GES DISC long-term data analysis services using AIRS and CMS methane data as an example

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Abstract

NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) archives and distributes rich collections of data on atmospheric greenhouse gases from multiple satellite missions and model results. Included in this collection of greenhouse gas data is methane. Atmospheric methane is a powerful greenhouse gas contributing ~0.5 (W/m^2) to total radiative forcing, and its concentration has increased by ~150% since 1750 (Dlugokencky et al., 2011). Observations or estimates of methane emissions typically have sparse spatial and temporal coverage. The lack of comprehensive spatial and temporal coverage of methane source and sink observations has made understanding atmospheric methane trends challenging.

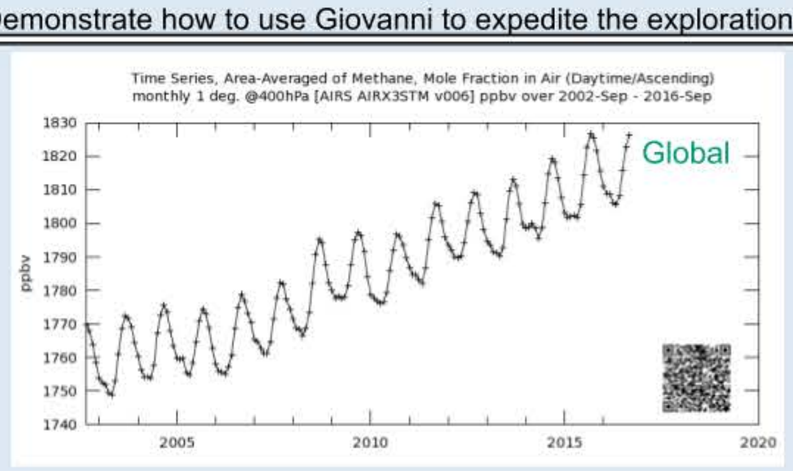
The GES DISC aims to provide the scientific community with resources and tools to better understand changes in atmospheric greenhouse gases and their underlying causes. This study serves as an example of how one might utilize GES DISC data and services to study greenhouse gases. We utilize methane concentration data from the Atmospheric Infrared Sounder (AIRS) (*AIRX3STM V6*) and methane emissions data from the Carbon Monitoring System (CMS) (*CMS_CH4_FLX_NA*). We demonstrate how Giovanni can be used to expedite the processing of greenhouse gas data to more easily and quickly compute growth rates. Comparisons of AIRS methane growth rates and CMS methane emissions suggests wetland emissions may impact methane growth rate trends over North America, but further study is needed to understand the impacts of advection and methane sink processes. Further study of the impacts on advection and sink processes on methane growth rates can be prototyped using Giovanni. As the record for CMS methane data lengthens, so can the time period used in the analysis. Longer time-series would provide a better understanding of source, sink, advection processes on the variability of methane growth rates.

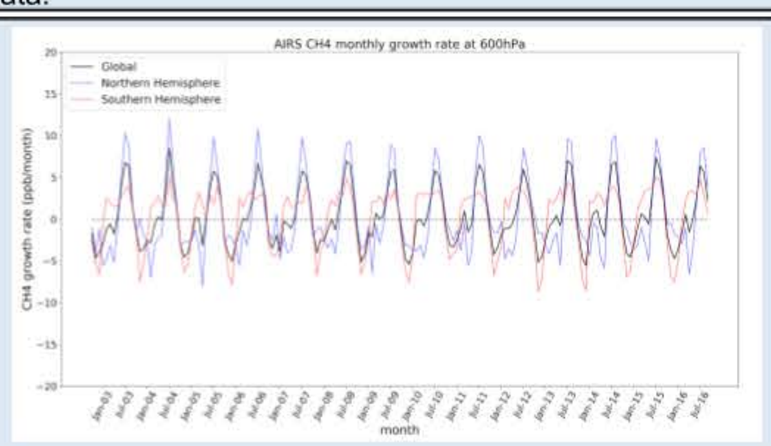
Goals

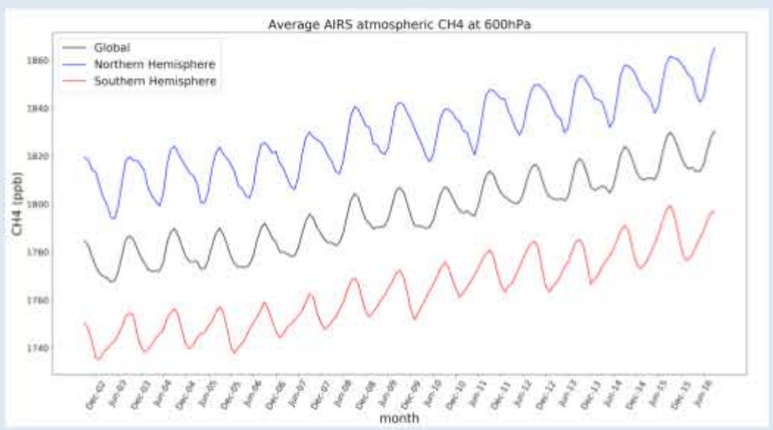
- Use Giovanni and GES DISC data to study the distributions and trends of trace gases.
- Demonstrate how to use Giovanni to expedite the exploration of data.

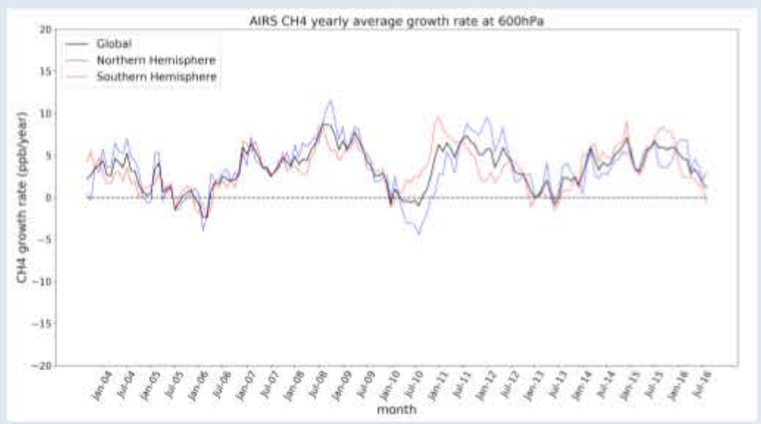
Use Giovanni to explore data & expedite analysis

- Perform spatial, temporal, and variable subsetting.
- Visualize data before download.
- Use Giovanni services to conduct simple analysis.
- Spatially average methane for the entire AIRS time period.
- Download analyzed data.
- Use downloaded data to conduct further analysis.
- HowTo: calculate greenhouse gas growth rates using Giovanni



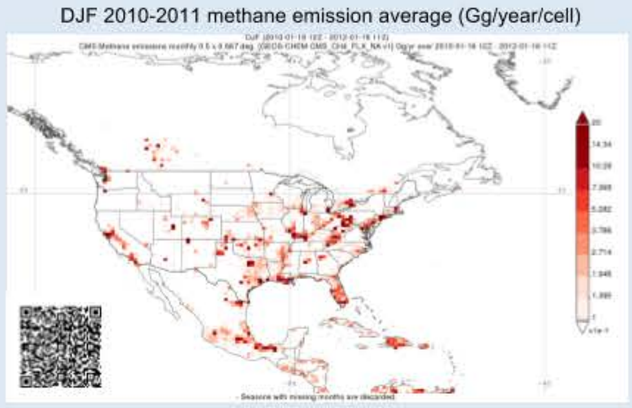


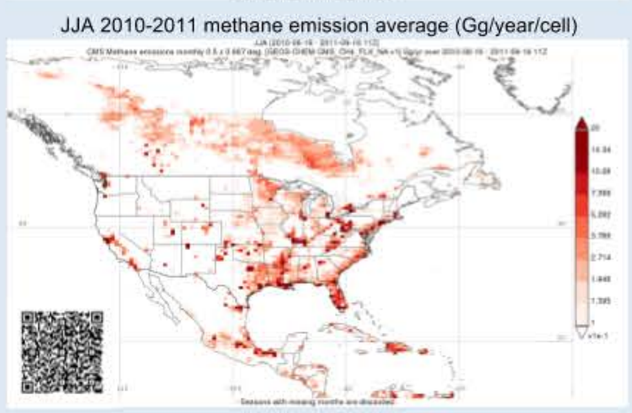


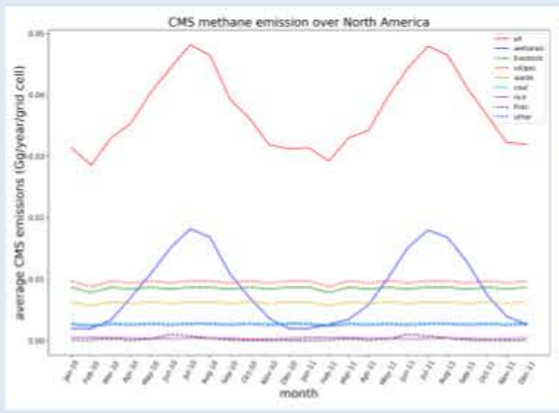


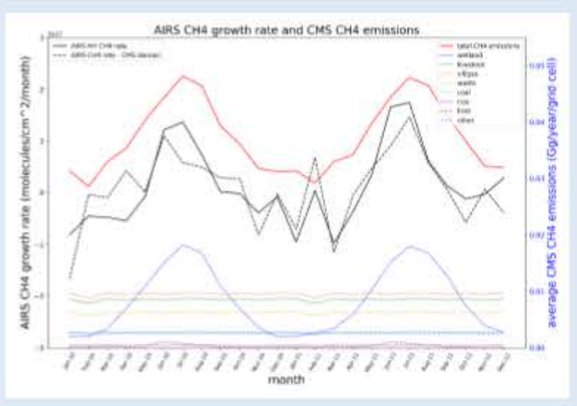
Utilize multiple GES DISC datasets

- Use GES DISC datasets in concert, to better understand atmospheric trace gas trends.
- Carbon Monitoring System emissions data provides estimates of carbon and methane emissions.
- How do trends of methane emissions and concentrations compare?
- Are additional data needed to understand this comparison?
  - In our example, yes.
  - Supplement advection terms with MERRA-2. What about methane sinks?







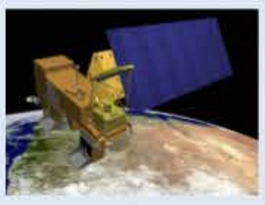


Prototype your study with GES DISC data and services

★ Use Giovanni to explore the feasibility of a study:

- Can AIRS and CMS methane data be used as a constraint for methane sinks over North America?
- Solve for sinks and compare methane losses to other estimates.
- What is the relative contribution of methane emissions, advection, and sinks to the growth rate?
- *Note: Giovanni does not calculate uncertainty or error.*

AIRS



CMS

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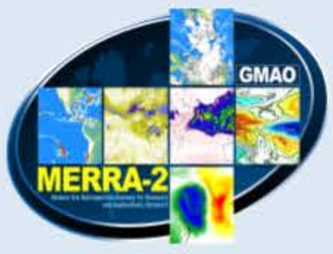
MERRA-2



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

Acknowledgments

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References

Dlugokencky, E. J., Nisbet, E. G., Fisher, R., & Lowry, D. (2011). Global atmospheric methane: budget, changes and dangers. *Philosophical Transactions of the Royal Society of London A: Mathematical, Physical and Engineering Sciences*, *369*(1943), 2058-2072.
CMS methane emissions (DOI: 10.5067/RF3R3G9I3UVX)
AIRS methane (DOI: 10.5067/AQUA/AIRS/DATA319)