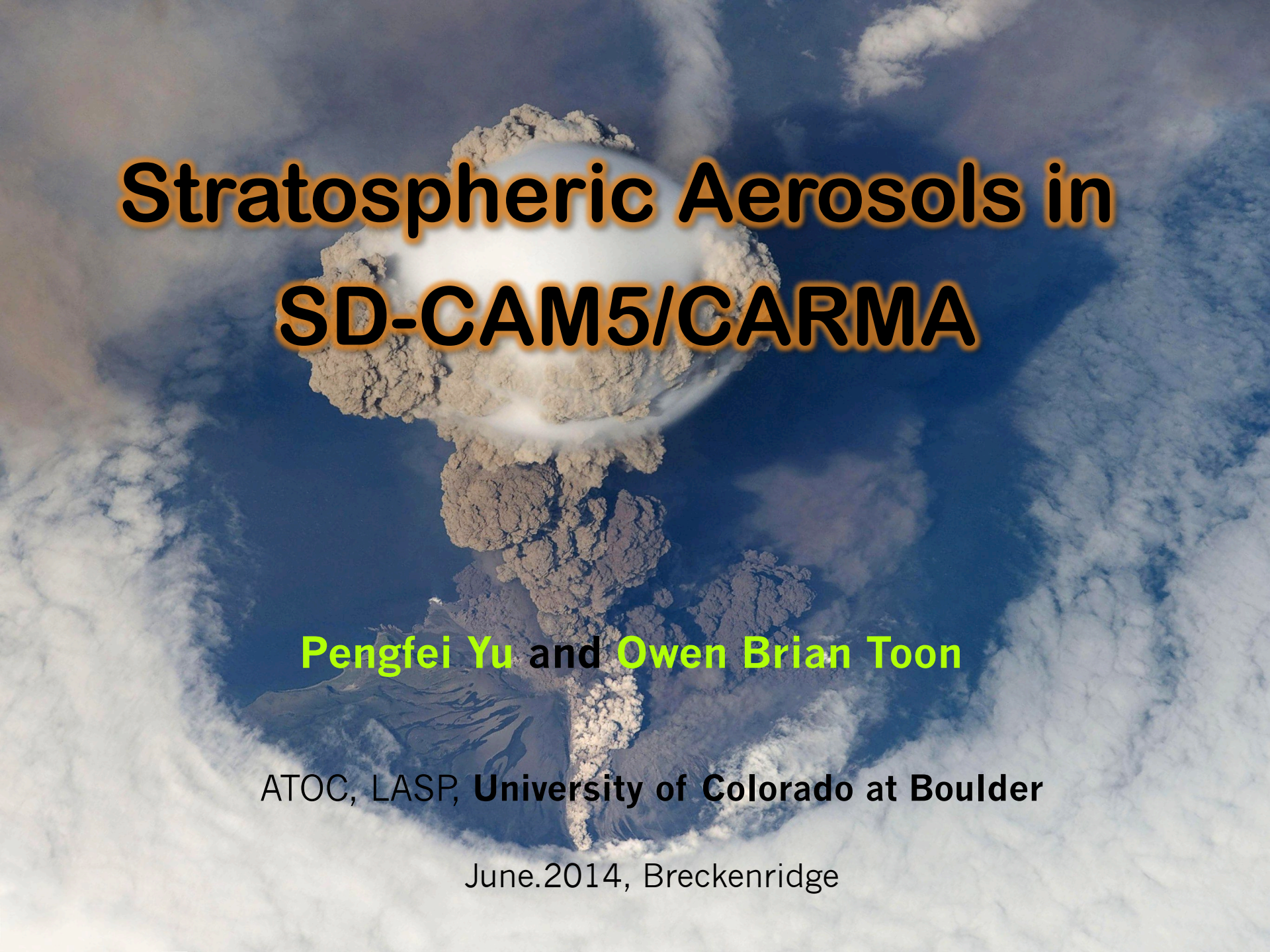


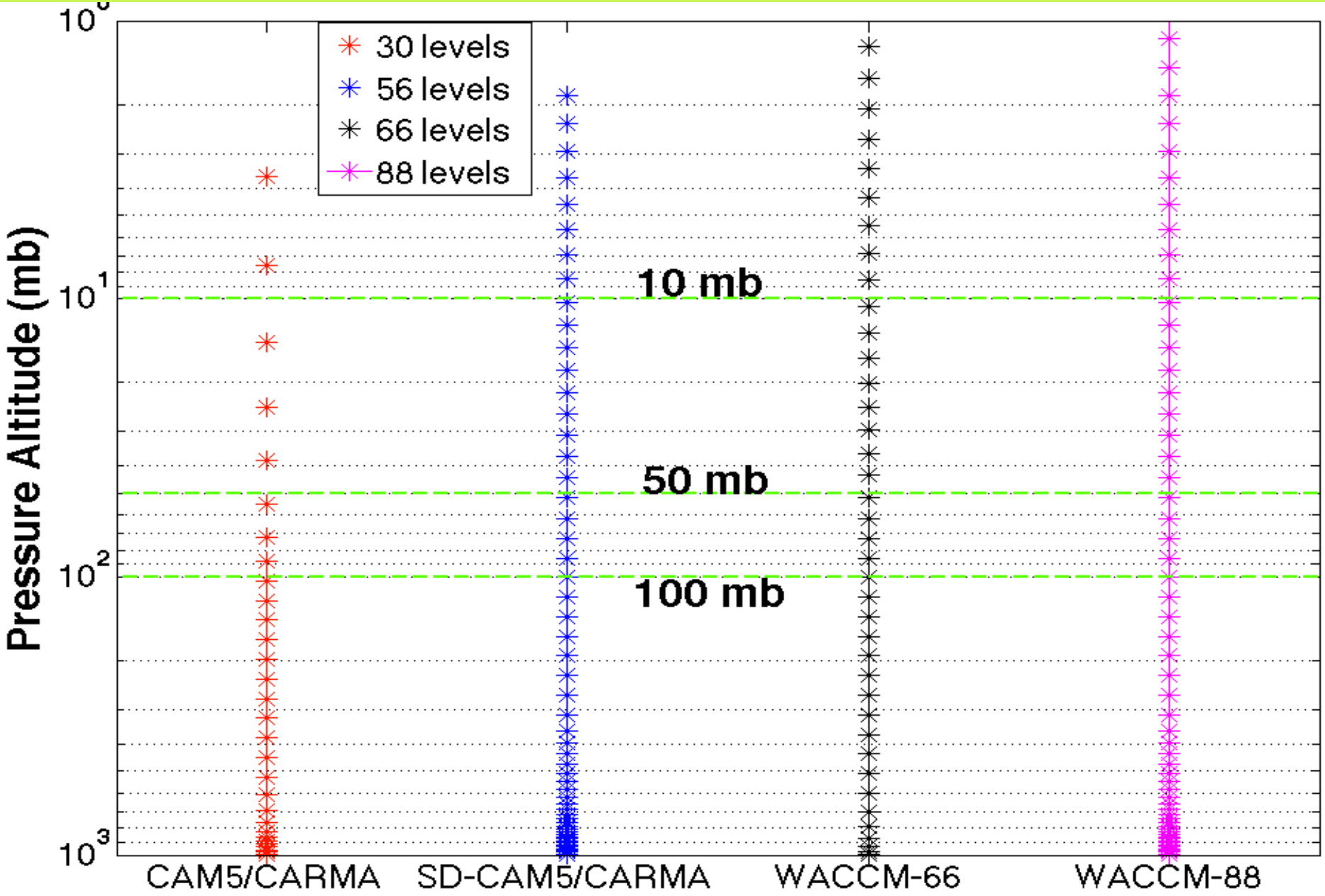
Stratospheric Aerosols in SD-CAM5/CARMA

Pengfei Yu and Owen Brian Toon

ATOC, LASP, **University of Colorado at Boulder**

June.2014, Breckenridge

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



CARMA	Default Modal	Bulk
H2SO4 + hv -> SO3 + H2O		
SO2 + hv -> SO + O		
SO3 + hv -> SO2 + O		
OCS + hv -> S + CO		
SO + hv -> S + O		
DMS + OH -> .5 * SO2 + .5 * HO2	DMS + OH -> SO2; DMS + OH -> .5 * SO2 + .5 * HO2	DMS + OH --> a*SO2 + (1-a)*MSA
DMS + NO3 -> SO2 + HNO3	DMS + NO3 -> SO2 + HNO3	DMS + NO3 --> SO2
OCS + O -> SO + CO	SO2 + OH -> H2SO4	SO2 + OH + M --> SO4 + M
OCS + OH -> SO2 + C + H		
S + OH -> SO + H		
S + O2 -> SO + O		
S + O3 -> SO + O2		
SO + OH -> SO2 + H		
SO + O2 -> SO2 + O		
SO + O3 -> SO2 + O2		
SO + NO2 -> SO2 + NO		
SO2 + OH + M -> HSO3 + M		
HSO3 + O2 -> SO3 + HO2		
SO3 + H2O -> H2SO4		
S(IV) + H2O2 --> SO4	S(IV) + H2O2 --> SO4	S(IV) + H2O2 --> SO4
S(IV) + O3 --> SO4	S(IV) + O3 --> SO4	S(IV) + O3 --> SO4

Sulfur Chemistry in CAM5/CARMA is developed by Mike Mills

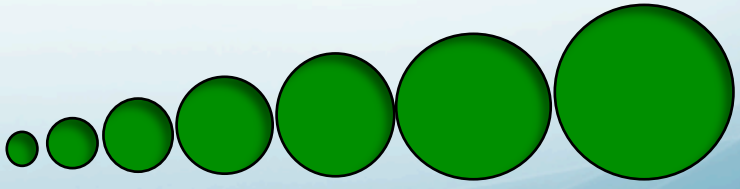
We are interested in:

- **Aerosol composition in UTLS and above:**

  Sulfate ≈ Organics @ UTLS

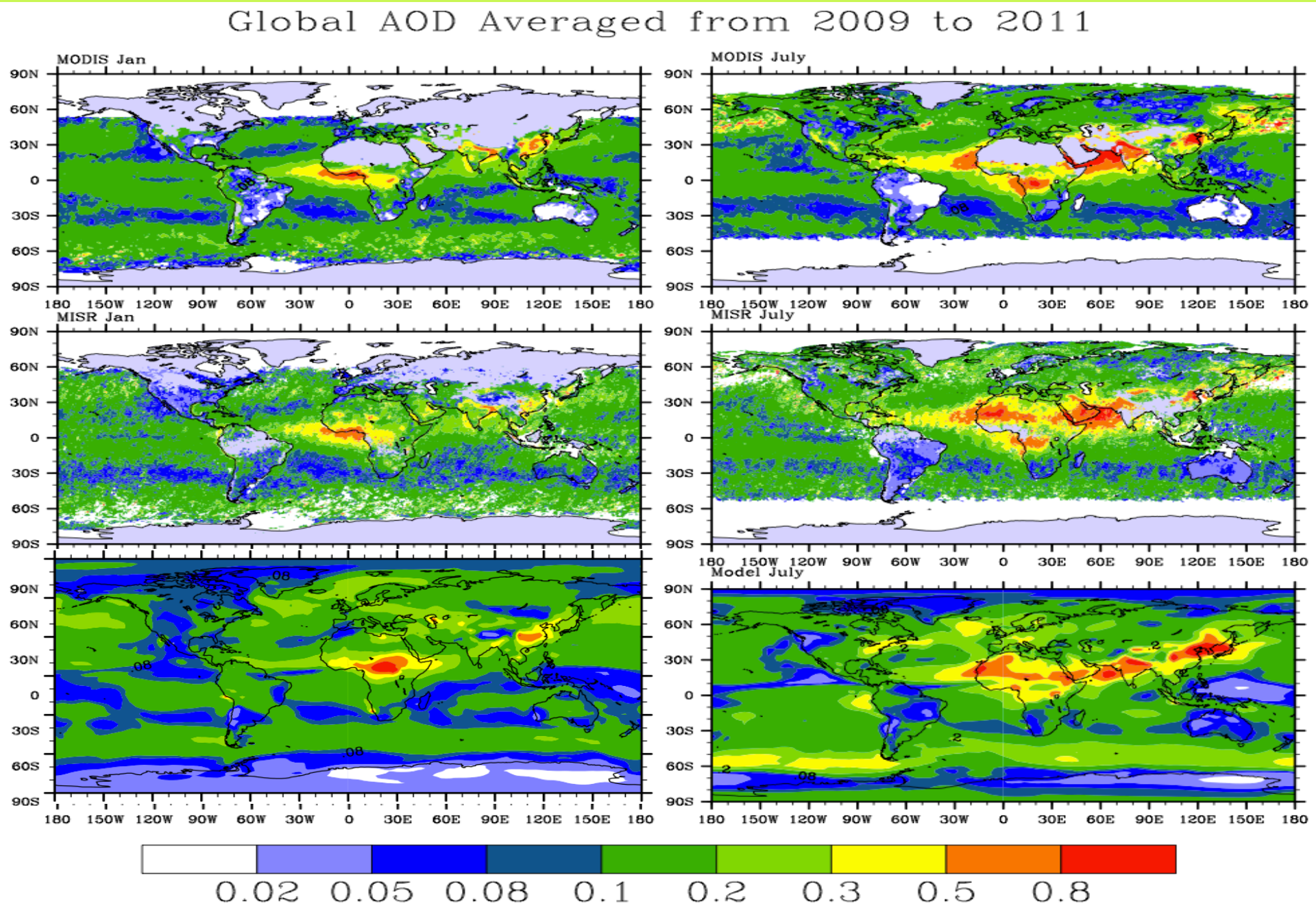
- **Aerosol properties in UTLS and above**

  Size distribution, Effective Radius

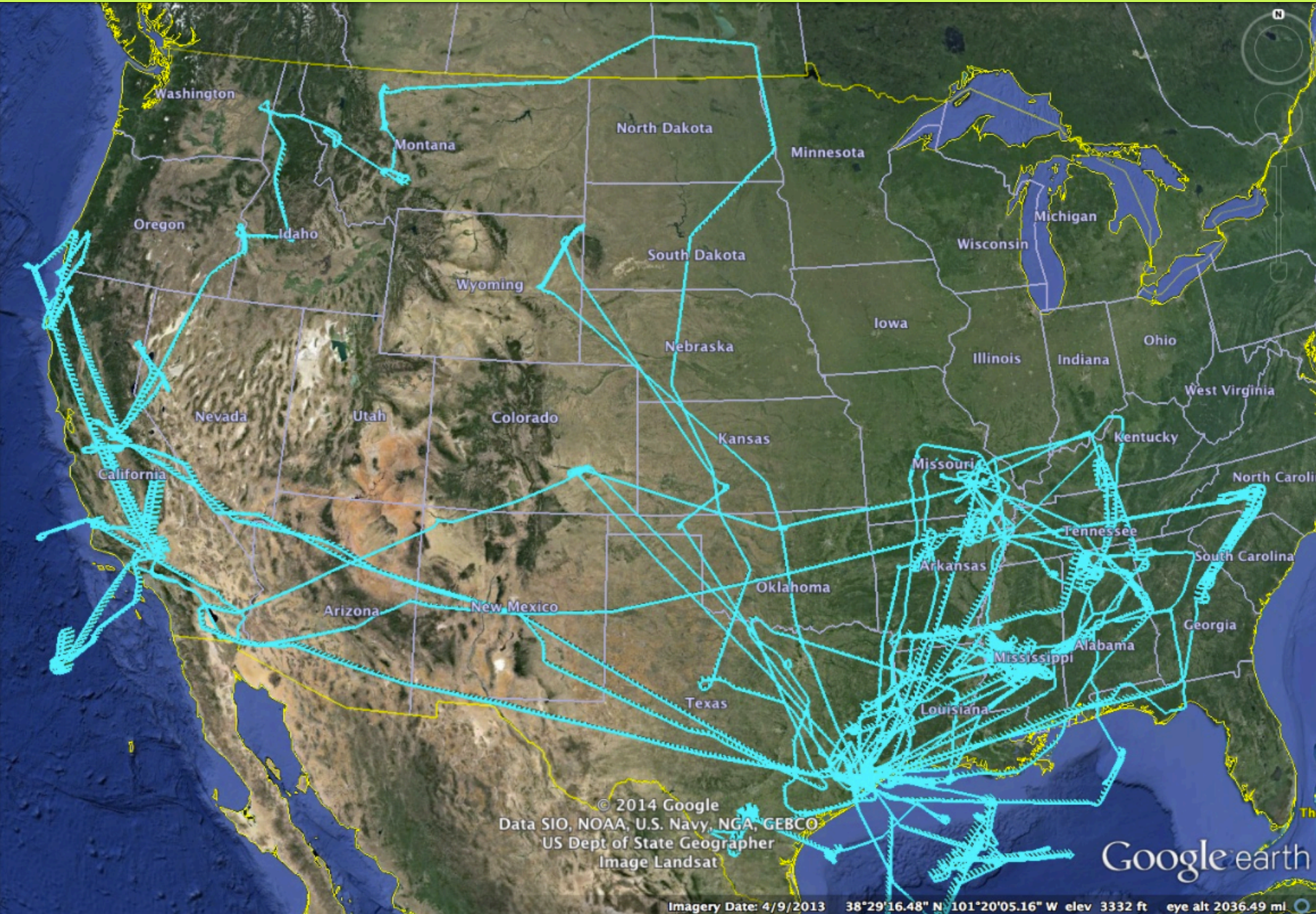


CARMA is sectional model

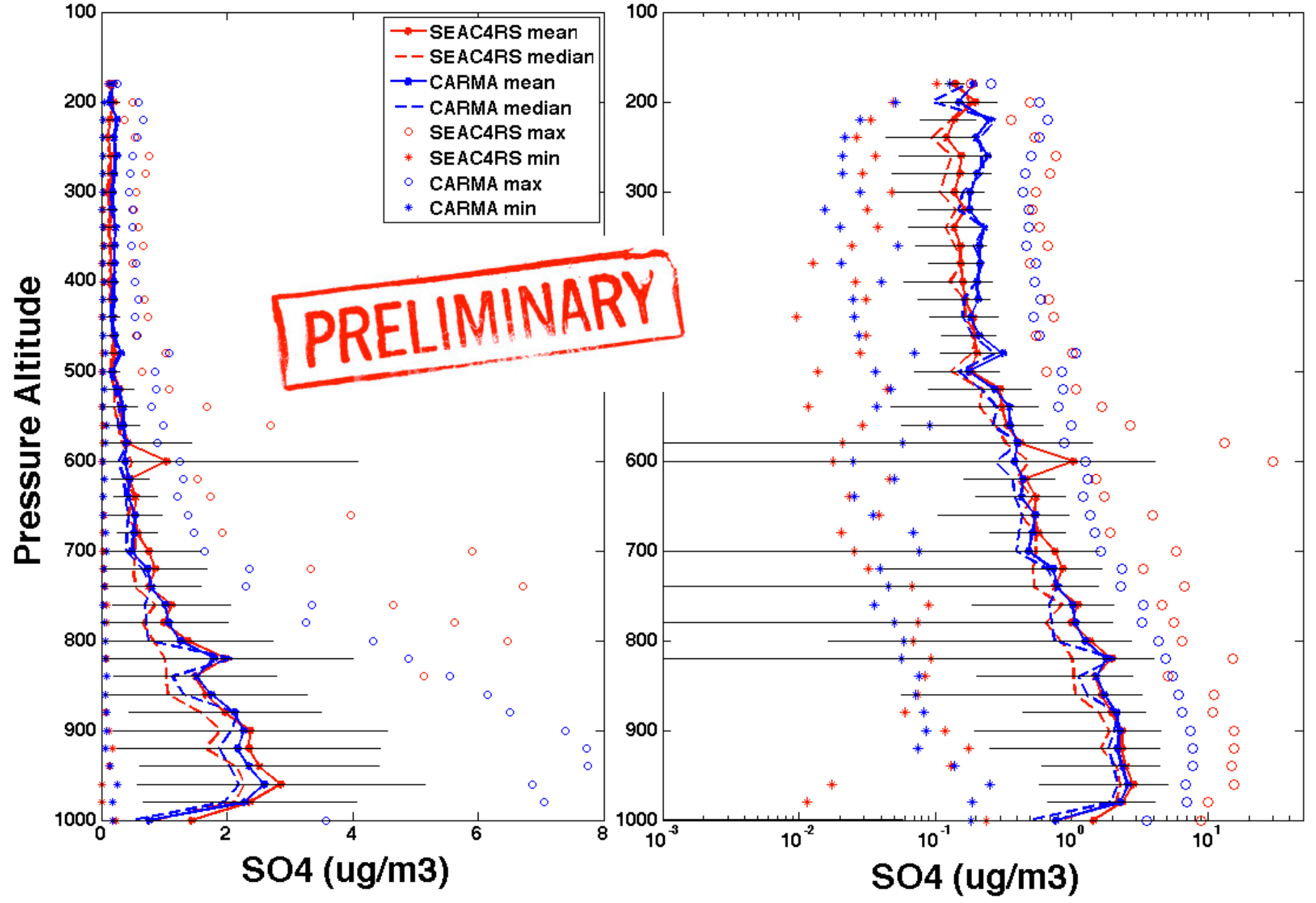
Model Captures Aerosol Optical Depth distribution



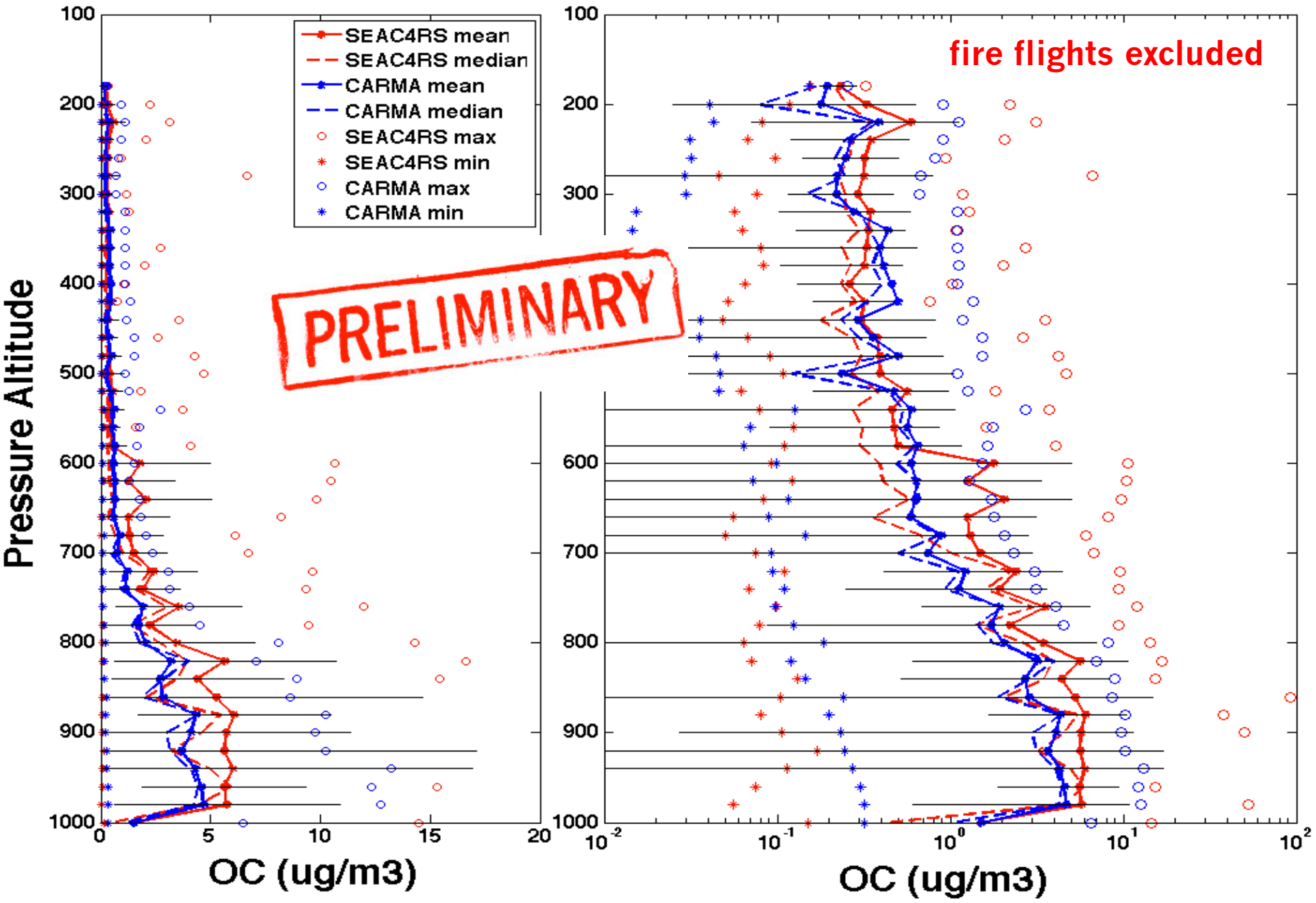
SEAC4RS happens in Southeast US: Aug-Sep, 2013

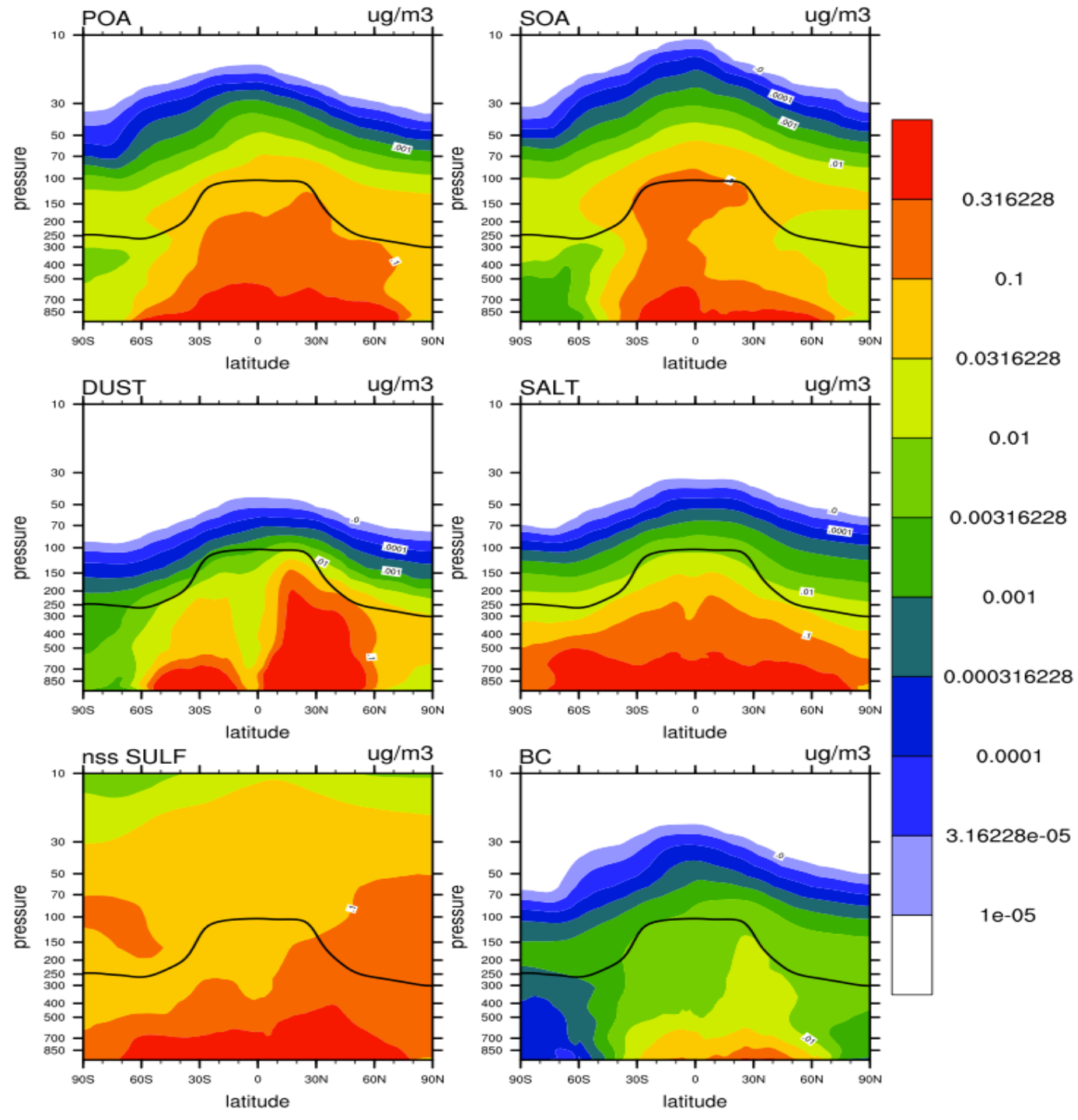


Model captures SO_4 in troposphere

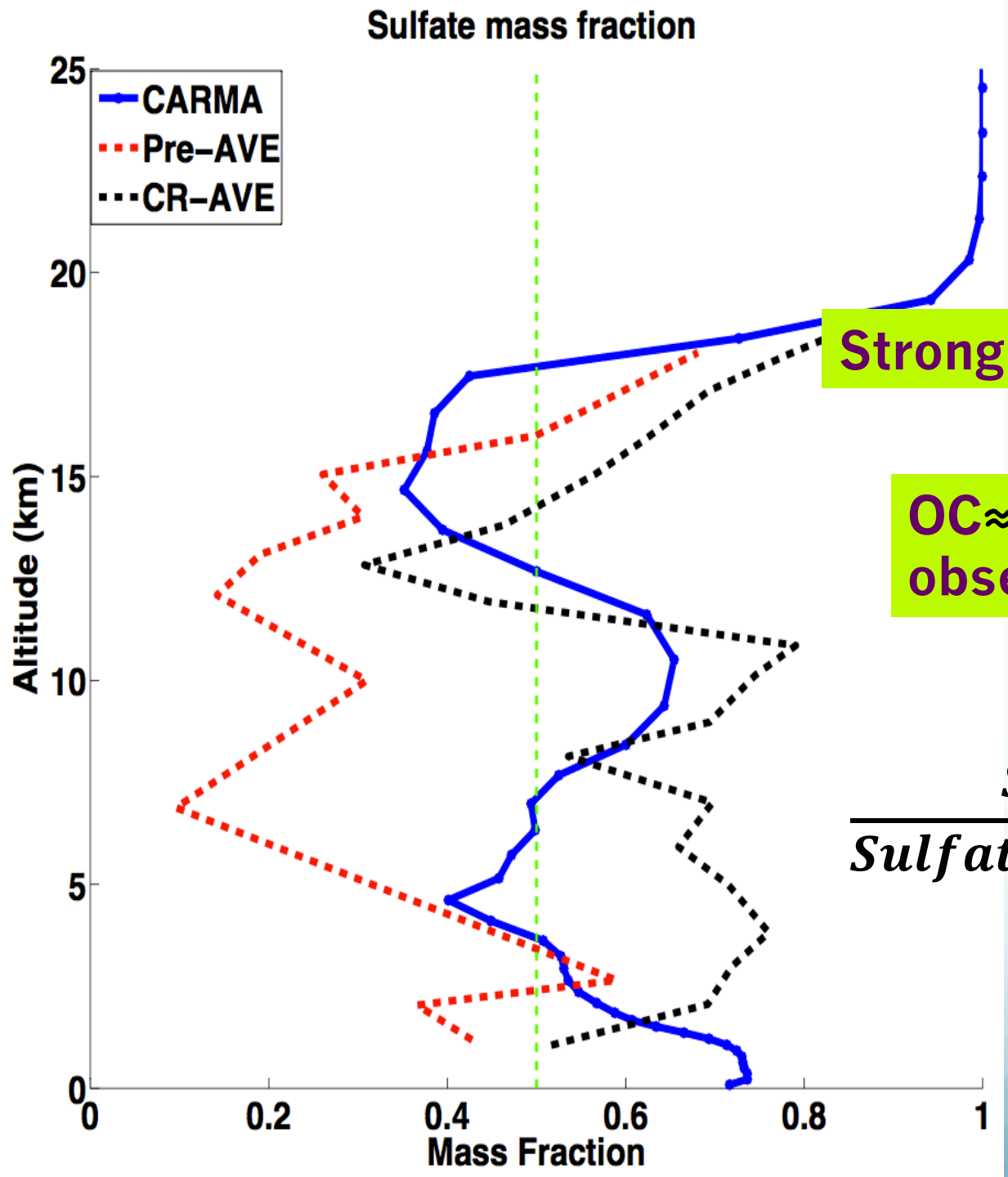


Model captures OC in troposphere





At UTLS, organics and sulfate dominate

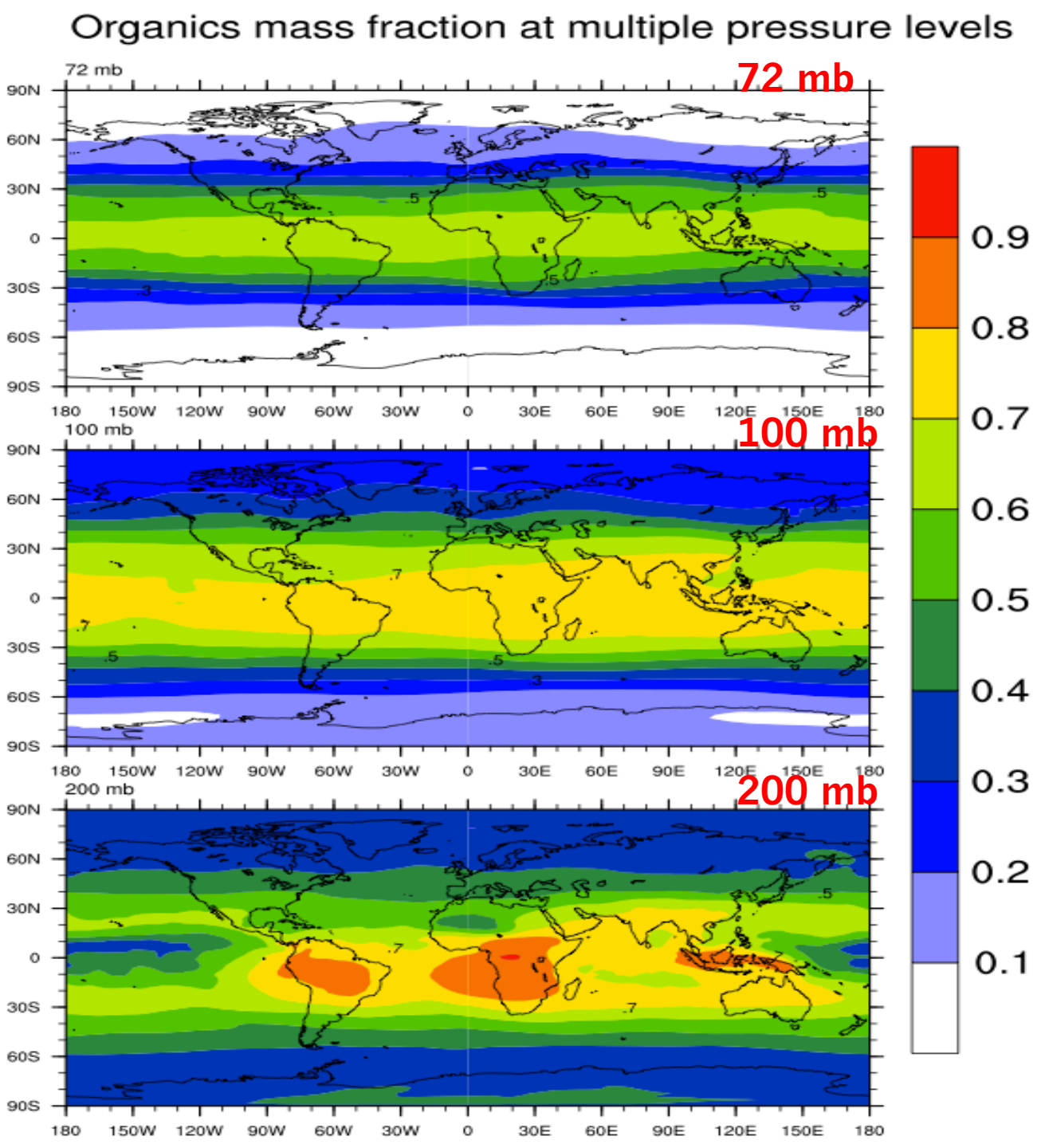


Strong gradient above UTLS

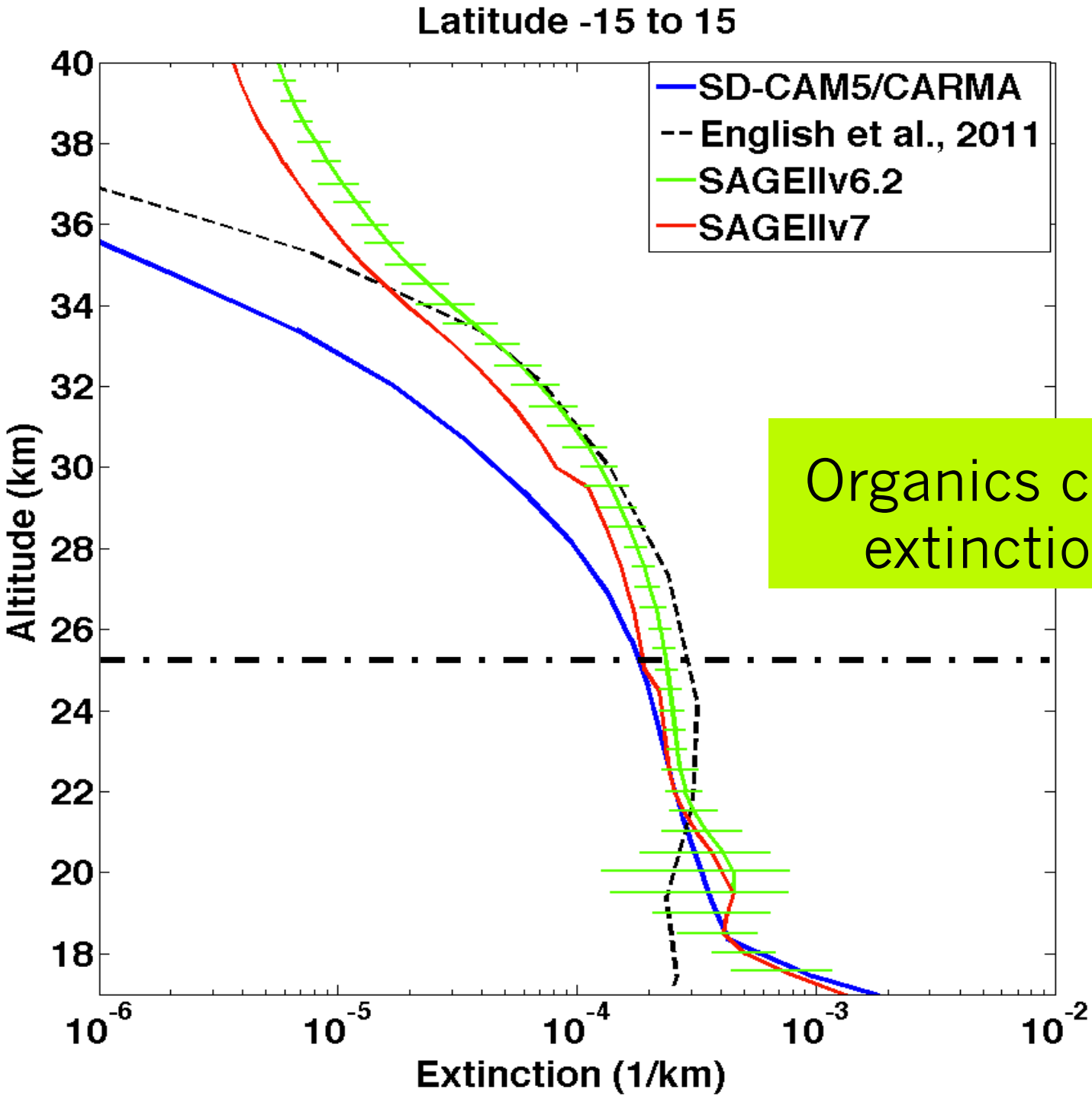
OC≈SULF at UTLS by observation

$$\frac{Sulfate}{Sulfate + Organics}$$

Froyd et al., 2009

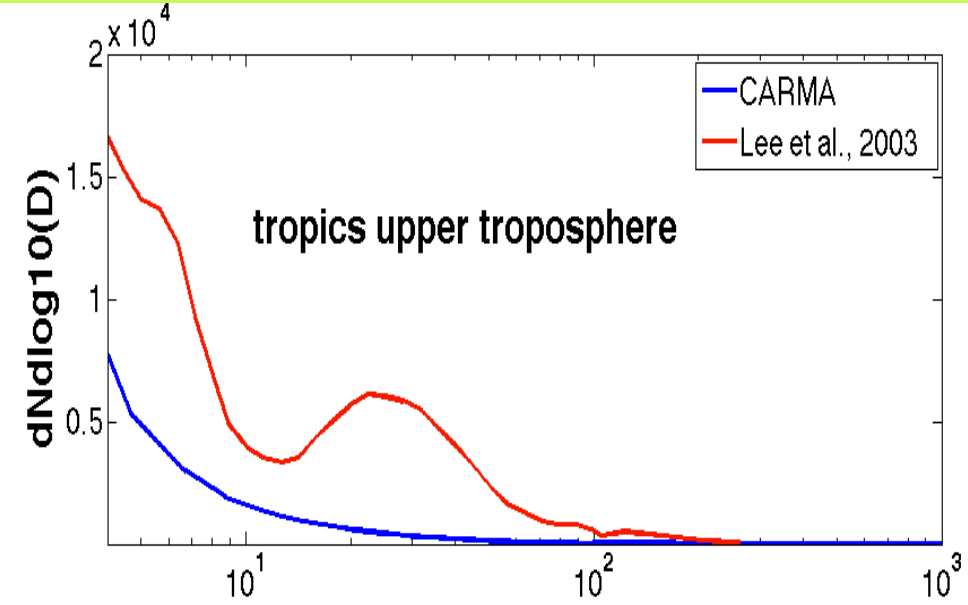


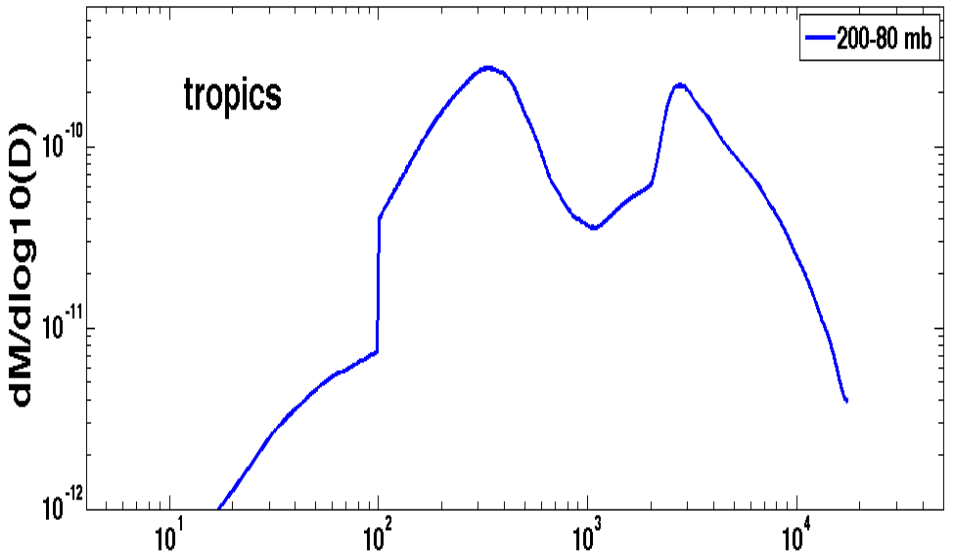
OC≈SULF
@ UTLS
by simulation

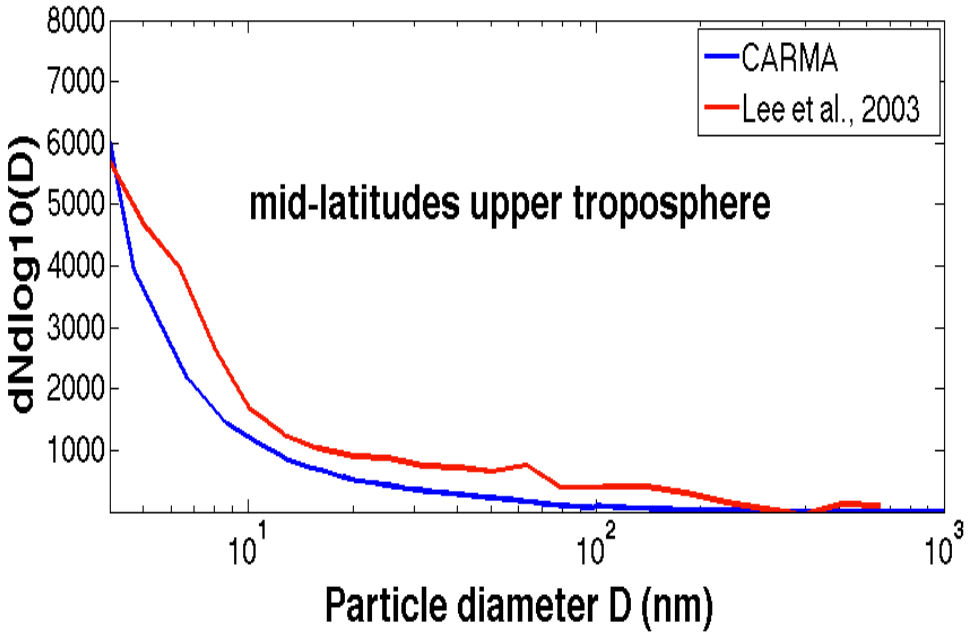


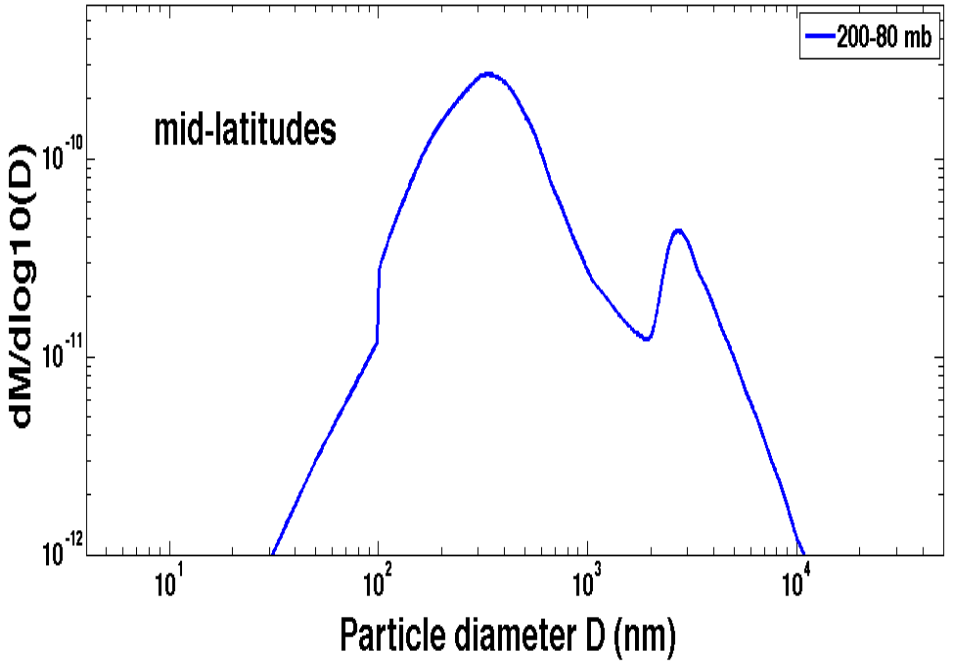
Organics contributes to extinction at UTLS

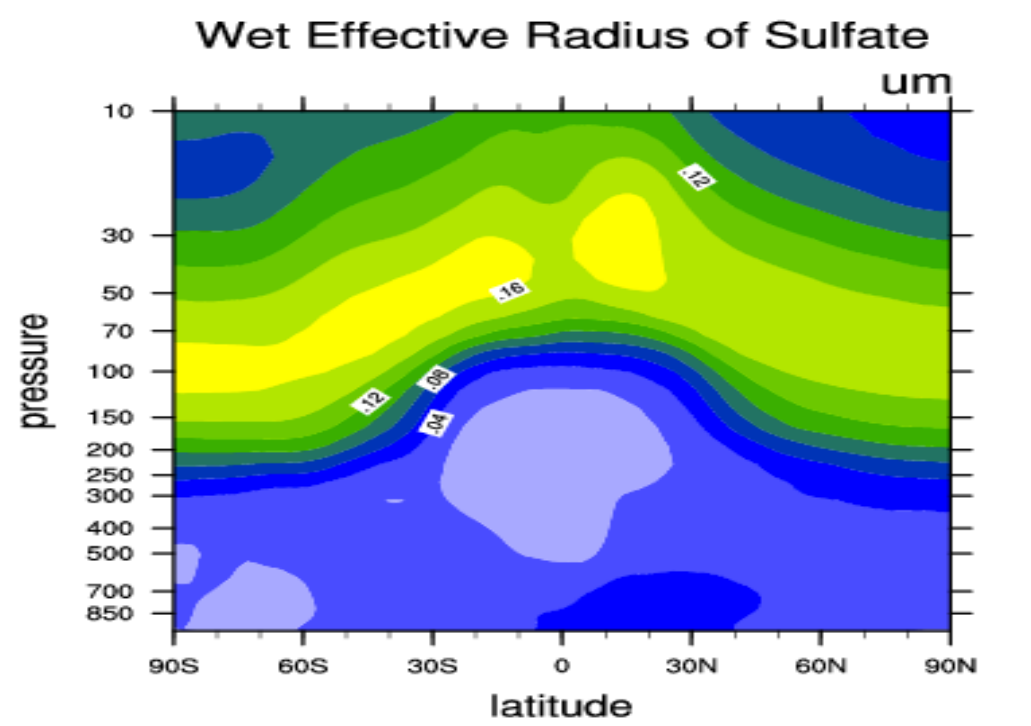
Model matches aerosol number in mid-latitude, while underestimates number in tropics

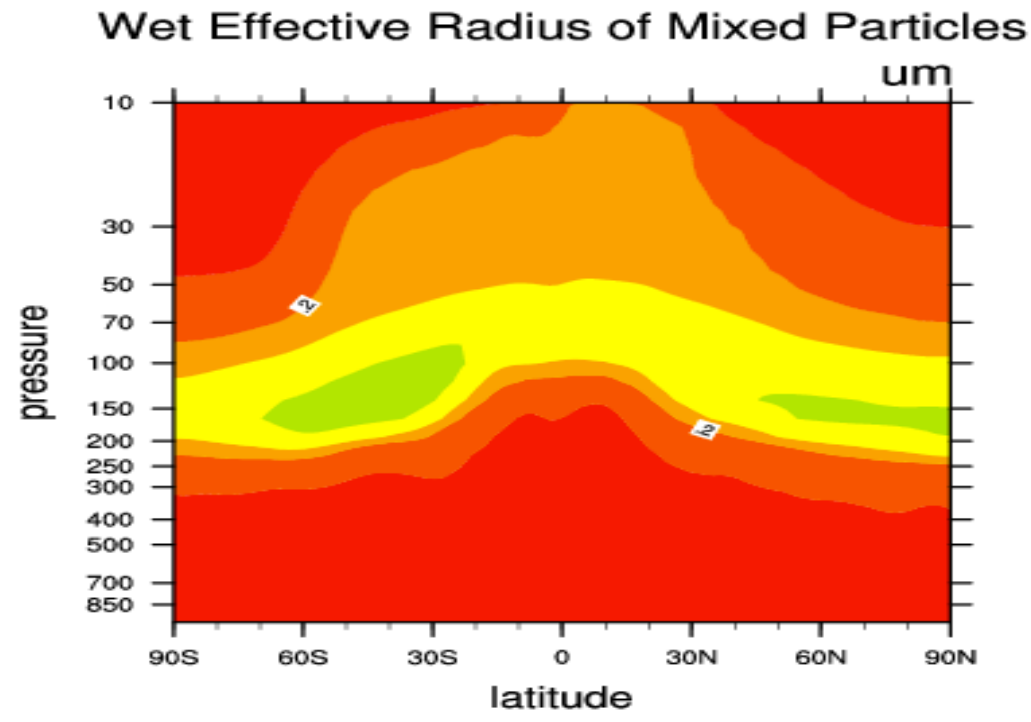


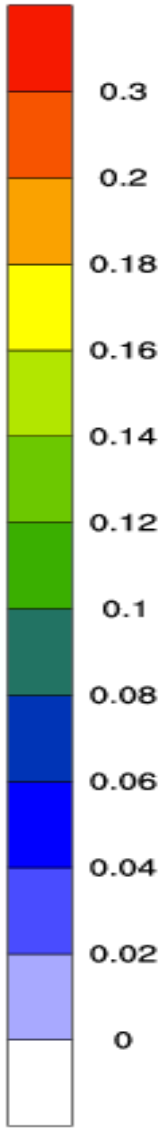








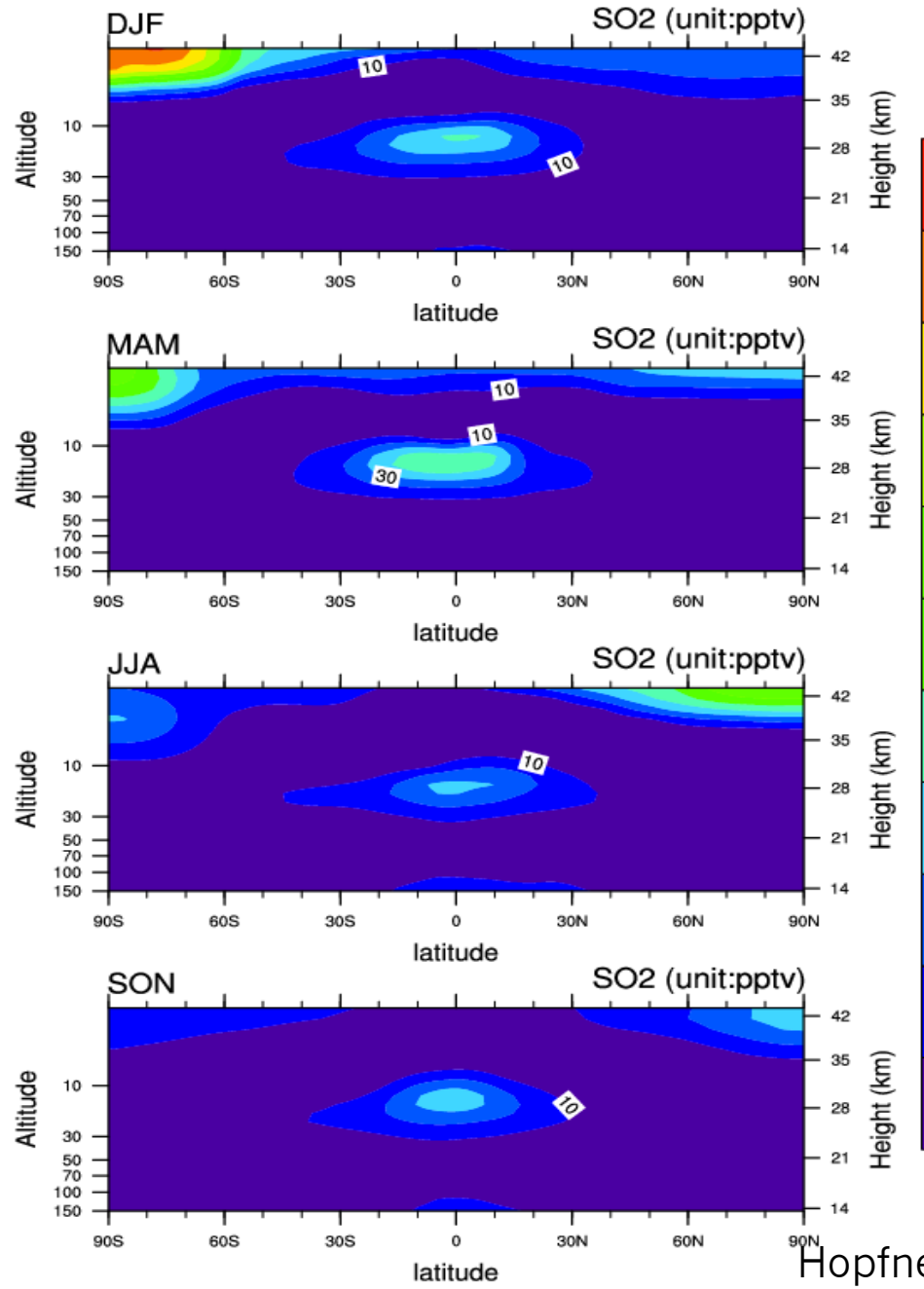


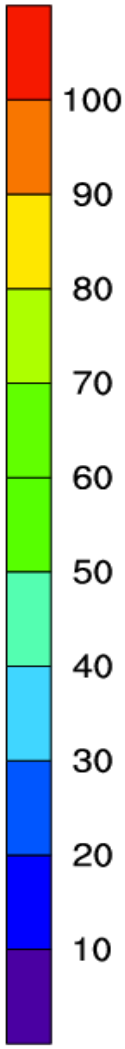


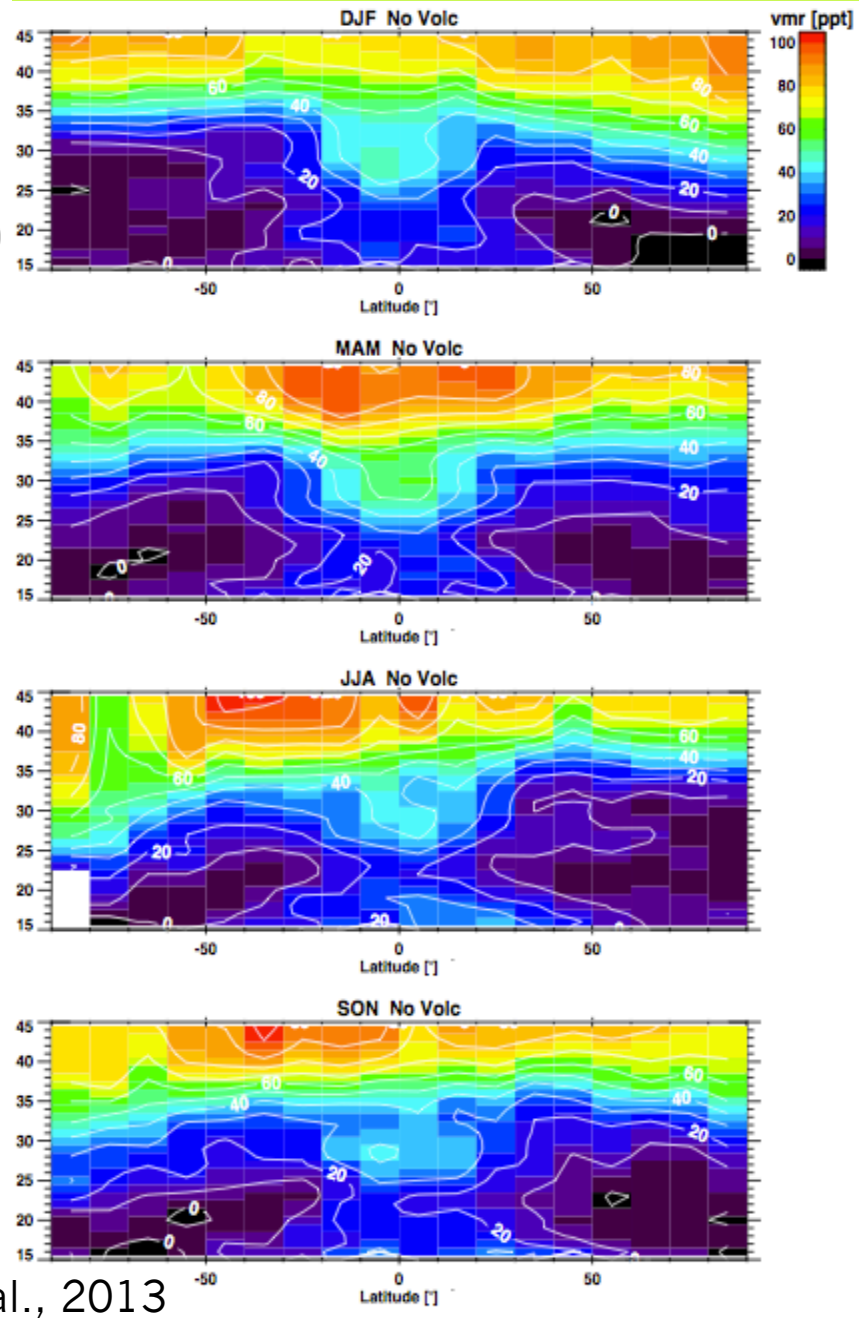
Sulfate effective radius in stratosphere is between 0.1 to 0.18 um in stratosphere

Mixed particles effective radius at UTLS is 0.16 um

CESM has problem with SO2 in Stratosphere?

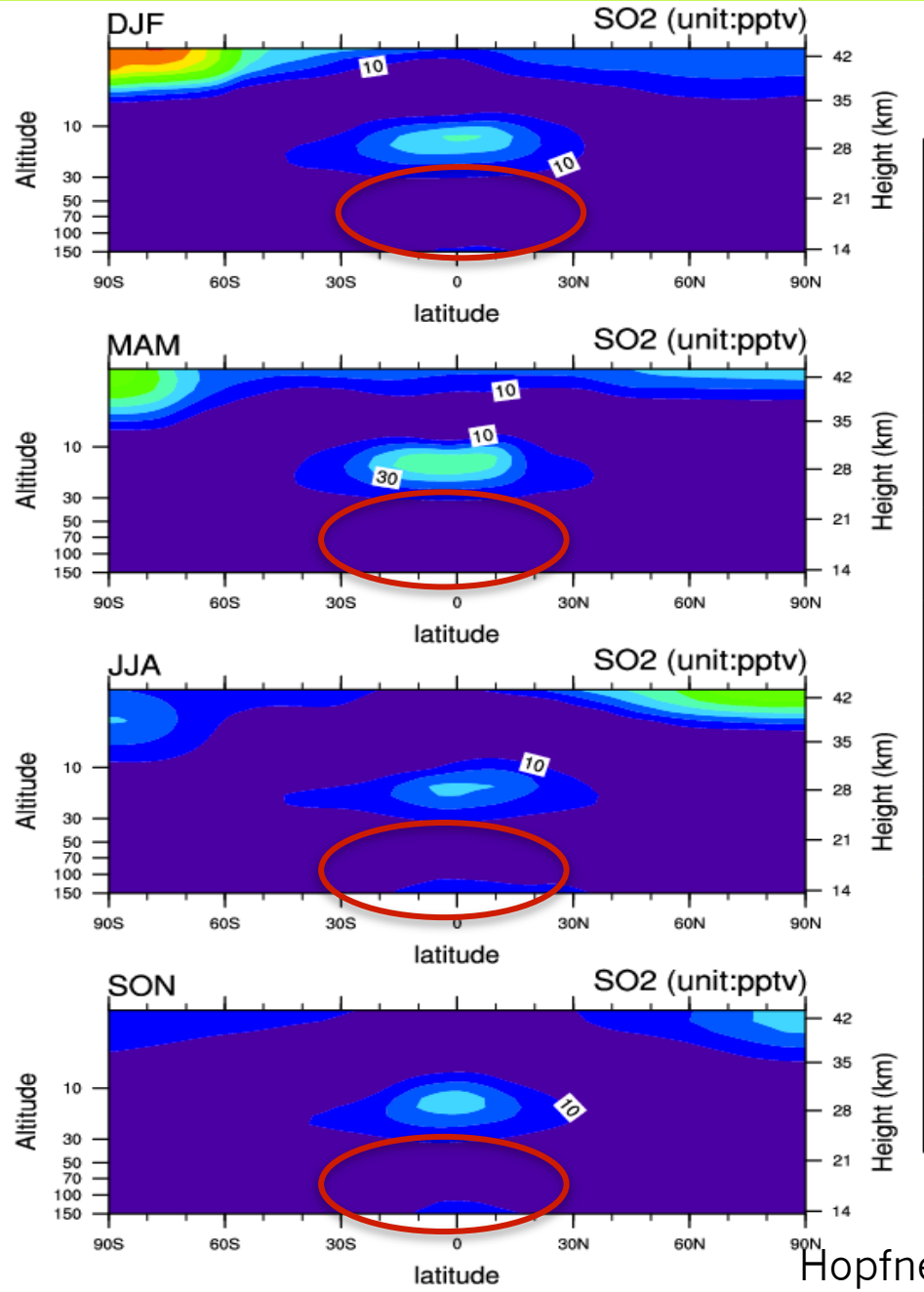


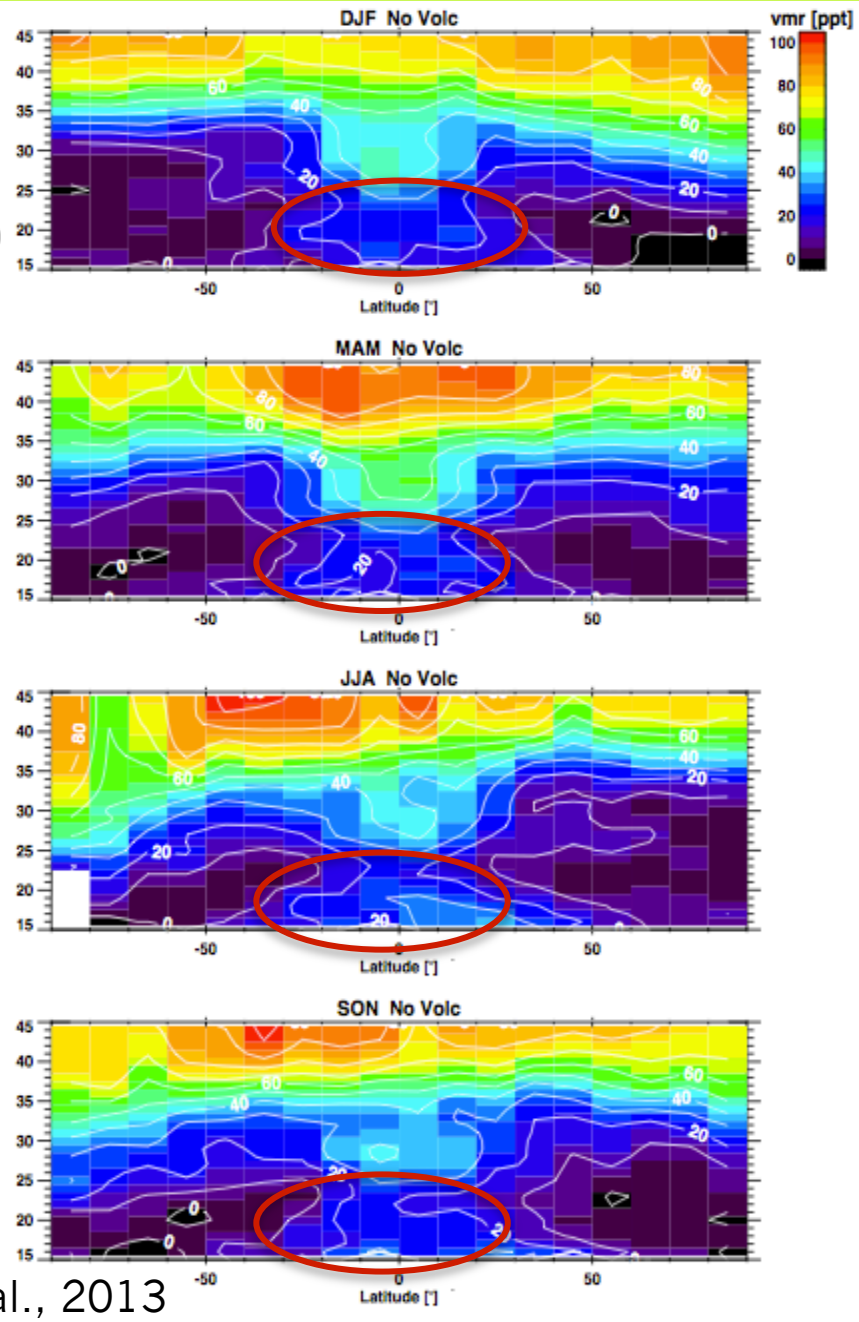




Hopfner et al., 2013

CESM has problem with SO2 in Stratosphere?





Hopfner et al., 2013

Conclusions

- CARMA is a Sectional aerosol model coupled with CAM5;
- CARMA can be easily coupled with WACCM as well;
- At UTLS, sulfate mass ≈ organics mass; above UTLS, sulfate dominates;
- Sulfate effective radius is roughly 0.1~0.18 um in stratosphere;
- Mixed particle effective radius is roughly 0.16 um in UTLS;
- CESM might have problem with SO2 in stratosphere, but with lots of uncertainties in observation.

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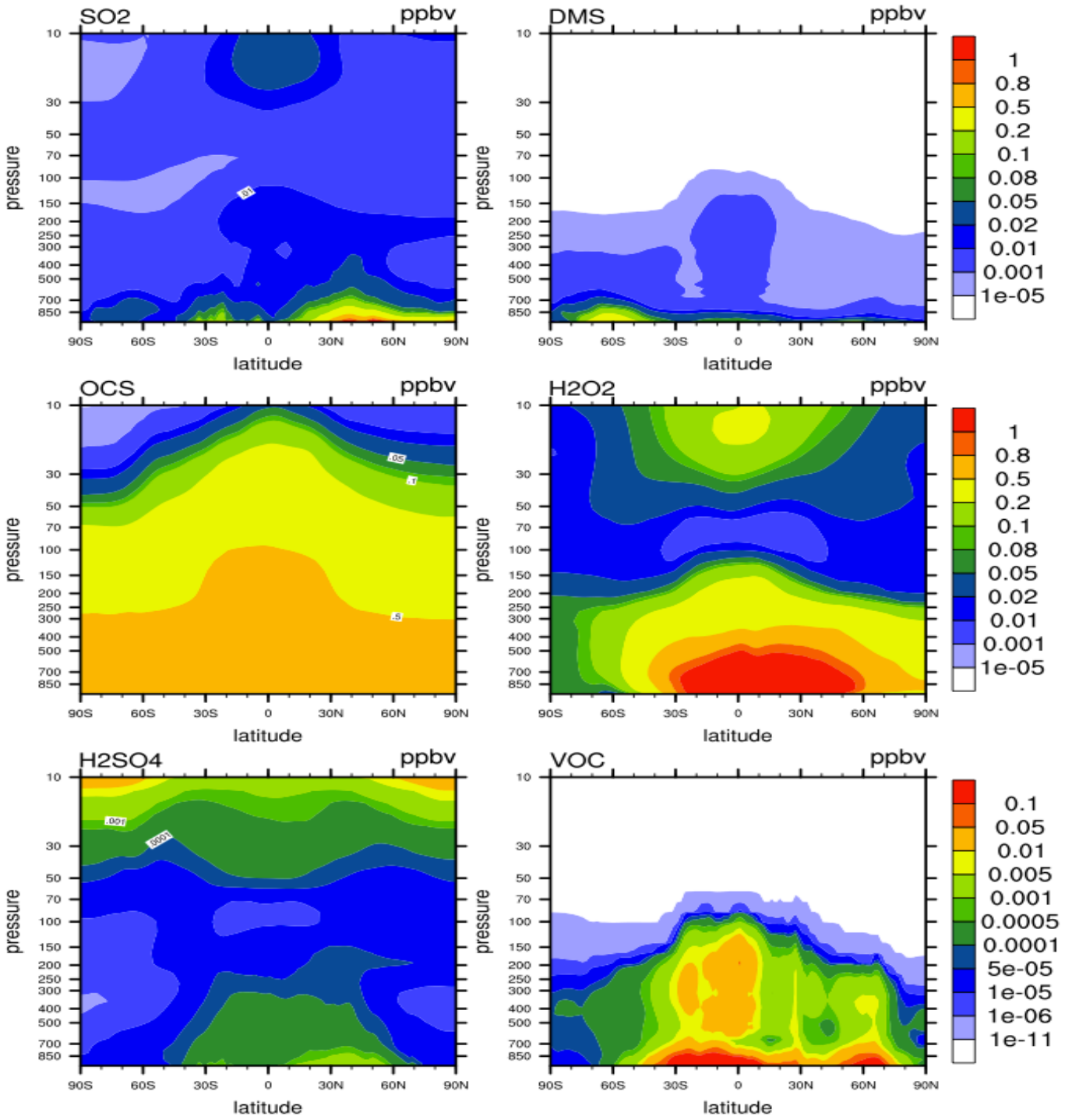
Thanks **Charles Bardeen** (NCAR) and **Ryan Neely** (NCAR, Leeds)

@ Houston, SEAC4RS, Sep.2013



SO2, DMS, OCS, H2SO4, H2O2, VOCs