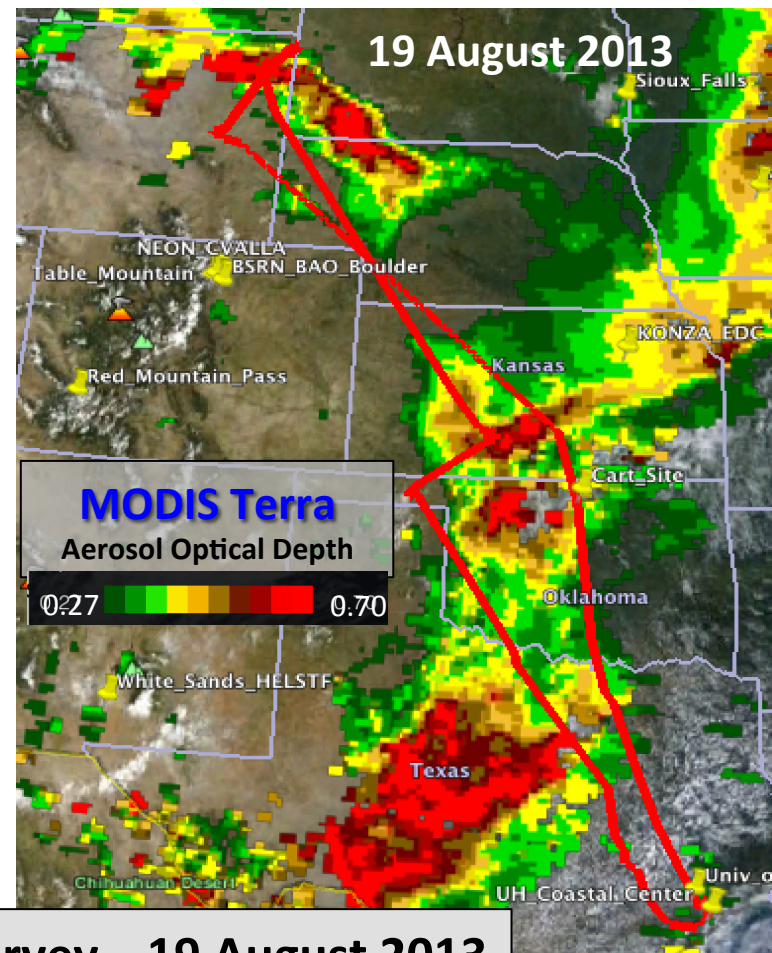
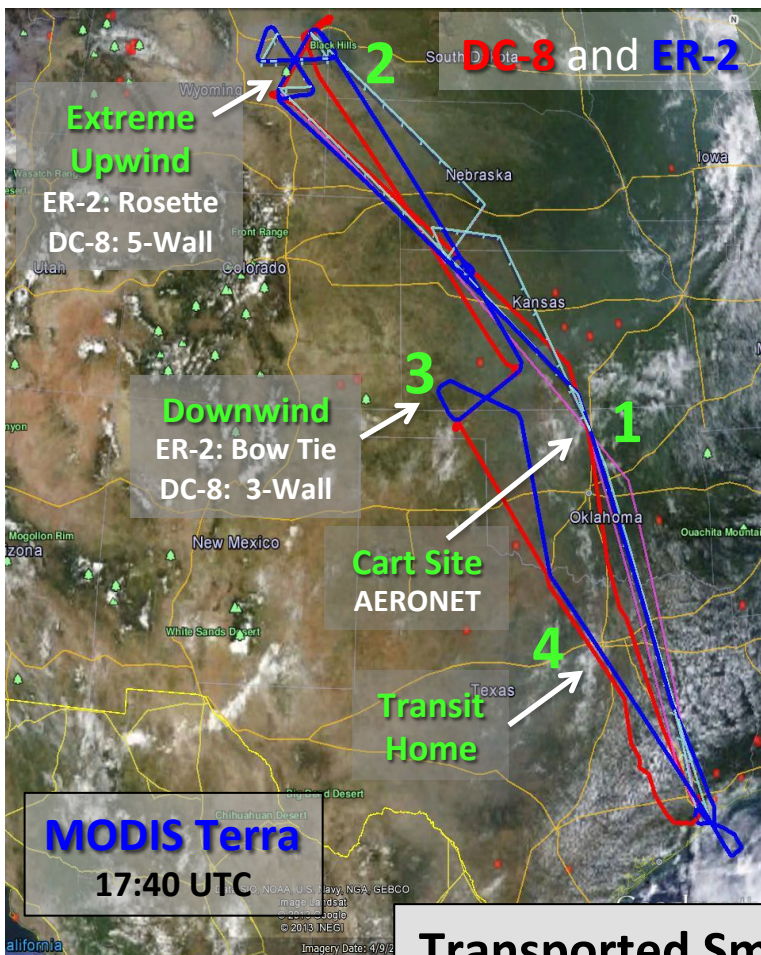


A Three-way Street:

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

Ralph Kahn NASA Goddard Space Flight Center

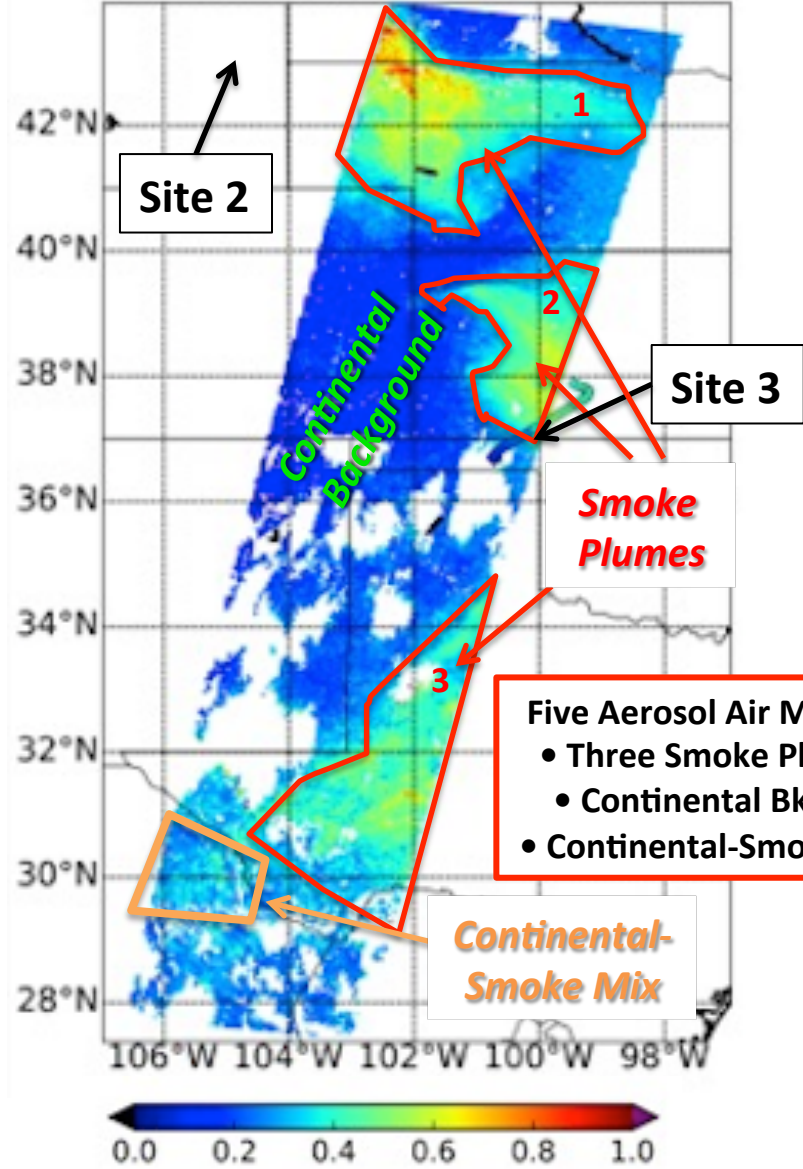


Transported Smoke Survey 19 August 2013

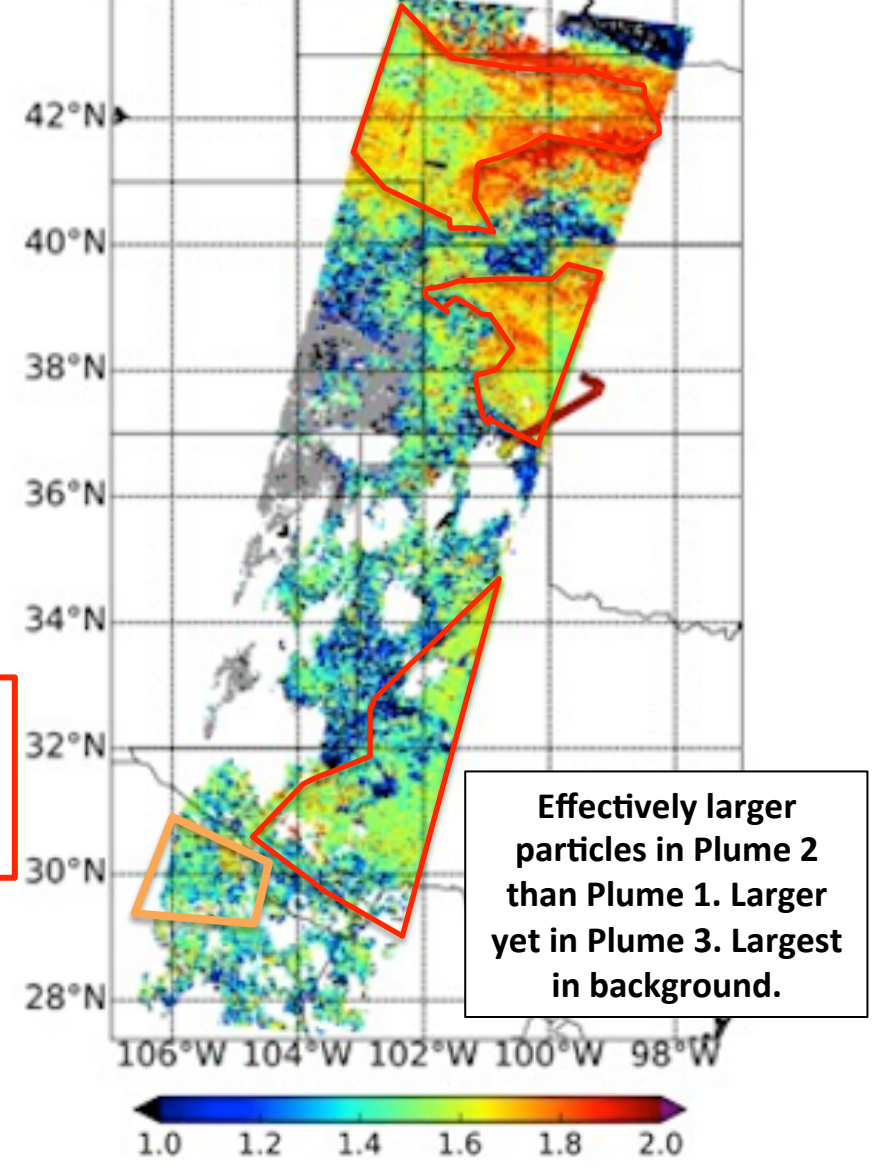
MISR Overview

Research Retrievals 19 August 2013

Aerosol Optical Depth (558nm)

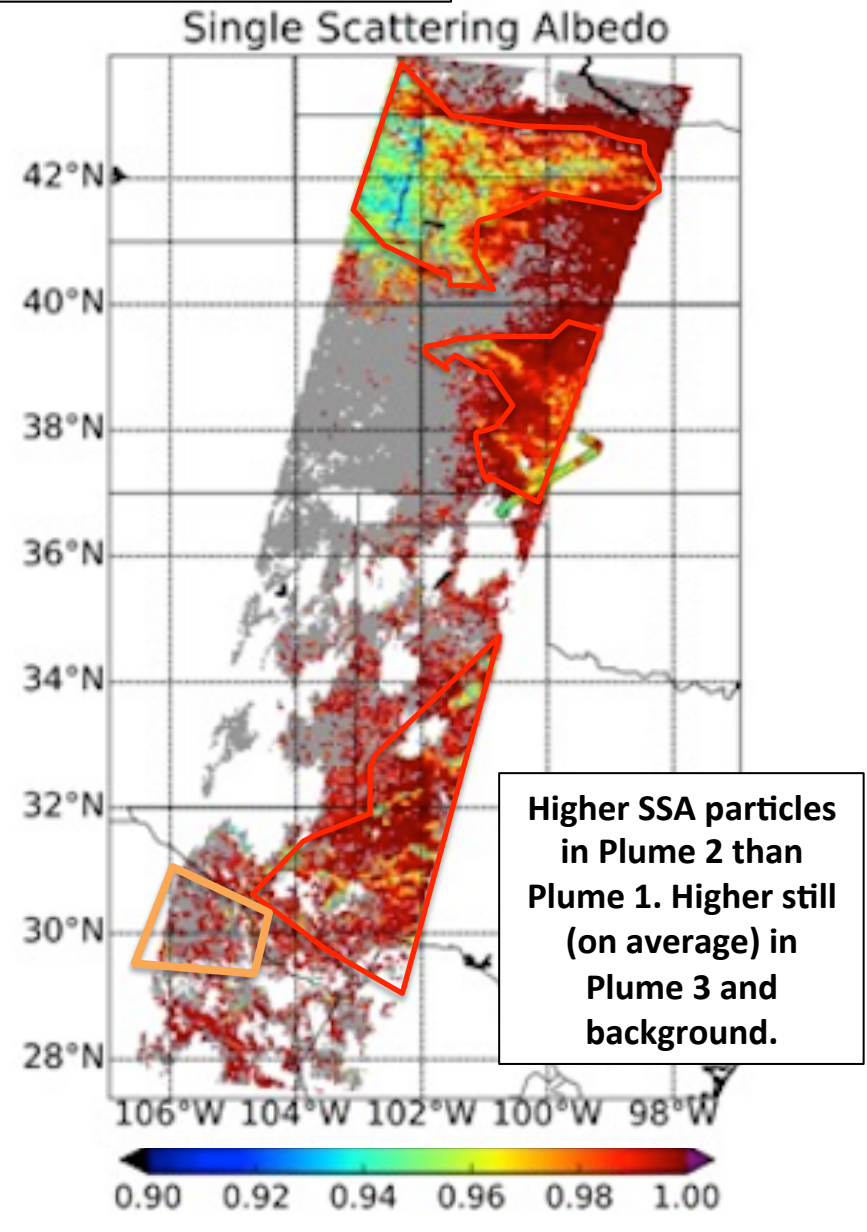
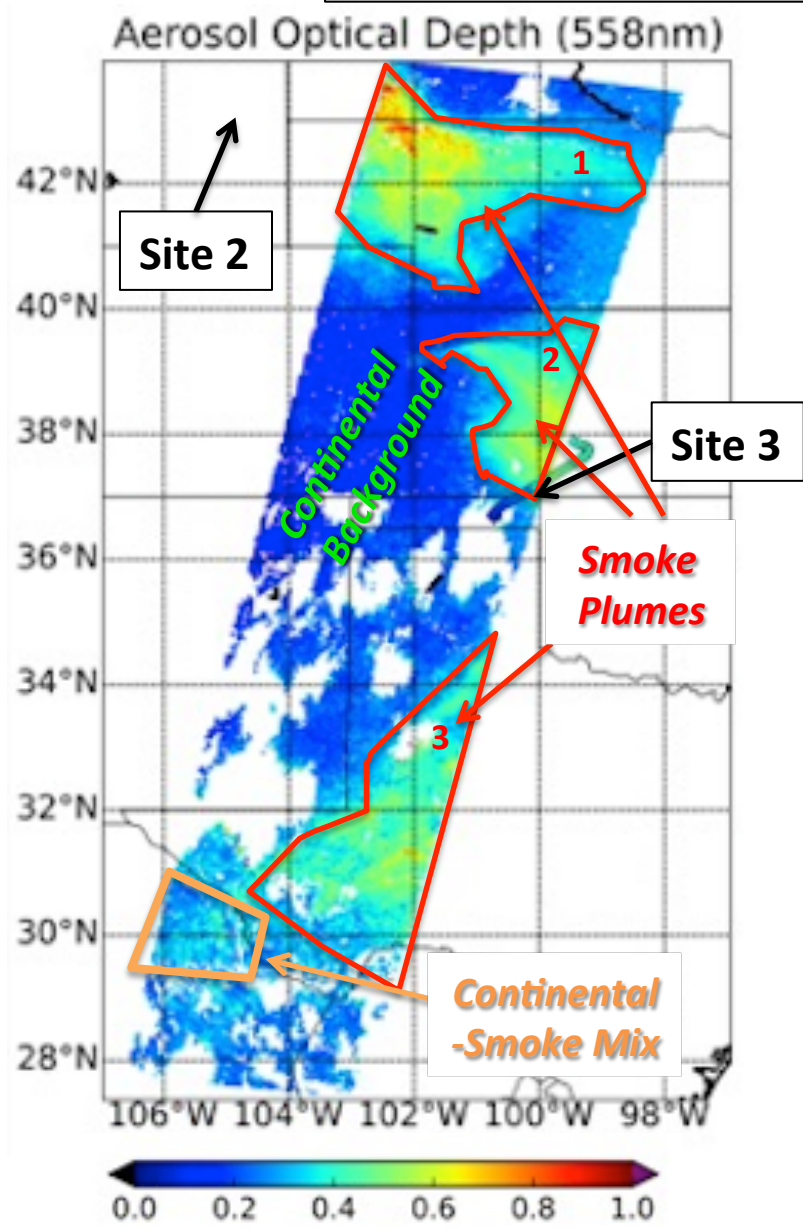


Angstrom Exponent



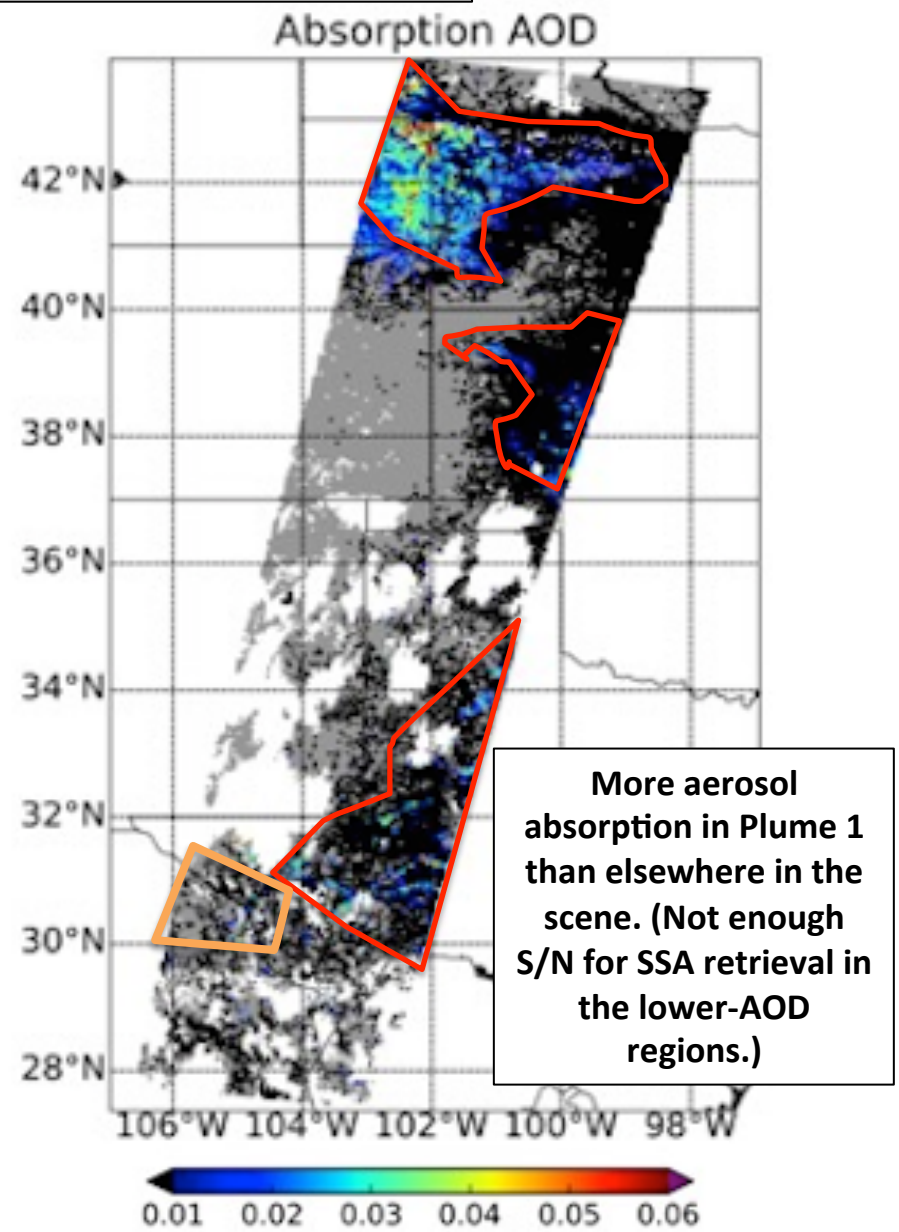
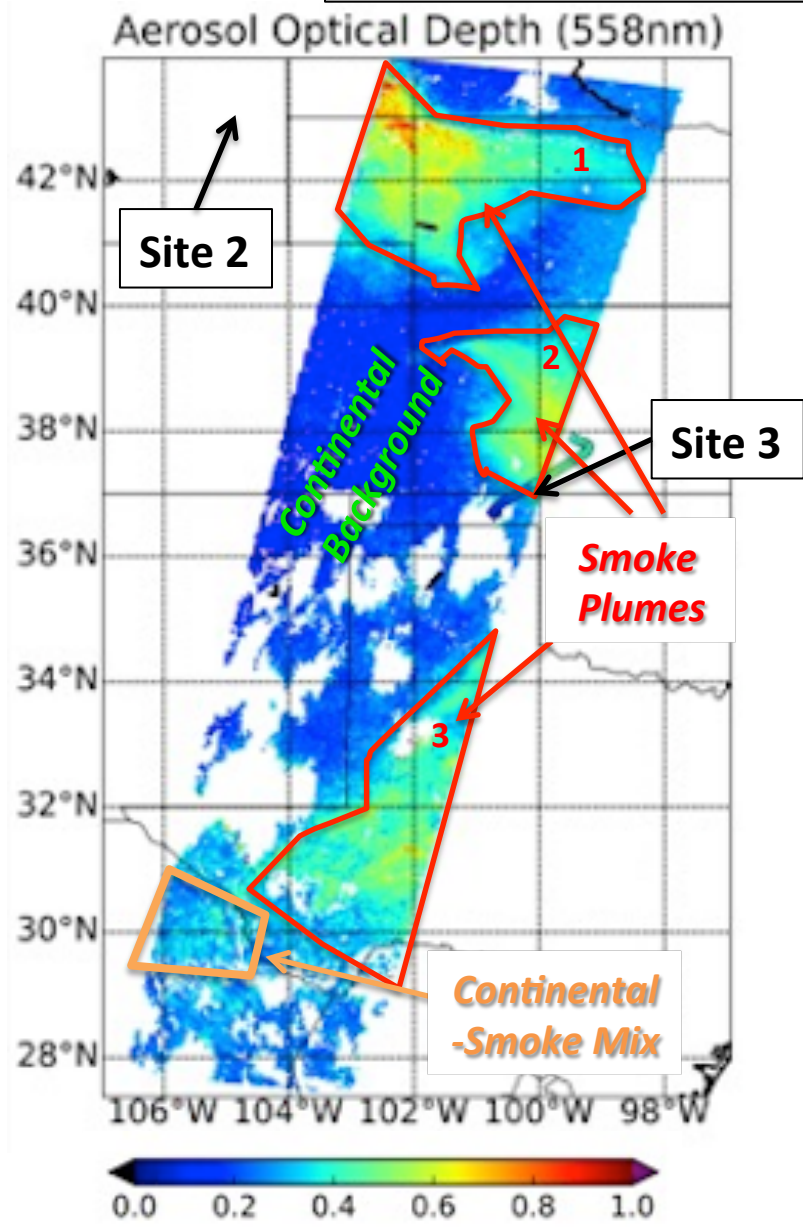
MISR Overview

Research Retrievals 19 August 2013



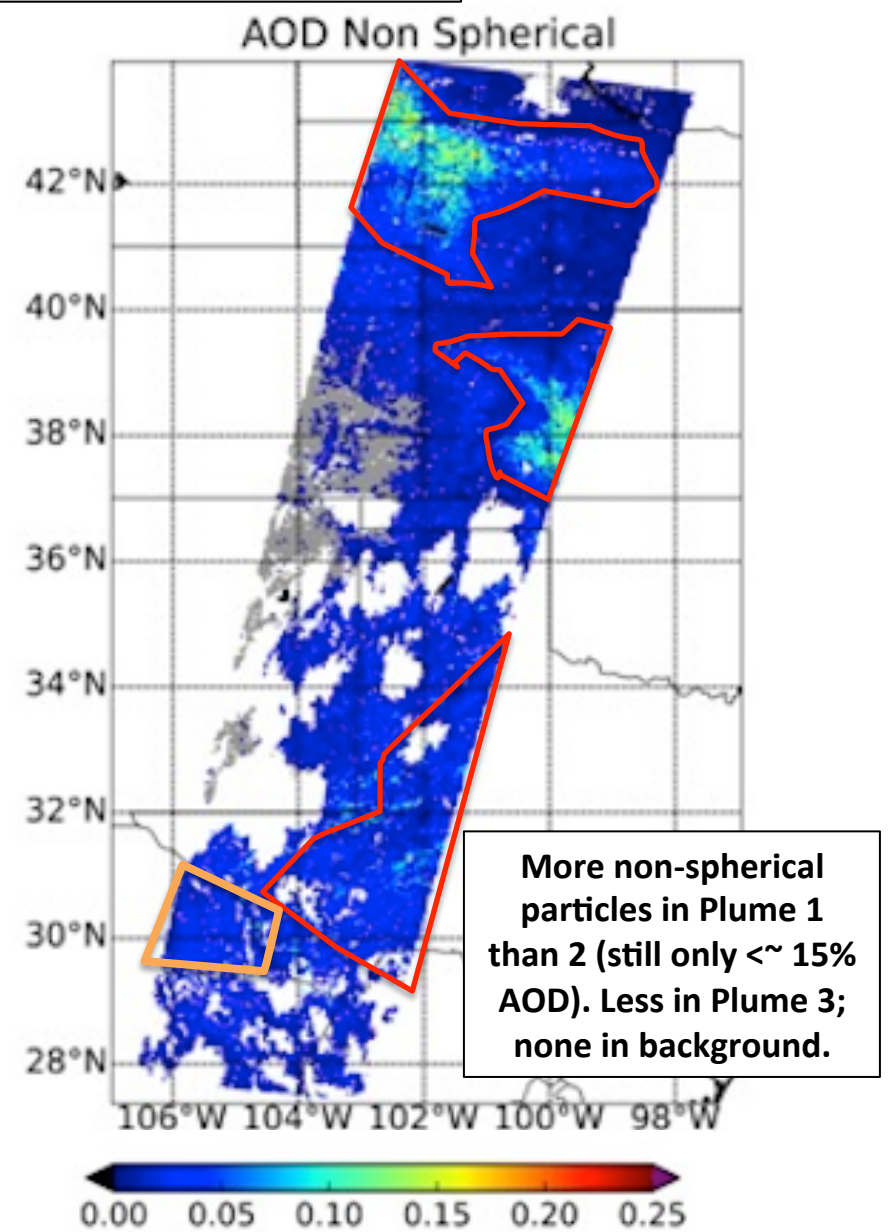
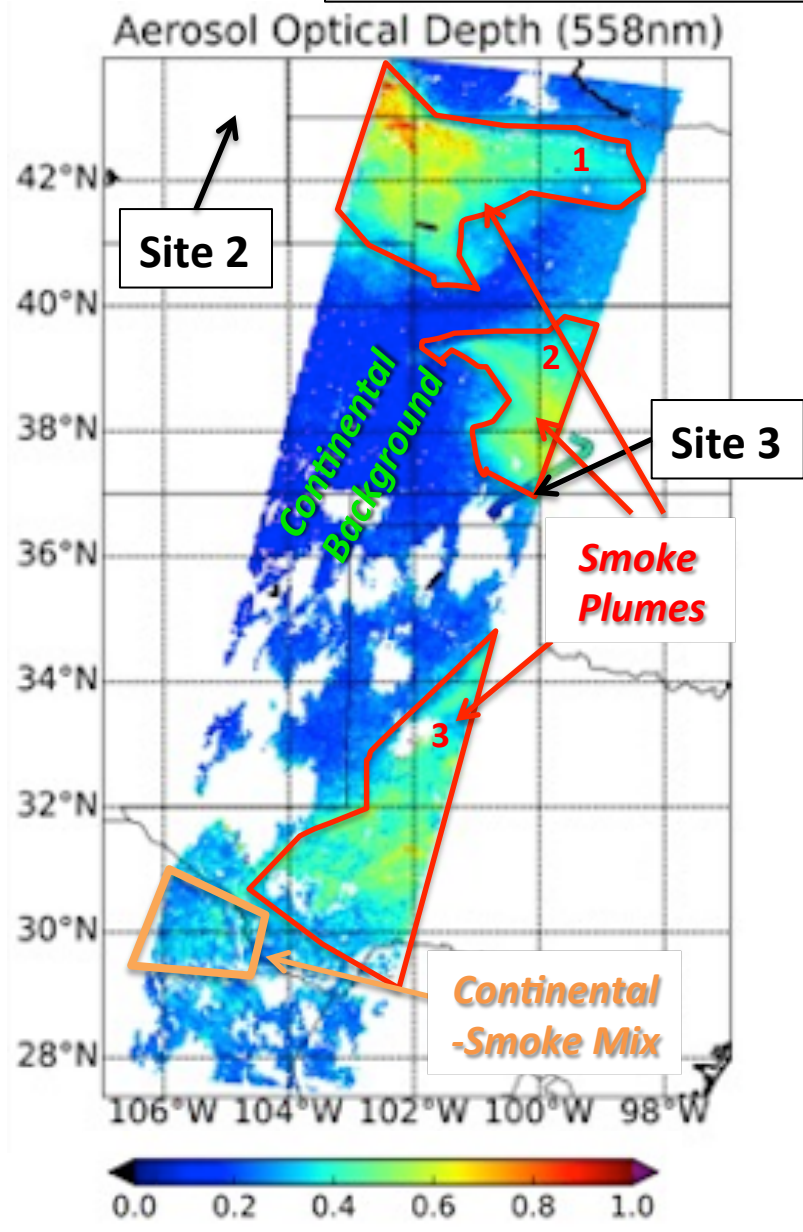
MISR Overview

Research Retrievals 19 August 2013



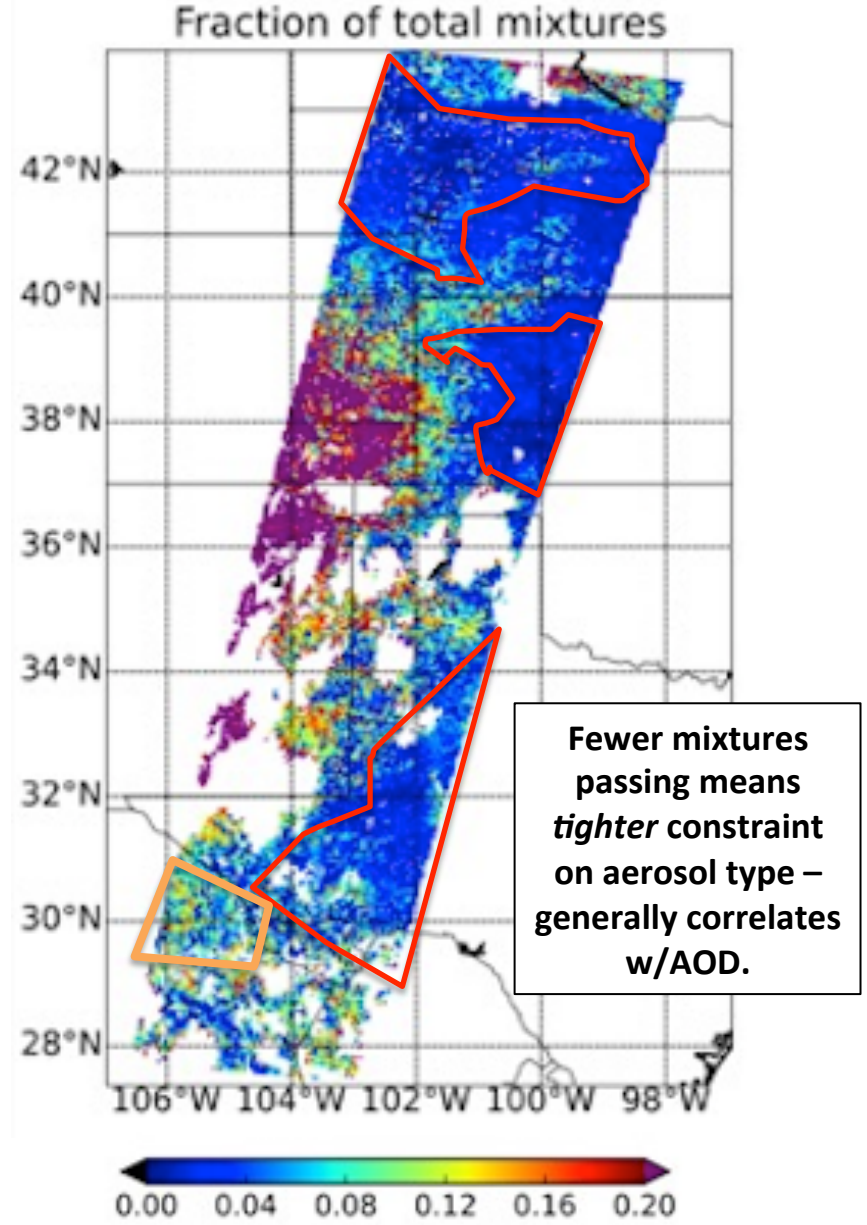
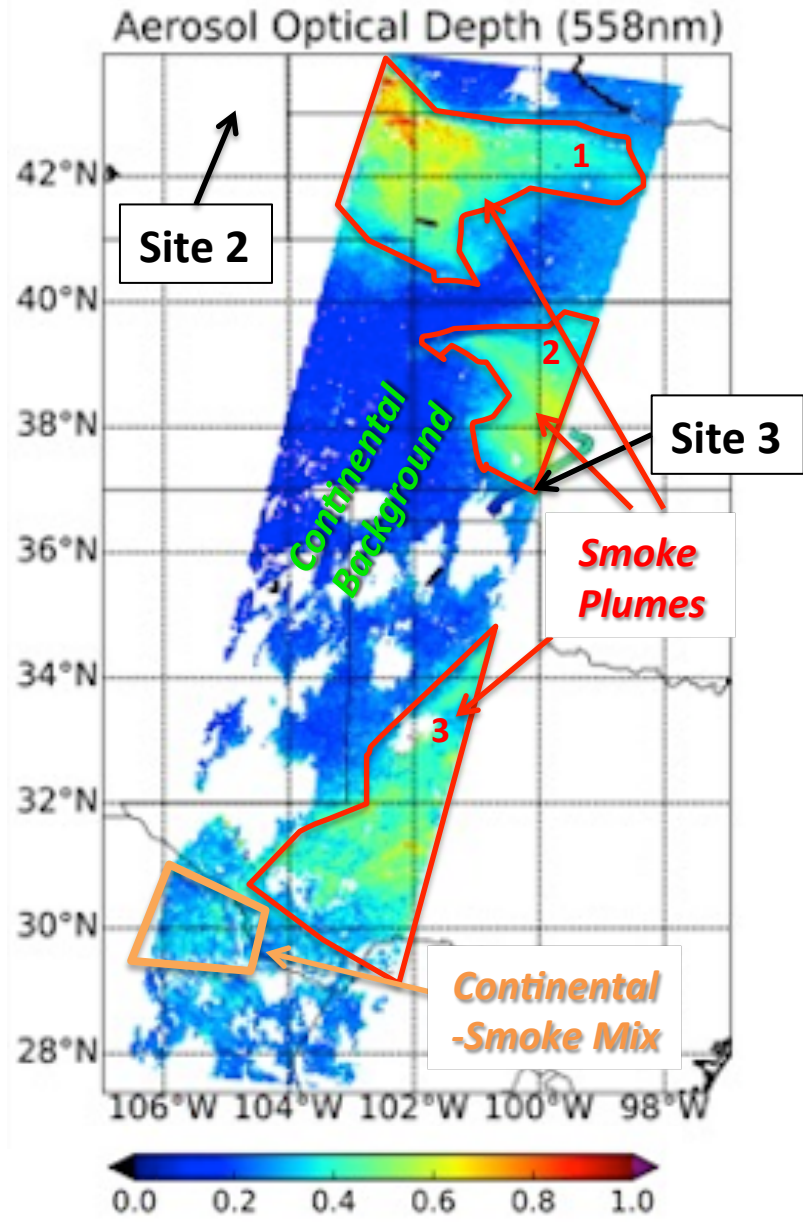
MISR Overview

Research Retrievals 19 August 2013



MISR Overview

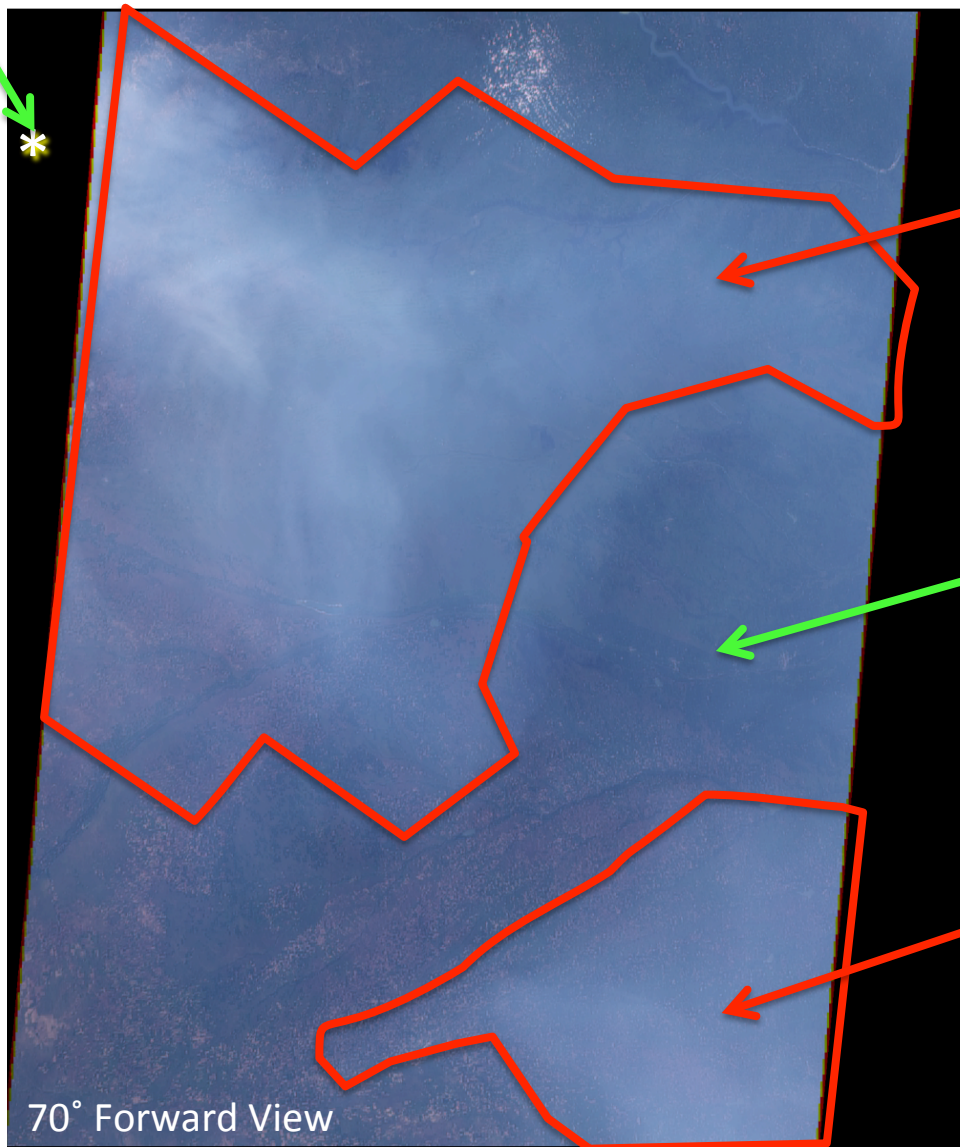
Research Retrievals 19 August 2013



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

**Aerosol-type
Predictions**

Model Validation

- Parameterizations
- Climate Sensitivity
- Underlying mechanisms

Remote-sensing Analysis

- Retrieval Validation
- Assumption Refinement

Regional Context

CURRENT STATE

- Initial Conditions
- Assimilation

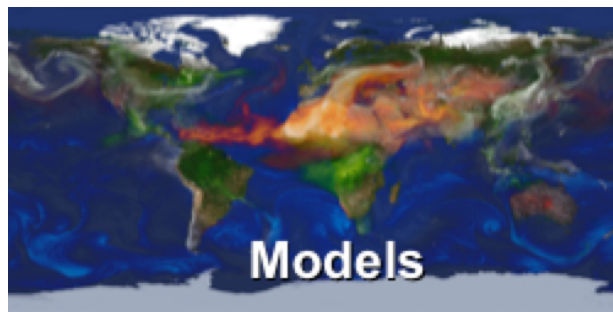


Suborbital

targeted chemical &
microphysical detail

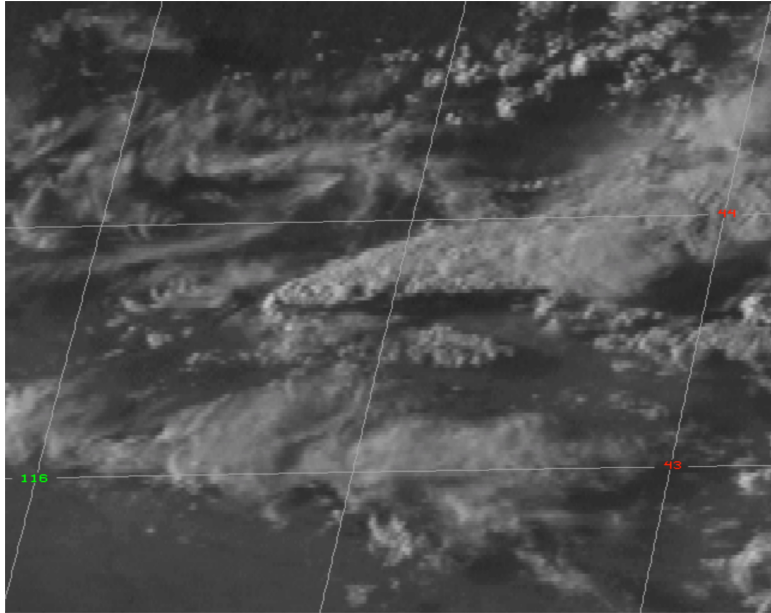


point-location
time series



Models

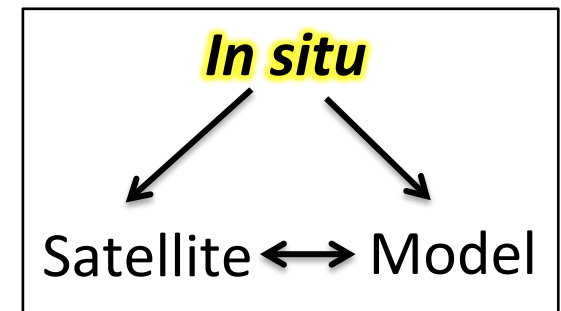
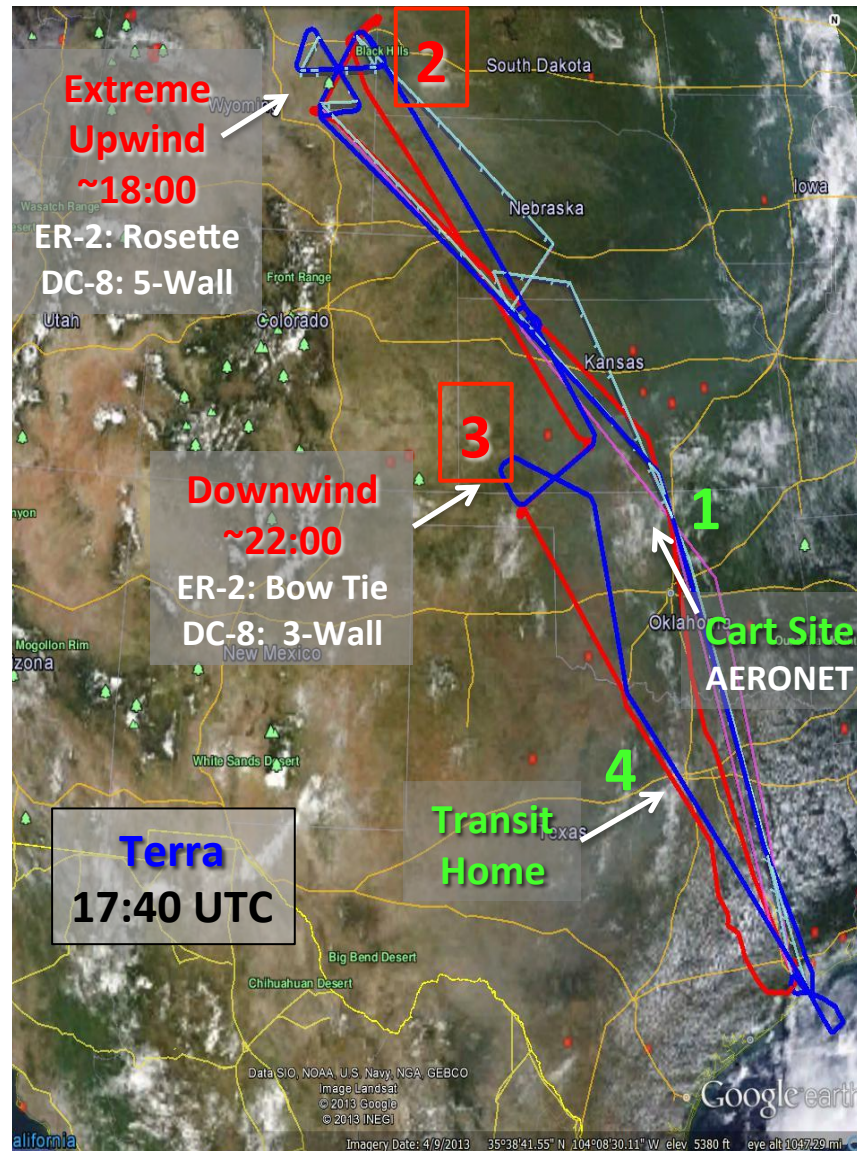
space-time interpolation,
**DARF &
Anthropogenic
Component**
calculation and prediction



Three Stories:

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

Story 1: Aerosol Air-Mass-Type Validation

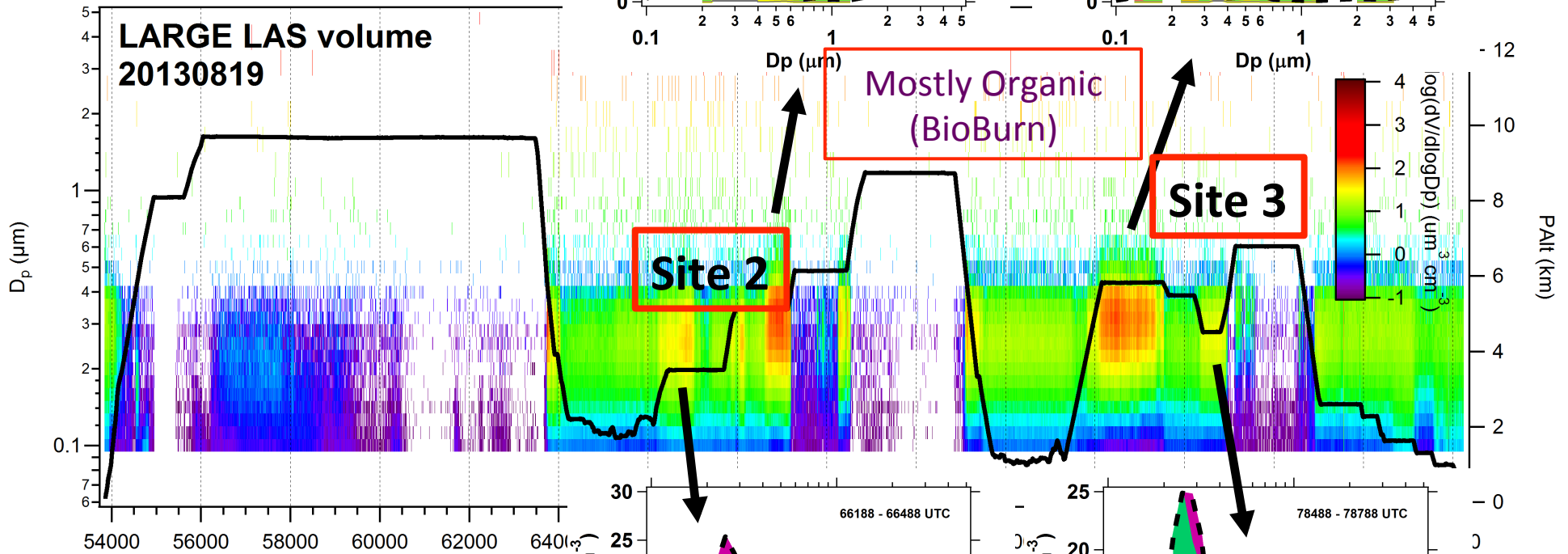
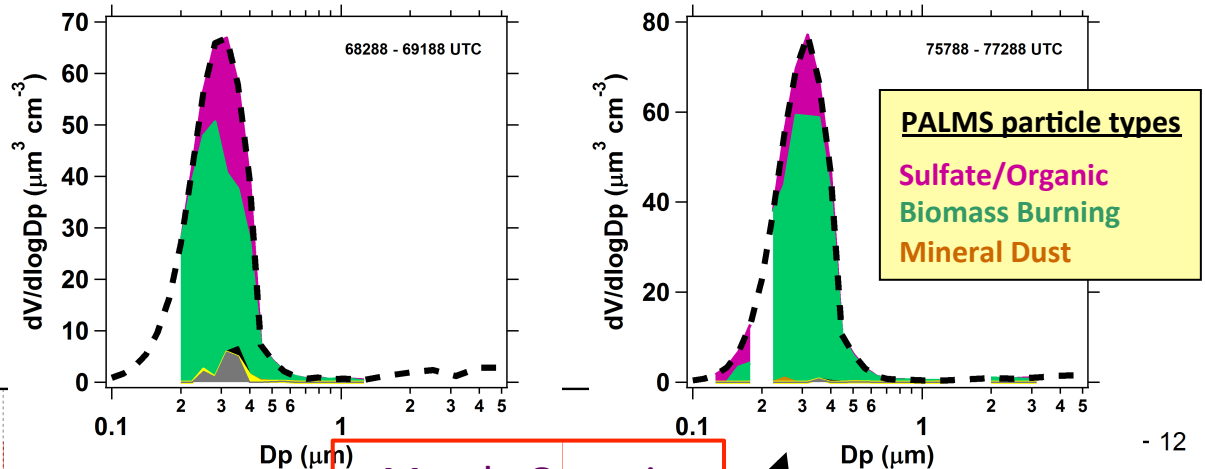


Comparing the retrieved and modeled AOD, size, shape, and SSA with *in situ* measurements

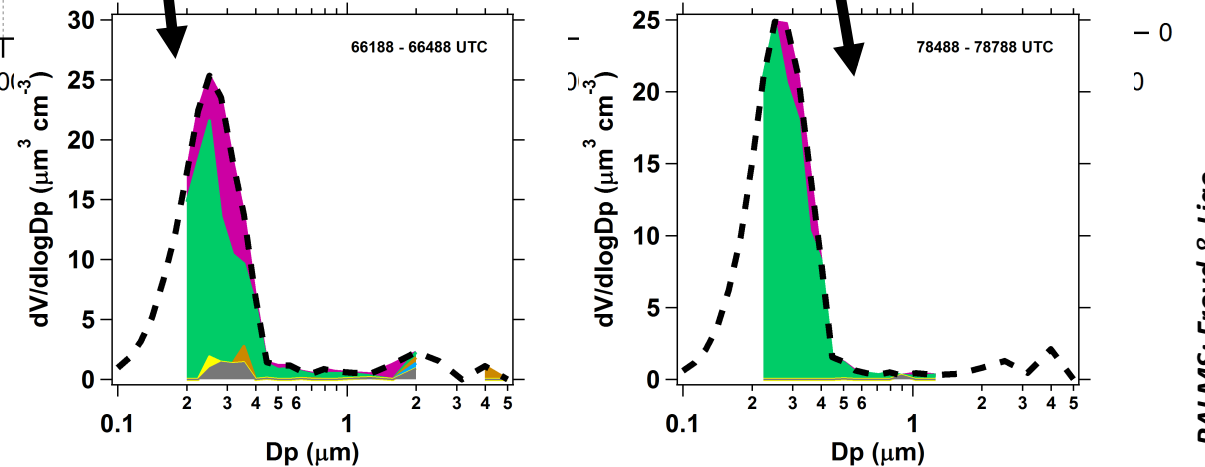
- (a) qualitatively and
- (b) quantitatively for five regions

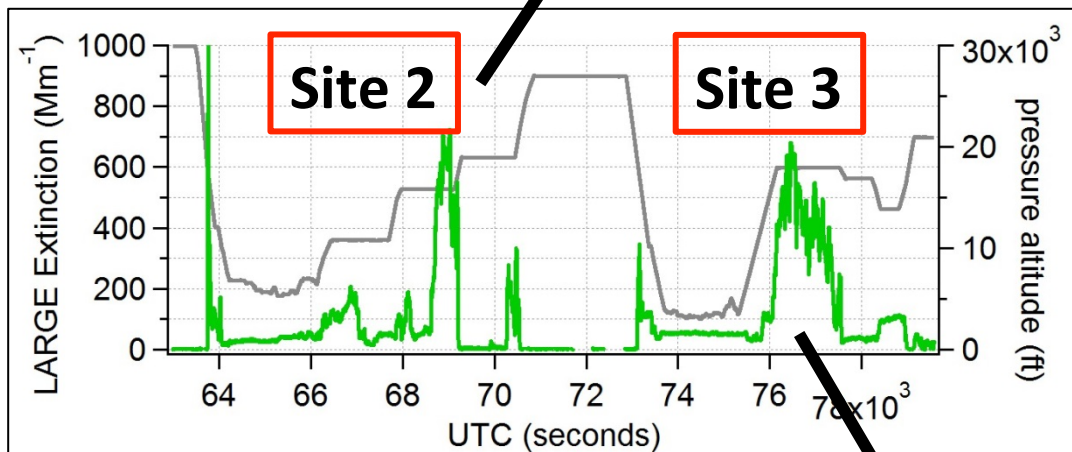
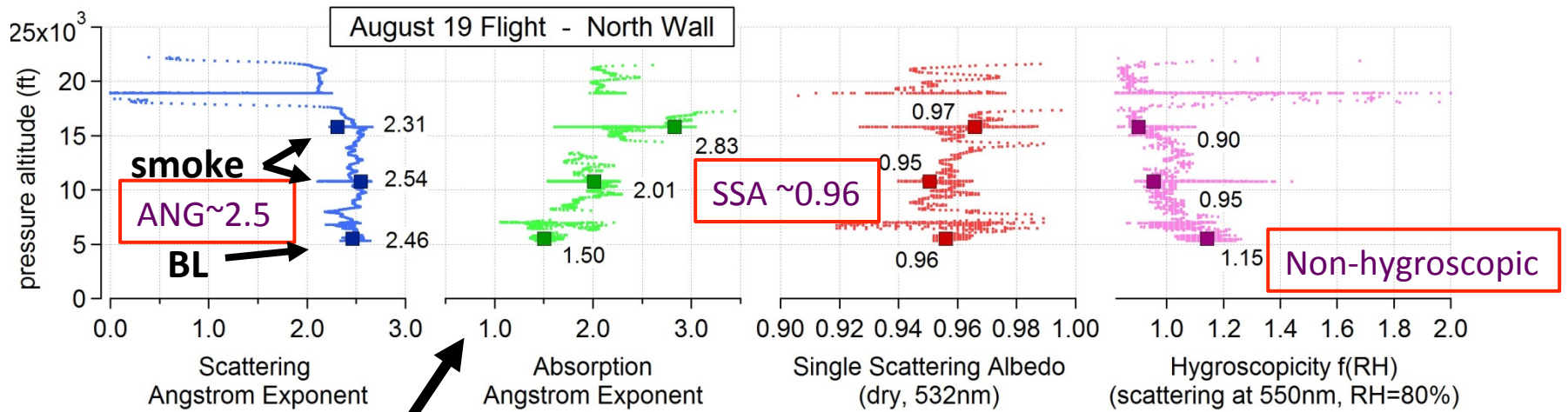
[3 Smoke Plumes; Continental Background; Continental-Smoke Mix]

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

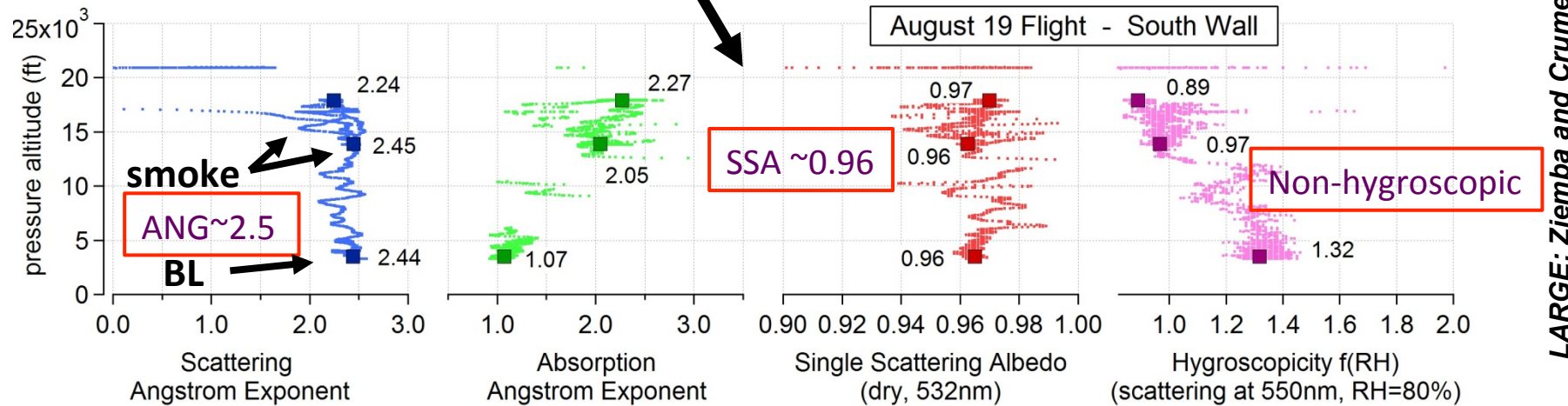


- Some compositional differences:
 Older plumes have lower nitrate, higher organic content



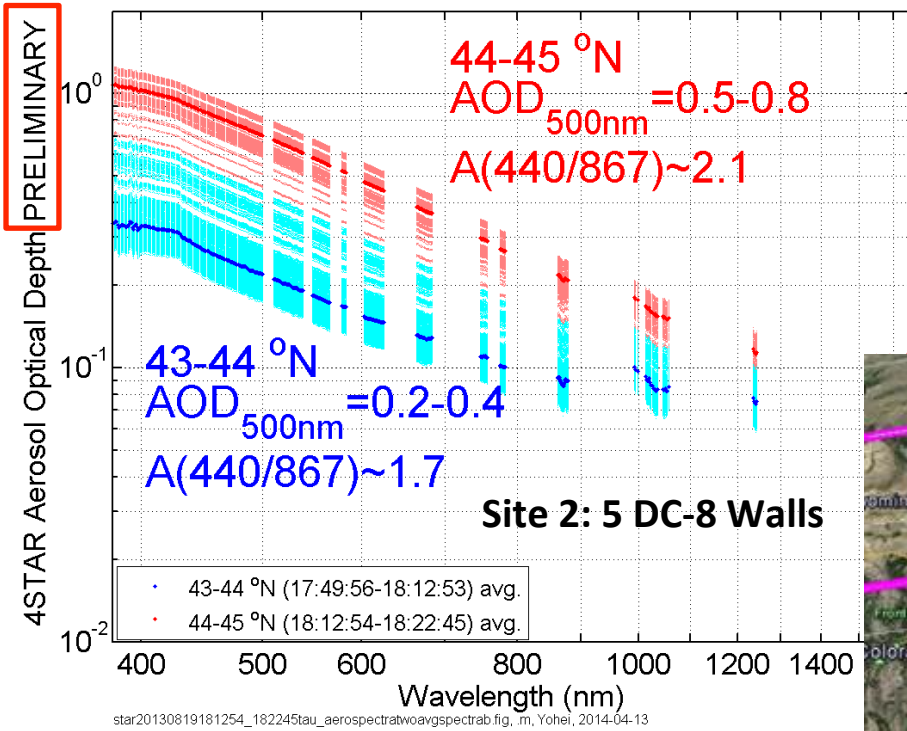


- Altitude-dependence of optical properties is relatively unchanged between the plumes
- Smoke plume is non-hygroscopic
- SSA and abs-AE indicate organic coatings are significant



LARGE: Ziemba and Crumeyrolle

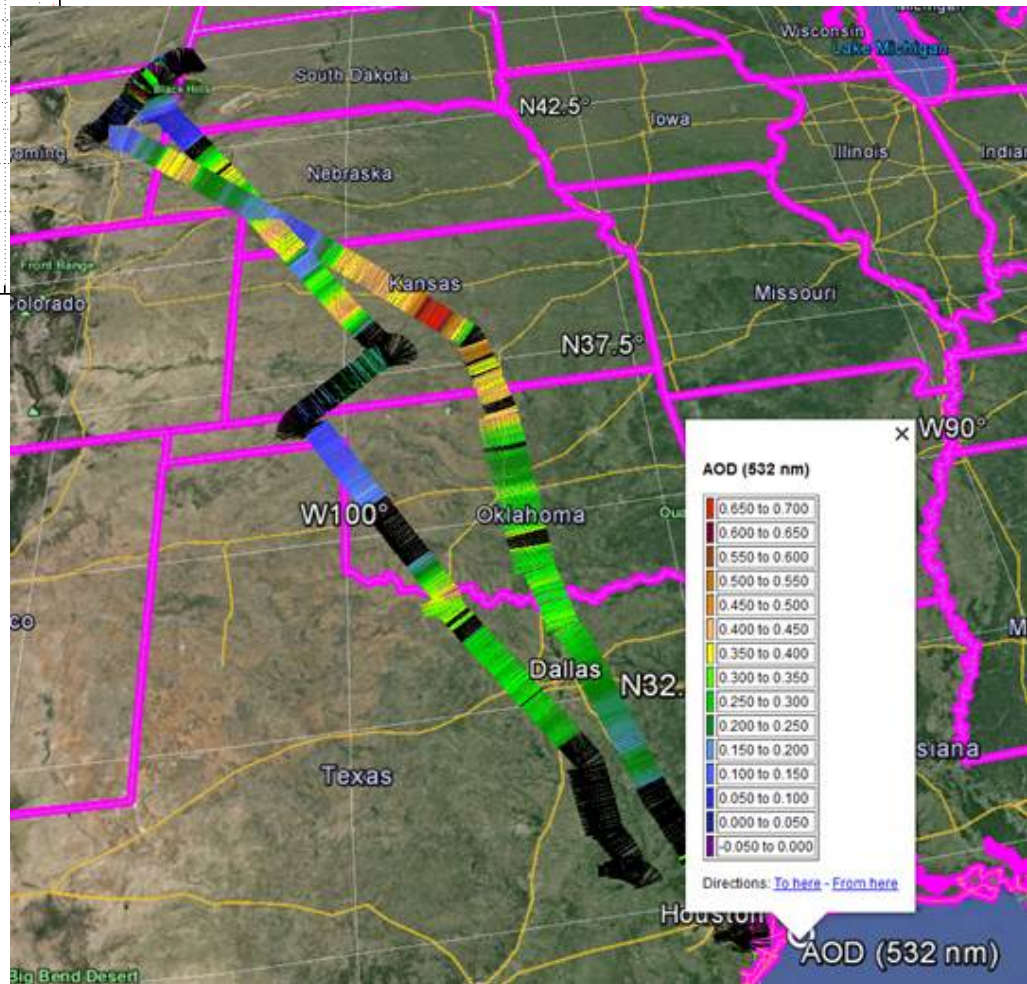
20130819, DC-8 2 km Alt.



4-STAR Team, Shinozuka et al.

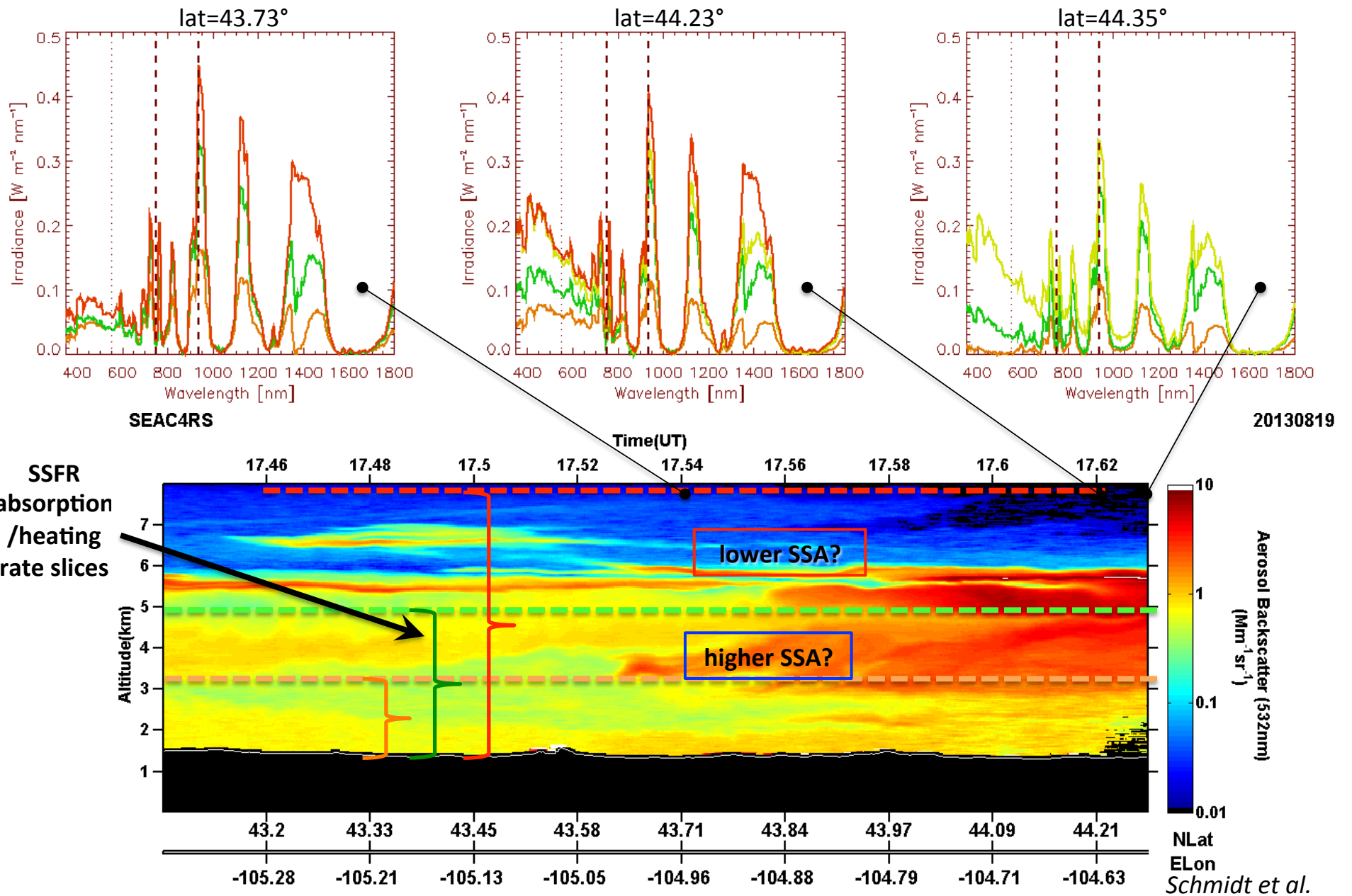
MISR AOD/ANG
Validation
19 August 2013

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.)



HSRL Team, Ferrare et al.

Site 2 Upwind Smoke: SSFR Multiple Layer SSA

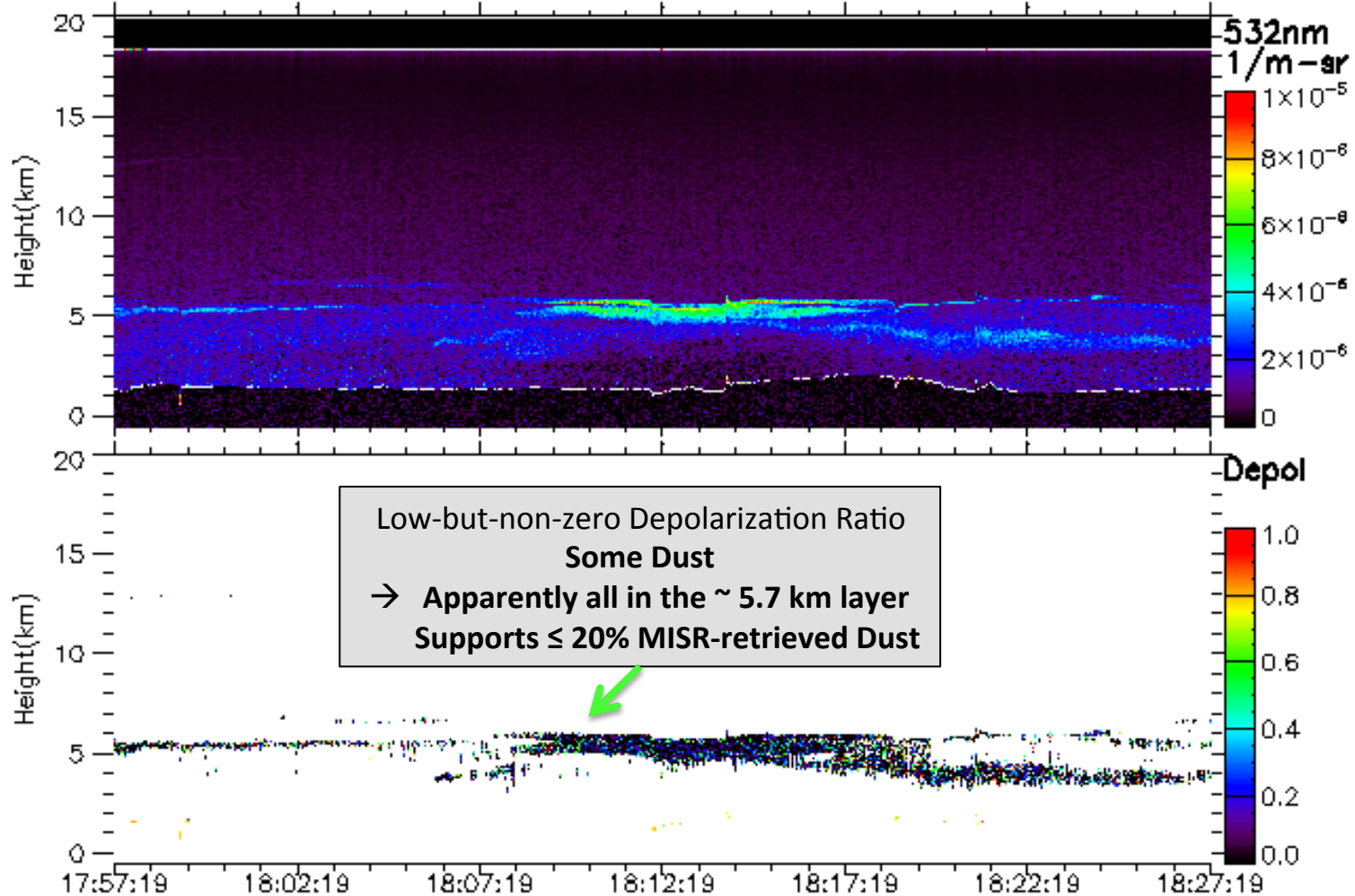


CPL Backscatter & Depolarization Ratio

19 August 2013 Site 2 Rosette

ER2-CPL SEAC4RS 19Aug13

Attenuated Backscatter Coefficient and Depolarization



MISR Smoke Plume 1

FrNon-Sph 0.05-0.2 (mostly spherical)

SAM-CAAM

[Systematic Aircraft Measurements to Characterize Aerosol Air Masses]

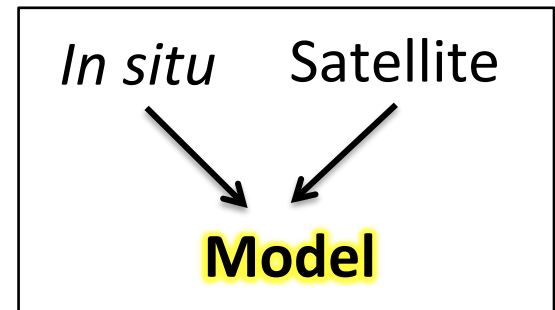
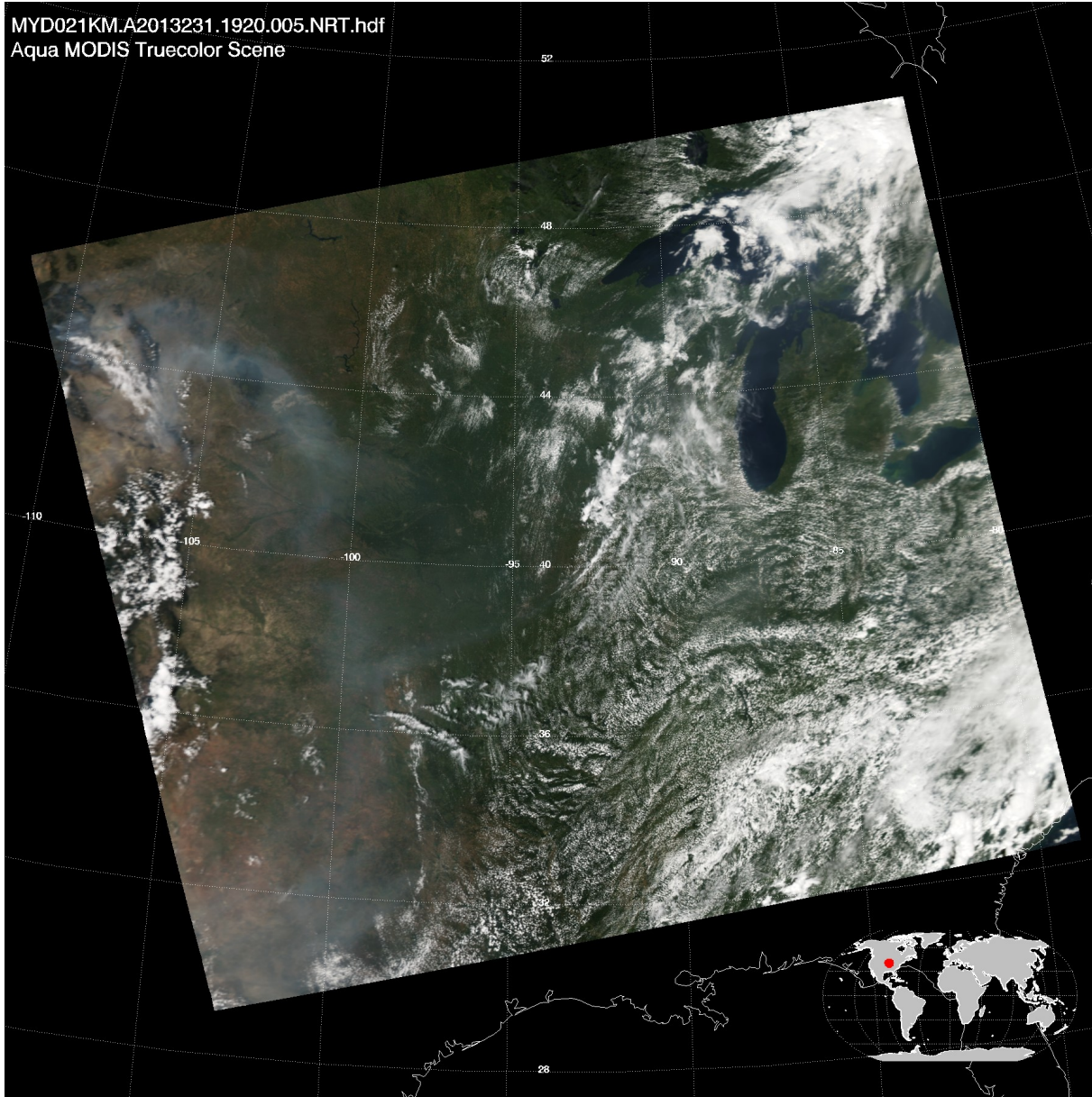


[This is currently a *concept-development effort*, not yet a project]

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 and species-specific aerosol mass and size tracked in aerosol transport & climate models*

Story 2: Upwind Smoke Source & Injection Height

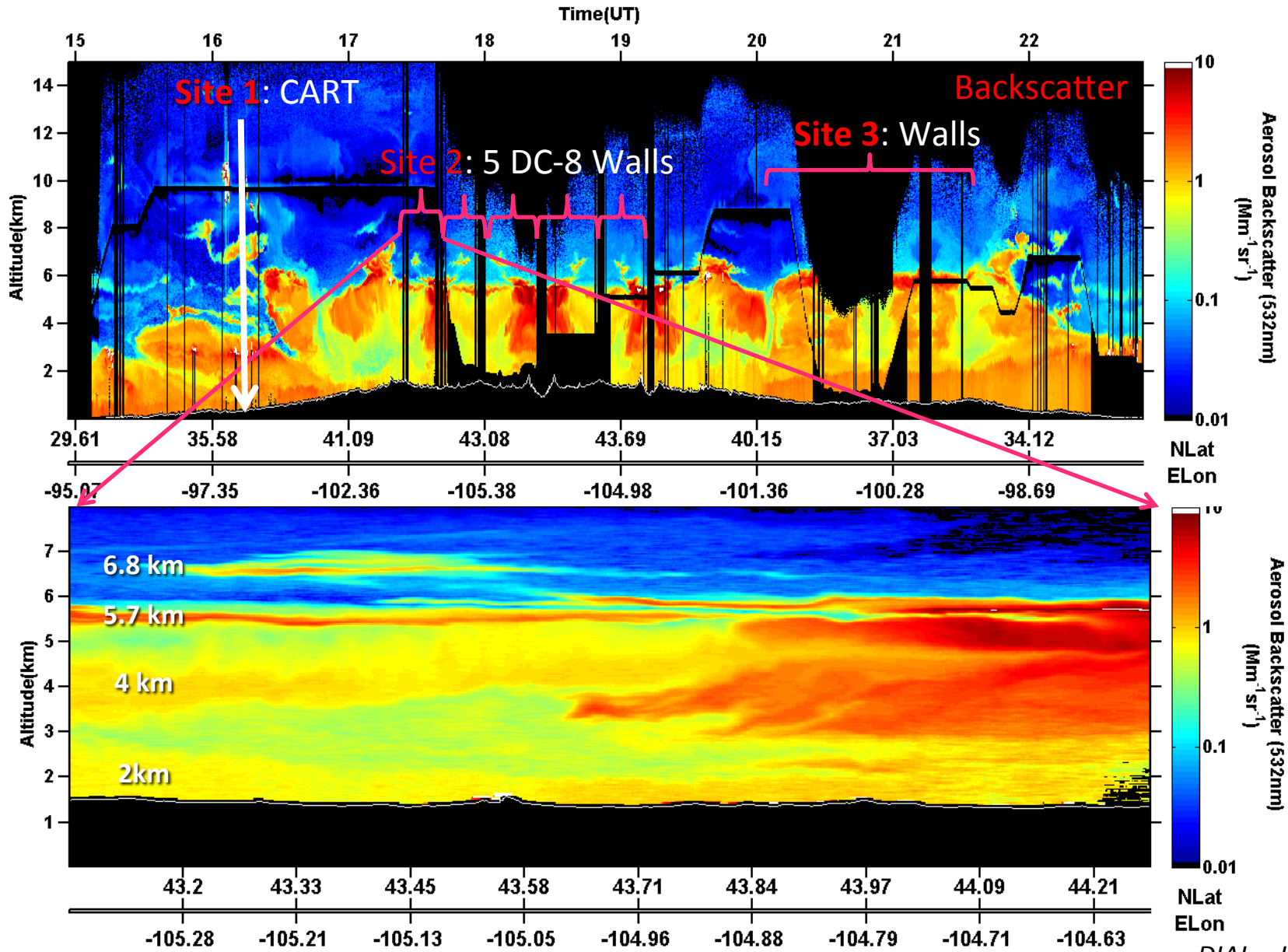


Using the 3-D AOD distribution from satellite and *in situ* measurements to constrain the model, which in turn identifies probable source locations and injection heights (also aerosol type)

Site 2 Upwind Smoke: DC-8 DIAL Curtain

SEAC4RS

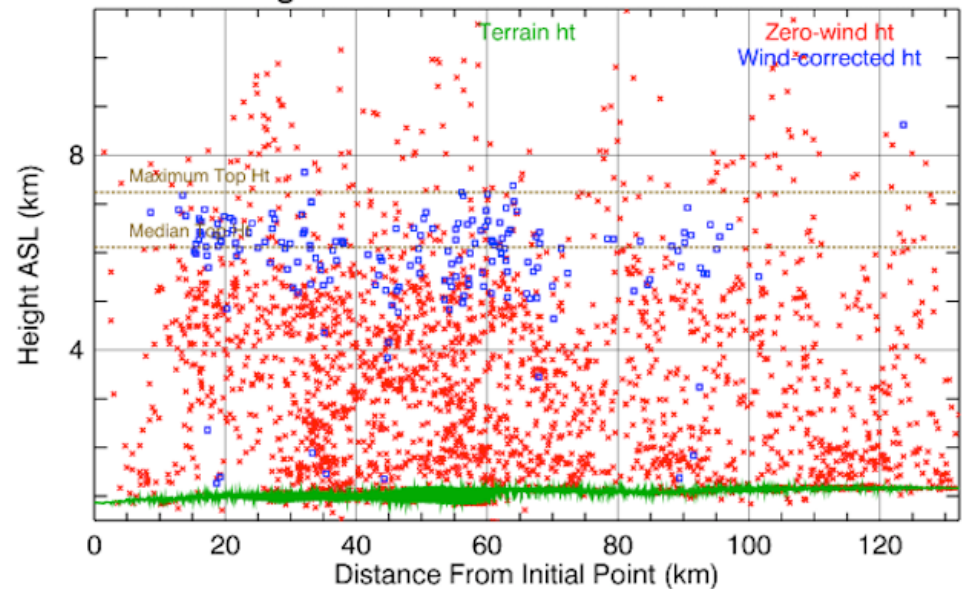
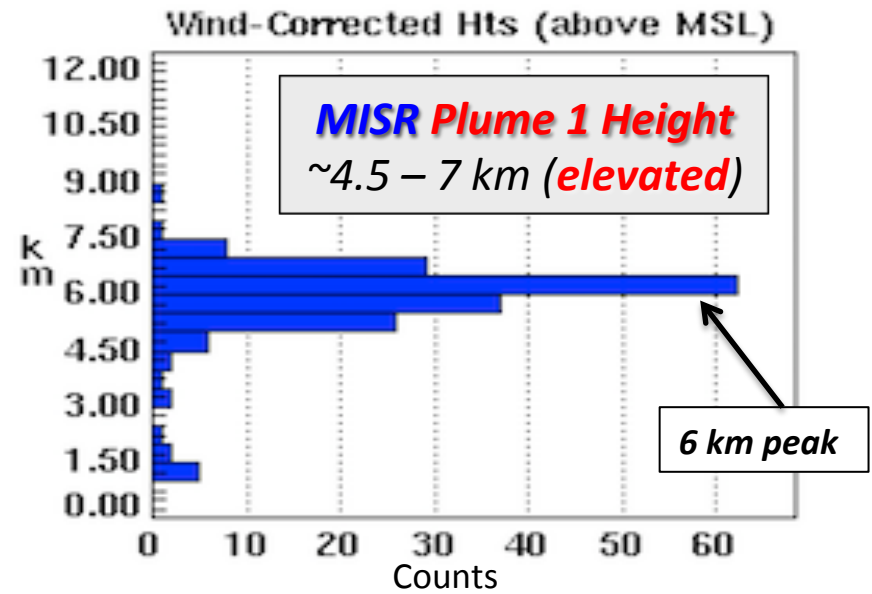
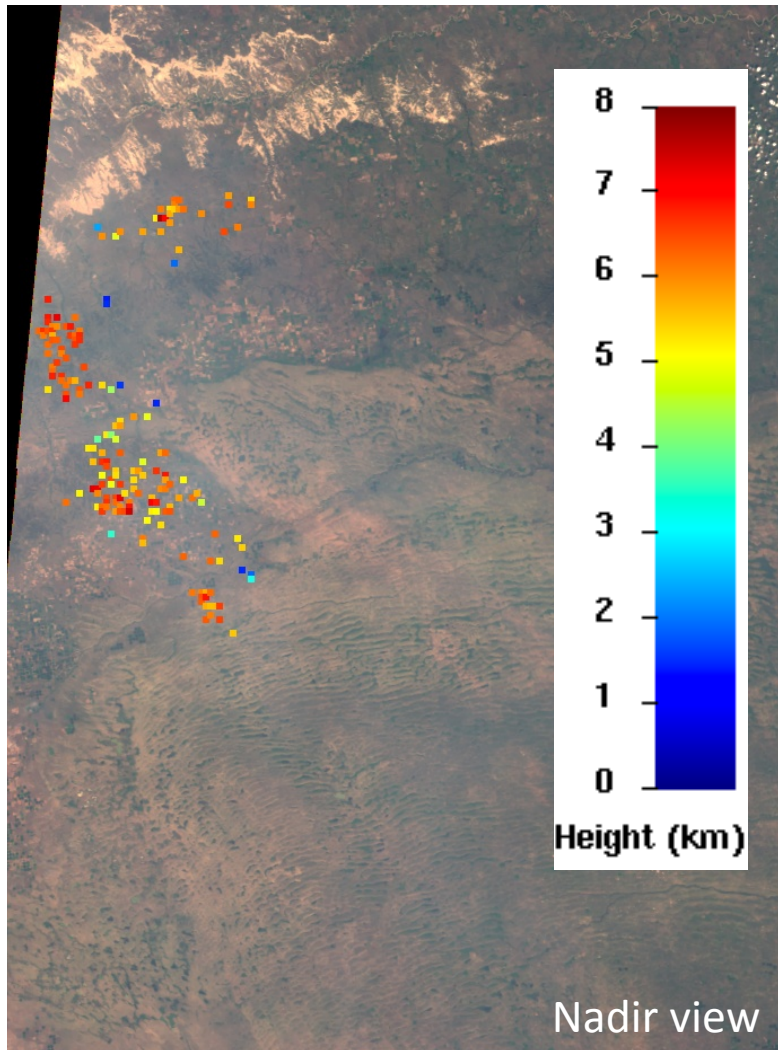
20130819



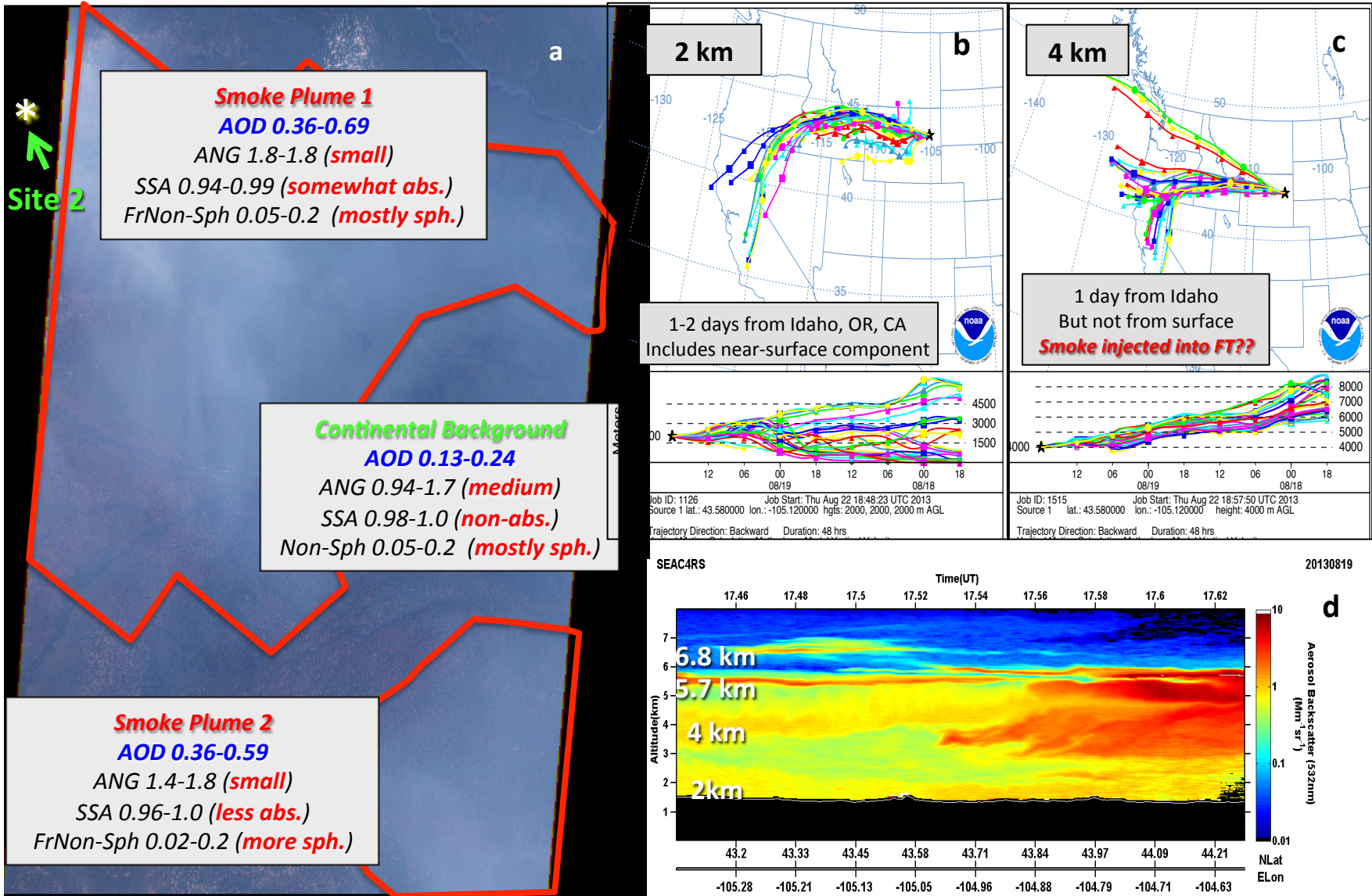
DIAL – Hair et al.

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

19 August 2013

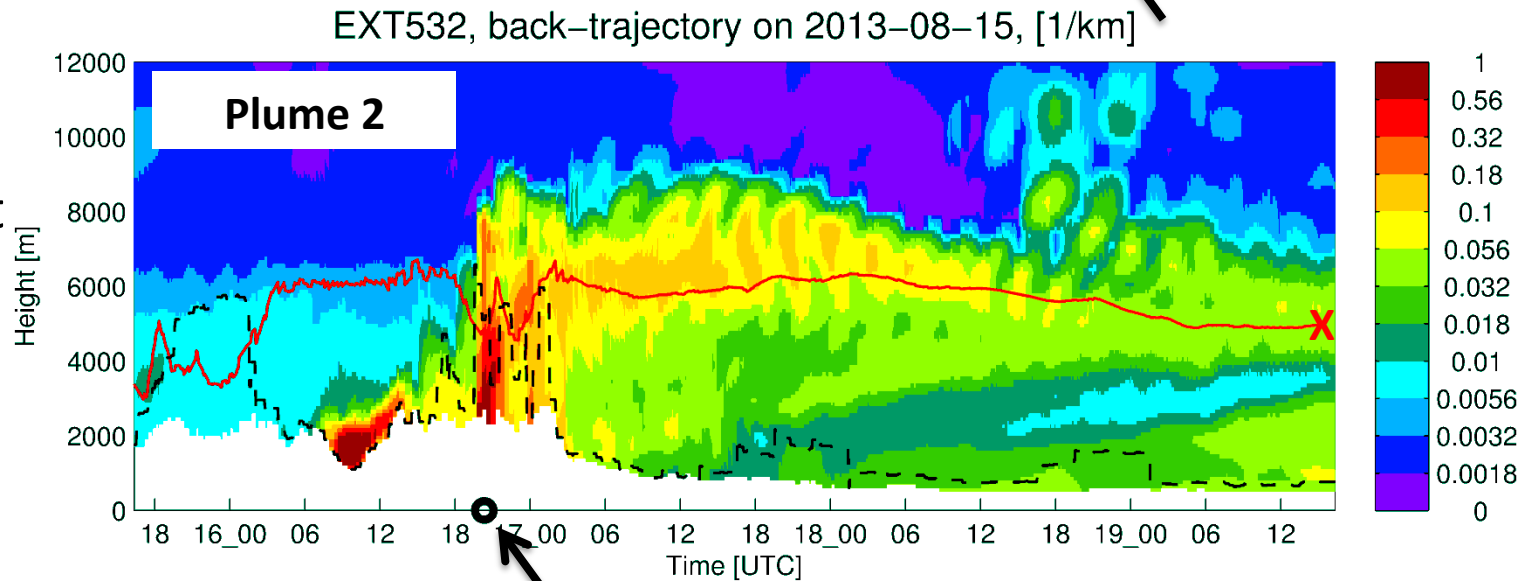
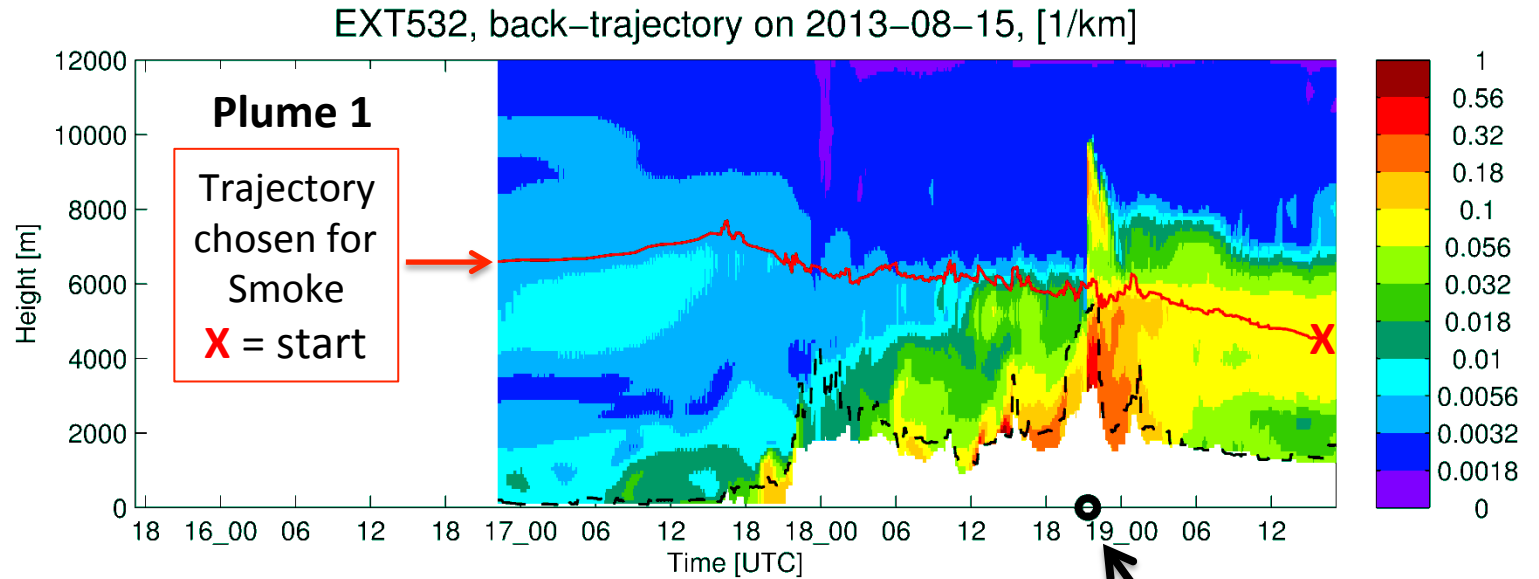


Model-Measurement Aerosol Source Characterization



U. Iowa Modeling – Curtain Along Back Trajectory

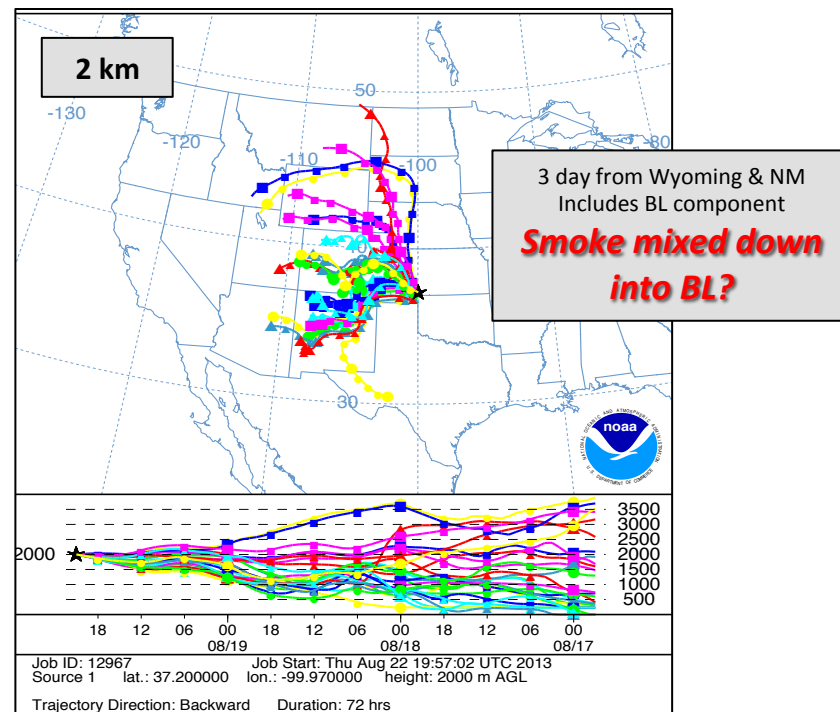
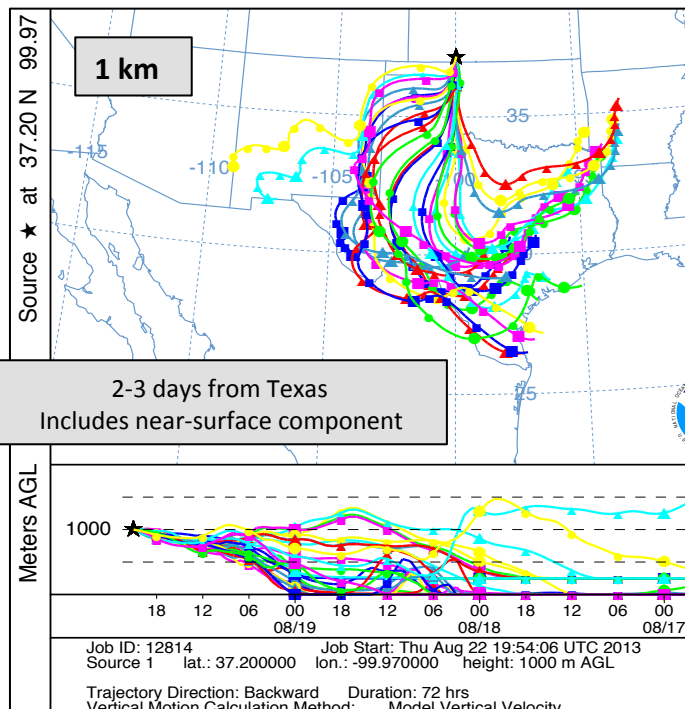
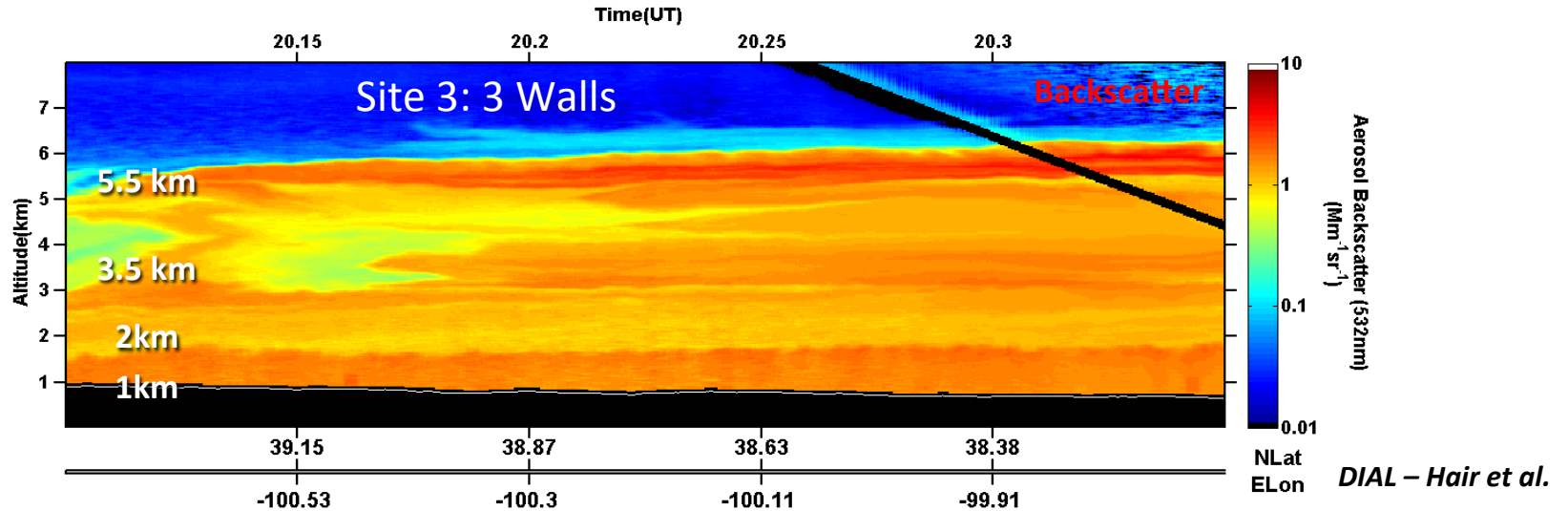
- Red solid line: Particle height
- Black segmented line: PBL height
- Black circle: first fire location that the particle intersects



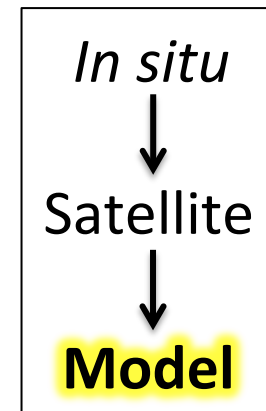
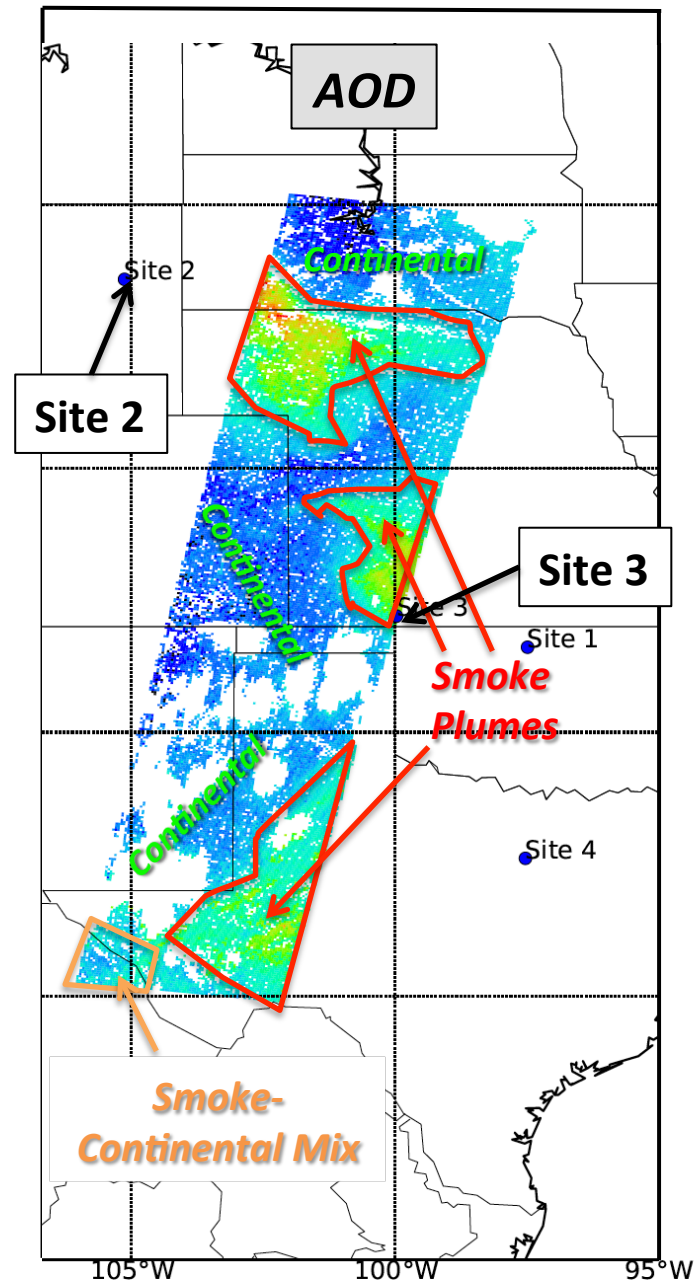
Model-Measurement Aerosol Source Characterization

SEAC4RS

20130819



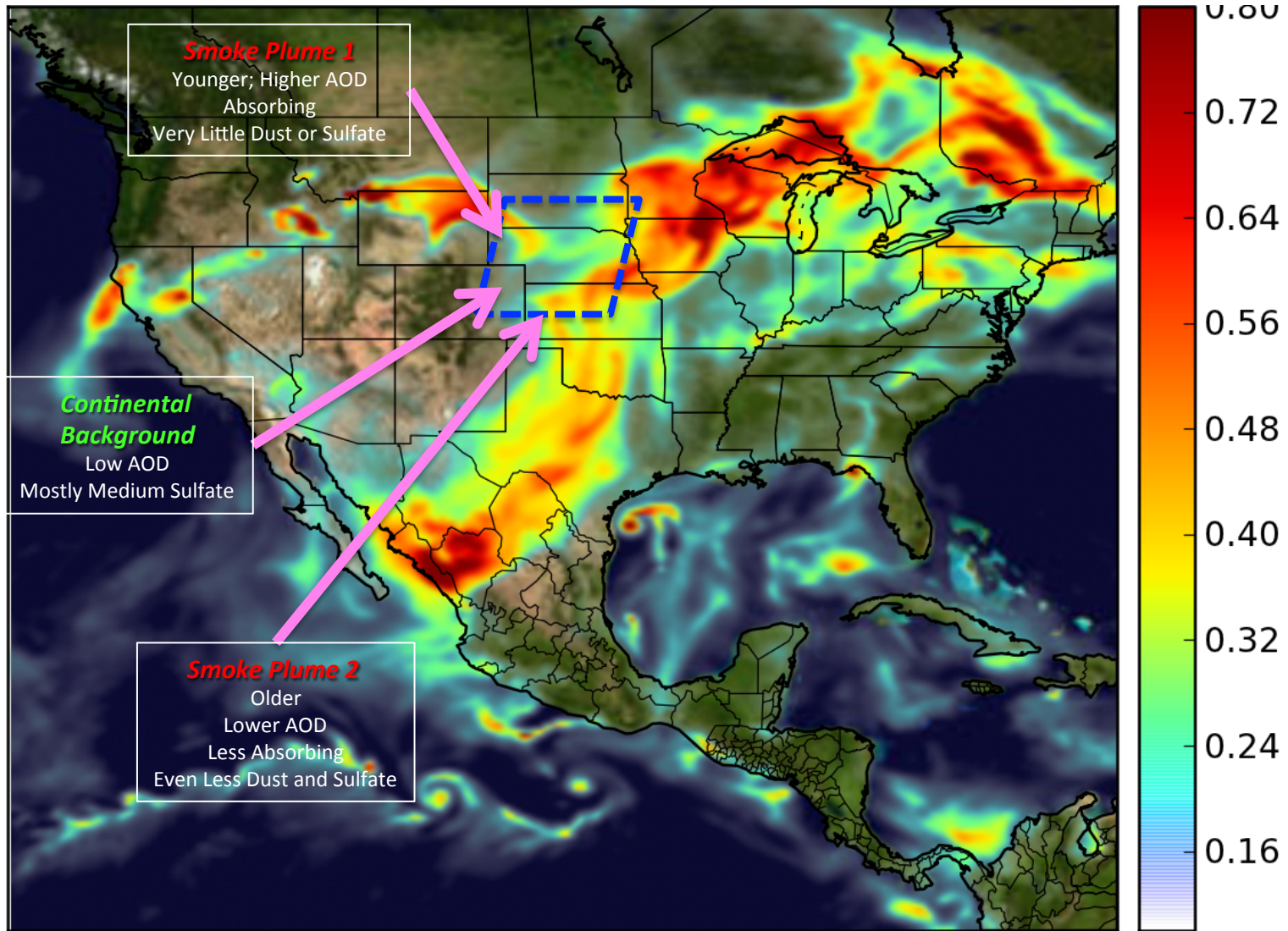
Story 3: Regional Aerosol Characterization



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

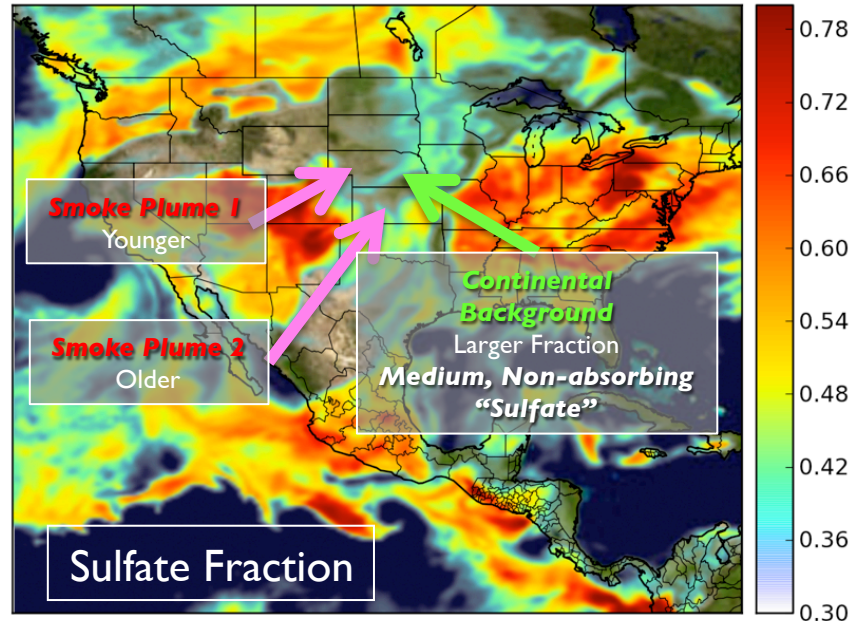
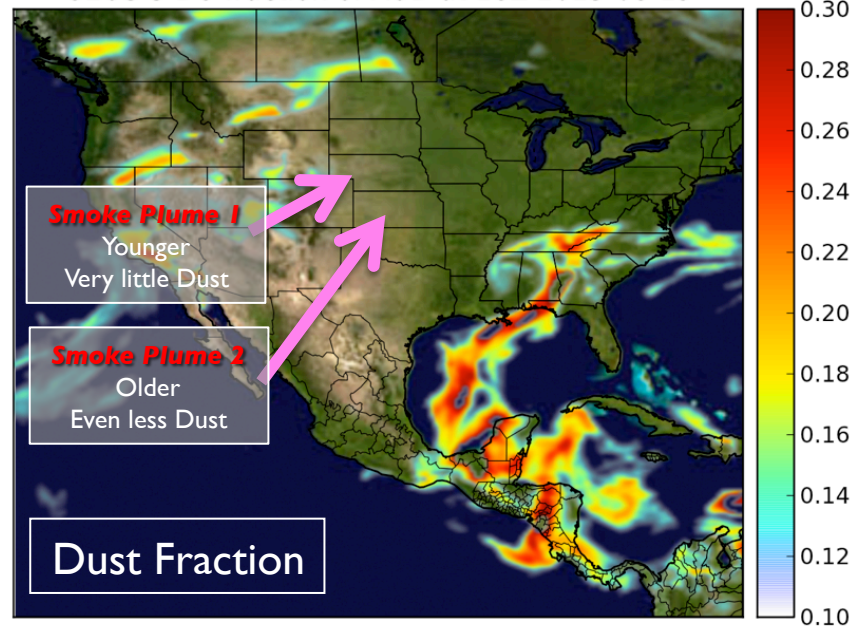
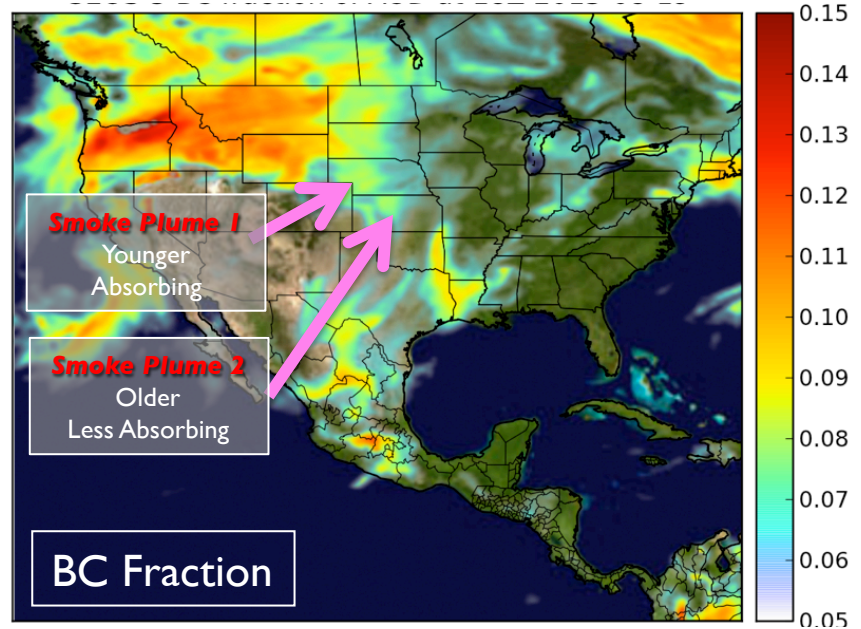
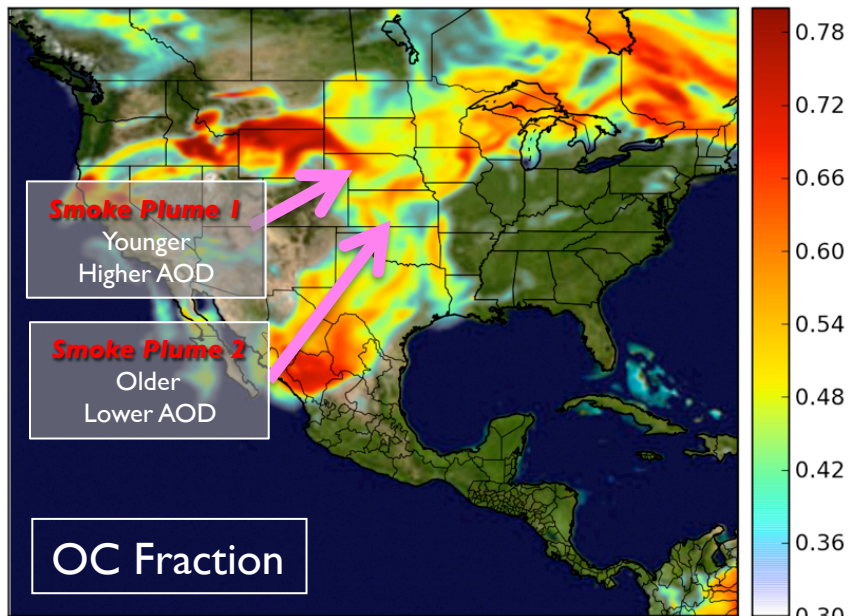
GEOS-5 MODEL Aerosol Optical Depth

19 August 2013 18 UTC



GEOS-5 MODEL Aerosol Type

19 August 2013 18 UTC



From: Randles & Da Silva



Satellites

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

**Aerosol-type
Predictions**

Model Validation

- Parameterizations
- Climate Sensitivity
- Underlying mechanisms

Remote-sensing Analysis

- Retrieval Validation
- Assumption Refinement

Regional Context

CURRENT STATE

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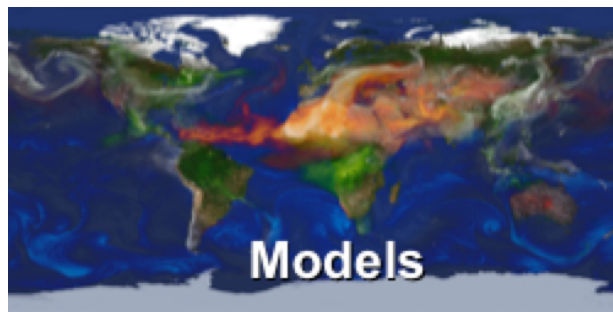


Suborbital

targeted chemical &
microphysical detail



point-location
time series



Models

space-time interpolation,

**DARF &
Anthropogenic
Component**

calculation and prediction