CAM4/CAM5 Comparison

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- ❑ Introduction
- ❑ Ozone Comparison
- ❑ Aircraft Climatology
- ❑ OH
- ❑ Aerosols

Simone Tilmes, Chemistry-Climate Working Group Meeting, 29 February 2012

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The Community Atmospheric Model (CAM)

Model	CAM3	CAM4	CAM5
Release	**June 2004**	**April 2010**	**June 2010**
Shallow Convection	Hack (1994)	Hack (1994)	Park et al. (2009)
Deep Convection	Zhang and McFarlane (1995)	Neale et al. (2008)	Neale et al. (2008)
Microphysics	Raschand Kristjansson(1998)	Rasch and Kristjansson (1998)	Morrison and Gettelman(2008)
Macrophysics	Rasch and Kristjansson (1998)	Rasch and Kristjansson (1998)	Park et al. (2011)
Radiation	Collins et al. (2001)	Collins et al. (2001)	Iaconoet al. (2008)
Aerosols	Bulk Aerosol Model	Bulk Aerosol Model BAM	Modal Aerosol Model Ghan et al. (2011)
Dynamics	Spectral	Finite Volume	Finite Volume

= New parameterization/dynamics

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Compsets	Model (phys)/ radiation	Chemistry	Components / Meteorology
B_2000_TROP_MOZART (BMOZ) F_2000_TROP_MOZART (FMOZ)	CAM4, active CAM4, passive	trop_mozart trop_mozart	All active Prescr. ocn/ice, CLM dry dep
F_2000_MOZMAM (FMOZMAM) F_2000_STRATMAM_TSC (FMOZMAM) F_SD_MOZMAM (FSDMOZMAM)	CAM5, passive	trop_mozart trop/ strat_mozart trop_mozart	 GEOS5 (56lev)
F_SD_CAMCHEM (FSDCHM) F_SD_BAM (FSDBAM) F_TROP_STRAT_CHEM (FTSC)	CAM4, passive CAM4, passive	trop_mozart trop_bam trop/strat_moz art	Prescr. ocn/ice, clm dry dep, offline: GEOS5 (56lev), CN-cycle Prescr. ocn/ice, clm dry dep, CN-cycle
B_2000_CN_CHEM (B2000CNCHM) B_1850_CN_CHEM (B1850CNCHM) F_1850_CN_CHEM (F1850CNCHM) B_1850-2000_CN_CHEM (B20TRCNCHM)	CAM4, active	super_fast_llnl	MEGAN VOC emis CLM dry dep, land nitrogen cycle

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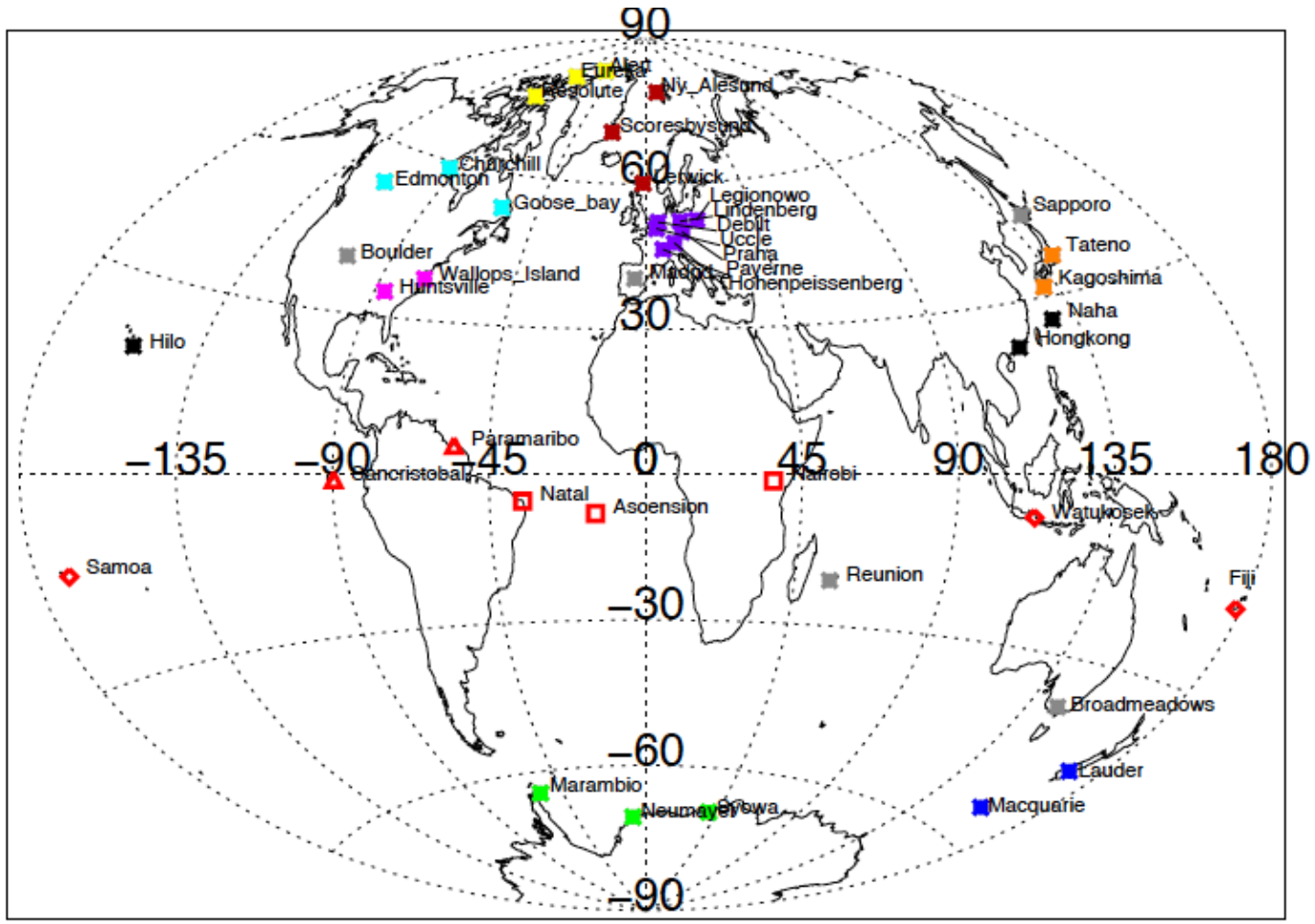
Simulations

- **CAM5Chem 2000**
  extended trop/start_mozart chemistry (12 years)
  RCP4.5 emissions, TMS turned on

- **CAM4Chem 2000-2006**
  extended trop/strat_mozart chemistry + VSLspecies
  POET/GFED emissions, TMS turned off

Ozone Climatology



- NH polar West
- NH polar East
- Canada
- US
- Western Europe
- Japan
- NH Subtropics
- W–Pacific/E–India
- equat.Americas
- Atlantic/Africa
- SH mid–lat
- SH polar

Tilmes et al., ACPD 2011

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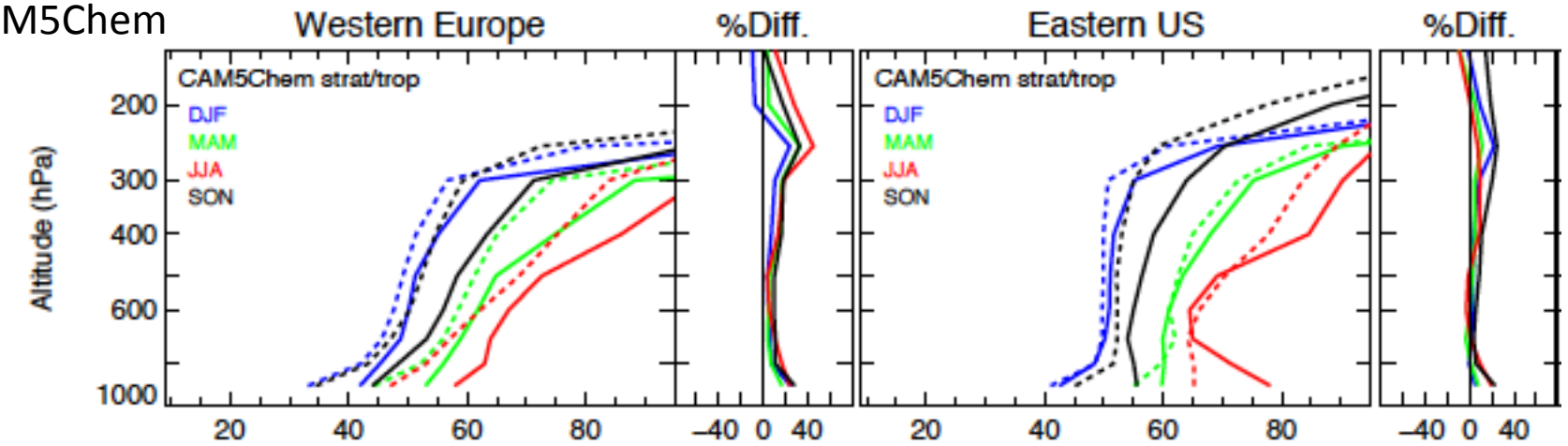
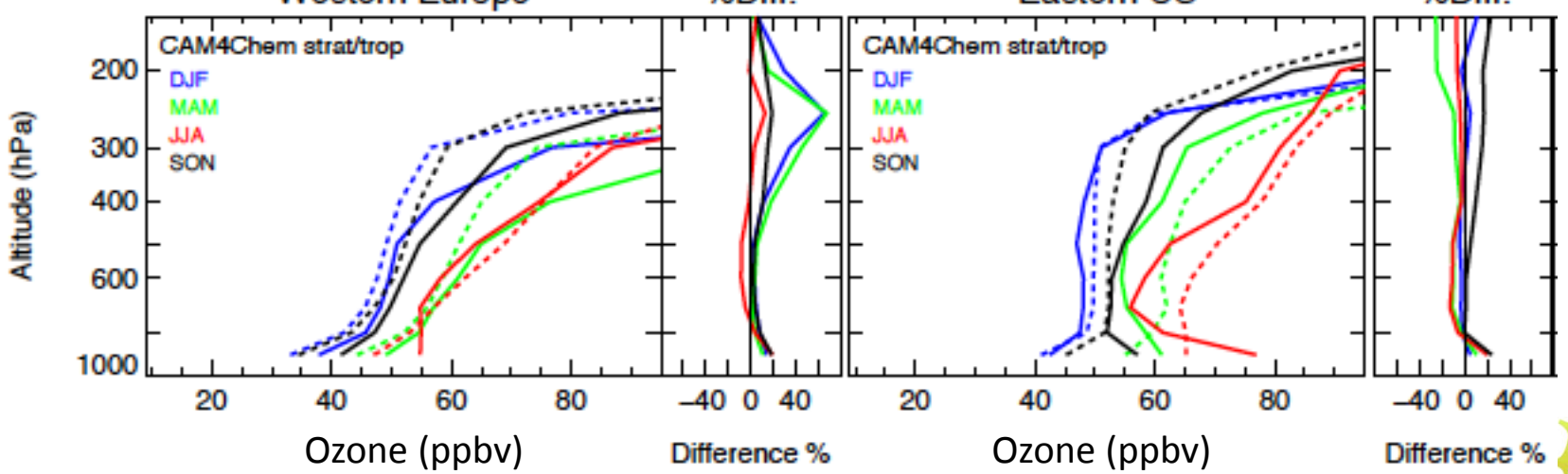
Comparison of Ozone Profiles: Model (solid), Data (dashed)

CAM5Chem



CAM4Chem



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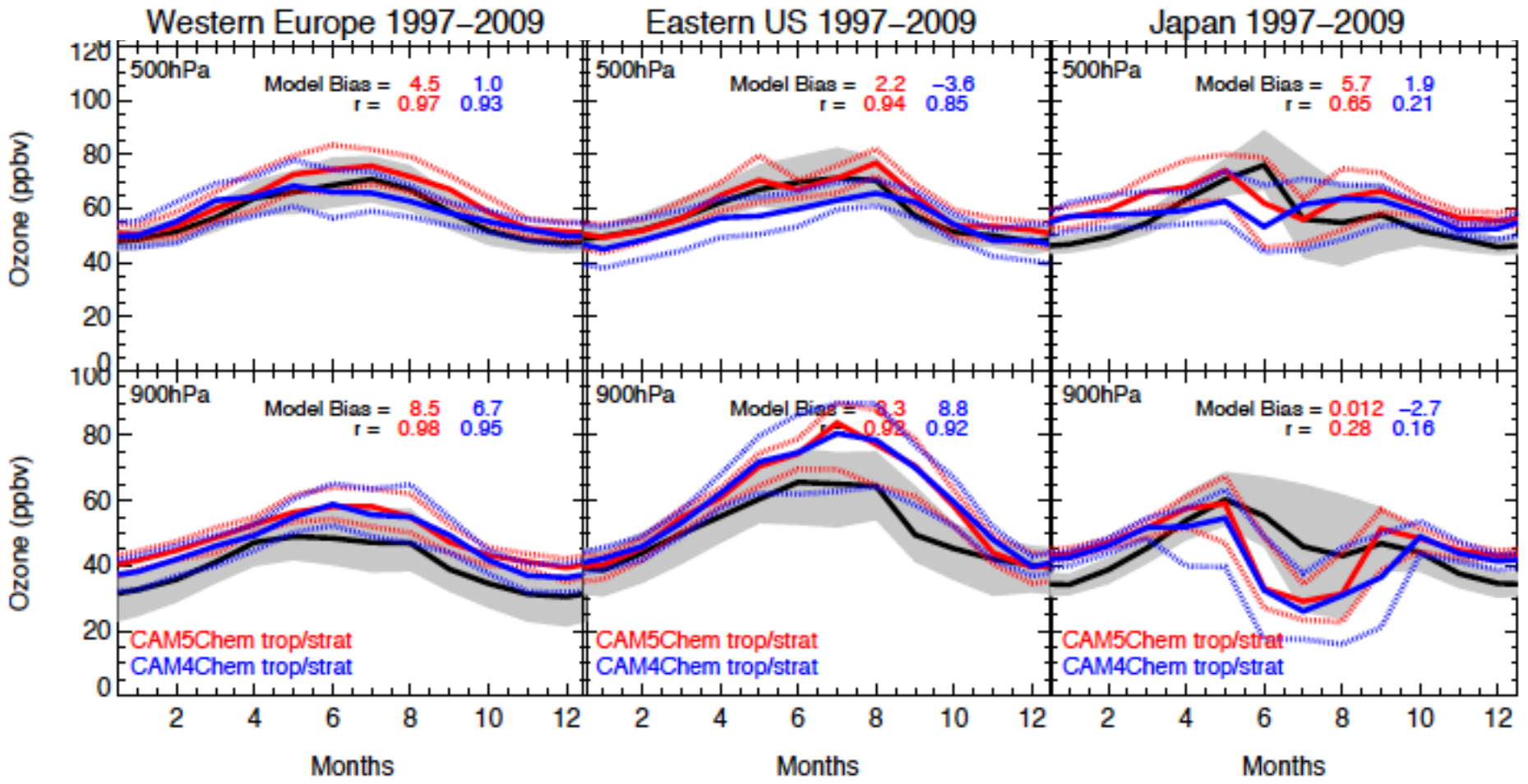
Seasonal Cycles: Data, CAM5Chem, CAM4Chem



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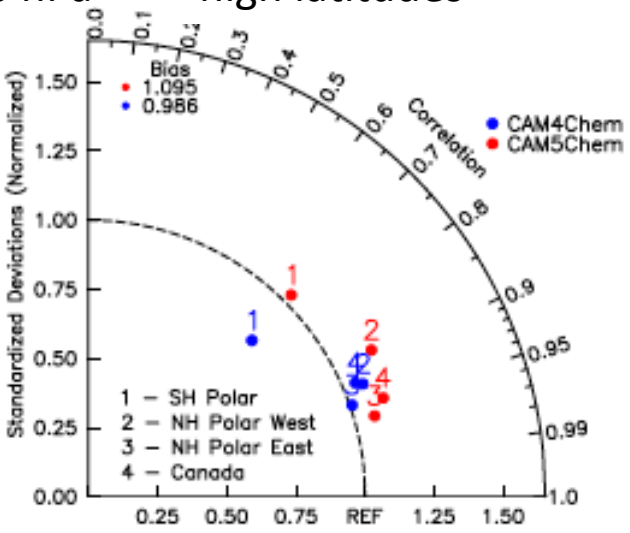
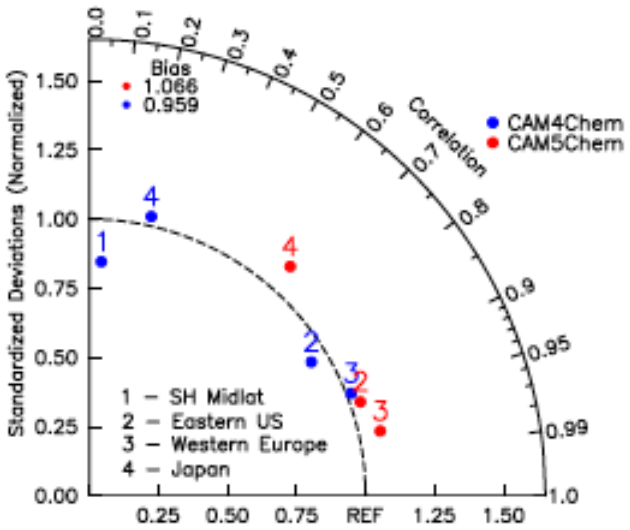
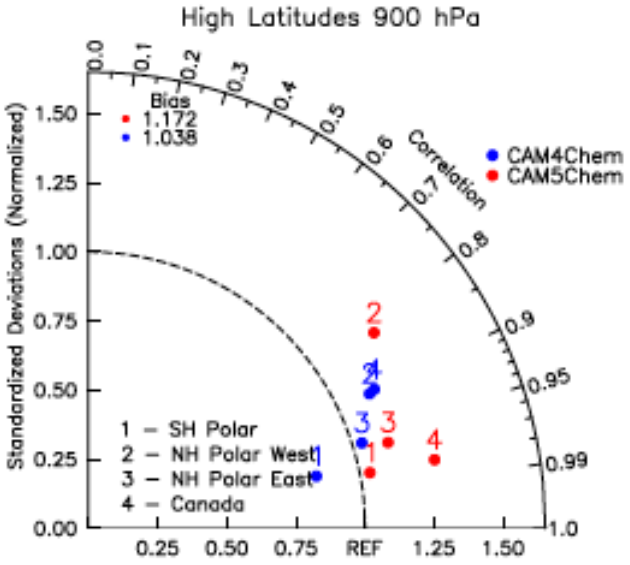
500 hPa high latitudes

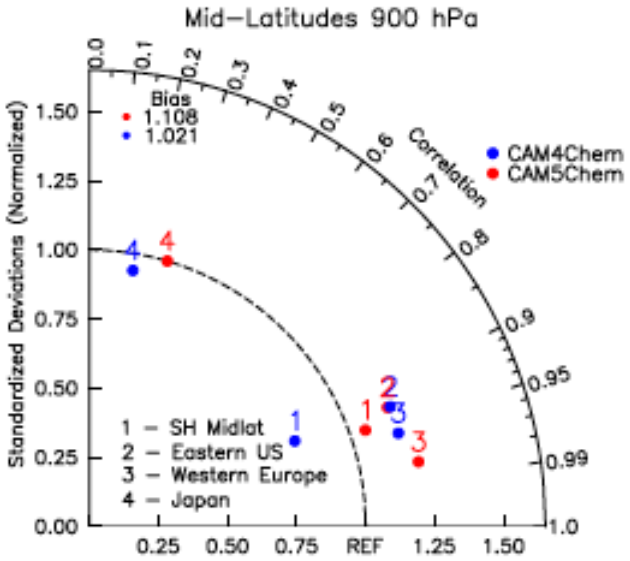


mid-latitudes



900 hPa





Normalized deviation from the observed annual mean

Versus

Correlation coefficient Between models and Observations (seasonality)

CAM5Chem

CAM4Chem

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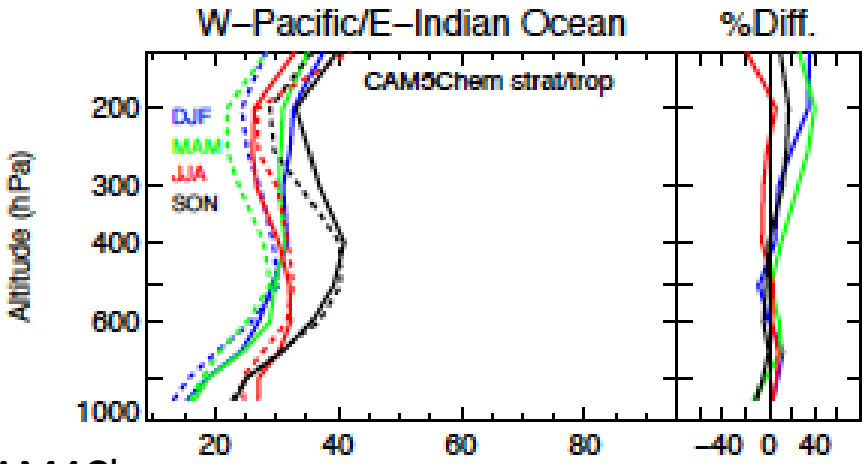
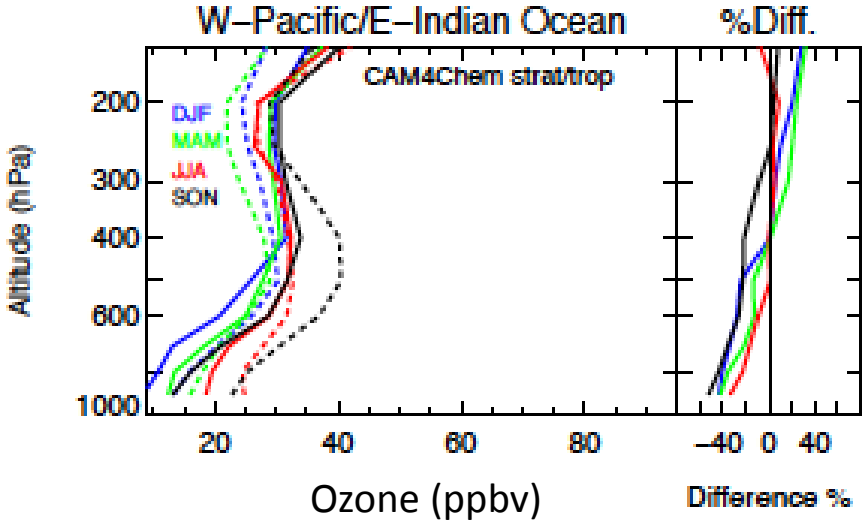
Model (solid), Data (dashed)

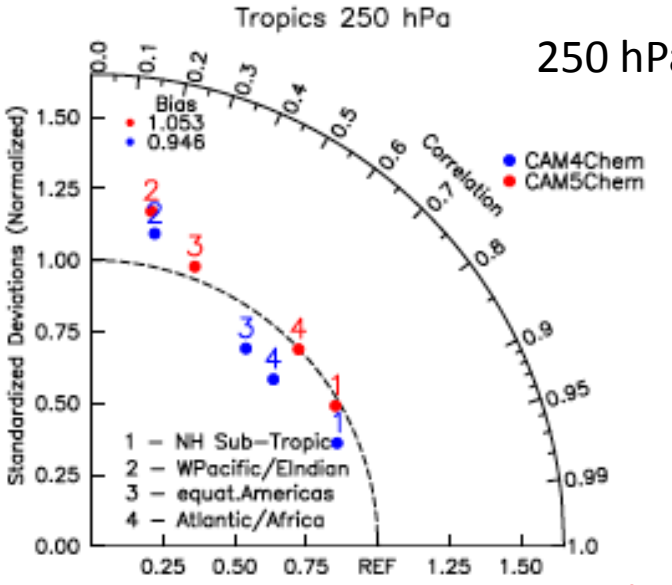
CAM5Chem



CAM4Chem



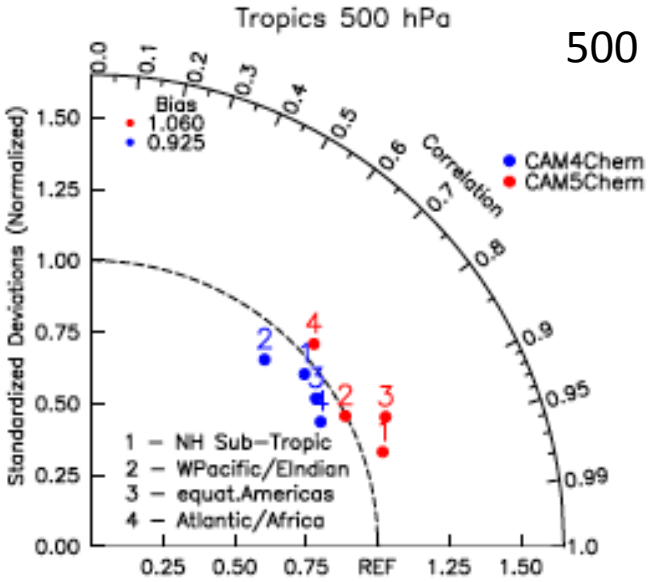
250 hPa



CAM5Chem

CAM4Chem

500 hPa



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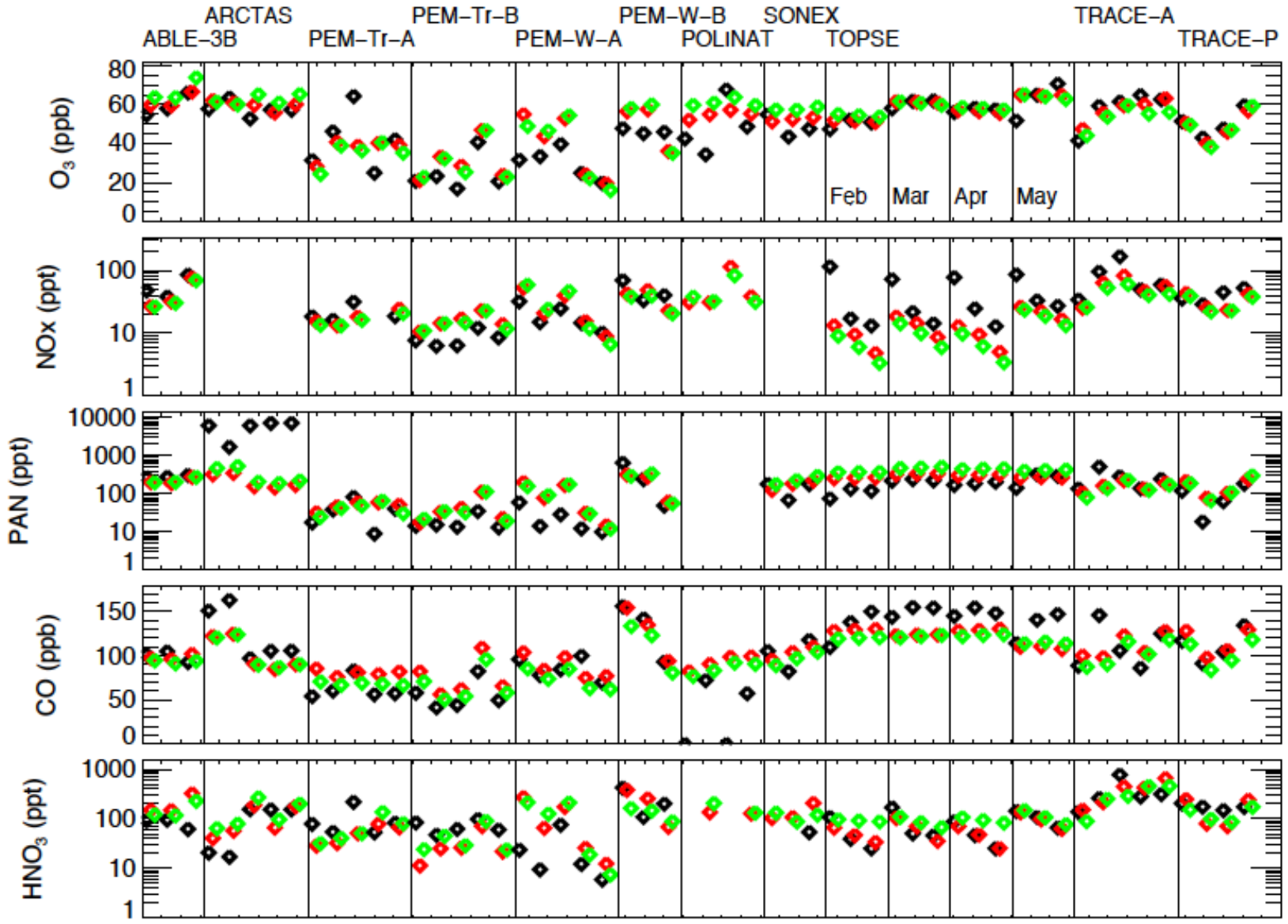
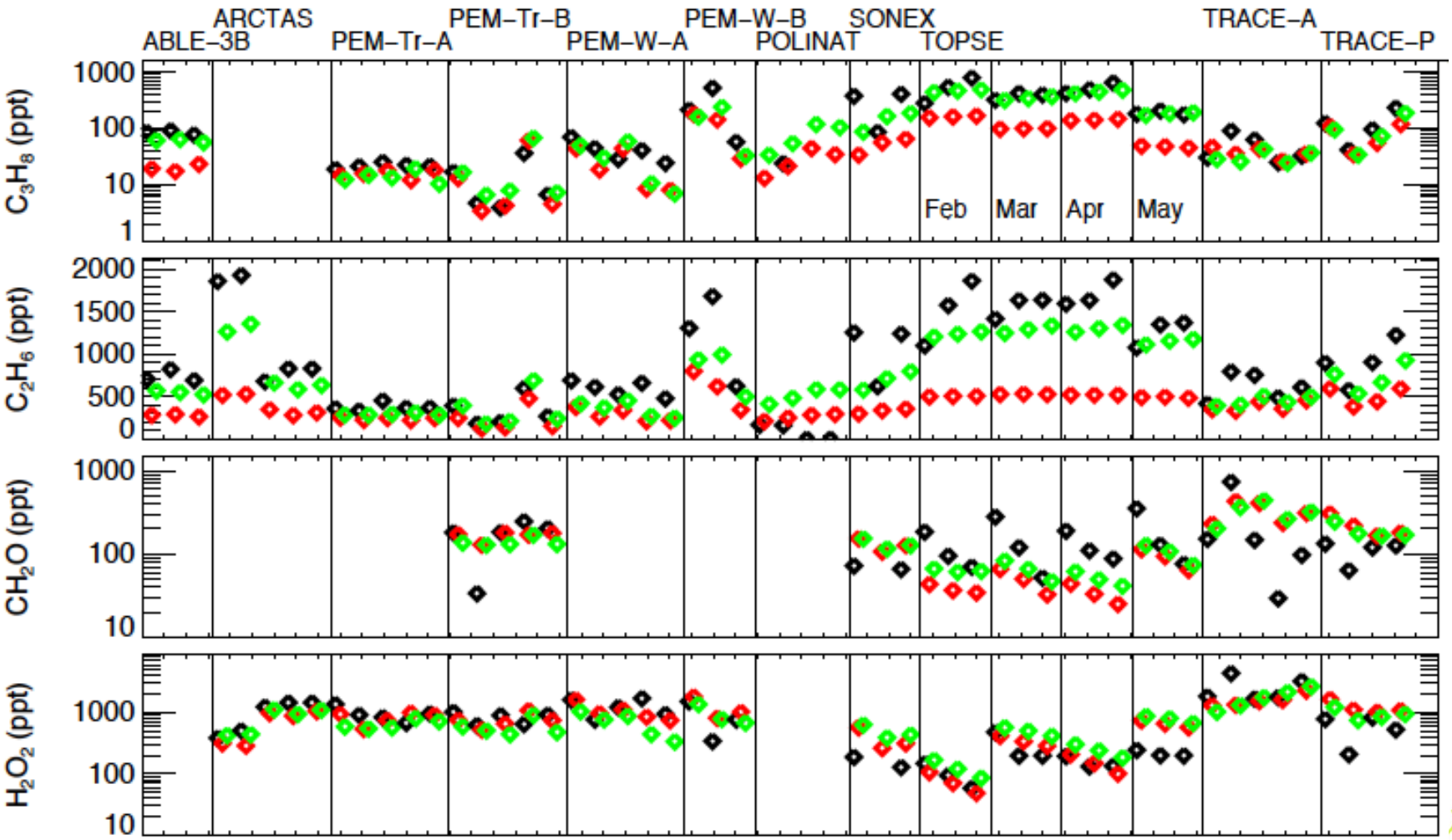
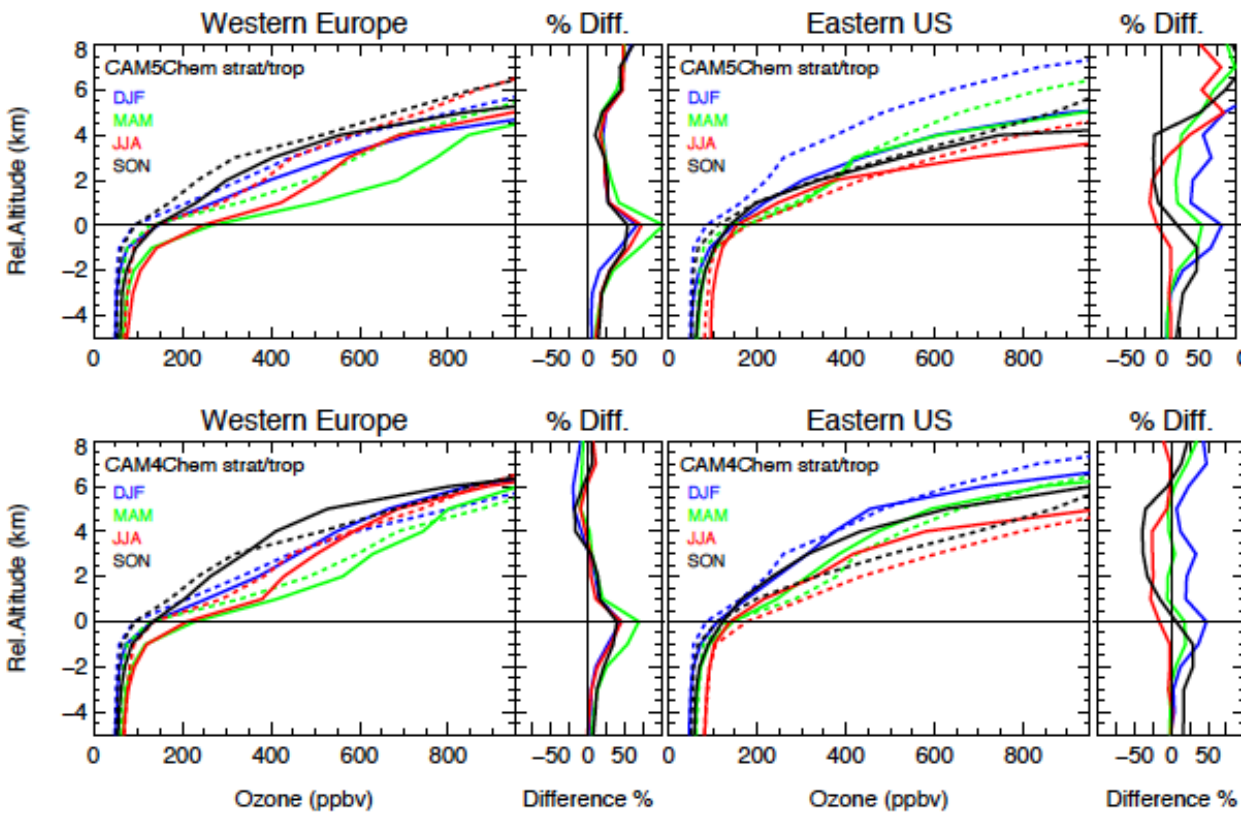


Aircraft
CAM5
CAM4

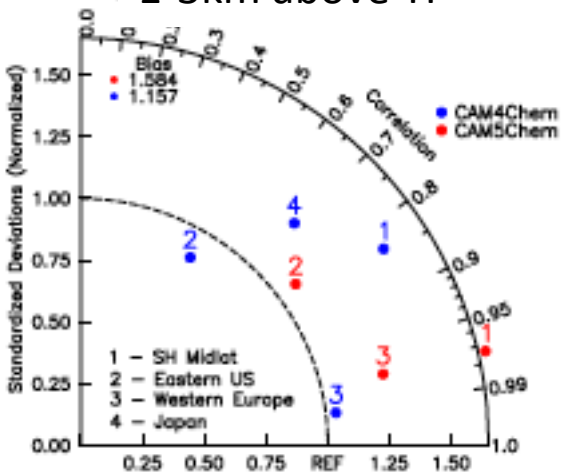
2-6km average


ABLE–3B
ARCTAS
PEM–Tr–A
PEM–Tr–B
PEM–W–A
PEM–W–B
POLINAT
SONEX
TOPSE
TRACE–A
TRACE–P
Feb
Mar
Apr
May
C_3H_8 (ppt)
C_2H_6 (ppt)
CH_2O (ppt)
H_2O_2 (ppt)
aircraft campaigns

UTLS Profiles: Model (solid), Data (dashed)



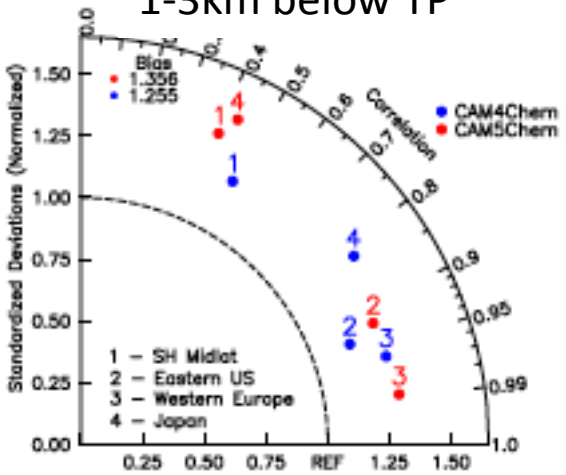
1-3km above TP



CAM5Chem

CAM4Chem

1-3km below TP



Ozone below the TP overestimated
Ozone in the LMS too high in CAM5

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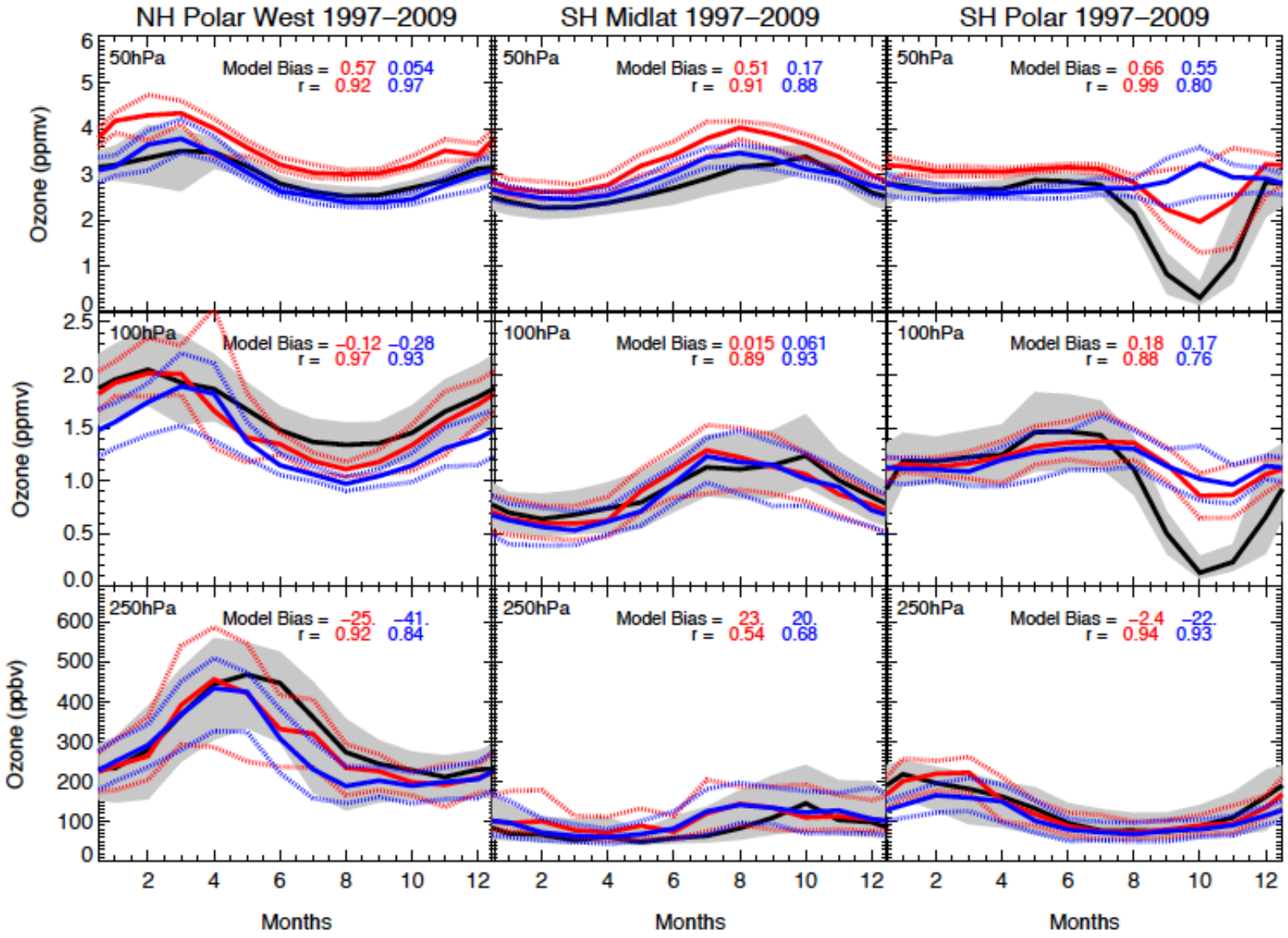
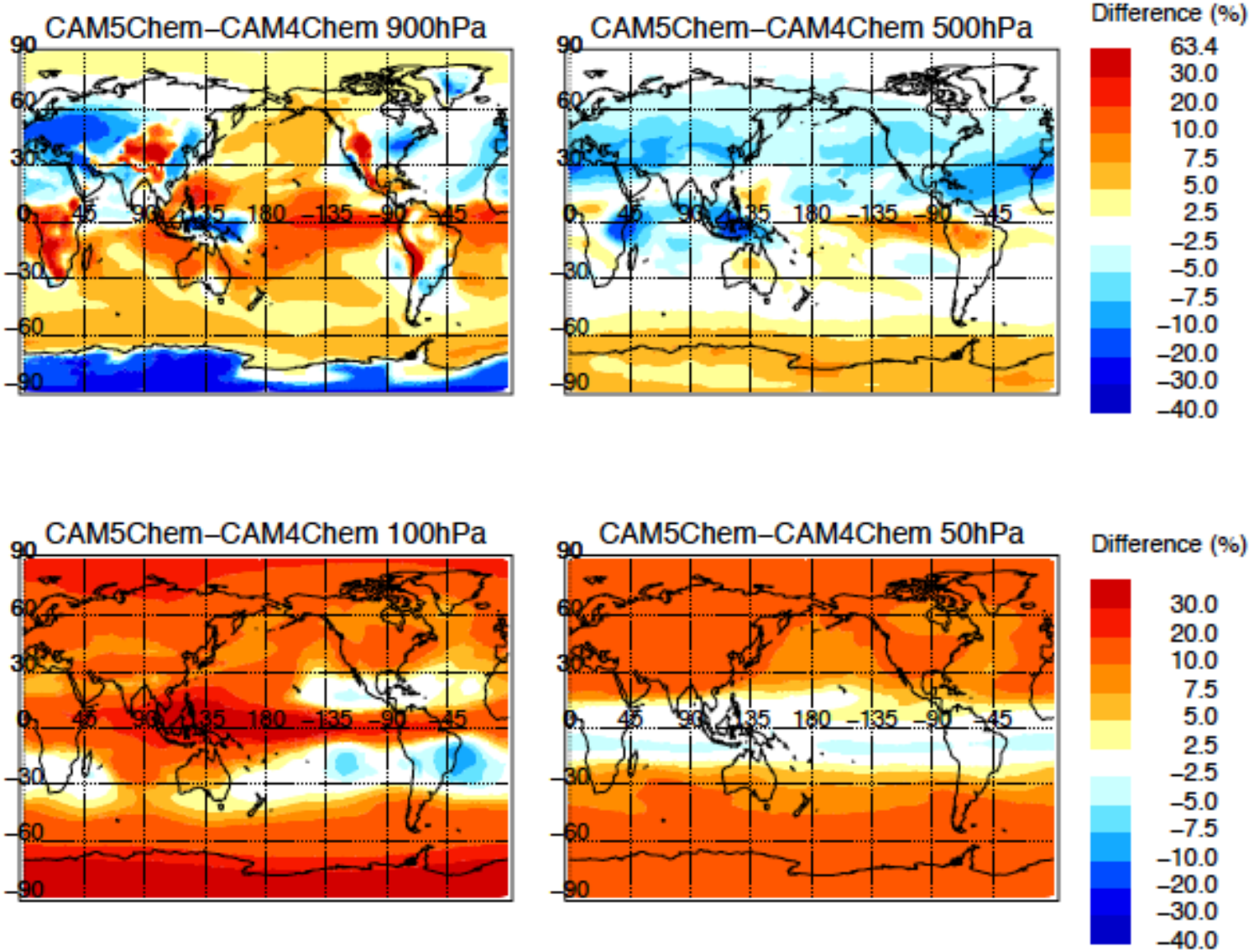
Seasonal Cycles: Data, CAM5Chem, CAM4Chem

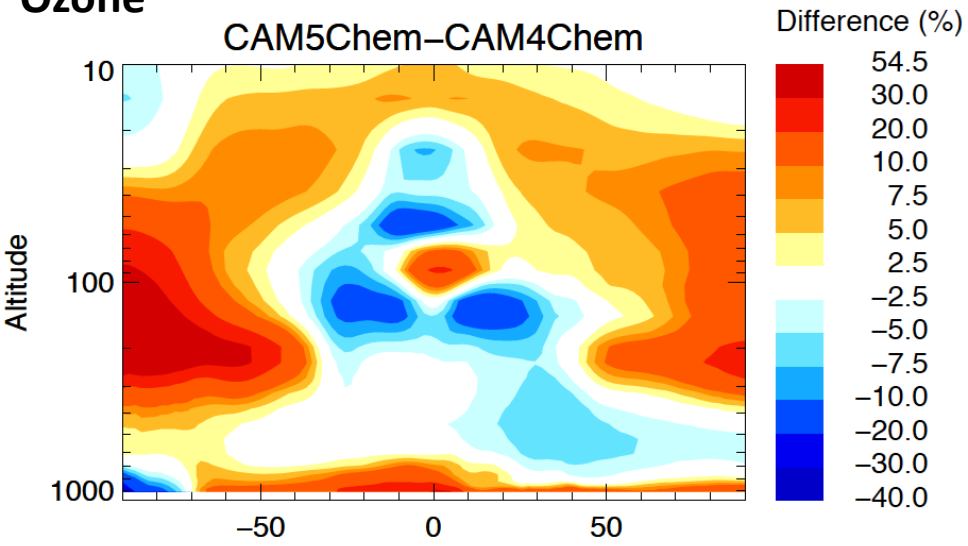


Ozone, CAM5Chem – CAM4Chem

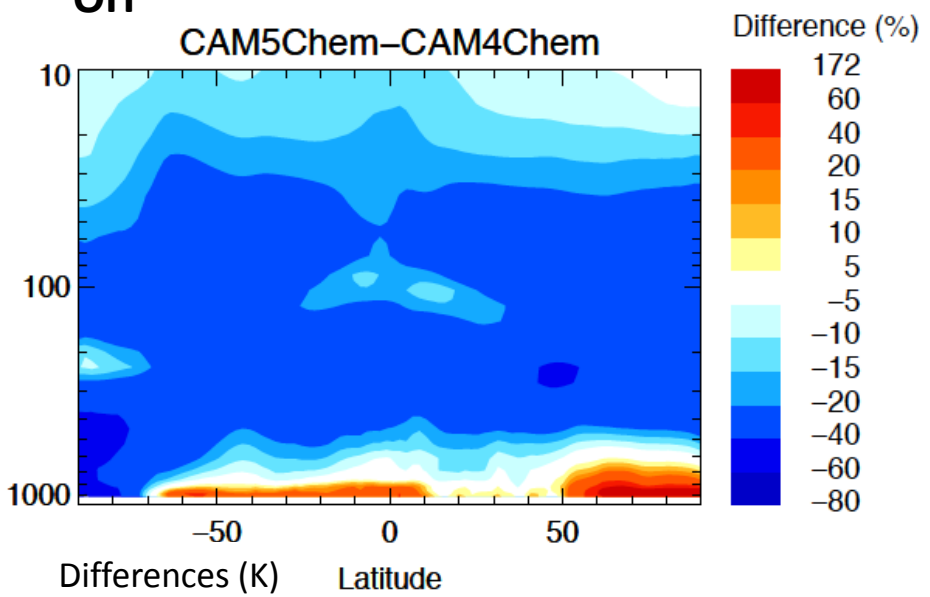


CAM5Chem – CAM4Chem

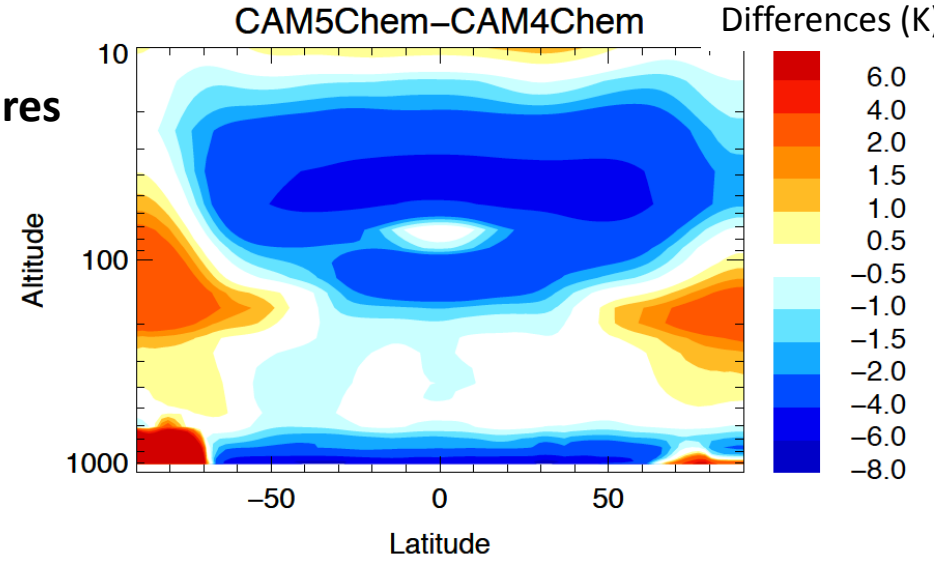
Ozone



OH



Temperatures



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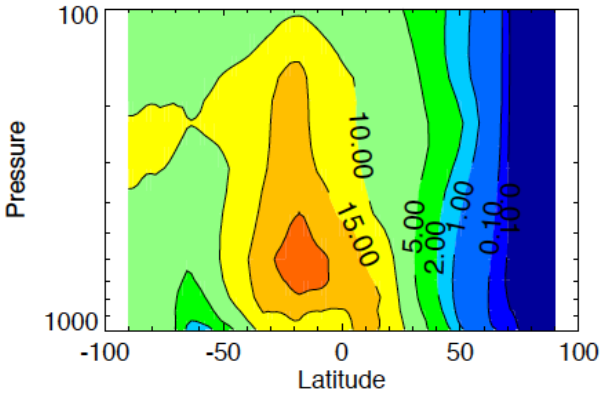
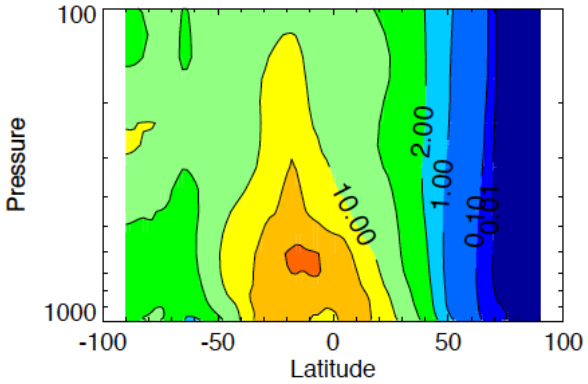
OH Comparisons, Model, Spivakovsky Climatology

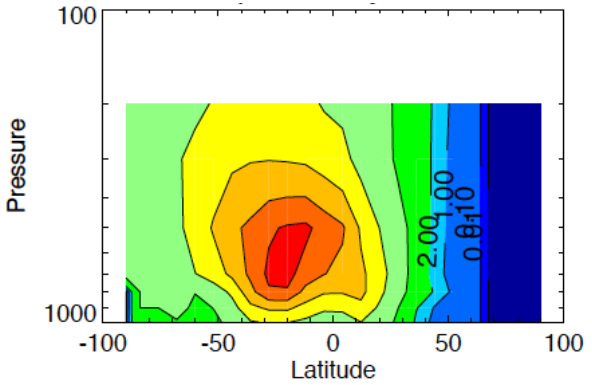
CAM4Chem January



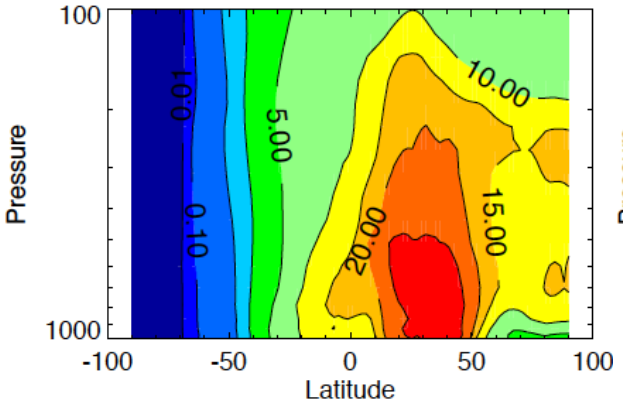
CAM5Chem January



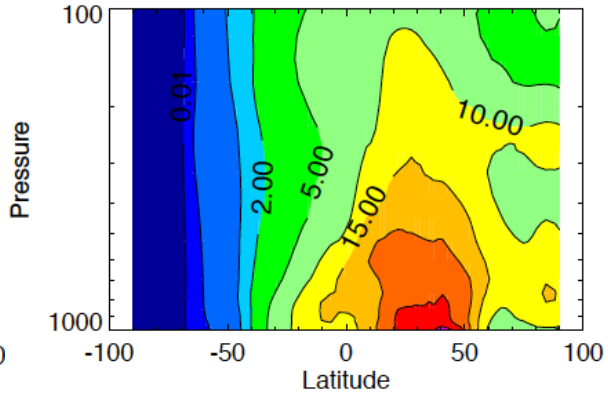
Spivakovsky



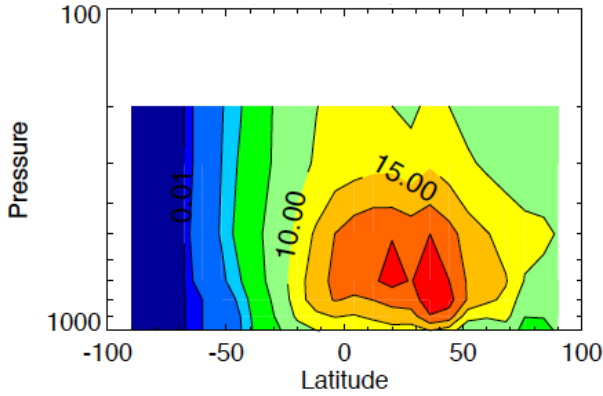
CAM4Chem July



CAM5Chem July



Spivakovsky



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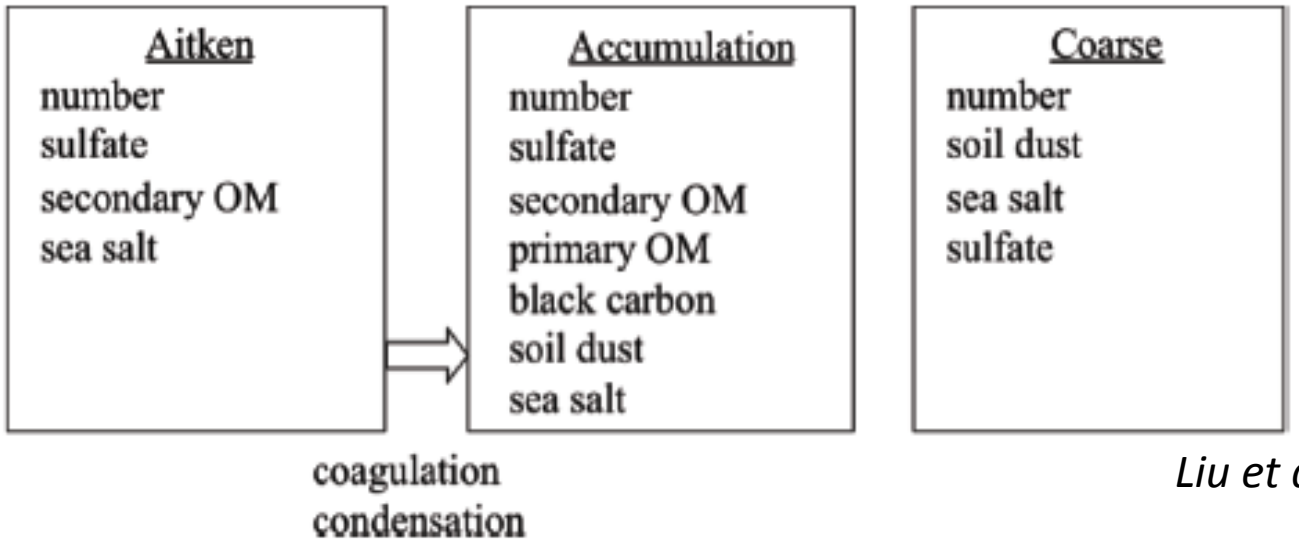
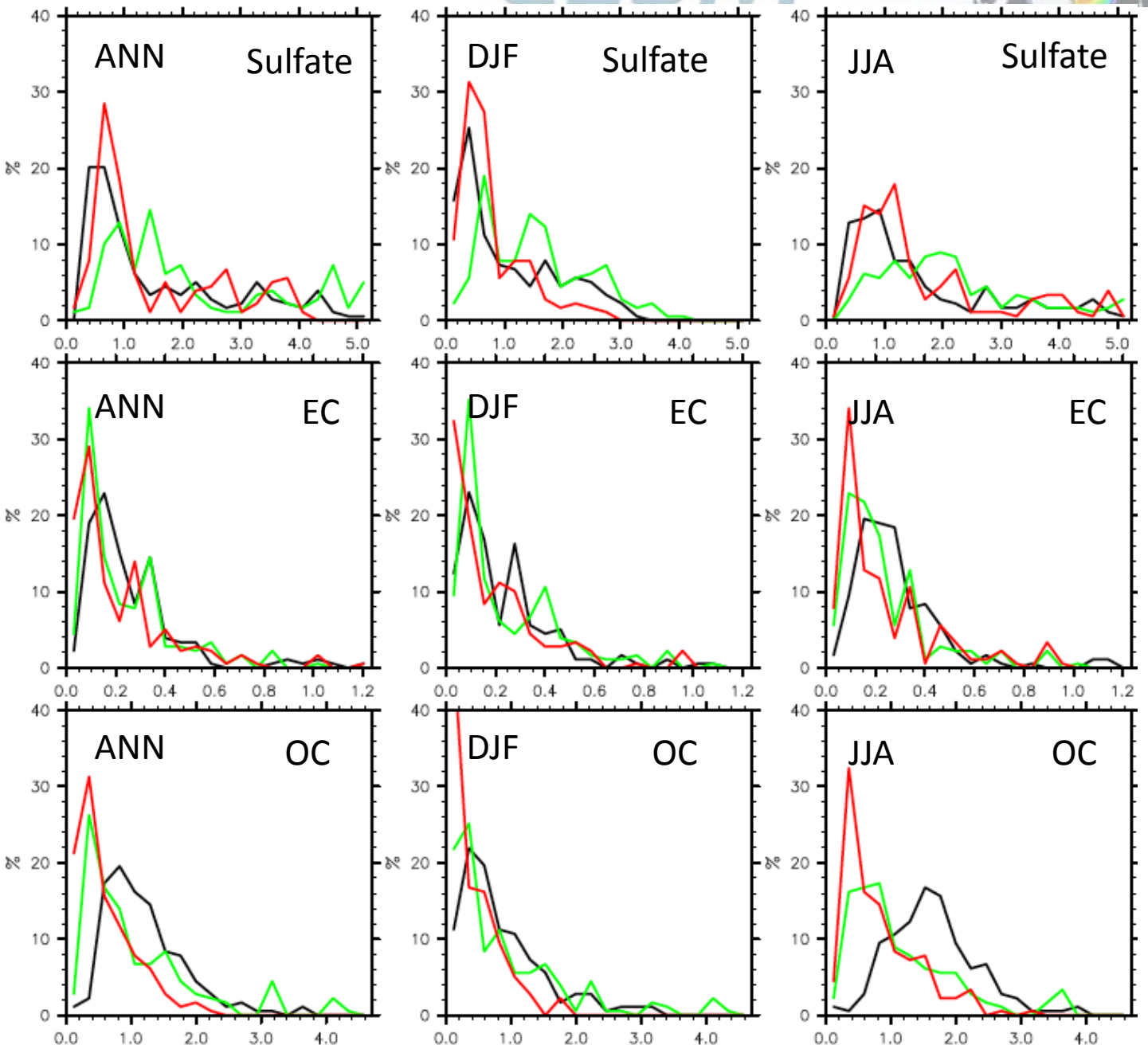
Aerosols: CAM4 bulk scheme, CAM5 modal aerosol model (MAM)



Liu et al., 2011

Fig. 2. Predicted species for interstitial and cloud-borne component of each aerosol mode in MAM3. Standard deviation for each mode is 1.6 (Aitken), 1.8 (accumulation) and 1.8 (coarse mode).



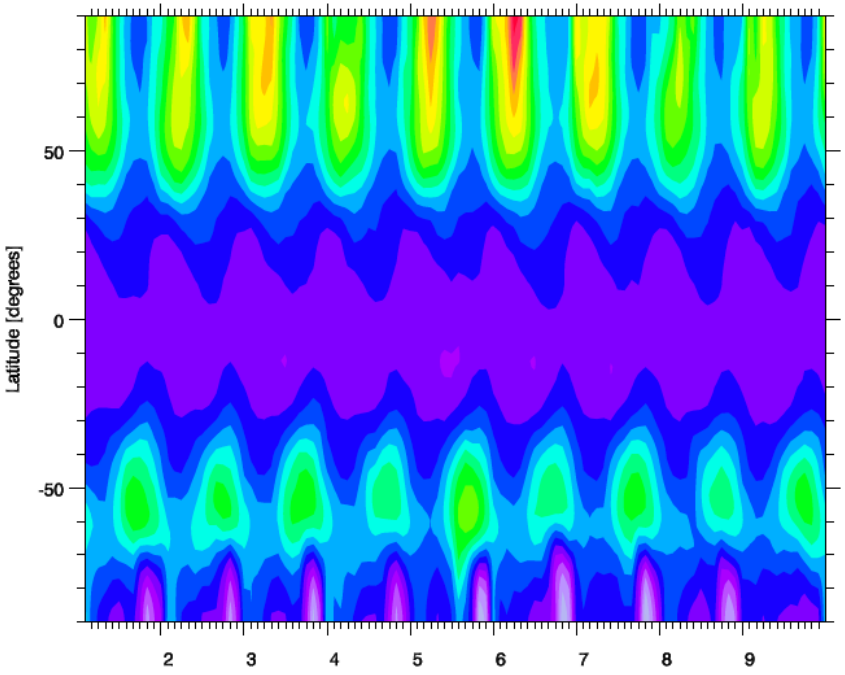
CAM5Chem
CAM4Chem
IMPROVE

Conclusions

- Realistic representation of tropospheric chemistry for both CAM4Chem and CAM5Chem
- High bias in surface ozone in summer for Europe and Easter US and low bias for Japan, in both simulations
- Differences at the surface are likely due to different emissions
- High bias of ozone in CAM5Chem compared to CAM4Chem in the stratosphere, different presentation of the TMS with impact on the dynamics
- Low bias of temperature in the stratosphere in CAM5Chem
- OH reduced in CAM5Chem (more realistic altitude distribution)
- Improved representation of sulfates in CAM5Chem

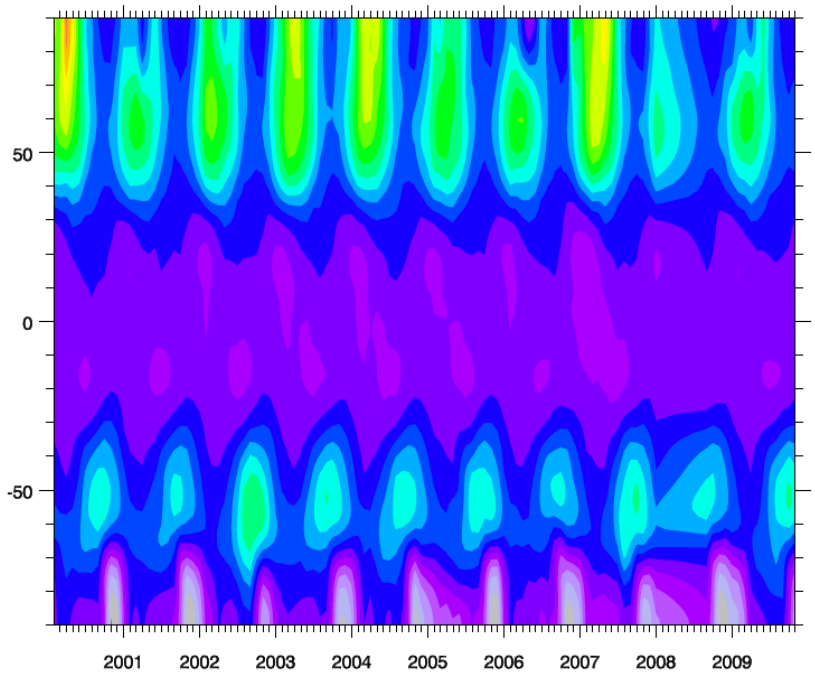
Column Ozone Zonal Average

CAM5Chem

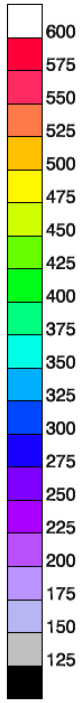


years

CAM4Chem



years



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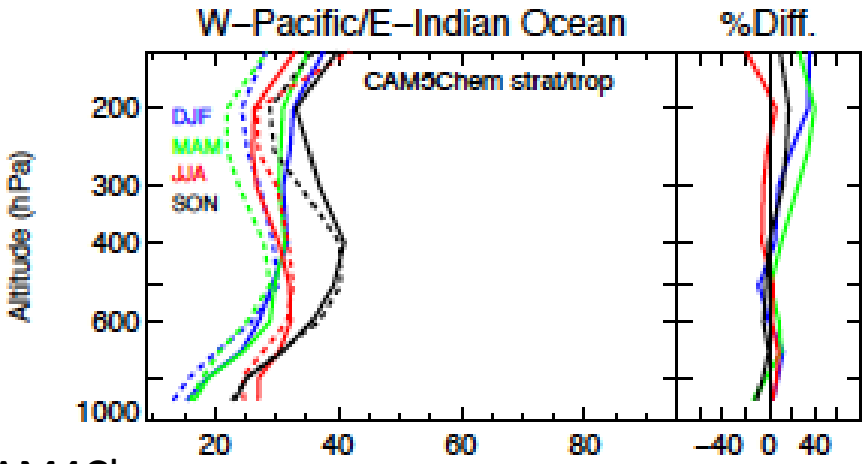
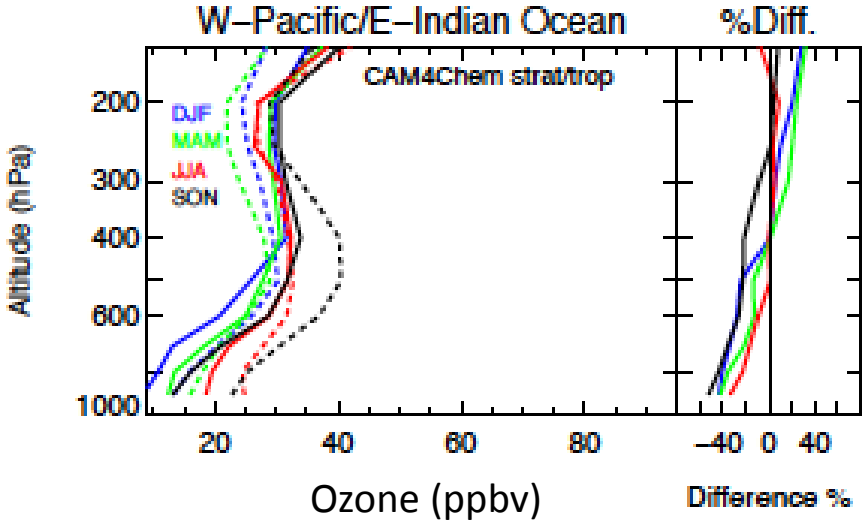
Model (solid), Data (dashed)

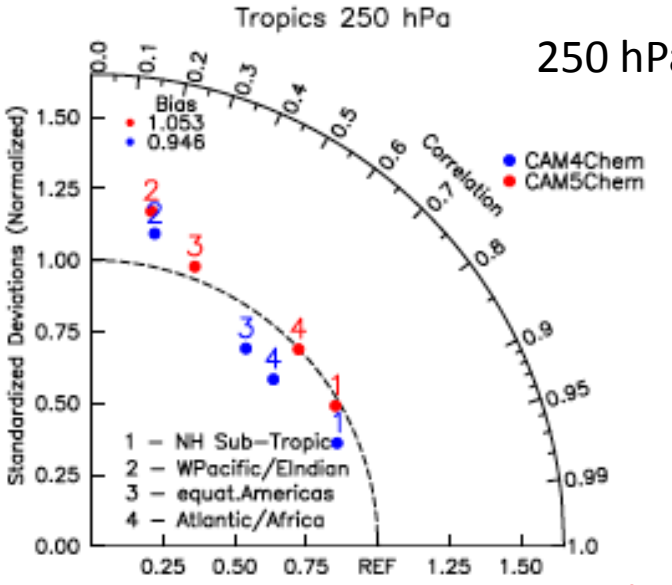
CAM5Chem



CAM4Chem



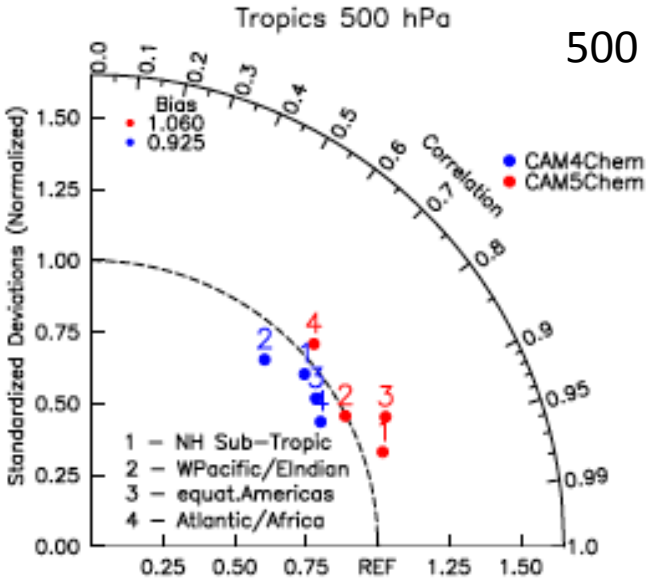
250 hPa



CAM5Chem

CAM4Chem

500 hPa



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