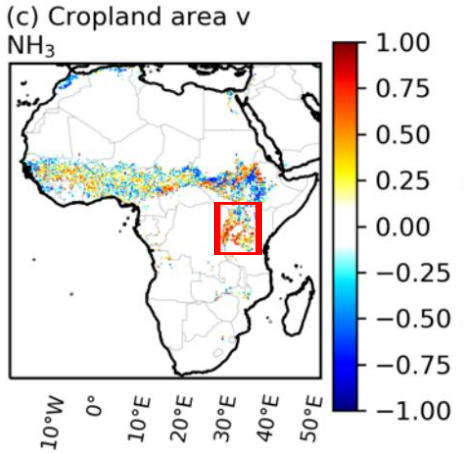


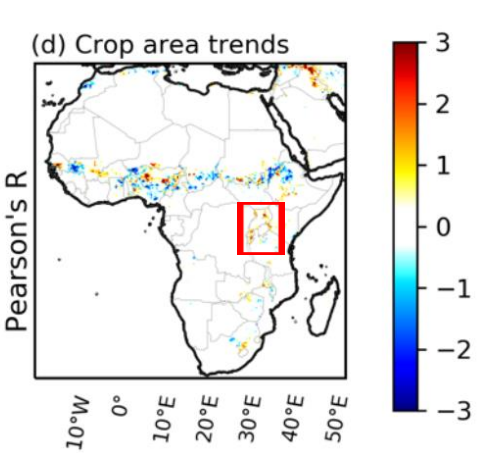
(Hickman et al., 2020)

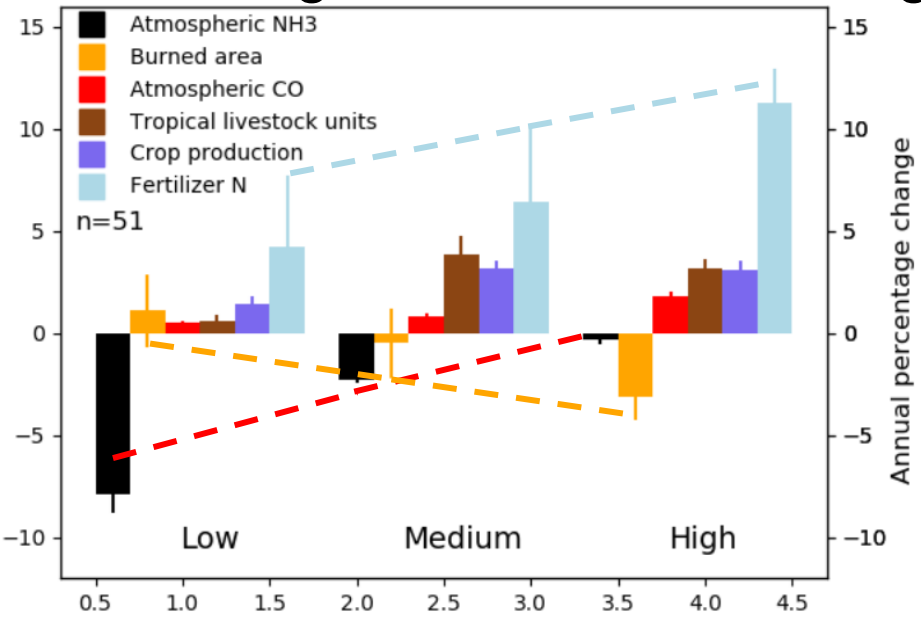
Results——Africa (2008-2017)

- regional hotspots:
  - the Lake Victoria Basin: increasing agricultural activity
    - increasing density of agricultural land
    - positively correlated with increases in NH3
- National-scale relationships
  - relationship between agriculture and NH3
  - changes in biomass burning

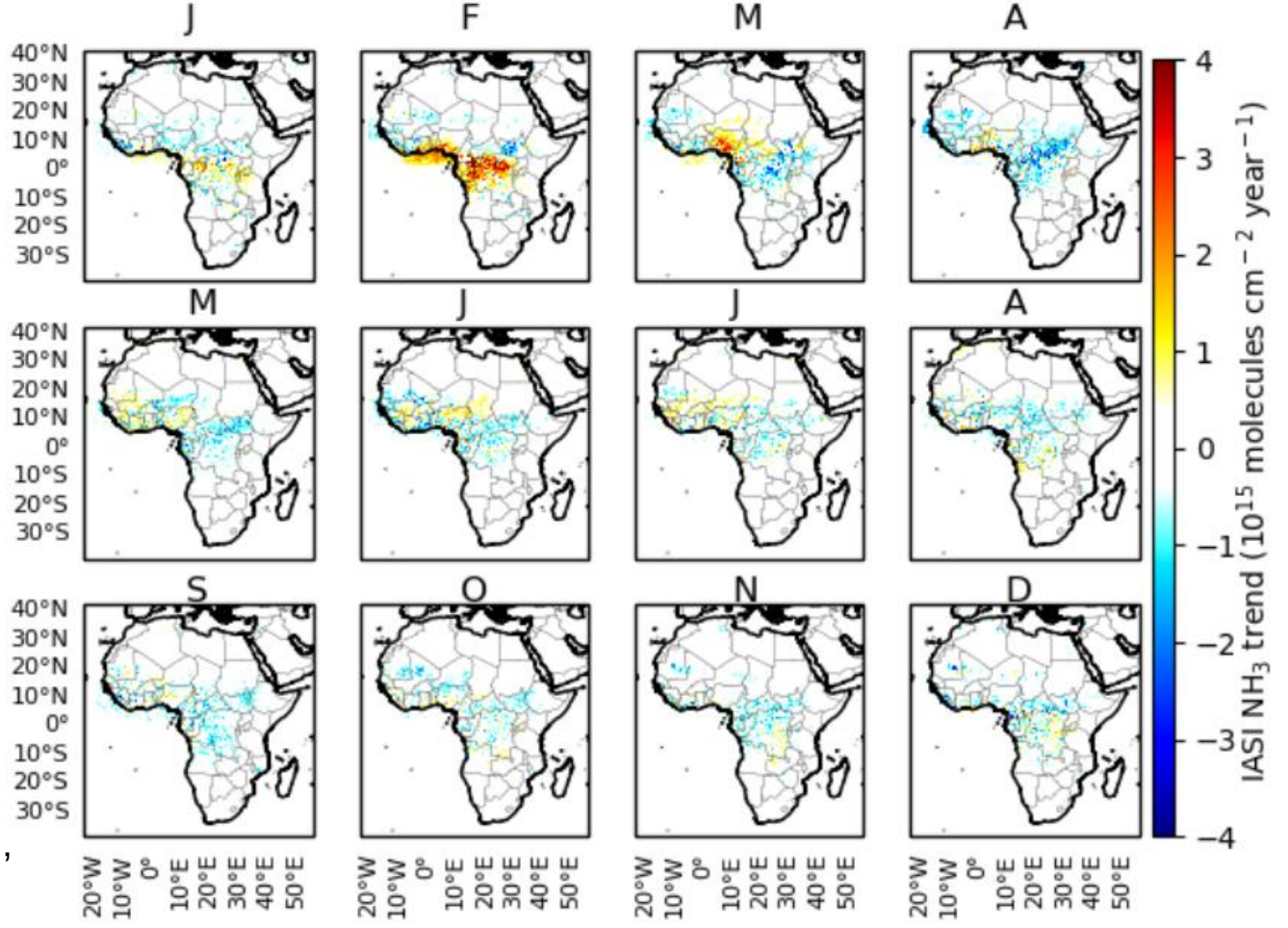








(Hickman et al., 2020)



Questions?