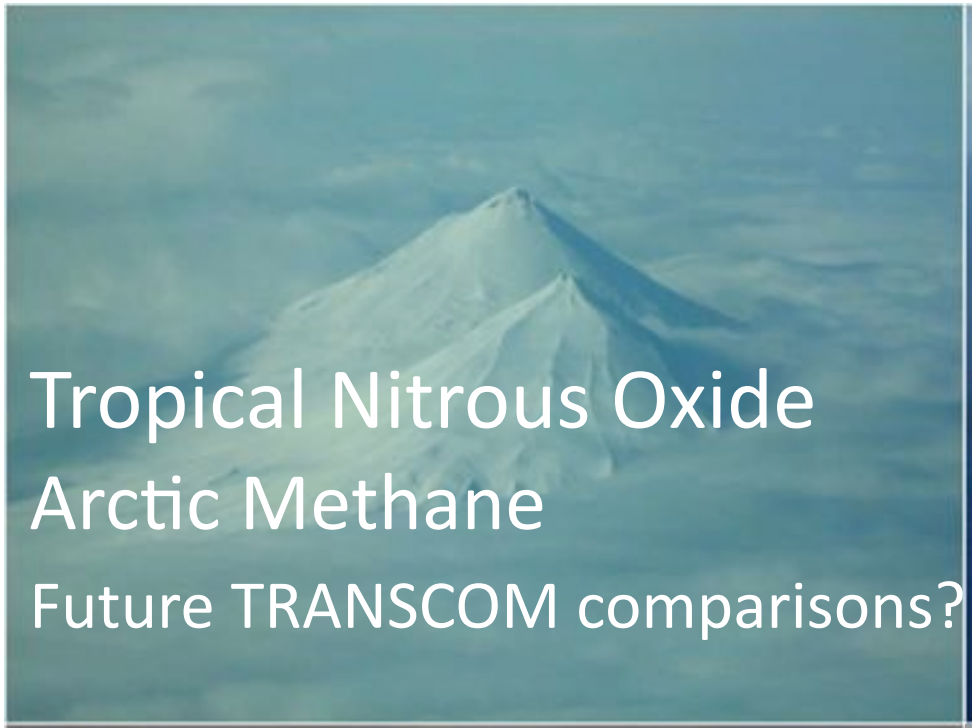
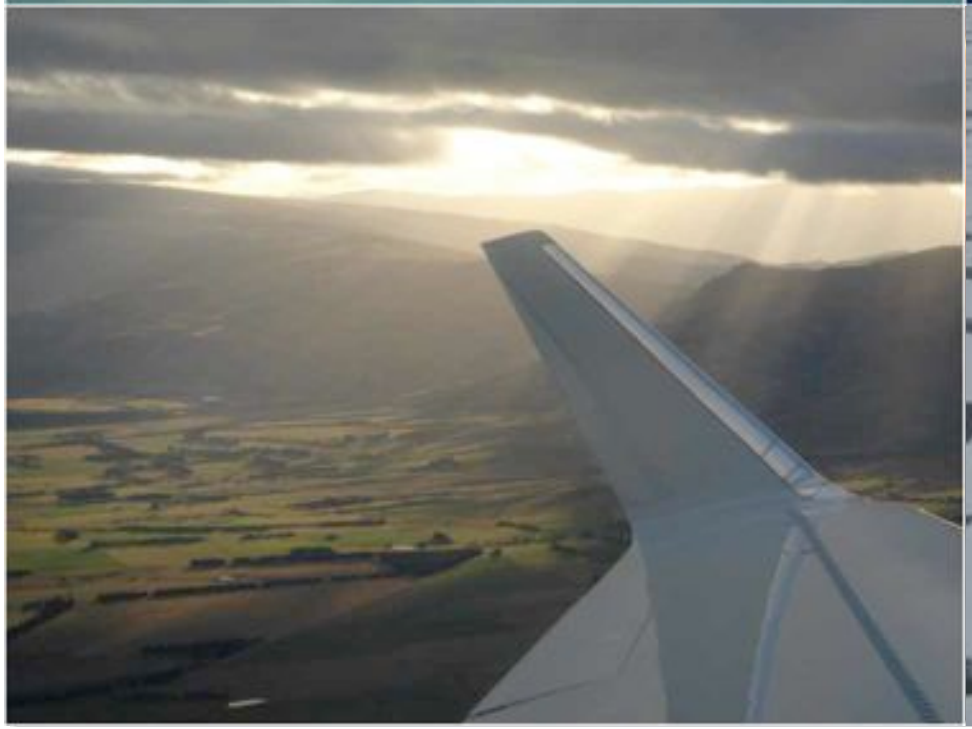
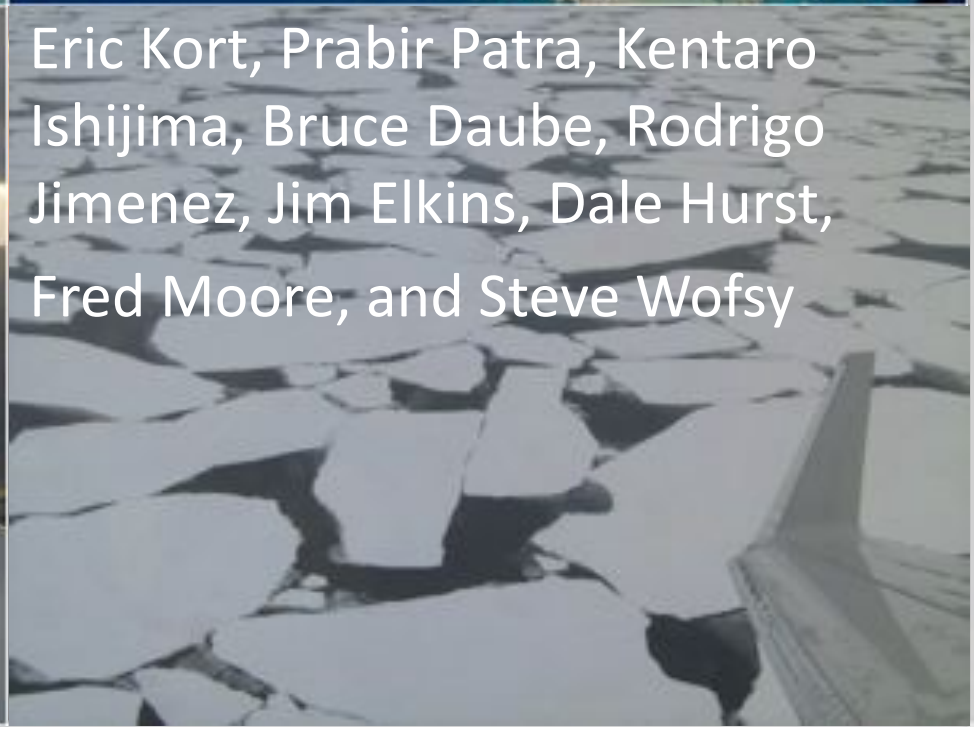


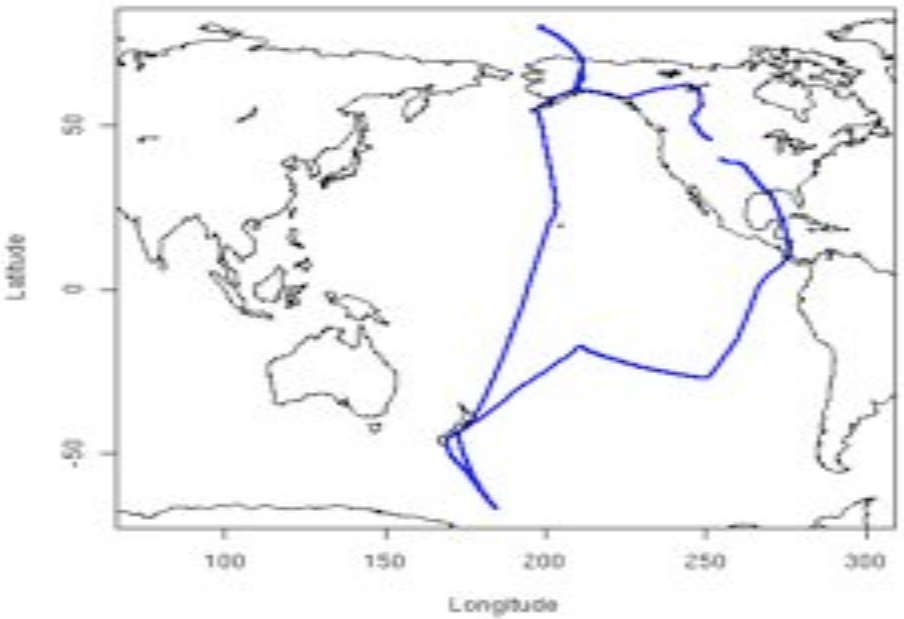
Tropical Nitrous Oxide
Arctic Methane
Future TRANSCOM comparisons?



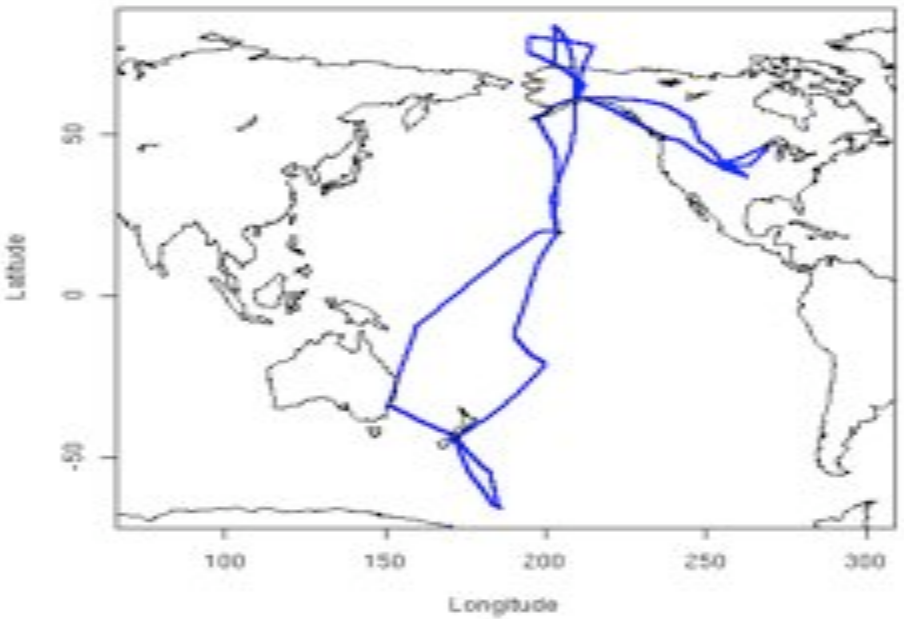


Eric Kort, Prabir Patra, Kentaro Ishijima, Bruce Daube, Rodrigo Jimenez, Jim Elkins, Dale Hurst, Fred Moore, and Steve Wofsy

HIPPO-1: January 2009

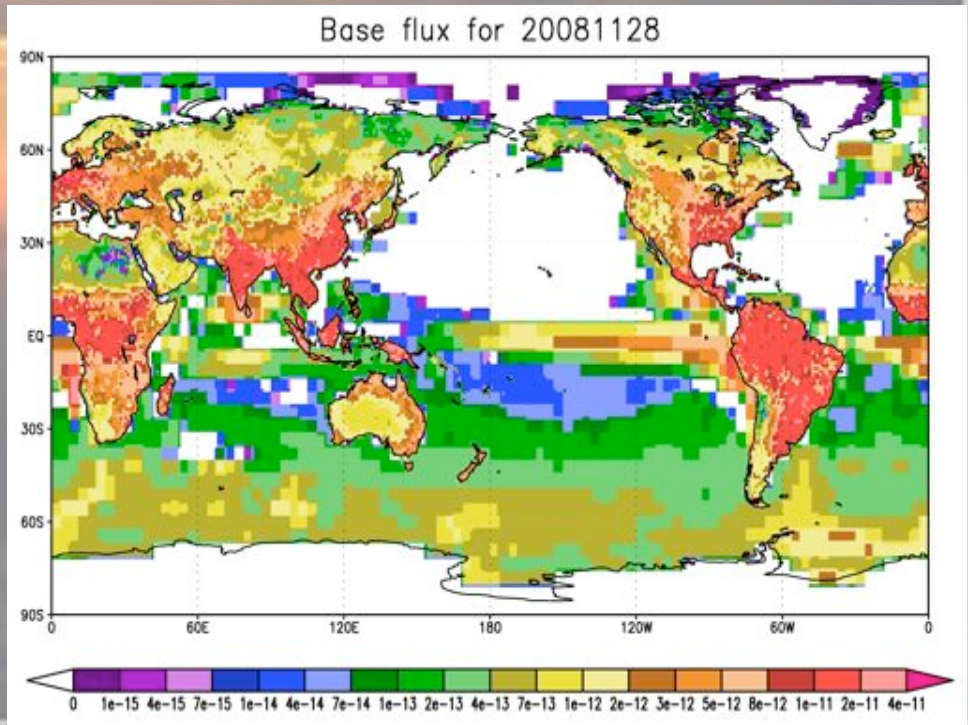


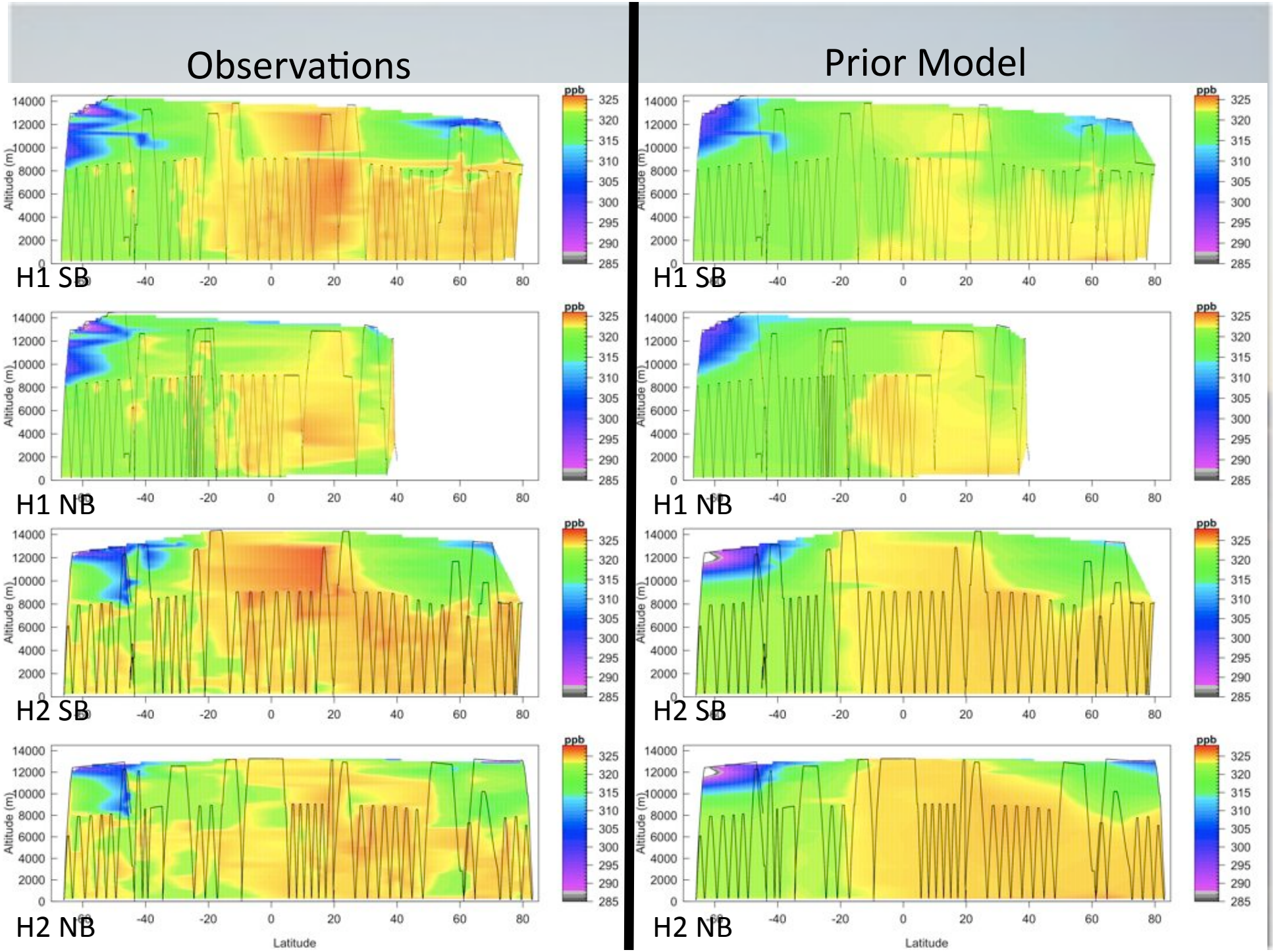
HIPPO-2: October/November 2009



Model

- ACTM (JAMSTEC, Prabir Patra & Kentaro Ishijima)
- T42, (~2.8° x 2.8°), 67 vertical levels (to 90 km)
- Nudged to JRA-25 winds and temperature
- Stratospheric loss explicitly modeled
- Emissions
  - EDGAR v4.0 (anthropogenic)
  - Jin & Gruber ocean fluxes
  - EDGAR 2 natural soil fluxes

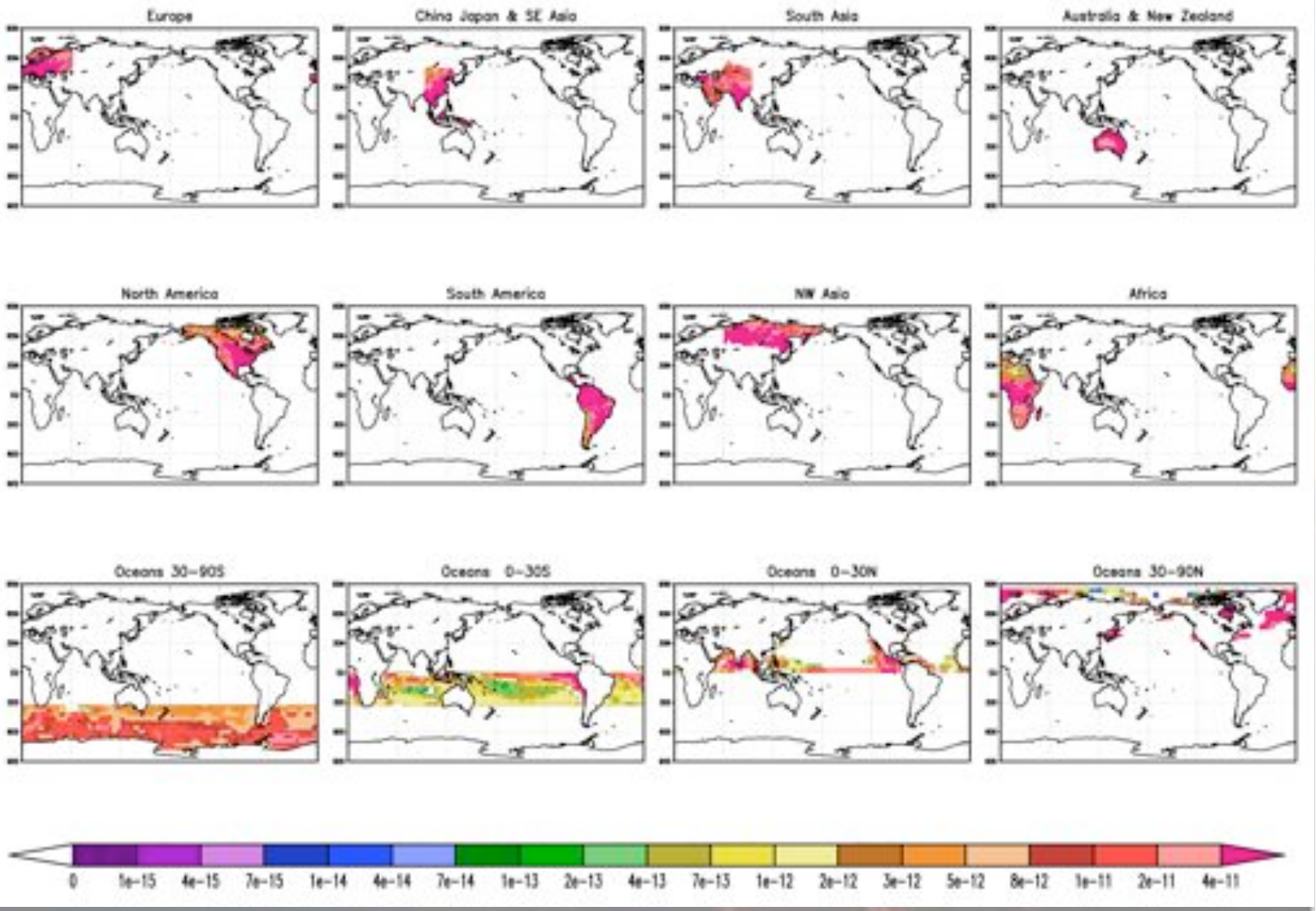



Observations
Prior Model
H1 SB
H1 NB
H2 SB
H2 NB
Altitude (m)
Latitude
ppb

Inversion

12 Regions

3 time windows



Pulse 1: 6-3 weeks prior mission start

Pulse 2: 3 weeks prior to mission start

Pulse 3: mission start + 3weeks

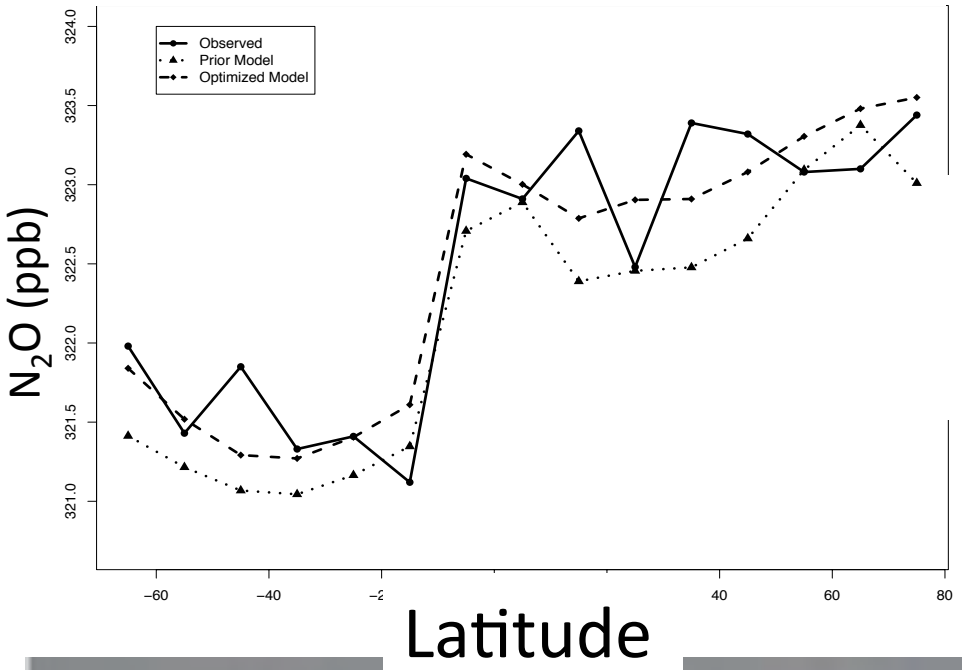
‘Surface’ Optimization

Solid Line: Observed

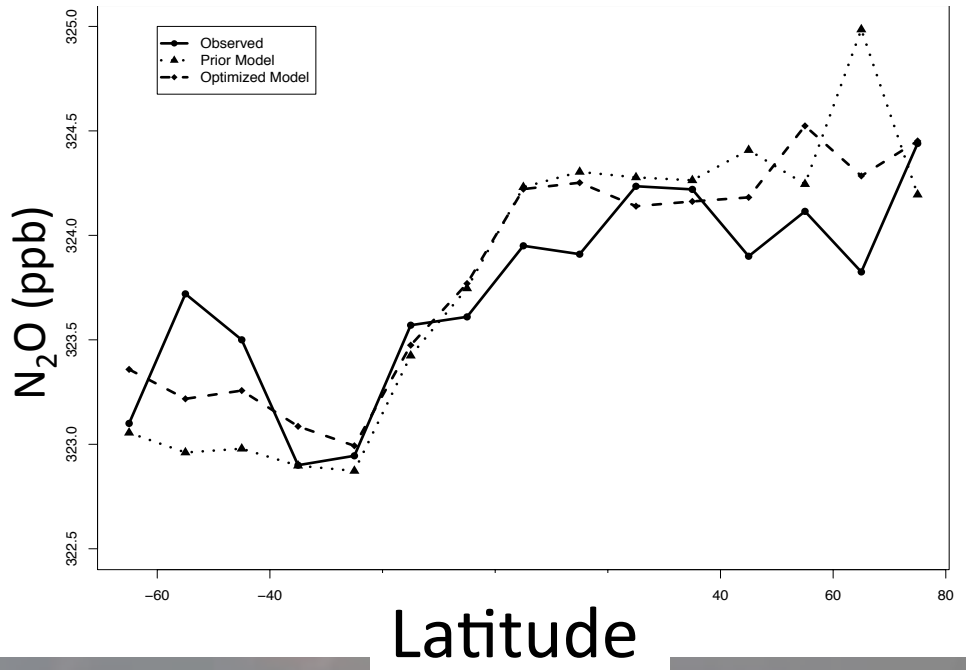
Dotted Line: Prior Model

Dashed Line: Optimized Model

January 2009: Latitudinal gradient 500m

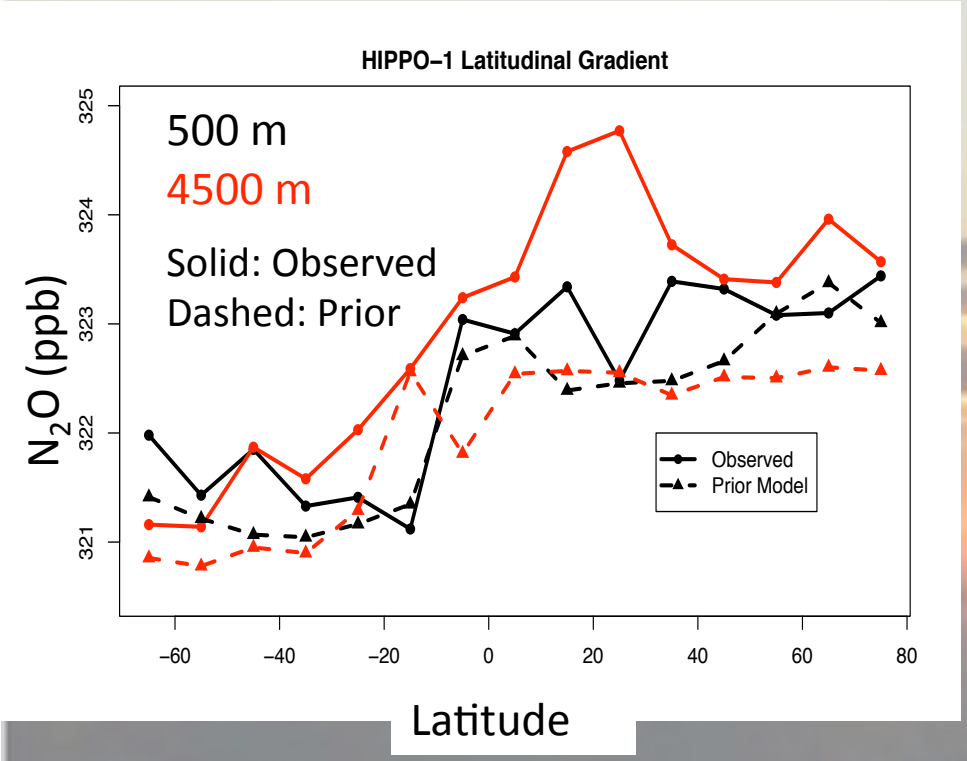


Oct/Nov 2009: Latitudinal gradient 500m



Prior model accurately captures ‘surface’ observations, inversion makes no significant changes to prior flux fields

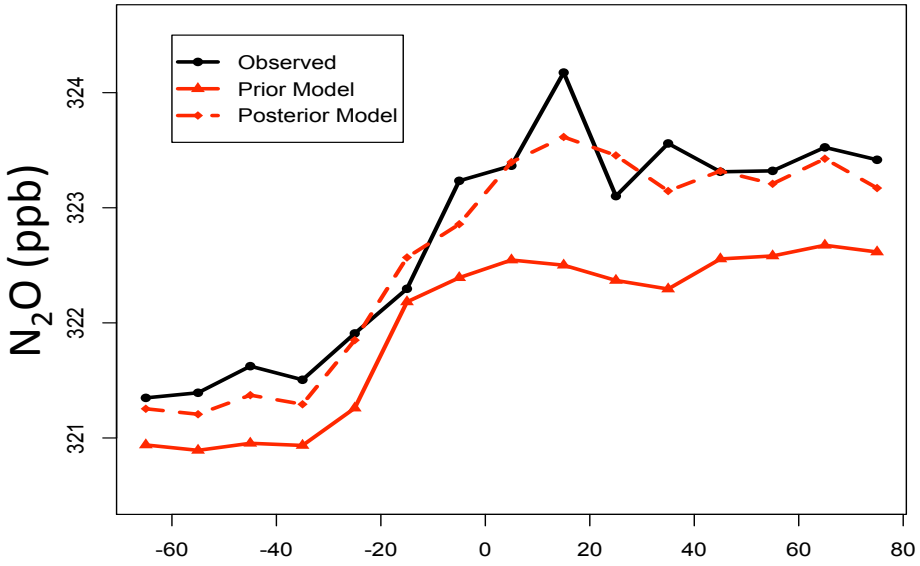
Considering the middle troposphere



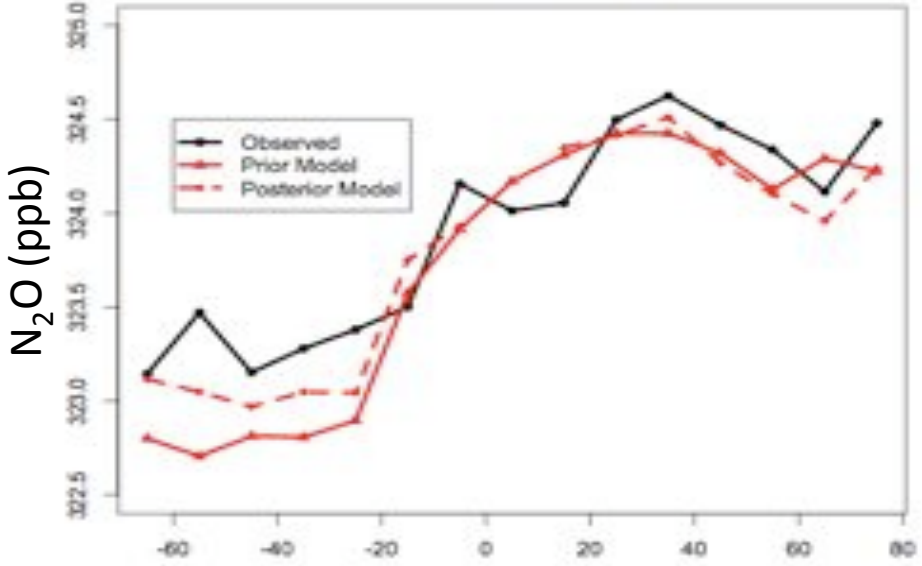
- Large discrepancies through middle troposphere
- Reverse vertical gradient in observations not in prior model
- Perform inversion with all tropospheric data
- Compare total column

Total Column

HIPPO-1: January 2009



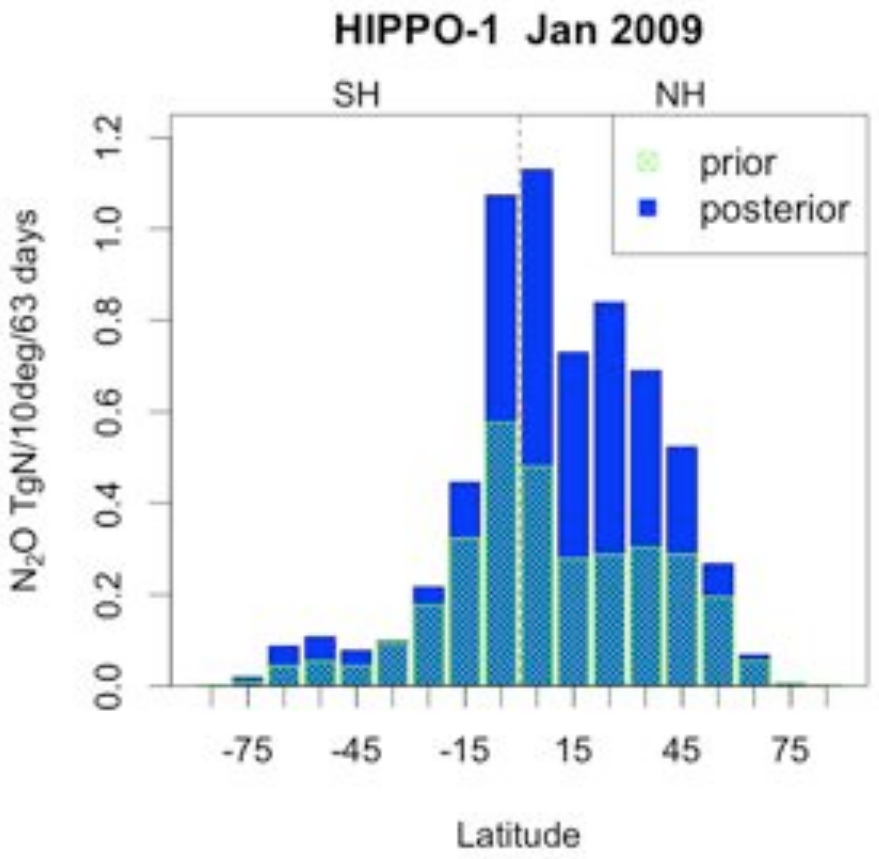
HIPPO-2: Oct/Nov 2009

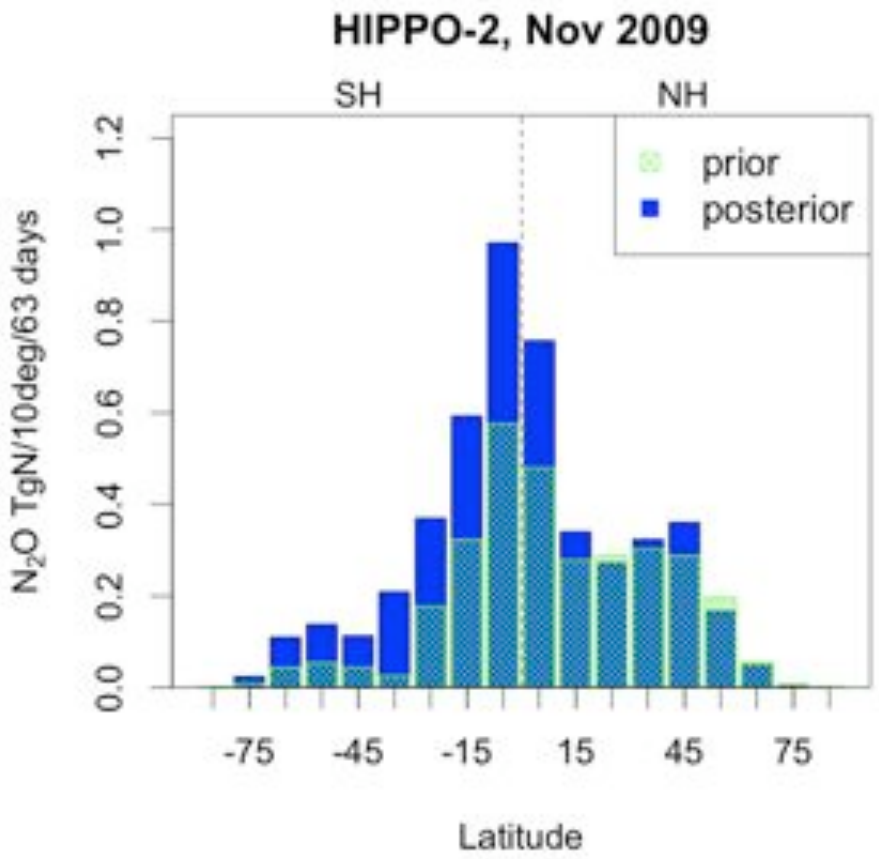


Optimized model significantly improves model-data agreement

- Tropical Bulge in HIPPO-1
- Southern Hemisphere in HIPPO-2

Latitudinal Distribution of Emissions

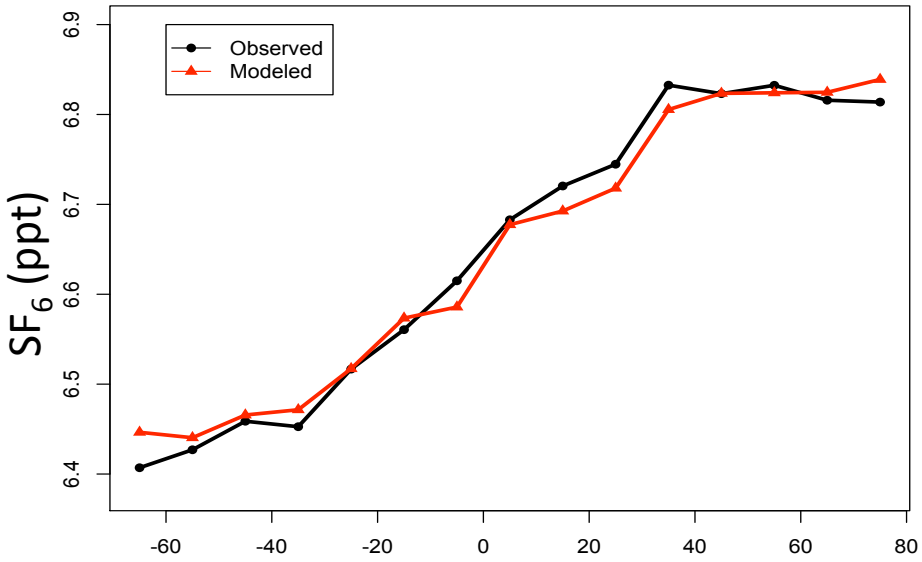




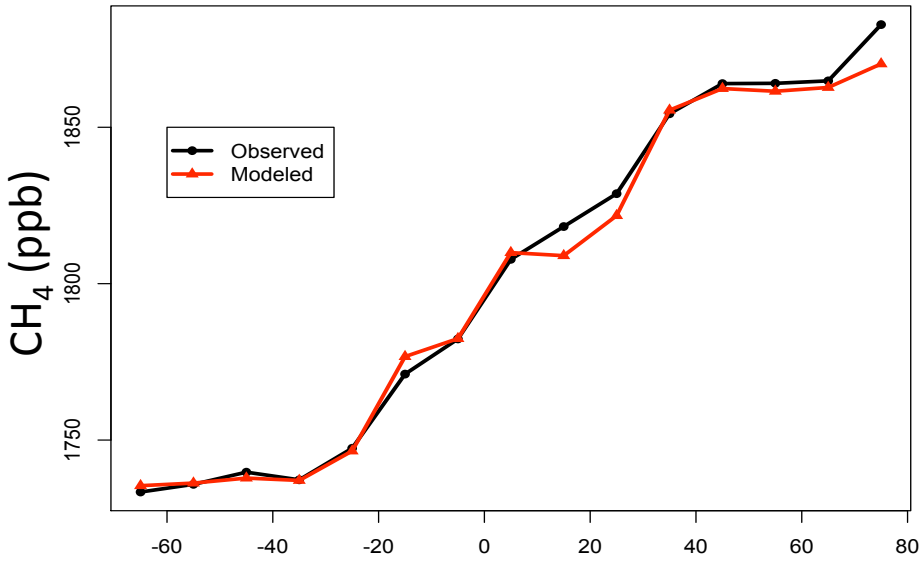
- Both HIPPO-1 & 2 show large increase in tropical emissions
- HIPPO-1 also increases emissions at higher northern latitudes (SE Asia)
- HIPPO-2 emissions increase throughout southern latitudes

Transport Validation

Sulfur hexaflouride



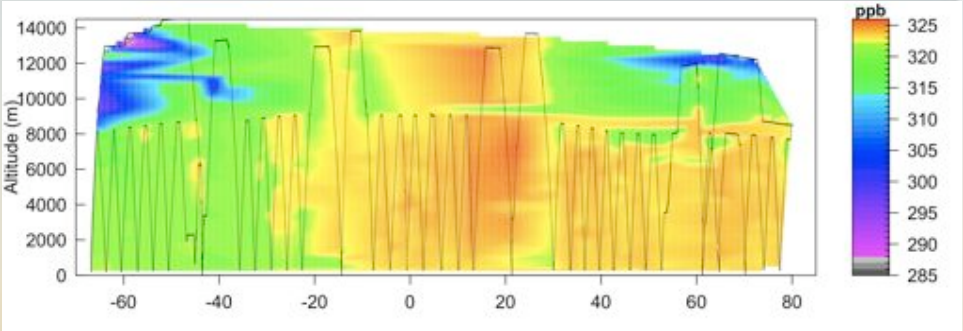
Methane



- Excellent agreement between observations and model for SF_6
- Also excellent agreement w/ Methane

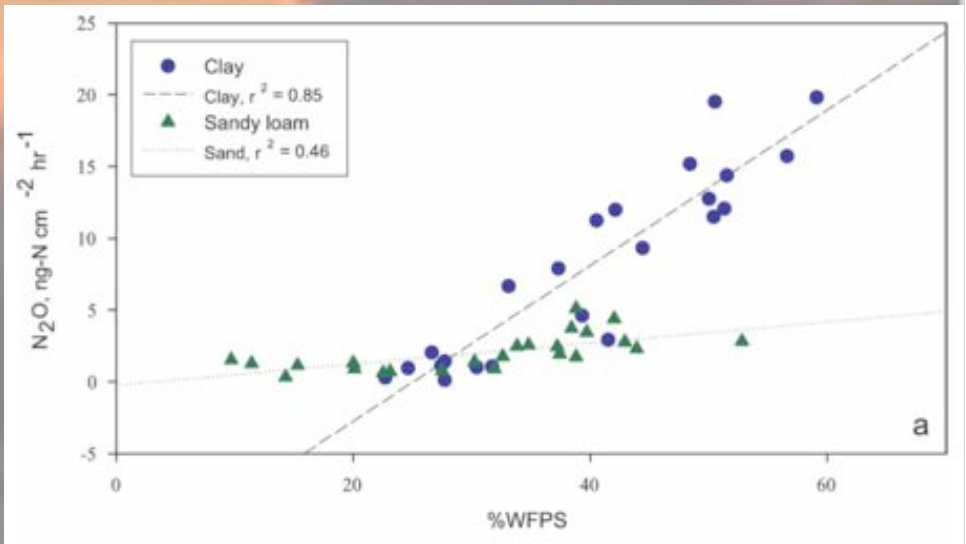
N_2O at altitude

- Signal from large Tropical Emissions



- Large-scale convective activity lofts to significant altitude

- Source may wink on and off



Keller et. al. Earth Interactions 2005

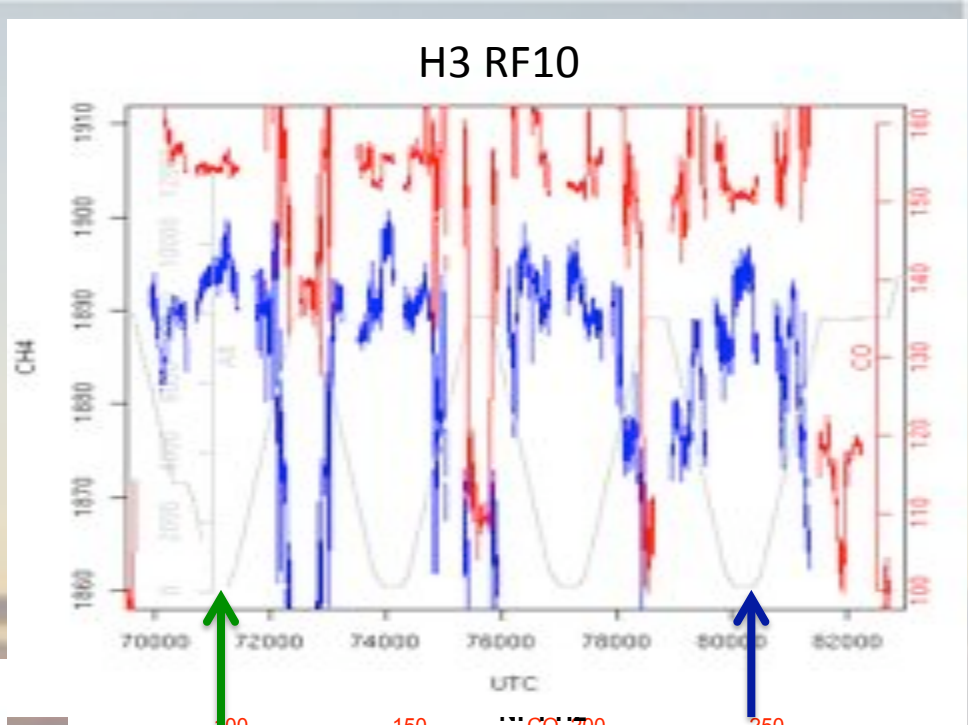
Summary

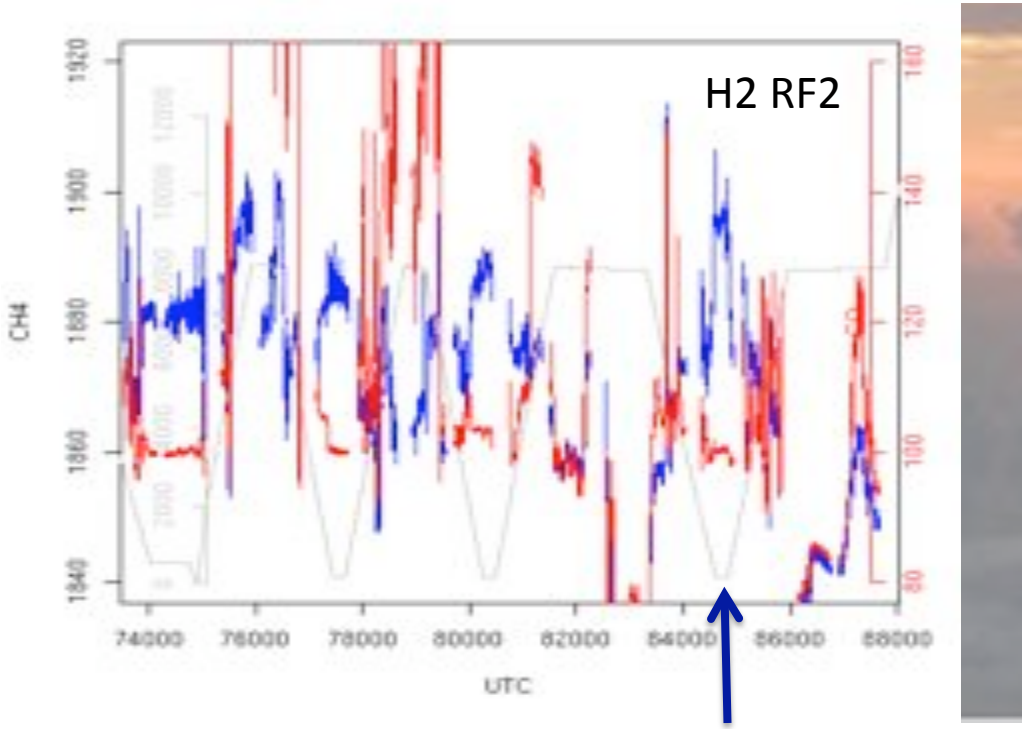
- Global model accurately captures near-surface N_2O distributions, but fail to capture the vertical distribution
- Large (1 Tg N), temporally variant emissions are necessary to bring model & observations into agreement
- Tropics show persistent, multi-season enhanced emissions
  - January, 0-30N 157%, 0-30S 61 % increases
  - November, 0-30N 30%, 0-30S 79% increases
- Global inversions using only remote surface observations fail to capture these large emissions

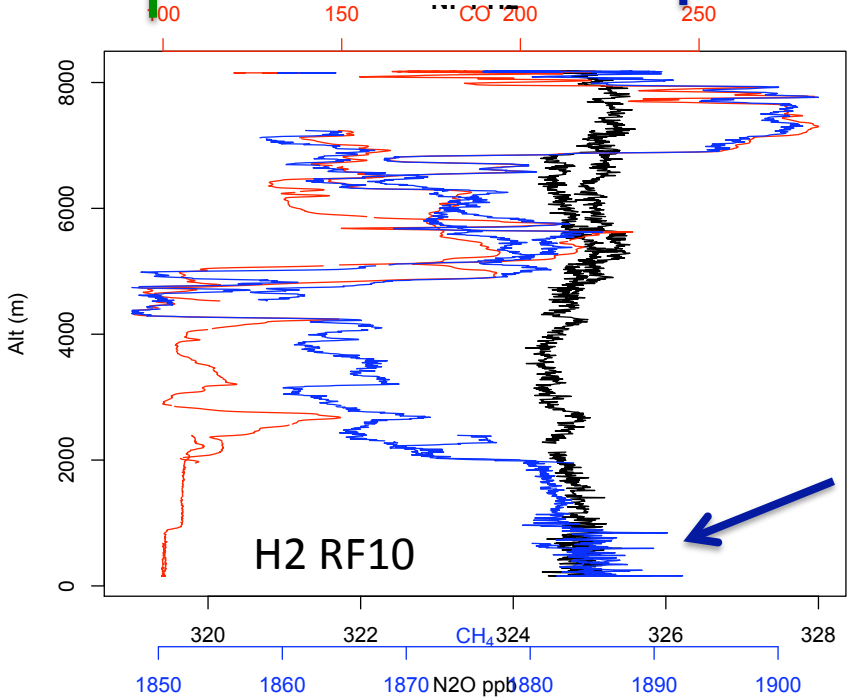
Arctic CH4 sources

Enhancement in Arctic boundary layer: at time some correlation with CO, but at times coincident with low CO- possibly non-anthropogenic arctic sources

Time series & Profile, CH4 (blue), CO (red), Alt (gray), N2O (black)







Back of the envelope: simple 2-box model

- Define marine boundary layer, free troposphere, and exchange velocity
  - Flux=V (C_{mbl}-C_{ft})
    - Define V from mbl height (~1km) & ventilation time (~10days)
  - 10 ppb gradient -> flux 0.007 mg/(d m^2)
  - 50 ppb gradient, only 12 hrs over source region, ventilation time 5 days
    - Flux 0.7 mg/(d m^2)
- Compare to Shakhova et al
  - mean 3.67 mg/(d m^2), hotspots 11.8 mg/(d m^2)

Future TRANSCOM comparisons?

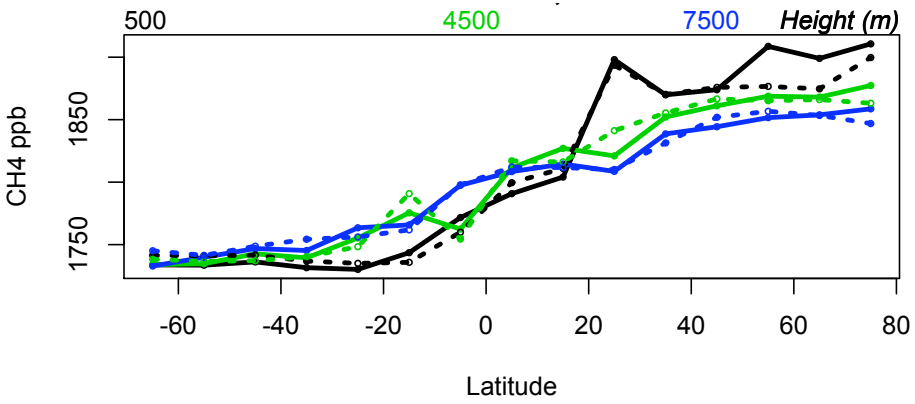
- Conversation started
- Potential for multiple models with consistent emissions (& OH) fields for
- CO2, CH4, SF6, MCF, Radon

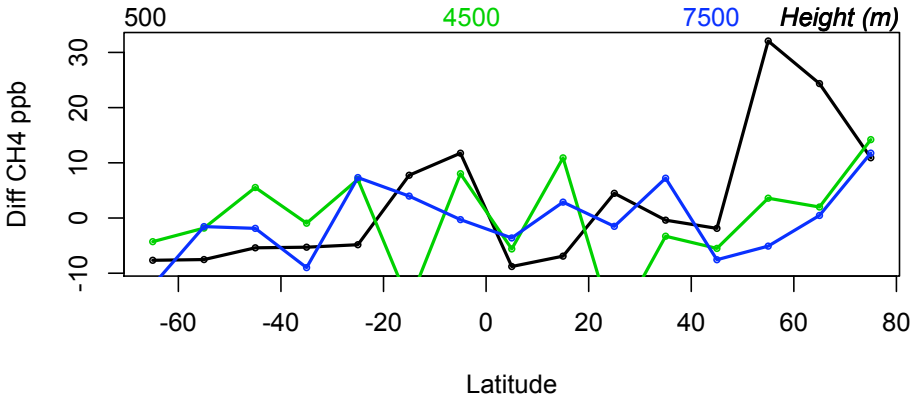
Methane- Model vs. Measurement

- ACTM model, 2009
  - 2 OH field (ACTM & TCOM)
  - 2 emissions fields (ctl & ext)
- Assessment of latitudinal & vertical gradients

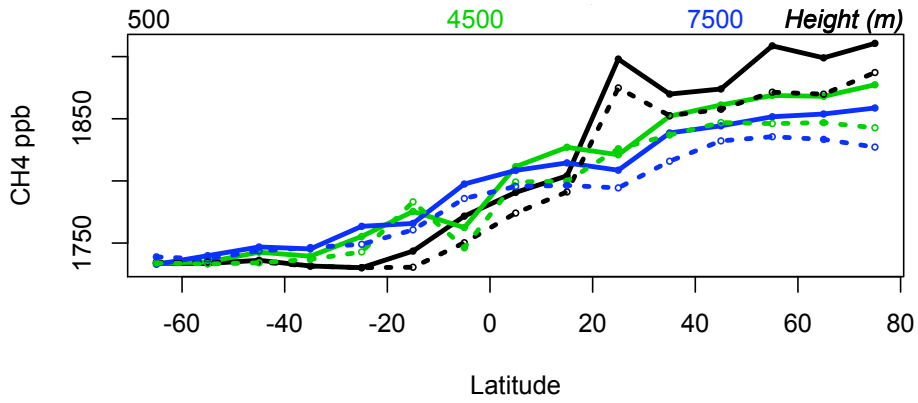
January 2009, different OH

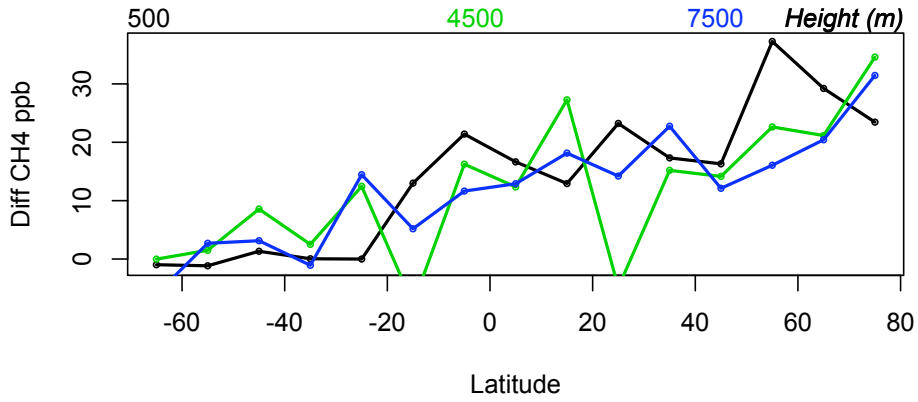
TCOM OH





ACTM OH

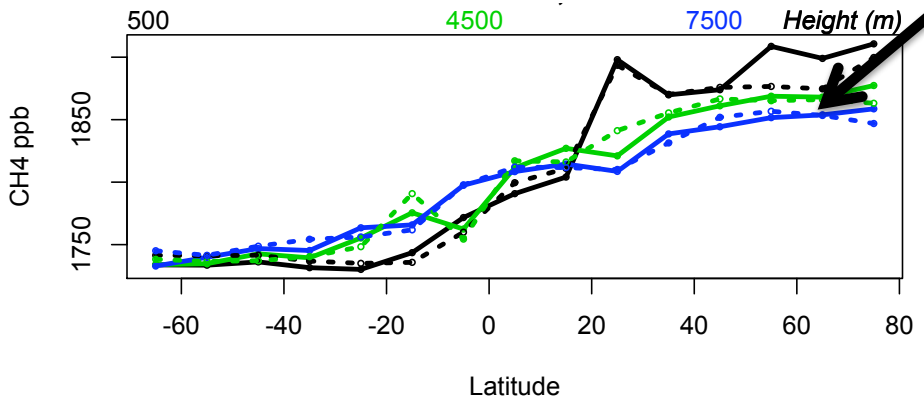


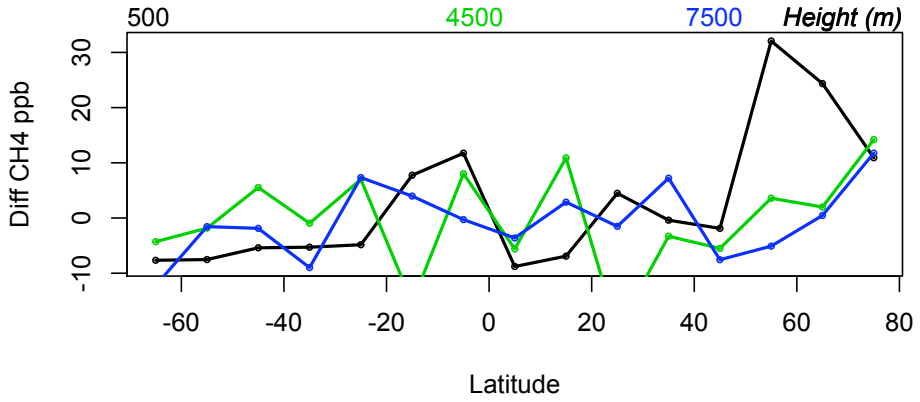


January 2009, different OH

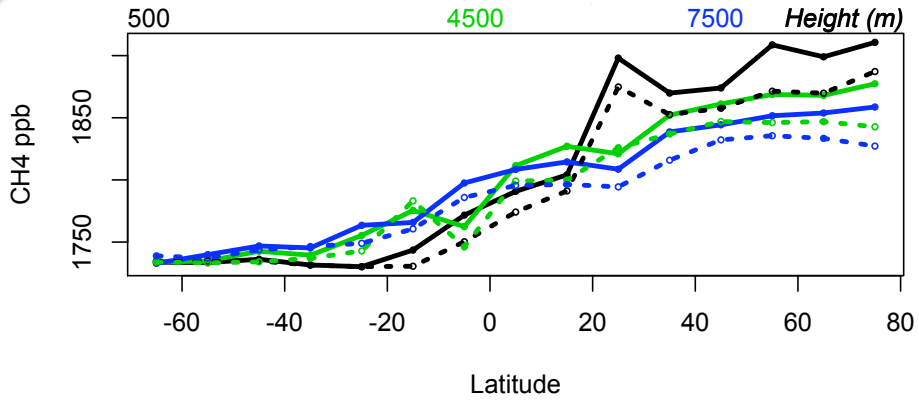
Excellent agreement

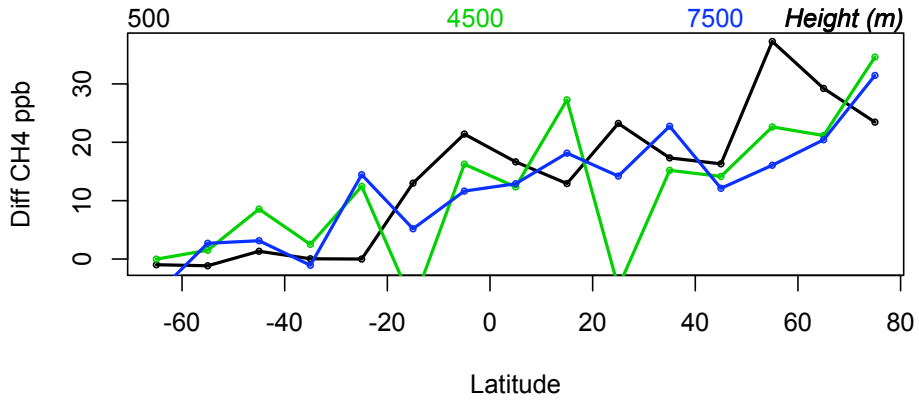
TCOM OH





ACTM OH

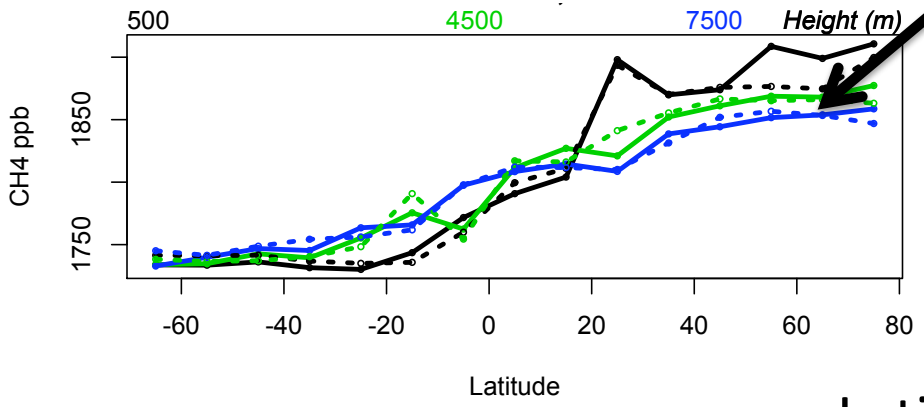




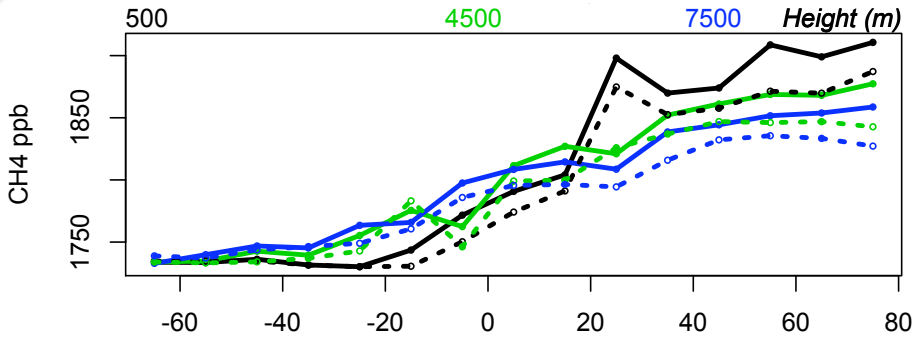
January 2009, different OH

Excellent agreement

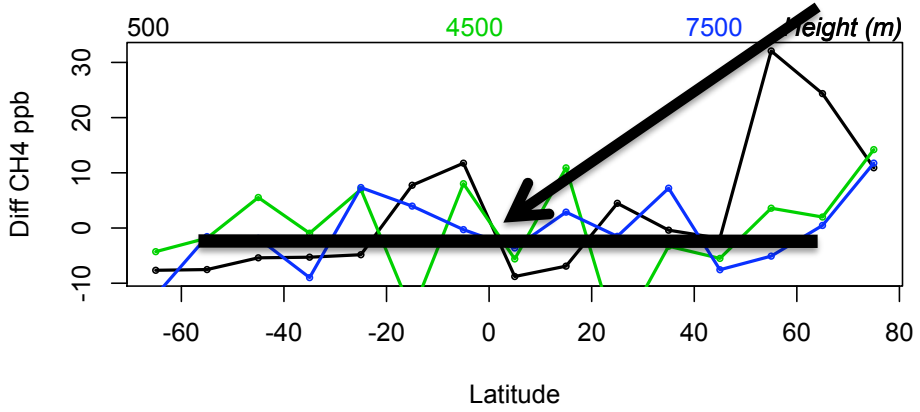
TCOM OH

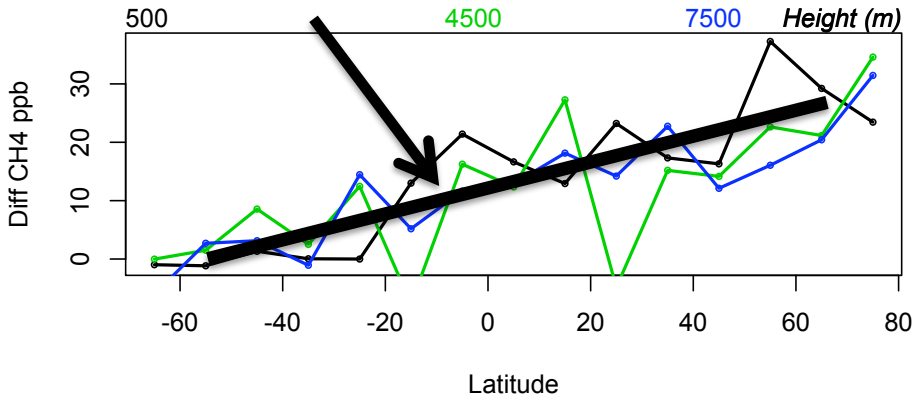


ACTM OH



Latitudinal gradient difference

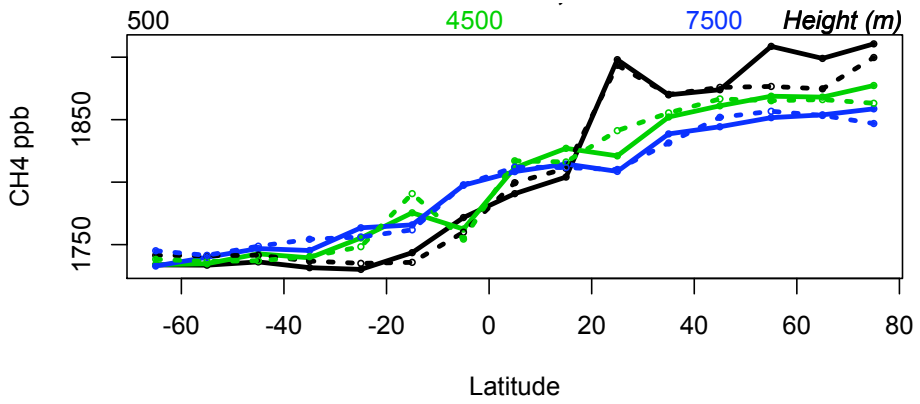


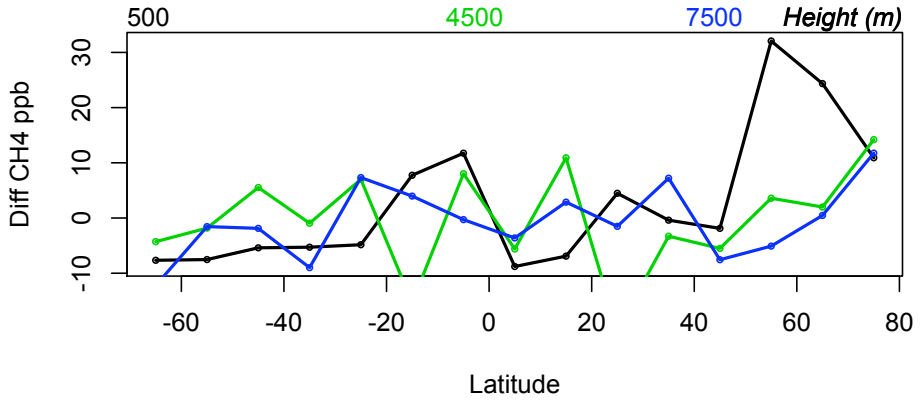


January 2009, different emissions

Differences negligible compared to OH

TCOM OH, CTL emissions





TCOM OH, EXT emissions