~~Limited Radiative Impact of Asian Tropopause Aerosol Layer~~

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By C. Monet, 1901

Composition and Radiative Impacts of ATAL Simulated by CESM/CARMA

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Main Points of This Presentations

1. UTLS aerosols in CESM/CARMA are constrained by multiple observations;

2. CESM/CARMA is able to reproduce properties of ATAL;

3. Model suggests AOD of ATAL is minimal

4. Model suggests ATAL makes 15% of net heating rate;

5. Model suggests Asian Summer Monsoon may NOT be able to transport ozone-sensitive chemicals to destroy ozone in tropical stratosphere.

CARMA is a Sectional Aerosol Microphysics/Radiation model coupled with CESM

Yu et al., 2015, JAMES

CAM5/CARMA Model

CARMA
3. Nucleation

BHN: Zhao and Turco (1995)
H_2O vp over H_2SO_4 : Lin and Tabazadeh (2001)
H_2SO_4 vp: Giauque (1959), Ayers et al. (1980), Kulmala (1990)

CAM5
2. Chemistry

SOA: Gas/Particle partitioning

Sulfur chemistry

Aqueous chemistry

CAM5 CARMA
1. Emissions

POA/BC: GFEDv3&FINN, GAINS

Sea Salt: Fan and Toon (2011)

Dust: Su and Toon (2009)

Sulfate: English et al. (2011)

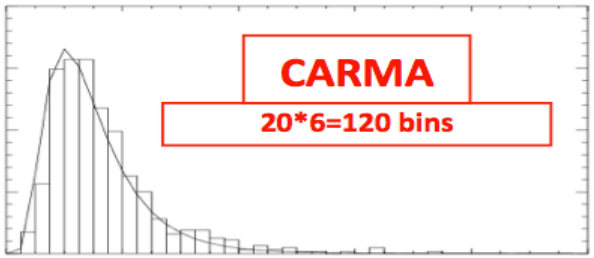
VOC: monoterpenes, isoprene, benzene, toluene and xylene

CARMA
4. Condensational growth

Wt %: Tabazadeh et al. (1997)

1.9°x2.5° resolution
Dynamics/Transport
CAM5

CARMA
20*6=120 bins



CARMA
5. Coagulation

Brownian

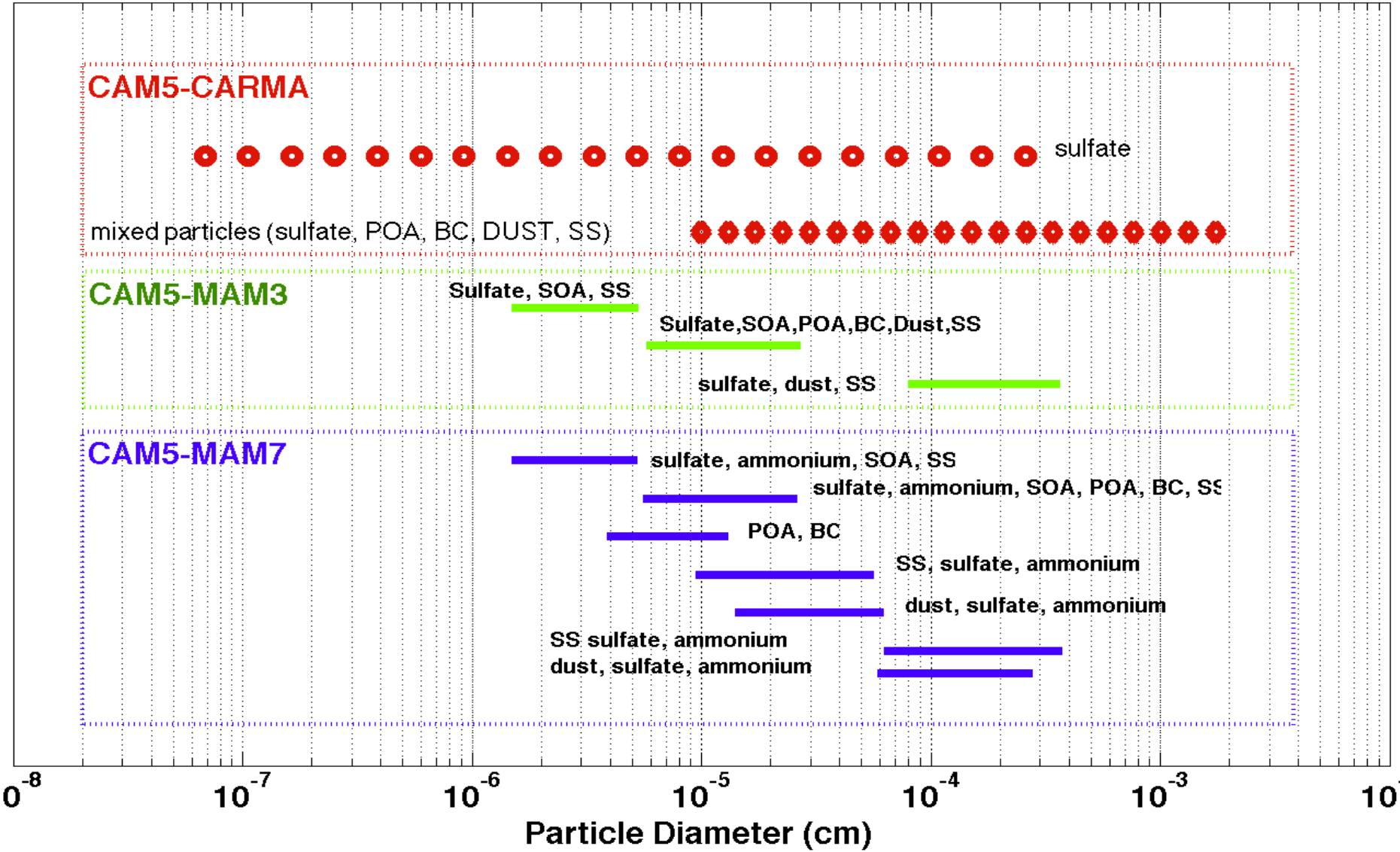
CAM5 CARMA
6. Dry deposition

CAM5 CARMA
7. Aerosol activation/ cloud Evaporation

CAM5 CARMA
8. Wet deposition

CARMA has wider size range of aerosols than MAM

POA includes biomass burning organics, anthropogenic organics, marine organics and biological particles.



- P1. UTLS Aerosols Simulated in CESM/CARMA
- P2. ATAL from POPs and CESM/CARMA
- P3. Radiative Properties of ATAL from CESM/CARMA
- P4. Asian Summer Monsoon and Stratospheric Ozone

- **P1. UTLS Aerosols Simulated in CESM/ CARMA**
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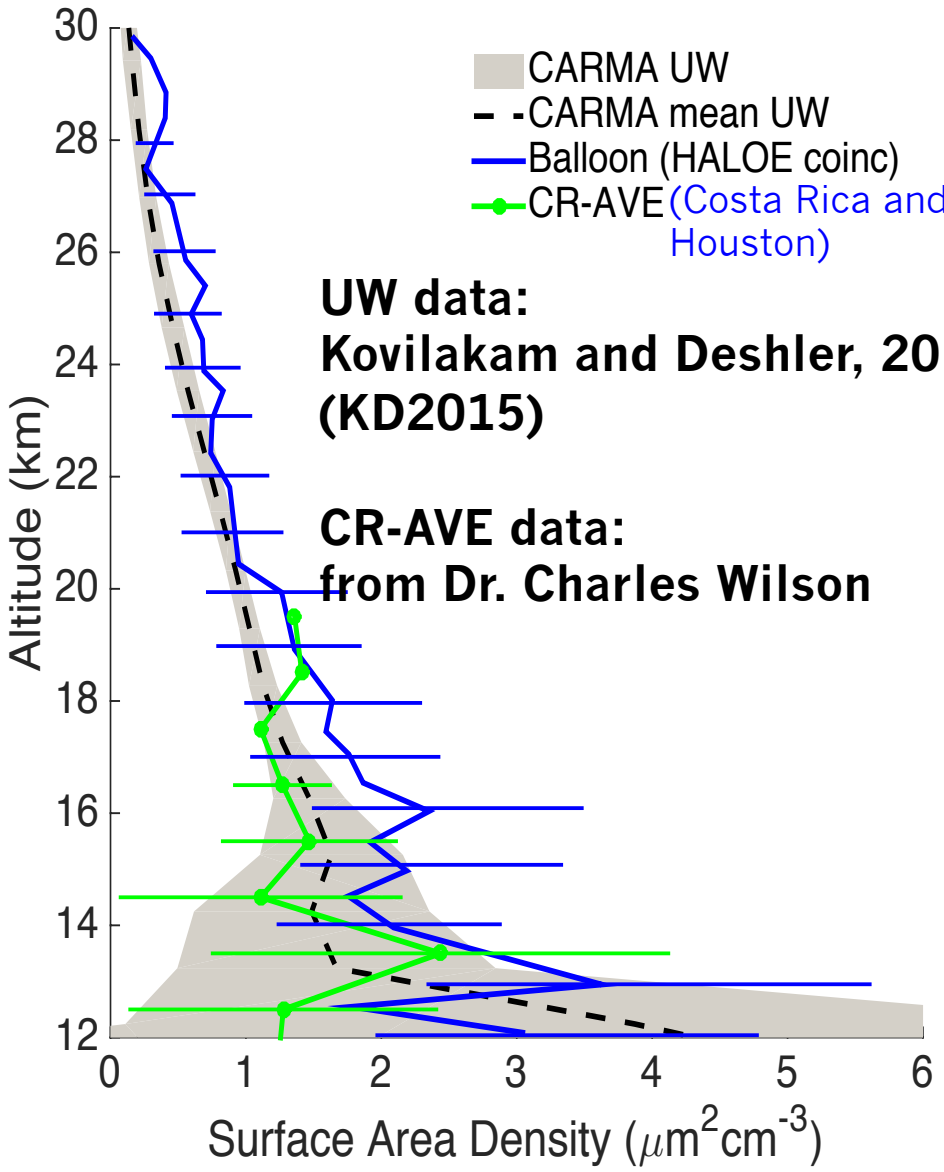
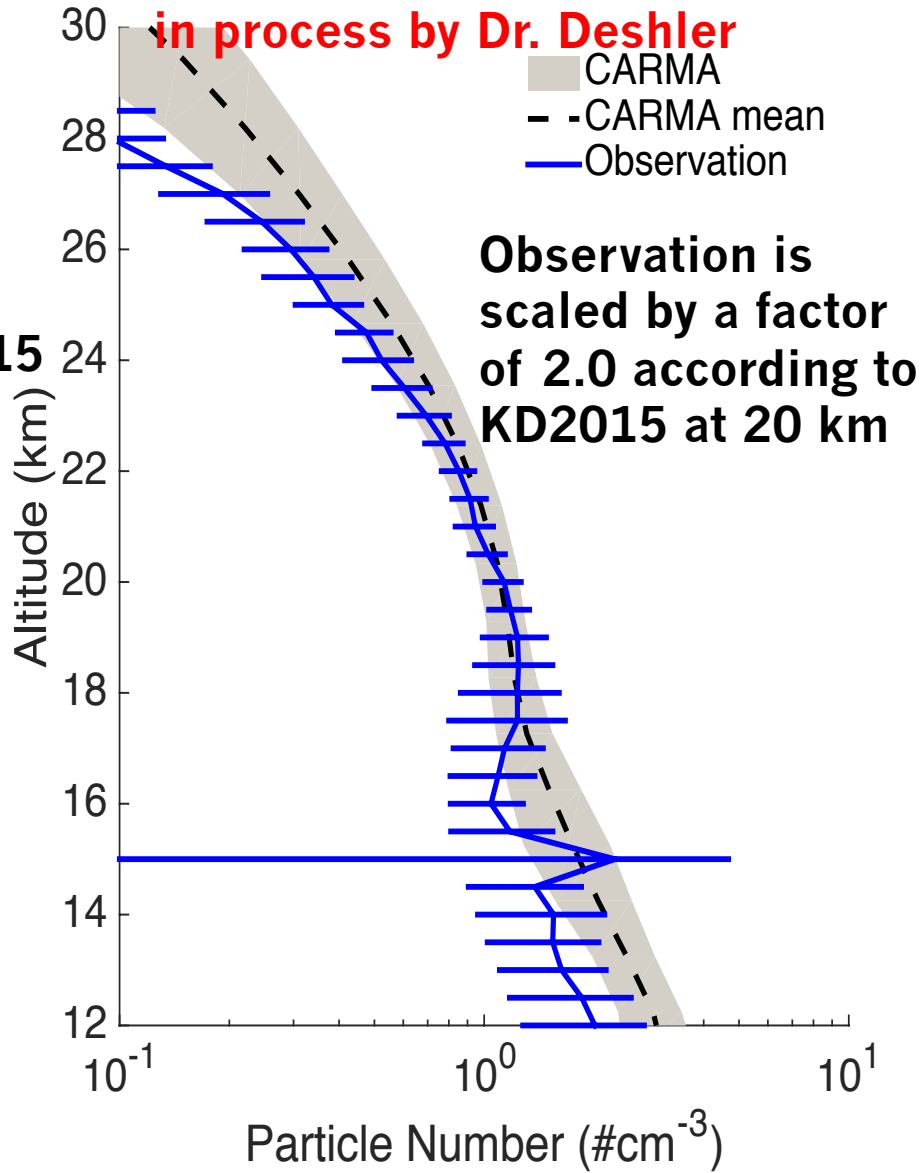
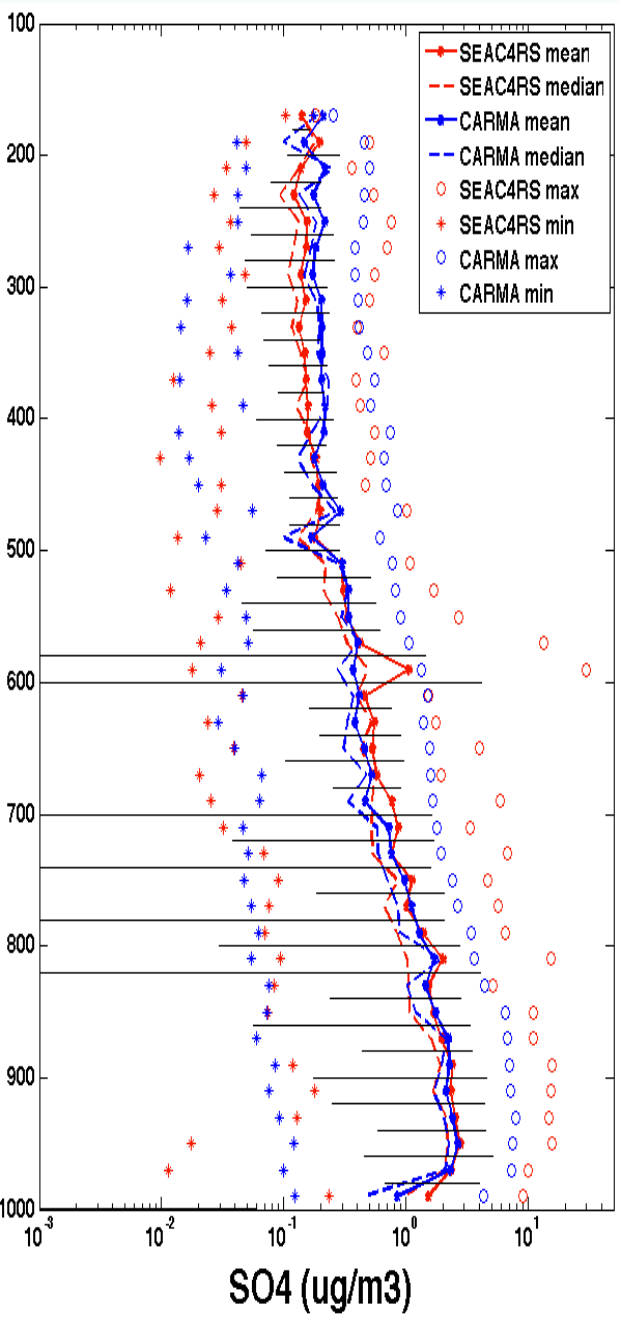
Model's aerosol surface area density and composition

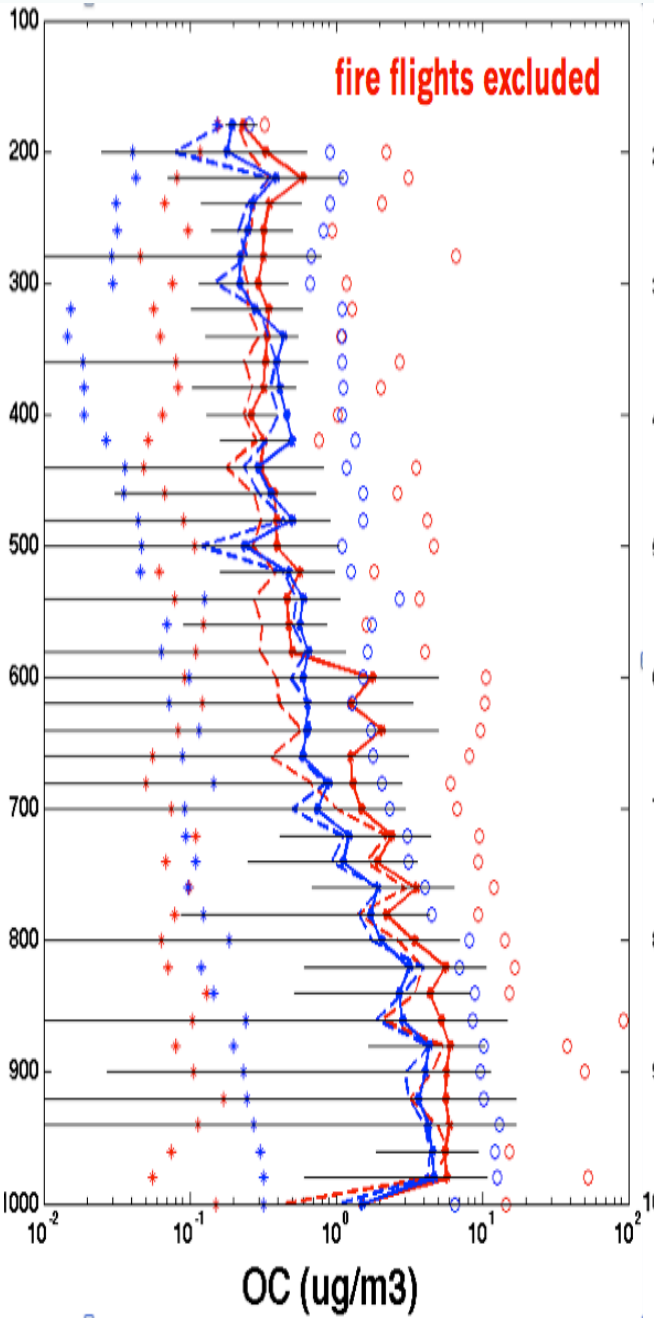


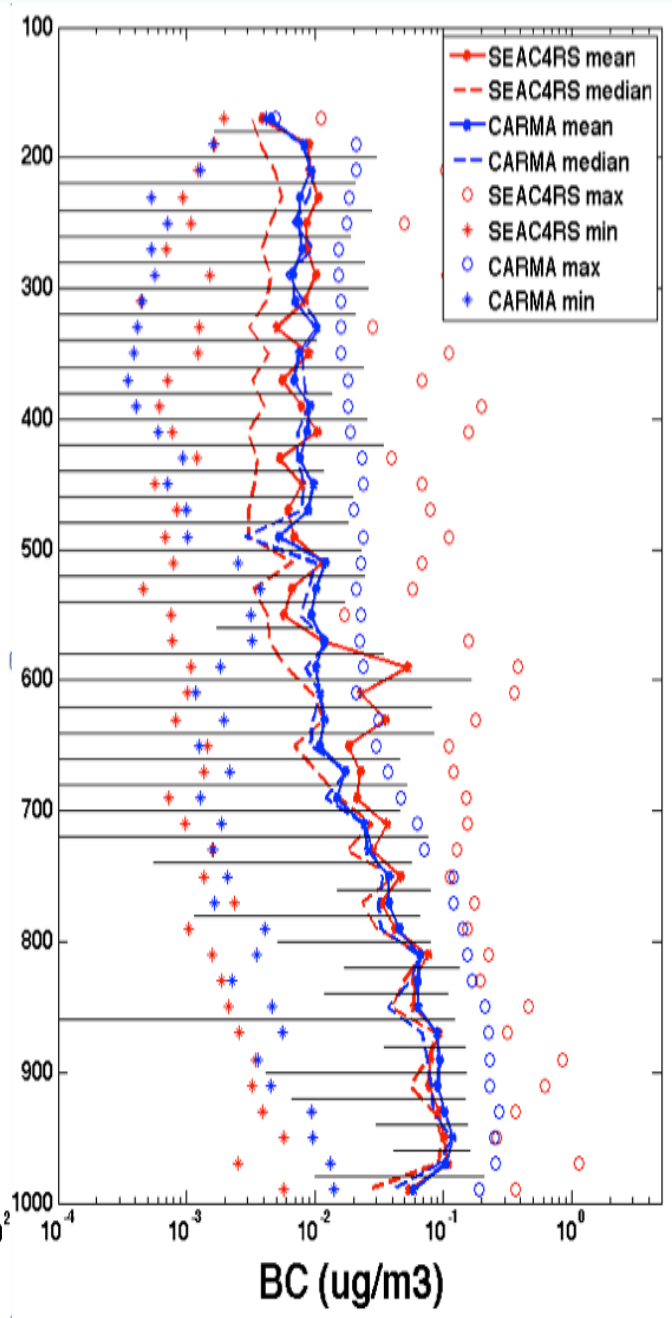
Note: Number Conc. data is still in process by Dr. Deshler



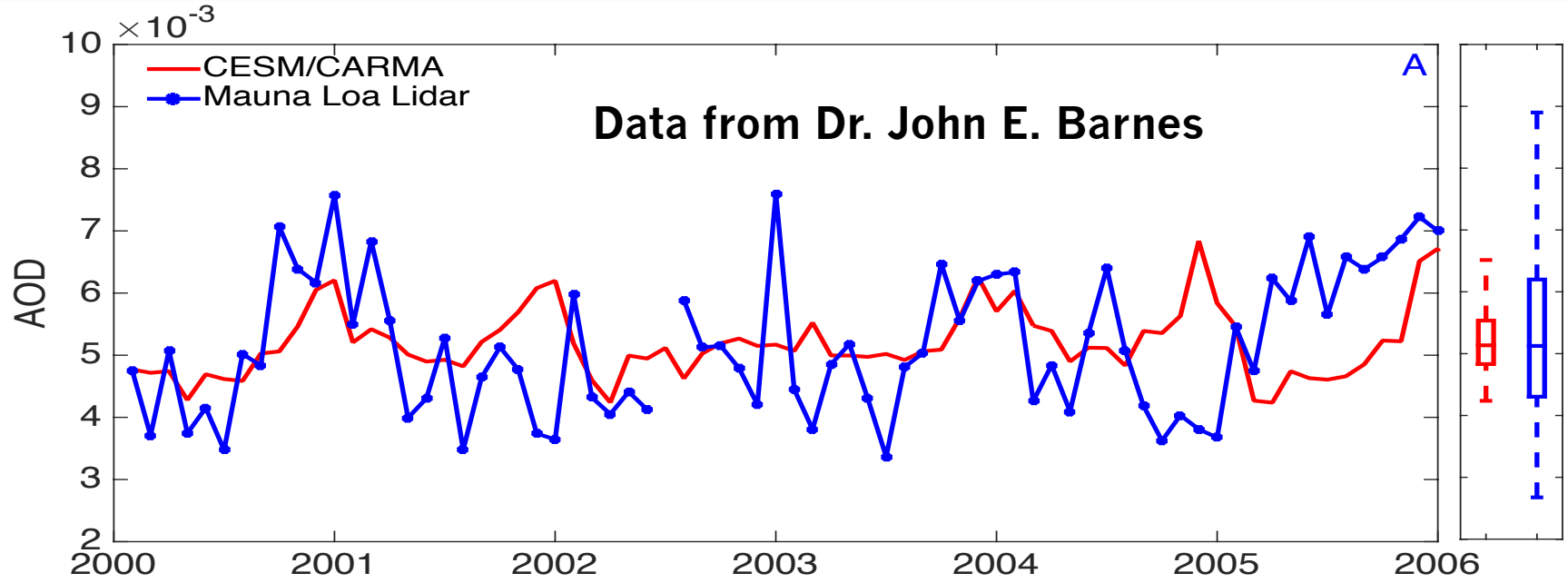
Model captures SO_4/OC/BC in troposphere of US

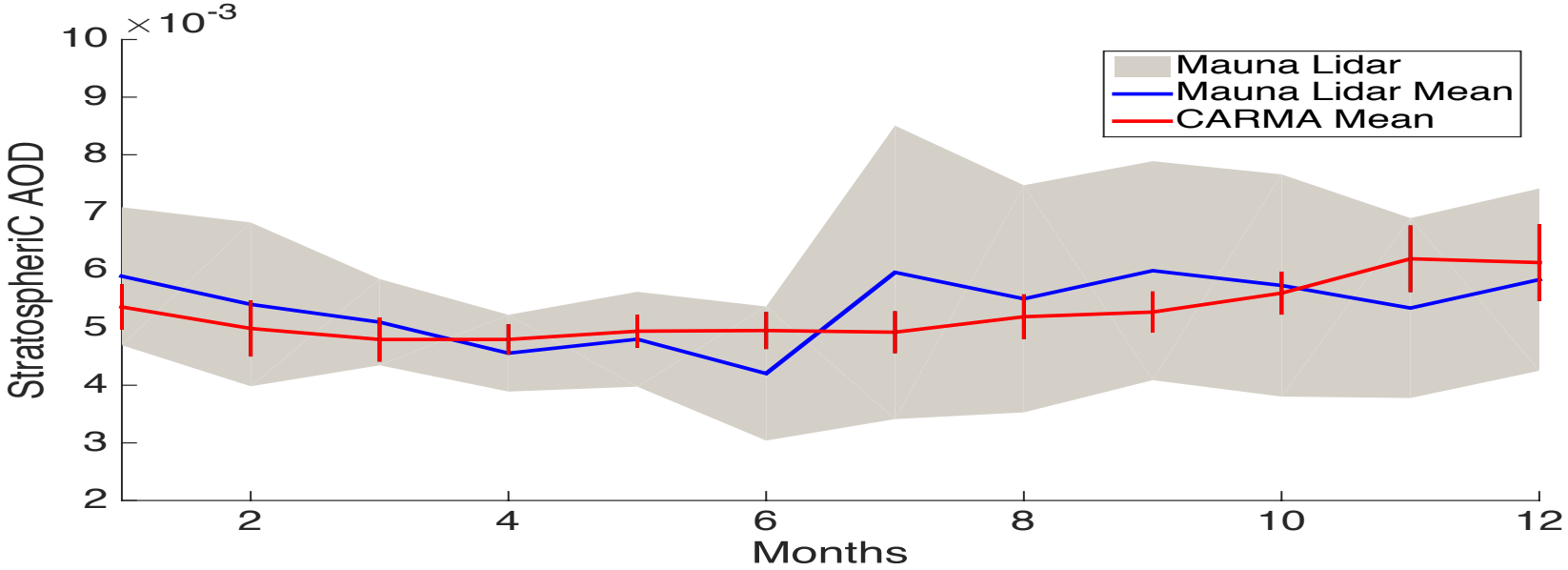




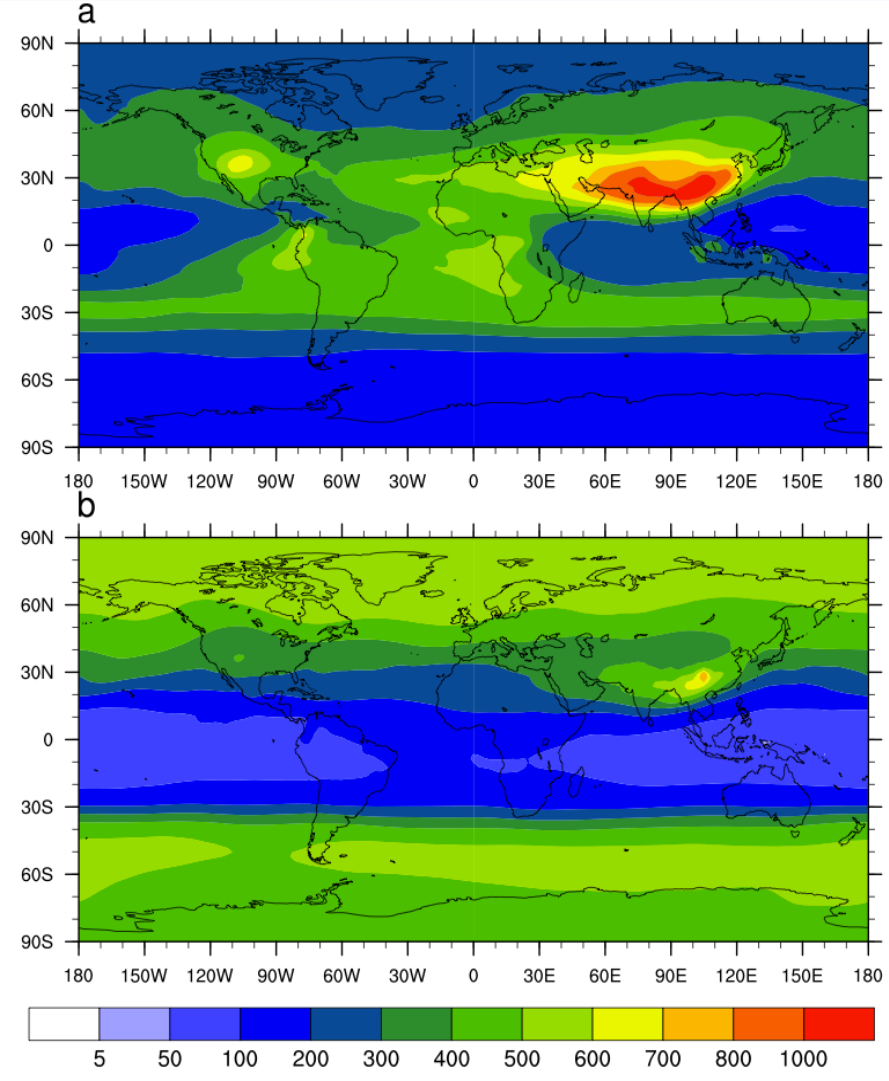


Modeled Stratospheric AOD with Mauna Loa Lidar

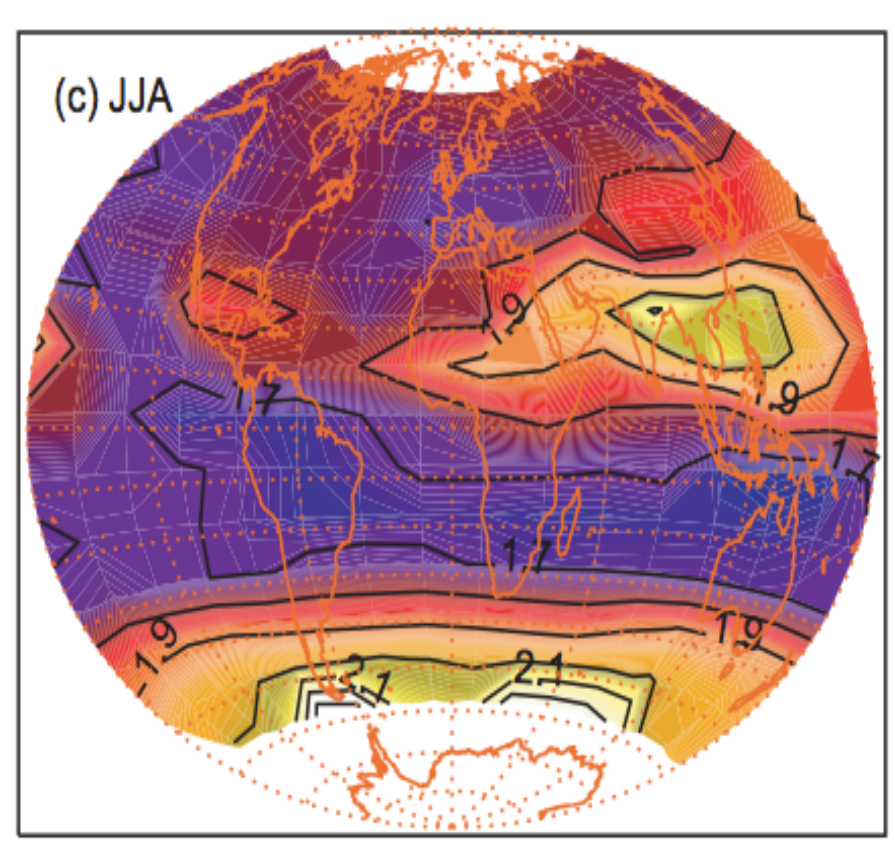




CESM/CARMA can reproduce ATAL: Organics + Sulfate

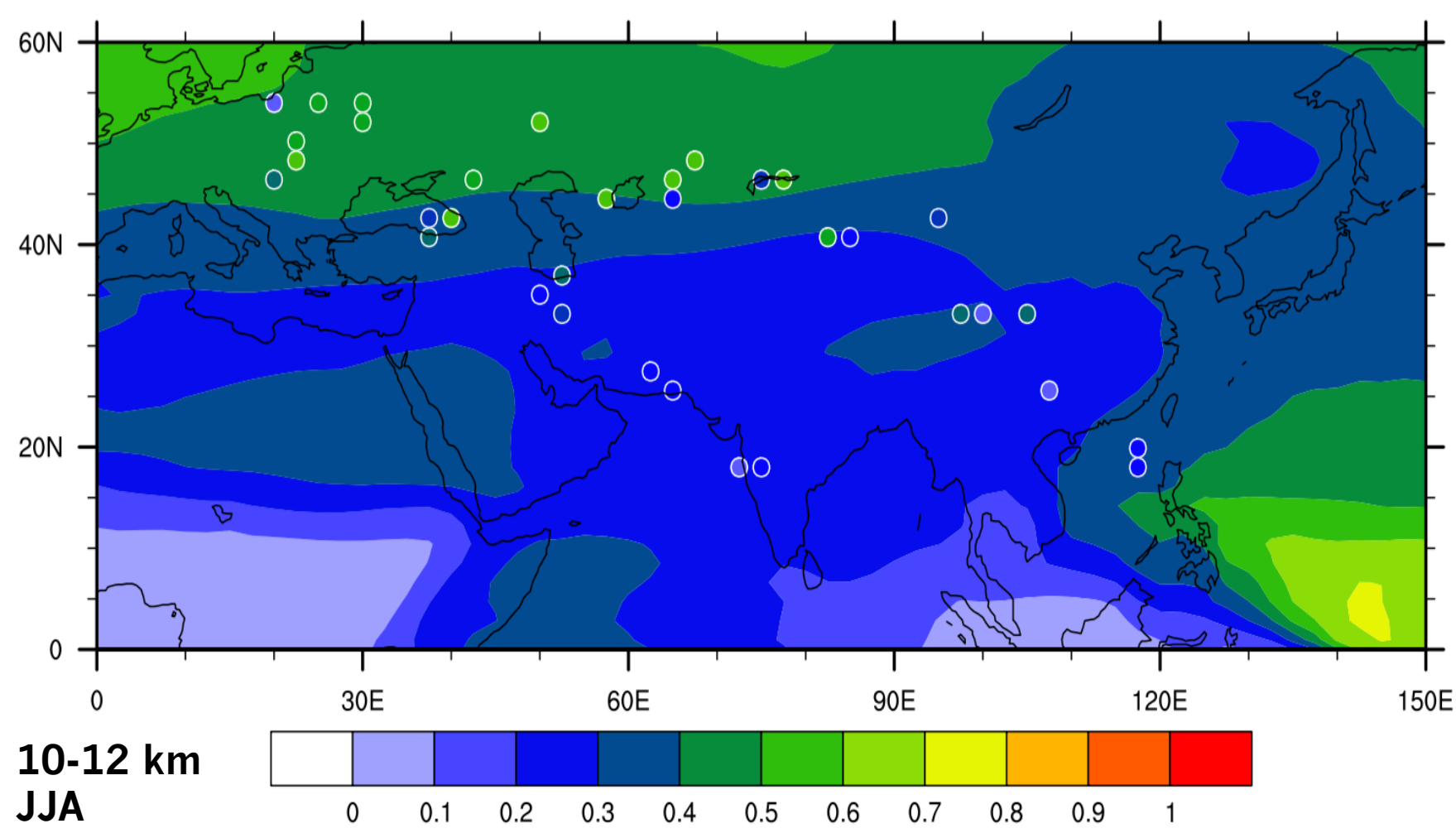


Yu et al., 2015b, GRL

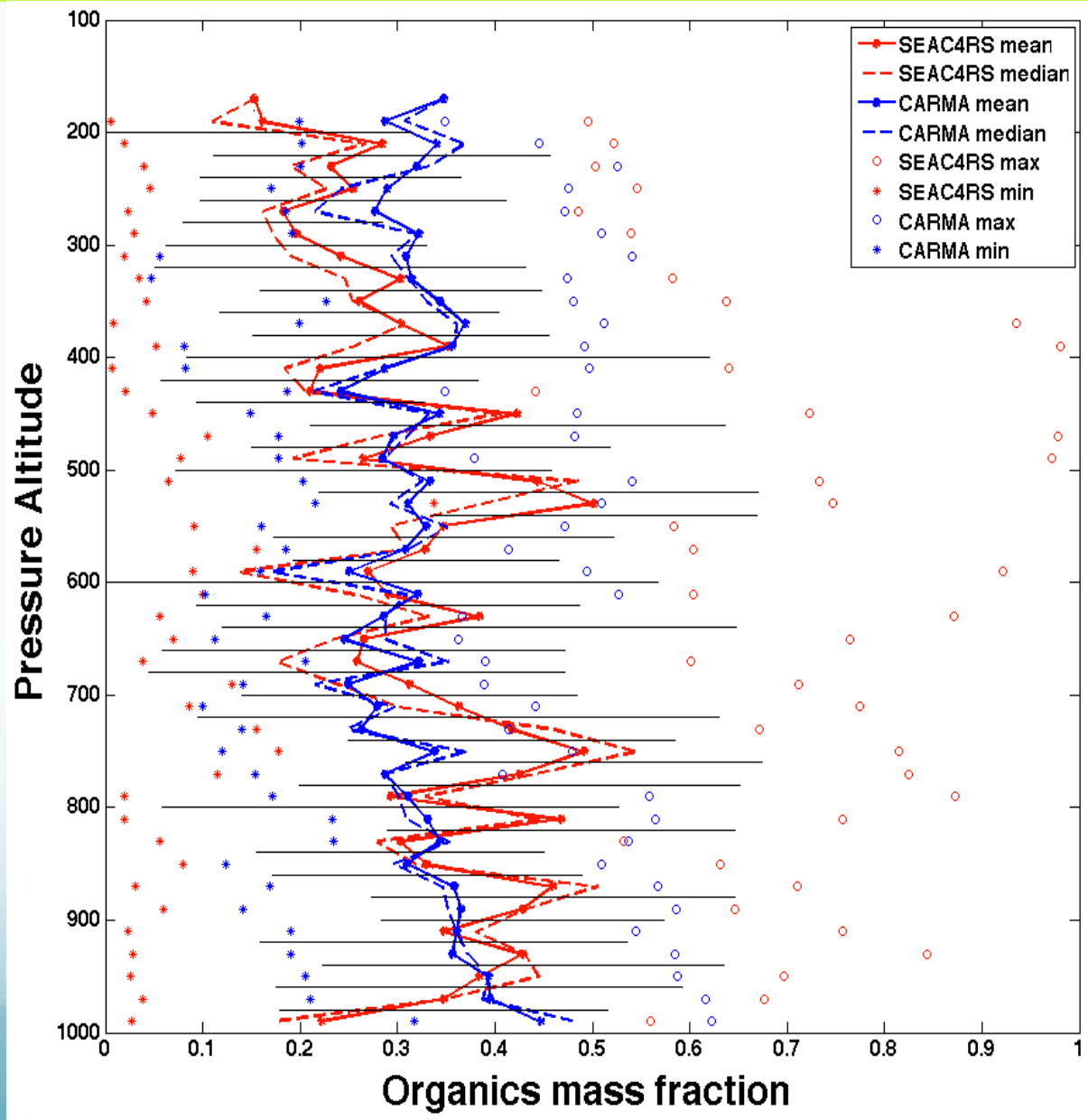


Thomason and Vernier, 2013, ACP

Model agree with observed CARIBIC S/C Ratio in upper troposphere



Model agrees with observed OC/SO4 mass fraction over US from SEAC4RS



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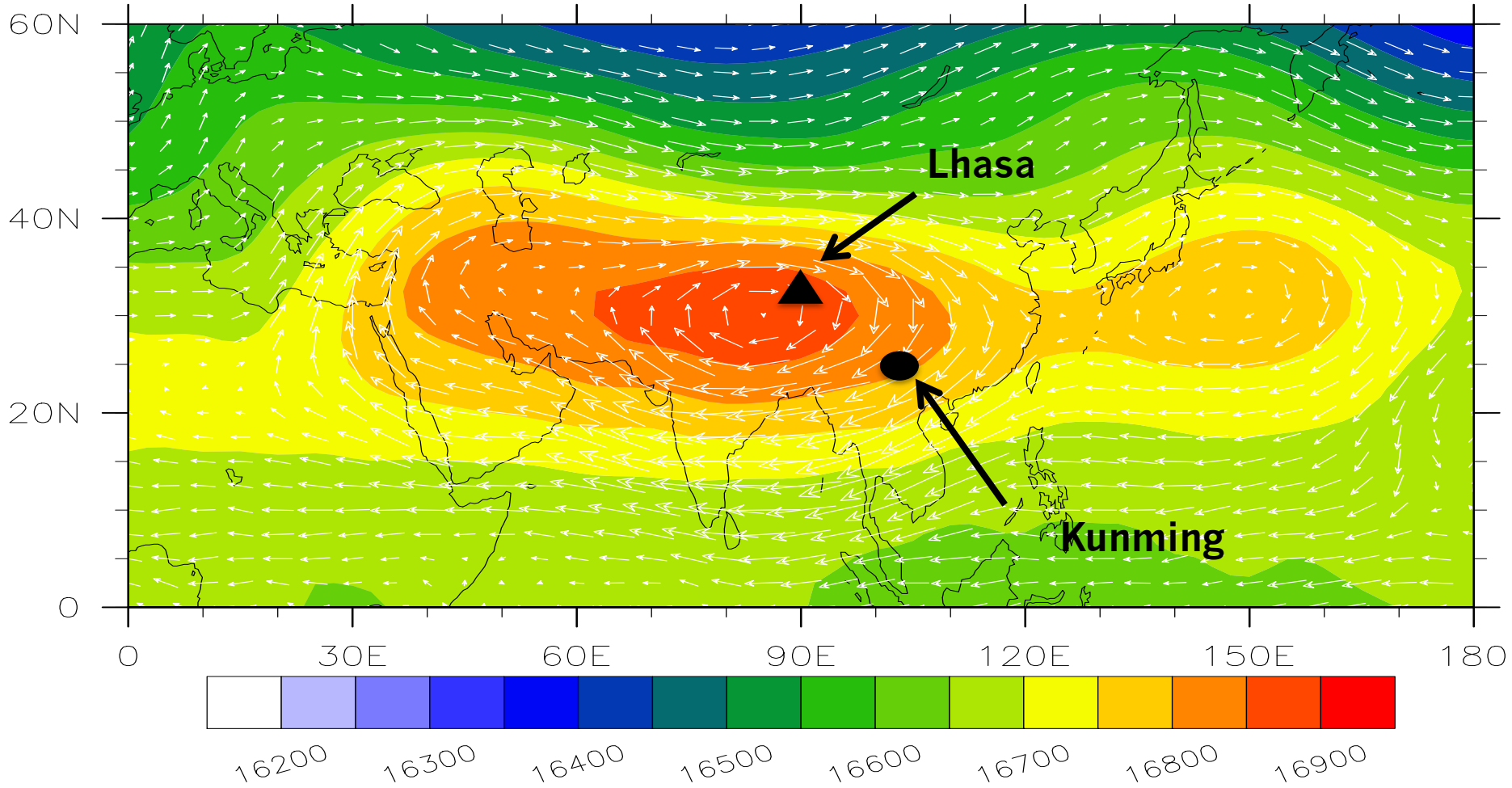
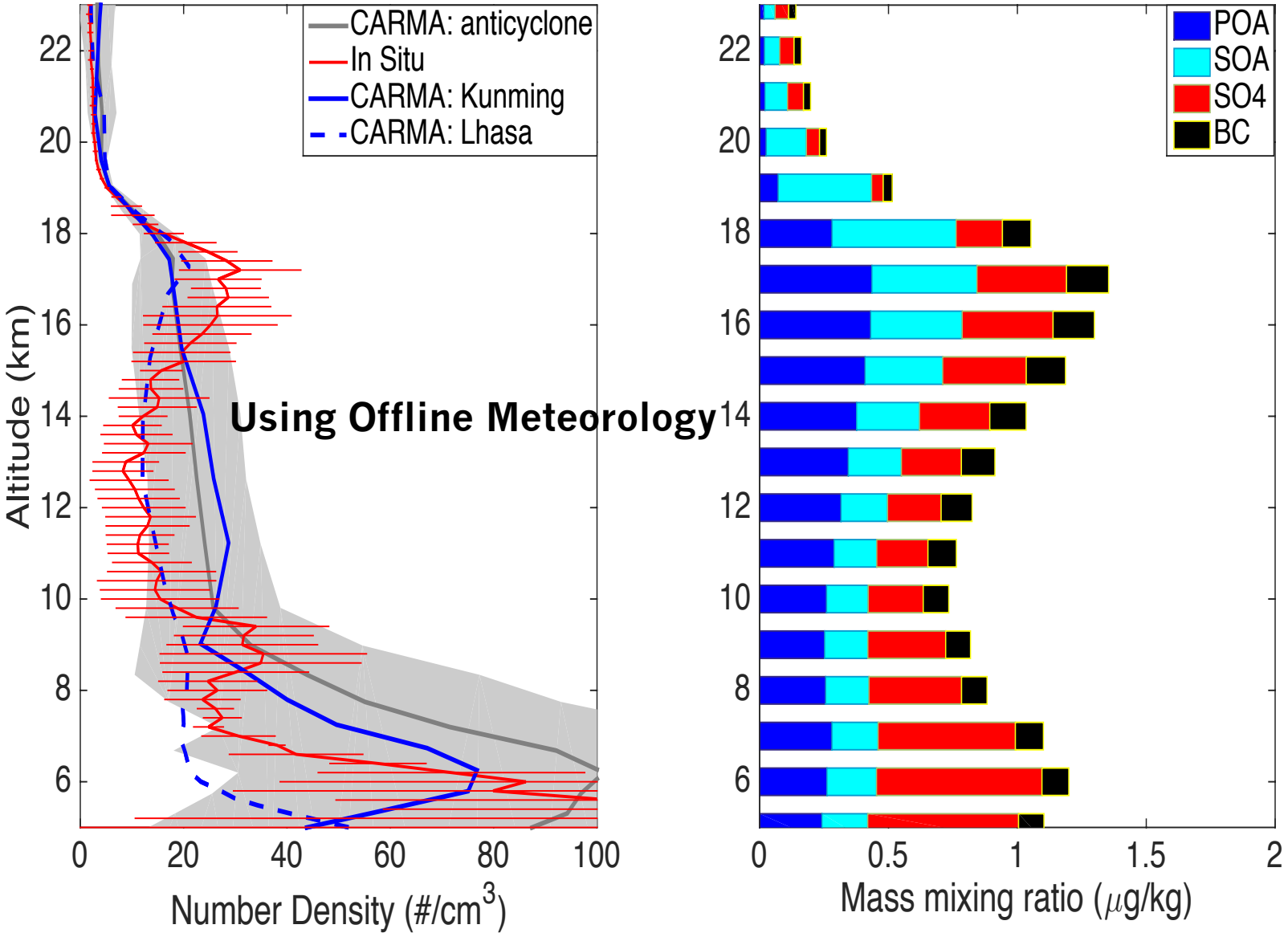
POPs Measurements at Kunming, China (Aug, 2015)

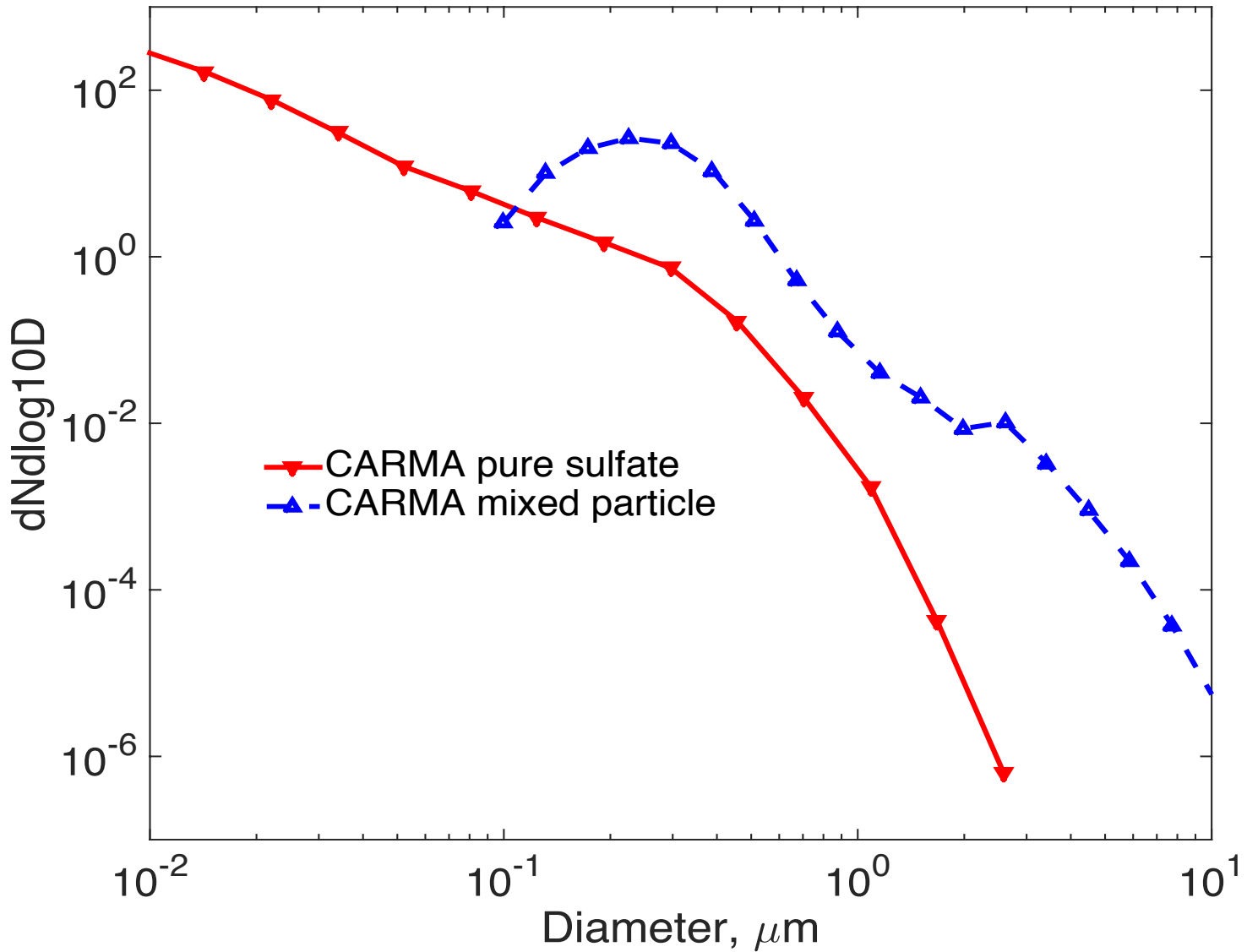


- Offline Winds: GEOS5 reanalysis
- 1.9x2.5, 56 levels (with 21 levels above 100 hPa)
- OC/BC Emissions: GFEDv3, ECLIPSE
- SO2 Emissions: Emmons et al. (2010)
- VOC Emissions: MEGAN
- Base Chemistry: MOZART-4
  - ✓ Detailed Sulfur Chemistry
  - ✓ Heterogeneous Chemistry
  - ✓ SOA Chemistry (VBS)
- Optics: Mie Optics; RRTMG

Model compare well with in-situ measurements at Kunming, Aug. 2015



Modeled Particle size distribution has one mode with 0.2μm in diameter--->Sulfate and OC



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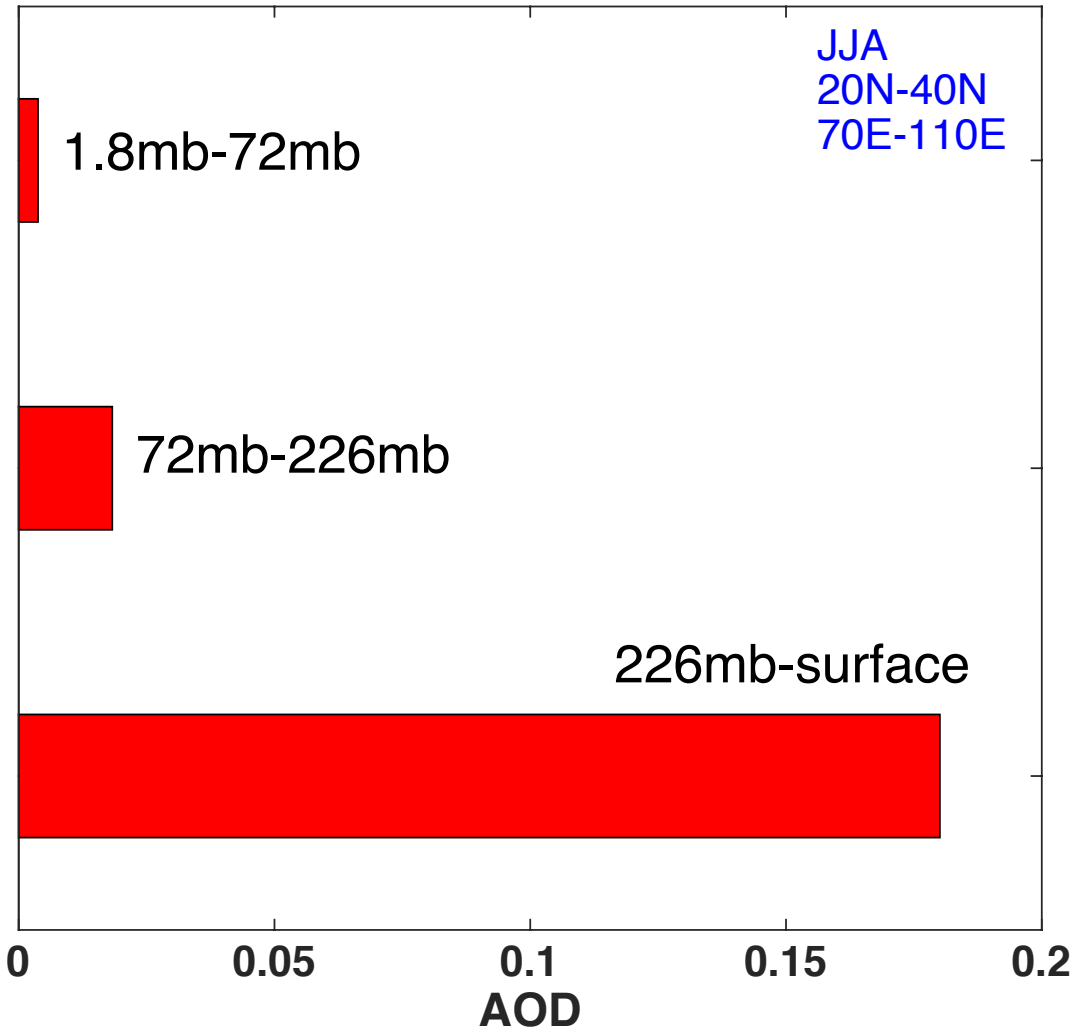
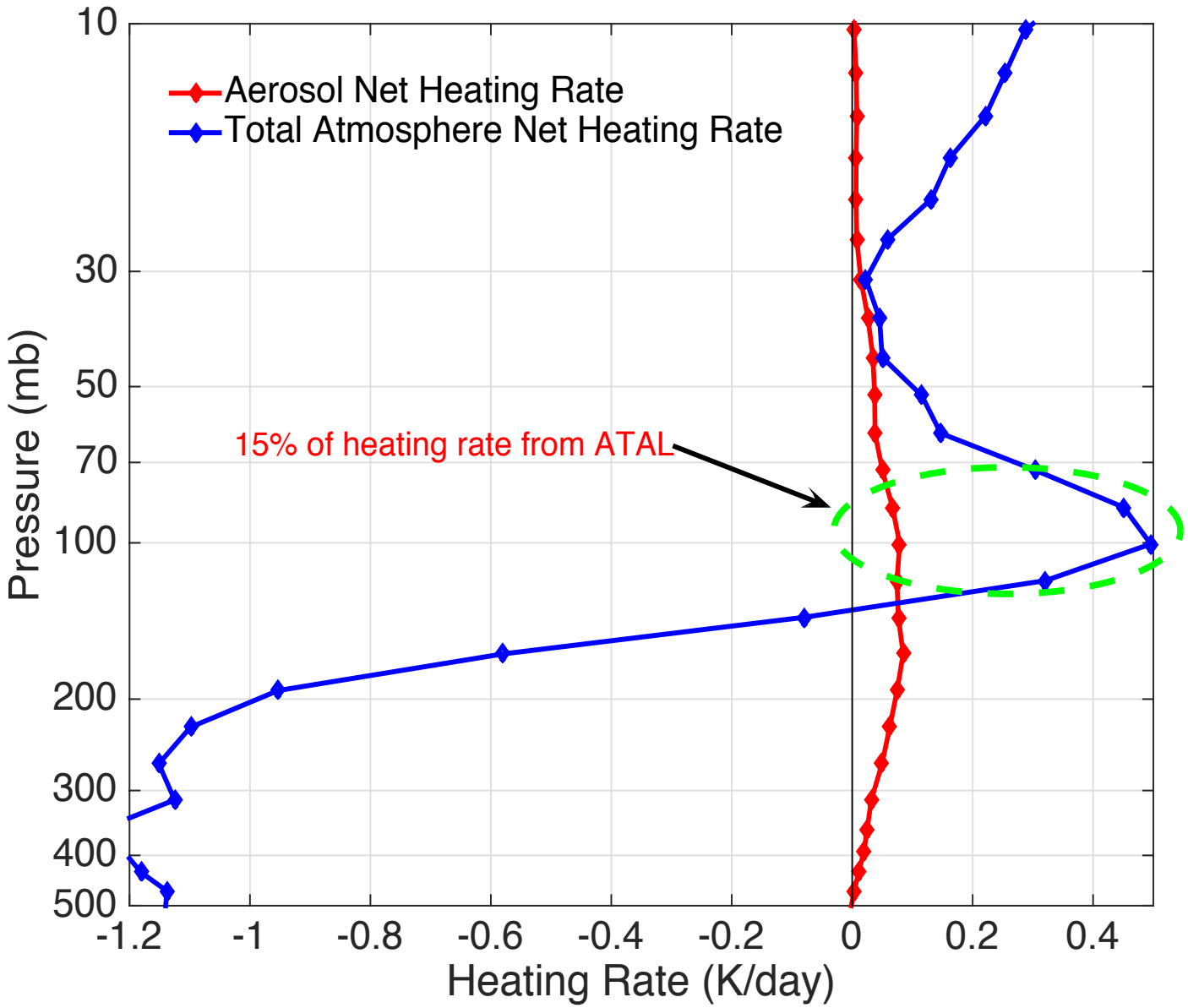
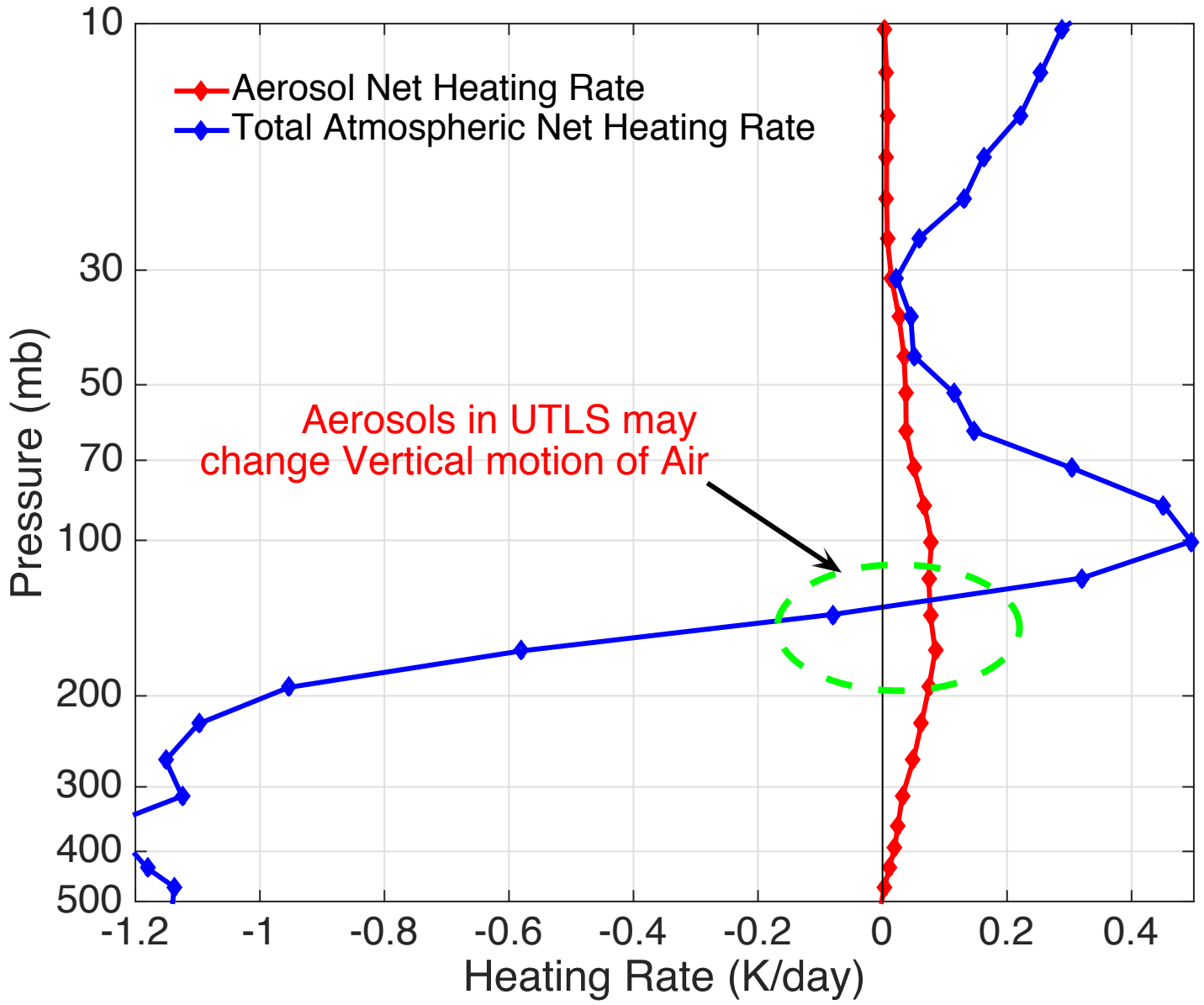
Tropospheric AOD dominates the Column



ATAL contribute to 15% of Heating Rate



ATAL may impact on Air vertical motion



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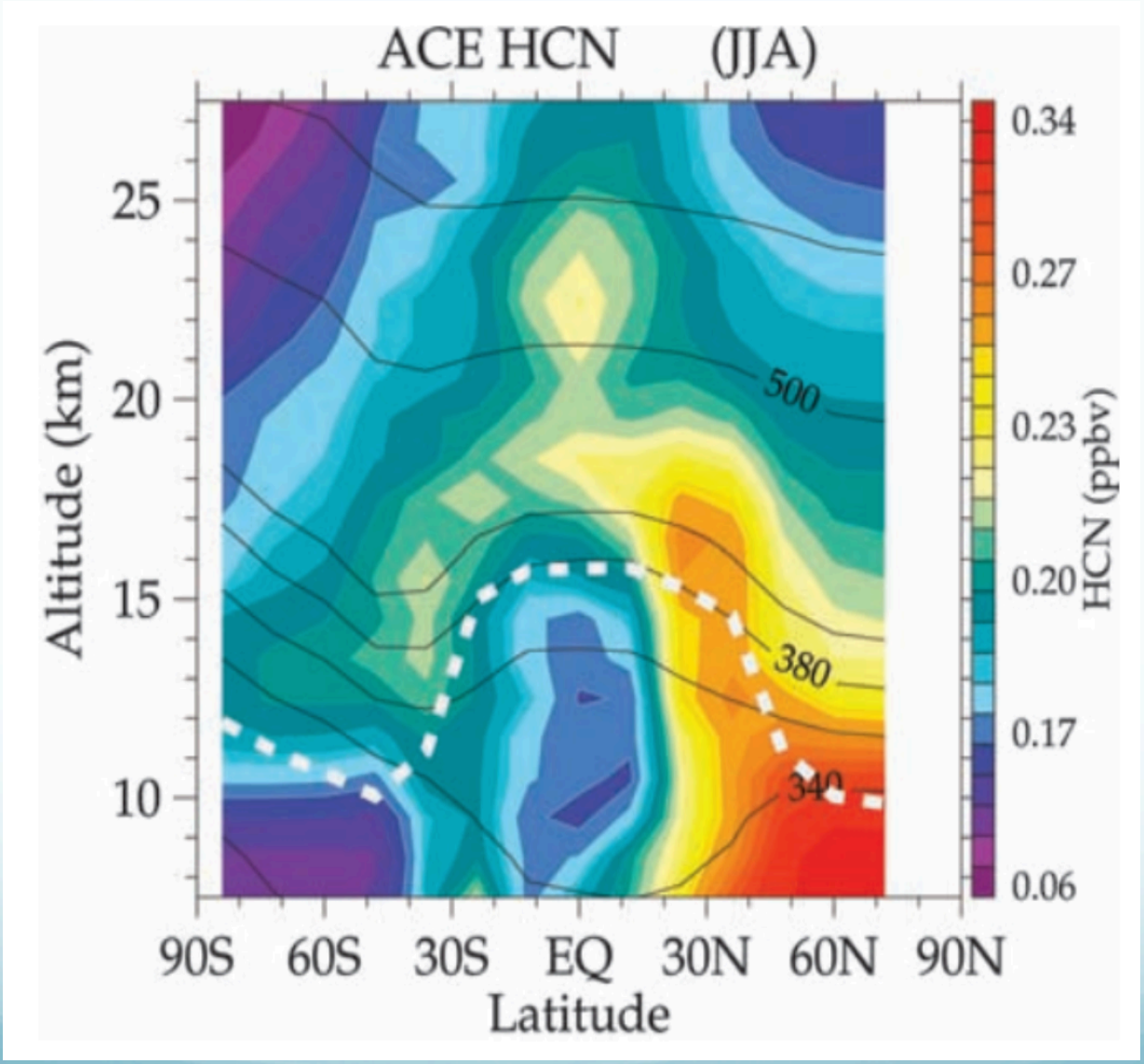
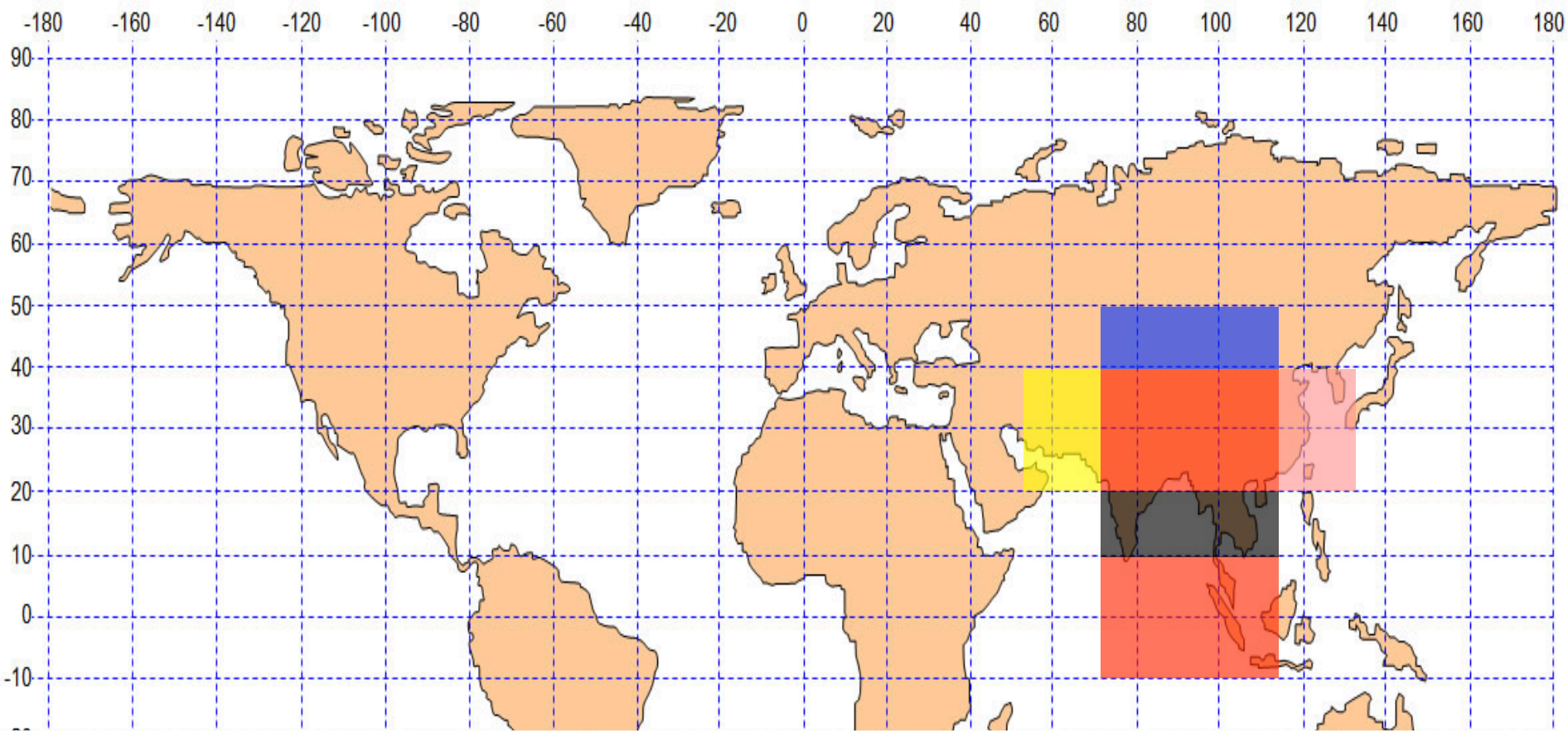
Asian Summer Monsoon may destroy ozone?

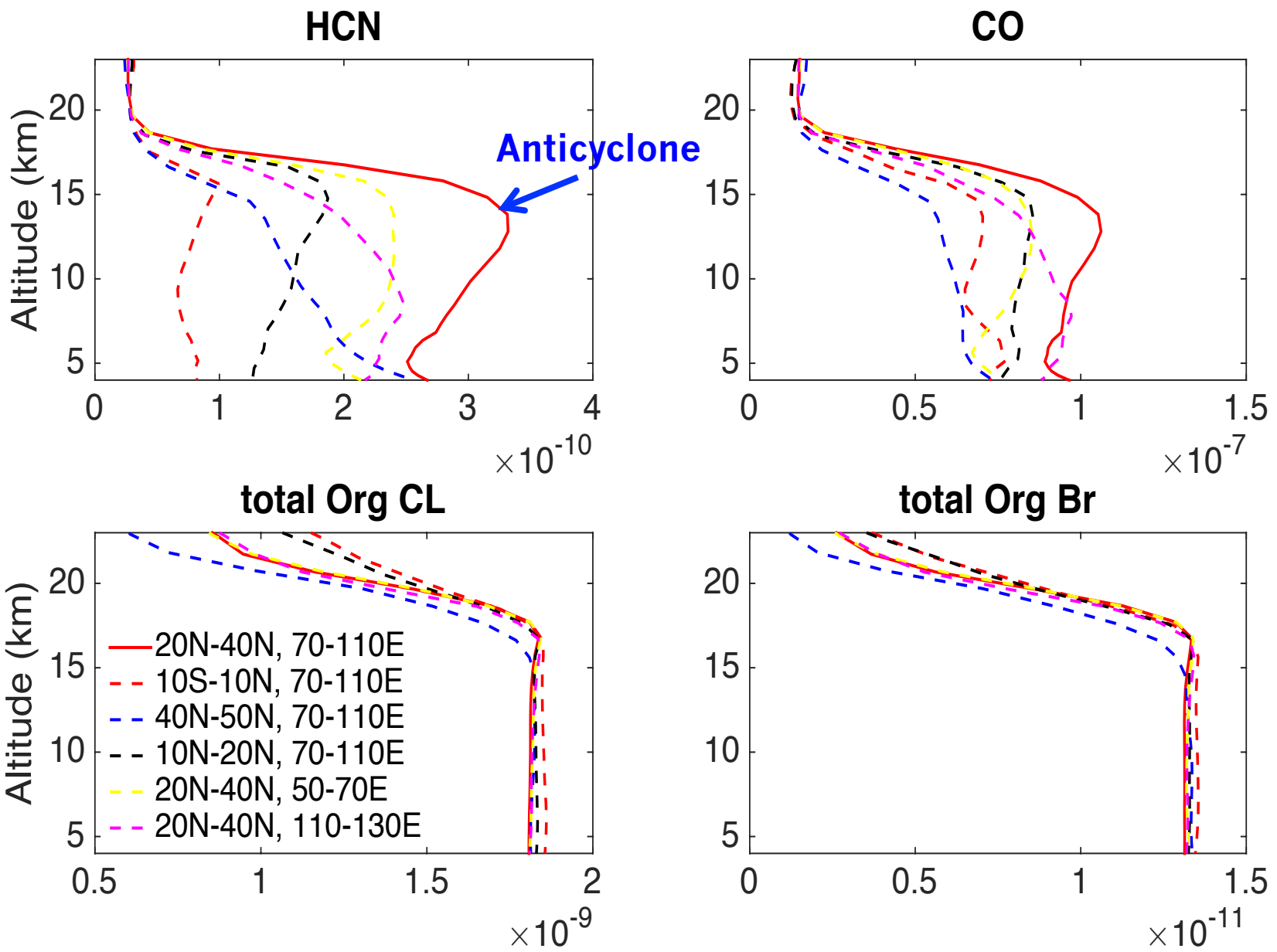


Randel et al., 2010

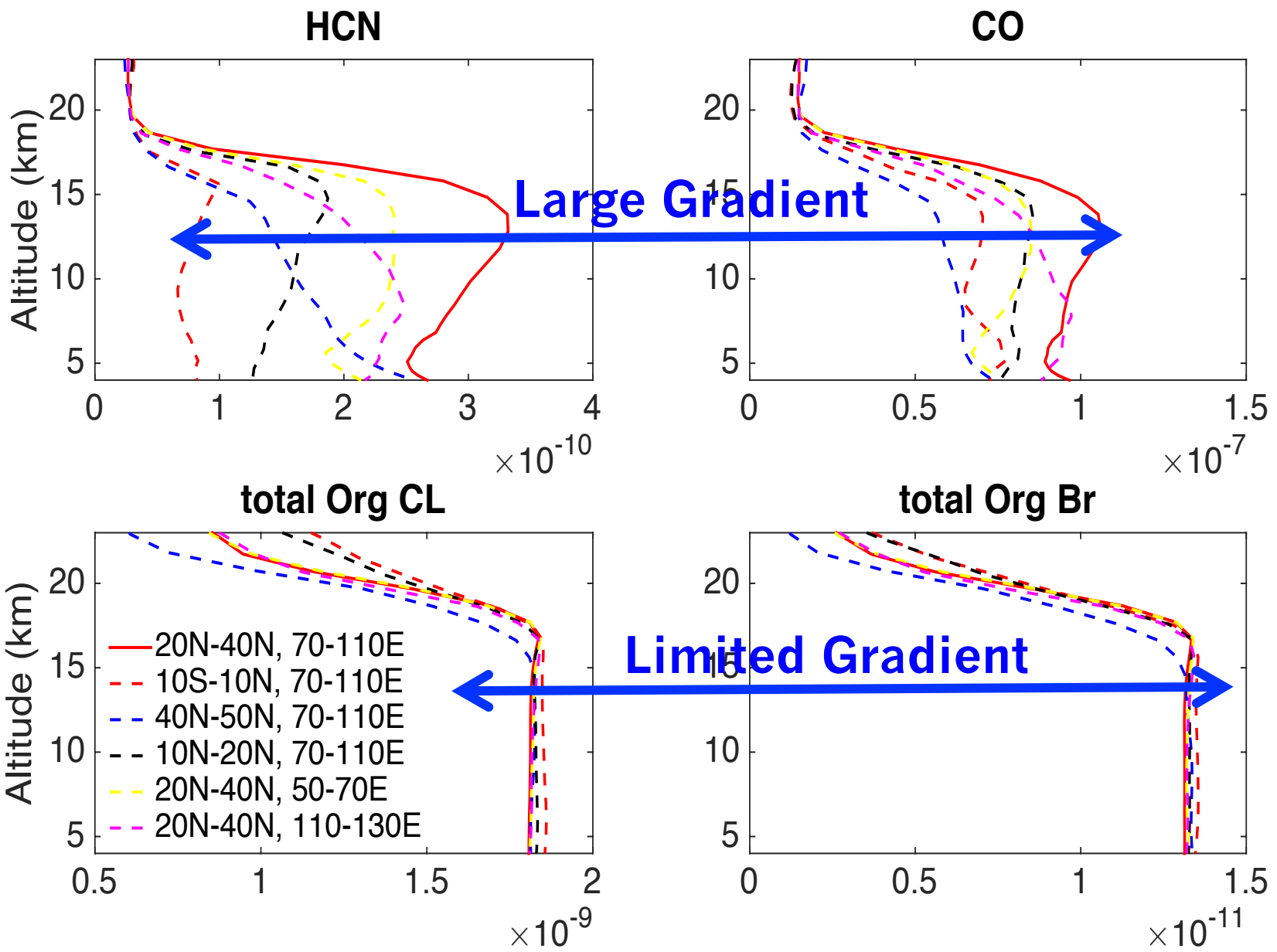


Several boxes in the model to diagnose Chemical' spatial distribution

Chemicals' distribution by latitudes



Chemicals' distribution by latitudes



Summary

1. UTLS aerosols in CESM/CARMA are constrained by multiple observations;
2. CESM/CARMA is able to reproduce properties of UTLS observed;
3. Model suggests ATAL makes 15% of net heating rate;
4. Model suggests Asian Summer Monsoon is transporting HCN, CO from Asia to tropics;
5. Model suggests Asian Summer Monsoon may not be able to transport ozone-sensitive chemicals to destroy ozone in tropical stratosphere.

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@ Houston, SEAC^{4}RS, Sep.2013

SD-CAM5/CARMA has similar vertical resolution around UTLS compared with WACCM