# AIRS Global Daily Ammonia Products

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# Why Ammonia

- Global ammonia ($NH_3$) emissions have been increasing due to the dramatically increased agricultural livestock numbers together with the increasing use in nitrogen fertilization (Sutton *et al.*, 1993).

- Atmospheric ammonia has impacts to the ecosystems on both local scales, acidification and eutrophication, and global (transboundary) scales through formation of fine ammonium containing aerosols.

- Measurements with daily and large global coverage are challenging and have been lacking partly because the lifetime of $NH_3$ is relatively short and partly because it requires high sensitivity for the retrievals that can be only obtained from areas with high thermal contrasts near the surface (Clarisse *et al.*, 2010).

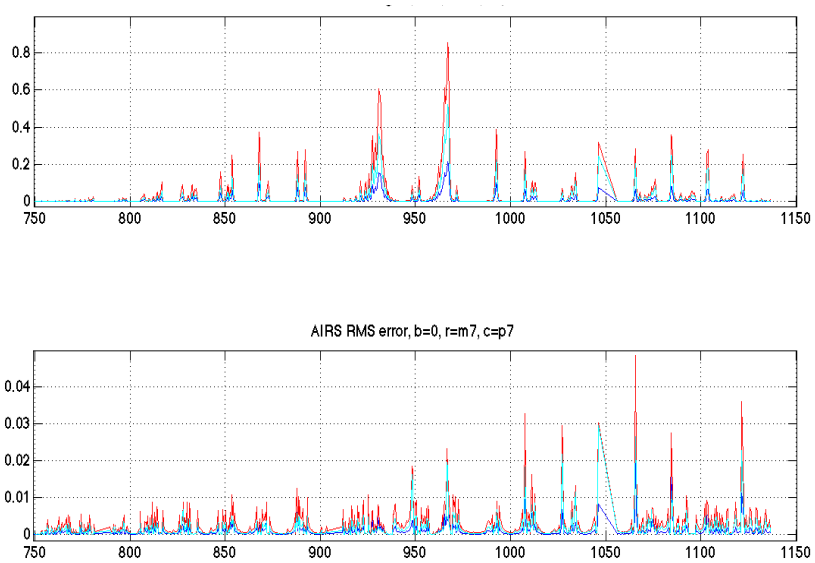
# Methodology

- Retrievals using the Optimal Estimation (OE) technique.
- AIRS Cloud Cleared Radiances are used (CCR).
- AIRS L2 products other than $NH_3$ are used in the Forward Model (FM) SARTA.
- Error Covariance matrices and a priori profiles are computed from MOZART climatology.

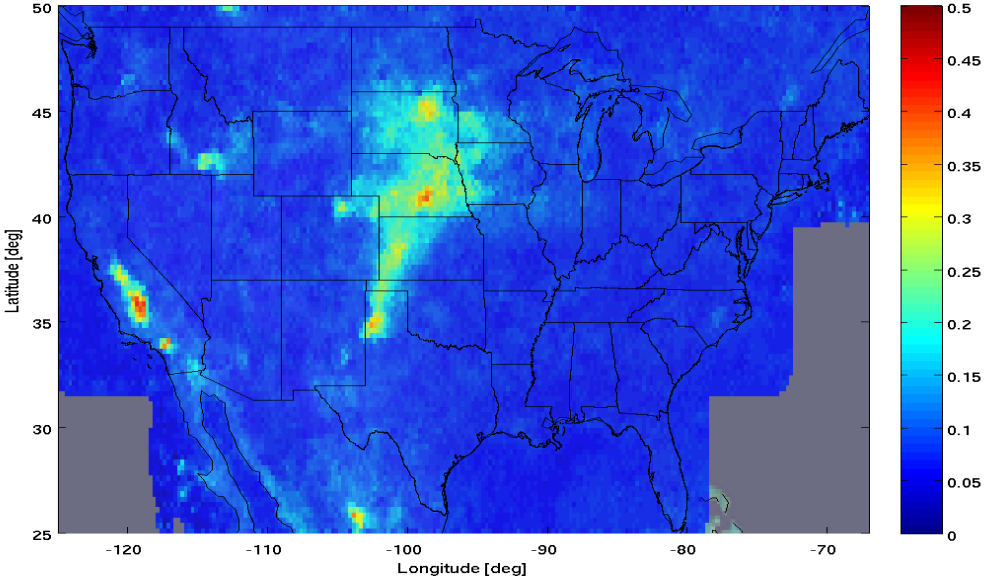
# Contributions of Scott Hannon for AIRS Ammonia Products

- Added $NH_3$ coefficients into AIRS forward model SARTA…
- Developed AIRS $NH_3$ sensitivities based on the Brightness Temperatures (BT), which we used in the proposal to NASA.

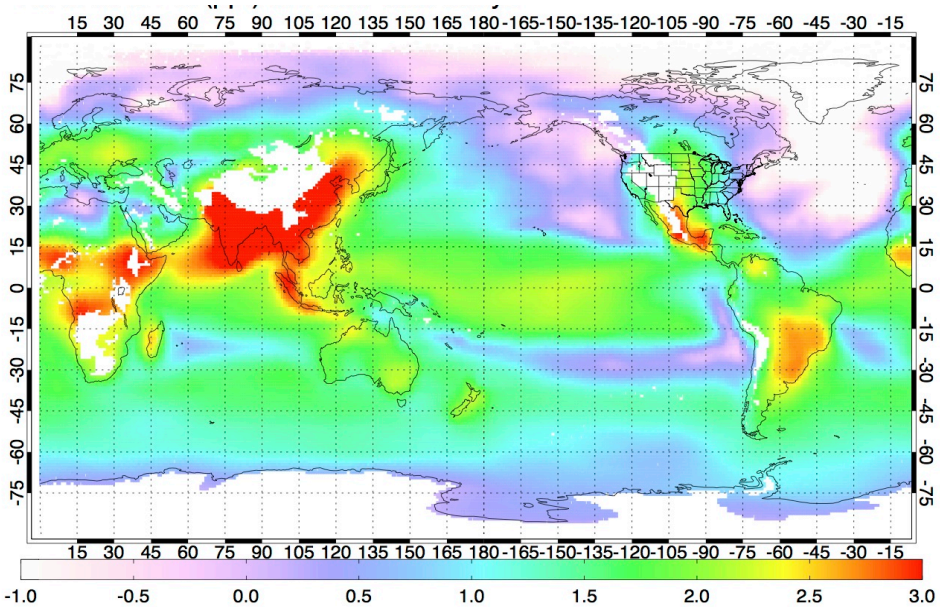
AIRS $NH_3$ spectral RMS
Signals (top) and Errors (bottom)

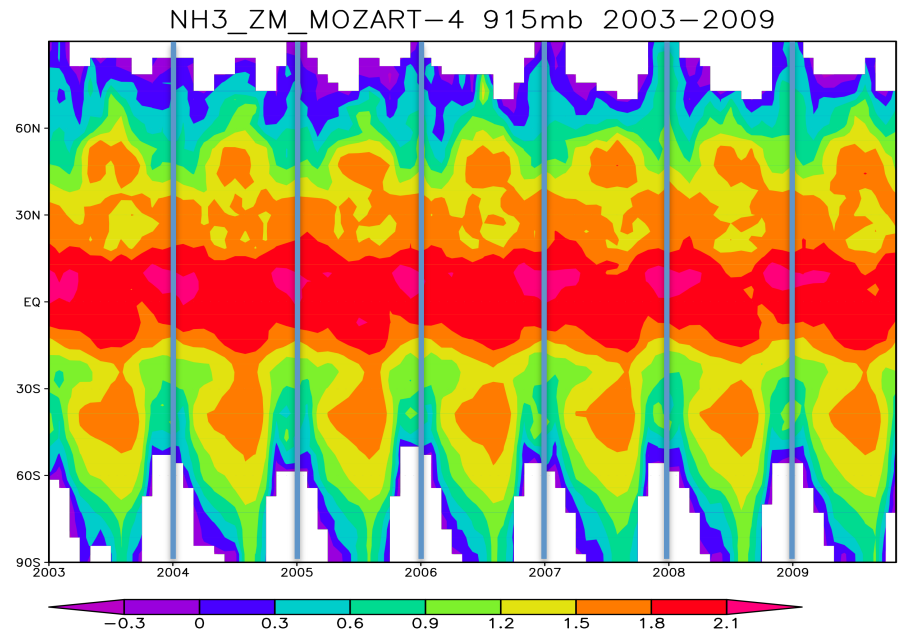



AIRS Ammonia signals from BT fitting
(2004/05/05-20) using pure clear scenes



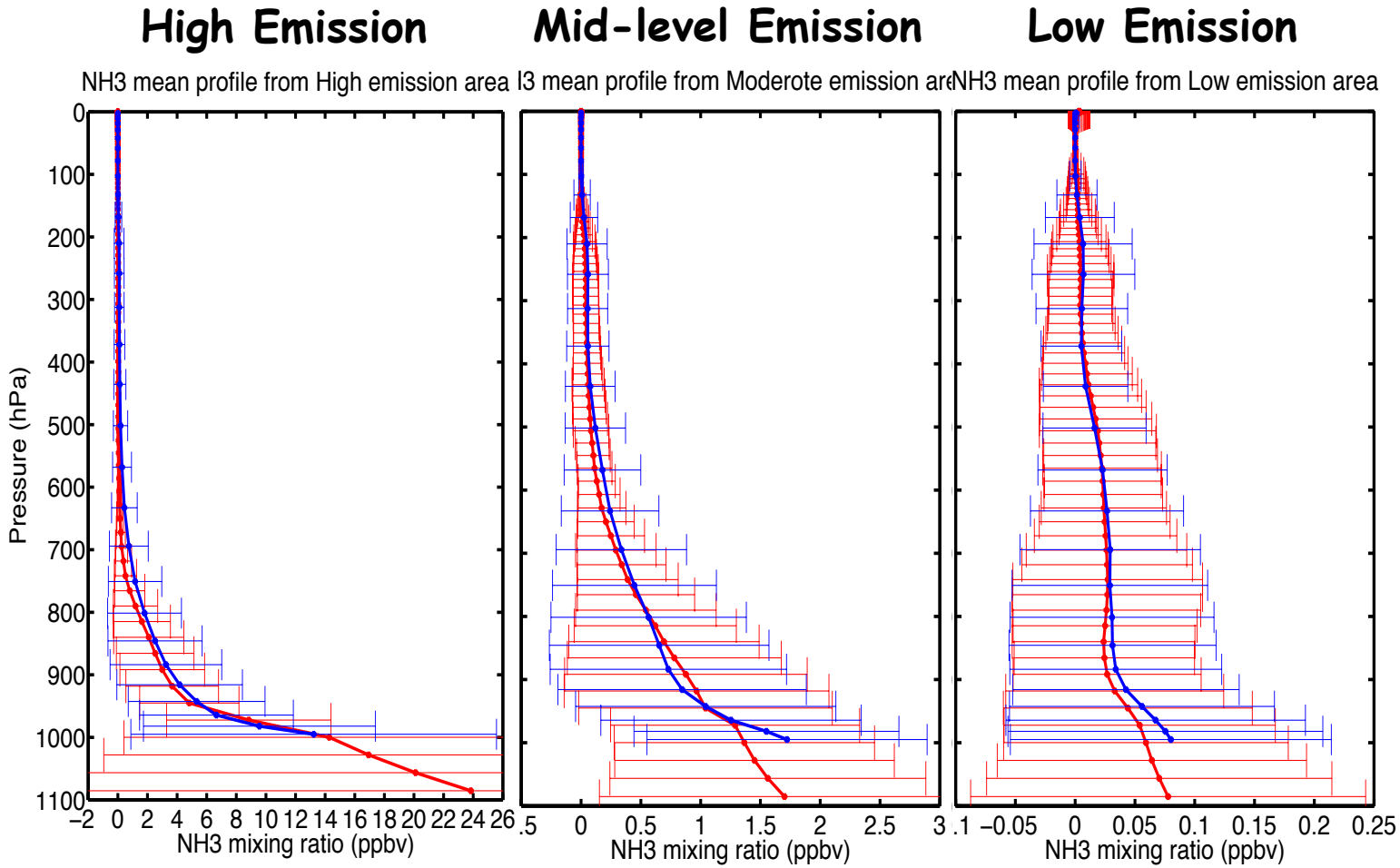
# MOZART Model Ammonia Monthly Mean (May, 2003-2009)



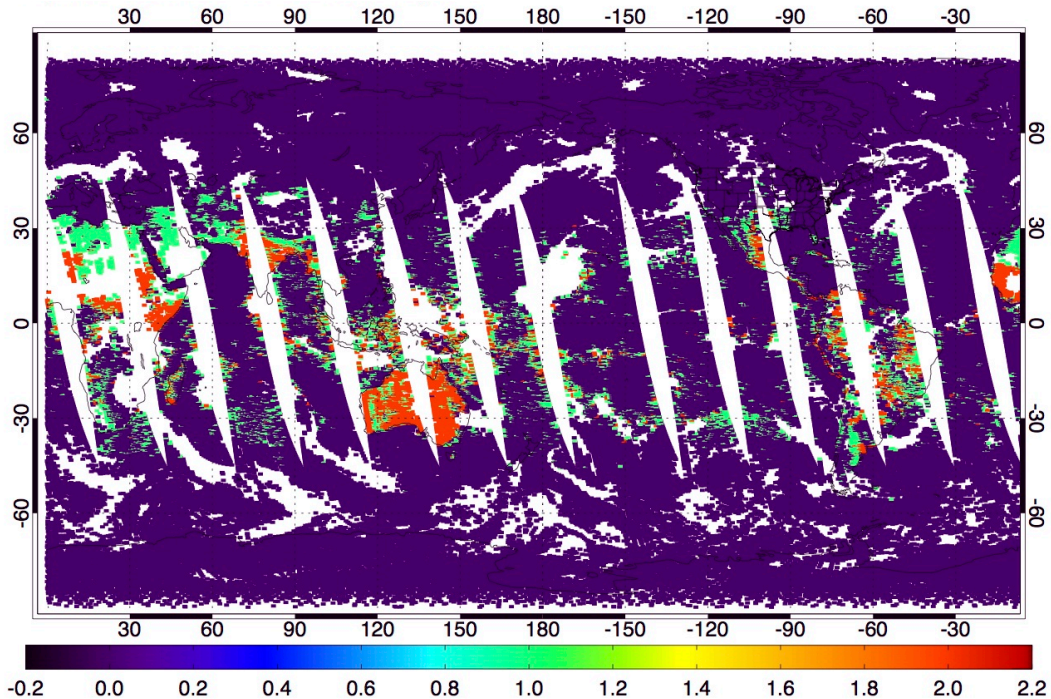

- MOZART climatology shows know emission sources.
- Zonal mean time series indicate in the tropics emission peaks in the winter season and in the mid-latitudes peaks in the summer.
- MOZART $NH_3$ fields have not been validated (private communication with L. Emmons).

# AIRS $NH_3$ *A priori* with covariance derived from MOZART climatology



# Determination of a priori

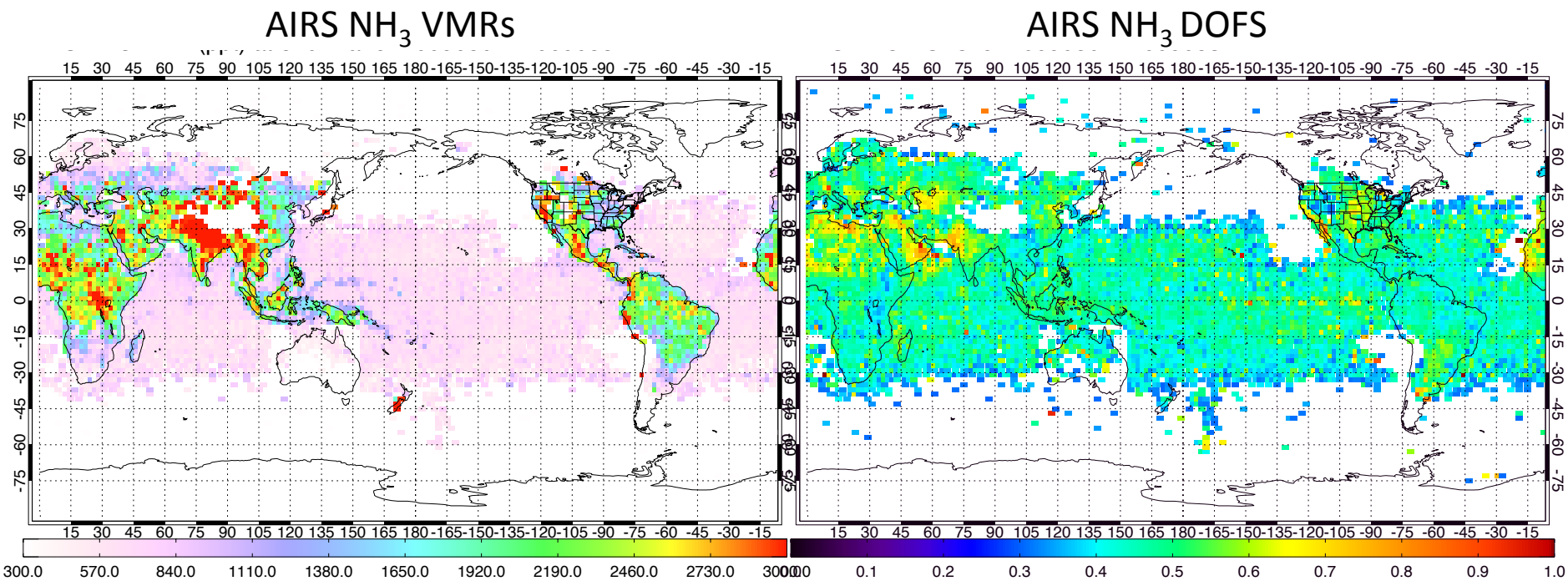
Example on 20060304




- $$\frac{R_{strong} - R_{weak}}{NEdT}$$

- Used to identify different emission signals.

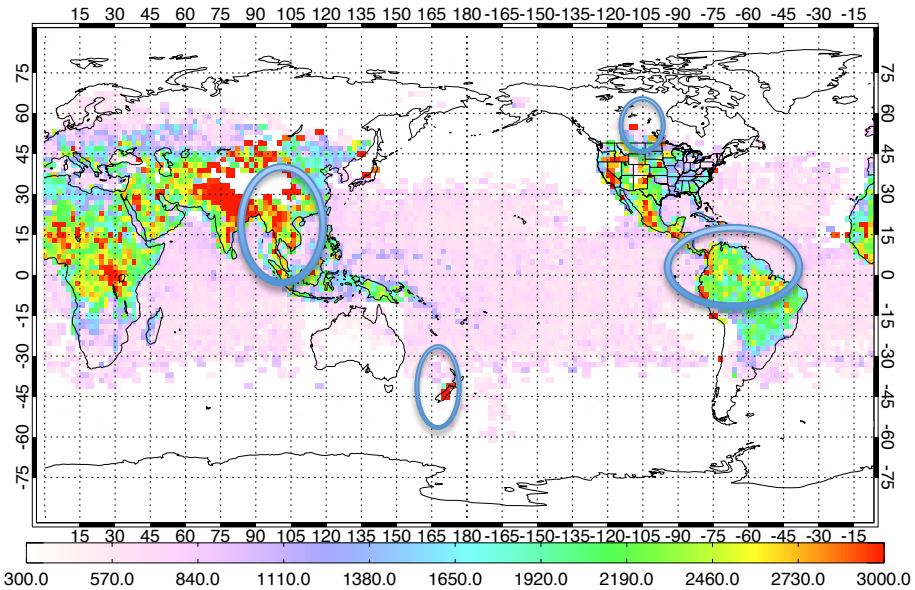
# AIRS $NH_3$ VMRs (pptv) at 840hPa and DOFS for May 1-31, 2009



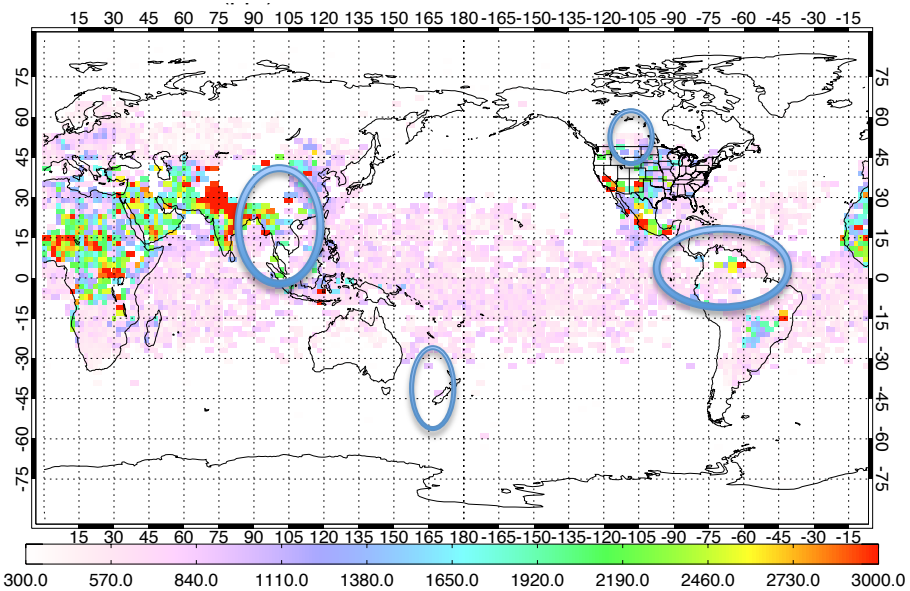

- High $NH_3$ identifies all known sources.
- DOFS 0.3 to greater than 1.0.

# Current Issues

CCR with Cloud Fraction=1.0



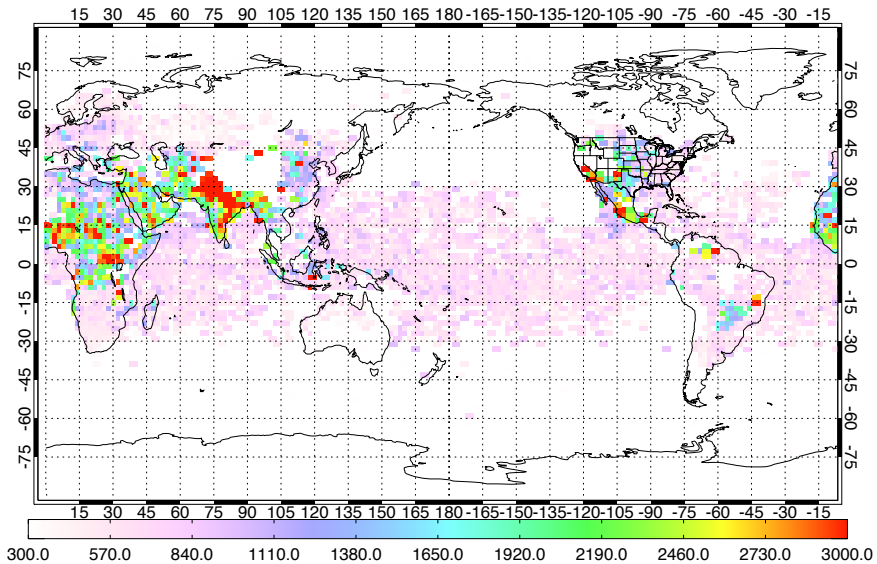

CCR with Cloud Fraction=0.0



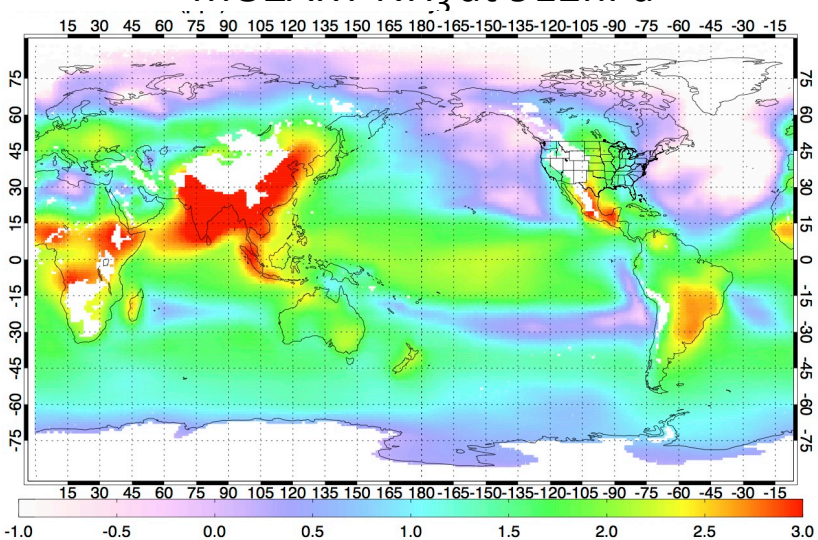

- CCR verses L1 clear radiances
- Selection of a priori

# Comparisons with MOZART $NH_3$

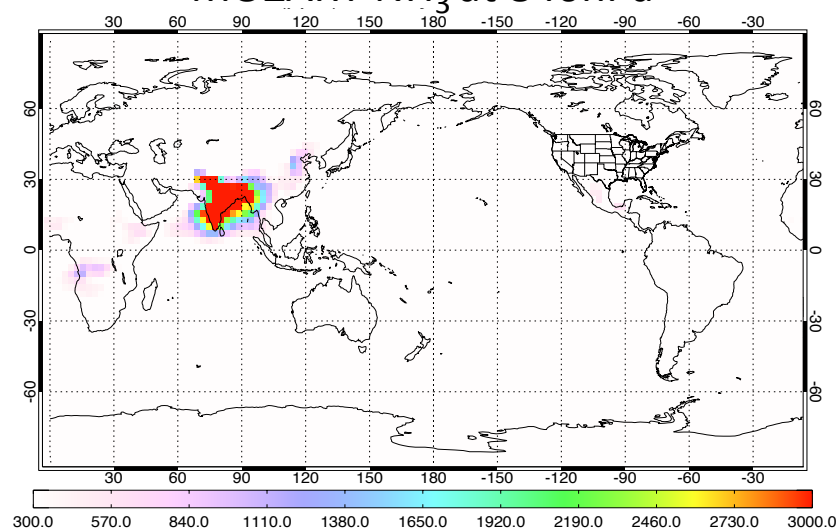
AIRS $NH_3$ VMRs w/ Cloud Fraction=0



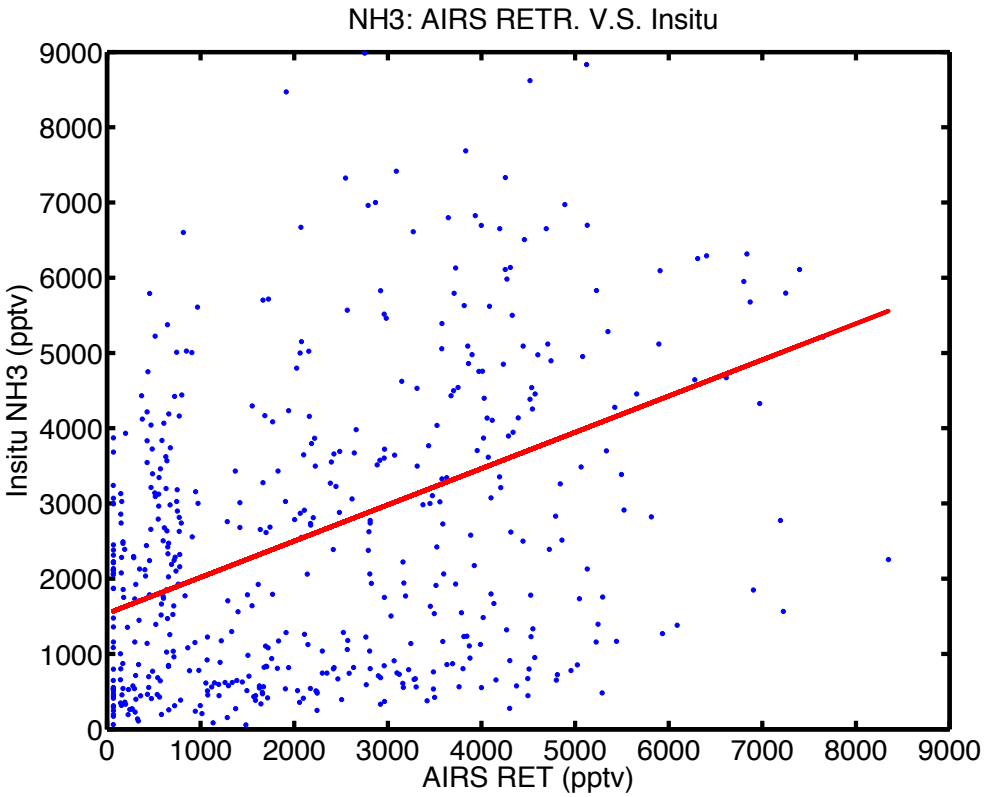

MOZART $NH_3$ at 912hPa

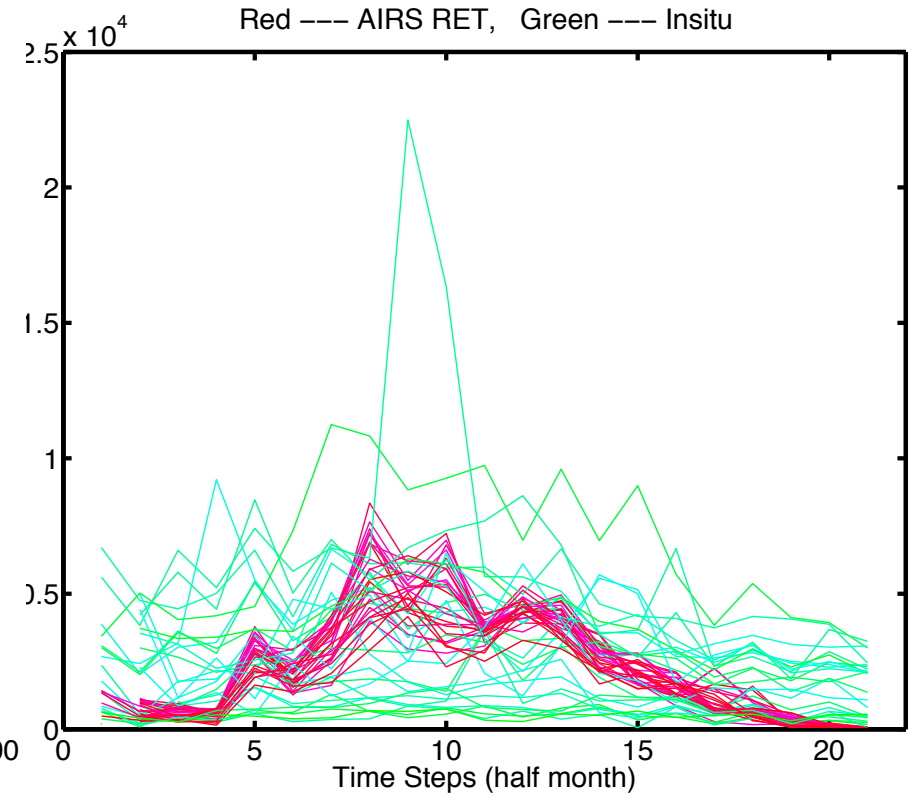



MOZART $NH_3$ at 840hPa



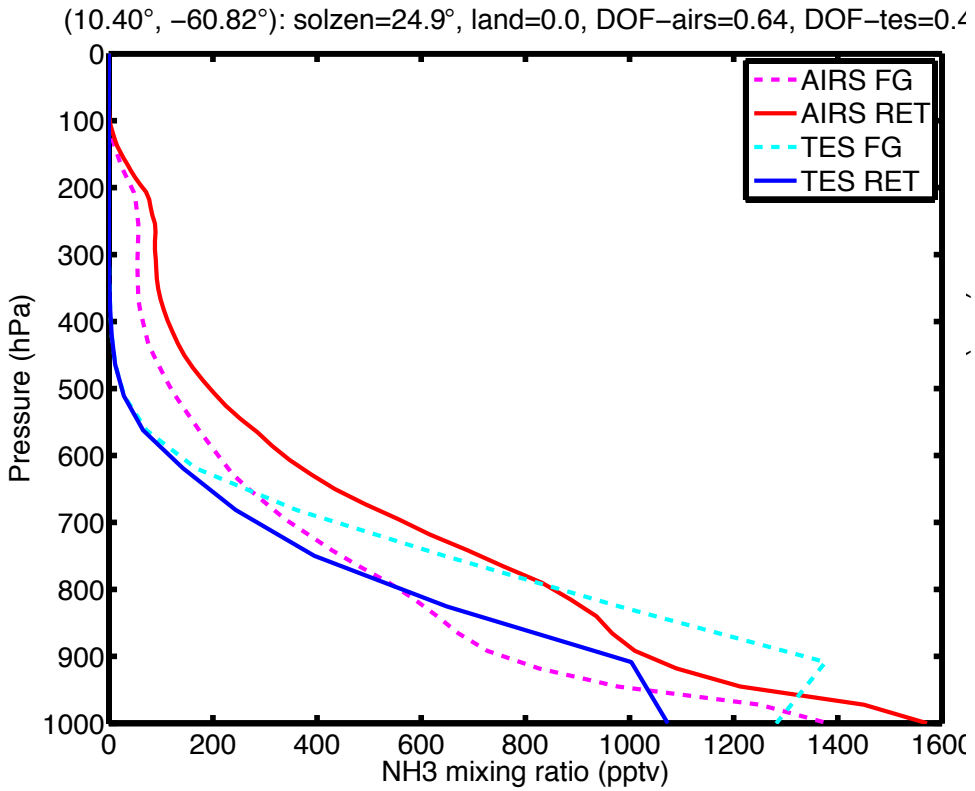
# Remaining – Validation with *In Situ* Measurements

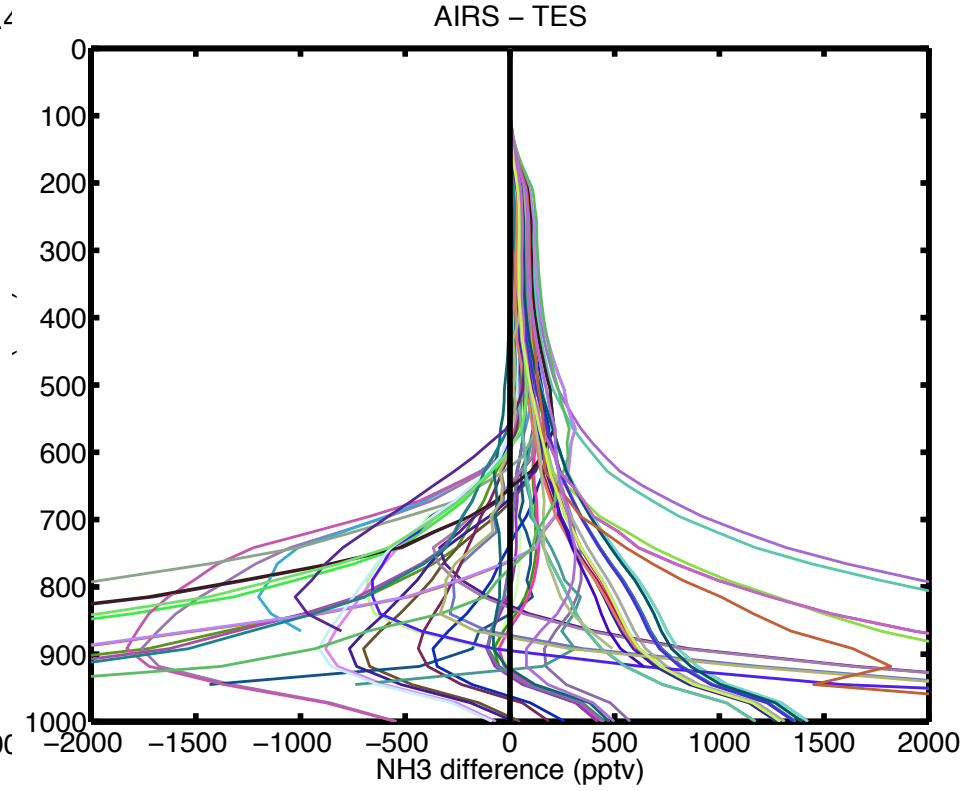



- Twenty five in situ surface sites from US EPA.
- NOT good! Yet!

# Remaining - Inter-comparison



# Summary

- AIRS captures global $NH_3$ emission sources due to natural and anthropogenic activities with good accuracies.
- AIRS DOFS for $NH_3$ ranges from 0.3 to greater than 1.0 over emission regions.
- More efforts are needed in the selection of spectral channels and to reduce noise possibly due to cloud and/or surface effects, as well as the selection of a priori profiles.
- Carry out comparisons to models such as GEOS-Chem, GMI, and CMAQ.
- More Validations with in situ measurements
- Inter-comparing with other satellite sensors, i.e., TES and IASI $NH_3$.