Ozonesonde Evaluation of Near-Tropopause Ozone in the GMI Combo model: Update

David Considine
NASA Langley Research Center

Jennifer Logan
Harvard University

Bryan Duncan and Mark Olson
NASA GSFC and UMBC GEST Center

Study Goals:
- Evaluate Combo model near-tropopause ozone using ozonesonde climatologies

This time:
- Include pressure-coordinate comparisons in addition to tropopause-referenced.
- Evaluate differences between combo model at 2x2.5 vs 4x5 resolution.

Logan Ozonesonde Climatology

Monthly averaged ozone profiles referenced to thermal (lapse rate) tropopause.

- Range: -6 km to +6 km, 1km resolution.
- Sonde data from 24 sites: 8 tropical, 11 midlatitude, 5 high latitude.
- Sondes accumulated between 1978 and 2002, but stations differ in time periods and number of sondes in average.
- Logan, J., JGR 104, 16,115-16,149, 1999

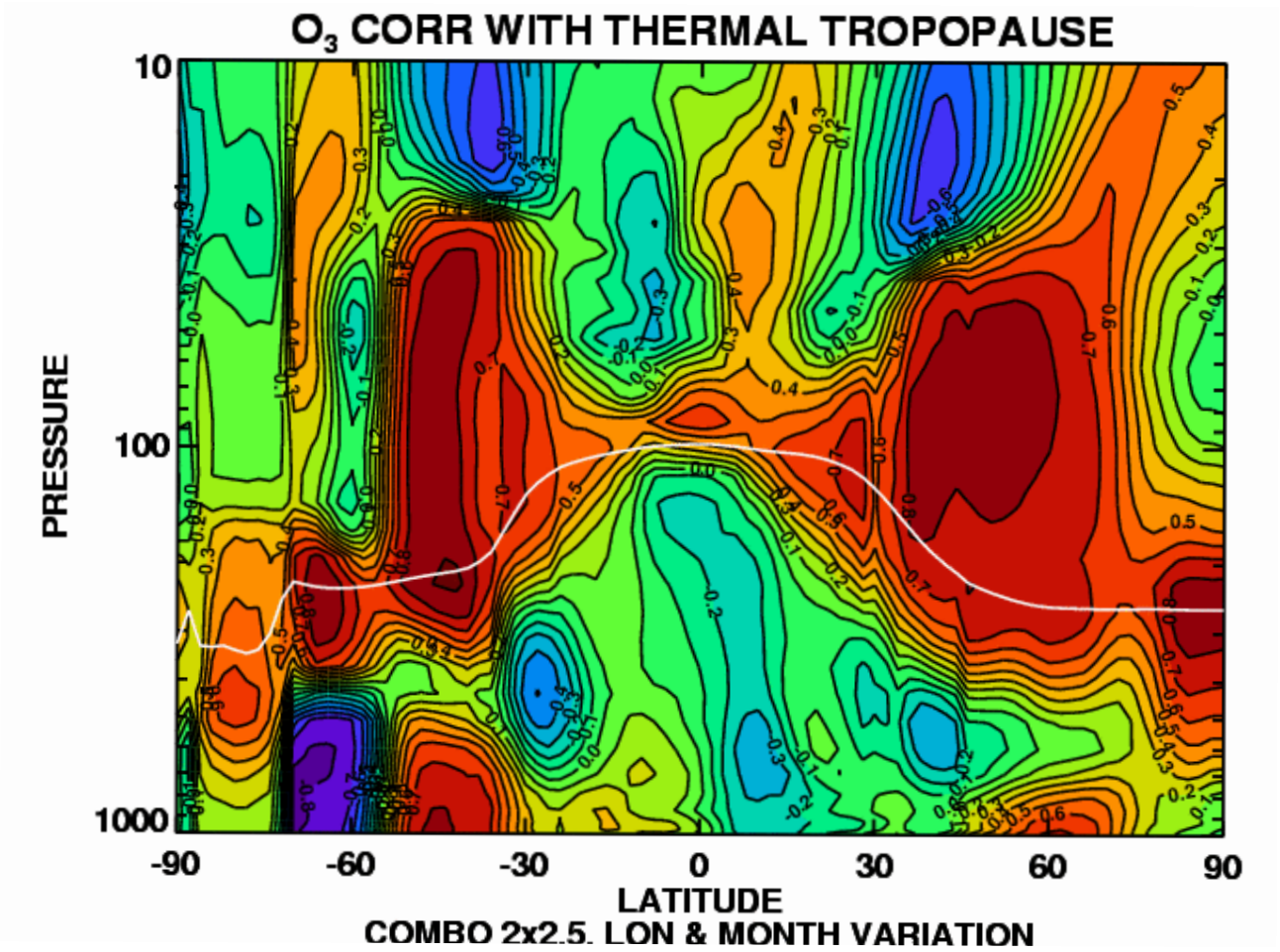
Monthly mean ozone profiles on pressure surfaces

- Range to 10 hPa
- 18 Stations with associated mean tropopause height data
- Same time period as tropopause-referenced.
- Subset of tropopause-referenced profiles

Model Runs:

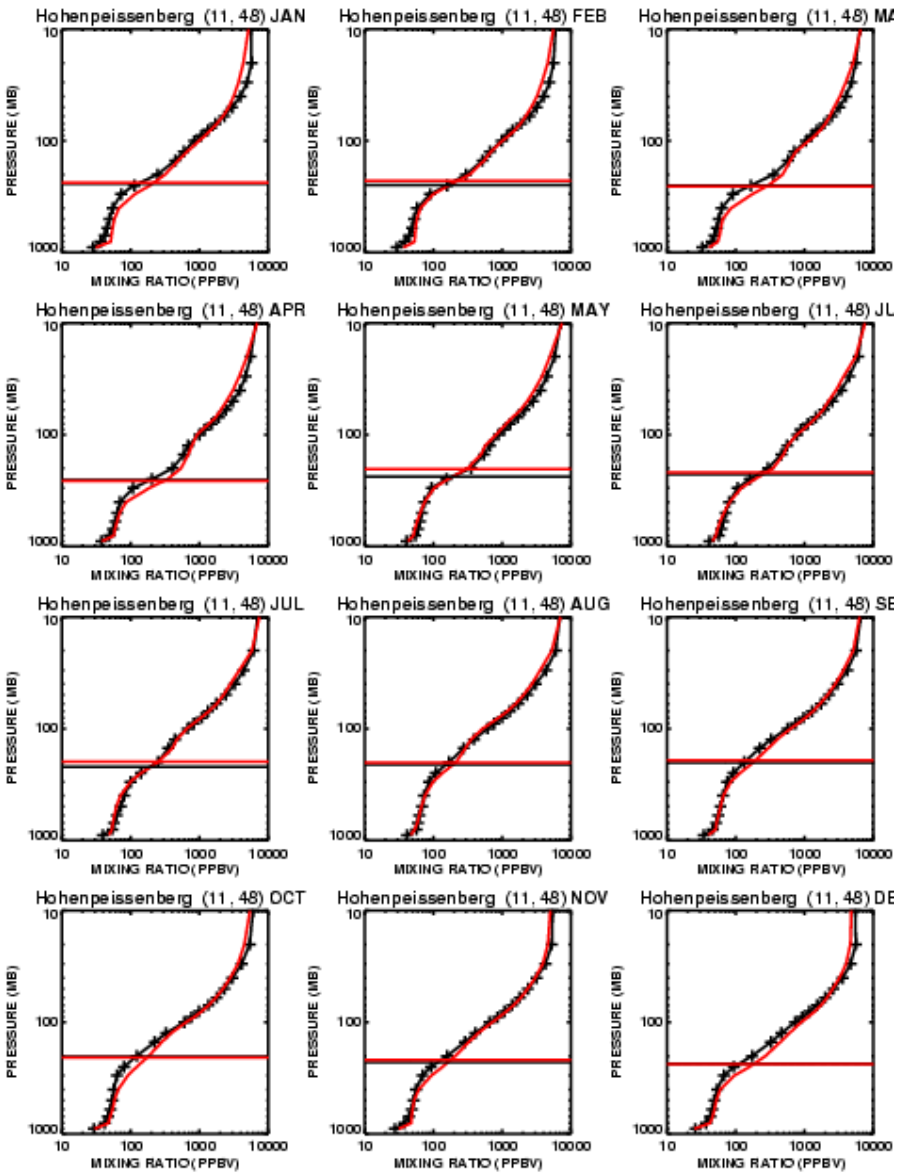
- Older fvgcm 4x5 run (circa June - not the 5-year 4x5 run)
- More recent 2x2.5 run (circa August)

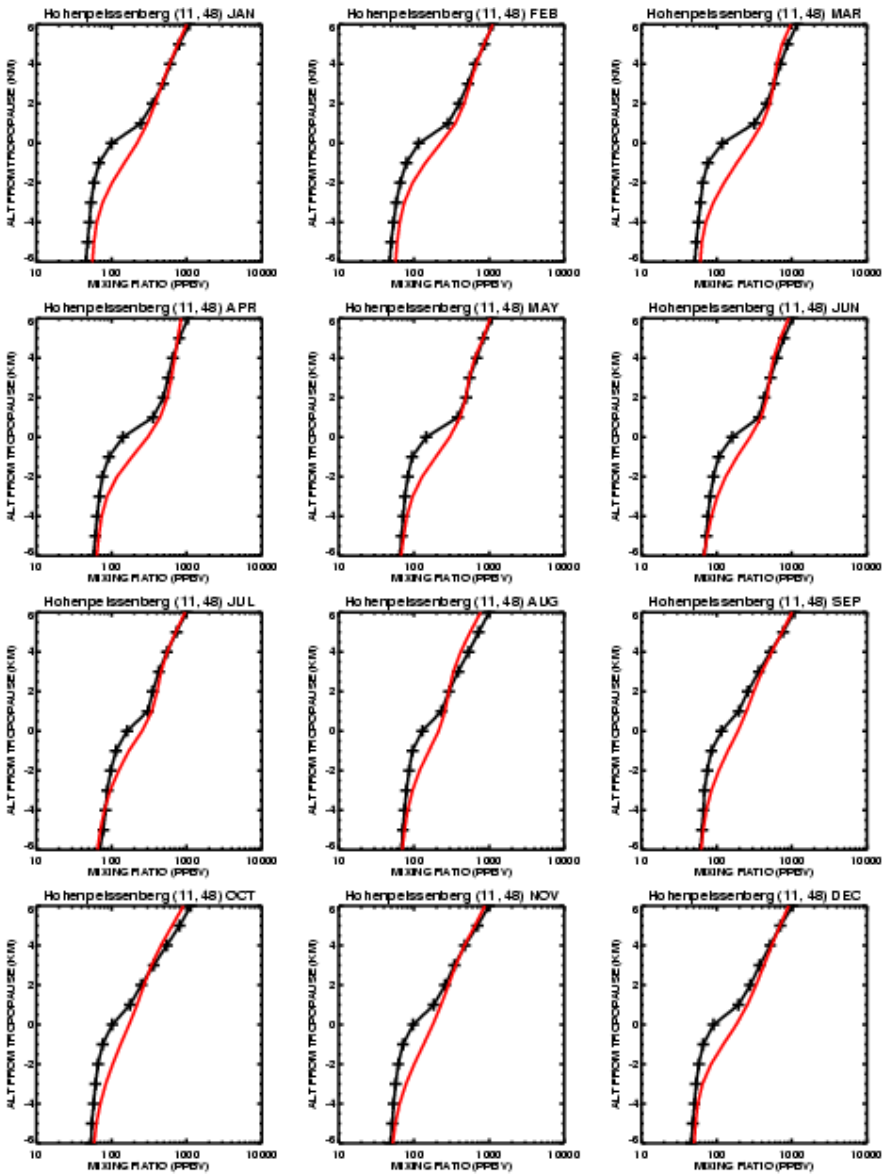
Linear correlation coefficient characterizing longitudinal and monthly variation of monthly average ozone with monthly average tropopause pressure



High correlation near tropopause suggests tropopause-relative coordinate useful.

Combo 2x2.5 model comparisons with sonde climatology at Hohenpeissenberg, all months

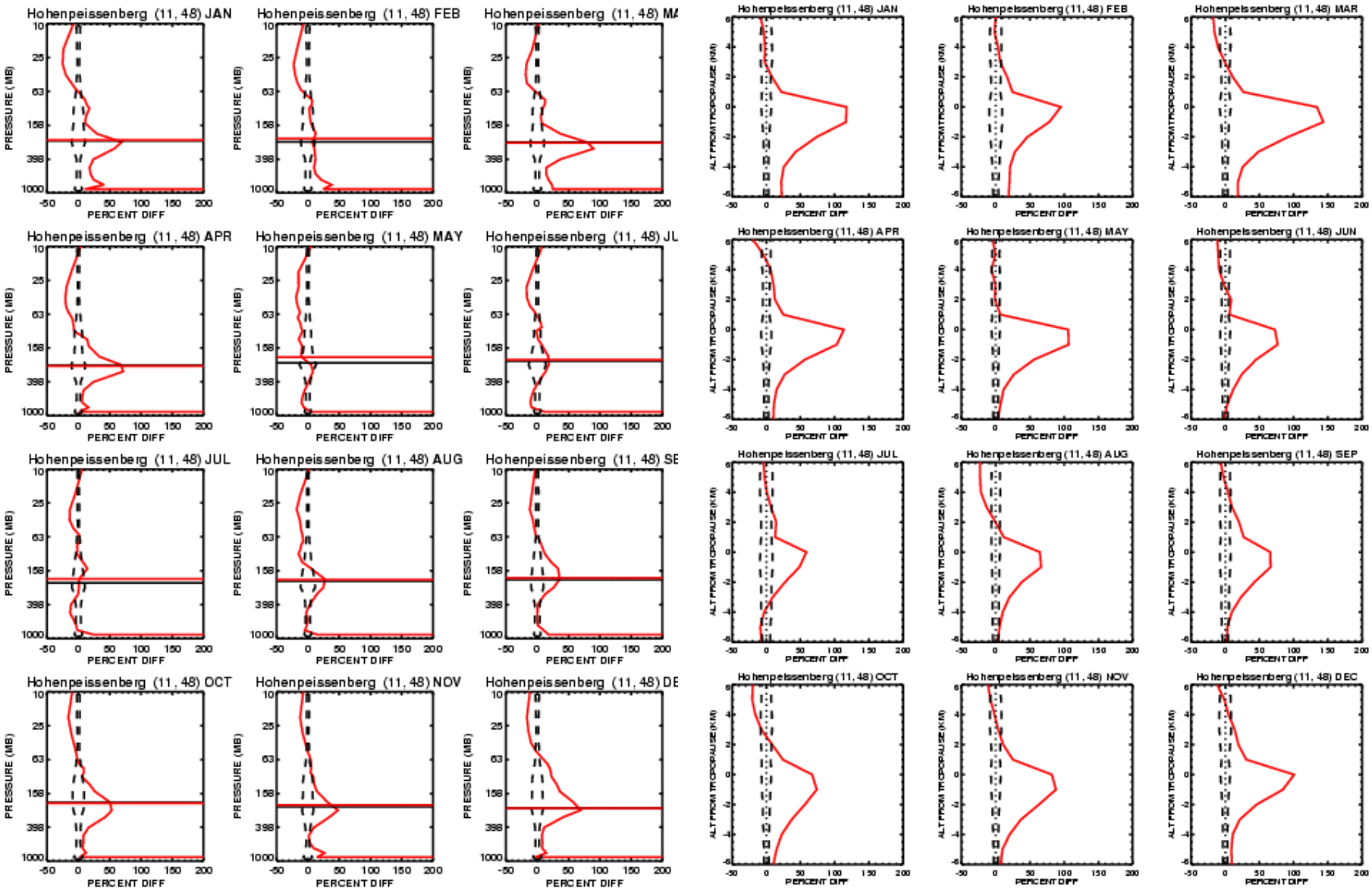




PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

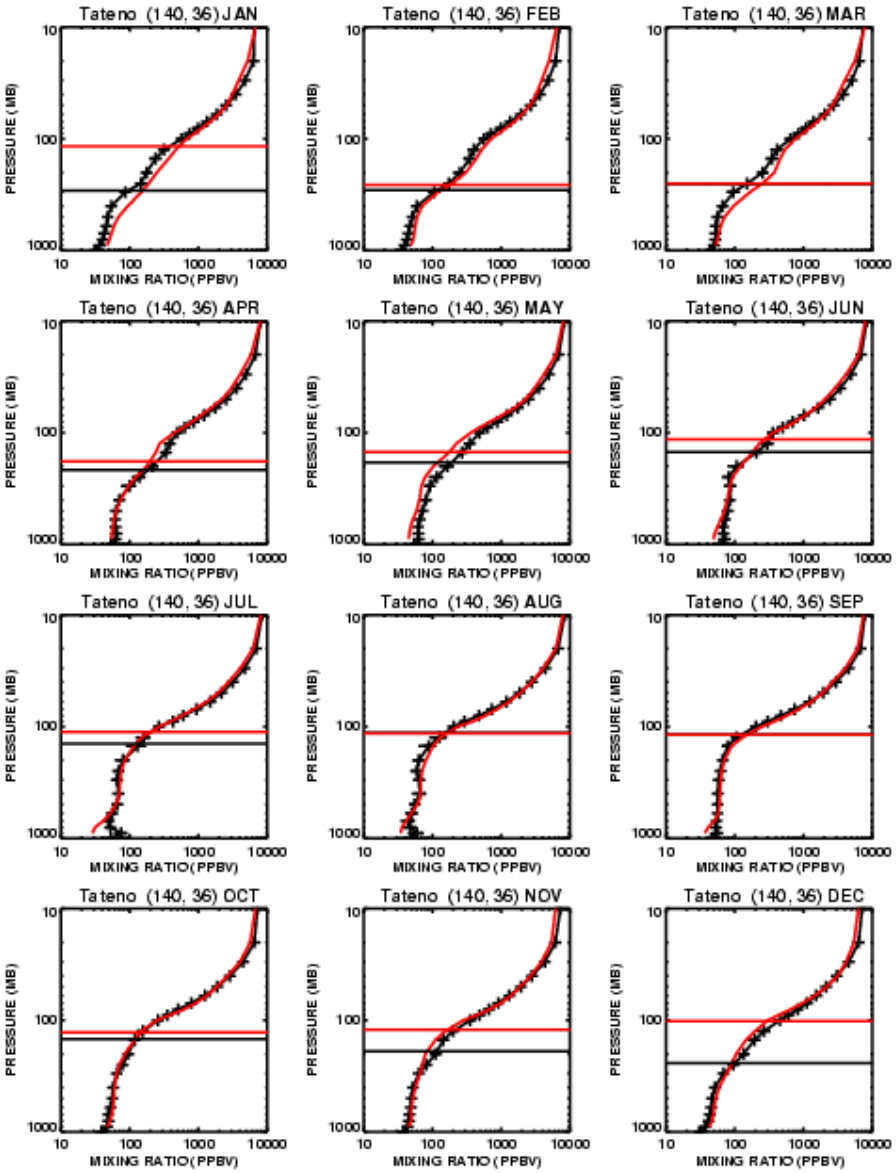
Combo 2x2.5 model percent diff comparisons with sonde climatology at Hohenpeissenberg, all months

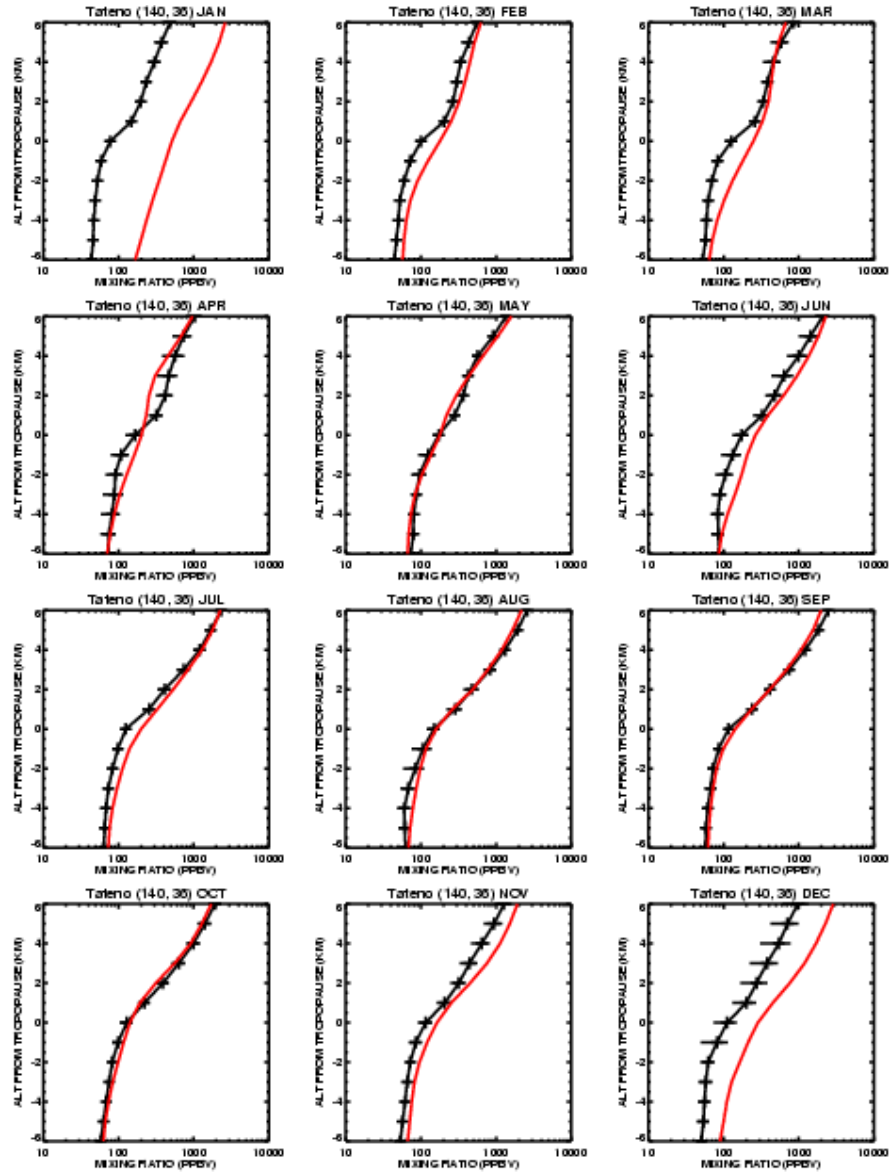


PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

Combo 2x2.5 model comparisons with sonde climatology at Tateno, all months

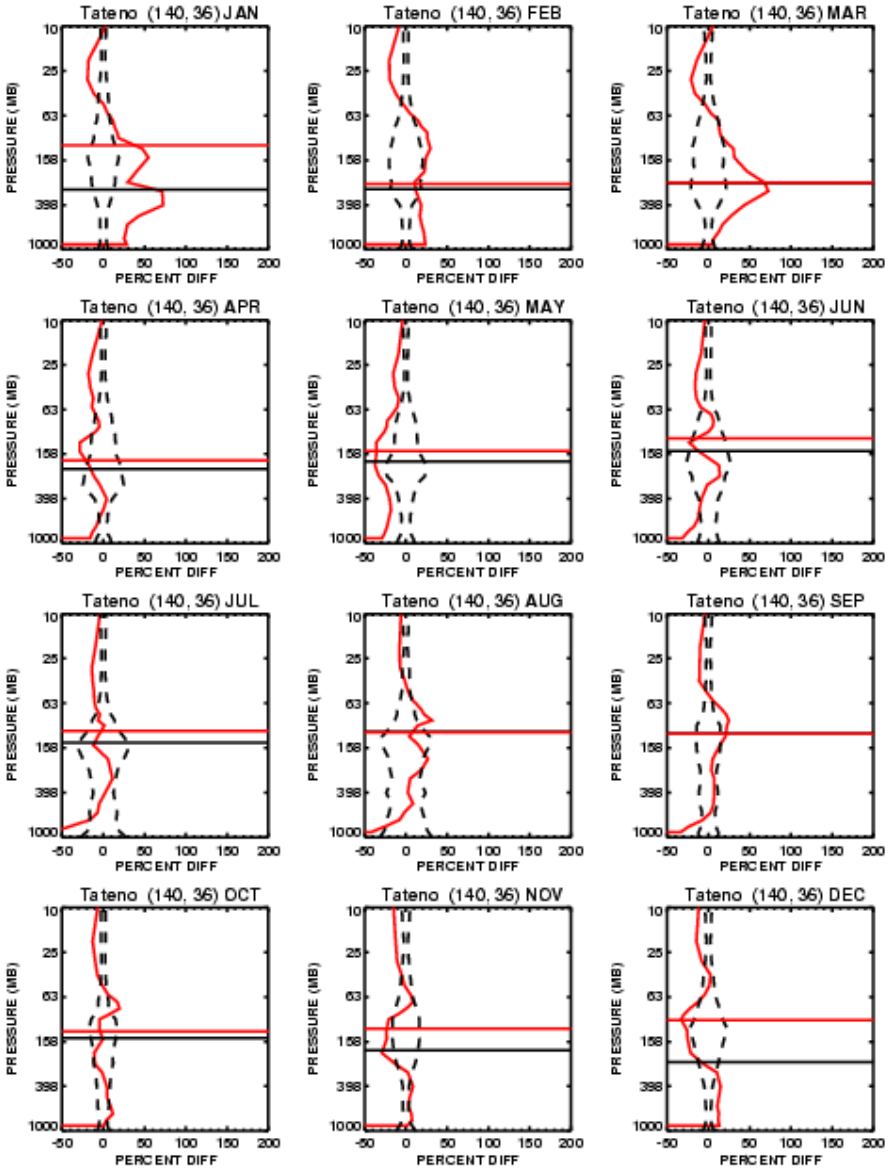




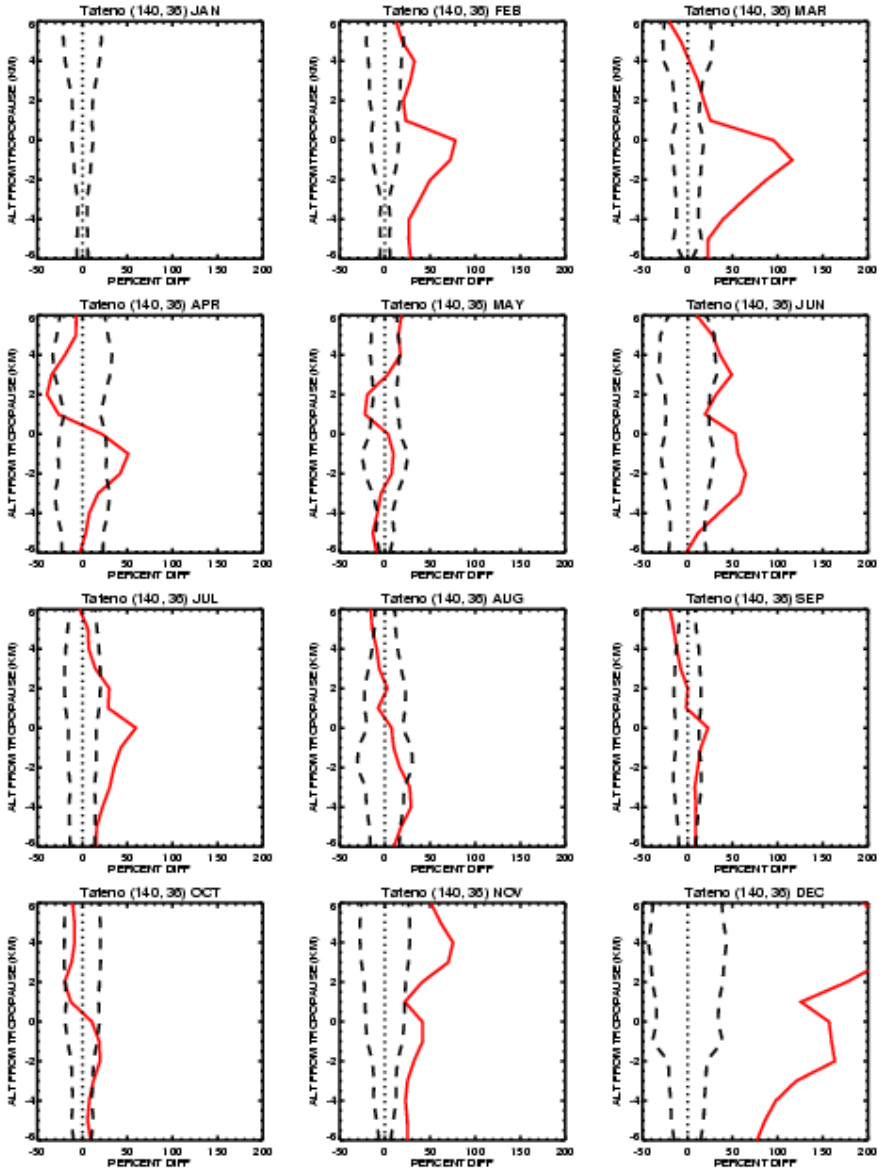
PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

Combo 2x2.5 model percent diff comparisons with sonde climatology at Tateno, all months

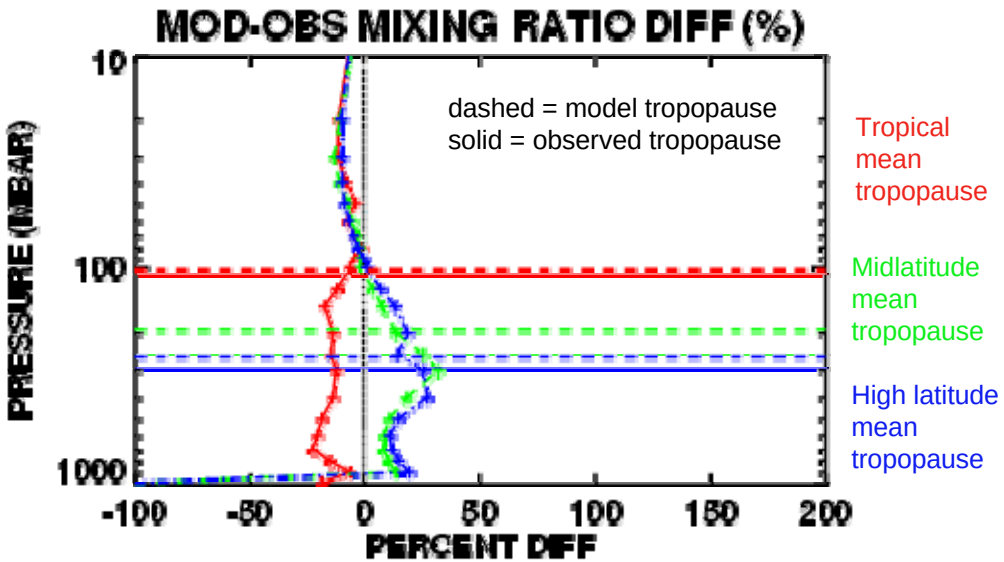


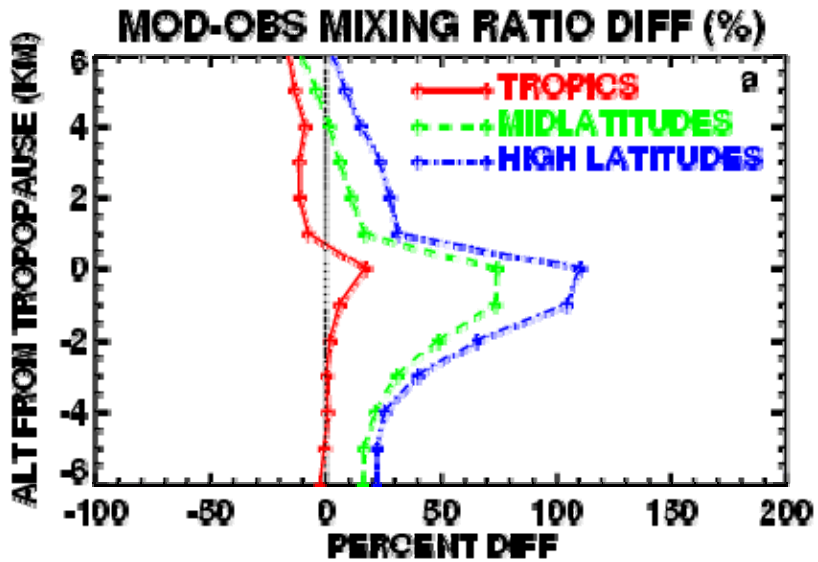
PRESSURE COORDINATE

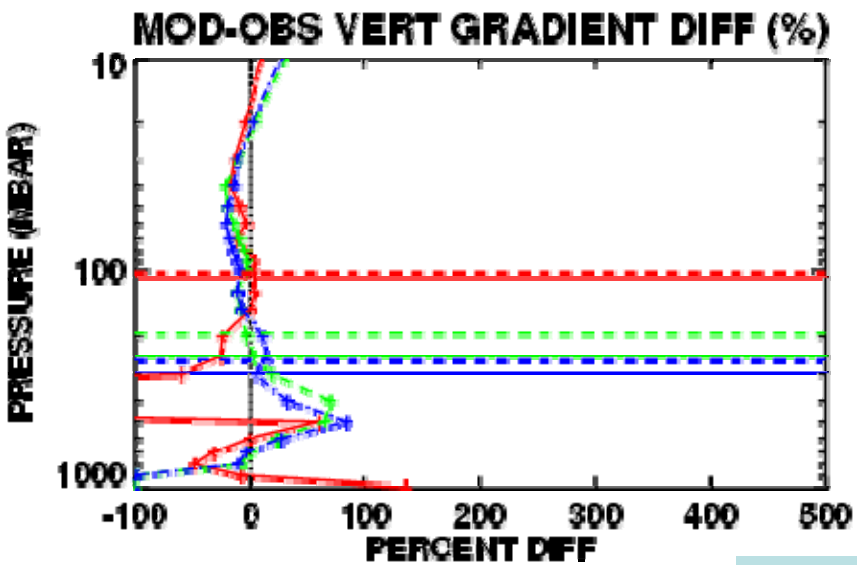


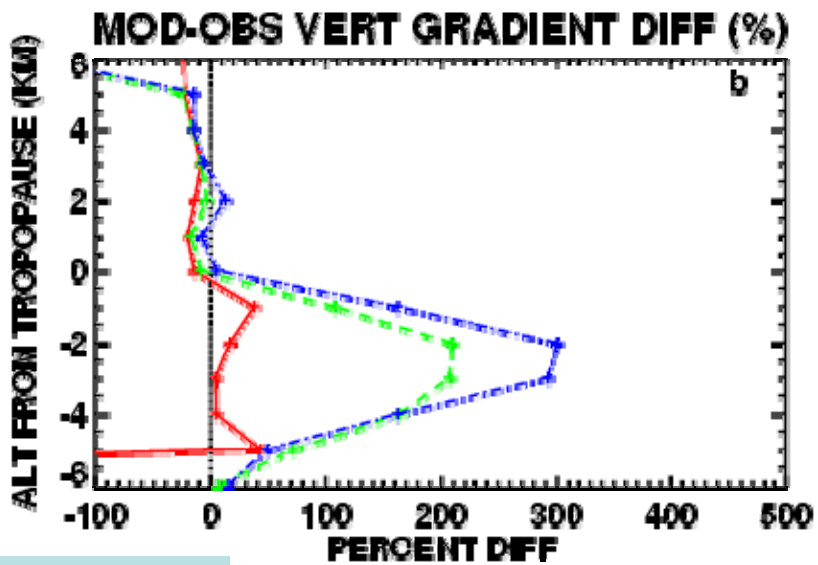
TROPOPAUSE-RELATIVE

Annual average profiles in tropics, NH midlatitudes, and NH high latitudes







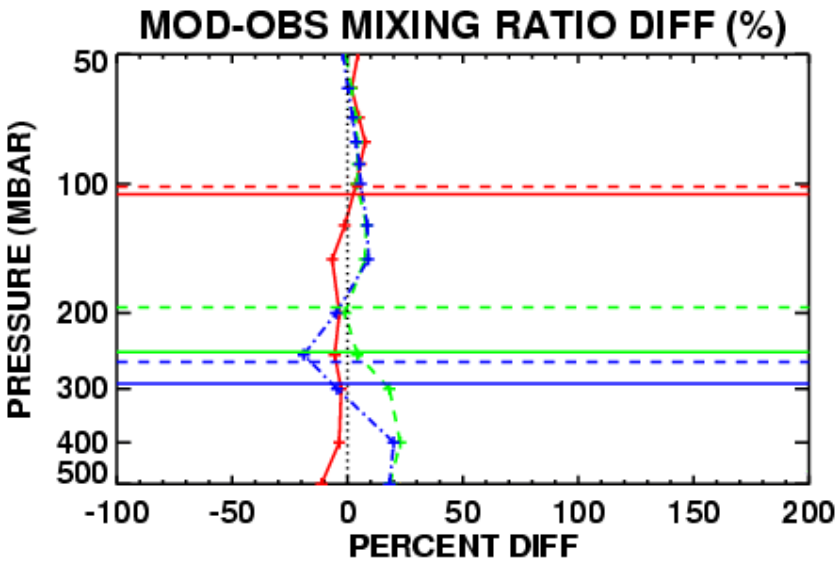


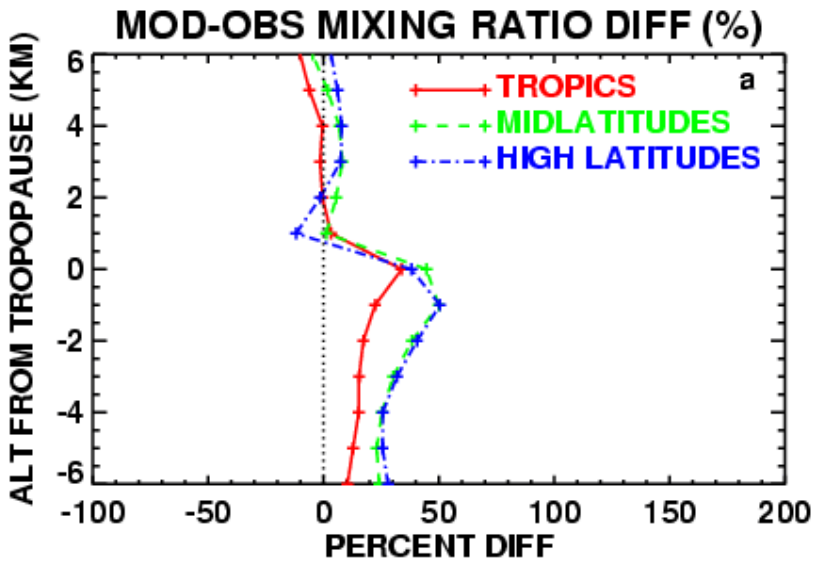
PRESSURE COORDINATE

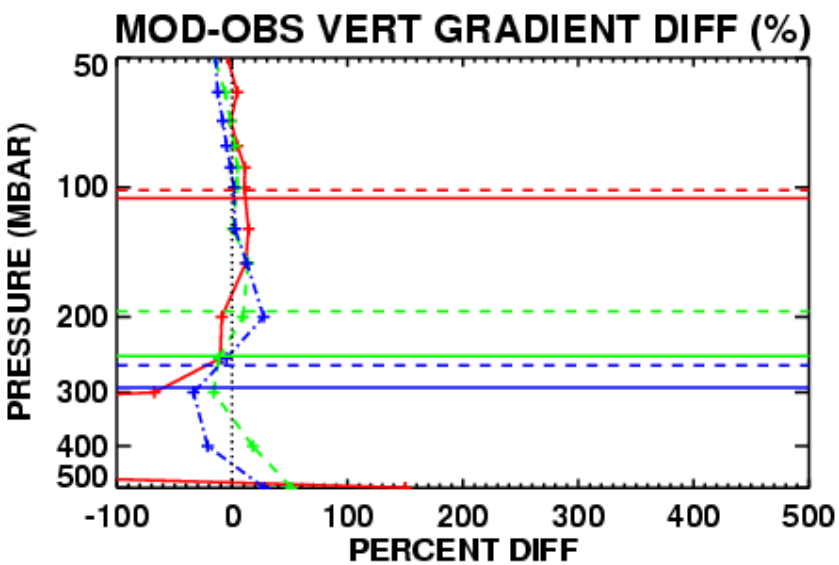
- Combo 2x2.5 run
- Std. tropopause definition
- Lats bet. 35N-45N excluded

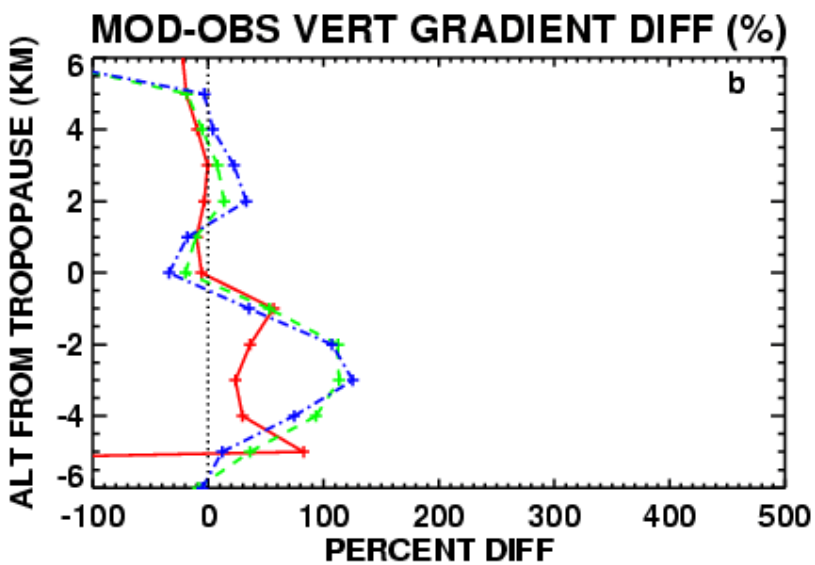
TROPOPAUSE-RELATIVE

• Combo 4x5 run (May 2005 version, but still fvgcm), Std. tropopause definition, Lats bet. 35N-45N excluded





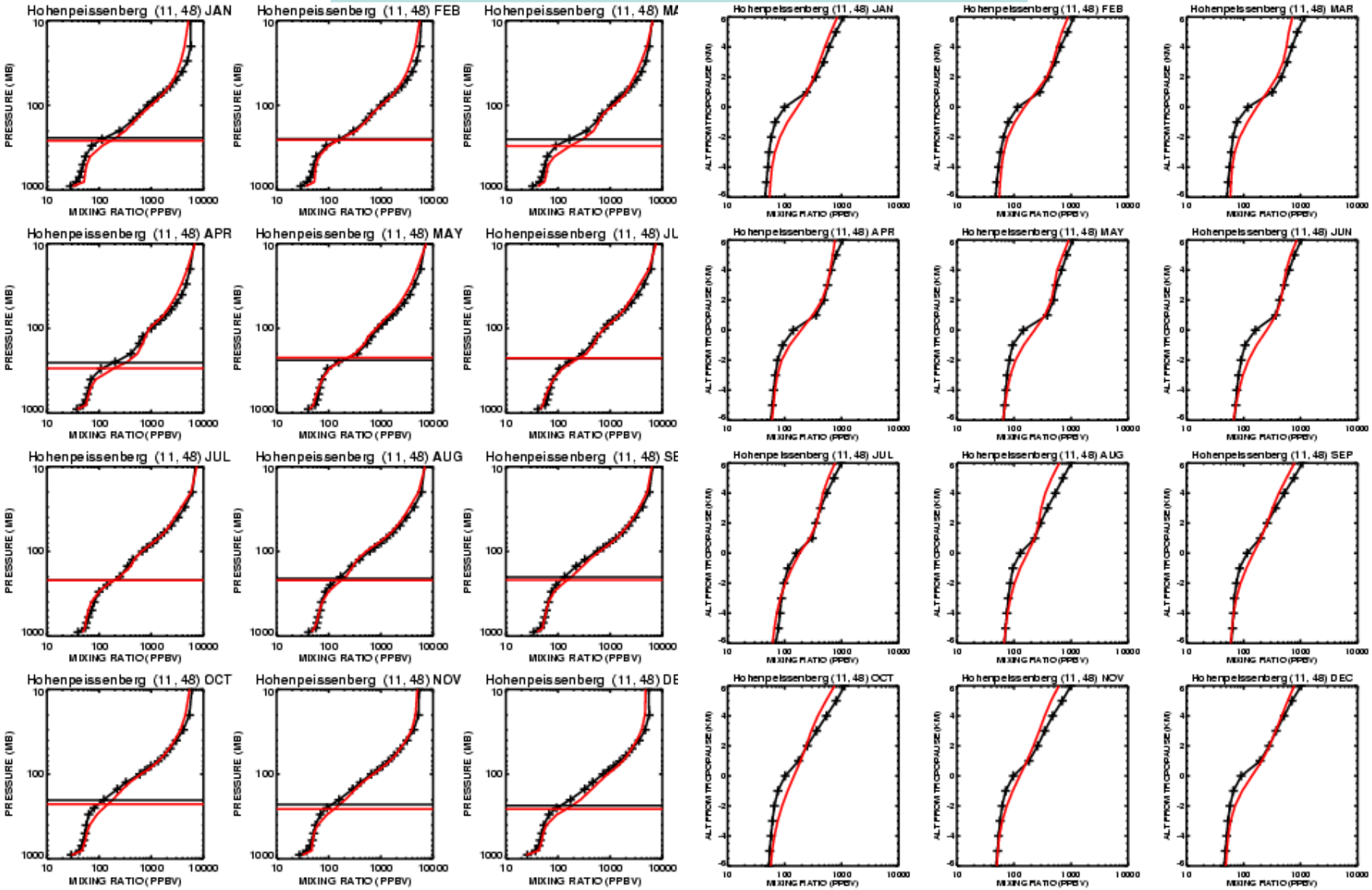




PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

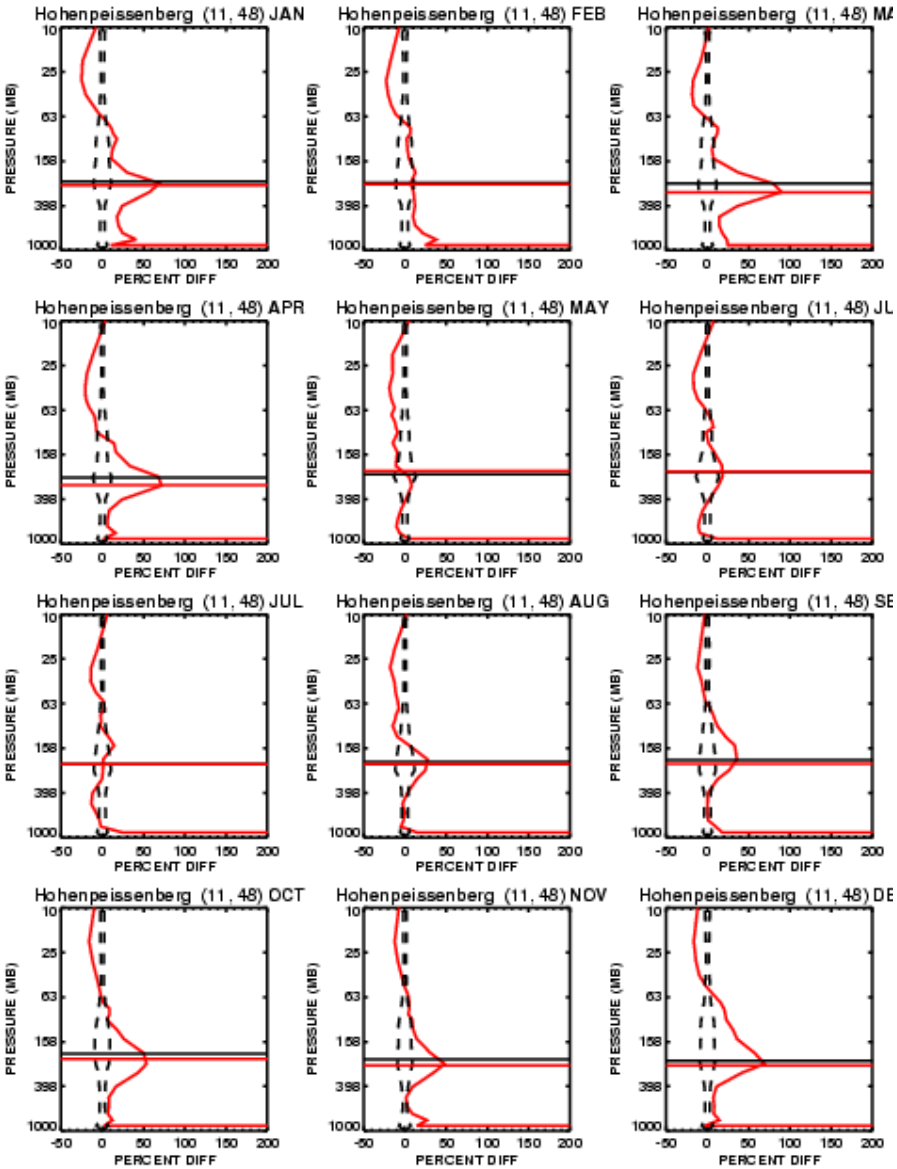
• Combo 2x2.5 run at Hohenpeissenberg
• Modified tropopause definition (lapse rate < 4 K/km)



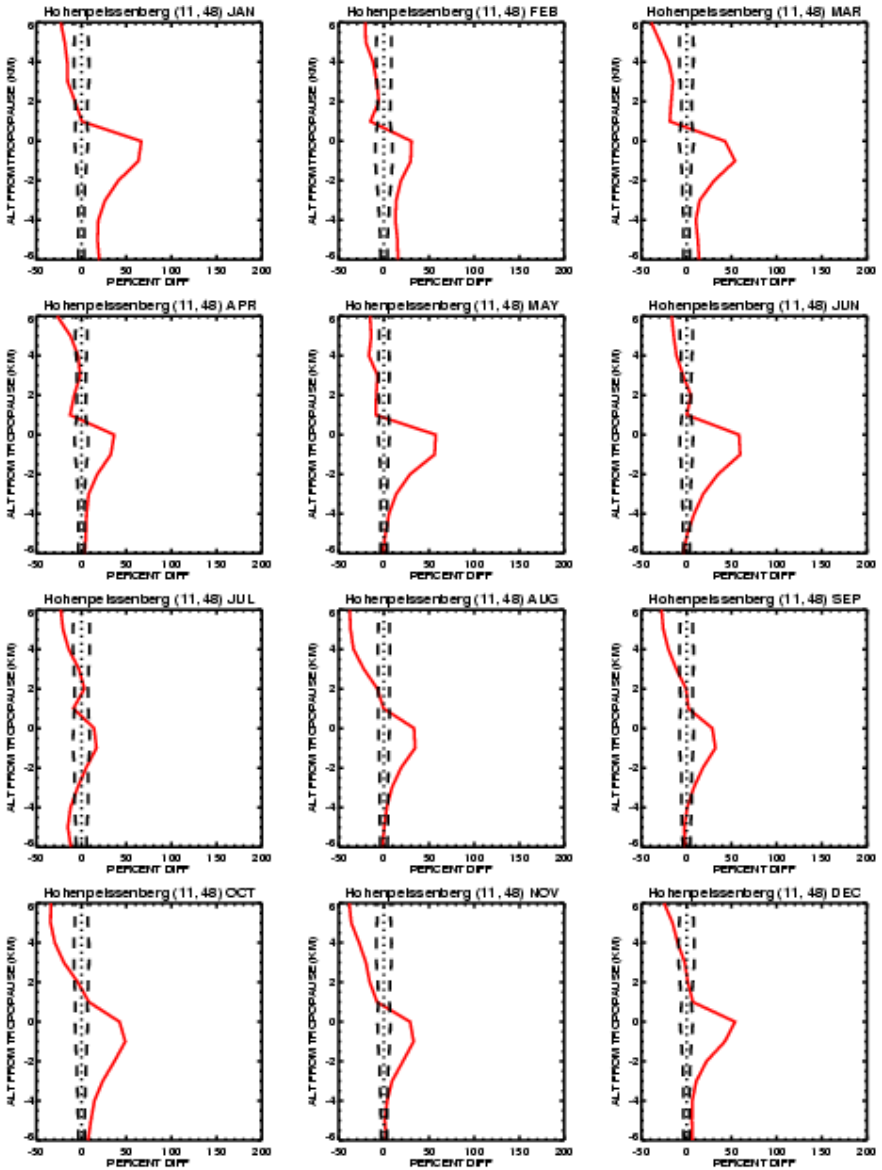
PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

- Combo 2x2.5 run percent differences at Hohenpeissenberg
- Modified tropopause definition (lapse rate < 4 K/km)

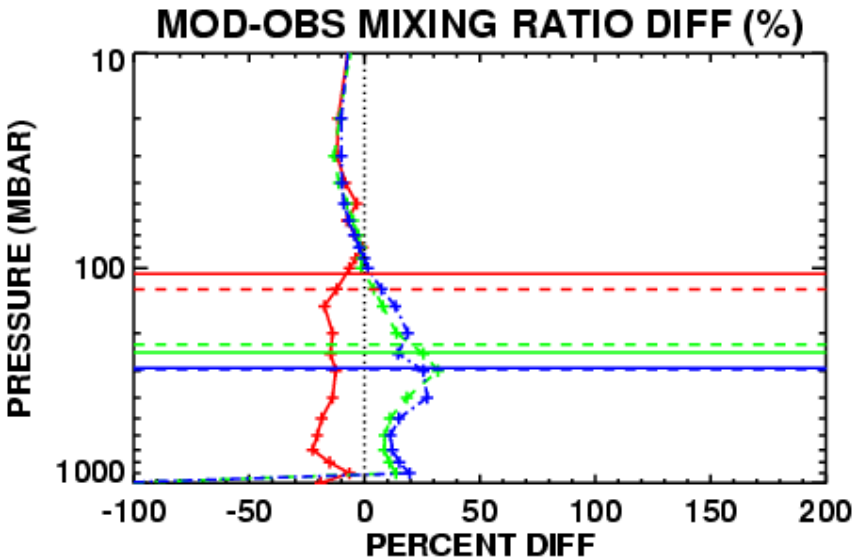


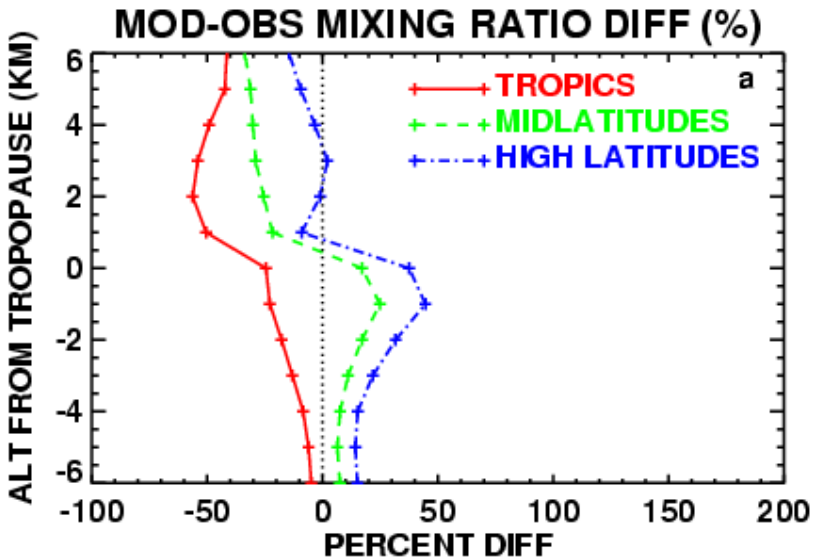
PRESSURE COORDINATE

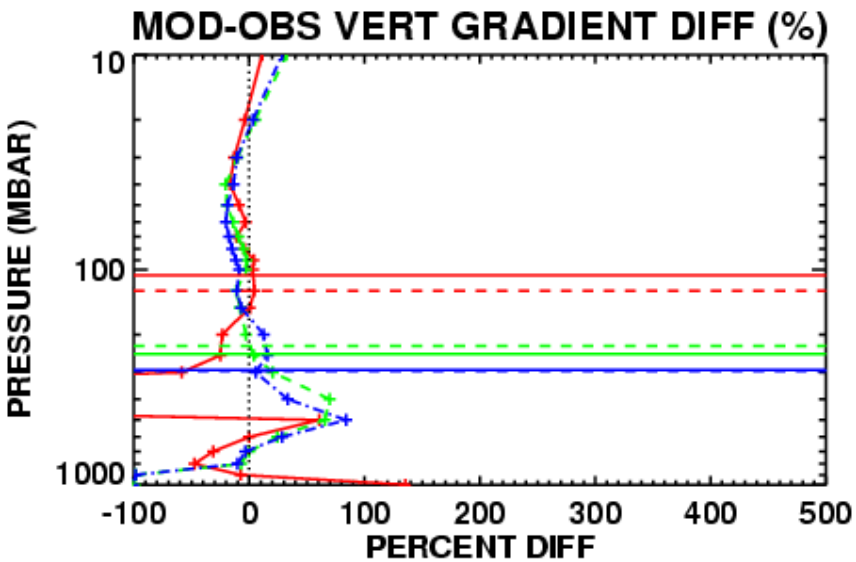


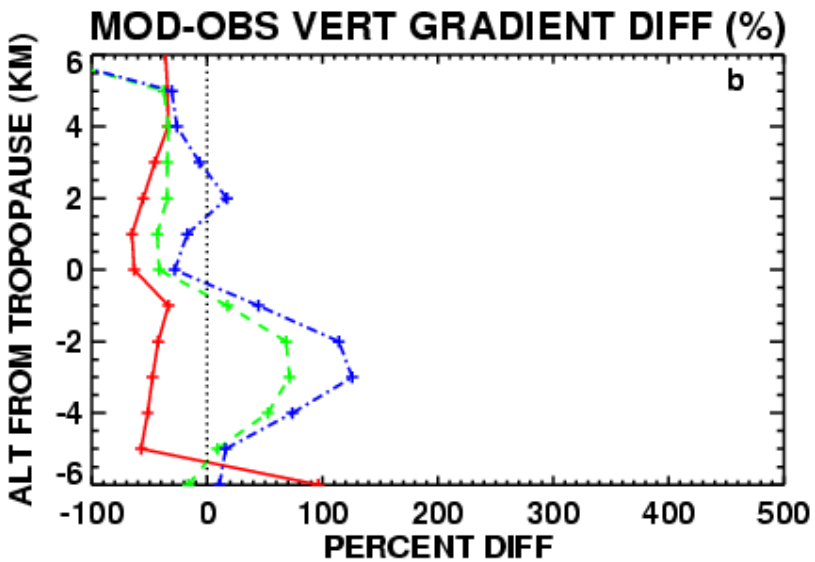
TROPOPAUSE-RELATIVE

Combo 2x2.5 run, Modified tropopause definition (lapse rate < 4 K/km), Lats between 35N-45N excluded





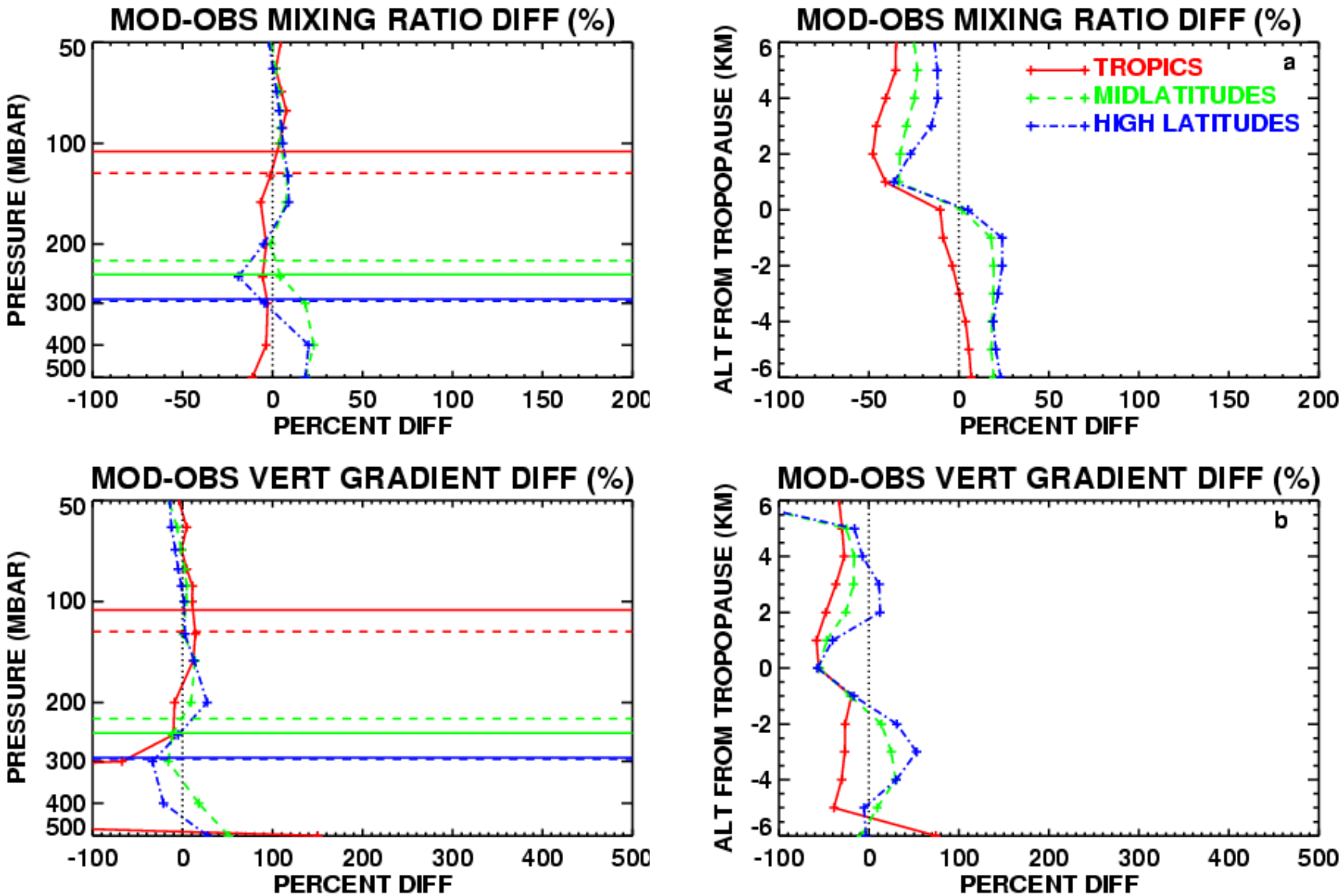




PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

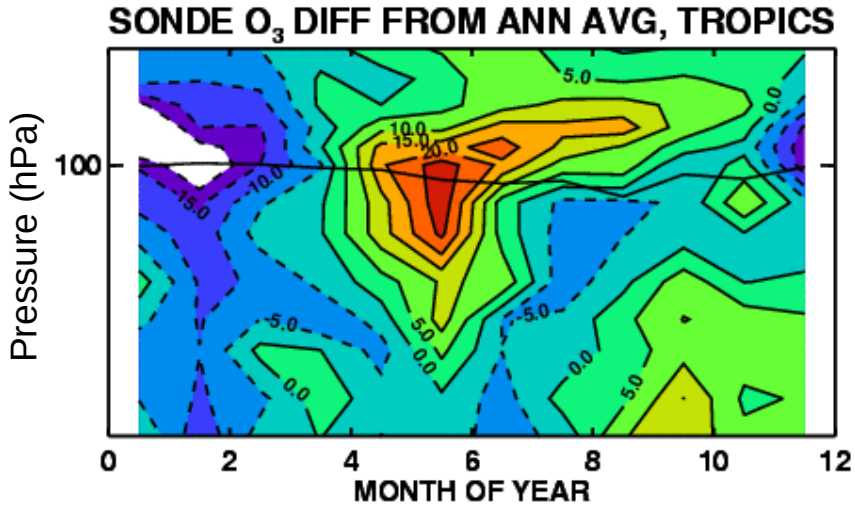
Combo 4x5 run (May 2005 vintage), Modified tropopause definition, Lats between 35N-45N excluded

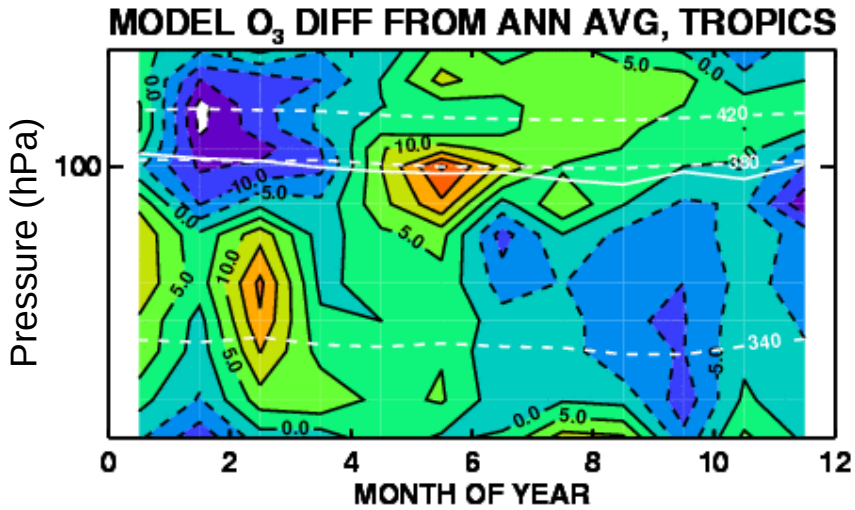


PRESSURE COORDINATE

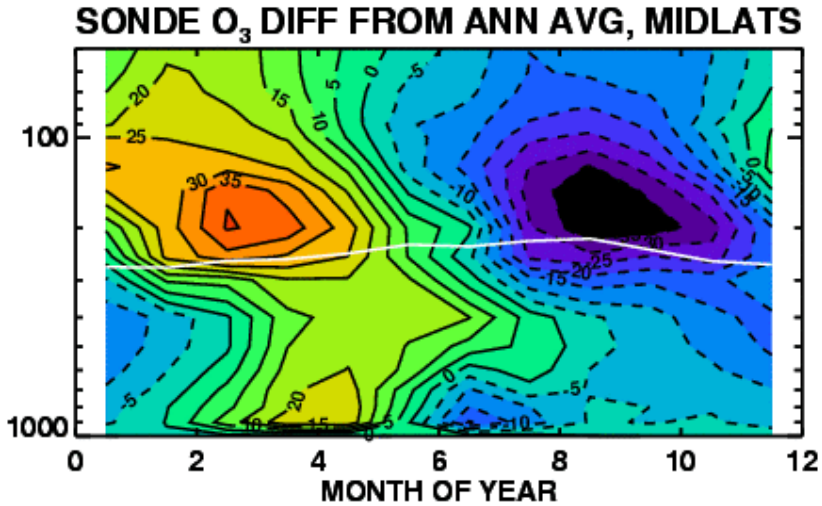
TROPOPAUSE-RELATIVE

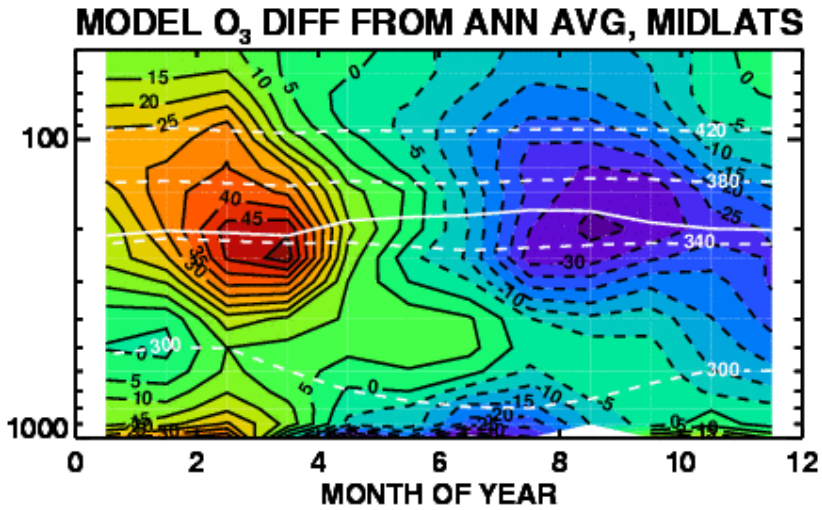
Model vs. obs seasonal cycle relative to annual mean in tropics (percent)



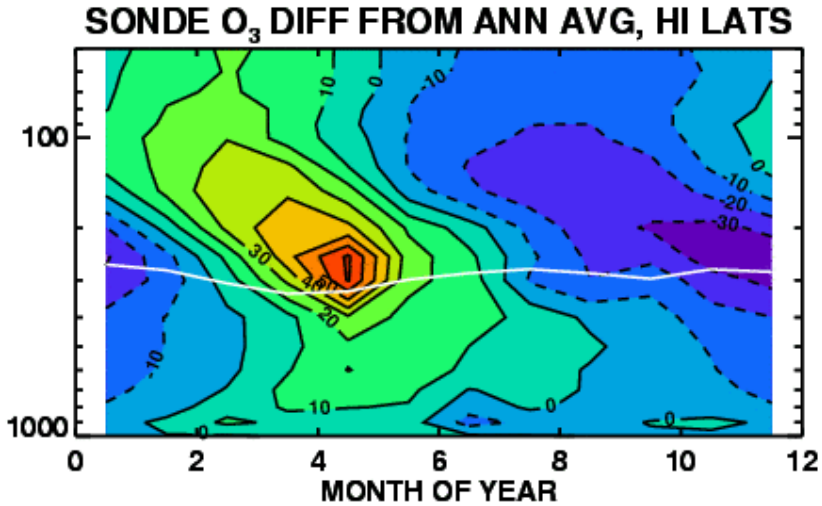


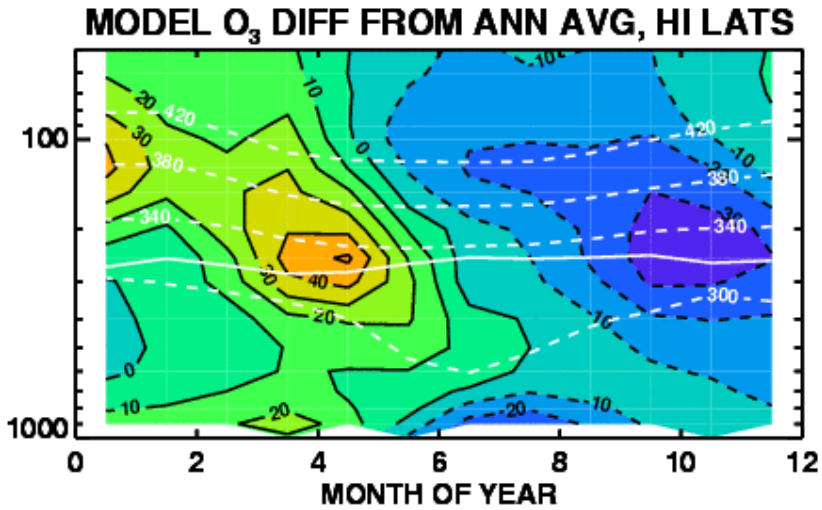
Model vs. obs seasonal cycle relative to annual mean in midlats (percent)



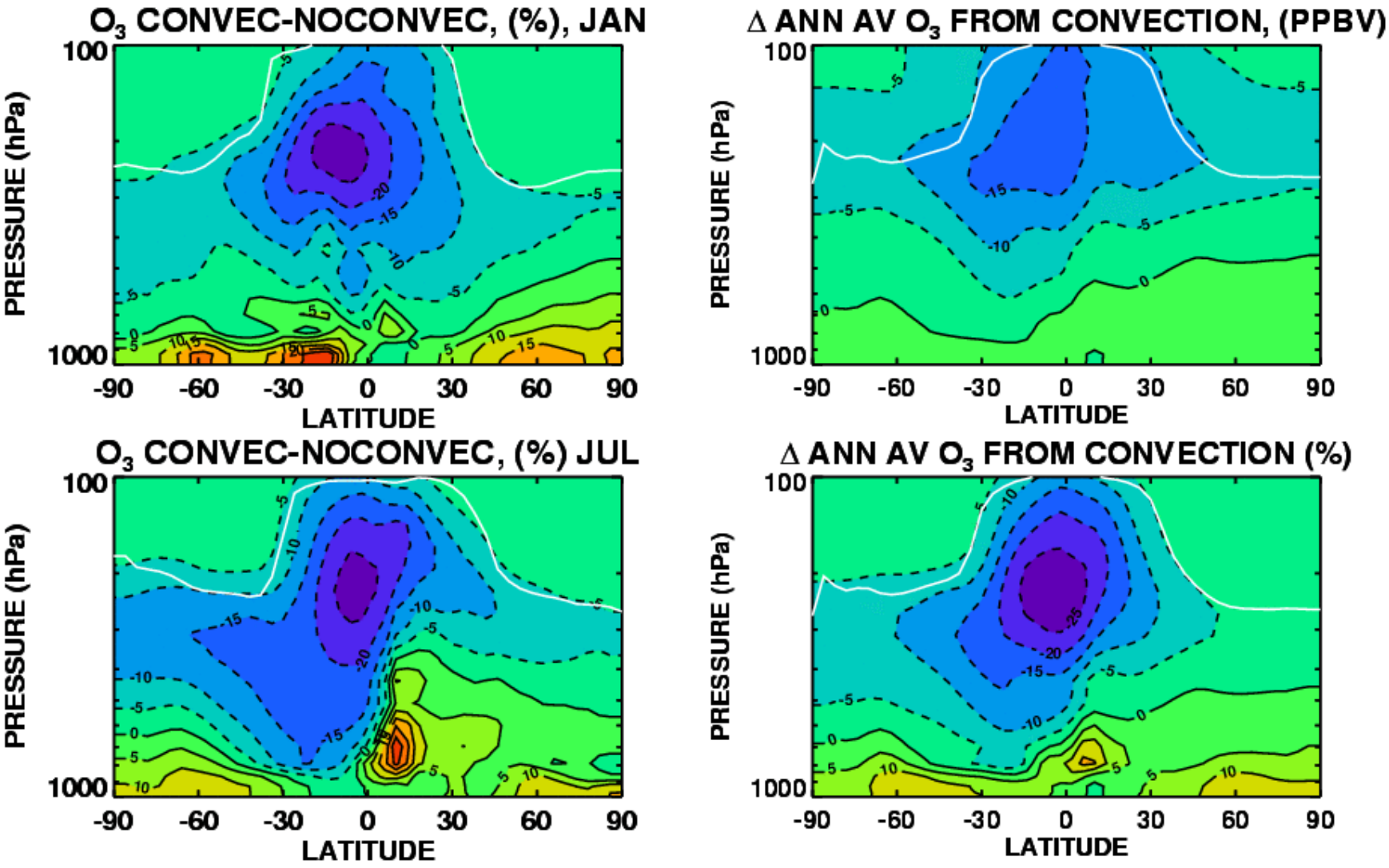


Model vs. obs seasonal cycle relative to annual mean in high lats (percent)

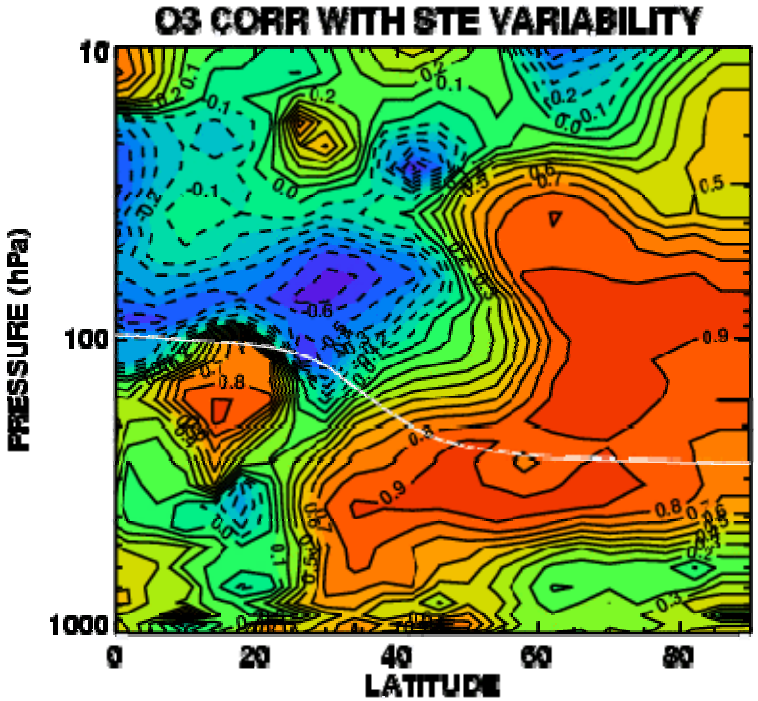


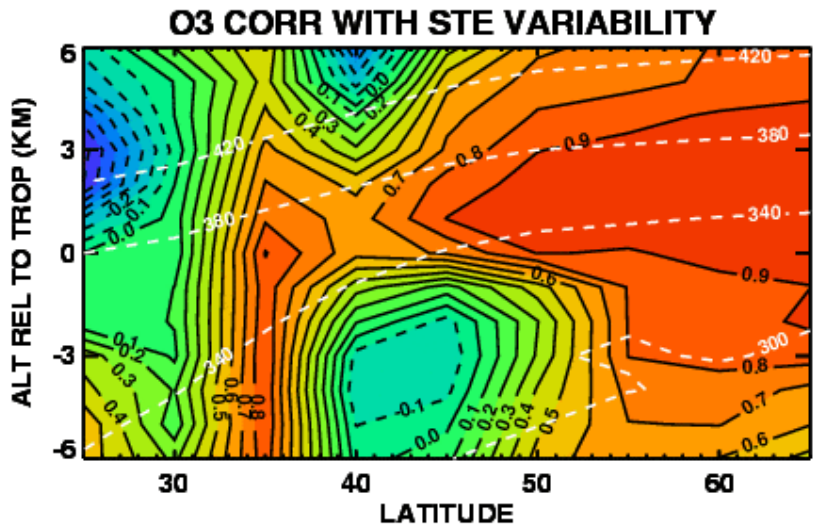


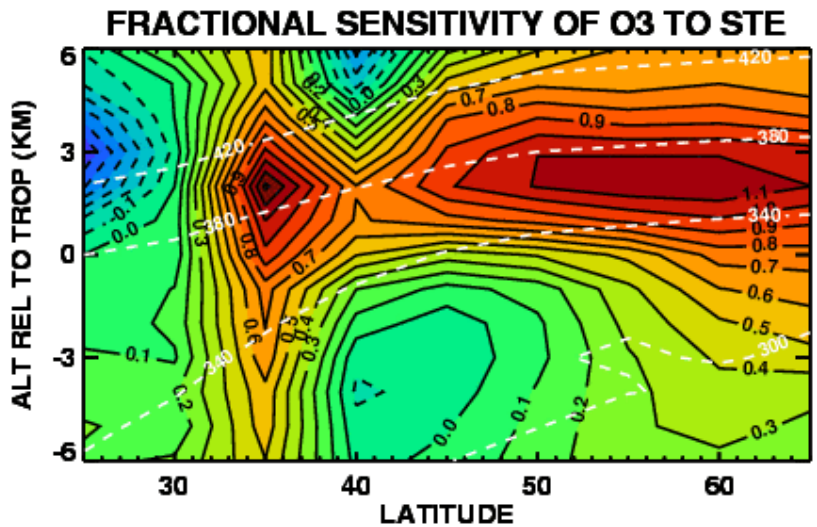
Effects of convection on UT ozone concentrations in GMI combo model



Correlation of annual mean ozone with interannual variation in cross-trop ozone flux







PRESSURE COORDINATE

TROPOPAUSE-RELATIVE

Conclusions

- Combo model ozone (ann average, 2x2.5 resolution) compares well with sonde climatology on pressure coordinates.
  - 10-15% low 20-30 hPa, 20% low in tropical troposphere, 30% high mid to high lats near tropopause.
  - Older 4x5 run in better agreement with obs than 2x2.5 run.
- Model/obs comparisons relative to thermal tropopause appear compromised due to difficulty identifying “true” model thermal tropopause.
  - Low model resolution leads to high-biased tropopause.
  - Attempts to fix problem not successful - how much of discrepancy is due to picking an incorrect tropopause height?.
- 2x2.5 combo model reproduces well amplitude of seasonal cycle in ozone relative to mean in mid and high latitudes.
  - Peak amplitudes at tropopause
  - Gradients across tropopause weak in model.
  - Model peak in tropopause too early.
- Convection reduces tropical UT ozone mixing ratios by up to 30%, but < 10% effect at high latitudes.
- Strong positive ozone correlation with NH extratropical ozone flux across tropopause at mid to high latitudes -> driven by residual circulation.
  - This doesn’t seem to me to be so obvious - one might think that higher flux might deplete near-tropopause ozone - leading to anticorrelation.