Composition of Asian Tropopause Aerosol Layer and North American Tropospheric Aerosol Layer

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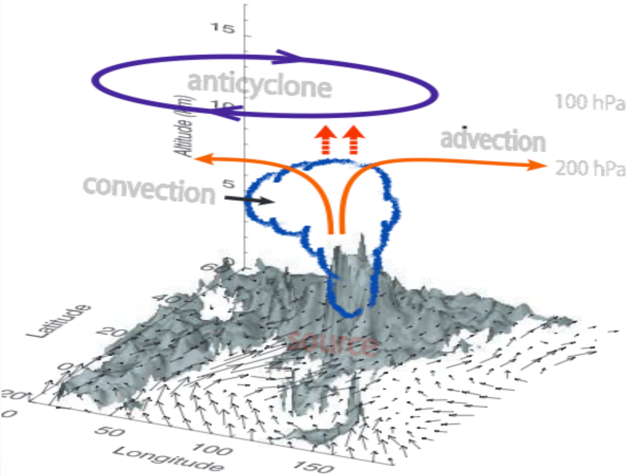
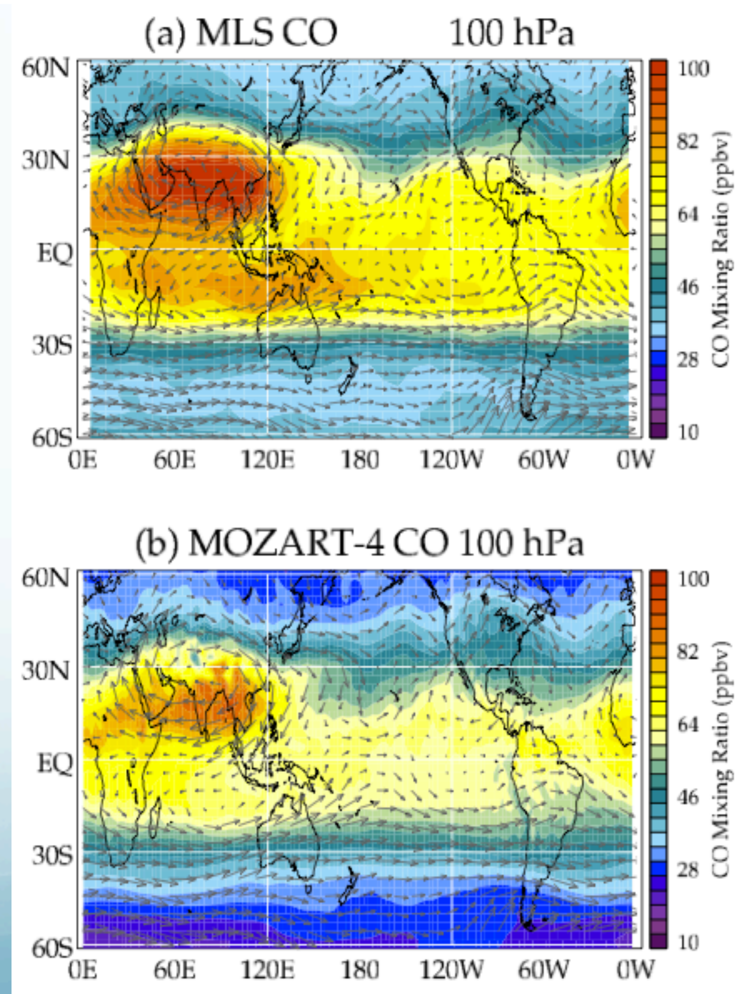
Feb. 2015, NCAR

Motivation I: previous studies show pathway from Trop to Stratosphere, i.e. Asian summer monsoon



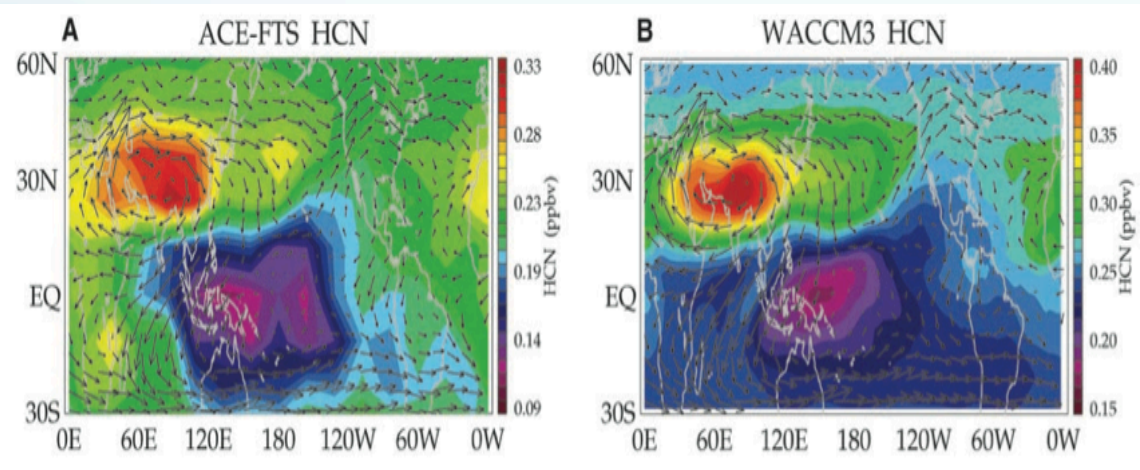
Transport pathways of carbon monoxide in the Asian summer monsoon diagnosed from Model of Ozone and Related Tracers (MOZART)

Mijeong Park,[1] William J. Randel,[1] Louisa K. Emmons,[1] and Nathaniel J. Livesey[2]

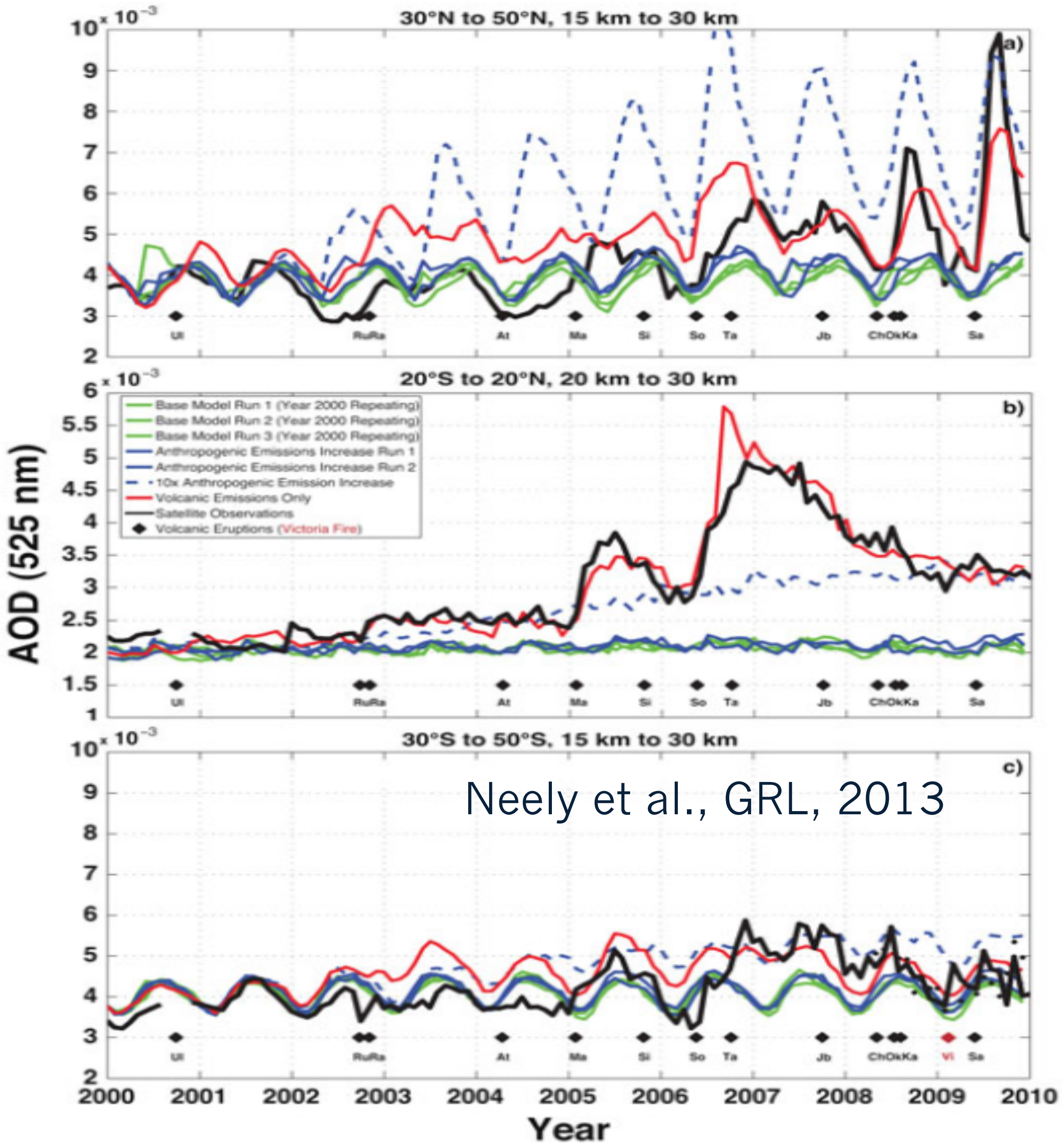


Asian Monsoon Transport of Pollution to the Stratosphere

William J. Randel,[1*] Mijeong Park,[1] Louisa Emmons,[1] Doug Kinnison,[1] Peter Bernath,[2,3] Kaley A. Walker,[4,3] Chris Boone,[3] Hugh Pumphrey[5]



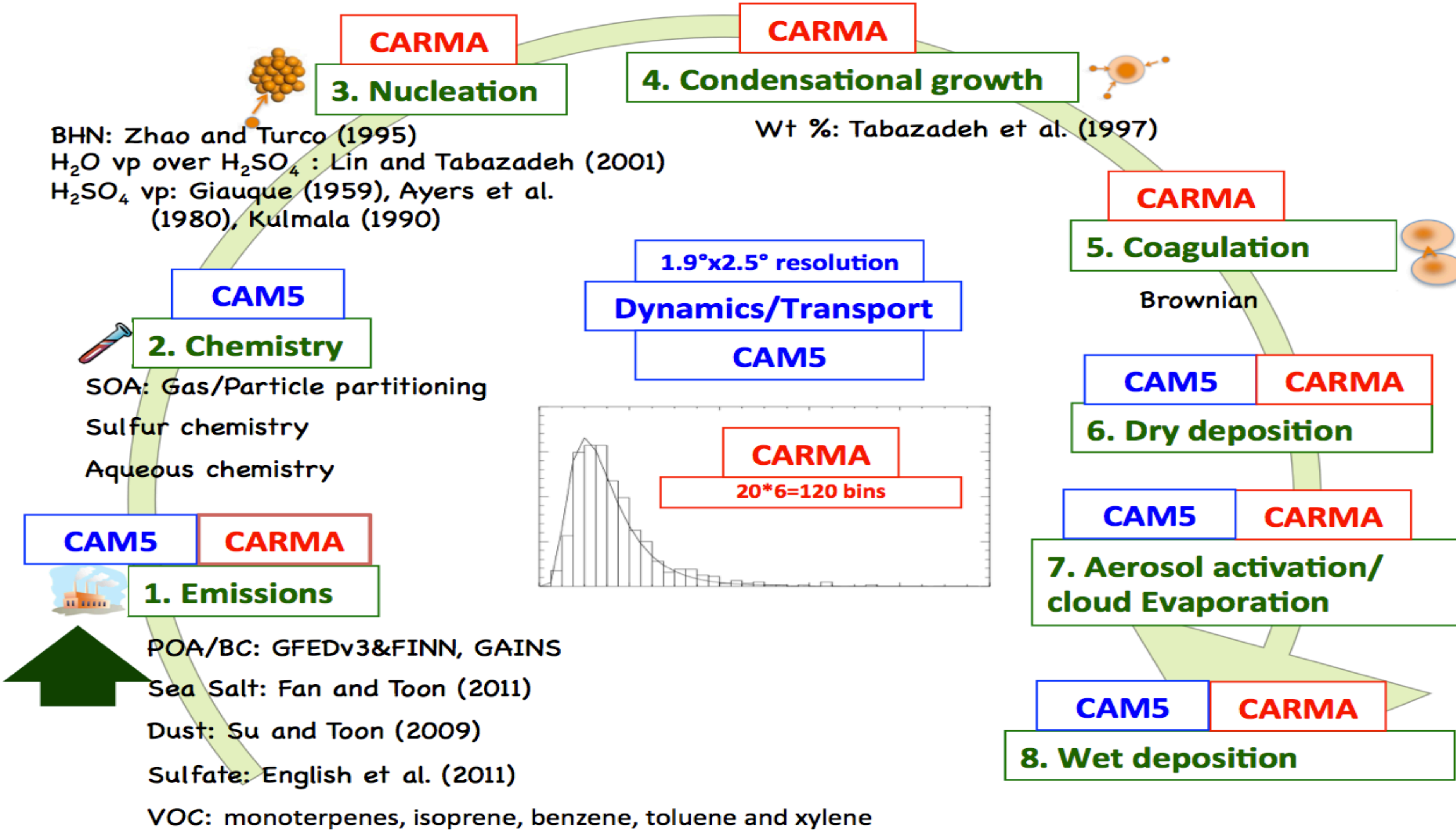
Motivation II: Impacts of emissions on stratospheric aerosols may explain part of "warming hiatus"



Neely et al., GRL, 2013

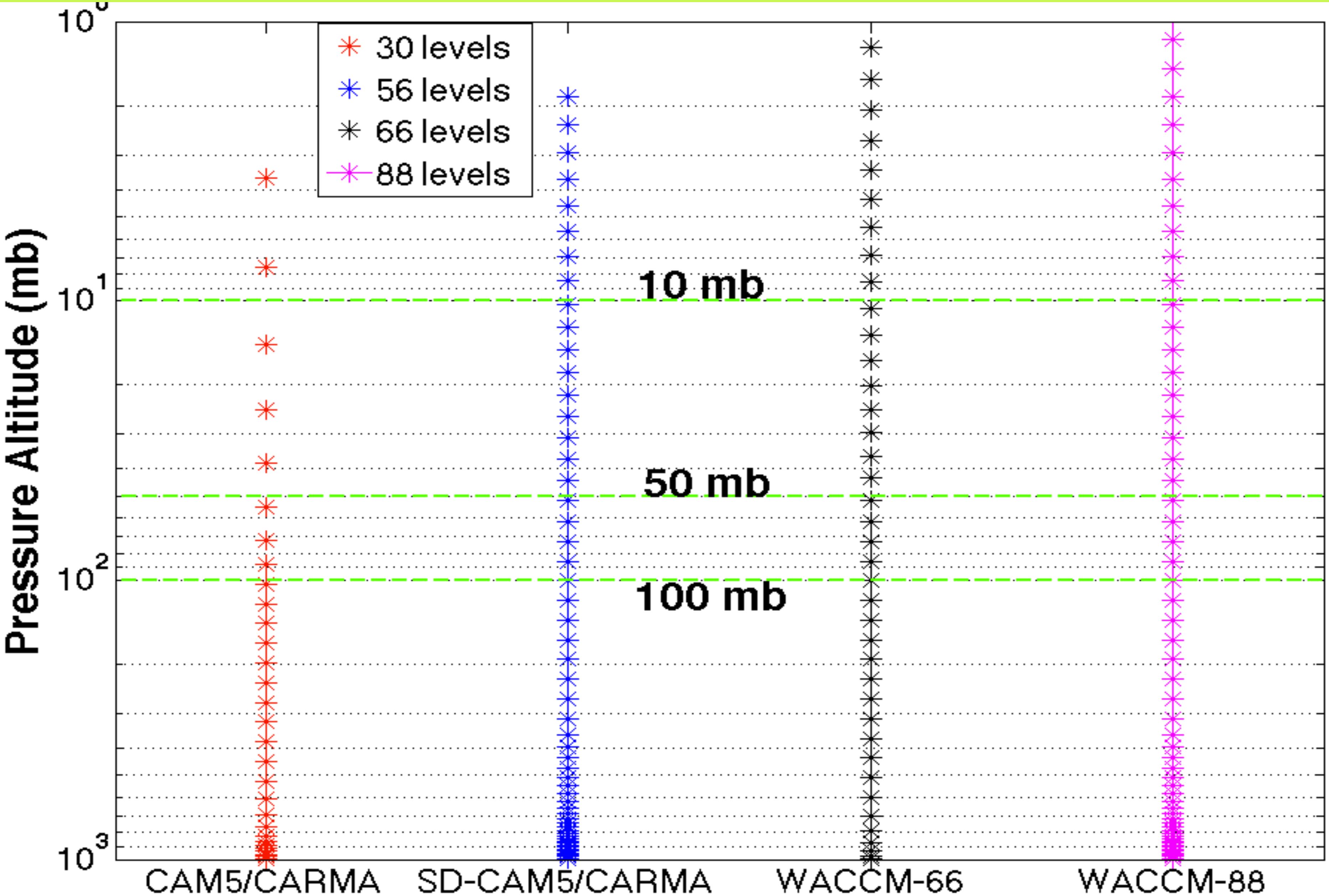
CARMA is a Sectional Aerosol Microphysics/ radiation model coupled with CAM5

CAM5/CARMA Model



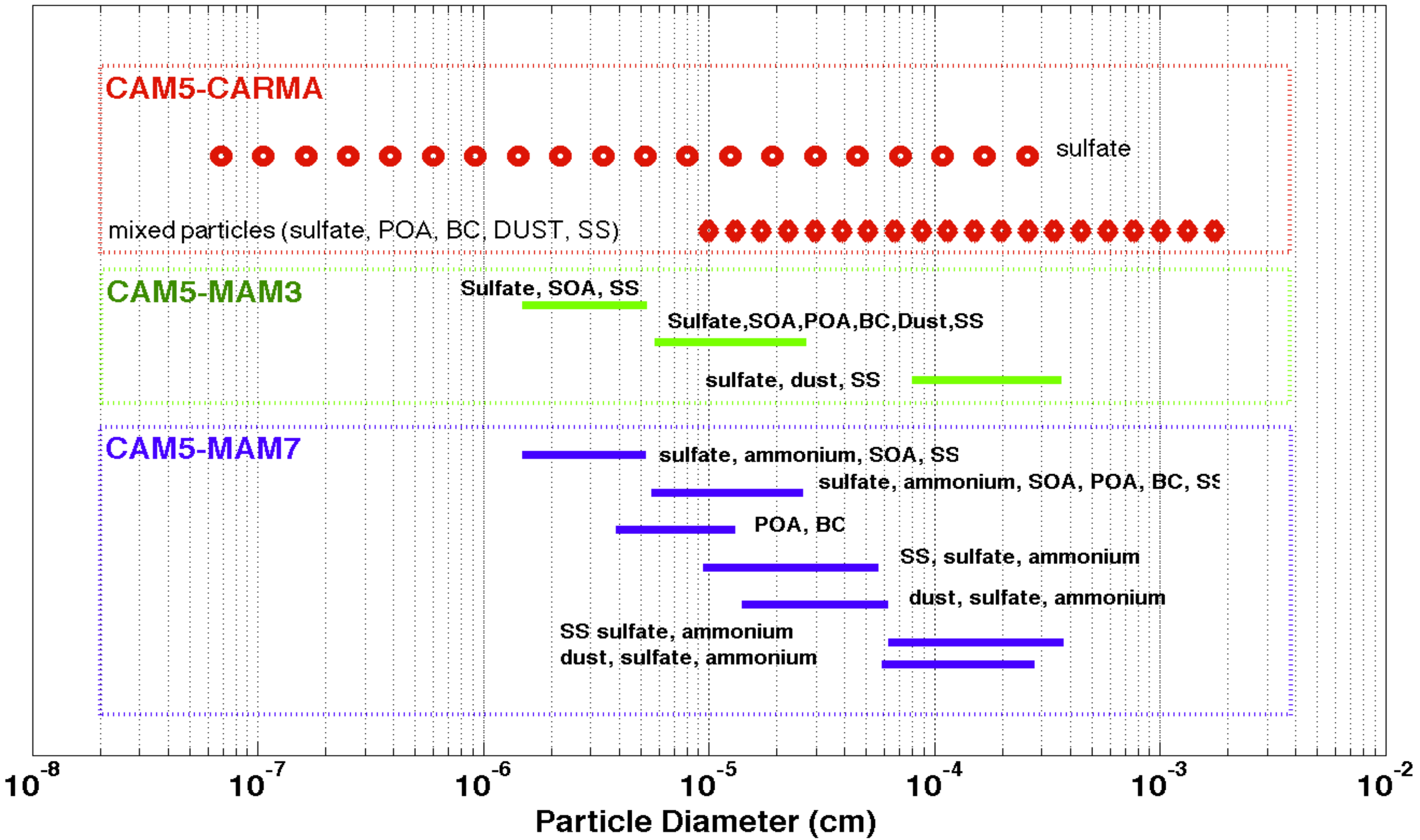
CARMA is coupled with CAM5 by Charles Bardeen, ACD, NCAR

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

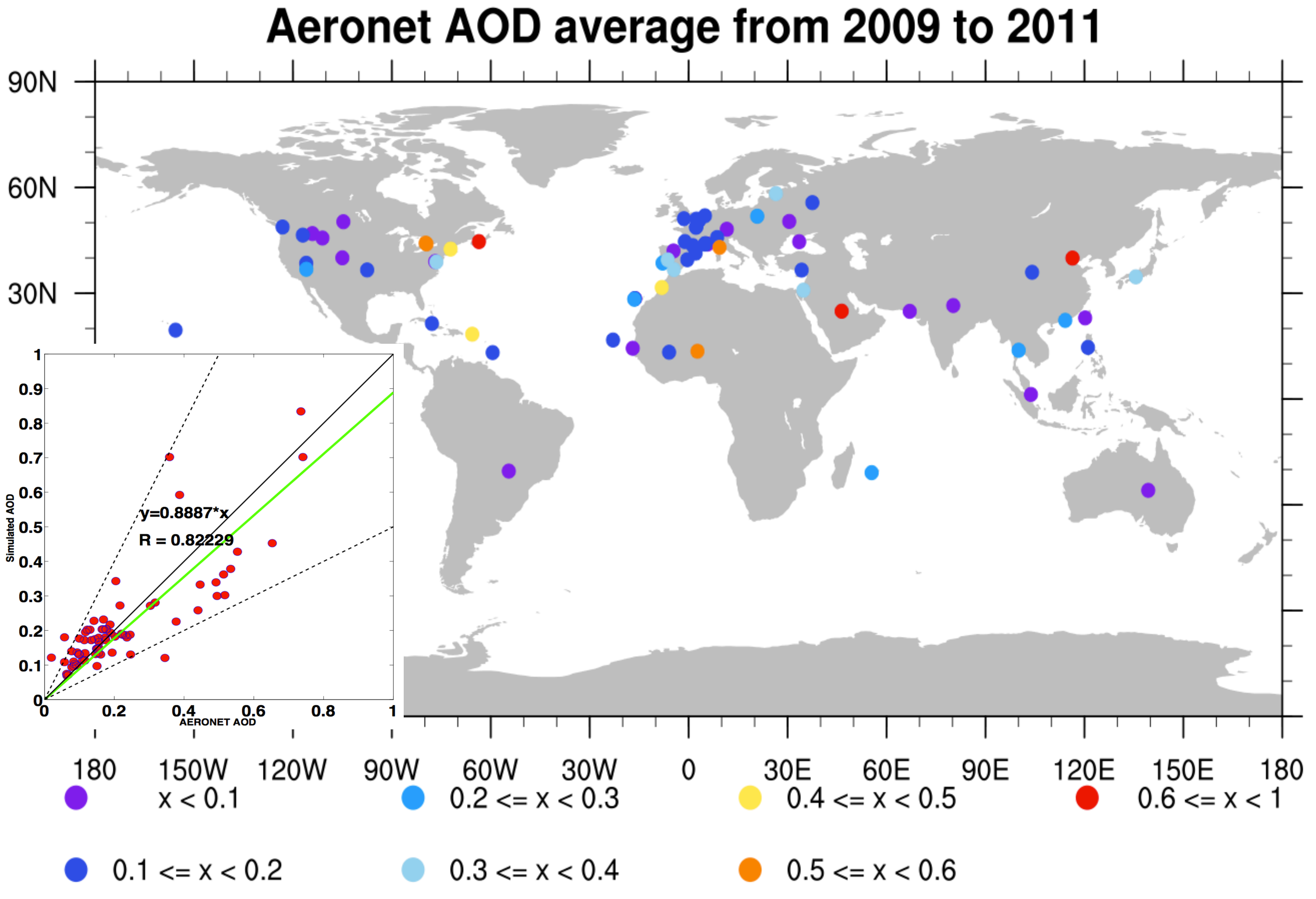


CARMA has wider size range of aerosols than MAM

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



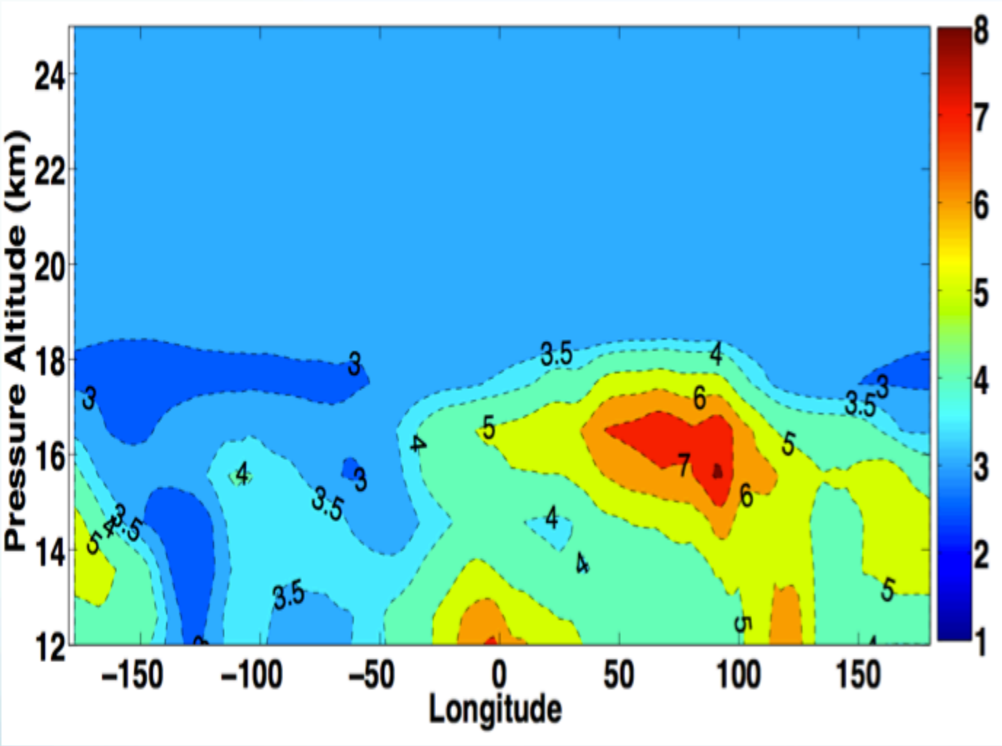
Model captures 89% of AeroNet AOD on average

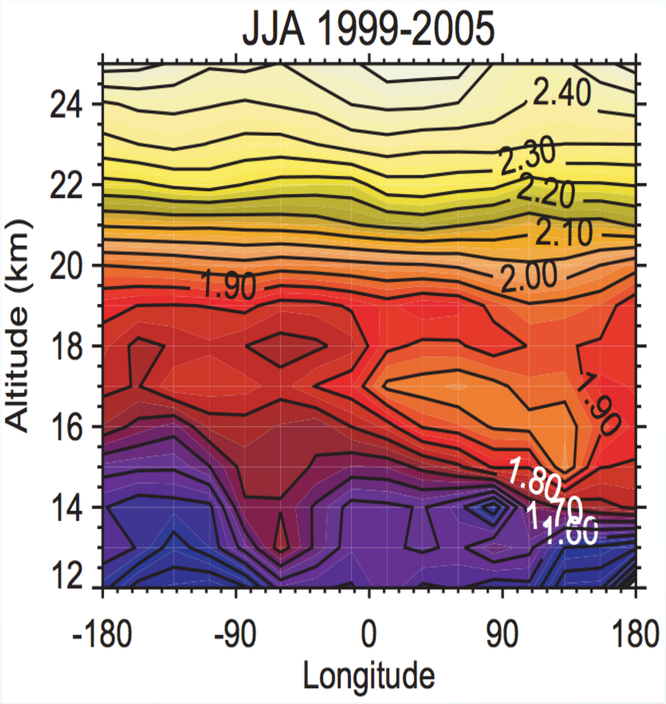


CARMA predicts aerosol layer in UTLS over Asia and North America

Extinction Ratio at 1020 nm

Total extinction/molecular extinction

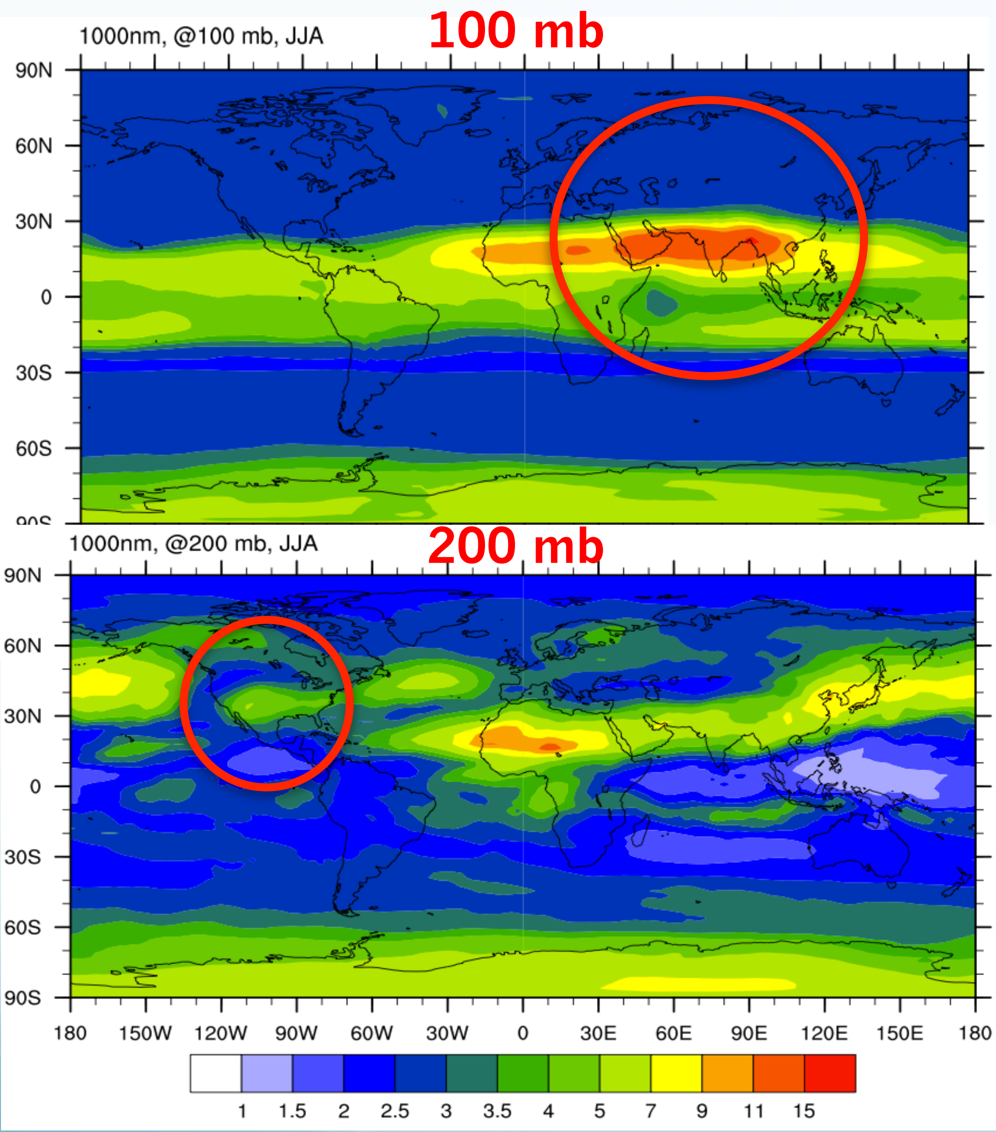




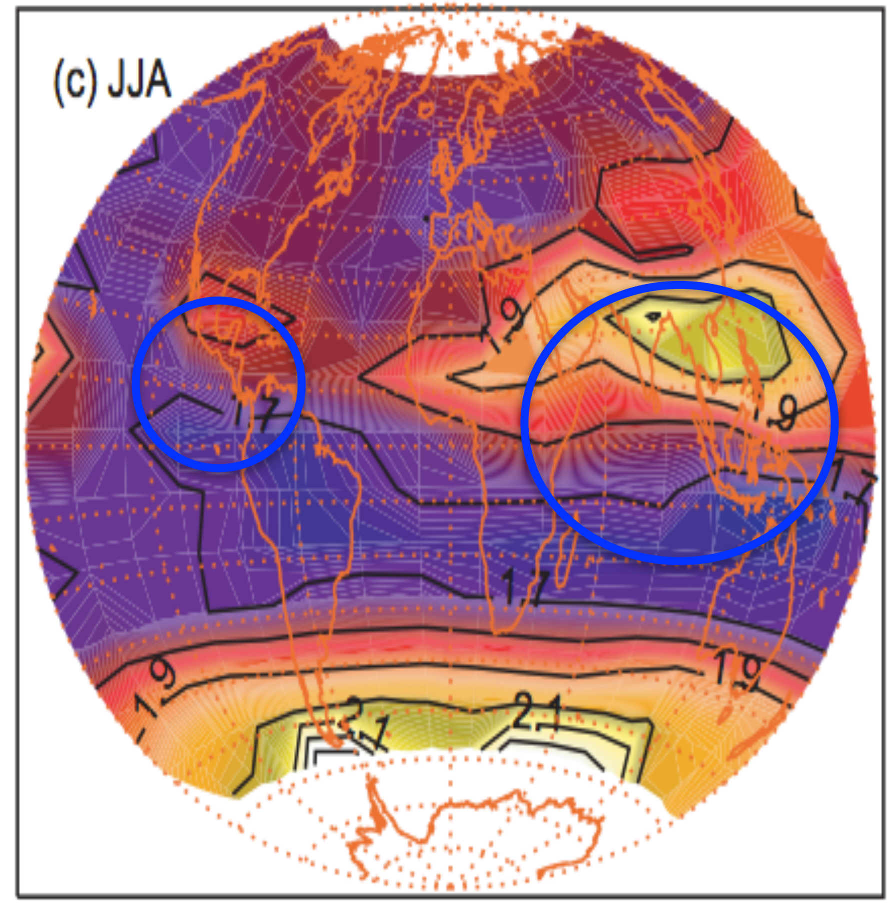
$$\text{Extinction Ratio} = \frac{aerosol\ extinction + molecular\ extinction}{molecular\ extinction}$$

Thomason and Vernier, 2013

CARMA extinction ratio has maximum in ATAL and NATAL

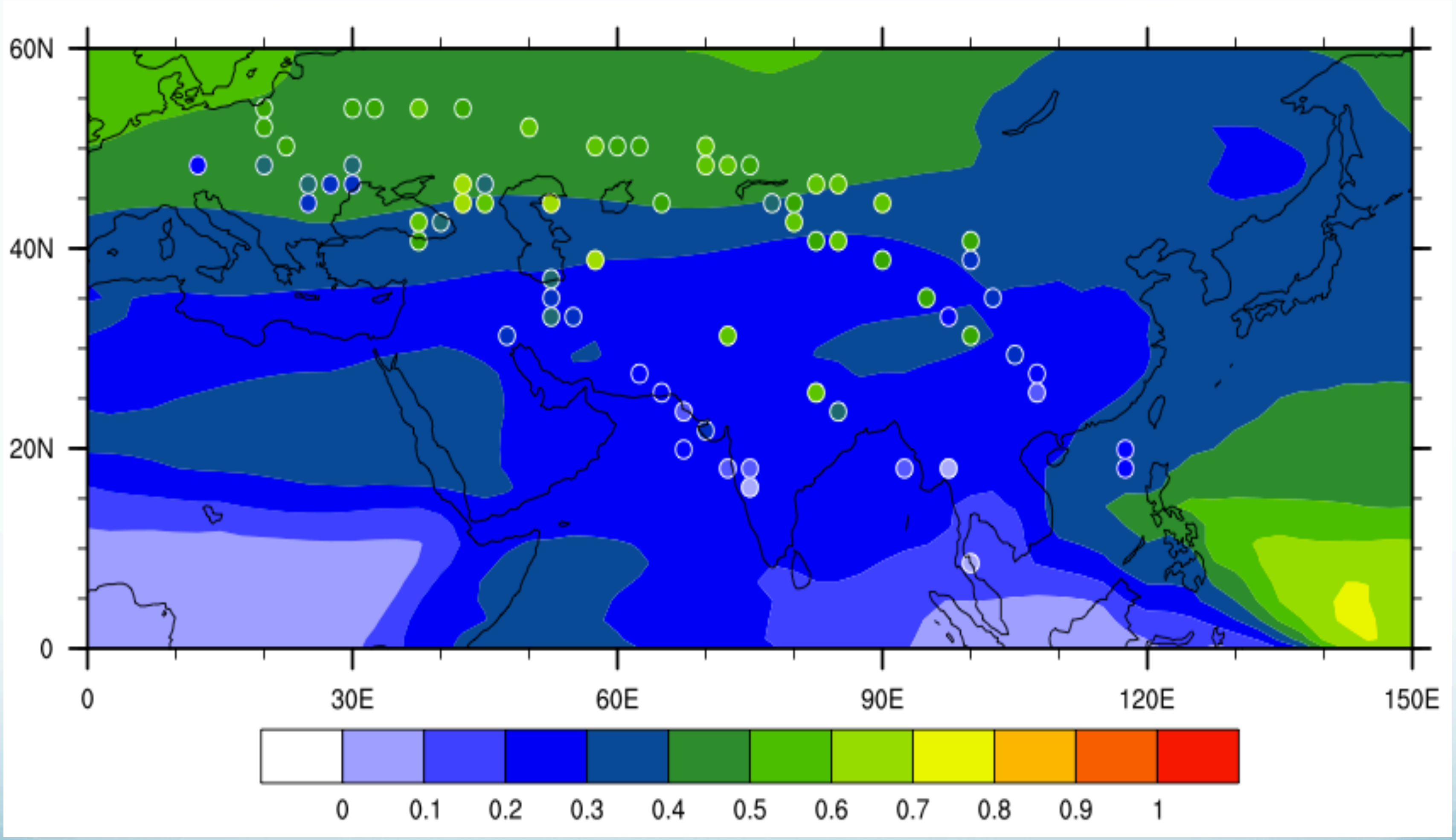


Thomason and Vernier, 2013



Extinction Ratio at 1020 nm

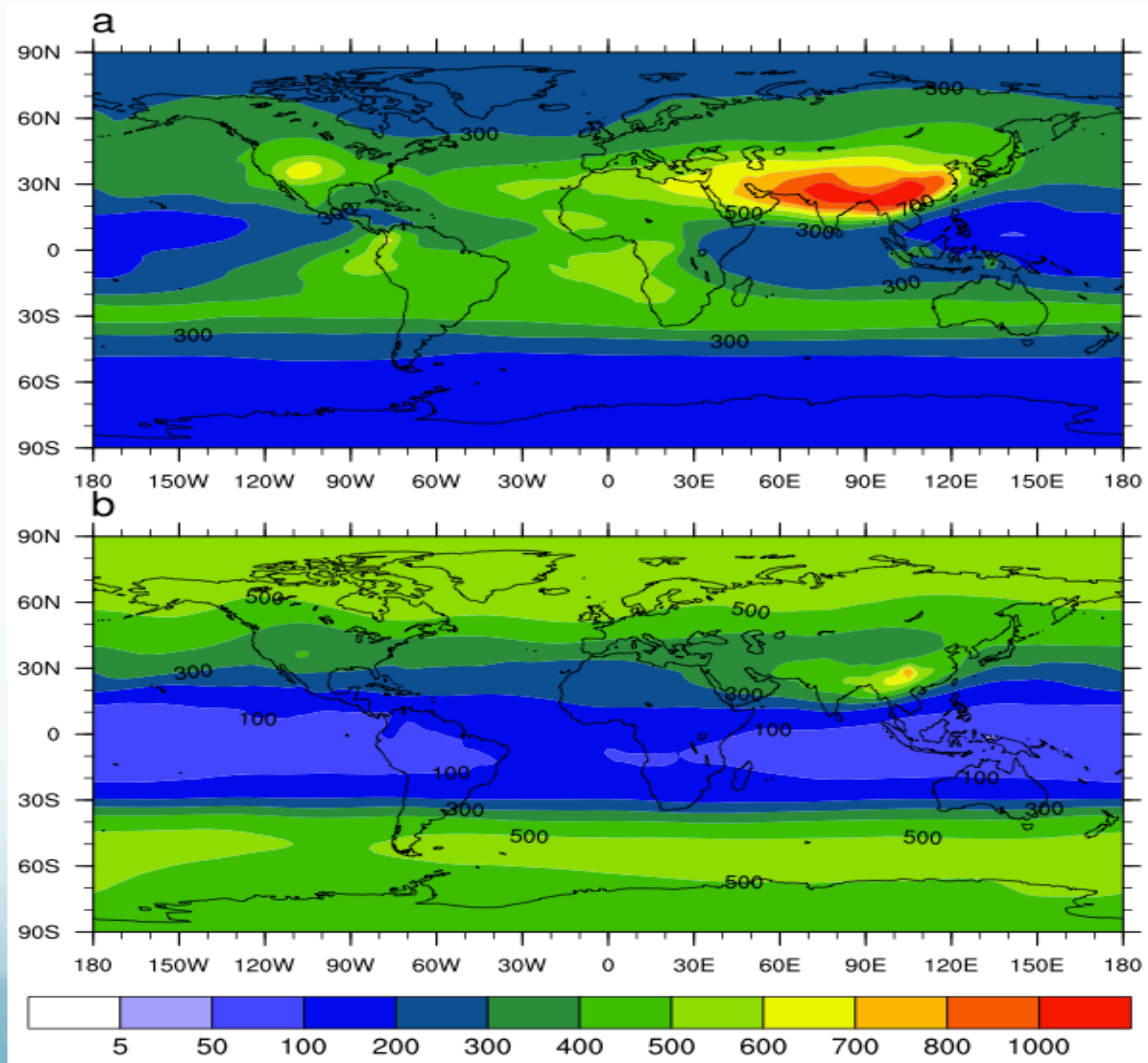
Both CARMA and CARIBIC shows strong gradient of S/C ratio from Europe to Asia



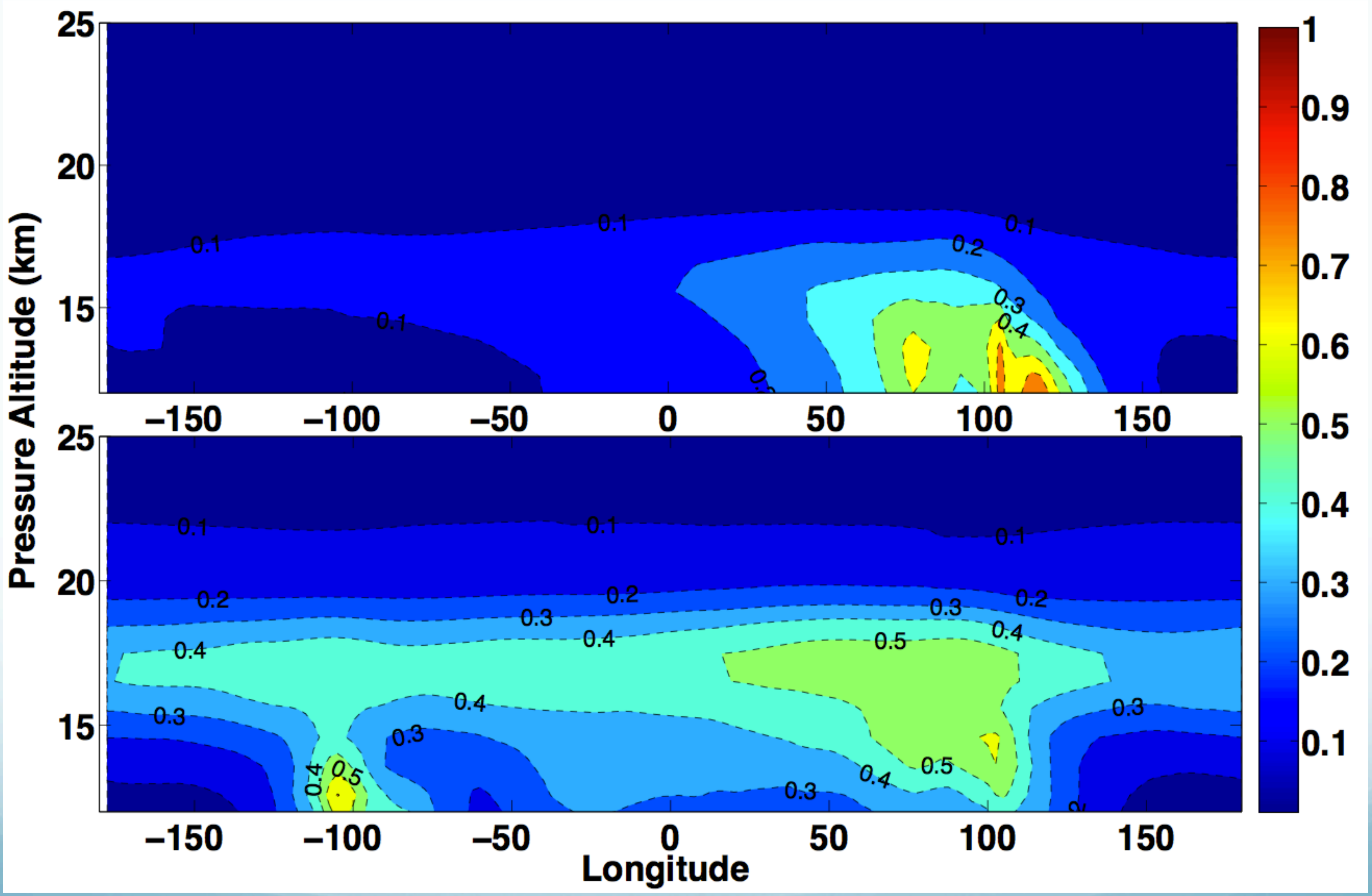
Asian Tropopause Aerosol Layer is mainly composed of Organics and Sulfate

Organics

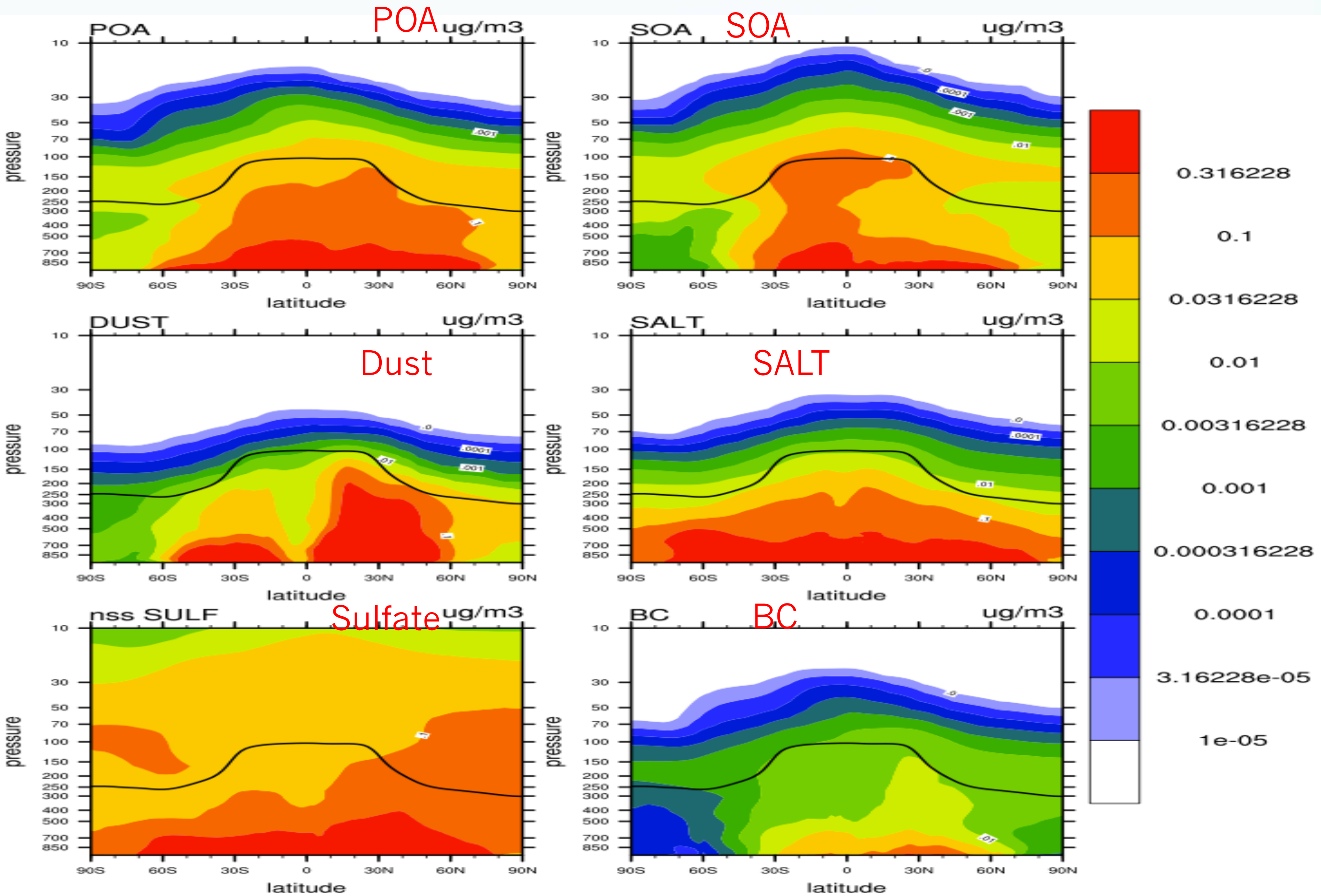
Sulfate



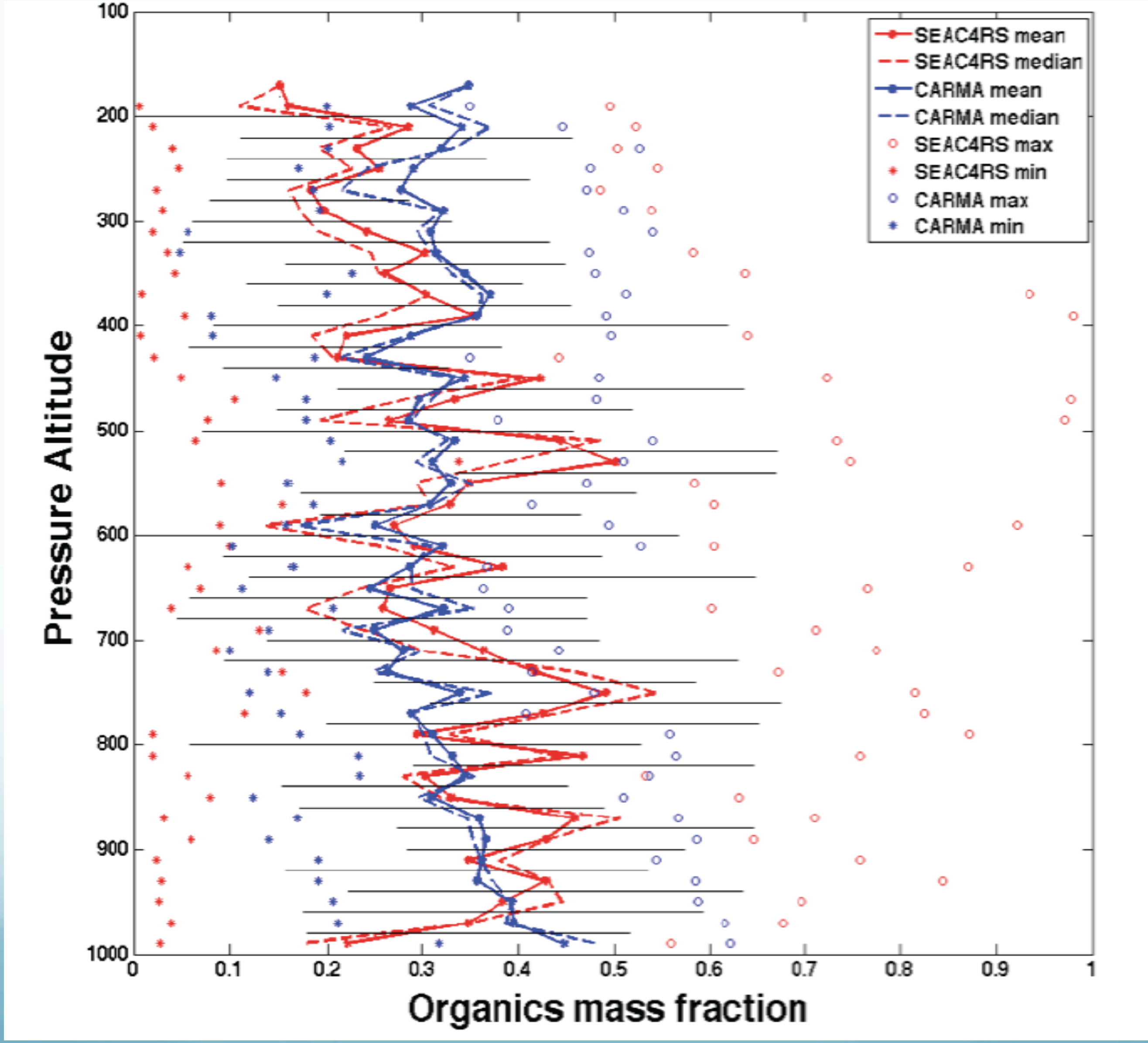
ATAL's organics are composed of POA and SOA; NATAL's are composed of SOA



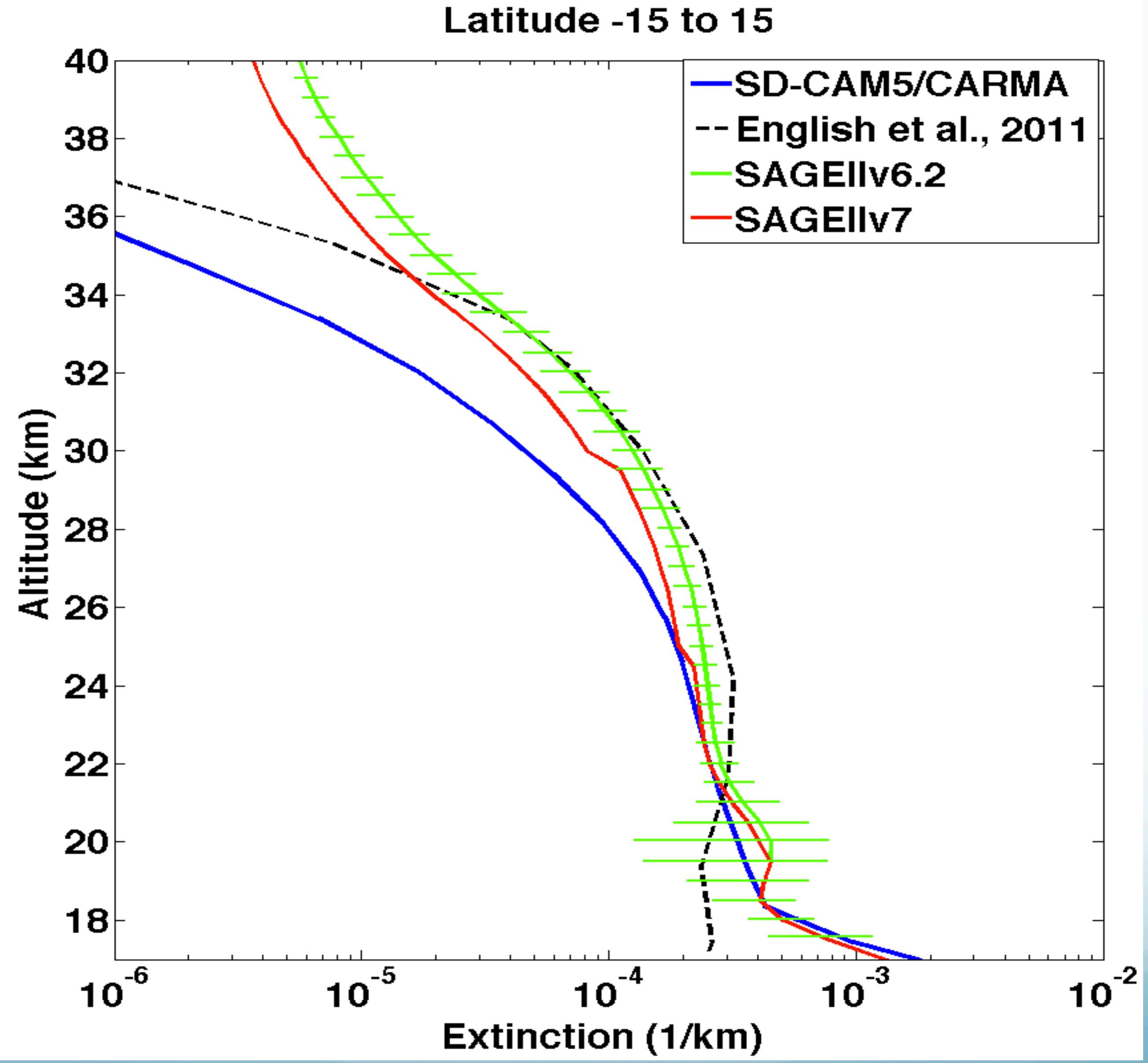
In the UTLS, organics and sulfate dominate

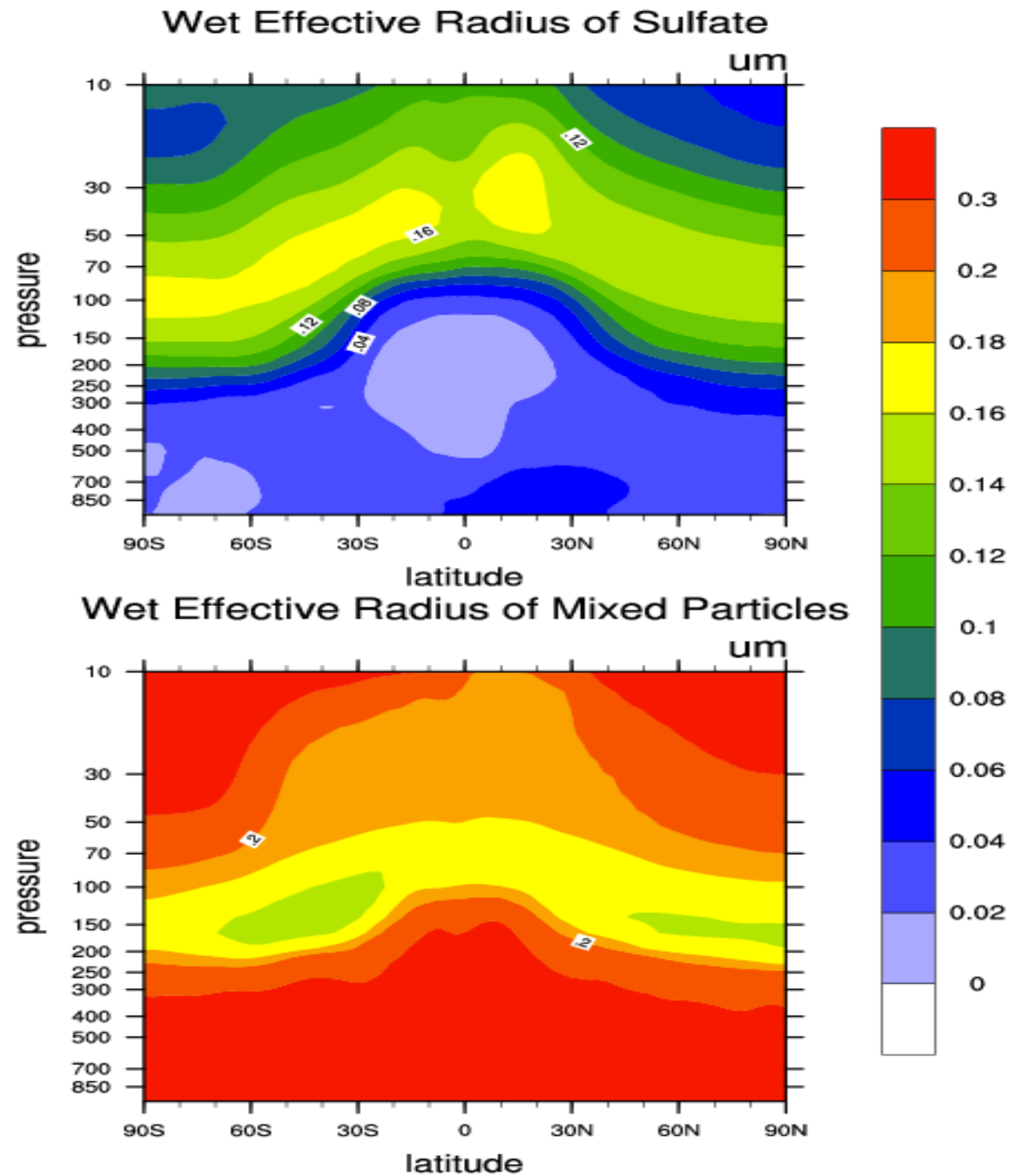


Organics Mass Fraction compared with SEAC4RS data



Organics contributes to extinction at UTLS

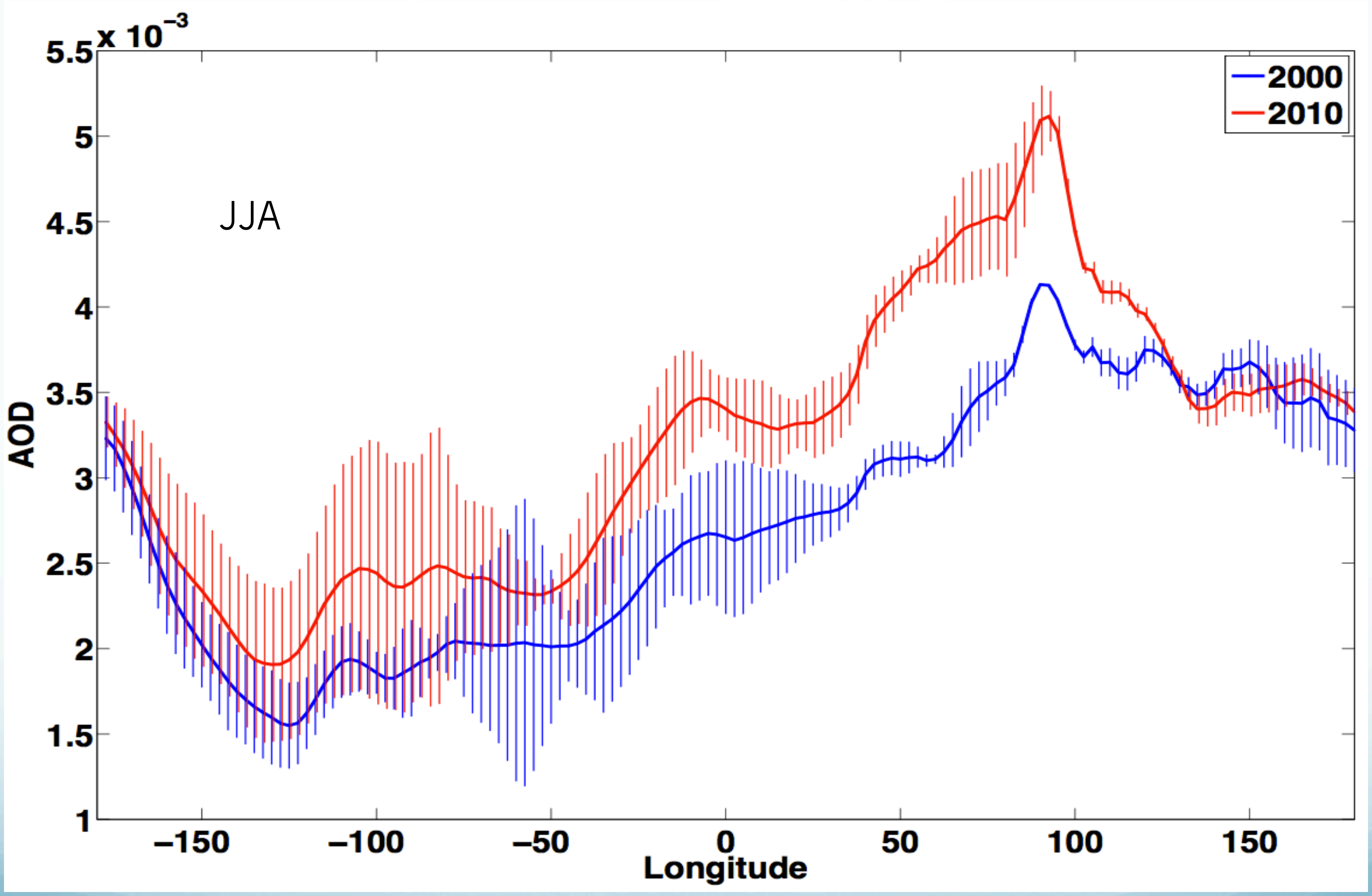




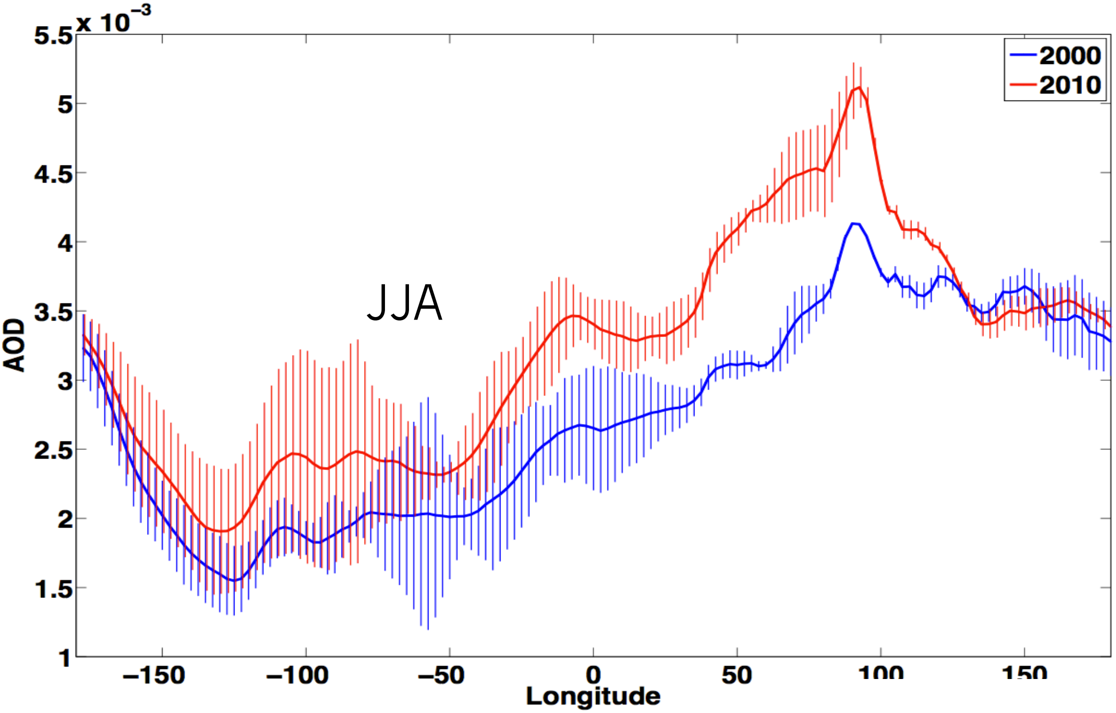
Sulfate effective radius is between 0.1 to 0.18 um in stratosphere

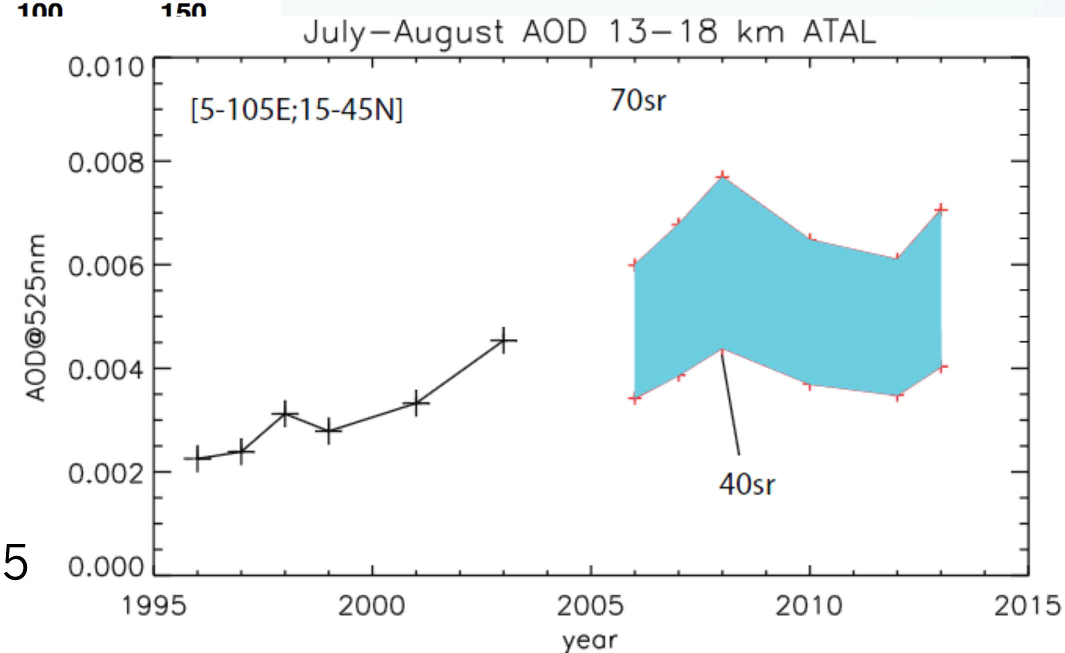
Mixed particles effective radius at UTLS is 0.16 um

ATAL intensity increases by 25% from 2000 to 2010



ATAL intensity increases by 25% from 2000 to 2010

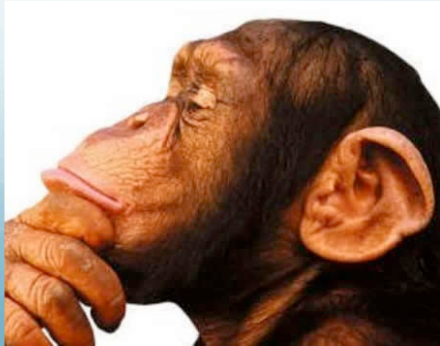




Vernier et al., GRL, 2015

Conclusions

- At UTLS, sulfate mass ≈ organics mass; above UTLS, sulfate dominates;
- Mixed particle effective radius is roughly 0.16 um in UTLS;
- CARMA does predict ATAL and NATAL during JJA;
- ATAL is mostly composed of organics and sulfate;
- NATAL is mostly composed of SOA, with sulfate as background;
- ATAL intensity increases by 25% from 2000 to 2010



THANKS

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Mike Mills (NCAR)

Yellowstone (NSF&NCAR)

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