Aerosol modeling: Sulfate and organics in UTLS

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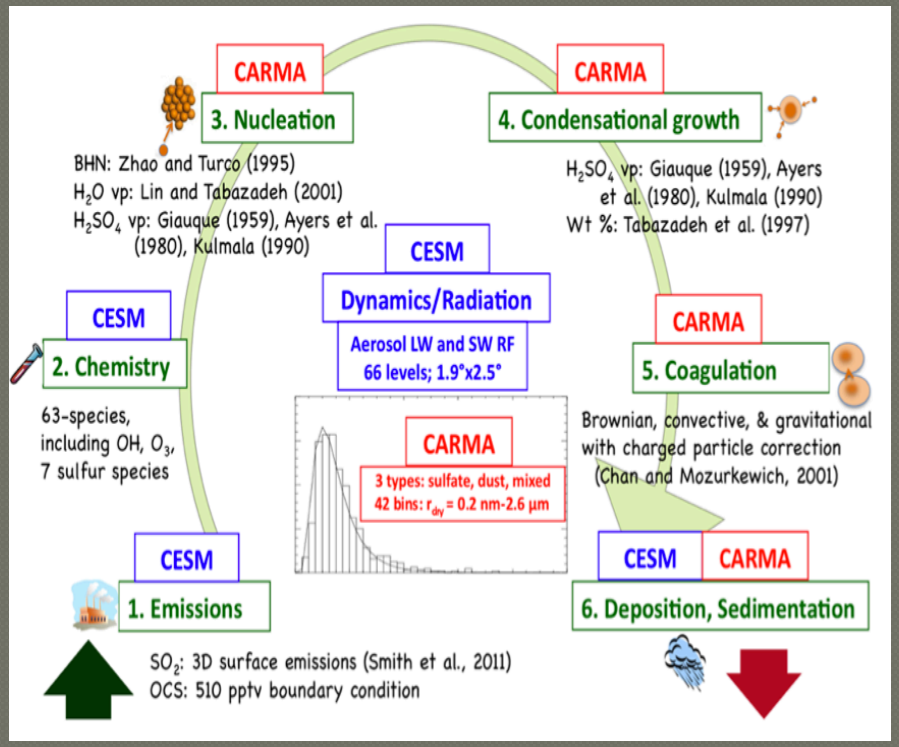
We want to know aerosol composition in UTLS because it affects cirrus nucleation

We can model aerosol composition using CESM/CARMA

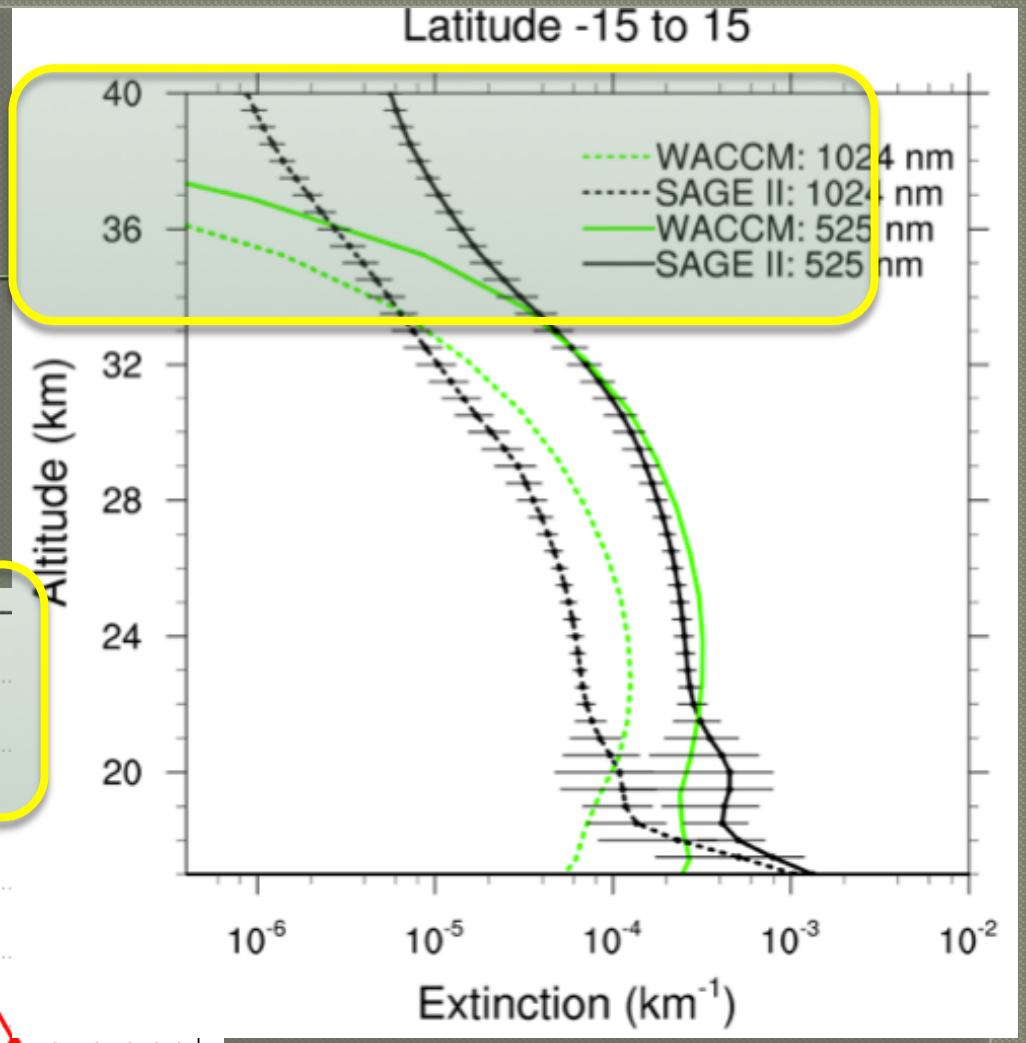


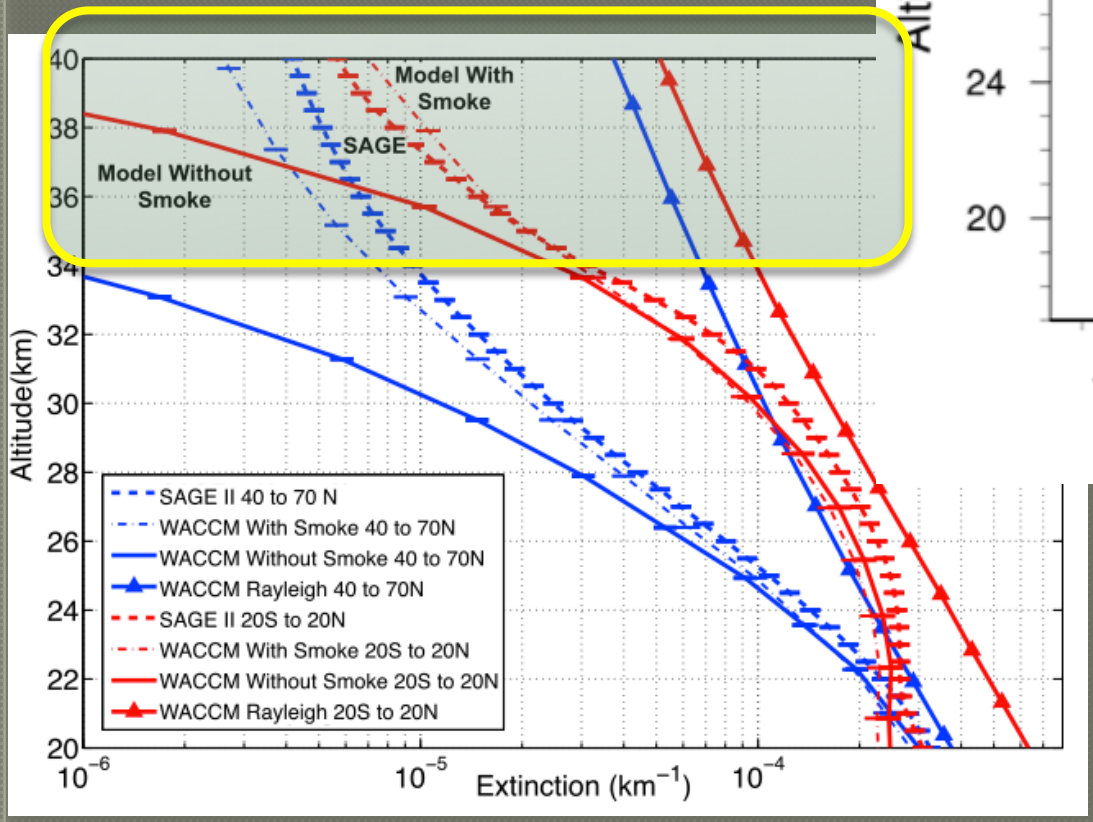
- ❖Sulfate Model (English et al.,2011)
- ❖Dust Model (Su and Toon, 2009)
- ❖Sea Salt Model (Fan and Toon, 2011)
- ❖Smoke Model
- ❖Sea salt/sulfate Model

- ❖Coupled Aerosol model (sulfate, dust, sea salt and smoke)

- The Community Earth System Model (CESM)
- Community Aerosol and Radiation Model for Atmospheres (CARMA)

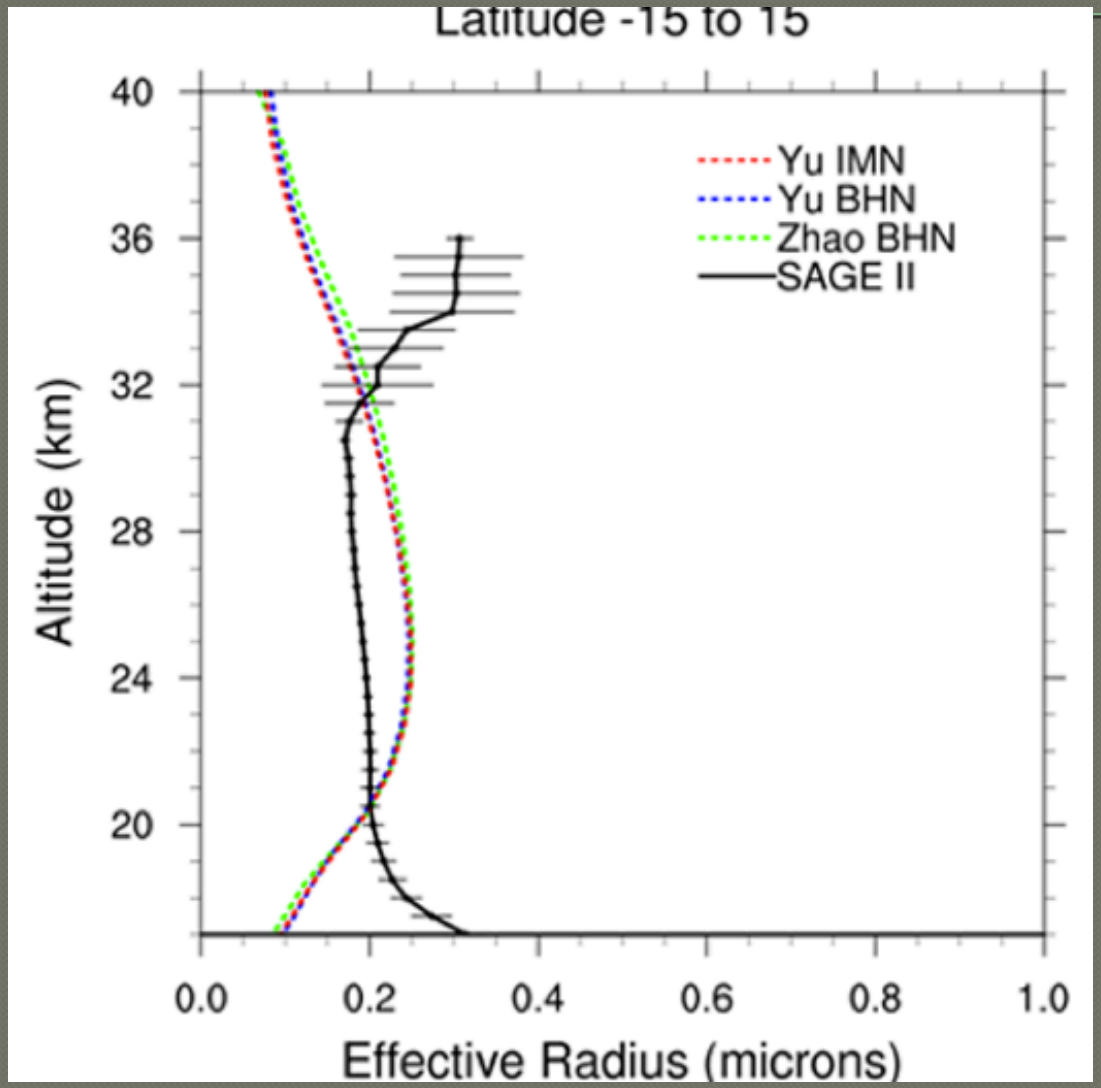
Pure sulfate model (English et al., 2011) missed some extinction in UTLS regions





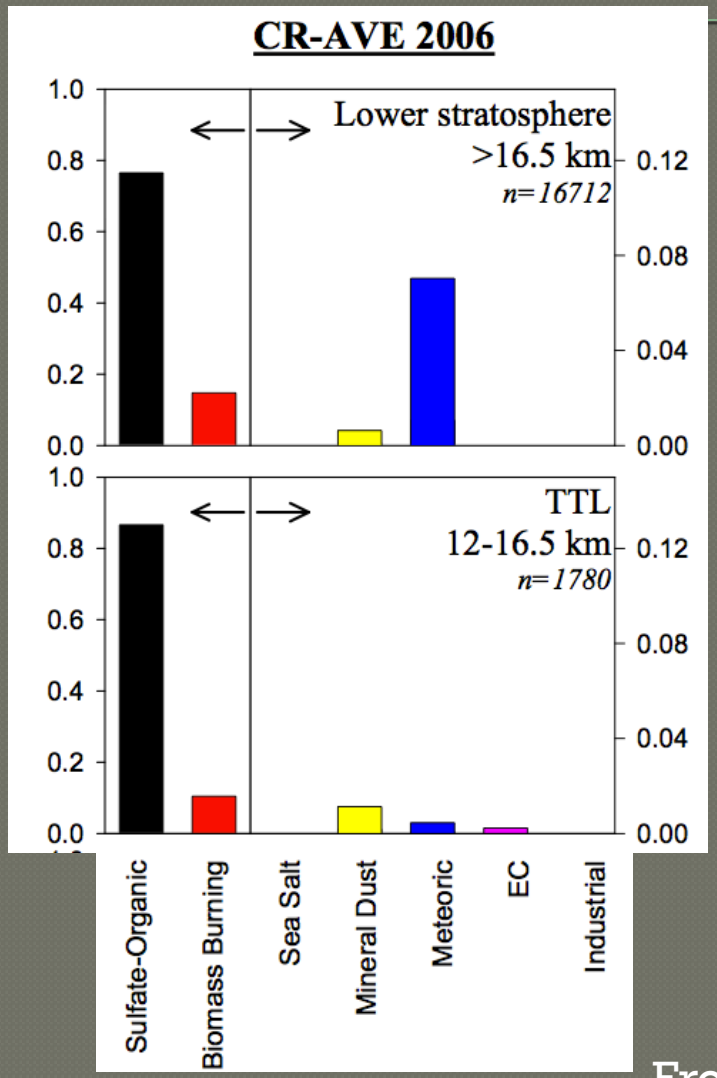
Adding meteoritic smoke
Neely et al., 2011

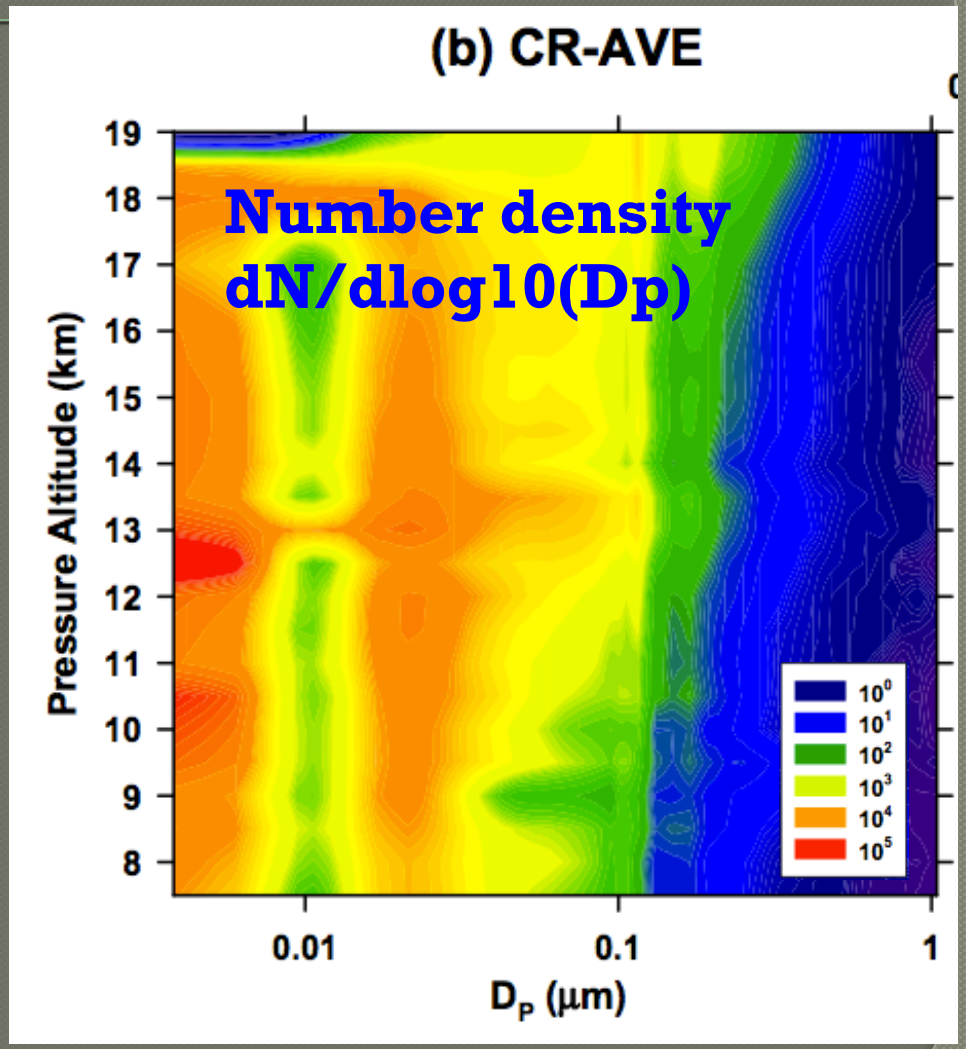
The missed extinction could result from other mixed aerosols



Sulfate model (English et al., 2011)

In UTLS region, larger size particles exist and contribute to the aerosol extinction profile.





Froyd et al., 2009

Adding other type of aerosols in the pure sulfate model

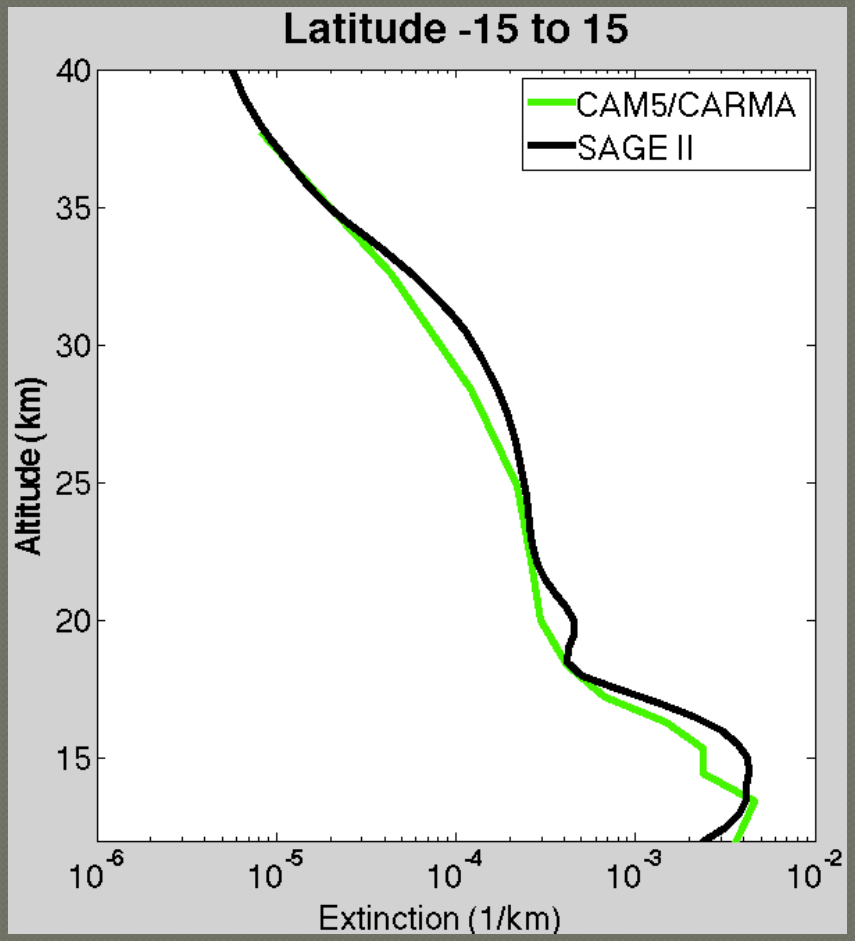
Pure sulfate （0.2nm-1.3um）

- Pure sulfate

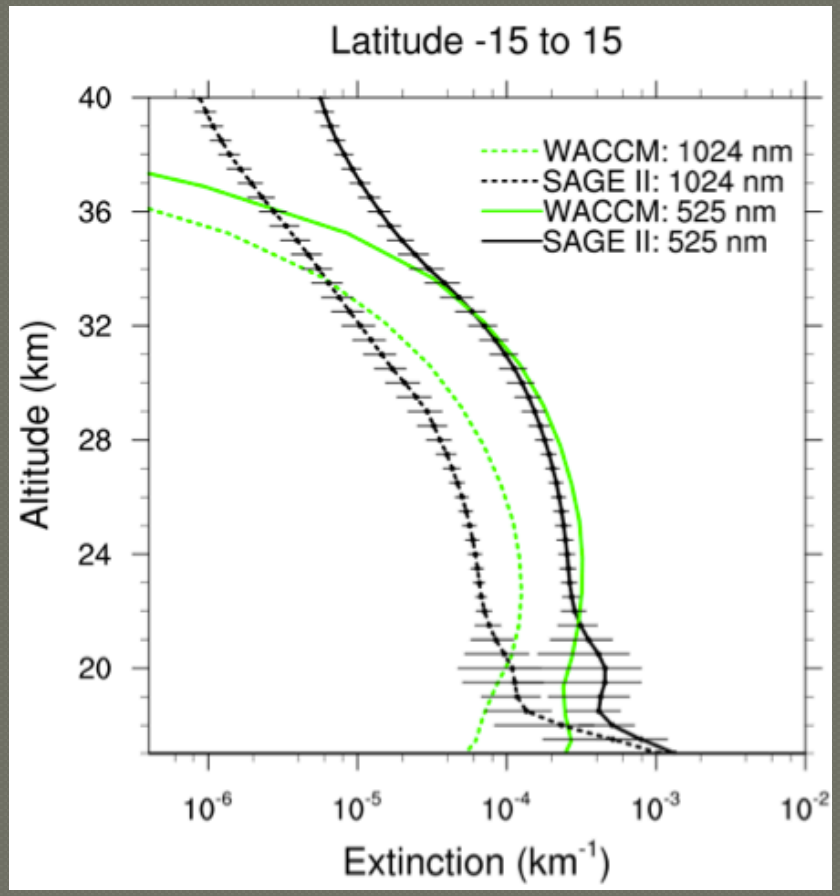
Mixed aerosols (0.01um-15um)

- Organics, EC, sulfate, sea salt, dust

Extinction of coupled aerosol model agree better with data because we have large sulfate

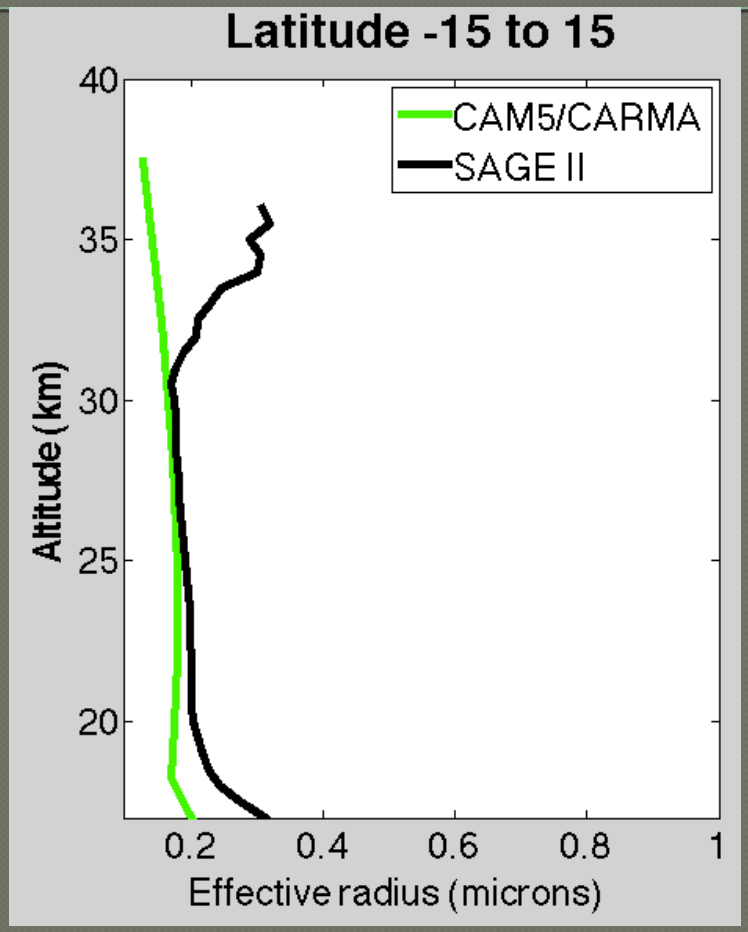


From 12 km to 40 km
CAM5/CARMA

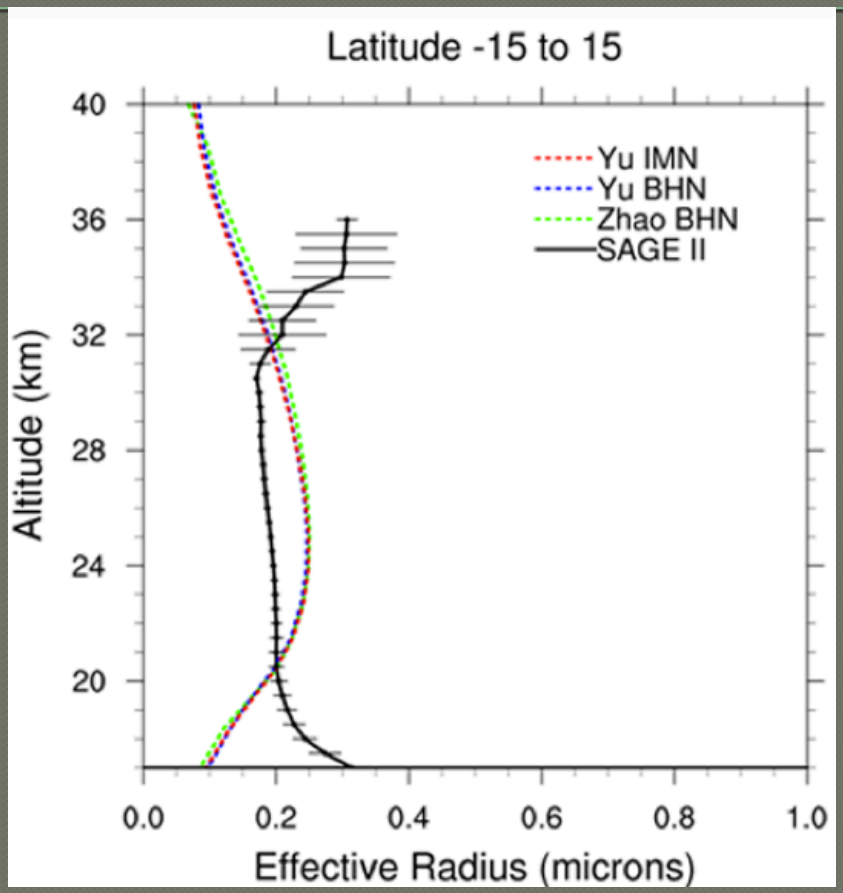


From 17 km to 40 km
English et al., 2011

Effective radius vertical profile of coupled aerosol model agree better with observation in UTLS



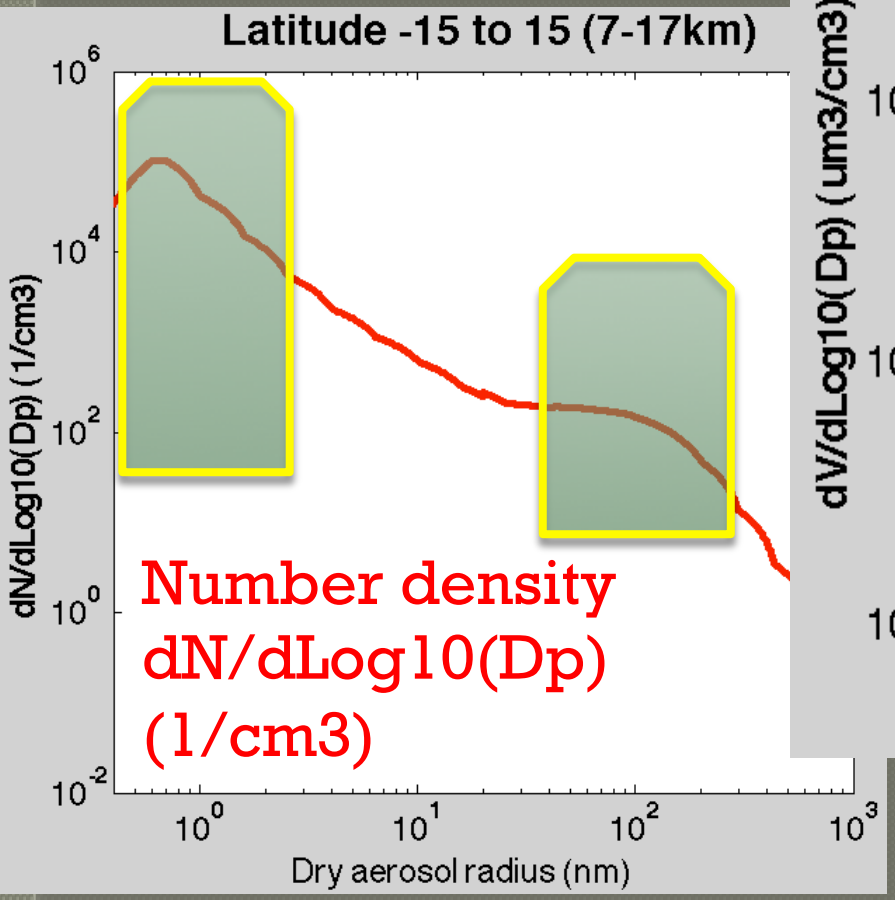
From 17 km to 40 km

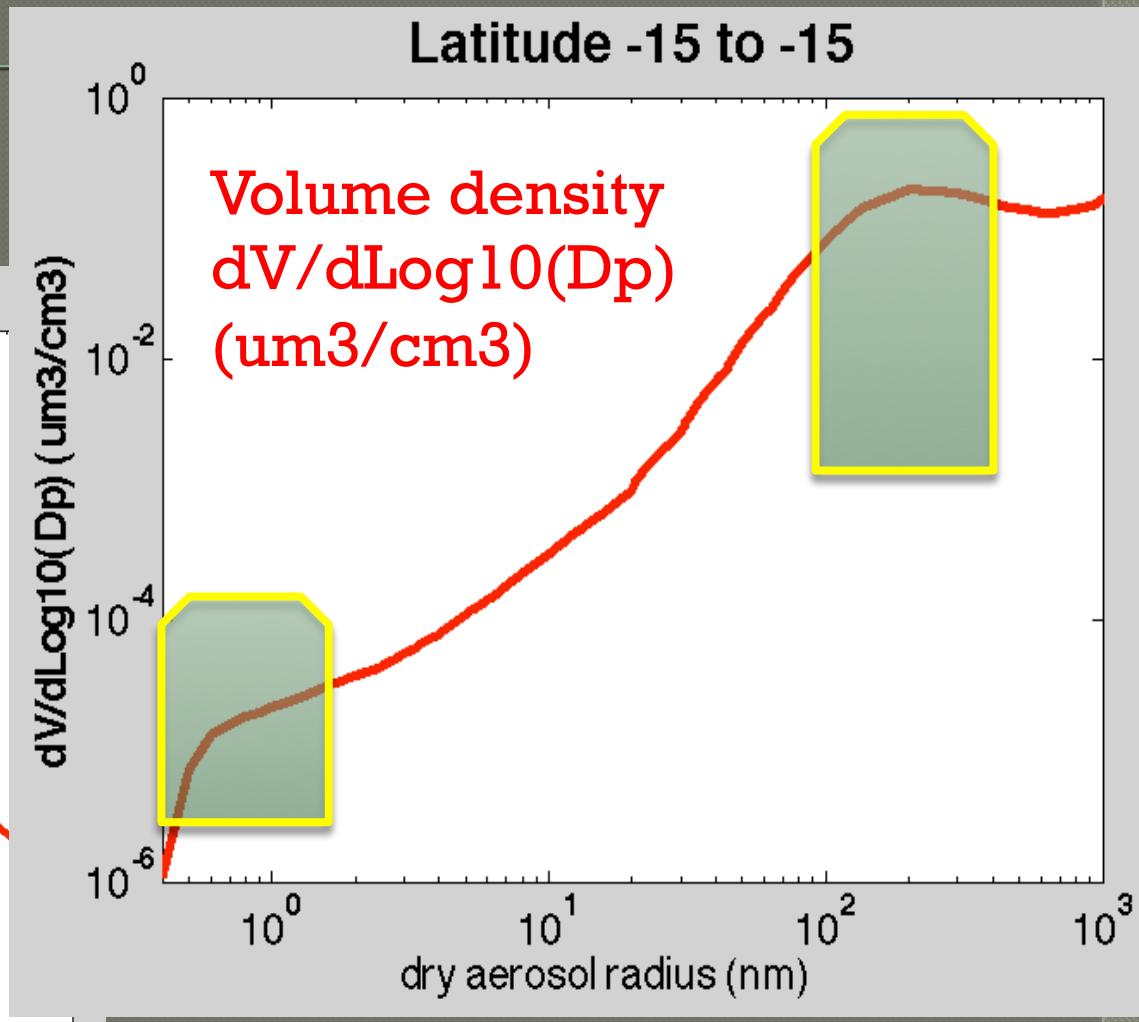


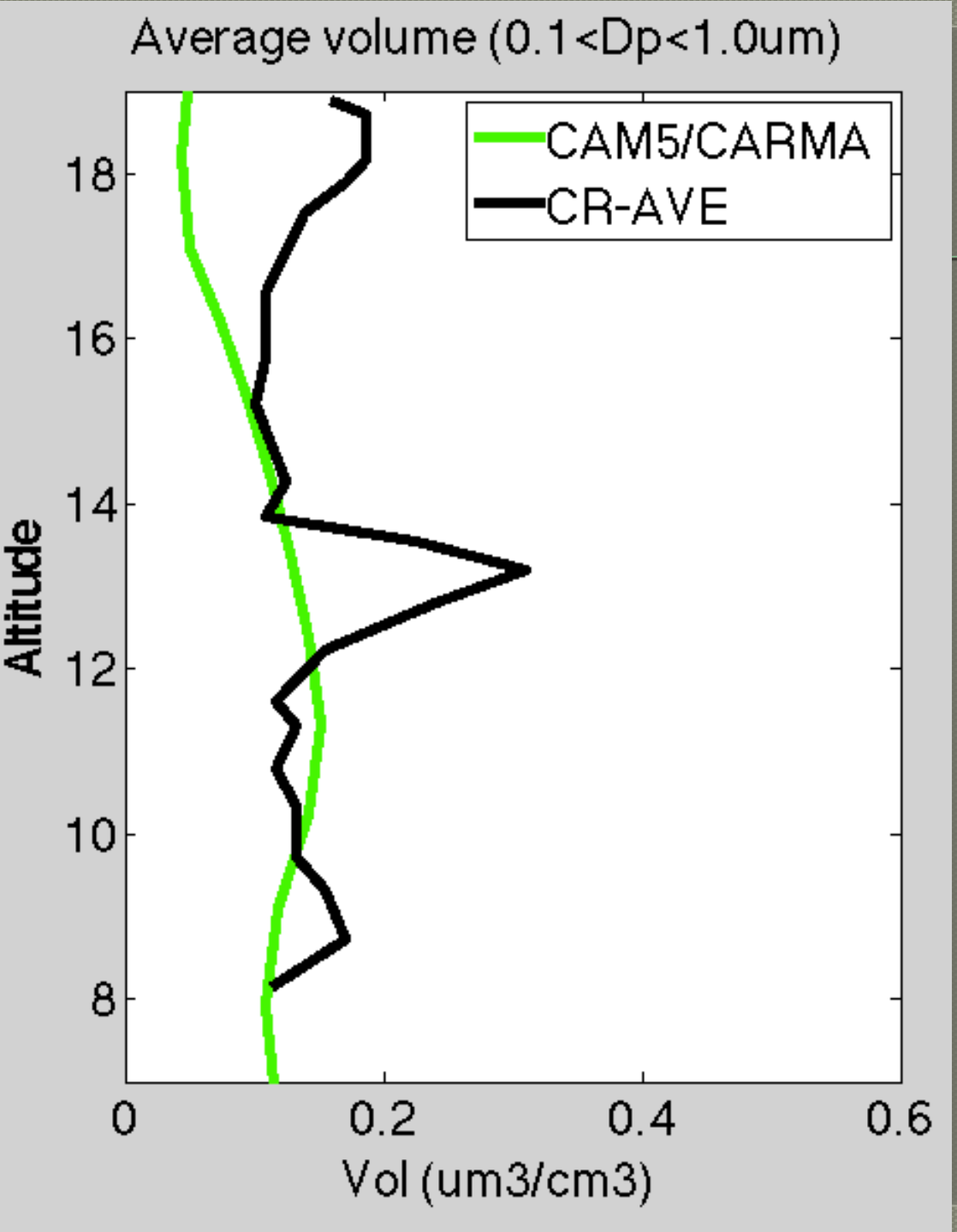
From 17 km to 40 km
English et al., 2011

Both Number and Volume size distribution show two modes: pure sulfate and mixed particle

Tropical troposphere
7-17 km



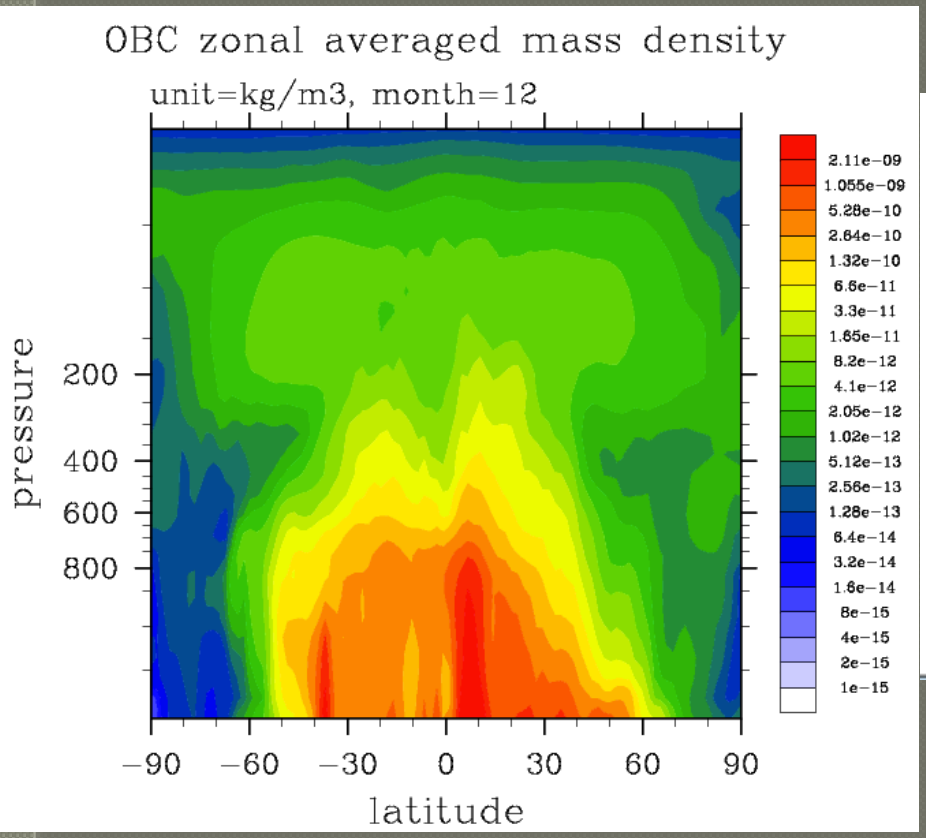


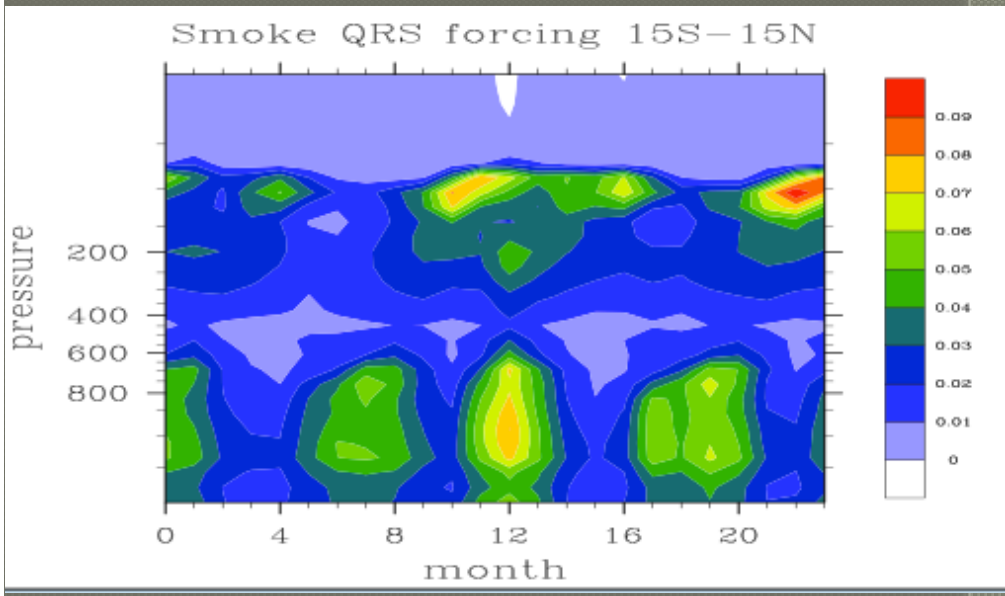


Our bigger volume mode agrees well with observation of CR-AVE campaign

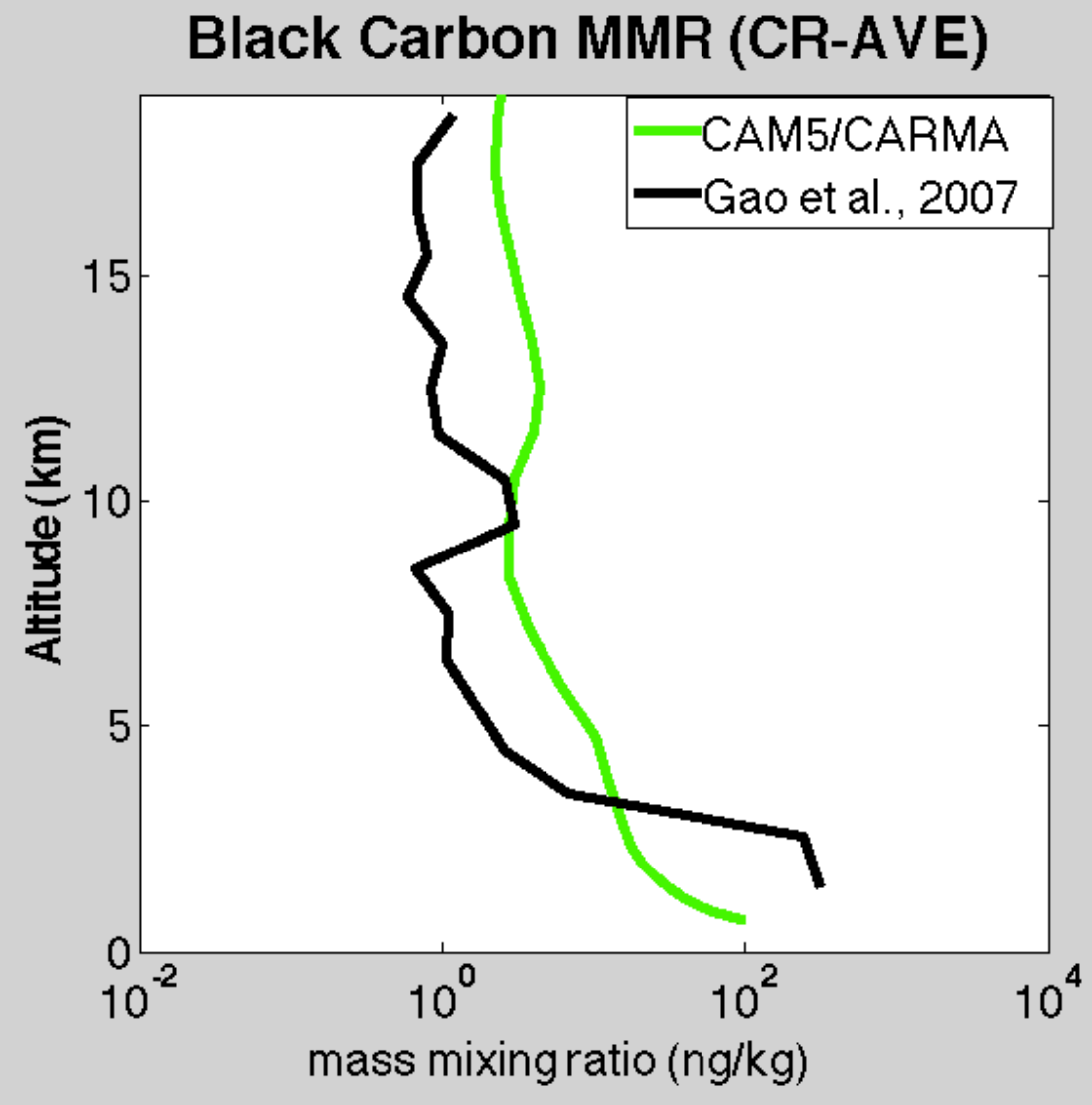
Froyd et al., 2009

Organics zonal averaged mass density is highest in tropics; solar heating rate peaks both in UTLS and boundary layer

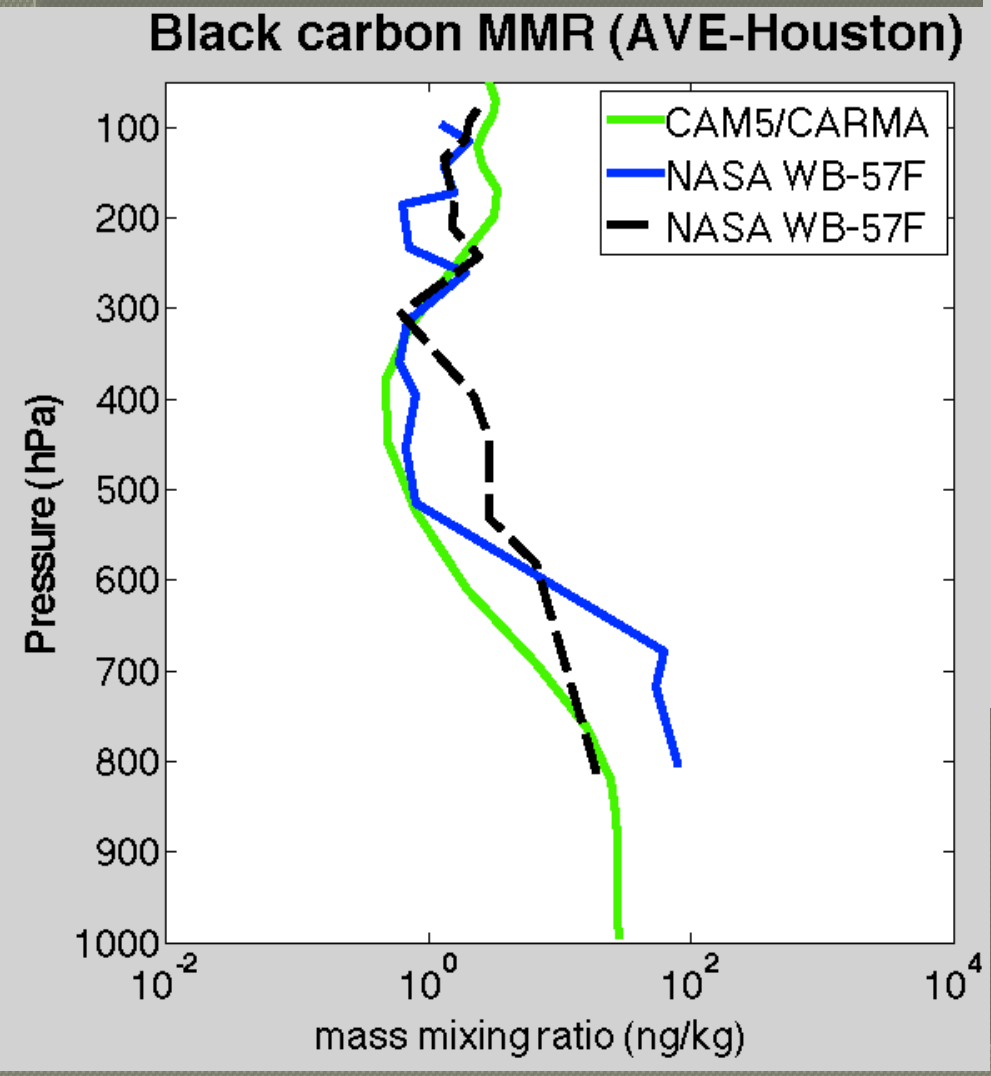


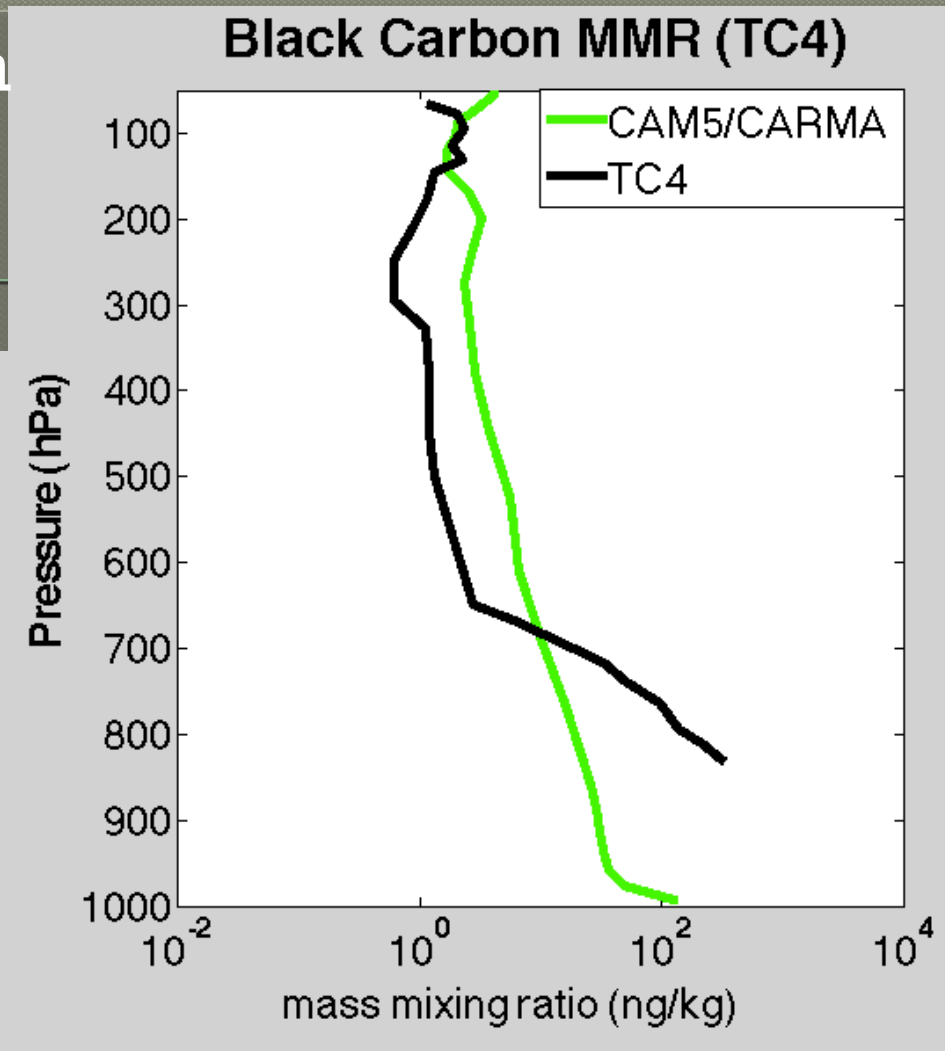


BC mmr comparison with CR-AVE SP2 data

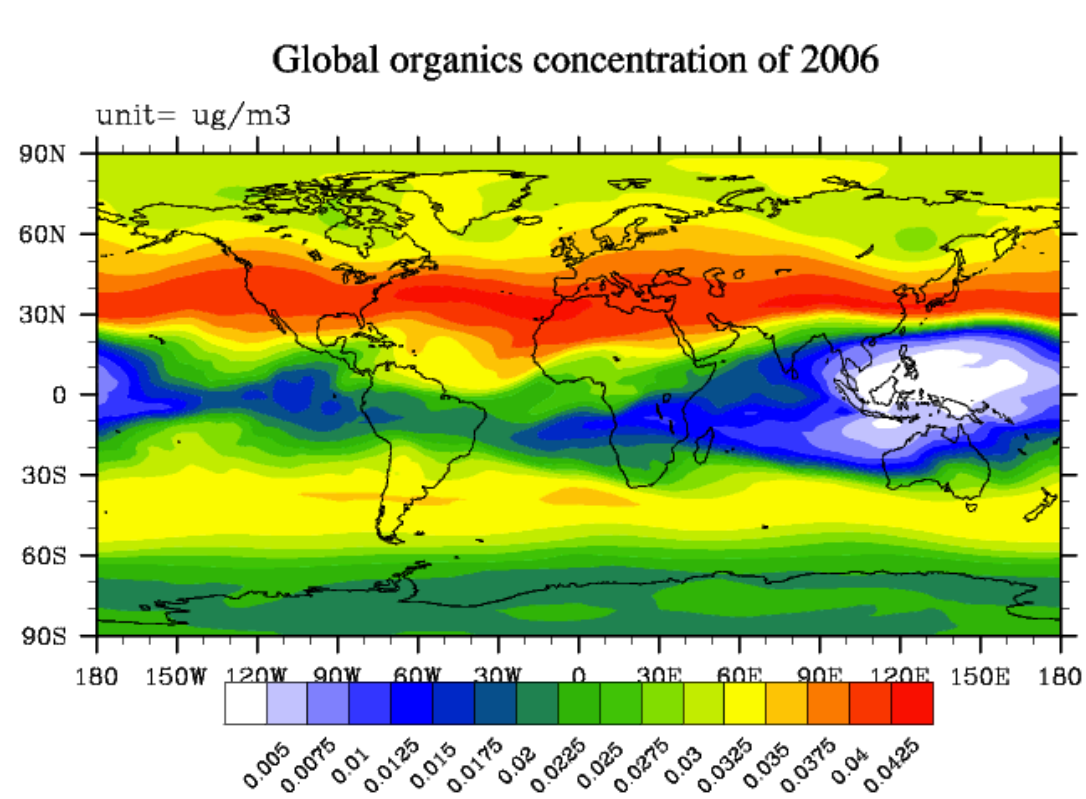


TC4 campaign 2007 Aug

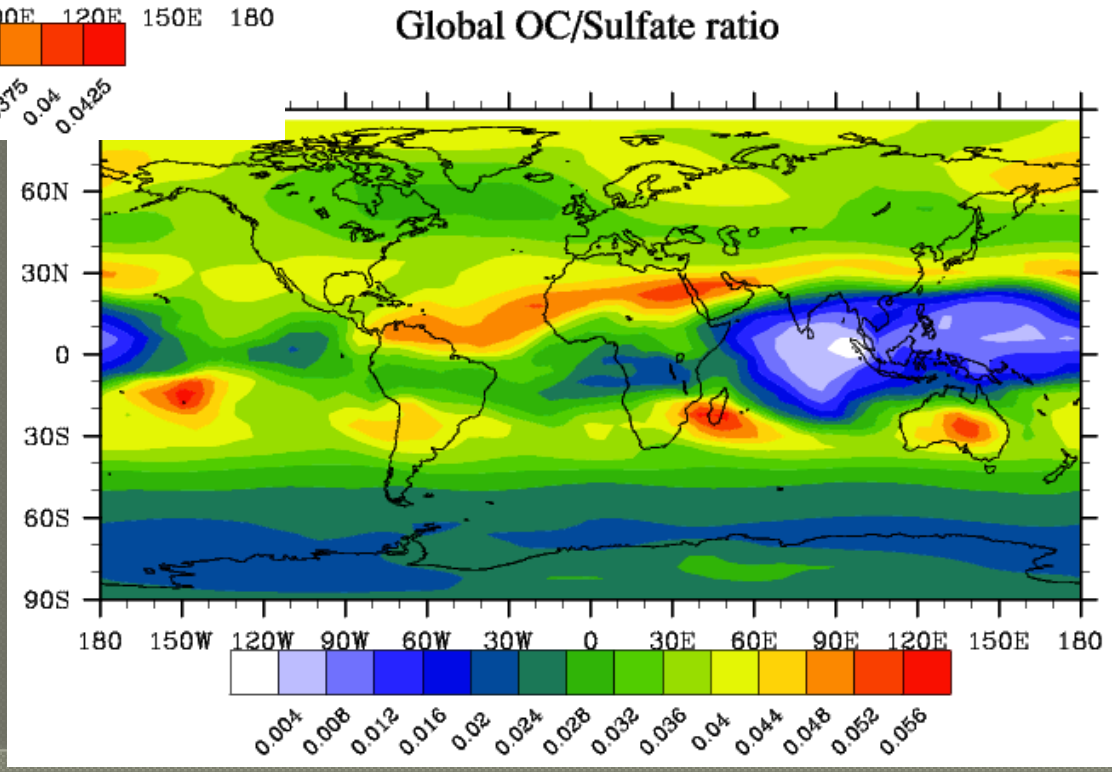




AVE-Houston campaign 2004 Nov



OC global distribution at 121 mb shows minimum OC concentration in tropics



OC/sulfate ratio ranges from 0.4% to 5% in tropics which is one order of magnitude smaller than observation of Froyd et al., 2009

4. Conclusions

- Model and observation indicate that besides pure sulfate aerosol, we have larger particles (mixed sulfate and organics) in UTLS region.
- Our model under-estimates organics emission (either from surface or from gas-phase condensation)

Thanks, the end