

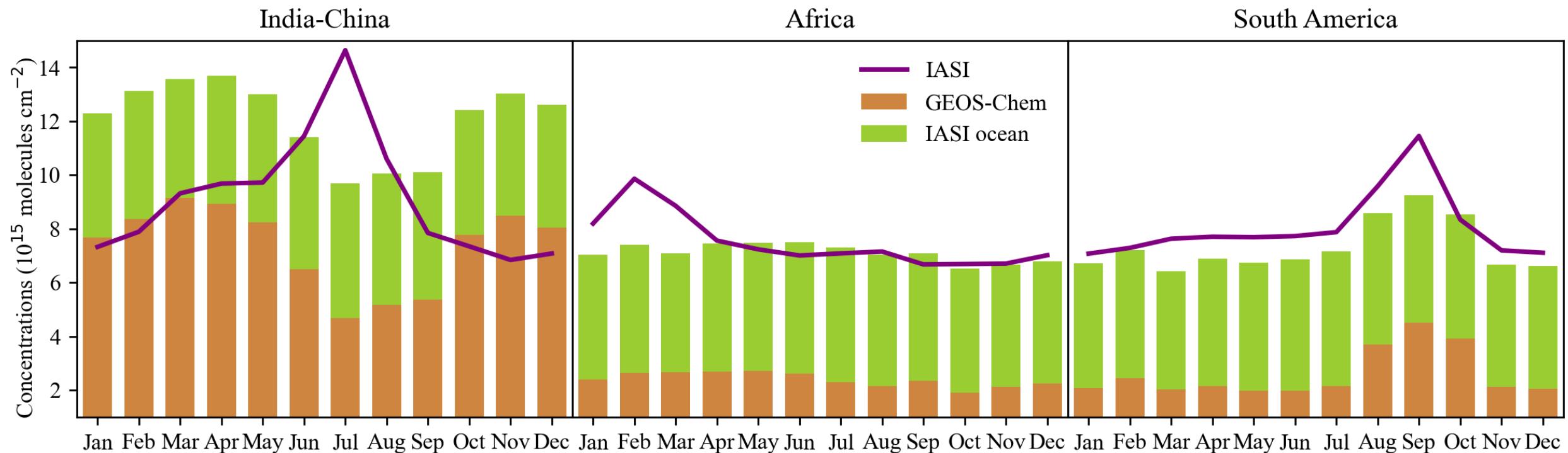
Observed and simulated Ammonia concentration 9

IASI data and GEOS-Chem simulation

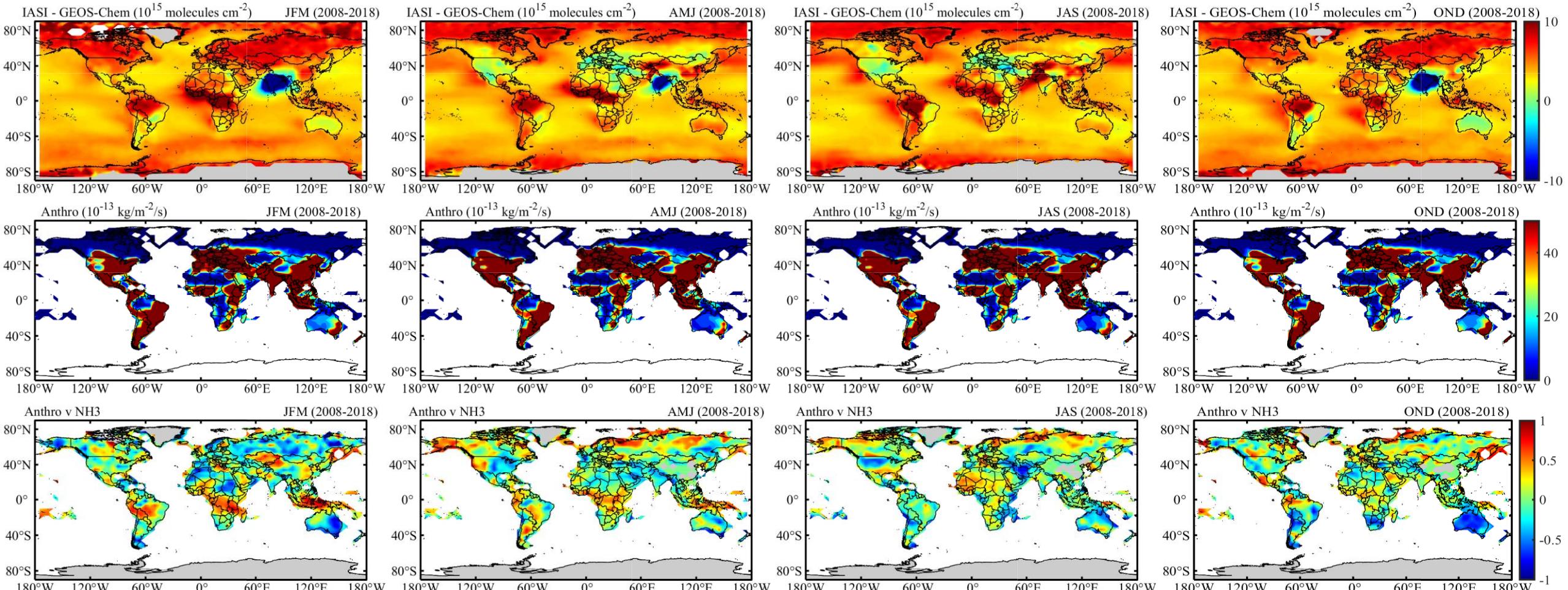
2020.12

- Accomplished:
 - 1. monthly concentration mean over the India-China, Africa and South America
 - 2. seasonal concentration mean difference distribution
 - 3. Spatial correlations between mean seasonal concentration with emissions (anthropogenic, natural, biomass burning)
- Ammonia Data:
 - IASI total columns: Reanalyzed IASI/Metop-A
 - Daily, L2, $1^\circ \times 1^\circ$ (2008-2018)
 - GEOS-Chem simulation, $4^\circ \times 5^\circ$, daily
 - column concentration (2008-2018)
- meteorological input data
 - ECMWF ERA5 skin temperature, $0.25^\circ \times 0.25^\circ$
 - hourly data on single levels (2008-2018), 9:00/10:00
- Ongoing:
 - 1. download CrIS NH₃ data (2018)

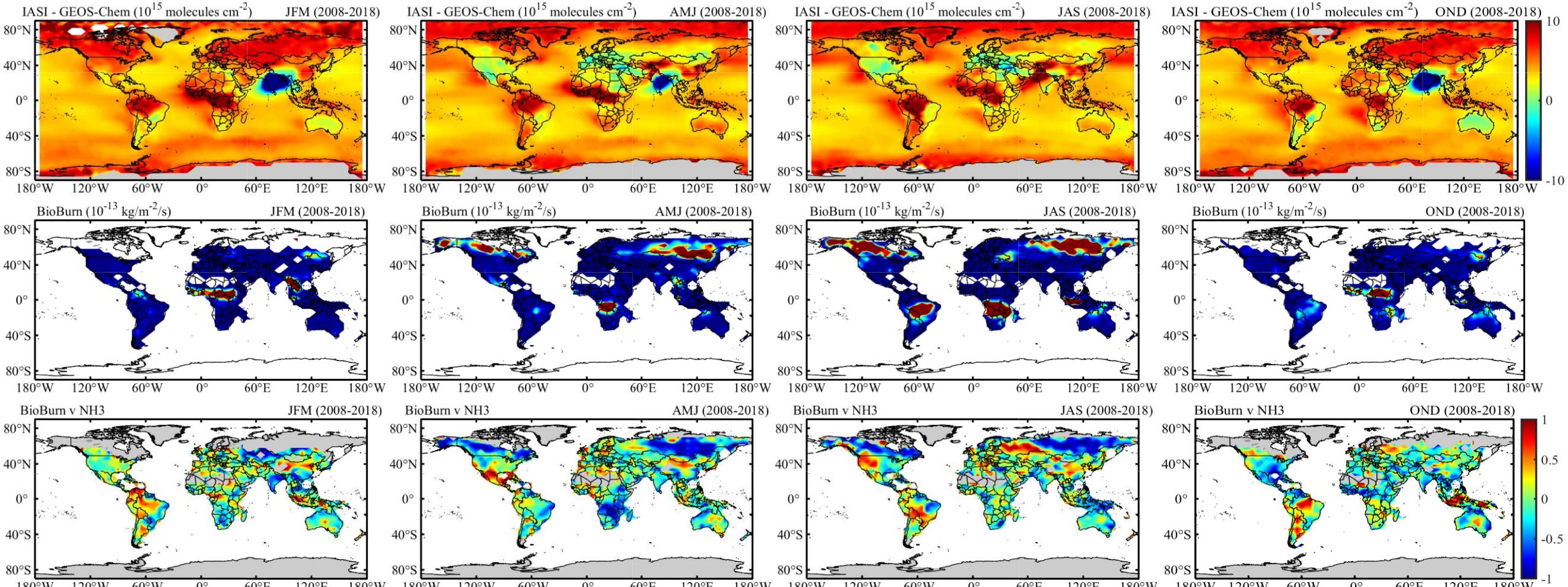
Mean monthly NH₃ over the India-China, Africa and South America



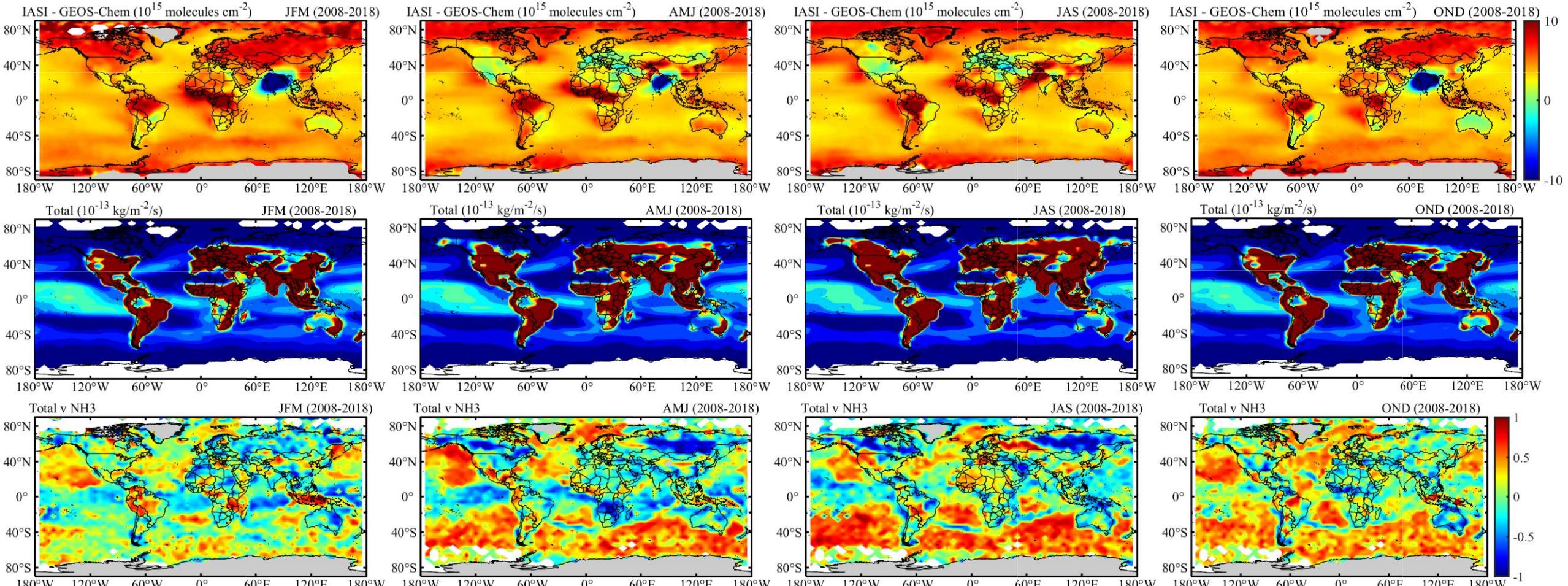
Seasonal mean difference spatial distribution and its spatial relationship with anthropogenic emissions

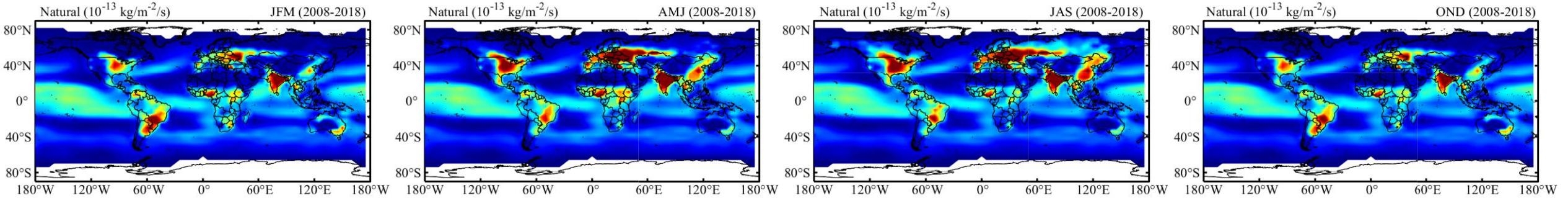


Seasonal mean difference spatial distribution and its spatial relationship with biomass burning emissions



Seasonal mean difference spatial distribution and its spatial relationship with total emissions



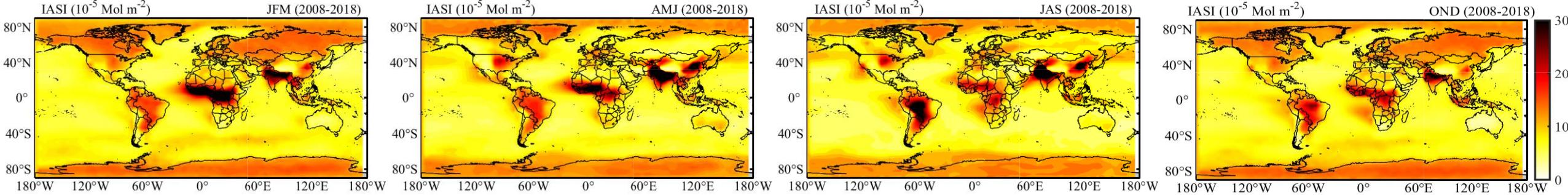


IASI daily data

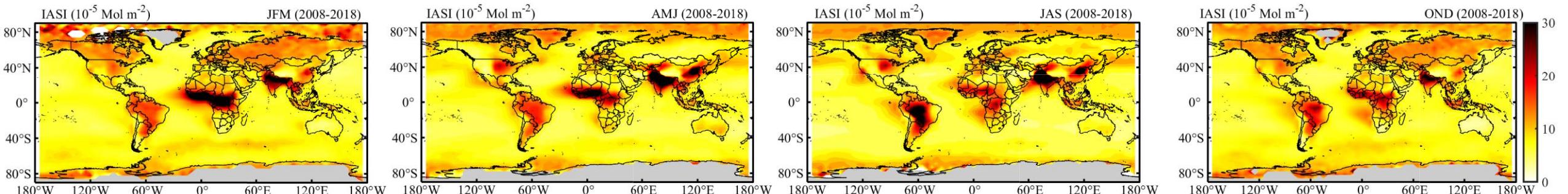
- Missing date (37 days):
 - 2008 (13 days): 1.17-18, 3.20-3.26, 12.10-11, 12.30-31
 - 2009 (3 days): 1.1, 1.23, 10.1
 - 2010 (5 days): 5.18, 8.31, 9.1-9.3
 - 2011 (2 days): 10.23-24
 - 2012 (0)
 - 2013 (2 days): 11.6-7
 - 2014 (7 days): 2.19-2.20, 9.9-9.13
 - 2015 (3 days): 4.10-4.12
 - 2016 (0)
 - 2017 (1 day): 6.7
 - 2018 (1 day): 12.31
- Filter
 - Cloud coverage: [0, 25%]
 - Skin temperature: > 263.15 K

IASI total column concentration of seasonal mean

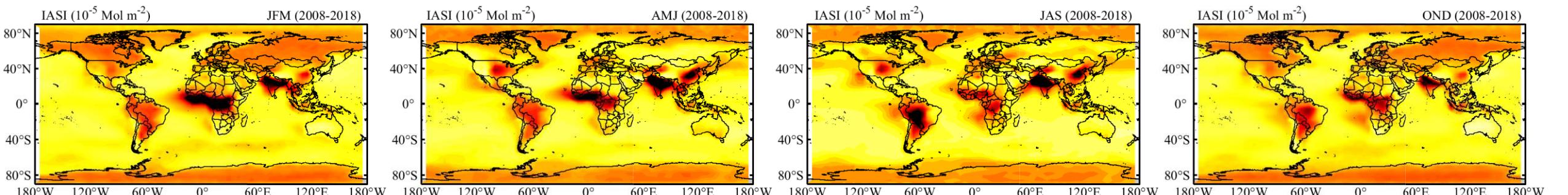
No filter (daily)



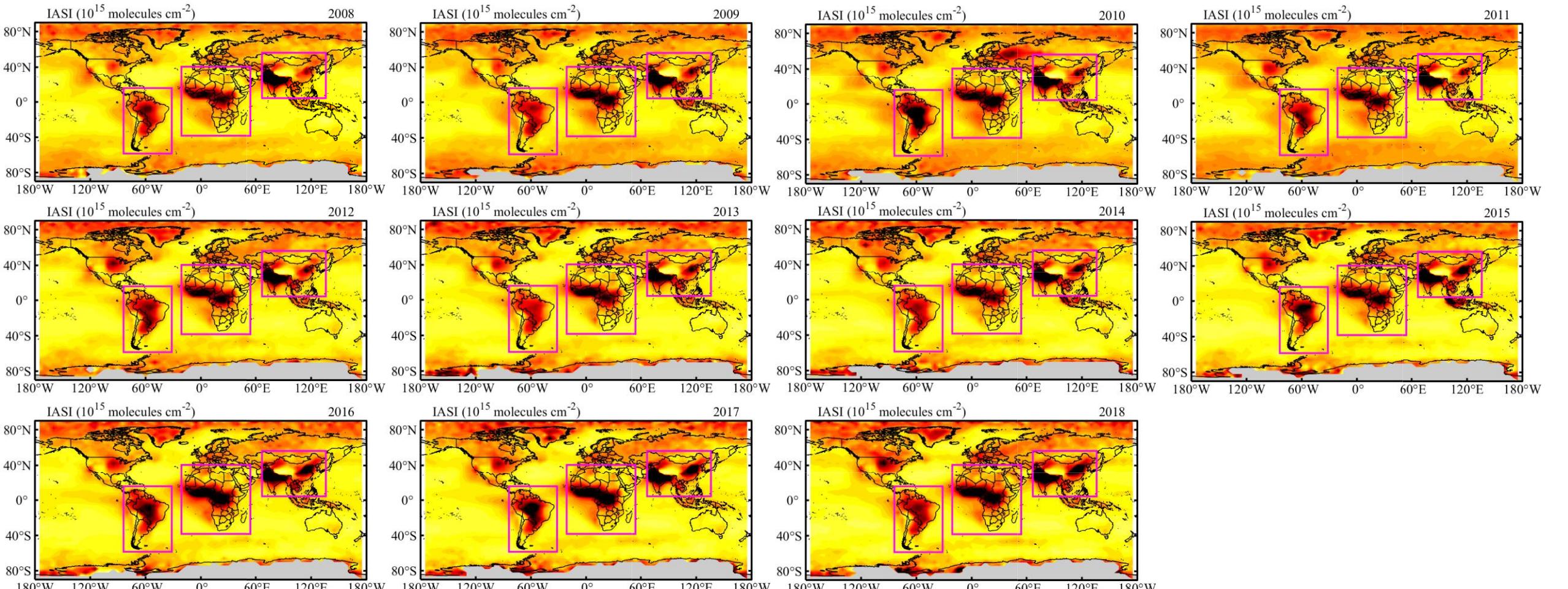
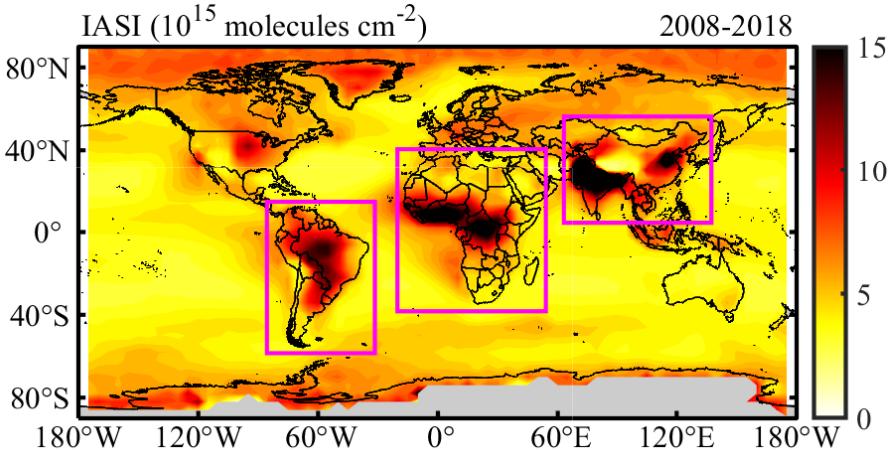
With filter (daily)



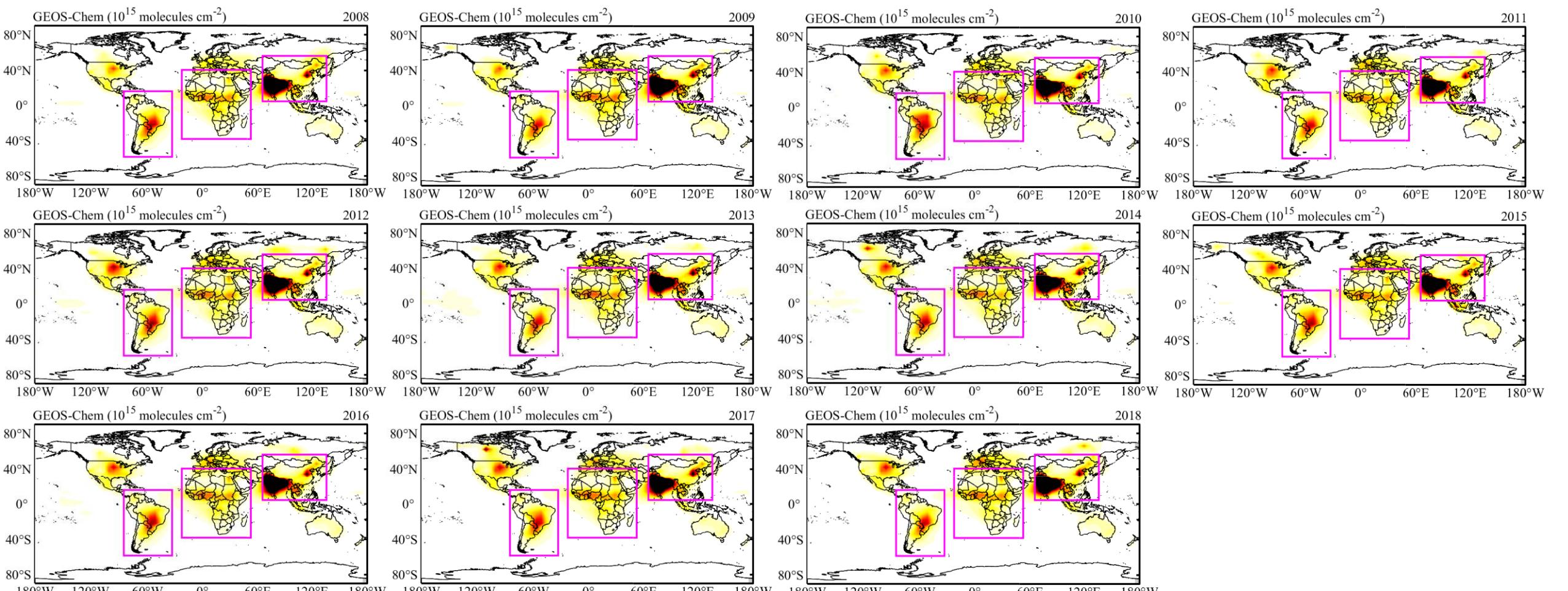
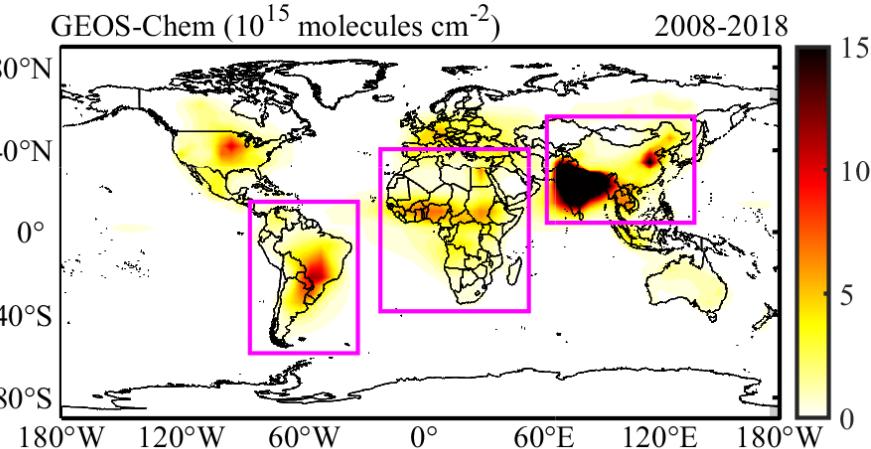
Monthly



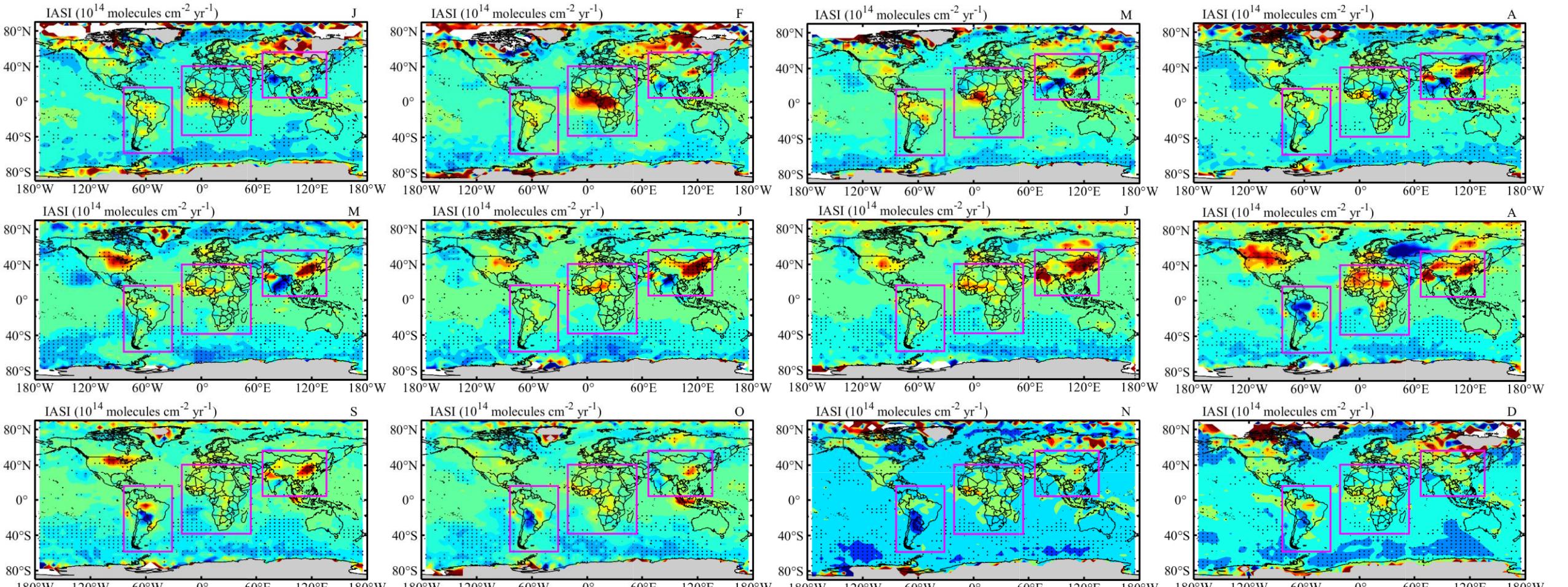
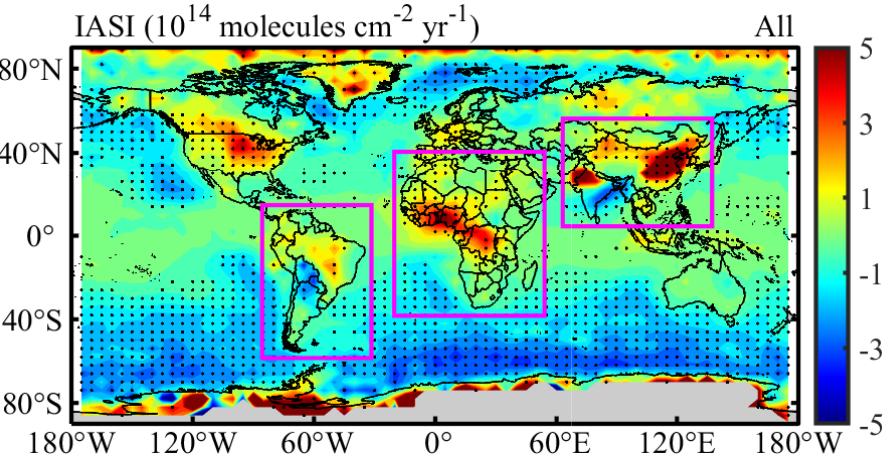
IASI mean in annual concentration distribution



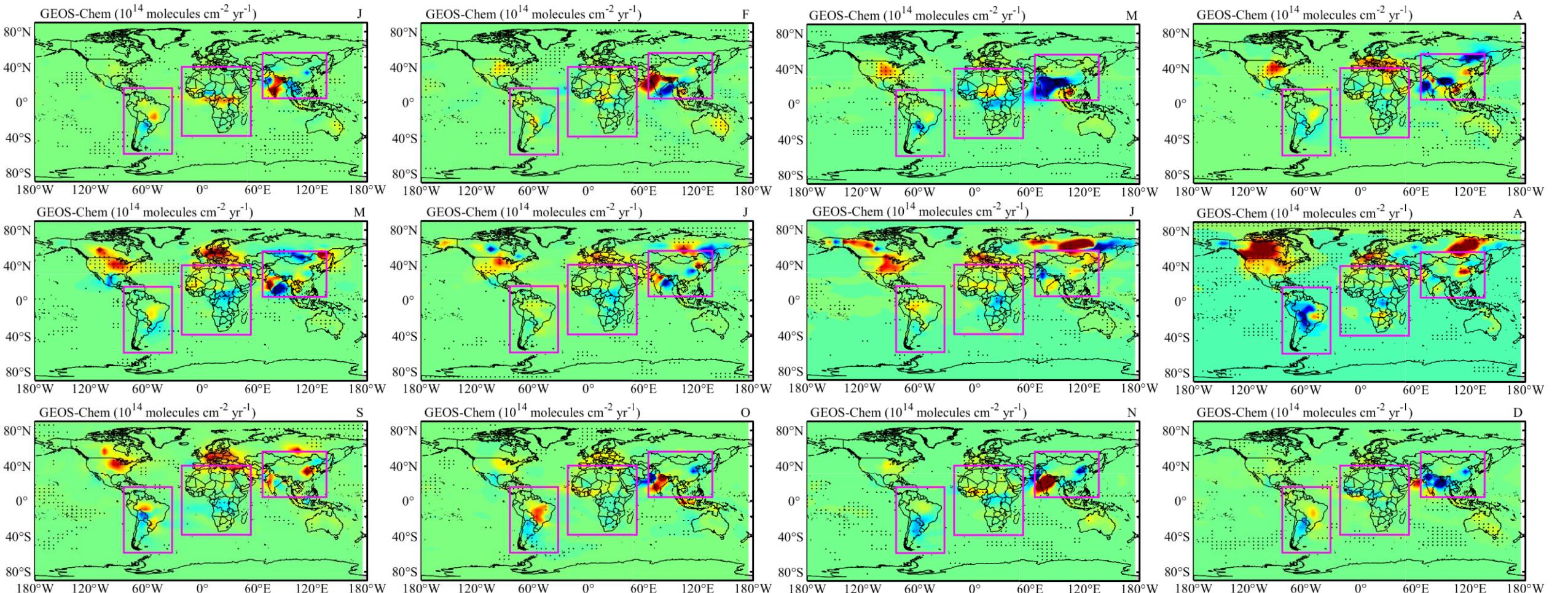
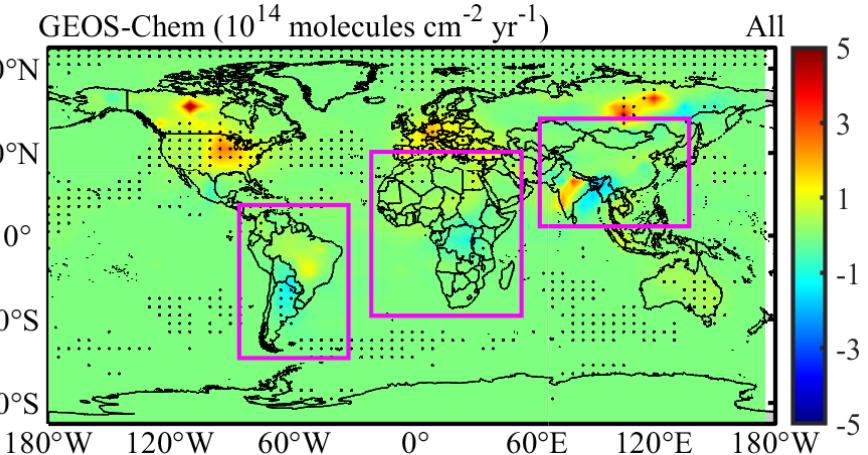
GEOS-Chem mean in annual concentration distribution



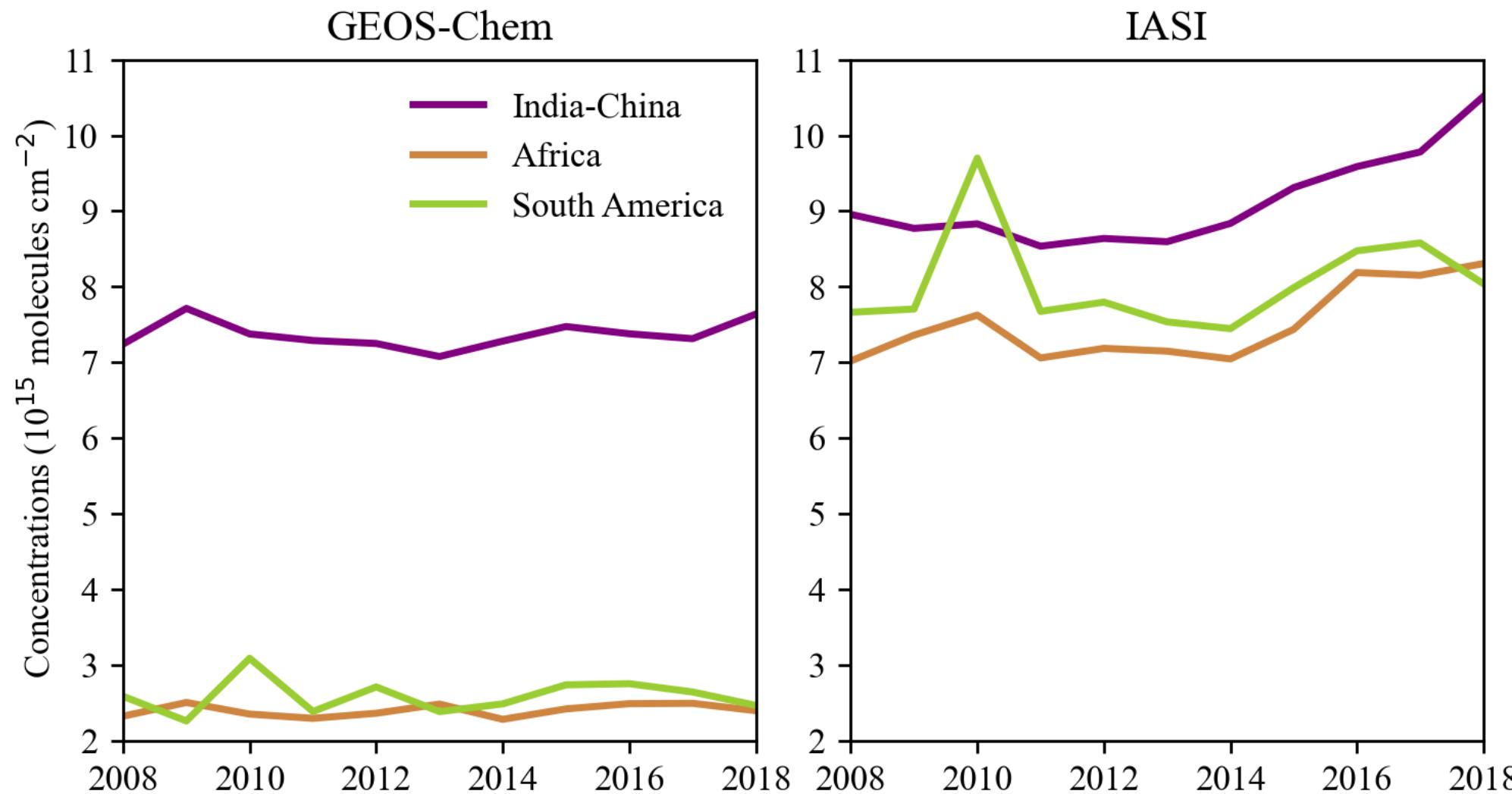
IASI trend in monthly concentration distribution



GEOS-Chem trend in monthly concentration distribution



Annual concentration mean of GEO-Chem and IASI over the India-China, Africa and South America



total column concentration

- $\Omega = \sum_{i=1}^{47} c_i \times rho_i \times h_i \times k$
 - Ω : total column concentration, [mol/m²]
 - c_i : 'IJ-AVG-\$_NH3', mixing ratio for each level, [ppbv] to [v/v] (*1E-9)
 - rho_i : 'TIME-SER_AIRDEN', air density for each level, [molecules/cm³]
 - h_i : 'BXHGHT-\$_BXHEIGHT', grid box height for each level, [m] to [cm] (*100)
 - k : 1/6.02214179E19, multiplication factor to convert [molecules/cm²] to [mol/m²]

Regrid 180x360 to 46x72

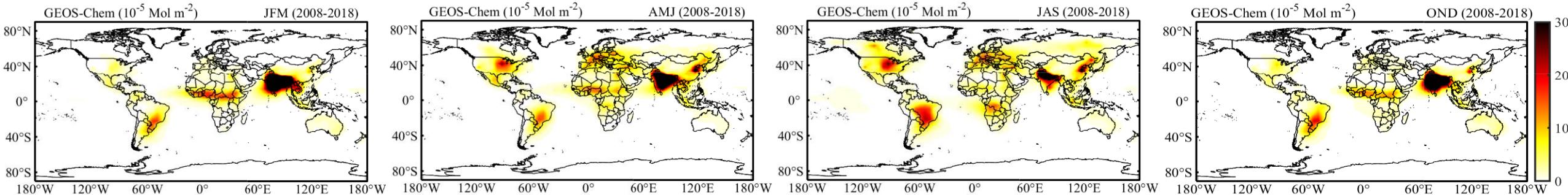
- Latitude: 46 degrees
 - 88°-90°: 2x5 to 1x1, 2 degrees
 - 0-88°: 4x5 to 1x1, 44 degrees
- Method:
 - Step1: mask ocean, set as NaN
 - Step2: calculate mean value in each upscaling grid

emissions

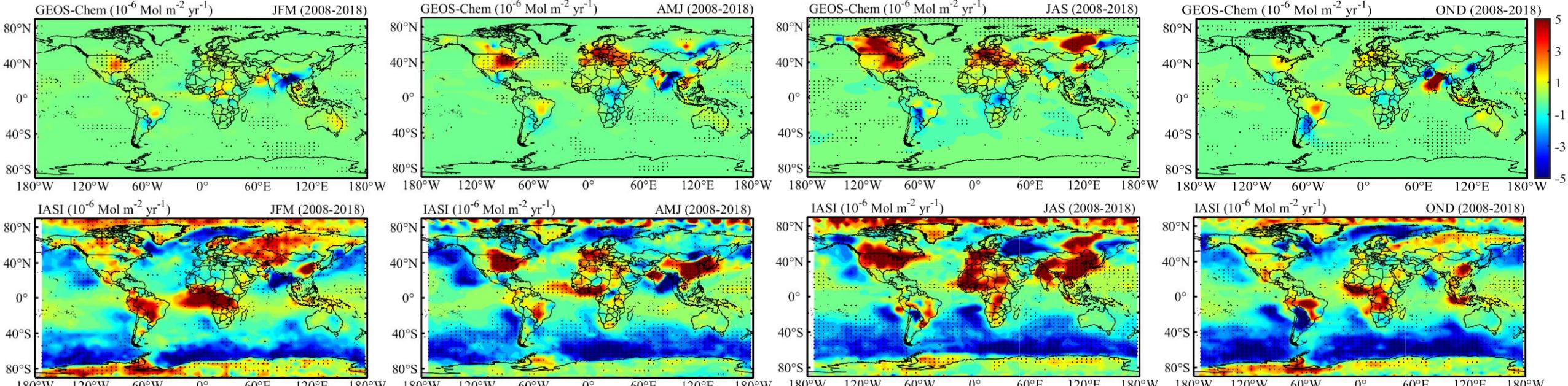
- Anthropogenic
 - APEI: Historical Canadian emissions (1990-2014)
 - NEI2011_MONMEAN: US emissions
 - MIX: Asian anthropogenic emissions
 - DICE_Africa: emissions from inefficient combustion over Africa
 - CEDS: Global anthropogenic emissions
 - POET_EOH: aldehydes and alcohols
 - TZOMPASOSA: global fossil fuel and biofuel emissions of C2H6 for 2010
 - XIAO_C3H8: C2H6 and C3H8
 - AFCID: PM2.5 dust emission
- Natural
 - GEIA_NH3: 1990 (obsolete now)
 - SEABIRD_DECAYING_PLANTS: the oceanic emissions of acetaldehyde
 - NH3: the Arctic seabird
- Biomass burning
 - GFED4: biomass burning emissions
- Ship
 - CEDS_SHIP
 - SHIP

Seasonal concentration mean and trend spatial distribution (monthly)

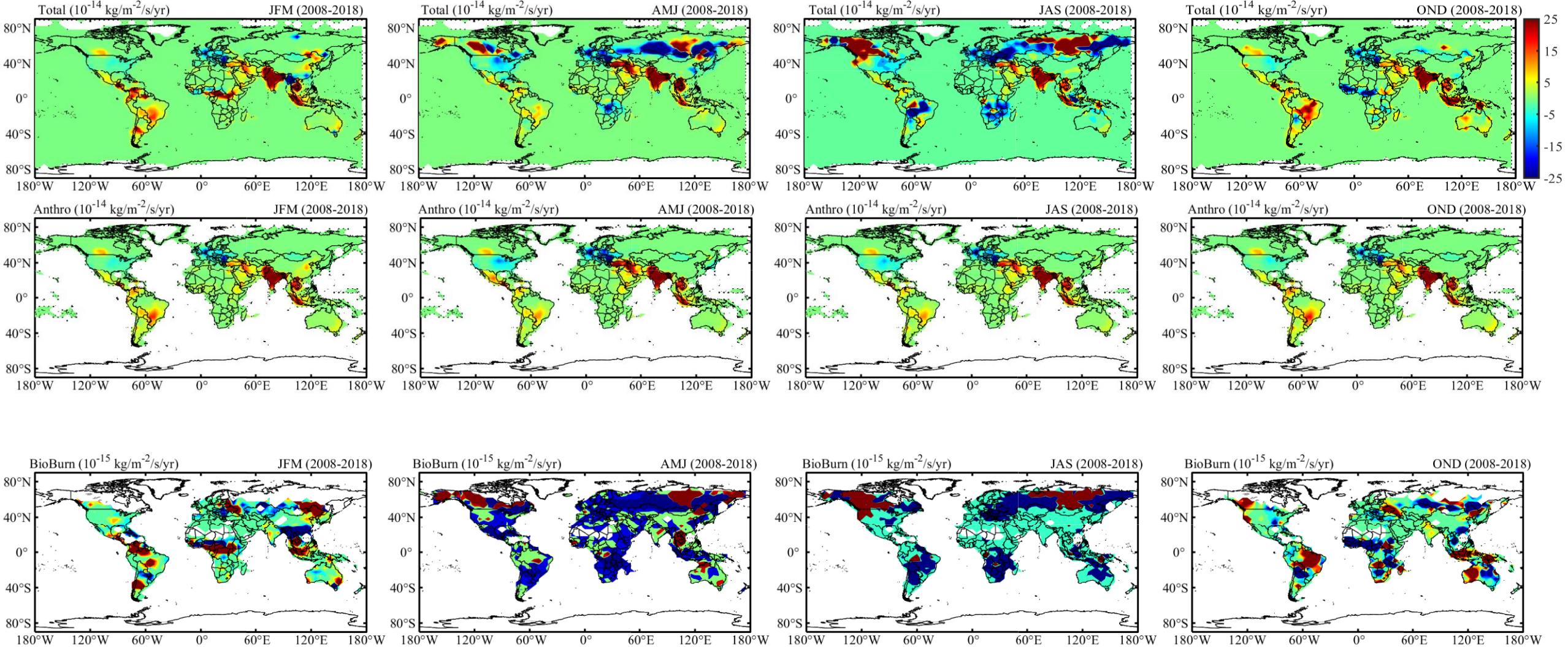
Mean



Trend

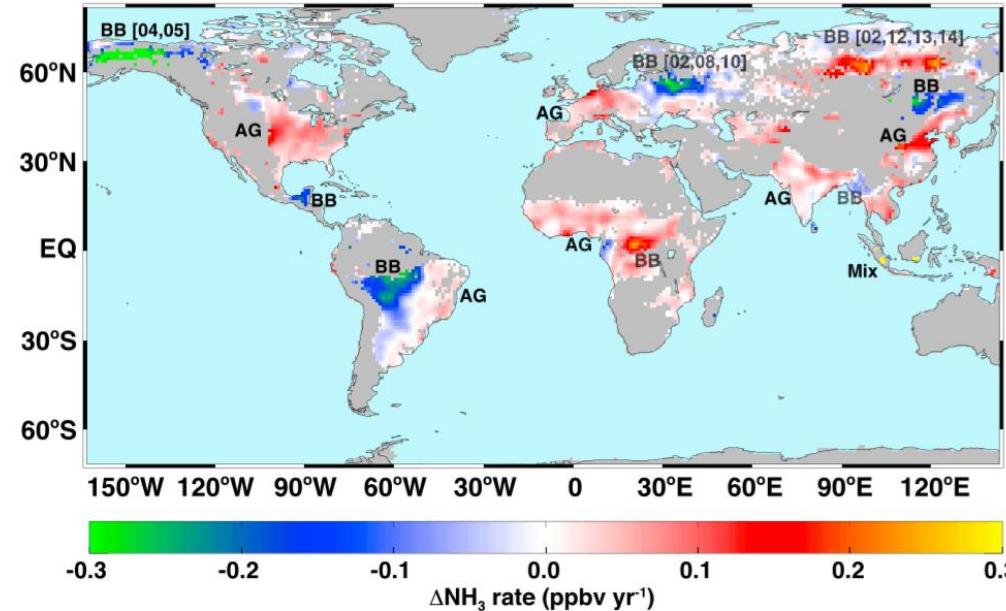


Seasonal emission trend spatial distribution (monthly)



Increased atmospheric ammonia over the world's major agricultural areas detected from space

- provides evidence of substantial increases in atmospheric ammonia (NH₃) concentrations (14 year) over several of the world's major agricultural regions
- The rate of change of NH₃ volume mixing ratio (VMR) in parts-per-billion by volume (ppbv) per year computed
 - BB: biomass burning
 - AG: agricultural



(Warner et al, 2017)

End