CAM4/CAM5 Comparison

- Differences between CAM4/CAM5, Importance of Chemistry
- Comparison of chemical species
- Case Studies
- Comparison to Observations

NESL

NSF

CAM4 / CAM5 Comparisons

General Differences:

• CAM5: improved physics, shallow convection scheme, cloud macro and microphysics

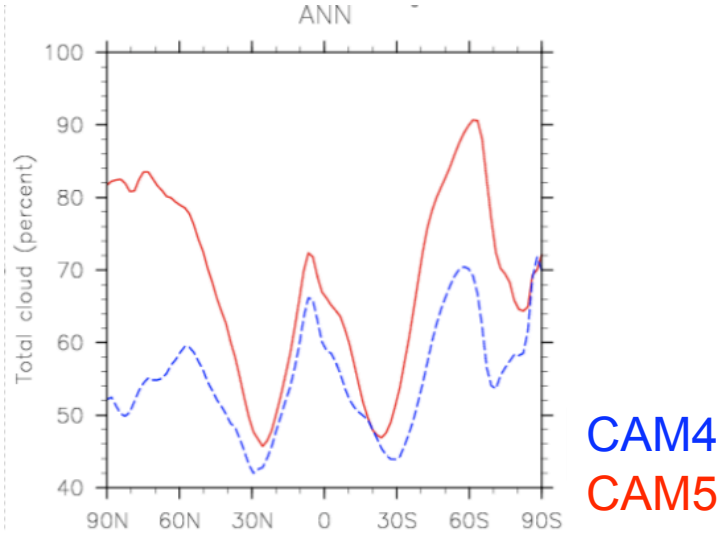
• Differences in the radiation scheme

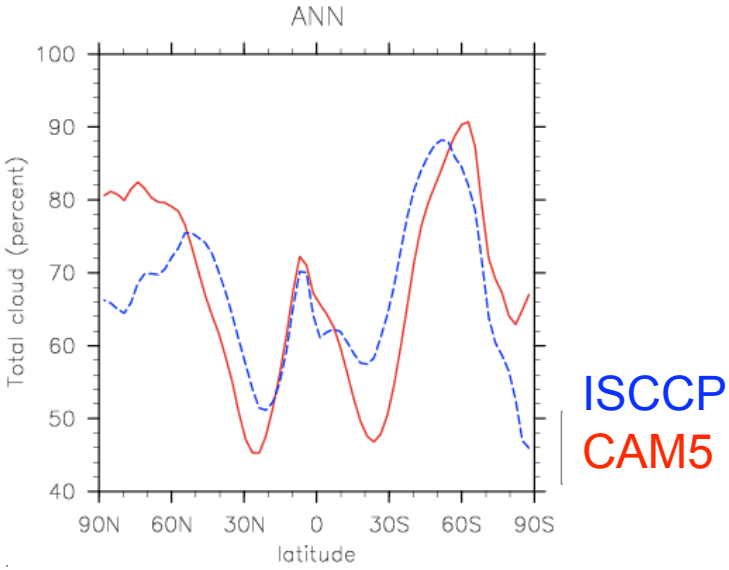
• Differences in the aerosol model (BAM vs. MAM)

➢ CAM4/ CAM5 similar cloud radiative forcing

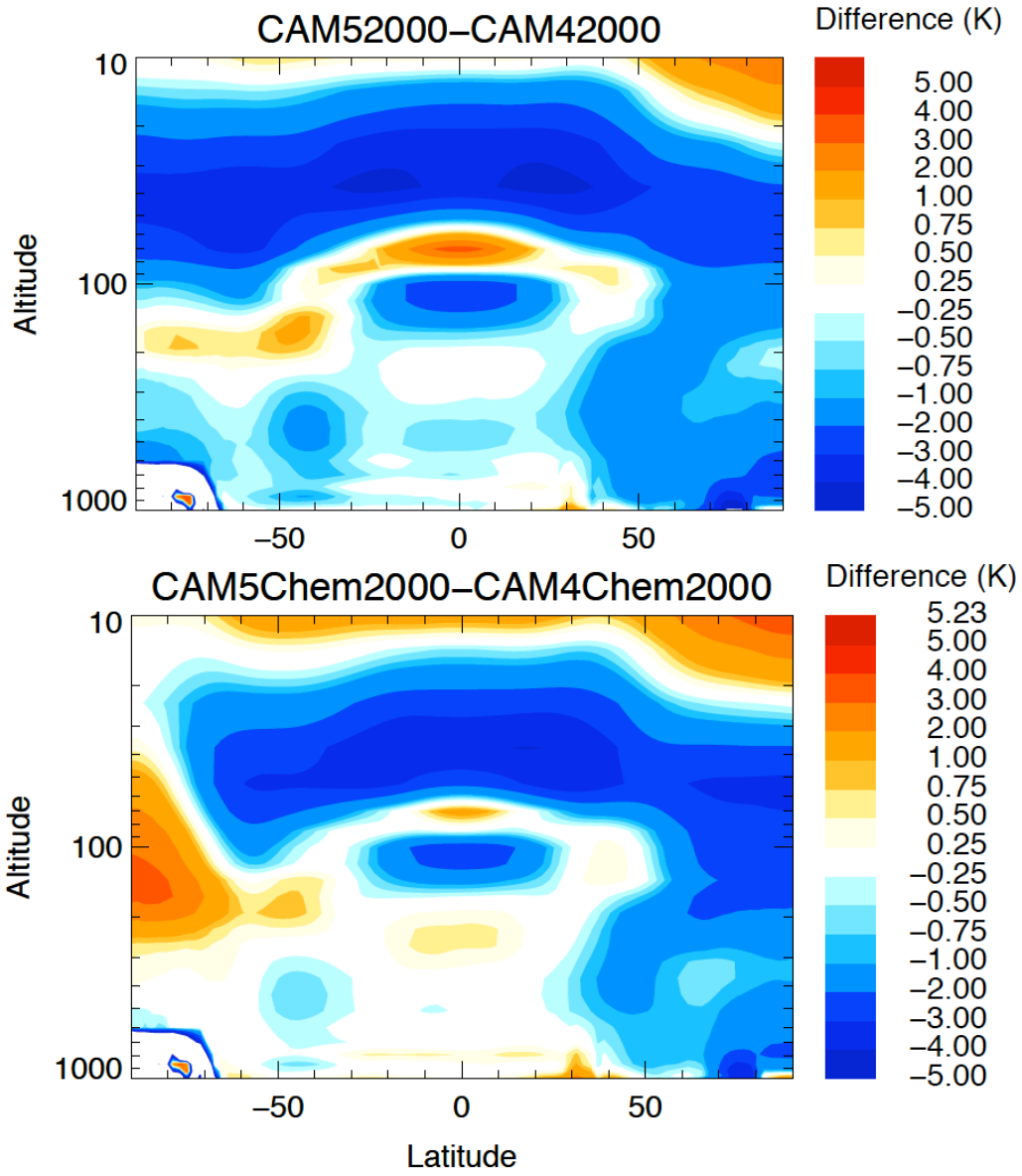
➢ CAM5: more realistic cloud properties (Kay et al., 2012)

- ❑ improved (more) total clouds
- ❑ reduced optical thick clouds
- ❑ increased mid-level clouds

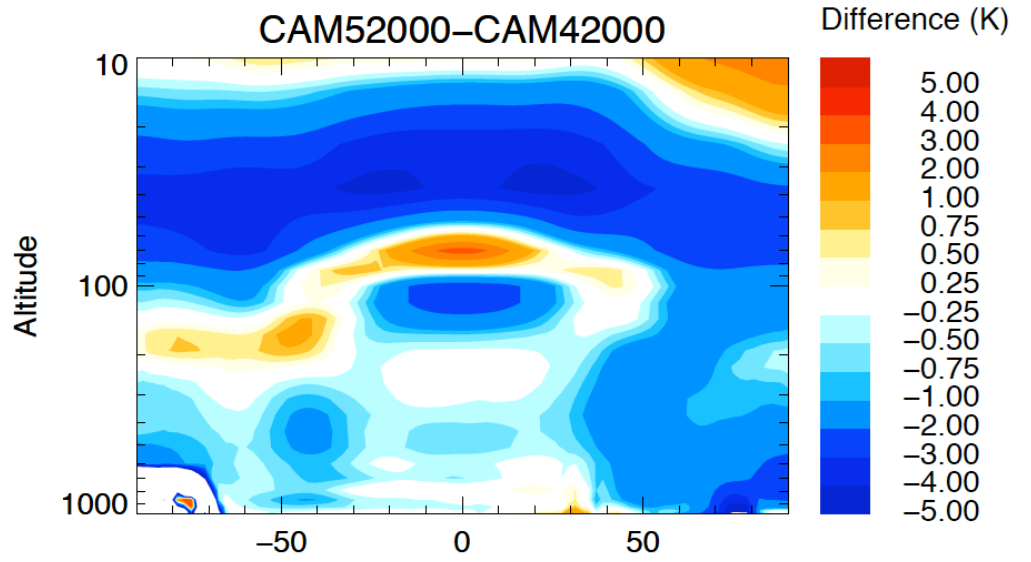


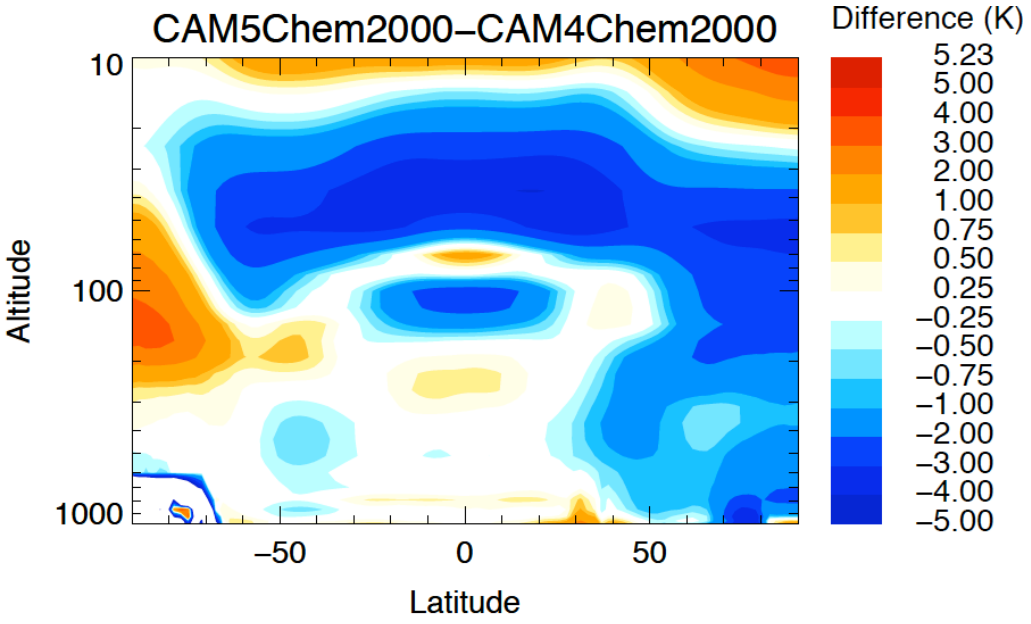


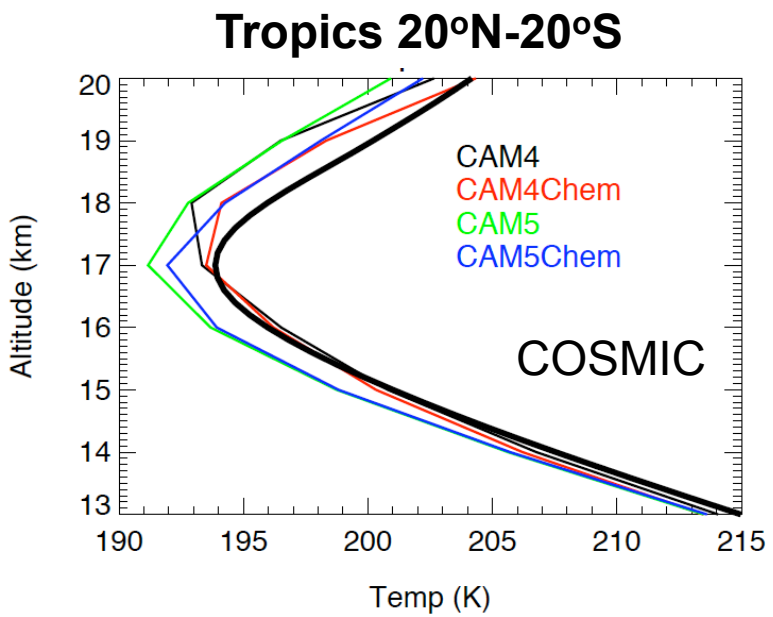
Temperatures in CAM4 / CAM5

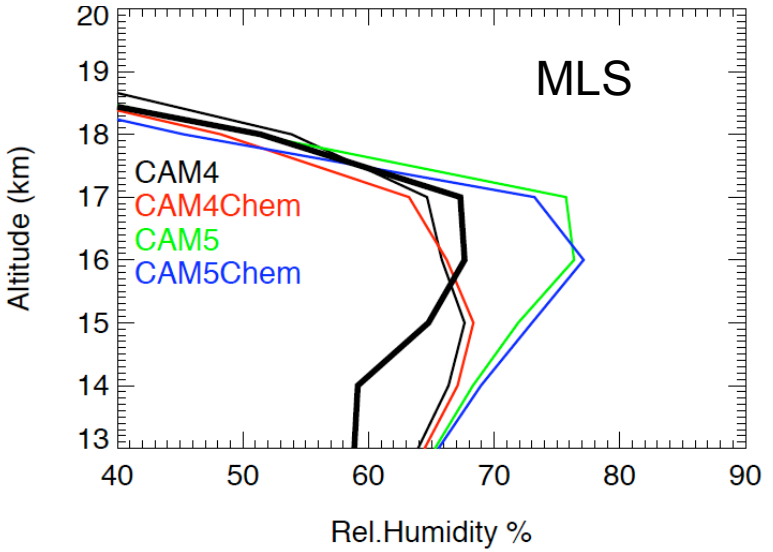


Temperatures in CAM4 / CAM5

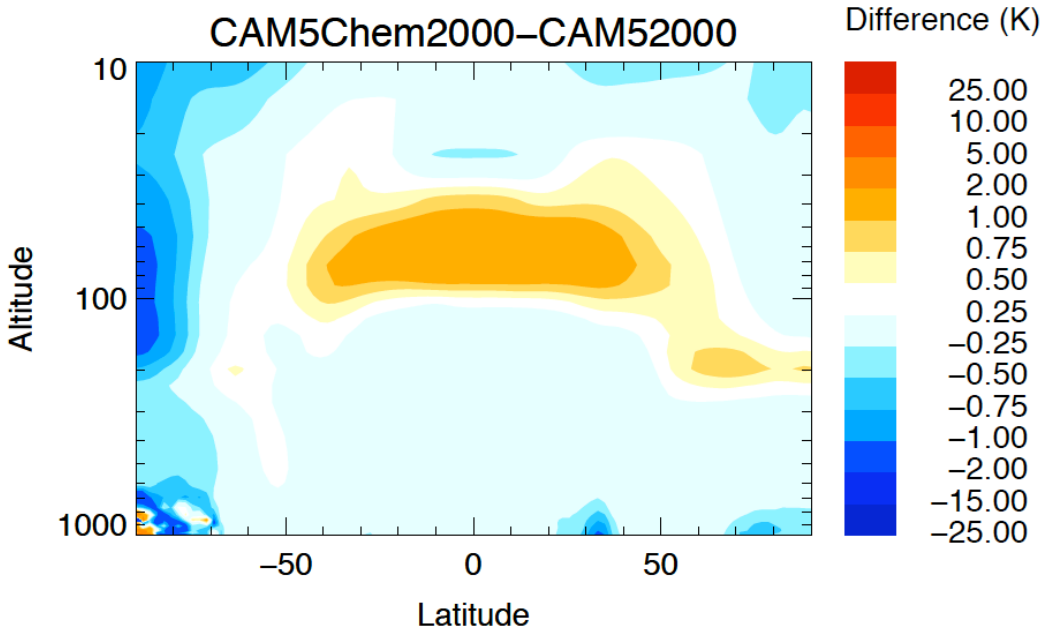




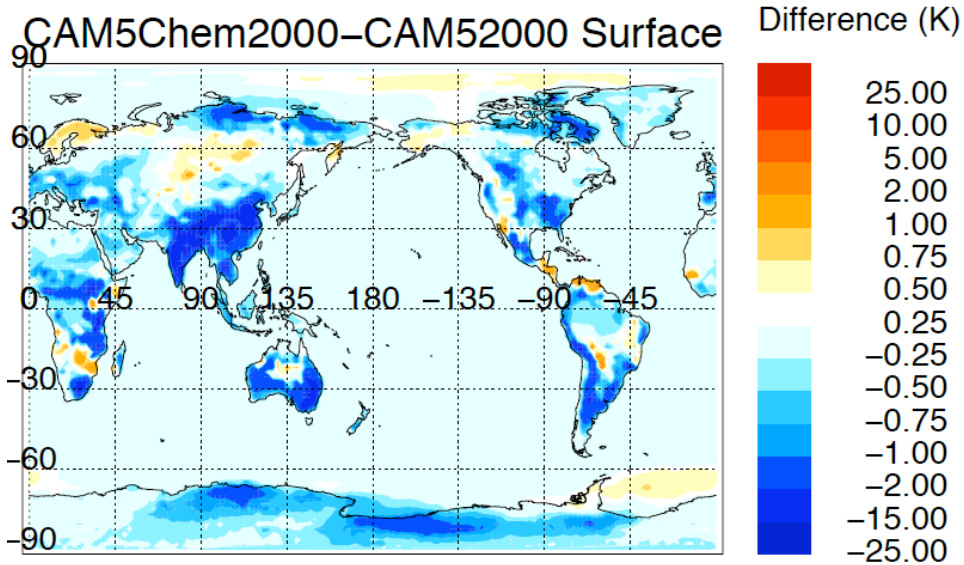




Importance of Chemistry

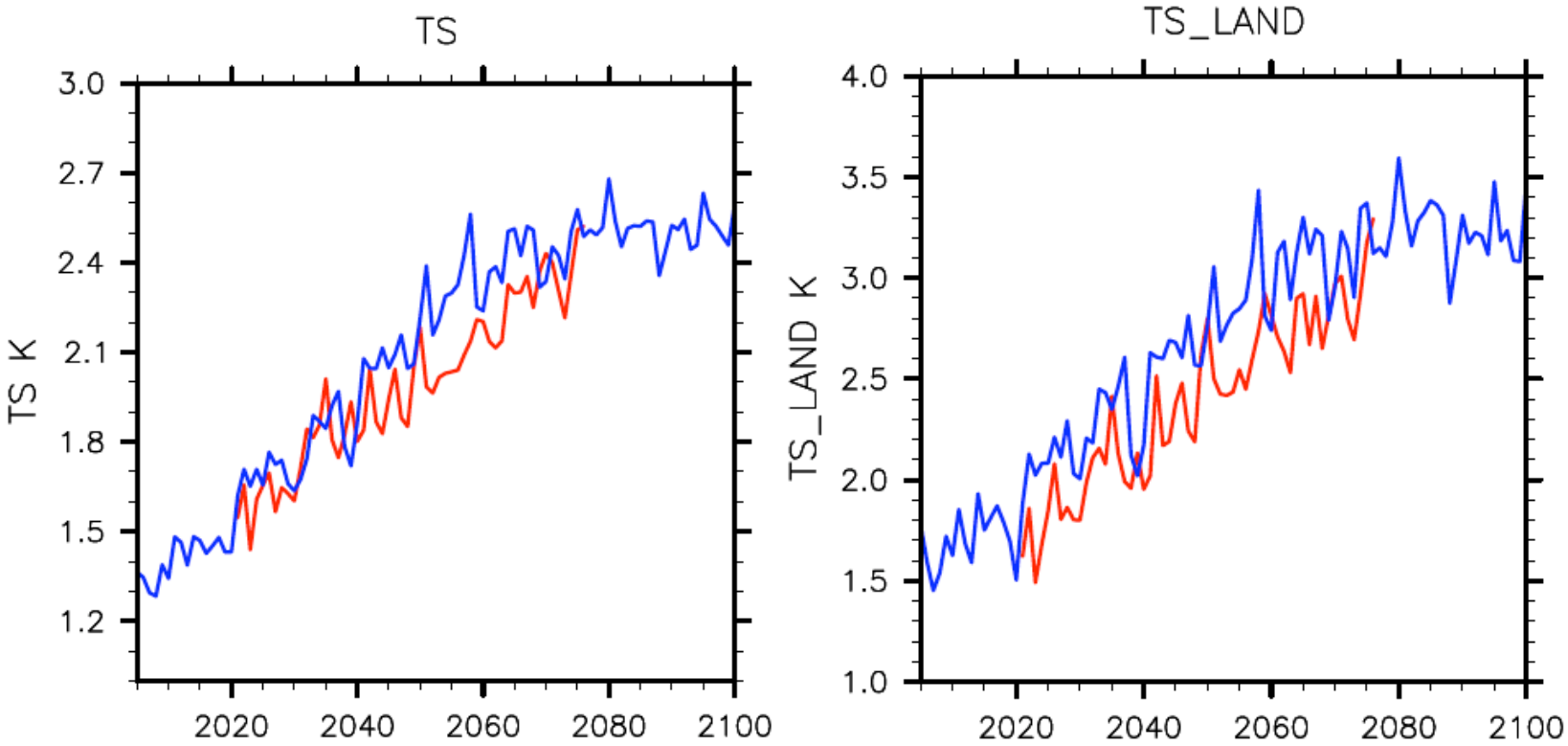


Addition of chemistry results in differences in zonal mean temperatures and surface temperatures



Importance of Chemistry

CAM4 versus CAM4Chem 1deg, RCP 4.5 simulations



Temperatures with regard to 1850 conditions

- **Smaller TS over land**
- **Implications for geo-engineering simulations!**

Simulations comparing CAM4/ CAM5 with Strat/Trop Chemistry

- CAM4Chem 2000 BAM, (trop/strat chemistry)
- CAM5Chem 2000 MAM (trop/strat chemistry)
- CAM5Chem 2000 MAM Case Studies

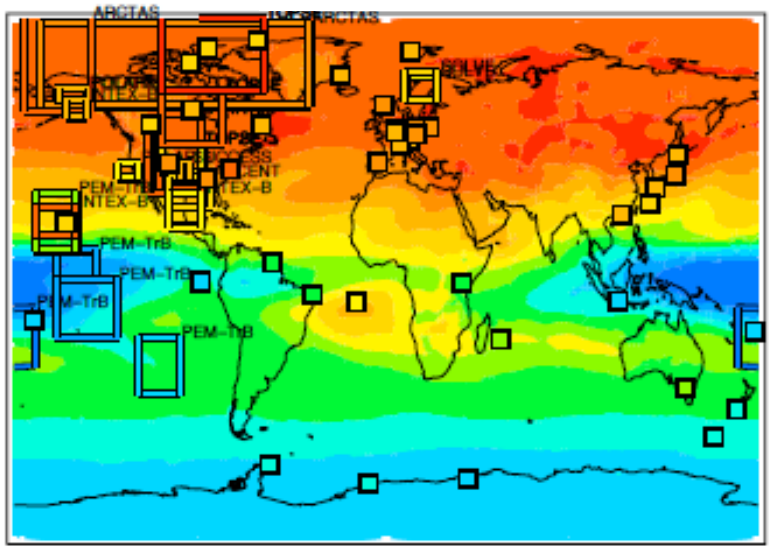
For CAM5Chem, Aerosols/Chemistry interaction
chemistry passes (SO_2, DMS, H_2SO_4) to MAM

Comparisons between CAM4Chem and CAM5Chem

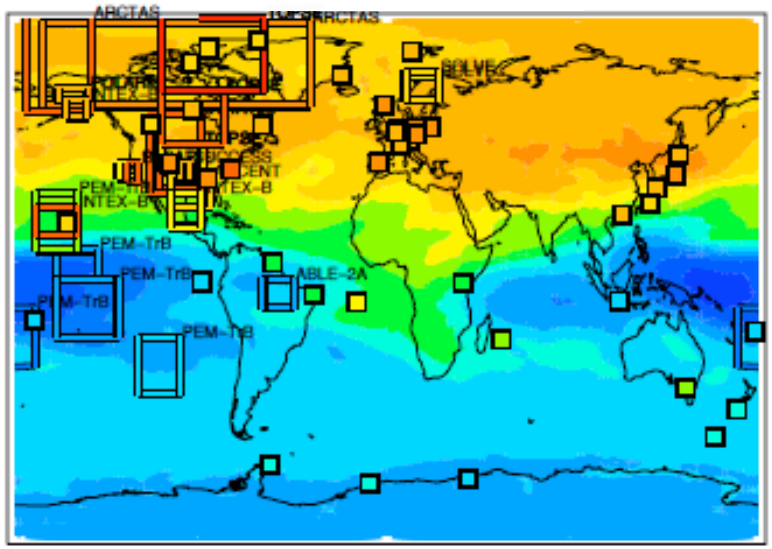
2-5 km average

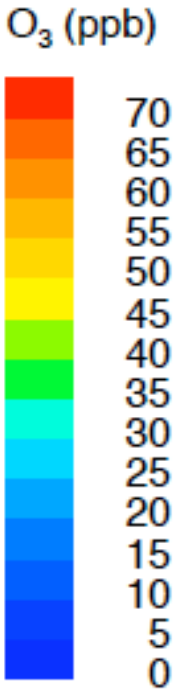
Ozone

CAMChem4



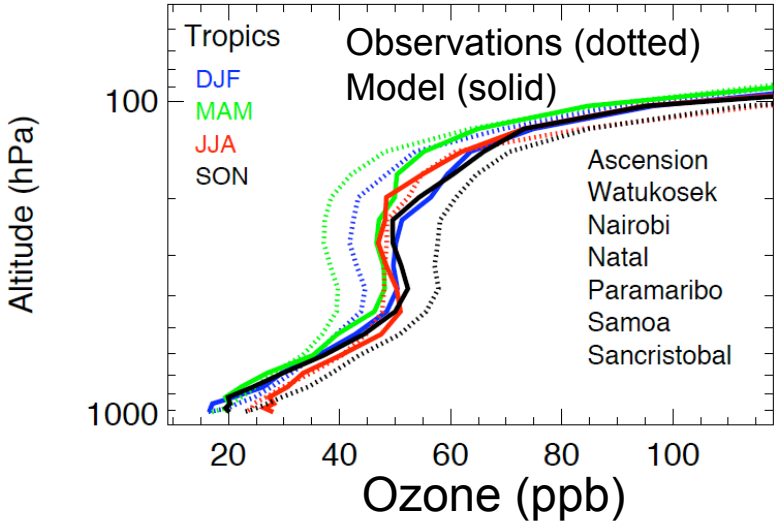
CAMChem5



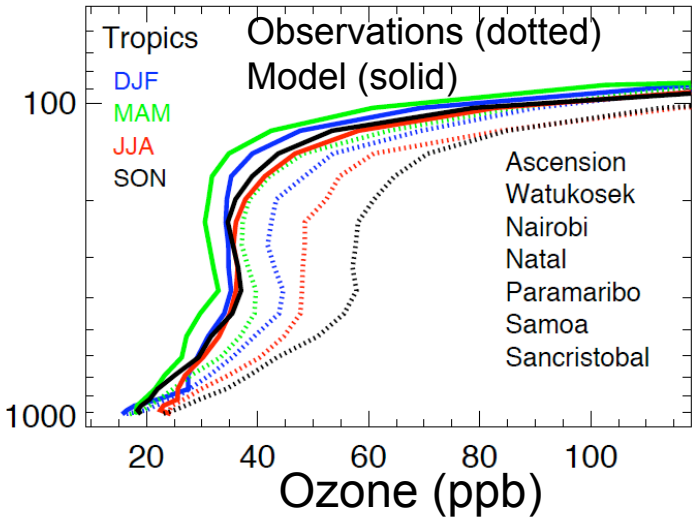


Tropics 20°N-20°S

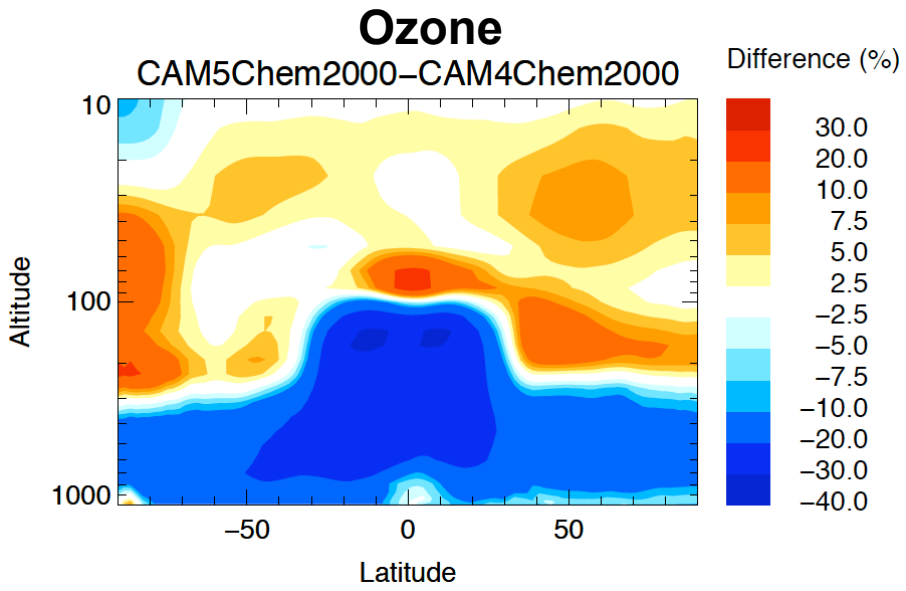
CAMChem4

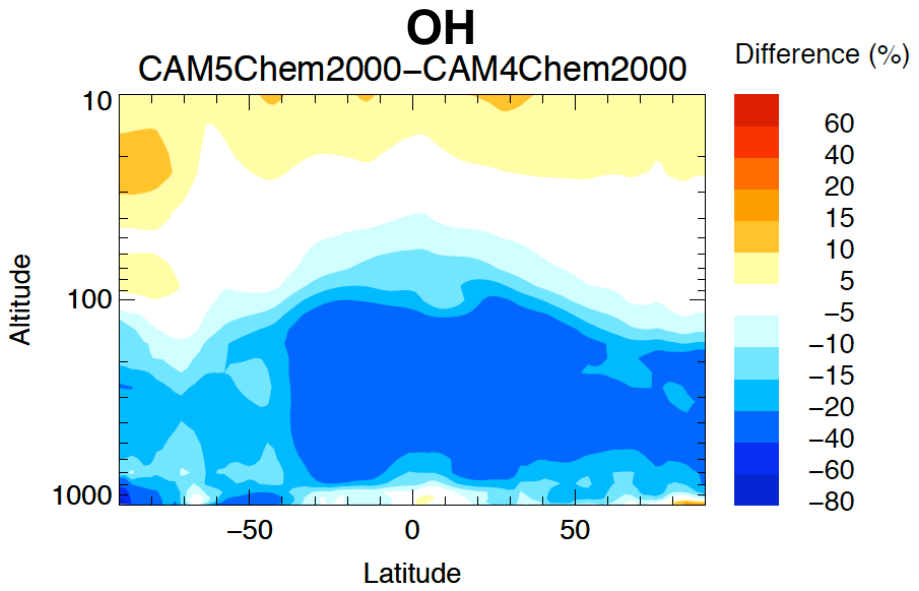


CAMChem5



Comparison between CAM4Chem and CAM5Chem



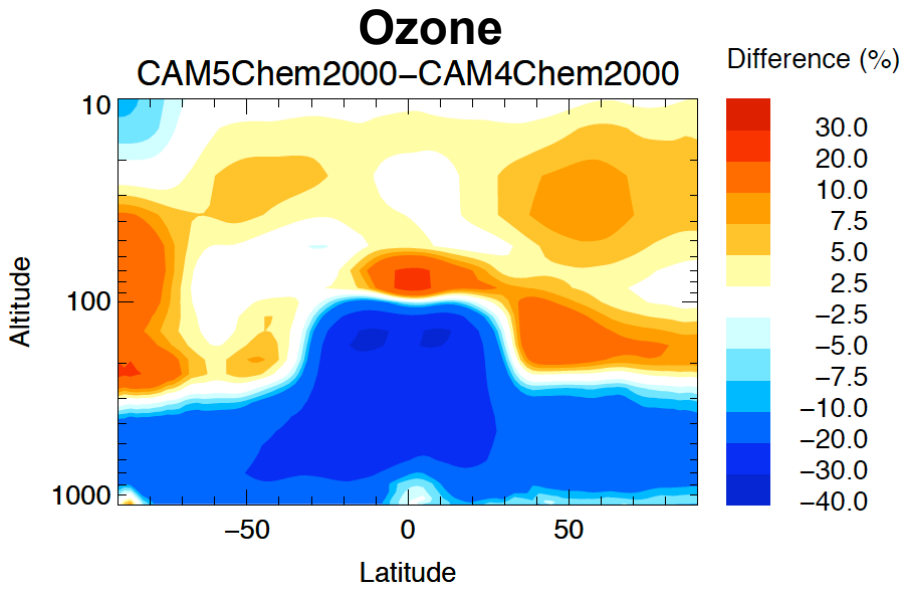


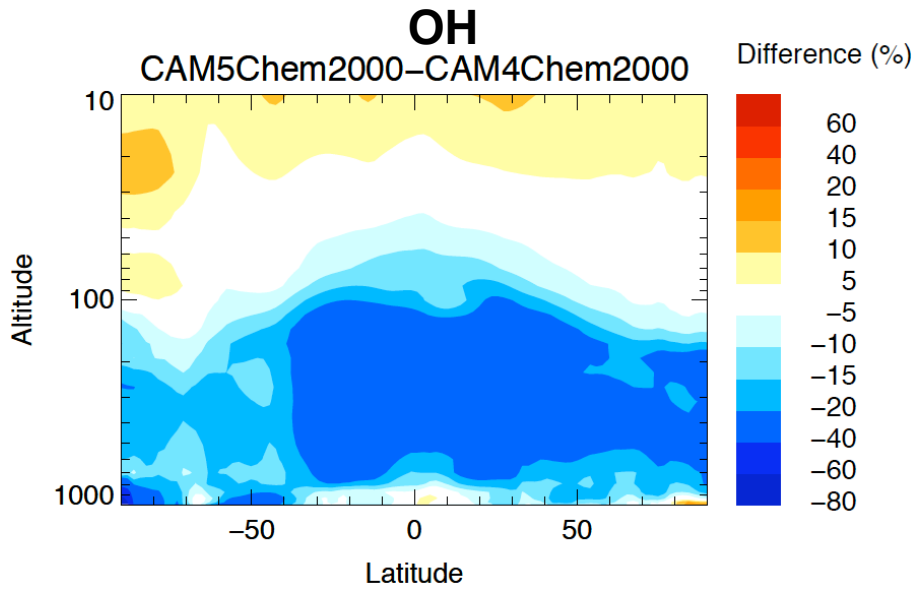
CH_4 Lifetimes:

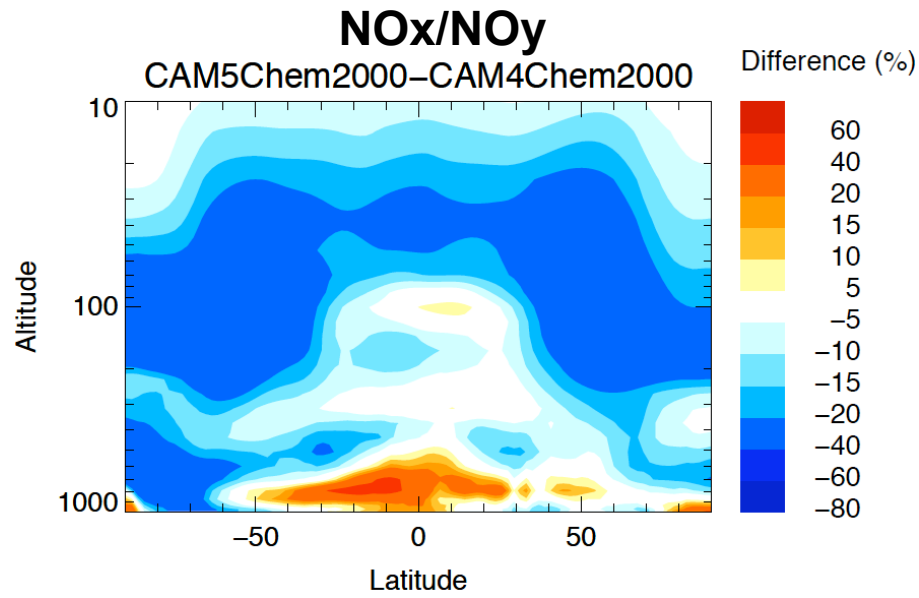
CAM4Chem: 8.4

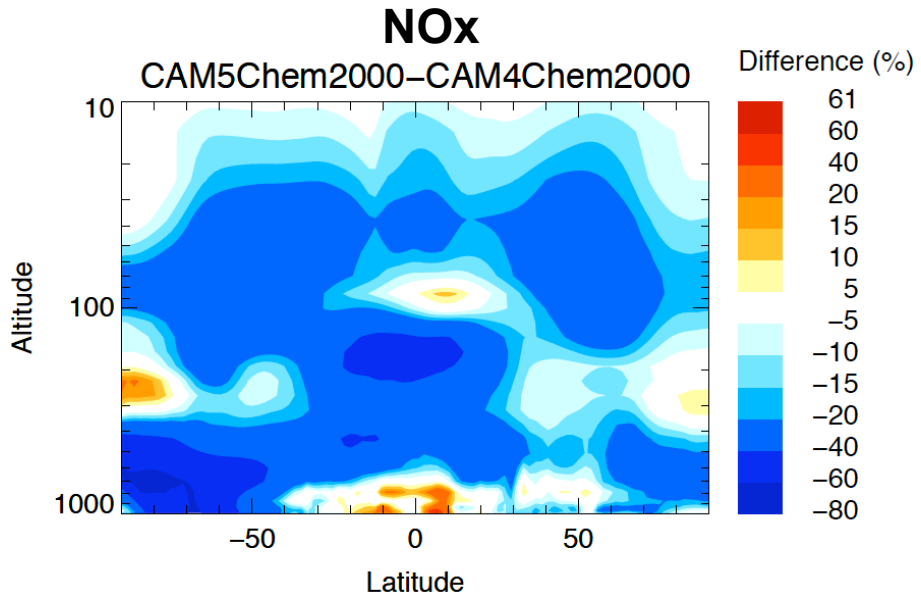
CAM5Chem: 10.2

Comparison between CAM4Chem and CAM5Chem



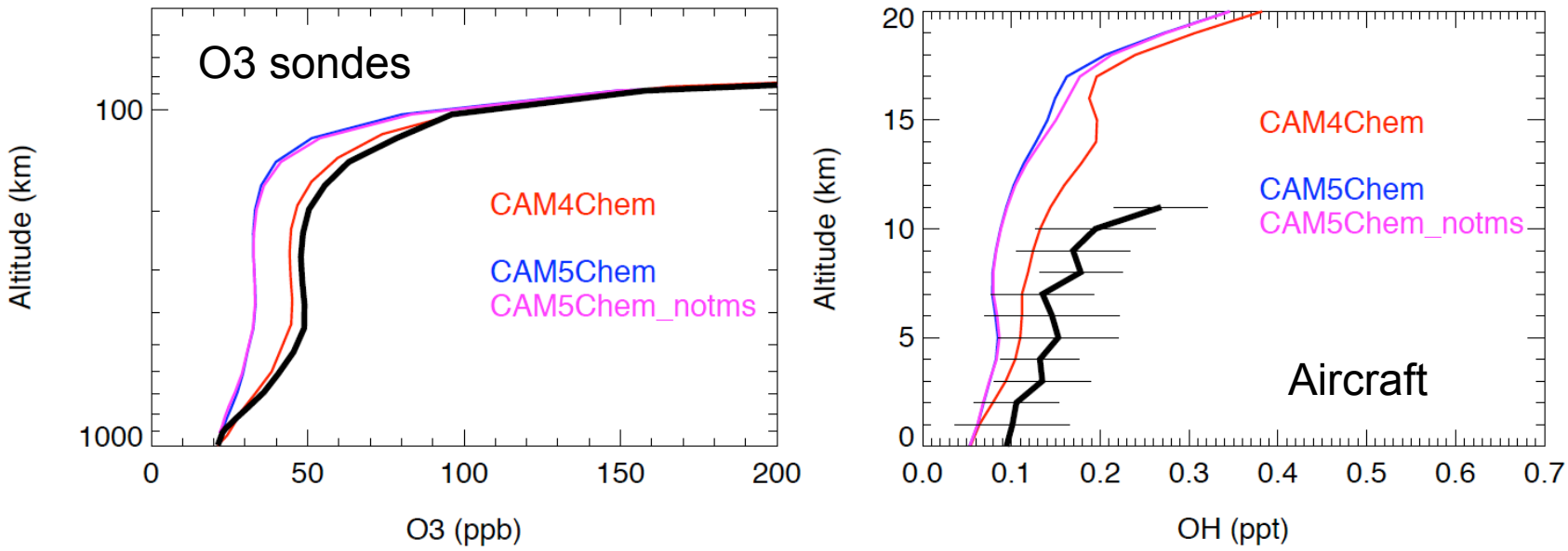






Comparison between CAM4Chem and CAM5Chem

Tropics 20°N-20°S

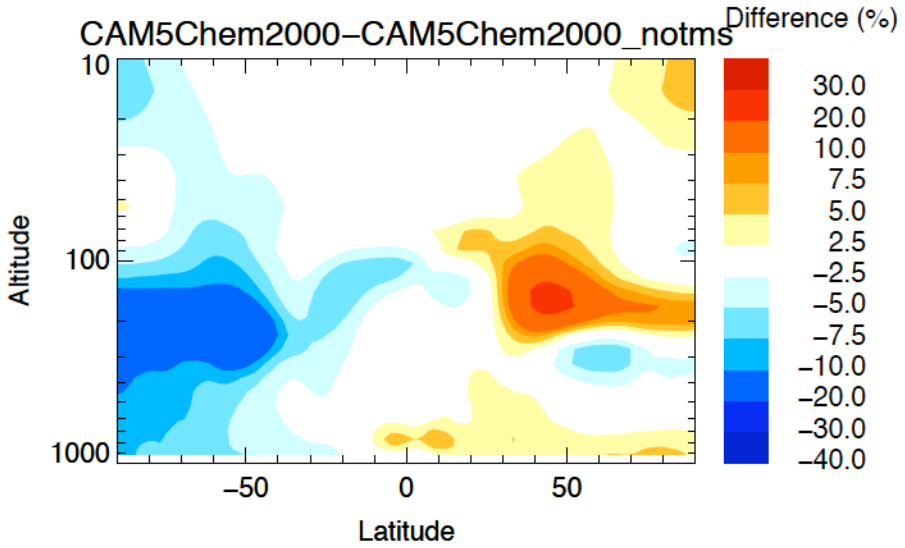


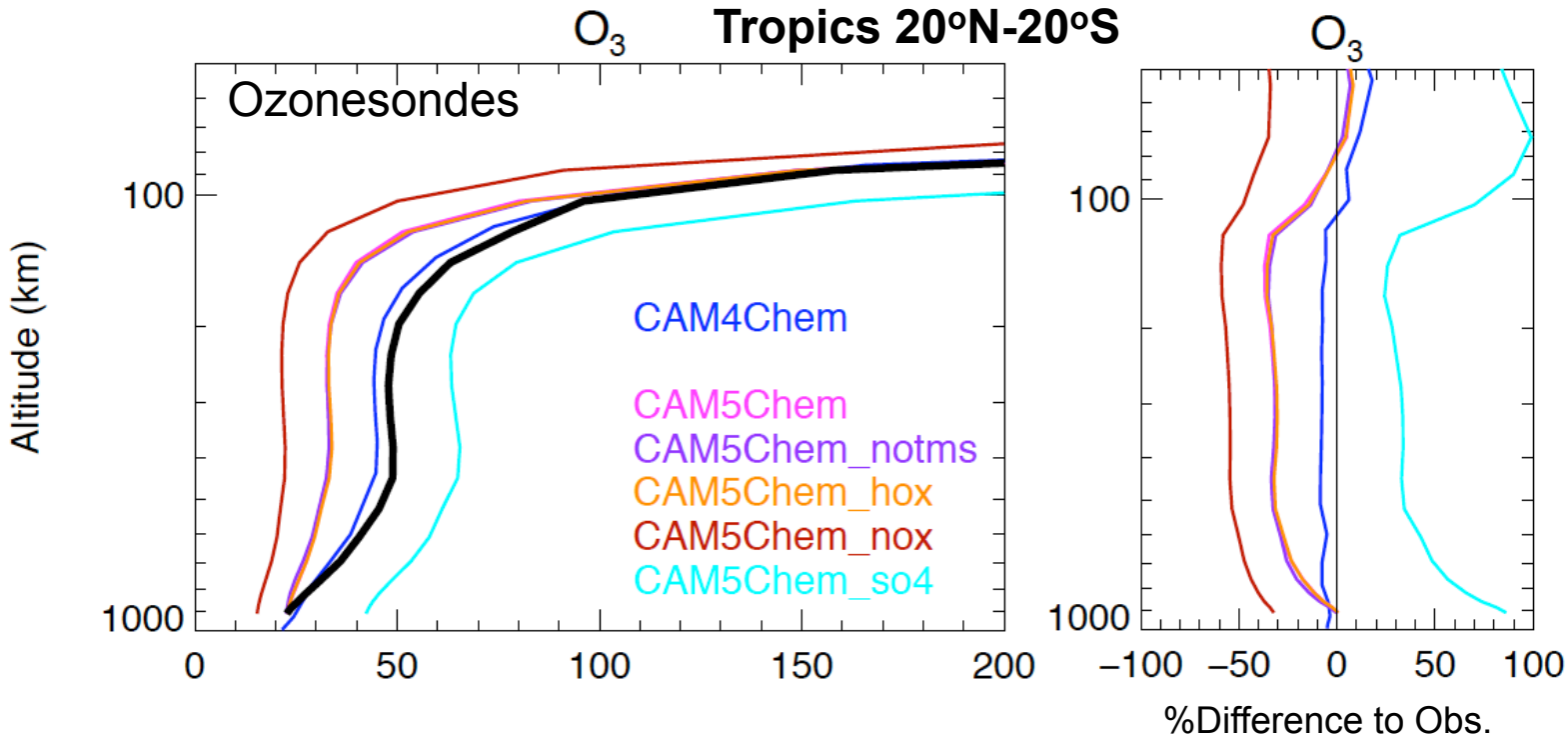
CH_4 Lifetimes:

CAM4Chem: 8.4

CAM5Chem: 10.2

CAM5Chem noTMS: 10.0



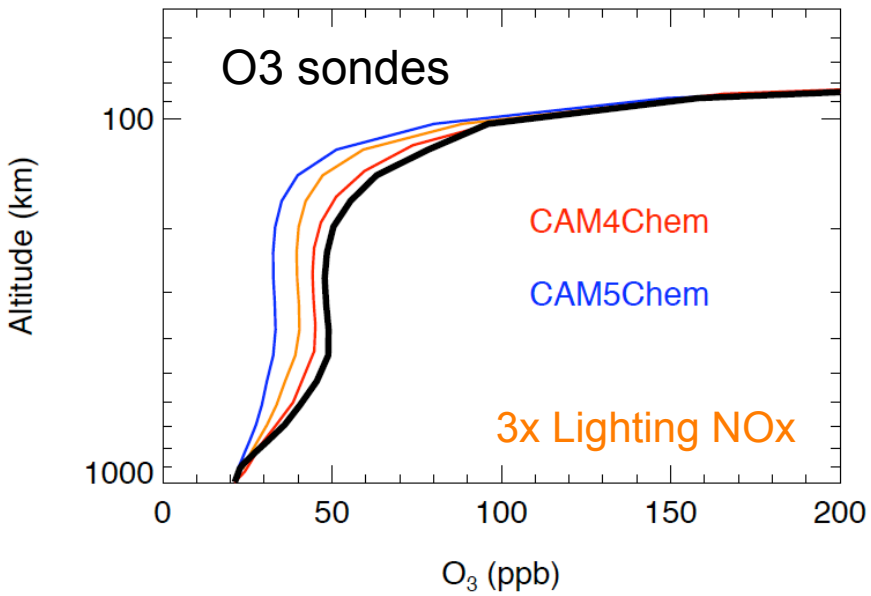


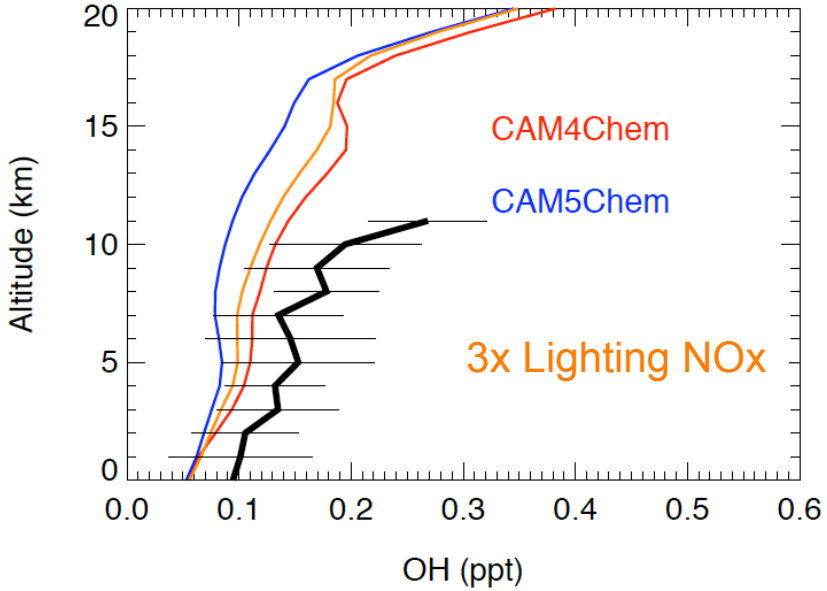
Case studies: CAM5Chem 2000 MAM

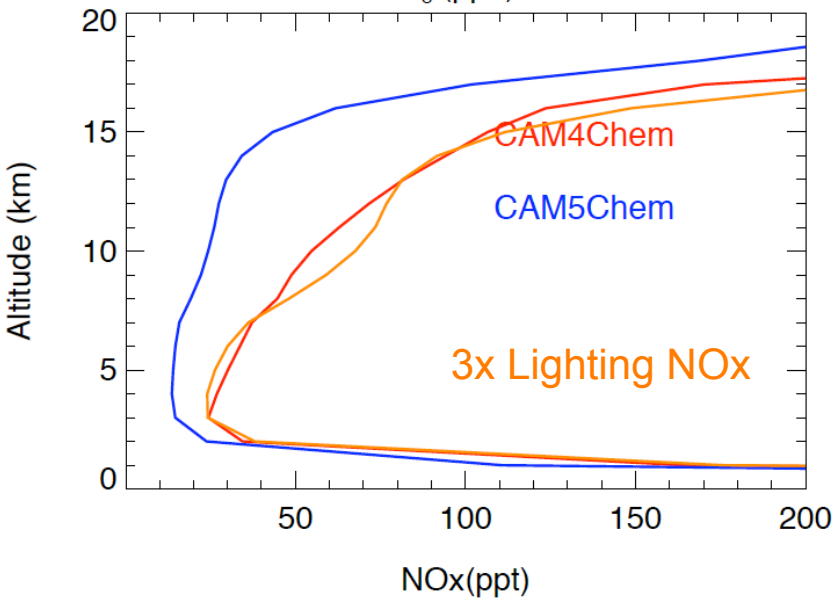
- ❑ no HO_2 reaction on aerosols (CAM5Chem_hox)
  HO_2 -> $0.5H_2O_2$
- ❑ no NOx, N_2O_5 reactions on aerosols (CAM5Chem_nox)
  N_2O_5 -> 2 * HNO_3
  NO_3 -> HNO_3
  NO_2 -> 0.5*OH + 0.5*NO + 0.5*HNO_3

Impact of Lightening NOx

Tropics 20°N-20°S







CH_4 Lifetimes:

CAM4Chem: 8.4

CAM5Chem: 10.2

CAM5Chem L-NOx: 9.2

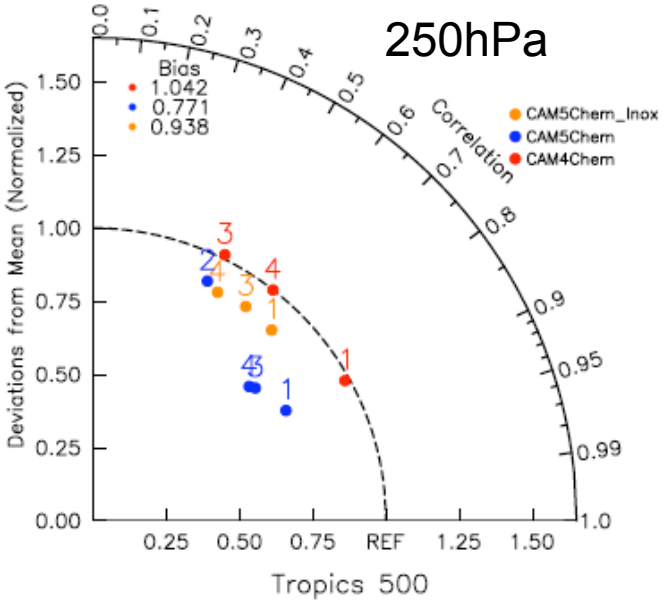
Lightening NOx (TgN/y):

CAM4Chem: 3.5-4.5

CAM5Chem: 1.5-2.5

CAM5Chem L-NOx: 3 - 6

Comparisons to Ozonesondes



Tropics

1: NH SubTropics
2: W-Pasific/E-Indian
3: equ. Americas
4: Atlantic / Africa

CAM4Chem
CAM5Chem
CAM5Chem L-NOx

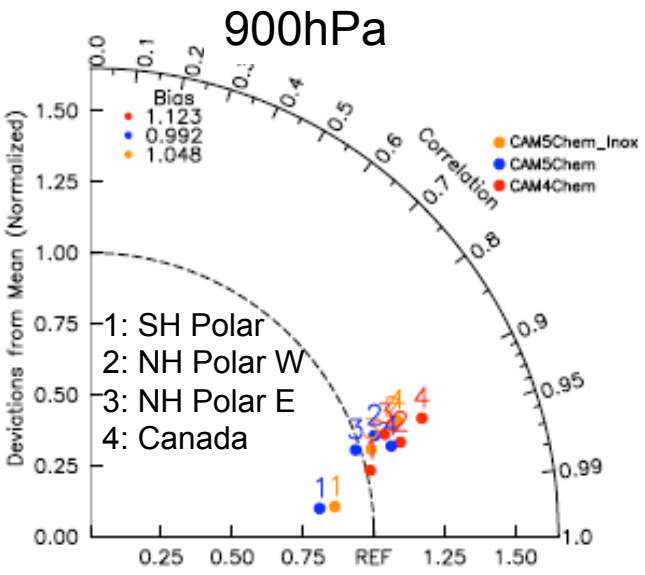
Improved Ozone in the Tropics if adding 3x more lightening NOx to CAM5Chem.

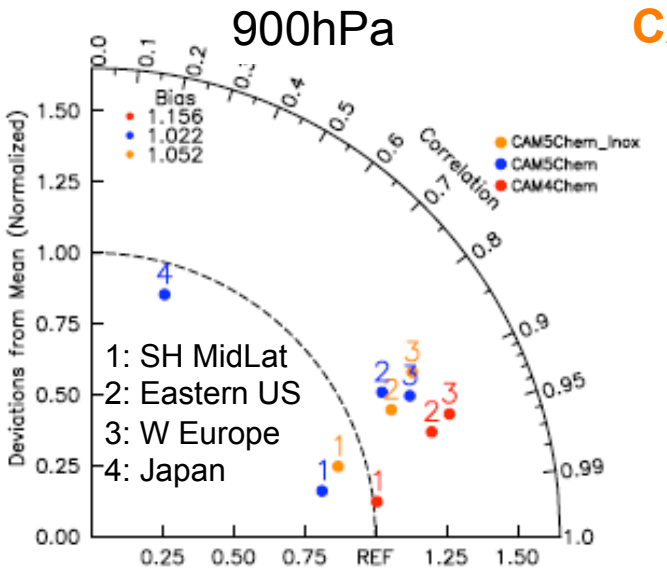
Comparisons to Ozonesondes

High Latitudes

Mid-Latitudes

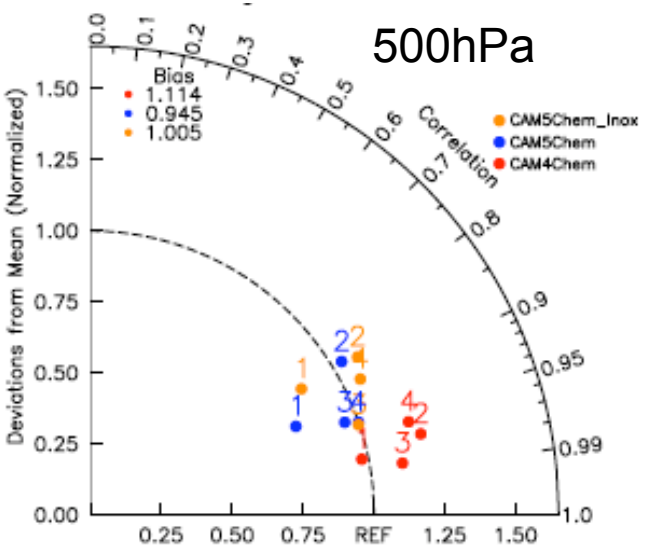
CAM4Chem
CAM5Chem
CAM5Chem L-NOx

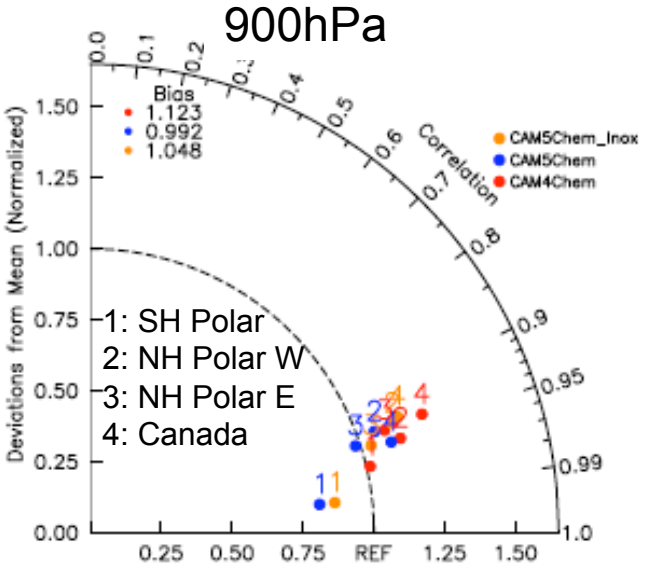




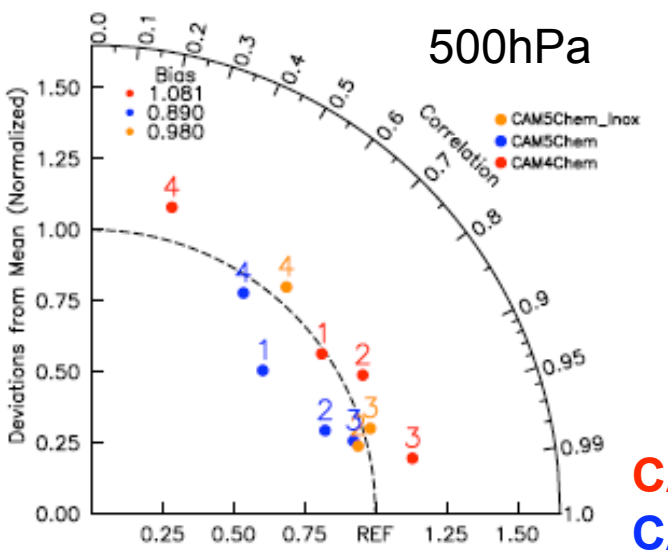
Comparisons to Ozonesondes

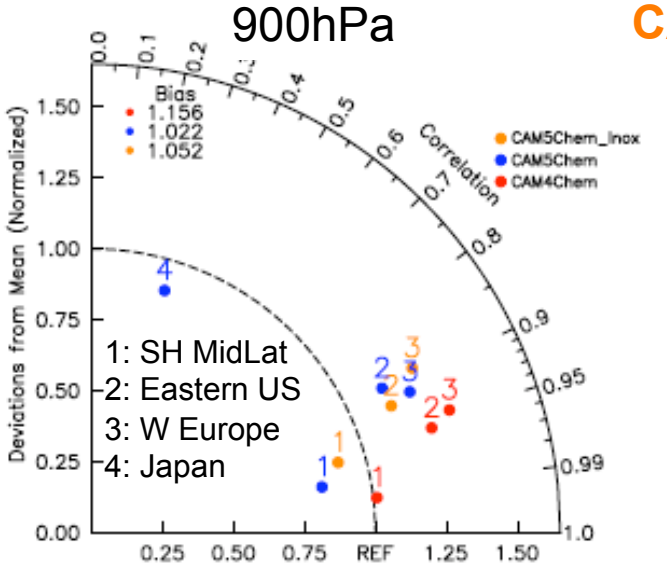
High Latitudes





Mid-Latitudes

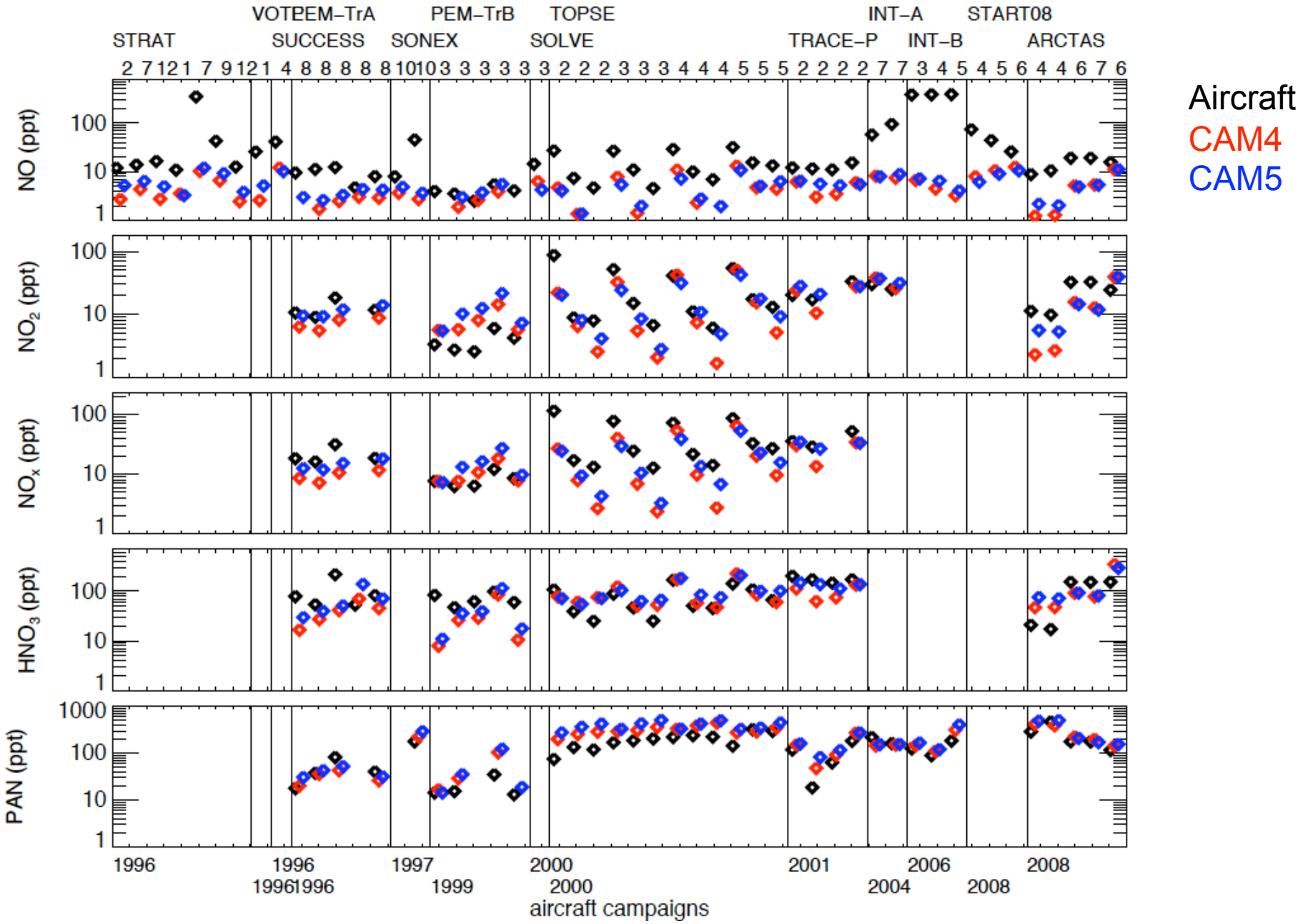




CAM4Chem
CAM5Chem
CAM5Chem L-NOx

Ozone underestimated at 250hPa

Comparison to Aircraft observations: 2-6km average



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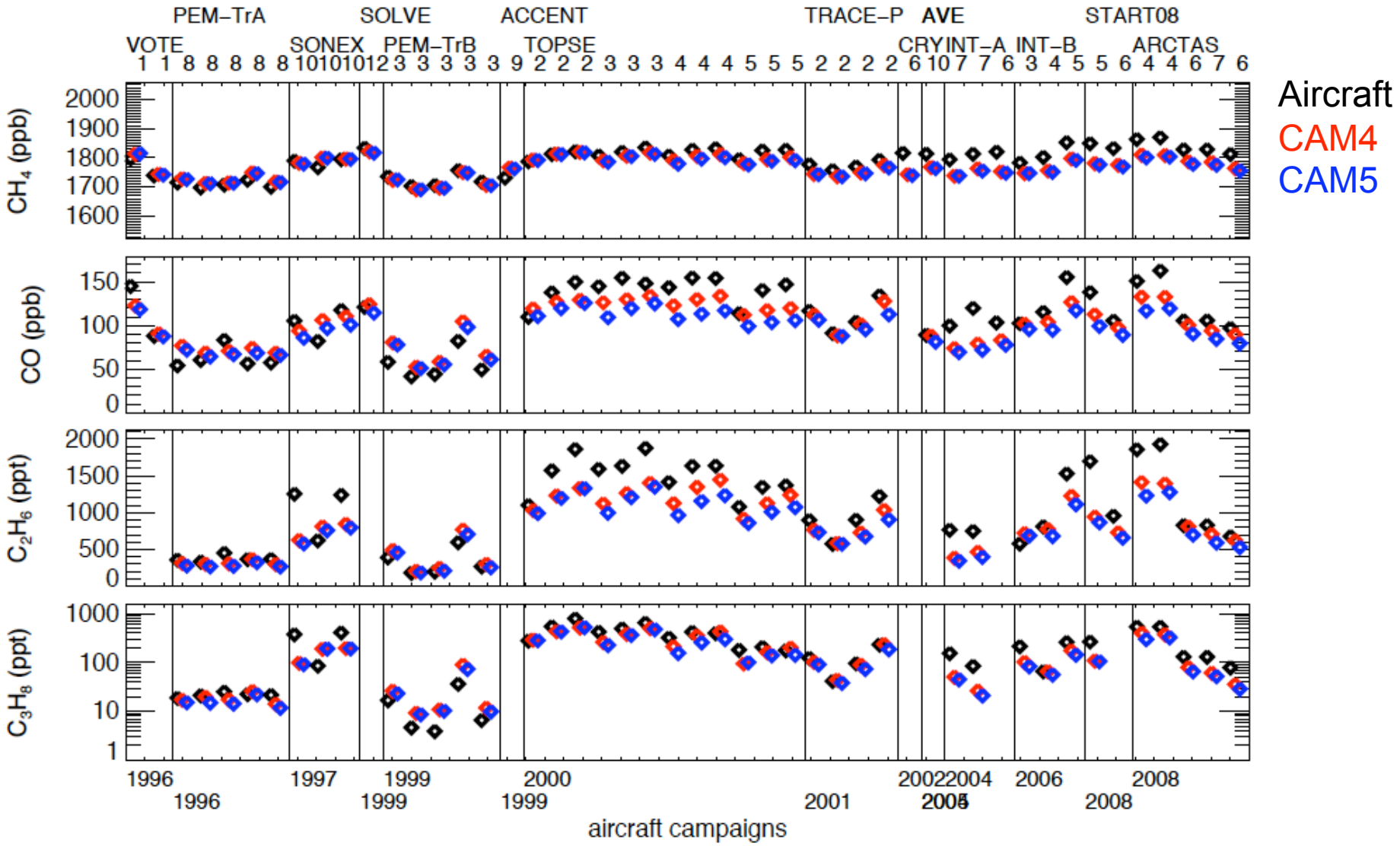

Conclusions

- Representation of clouds more reasonable in CAM5
- Significant temperature changes if adding chemistry, cooler surface temperatures
- NOx/NOy decrease in the stratosphere due to aerosols, which leads to more ozone
- CAM5 Chemistry much improved (even to CAM4 in the Tropics) if adding 3x more lightening NOx
- NOx still too low in mid/high latitudes (compared to aircraft)
- NOx too low, PAN too high in mid/high latitudes in the model
- Ethane and CO underestimated in mid/high latitudes