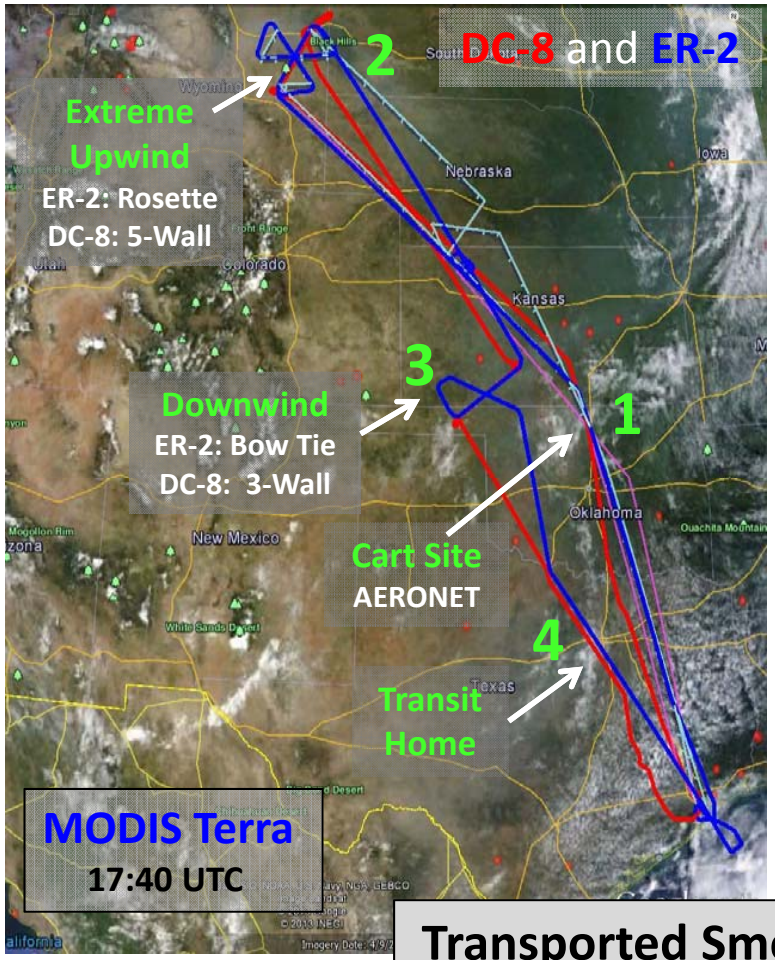
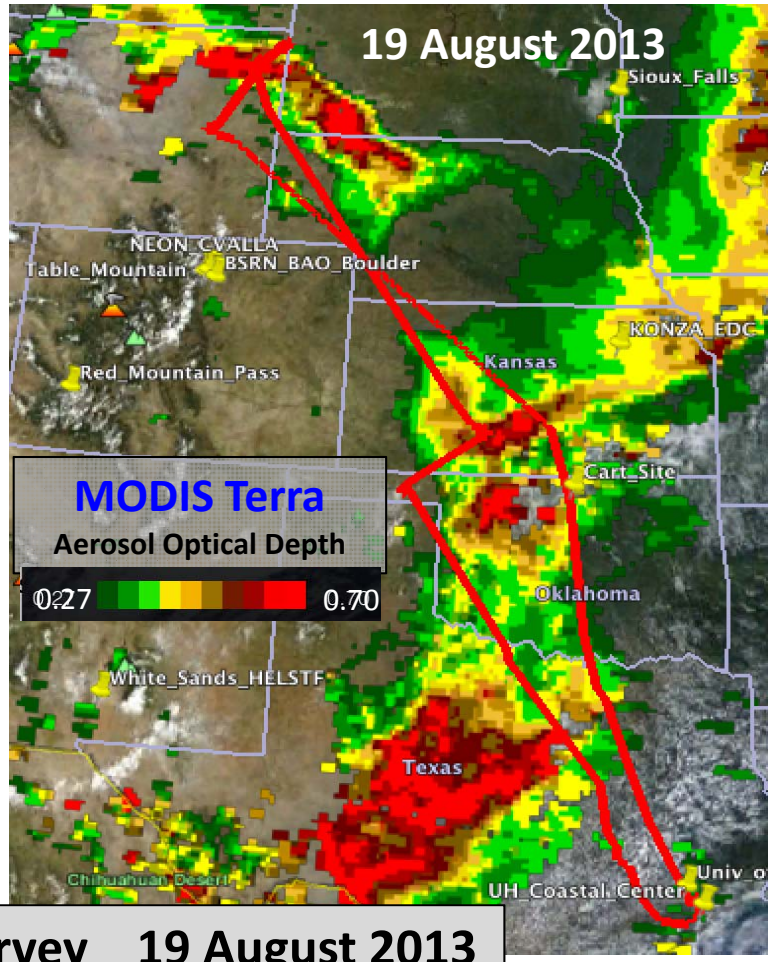
A Three-way Street:

MISR & MODIS Provide Context, *SEAC⁴RS* Provides Detail, & *Models* Complete the Picture

Ralph Kahn ***NASA Goddard Space Flight Center***

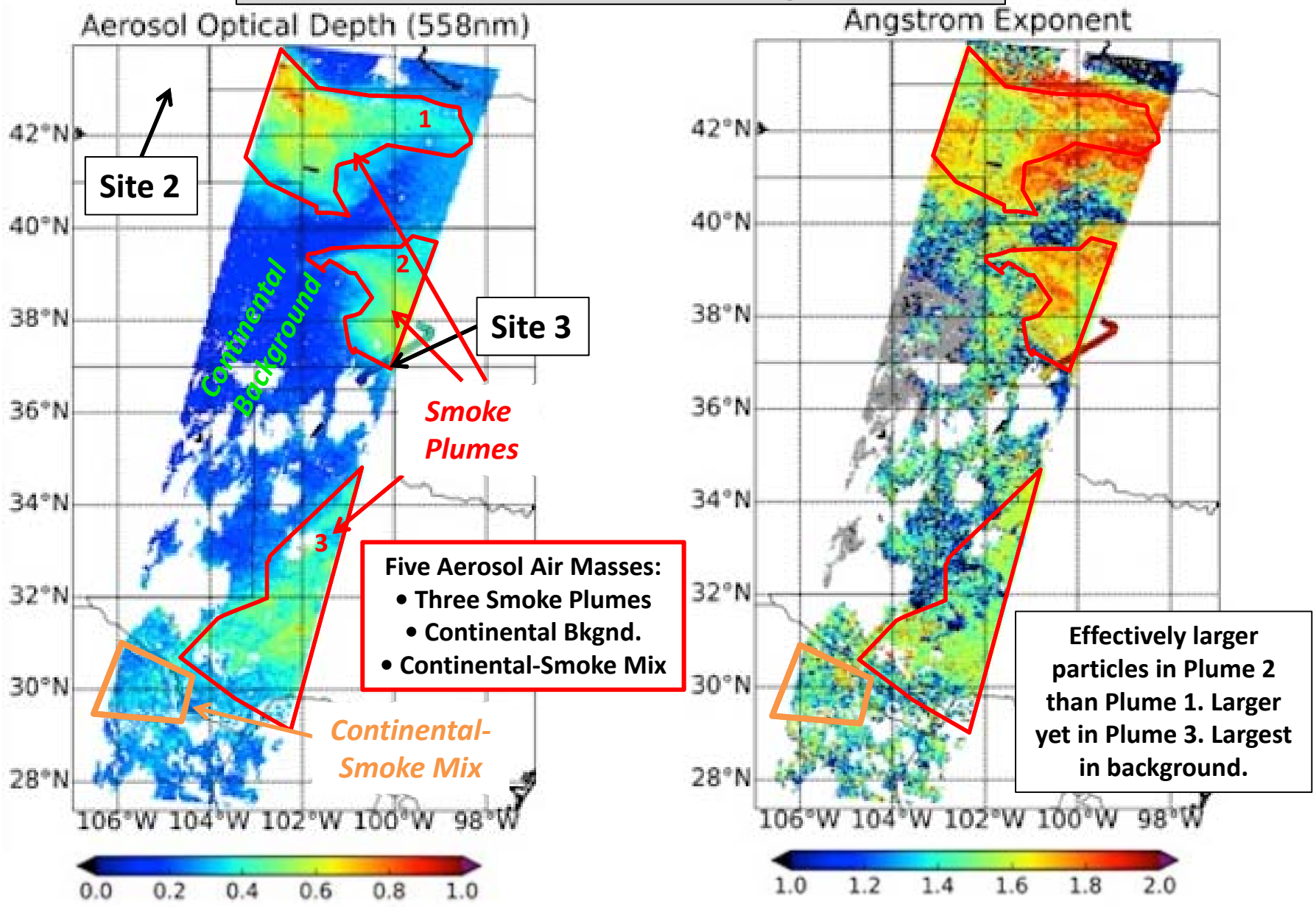




Transported Smoke Survey 19 August 2013

MISR Overview

Research Retrievals 19 August 2013



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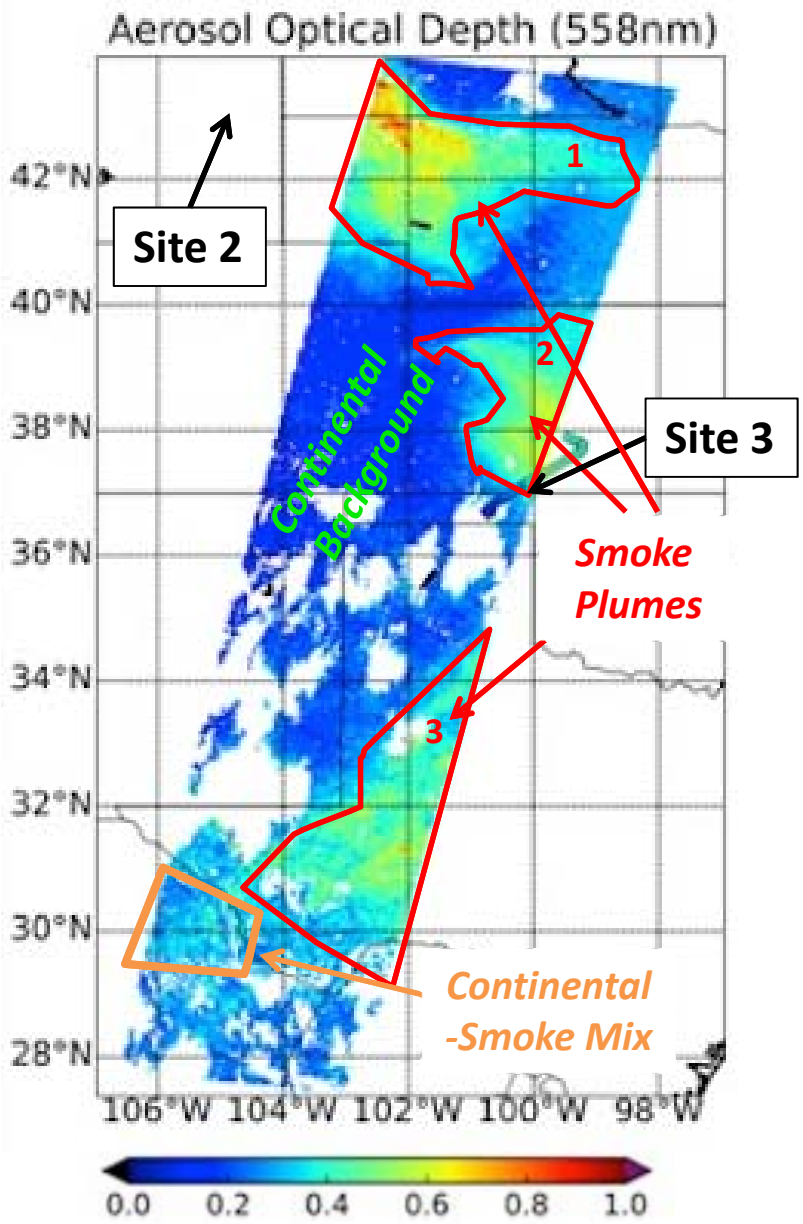

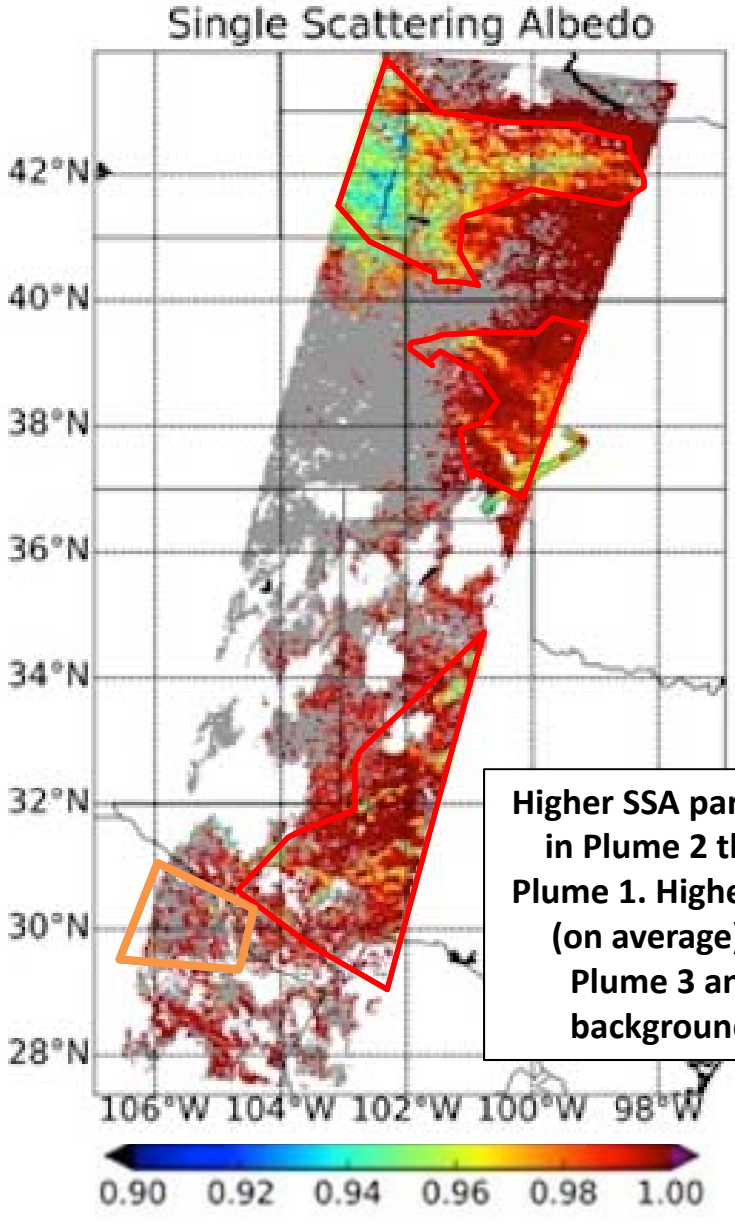

Higher SSA particles in Plume 2 than Plume 1. Higher still (on average) in Plume 3 and background.

MISR Overview

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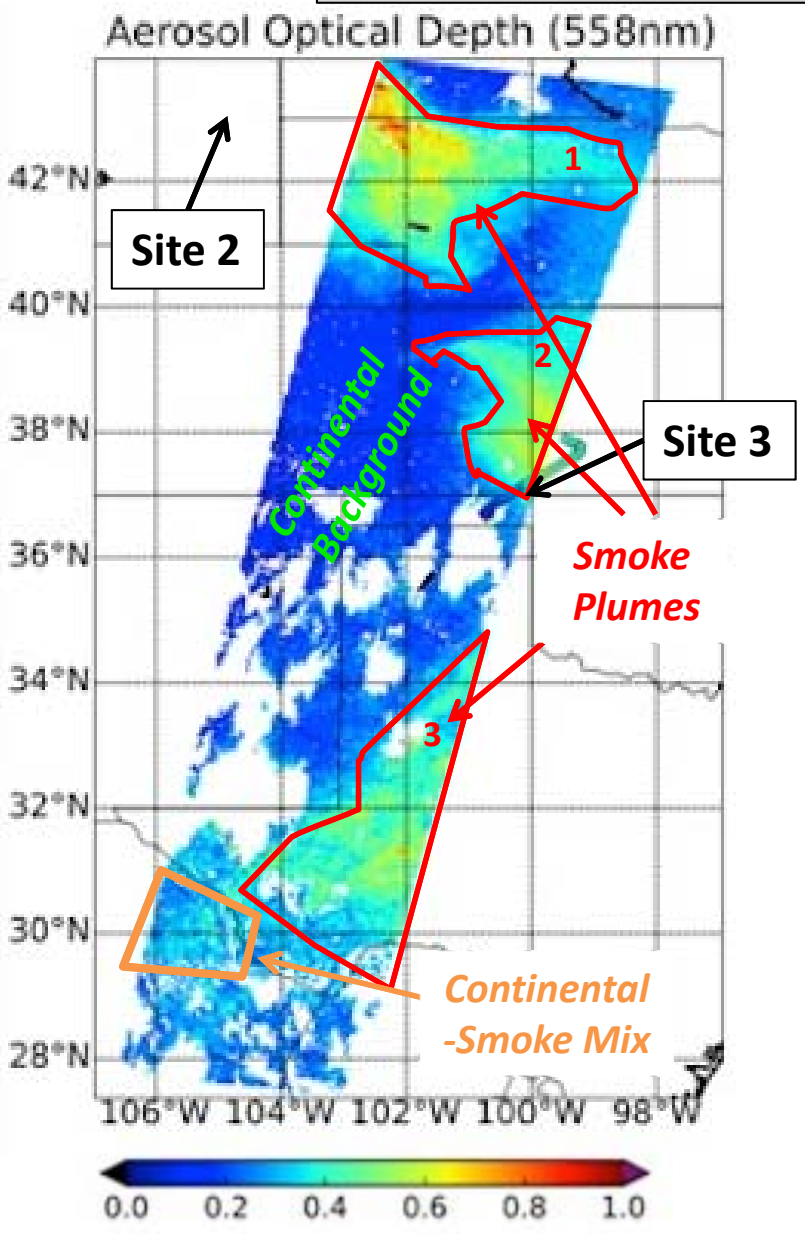
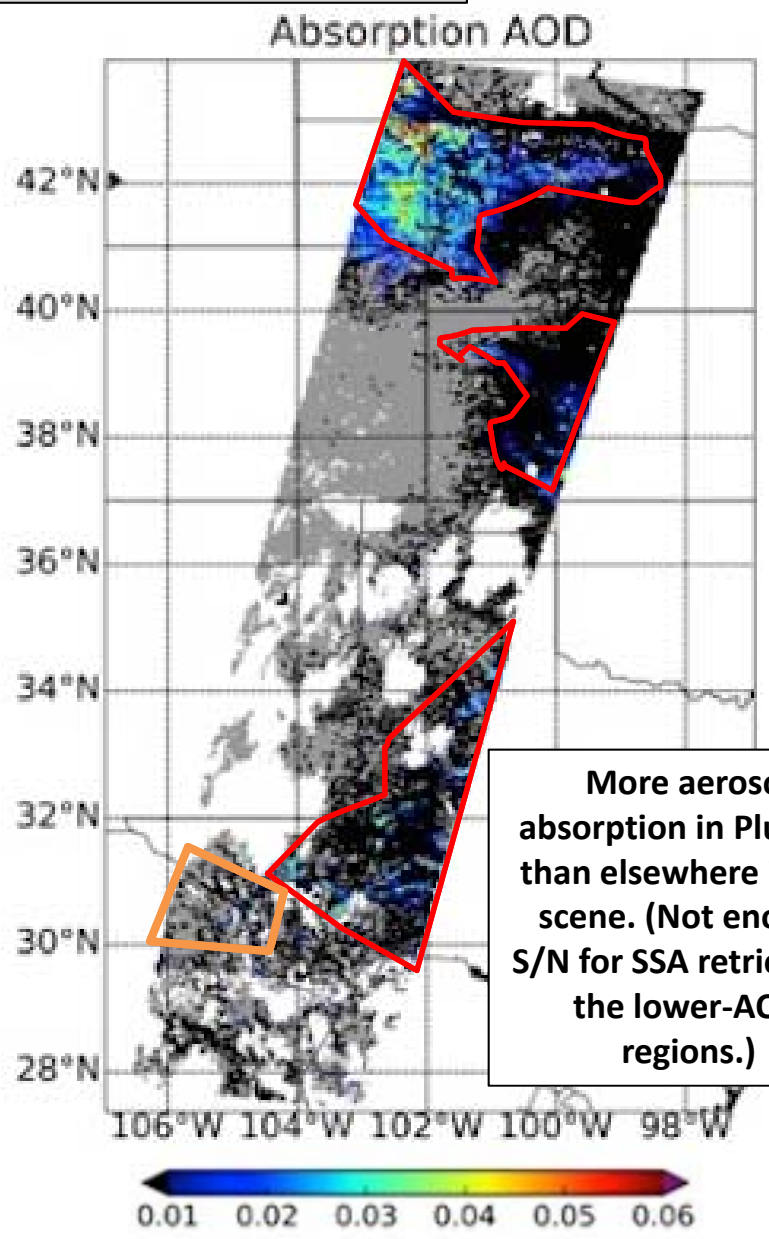
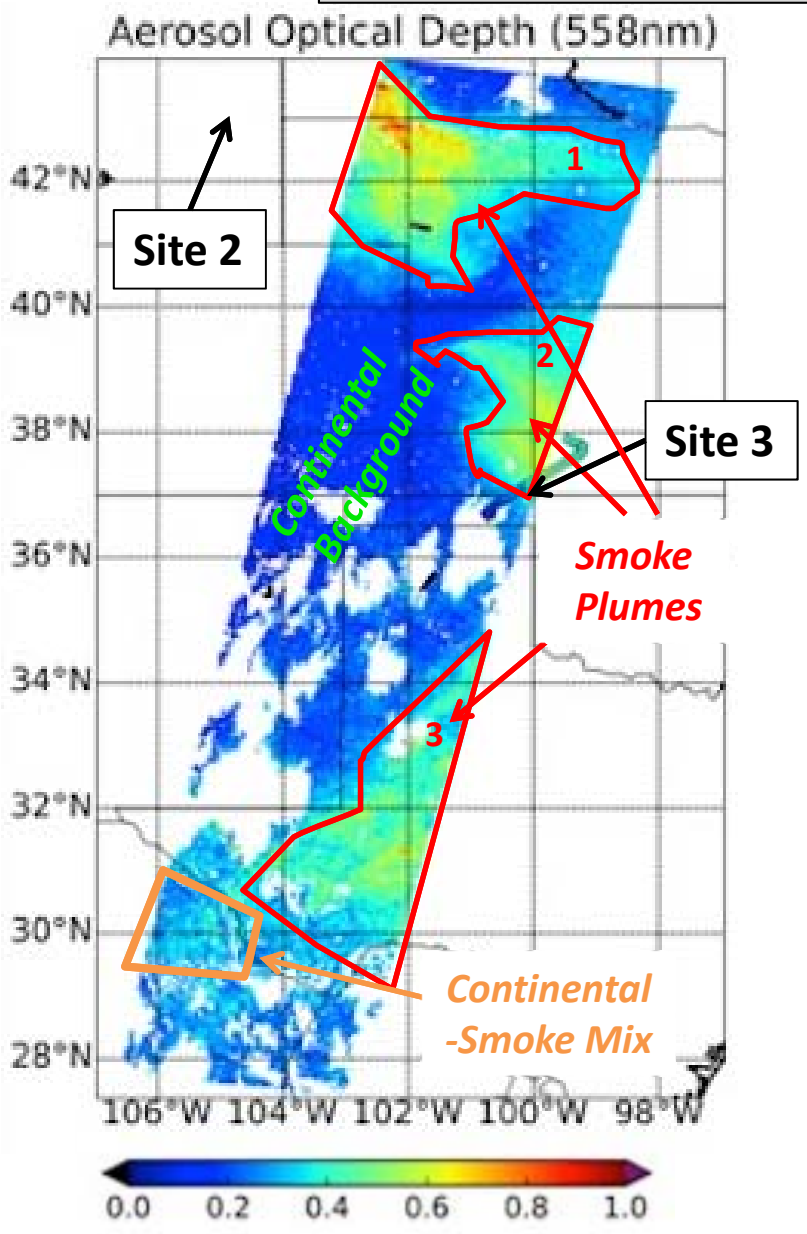


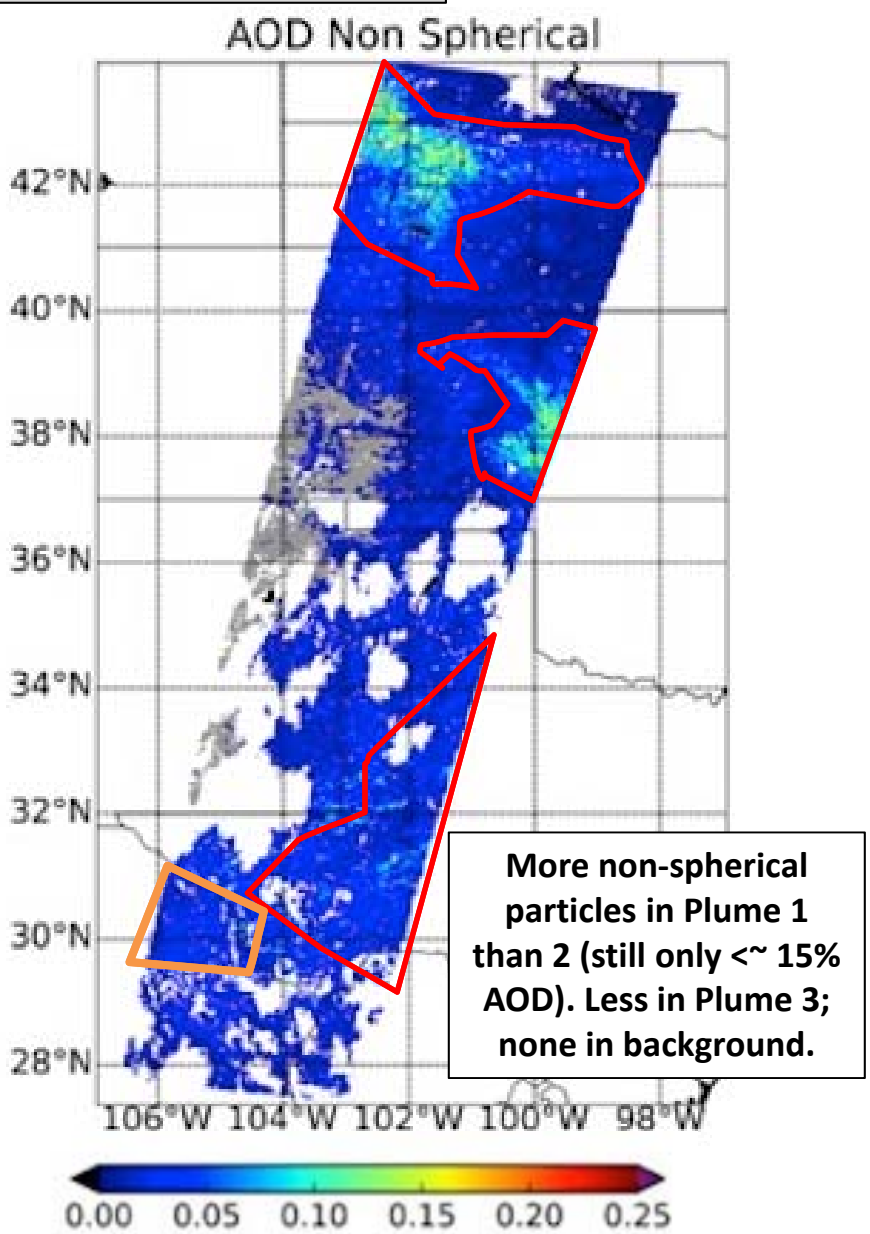


More aerosol absorption in Plume 1 than elsewhere in the scene. (Not enough S/N for SSA retrieval in the lower-AOD regions.)

MISR Overview

Research Retrievals 19 August 2013

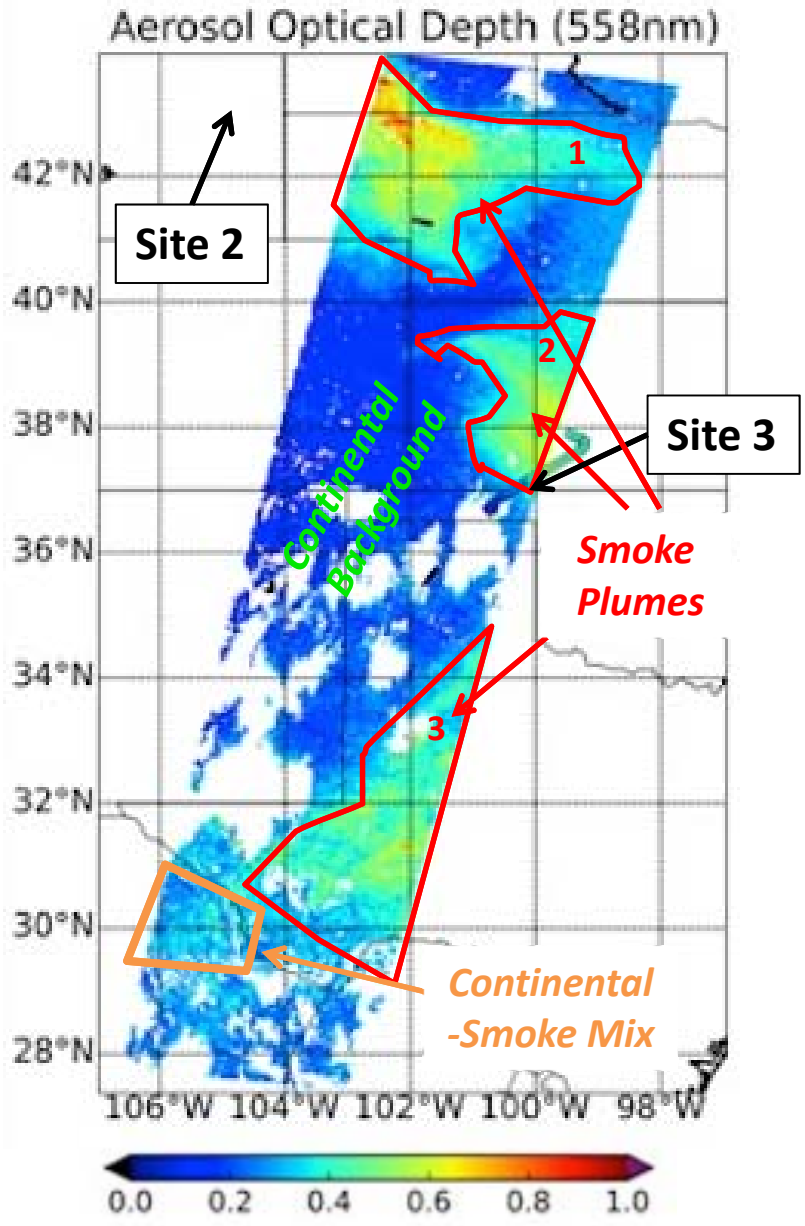


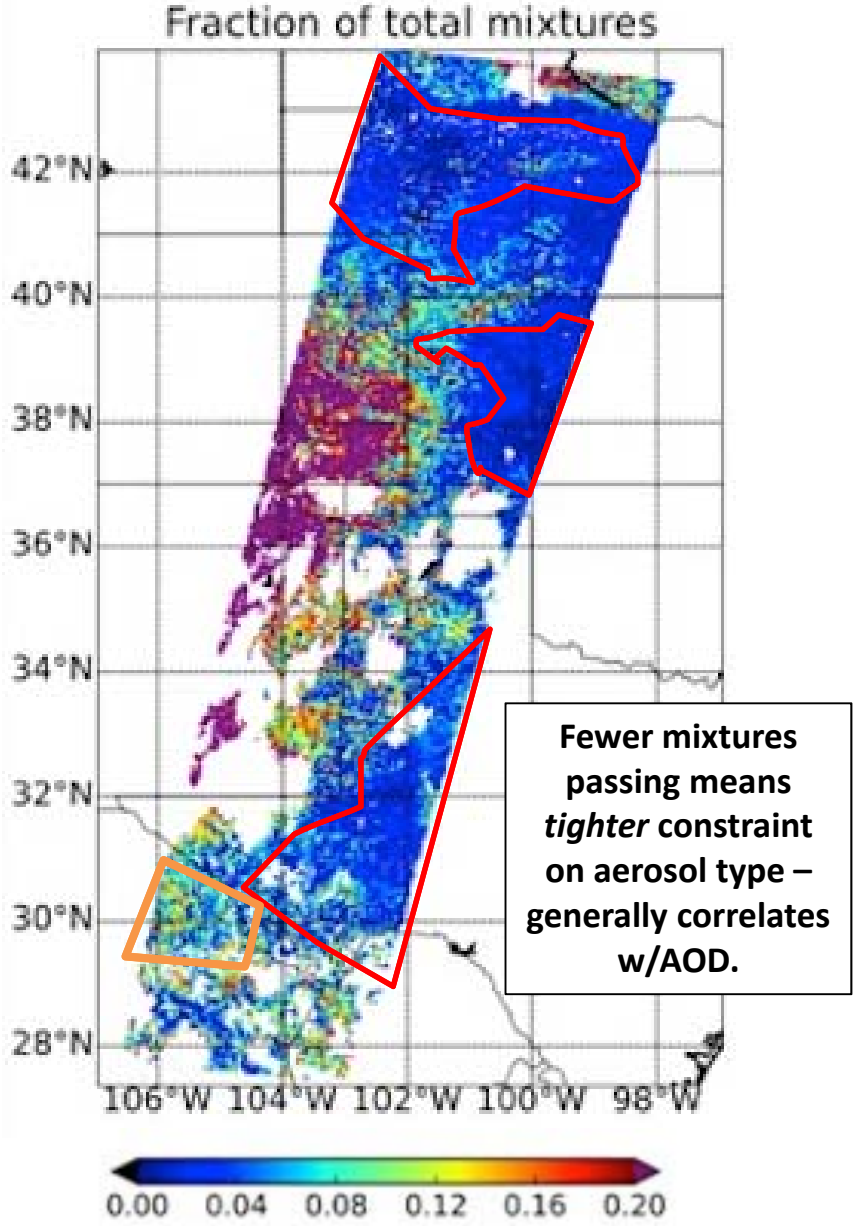


More non-spherical particles in Plume 1 than 2 (still only <~ 15% AOD). Less in Plume 3; none in background.

MISR Overview

Research Retrievals 19 August 2013



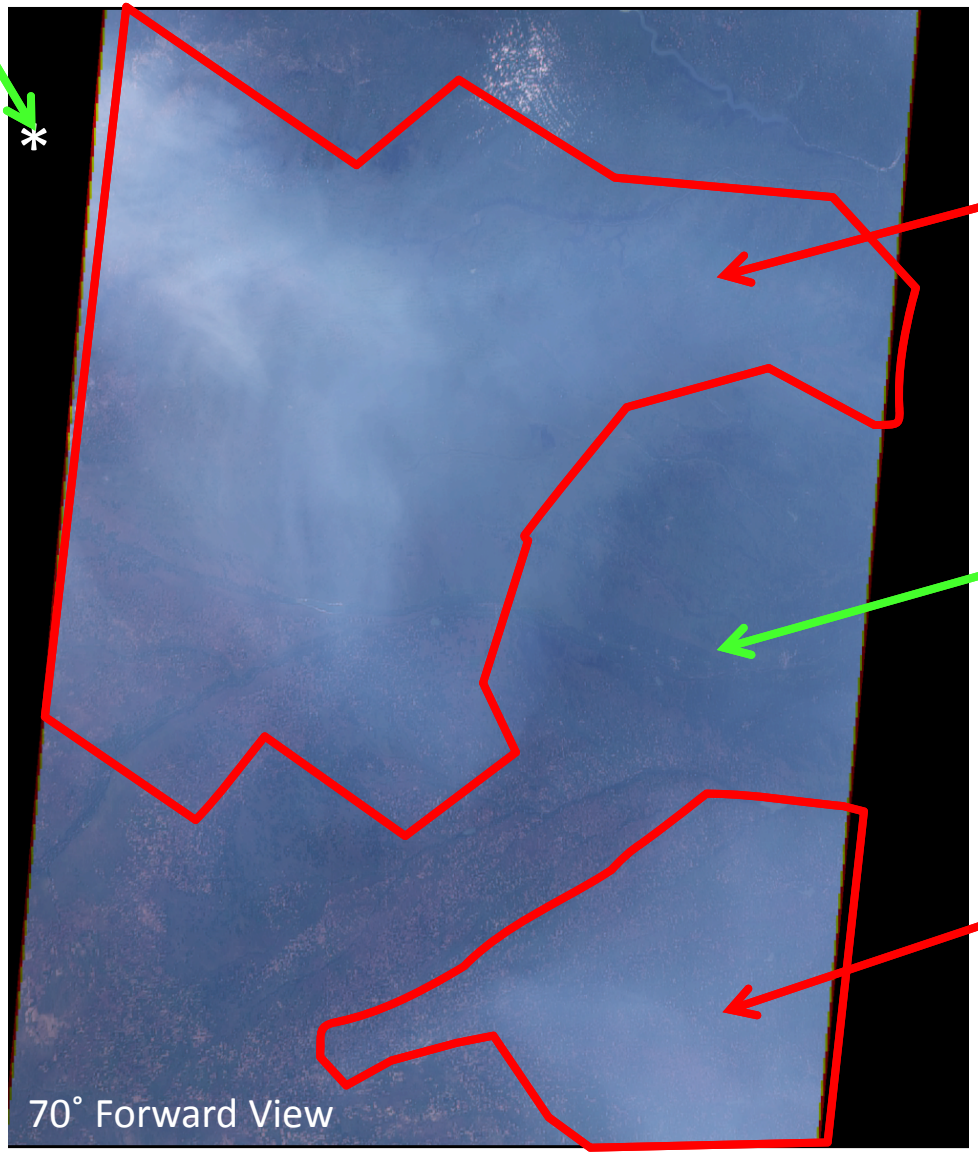


Fewer mixtures passing means *tighter* constraint on aerosol type – generally correlates w/AOD.

MISR Aerosol Type (Research Algorithm)

19 August 2013

Site 2



Smoke Plume 1
AOD 0.36-0.69
*ANG 1.4-1.8 (**small**)*
*SSA 0.94-0.99 (**somewhat abs.**)*
*FrNon-Sph 0.05-0.2 (**mostly sph.**)*

Continental Background
AOD 0.13-0.24
*ANG 0.94-1.7 (**medium**)*
*SSA 0.98-1.0 (**non-absorbing**)*
*FrNon-Sph 0.05-0.19 (**mostly sph.**)*

Smoke Plume 2
AOD 0.36-0.59
*ANG 1.4-1.8 (**small**)*
*SSA 0.96-1.0 (**less absorbing**)*
*FrNon-Sph 0.02-0.2 (**more sph.**)*

Passive-remote-sensing ***Aerosol Type*** is a ***Total-Column-Effective***, ***Categorical*** variable!!

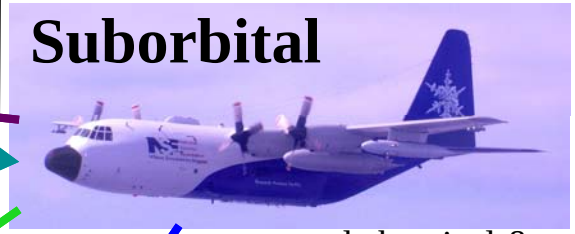
Satellites

frequent, global *snapshots*; aerosol amount & aerosol type maps, plume & layer heights

Remote-sensing Analysis
- Retrieval Validation
- Assumption Refinement

Regional Context

Suborbital



targeted chemical & microphysical detail

point-location time series

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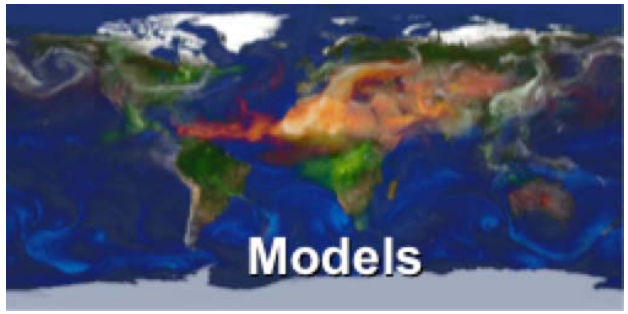
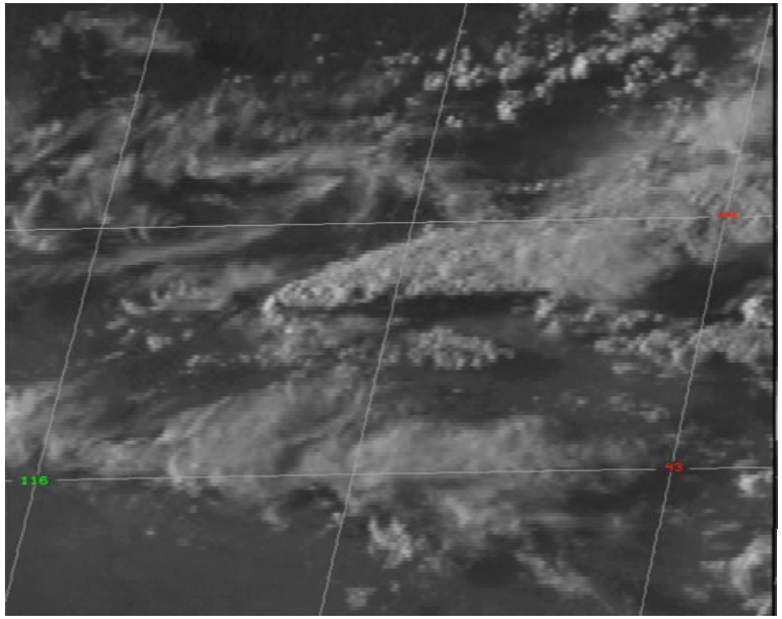


space-time interpolation,

DARF & Anthropogenic Component

calculation and prediction

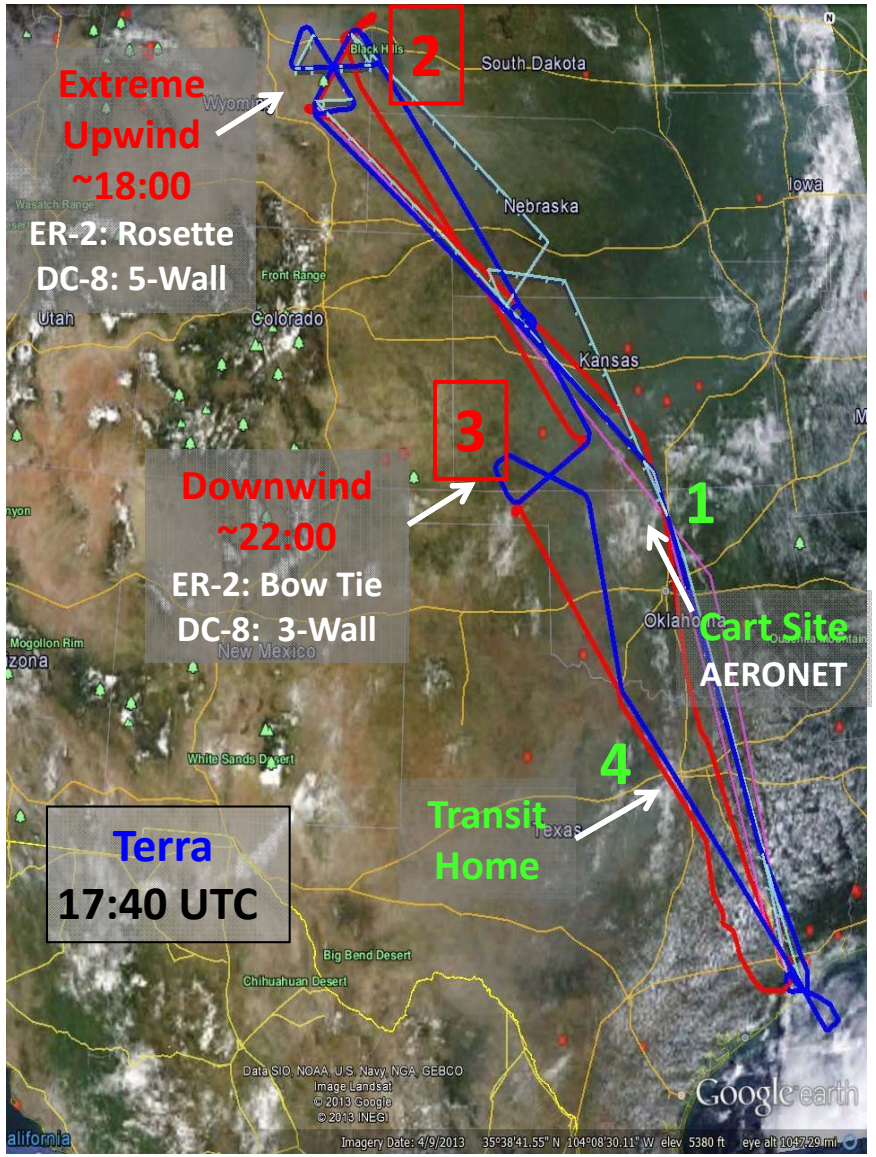
Kahn, Survy. Geophys. 2012

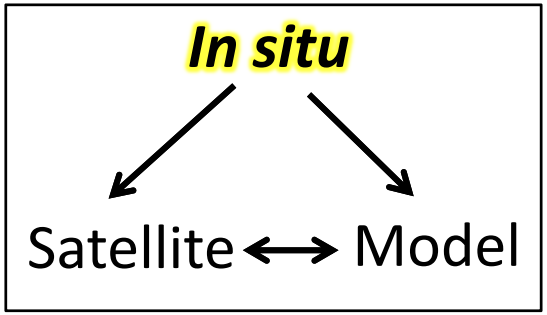


Three Stories:

- ***Aerosol Air-Mass-Type Validation***
- ***Upwind Smoke Source & Injection Height***
- ***Regional Aerosol Characterization***

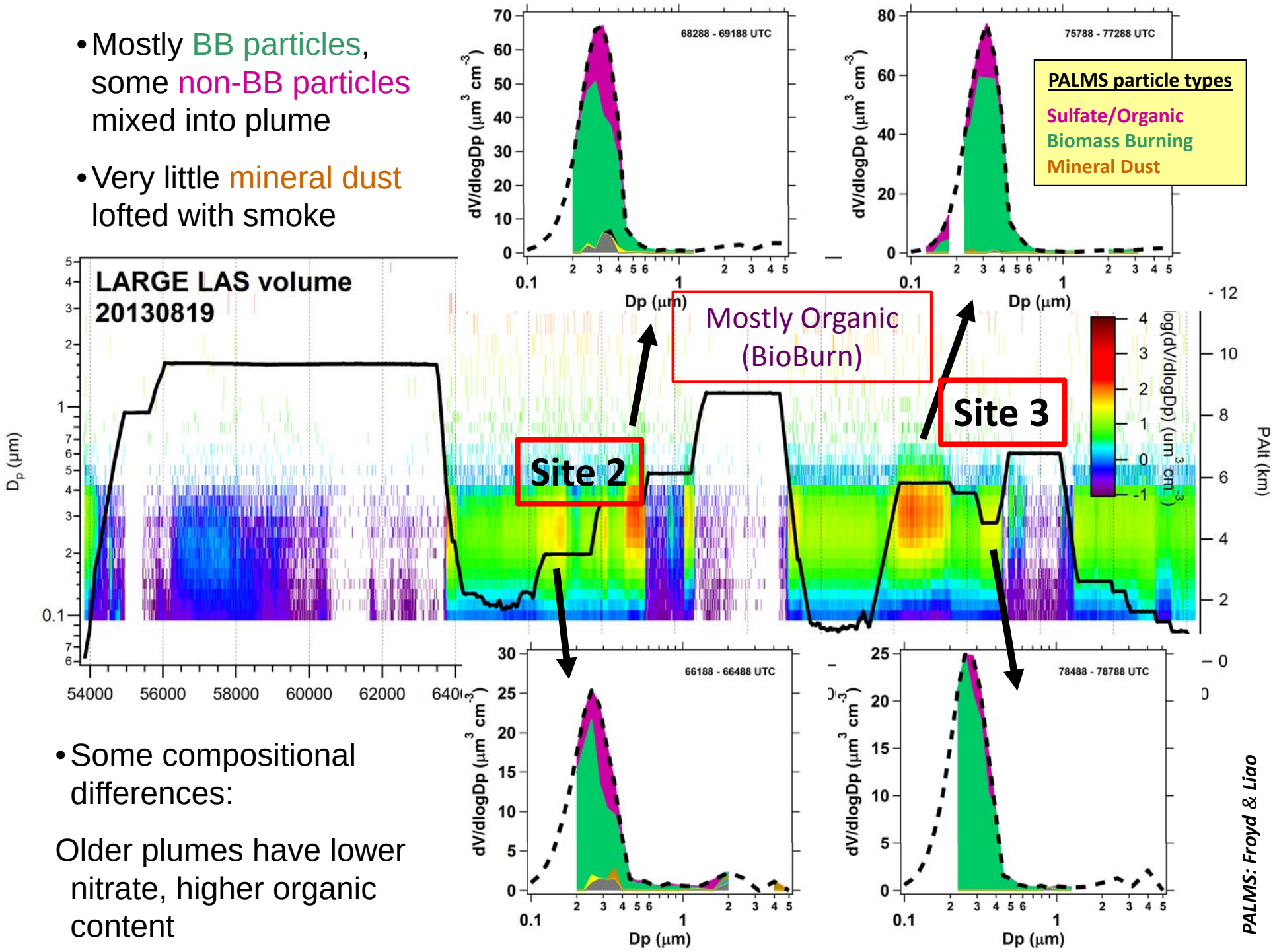
Story 1: *Aerosol Air-Mass-Type Validation*





Comparing the retrieved and modeled AOD, size, shape, and **SSA** with *in situ* measurements
(a) qualitatively and
(b) quantitatively
for five regions
[3 Smoke Plumes;
Continental Background;
Continental-Smoke Mix]

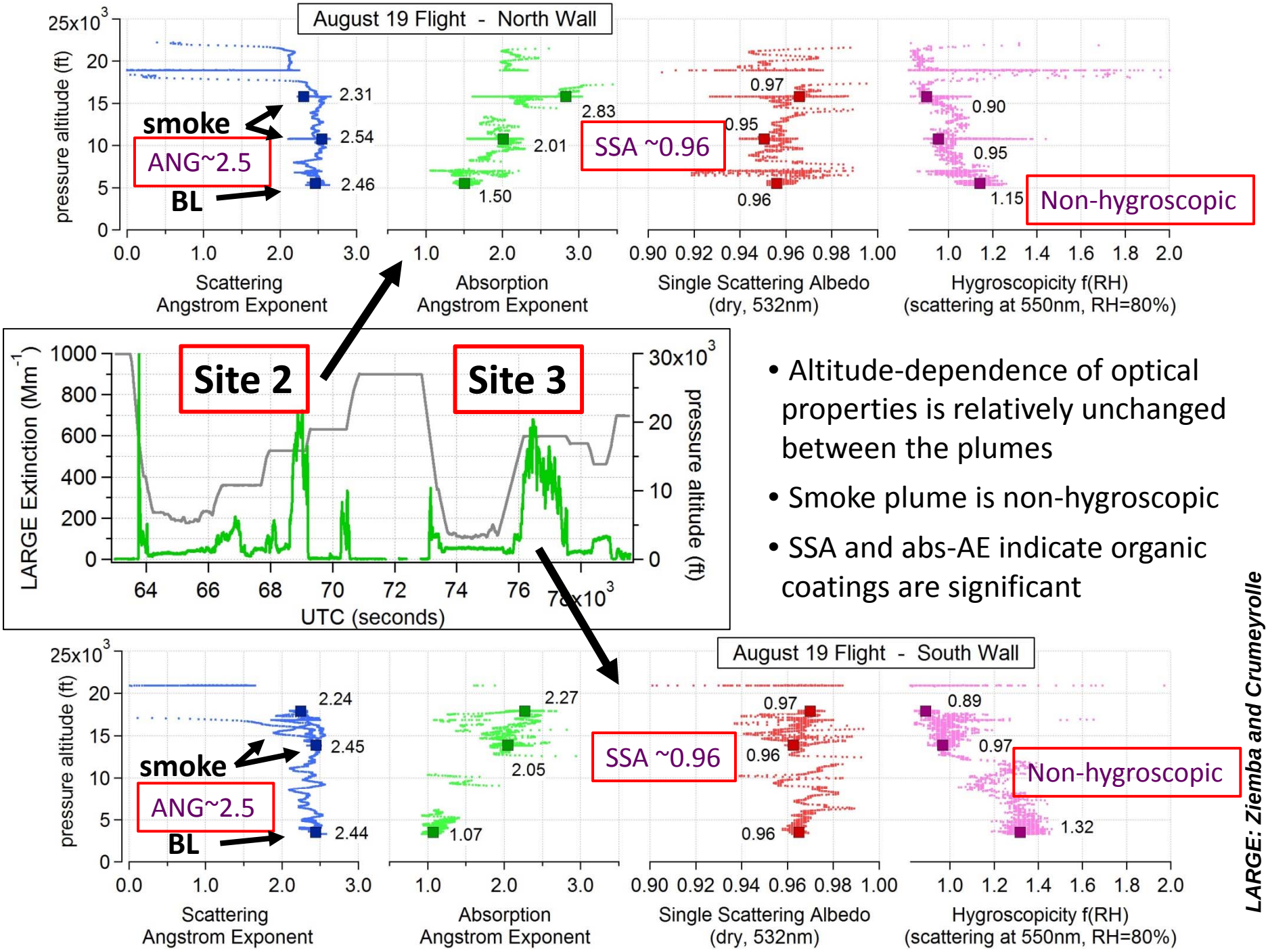
- Mostly BB particles, some non-BB particles mixed into plume
- Very little mineral dust lofted with smoke



- Some compositional differences:

Older plumes have lower nitrate, higher organic content

PALMS: Froyd & Liao

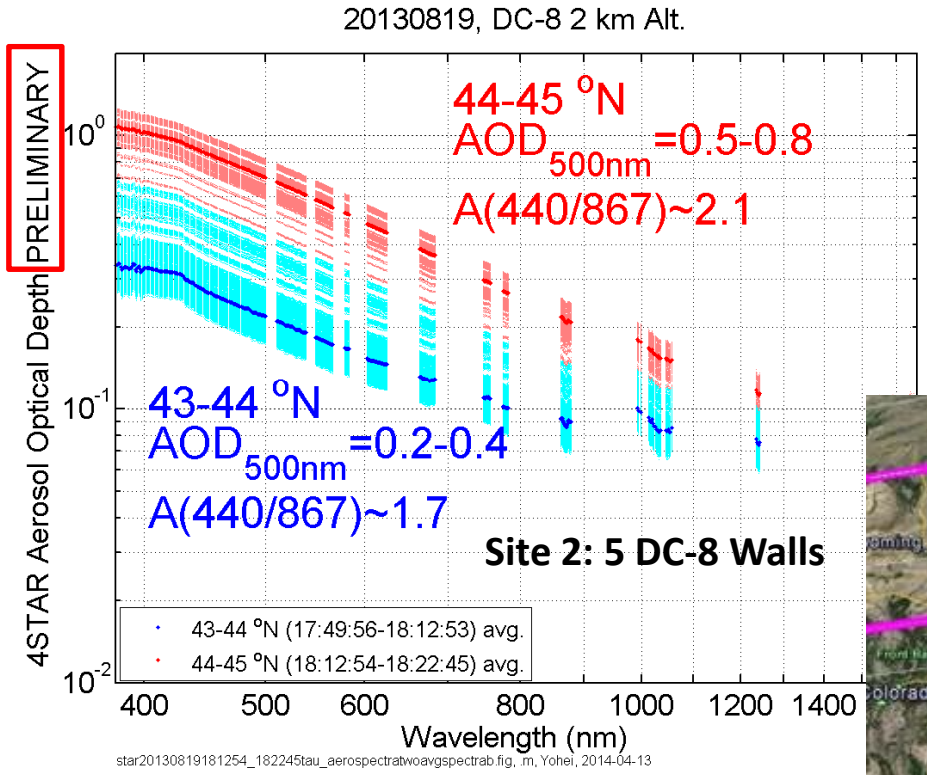


- Altitude-dependence of optical properties is relatively unchanged between the plumes
- Smoke plume is non-hygroscopic
- SSA and abs-AE indicate organic coatings are significant

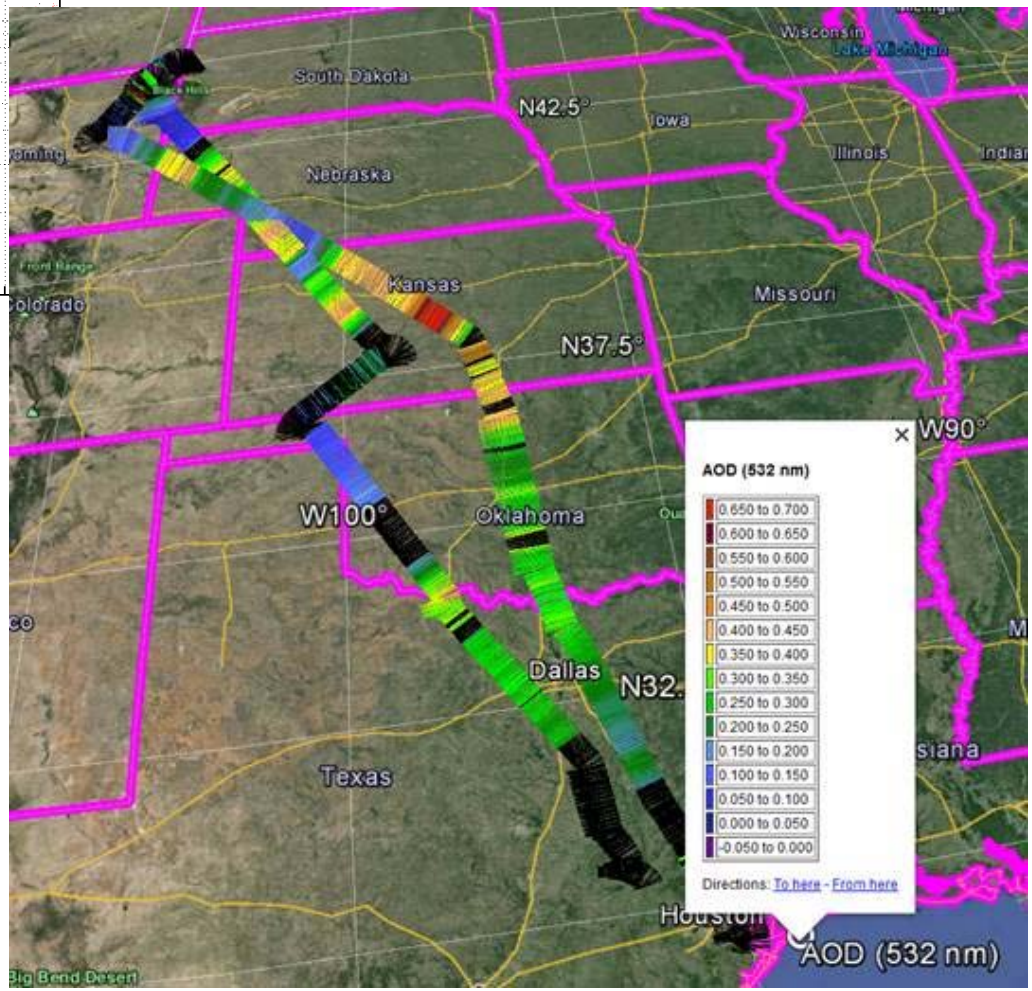
LARGE: Ziemba and Crumeyrolle

MISR AOD/ANG Validation

19 August 2013



4-STAR Team, Shinozuka et al.



HSRL Team, Ferrare et al.

***MISR* Smoke Plume 1**

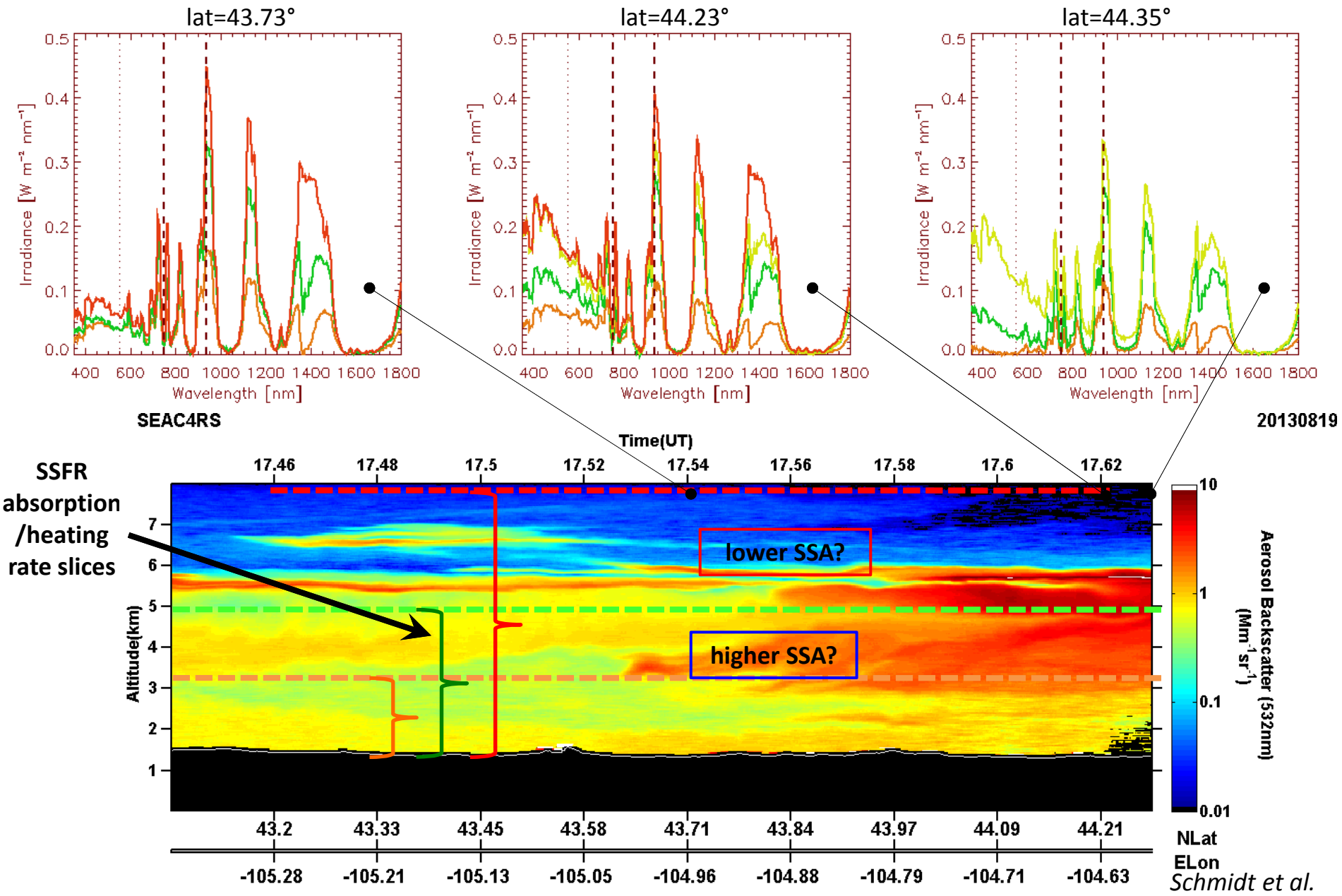
AOD 0.36-0.69

*ANG 1.4-1.8 (**small**)*

*SSA 0.94-0.99 (**somewhat abs.**)*

*FrNon-Sph 0.05-0.2 (**mostly sph.**)*

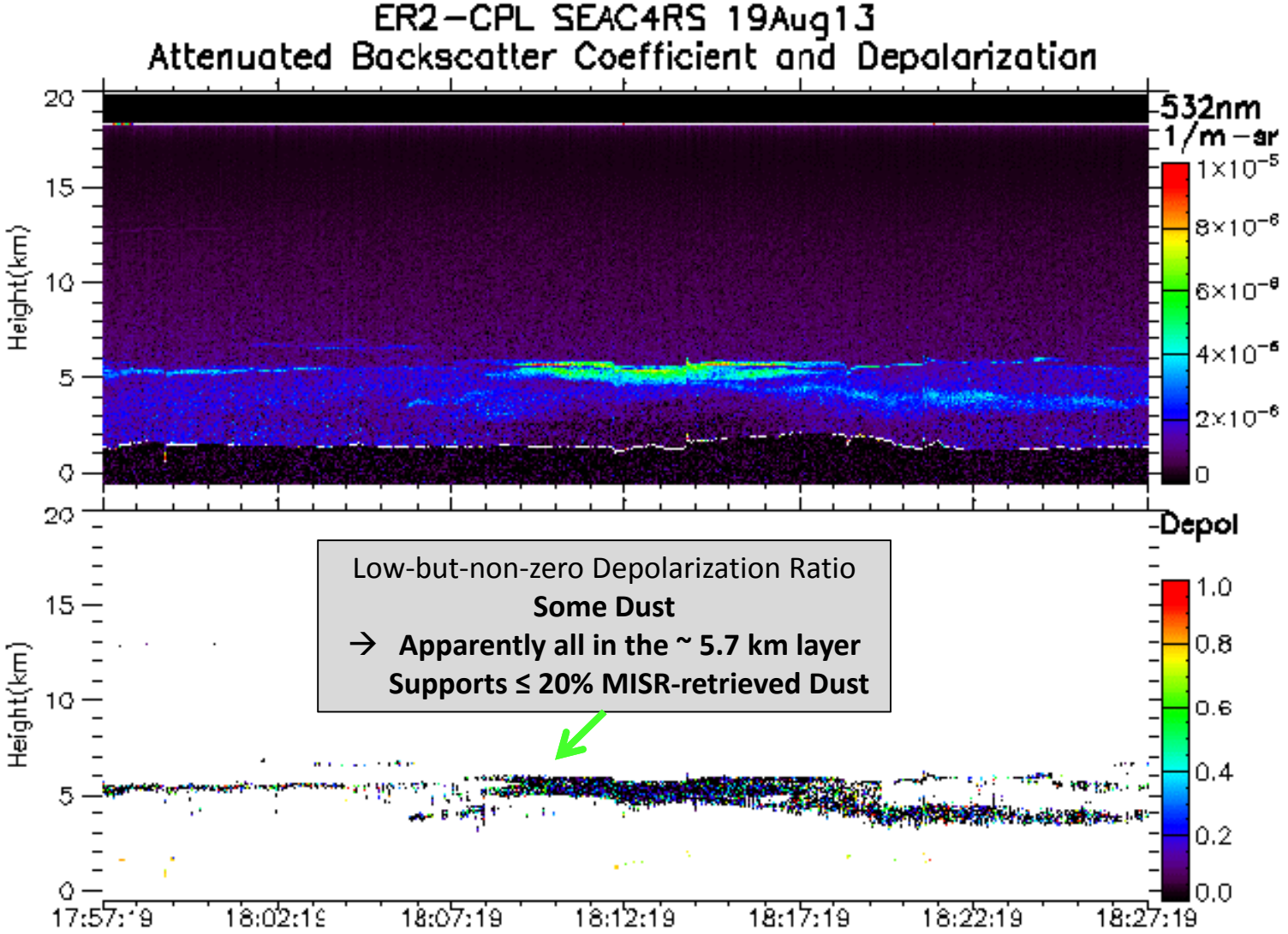
Site 2 Upwind Smoke: SSFR Multiple Layer SSA



Schmidt et al.

CPL Backscatter & Deploarization Ratio

19 August 2013 Site 2 Rosette



Low-but-non-zero Depolarization Ratio
Some Dust
→ **Apparently all in the ~ 5.7 km layer**
Supports ≤ 20% MISR-retrieved Dust

MISR Smoke Plume 1

*FrNon-Sph 0.05-0.2 (**mostly spherical**)*

CPL Team – Yorks et al.

SAM-CAAM

[Systematic Aircraft Measurements to Characterize Aerosol Air Masses]

[This is currently a ***concept-development effort***, not yet a project]

Primary Objectives:

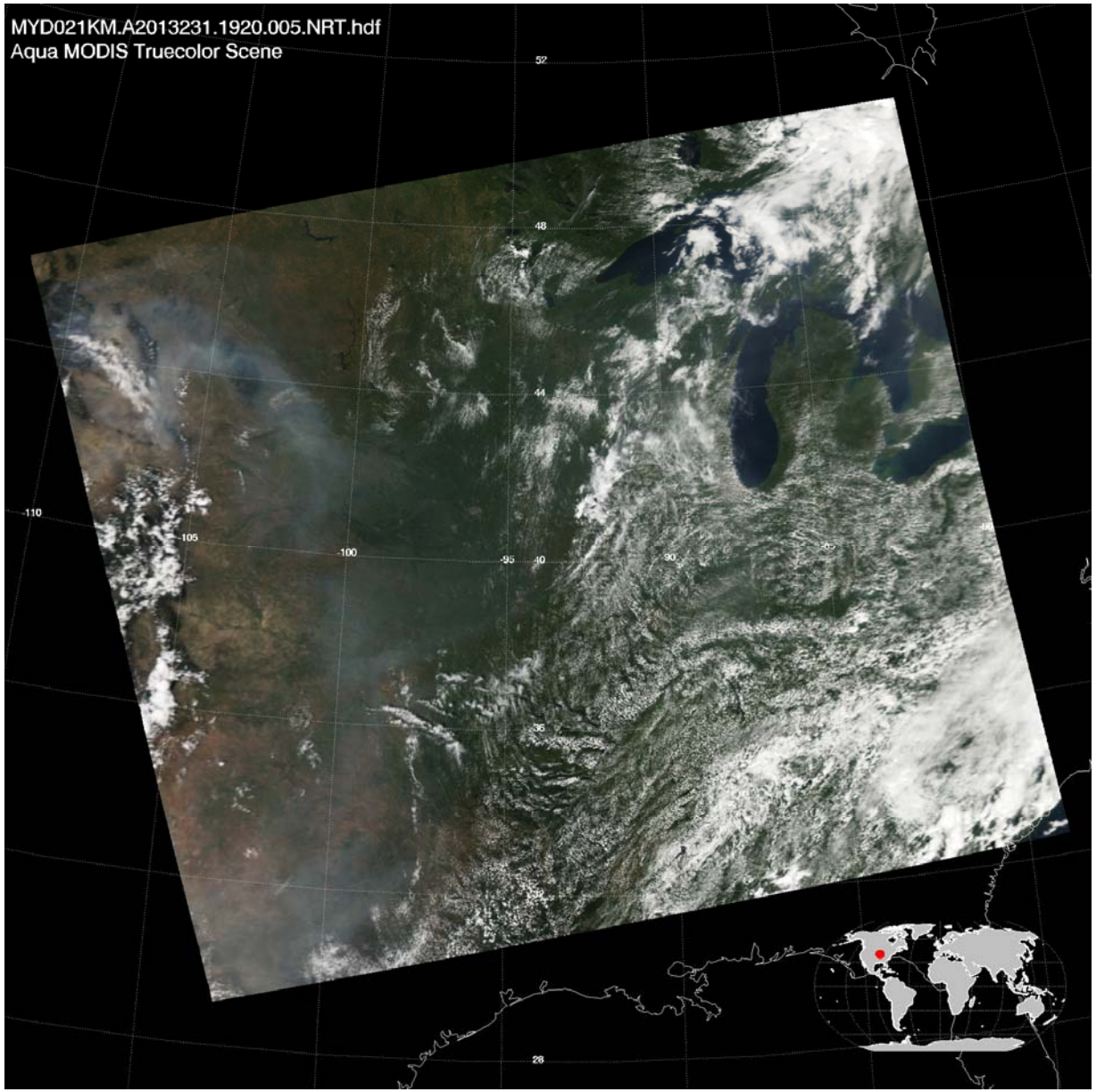
- **Interpret and *enhance 15+ years of satellite aerosol retrieval* products**
- ***Characterize statistically particle properties*** **for major aerosol types globally,**

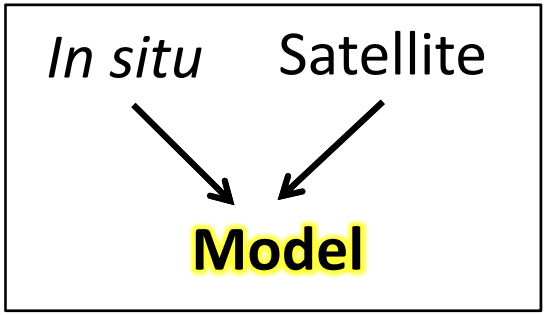
to provide detail unobtainable from space, but needed to *improve*:

-- Satellite aerosol *retrieval algorithms*

-- The *translation between satellite-retrieved aerosol optical properties*

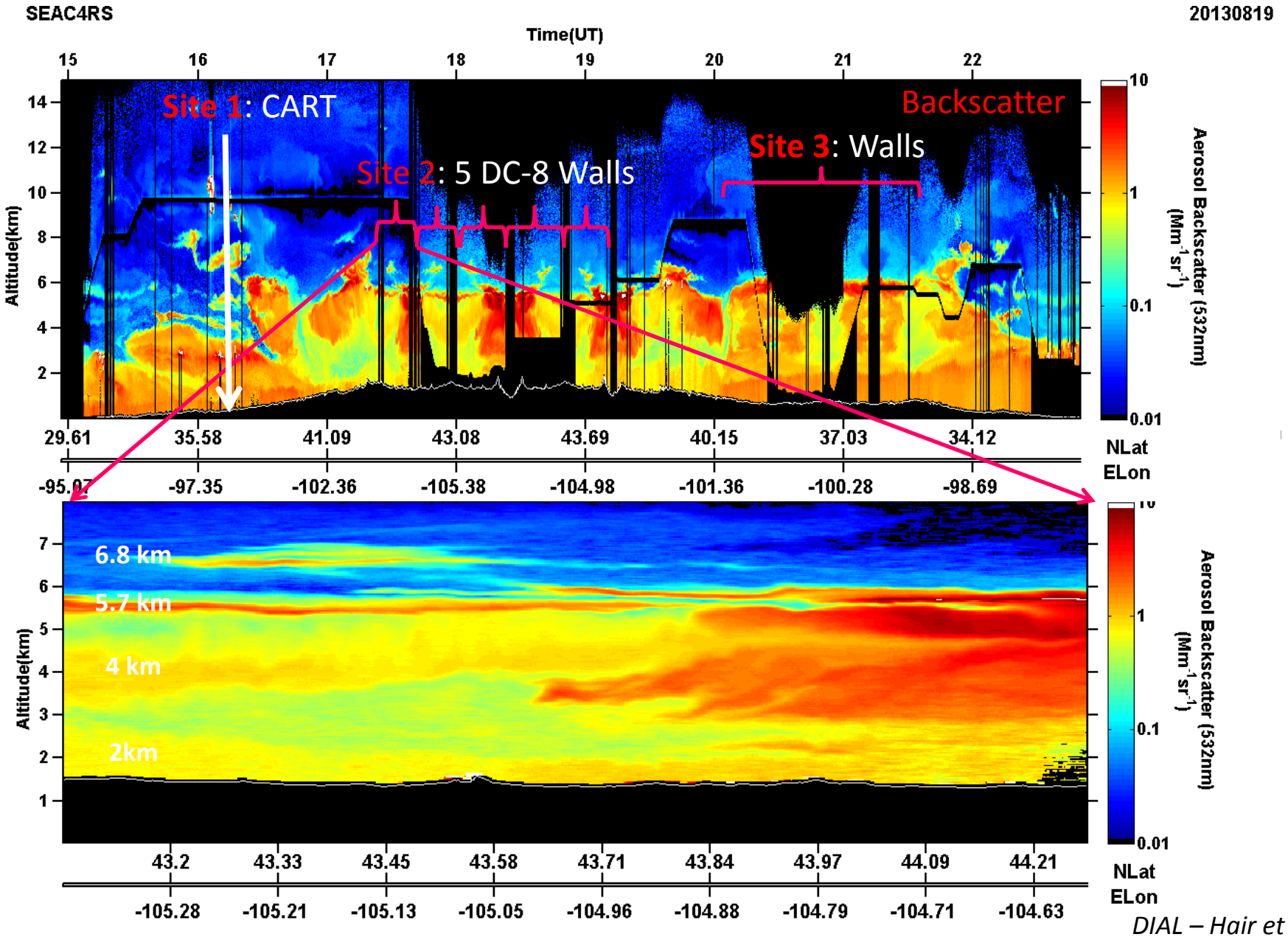
Story 2: *Upwind Smoke Source & Injection Height*





Using the 3-D AOD distribution from satellite and *in situ* measurements to constrain the model, which in turn identifies probable source locations and injection heights (also aerosol type)

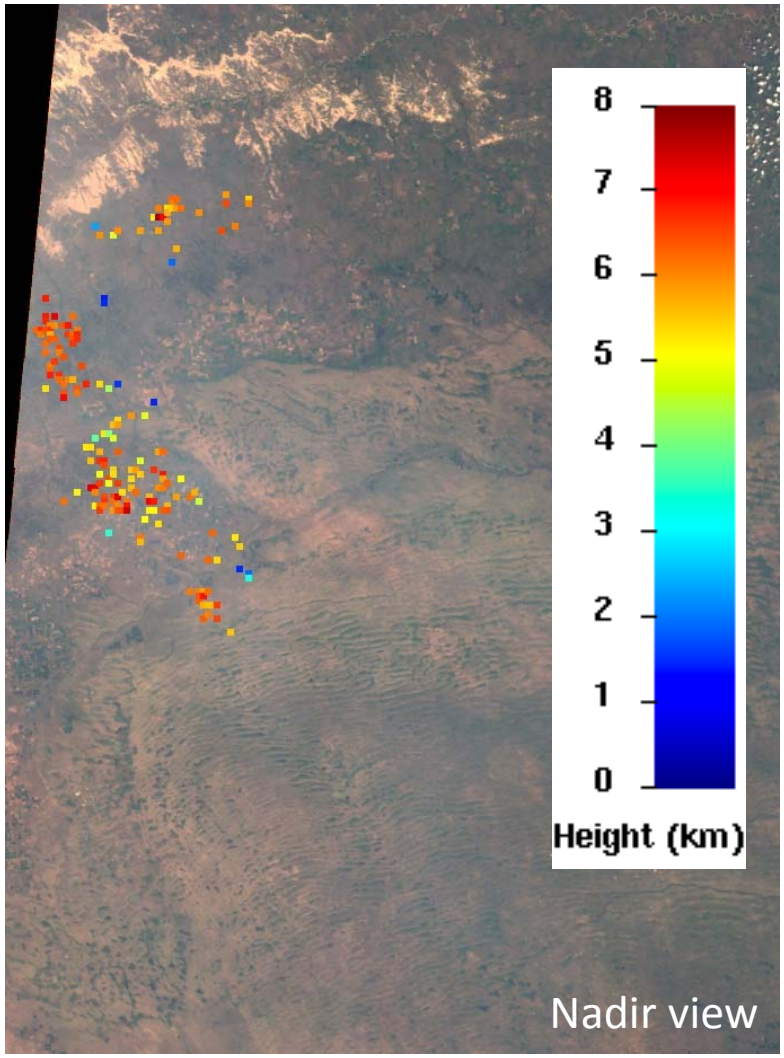
Site 2 Upwind Smoke: *DC-8 DIAL* Curtain

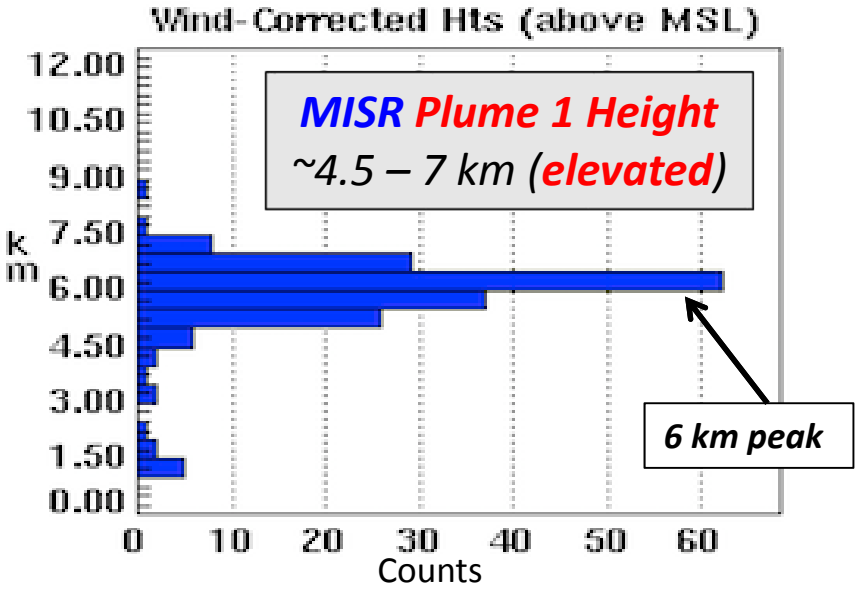


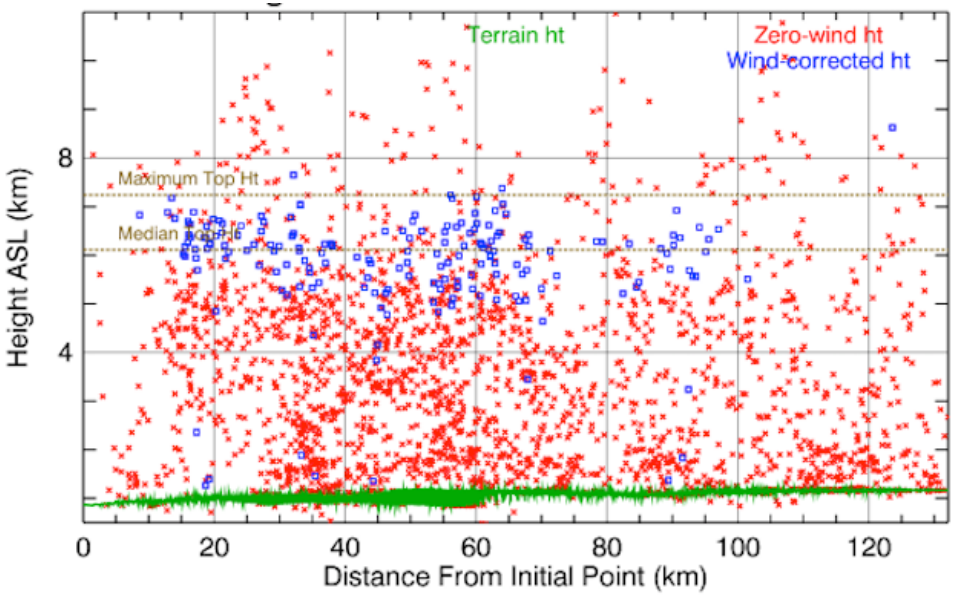
DIAL – Hair et al.

MISR Plume Height (*Level of Max Contrast*) Near Site 2

19 August 2013

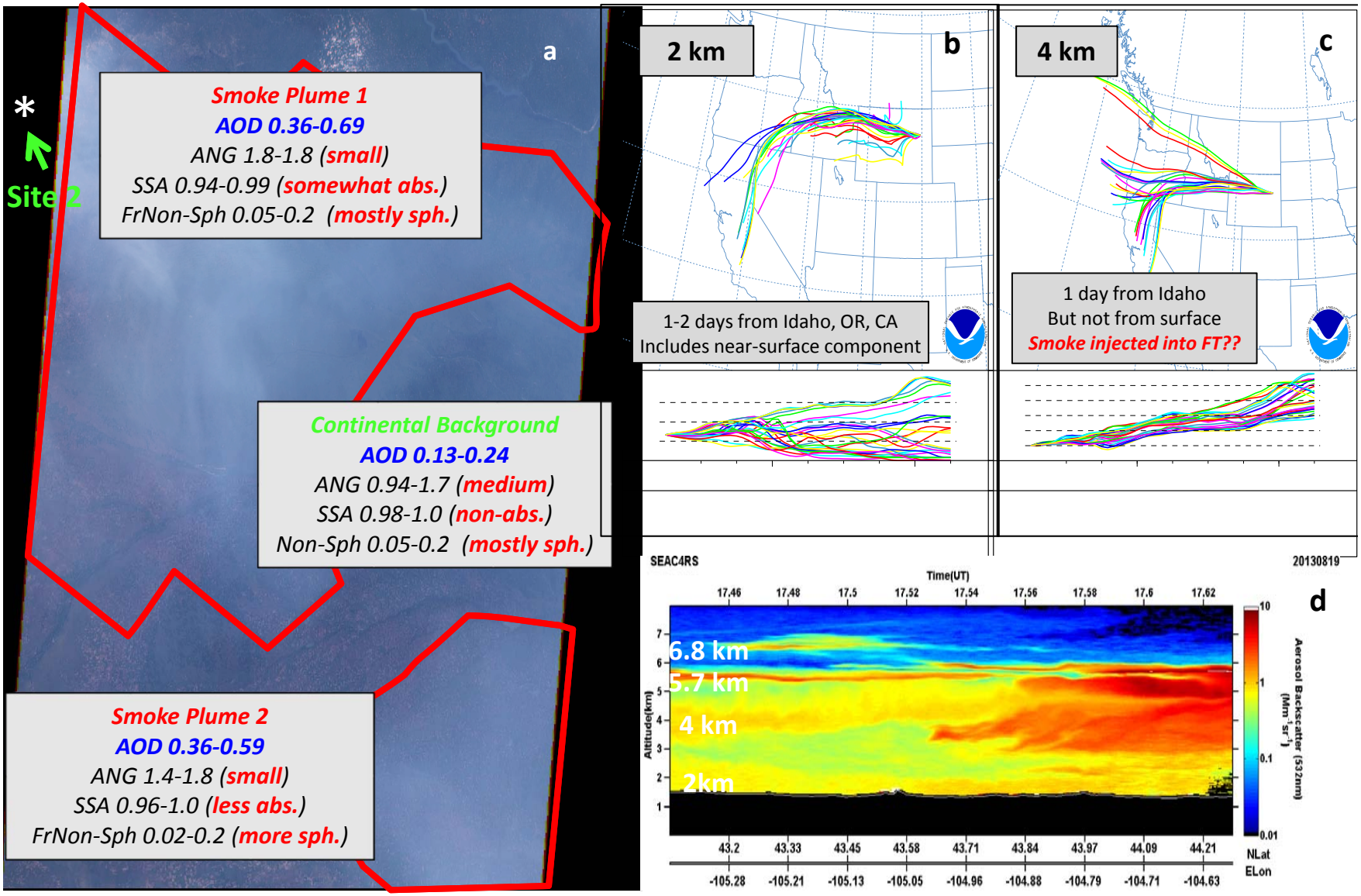






MISR Team – D. Nelson et al.

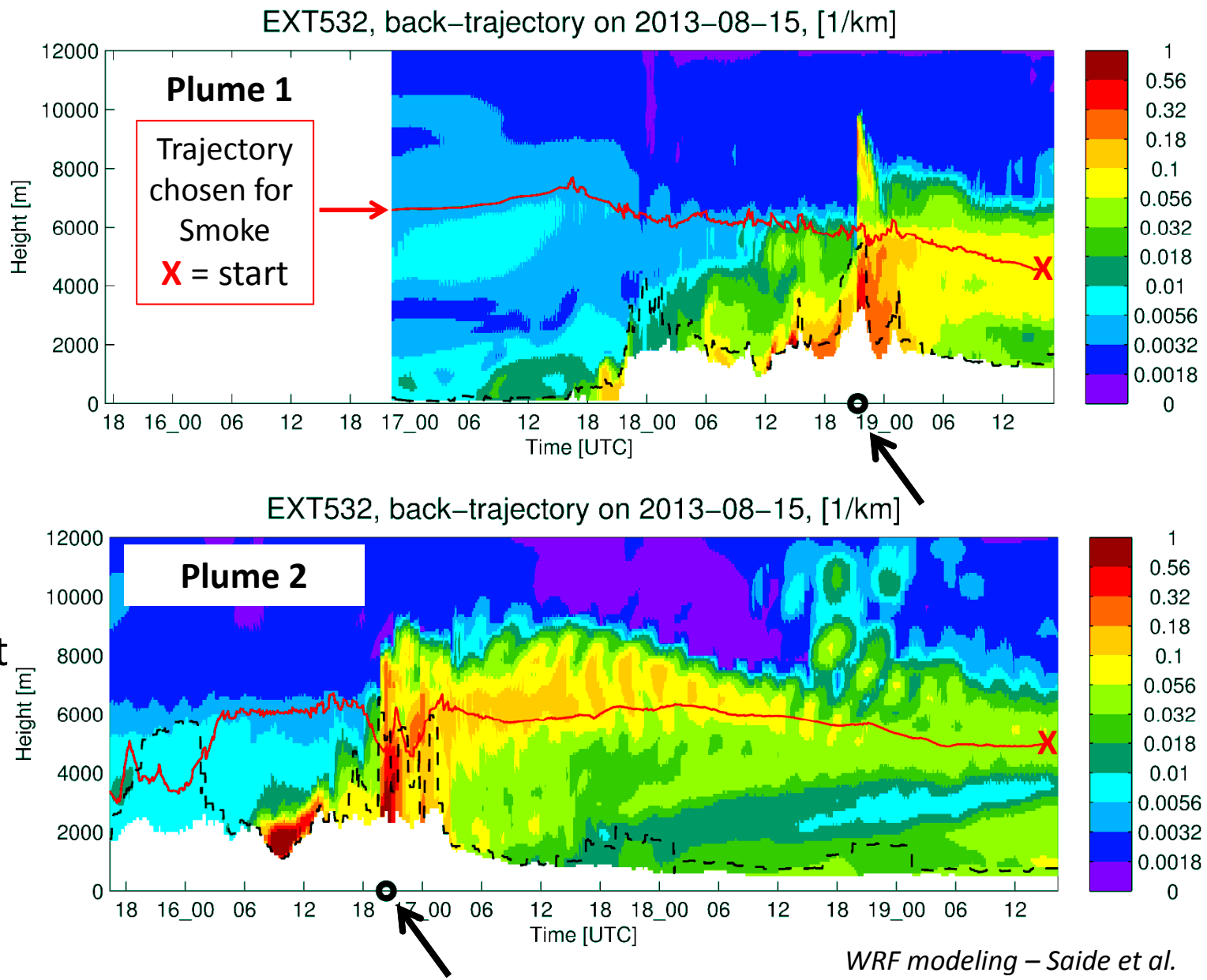
Model-Measurement Aerosol Source Characterization



DIAL – Hair et al.

U. Iowa Modeling – Curtain Along Back Trajectory

- Red solid line: Particle height
- Black segmented line: PBL height
- Black circle: first fire location that the particle intersects



WRF modeling – Saide et al.

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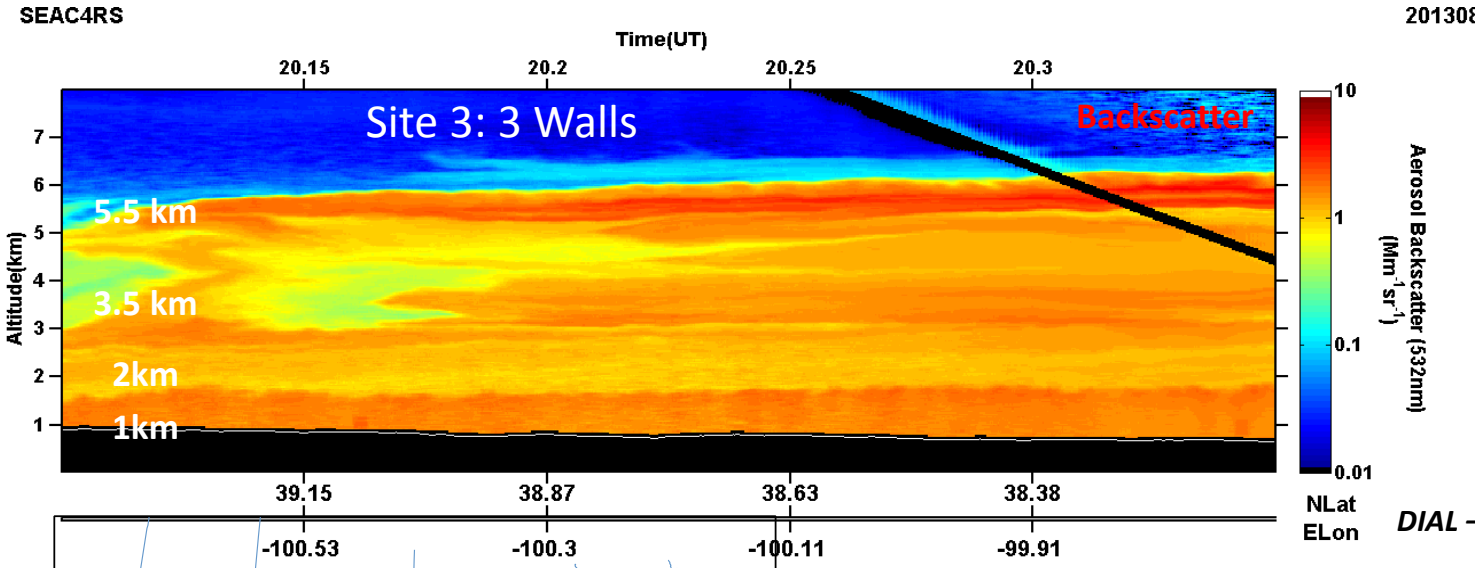

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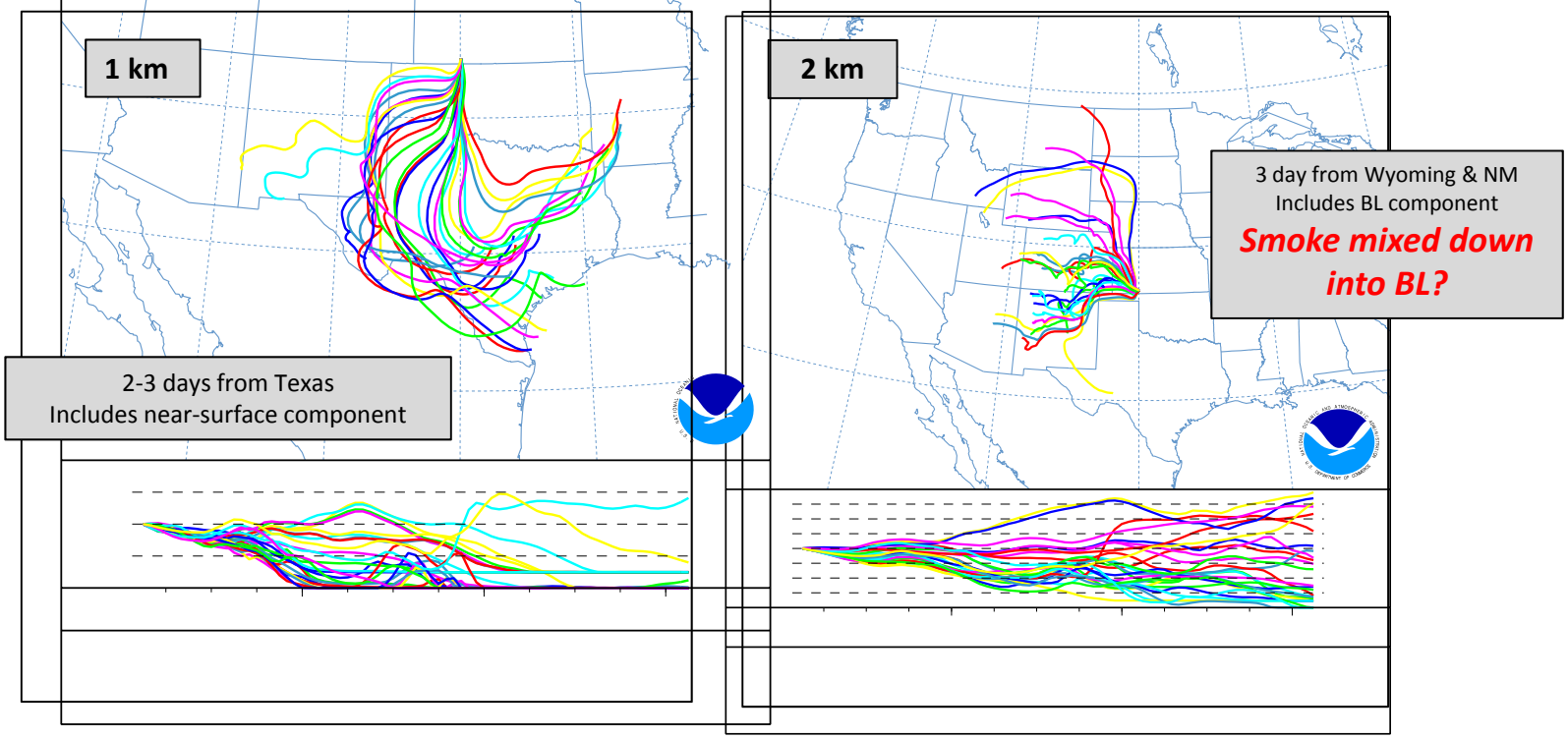
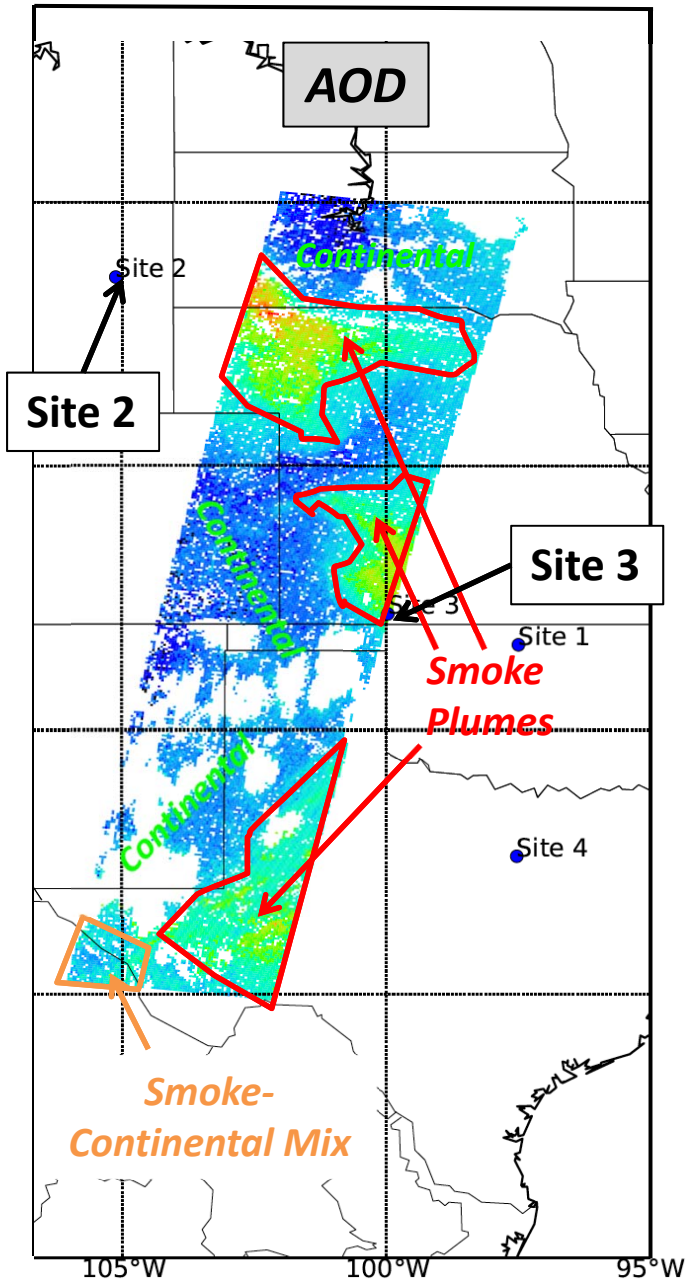


Story 3: *Regional Aerosol Characterization*

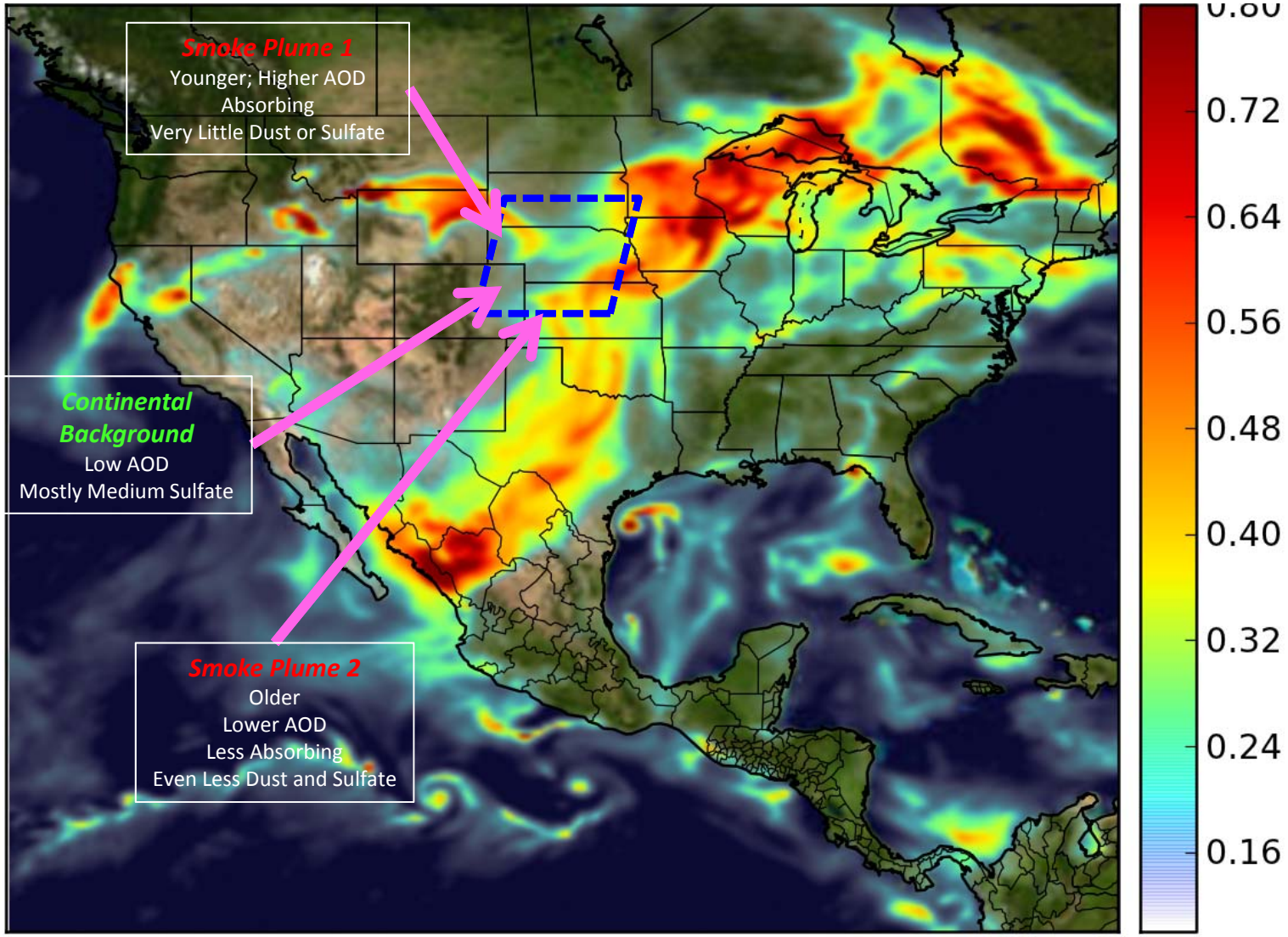


In situ
↓
Satellite
↓
Model

Using the *in situ* measurements to add microphysical detail to the satellite aerosol type mapping, and then use the satellite 2-D AOD and type distributions, plus available 3-D data, to constrain larger-scale model aerosol amount and type mapping

GEOS-5 MODEL Aerosol Optical Depth

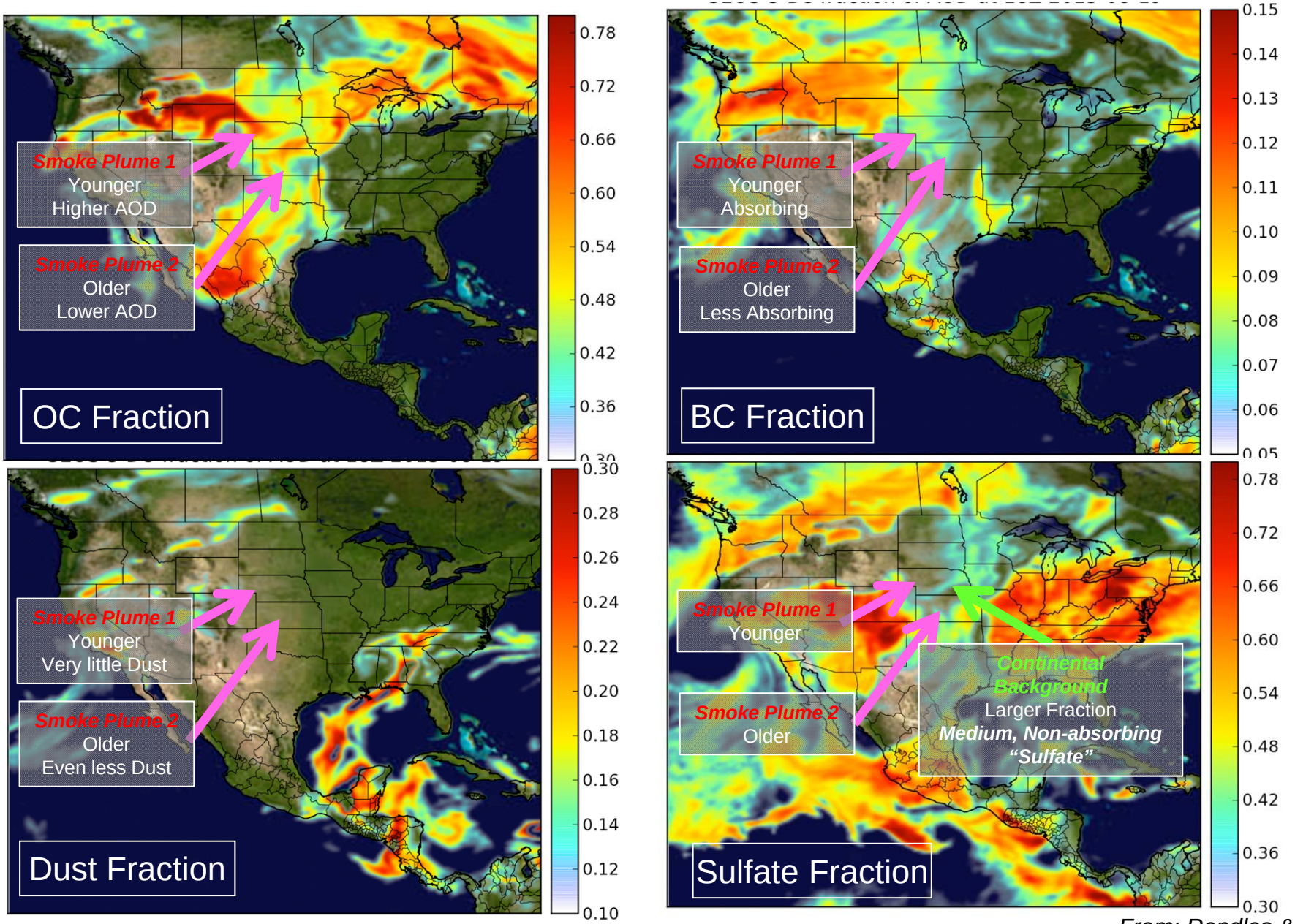
19 August 2013 18 UTC



From: Randles & Da Silva

GEOS-5 MODEL Aerosol Type

19 August 2013 18 UTC



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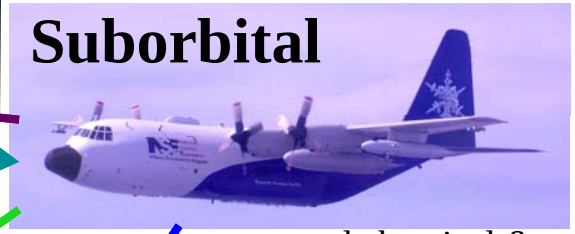

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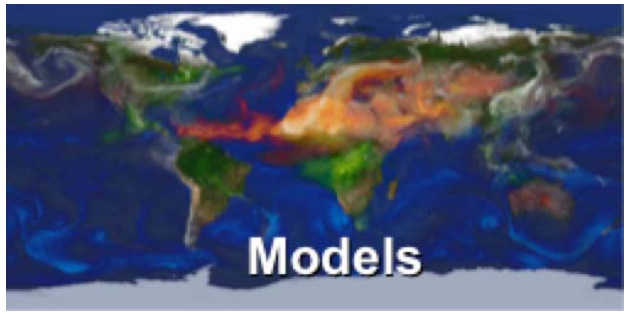

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