CrIS CH_4 and Comparisons to AIRS CH_4

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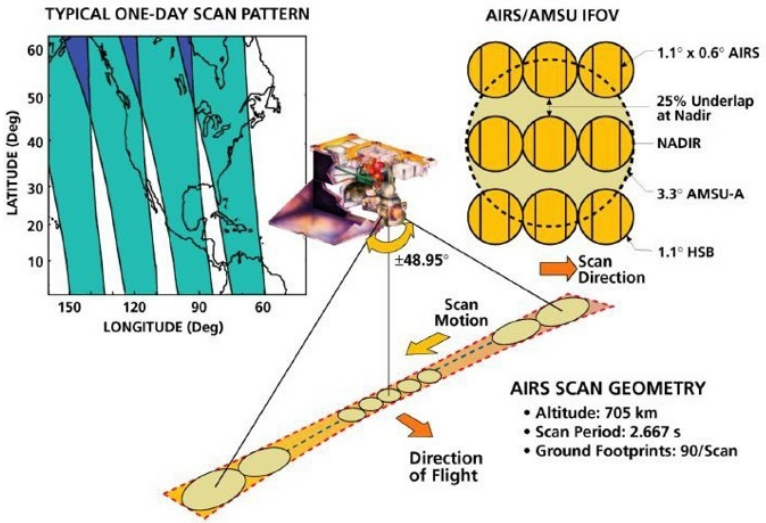
- To establish consistent data record between AIRS and CrIS;
- Our NASA N_2O grant (NNX14AJ24G) is wrapping up, the last step to obtain CH_4 based on improved N_2O retrievals

AIRS and CrIS – Hyperspectral thermal sensors for continued data records

AIRS – Atmospheric InfraRed Sounder
Grating spectrometer
Covers 650-2665 in three bands with a total of 2378 channels
13.5 km FOV at nadir, contiguous
Launched on Aqua in 2002

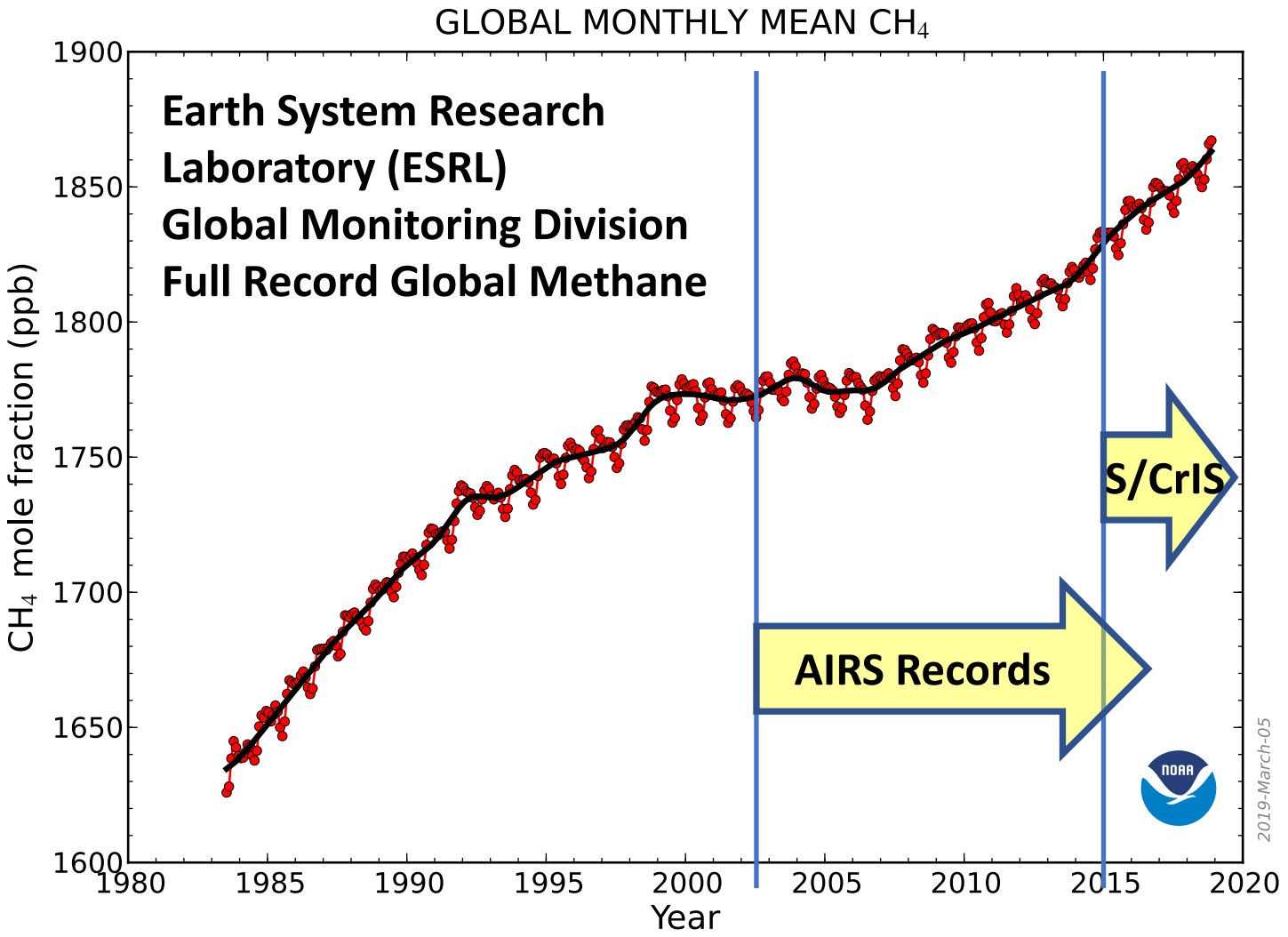
CrIS – Cross-track Infrared Sounder
Michelson interferometer
3x3 14 km FOVs at nadir, contiguous
Launched on S-NPP in 2011



Cloud-Clearing – Improve the daily coverage to ~ 50-70% compared to the 10% clear coverage
Uses jointly with a microwave sensor, e.g., AMSU on Aqua
Reduce L2 spatial resolution from 13.5 km to ~45 km

Why Study CH_4 Using AIRS/CrIS

- Atmospheric CH_4 one of the most important long-life greenhouse gases after carbon dioxide (CO_2), which accounts for 18% of the total anthropogenically produced green-house gas radiative forcing (*IPCC*, 2007).
- Tropospheric methane oxidation will lead to the formation of ozone.
- Enriching moisture in the stratosphere (e.g. Brasseur et al., 1998).
- A concern if the CH_4 release from permafrost soils and continental shelves, a likely positive feedback of Arctic warming.



https://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/#global_data

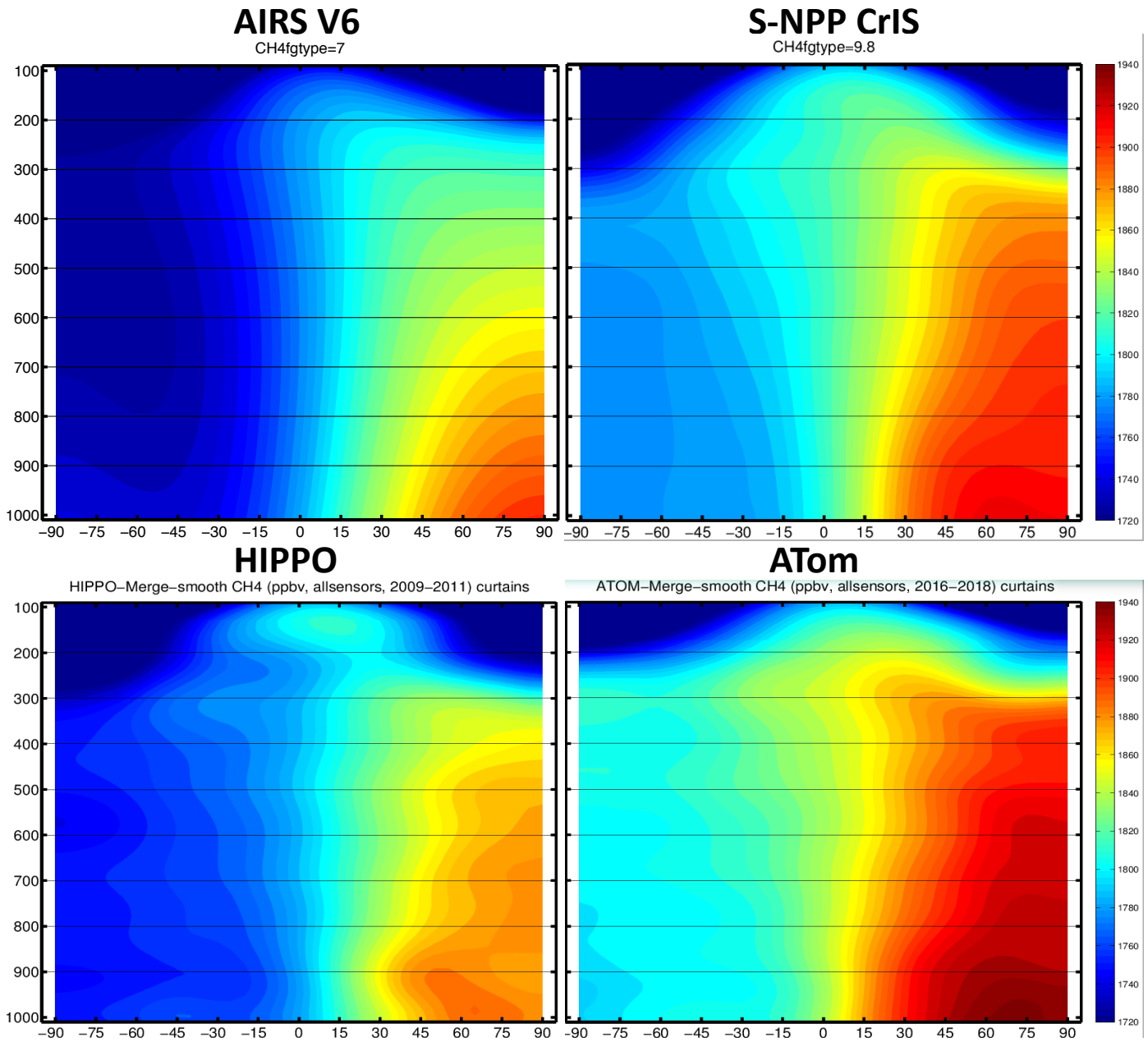
New Retrieval Factors Examined

- A priori
- Retrieved N_2O effects on CH_4
- Error effects from Cloud-cleared radiances and other trace gases
- Comparison between AIRS V6 and CrIS CH_4

CH_4 *A Priori*

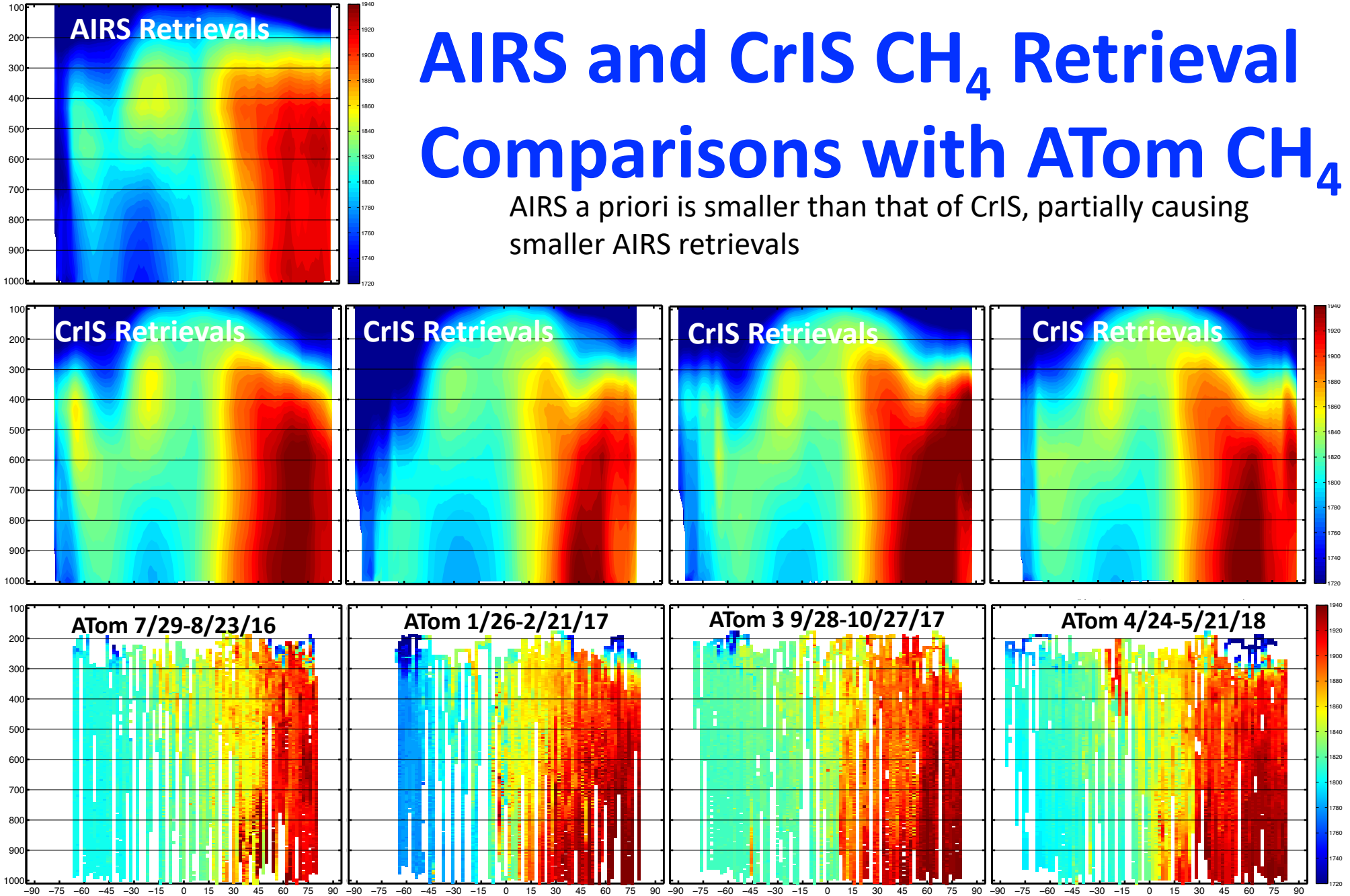
A priori

In Situ

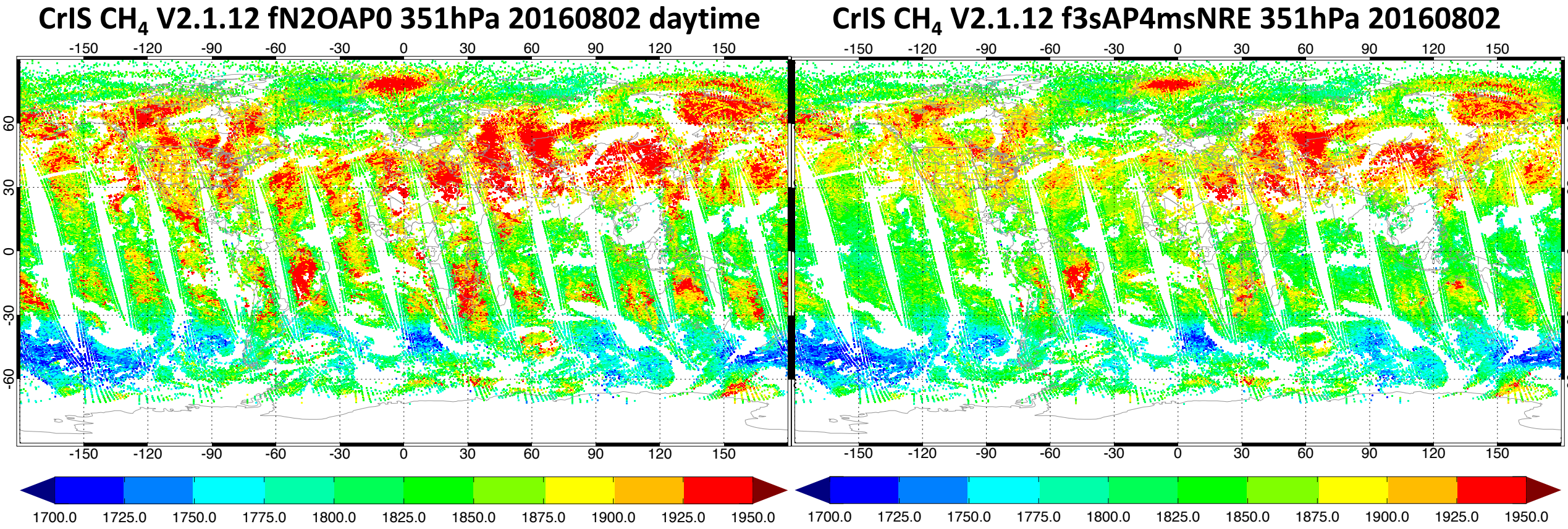


AIRS and CrIS CH_4 Retrieval Comparisons with ATom CH_4

AIRS a priori is smaller than that of CrIS, partially causing smaller AIRS retrievals



NUCAPS CrIS CH_4 Before and After

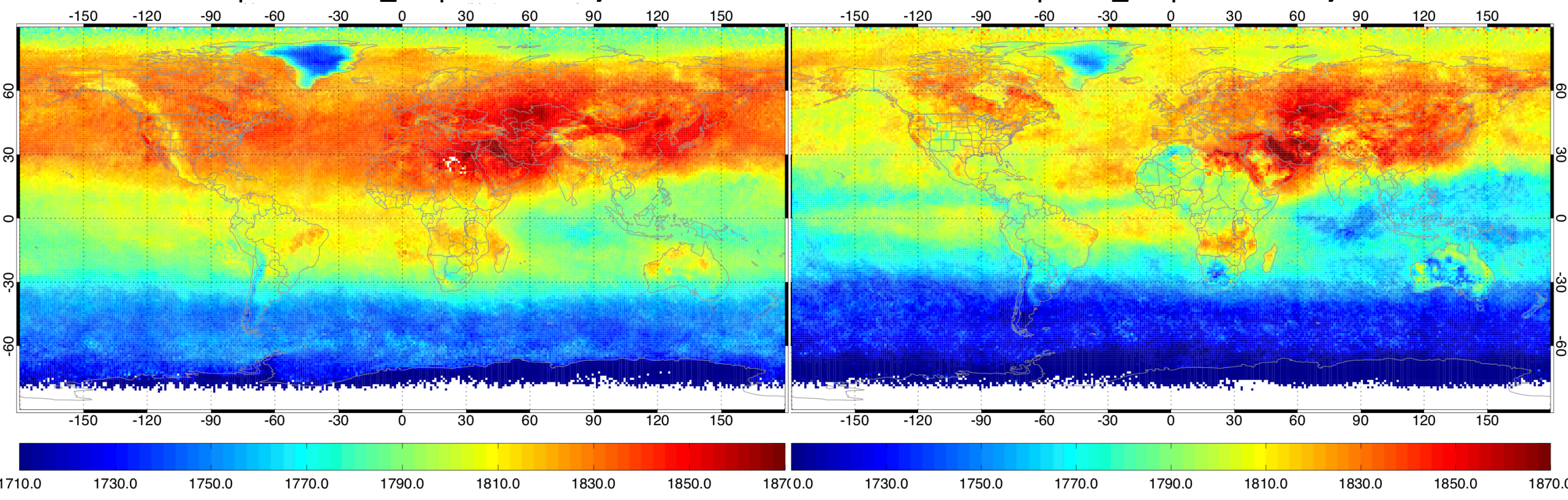


- Before (left) and after (right)
- Removed crosstrack biases and provided realistic values based on validations
- CrIS results are not final due to ongoing tuning

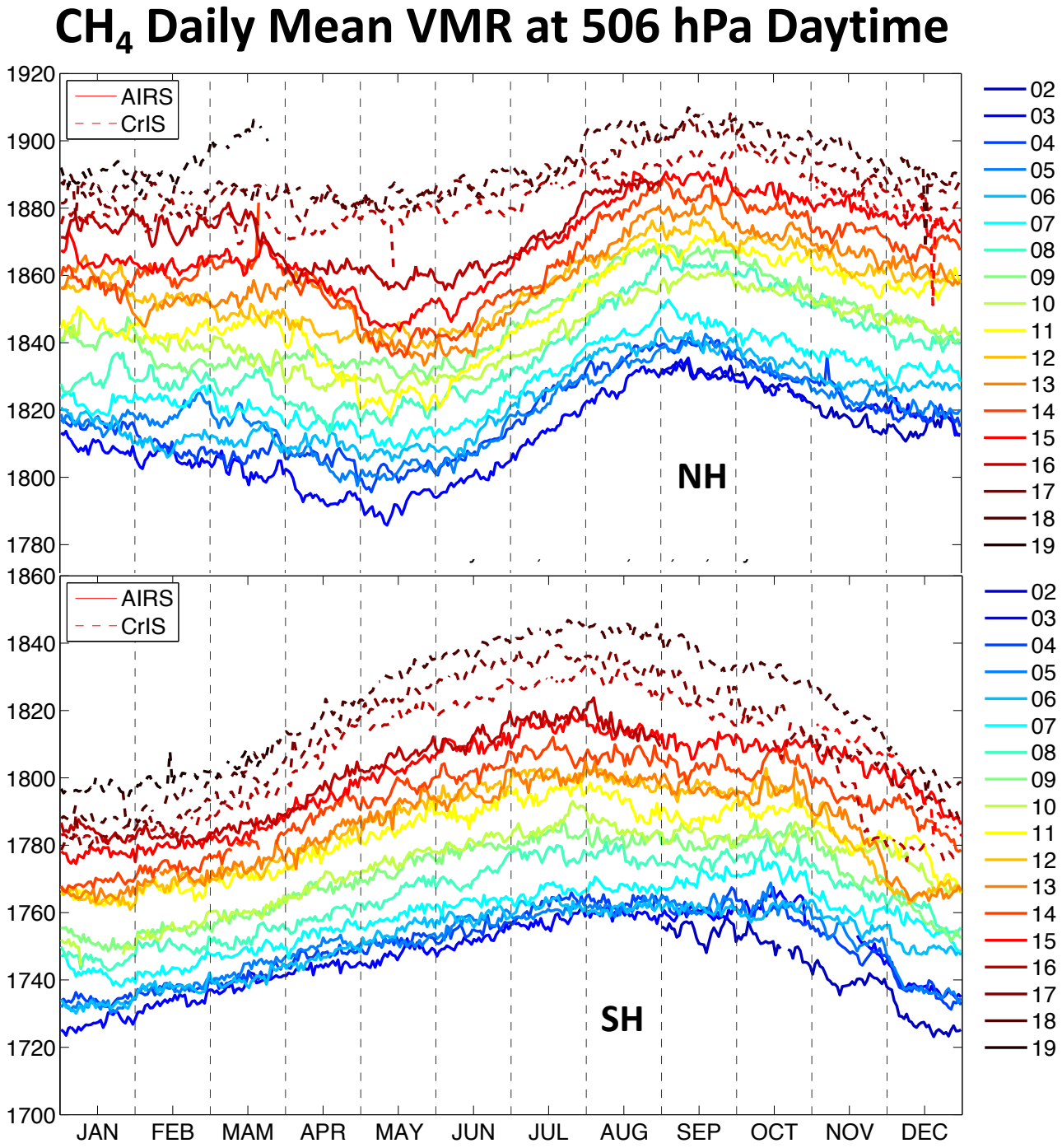
A Comparison of AIRS and CrIS XCH_4 VMRs

CrIS CH_4 V2.1.12 X_CH_4 201608 daytime

AIRS CH_4 V6 X_CH_4 201608 daytime



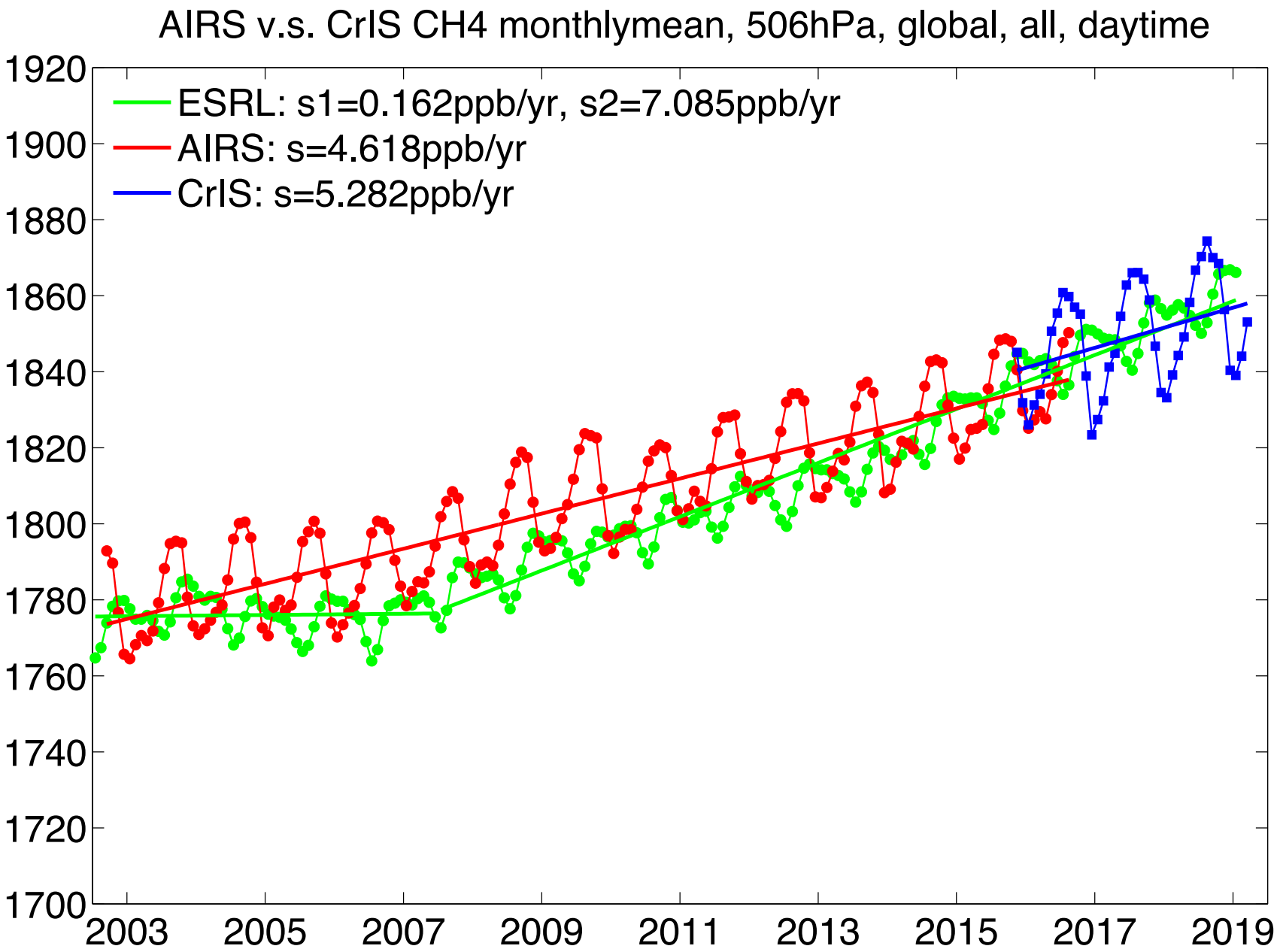
- Mostly similar patterns, CrIS CH_4 more zonal effects;
- Lower values for CrIS CH_4 over the Arctic;
- CrIS CH_4 higher than AIRS due to higher a priori.



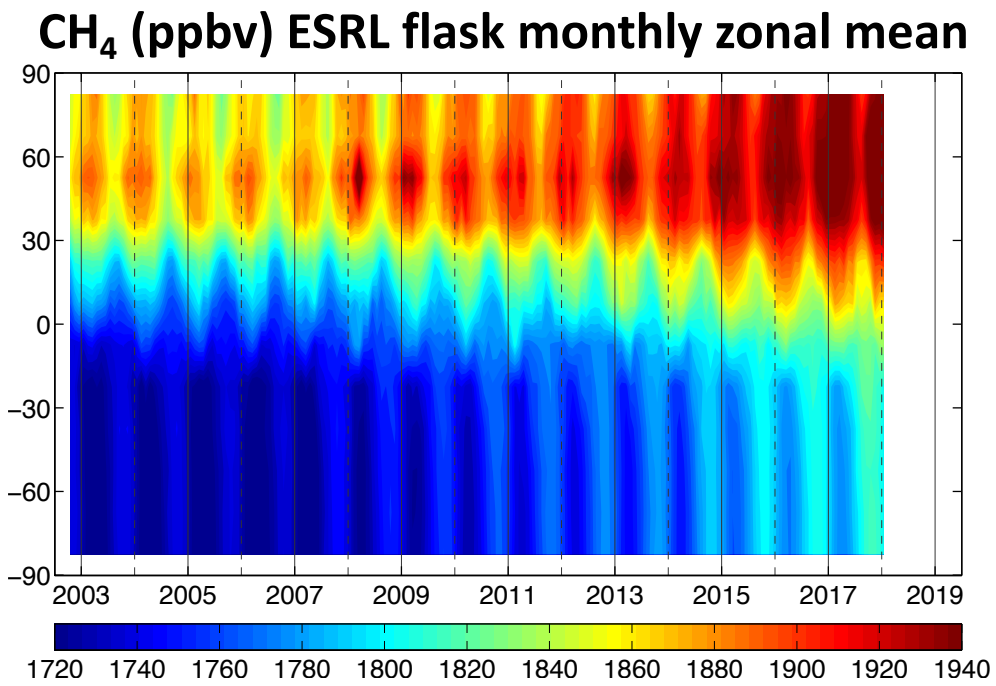
Seasonal Variations and Trends

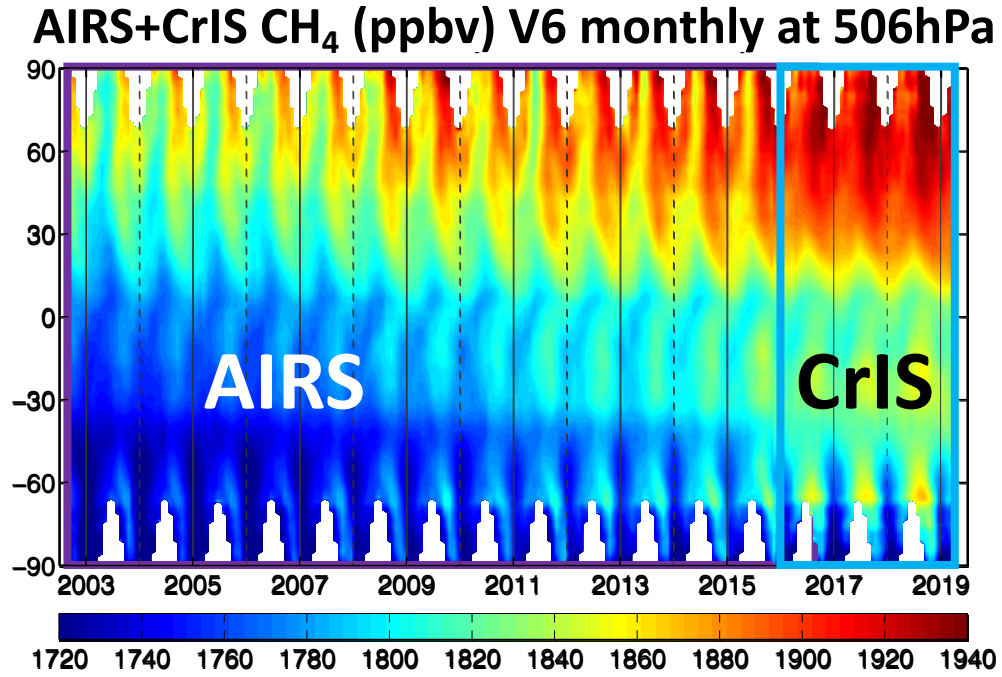
- High values in the fall and a second peak in the spring in the NH; One peak in the SH during winters.
- Increases about the same amount in all seasons.

Global Monthly Mean CH_4 Trends



- CrIS (blue) and AIRS V6 (red) mid-tropospheric CH_4 records agree very well, and with ESRL https://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/#global_data measurements;
- ESRL CH_4 shows sudden increase in 2008, but AIRS not as obvious.



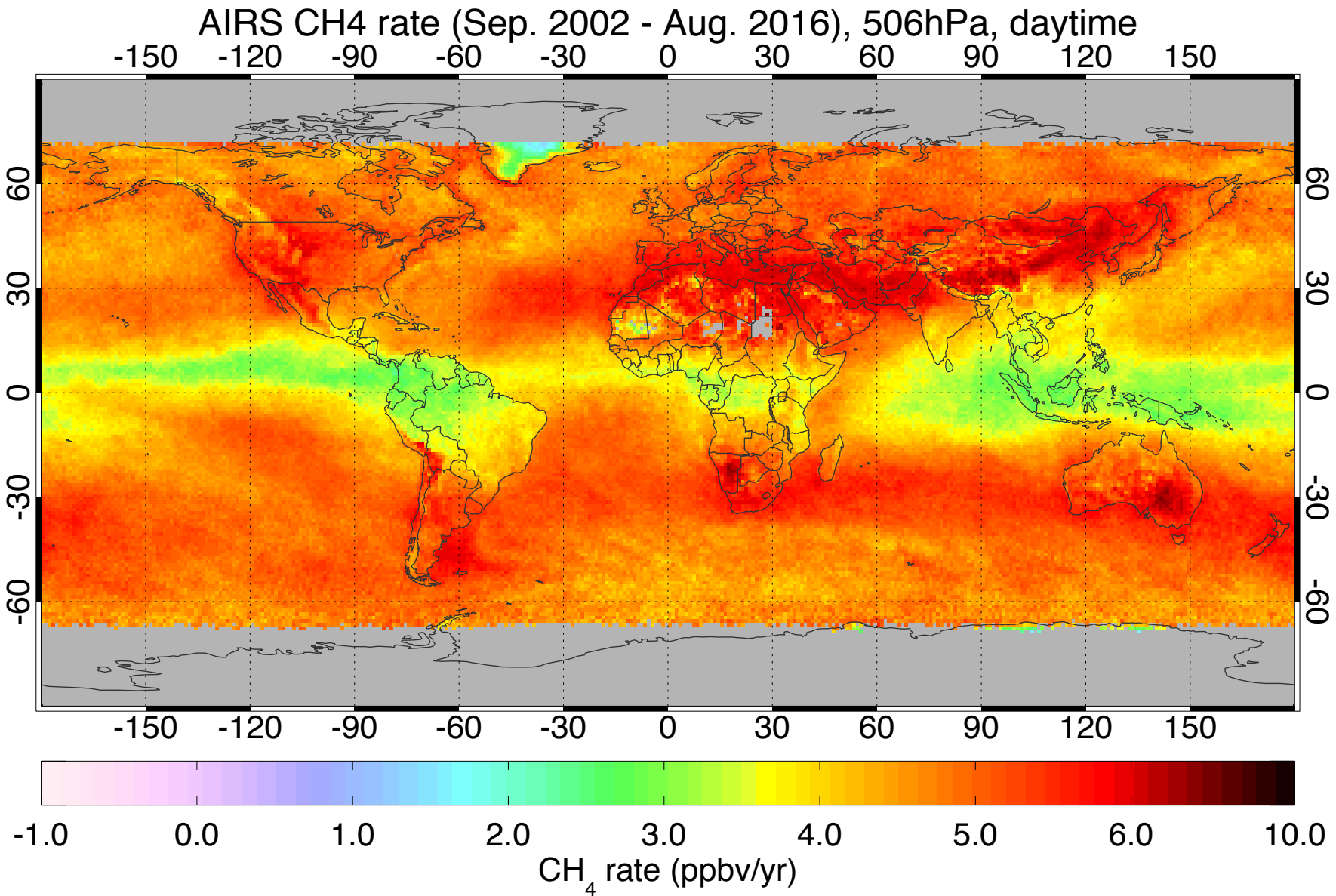


CH_4 Trends at Latitudes AIRS V6 (lower left) + CrIS (lower right) Compared w ESRL's (top)

- ESRL (top) smeasurement shows increasing trends https://www.esrl.noaa.gov/gmd/ccgg/trends_ch4/#global_data;
- ESRL CH_4 shows sudden increase in 2008, but AIRS not as obvious;
- AIRS and CrIS continued data records show similar patterns as seen by ESRL.

AIRS CH_4 Global Trends

- Major increases over regions with anthropogenic activities



Summary

- AIRS V6 CH_4 retrievals perform very well;
- The continued data records from AIRS and CrIS are promising;
- The new CrIS mid-wave channels issue do affect CH_4 from Apr. 2019.