Quantifying Atmospheric Methane Growth Rates from AIRS with Giovanni

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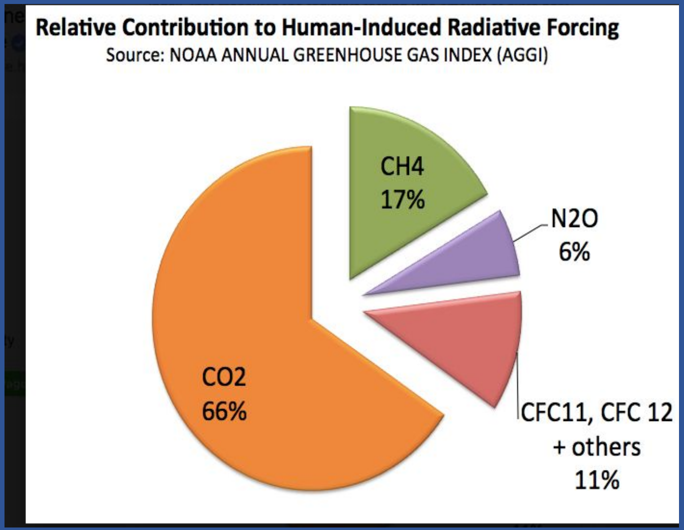
Motivation



- Methane is a strong greenhouse gas.
- Use methane emission estimates to better understand trends in atmospheric methane growth rates.

  ⇒ Link the bottom-up and top-down perspectives

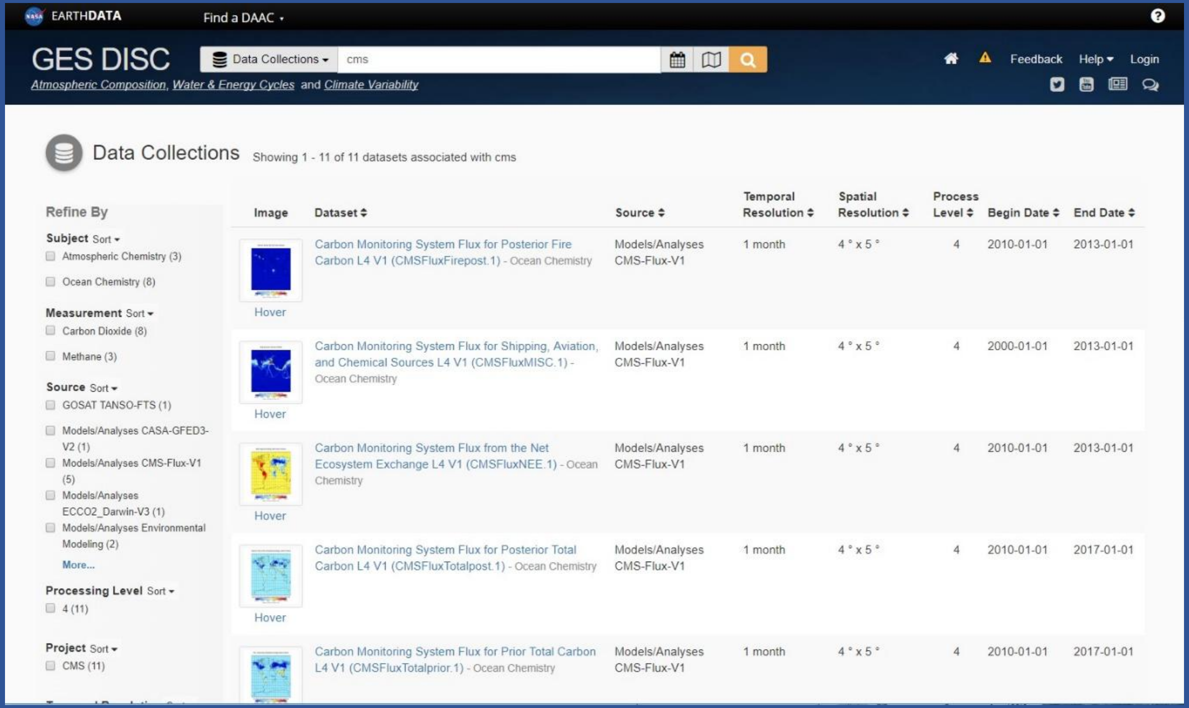
Goal

1. Use Giovanni and GES DISC data to study the distributions and trends of trace gases.
   - Example: AIRS methane growth rates and CMS methane emissions data.
2. Demonstrate how to use Giovanni to expedite the exploration of data.

Outline

1. Introduce Carbon Monitoring System data
2. Show AIRS methane growth rates
3. Can we use emissions data to understand the causes of AIRS methane growth rate trends?
    - Spoiler alert: I don't know, but you might.
4. Potential for box-modeling?
    - Discuss caveats and challenges

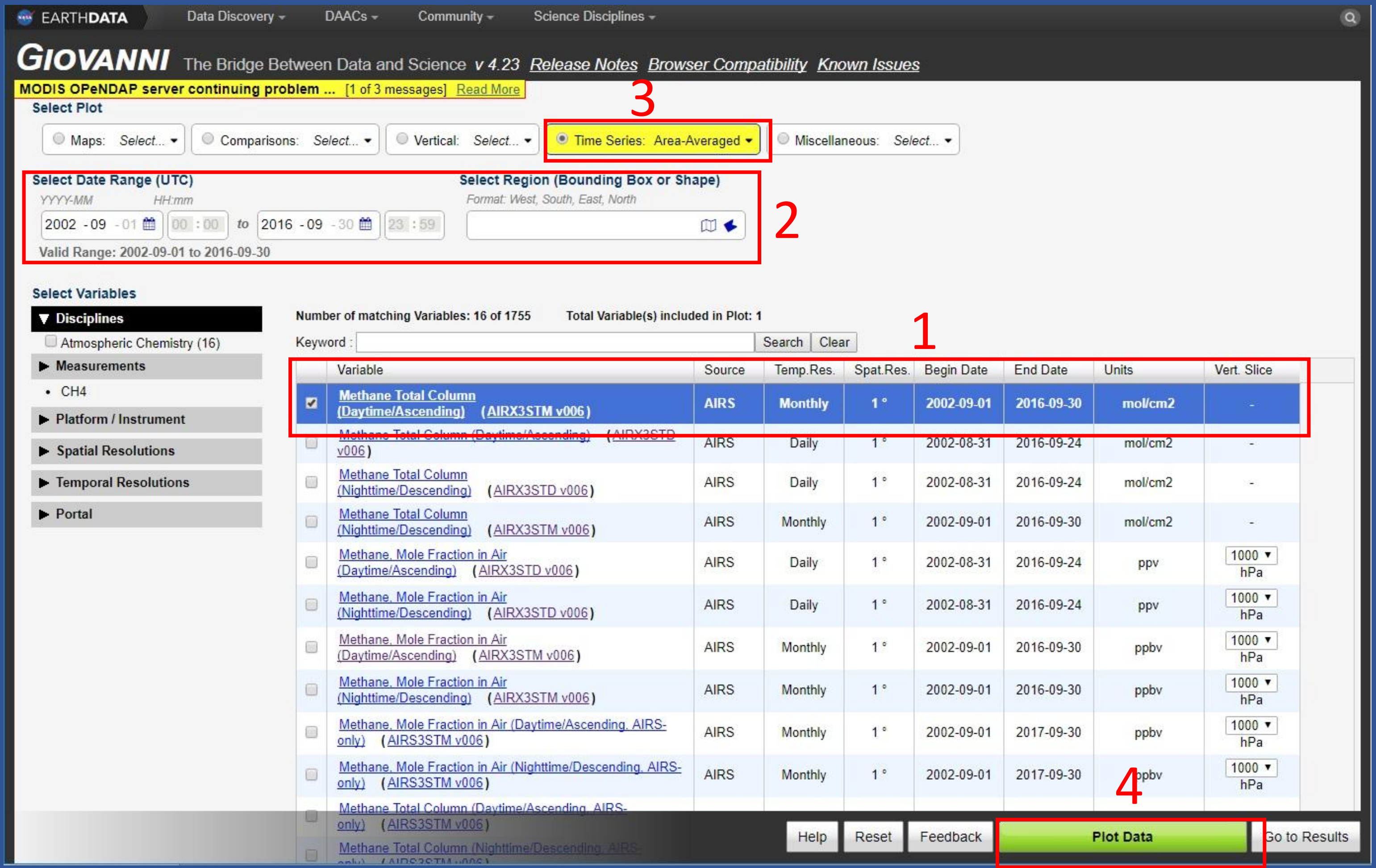
GES DISC CMS data



https://disc.gsfc.nasa.gov/

- NASA Carbon Monitoring System (CMS)
  - Quantify carbon reservoirs and fluxes
    - Uses numerous instruments and models to collect data
  - 10 datasets CMS datasets for various carbon cycling processes (fires, transportation, terrestrial and oceanic NPP, fossil fuel sources)
    - Bulk carbon fluxes
    - Global domain with varying temporal resolutions and time periods
  - CMS methane emission data for:
    - North America, Mexico, Canada
    - resolution of 0.5x0.667 (NA) and 0.1x0.1 (CA,MX)

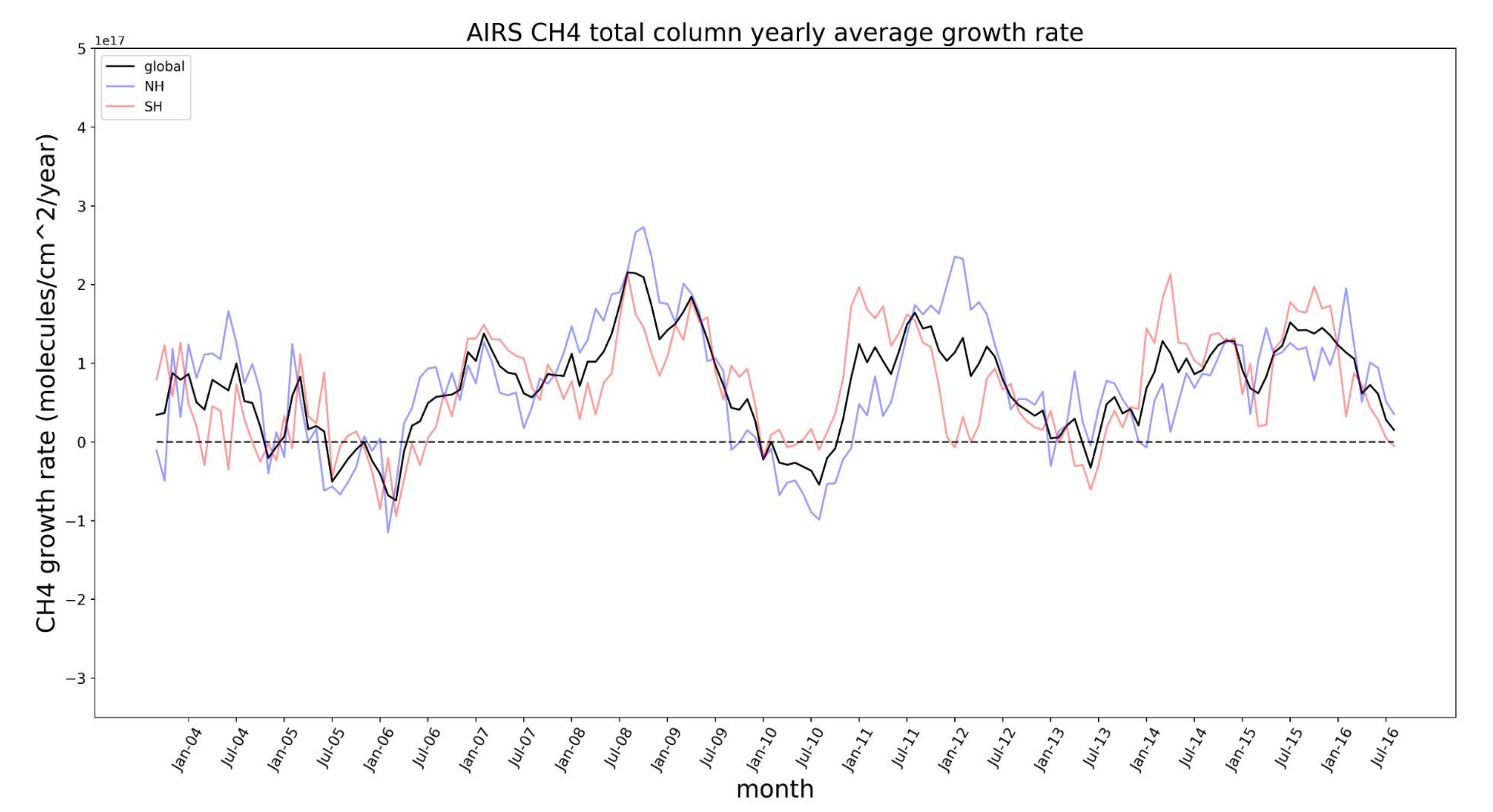
Compute atmospheric methane growth rates with Giovanni



1. Select variable (methane total column- AIRX3STM v6)
2. Subset temporal and spatial domains.
3. Select service (Time Series: Area-Averaged)
4. Hit “Plot Data” and wait ~2 minutes
5. Download .csv file

- Total time is ~10 minutes.
- Monthly products only

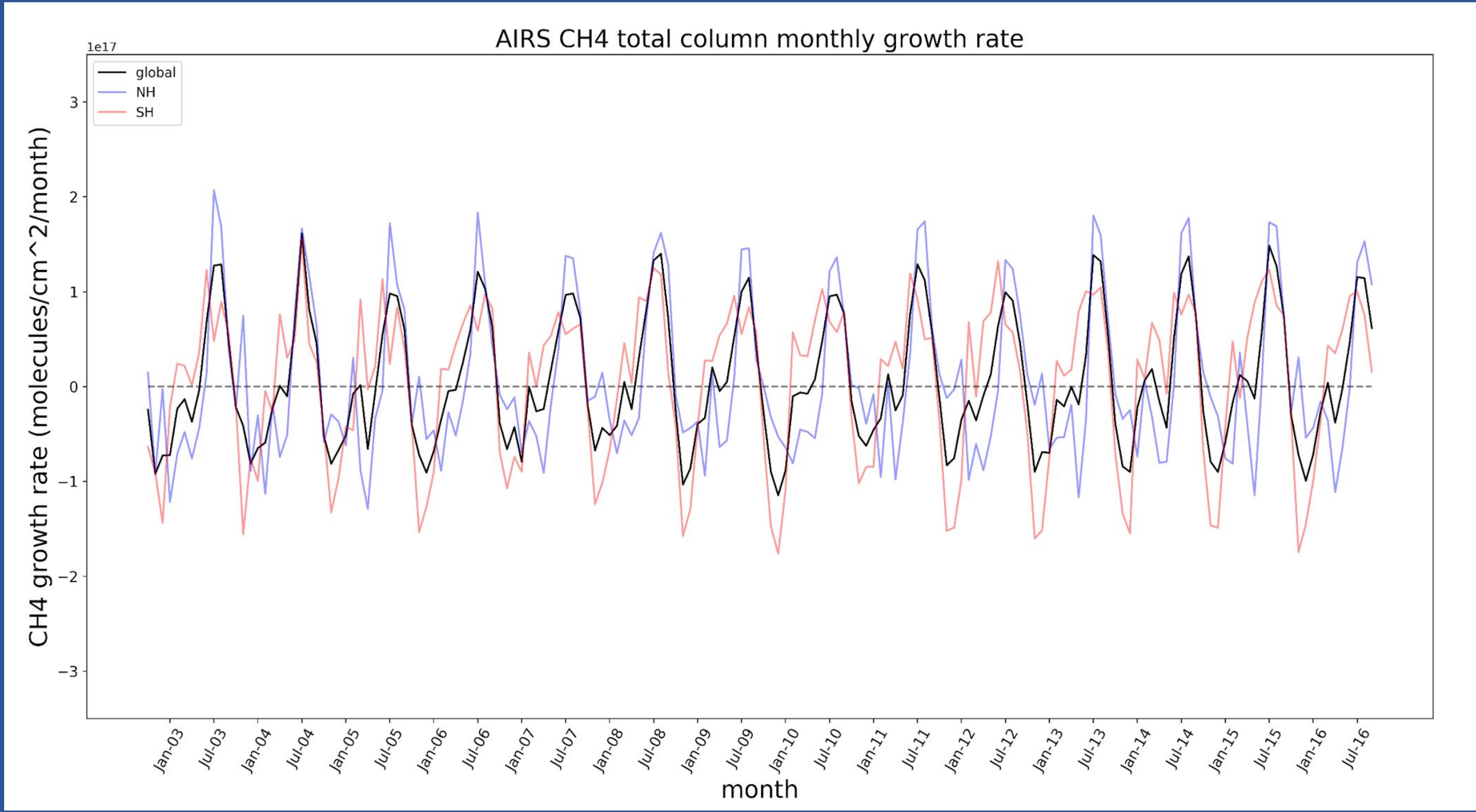
AIRS atmospheric methane growth rates



Currently do not have long enough CMS methane time series to study the trends

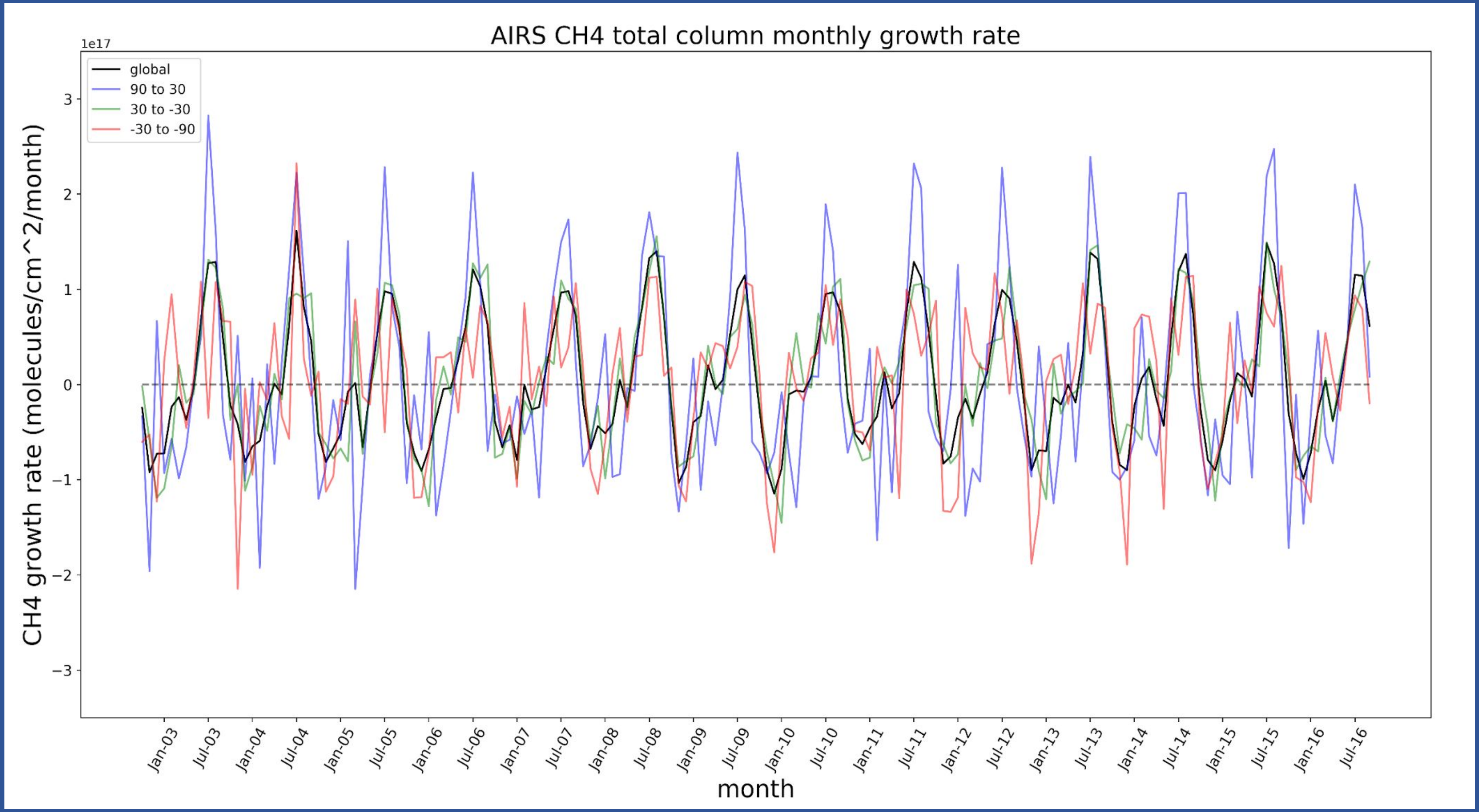
CH_4 growth rate = $CH_{4month(n)} - CH_{4month(n-12)}$ (Simpson et al. 2006; Rigby et al. 2008)

How to calculate atmospheric methane growth rates



CH_4 growth rate = $CH_{4month(n)} - CH_{4month(n-1)}$ (Simpson et al. 2006; Rigby et al. 2008)

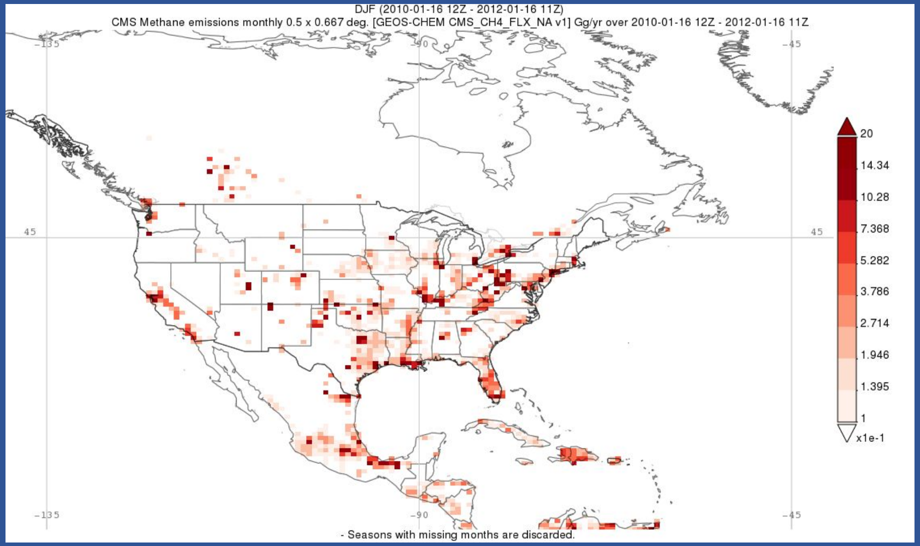
How to calculate atmospheric methane growth rates



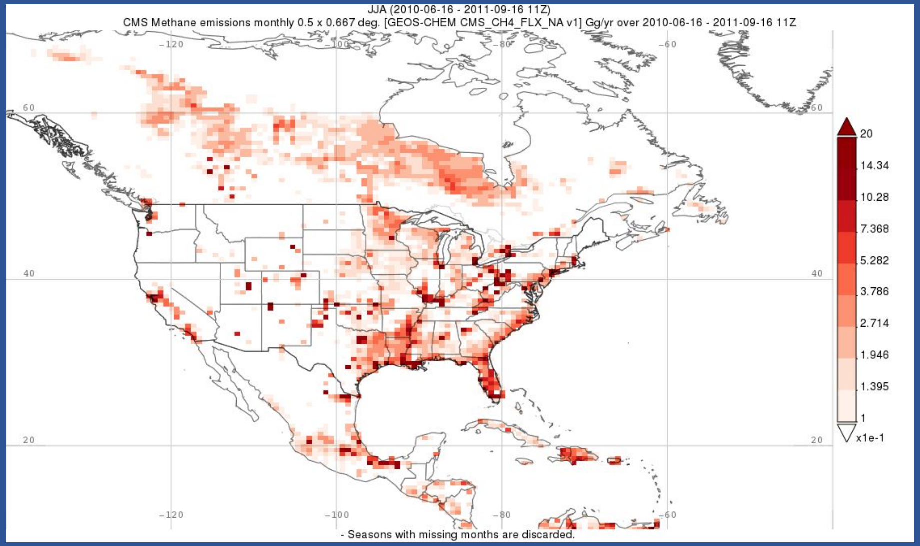
- Larger variability in the maximum growth rate for 90N to 30N than for other domains
- Can we attribute seasonal trends and variability in maximums in the northern hemisphere to source or sink processes?

Carbon Monitoring System (CMS) methane emissions data

DJF 2010-2011 methane emission average (Gg/year/cell)

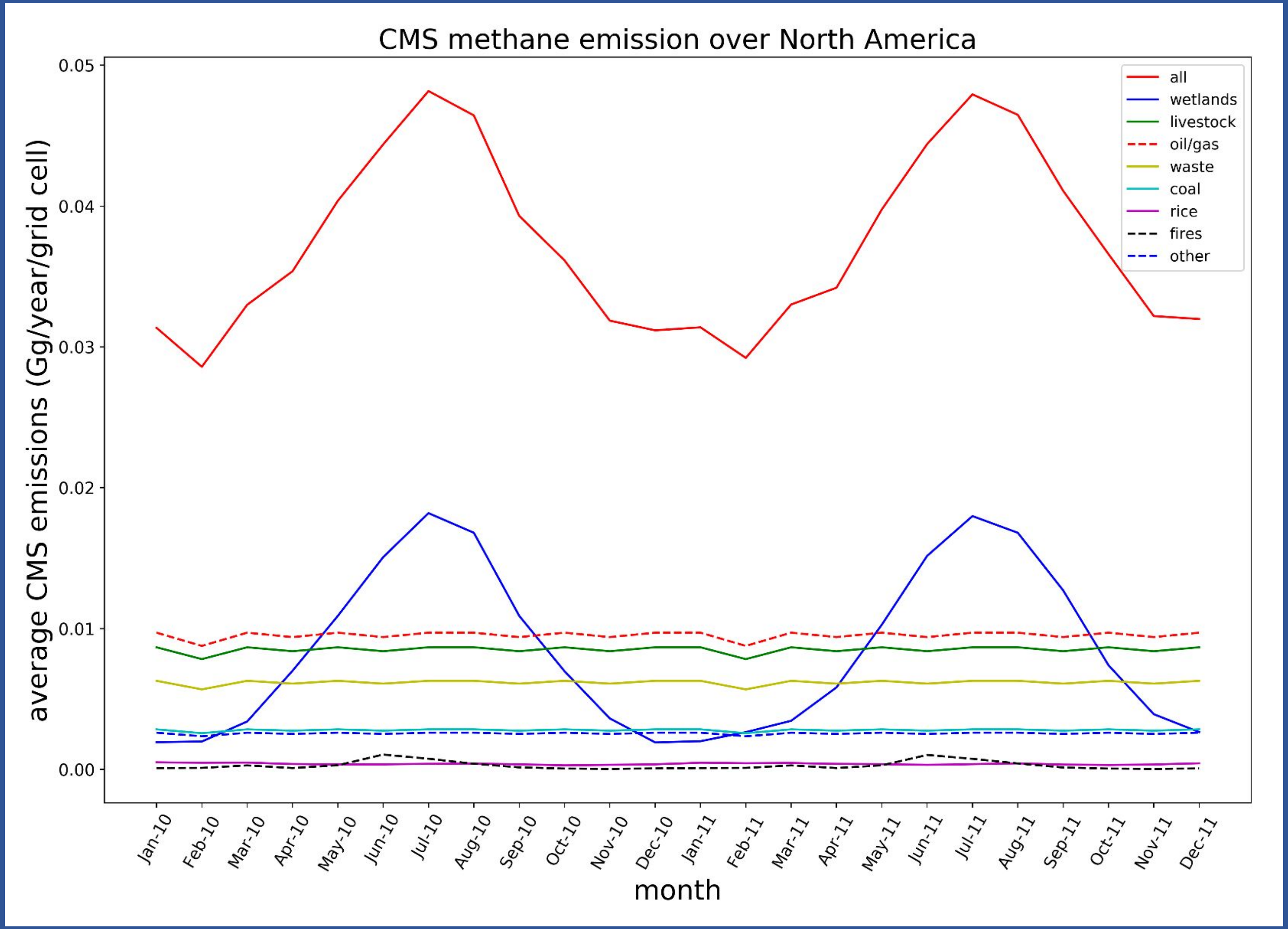


JJA 2010-2011 methane emission average (Gg/year/cell)



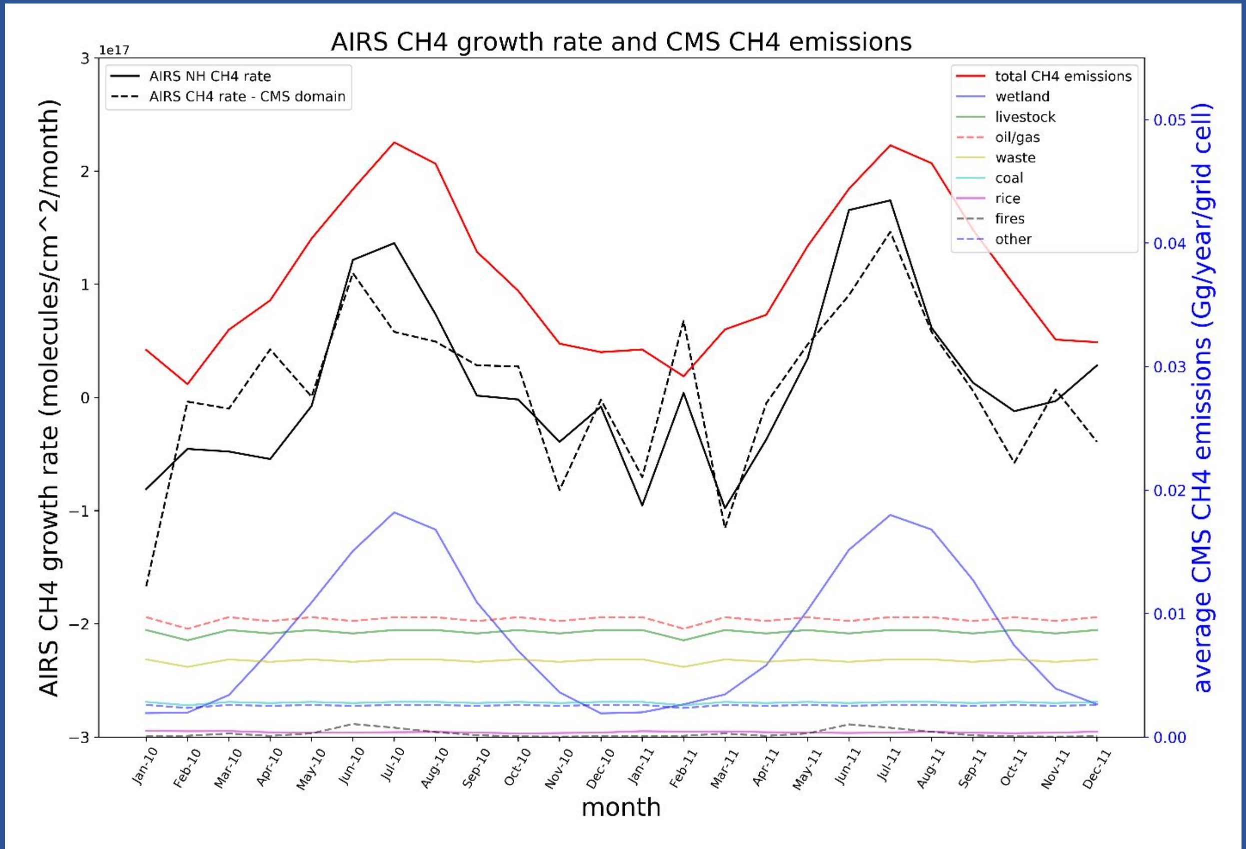
https://disc.gsfc.nasa.gov/datasets/CMS_CH4_FLX_NA_V1/summary?keywords=ch4

DOI: 10.5067/RF3R3G9I3UVX



Turner et al. 2015

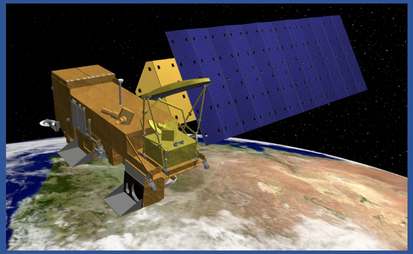
Carbon Monitoring System (CMS) methane emissions data

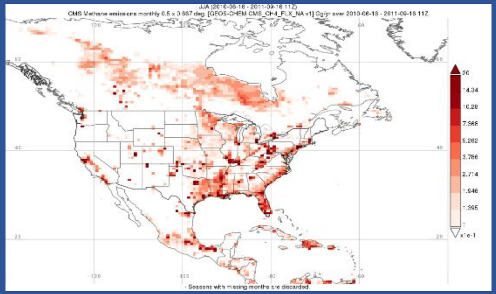


- Must also consider influence of sinks and air mass advection on methane growth rates
- compare sink and advection terms with observations

$$\frac{dCH4}{dt} = \Sigma\, sources \; - \; \Sigma\, sinks + \nabla CH4$$

Box modeling





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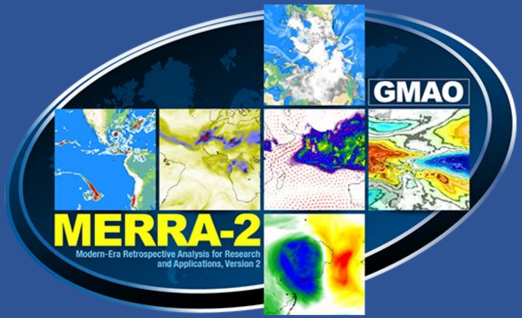

$$\frac{dCH4}{dt} = \Sigma\, sources - \Sigma\, sinks + \nabla CH4$$

- Can AIRS and CMS methane data be used as a constraint for methane sinks?
- Solve for sinks, compare methane losses to other estimates.
- Must consider uncertainty and error.

Conclusions

- Interesting trends in AIRS methane growth rates exist.
- CMS data could be used in concert with AIRS data to better understand these trends.
    - Caveats: Uncertainty in the data and short CMS time period
- This analysis could be expanded to utilize other CMS datasets and AIRS variables.