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

*Kahn, Surveys Geophys. 2012*
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]

### 19 August 2013

**MODIS Terra**
- Aerosol Optical Depth
- Extreme Upwind
  - ER-2: Rosette
  - DC-8: 5-Wall
- Downwind
  - ER-2: Bow Tie
  - DC-8: 3-Wall
- Transit Home
- Cart Site AERONET
- 17:40 UTC
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

17:40 UTC
Path 031
Orbit 72716

South Dakota
Nebraska
Kansas
MISR Aerosol Optical Depth (Research Algorithm)
19 August 2013

Smoke Plume 1
AOD 0.35 – 0.9

Smoke Plume 2
AOD 0.3 – 0.6

Continental Background
AOD 0.15 – 0.2

Smoke Plume 1
Nadir View

Smoke Plume 2
Nadir View

Site 2
Site 2

MISR Aerosol Type (Research Algorithm)
19 August 2013

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

MISR Smoke Plume 1
SSA 0.94-0.98 (absorbing)

- 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

lower SSA?
higher 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 (mostly spherical)
MISR Team – D. Nelson et al.
Site 2 Smoke Transports
19 August 2013

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 sph.)

Smoke Plume 2
AOD 0.35-0.6
ANG 1.6-2.0 (smaller)
SSA 0.96-0.98 (less abs.)
FrNon-Sph 0-0.1 (more sph.)

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

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

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

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

**Plume 2**

`WRF modeling – Saide et al.`
GEOS-5 MODEL Aerosol Optical Depth
19 August 2013 18 UTC

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 Team – DaSilva & Randles
GEOS-5 MODEL Aerosol Type
19 August 2013 18 UTC

**OC Fraction**
- **Smoke Plume 1**
  - Younger
  - Higher AOD
- **Smoke Plume 2**
  - Older
  - Lower AOD

**BC Fraction**
- **Smoke Plume 1**
  - Younger
  - Absorbing
- **Smoke Plume 2**
  - Older
  - Less Absorbing

**Dust Fraction**
- **Smoke Plume 1**
  - Younger
  - Very little Dust
- **Smoke Plume 2**
  - Older
  - Even less Dust

**Sulfate Fraction**
- **Smoke Plume 1**
  - Younger
- **Continental Background**
  - Larger Fraction
  - Medium, Non-absorbing
  - "Sulfate"
As expected, Smoke Air Masses: Higher AOD, Smaller, Darker, More Non-Spherical