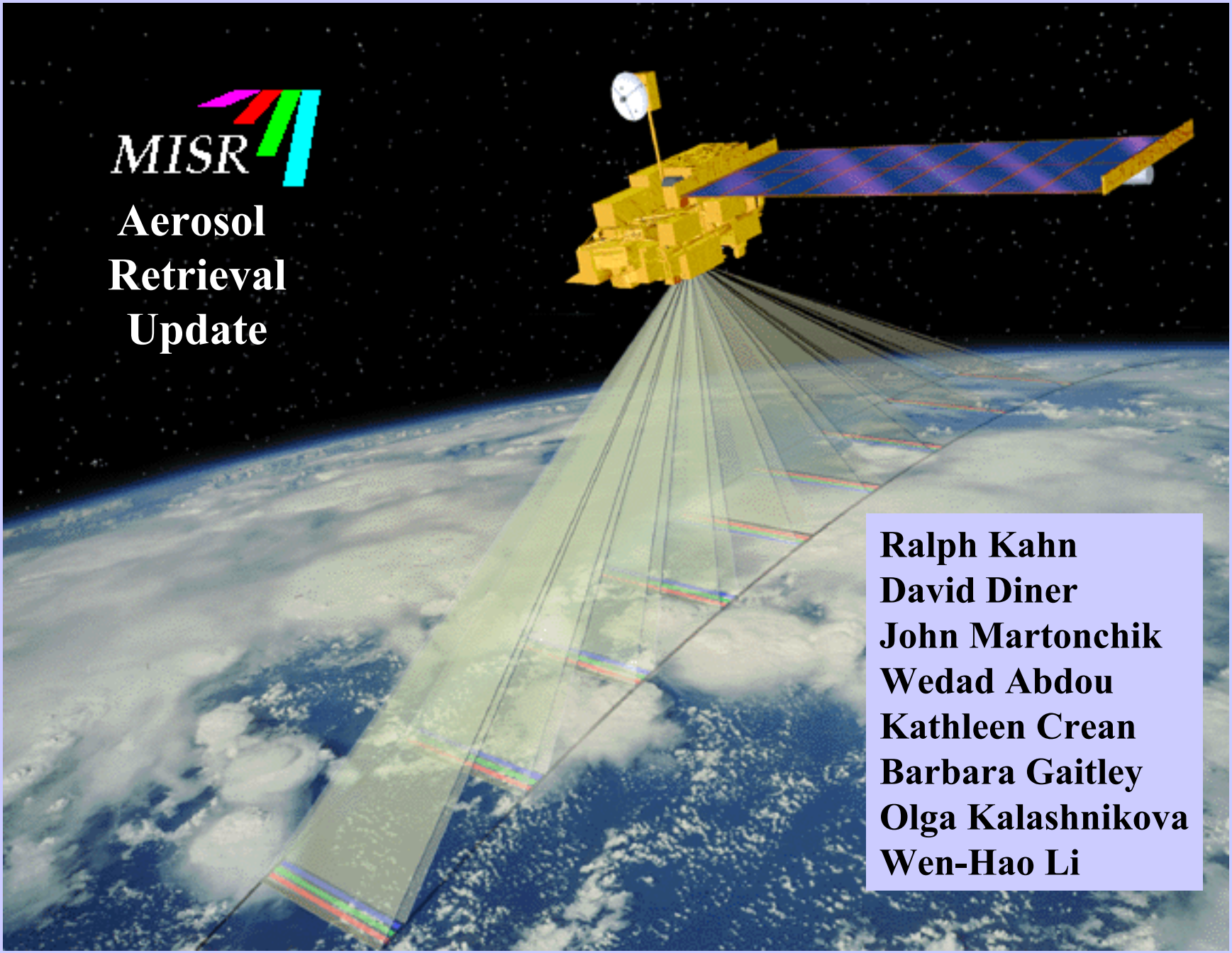
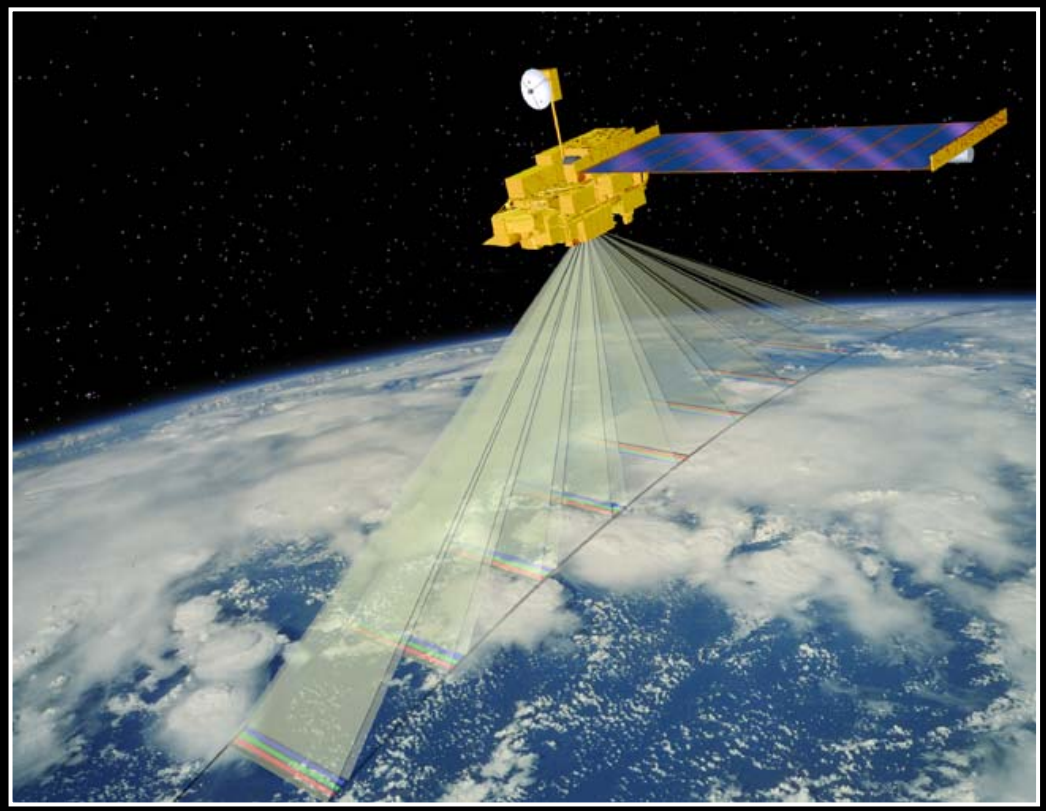

MISR
Aerosol
Retrieval
Update
Ralph Kahn
David Diner
John Martonchik
Wedad Abdou
Kathleen Crean
Barbara Gaitley
Olga Kalashnikova
Wen-Hao Li

MISR

Multi-angle Imaging SpectroRadiometer



Nine view angles at Earth surface: 70.5º forward to 70.5º aft

Four spectral bands at each angle: 446, 558, 672, 866 nm

Seven minutes to observe each scene at all 9 angles

400-km swath

Global coverage about once per week

275 m - 1.1 km spatial sampling

Air mass factors from 1 (nadir) to 3

Scattering angles from ~60˚ to ~160˚ in mid-latitudes

MISR MULTI-ANGLE CAPABILITY – MORE INFORMATION ABOUT AEROSOLS

EXPECATIONS based on simulations over cloud-free, calm ocean:

- **Aerosol Extinction Optical Depth (τ_a)**

  -- to better than 0.05 or 20%, whichever is larger, under typical conditions, for commor aerosol types except soot, even if the particle microphysical properties are poorly know

- **Particle Size (r_a)**

  -- "Small," "Medium," and "Large" size discrimination over Accumulation Mode -- these are the key distinctions needed to assess aerosol impact on vis spectrum

- **Indices of Refraction (nr, ni)**

  -- Two to four compositional groups
  (absorbing & non-absorbing, or "dark" and "light")

- **Spherical vs. Nonspherical** for Sahara dust, Asian dust, and possibly thin cirrus

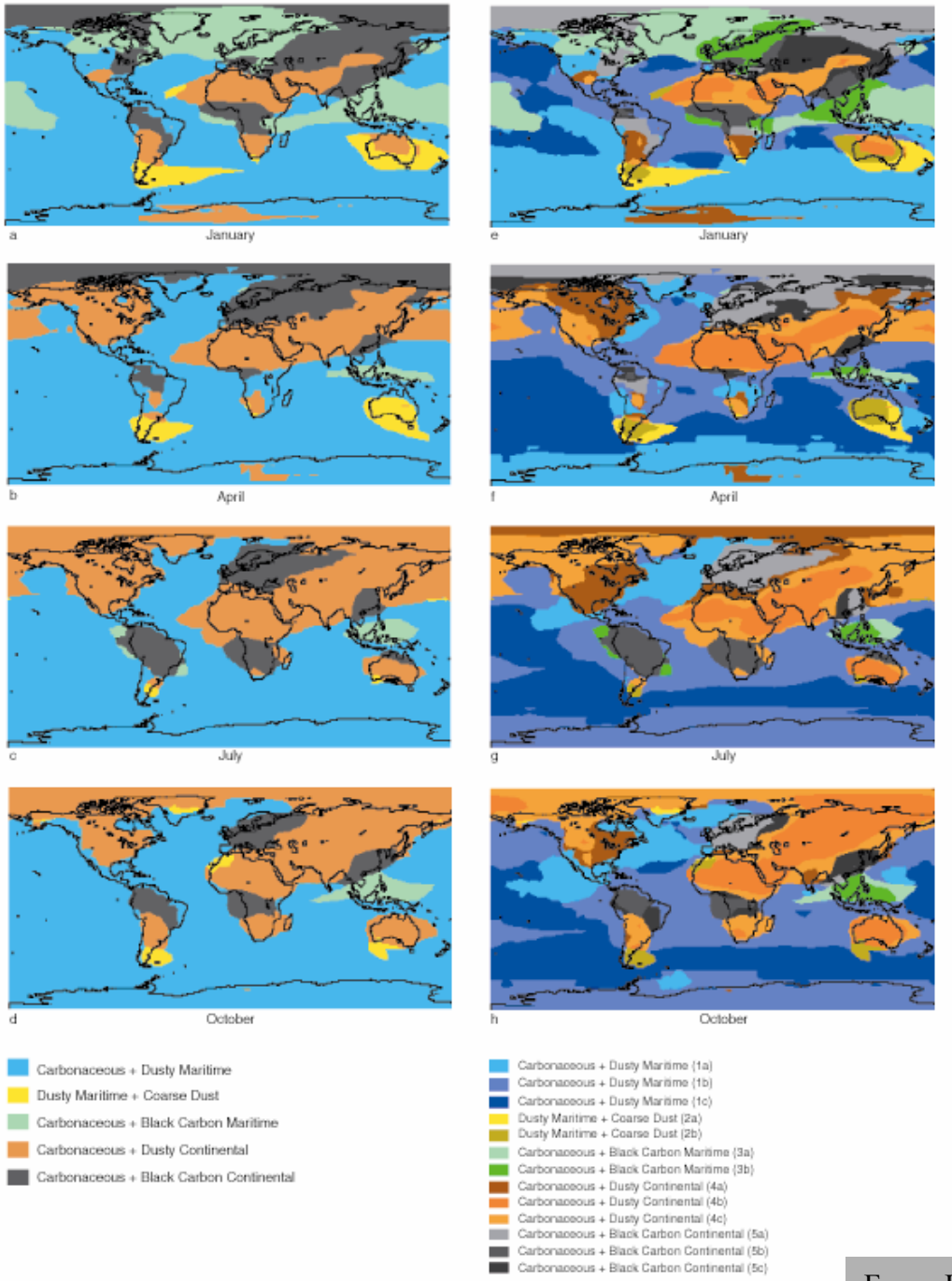
- **Poorer Sensitivity for ni >~ 0.008 (Black Carbon)**

➔ Under good conditions, we expect MISR to distinguish **about 12 aerosol types** based on size, shape, and composition

MISR Multi-angle Aerosol Retrieval Strengths -

- Sensitivity to Aerosols over Land
- Sensitivity to Aerosol over Very Bright Surfaces (e.g., Desert)
- Sensitivity to Particle Sphericity at least over dark water
- Sensitivity to Bi- and even Tri-modal Distributions in some cases
- Crude Sensitivity to Single-Scattering Albedo [~ 1.0 vs. 0.88 vs. 0.80 over dark water]
- Sensitivity to Optically Thin hazes over land and water
- Sensitivity to Plume Height

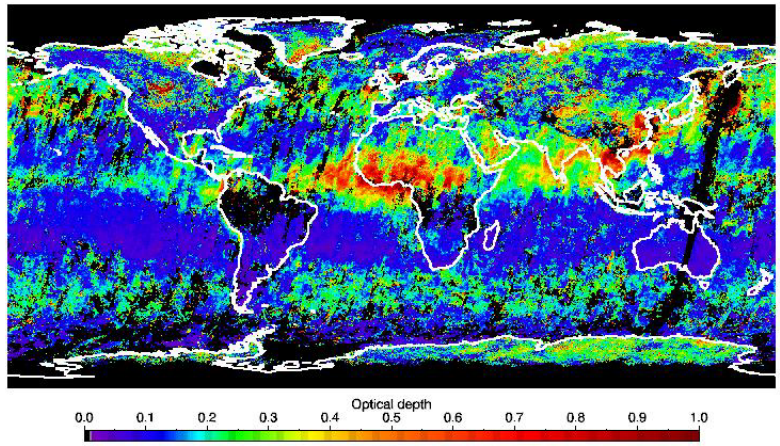
Simulated
Global, Monthly
Aerosol Maps
Based on Expected
MISR Sensitivity



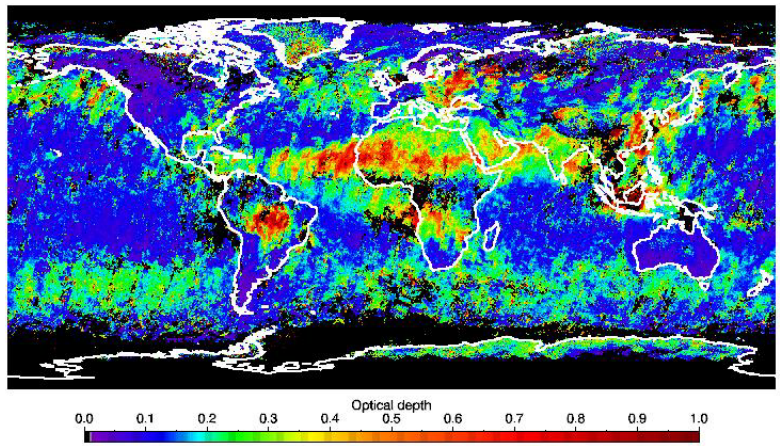
From: Kahn et al., 2001

Global Aerosol Optical Depth Products

MISR optical depths (558 nm)



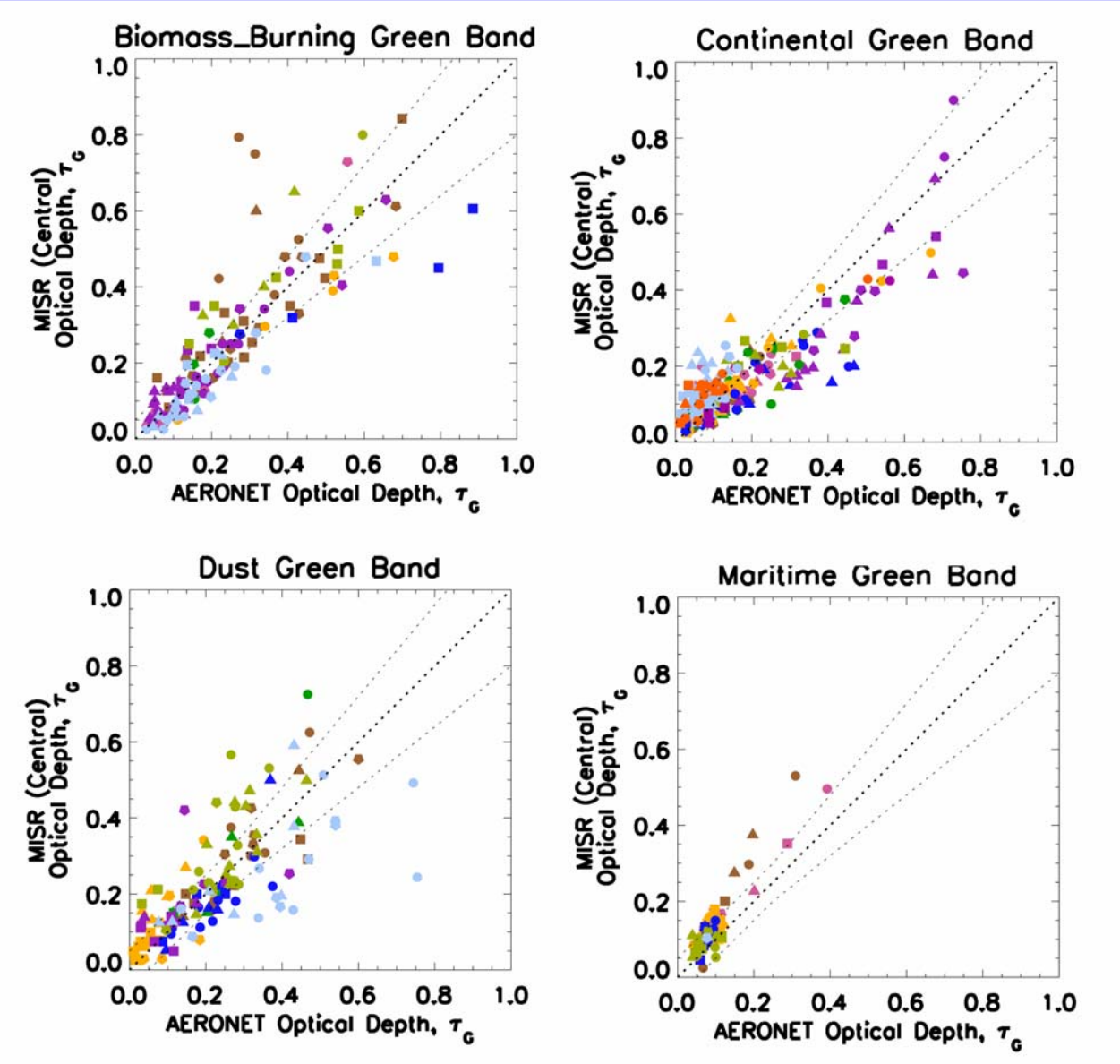
March 2002



September 2002

Scatter Plots Showing 579 MISR-AERONET Coincident AOT Events

32 sites, during 2001-2002; Stratified by Expected Aerosol Type



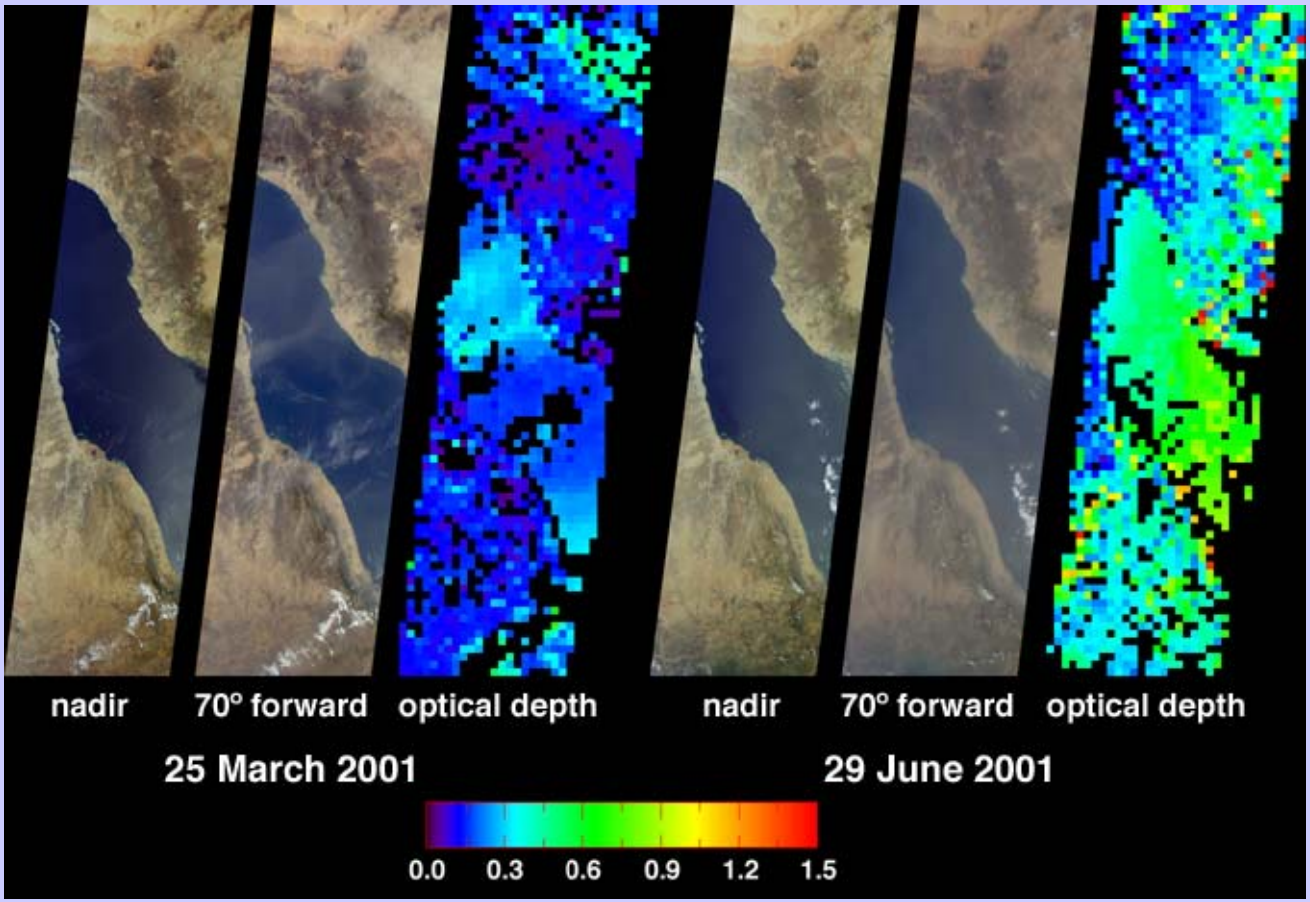
Overall:

- **About 2/3 fall within 0.05 or 20% * AOT**
- **About 1/3 fall within 0.02 or 10% * AOT**

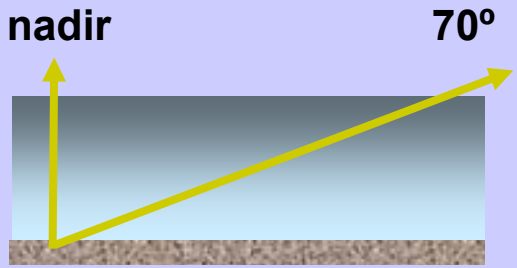
Correlation Coeffs. > 0.8 in all categories except Dusty, which are > 0.72

From: Kahn, et al., 2004, JGR (submitted)

Sensitivity to aerosols over bright surfaces



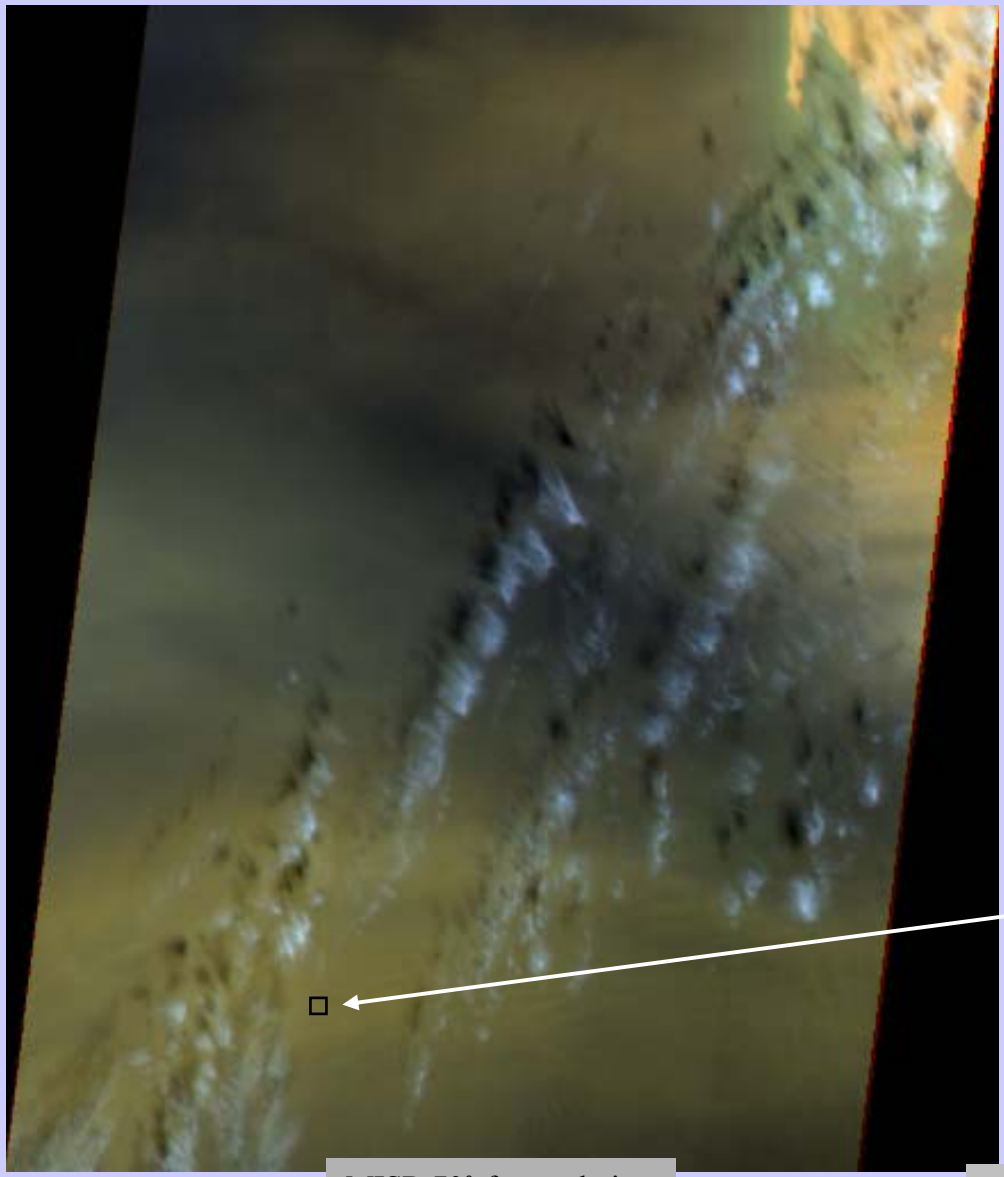
Thin haze over land is difficult to detect in the nadir view due to the brightness of the land surface



Saudi Arabia, Red Sea, Eritrea

Over Bright Desert Sites, mid-vis. AOT to ±0.07 [Martonchik et al., GRL 2004, submitted]

Particle Sphericity -- Optically Thick Saharan Dust Plume over Dark Water
Near Cape Verde, March 02, 2003



MISR Research Retrieval Results

AOT_{MISR} = 2.3

AOT_{ARNT} = 2.2

75% medium grains (2% hematite)
15% coarse spheroids (2% hematite)
5% medium non-absorbing spheres
5% coarse non-absorbing spheres (Sea Salt)

Primary Research Retrieval Patch

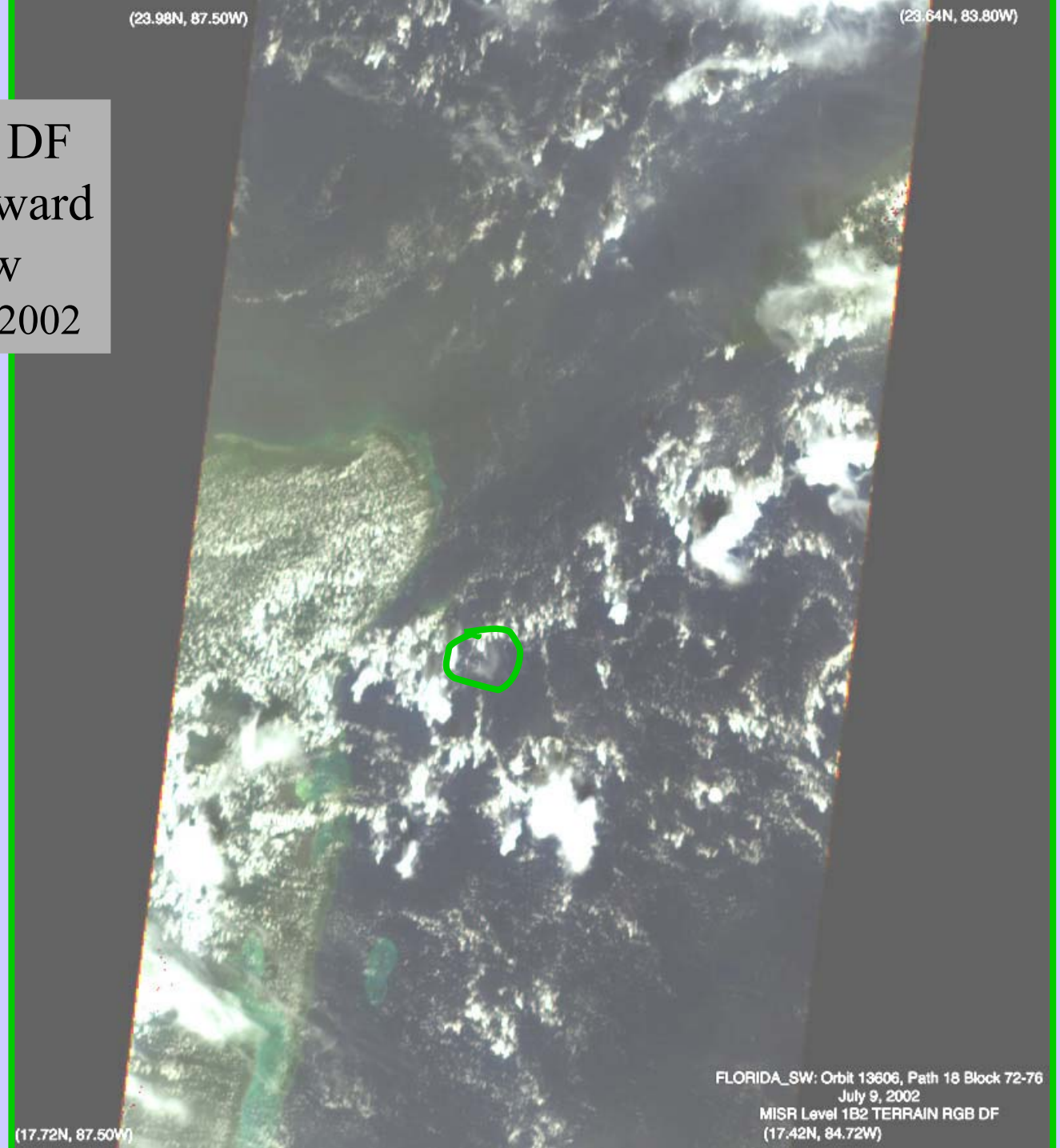
Cape Verde AERONET Station

*

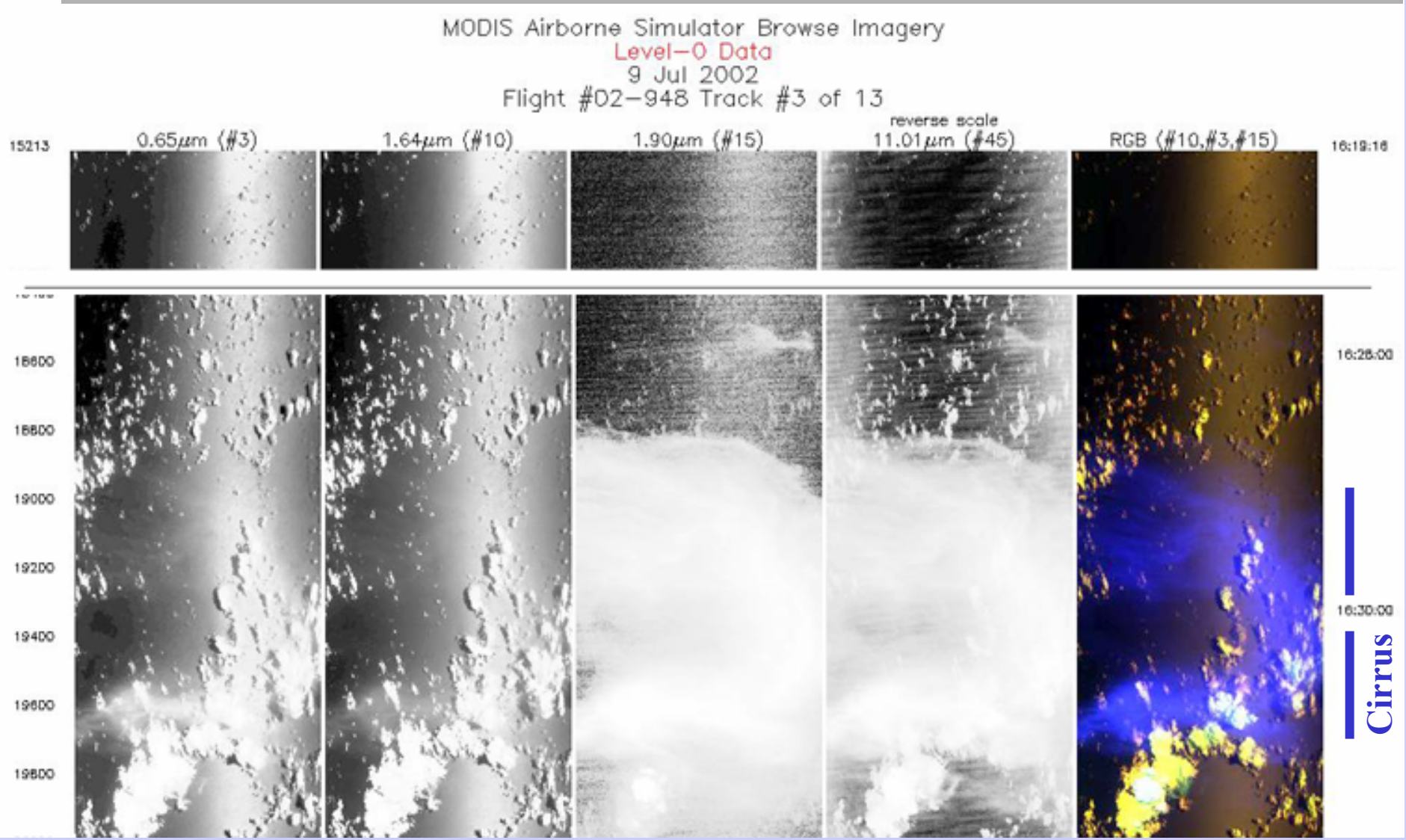
MISR 70°-forward view

From: Kalashnikova, et al., 2004, JGR (submitted)

MISR DF
70° Forward
View
July 09, 2002



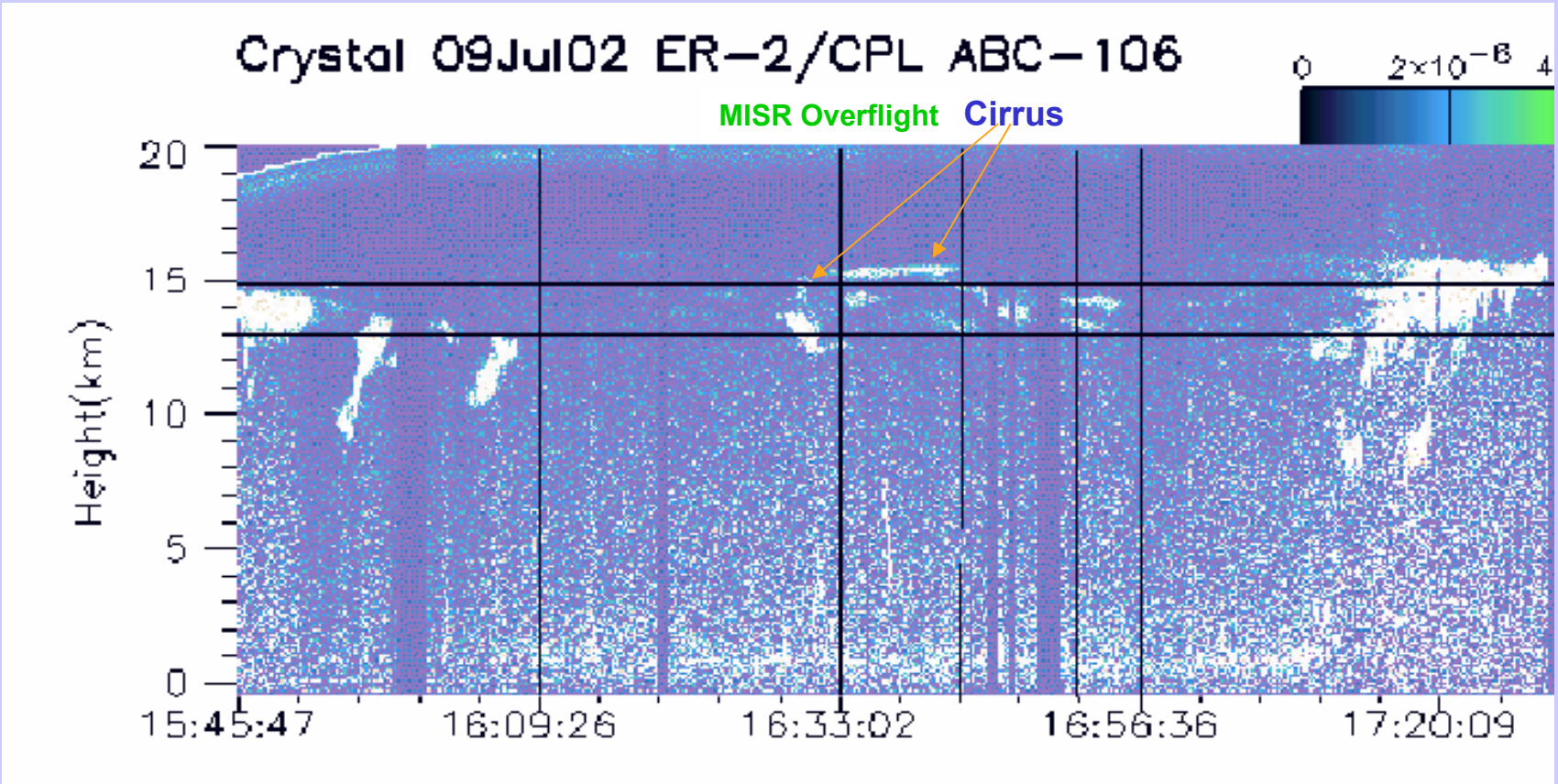
MAS: MODIS Airborne Simulator - ER-2, July 09, 2002



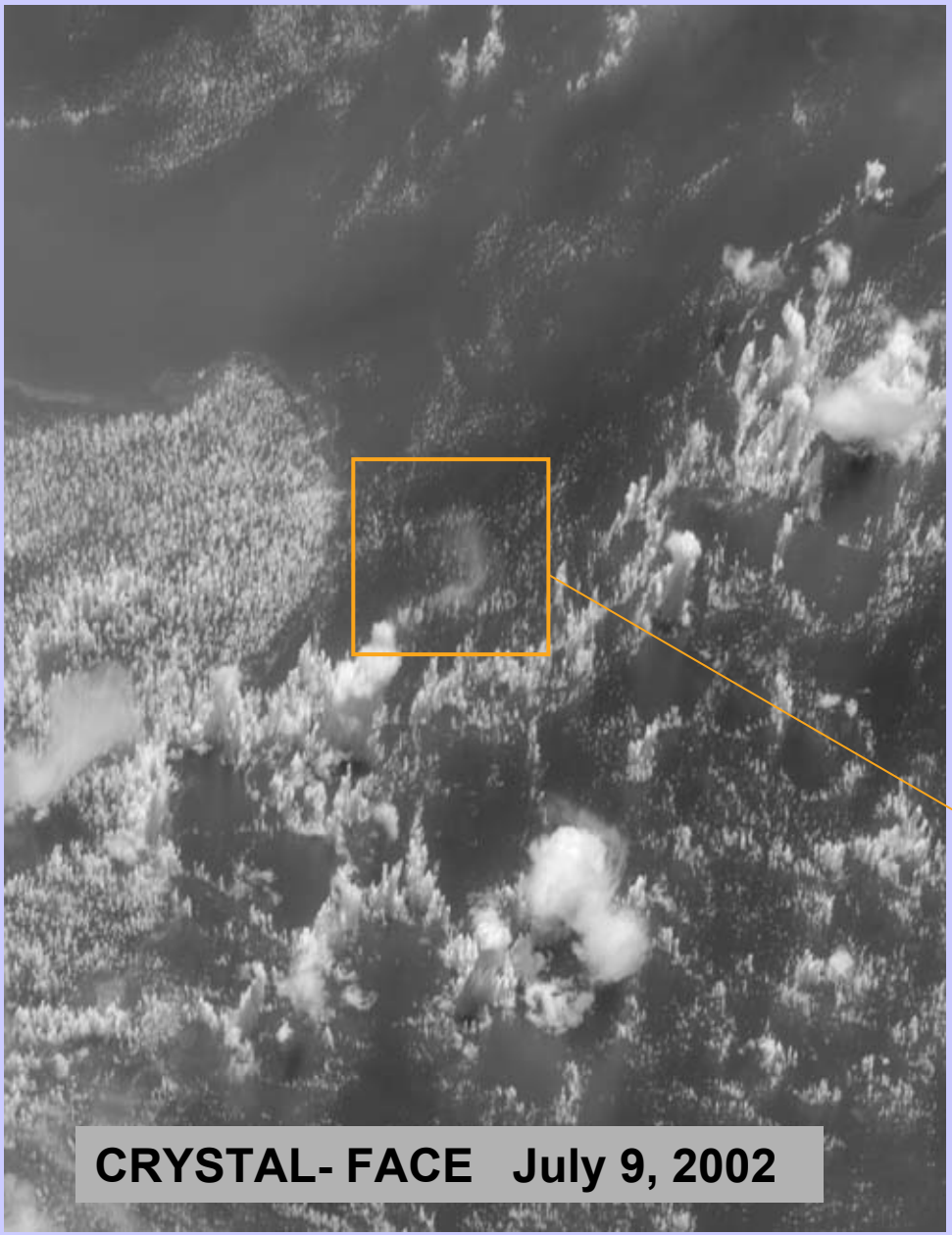
ER-2: 16:29 to 16:31 UTD; 20.70 to 20.48 N lat.; 86.45 to 86.51 W lon.; 20.39 to 24.45 km elev.

WB-57: 16:33:52 to 16:36:00 UTC [59632 to 59760]; 20.71to 20.48 N lat.; 86.45 to 86.51 W lon; 15.47 to 15.45 km elev.

CPL: Cloud Physics LIDAR - ER-2



Multi-Modal Distributions and Particle Sphericity



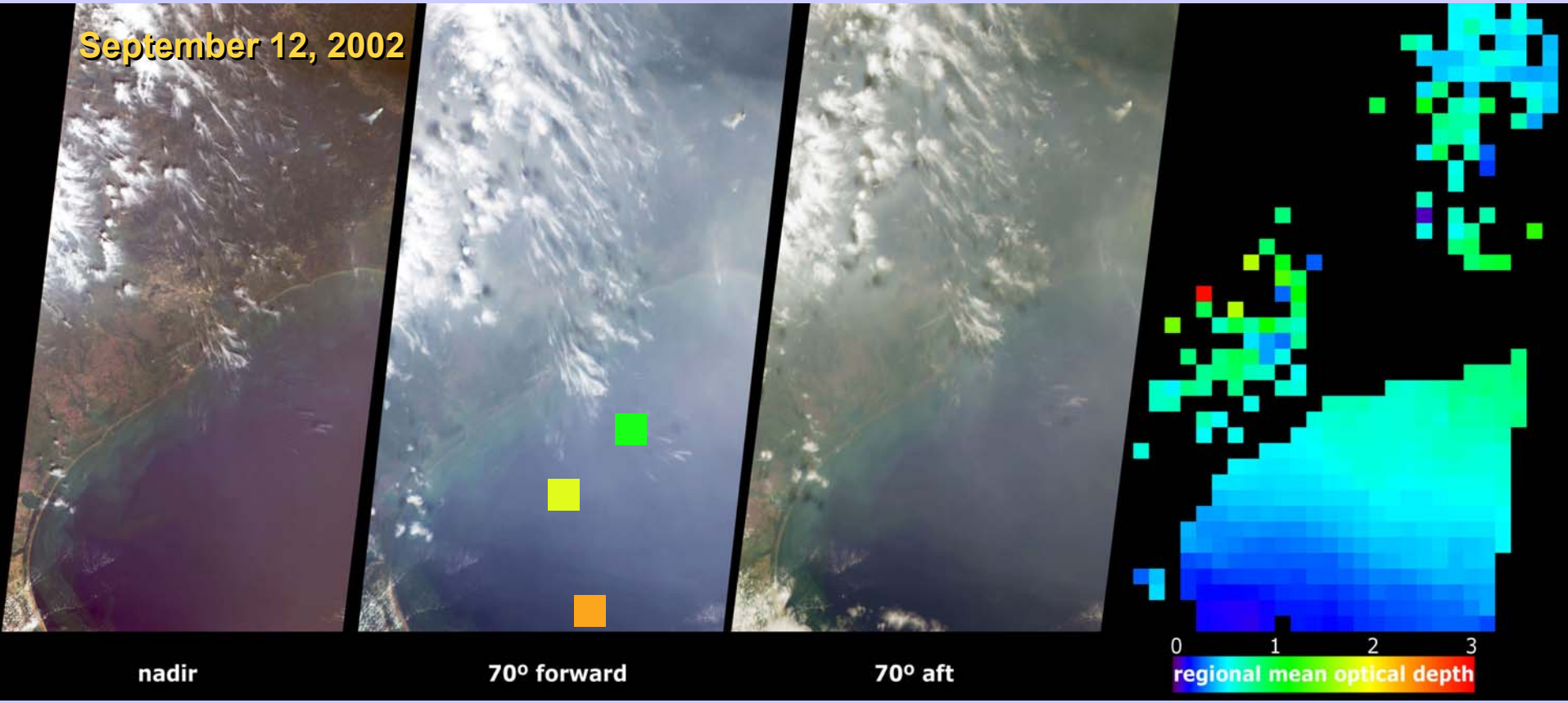
MISR Research retrieval Identified Three aerosol components:

- **Thin Cirrus**
  - **confirmed by MAS instrument**
- **Background Maritime**
  - **medium, spherical, non-absorbing**
- **Sahara Dust**
  - **predicted by NAPS model**
  - **measured by PALMS**

Optical depth (558 nm) = 0.20
35% cirrus
50% small spherical non-absorbing
15% dust

Pollution Particle Amount, Size, and Single Scattering Properties

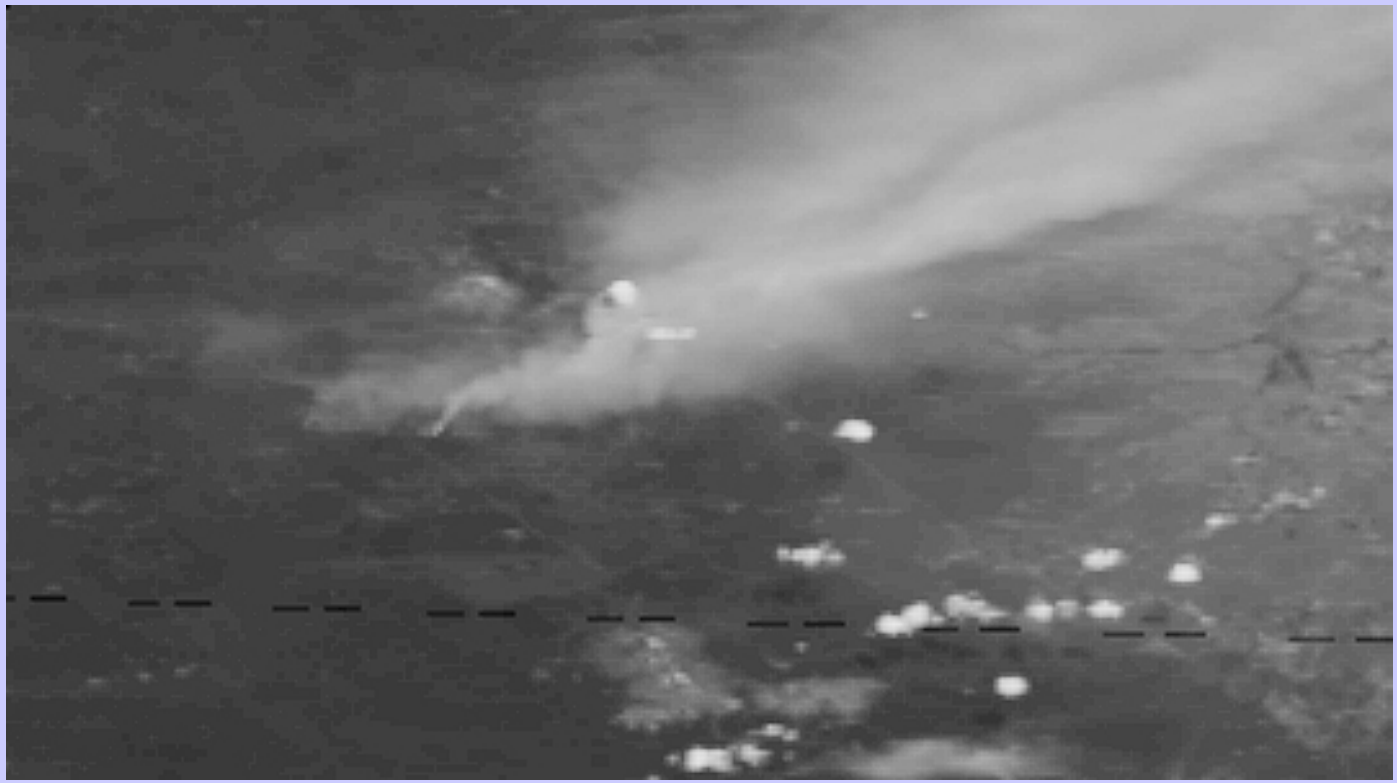
Galveston Bay near Houston, TX, September 12, 2002



MISR Research retrieval: mixtures of small & medium, spherical, low-absorbing particles

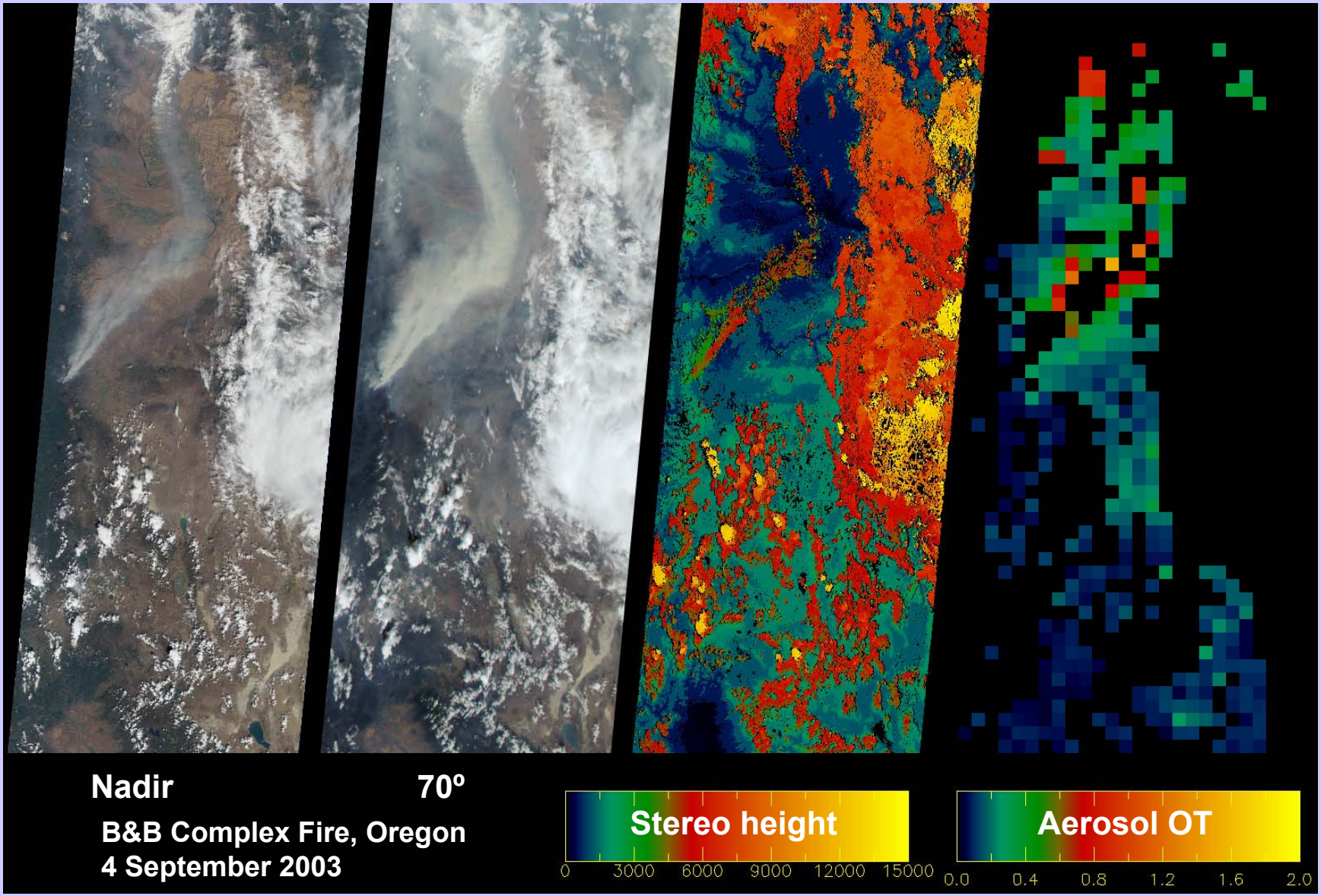
558 nm AOT	Component 1	Component 2	Component 3
0.60	60% spherical r_{eff} = 0.12 μm	35% spherical r_{eff} = 0.26 μm	5% cirrus
0.45	85% spherical r_{eff} = 0.12 μm	15% spherical r_{eff} = 0.57 μm	--
0.25	85% spherical r_{eff} = 0.12 μm	15% spherical r_{eff} = 0.57 μm	--

Perspective views from 5 angles

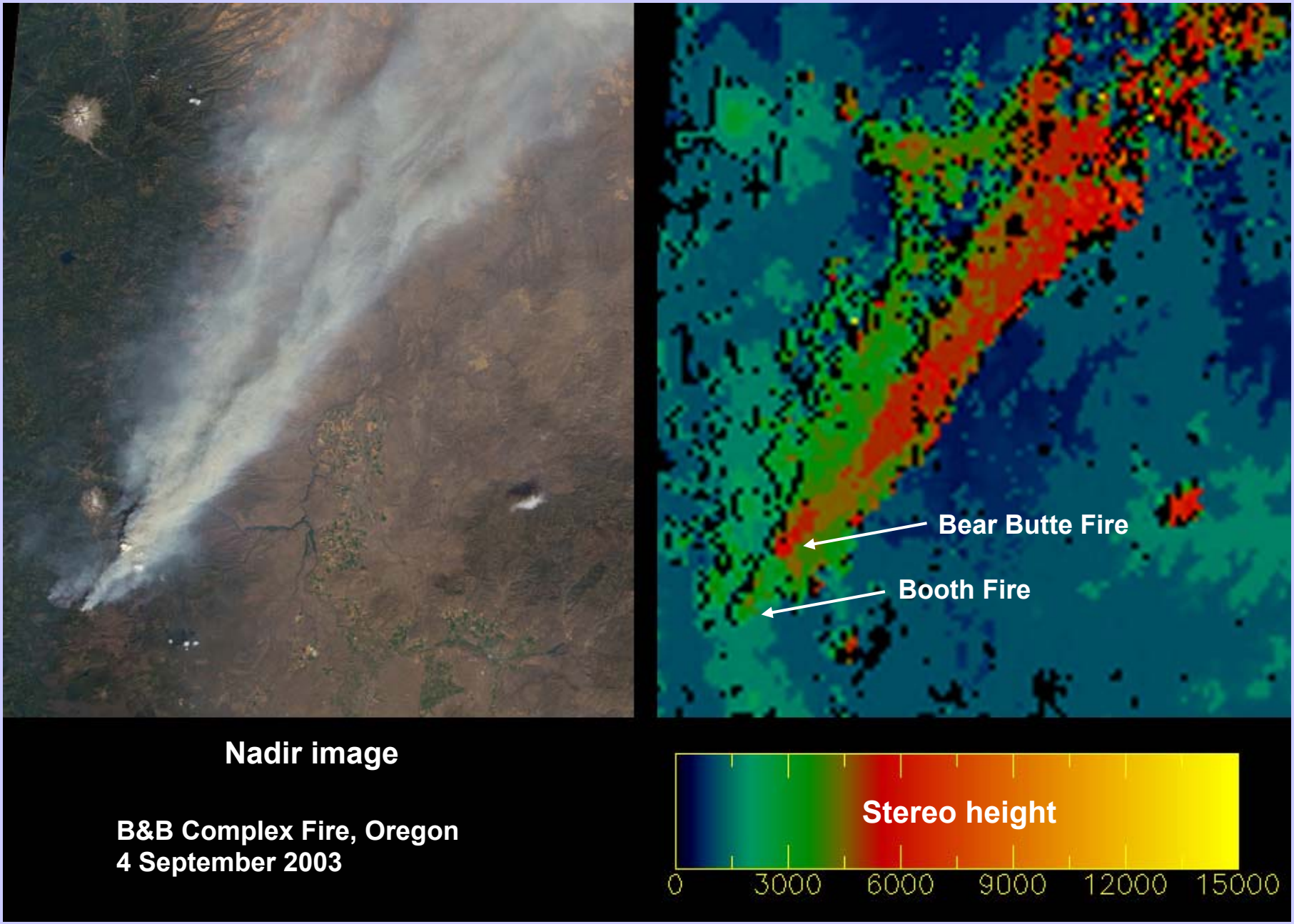


B&B Complex Fire, Oregon
4 September 2003

Aerosol Plume Observations

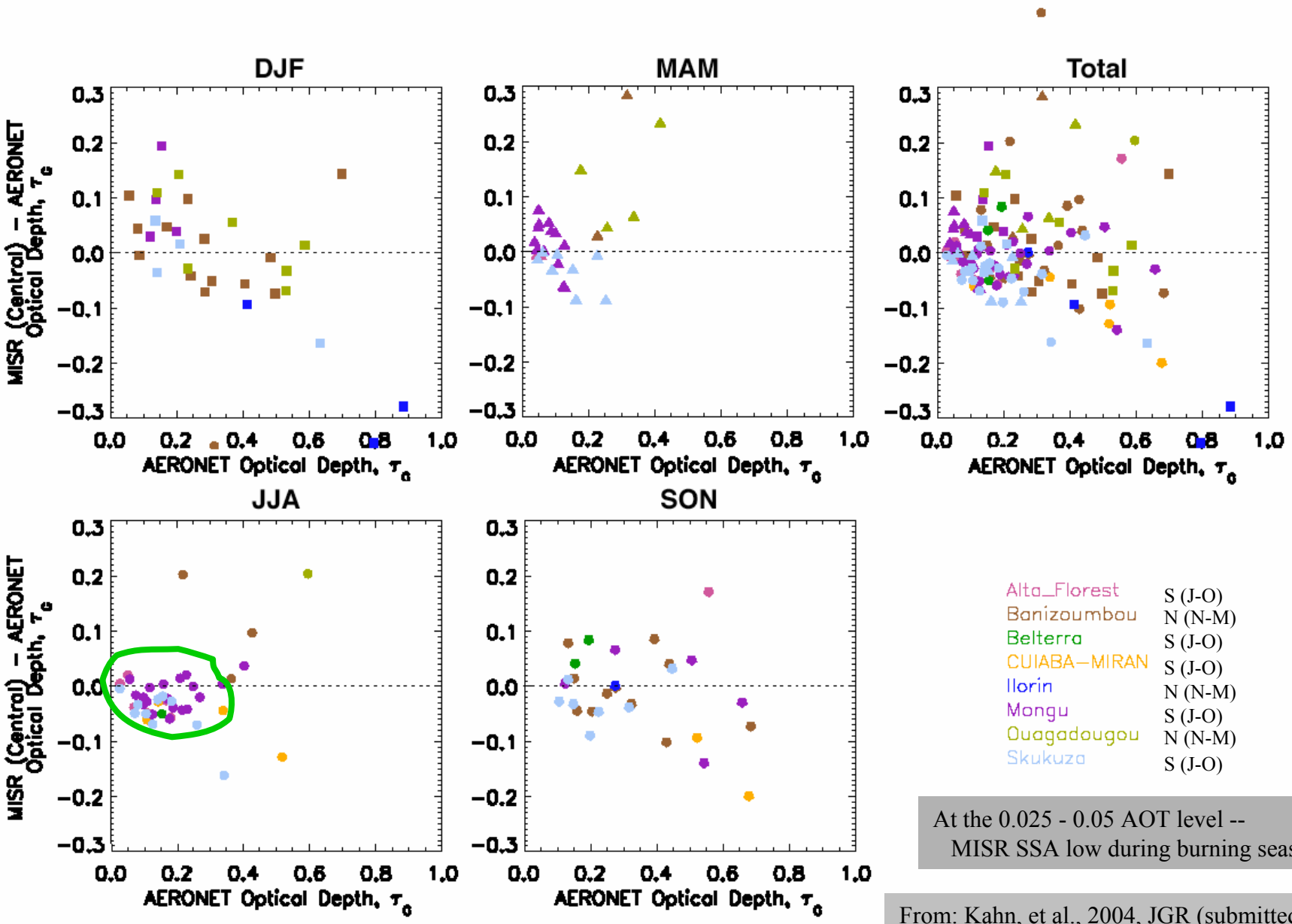


Plume-height mapping using stereo (detail)



135 MISR-AERONET Coincident AOT Difference Plots

Biomass Burning Sites; 2001-2002; Stratified by Season

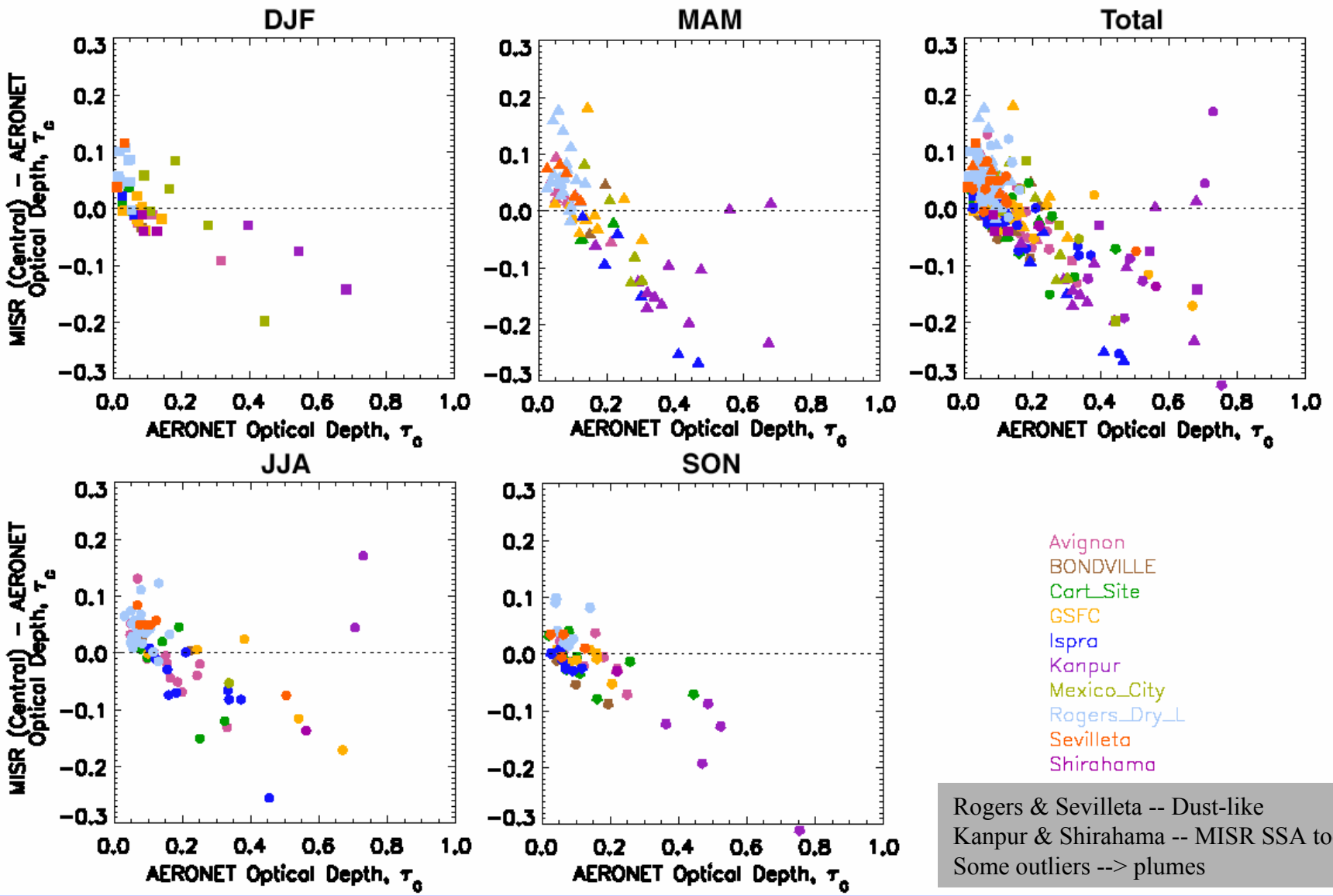


At the 0.025 - 0.05 AOT level --
MISR SSA low during burning season

From: Kahn, et al., 2004, JGR (submitted)

247 MISR-AERONET Coincident AOT Difference Plots

Continental Sites; 2001-2002; Stratified by Season

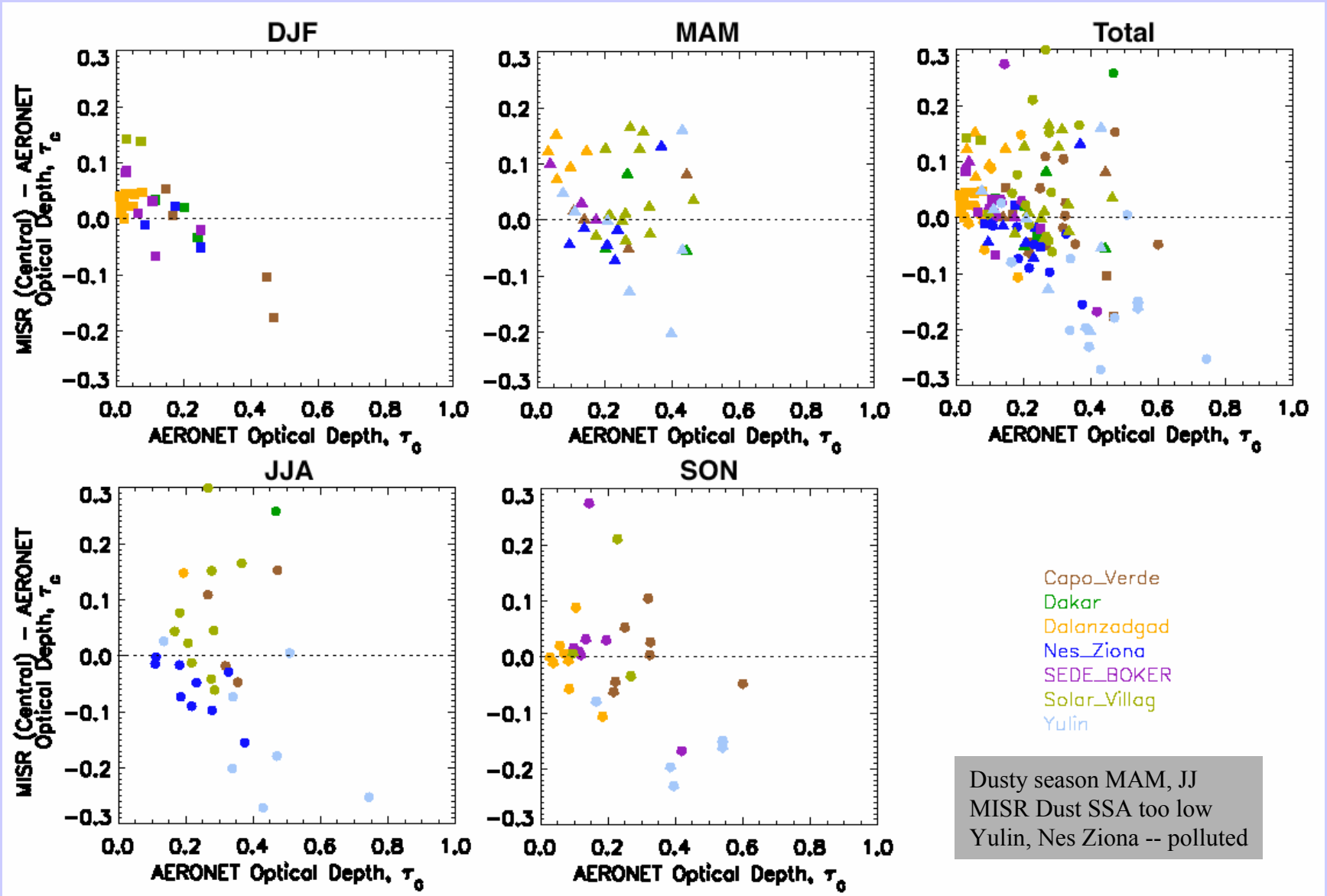


Rogers & Sevilleta -- Dust-like
Kanpur & Shirahama -- MISR SSA too low
Some outliers --> plumes

From: Kahn, et al., 2004, JGR (submitted)

132 MISR-AERONET Coincident AOT Difference Plots

Dusty Sites; 2001-2002; Stratified by Season

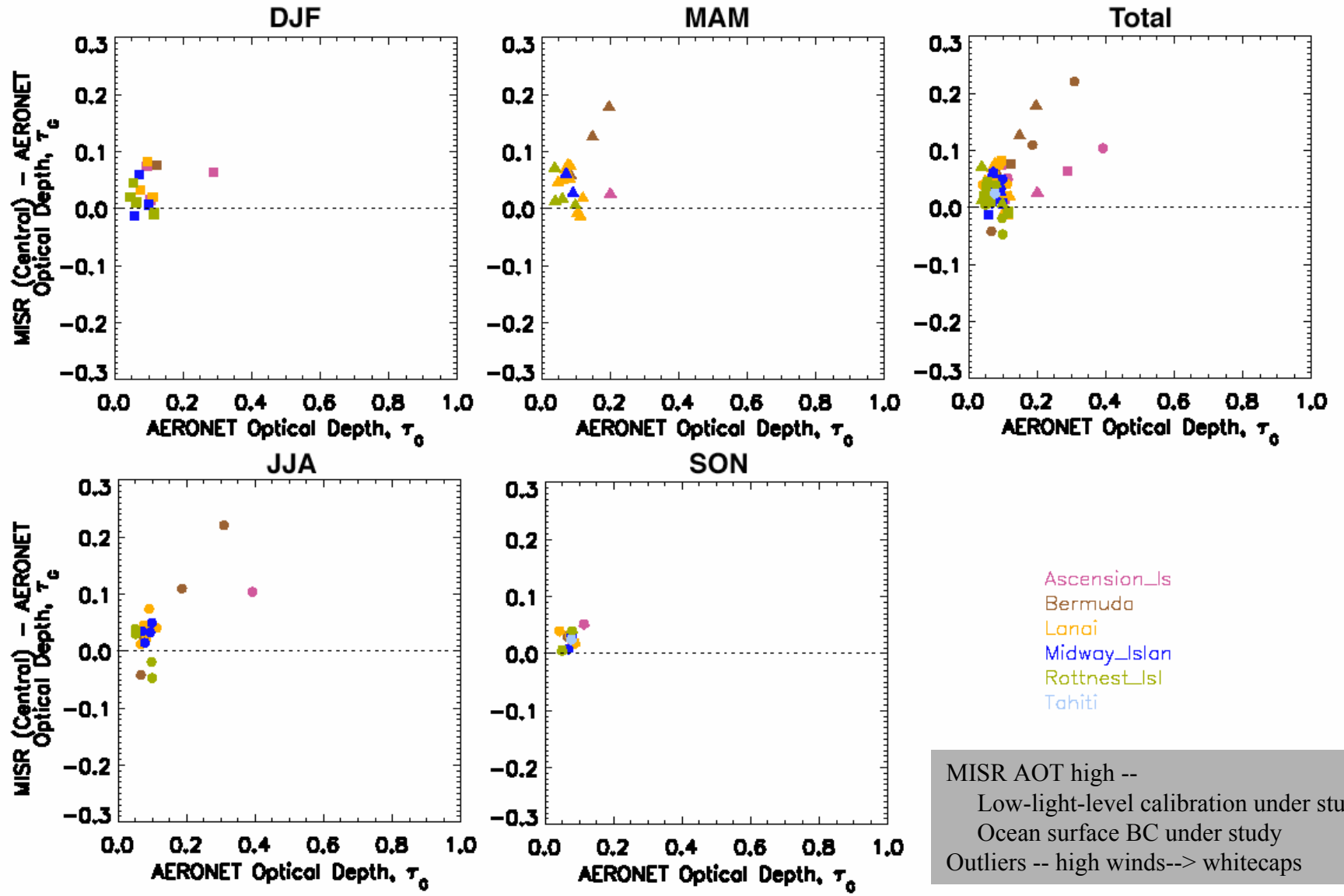


Dusty season MAM, JJ
MISR Dust SSA too low
Yulin, Nes Ziona -- polluted

From: Kahn, et al., 2004, JGR (submitted)

65 MISR-AERONET Coincident AOT Difference Plots

Maritime Sites; 2001-2002; Stratified by Season



MISR AOT high --
Low-light-level calibration under study
Ocean surface BC under study
Outliers -- high winds--> whitecaps

From: Kahn, et al., 2004, JGR (submitted)

Island events

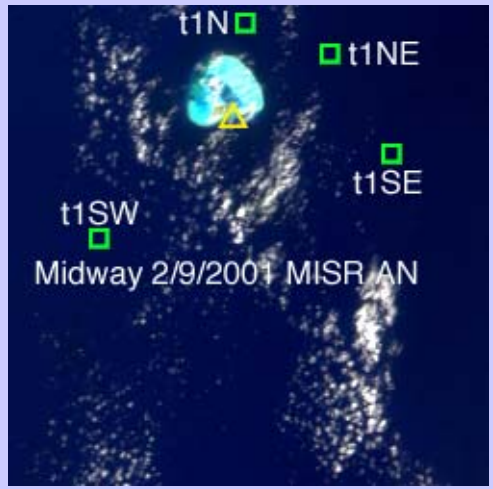
Selection criteria:

- Isolated from major land (Case 1 waters)
- Mostly cloud-free
- High-quality AERONET retrieval
- AOT < 0.3
- AOT variability low
- Near-surface wind-speed low
- Aerosol air mass likely to be Clean Maritime

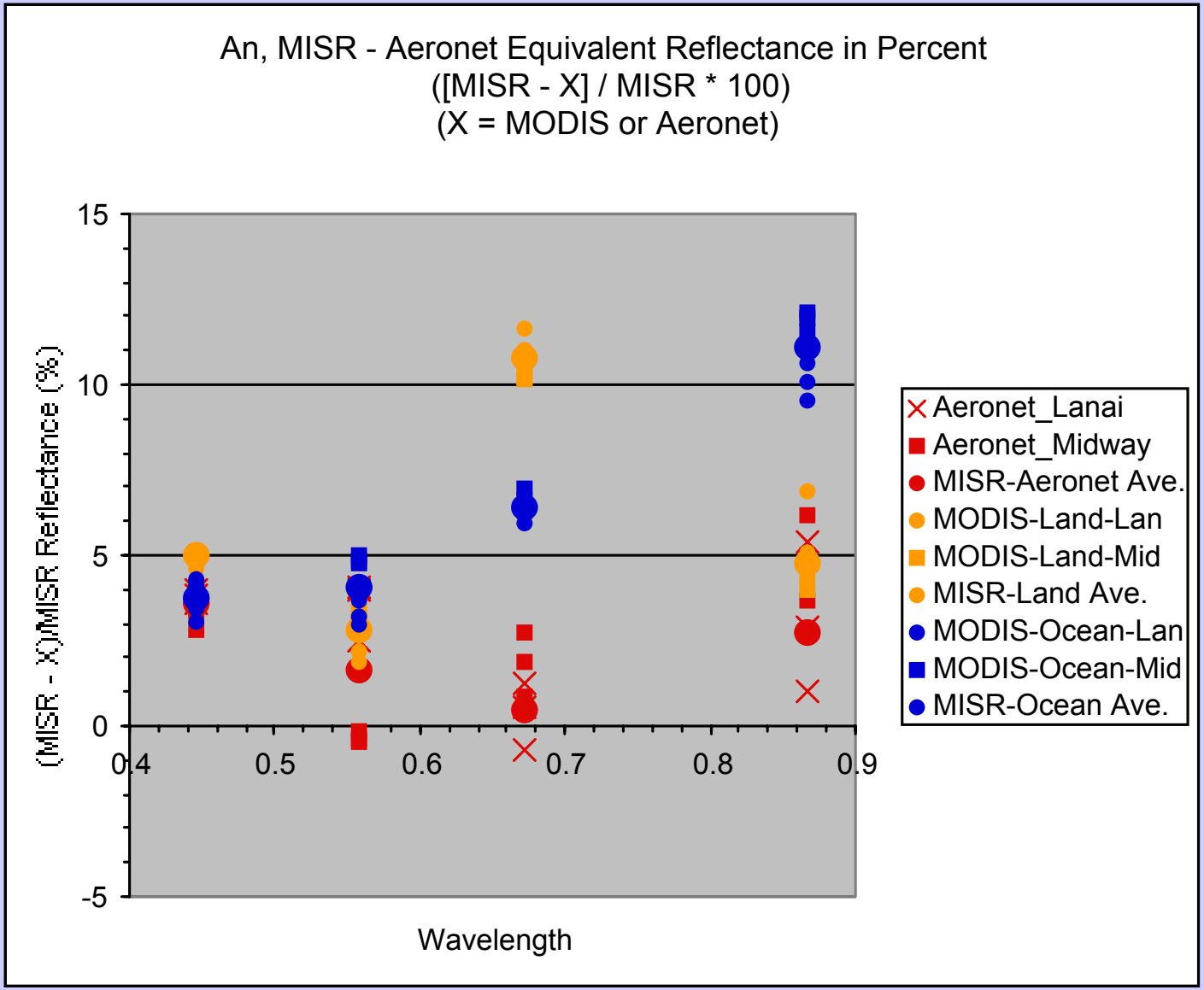
Data collected for each event:

- Wind speed (local Met. Station, scatterometer)
- Wind speed variability (local Met. Station, scatterometer)
- Surface pressure (local Met. Station)
- Column ozone amount (TOMS)
- Airmass history (NOAA HYSPLIT)
- AOT (AERONET)
- AOT variation (AERONET time series)
- Aerosol refractive indices (AERONET)
- Aerosol size distribution (AERONET)

Use Mie code to calculate SSA, Q_{ext}, $P(\theta)$



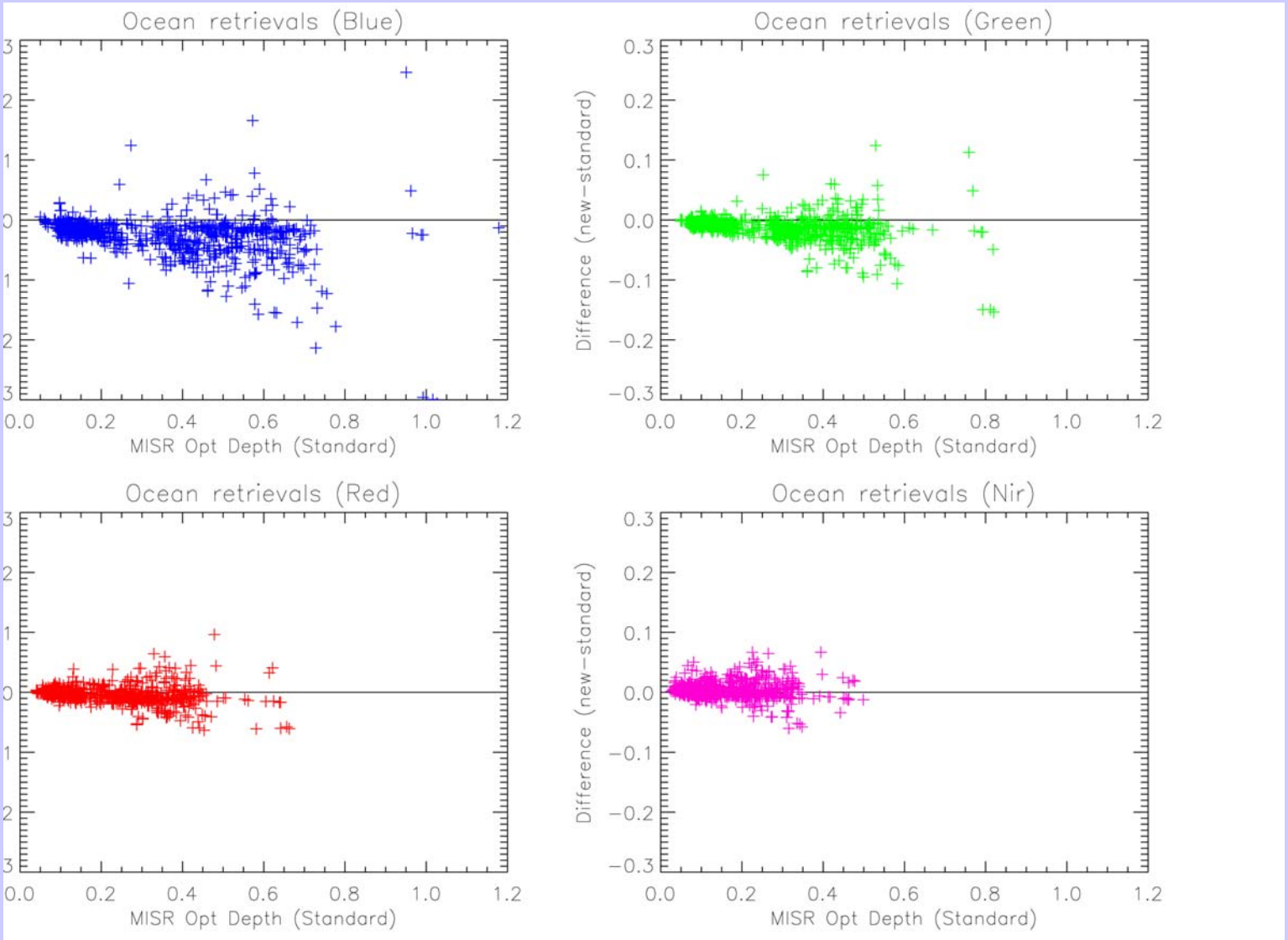
MISR Low-Light-Level Nadir Reflectance Inter-Comparison
Clean Island Sites;MODIS-Land, MODIS-Ocean, AERONET+Model



From: Kahn, et al., 2004 (in preparation)

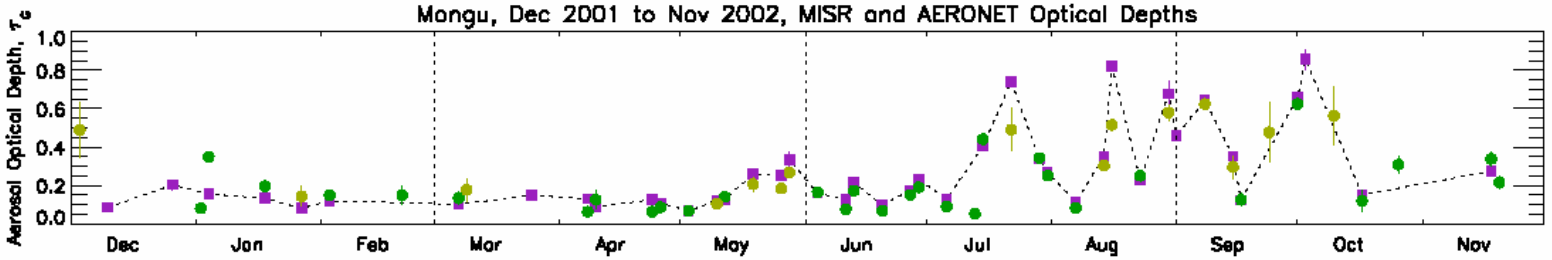
Impact of Band-to-Band Calibration on MISR AOT Retrieval

[0%-0%-3%-1%Spectral Correction (Bruegge et al.)] - [MISR Standard]

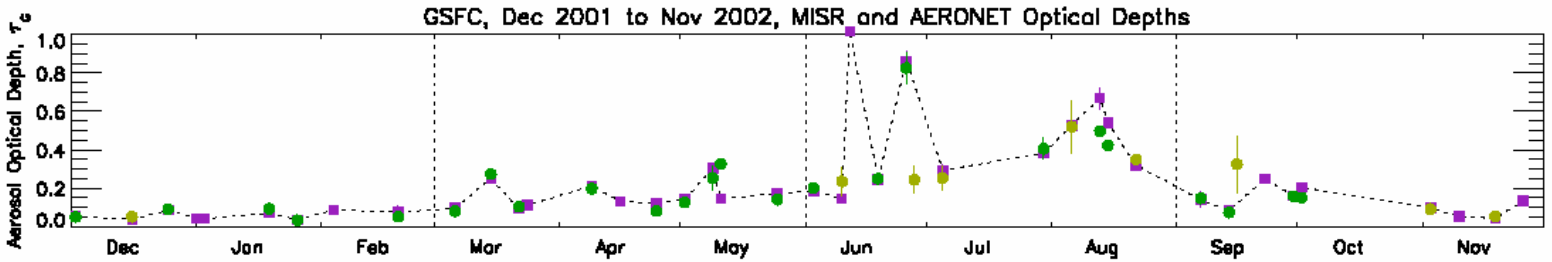


This change alone amounts to $\Delta\tau_a$ of ~ -0.025 in the Green, about half the original discrepancy

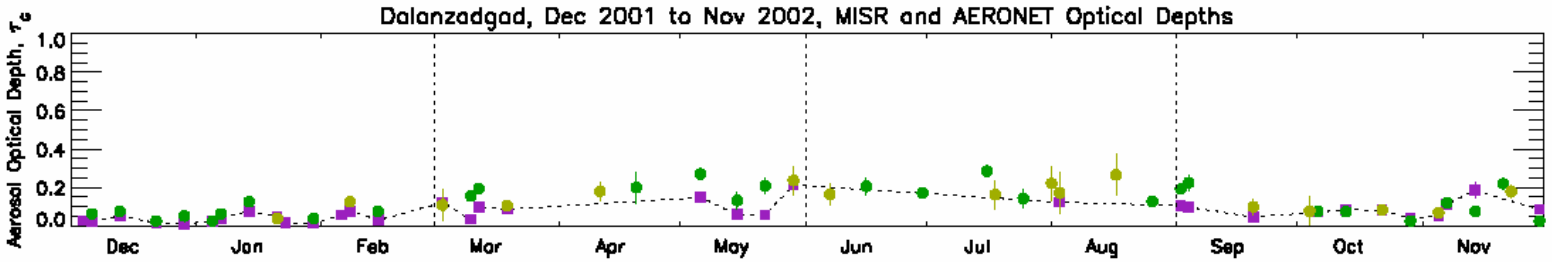
MISR & AERONET AOT Time Series at Four Sites



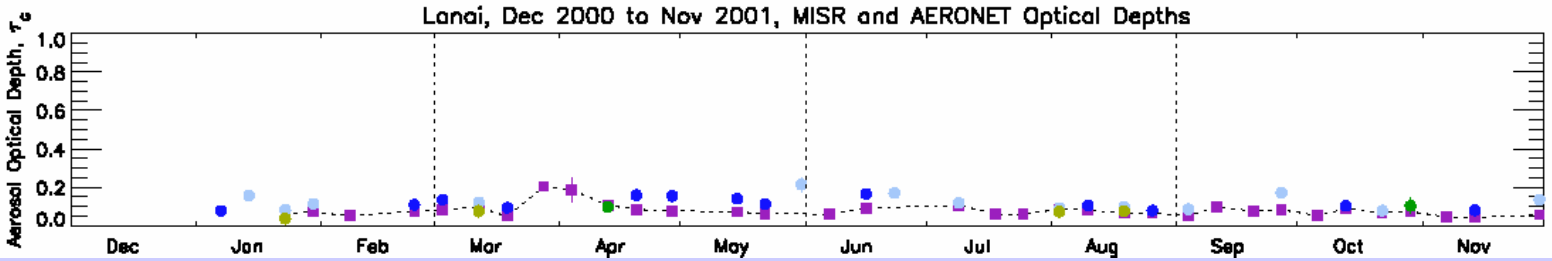
Biomass



Continental



Dusty

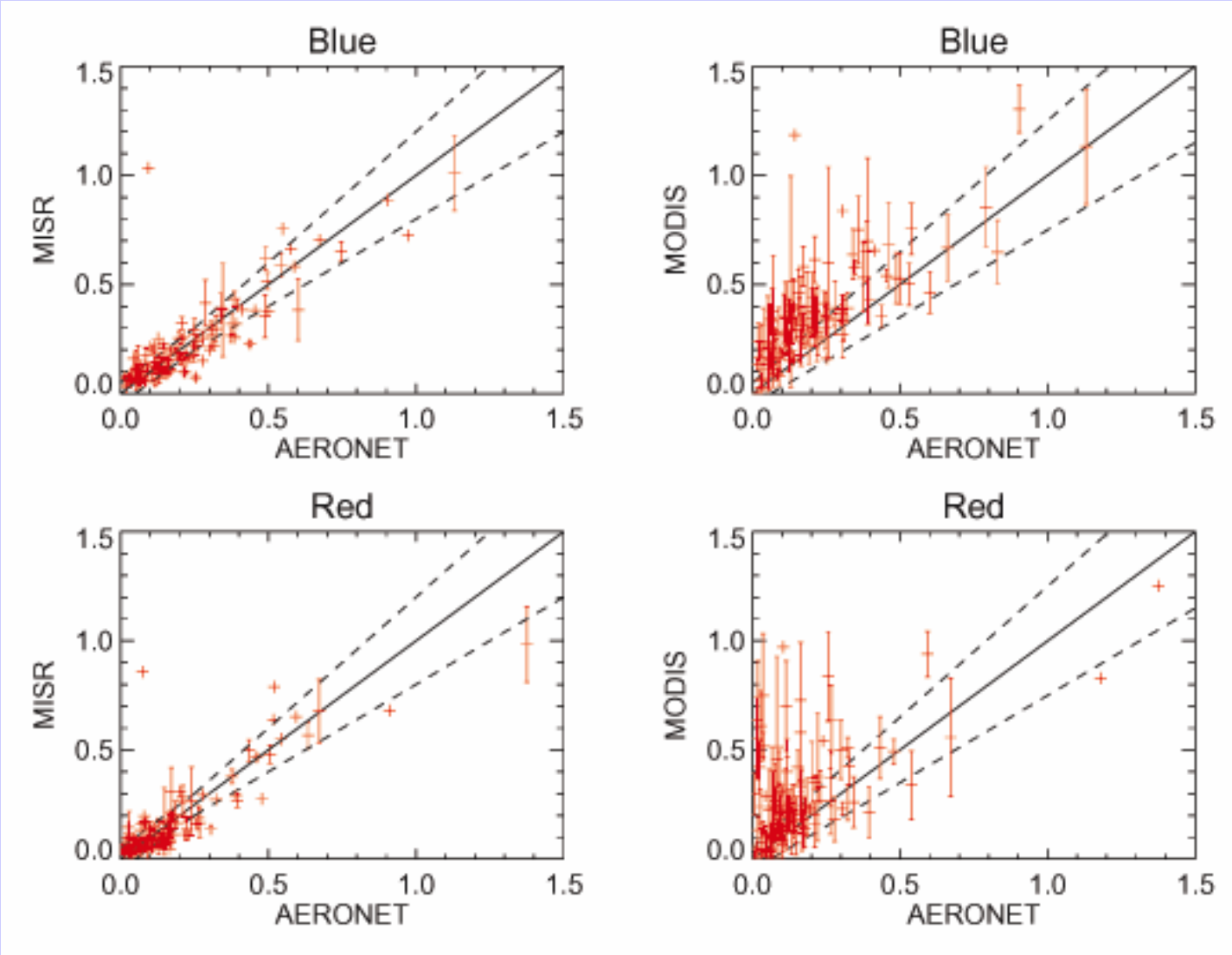


Maritime

From: Kahn, et al., 2004, JGR (submitted)

127 MISR- AERONET & 113 MODIS-AERONET Coincident AOT Comparisons

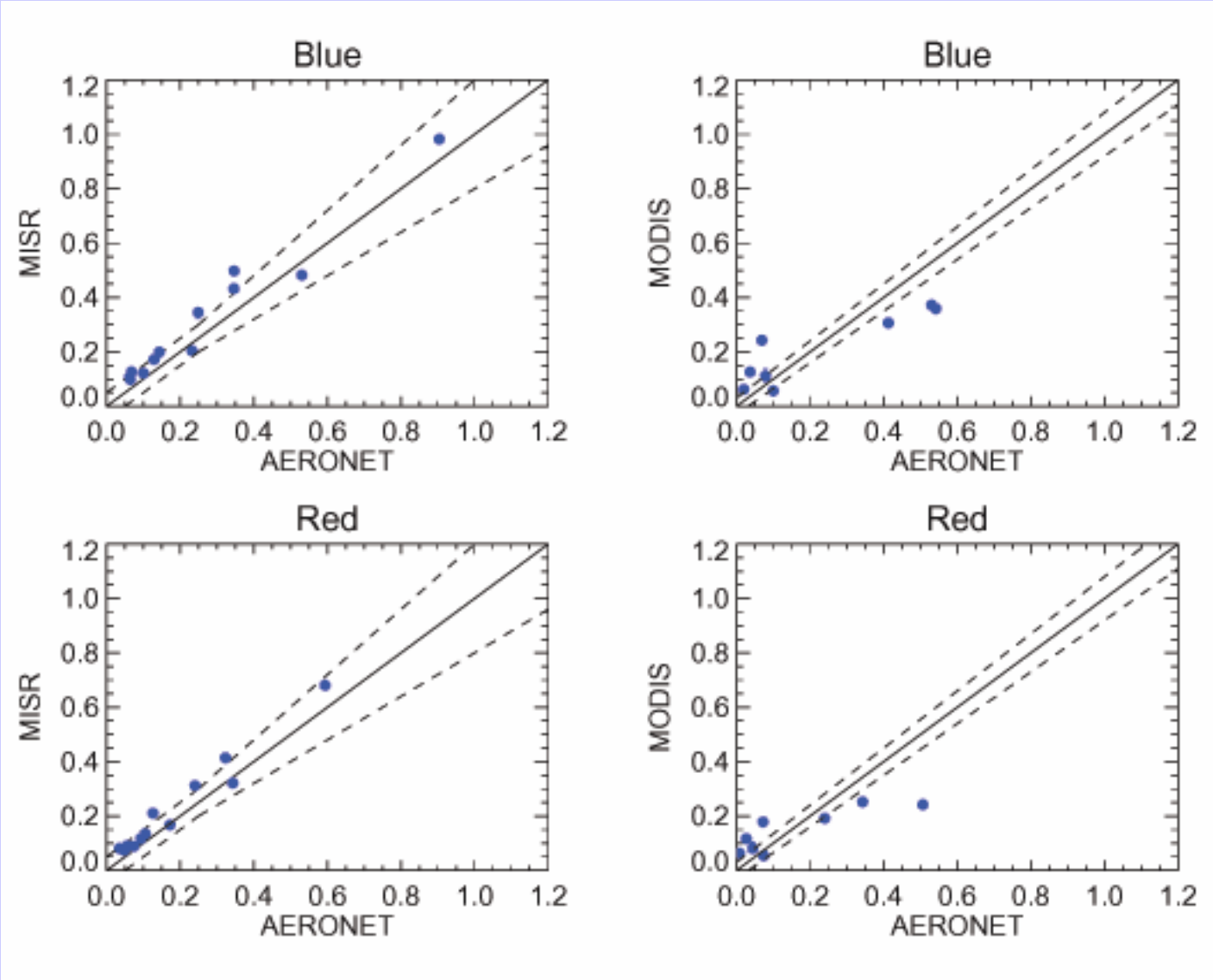
Over Land; March, June, and September 2002



From: Abdou, et al., 2004, JGR (submitted)

MISR-AERONET & MODIS-AERONET Coincident AOT Comparisons

Over Dark Water; March, June, and September 2002



From: Abdou, et al., 2004, JGR (submitted)

EXPECTED NEAR-TERM UPGRADES TO THE MISR AEROSOL RETRIEVAL STANDARD ALGORITHM –

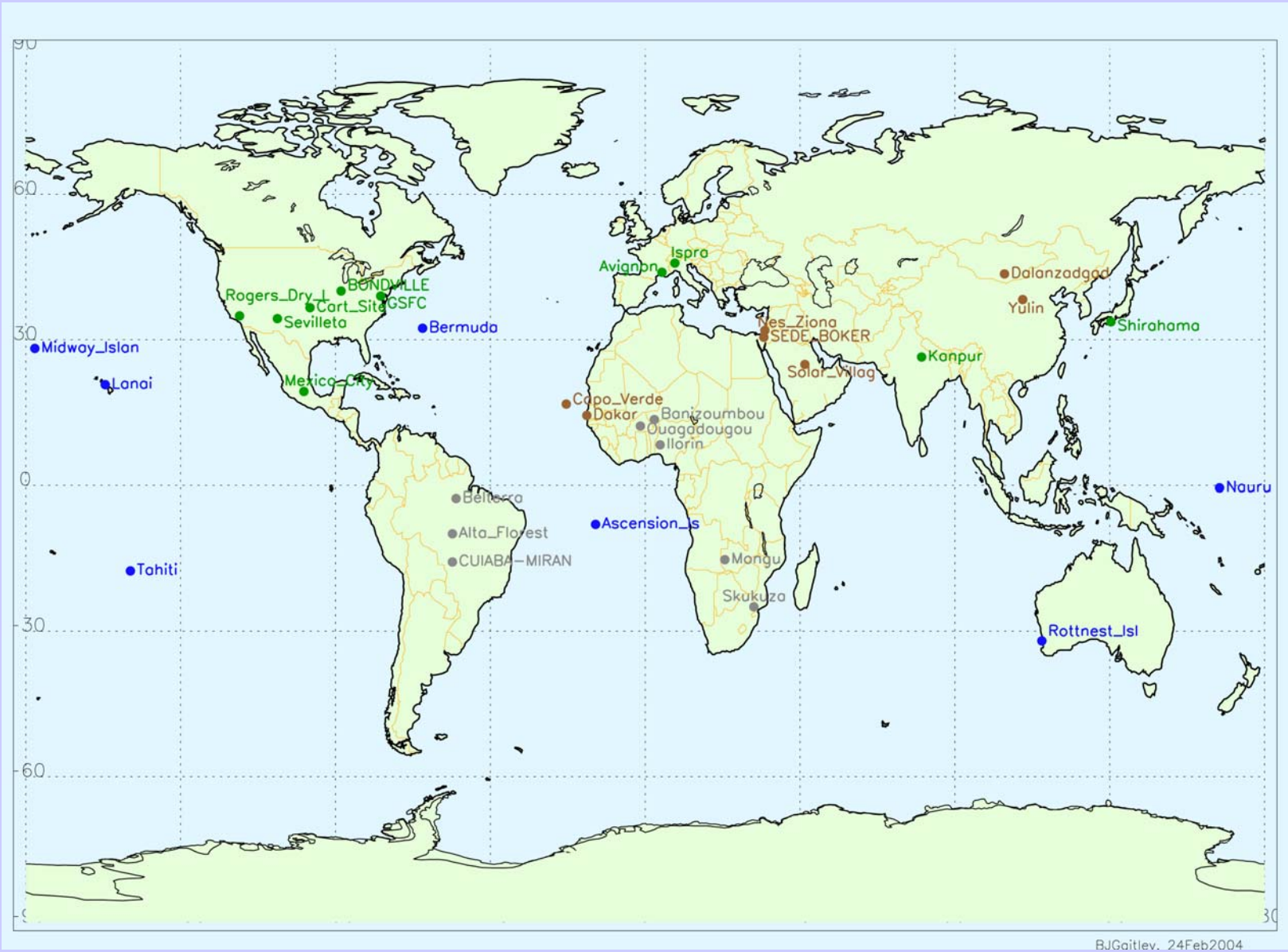
- **Improved Low-light-level Calibration**
- **More realistic Mineral Dust optical models**
- **Additional, Darker Spherical Pollution and Biomass Burning analogs**
- **A Richer Selection of Bi-modal Mixtures**

Should reduce remaining MISR-AERONET discrepancies by about half.

MISR data available from the NASA Langley Atmospheric Sciences Data Center

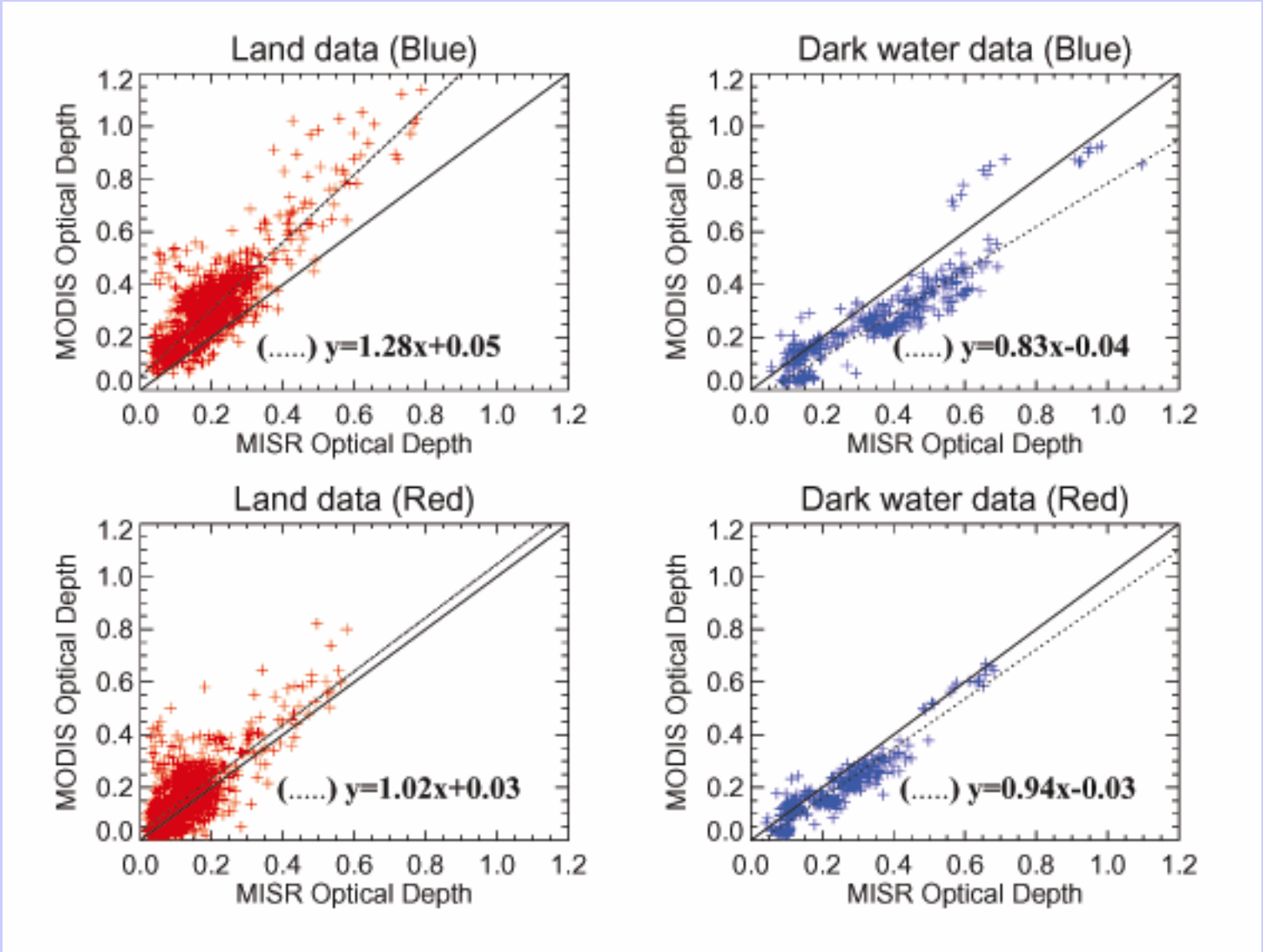
http://eosweb.larc.nasa.gov/

32 AERONET Site Locations
Colored According to Expected Aerosol Type



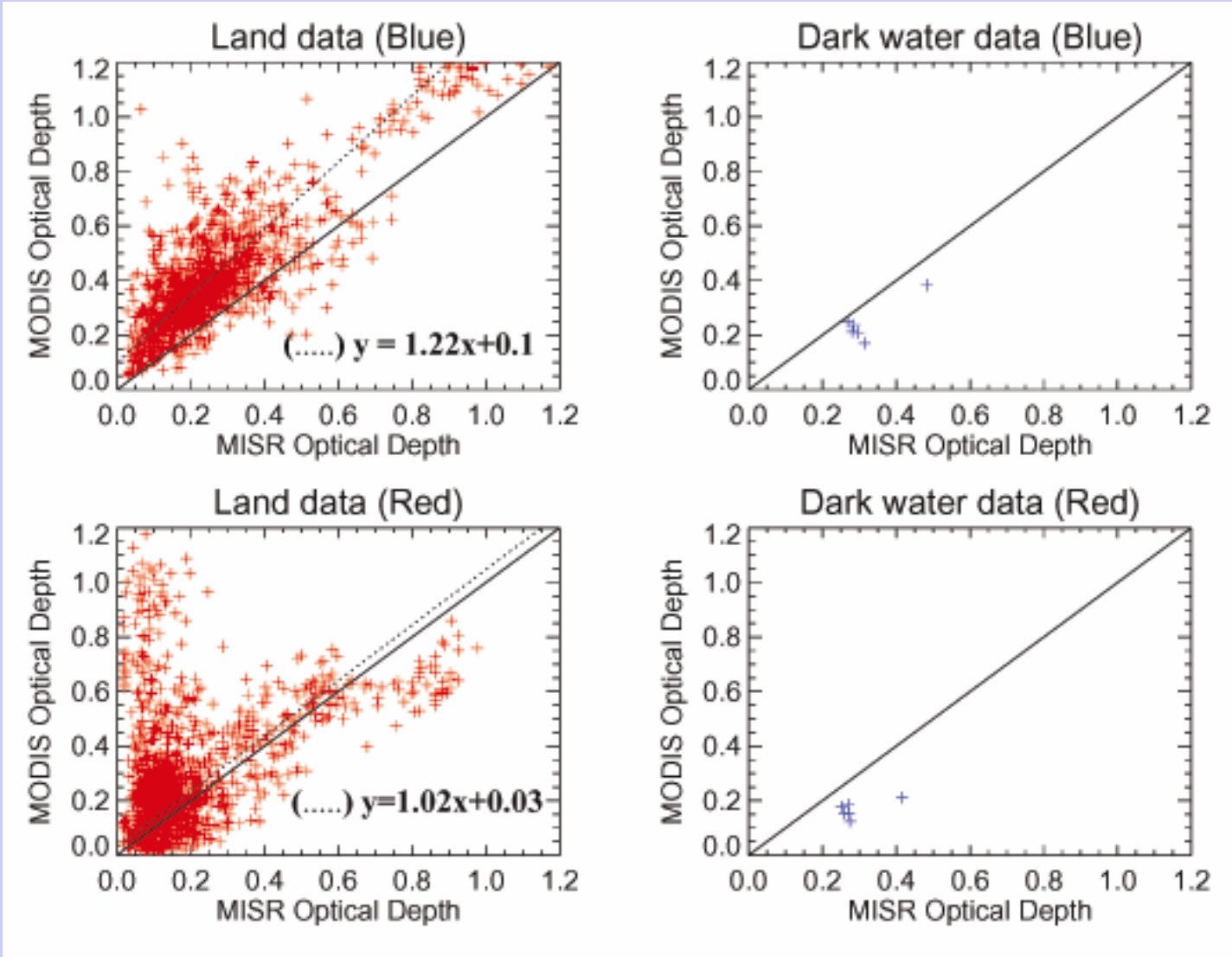
From: Kahn, et al., 2004, JGR (submitted)

MISR-MODIS Coincident AOT Comparisons over 62 AERONET sties, March 2002



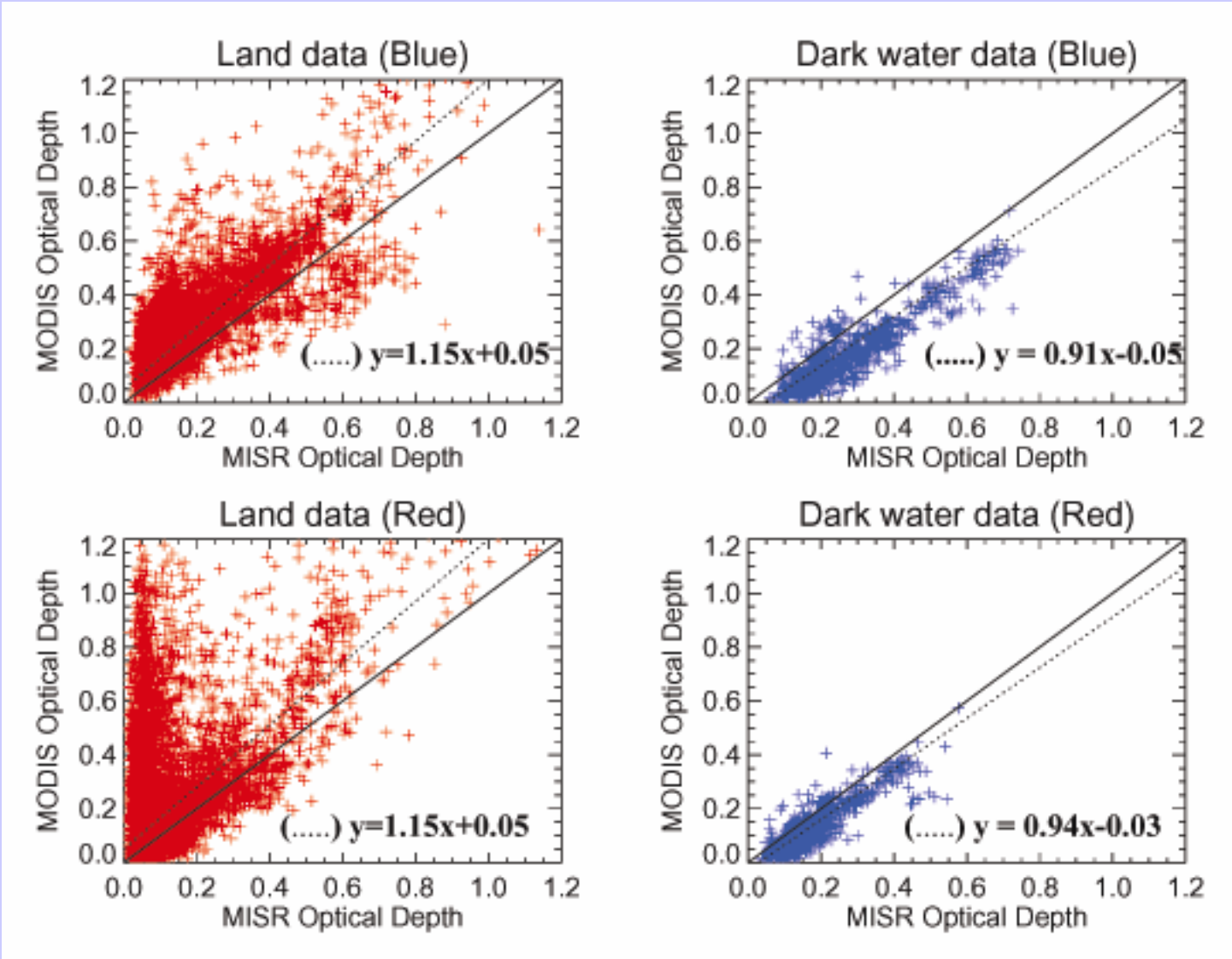
From: Abdou, et al., 2004, JGR (submitted)

MISR-MODIS Coincident AOT Comparisons over 62 AERONET sties, June 2002



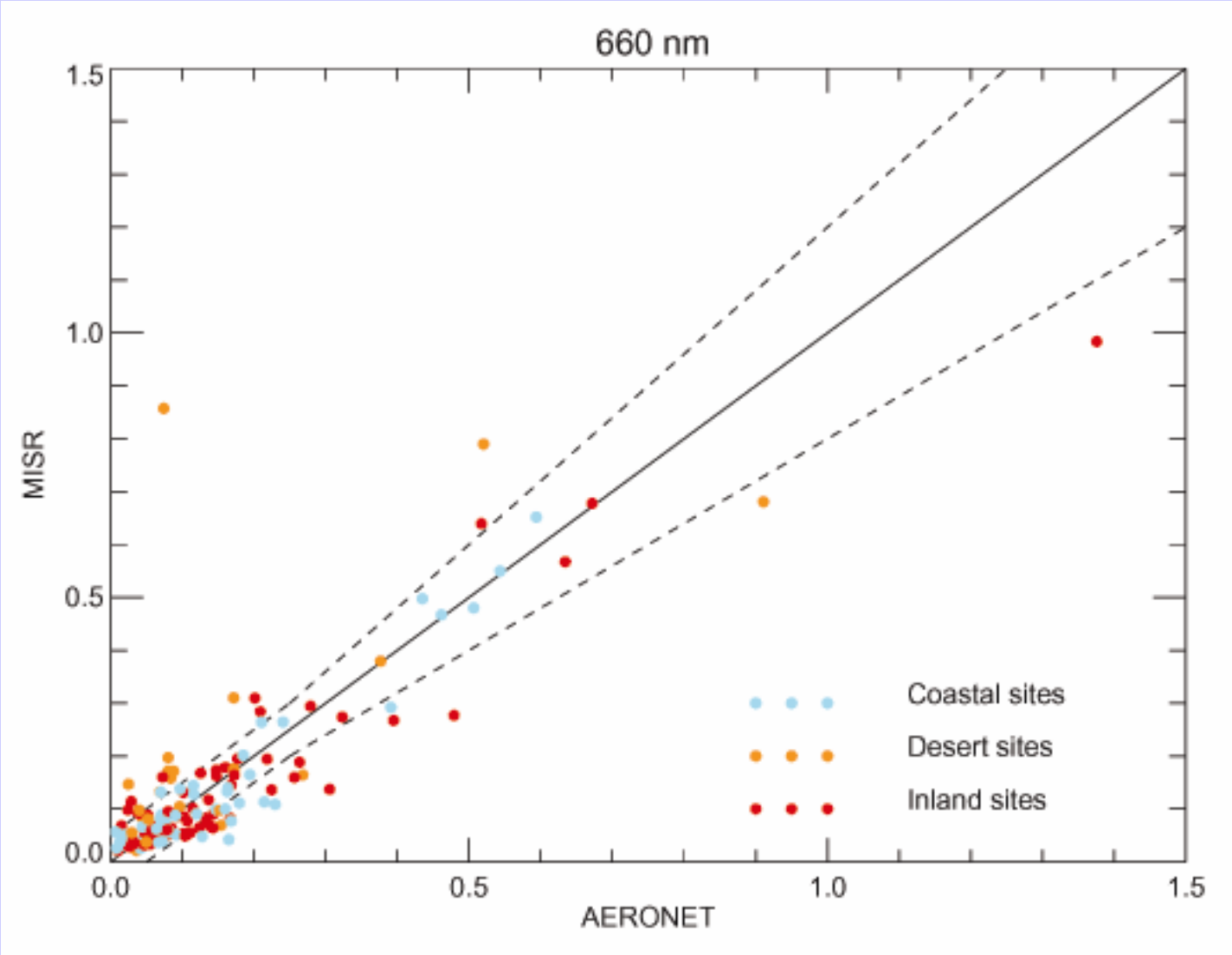
From: Abdou, et al., 2004, JGR (submitted)

MISR-MODIS Coincident AOT Comparisons over 62 AERONET sties, September 2002



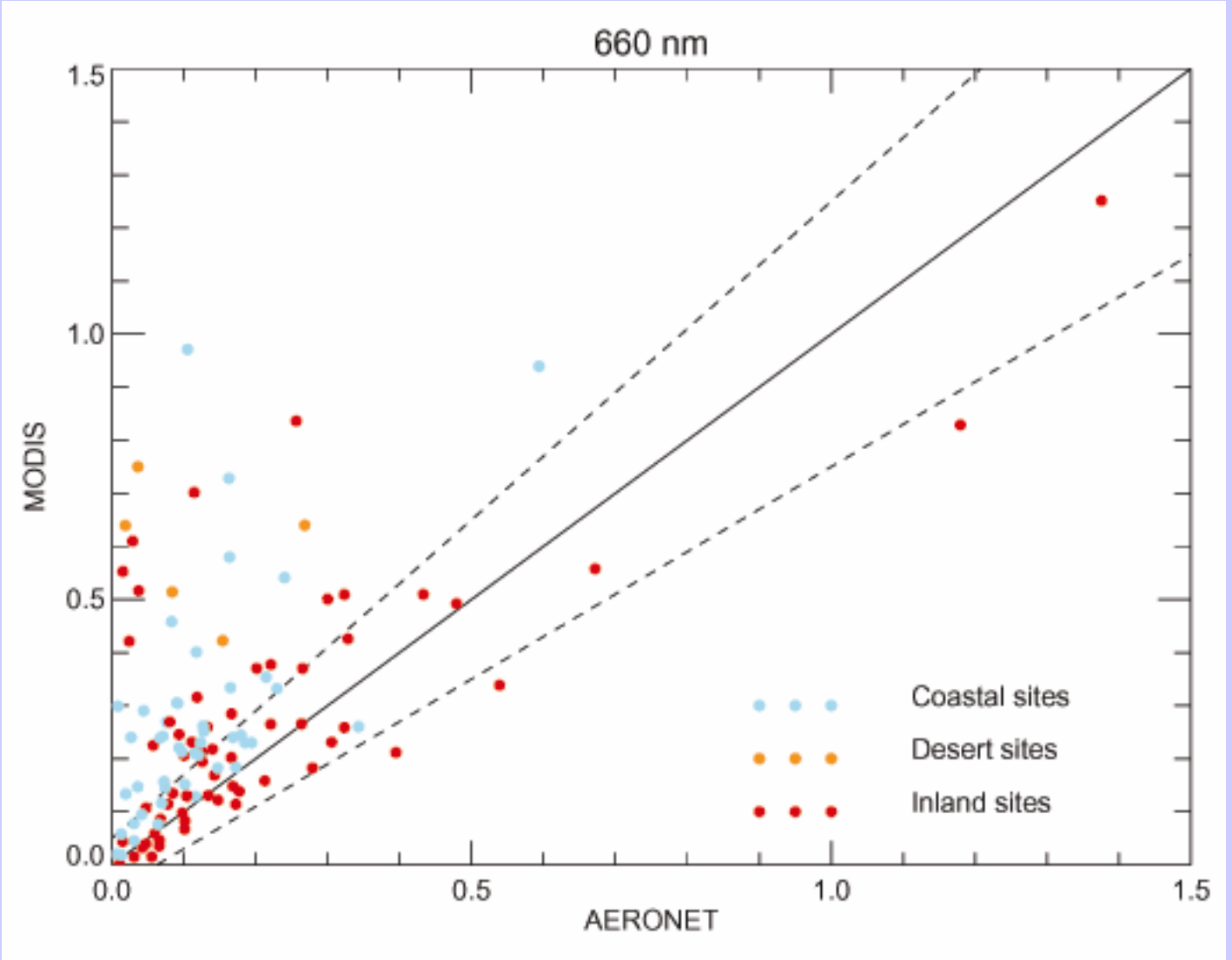
From: Abdou, et al., 2004, JGR (submitted)

MISR- AERONET Coincident AOT Comparisons
Over Land; March, June, and September 2002



From: Abdou, et al., 2004, JGR (submitted)

MODIS-AERONET Coincident AOT Comparisons
Over Land; March, June, and September 2002



From: Abdou, et al., 2004, JGR (submitted)