Evaluation of GMI simulations with TES ozone and CO data, and in situ data.

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Strategy for indirect validation of TES ozone

- **By evaluating the model with in-situ data, we learn where the model does well and where there are deficiencies.**

  Profile data available for ~50 locations (sondes and MOZAIC).

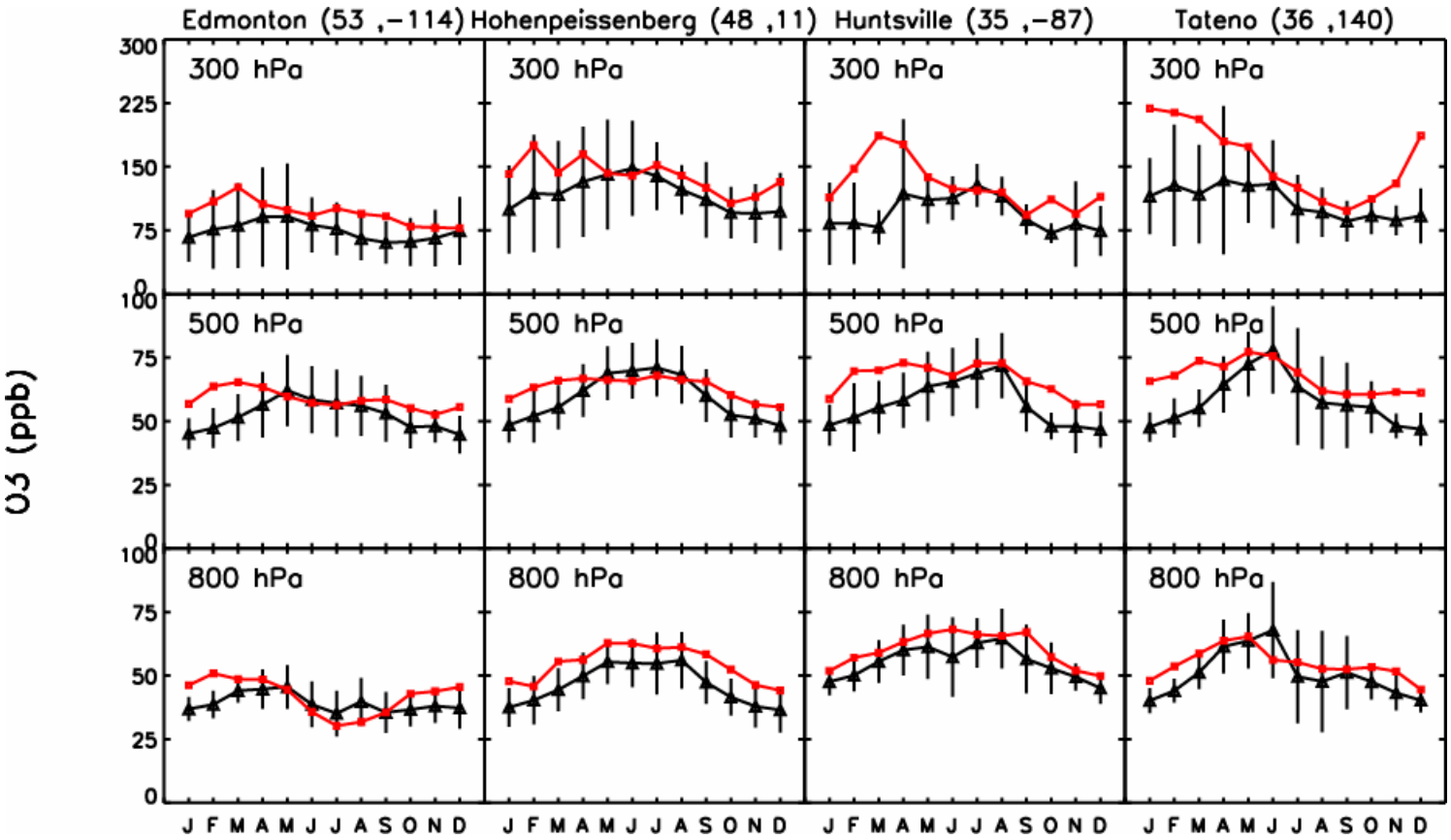
- **Having "calibrated" the model performance, compare the model and TES ozone.**

- **If the model and TES agree where we know the model does well, we are confident that the discrepancies in other regions are "real".**

- **Explore the causes of these discrepancies**

Ozone at N. extratropics, DAS, and observations
N. extratropics:

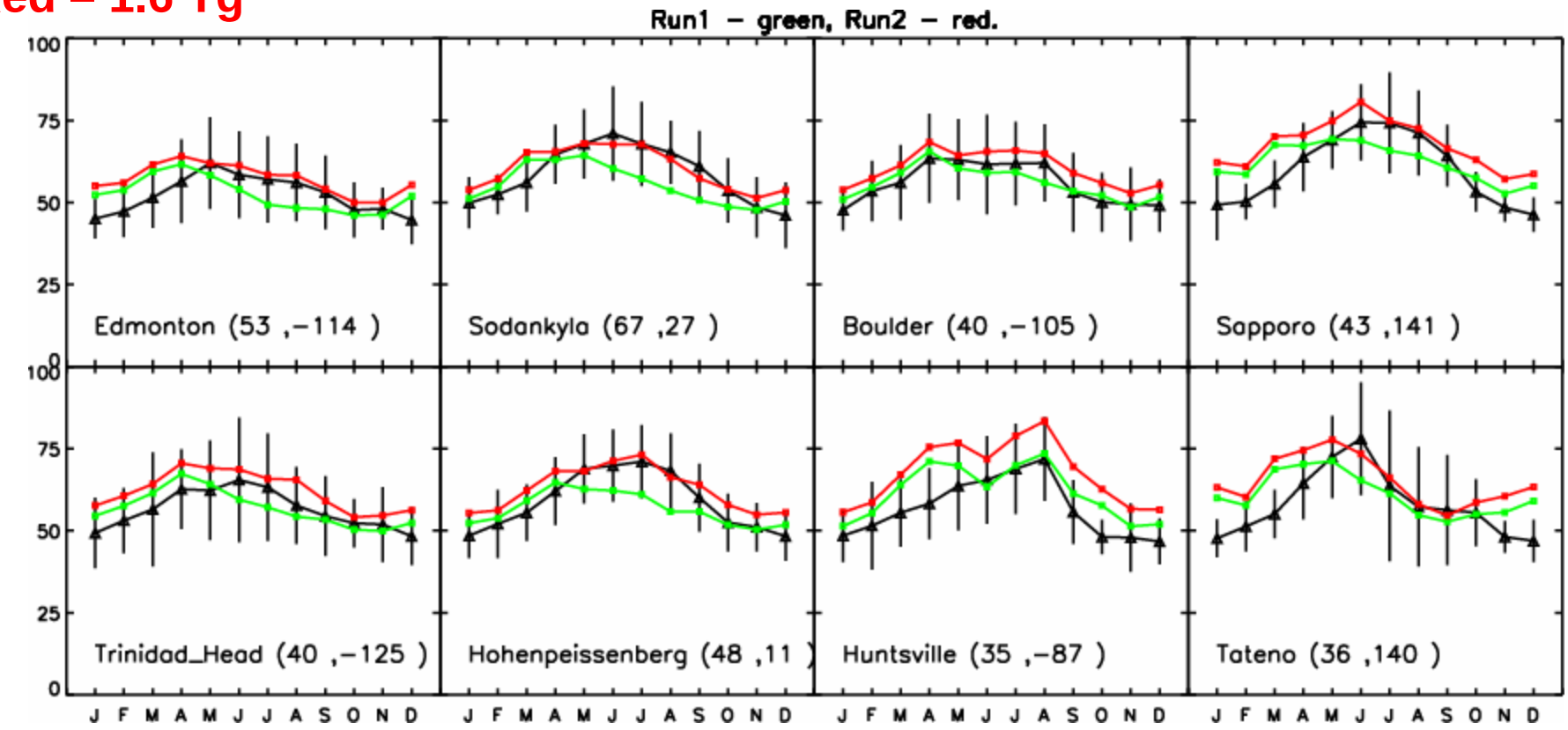
Model is too high at 500 hPa except in summer



The Combo-DAS appears to bring too much ozone down from the strat.
Note that the seasonal amplitude is too low in mid-trop.

GEOS-Chem – effect of increased lightning in extratropics (from 0.4 Tg to 1.6 Tg)

Green – 0.4 Tg
Red – 1.6 Tg

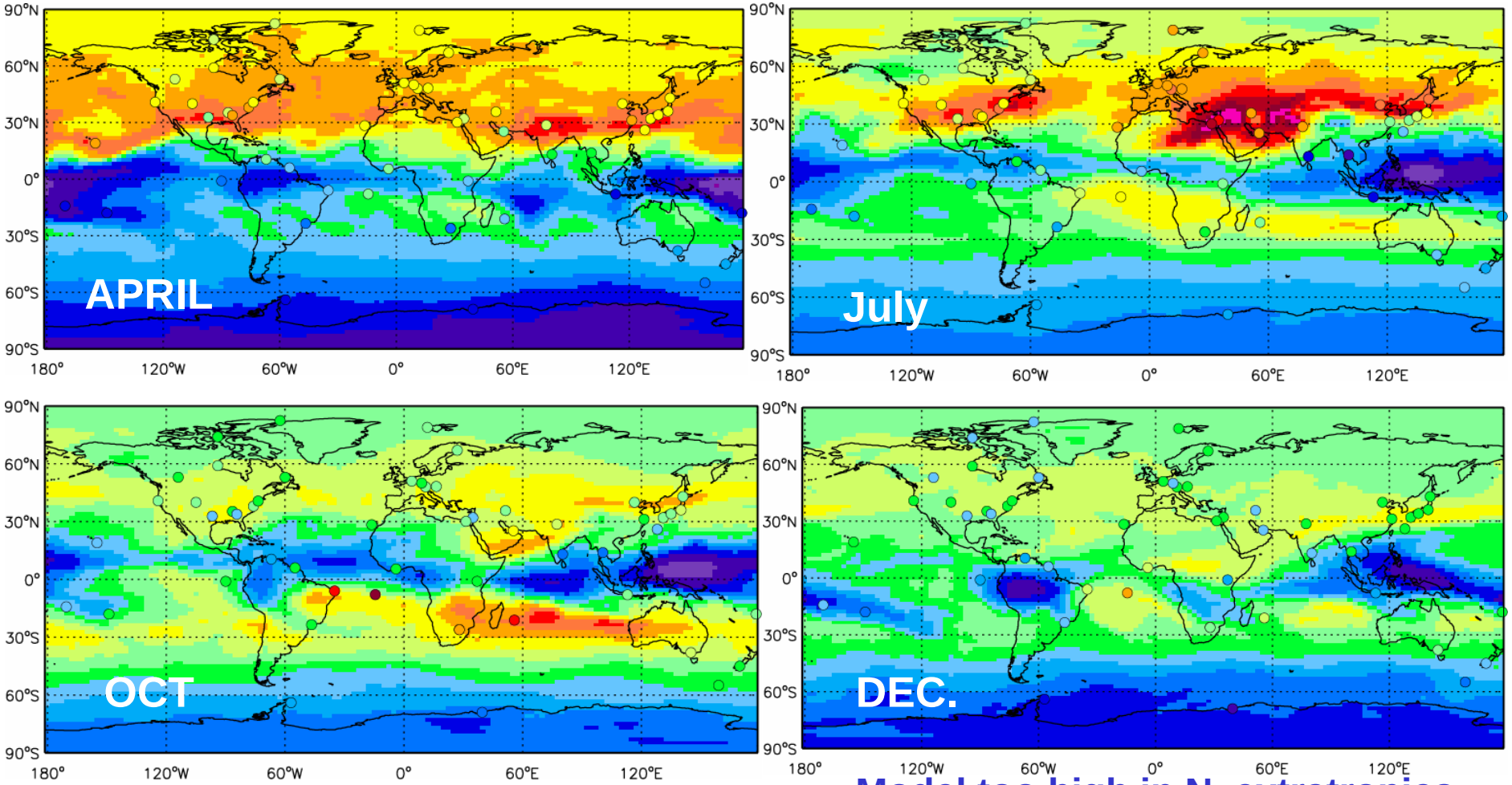


GEOS-Chem, with SYNOZ, does not have quite such high ozone at mid-lat. in winter.
Higher lightning gives more realistic amplitude, but causes some problems

DAS vs. in-situ data 500 hPa, 2005

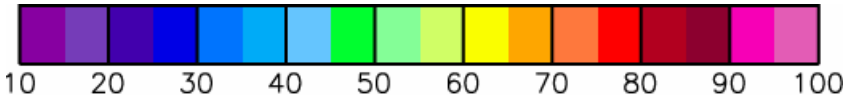
Model too high in N. extratropics

Model too low over U.S., OK in Europe



Model too low in S. Atlantic

Model too high in N. extratropics



TES – DAS comparisons

- Focus on July 2005 - June 2006
  - BB emissions not yet available for 2006
- TES data much sparser before July 2005, before routine limb soundings were dropped.
- The CO data quality is much better after Dec. 2005, due to warm-up of optical bench. CO data not reliable for lat. >60º
- Ozone validation with ~1600 sondes shows TES is biased high by ~5 ppb at 500 hPa (Nassar et al., Richards et al).
- CO validation with INTEX-B data and Ave data – TES within 15% - relatively few comparisons (Luo et al., Lopez et al.)

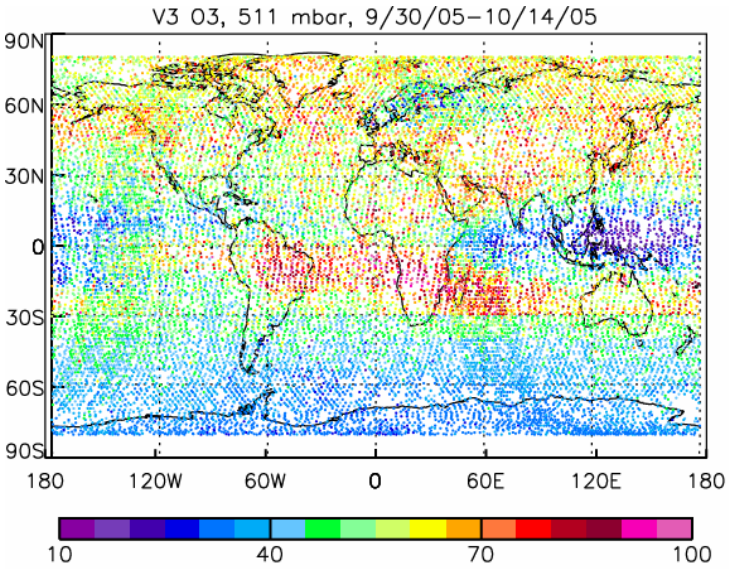
TES – DAS comparisons cont.

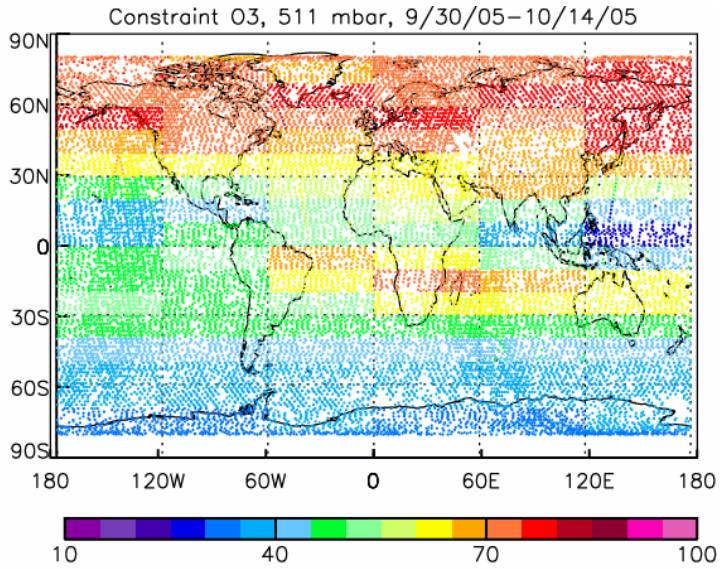
- Model sampled at TES profile locations on same day, and AKs and prior applied.
- TES prior from MOZART model
- Results gridded on 2x2.5 grid
- TES data selection used for ozone
  - Data quality flag
  - Emission layer flag
  - Omit profile if effective cloud optical depth > 2 above layer
  - Filtered on value of AK diagonal (omit <0.02, 18N-18S, or <0.01)
- Difference [(DAS with AK) –TES] removes prior
- If TES retrieval is mostly the prior, we are comparing the Combo model and MOZART

Some issues about TES ozone

Standard retrieval

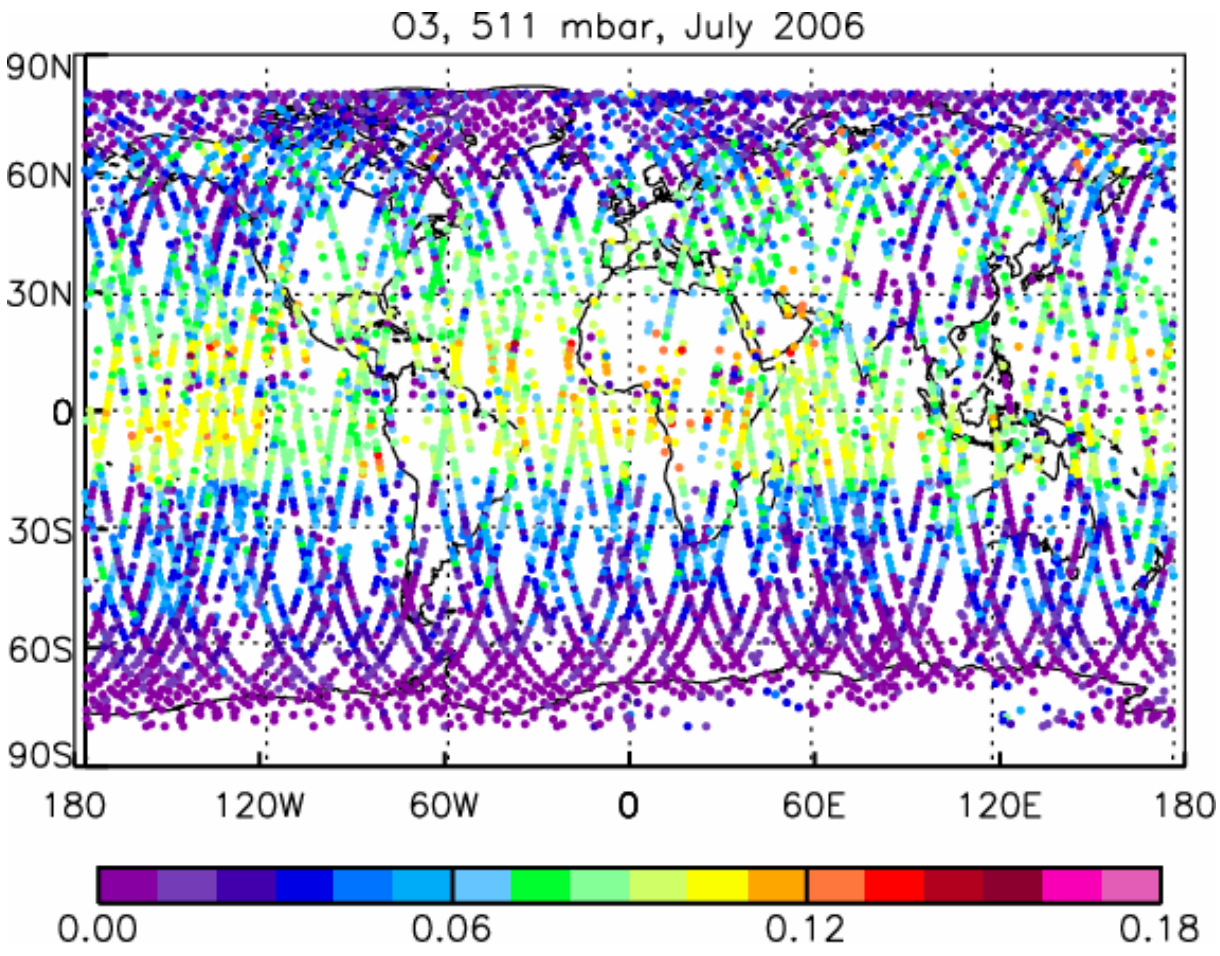
Prior, from MOZART, 10°x60 ° avg.





Blocks (10°x60°) in retrieval are from the prior, MOZART model.

Diagonal of the AK, 3 Global Surveys, latest version



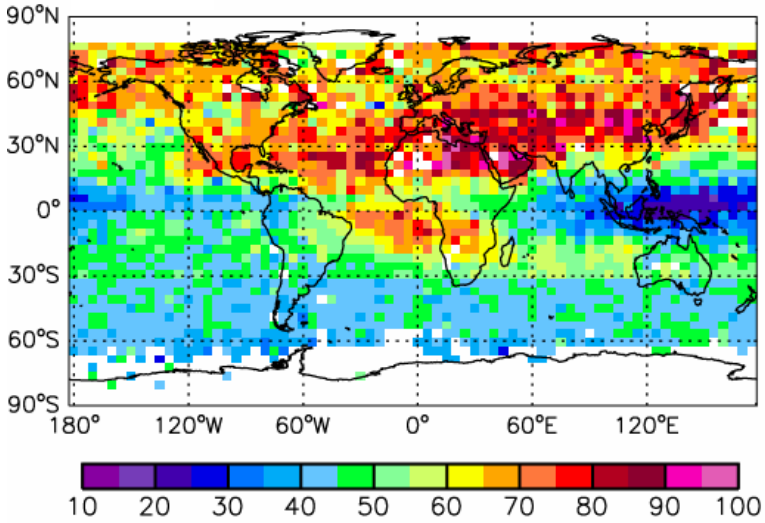
Constraint matrix changes at ±18º, ±54º.

Line at 18º is due to this change.

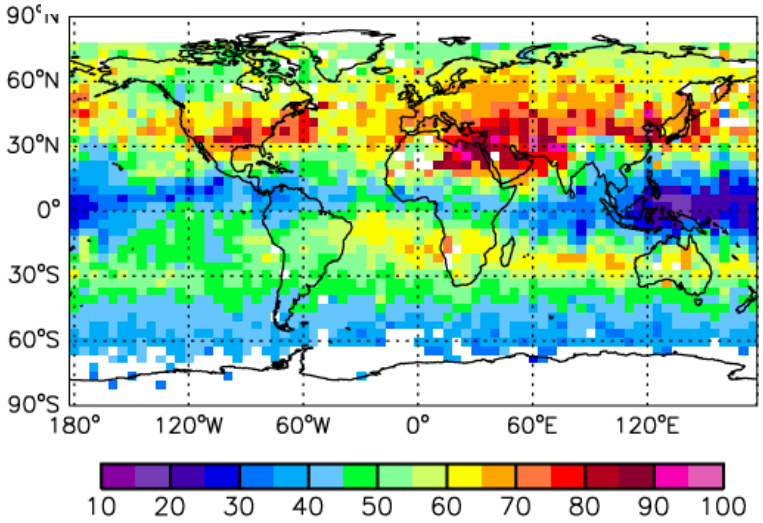
TES has best sensitivity in the tropics.

Combo-DAS vs. TES ozone, 511 hPa, July 2005

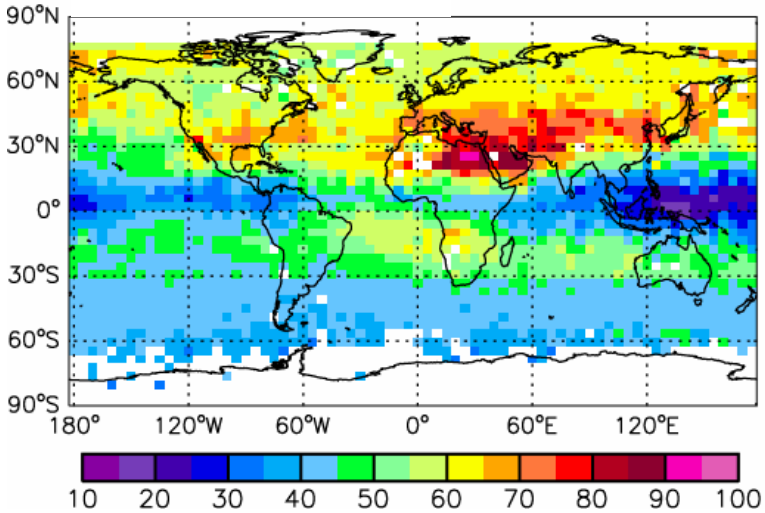
TES S, 511 mbar, 7/04/05–7/30/05



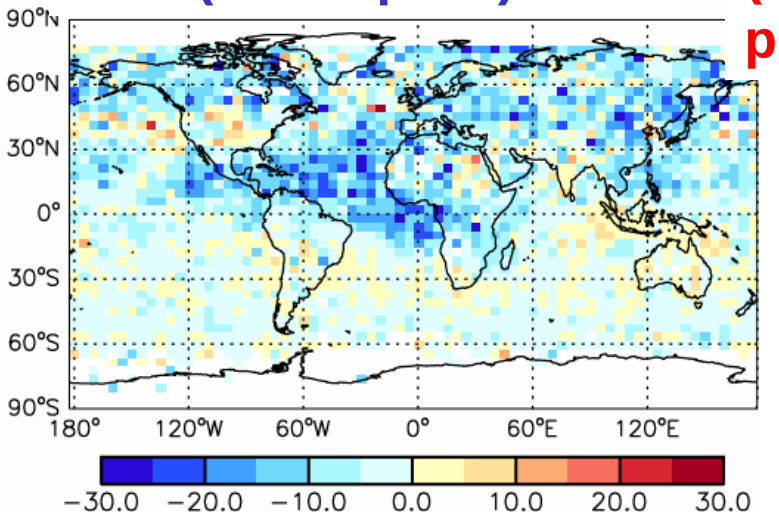
DAS w/o AK, 511 mbar, 7/04/05–7/30/05



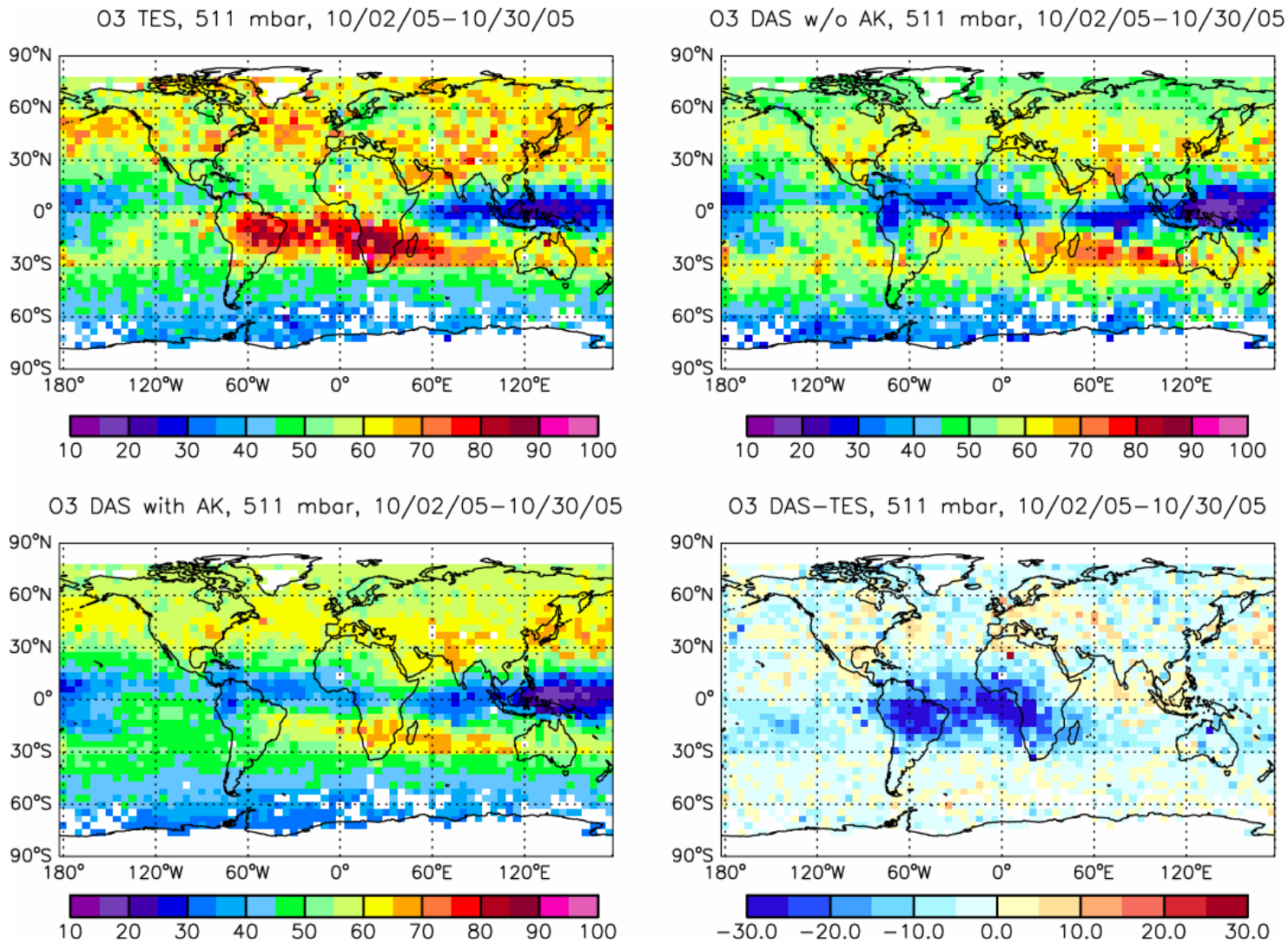
DAS with AK , 7/04/05–7/30/05



DAS (w. AK/prior) –TES /05 **(removes prior)**



Combo-DAS vs. TES ozone, 511 hPa, October, 2005



- **Are the discrepancies between the DAS run and the in-situ data the same as those between the DAS and TES?**

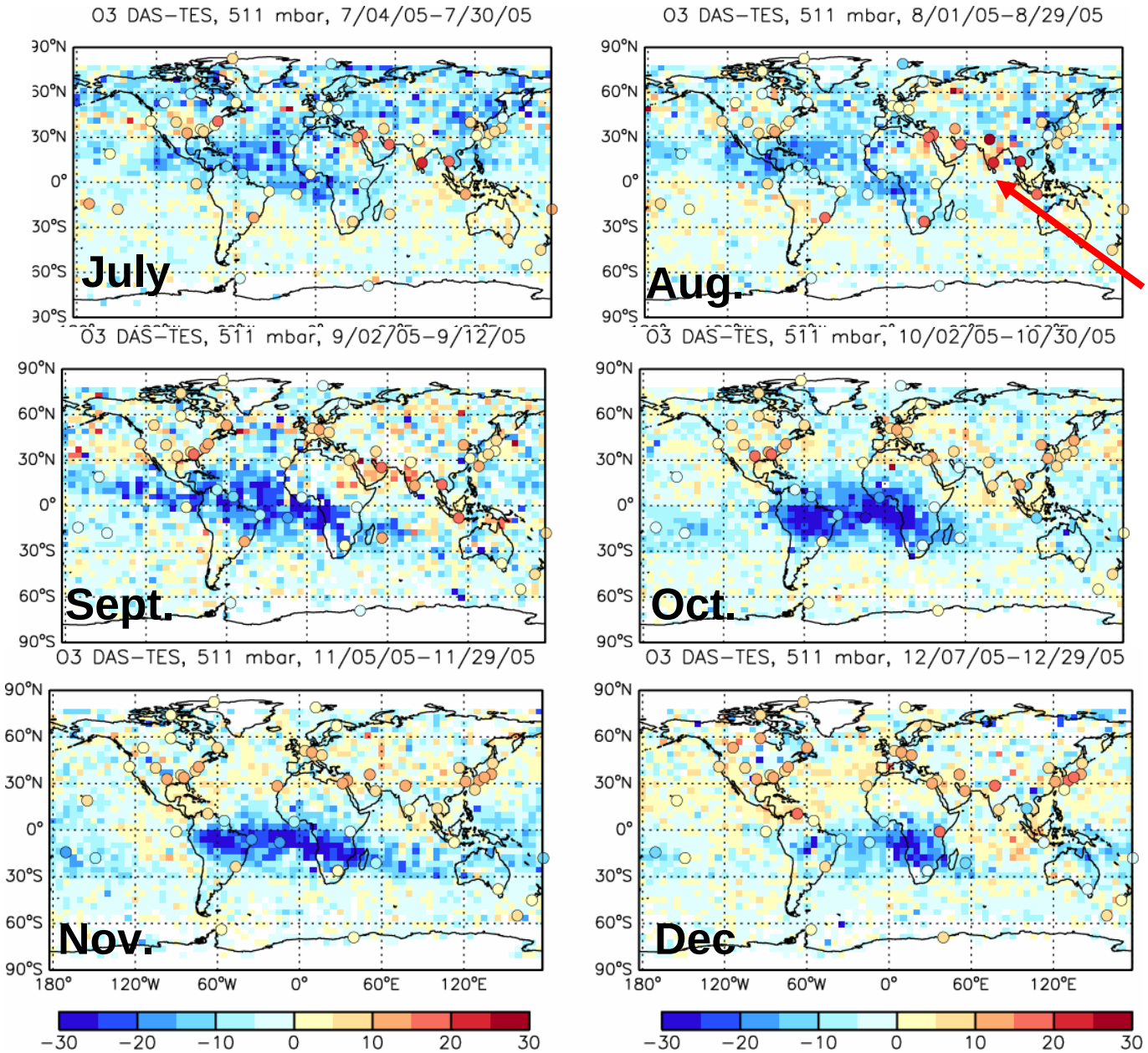
- **We are comparing the DAS and TES matched in space and time, with TES AK and prior applied.**

- **For the in-situ data (sondes and MOZAIC) we are comparing a multi-year mean and the DAS, so interannual variability could be an issue.**

- **TES is biased high by ~5 ppb in general, and by ~10 ppb in winter at N. extratropics.**

Difference plots, July 2005 – Dec. 2005

Indirect validation

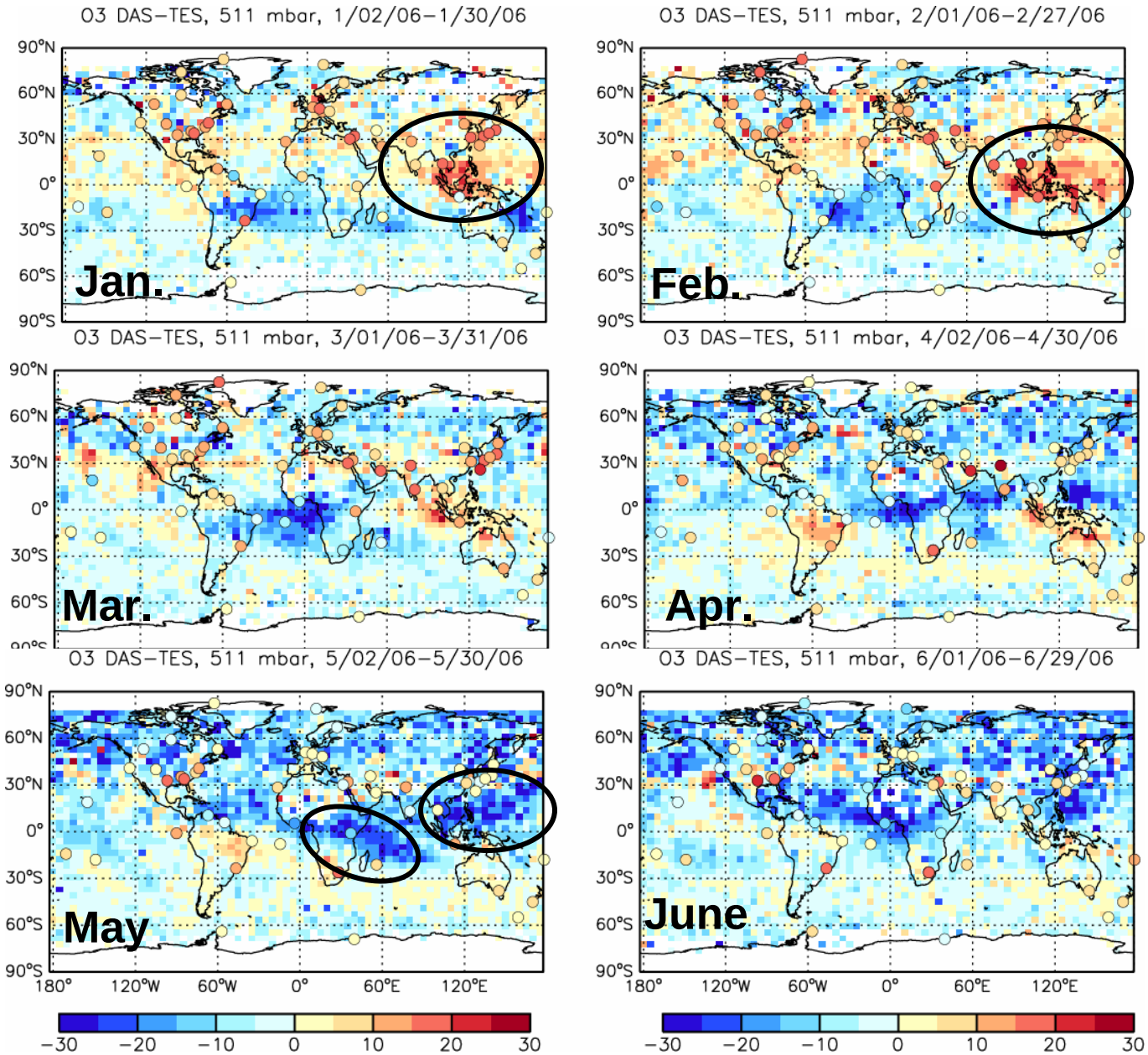


(DAS-TES) is similar to (DAS-in situ) in summer, allowing for TES bias of ~5 ppb.

A few exceptions however.

TES bias is higher in winter extratropics, ~10 ppb

Difference plots, Jan 2006 – June 2006

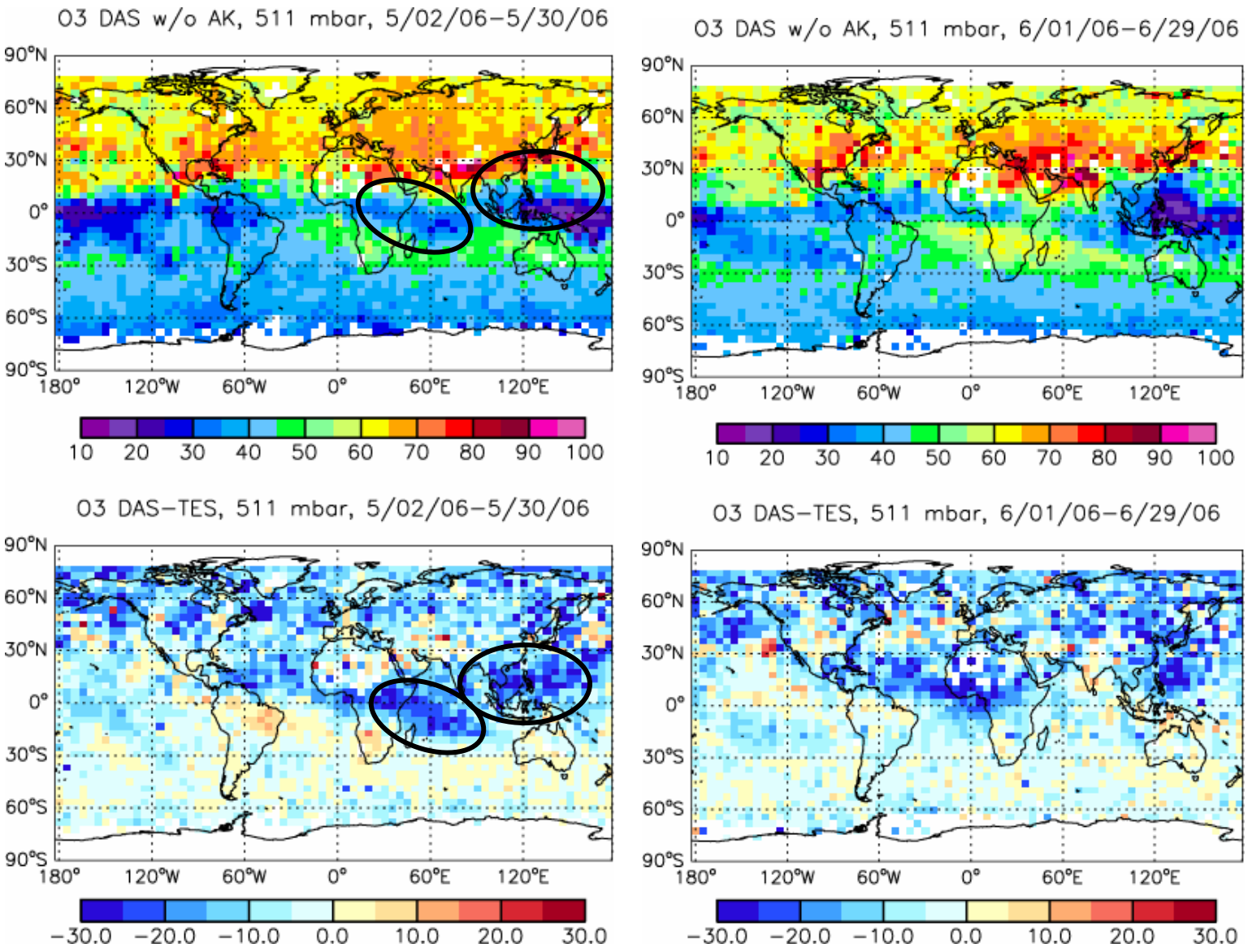


Ozone too high over Indonesia in Jan., Feb.

Revisit after looking at CO

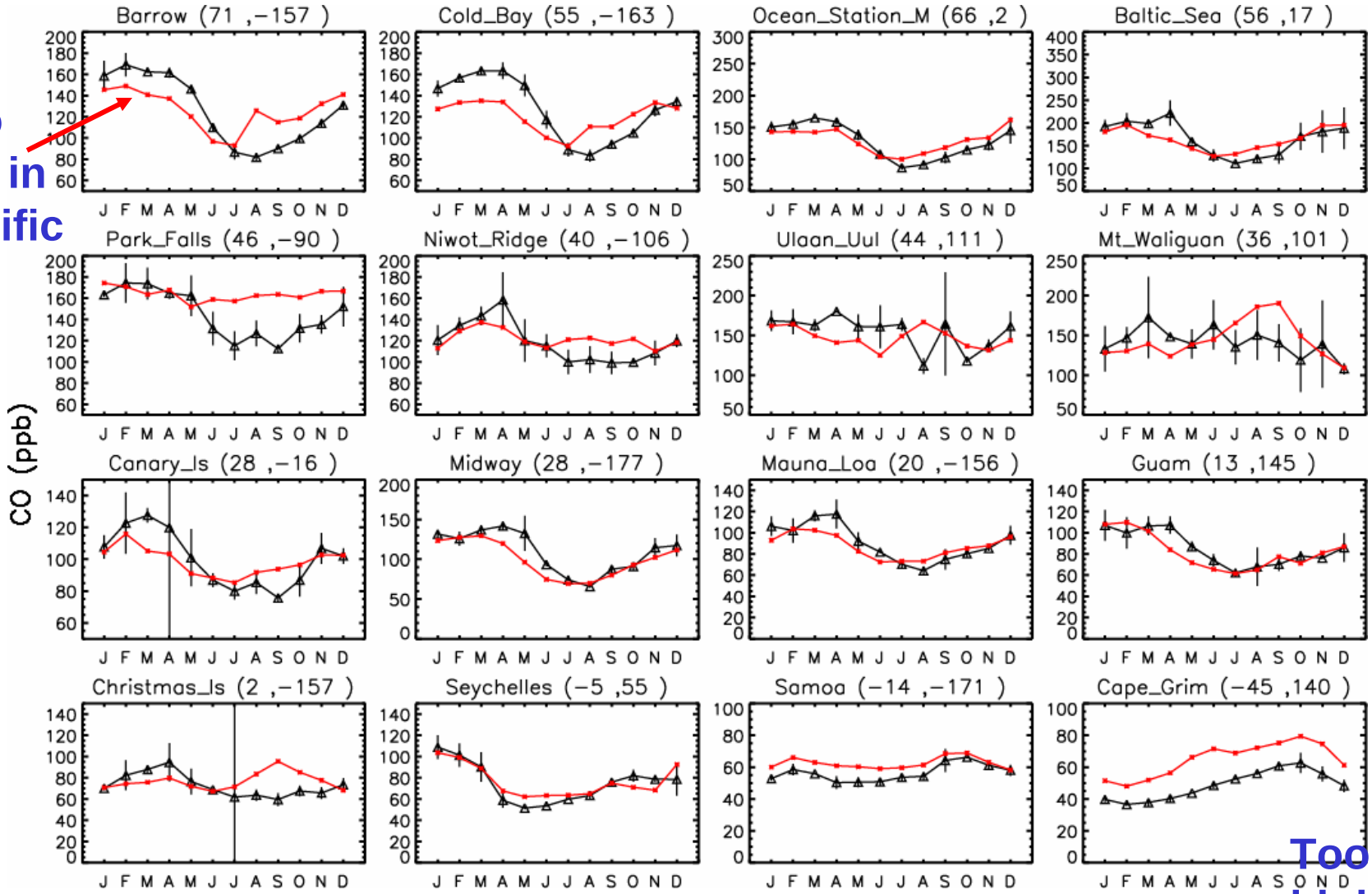
Ozone too low over Indian Ocean, W. Pacific in June

Highlight June and July



CO at GMD surface stations – DAS in red

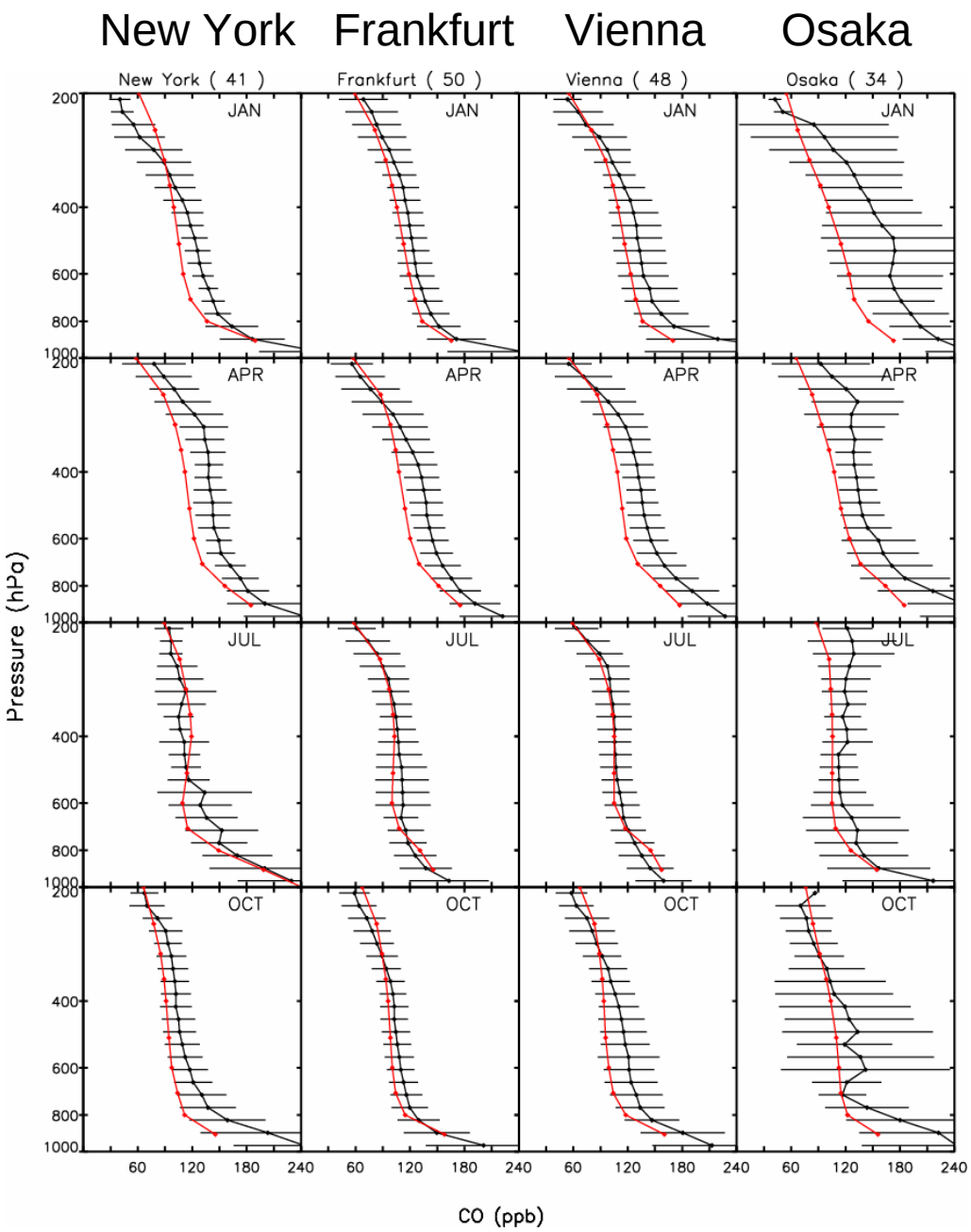
Too low in Pacific



Too high in SH

CO surface data for 1999-2001 (FF emissions for 2000)

CO profiles, MOZAIC data, US, Europe, Japan

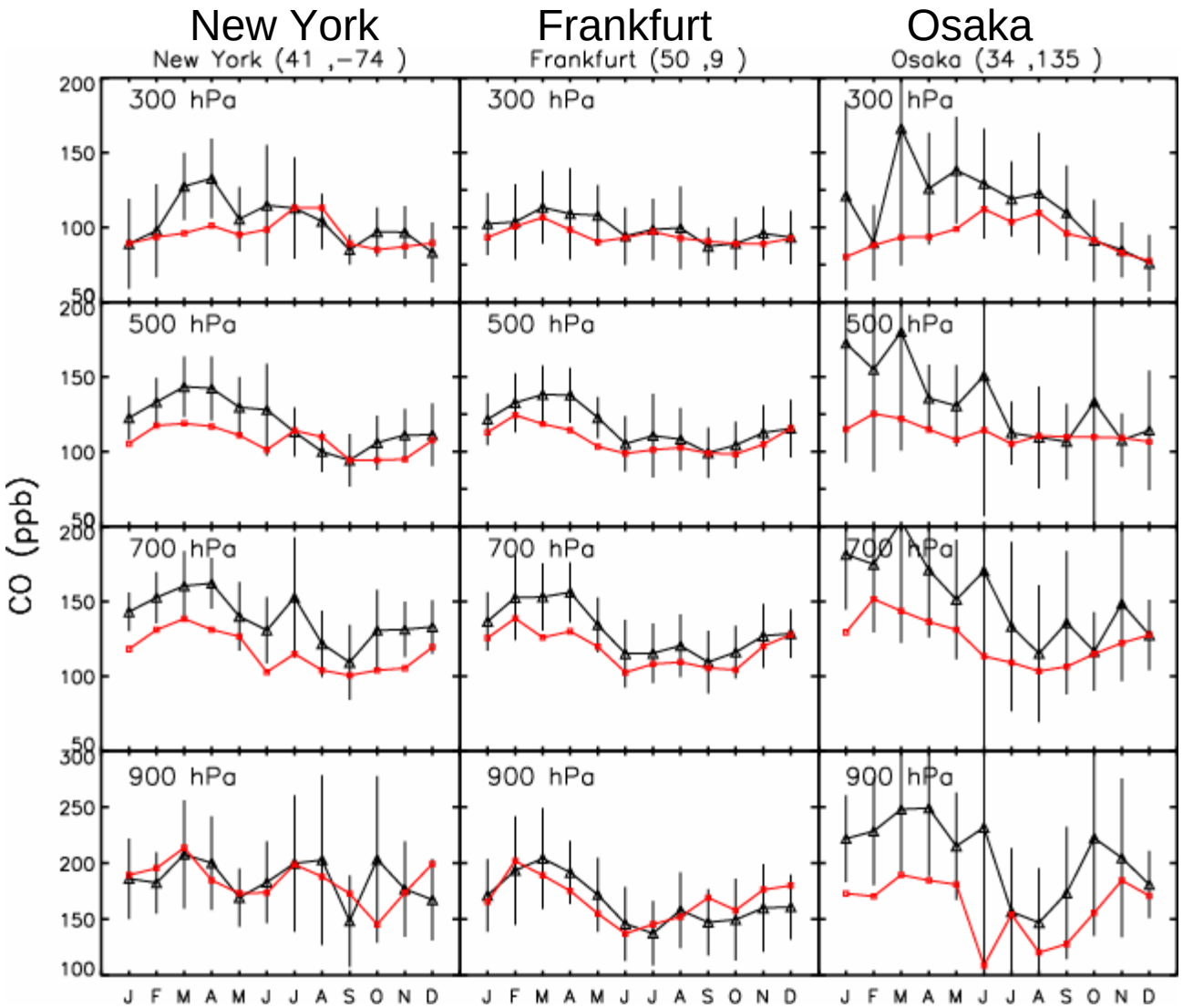


DAS is low over Japan in Jan.

DAS is low in April everywhere

DAS is OK in July, Oct.

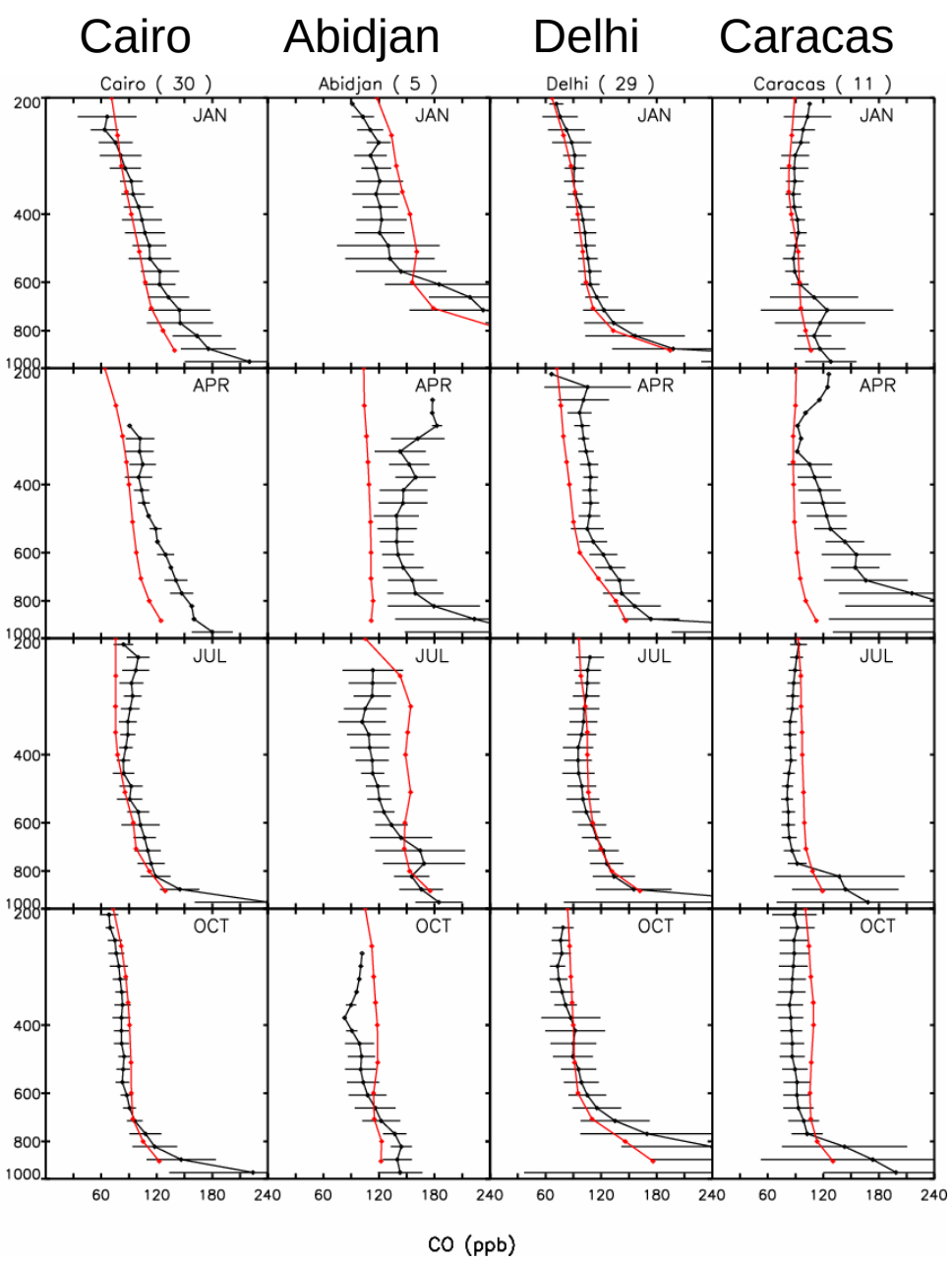
CO seasonal cycle, MOZAIC comparison



DAS is too low in the first part of the year at 500 hPa.

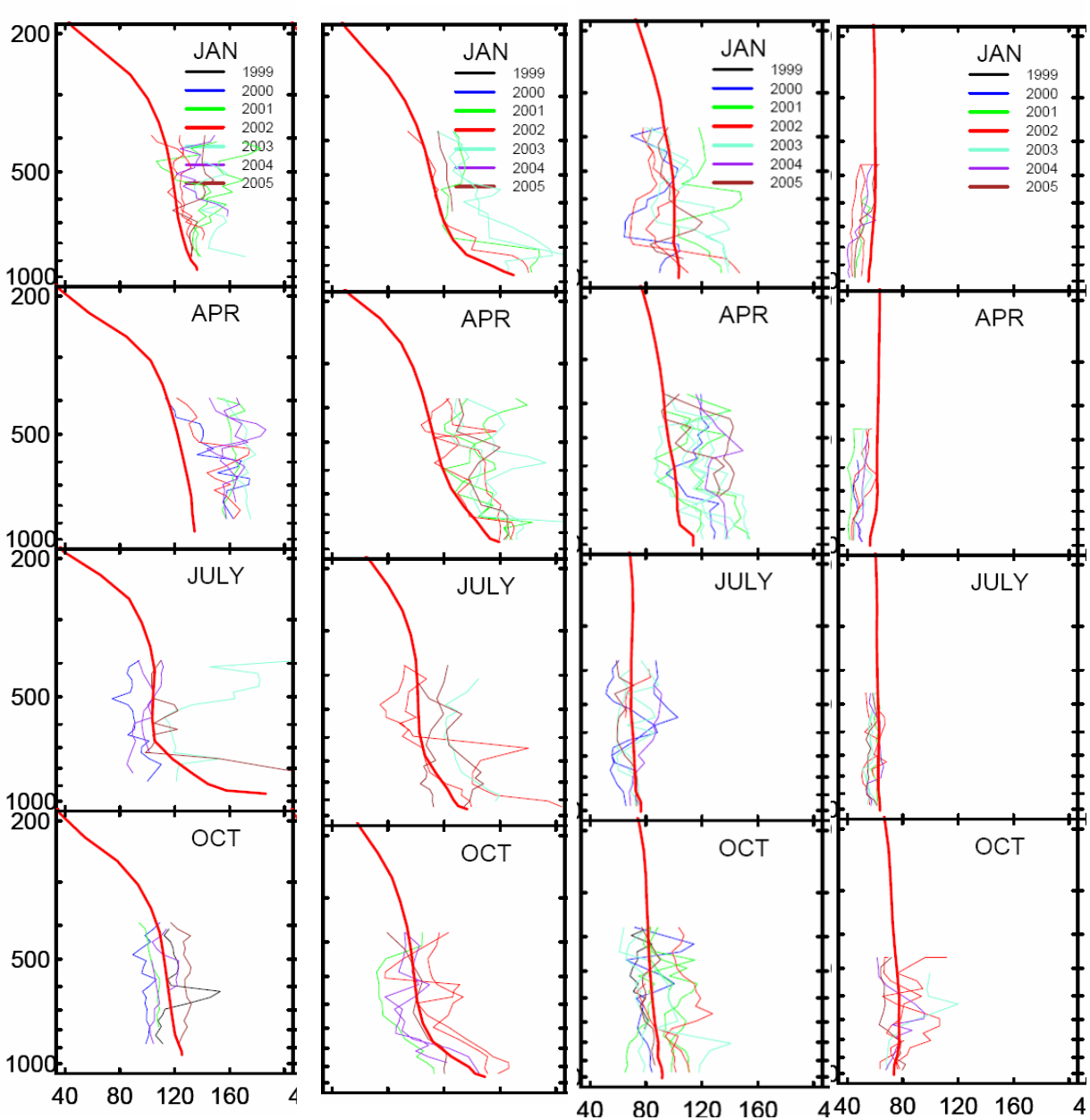
The amplitude of the seasonal cycle is too low – similar to MOPITT comparisons of Prasad

CO profiles, MOZAIC



Locations were picked as they had the most CO profiles

Poker Flats Alaska | **Harvard For. Mass.** | **Molokai Is Hawaii** | **Raratonga 21 S**



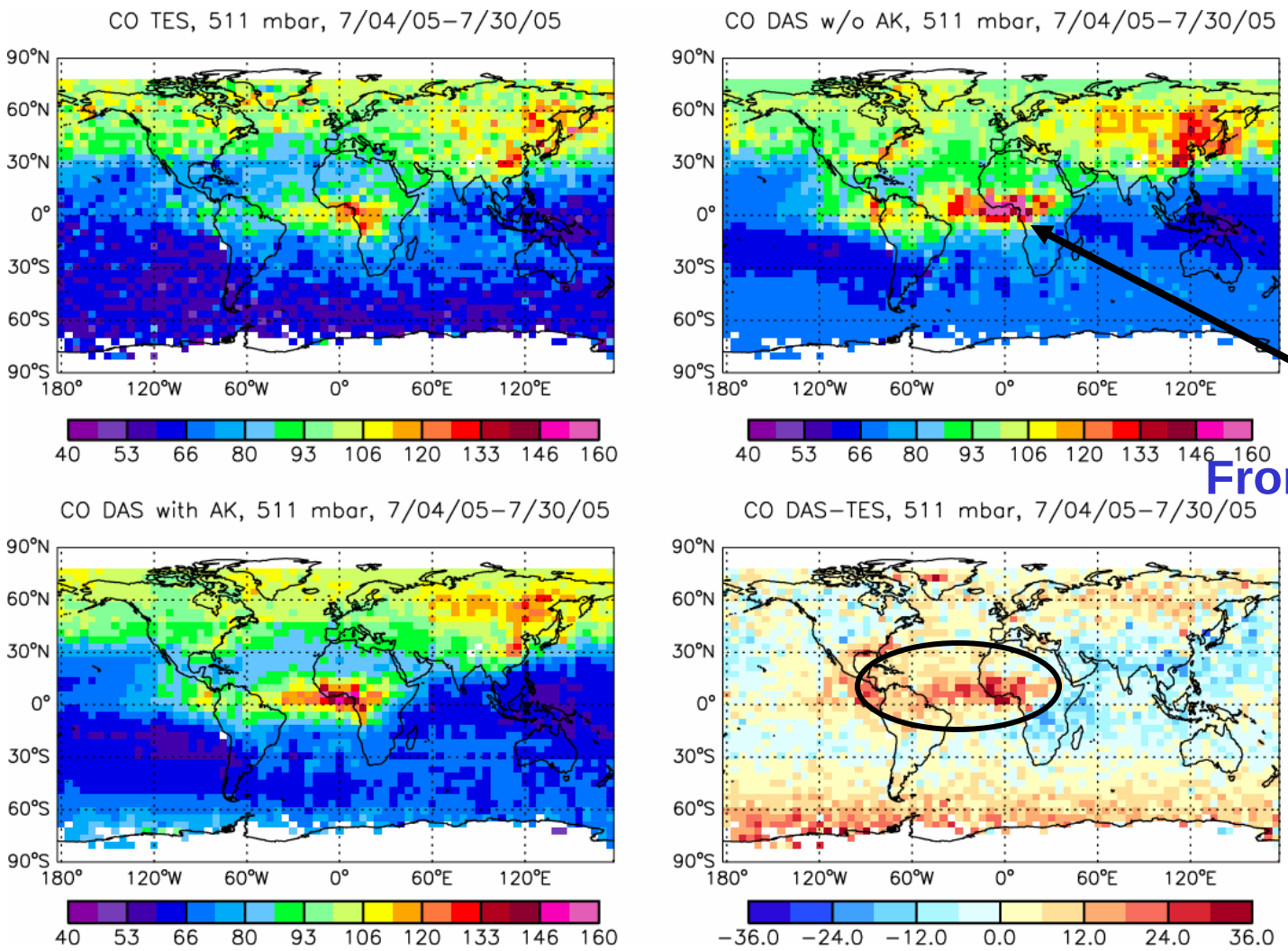
Data from NOAA/ESRL/GMD.

Not many profiles

At NH sites, consistent with surface data, model too low in spring.

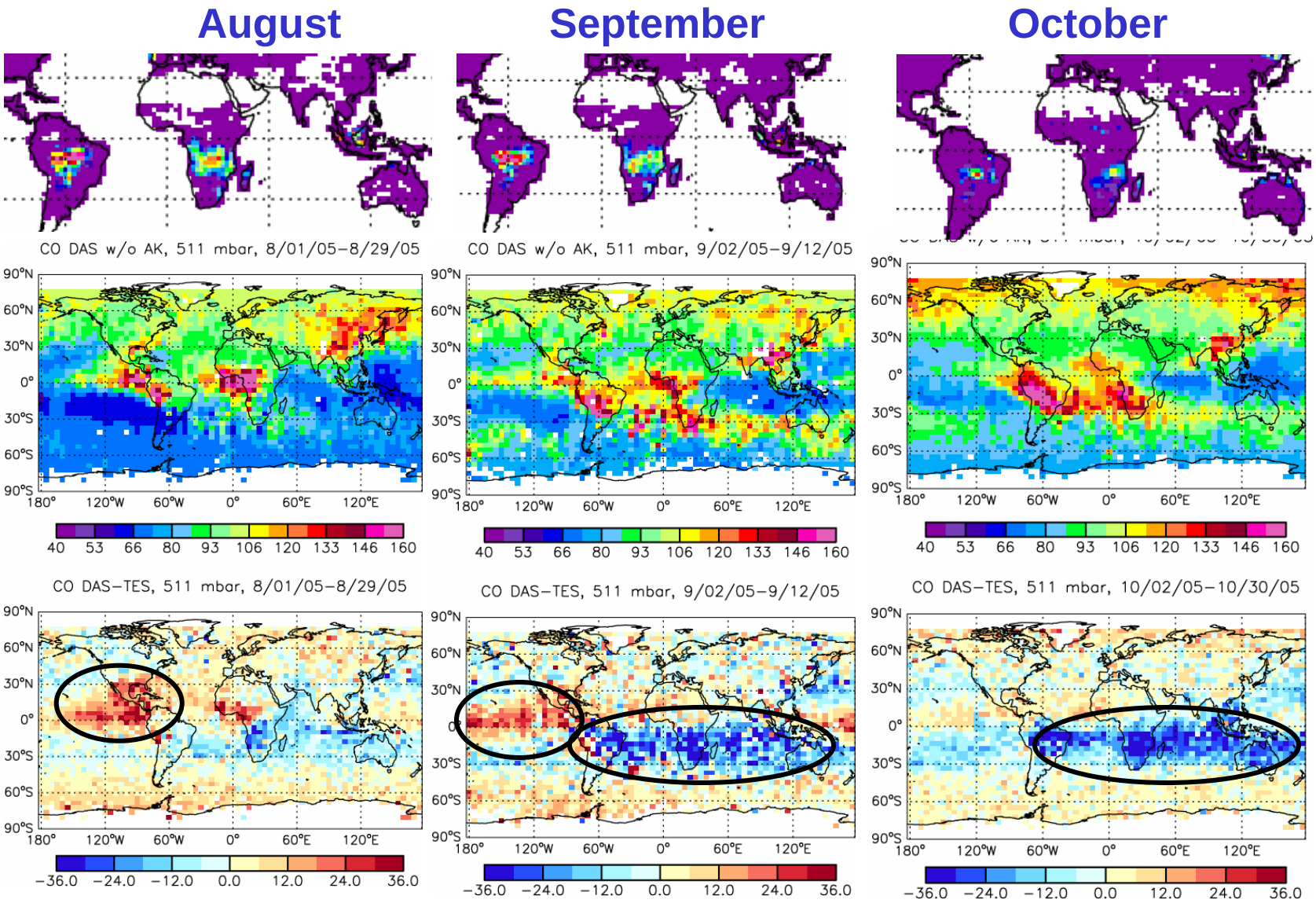
At Raratonga, similar to Samoa (14 S)

DAS compared to TES CO at 500 hPa, July 2005



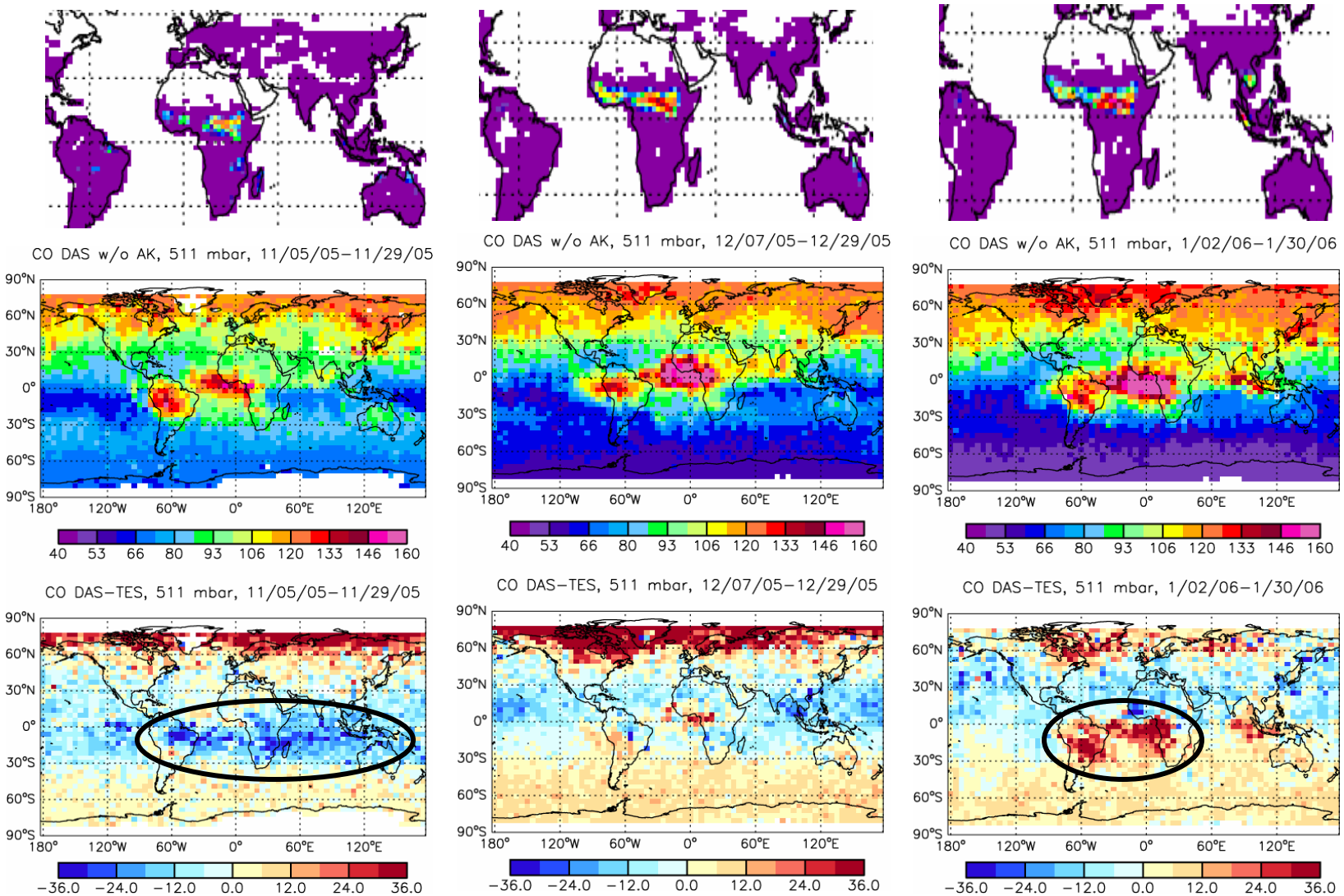
From BB in S. Africa

Fire emissions (top), DAS CO (middle), DAS (w/AK, prior) –TES (bottom)



In July, CO is displaced to NE by easterlies; in Oct. CO circulates over S. Atlantic and to Indian Ocean

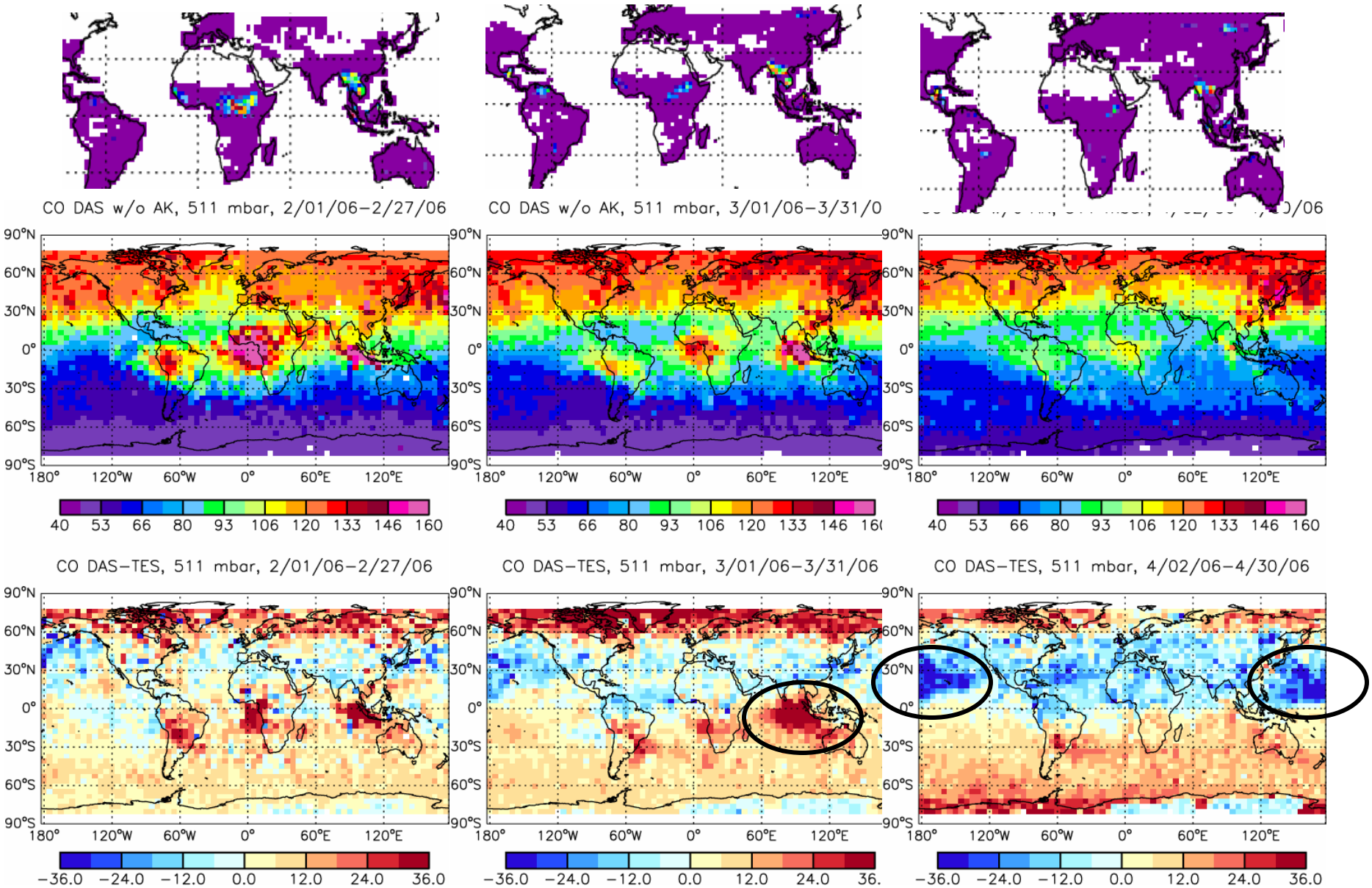
November December January 2006



From SH BB

From NH BB

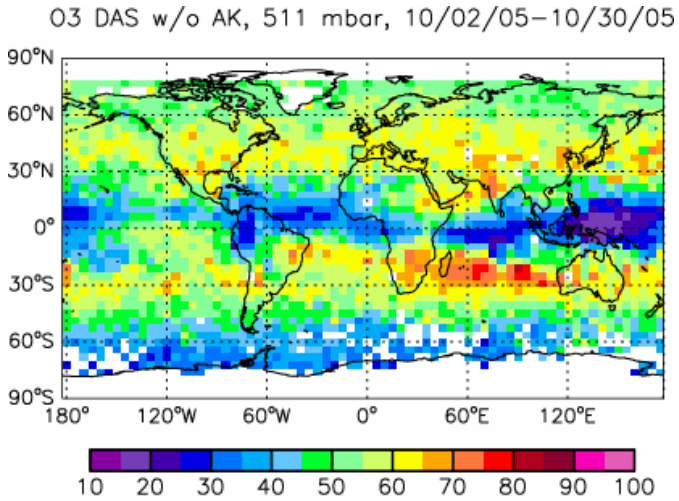
February March April 2006

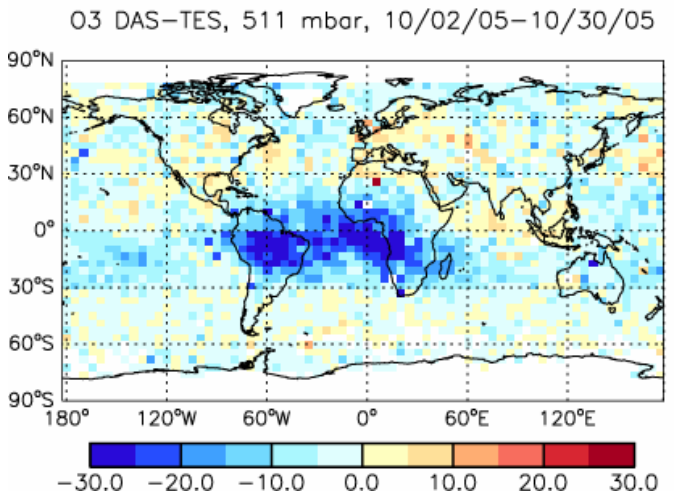


From BB in SE Asia

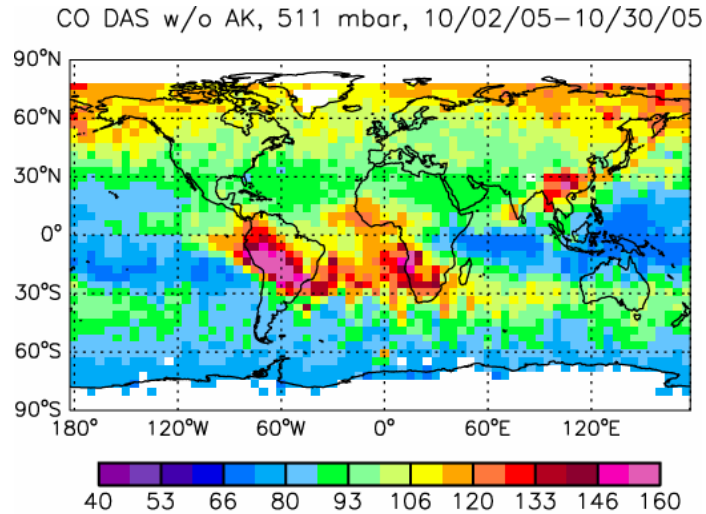
CO low over N. Pacific

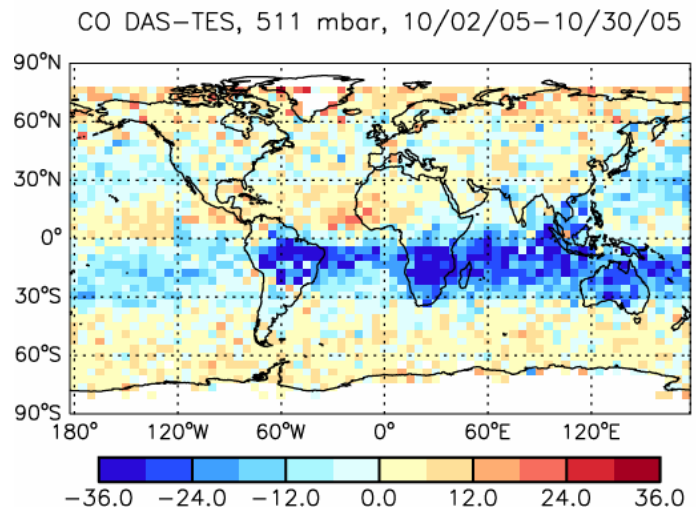
Ozone and CO, October 2005





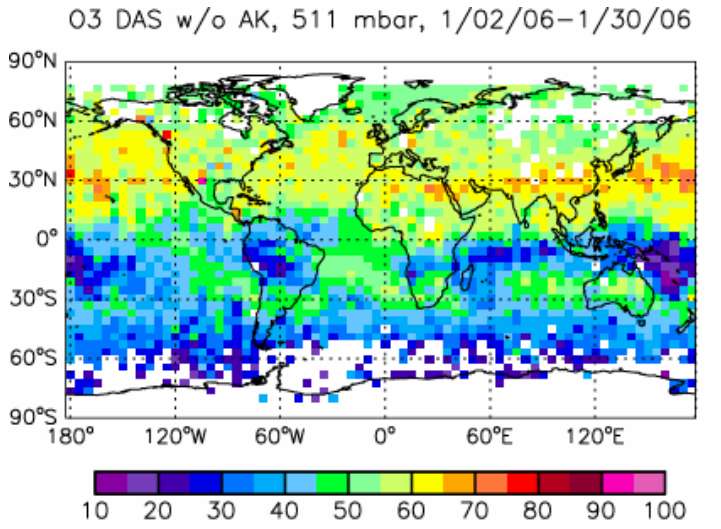
TES shows ozone max. over Atlantic, model max. is over Indian Ocean.

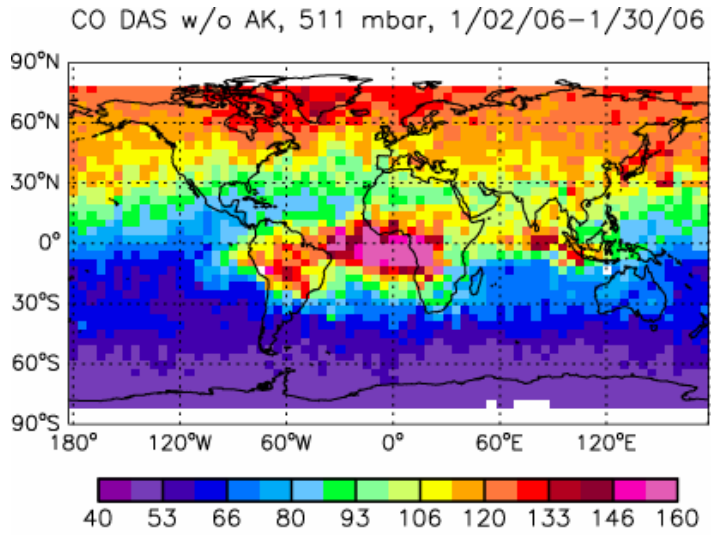


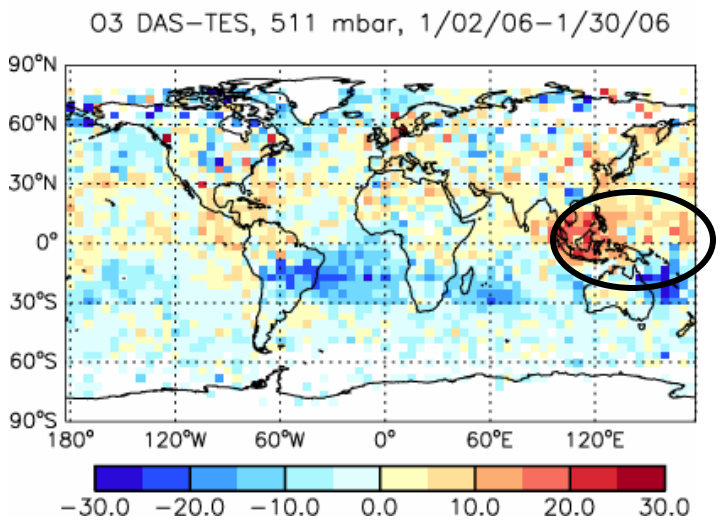


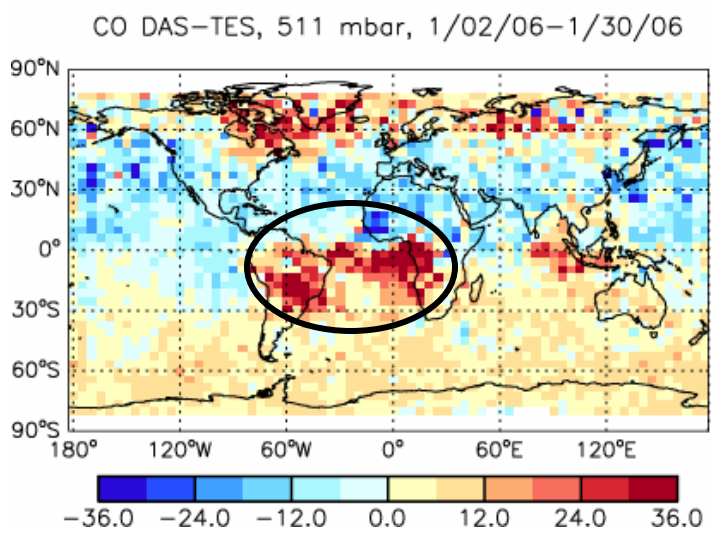
TES shows DAS CO too low over Africa and Indian Ocean

Ozone and CO, January, 2006









Largest ozone discrepancy over SE Asia

Largest CO discrepancy over Brazil, C. Africa

Concluding comments – TES data

- The COMBO-DAS looks remarkably like sonde/MOZAIC data in many regions, except extratropical winter/spring.
- TES ozone product has the most sensitivity in the tropics
- Need to look carefully at TES sensitivity in the extratropics, in winter/spring (more validation being done of TES CO with MOZAIC).
- V003 of TES data being reprocessed, and they are working on improvements for the next version of TES retrieval algorithms
- TES CO validation with MOZAIC data will give more insight into biases

Some other issues

- For CO, are DAS/TES biases similar to DAS/MOPITT biases, and DAS/AIRS biases?
- Will lightning that is consistent with convection change DAS ozone much?
- Lots of analysis still to do ….