Rim Fire Simulated in CESM/CARMA

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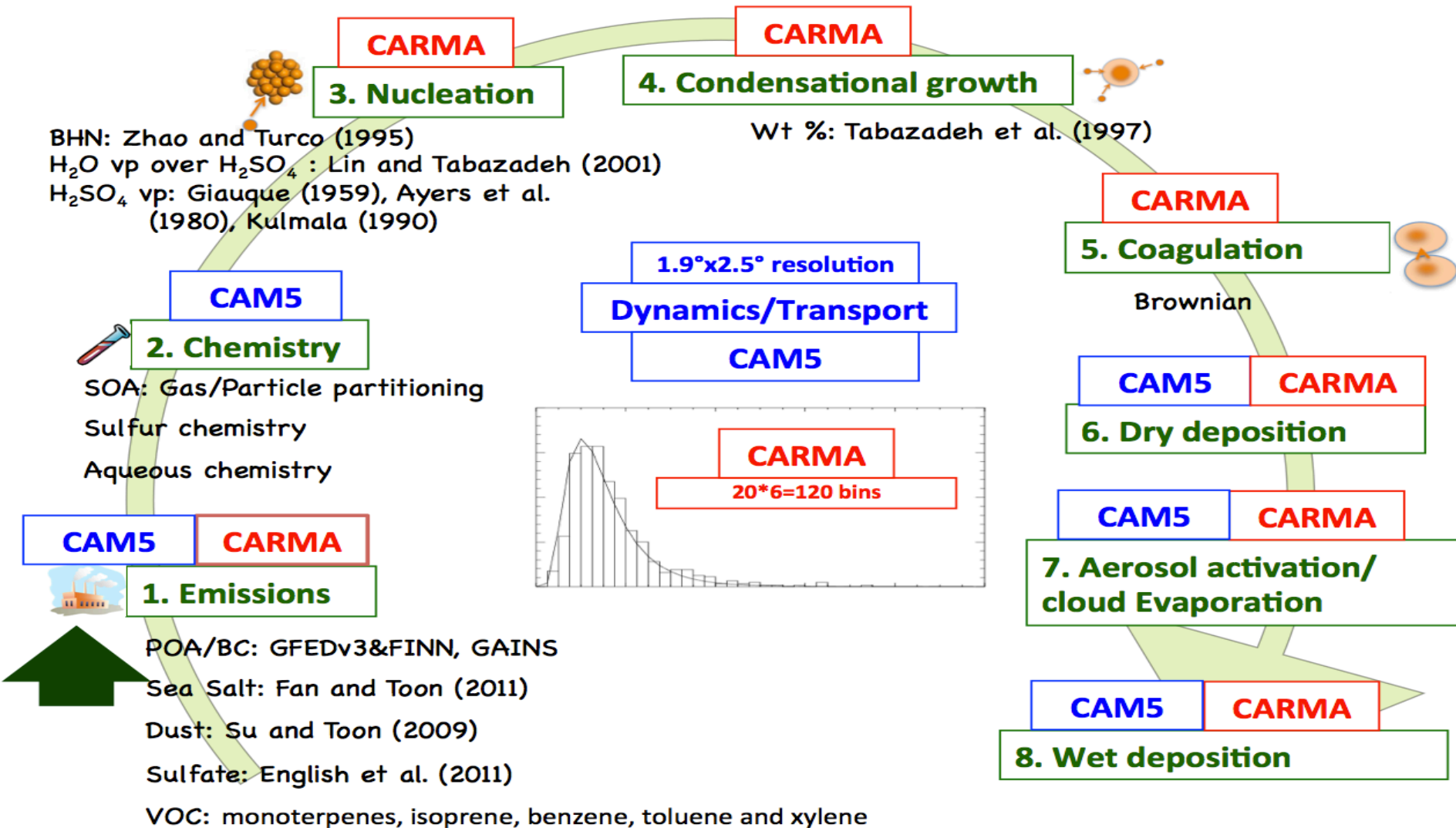**LARGE Team, AMS Team, HDSP2 Team, CRDS Team**

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[2]NCAR, [3]University of Iowa

June.2015, CESM Workshop

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

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)

CARMA
4. Condensational growth

Wt %: Tabazadeh et al. (1997)

CARMA
5. Coagulation

Brownian

CAM5
2. Chemistry

SOA: Gas/Particle partitioning
Sulfur chemistry
Aqueous chemistry

1.9°x2.5° resolution
Dynamics/Transport
CAM5

CARMA
20*6=120 bins

CAM5   **CARMA**
6. Dry deposition

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

CAM5   **CARMA**
7. Aerosol activation/ cloud Evaporation

CAM5   **CARMA**
8. Wet deposition
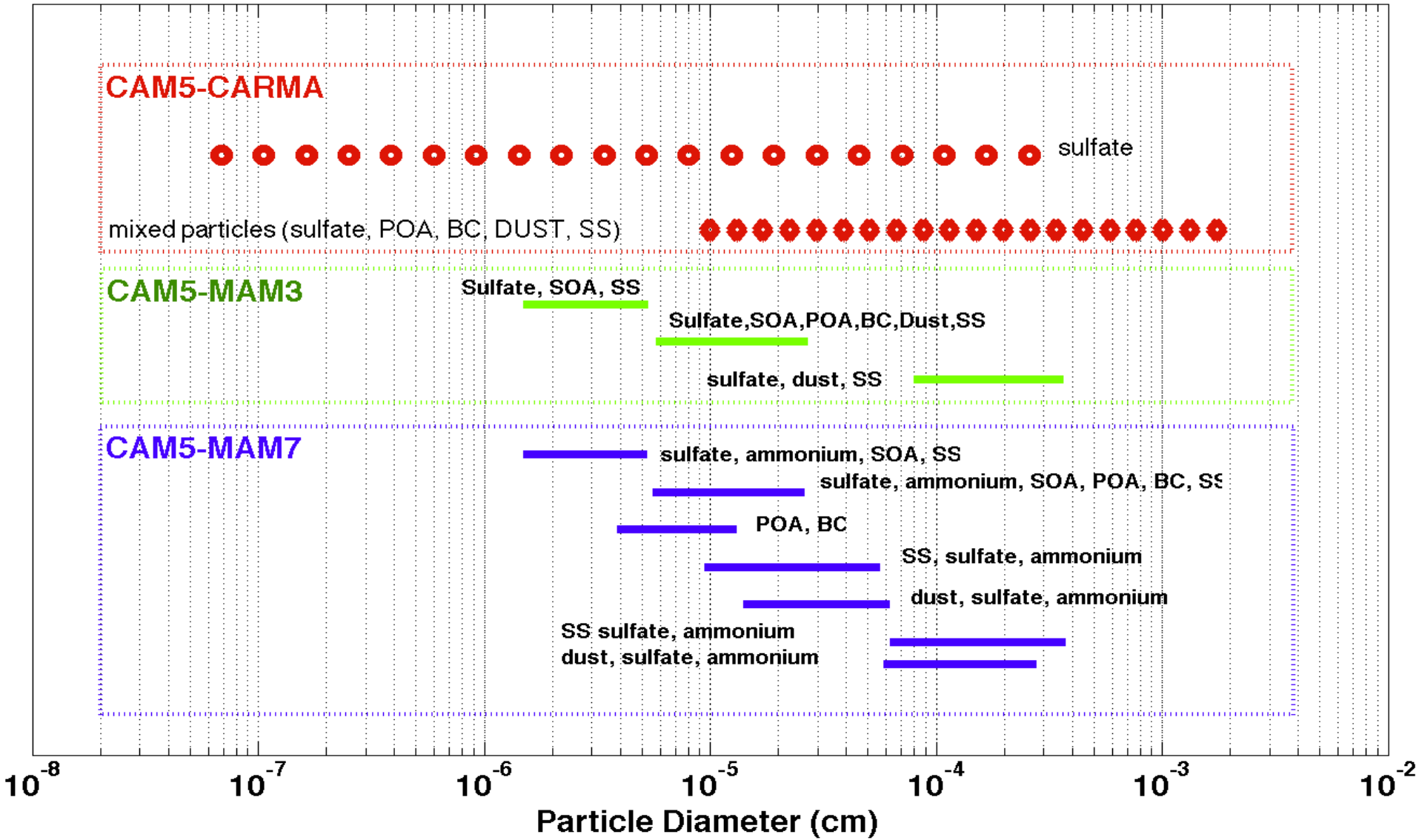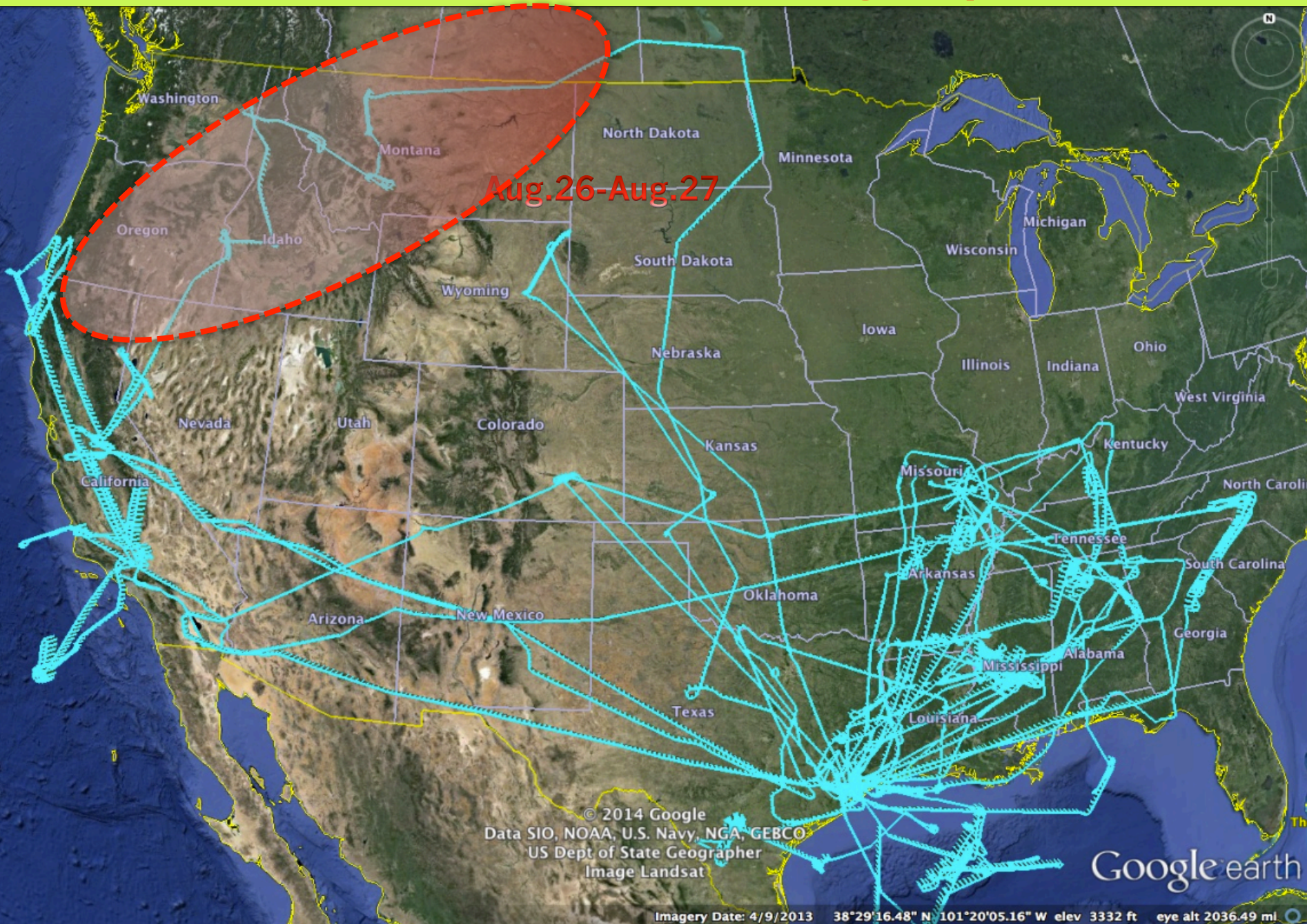
CARMA is coupled with CAM5 by Charles Bardeen, ACD, NCAR

CARMA has wider size range of aerosols than MAM

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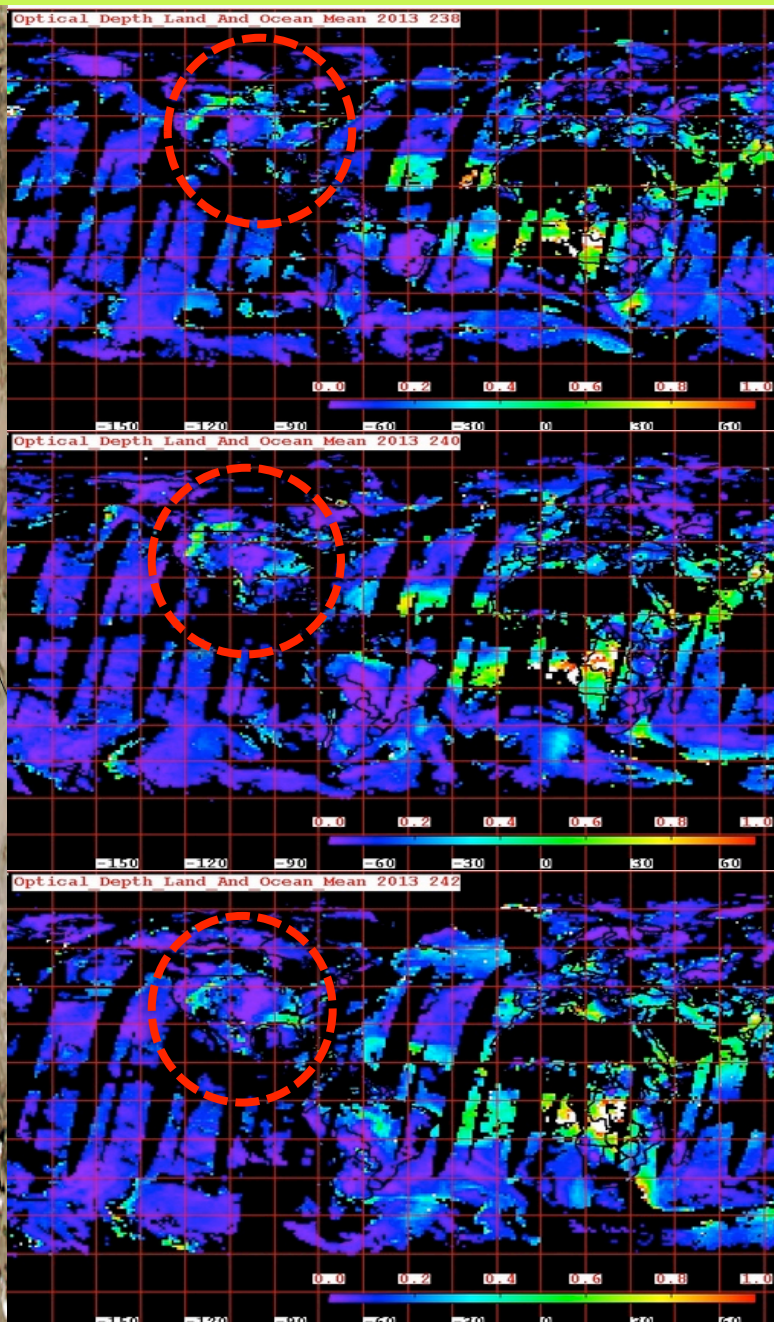

CAM5-CARMA
sulfate
mixed particles (sulfate, POA, BC, DUST, SS)

CAM5-MAM3
Sulfate, SOA, SS
Sulfate, SOA, POA, BC, Dust, SS
sulfate, dust, SS

CAM5-MAM7
sulfate, ammonium, SOA, SS
sulfate, ammonium, SOA, POA, BC, SS
POA, BC
SS, sulfate, ammonium
dust, sulfate, ammonium
SS sulfate, ammonium
dust, sulfate, ammonium

Particle Diameter (cm)
10^{-8} 10^{-7} 10^{-6} 10^{-5} 10^{-4} 10^{-3} 10^{-2}

SEAC⁴RS - Southeast US: Aug-Sep, 2013

Aug.26-Aug.27

Model captures OC/BC in troposphere

fire flights excluded

AMS

SP2

Legend:
- SEAC4RS mean
- SEAC4RS median
- CARMA mean
- CARMA median
- SEAC4RS max
- SEAC4RS min
- CARMA max
- CARMA min

OC (ug/m3)

BC (ug/m3)
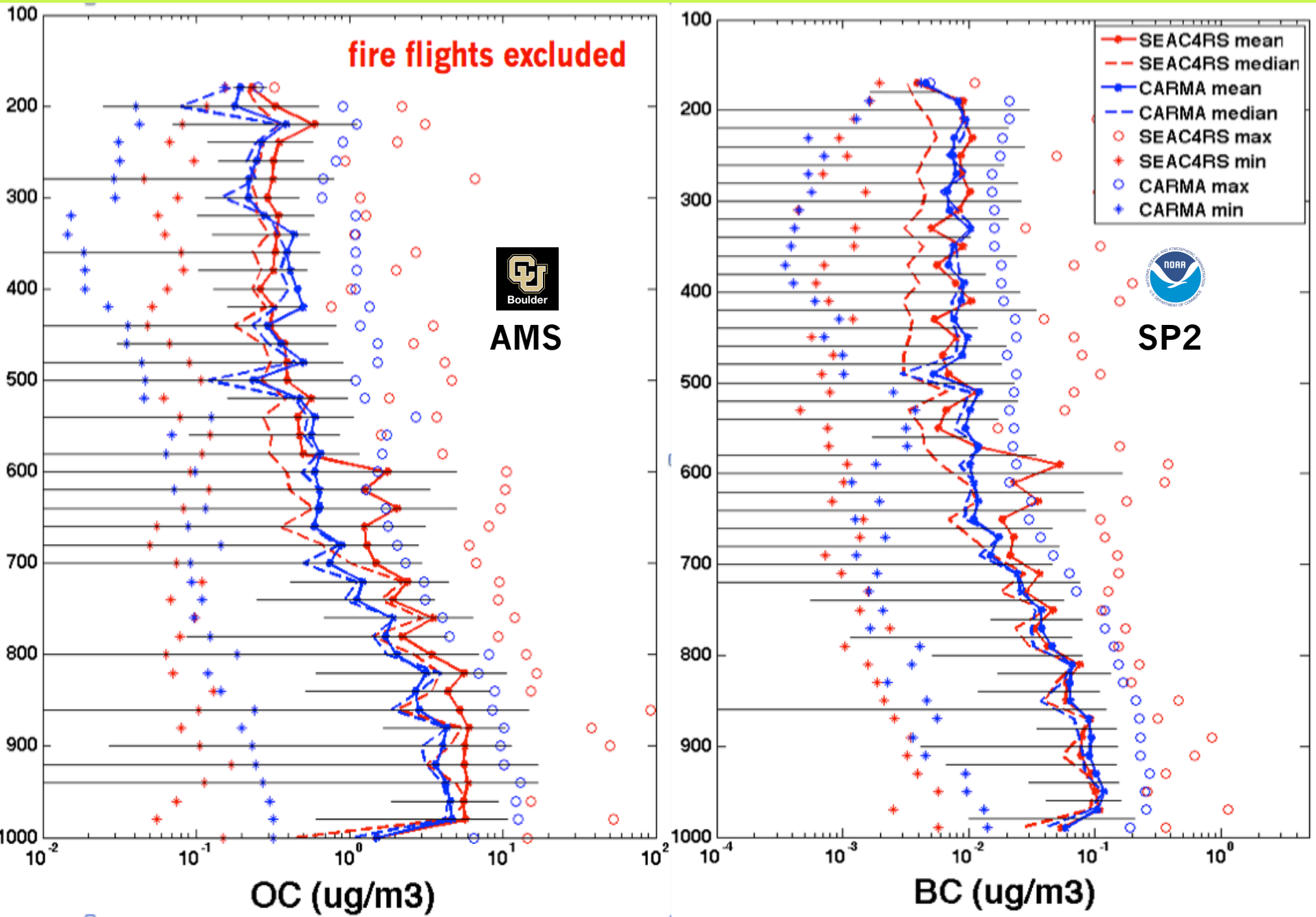
MODIS shows Rim Fire plumes, Aug.2013

Aug.26

Aug.28

Aug.30

Conclusions in this Talk

- **Injecting** Rim Fire emission at 600-700 mb;

- **CARMA predicts Rim Fire Aerosol Mass within data variability;**

- **CARMA predicts Rim Fire Aerosol Number within data variability;**

- **Rim Fire Aerosol is roughly 0.1-0.2 um in Radius;**

- **CARMA predicts Rim Fire Aerosol Surface Area and Volume within data variability;**

- **CARMA underestimates Rim Fire Extinction by a factor of 5;**

- **POA Aging Process is not modeled.**

CARMA shows transport of Rim fire smoke
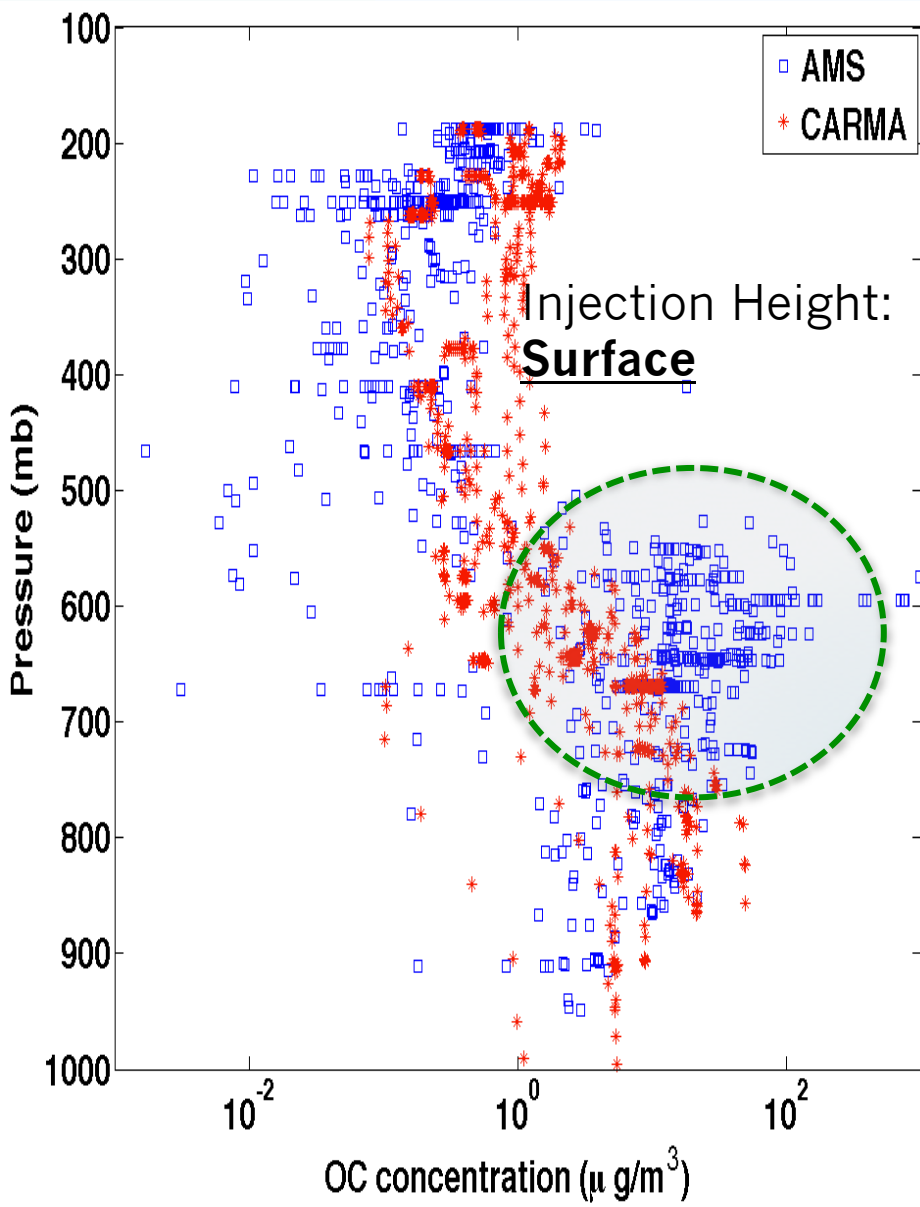

Aug.26   Aug.27
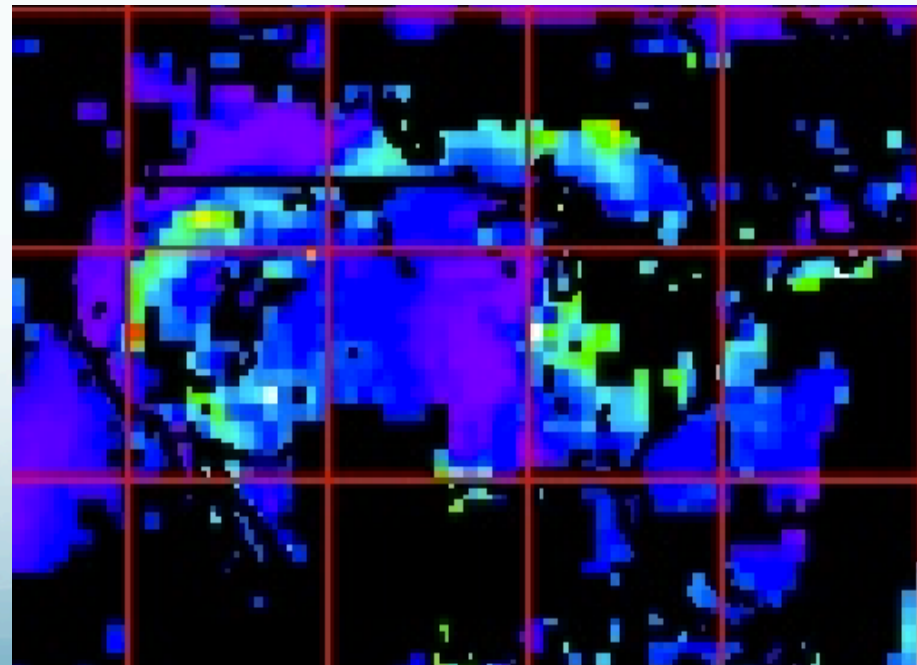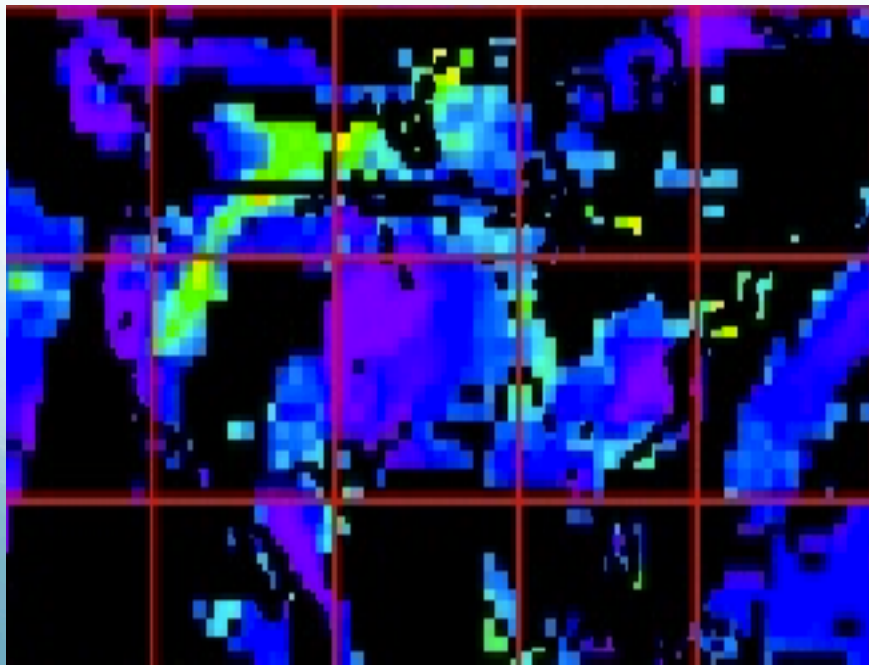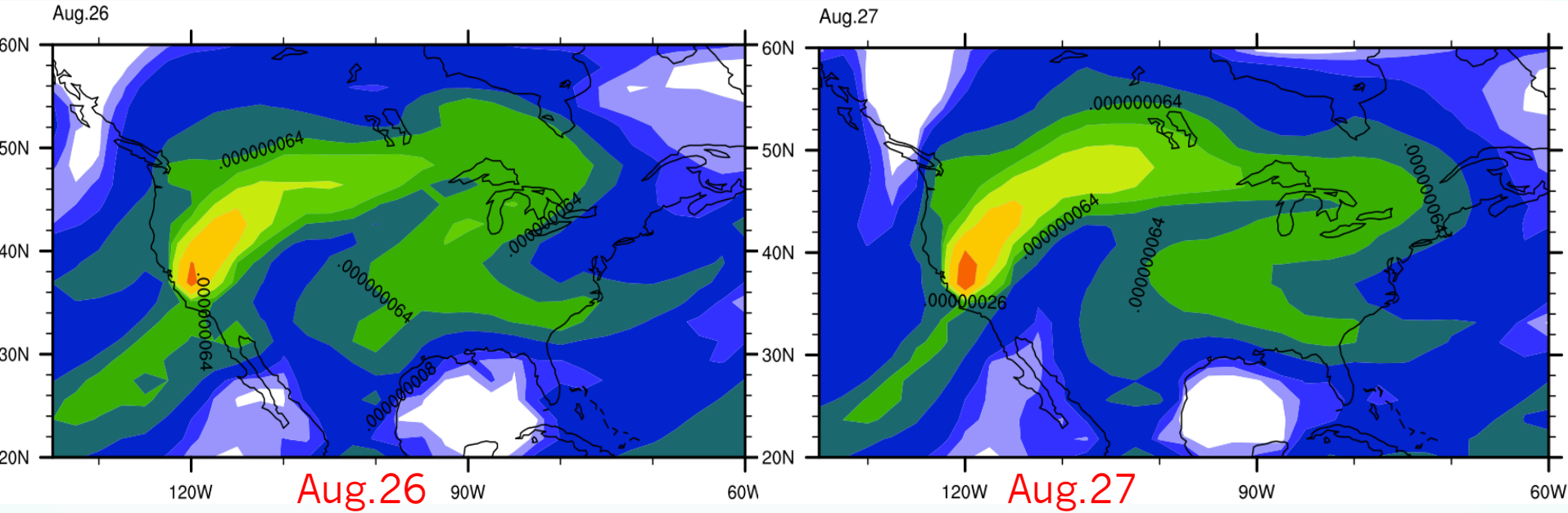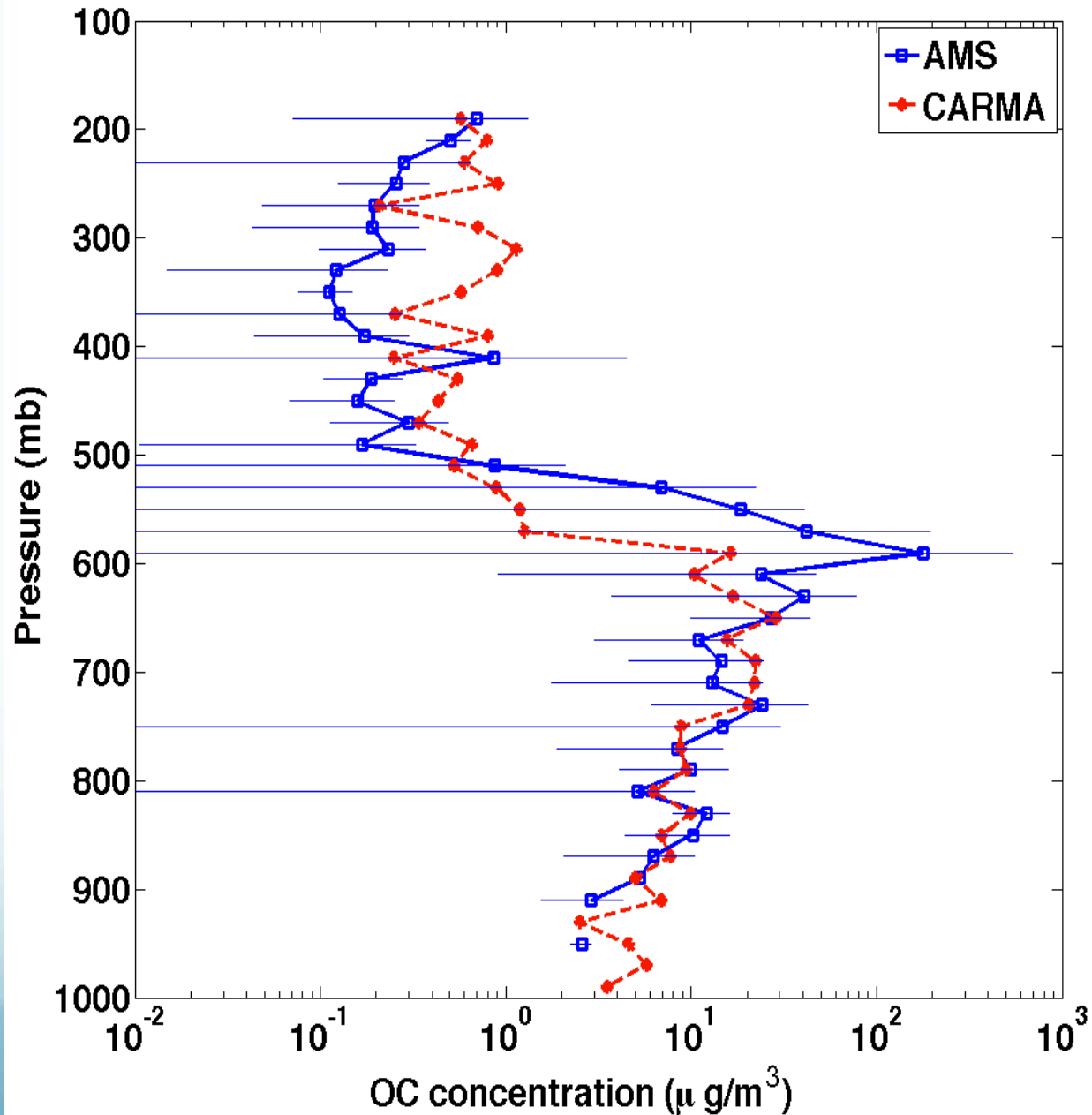
Flight tracks and OC concentrations
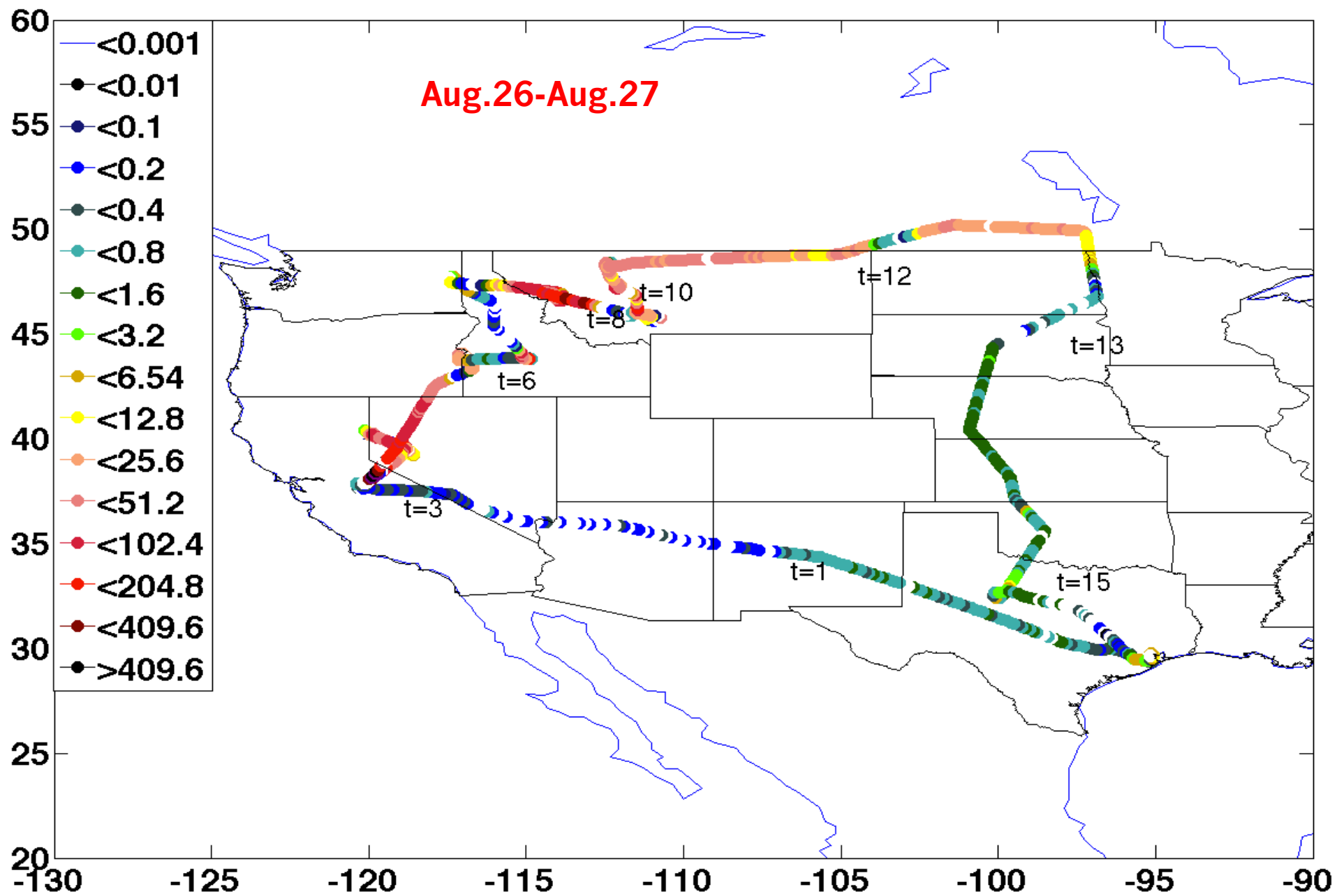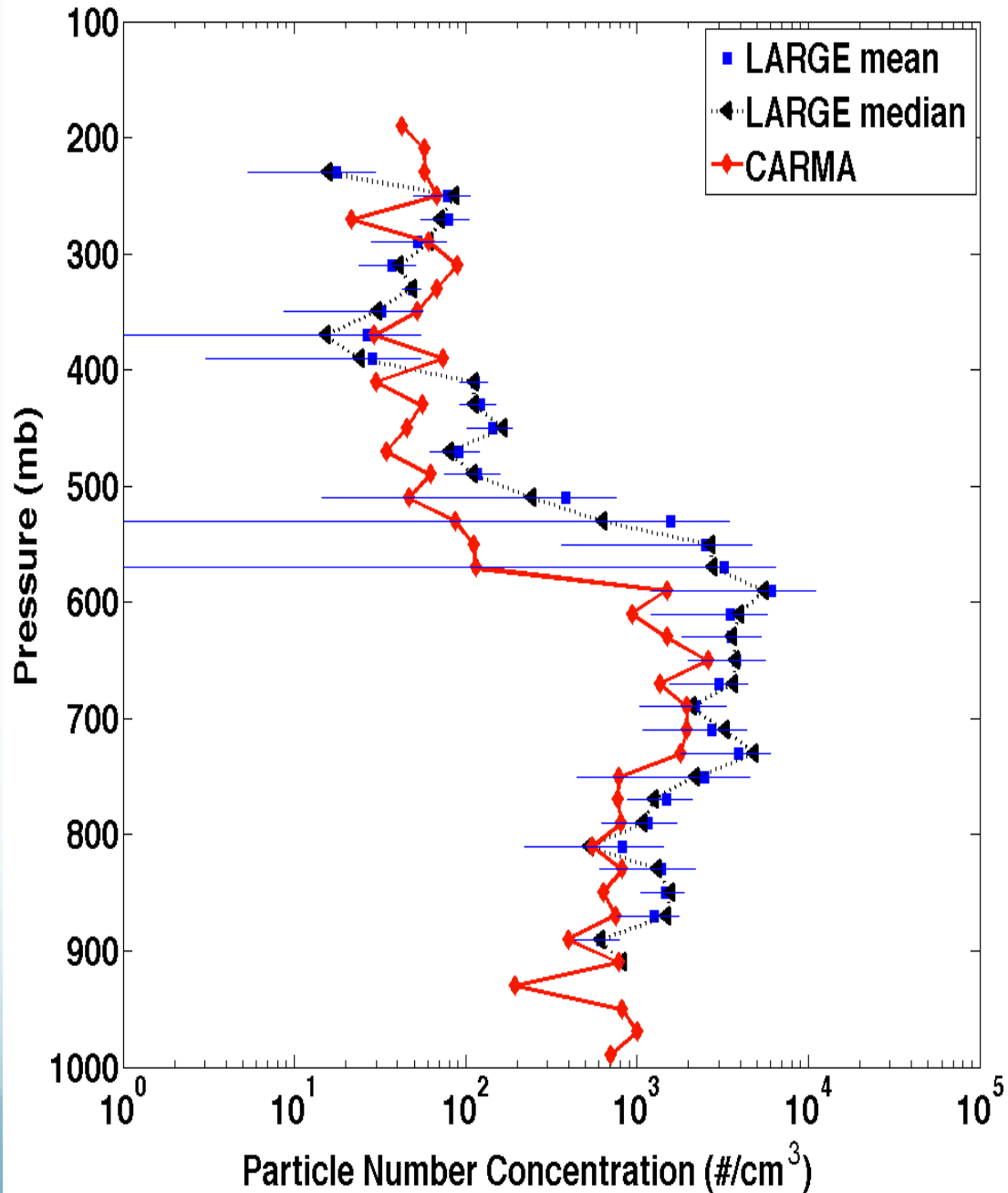
CARMA missed extreme values of organics
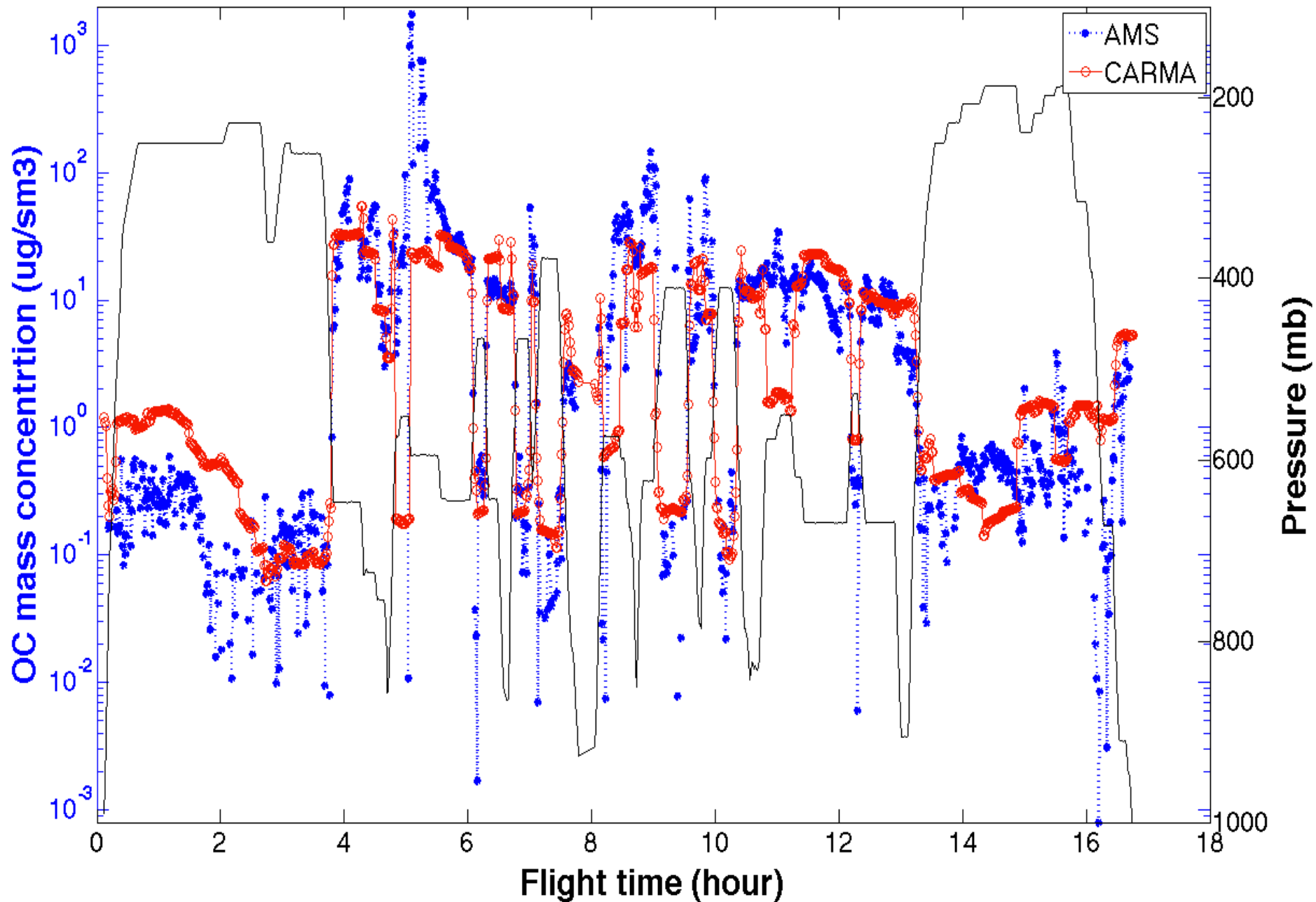
Putting fire emission into 600-700 mb gives better performance
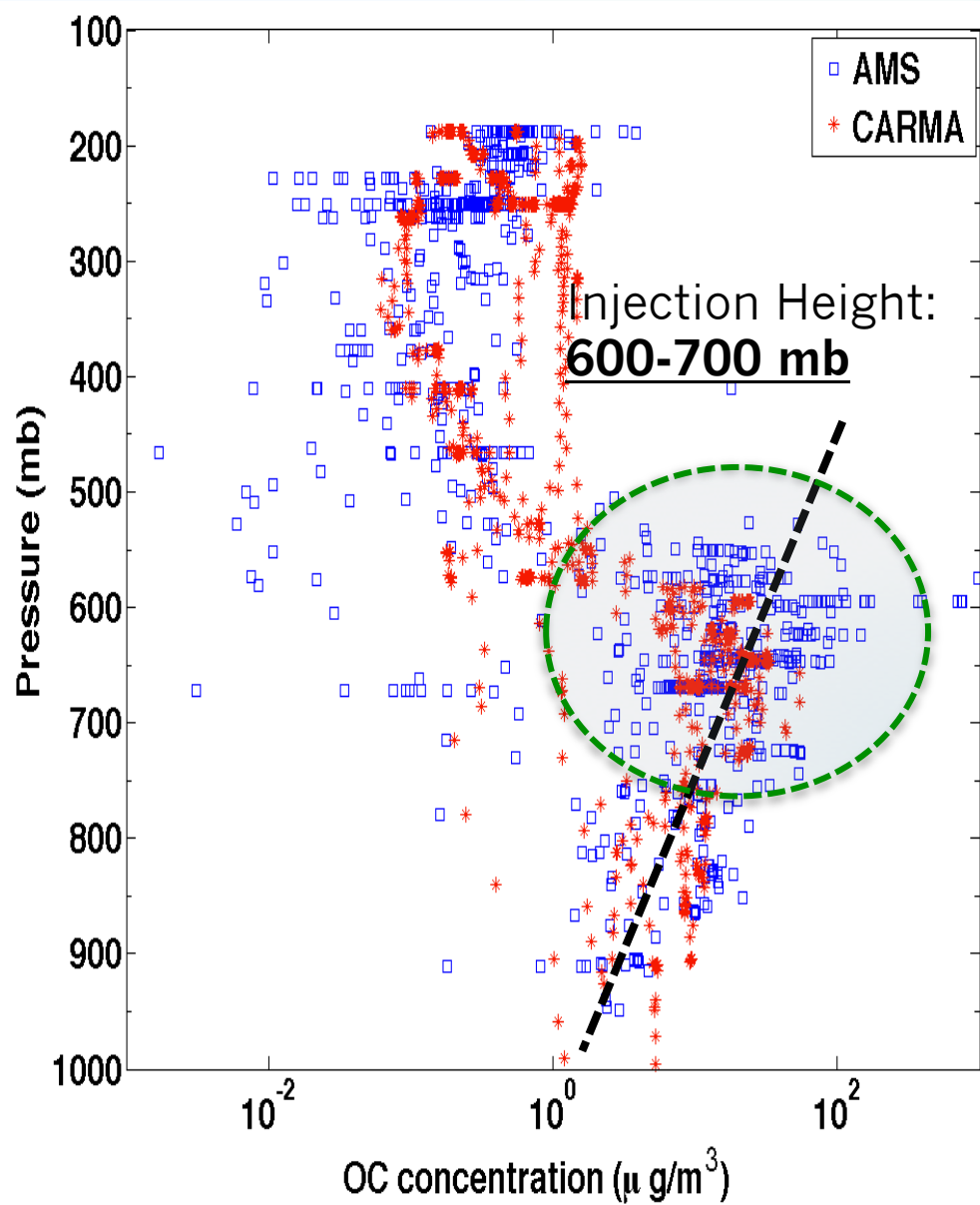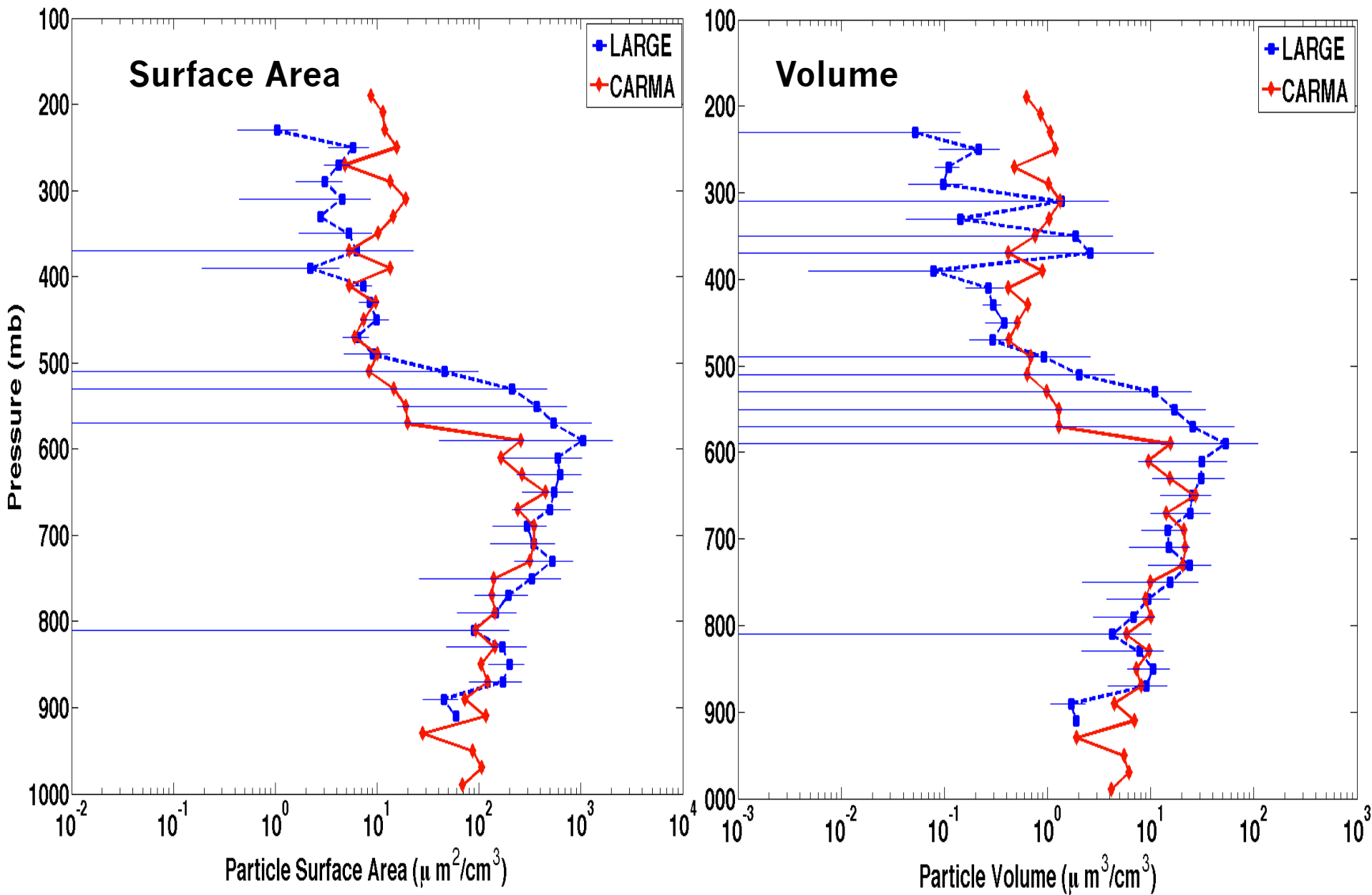
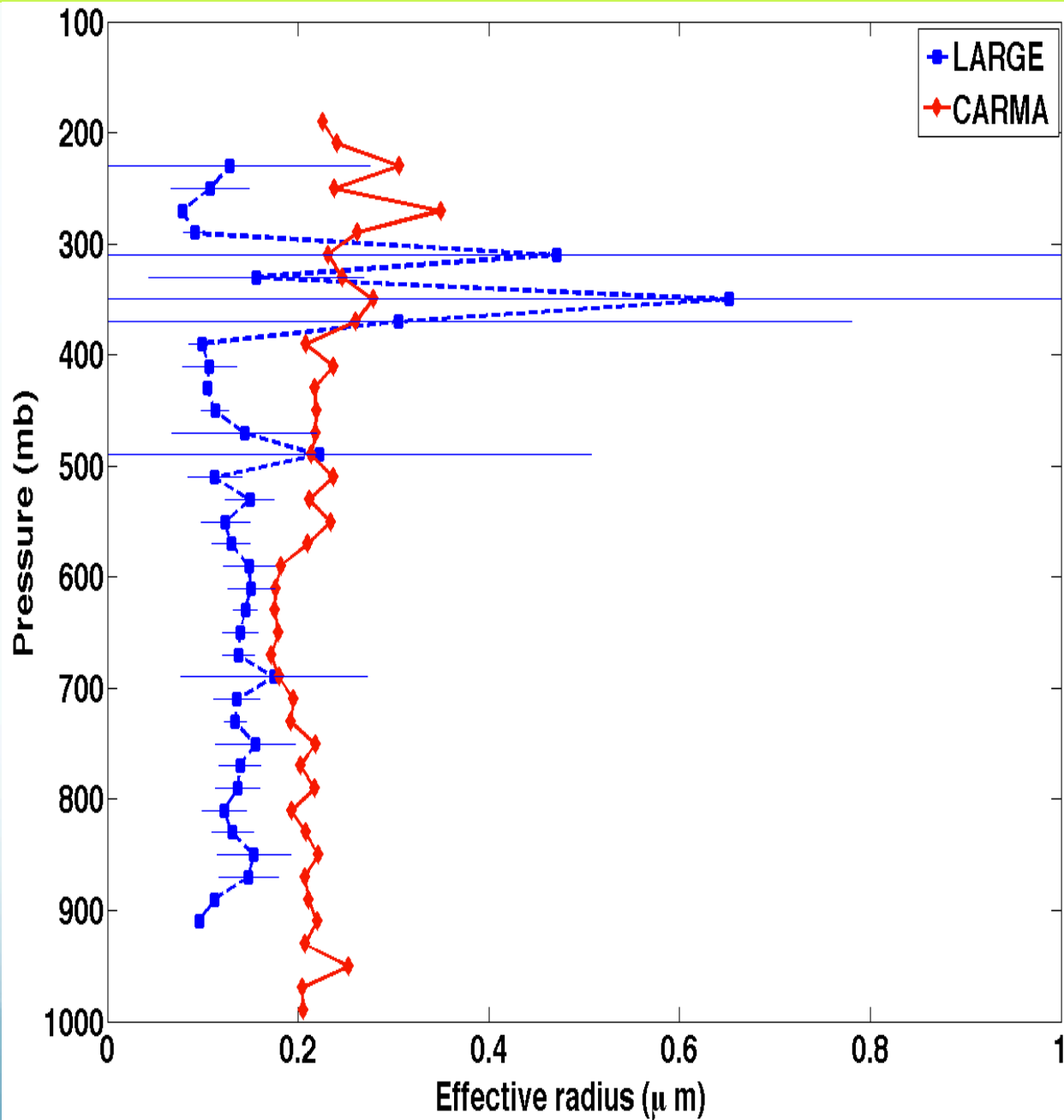# Putting fire emission into 600-700 mb gives better performance
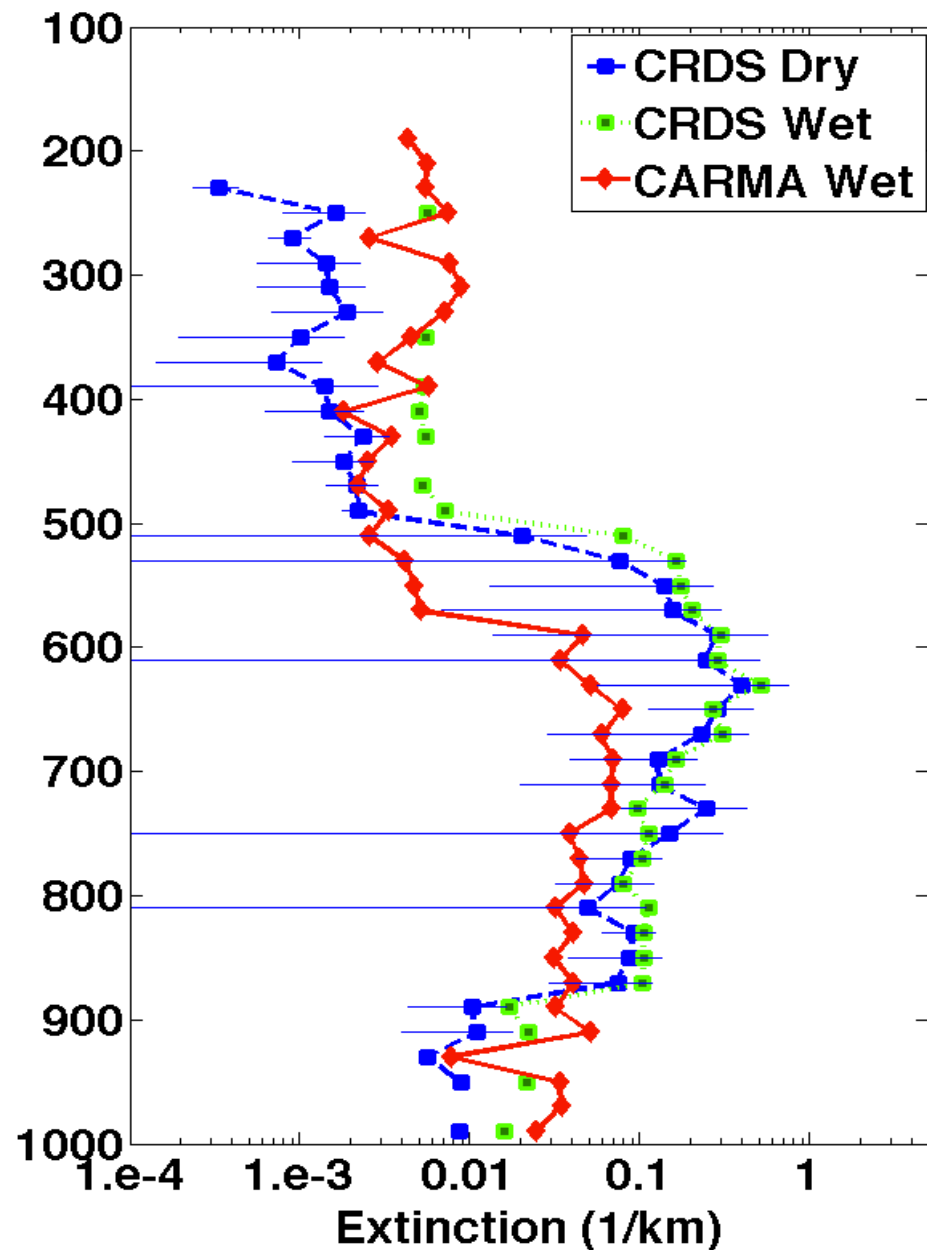
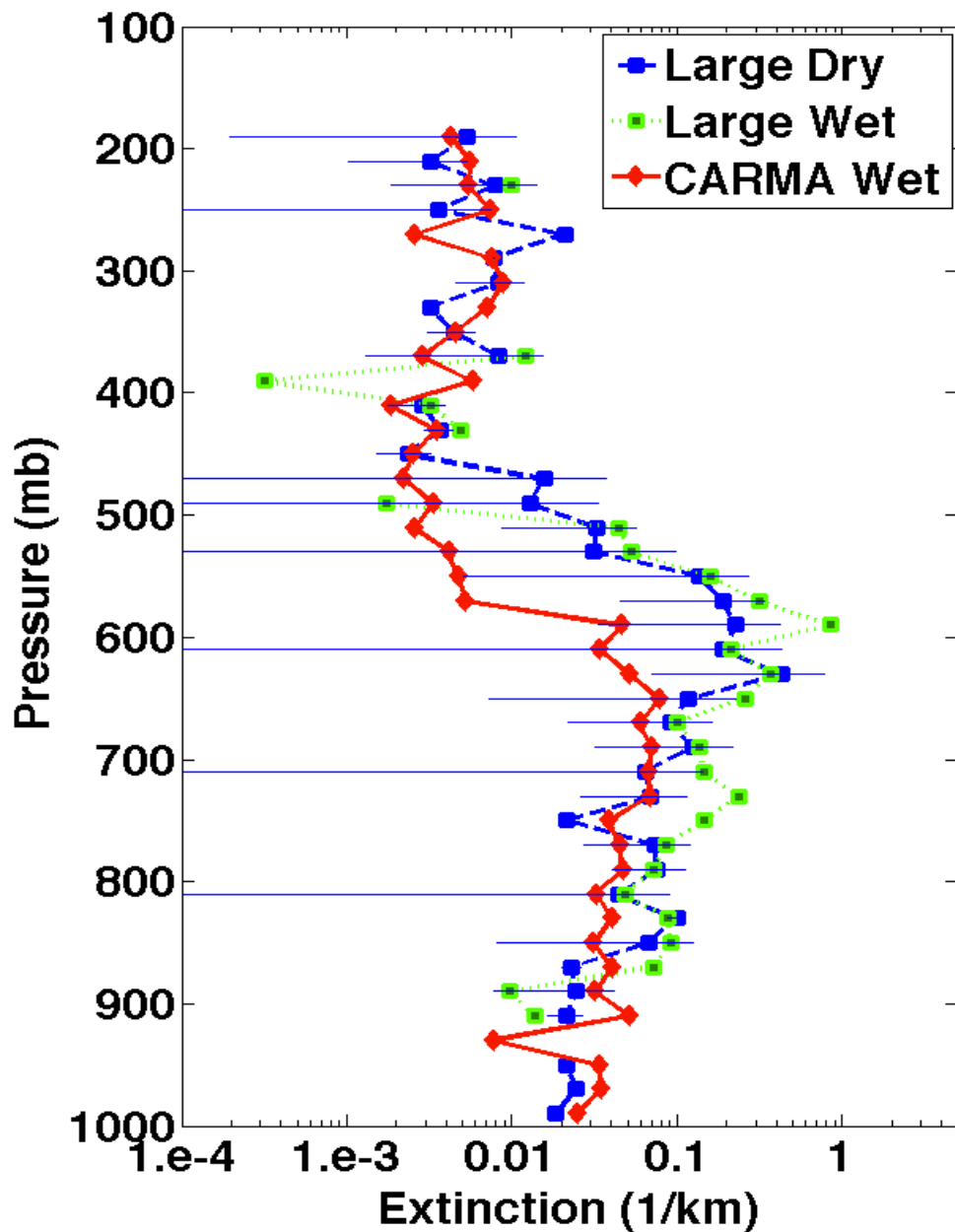# Model Captures Particle Number Concentration

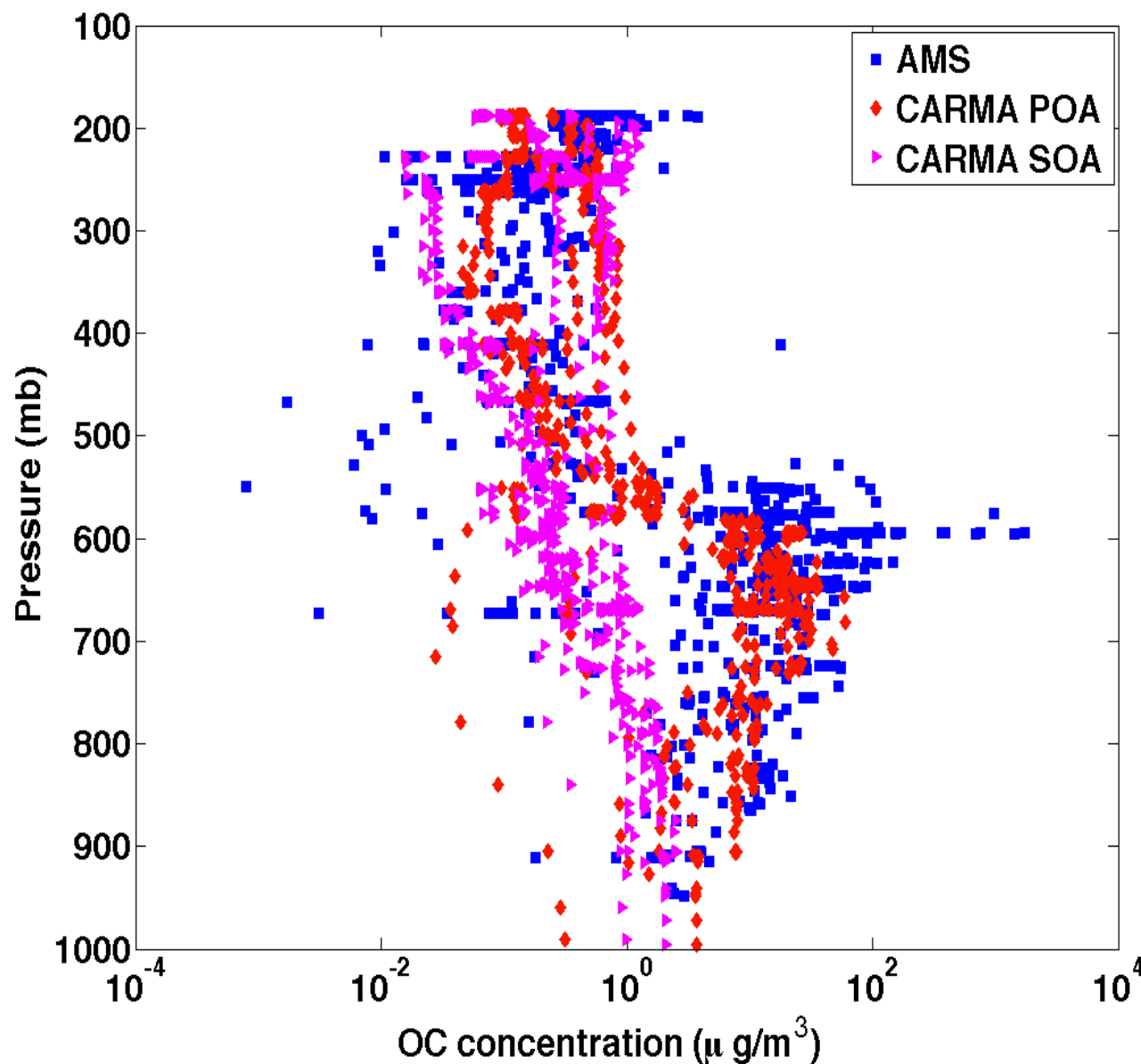# Model Captures Particle Surface Area and Volume Density

Effective radius of Rim Fire Smoke is 0.1-0.2 um

Model underestimates Aerosol Extinction at 600-700 mb from NASA LARGE and NOAA CRDS

SOA contributes to ~1% of Rim Fire Smoke by mass; SOA dominates in Upper Troposphere
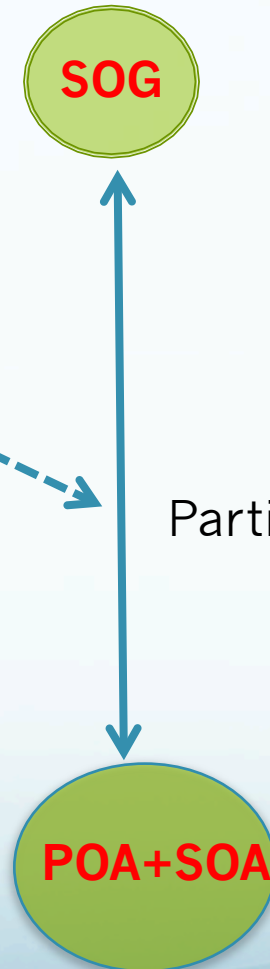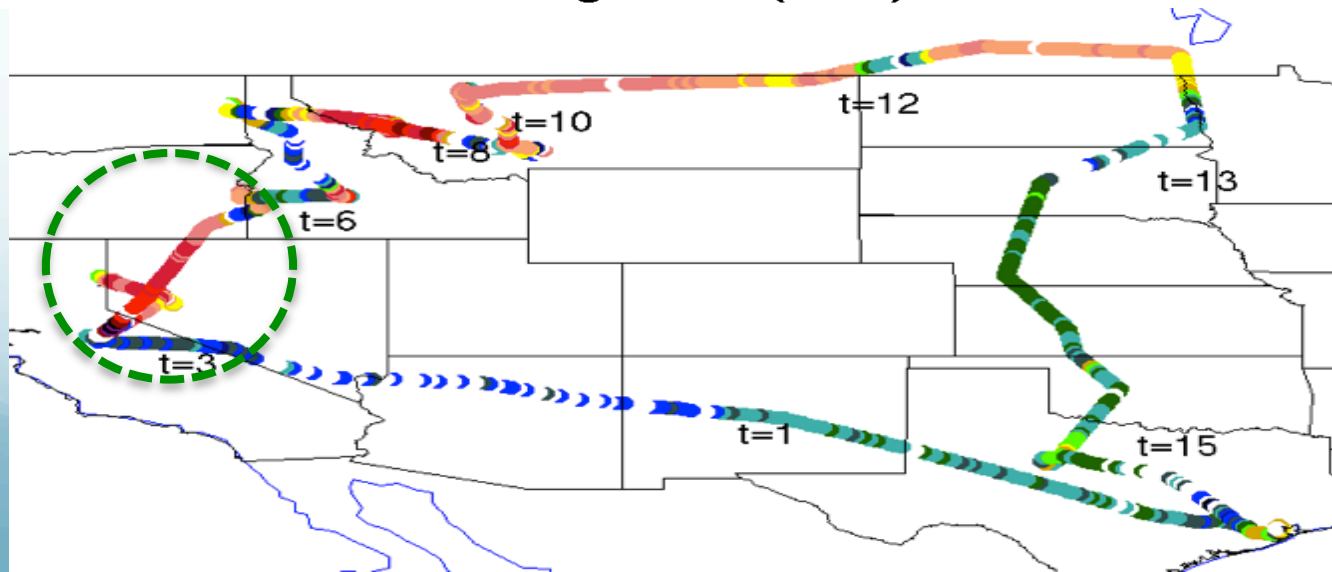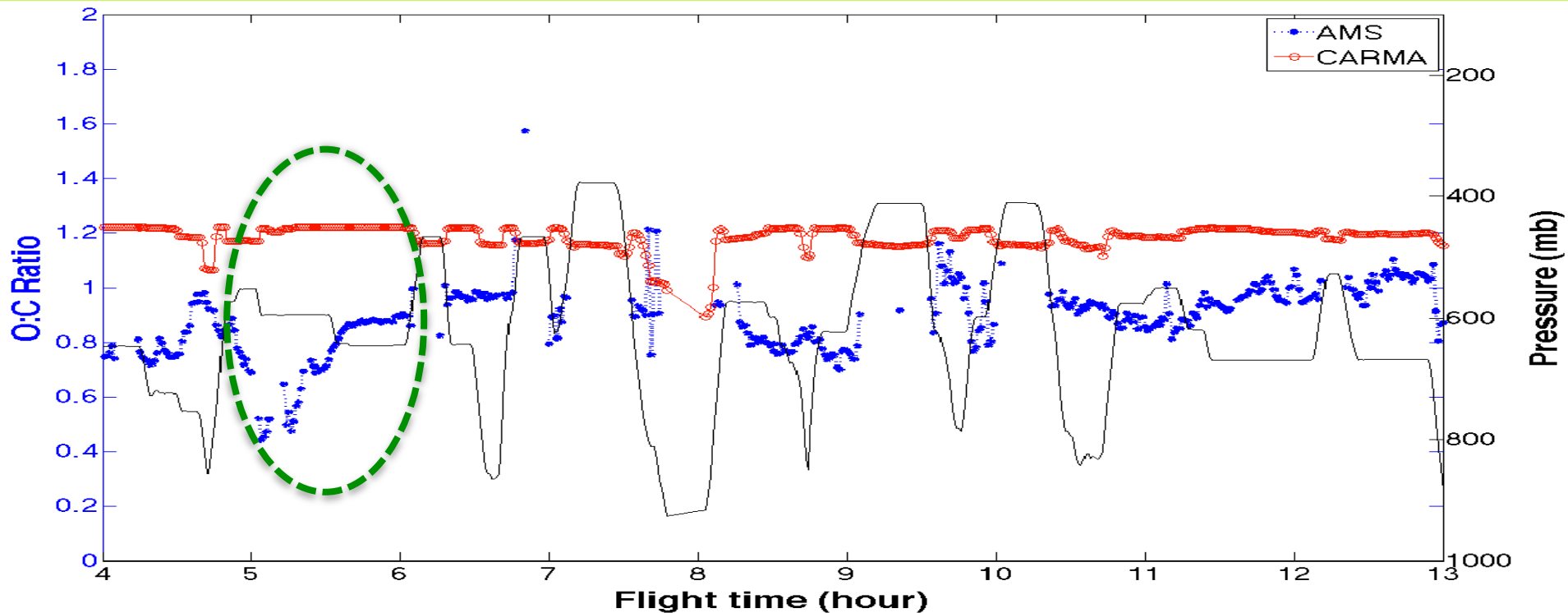
CARMA only consider SOA partitioning

Type I CARMA NO

Type II CARMA YES

POA

POA

Oxidant

SOG

POA+SOA

Partitioning

Robinson et al., 2007, Science

Model injected Aged Smoke

Conclusions

- CARMA can reproduce aerosol mass and number concentrations of rim fires with data's variability;

- Putting smoke emission in 600-700 mb gives better model performance.

- CARMA underestimates aerosol extinction coefficients;

- CARMA reproduces aerosol surface area and volume; the effective radius is 0.1-0.2 um.

- CARMA does show regional transport of smoke as observed by MODIS

- CARMA injected aged smoke.

THANKS

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

Putting fire emission into 600-700 mb gives better performance