Aerosol/Transport issues in VOCALS region

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Perspective

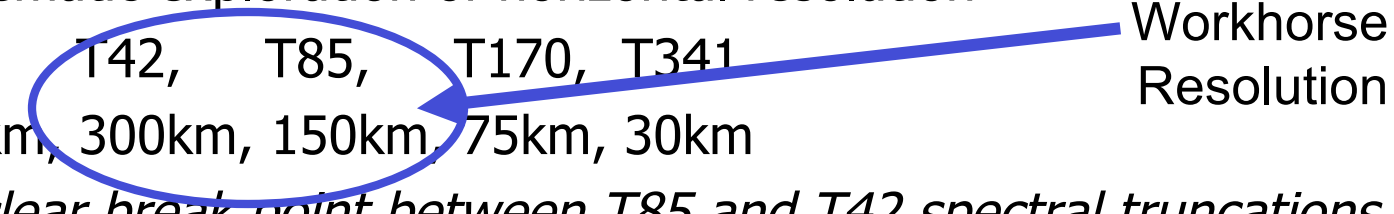
- Global climate modeler, a general rather than detailed perspective on the aerosol or cloud microphysics
  - Deliberate avoidance of discussion of PBL/clouds
- Capabilities and difficulties of models treating these problems.
- Avoid distinction between climate and chemical forecasting issues

Issues

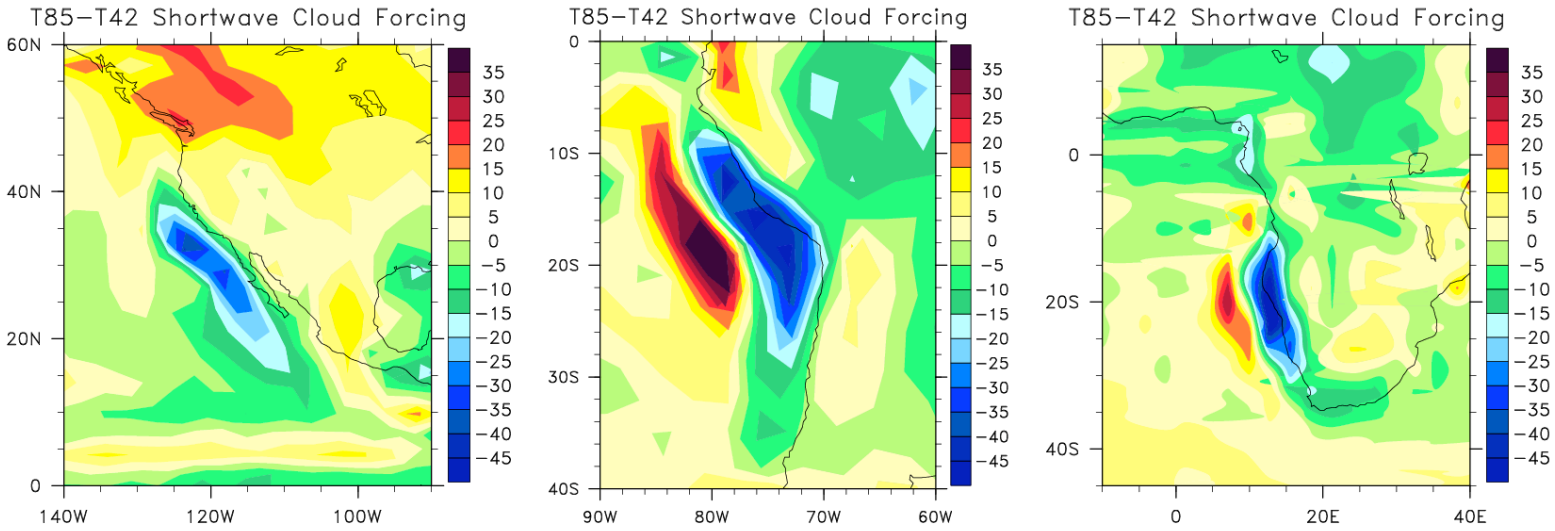
- Understanding is complicated by extremely strong gradients in:
  - Topography => wind fields, clouds, precipitation
  - SSTs, land/sea contrasts
- Uncertainties in Sources of constituents
  - Natural (SOA from VOC, DMS, Biomass burning)
  - Anthropogenic (Fossil fuel, Biomass burning, biofuel)
  - Choices of emission factors
- Aerosol/transport influenced by resolved meteorology, PBL processes, Clouds
- Sources are combination of
  - local (copper smelting, cities, etc)
  - Regional (e.g sea salt)
  - Remote (Northern hemisphere sources, Brazil)
- Sinks and Chemical transformation largely depend upon clouds and PBL processes

Resolution issues

- Climate models typically work at lower resolutions but expect reasonable response of system
  - Systematic exploration of horizontal resolution
  - T31, T42, T85, T170, T341
  - 500km, 300km, 150km, 75km, 30km
    - *clear break point between T85 and T42 spectral truncations*
    - *very modest improvements in mean climate above T85*



Resolution signals in CAM3 (T42 ⇒ T85)



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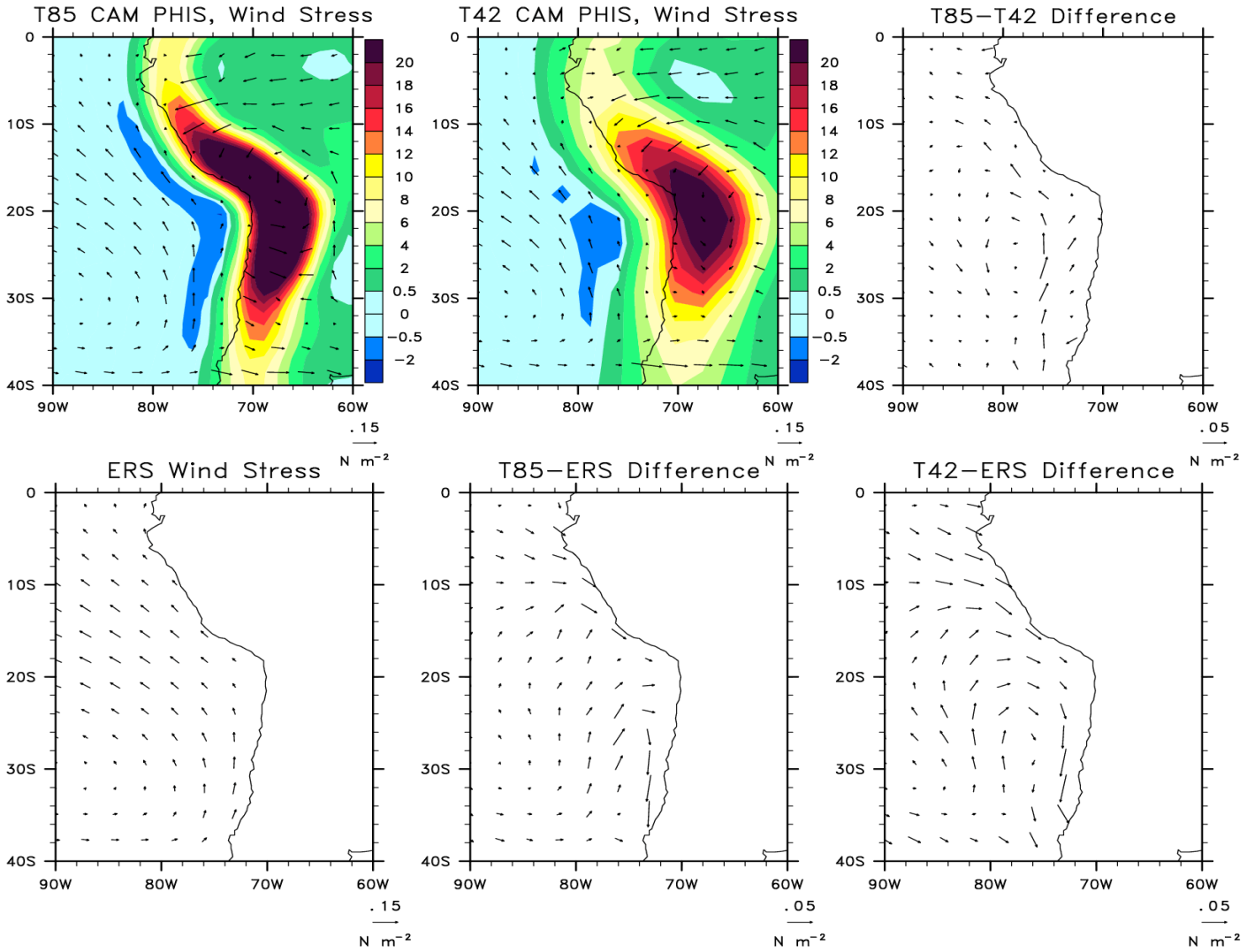

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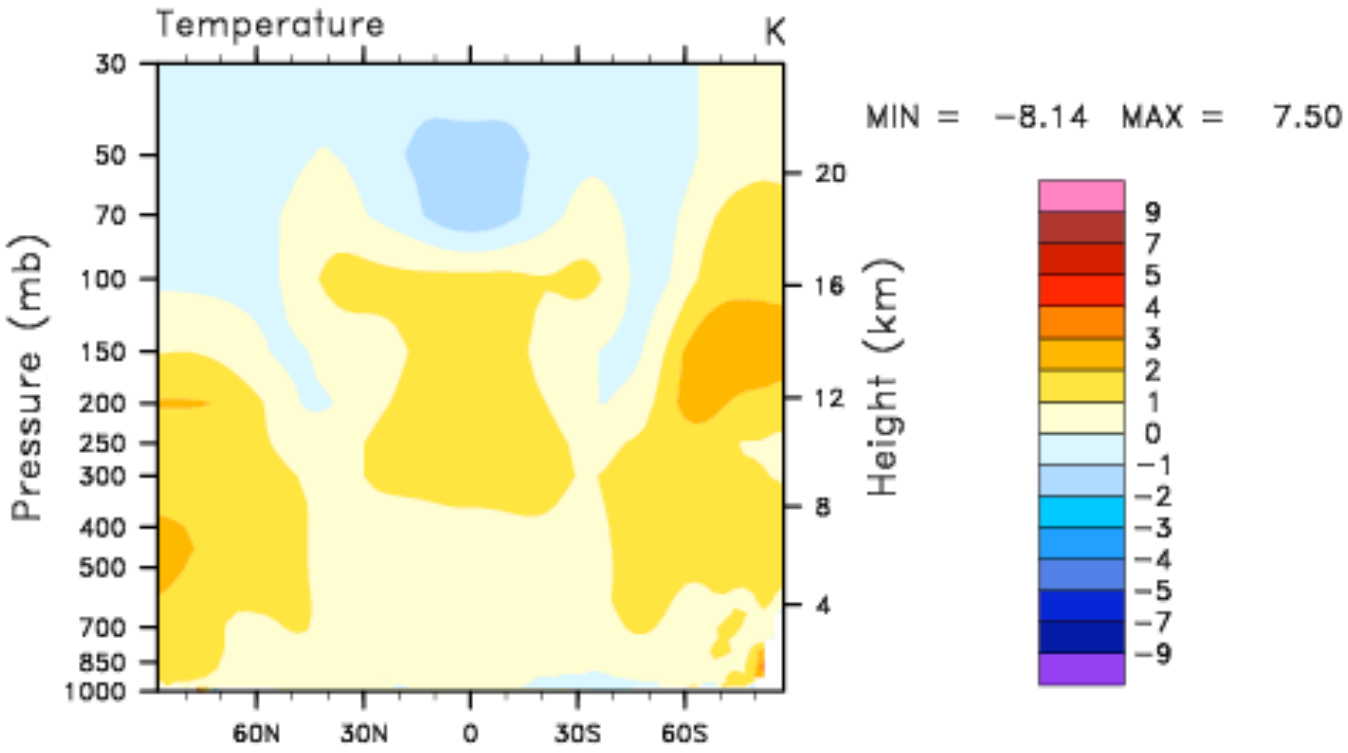
Resolution signals in CAM3 (T42 ⇒ T85)



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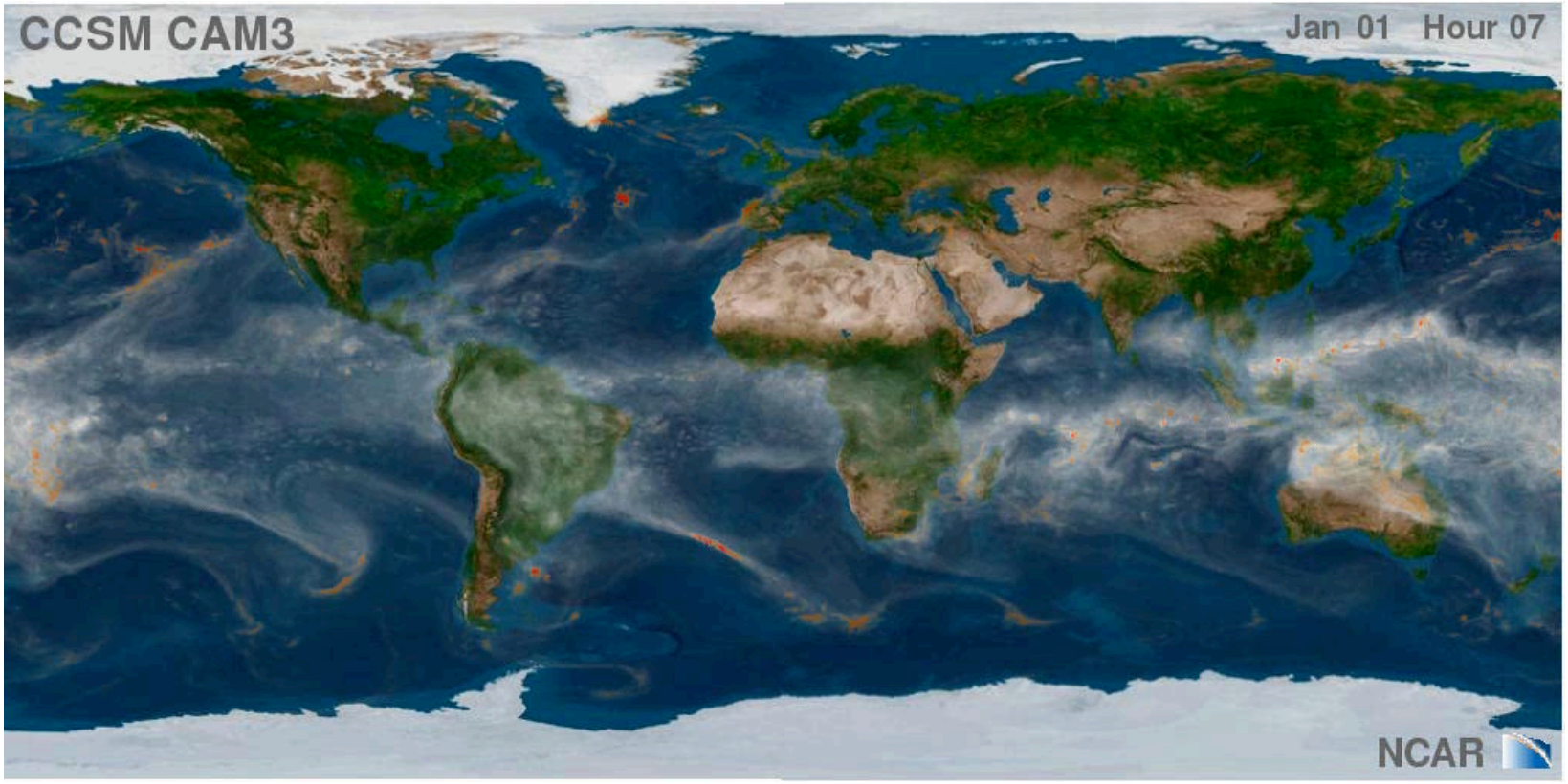
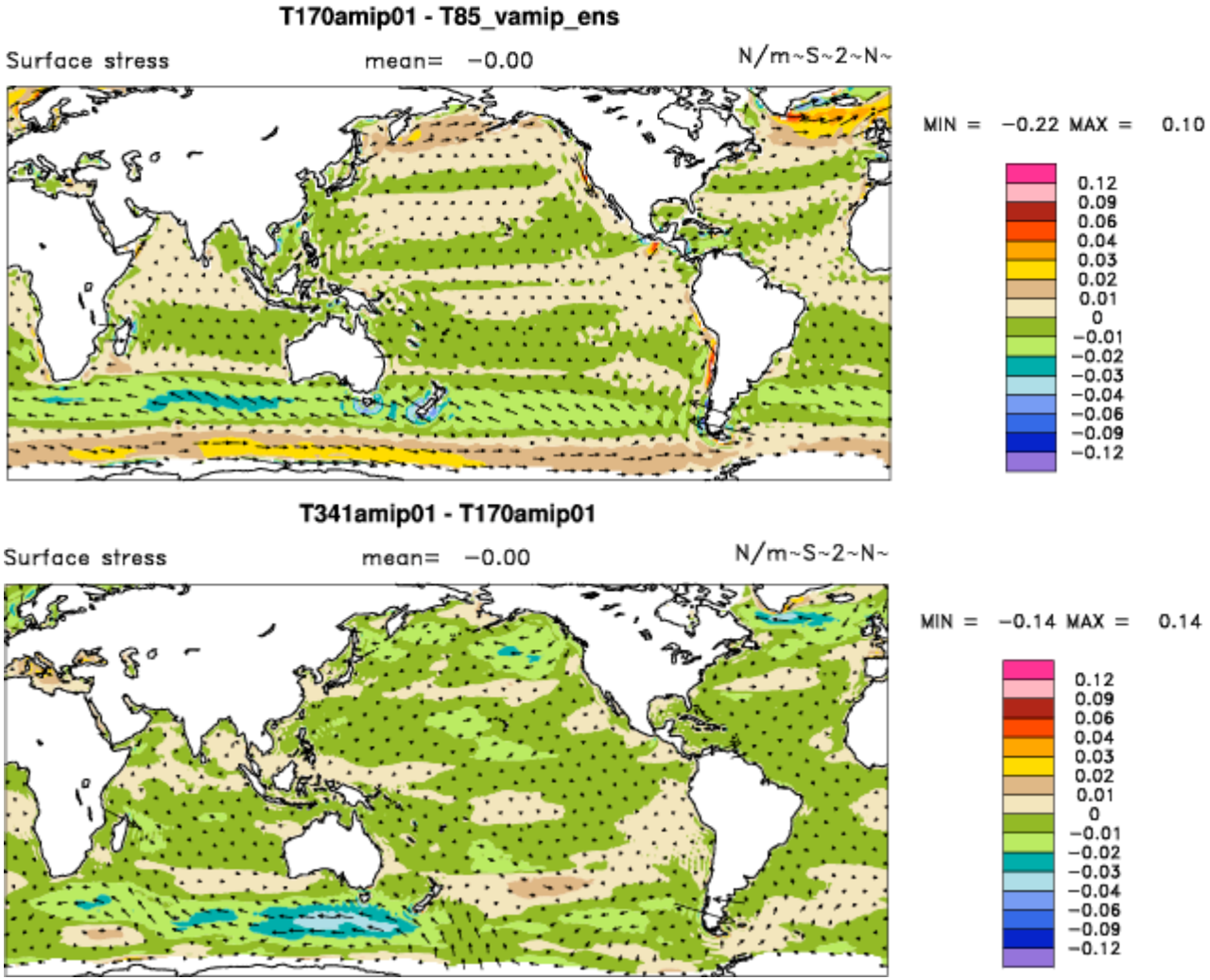
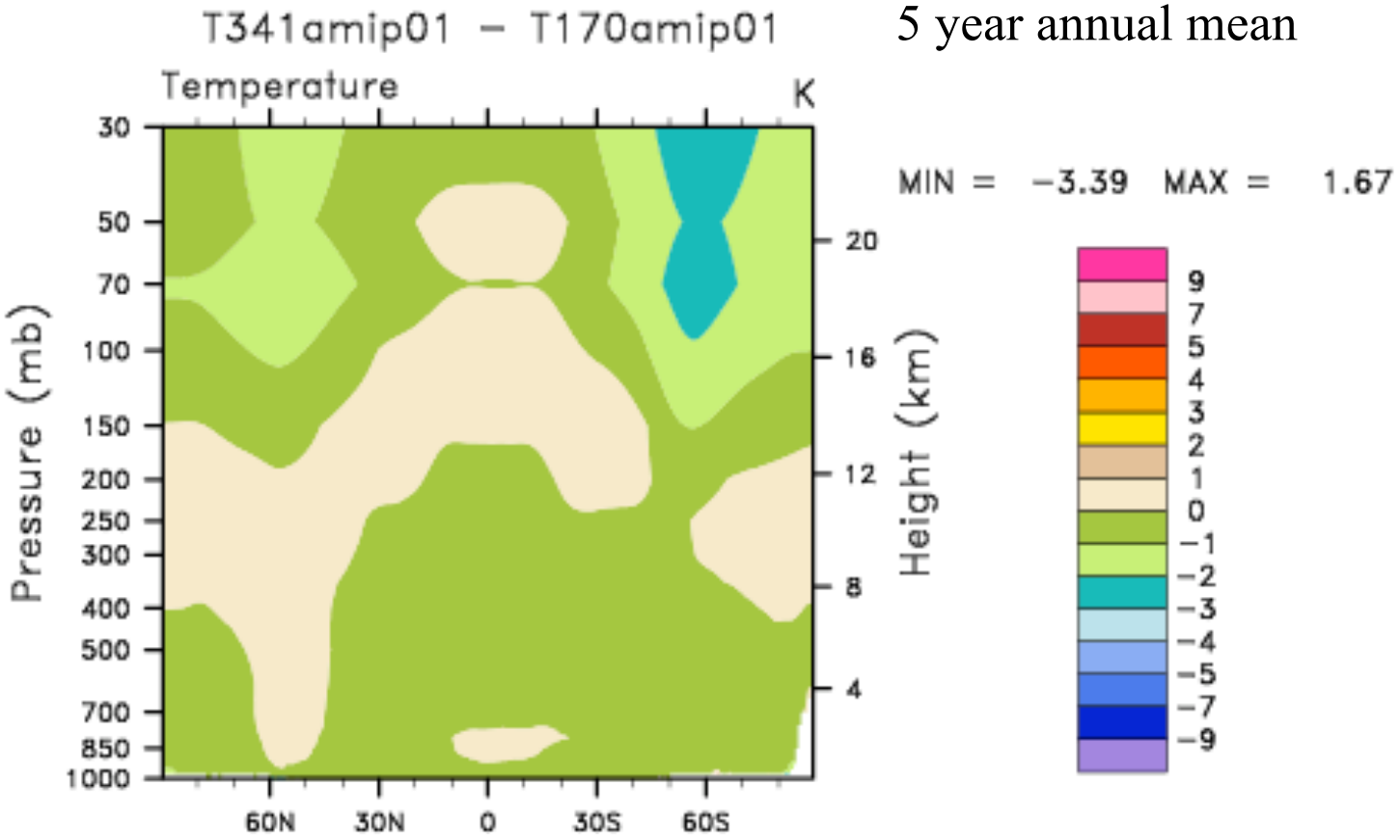
T341 Animation of Precipitable Water and precipitation



Resolution signals in CAM3 (T170 / T341)



Resolution signals in CAM3 (T170 ⇒ T341)



5 year annual mean

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Aerosol Source distributions

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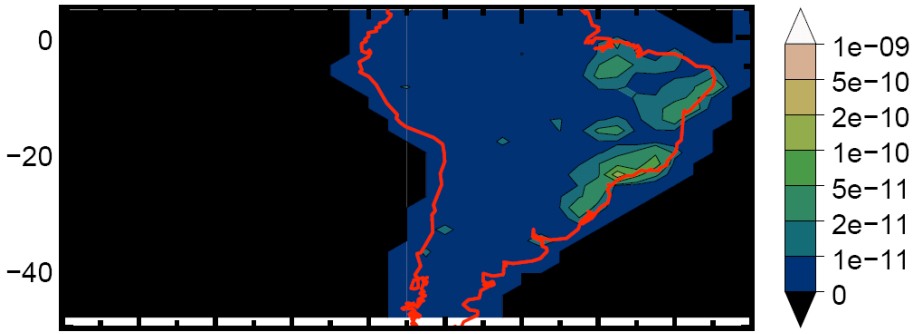

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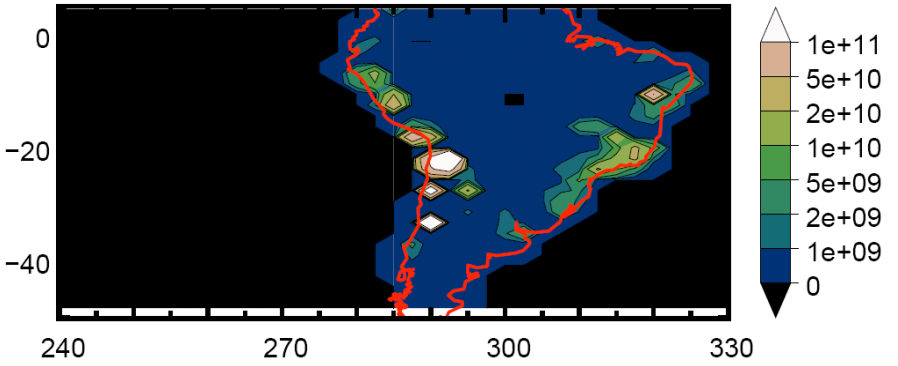

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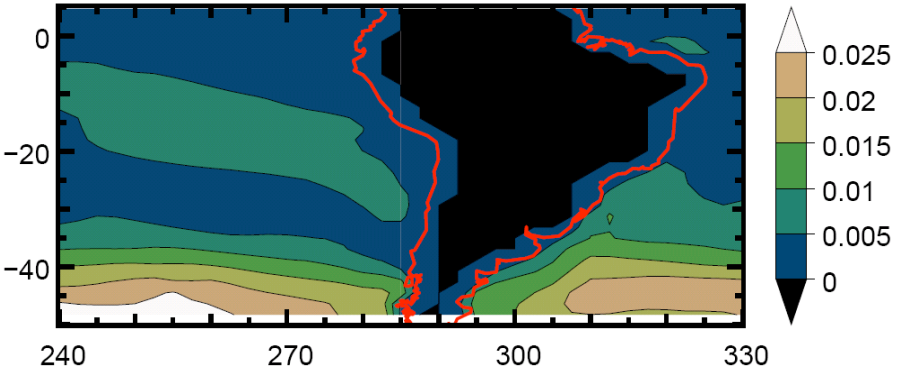

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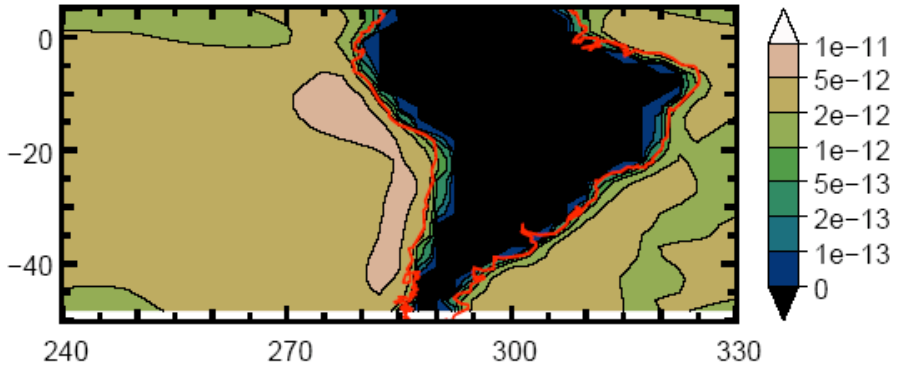

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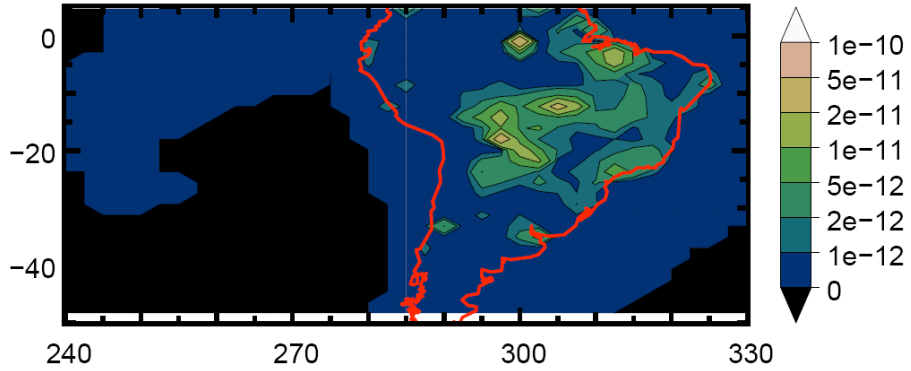

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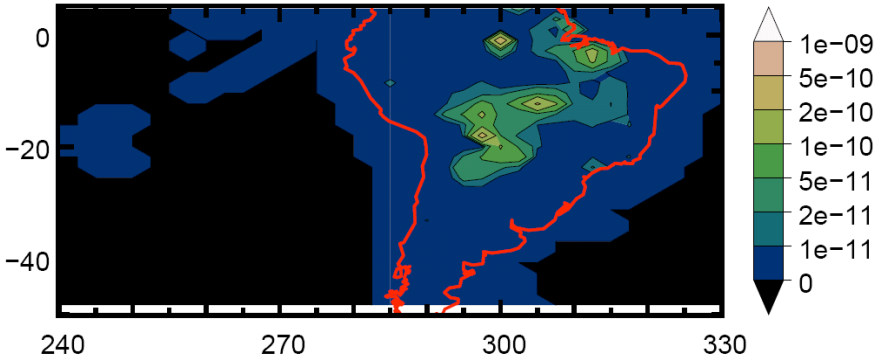
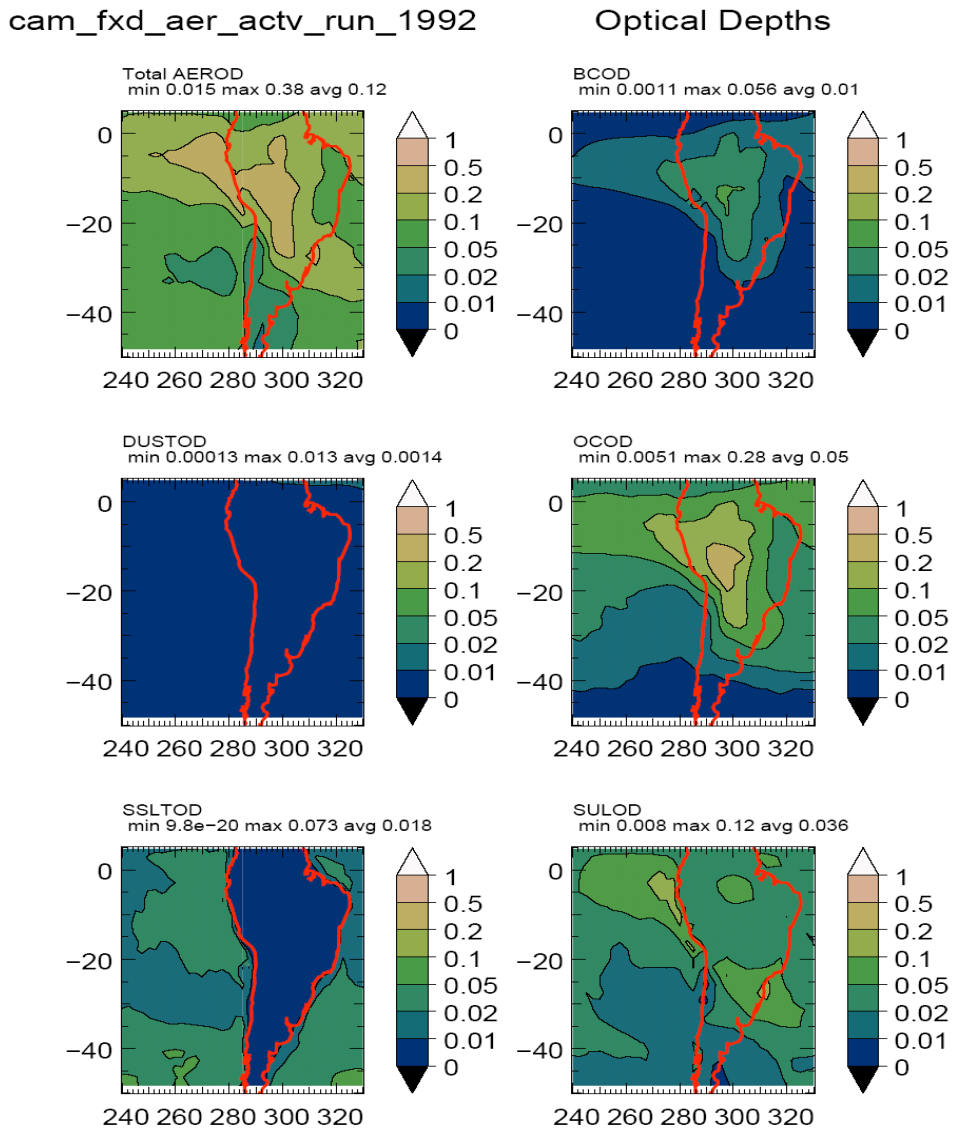


Aerosol Optical depth, total and by constituent type

Oct 1994



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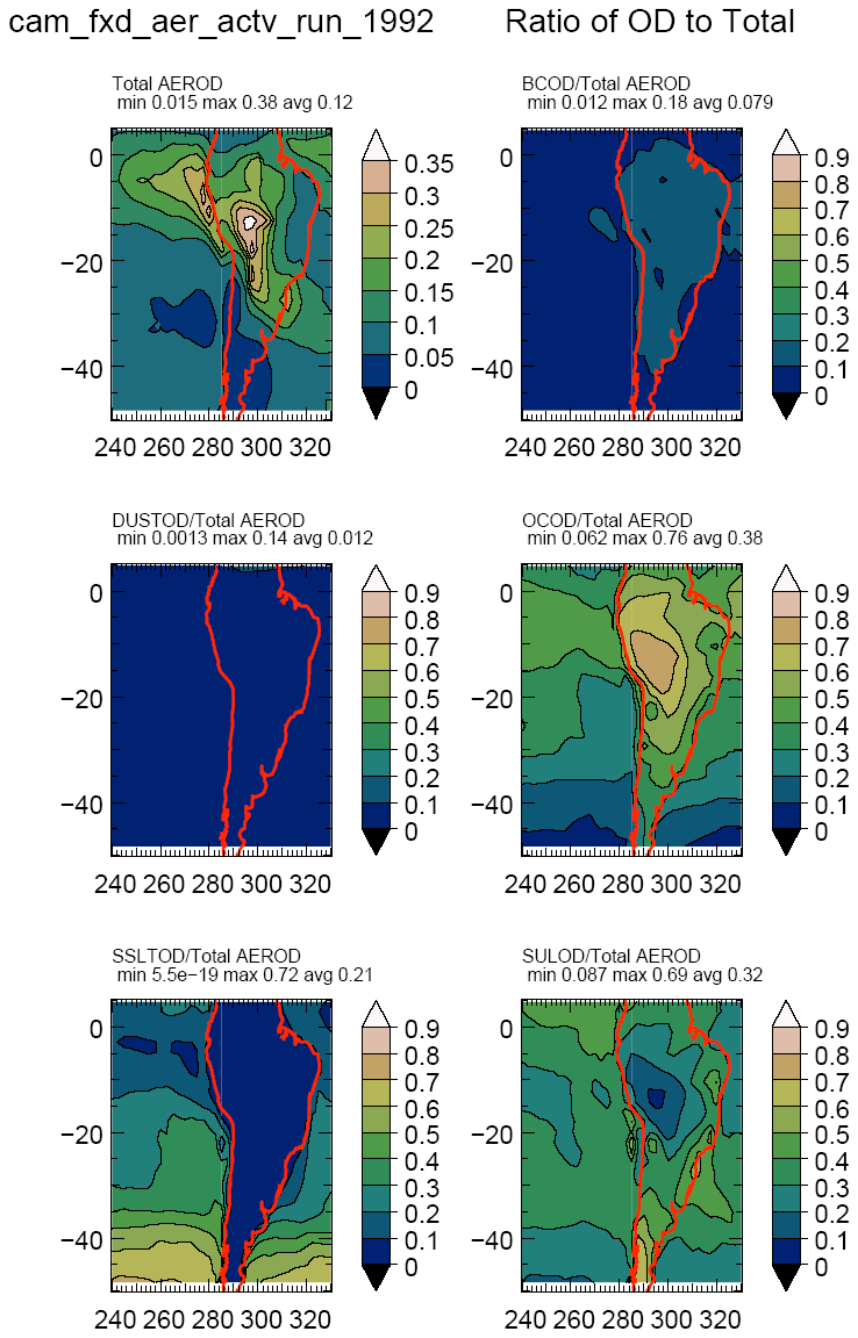
Ratio of component AOD to total AOD



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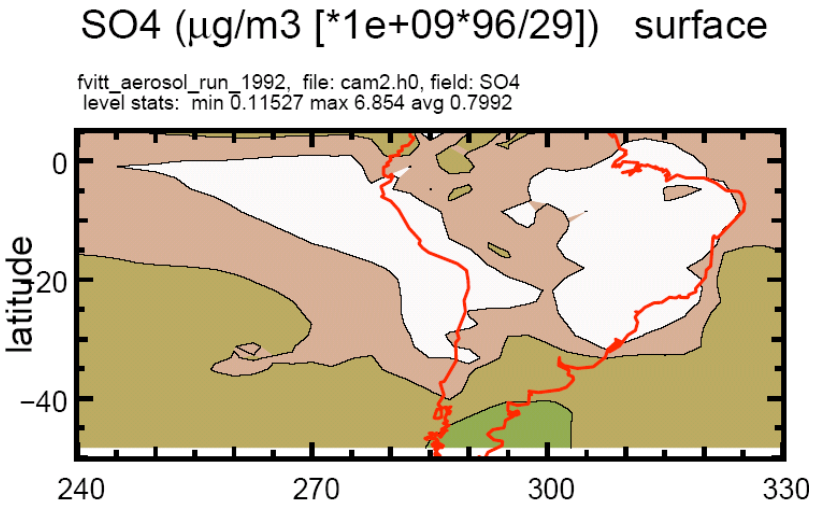
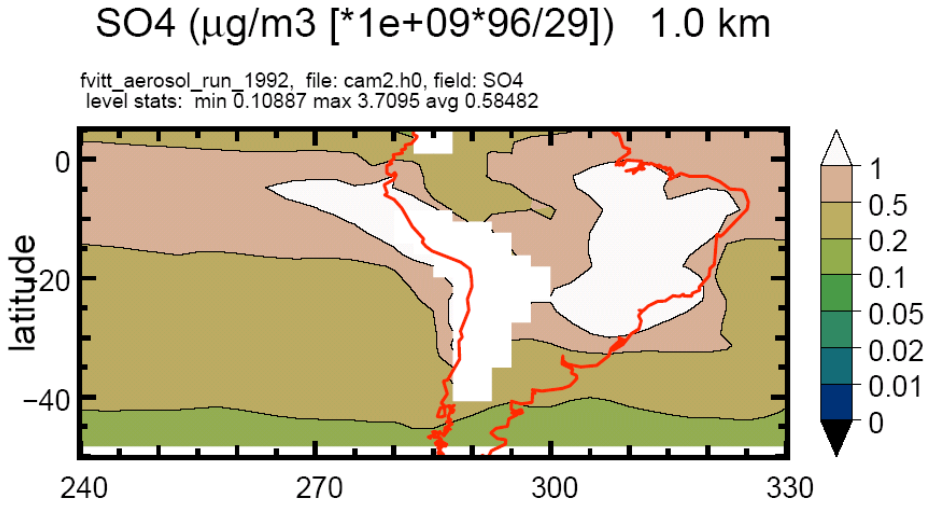
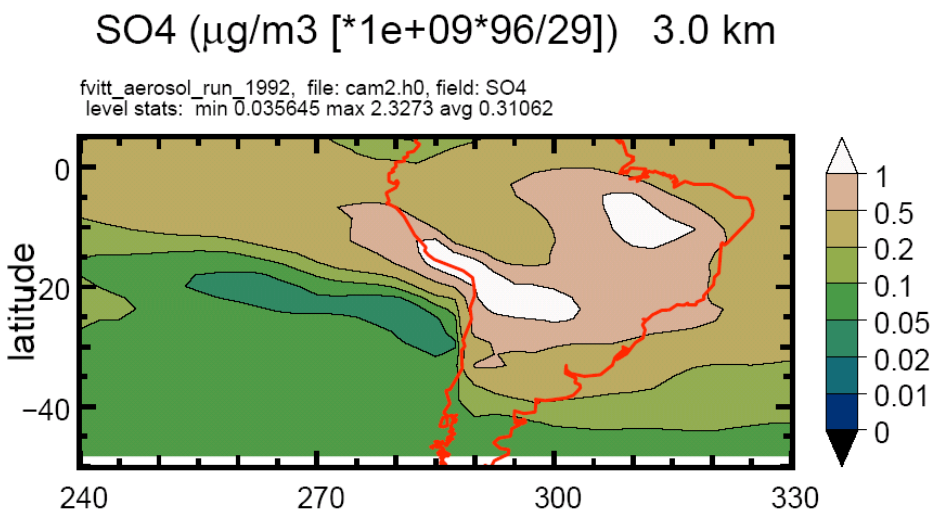
Sulfate Concentrations
(fixed height above sea level)







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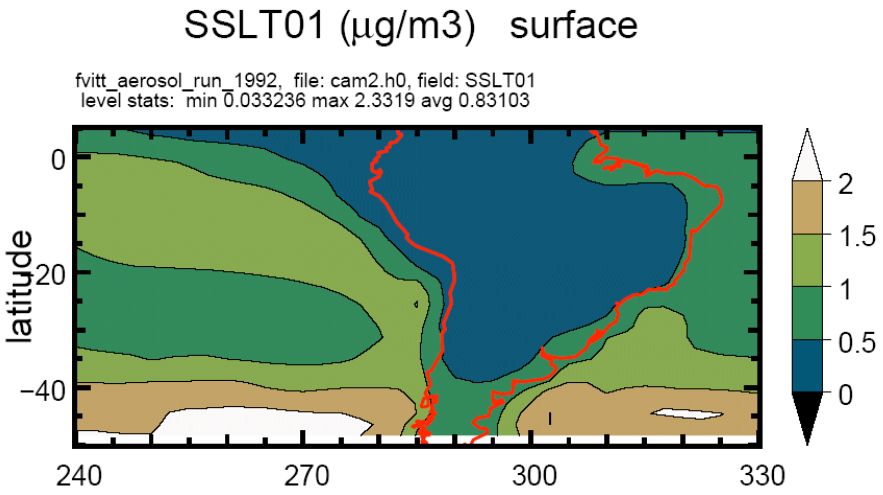
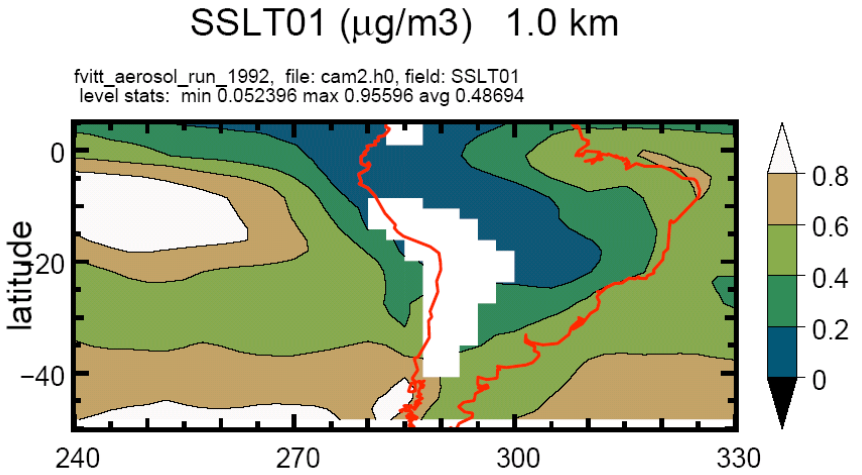
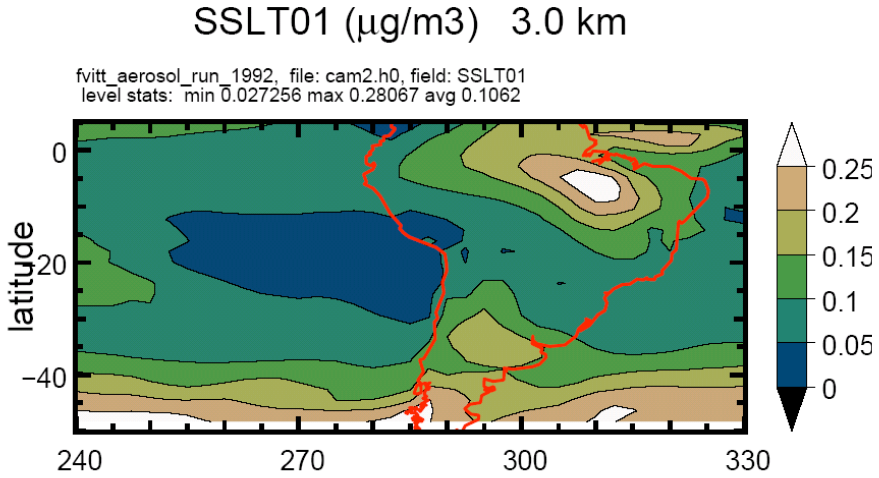
Submicron Sea Salt at fixed altitude above sea level (note diffs in contour interval)







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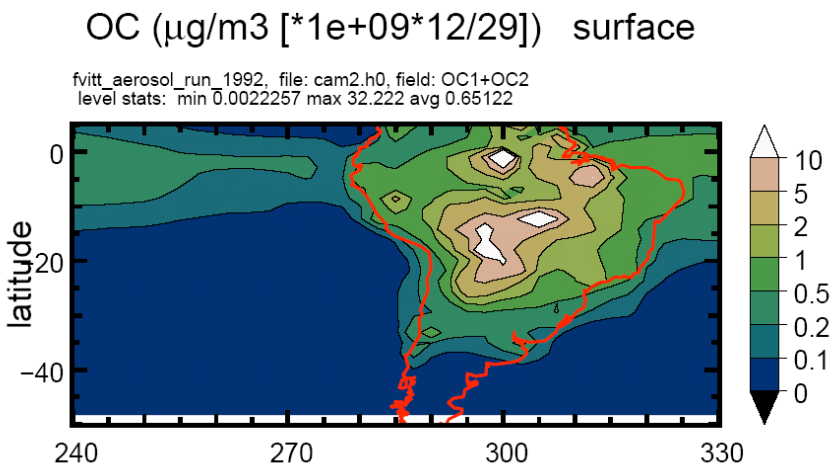
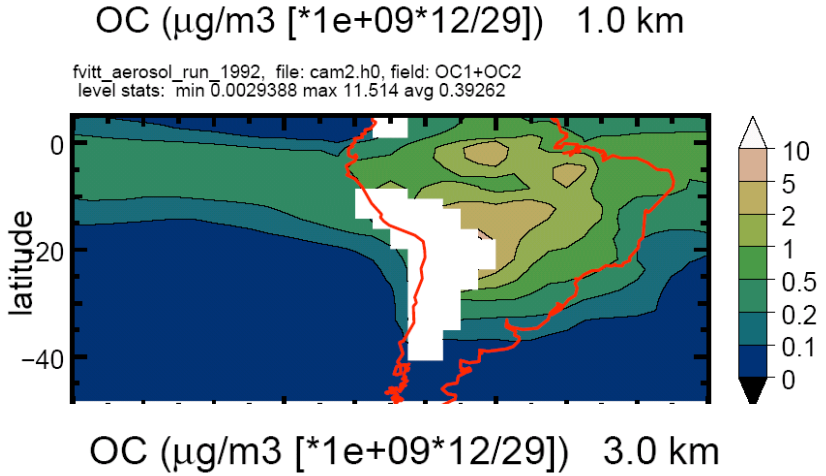
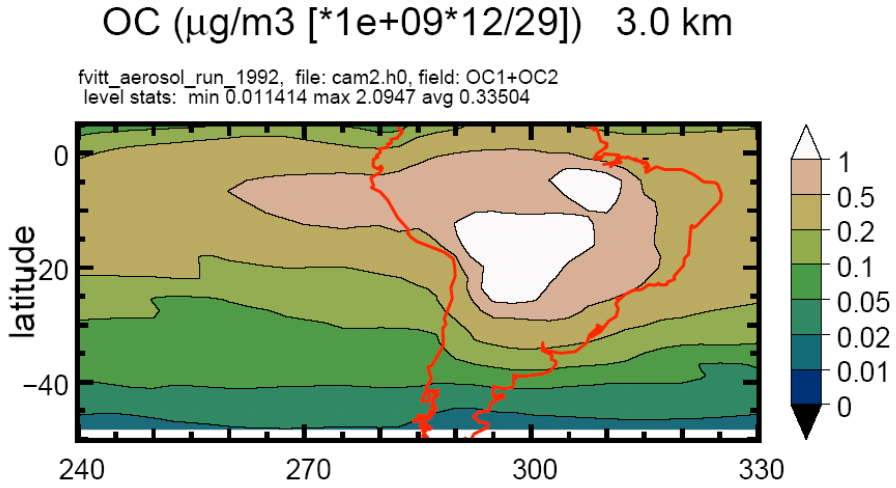
Organic Carbon at fixed height above sea level







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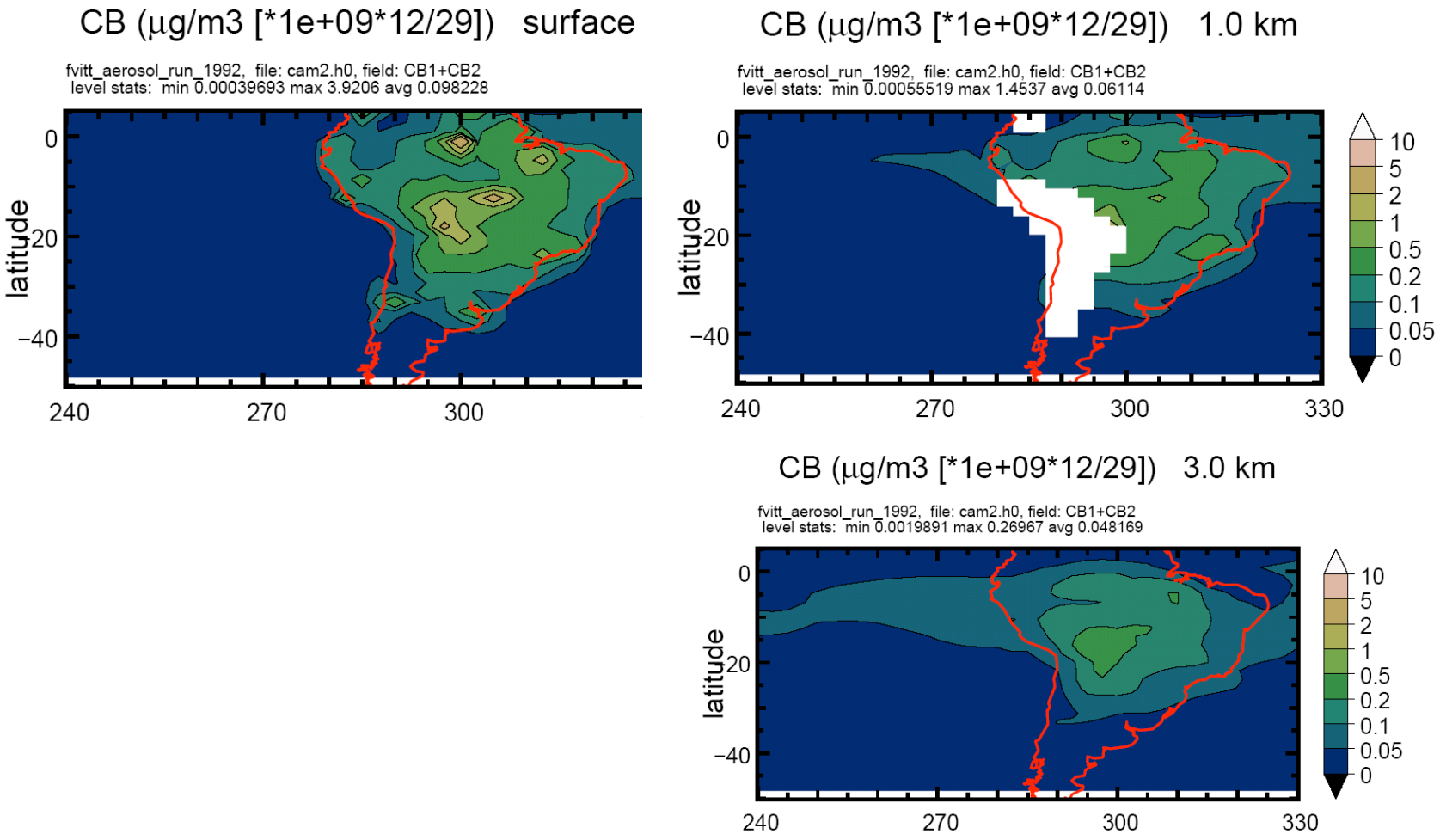
Black Carbon at fixed height above sea level



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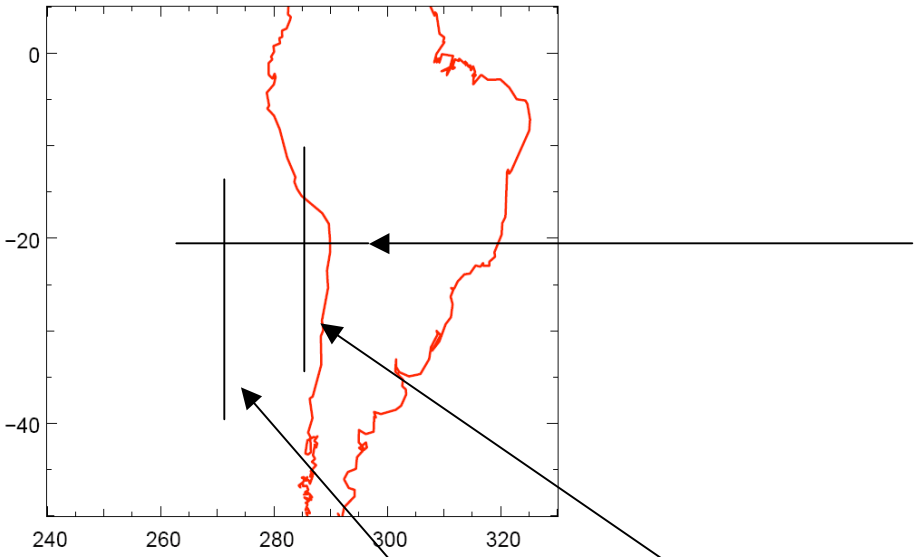
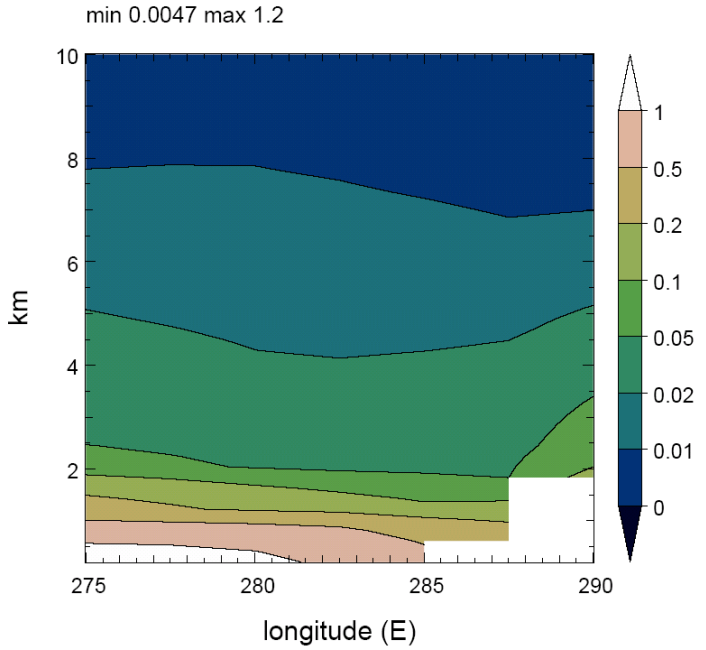
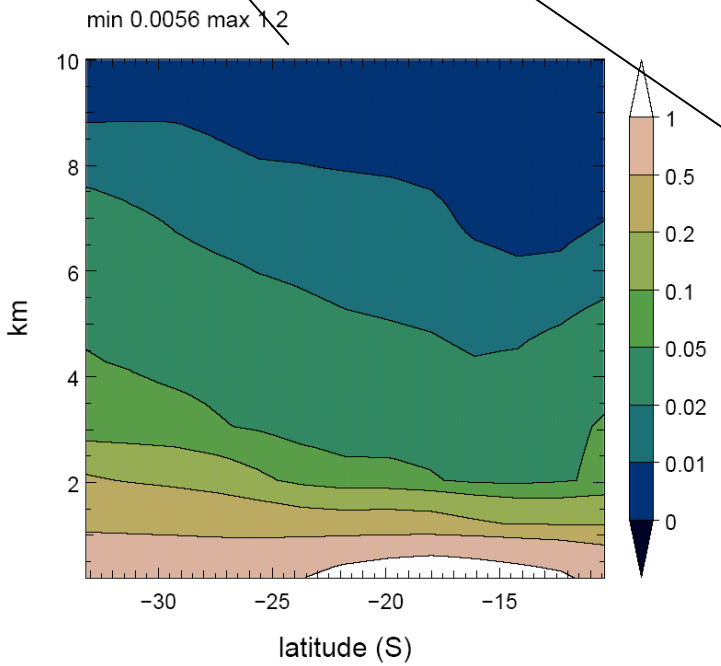
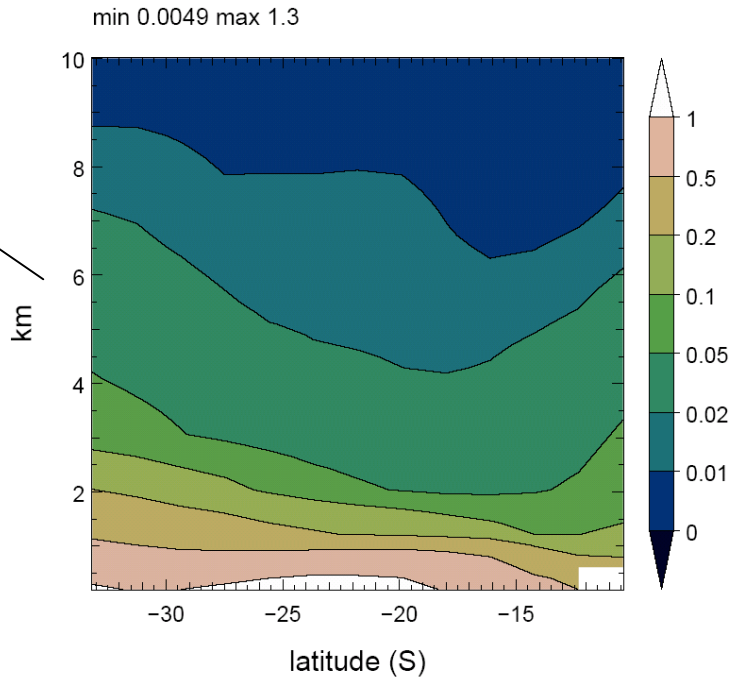
Sea Salt (submicron) Cross-sections









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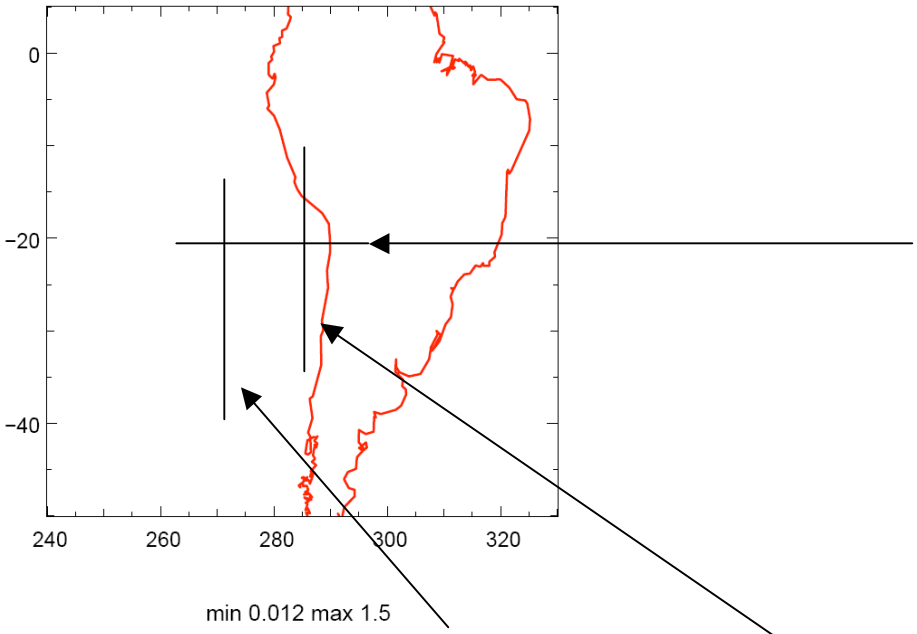
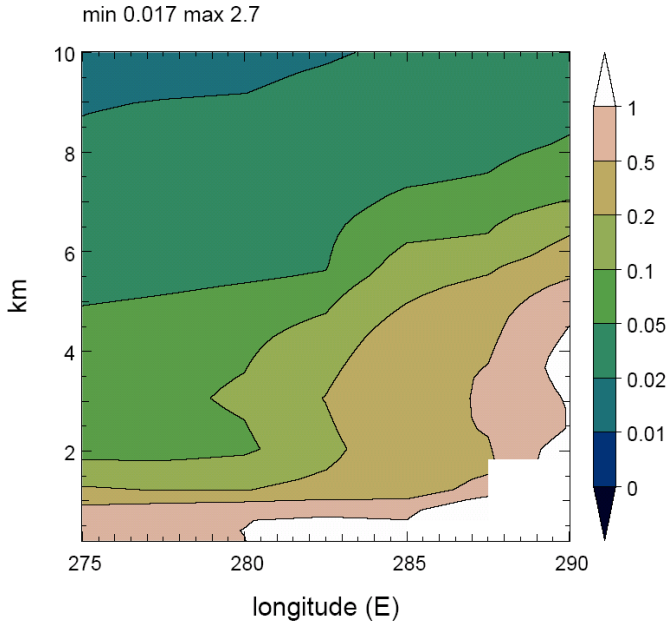
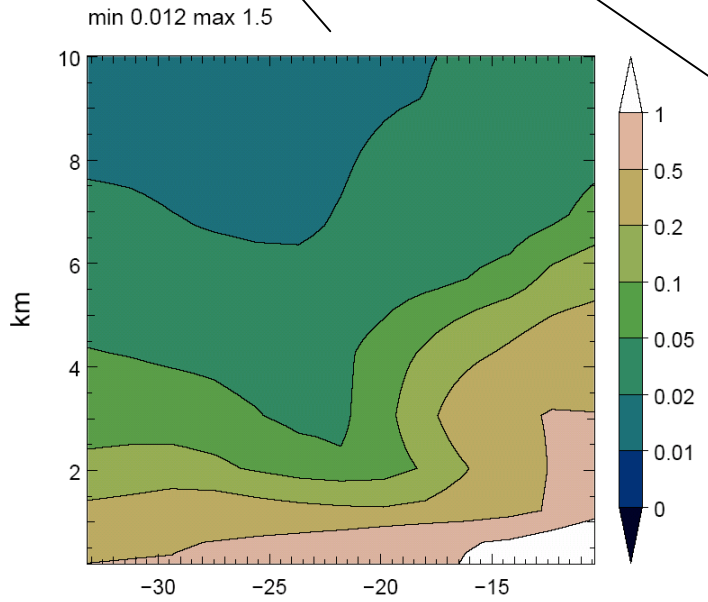
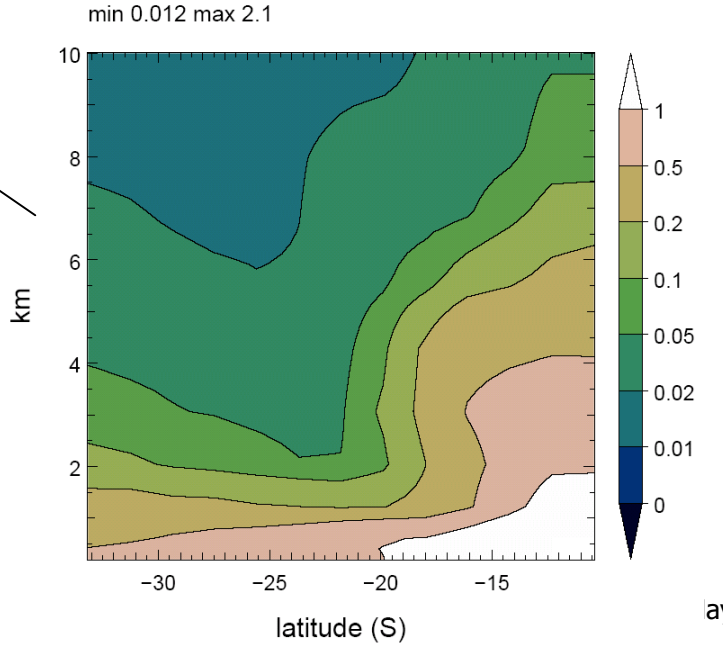
SO4 cross-sections









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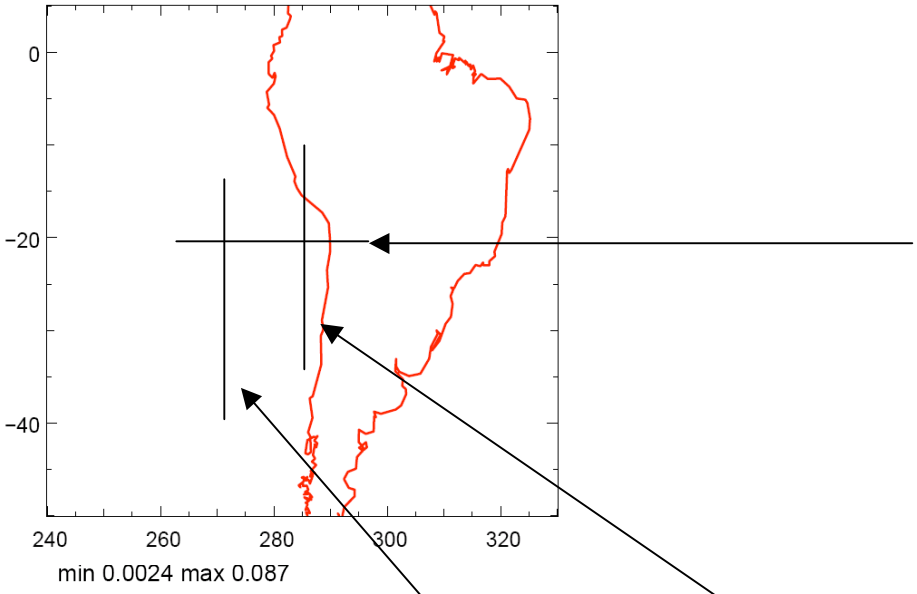
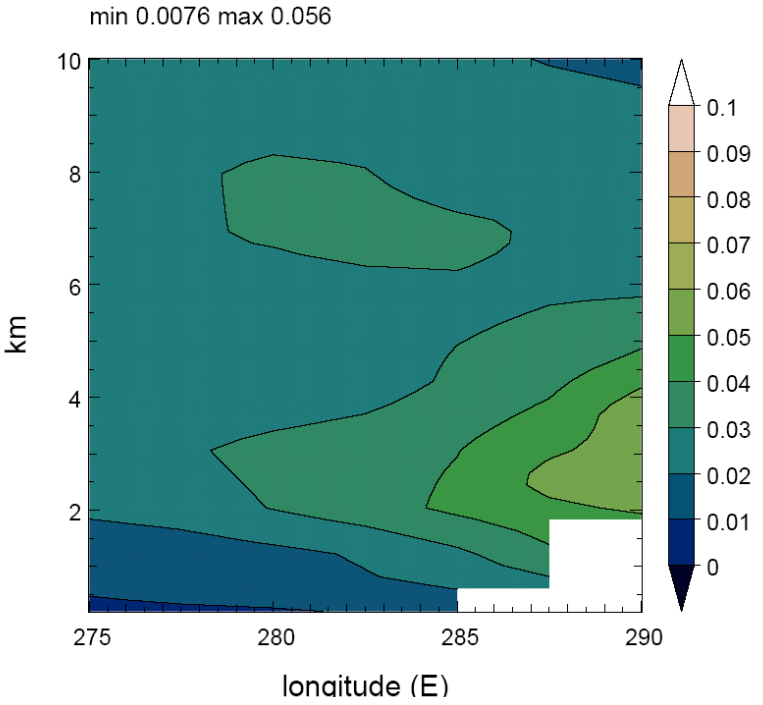
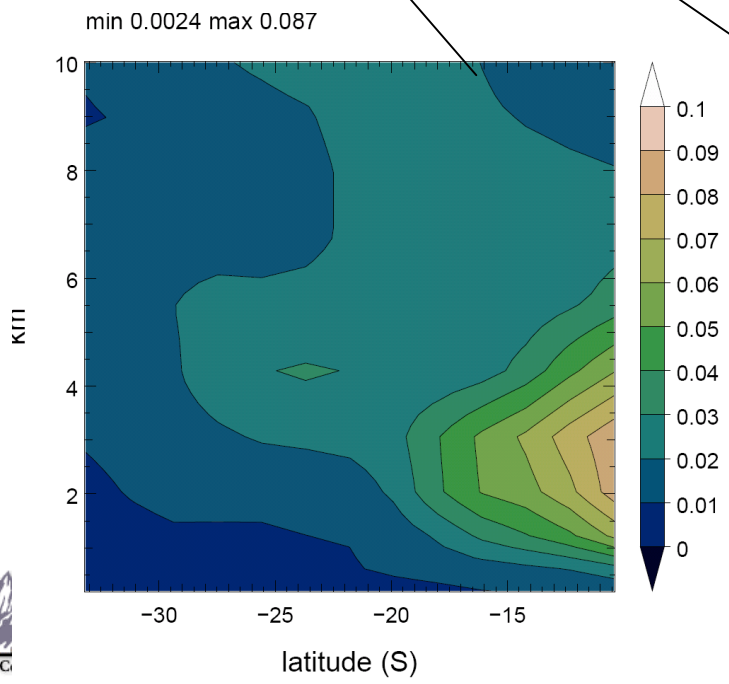
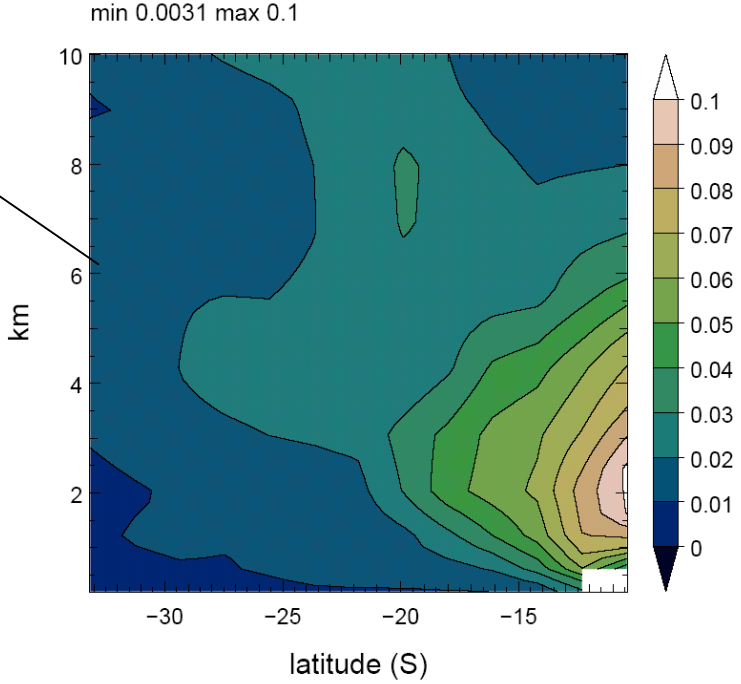
Black Carbon









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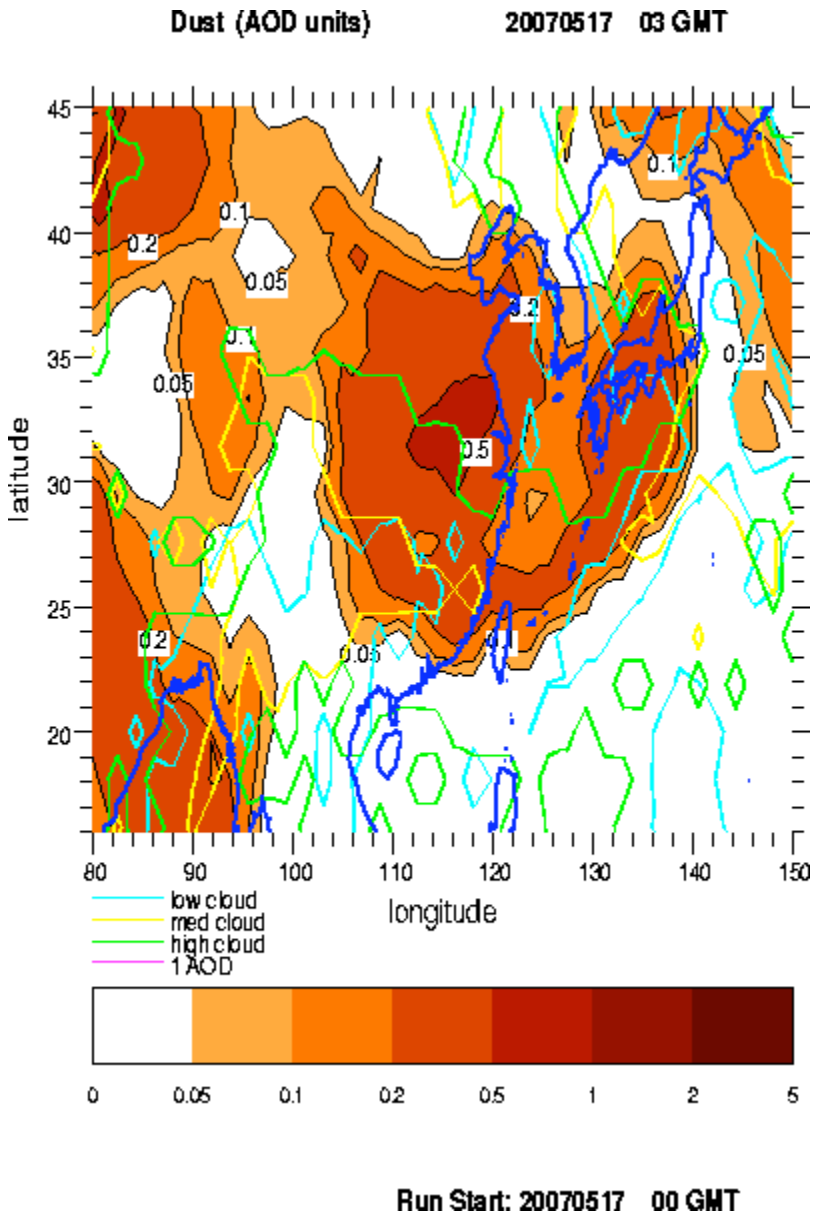
Aerosol Forecasting

- Can be used to
  - help guide field project
  - help interpret results
- Successful in
  - INDOEX
  - ACE-Asia
  - PACDEX (happening now)

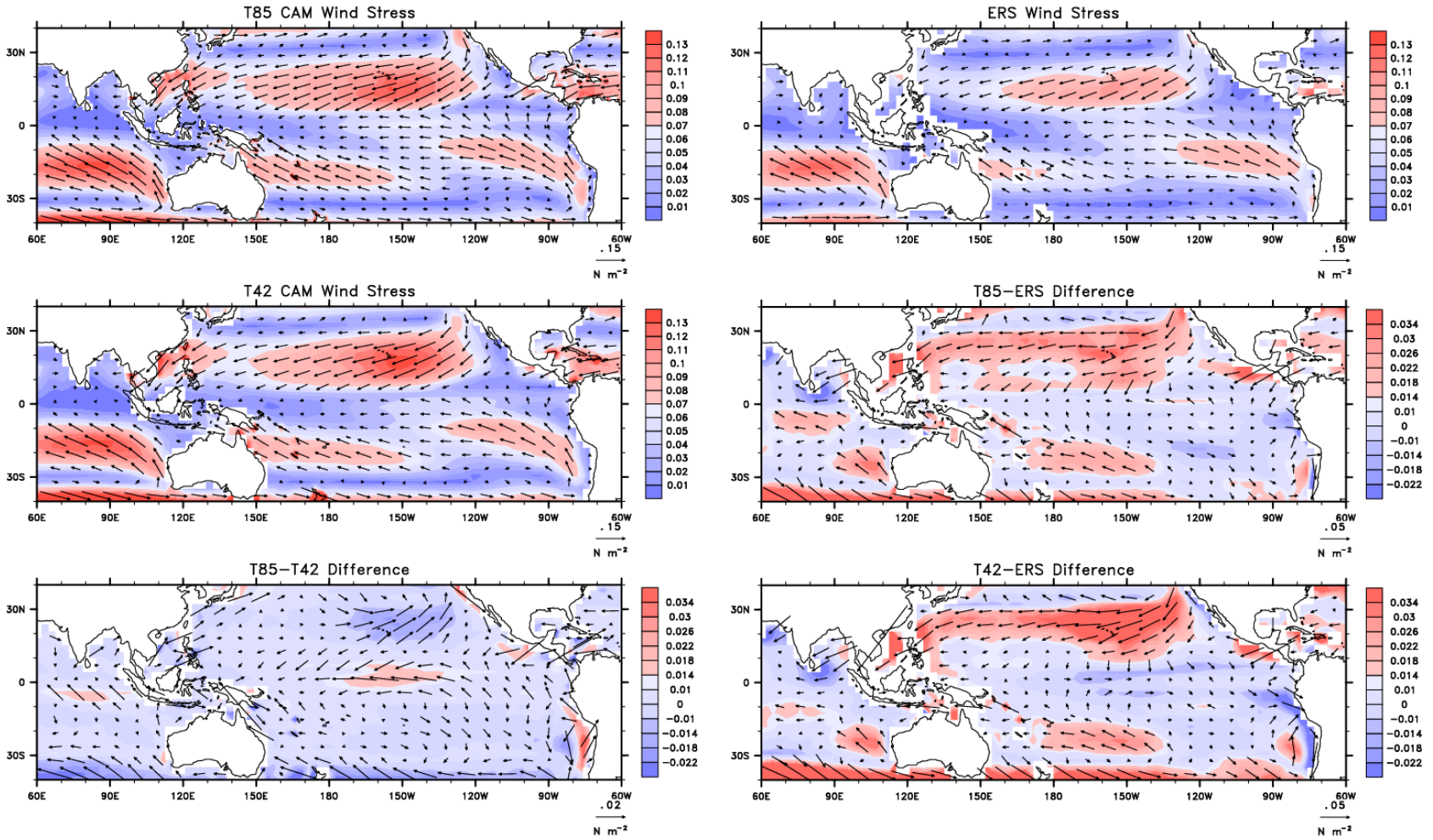


Closing thoughts

- This is a new regime to challenge aerosol transport and the subsequent impact on climate
  - Resolution/topography
  - Sources
  - Flow around topography
  - Potential for elevated plumes, difficulty for global models
  - Source for aerosols in clouds may be a combination of local and remote sources
  - Source for aerosols in clouds may come from cloud top, rather than from near surface
  - Dependence on ENSO
- Aerosol forecasting may prove useful to VOCALS

The End

Resolution signals in CAM3 (T42 ⇒ T85)



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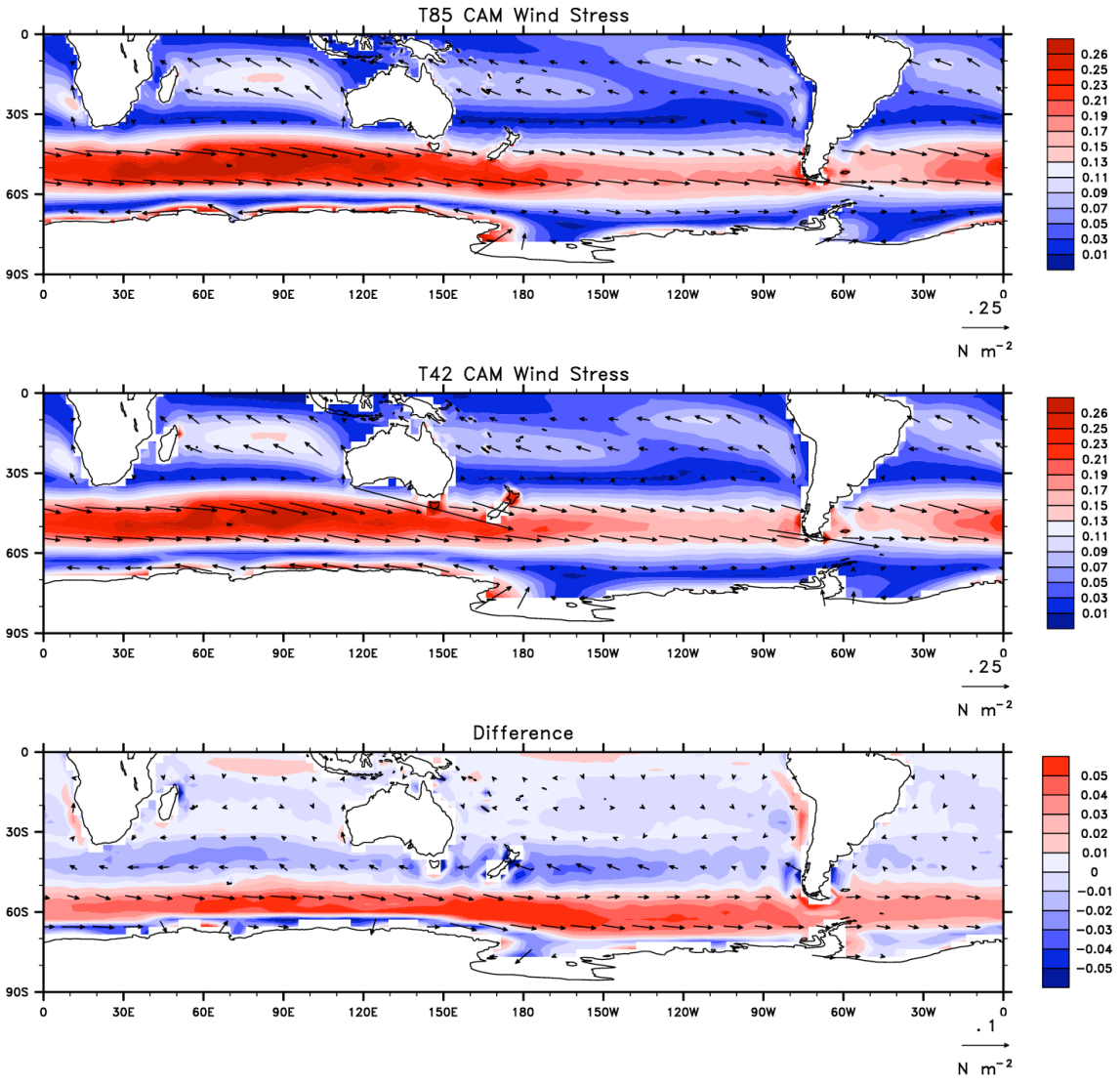

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Summary

- Horizontal resolution won't solve systematic error problems
  - important scales of motion span>10 orders of magnitude
    - *clear break point between T85 and T42 spectral truncations*
  - parameterization of physical processes is pacing progress
  - brute force strategy not an immediate 'operational' solution

- Systematically exploring new experimental frameworks
  - techniques to embed mesoscale modeling frameworks
    - *relatively inexpensive way to explore scale interaction questions*
    - *hierarchy of nesting techniques (one-way vs two-way, physics suite,)*

Evaluation of the experimental framework

- Analysis of initial experiments underway
  - analysis of climate metrics, both mean and variability
  - analysis of systematic biases imposed by specified lateral forcing

- Analysis of mean quantities in global simulations
  - suggests need to carefully treat lateral boundaries
  - need to specify *ALL* state information
  - need to consider variability properties of the lateral forcing

Example of Cloud Ice Water Loading