A Three-way Street: **MISR** and **MODIS** Provide Context, **SEAC4RS** Provides Detail and Validation, **Models** Compete the Picture

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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]

![Transported Smoke Survey Objectives Map](image)

**MODIS Terra**
- Aerosol Optical Depth
- 19 August 2013

**MODIS Terra**
- 17:40 UTC
- Extreme Upwind
- ER-2: Rosette
- DC-8: 5-Wall
- Downwind
- ER-2: Bow Tie
- DC-8: 3-Wall
- Cart Site
- AERONET
- Transit Home
- White Sands HELSTF
- Texas
- Nebraska
All Data Shown Are Preliminary

Please Contact the Individual Instrument Teams

For Further Information
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

Site 2

Nadir View

Continental Background

Smoke Plume 1

Smoke Plume 2

Continental Background

Aerosol Optical Depth (Research Algorithm)
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

Site 2
**MISR Aerosol Type** (Research Algorithm)

19 August 2013

**Effective Radius**

- **Smoke Plume 1**
  - EffRad 0.24-0.5

- **Smoke Plume 2**
  - EffRad 0.15-0.25

**Fraction AOD Non-Spherical**

- **Smoke Plume 1**
  - FrNon-Sph 0-0.2

- **Smoke Plume 2**
  - FrNon-Sph 0-0.1

- Continental Background
  - FrNon-Sph 0.0
**MISR Aerosol Type** (Research Algorithm)

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 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

**PALMS particle types**
- Sulfate/Organic
- Biomass Burning
- Mineral Dust

**8/19 PALMS + LARGE in situ aerosol**

**LARGE LAS Volume**

**Site 2**

**Site 3**

**Aircraft Altitude**

**Secs of Flight Day**

**GPS Alt (km) and PALMS BBfrac x 10**

**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:
- SSA 0.94-0.98 (absorbing)

MISR Smoke Plume 1
- 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 3:
- SSA ~0.96
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 (mostly spherical)
**MISR Plume Height** (Level of Max Contrast) Near Site 2

19 August 2013

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.)

**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)

**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.)

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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??

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DC-8 DIAL Curtain: Site 2

DIAL – Hair et al.
U. Iowa Modeling SEAC4RS 19 August 2013

Model AOD Forecast

MISR Path ER2 Flight

MISR 70°f image

Plume 1

Plume 2

550nm Aerosol Optical Depth for total column

0.04 0.07 0.1 0.15 0.2 0.3 0.4 0.6 1 1.2 1.5

Aerosol Extinction

HSRL-DIAL DC8 Flight

WRF-Chem DC8 Flight

Representative 4-Day Back Trajectories

WRF modeling – Saide 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.
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
**Aerosol Type**

**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
- **Smoke Plume 2**: Older, Medium, Non-absorbing, "Sulfate"
As expected, Smoke Air Masses: Higher AOD, Smaller, Darker, More Non-Spherical.