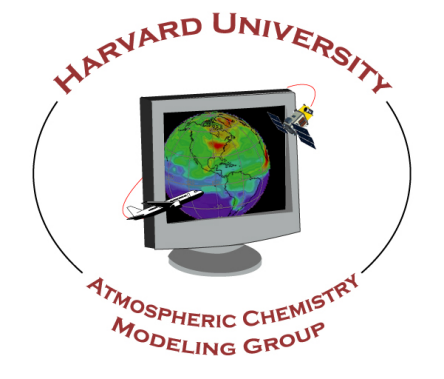
Drafted/planned HIPPO papers from Jacob's group

- Drafted (pre-HIPPO):
  - Magnitude and trends of wetland methane emissions from the Hudson Bay Lowlands (Canada), by Christopher Pickett-Heaps et al.
- Planned:
  - Validation of TES methane with HIPPO observations, by Kevin Wecht et al.
  - Global adjoint inversion of methane sources using TES observations, by Kevin Wecht et al.
  - Global simulation of black carbon aerosol sources and distributions evaluated with HIPPO data, by Qiaoqiao Wang et al.

Validation of TES Methane with HIPPO Observations

For Use in Adjoint Inverse Modeling

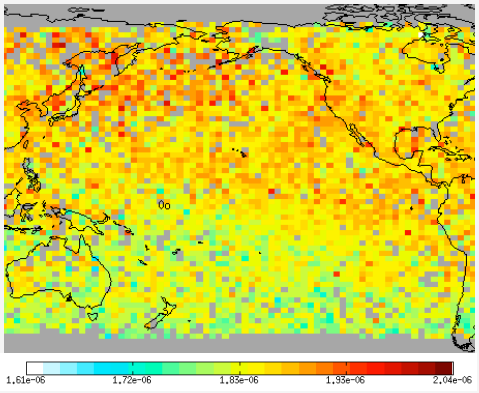


Kevin J. Wecht

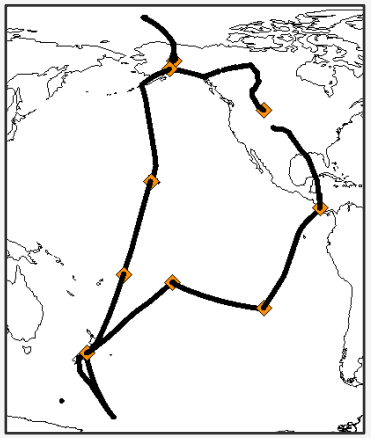
HIPPO Webcast 25 May 2010

Adjoint Inverse Modeling of Methane Sources

TES Methane



Validation

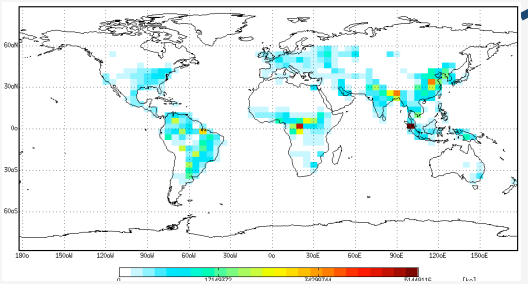


HIPPO Methane (Wofsy, Kort)

GEOS-Chem CTM

GEOS-Chem Adjoint

Apriori Sources



EDGAR v4, Kaplan, GFED 2, Yevich and Logan [2003]

Adjoint inverse analysis

OPTIMIZATION OF SOURCES

HIPPO provides:

- Large number of profiles
- Wide latitudinal range
- Remote from sources (reduces collocation error)

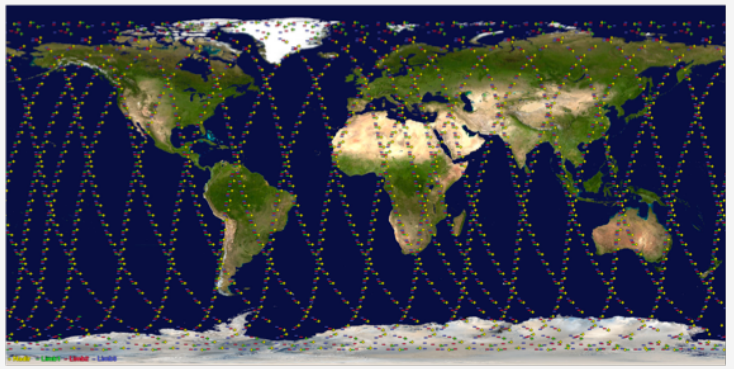
TES

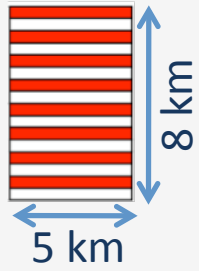
- Sun-synchronus orbit
  local overpass at 1:43pm
- Methane retrieval 7.658 – 7.740 µm
- Averaging kernels peak 200-400 hPa
- Degrees of Freedom for Signal 0.5-2.0
- Apriori from Mozart CTM
- Unit of comparison for this work is
  Representative Tropospheric
  Volume Mixing Ratio (RTVMR)

1 TES "global survey"

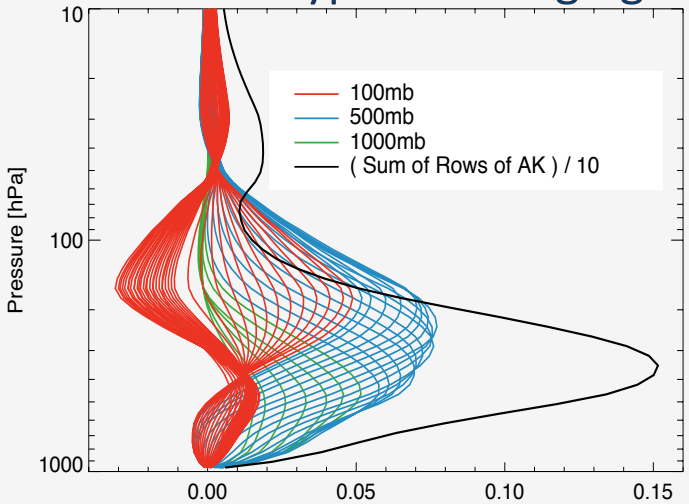
16 orbits, 26 hours, 2300 observations

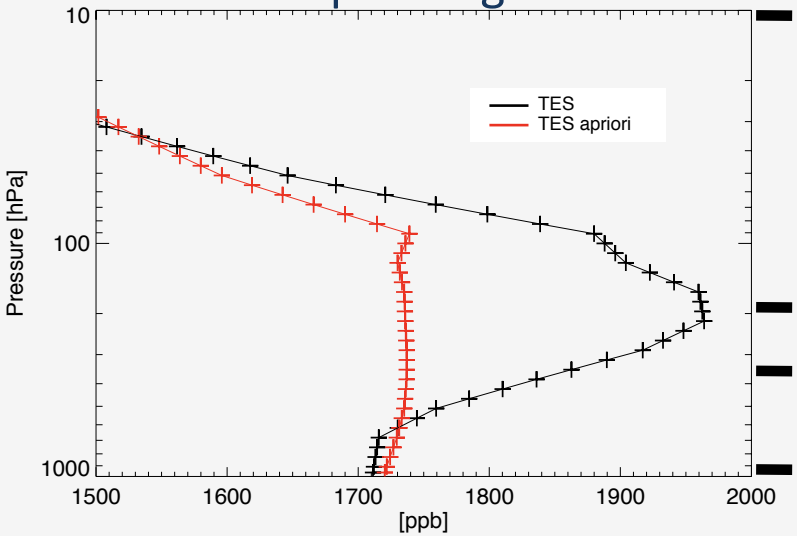
15-16 global surveys per month





Rows of typical averaging kernel and corresponding retrieval





RTVMR
(Payne et. al. 2009)

- Define 4-level pressure grid by shape of AK.
- Map retrieval to coarse grid.
- Concentration at 2nd pressure level is the RTVMR

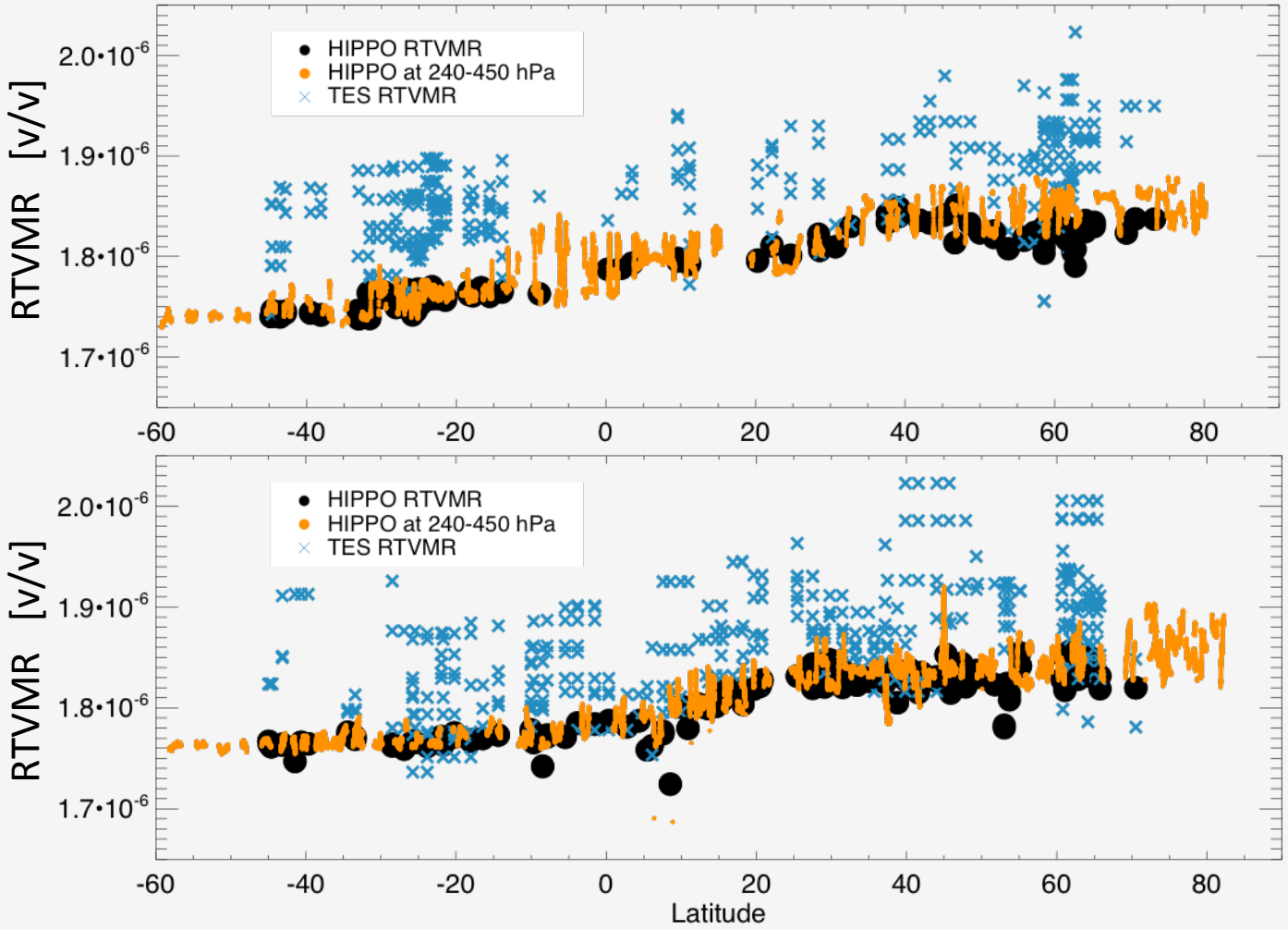
HIPPO v. TES by Latitude

HIPPO I

Jan 9-30, 2009

HIPPO II

Oct 22 – Nov 20, 2009

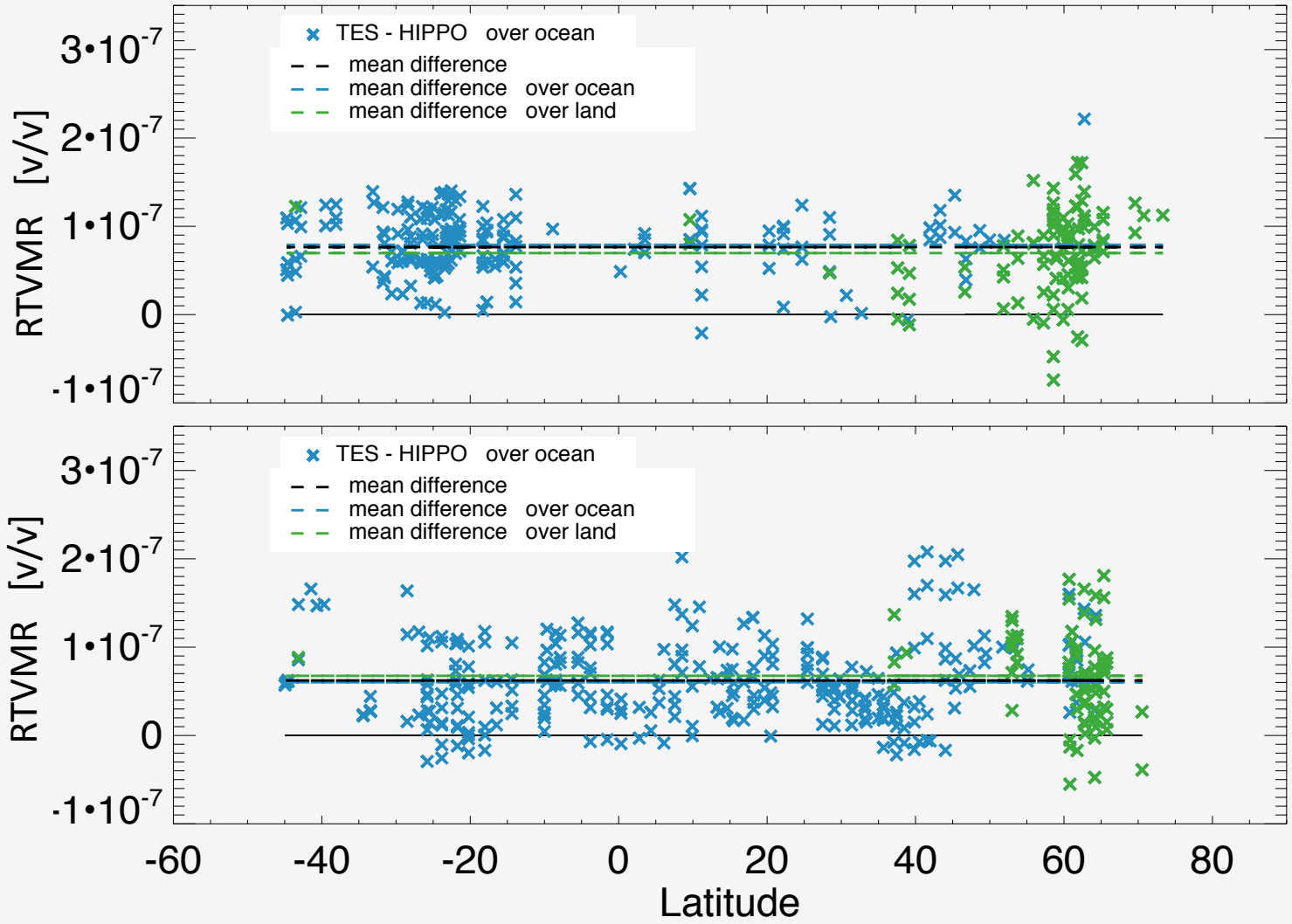


Positive bias and significant noise, but latitudinal gradient is captured.

HIPPO vs. TES by Latitude

HIPPO I
Jan 9-30, 2009

HIPPO II
Oct 22 – Nov 20, 2009

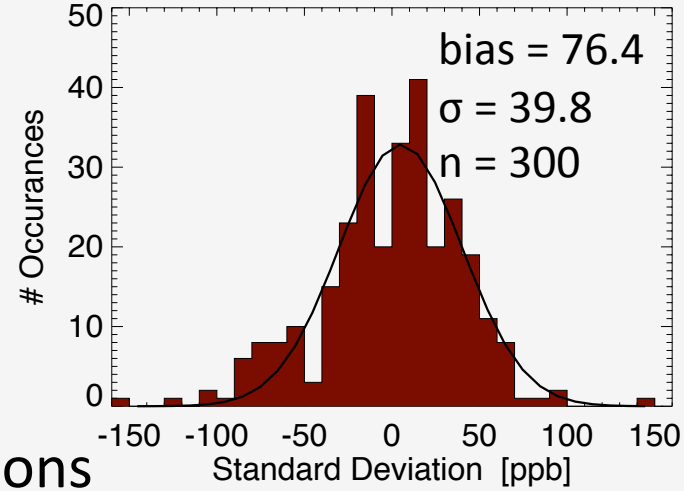


HIPPO I: **bias = 76.4 ppb,** **residual error = 39.8 ppb** **n = 300**

HIPPO II: **bias = 62.3 ppb,** **residual error = 47.3 ppb** **n = 379**

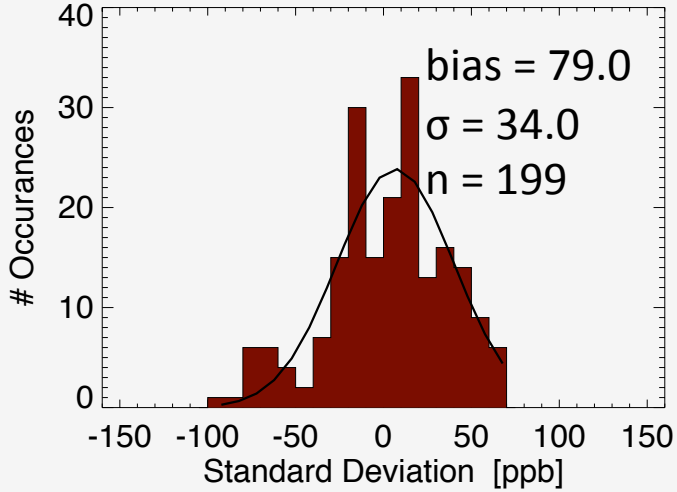
Distribution of Error – HIPPO I

All Observations



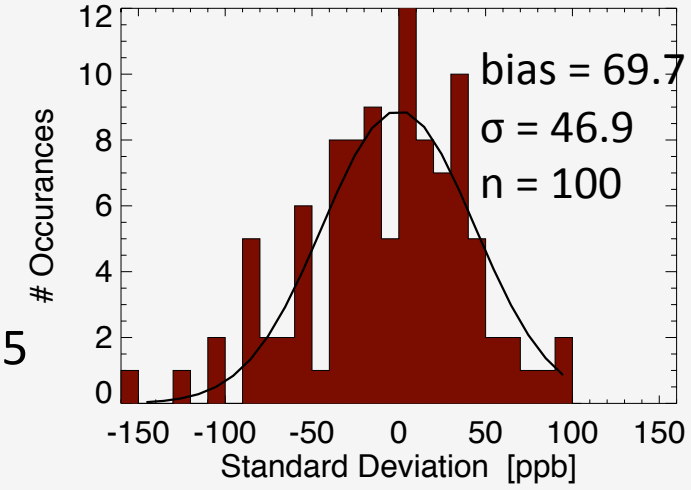
Normally distributed errors in HIPPO II comparison as well.

Ocean Observations



Welch's t-test suggests different mean biases.
p-value = 0.025-0.05

Land Observations



Ocean and land have different bias (p-value 0.025-0.05). Land has larger error.
Errors are normally distributed, important for derivation of inversion cost function.

Collocation Error

Mean bias [ppb], error [ppb], and # observations

All Observations

Units [ppb]	**24 Hours**	**12 Hours**
500 km	76.6 ± 39.8 n = 300	76.7 ± 34.6 n = 204
250 km	84.4 ± 31.5 n = 68	80.2 ± 27.8 n = 53

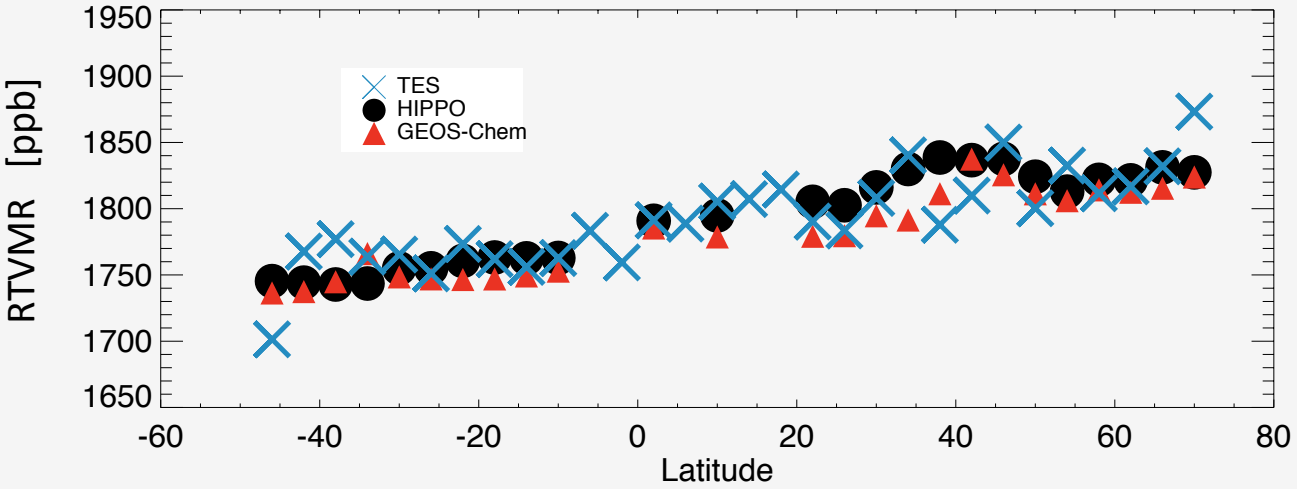
TES self-reported instrument error is 1.5-2.5 % ≈ 27-45 ppb

Varying coincidence criteria by a factor of 2 changes error more than bias.
Can I extrapolate for true instrument error?

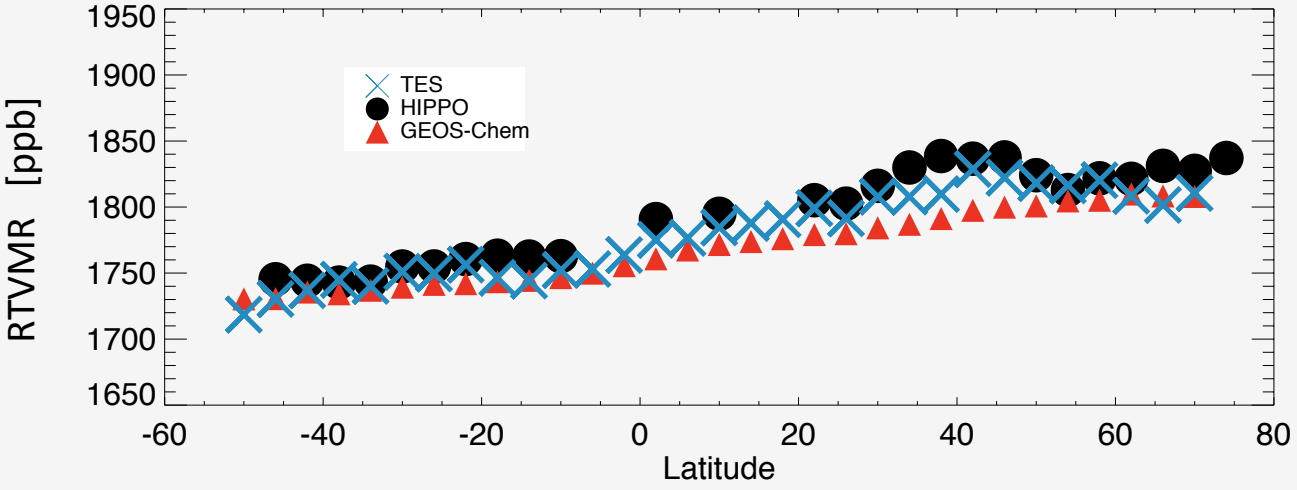
Model Comparison – HIPPO

TES (bias corrected) and GEOS-Chem matched to each HIPPO I vertical profile.

HIPPO I
Jan 9-30, 2009



TES (bias corrected) and GEOS-Chem during HIPPO I period over Pacific (150E to 120W)

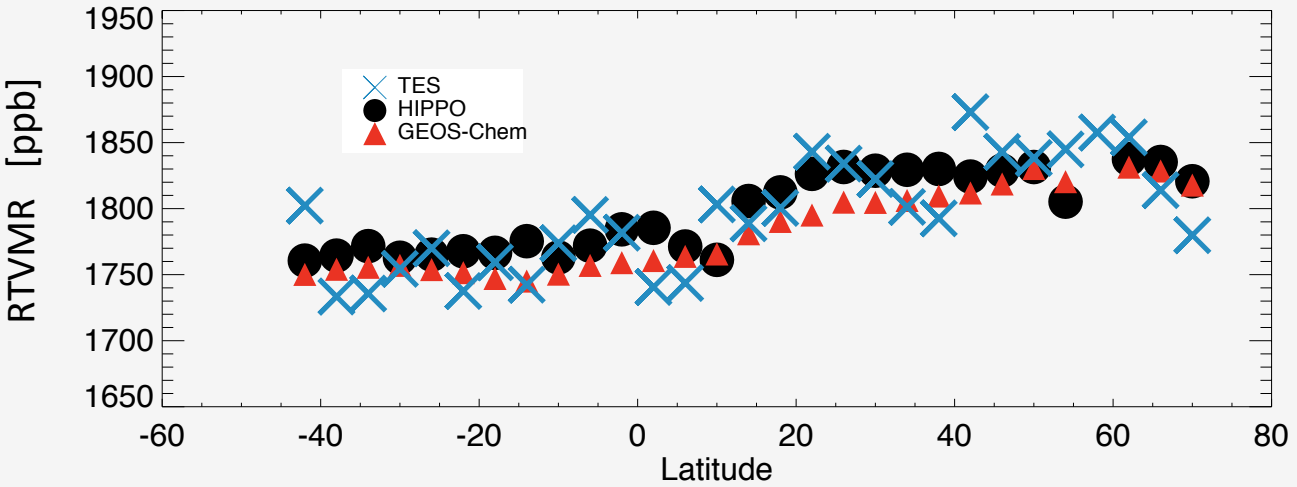


Model Comparison – HIPPO

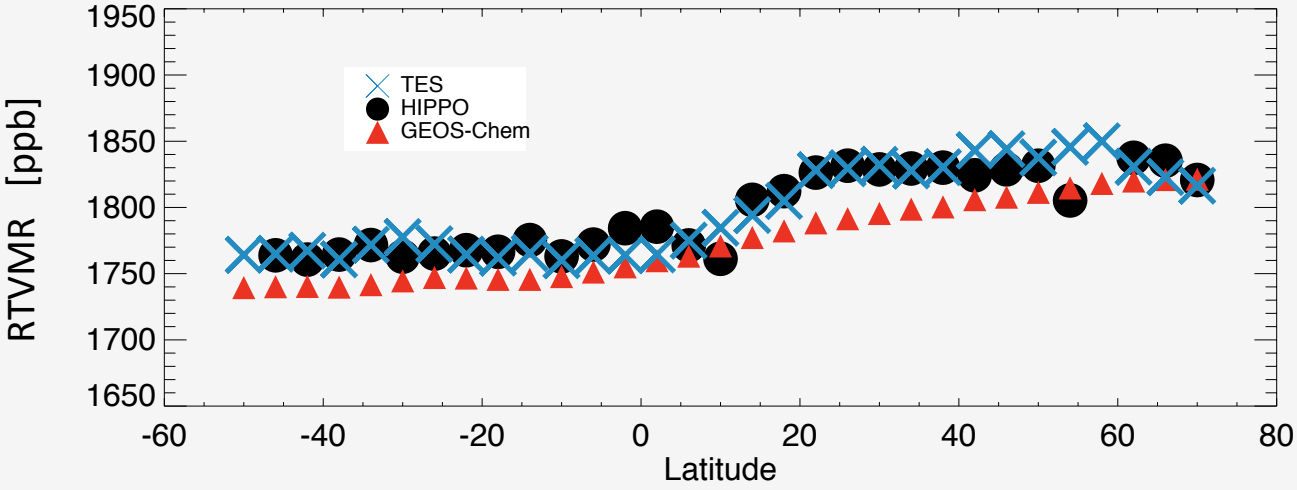
TES (bias corrected) and GEOS-Chem matched to each HIPPO I vertical profile.

HIPPO II

Oct 22 – Nov 20, 2009



TES (bias corrected) and GEOS-Chem during HIPPO I period over Pacific (150E to 120W)



Summary

- TES captures latitudinal gradient in HIPPO data
- TES is biased high but residual instrument error is within self-reported range
  - 80.2 ± 27.8 ppb during HIPPO I ← low end of self-reported range
  - 67.5 ± 45.9 ppb during HIPPO II ← high end of self-reported range
- Difference between land and ocean observations
- TES: known instrument problem in December 2009.
  - HIPPO II results indicative of instrument decline?
  - TES methane intermittent Jan 1 - April 27, 2010. Very few observations during HIPPO III.
  - Will validate again with HIPPO IV & V
- Enabling Inverse Modeling:
  - Time period: TES provides useful information through the end of HIPPO II.
  - Quantification of bias and error.
  - Error normally distributed.
  - Robust latitudinal gradient with greater coverage than surface stations
- HIPPO will be used to evaluate inversion results.

Contact: wecht@fas.harvard.edu