Atmospheric Chemistry in DOE-ACME

Philip Cameron-Smith (LLNL)

Ozone Hole [Cryosphere v1]

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  - Ozone hole -> surface winds (SAM) -> ocean upwelling -> ice-sheet melting.
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- Sulfur is top uncertainty in 20th-Century forcing, & therefore climate sensitivity [Carslaw, 2013].
- Dimethyl sulfide (DMS) affects climate:
  - Ocean ecosystem -> DMS emissions -> atm chem -> sulfate aerosols -> clouds -> climate.
  - Major aerosol source in pre-industrial and in future.
  - 4-6 W/m^2 global-mean in CESM1.2.2.
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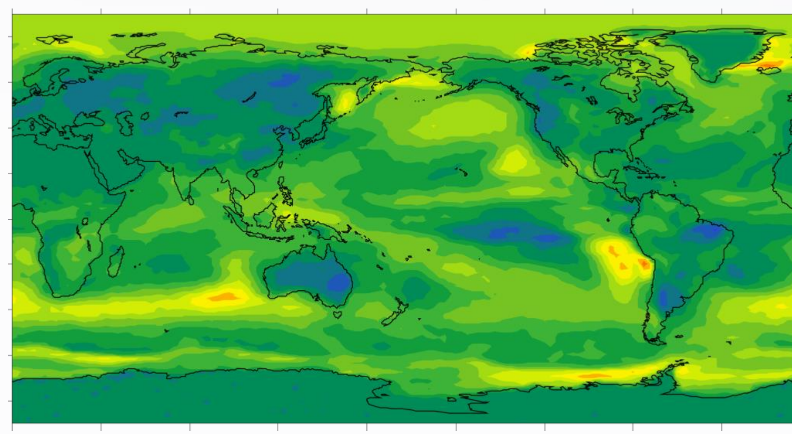

Change in reflective shortwave due to DMS in 1850

ACME Accelerated Climate Modeling for Energy

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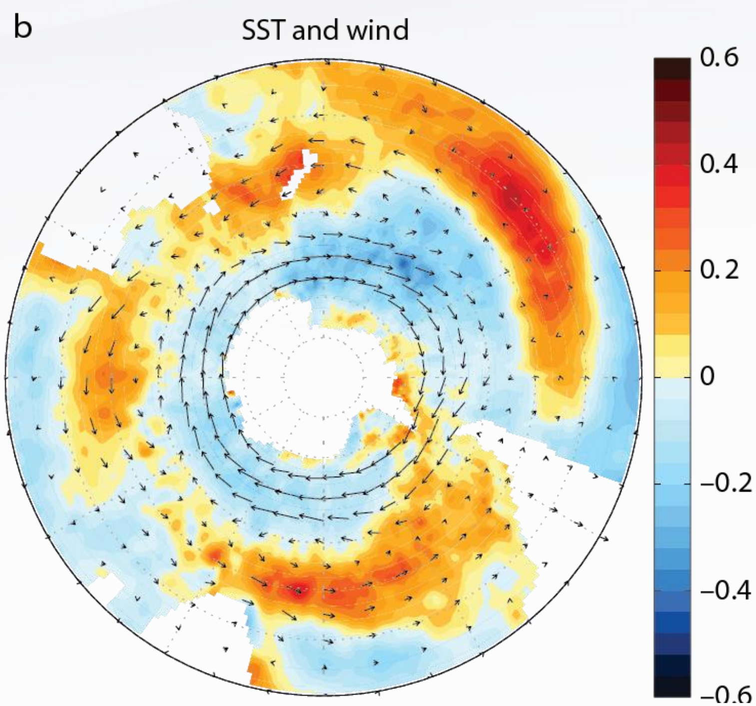
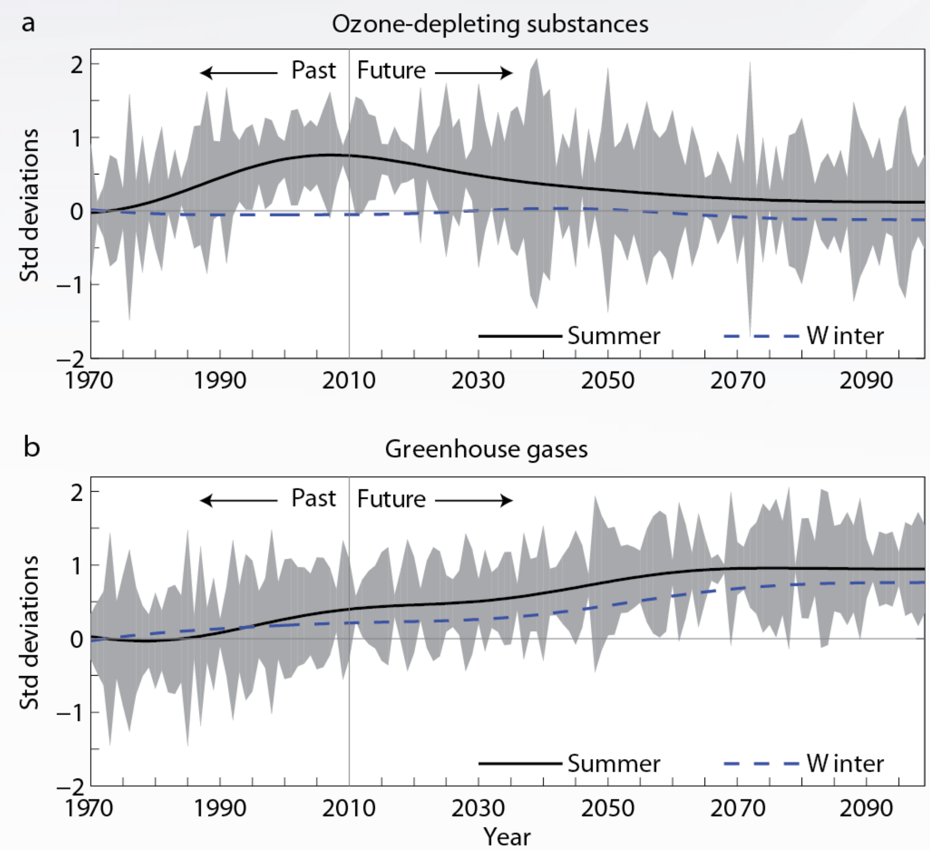
Ozone Hole Impacts Antarctic Winds

Ozone Hole [Cryosphere v1]

- Antarctic ozone-hole affects Southern Annual Mode (SAM).





[Thompson, et al., Nature Geo, 2011]

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Antarctic Winds Affect Temperature Next to Ice-Sheets

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  - Implement in ACME-atm using Linoz (1 tracer),
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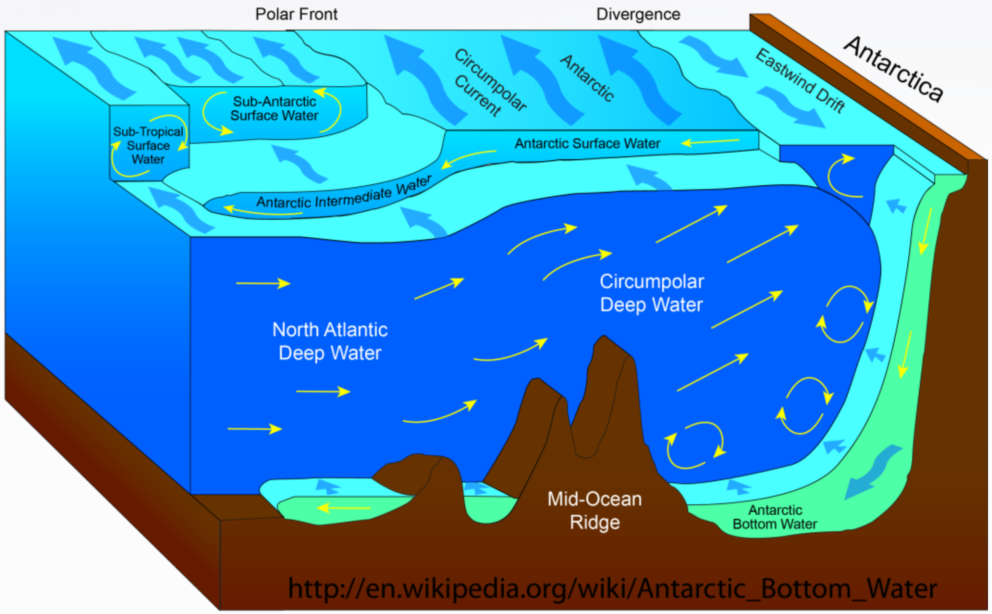

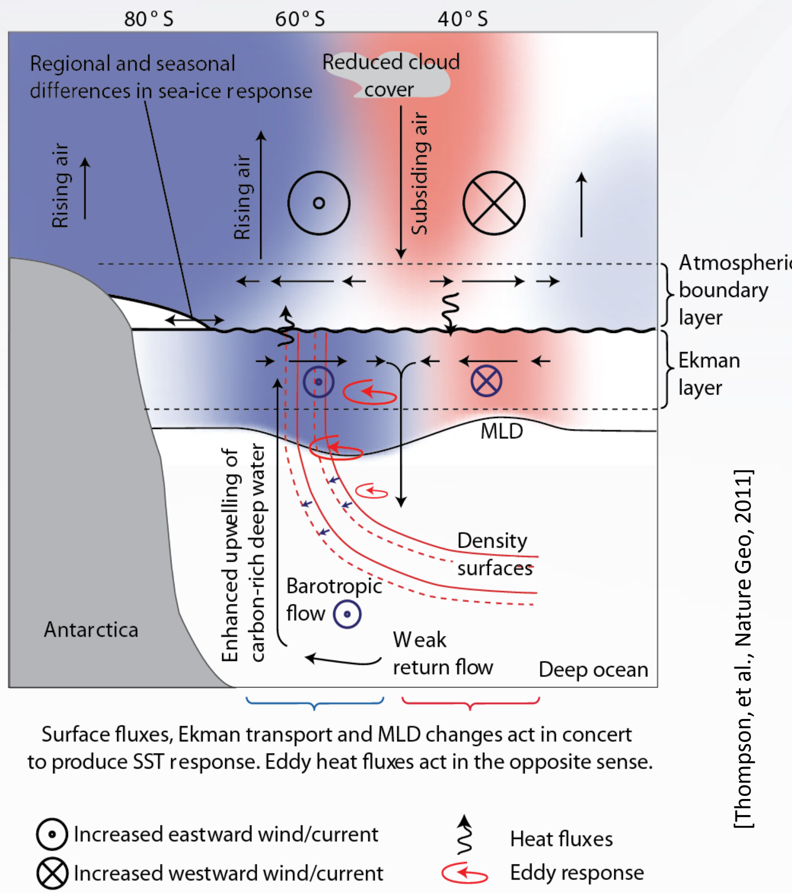

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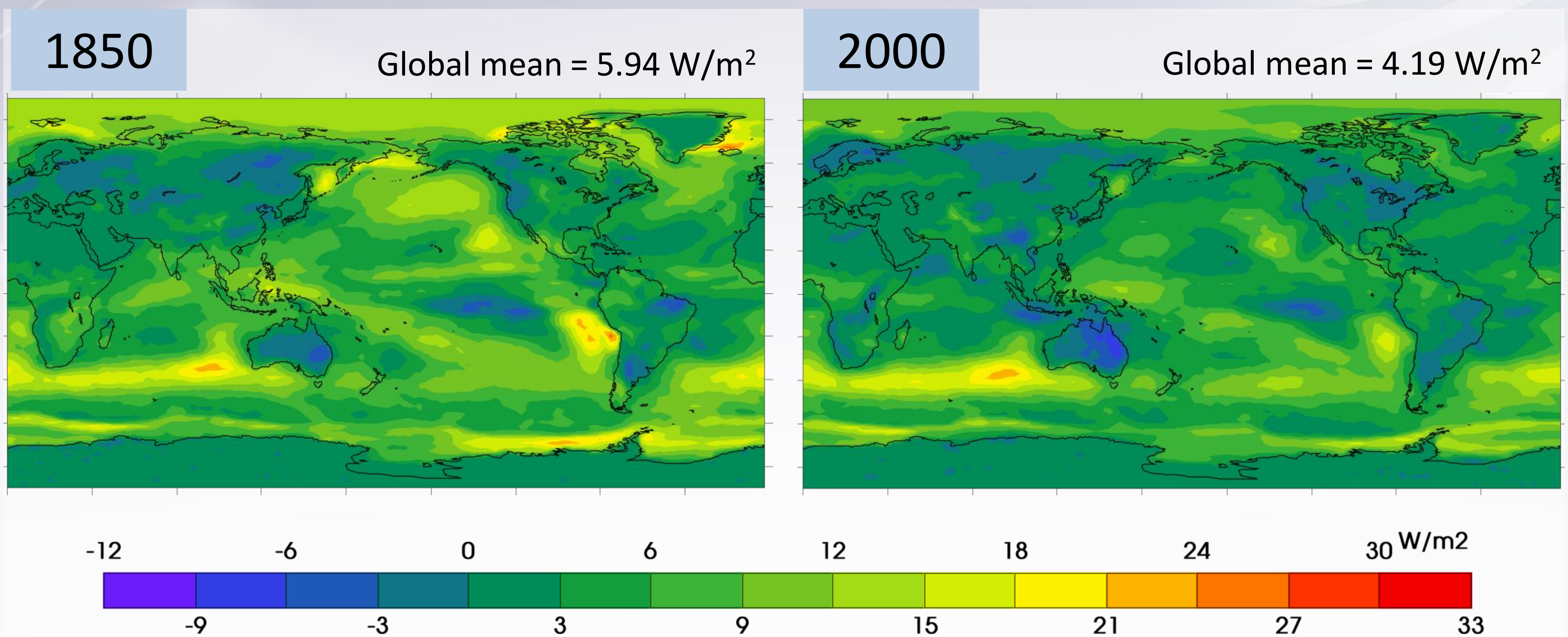
DMS Impacts TOA Reflected Shortwave



Reflected Shortwave shifts polewards, and decreases in magnitude to due competition with anthropogenic aerosols.

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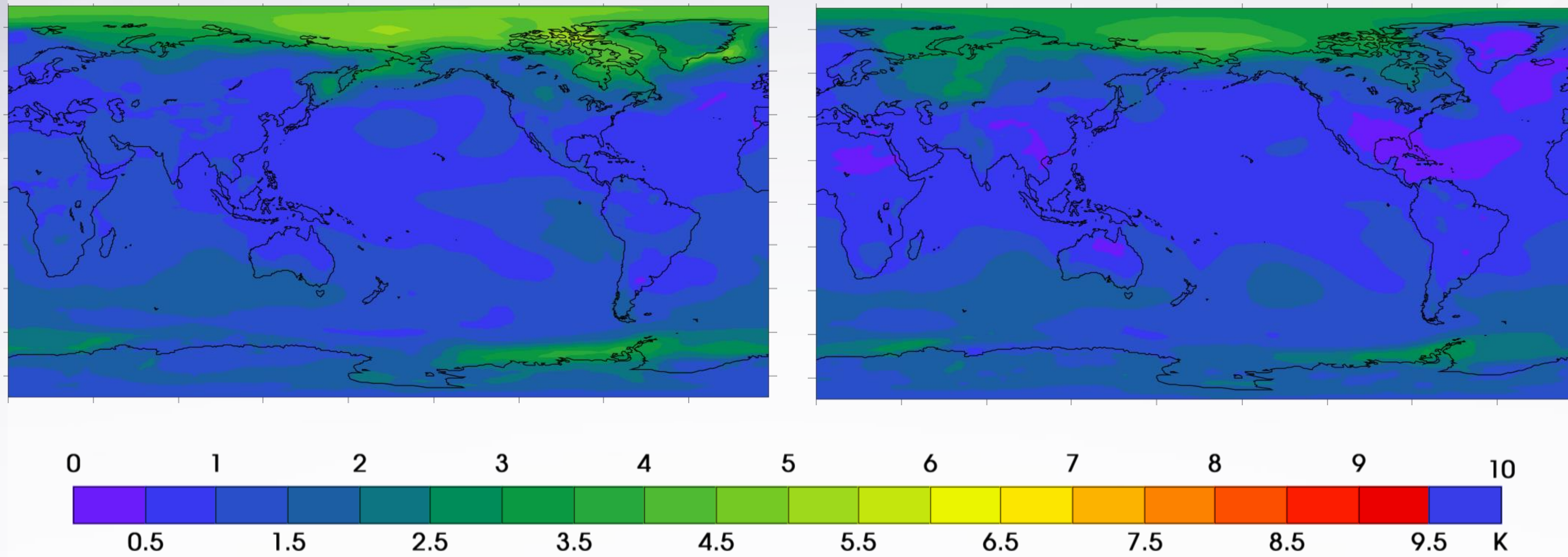
DMS Impacts Surface Temperature

1850 Global mean = 1.28 K

2000 Global mean = 1.10 K



Ice albedo feedback works in both directions.

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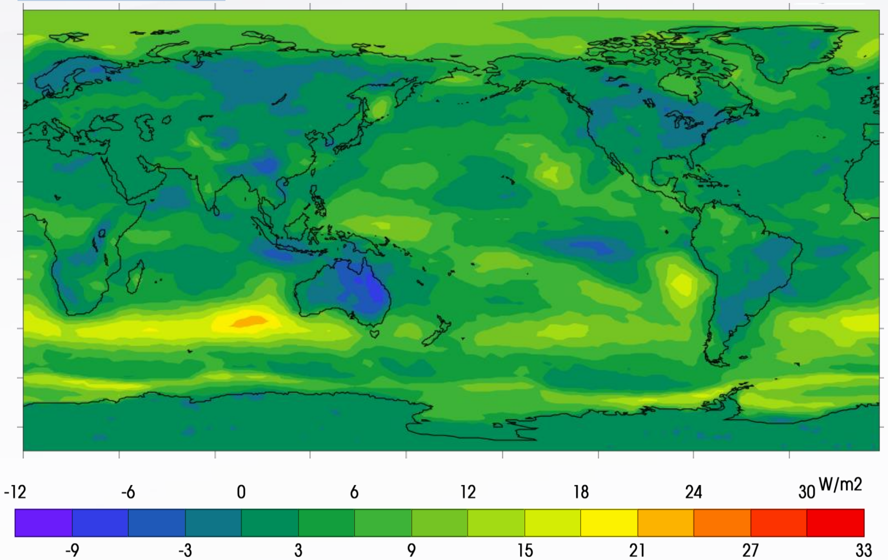
Short-wave sensitivity is only slightly higher than observations

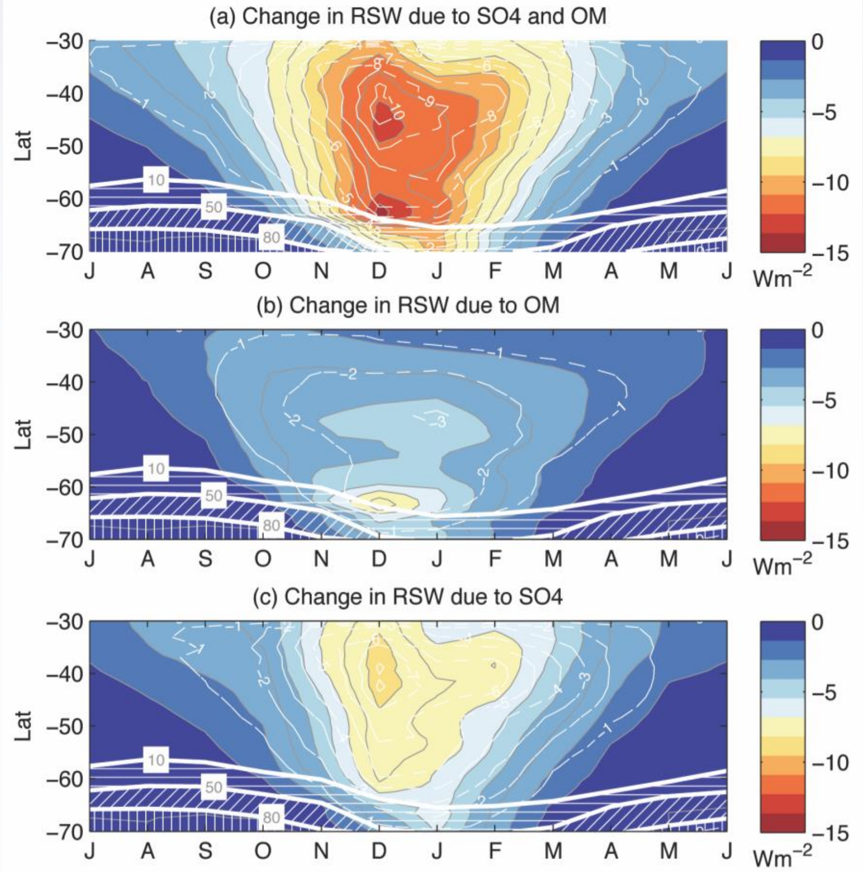
Model Shortwave Sensitivity to Aerosols

2000

Global mean = 4.19 W/m²



Observed Shortwave Sensitivity to Aerosols
McCoy, Burrows et al. (2015, submitted)



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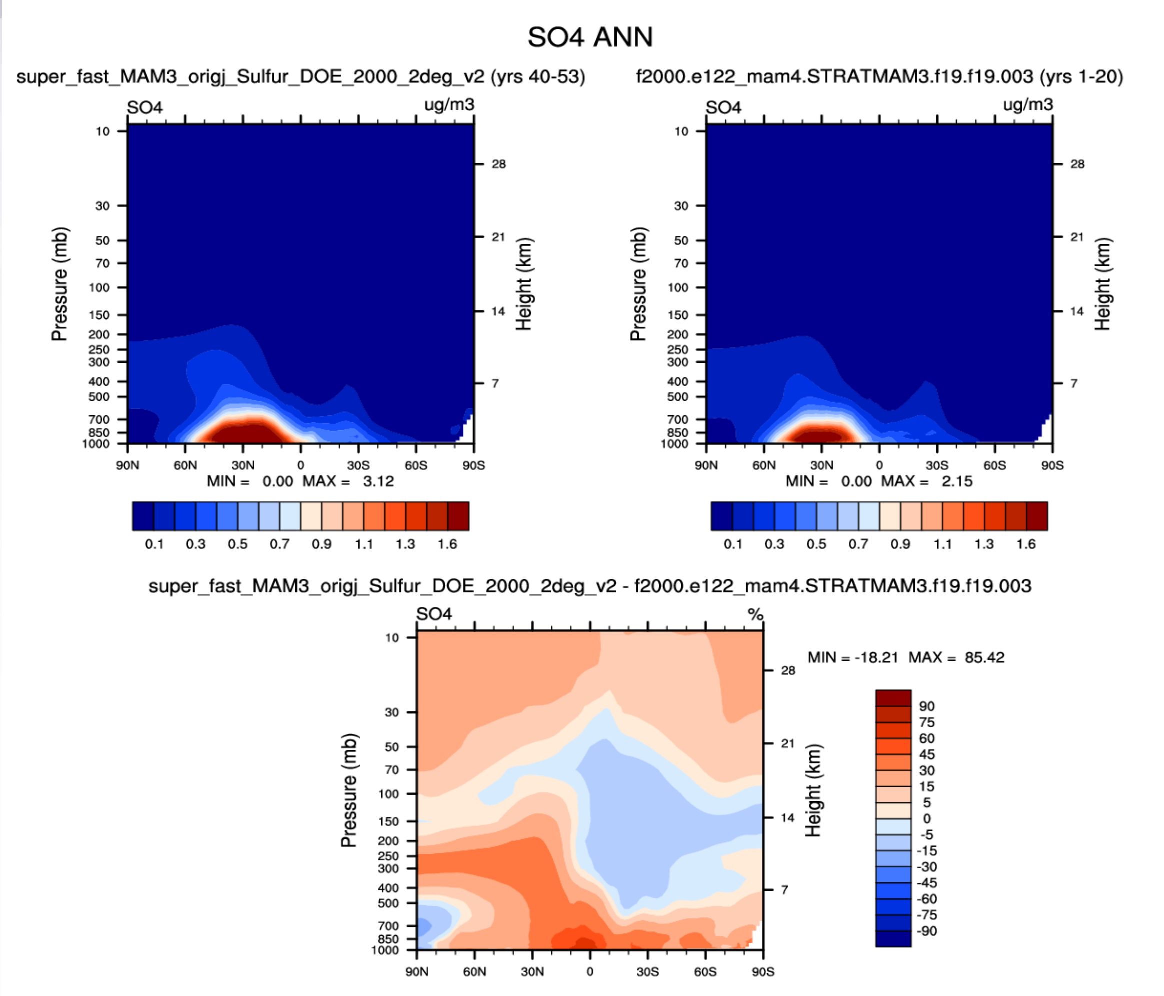
SO4 higher than reference from Simone. Maximum error at surface.



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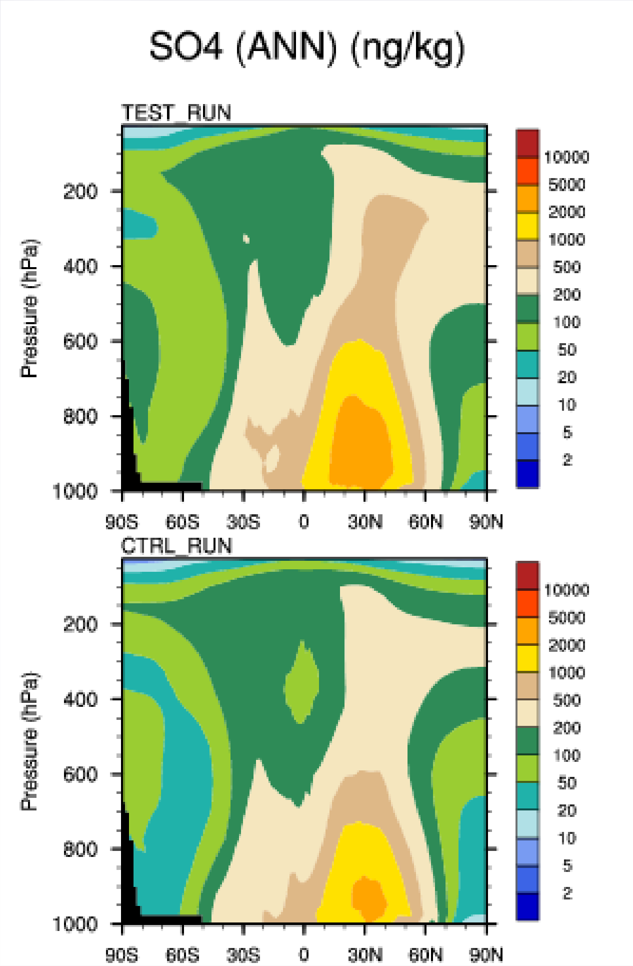
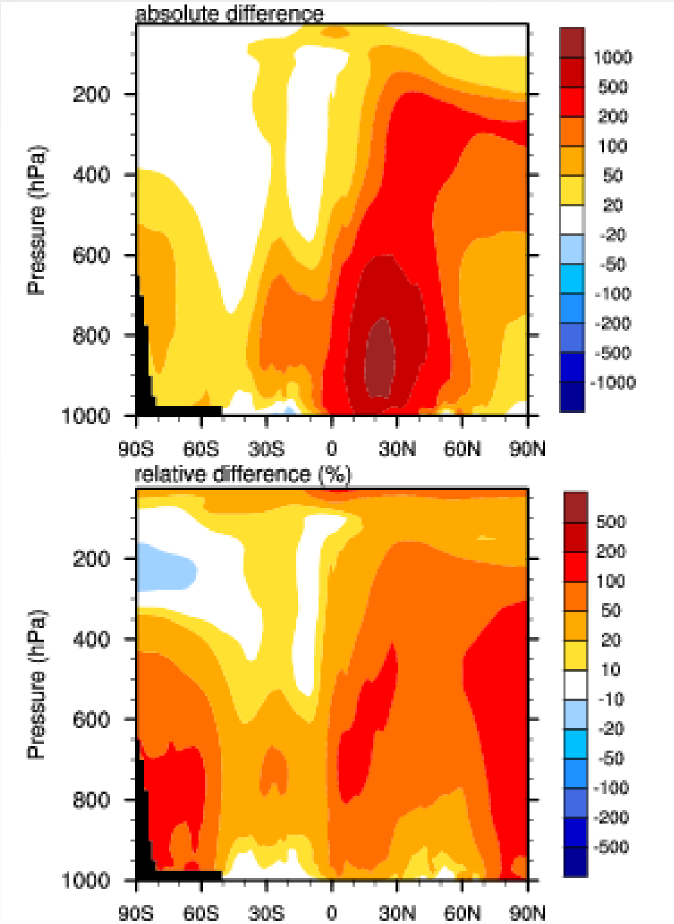
SO4 higher than reference from Manish. Maximum error aloft.





Diagnostic package from Po-Lun

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Lessons Learned

1. AMWG diagnostic with chemistry installed at ORNL (major credit to Simone).
   a. Now works on machines other than Yellowstone.
   b. Now works when output variables are not available
   c. Fixed a few bugs in tables and plots.
   d. Need many additional output variables.
      a. Will get many of those needed with `history_aerosol=.true.`
2. Don't use default lightning scaling.
   a. Caught error by using diagnostic package.
   b. It isn't added to cam_nl, unless specified.
   c. Default is `lght_no_prd_factor = 1`
   d. For 2 degrees, use `lght_no_prd_factor = 3`

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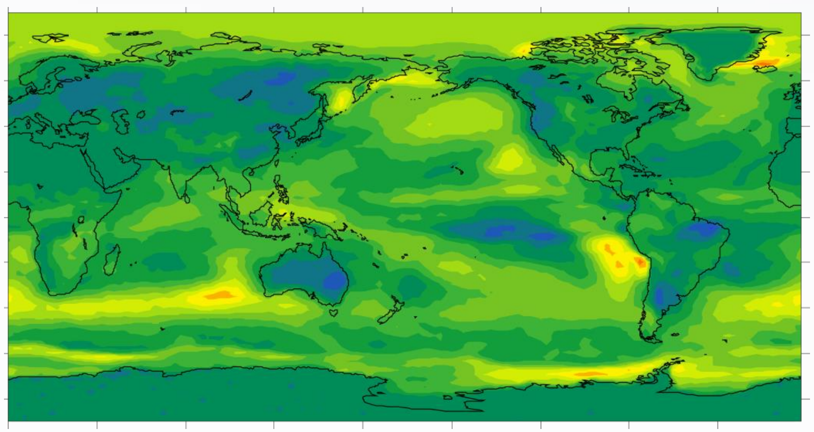

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