Sensitivity to Aerosol Parameterization & Lead-in to Discussion

Peter Hess

Two Models

1) CCSM with chemistry

– impacts of chemistry/aerosols on climate in a cost effective way

2) Chemistry Model within the CCSM

– benchmark for simplified versions

– effect of climate on chemistry/air quality

– model-measurement comparison

– Short-term impact studies

CCSM (with Chemistry)

- **Stage 1 (summer of 2007)**
  - Assemble the latest physical and biogeochemistry components
  - Begin coupled control runs

- **Stage 2: (end of 2007)**
  - **Finalization** of the new physical and biogeochemical components for CCSM 4.
  - Include a simple form of the indirect effects of aerosols
    (in development branch and *accepted* by SSC)

- **Stage 3 (early 2008)**
  - Test, finalize, and thoroughly understand the CCSM 4 run in fully coupled mode.

Aerosols for CCSM4

Bulk Schemes:

1) Prescribed Aerosols (CAM3)

2) Prognostic Aerosols: Dust (4 bins), SS (4 bins), OC, BC, and Sulfate (with input oxidants) (no NH4SO4)

3) Prognostic Aerosols with chemistry: Dust (4 bins), SS(4 bins), OC, BC, Sulfate (oxidants calculated interactively), NH4SO4

Mixed Schemes:

4) Ghan, 4 or 7 modes internally mixed. Input oxidants? NH4SO4?

5) Others…?

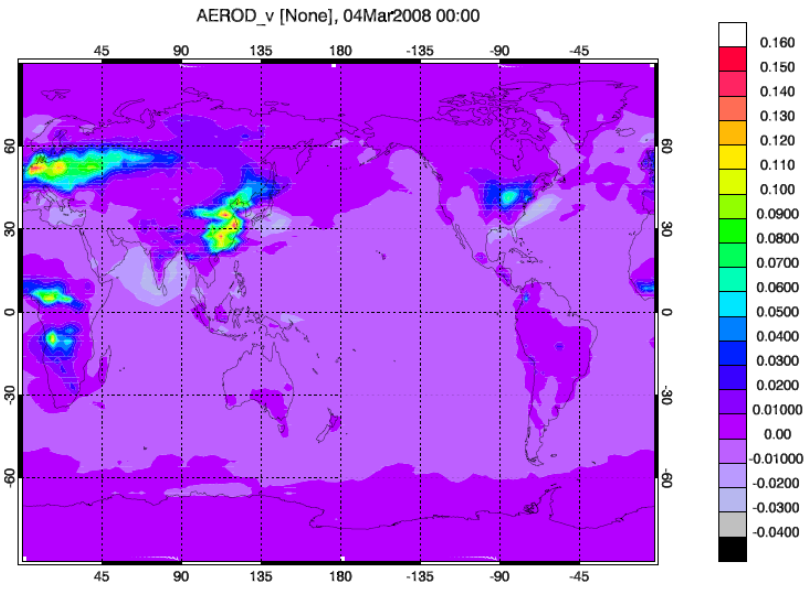
CAM-CHEM minus CAM3’

Full Chemistry/NH4NO3

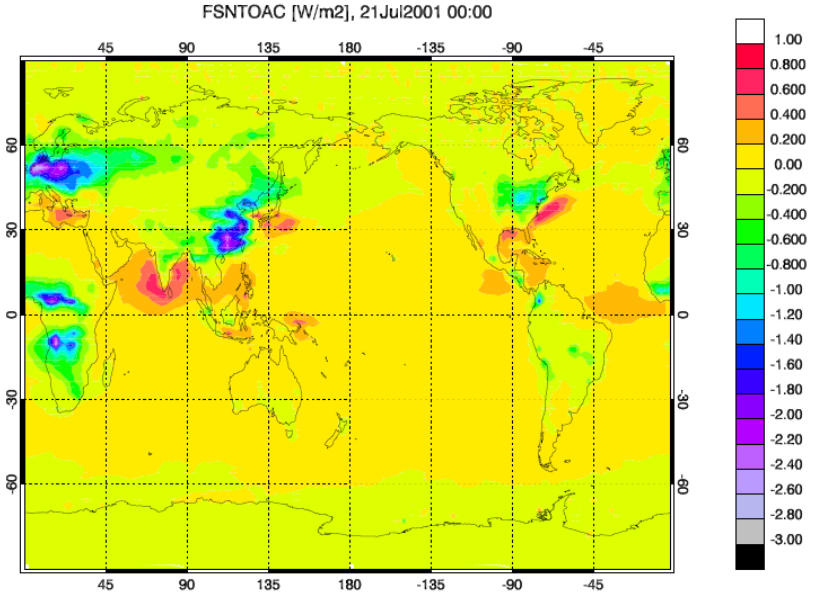
minus

Input Oxidants, No NH4NO3,Rasch/Barth Sulfate Param

AOD



TOAC



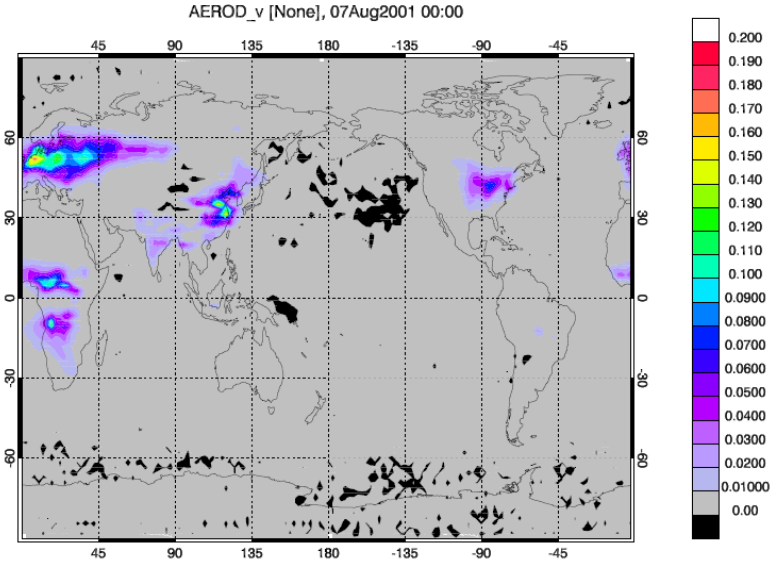
Diff [AOD] ~ 0.

Diff [TOAC] = .003 W/M^2

Run in offline mode

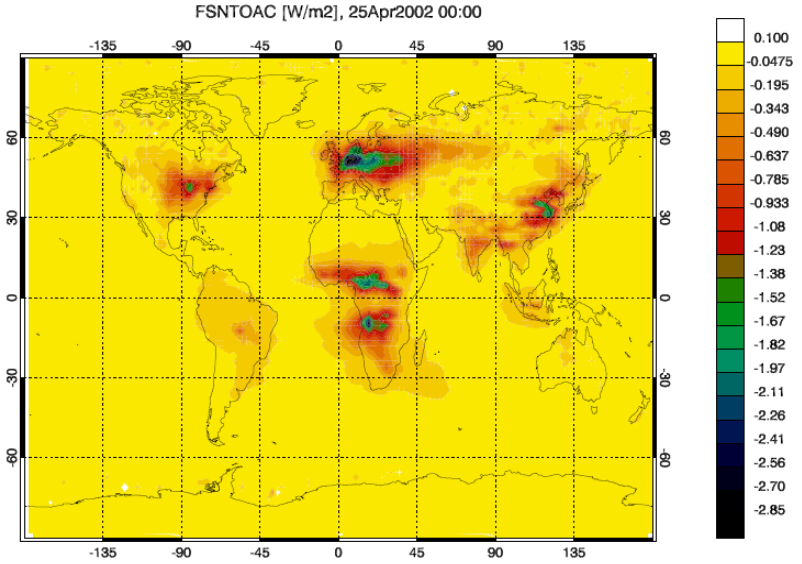
Full Chemistry/NH4NO3 *minus* Full Chemistry, No NH4NO3

AOD



Diff AOD = .004

TOAC

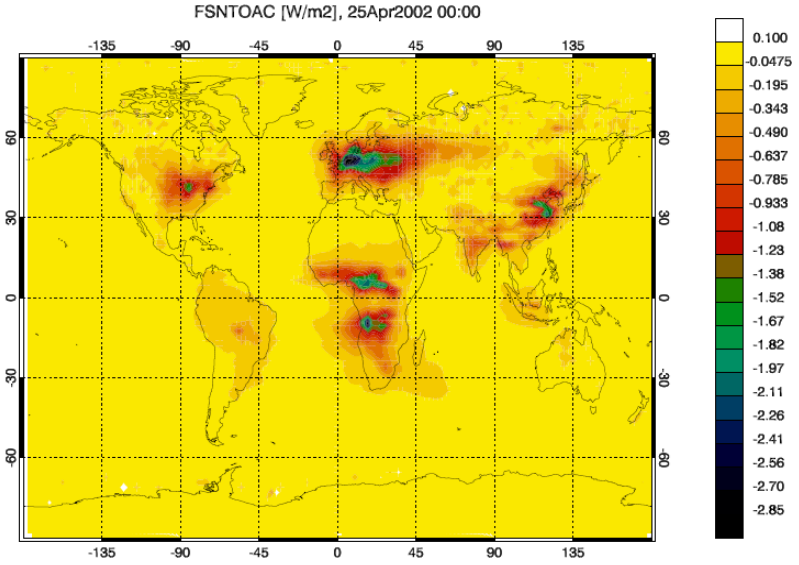


Diff TOAC = -.07 W/m^2

Cam-chem NH4NO3 *minus* Cam-chem no NH4NO3

Present Day SO2 emissions

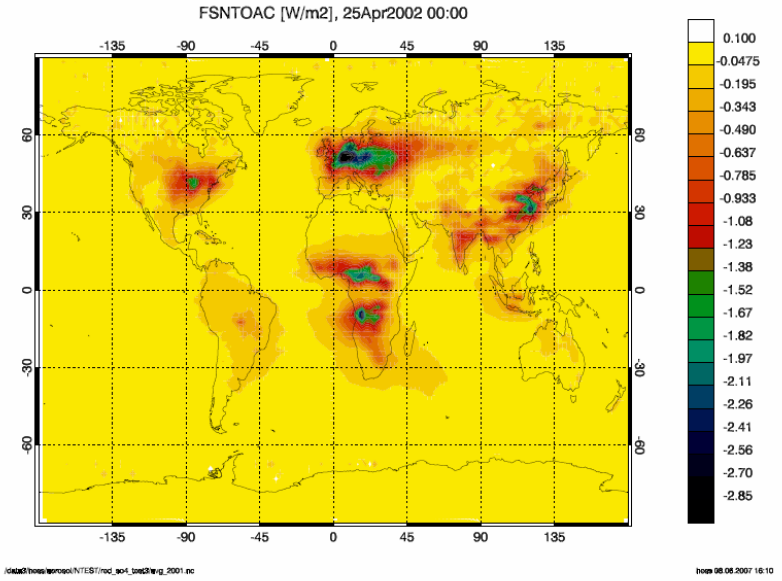
TOAC



Diff TOAC = -.07 W/m^2

50% Anthro SO2 emissions

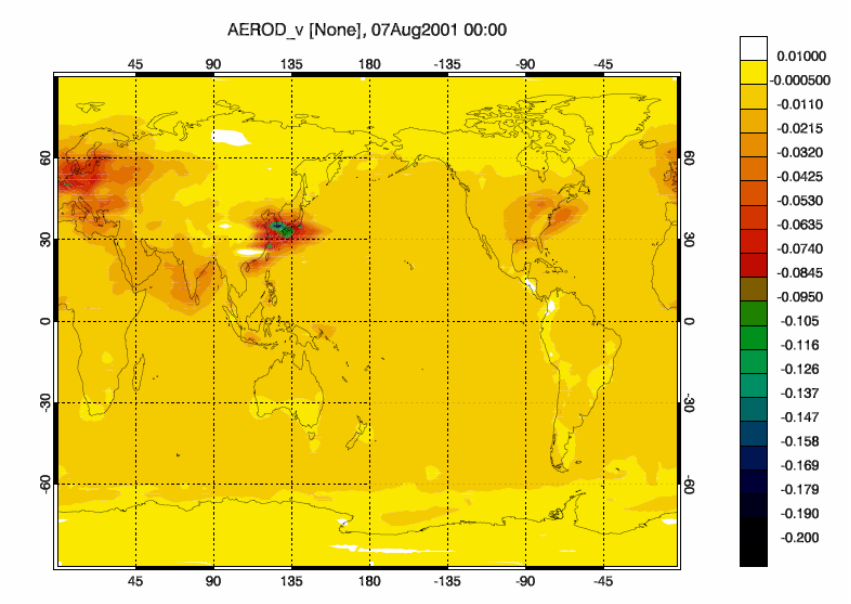
TOAC



Diff TOAC = -.09 W/m^2

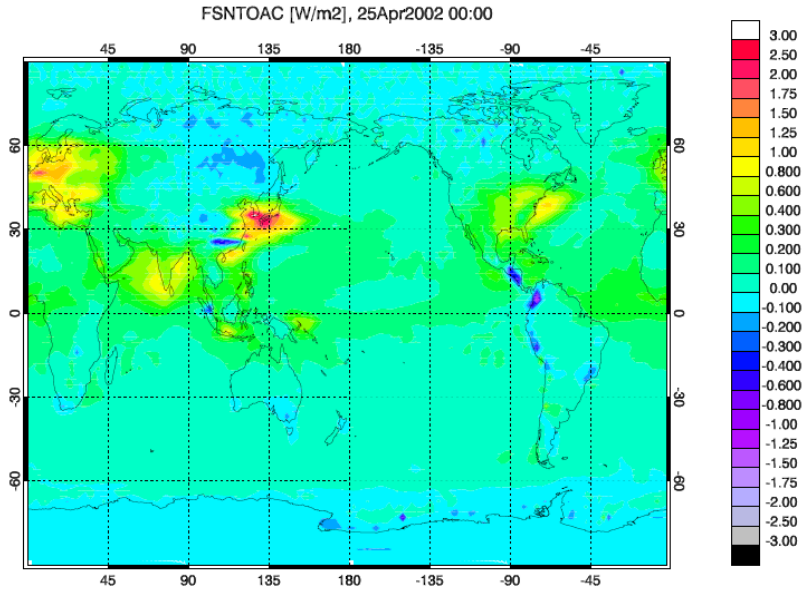
Cam-chem – Cam-chem (barth/rasch) No NH4NO3

AOD



Diff AOD = -.004

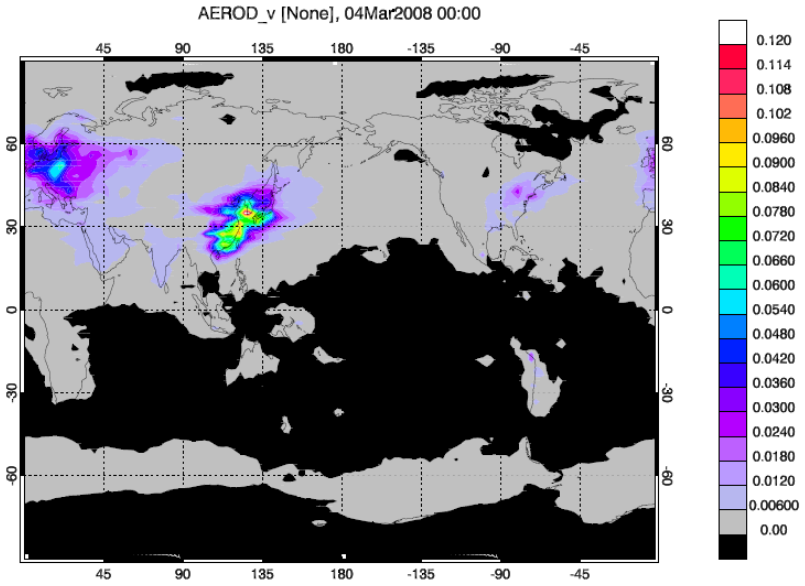
TOAC



Diff TOAC = .12 W/m^2

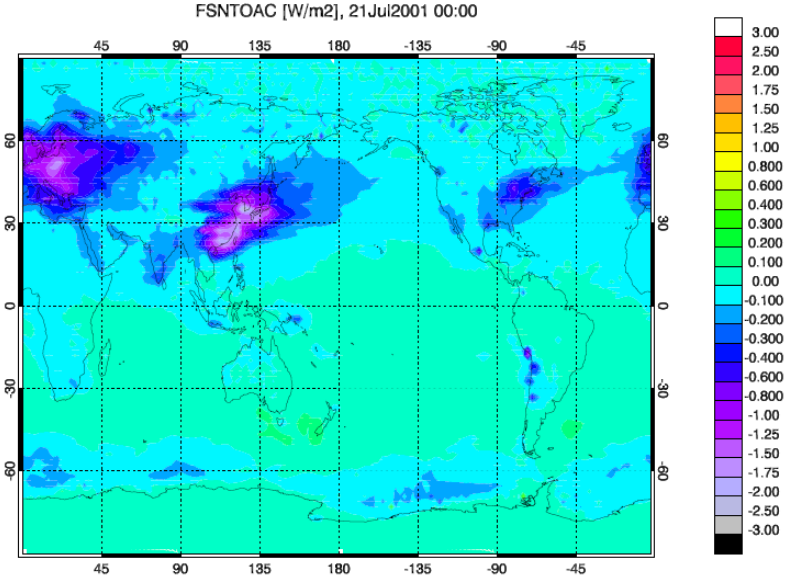
Barth/Rasch sulfate with chemistry *minus* Barth/Rasch sulfate with input oxidants

AOD



Diff AOD = .002

TOAC



Diff TOAC = -.05 W/m^2

Discussion Points

- ***General***
  - What are the candidate treatments of oxidant chemistry and aerosols?
  - Should more than one be supported on the trunk? For how long?

  Discrimination of Schemes
  - Do aerosols have to be simulated online to simulate direct and indirect effects?
  - Which oxidant chemistry needs to be treated to simulate direct and indirect effects?
  - How important is ammonia nitrate in the past/present/future?
  - What are the trade-offs between run time and realism in different representations of oxidant chemistry and aerosol physics?

  Emissions
  - Which aerosol sources are missing?
  - Can aerosol sources be treated independently of the representation of aerosol mixing state and size distribution? What simplifications in the representation of the aerosol mixing state and size distribution are acceptable?

  Dust and Seasalt
  - How should these be binned to interact with the microphysics

  What interfaces can be introduced that will facilitate the application of aerosol modules to the CCSM to treat*:*
  - Dependence of emissions on surface properties and processes
  - Dependence of dry deposition on surface properties
  - Gas-to-particle production of aerosol in clear air
  - Activation, aqueous-phase production and wet scavenging of aerosol (cloud-aerosol interactions)
  - Optical properties of aerosol

  Evaluation:
  - Which aerosol measurements would be most useful for validation?
  - Should the aerosol scheme(s) be represented in Aerocom?.