Validation of TES Methane with HIPPO Observations

For Application to Adjoint Inverse Modeling of Methane Sources

HIPPO Science Team Meeting
Boulder, CO

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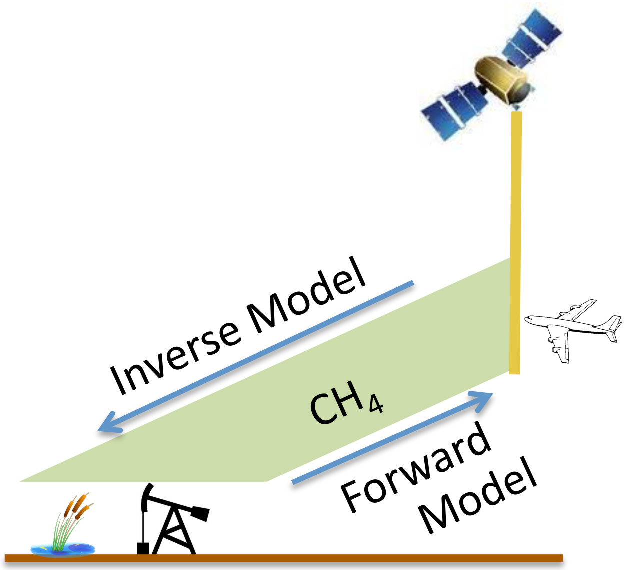
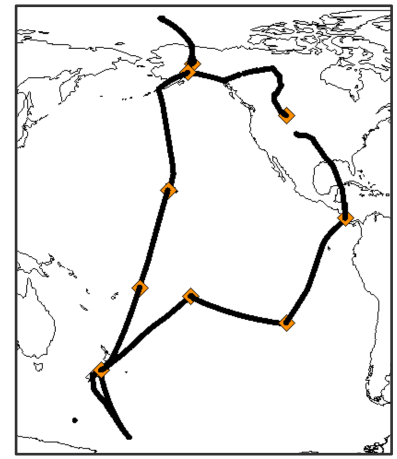
Adjoint Inverse Modeling of Methane Sources



HIPPO QCLS Methane *(Kort, Daube, Wofsy)* provides:

- Large number of profiles
- Wide latitudinal coverage
- Remote from sources (reduces colocation error)



Validation

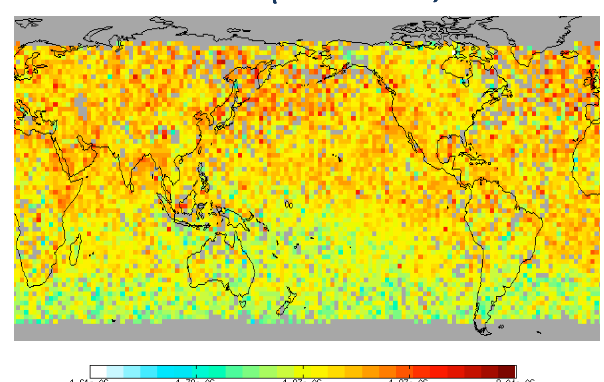
GEOS-Chem CTM

GEOS-Chem Adjoint

Other Methane

AIRS
Atmospheric Infrared Sounder
SCIAMACHY
Greenhouse gases Observing SATellite
GOSAT PROJECT
GOSAT Project

TES Methane *(Worden, Kulawik)*



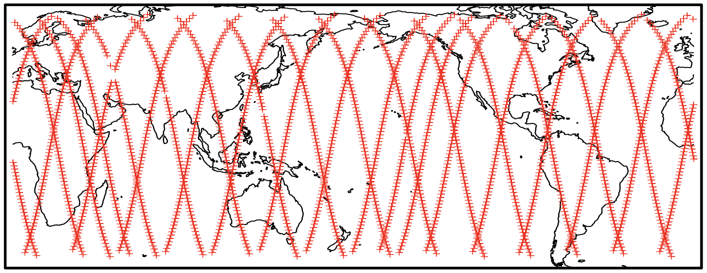
Adjoint inverse analysis

OPTIMIZATION OF SOURCES

TES Methane

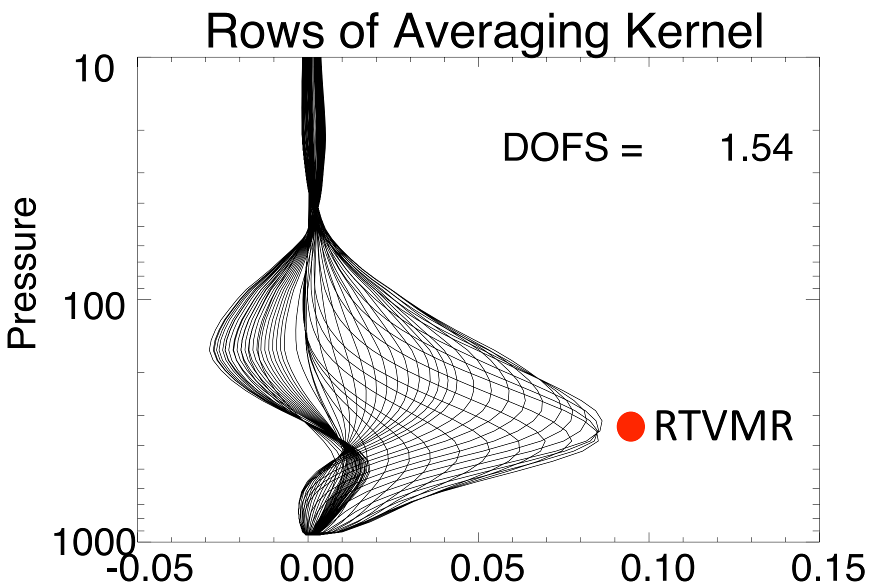
- Thermal IR, sun-synchronous orbit
- Observations since Sept 2004
- One global survey (GS) = 16 orbits, 26 h
- One 5x8 km^2 observation every 182 km
- 15-16 GS each month

1 Global Survey



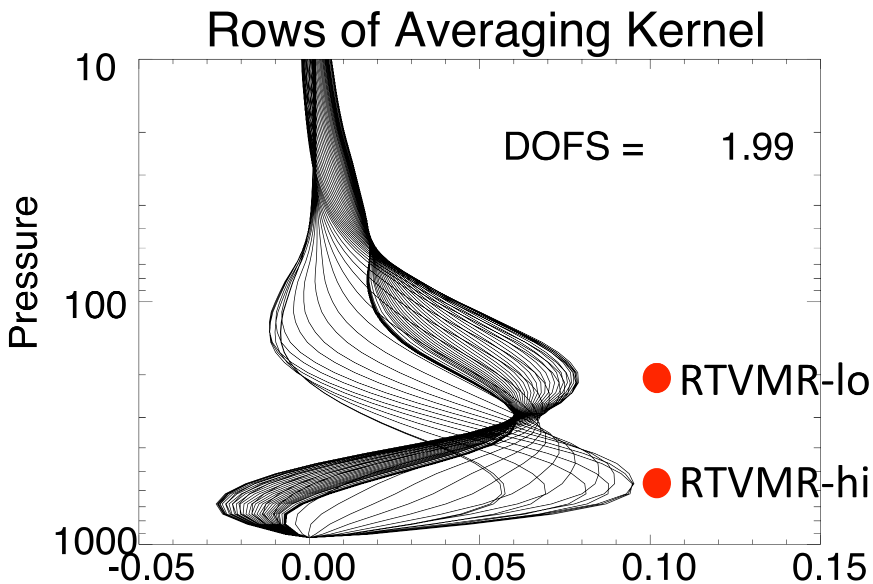
V004

- Methane retrieval 7.658 – 7.740 µm
- Degrees of Freedom for Signal 0.6-1.6
- Averaging kernels peak 200-400 hPa



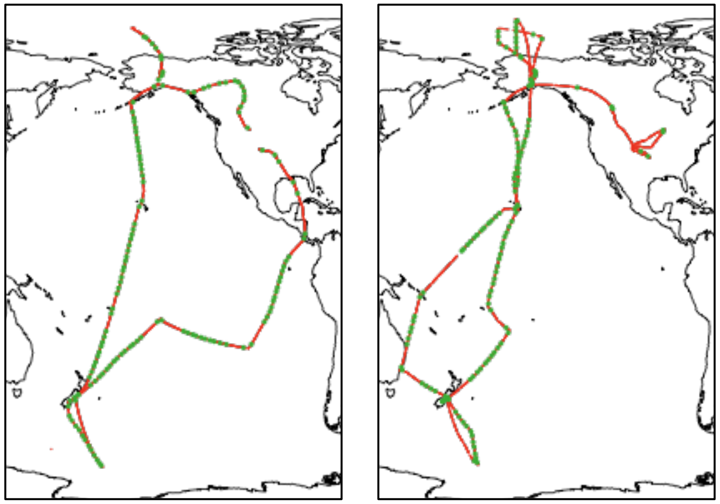
VNEW

- Expanded window, N_2O correction
- Degrees of Freedom for Signal 1.0-2.0
- Averaging kernels peak 200 & 500 hPa



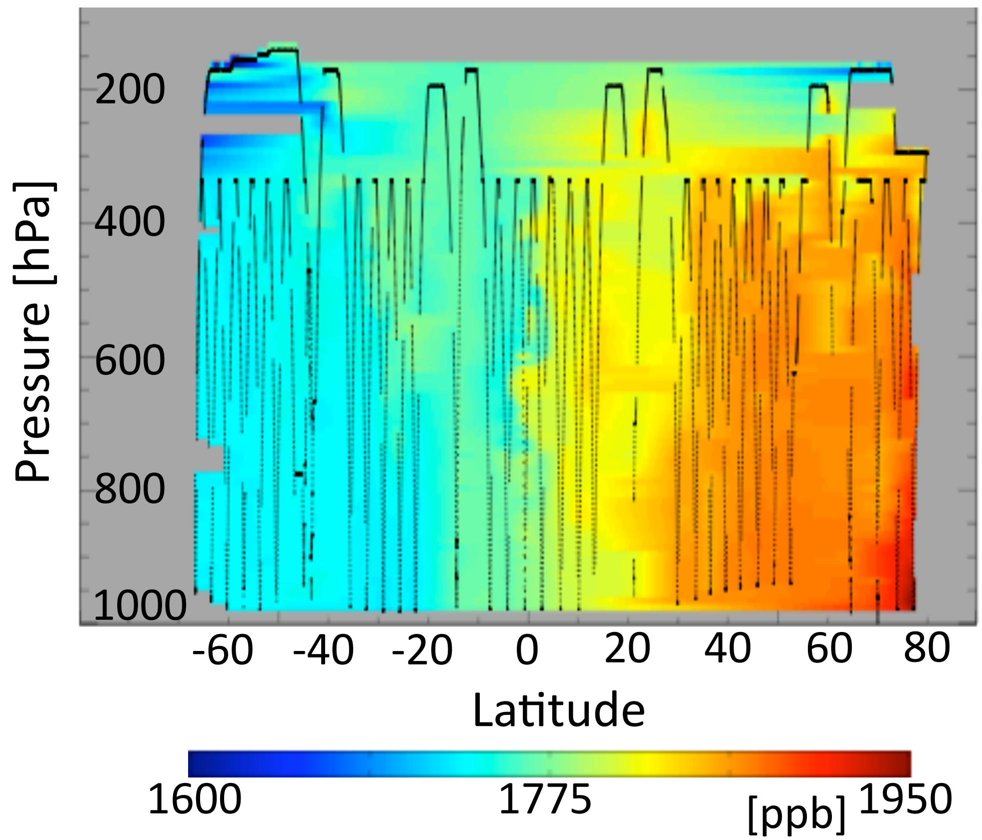
The Benefits of HIPPO Methane

HIPPO I HIPPO II



- HIPPO I & II only
- QCLS error << TES error
- Many, high profiles
- Latitudinal coverage
- Remote from local methane sources
- Dominant variability with latitude
- Little vertical variability
- Apply TES operator & RTVMR

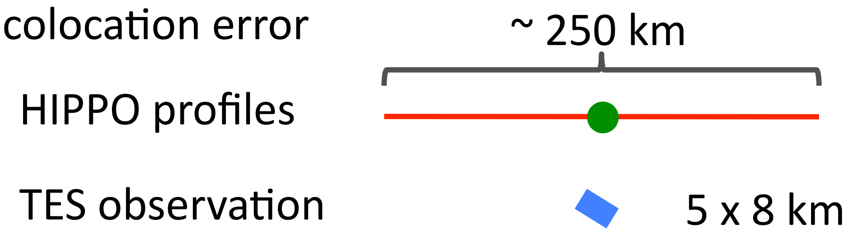
HIPPO I Southbound interpolated methane

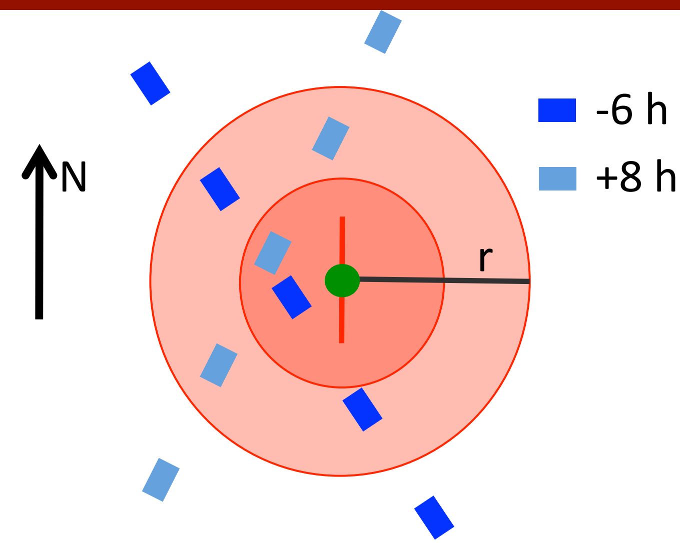


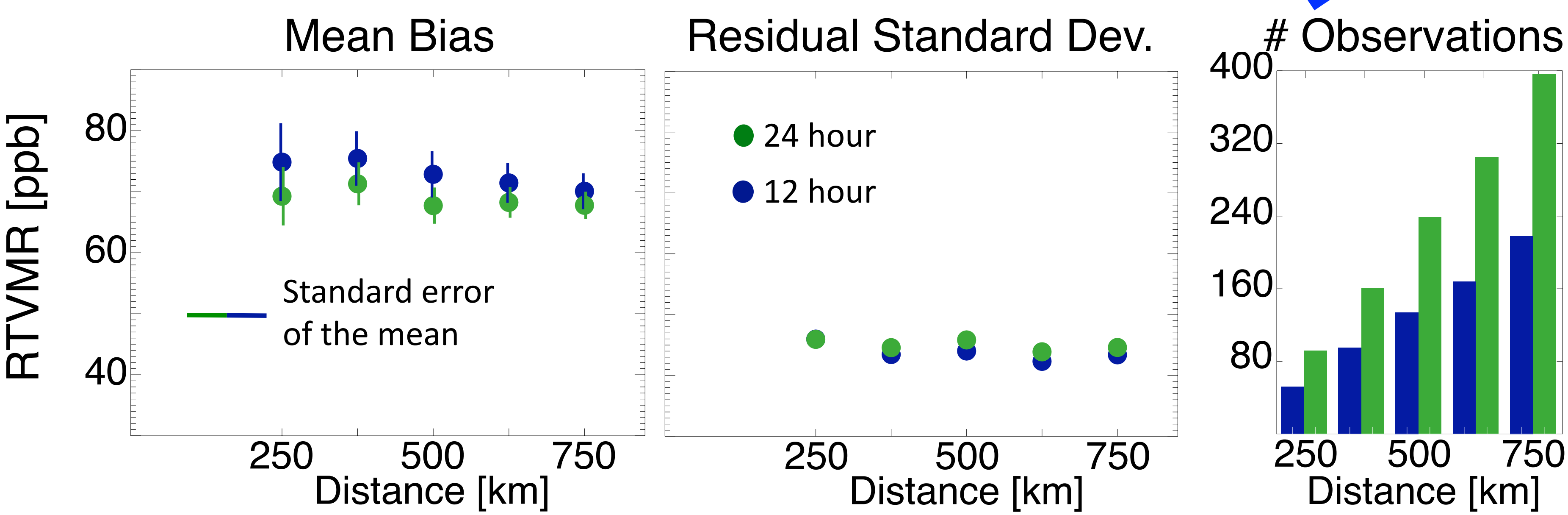
Using HIPPO and TES V004 to Define Coincidence Criteria

Validation characterizes mean bias and residual error.
Residual error contains contributions from:

1) error in the retrieval
2) colocation error





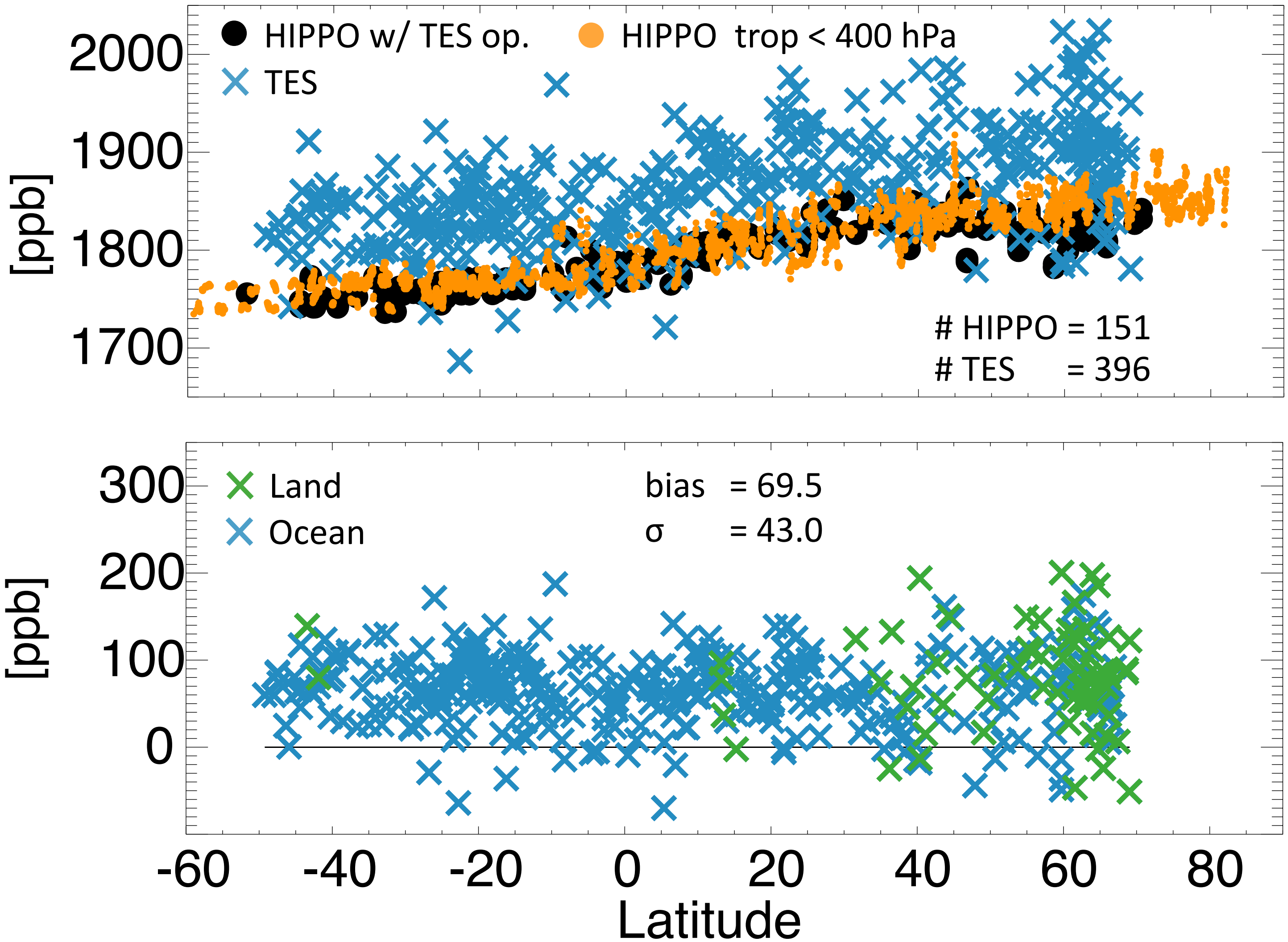


Coincidence requirements of ±750 km, ±24 h are sufficient. Consistent with remote Pacific.

TES V004 – HIPPO by Latitude

TES AND HIPPO RTVMR

TES – HIPPO Residual RTVMR



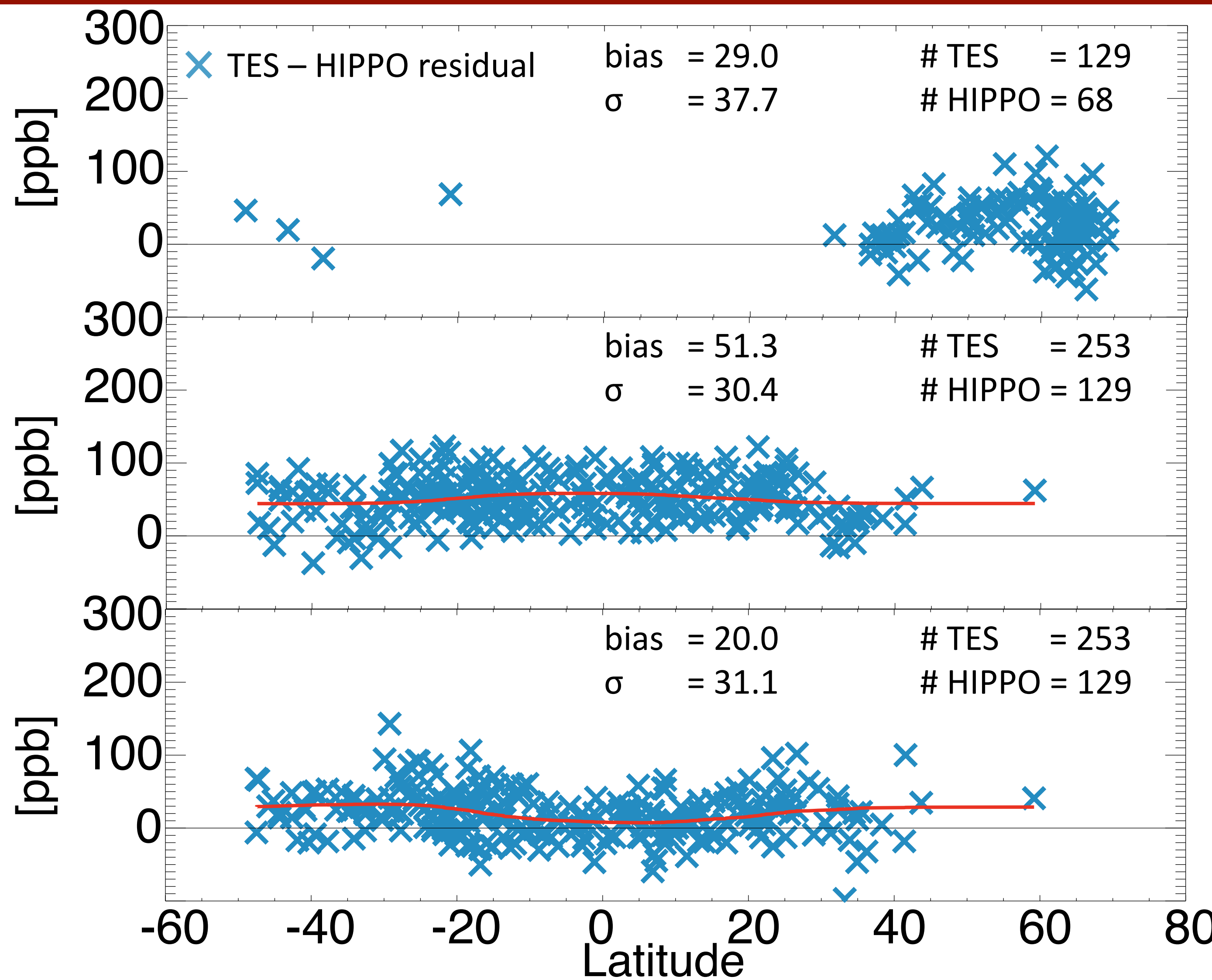
Positive bias and significant noise, but latitudinal gradient roughly captured.
Bias and error appear constant with latitude. Error larger than self-reported!

TES VNEW – HIPPO Residuals by Latitude

RTVMR
DOFS ≤ 1.6

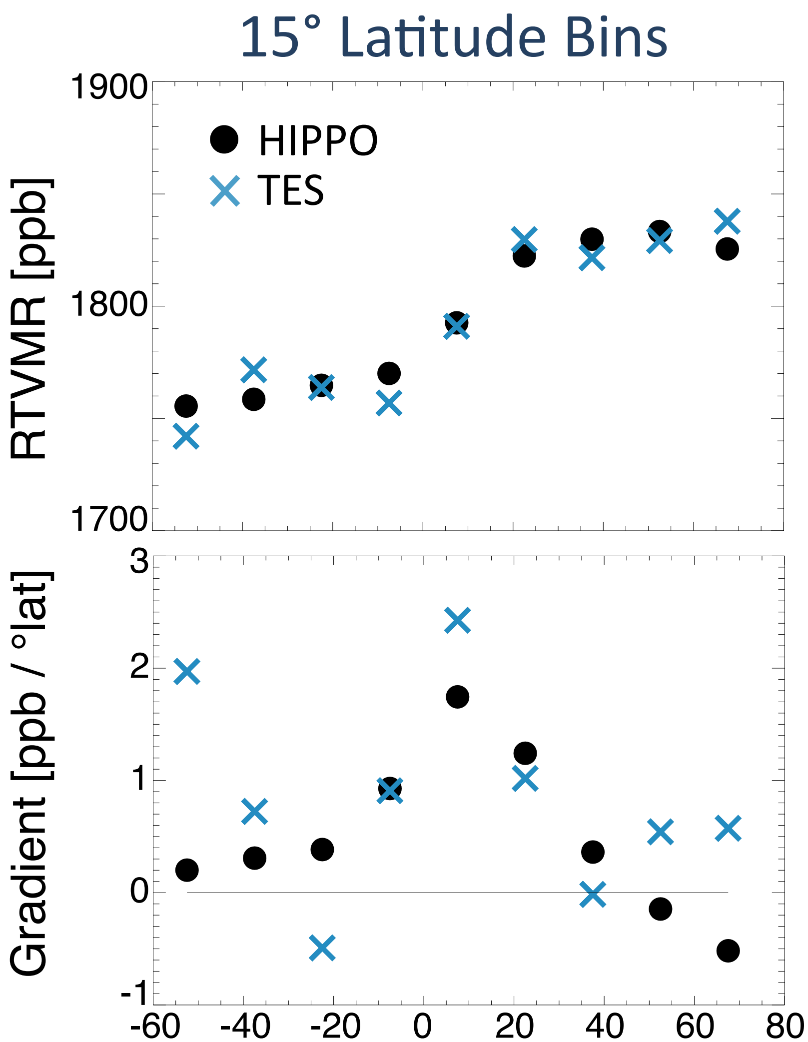
RTVMR-lo
DOFS > 1.6
~200 hPa

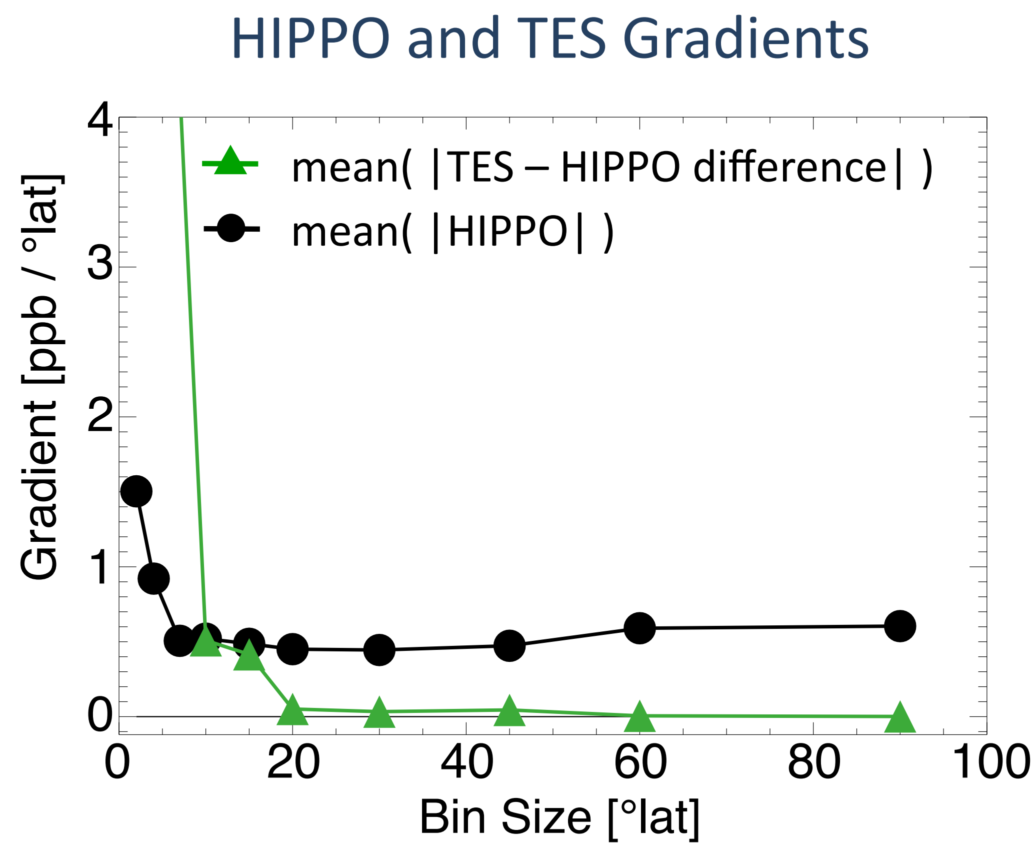
RTVMR-hi
DOFS > 1.6
~500 hPa



Bias and error reduced compared with V004 methane. RTVMR-hi bias is a function of latitude.

The Ability of TES V004 to Capture Latitudinal Gradients

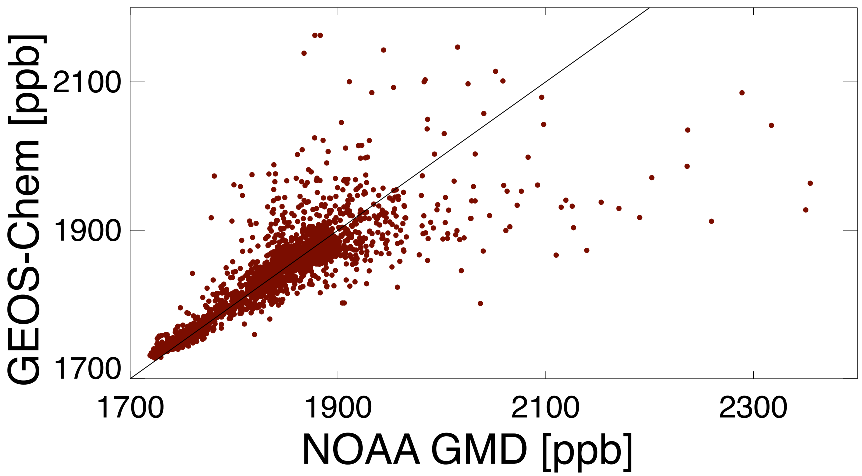


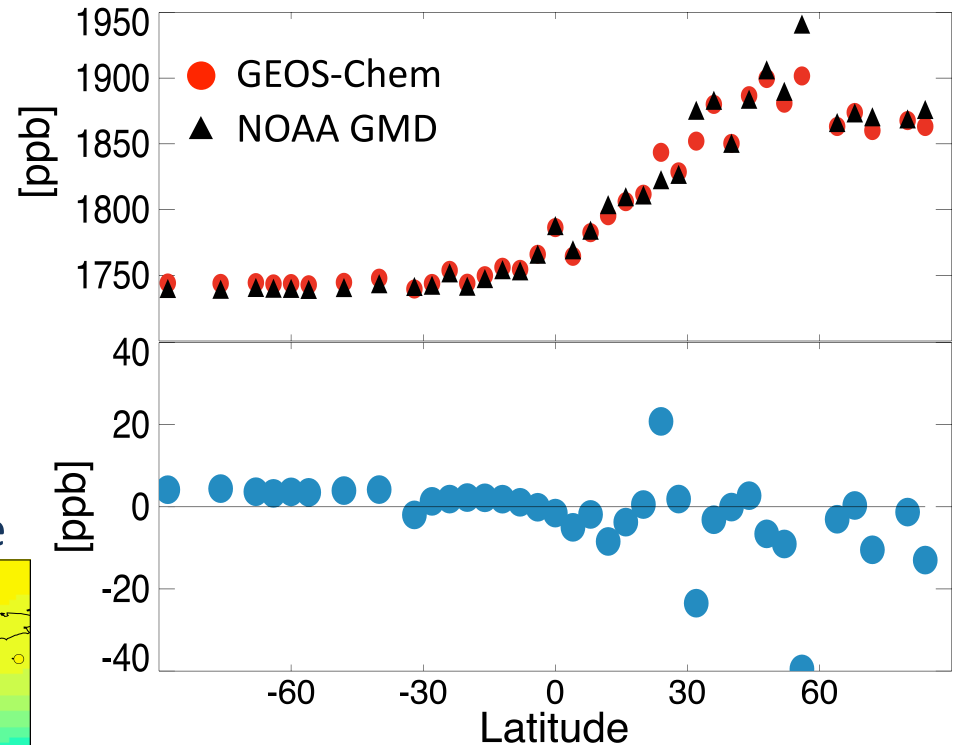


TES V004 captures HIPPO lat. gradients on a scale of ~20°. Informative for inverse modeling.

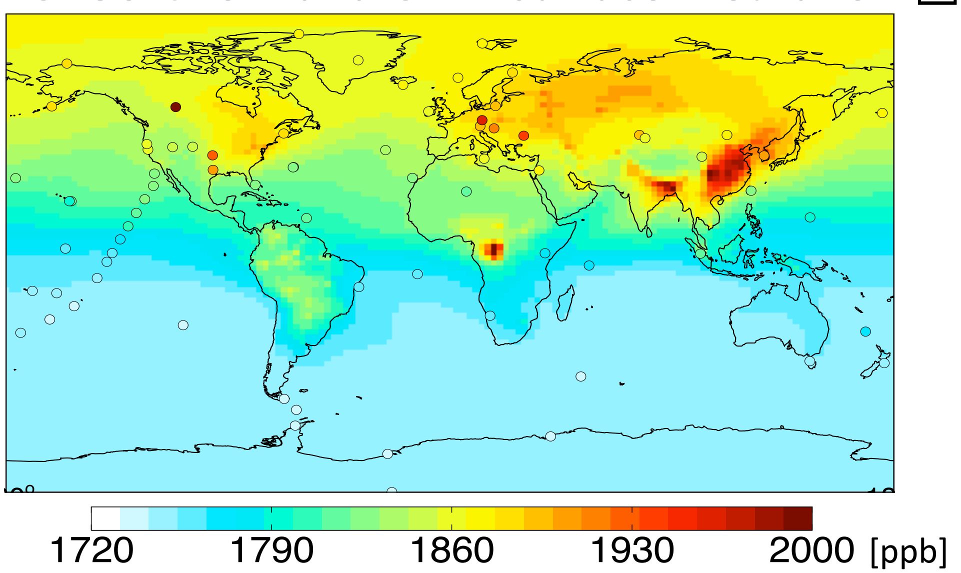
Model Comparison – NOAA GMD

2008 Annual Average





GEOS-Chem and GMD surface methane



- GEOS-Chem provides good simulation in the annual average
- Missing northern hemisphere sources?

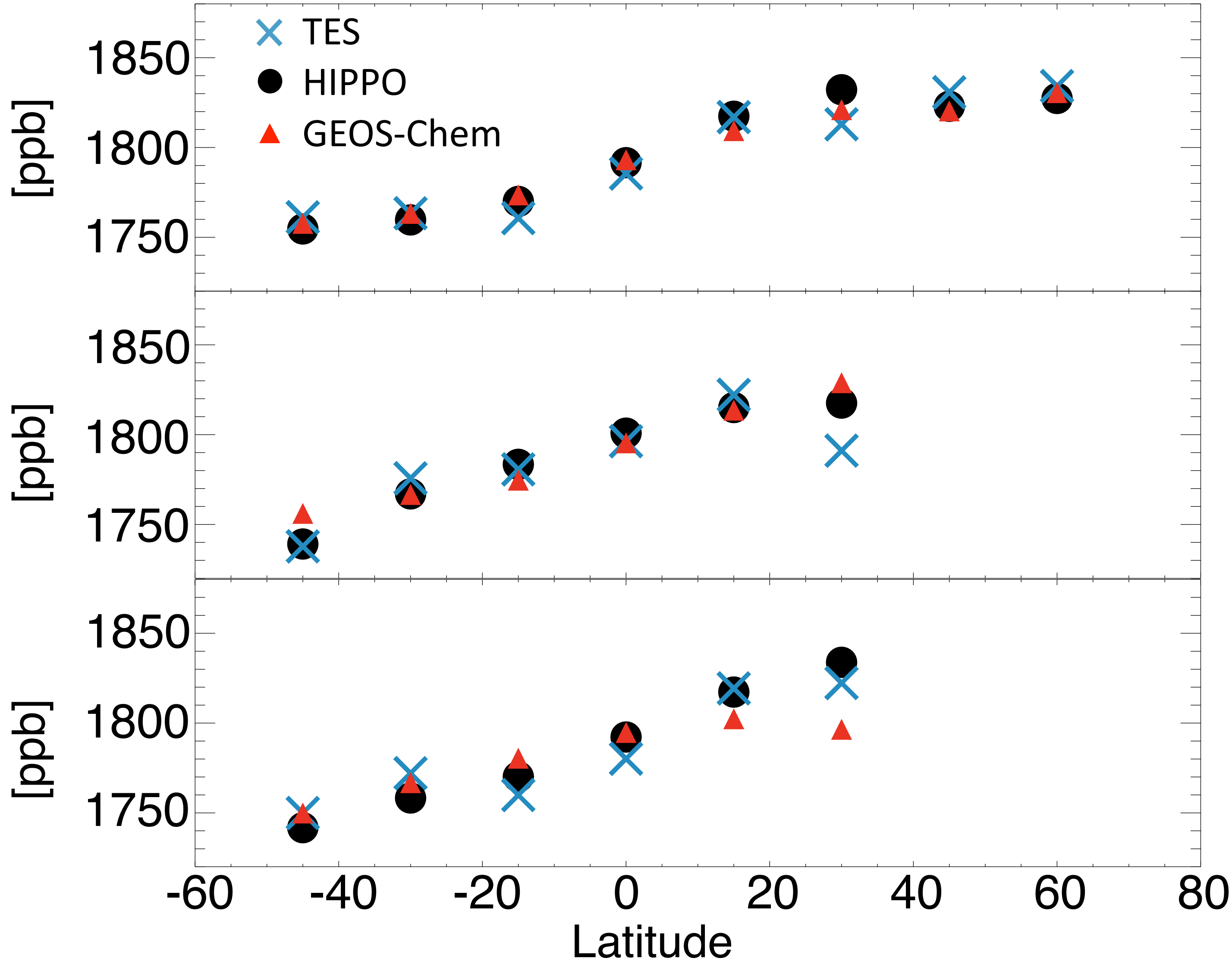
TES provides far greater spatial and temporal coverage than NOAA GMD

TES, HIPPO, GEOS-Chem

V004
RTVMR

RTVMR-lo
DOFS > 1.6
~200 hPa

RTVMR-hi
DOFS > 1.6
~500 hPa



VNEW reveals information not captured by V004.

Thank You!

Old TES CH_4 - Most recent public release

- TES is biased high and residual instrument error is > self-reported range
- Colocation error in VOLD validation is negligible
- TES captures latitudinal gradient in HIPPO data at ~20° resolution
- Enabling Inverse Modeling:
  - Characterization of bias and error
  - Robust latitudinal gradient with greater coverage than surface stations

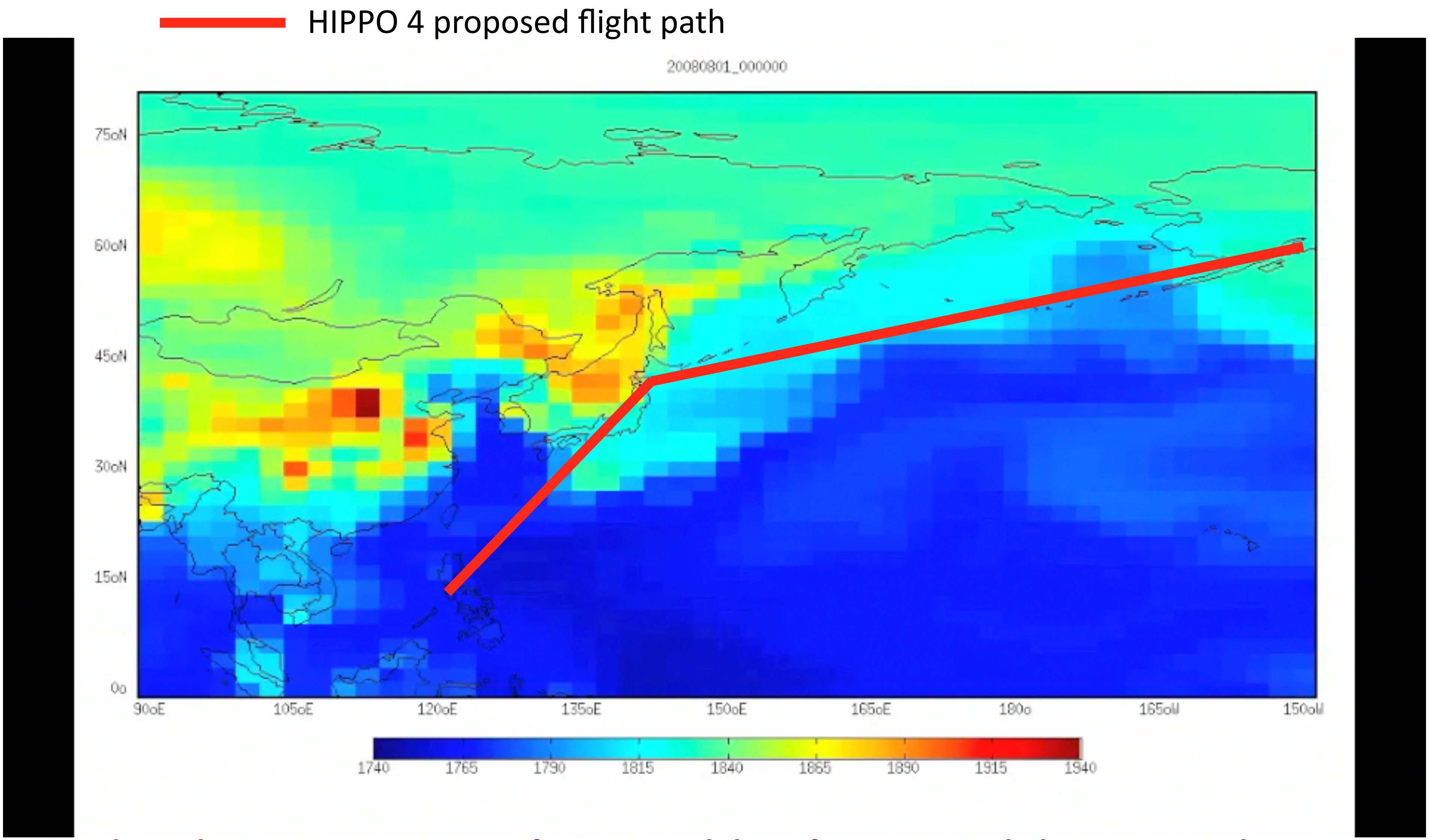
New TES CH_4

- Sensitivity lower in troposphere (important for inverse modeling)
- Error < old TES CH_4

Future Work

- **Validation of TES over source region**
- Adjoint Inversion with new TES CH_4
- Combine with total column measurement (SCIAMACHY, GOSAT)
- Focus on N.A. with GEOS-Chem nested-grid capability

GEOS-Chem Methane < 700hPa
July & August 2008



Coincident observations necessary for testing ability of TES to sample lower trop enhancements