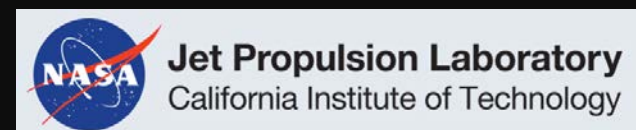


Towards a multispecies reanalysis of the stratosphere: doing chemistry with the MLS data and the GOES StratChem model

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Funded by NASA Modeling, Analysis and Prediction



What

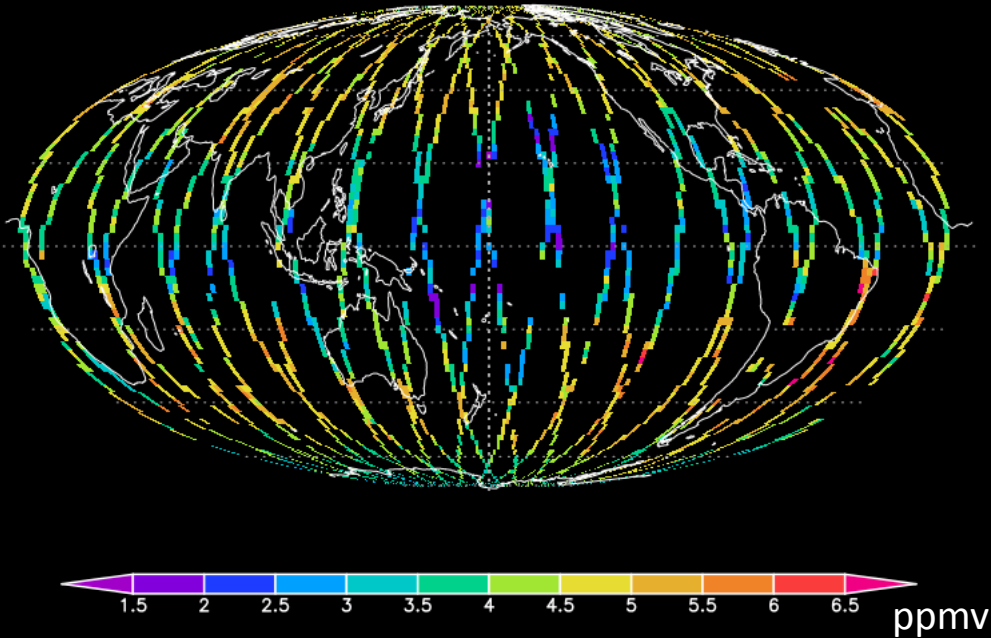
- A significant extension of NASA GMAO's GEOS Data Assimilation System to include assimilation of several stratospheric constituents beyond ozone
- Currently assimilating: water vapor, HNO_3 , HCl from **MLS**
- Planning: N_2O and potentially ClO

Why

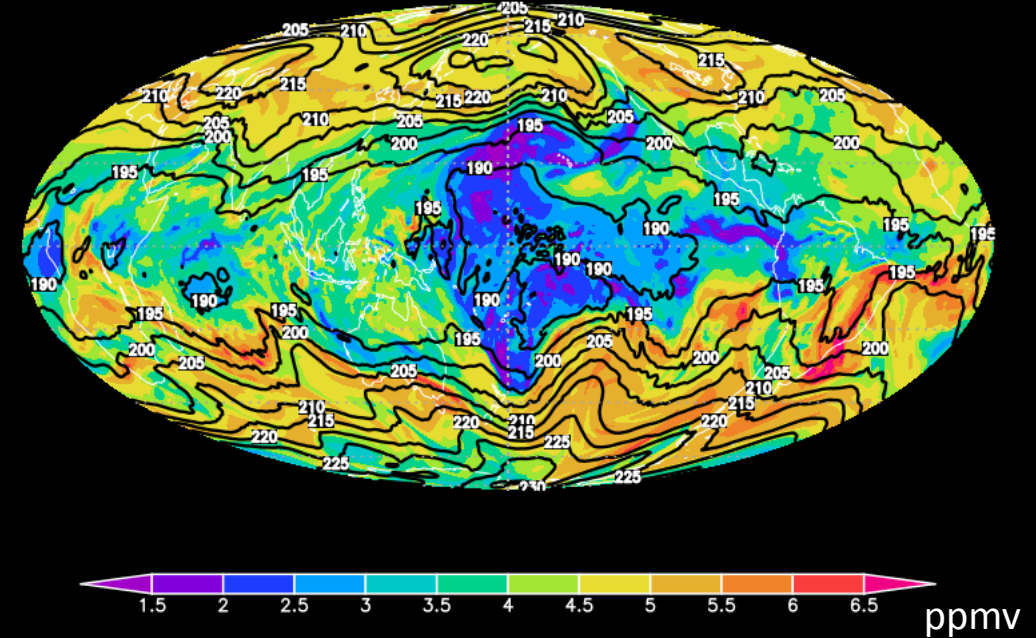
- To produce a mission-long reanalysis of the stratosphere for chemistry, composition and transport studies. Note, one such reanalysis exists: BASCOE Reanalysis of Aura MLS v2 (BRAM2)

This talk: water vapor analysis

MLS water vapor at 100 hPa, 2 Jan 2016



Assimilated MLS water vapor and MERRA-2 temperature at 100 hPa, 2 Jan 2016



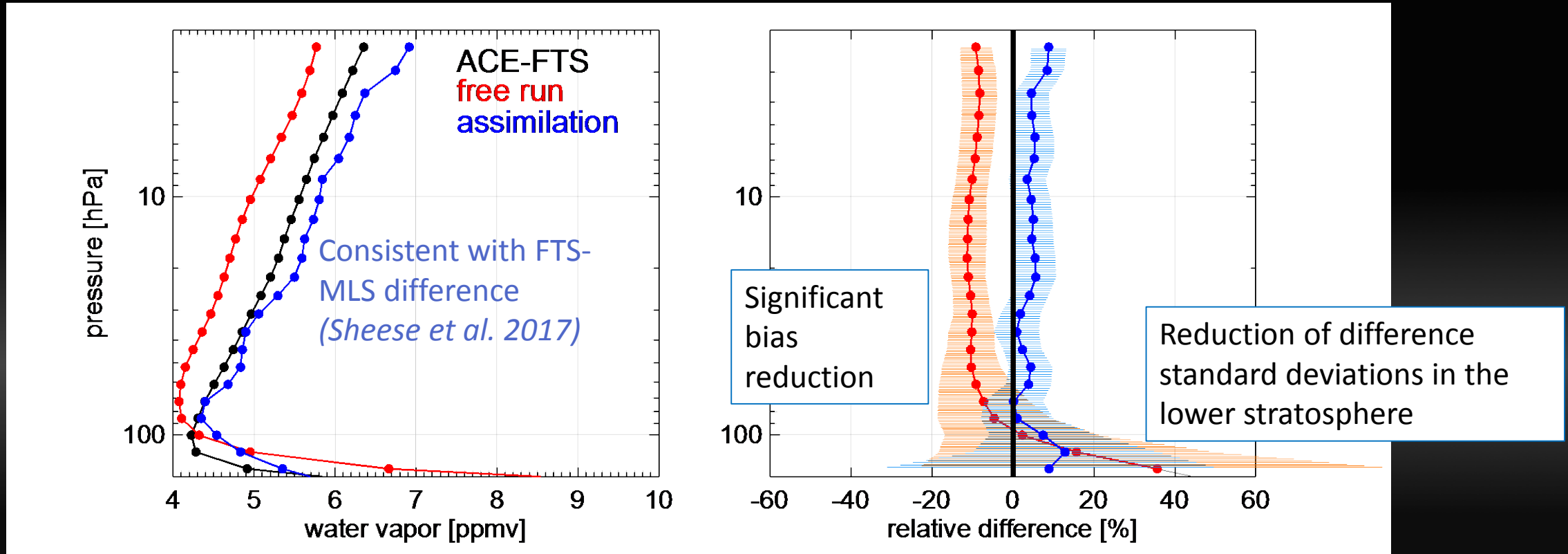
Data assimilation is a Bayesian method of combining and propagating information from observations in space and time using the governing equations and error estimates.

Data assimilation system

- This work uses a version of the GEOS general circulation model with a **stratospheric chemistry model** driven by MERRA-2 meteorology; GMAO analyses to date have used a simple parameterized chemistry scheme
- The family chemistry scheme, StratChem:
 - 51 transported and 17 derived species
 - 149 gas-phase and 39 photolysis reactions
 - Reaction rates follow the recommendations in *JPL 2015*
 - Includes a PSC scheme and heterogeneous reactions
- Currently assimilating ozone, water vapor, HNO₃, and HCl data from MLS and total ozone from OMI

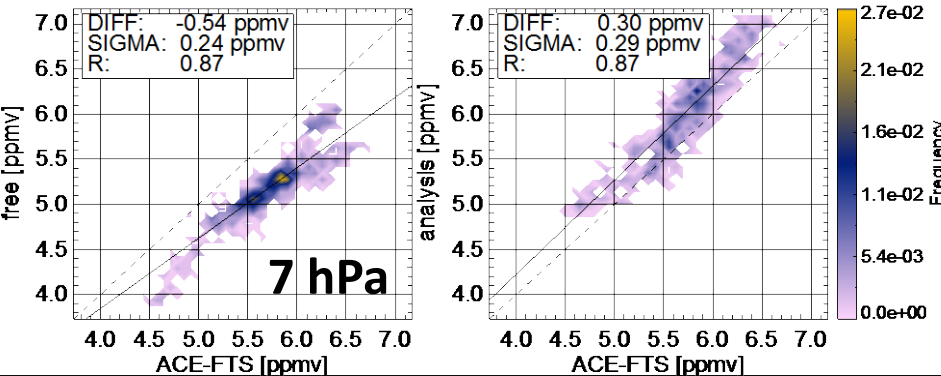
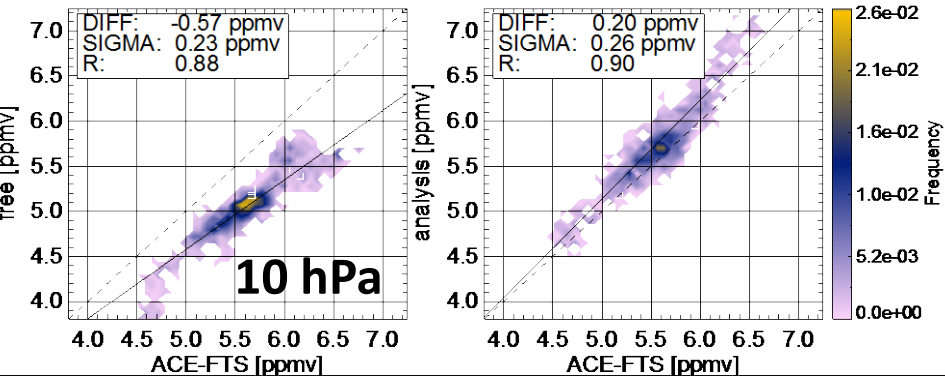
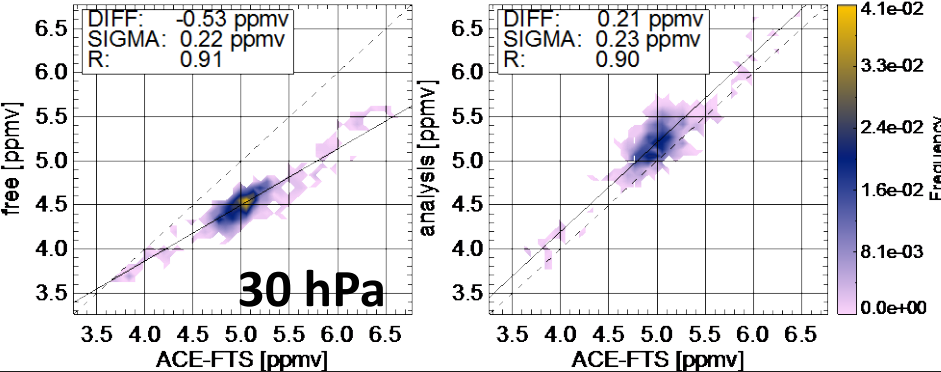
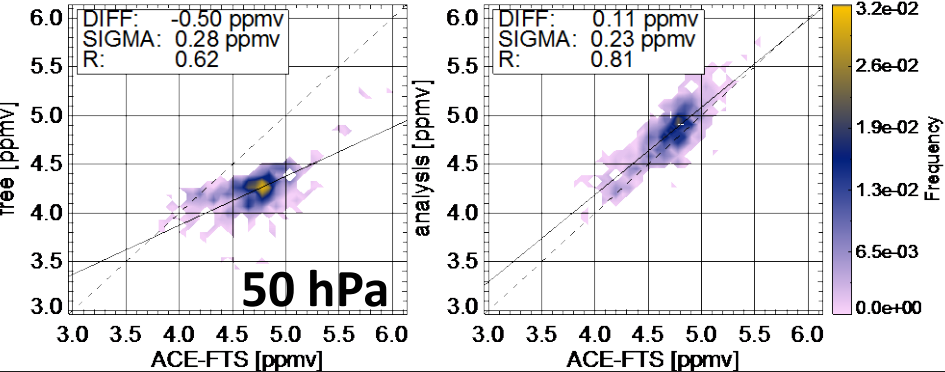
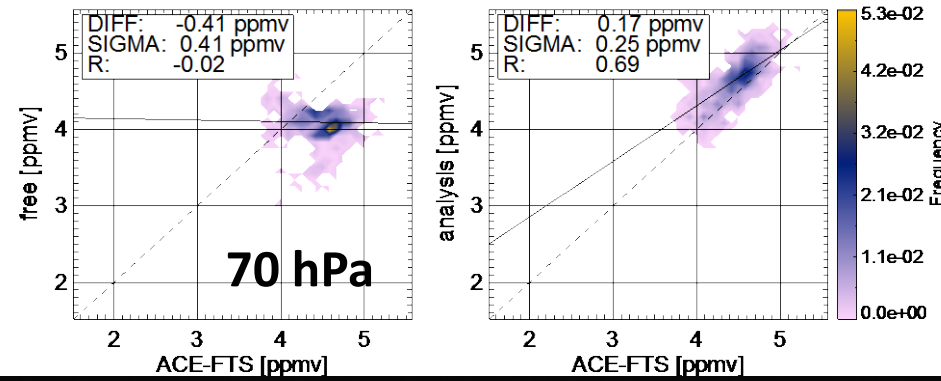
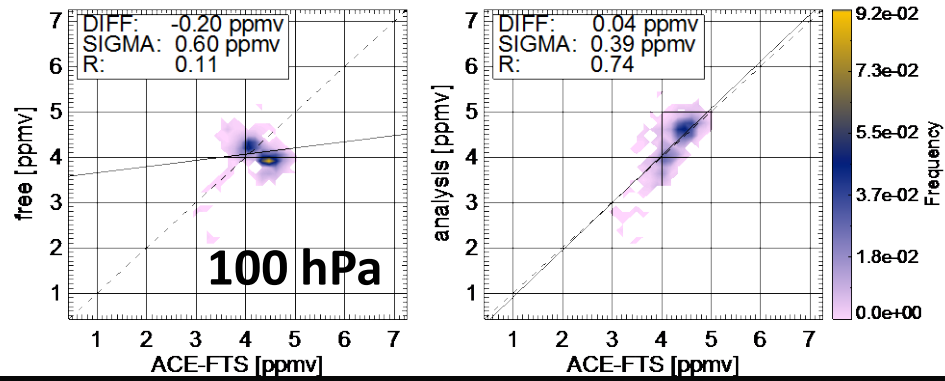
This presentation

Preliminary validation



Assimilation: a considerable improvement w.r.t. ACE -FTS

Note: the large difference standard deviations in the lower stratosphere are within ACE-FTS uncertainties estimated by Sheese et al., 2017



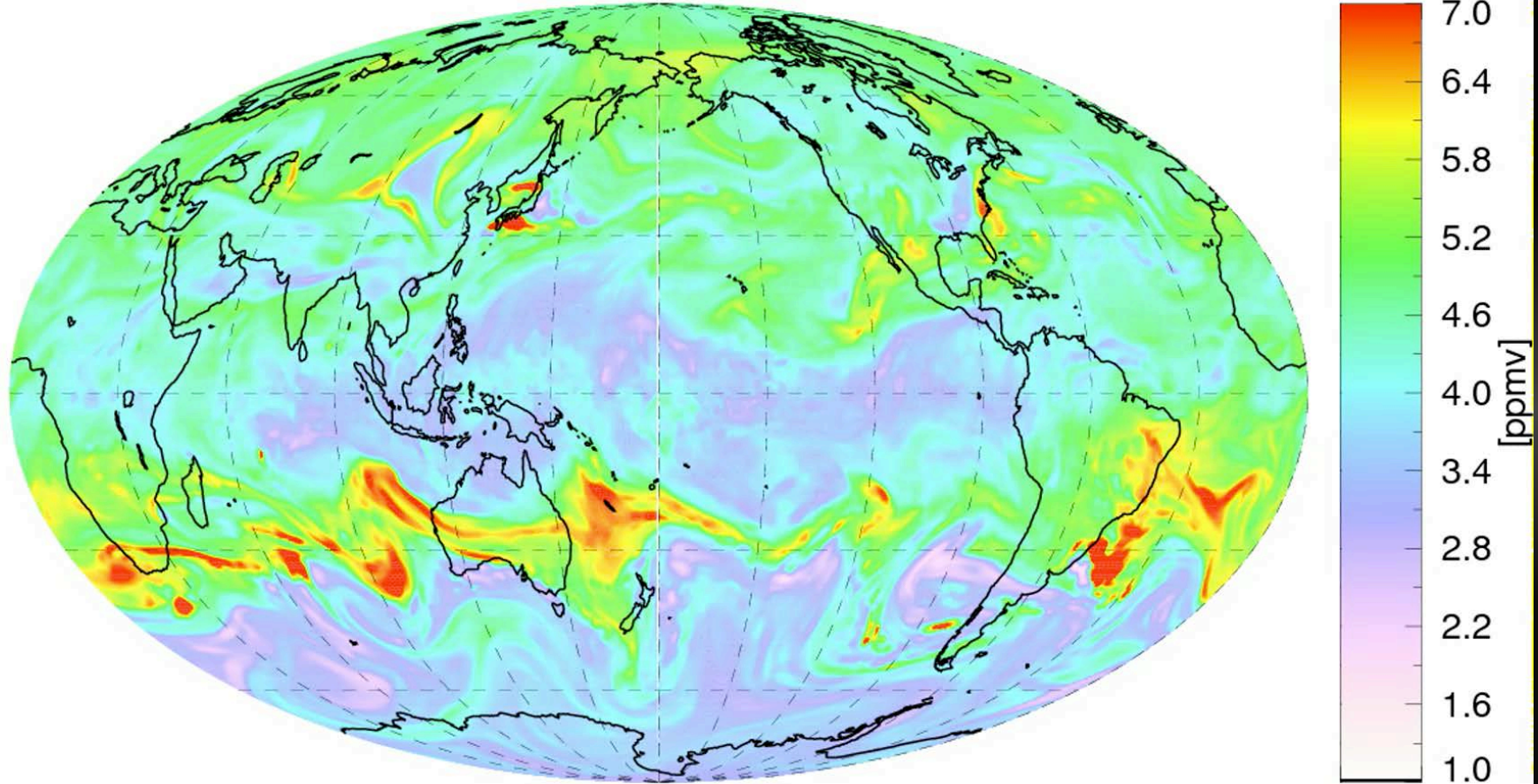
Joint probability distributions: ACE-FTS vs. free run and ACE-FTS vs. assimilation.

Improvement in all statistics at pressures > 50 hPa

The mean improves at all levels

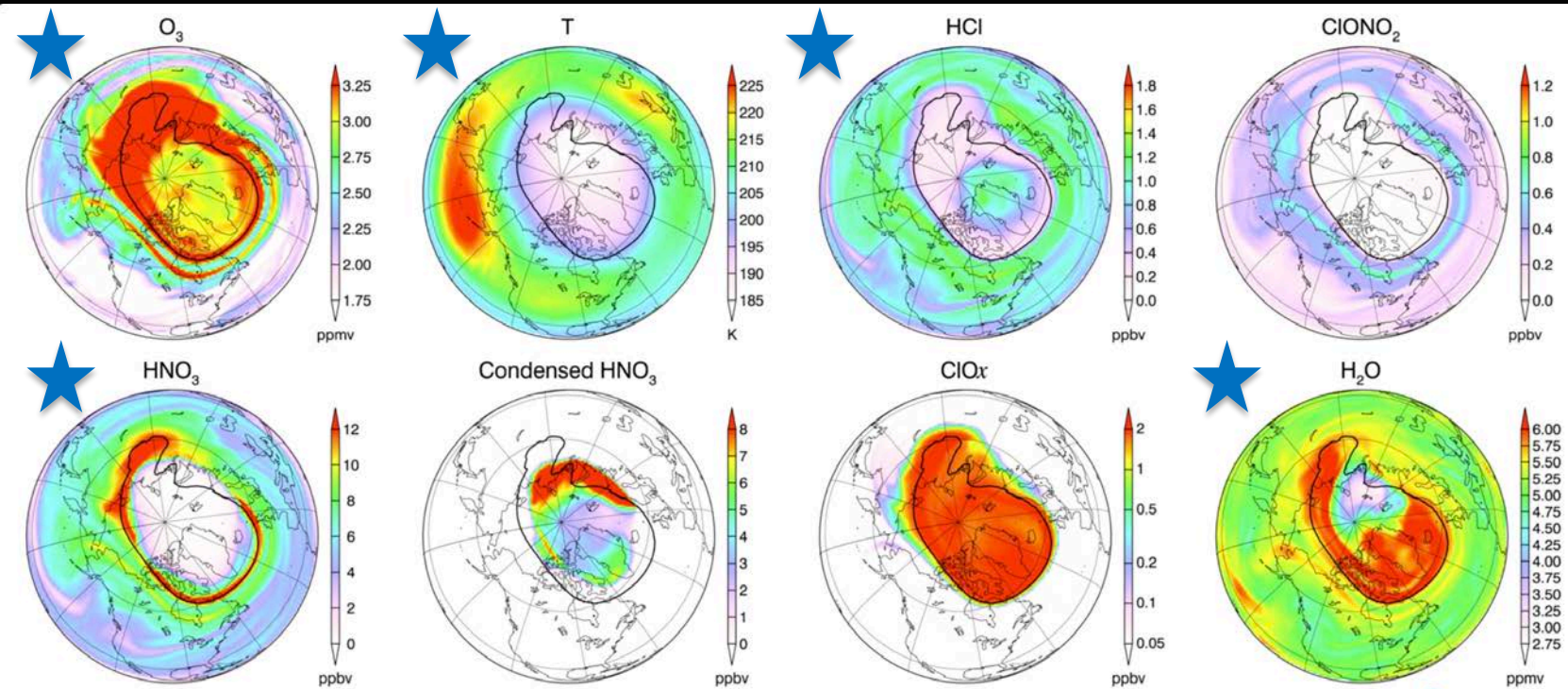
Water vapor on the 380-K isentrope

Analysis water vapor, 2015-12-10 : 00 UTC



Ongoing work

480-K isentrope, 1 January 2016



Chlorine activation, denitrification, dehydration and ozone depletion from the MLS data assimilation experiment

★ *Assimilated field*

- Assimilation of additional species: HNO_3 , HCl , N_2O , potentially ClO
- Assessing the performance of the GEOS-StratChem model: chemistry and transport
- Assessing the impact of HNO_3 and HCl assimilation on reactive nitrogen and chlorine budgets
- Comparison with the Belgian reanalysis, BRAM