What can we learn about tropospheric OH from satellite observations of methane?

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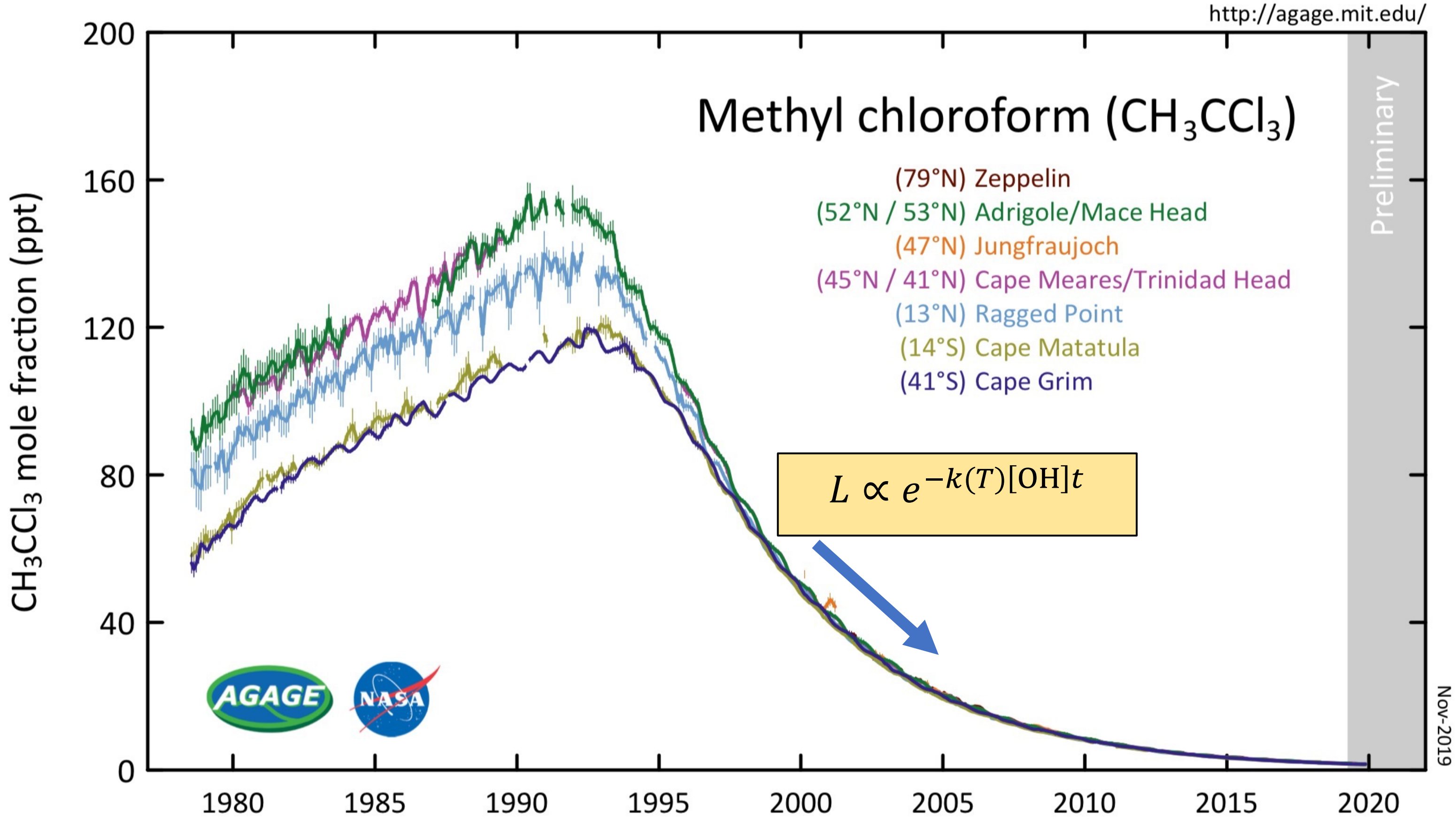
Modeling & estimating OH is a longstanding challenge

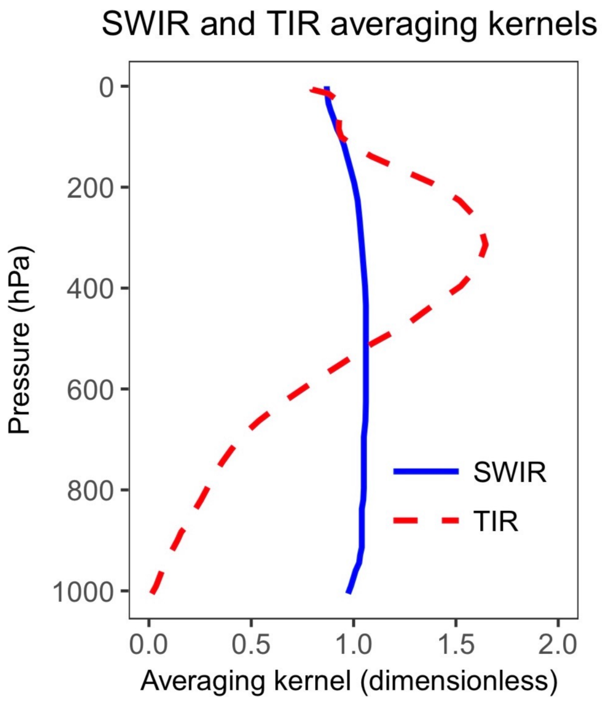
- Tropospheric OH is the main sink of atmospheric gasses including **methane**
- Mean global OH estimated using methyl chloroform decay as a proxy: **11.2 ± 1.3 molec./cm^3 x 10^5** *(Prather et al., 2012)*



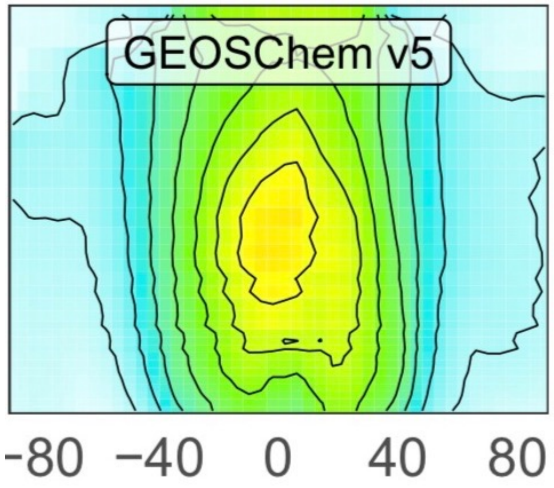
Challenges:

- OH interannual variability
- Long term trends in OH
- Methyl chloroform is running out

What can satellite observations tell us about OH?



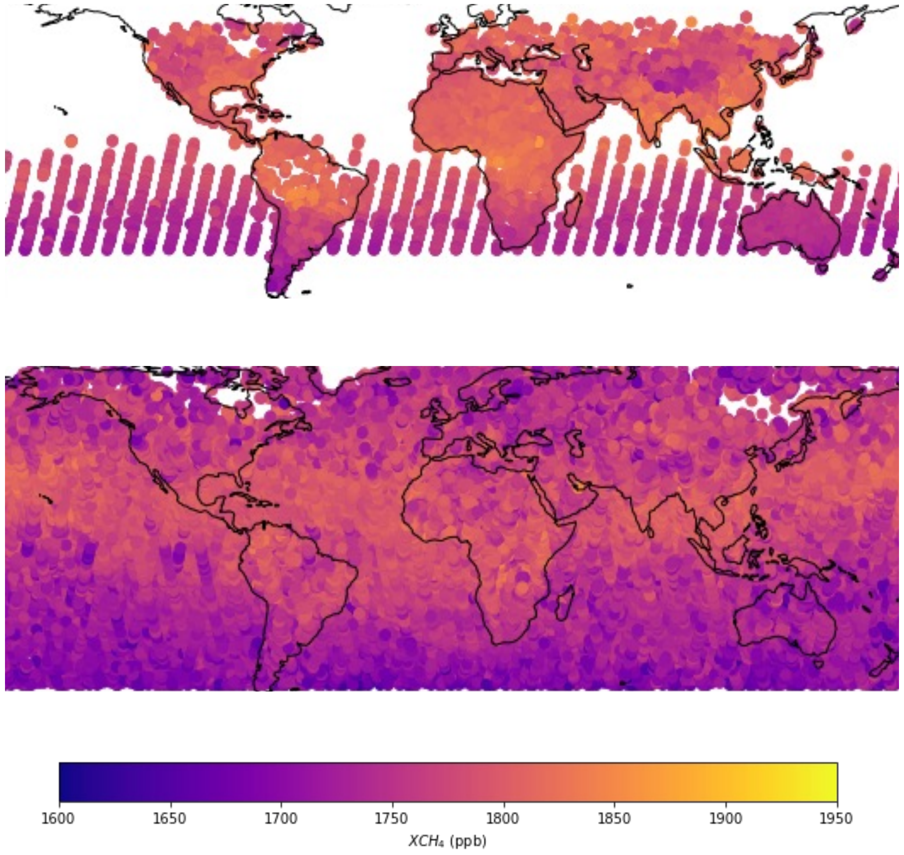
Methane loss in GEOS-Chem



Latitude

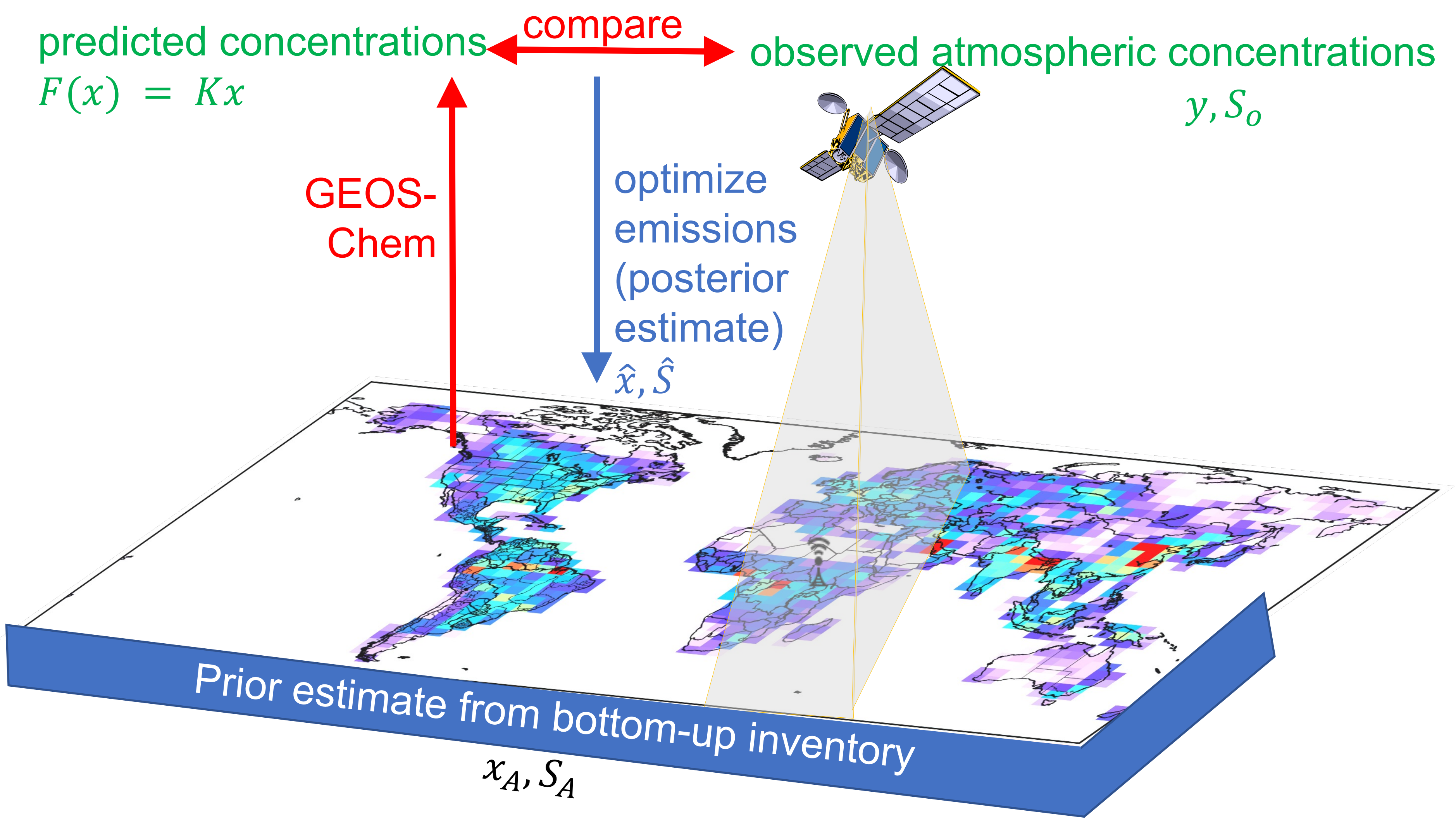
SWIR (GOSAT)

TIR (AIRS) +19ppb



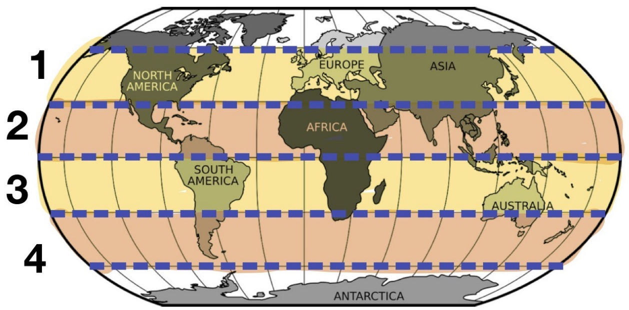
(Zhang et al. 2018)

We find the optimal estimate for emissions of **methane** and **concentrations of OH** using a Bayesian inversion.



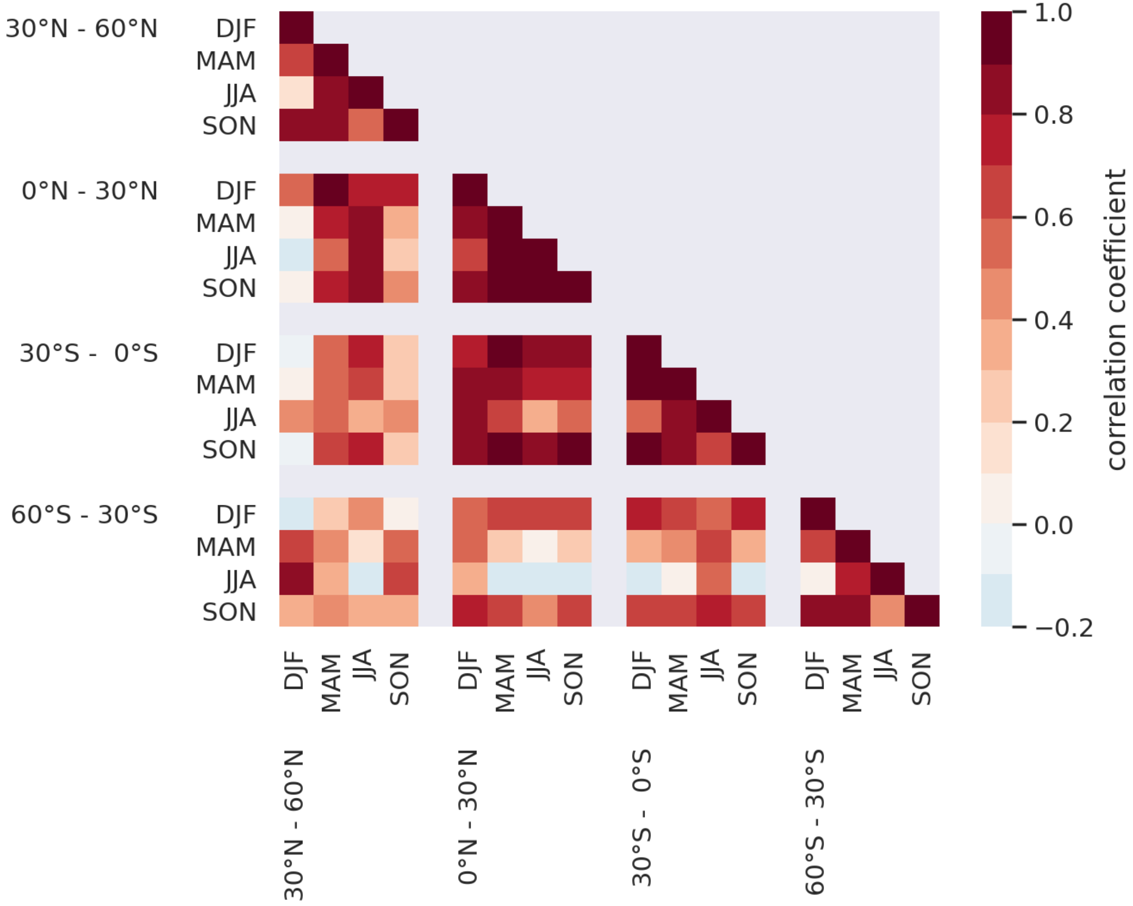
Prior errors in OH concentrations are spatially & temporally correlated

4 OH sections



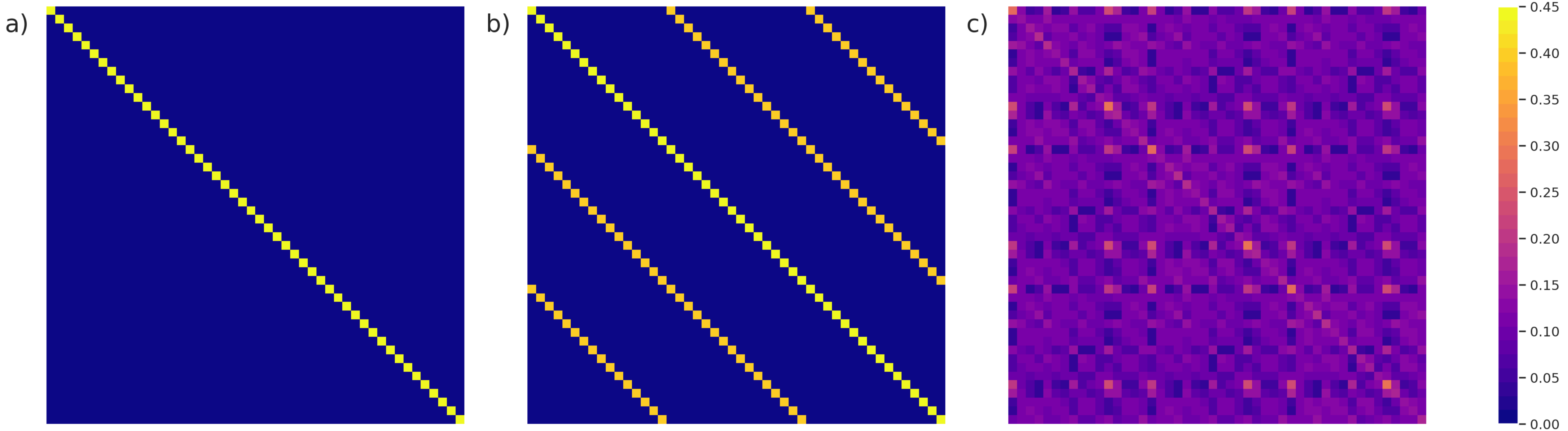
x 4 seasons x 3 years

Correlation between ACCMIP model members



ACCMIP = Atmospheric Chemistry and Climate Model Intercomparison Project

Past work has used different prior OH errors. We test 3 cases here.



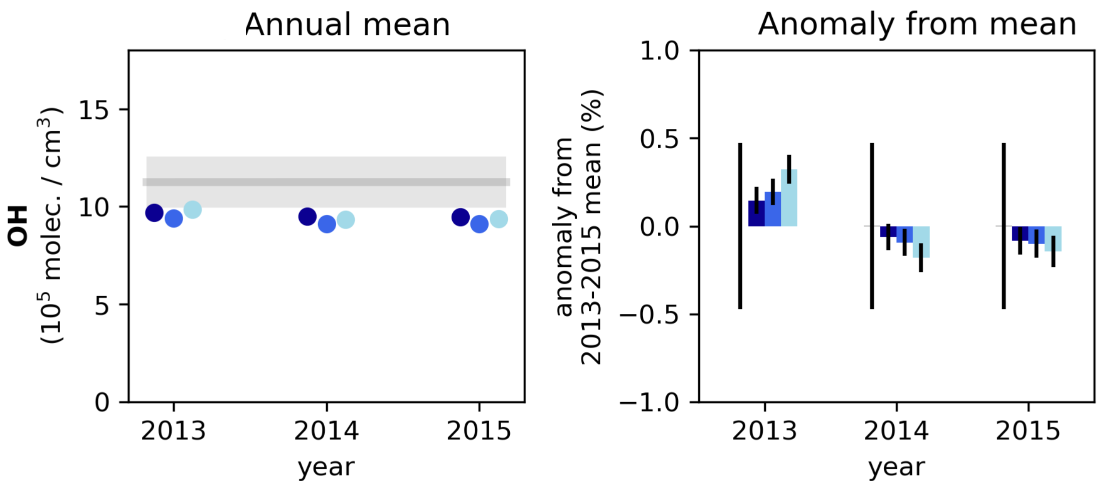
No correlations
- No error correlations

Correlated years
- Error correlations between years
- Latitude bands independent

Full correlations
- Error correlations between years
- ACCMIP-informed correlation between latitude bands

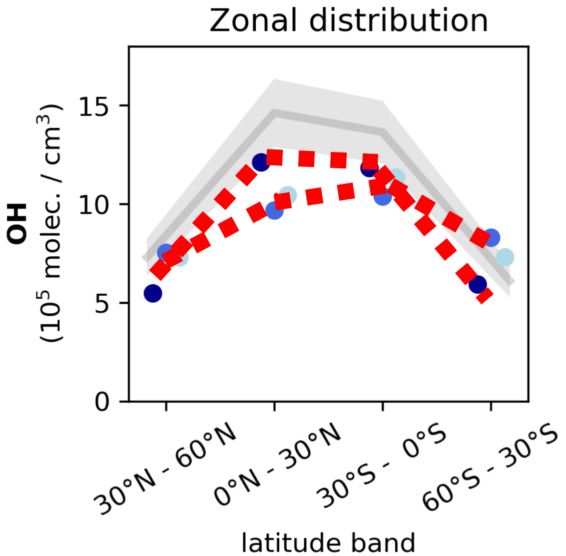
Error covariance matrices for 3 years x 4 seasons x 4 latitude bands

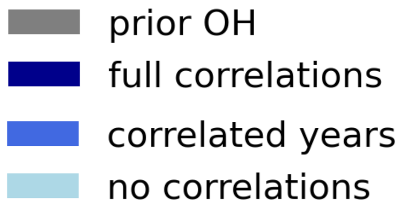
The prior OH errors have a large effect on the posterior solution



No prior error correlations between **years**

-> stronger corrections to interannual variability



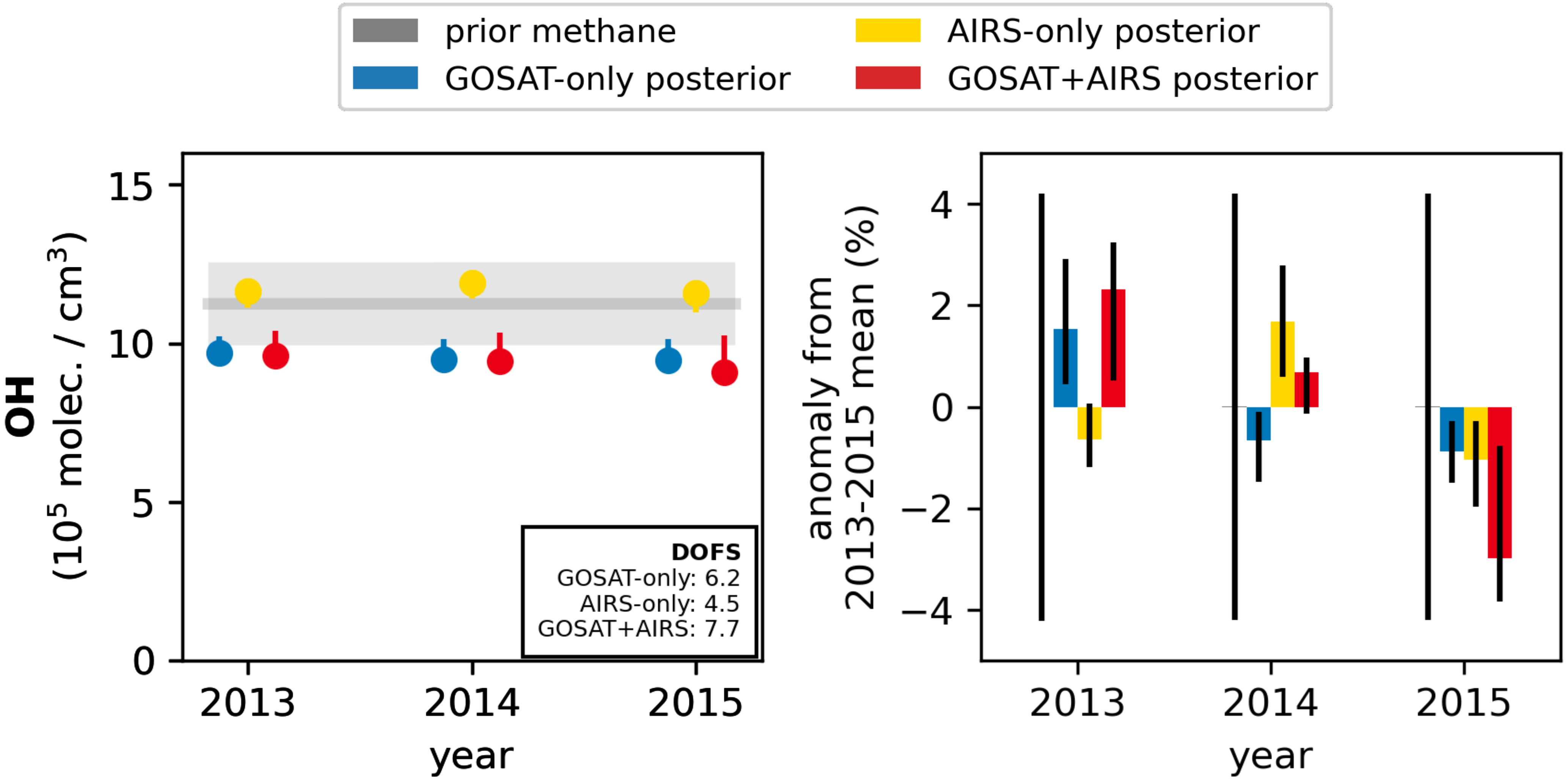


*GOSAT-only inversion shown with **posterior errors***

No prior error correlations between **latitude bands**

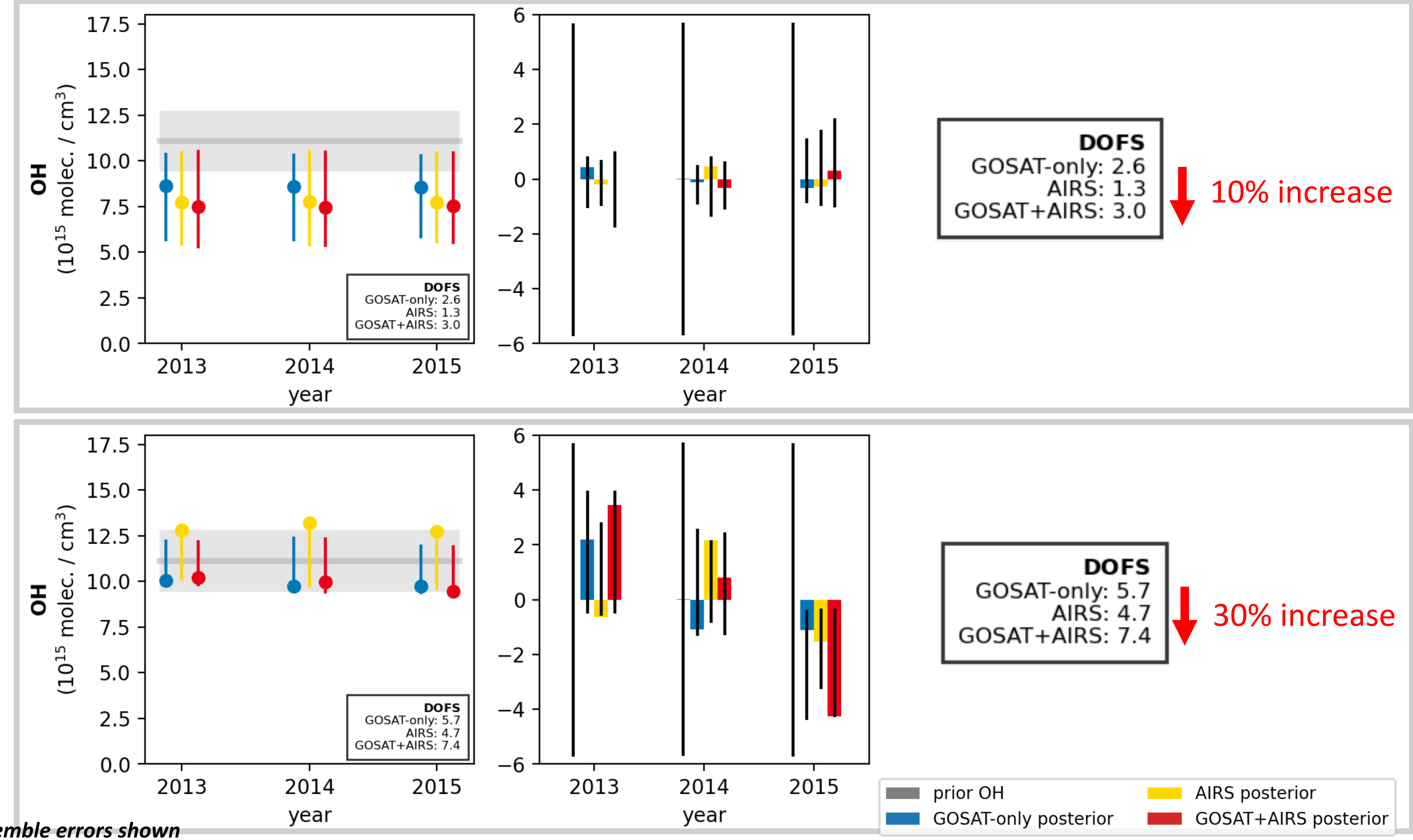
-> flatter zonal distribution, higher OH in the southern hemisphere

We gain additional information about interannual variability from AIRS.



ensemble errors shown

The posterior OH interannual variability is driven by **OH over the oceans.**

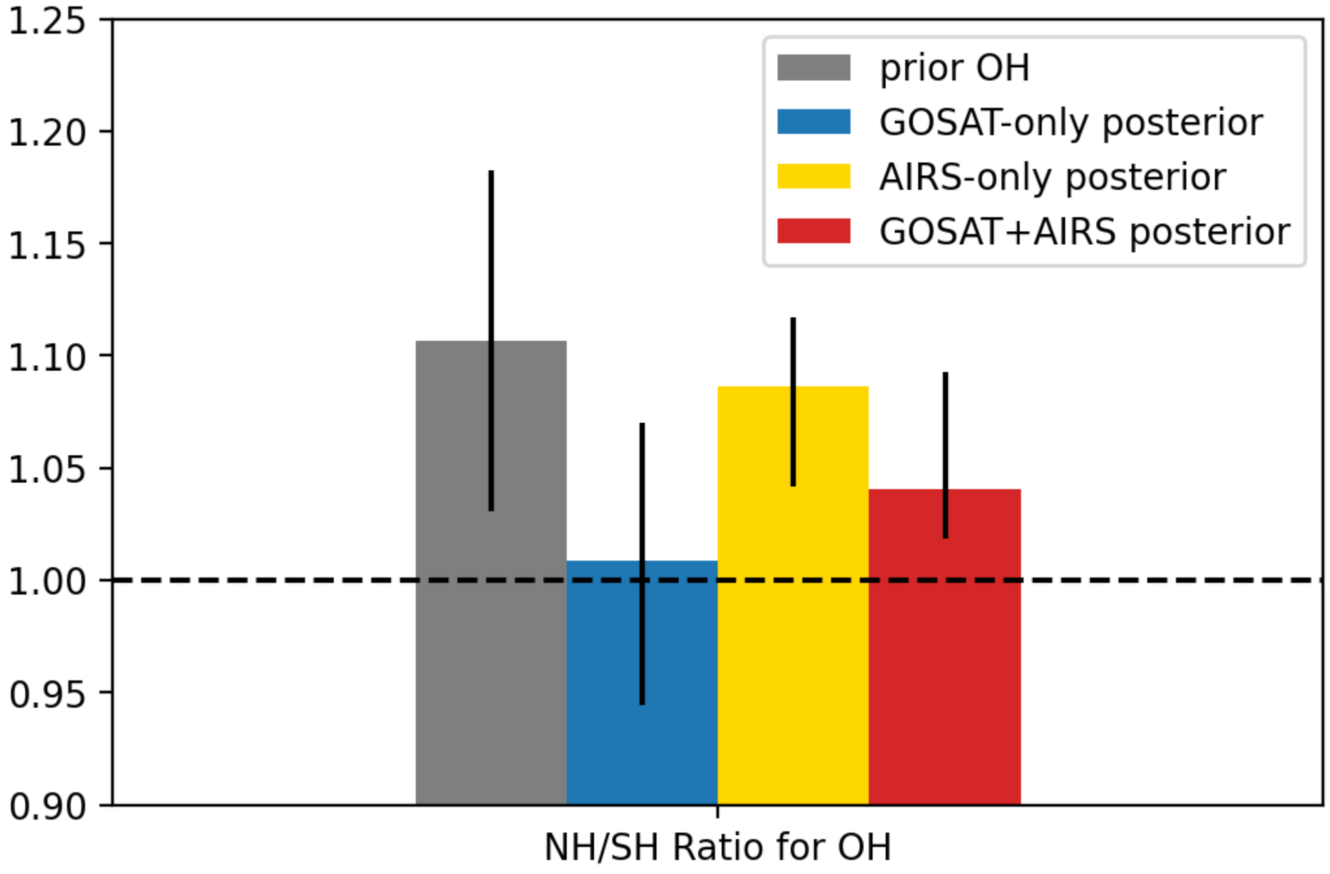


Land

Ocean

ensemble errors shown

All solutions suggest a flatter interhemispheric gradient for OH.



We find an interhemispheric ratio of:
1.01 ± 0.06 (GOSAT)
1.05 ± 0.04 (GOSAT+AIRS).

Lower than model-based approaches:
1.28 ± 0.1 *(Naik et al, 2013)*

Consistent with methyl-chloroform constraints:
0.97 ±0.12 *(Patra et al., 2014)*

ensemble errors shown

What have we learned about OH from satellite observations of methane?

1. SWIR observations alone can infer global mean OH and interhemispheric gradient.
2. Interannual variability of OH is driven by OH over the oceans, where TIR adds the most information.
3. We find interhemispheric ratio of OH is near unity.

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