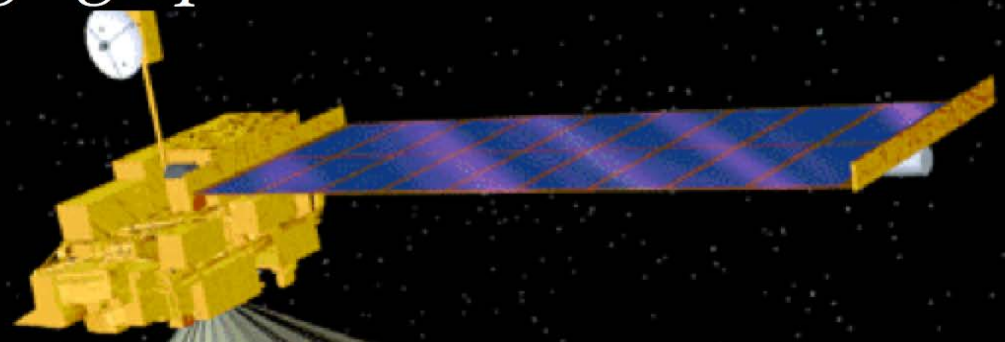
Multi-angle Imaging SpectroRadiometer

MISR

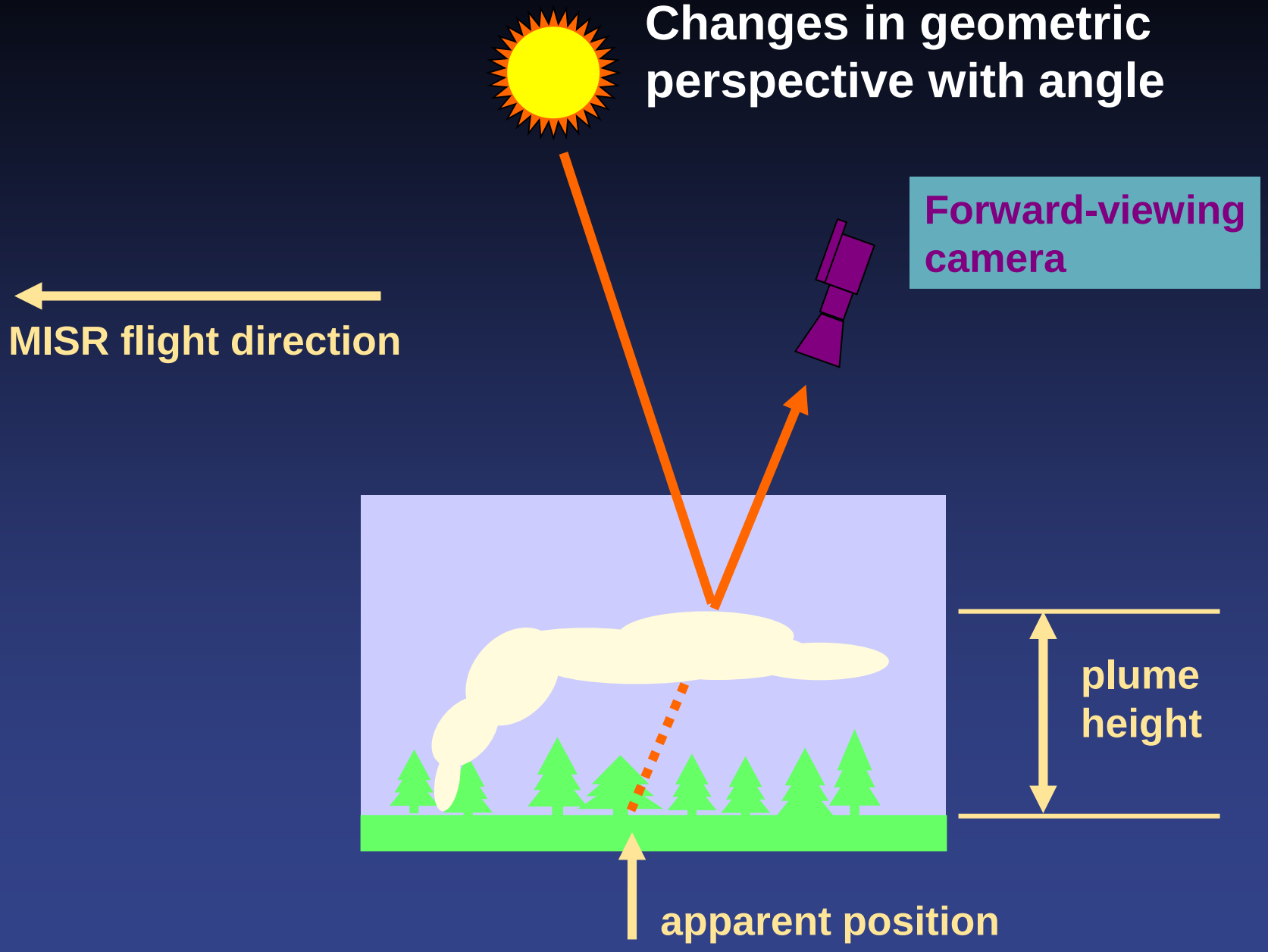


- Aerosol Plume Height
- Aerosol Optical Depth
- Some Particle Properties

http://www-misr.jpl.nasa.gov
http://eosweb.larc.nasa.gov

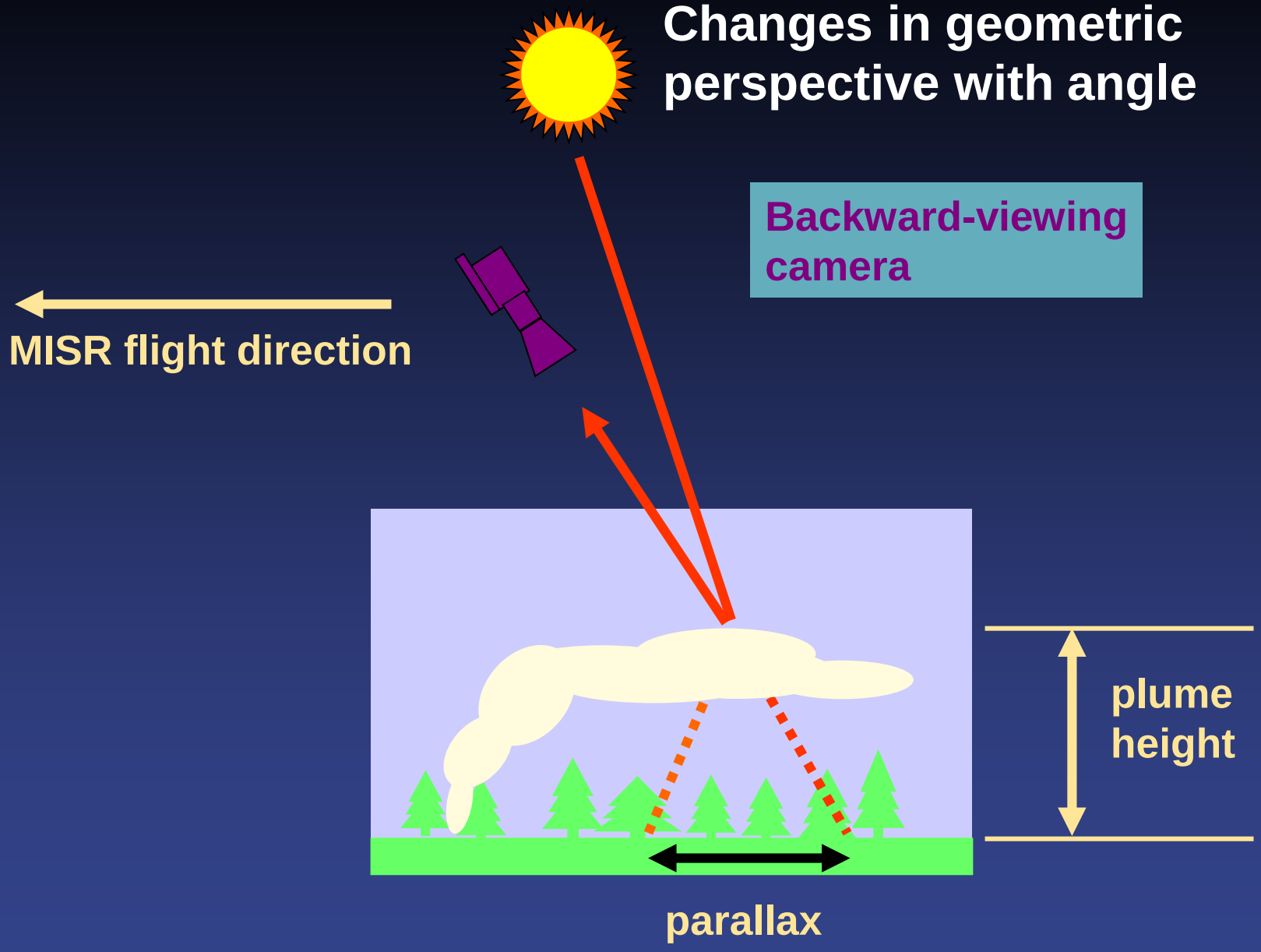
- **Nine CCD push-broom cameras**
- **Nine view angles at Earth surface: 70.5° forward to 70.5° aft**
- **Four spectral bands at each angle: 446, 558, 672, 866 nm**
- **Studies *Aerosols*, *Clouds*, & *Surface***

Changes in geometric perspective with angle



Diner 2003

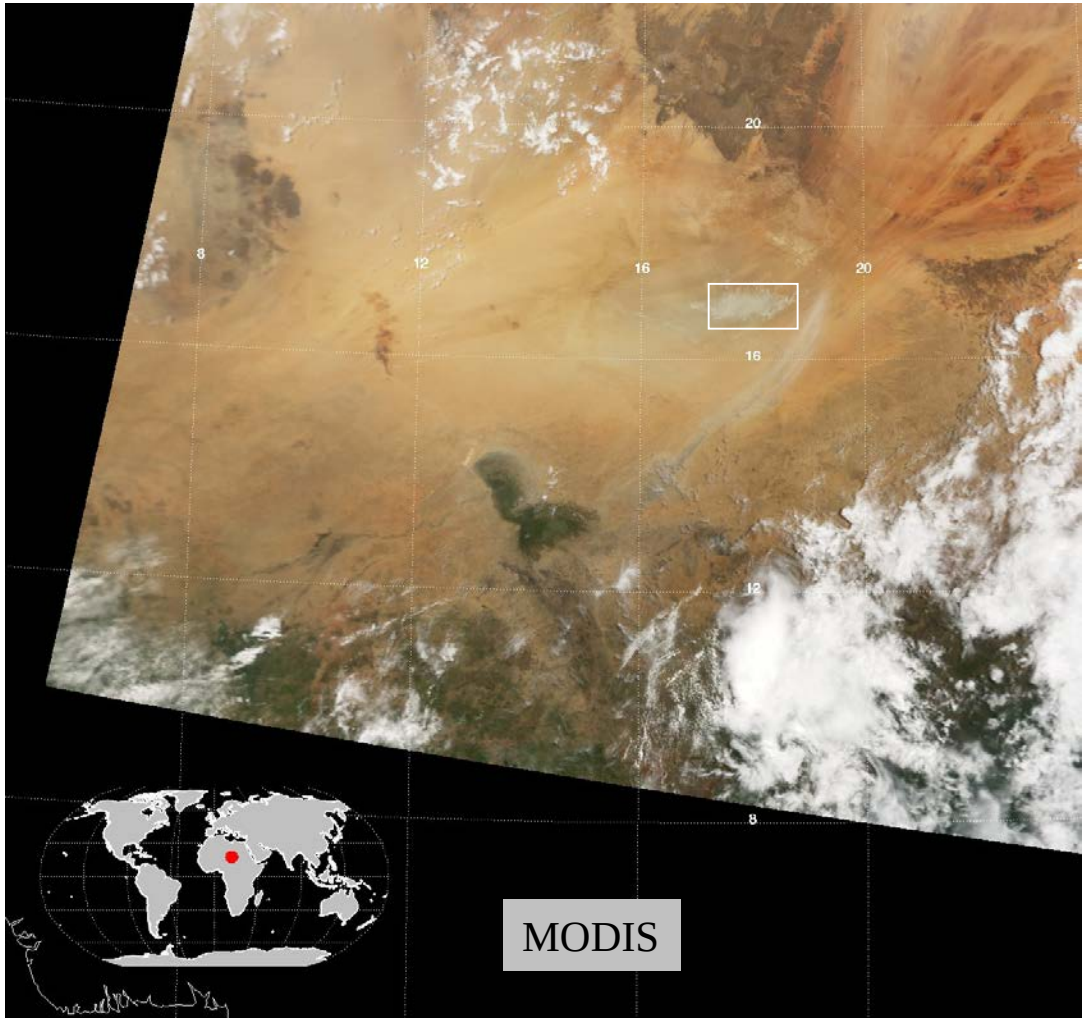
Changes in geometric perspective with angle

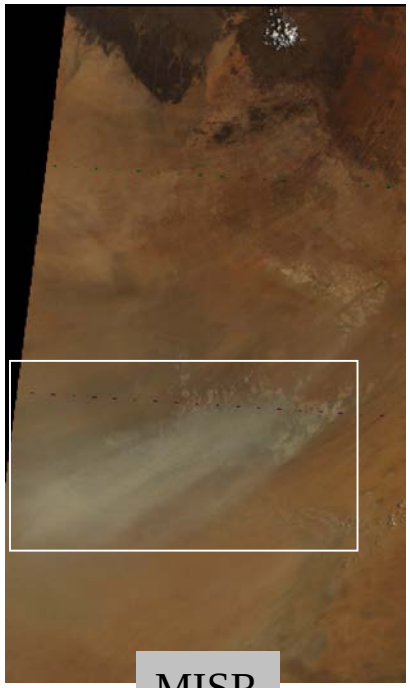


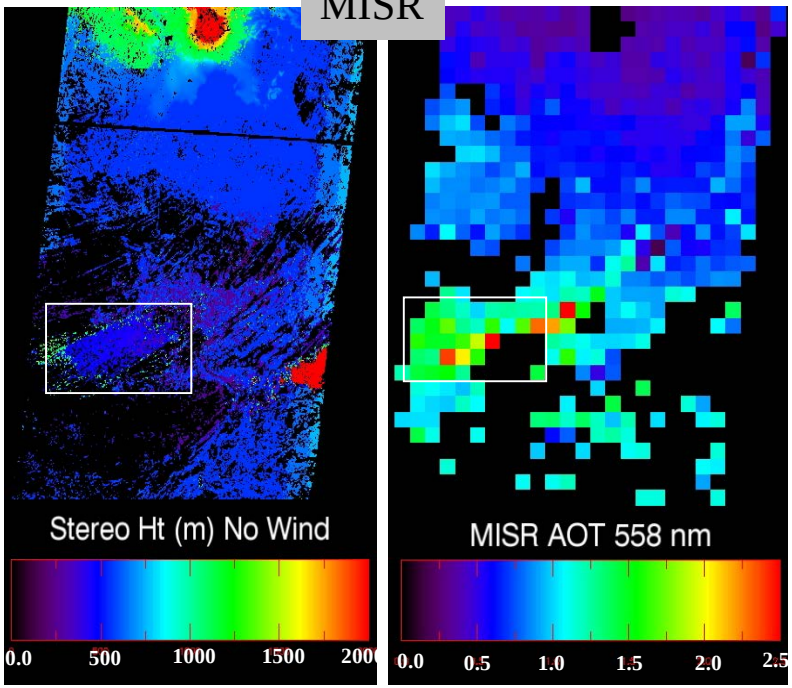
Diner 2003

Saharan Dust Source Plume

Bodele Depression Chad June 3, 2005 Orbit 29038





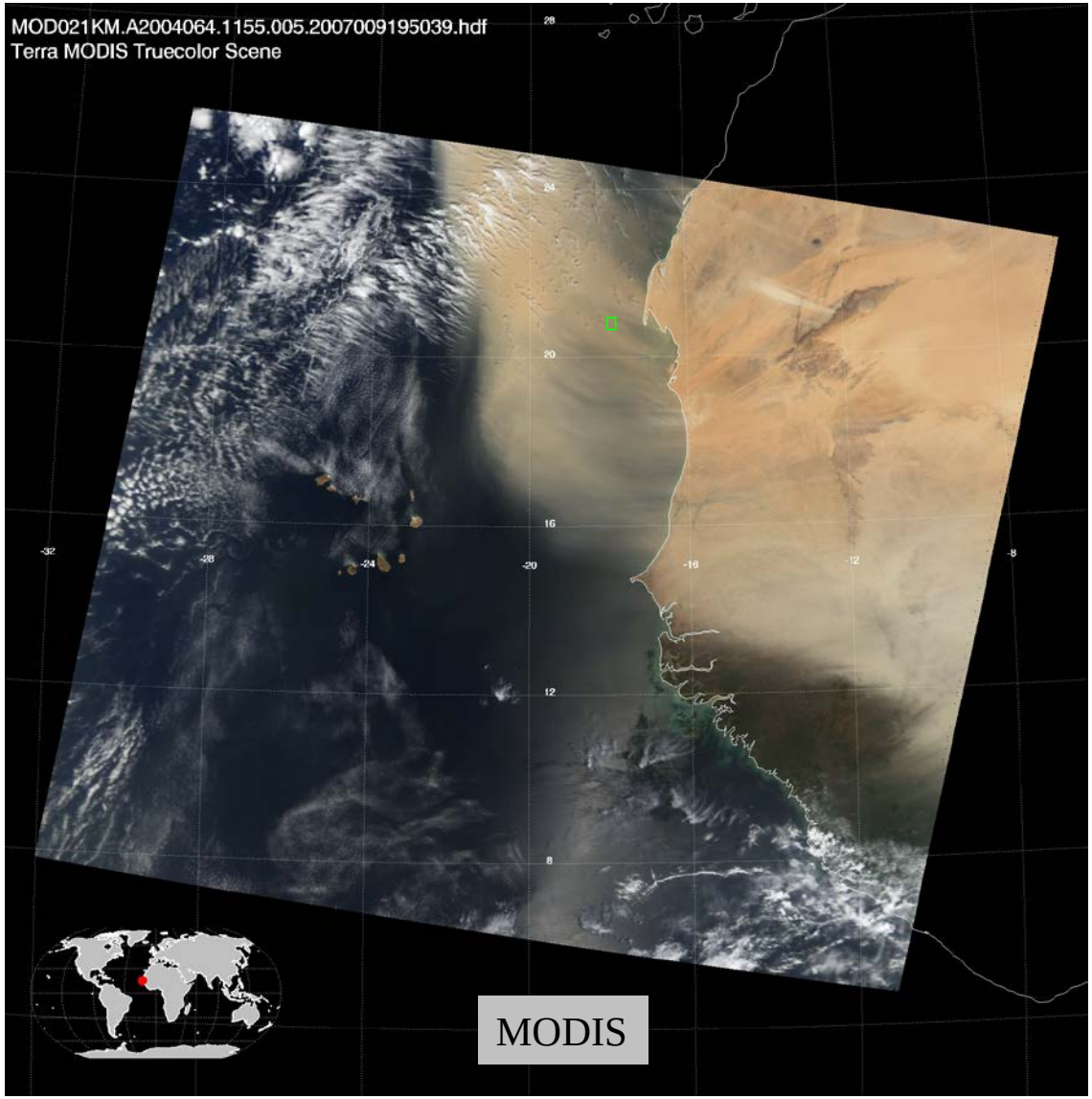


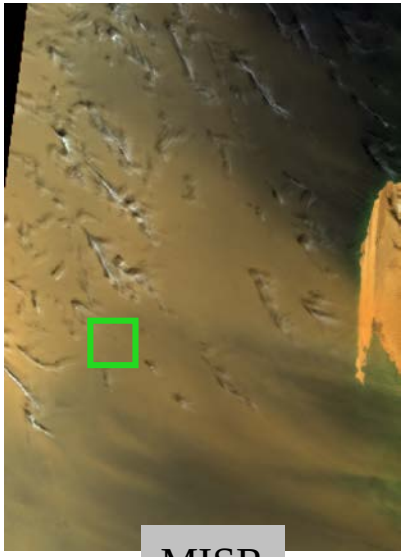
Dust is injected near-surface…

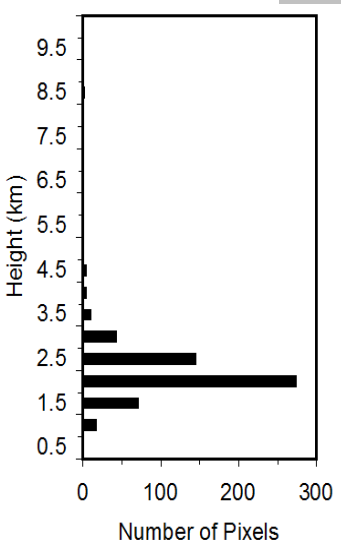
Kahn et al., JGR 2007

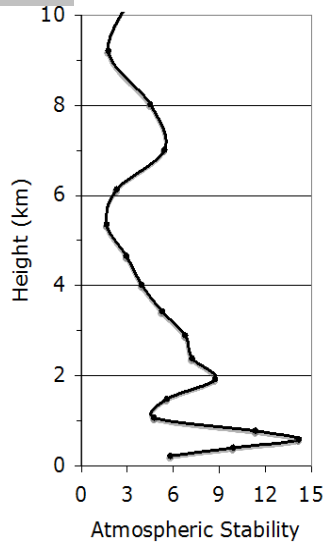
Transported Dust Plume

Atlantic, off Mauritania March 4, 2004 Orbit 22399







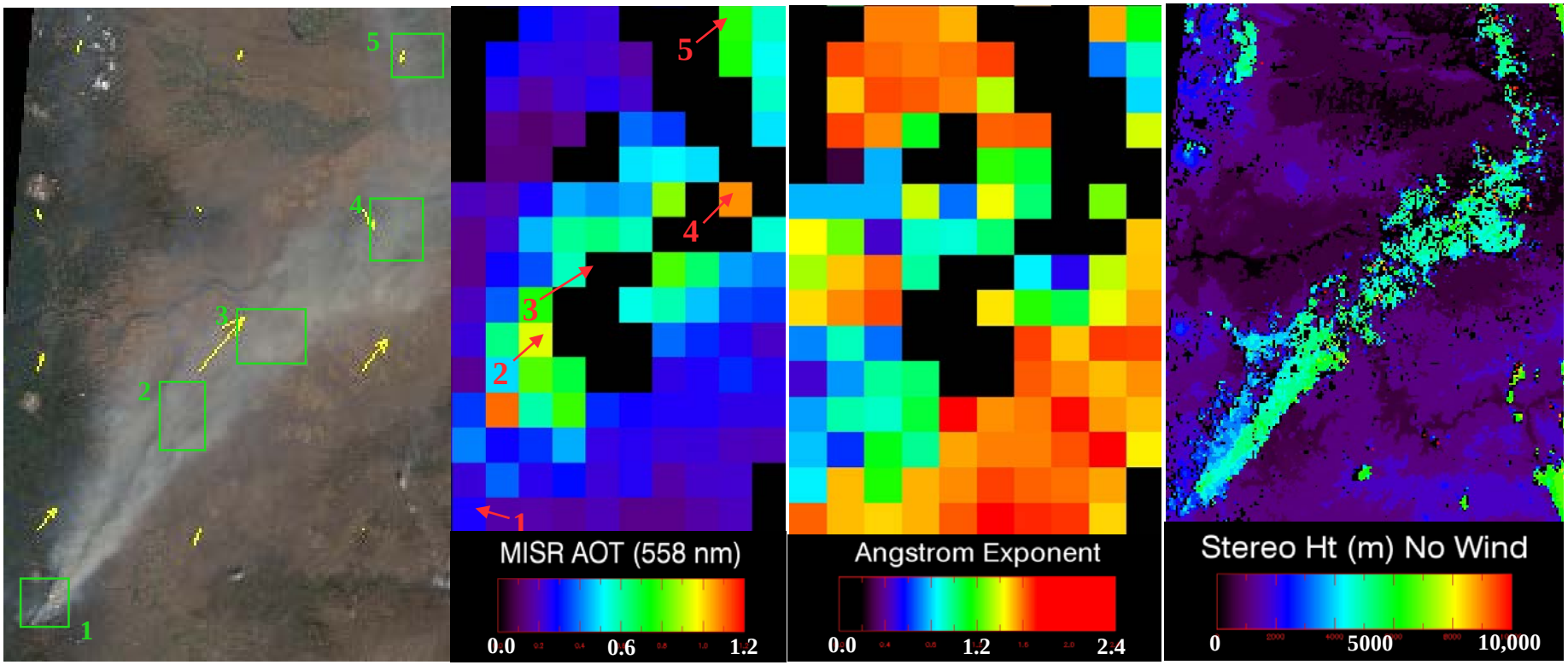


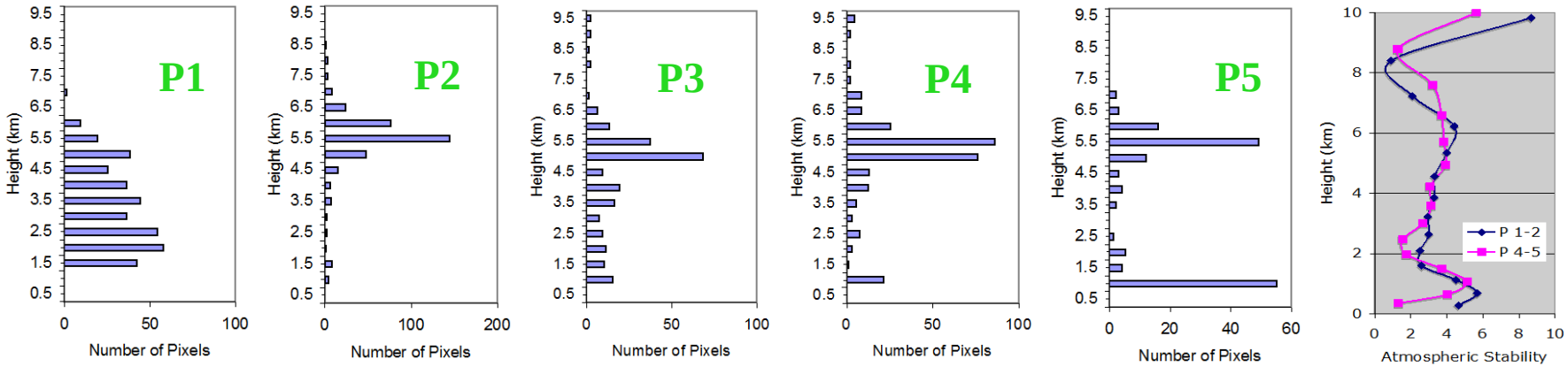
Transported dust finds elevated layer of relative stability…

Kahn et al., JGR 2007

Oregon Fire Sept 04 2003

Orbit 19753 Blks 53-55 MISR Aerosols V17, Heights V13 (no winds)

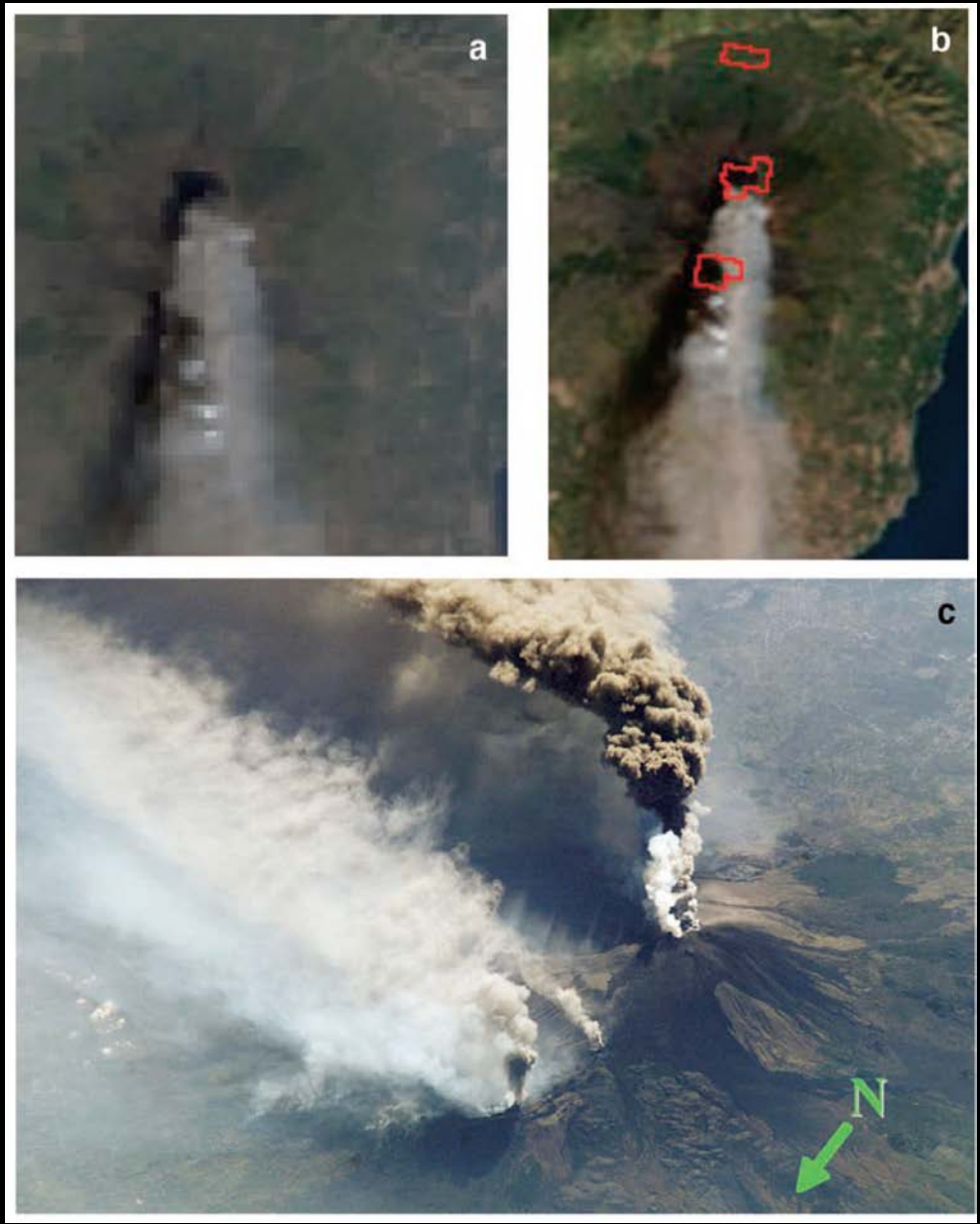




Kahn, et al., JGR 2007

MISR Aerosol Retrievals – Mt. Etna Eruption

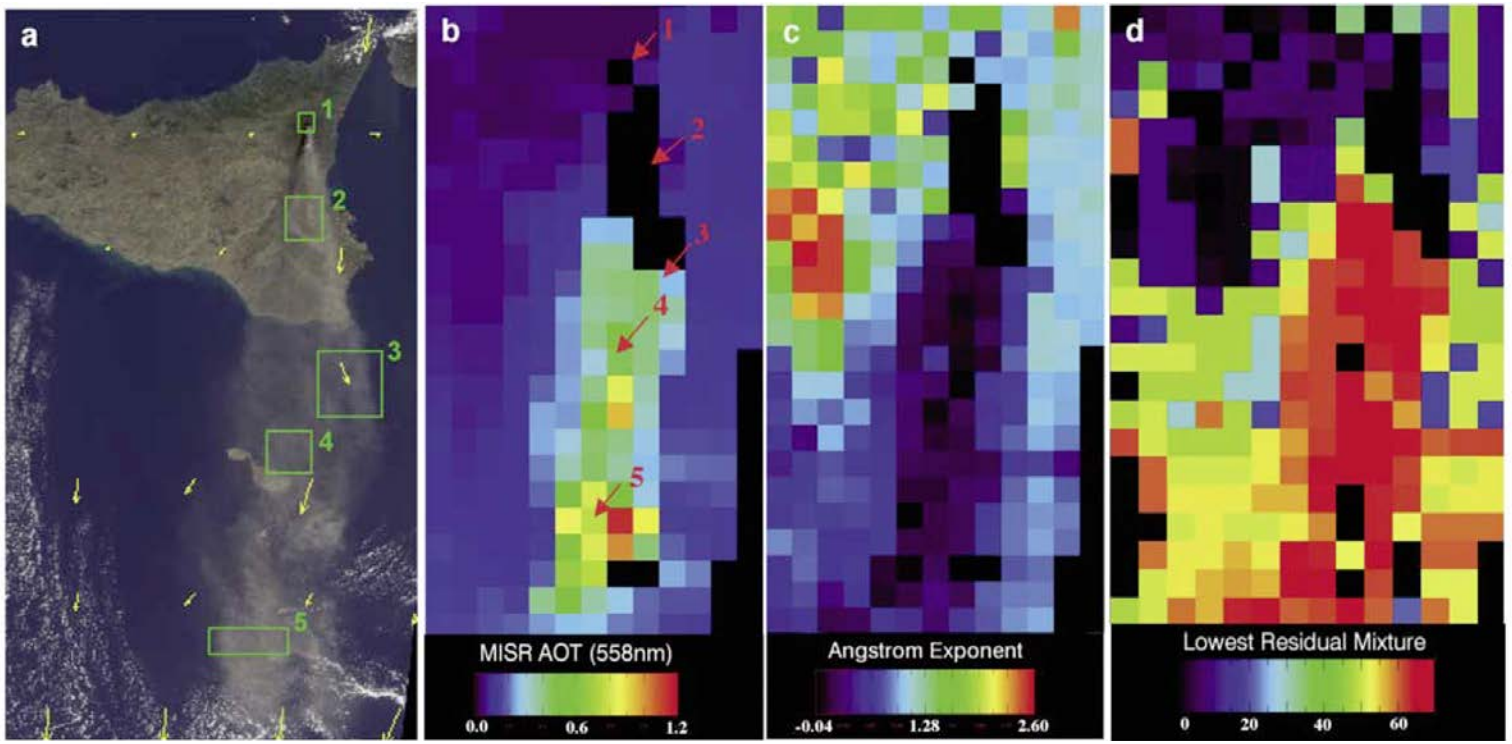
27 Oct. 2002 Orbit 15204 Path 189

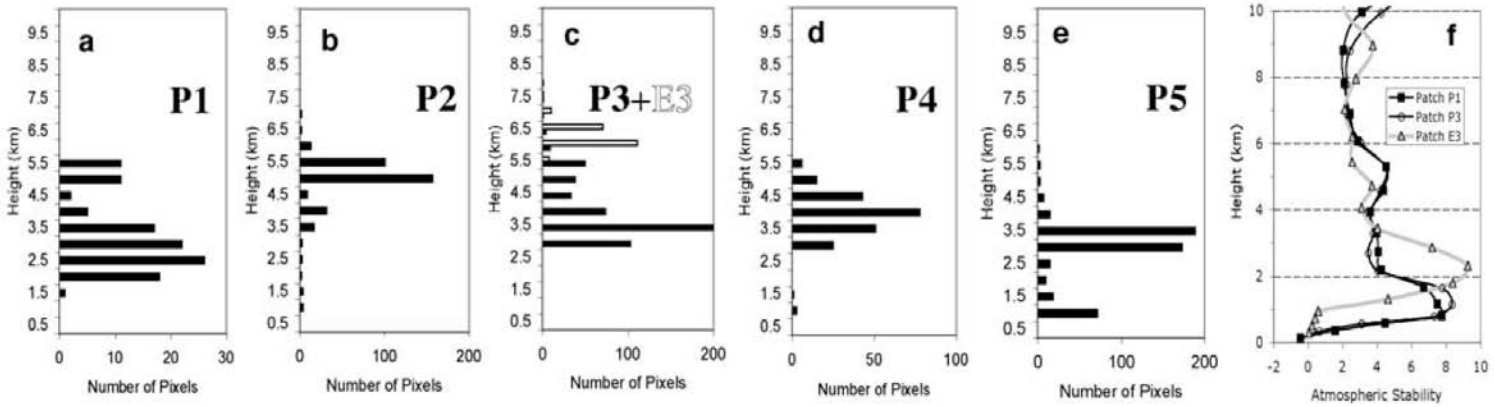


Kahn et al., JGR 2007

MISR Aerosol Retrievals – Mt. Etna Eruption

27 Oct. 2002 Orbit 15204 Path 189 Blk 60-63

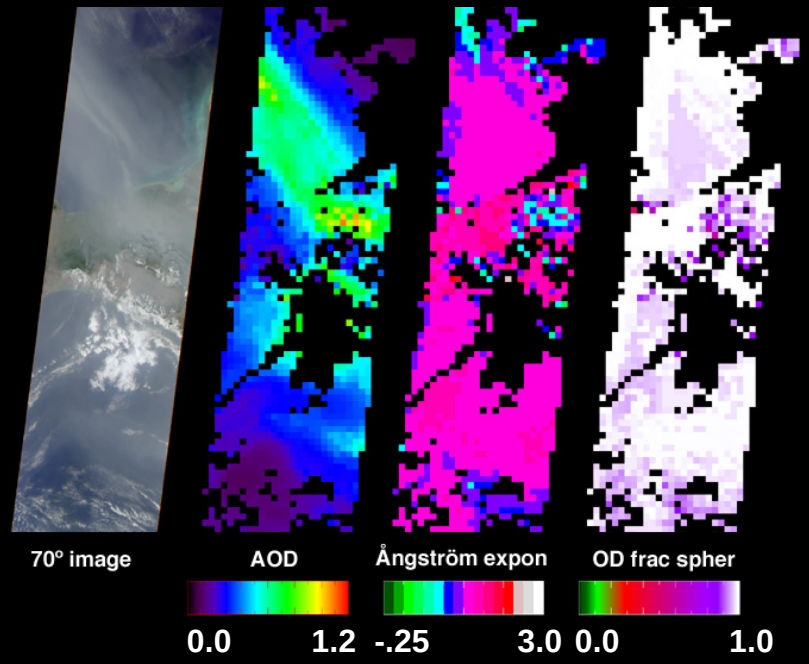




Kahn et al., JGR 2007

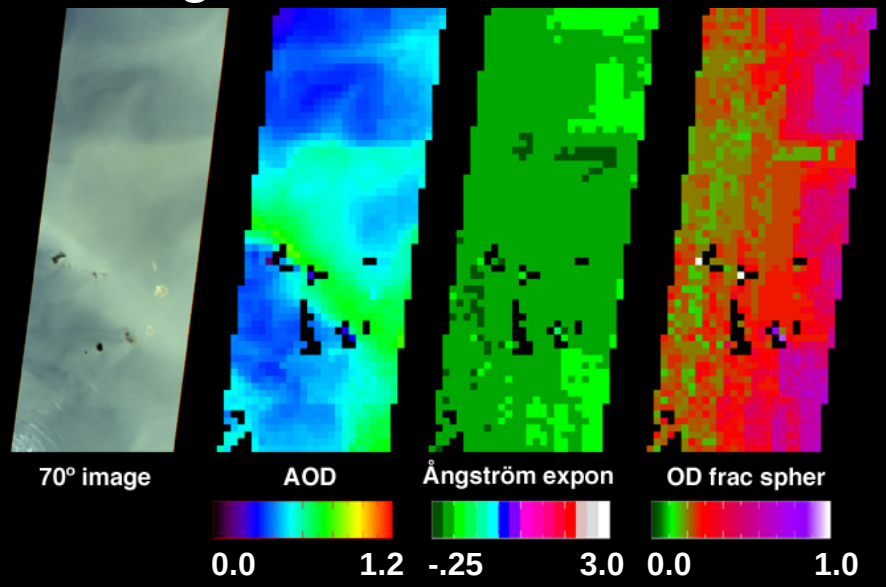
Smoke from Mexico -- 02 May 2002

Aerosol:
Amount
Size
Shape



Medium
Spherical
Smoke
Particles

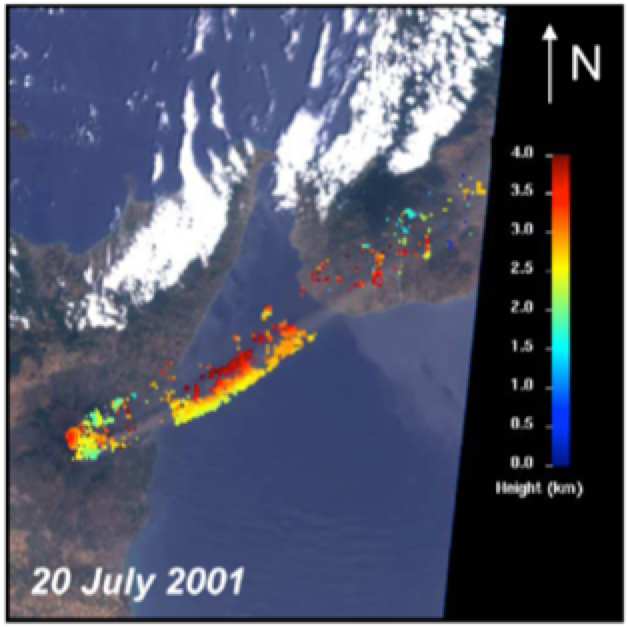
Dust blowing off the Sahara Desert -- 6 February 2004



Large
Non-Spherical
Dust
Particles

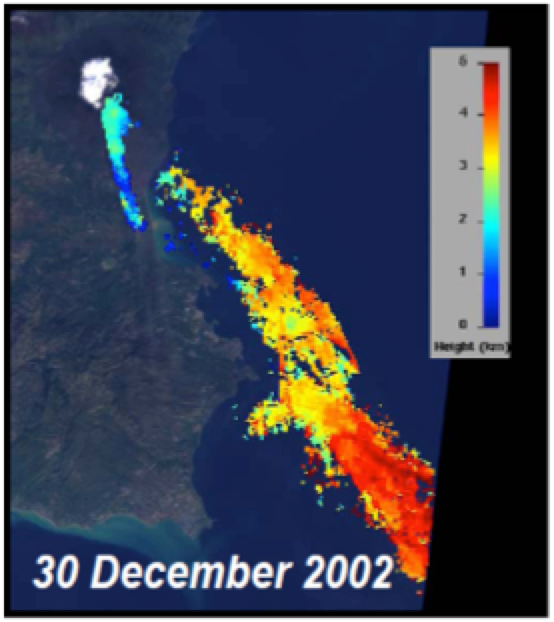
Mount Etna Plume Height and Eruption Style from MISR

Scollo, S. R.A. Kahn, D.L. Nelson, M. Coltelli, D.J. Diner, M.J. Garay, and V.J. Realmuto
MISR observations of Etna volcanic plumes. *J. Geophys. Res*. 2012



MISR nadir-viewing, true-color image showing Etna, with stereo-derived plume height superposed

29 Sept. 2006 – MISR retrieved mostly small spherical particles, indicating a sulfate/water-dominated plume



MISR stereo heights for the ash-dominated plume on 30 December 2002

Indications of Eruption Strength:

- ***Plume Height*** from MISR stereo imaging
- ***Ash to Sulfate/Water particle AOD ratio*** from MISR-retrieved particle shape and size

Mount Etna Plume Height and Eruption Style from MISR

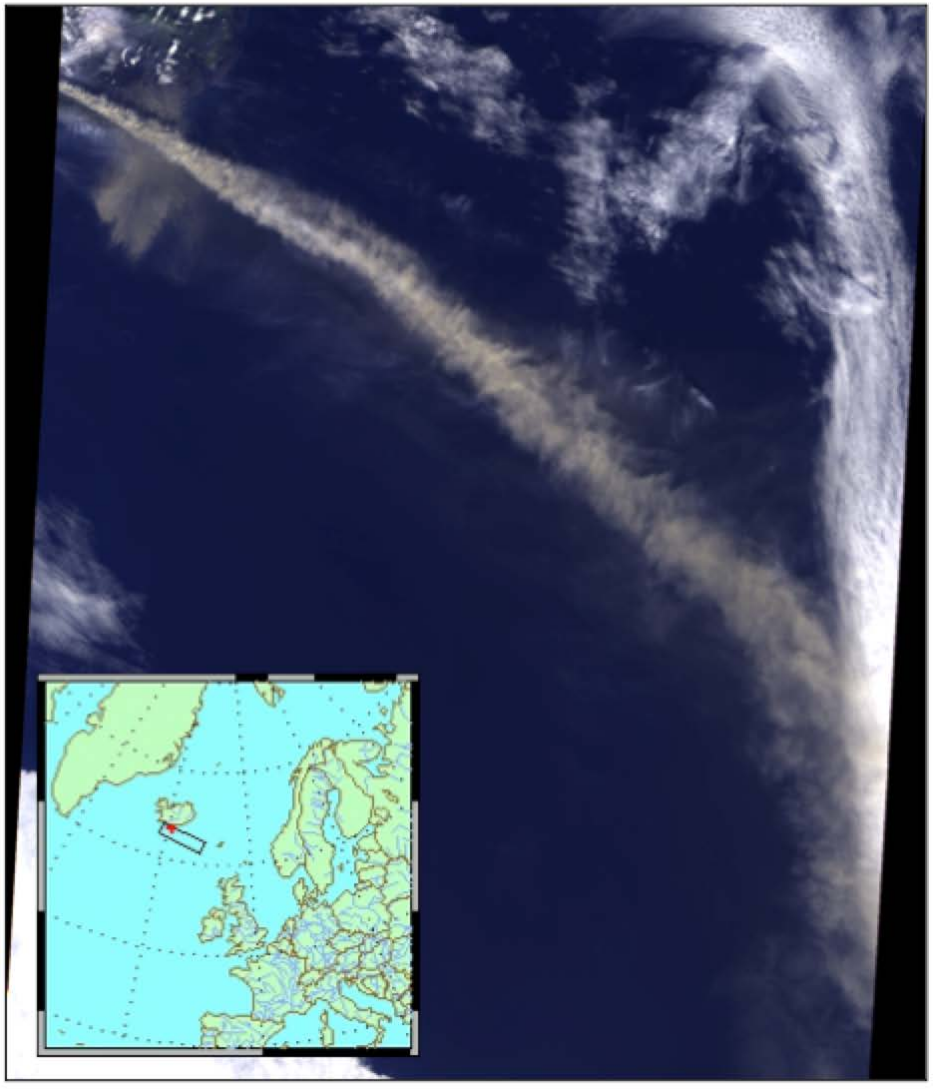
§Etna Eruption Time (UTC)	Mean AOD	AOD Range	AOD Sph. Fraction Mean	AOD Sph. Fract. Range	Small	Med	Large
***Ash*-Dominated, Both MISR & Surface Obs.**			**Mostly *Large*, *Non-Spherical***				
27 Oct 2002 at 10:00$	0.31	[0.04 0.58]	0.42	[0.1 1]	0.31	0.23	0.46
23 Dec 2002 at 09:54	0.11	[0.09 0.12]	0.43	[0.4 1]	0.40	0.11	0.49
30 Dec 2002 at 10:04$	0.11	[0.04 0.14]	0.76	[0 1]	0.35	0.16	0.49
***Sulfate/Water*-Dominated, Both MISR & Surface Obs.**			**Mostly *Small*, *Spherical***				
29 July 2001 at 10:01	0.18	[0.15 0.25]	0.93	[0.6 1]	0.77	0.09	0.13
23 Nov 2002 at 09:42$	0.13	[0.07 0.19]	0.97	[0.2 1]	0.56	0.24	0.20
08 Jan 2003 at 09:54	0.15	[0.13 0.16]	0.95	[0.8 1]	0.49	0.08	0.43
29 Sept 2006 at 09:52	0.22	[0.15 0.26]	0.87	[0.6 1]	0.75	0.13	0.12
16 Nov 2006 at 09:46	0.08	[0.05 0.13]	0.94	[0.6 1]	0.67	0.08	0.25
25 Nov 2006 at 09:46	0.10	[0.05 0.15]	1	[1 1]	0.61	0.03	0.36
Particle Type Surface Validation Data Lacking							
23 May 2000 at 10:08$	0.36	[0.26 0.38]	0.25	[0.2 0.4]	0.23	0.35	0.42
01 Jun 2000 at 10:02	0.14	[0.03 0.22]	0.89	[0.4 1]	0.72	0.15	0.13

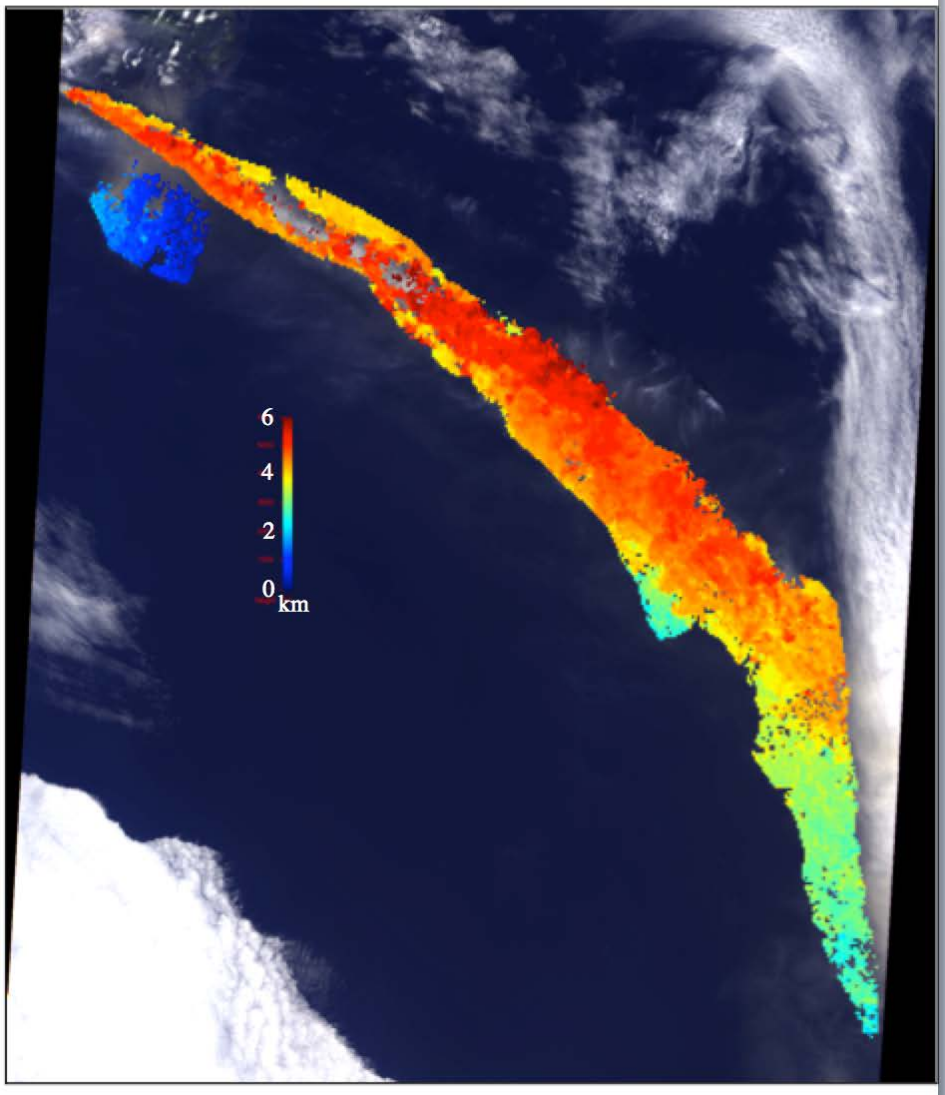
§ AOD Sph. Fraction Mean = Mean MISR-retrieved green band AOD value attributed to spherical particles
AOD Sph. Fract. Range = Range of MISR-retrieved green band AOD fraction attributed to spherical particles
Small = MISR-retrieved green-band AOD fraction of particles having small size (<0.35 μm radius)
Med = MISR-retrieved green-band AOD fraction of particles having medium size (0.35 < 0.7 μm radius)
Large = MISR-retrieved green-band AOD fraction of particles having large size (>0.7 μm radius)
$ Volcanic ash detected by MODIS

Scollo et al., JGR 2012

MISR Stereo-Derived Plume Heights

07 May 2010 Orbit 55238 Path 216 Blk 40 UT 12:39

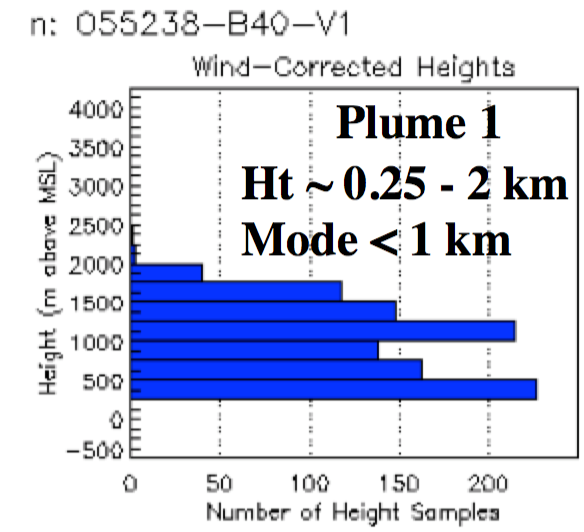




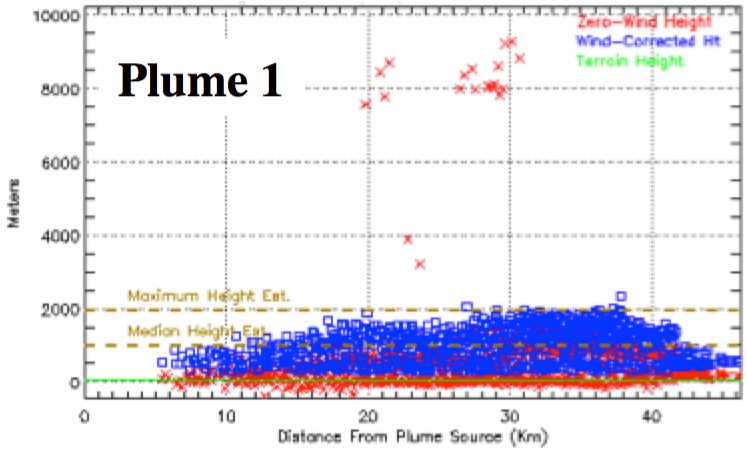
D. Nelson and the MISR Team, JPL and GSFC

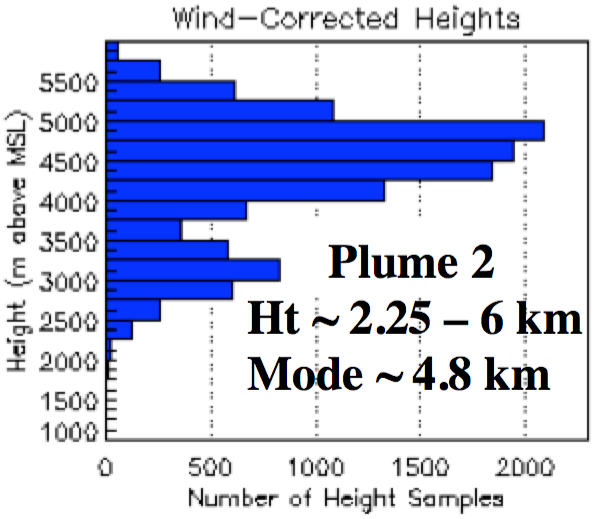
MISR Stereo-Derived Plume Heights

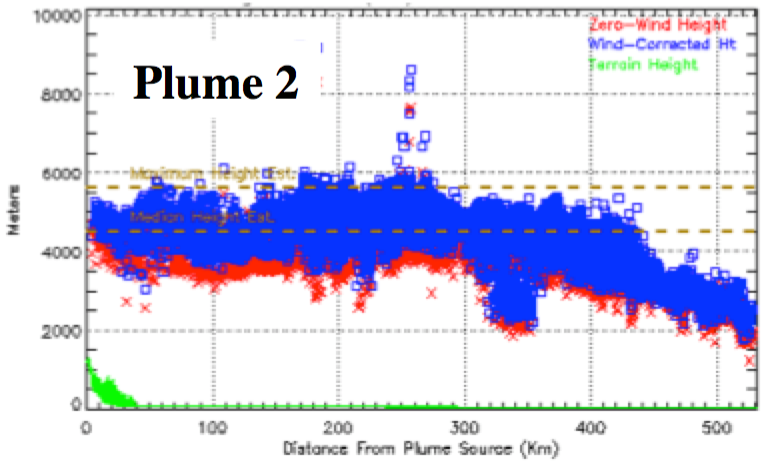
07 May 2010 Orbit 55238 Path 216 Blk 40 UT 12:39



Height: Blue = Wind-corrected



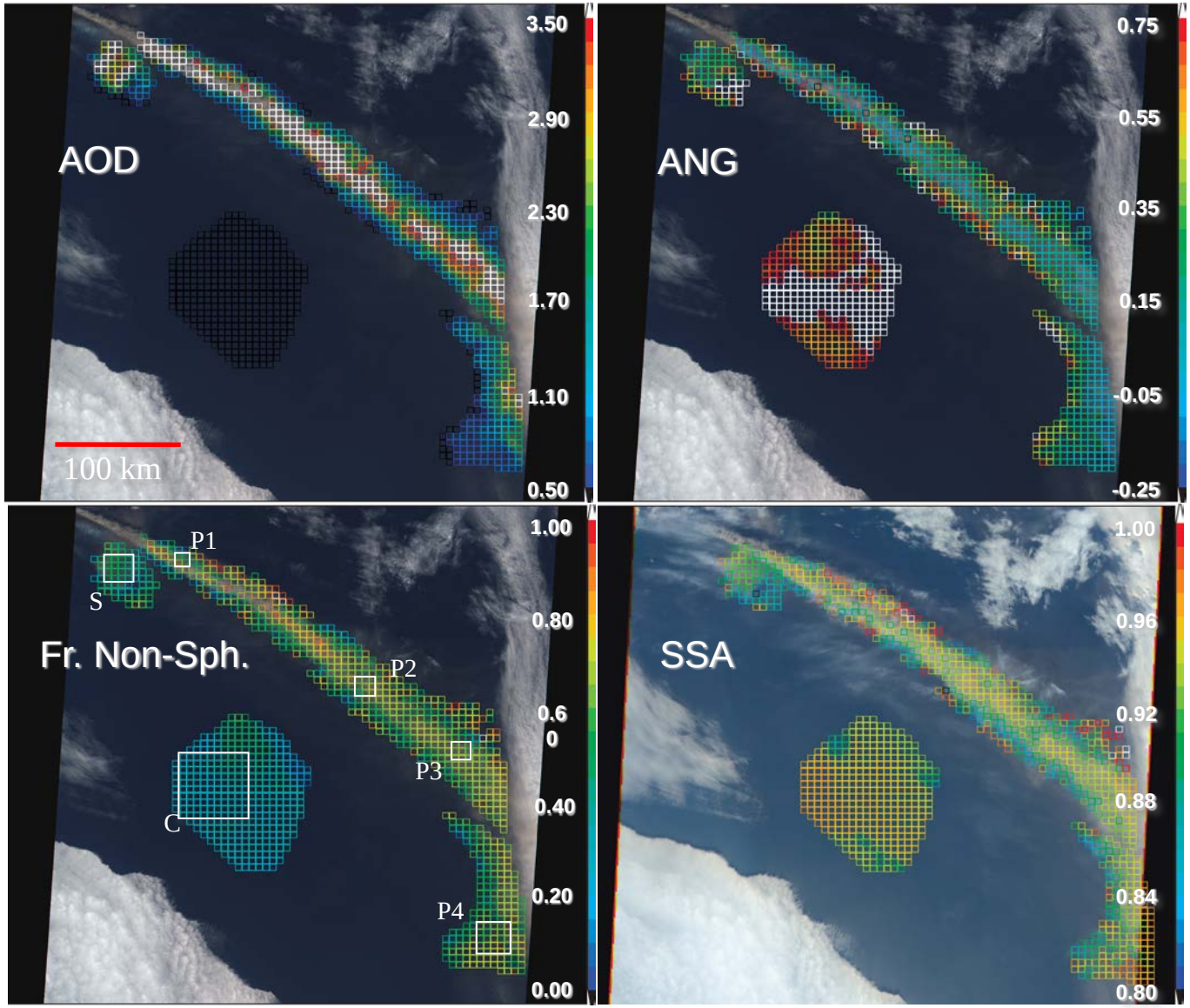




D. Nelson and the MISR Team

MISR Research Aerosol Retrievals

07 May 2010 Orbit 55238 Path 216 Blk 40 UT 12:39



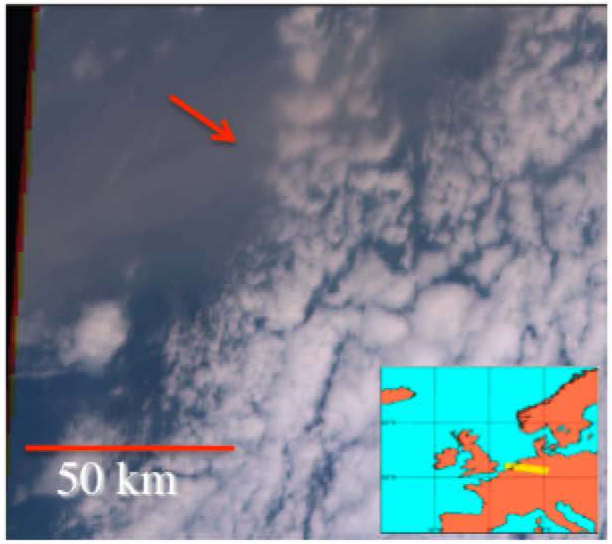
Plume Particles

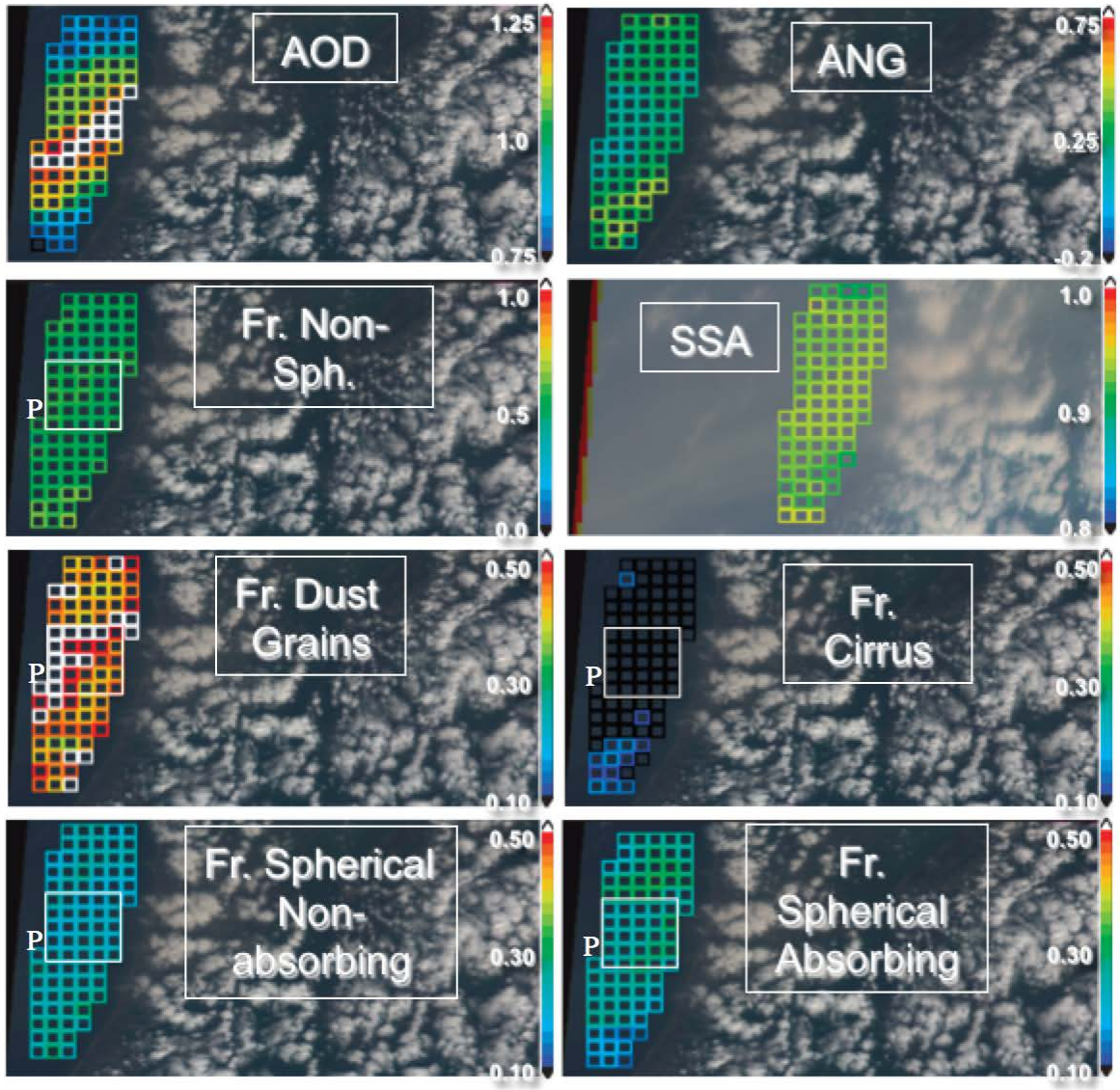
- Distinct from background
  - -- ***larger***, ***darker***
  - -- ***much higher AOD***
- ***Non-spherical*** dominated
- Brighten downwind
- Tend to decrease in size downwind

Kahn & Limbacher, ACP 2012

MISR Research ***Aerosol Retrievals***

16 April 2010 *Orbit 54931 Path 197 Blk 49 UT 10:45*





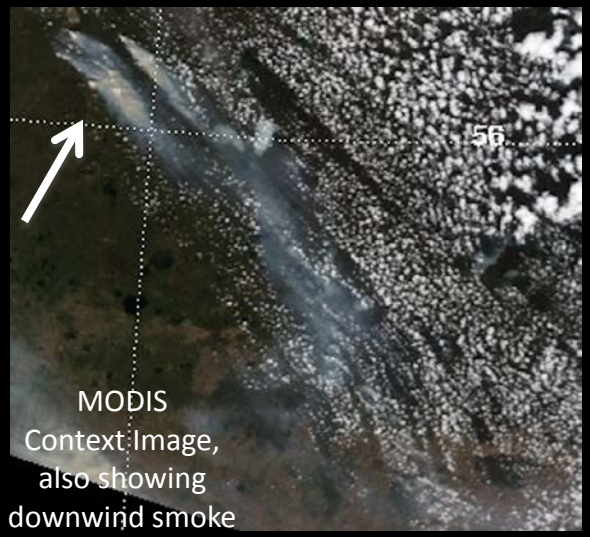
- ***1-2 days downwind*** of Iceland volcano source
- Distinctly ***high AOD*** (peak >1.25)
- Retrieved ~50% AOD ***non-spherical*** dust grains
- ***Medium*** particles ~ no "cirrus"
- Model ***back-trajectory needed*** to identify plume confidently

Kahn & Limbacher, ACP 2012

Ft. McMurray Wildfire Smoke Plume Heights

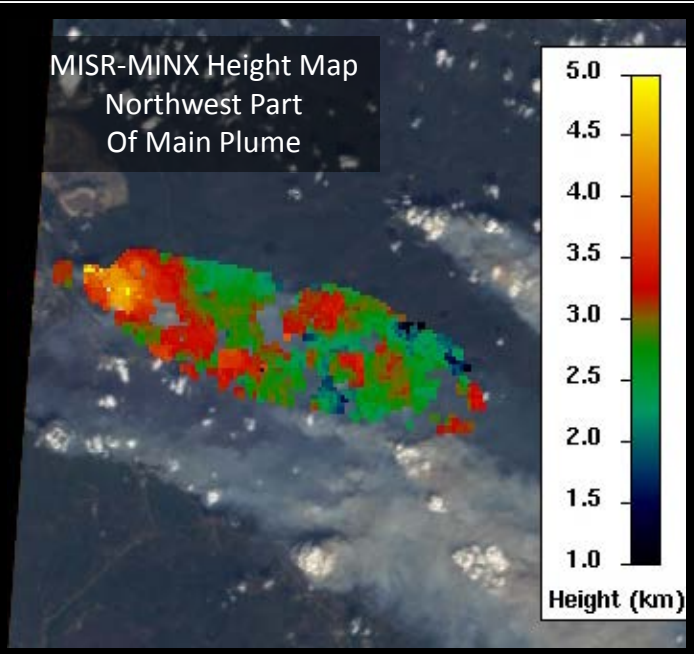
MISR Active Aerosol Plume-Height (AAP) Project 06 May 2016

The ***height*** at which smoke is lofted into the atmosphere affects ***how long*** it will stay aloft, ***how far*** it will travel, and ***how much of an impact*** it will have on air quality downwind, and regional climate.

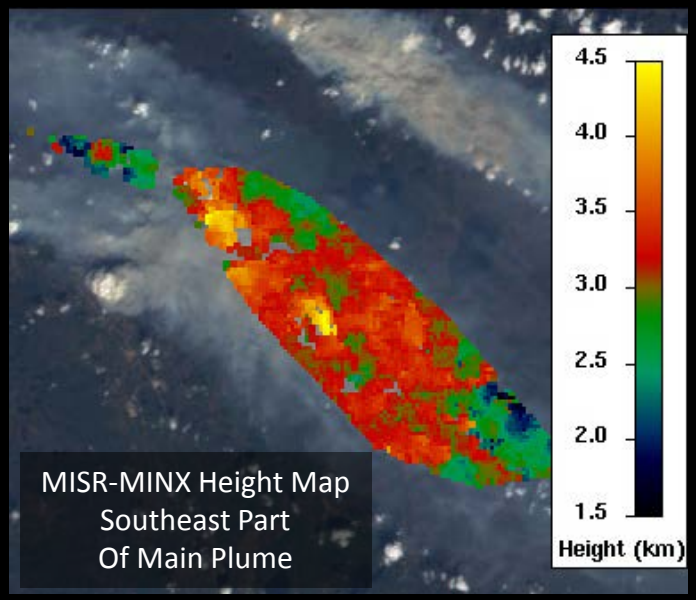


MODIS Context Image, also showing downwind smoke

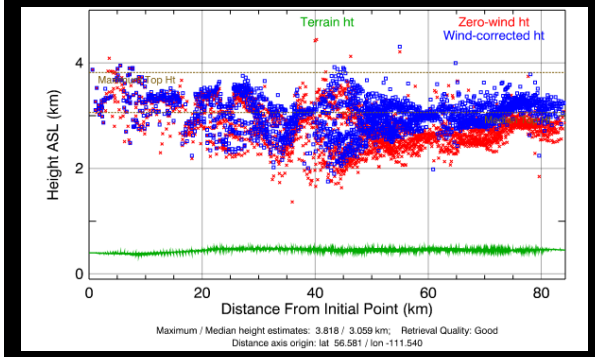
Parallax, the change in apparent plume position relative to the surface, as observed from the NASA Earth Observing System's Multi-angle Imaging Spectroradiometer (***MISR***) instrument, makes it possible to map the height of ***smoke***, ***dust***, and ***volcanic plumes*** near-source, where plume features are visible in the multi-angle views.



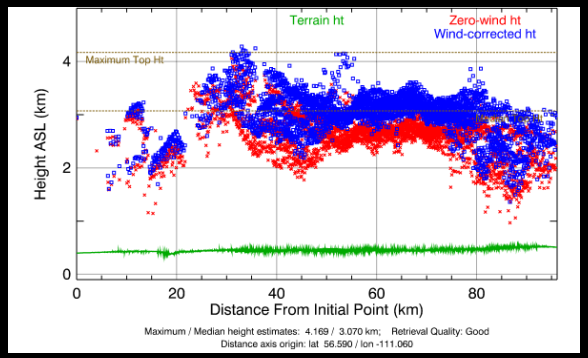
MISR-MINX Height Map
Northwest Part
Of Main Plume



MISR-MINX Height Map
Southeast Part
Of Main Plume



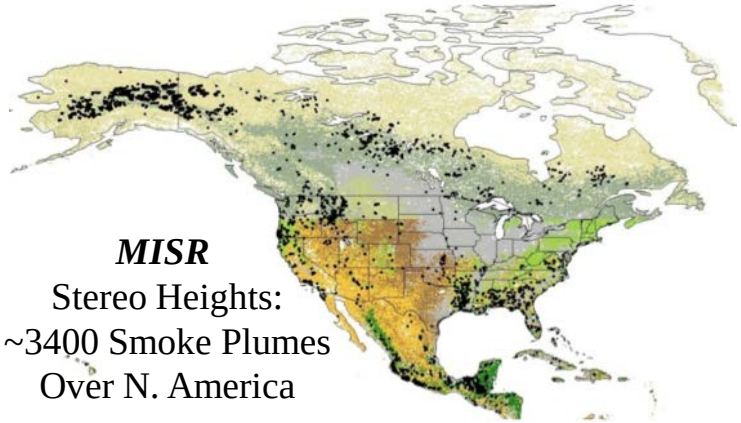
Zero-wind & Wind-Corrected
MISR Height Profiles
Downwind from Near-source



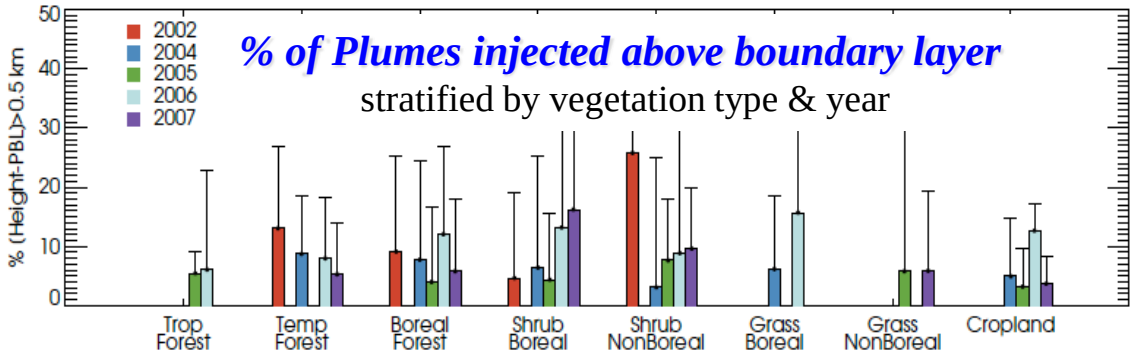
R. Kahn, **T. Kucsera** / NASA GSFC
T. Canty, **R. Bolt**, **CJ Vernon** / U. Maryland

Wildfire Smoke *Injection Heights* & *Source Strengths*

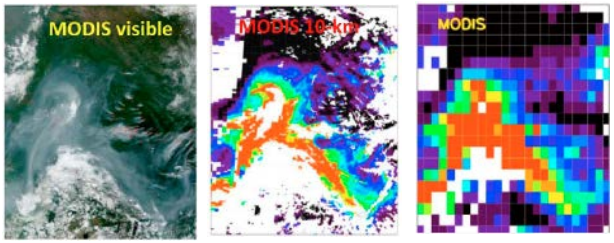
[These are *the two key parameters* representing aerosol sources in climate models]



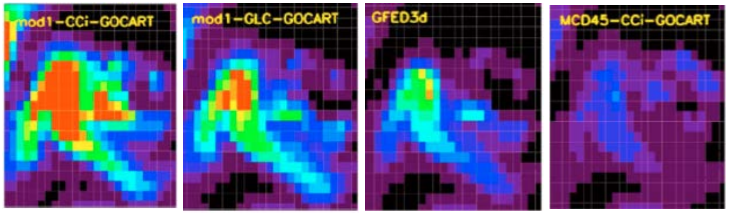
MISR
Stereo Heights:
~3400 Smoke Plumes
Over N. America



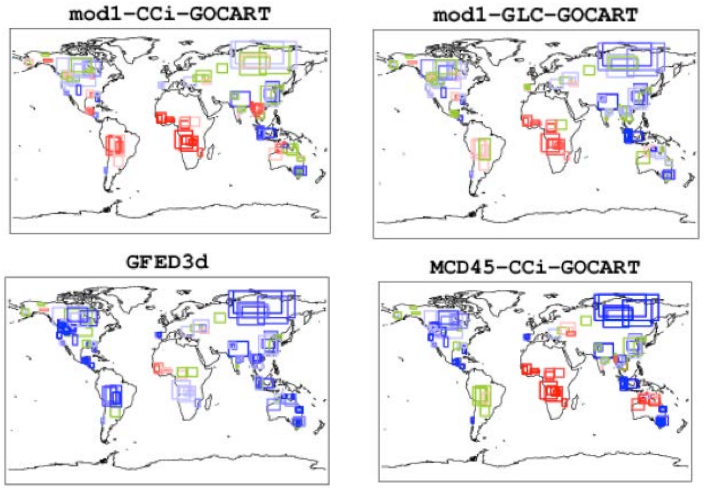
Val Martin et al. ACP 2010



MODIS Smoke Plume Image & Aerosol Amount Snapshots



GoCART Model-Simulated Aerosol Amount Snapshots
for *Different Assumed Source Strengths*



Different Techniques for *Assuming Model Source Strength*
Overestimate or ***Underestimate*** Observation
Systematically in Different Regions

Petrenko et al., JGR 2012

NASA Volcano Eruption Response Workshop Summary

- Desire to consider in advance ***how best to respond*** to a major eruption
  - Develop a realistic plan to ***maximize science***
  - Provide any appropriate ***societal support***
  - Key elements: ***coordination***, ***cooperation***, ***advance planning***

- Main ***response components***
  - Surface Networks (lidars, sun photometers)
  - Balloons
  - Aircraft
  - Satellites
  - Models

- Response ***time-scales***
  - $\leq$ 1 Hour
  - 1-6 Hours
  - ~ One Day
  - One Week
  - $\geq$ One Month

- A ***report*** is being complied