CAM-chem update

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CAM-chem GMDD paper

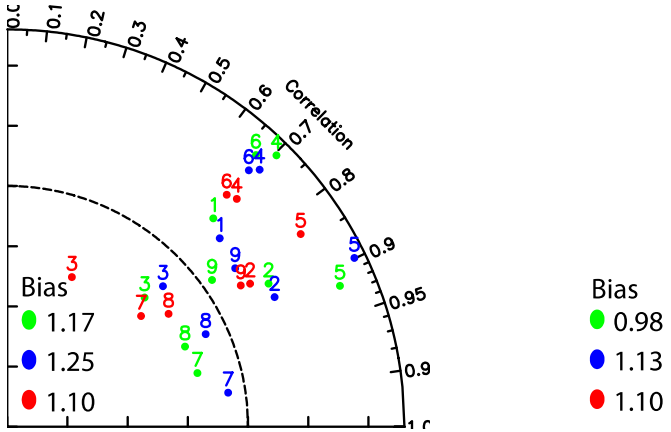
- Many thanks to all co-authors, especially Louisa, Simone, Peter and Francis.
- Should be available at GMD within a few weeks
- Led to many improvements in diagnostics

http://www.geosci-model-dev-discuss.net/4/2199/2011/gmdd-4-2199-2011.html

CAM-chem GMDD paper

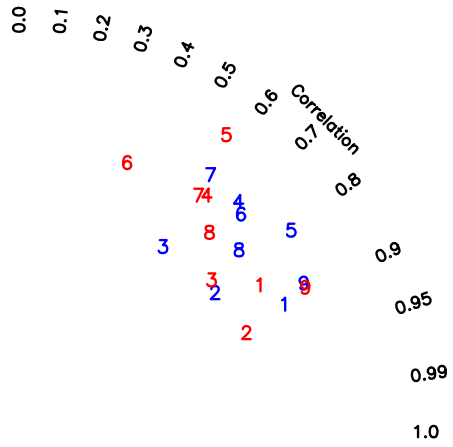
- Discusses all aspects of chemistry in CAM-chem
- Defines the MOZART-4 chemistry (not reduced or superfast) + BAM
- Compares simulations MERRA/GEOS-5/online with meteorological fields

Taylor diagrams

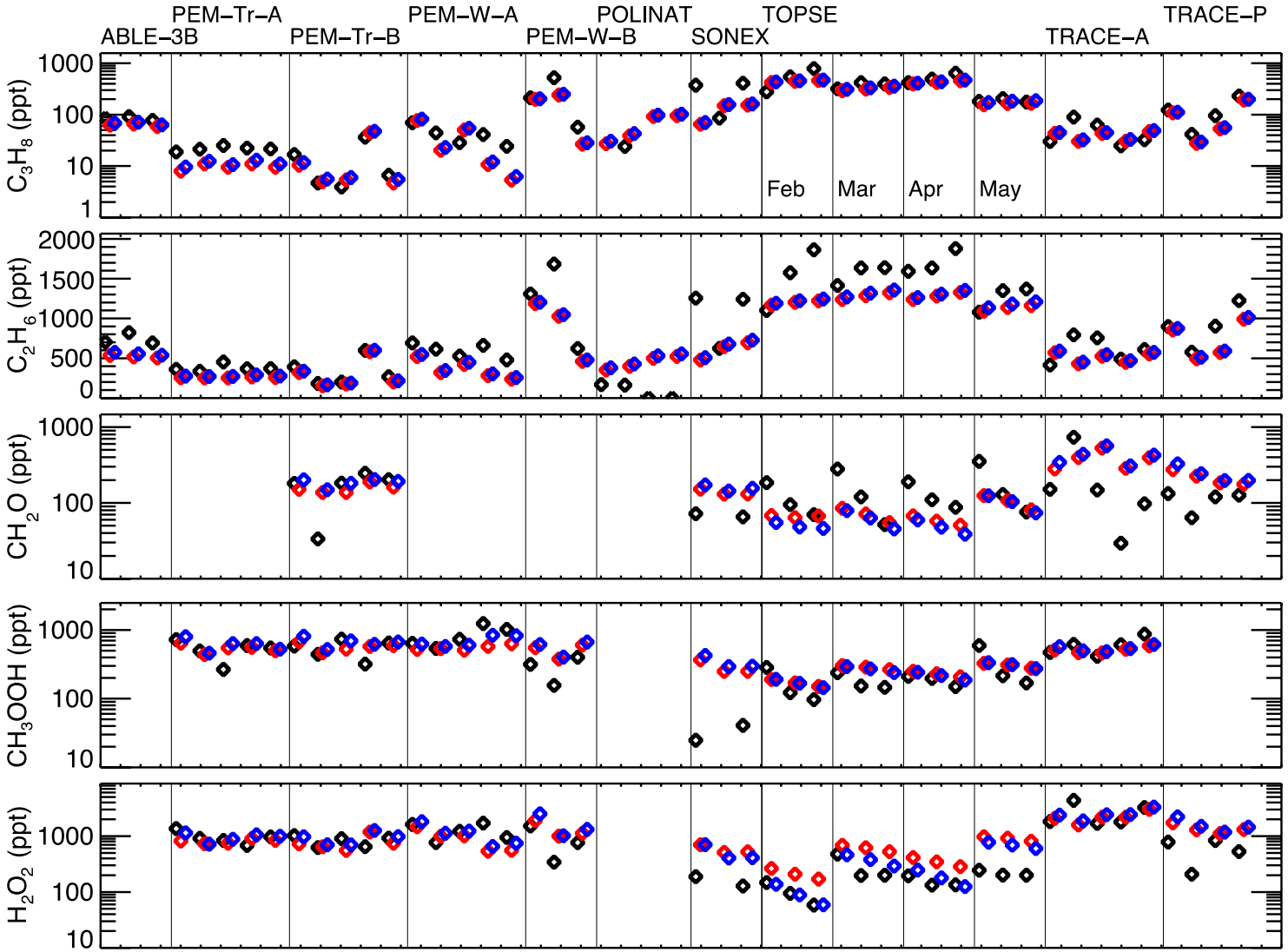


GEOS5
MERRA
Online

1-Tropics
2-SH Midlat
3-SH Polar
4-North America
5-West. Europe
6-Japan
7-NH Polar East
8-NH Polar West
9-Canada



Comparison with Emmons' climatology



Participation in ACCMIP

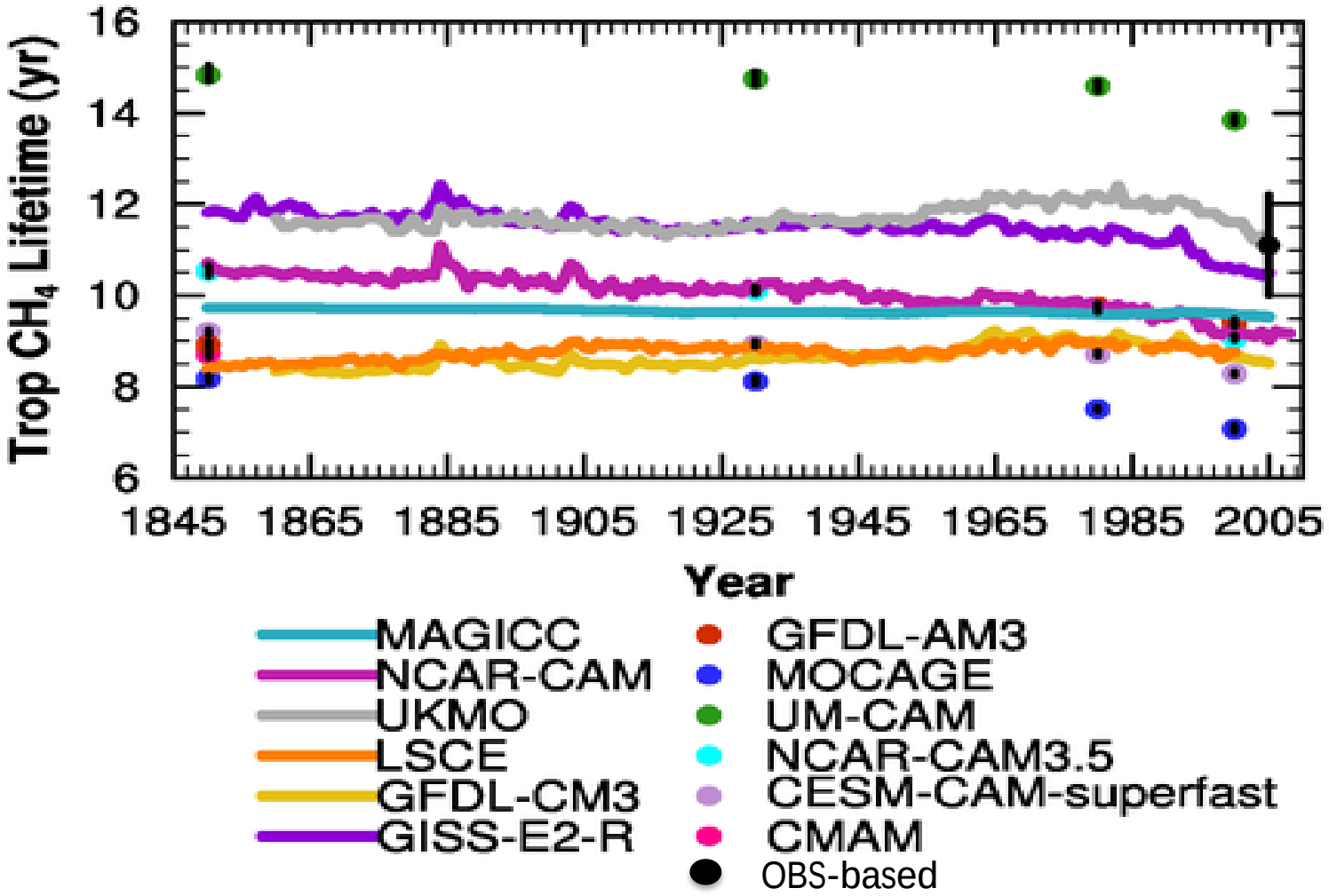
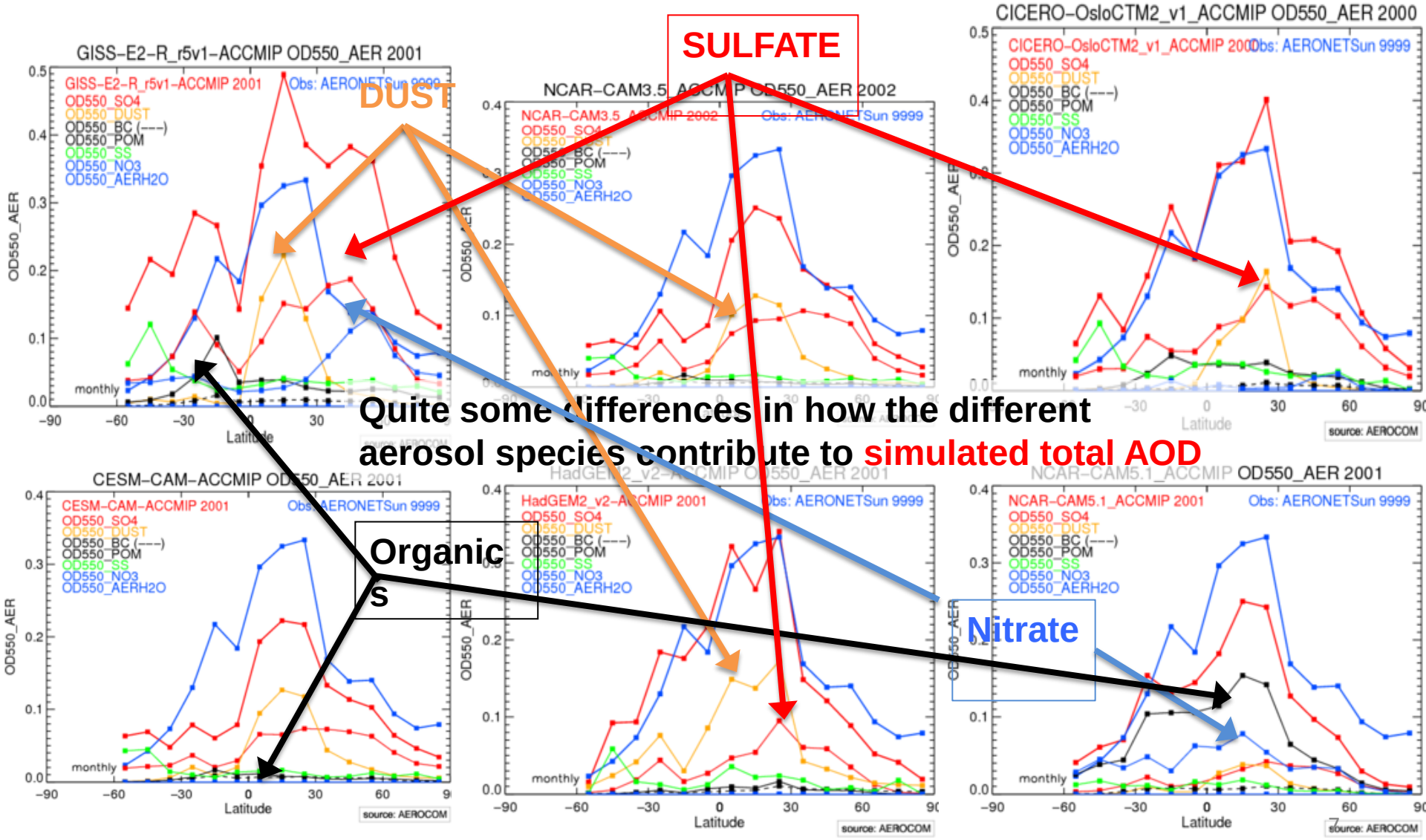


Figure courtesy of V. Naik, GFDL, 2012

AOD aggregated per latitude band
Against Aeronet AOD



ChemClim Development Plan (from Breckenridge 2011)

- Top Priority
  - Update to MEGAN/include maps when possible
  - Improvements to the dry deposition (better link with CLM)
  - Coupling chemistry with MAM and CAM5 physics
  - HOMME dynamical core
- Medium Priority
  - Update SOA mechanism: Colette Heald's additional SOA species
  - Implementation of FAST-J photolysis rate computation
- Low Priority
  - "Coarse resolution" FV
- Diagnostics:
  - Tools for model result differencing
  - Benchmark numbers: methyl chloroform lifetime, ozone budget terms, methane lifetime, mass-weighted tropospheric OH, lightning NOx, sf(co/nox/isoprene)

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  - HOMME dynamical core (DOE funding: A. Conley/P. Lauritzen)
  - kPP mechanism
  - Box Model or SCAM w/ chemistry
- Medium Priority
  - Update SOA mechanism: Colette Heald's additional SOA species (additional work by K. Barsanti)
  - Implementation of FAST-J photolysis rate computation (DOE funding: M. Prather/P. Cameron-Smith)
  - Conversion of preprocessor to KPP?
  - Vertical resolution and model top?
  - WACCM lite?
- Low Priority
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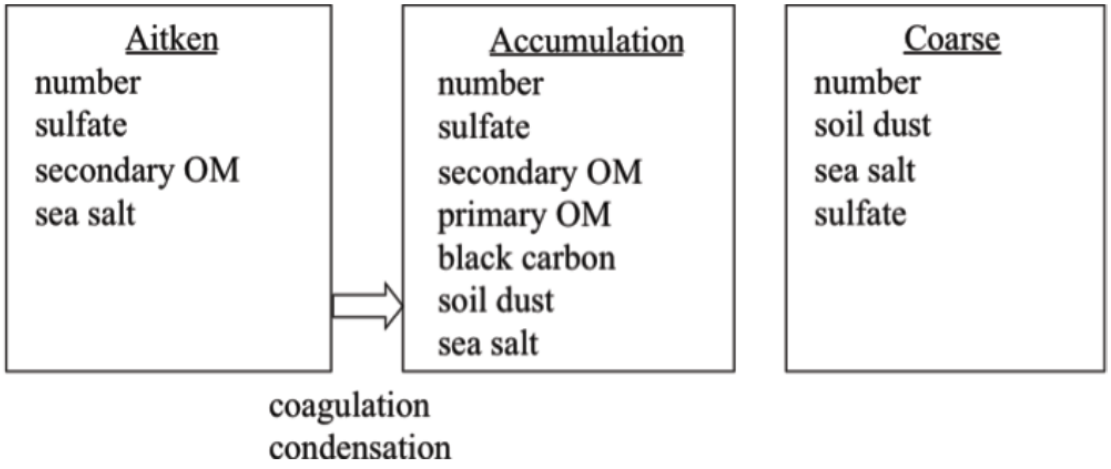
Coupling chemistry to MAM3 (1)

- MAM: Modal Aerosol Module (Liu et al., GMDD, 2011: www.geosci-model-dev-discuss.net/4/3485/2011)
- Very simplified chemistry (reads O_3, OH, NO_3 and HO_2 to compute DMS and SO_4 oxidation to H_2SO_4)



Coupling chemistry to MAM3 (2)

- Use MOZART mechanism (will also work with reduced NMHC) to provide O_3, OH, NO_3, HO_2 and H_2O_2
- Modify scheme to include H_2SO_4 (instead of directly making SO_4)
- Use surface area from MAM to compute rate for heterogeneous reactions on tropospheric aerosols

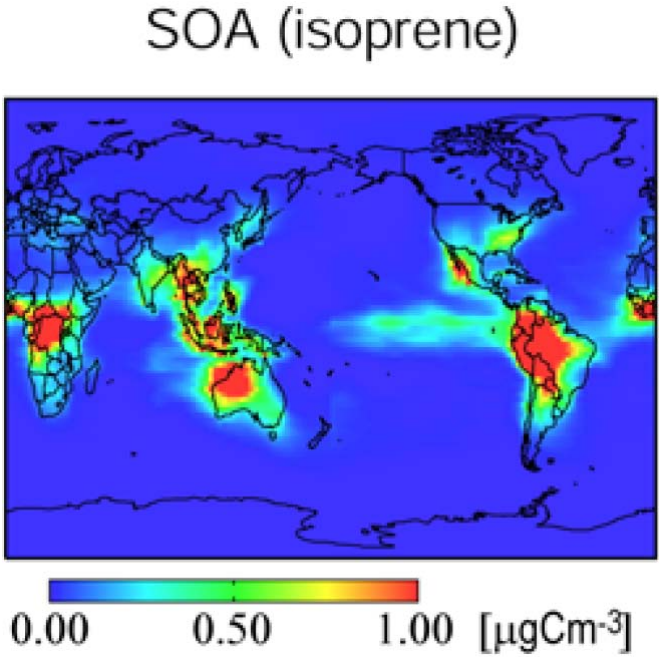
Coupling chemistry to MAM3 (3)

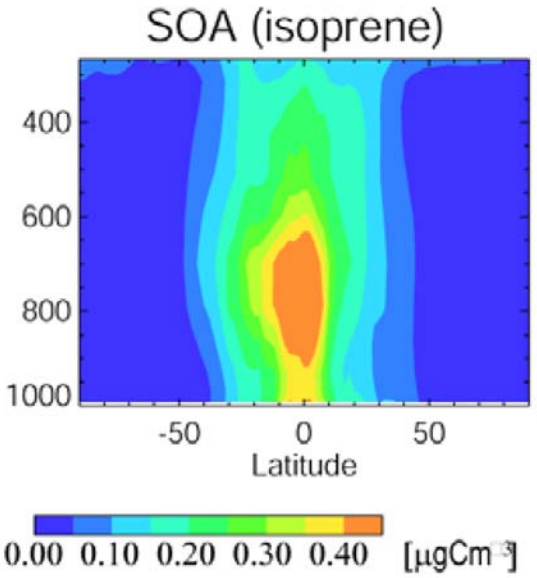
- Remaining issues (that we know ☺)
  - SOA in MAM not coupled with chemistry
  - Dry deposition is done differently (MAM needs size-dependent scheme)
  - SAD only from Aitken mode
- Status
  - Have performed several multi-year simulations for present-day, F case only
  - Initial evaluation (including clouds) indicates reasonable results
  - Code will be released in June 2012
  - Similar effort in WRF-chem
  - Evaluation in S. Tilmes' talk

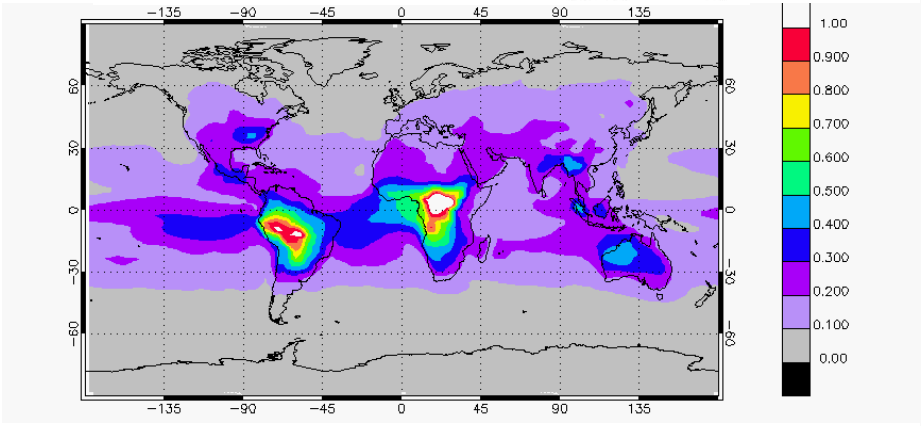
SOA (from C. Heald)

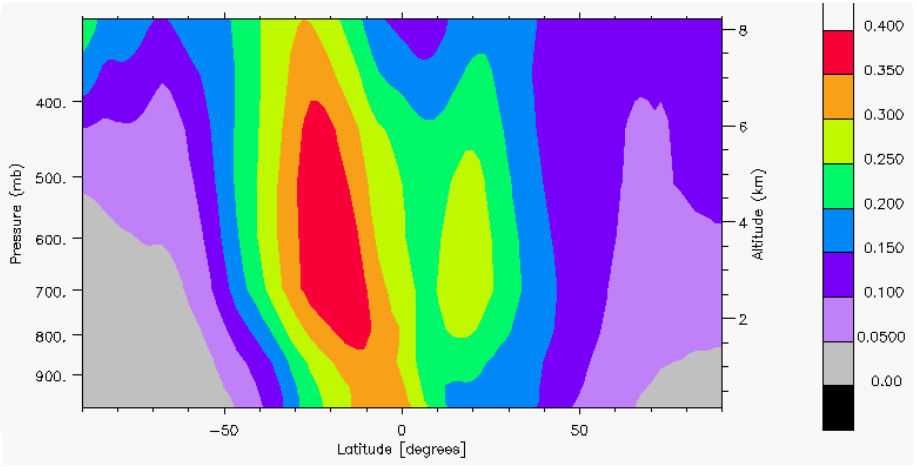
- Current version: two-product method (Lack et al., 2004)
- From Colette Heald (Heald et al., JGR, 2008)
  - Two-product method with high- and low-NO_x yields
  - Additional anthropogenic precursors (benzene, tolueneand xylene) and isoprene
  - Split SOA into classes (one per precursor)
  - T-dependent partitioning between gas-phase and solid-phase (following Chung and Seinfeld, 2002)
  - Adds 13 species

Comparison w/ Heald et al. (2008)



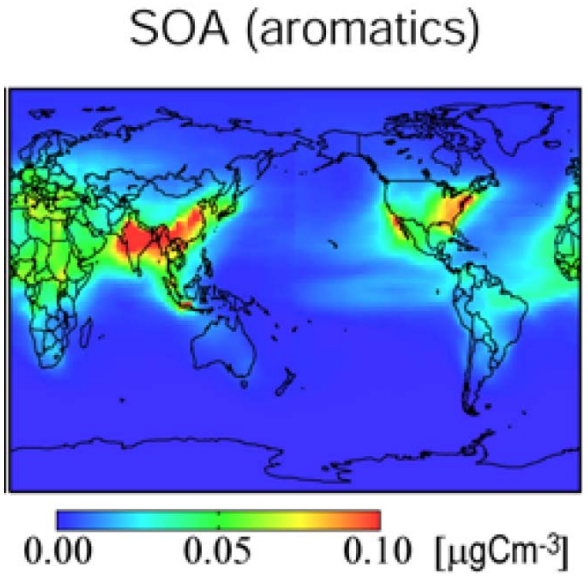


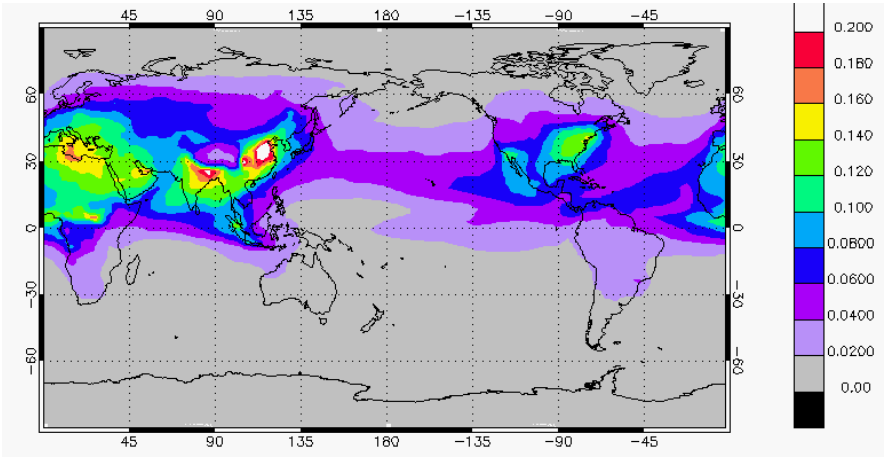




Simulation is for one-year only

Comparison w/ Heald et al. (2008)





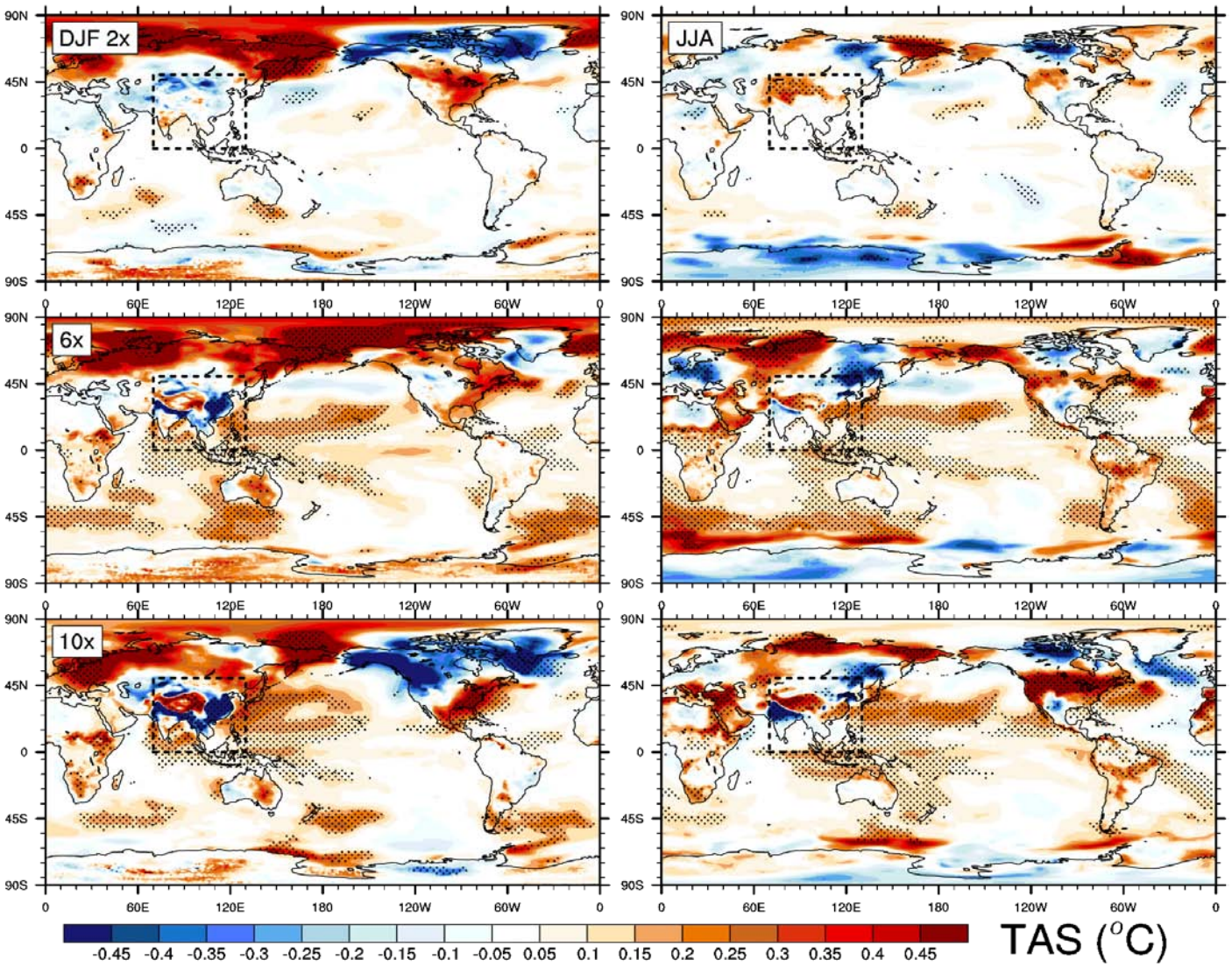
Approximately 2x SOA from aromatics

- Bug?
- Emissions?

Next steps: CSL allocation

- Development
  - New chemistry (halogen/CRI)
  - High-resolution (at least 0.5^{o})
  - Vertical resolution
  - SE dynamical core (ultimately with varying resolution!)
- Production
  - Chemistry-climate response to regional forcing
  - Benchmark simulations for CAM5-chem FV
    - PI control
    - 4xCO_2

Chemistry-climate coupling: BC



Teng et al., in preparation