A Three-way Street: 

**MISR** and **MODIS** Provide Context, 

**SEAC4RS** Provides Detail and Validation, 

**Models** Compete the Picture

*Ralph Kahn*

NASA Goddard Space Flight Center
Transported Smoke Survey Objectives

- Evaluate Imager & Polarimeter Sensitivity to Smoke Properties [remote sensing validation]
- Study Characteristics of Transported Smoke [chemistry/transport]
- Assess Radiative Impact of Smoke Layers [radiation closure]
All Data Shown Are Preliminary

Please Contact the Individual Instrument Teams

For Further Information
**MISR** (Multi-angle Imaging SpectroRadiometer) Overpass

Monday, 19 August 2013 17:40 UTC

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17:40 UTC
Path 031
Orbit 72716

- South Dakota
- Nebraska
- Kansas

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Path 031

MISR Track

9 Angles
4 Wavelengths
MISR Aerosol Type (Research Algorithm)
19 August 2013

Site 2

Angstrom Exponent

Smoke Plume 1
ANG 1.5-1.9

Smoke Plume 2
ANG 1.6-2.0

Single-Scattering Albedo

Smoke Plume 1
SSA 0.94-0.98

Smoke Plume 2
SSA 0.96-0.98
**MISR Aerosol Type** (Research Algorithm)
19 August 2013

**Site 2**

**Smoke Plume 1**
- AOD 0.35-0.9
- ANG 1.5-1.9 (*small*)
- SSA 0.94-0.98 (*absorbing*)
- FrNon-Sph 0-0.2 (*mostly spherical*)

**Continental Background**
- AOD 0.15-0.2
- ANG 1.0-1.5 (*medium*)
- SSA 0.99-1.0 (*non-absorbing*)
- FrNon-Sph 0.0 (*spherical*)

**Smoke Plume 2**
- AOD 0.35-0.6
- ANG 1.6-2.0 (*smaller*)
- SSA 0.96-0.98 (*less absorbing*)
- FrNon-Sph 0-0.1 (*more spherical*)

Passive-remote-sensing **Aerosol Type** is a **Total-Column-Effective, Categorical** variable!!
**MISR AOD/ANG Validation**
19 August 2013

**4-STAR Team, Shinozuka et al.**

**MISR Smoke Plume 1**
AOD 0.35-0.9
ANG 1.5-1.9 (small)
SSA 0.94-0.98 (absorbing)
FrNon-Sph 0-0.2 (mostly spherical)

**HSRL Team, Ferrare et al.**
- Mostly BB particles
- Some Sulfate/Organic mixed into plume
- Very little Mineral Dust lofted with smoke

General compositional makeup is similar for 4 plumes
Older plumes have lower nitrate, higher organic content

Plumes from 3-6 km alt, higher plumes are thicker
- 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.
Site 2 Upwind Smoke: SSFR Multiple Layer SSA

SSFR absorption/heating rate slices

higher SSA?

lower SSA?
Low-but-non-zero Depolarization Ratio
Some Dust
Apparently all in the ~ 5.7 km layer

MISR Smoke Plume 1
FrNon-Sph 0-0.2 \textit{(mostly spherical)}
**MISR Plume Height** (Level of Max Contrast) Near Site 2  
19 August 2013

MISR Team – D. Nelson et al.

**MISR Plume 1 Height**

~4.5 – 7 km (elevated)

Wind-Corrected Hts (above MSL)

Counts

6 km peak
**Site 2 Smoke Transports**
19 August 2013

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1-2 days from Idaho, OR, CA
Includes near-surface component

1 day from Idaho
But not from surface
Smoke injected into FT??

2 km

4 km

6.8 km
5.7 km
4 km
2 km

DC-8 DIAL Curtain: Site 2

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

EXT532, back-trajectory on 2013–08–15, [1/km]

Plume 1
Trajectory chosen for Smoke X = start

EXT532, back-trajectory on 2013–08–15, [1/km]

Plume 2

WRF modeling – Saide et al.
**Smoke Plume 1**
- Younger; Higher AOD
- Absorbing
- Very Little Dust or Sulfate

**Smoke Plume 2**
- Older
- Lower AOD
- Less Absorbing
- Even Less Dust and Sulfate

**Continental Background**
- Low AOD
- Mostly Medium Sulfate

**GEOS-5 MODEL Aerosol Optical Depth**
19 August 2013  18 UTC

GEOS-5 Team – DaSilva & Randles
Smoke Plume 1
Younger
Higher AOD

Smoke Plume 2
Older
Lower AOD

Smoke Plume 1
Younger
Absorbing

Smoke Plume 2
Older
Less Absorbing

Smoke Plume 1
Younger
Very little Dust

Smoke Plume 2
Older
Even less Dust

Continental Background
Larger Fraction
Medium, Non-absorbing
“Sulfate”

OC Fraction

BC Fraction

Dust Fraction

Sulfate Fraction
As expected, Smoke Air Masses: Higher AOD, Smaller, Darker, More Non-Spherical

14+ Years of ~ Once-weekly Global Data from MISR