CalCon
Utah State University
Logan, Utah
22-25 August, 2005

MISR 2005 calibration verification study

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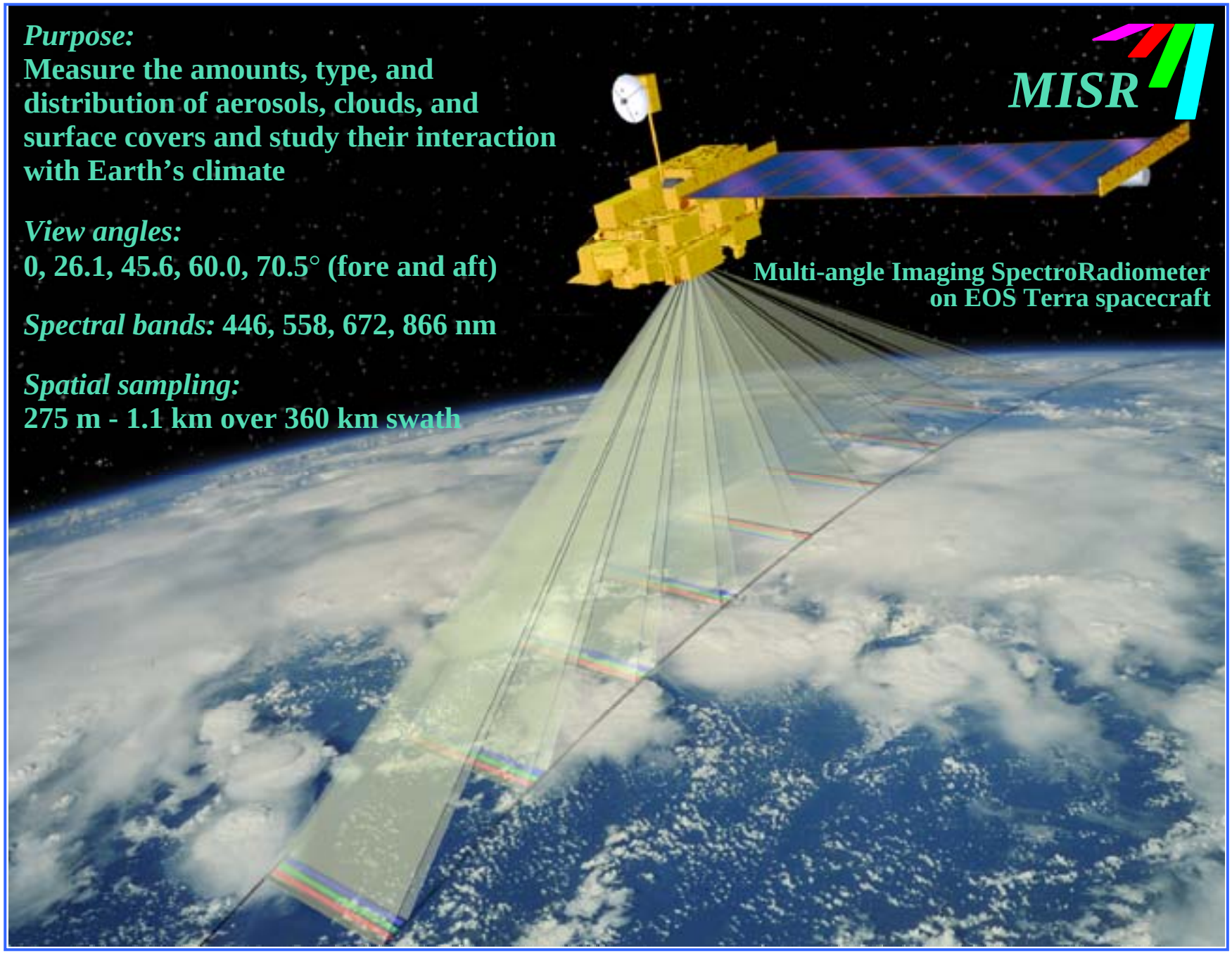
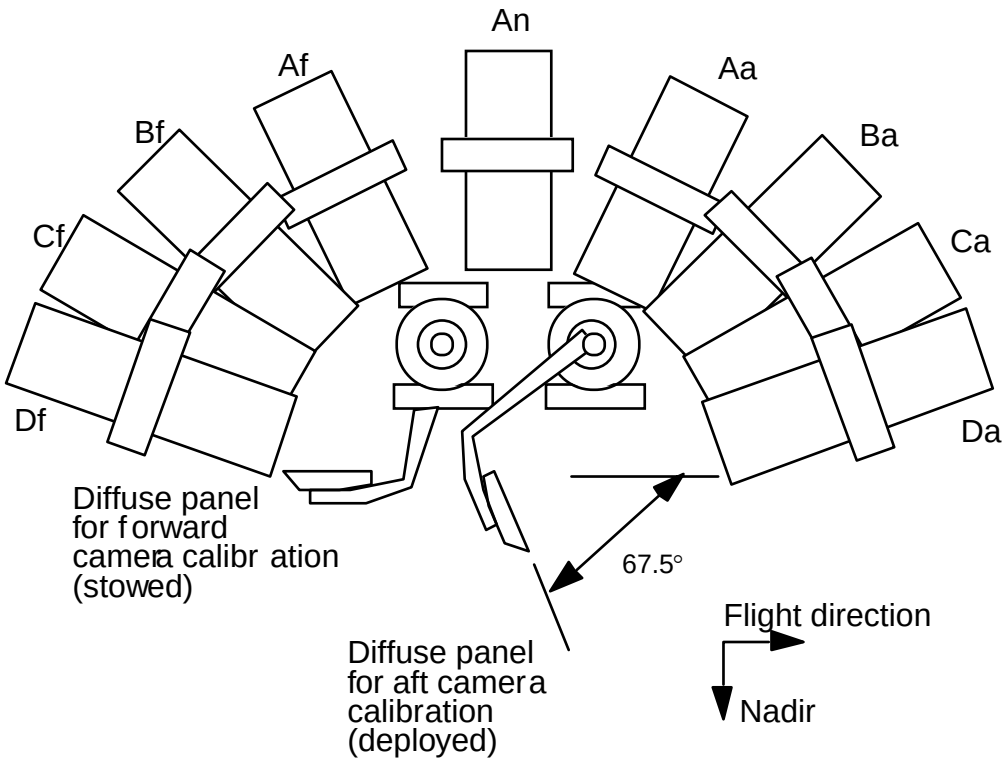
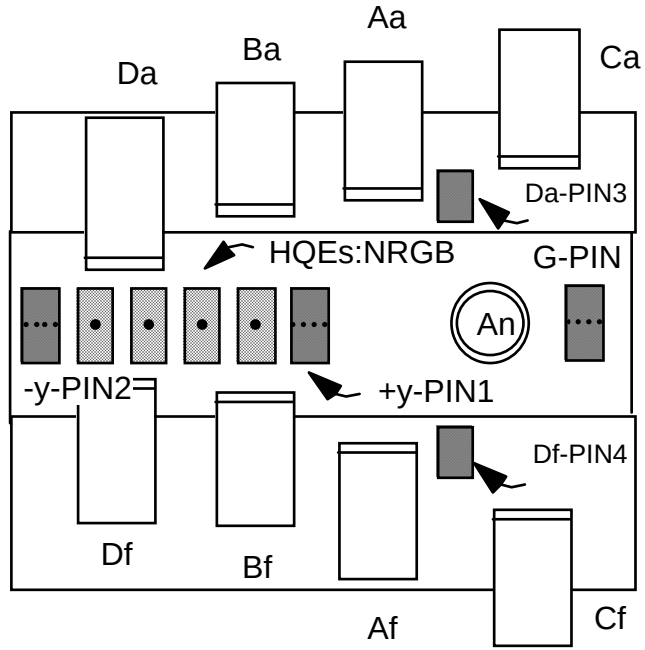
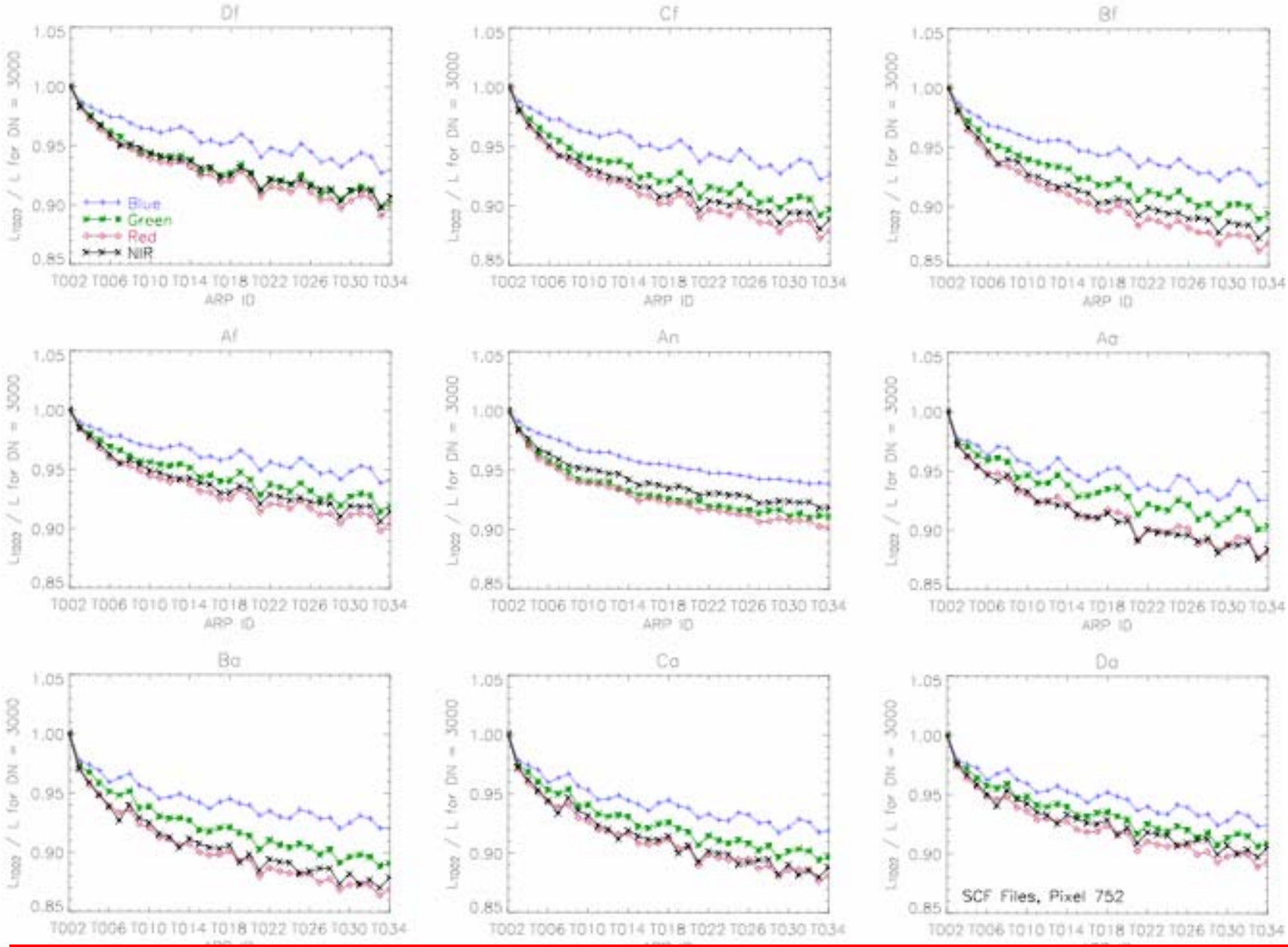

Purpose:
Measure the amounts, type, and distribution of aerosols, clouds, and surface covers and study their interaction with Earth's climate
View angles:
0, 26.1, 45.6, 60.0, 70.5° (fore and aft)
Spectral bands: **446, 558, 672, 866 nm**
Spatial sampling:
275 m - 1.1 km over 360 km swath
MISR
Multi-angle Imaging SpectroRadiometer on EOS Terra spacecraft

MISR's on-board calibrator





- Acquire bi-monthly on-board calibrator and dark-earth data
- Conduct annual overflight field campaigns (concurrent with AirMISR 2000-2004)



MISR trend profiles show an on-going 2% degradation/ year

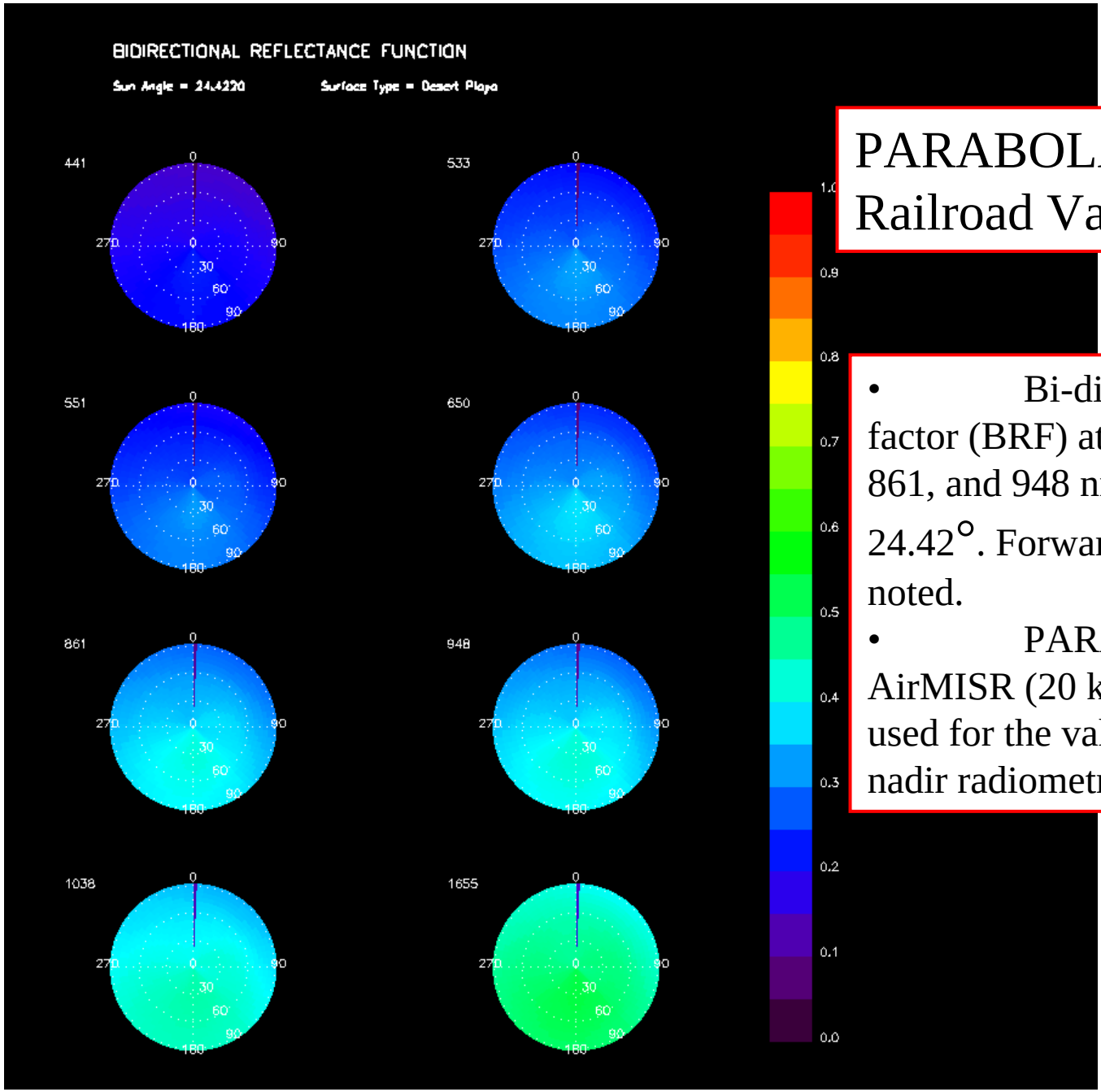
Series of process updates have led to an ever refined L1B2 data product

Correction name	Description	Analysis technique	Implementation date	L1B2 version
VC adjust	On-board calibrator tuned to ground truth	Vicarious Calibration, Lunar Lake 2000	2/24/2001	7
Linear offaxis	Coding error: Indices reversed in Spectralon BRF database	Vicarious Calibration (with sites at center and swath edge)	10/24/2001	10
PSF correction	Edge enhancement	Preflight measurements, on-orbit edge analysis, and MODIS verification	11/12/2002	16
Band adjust	3% decrease in the Red, 1.5% in the NIR	Vicarious Calibration, 2000-2004 campaigns	12/5/2003	22
Camera adjust	Channel dependent correction	Symmetry and lunar	11/2004	23

Sunrise at MudLake

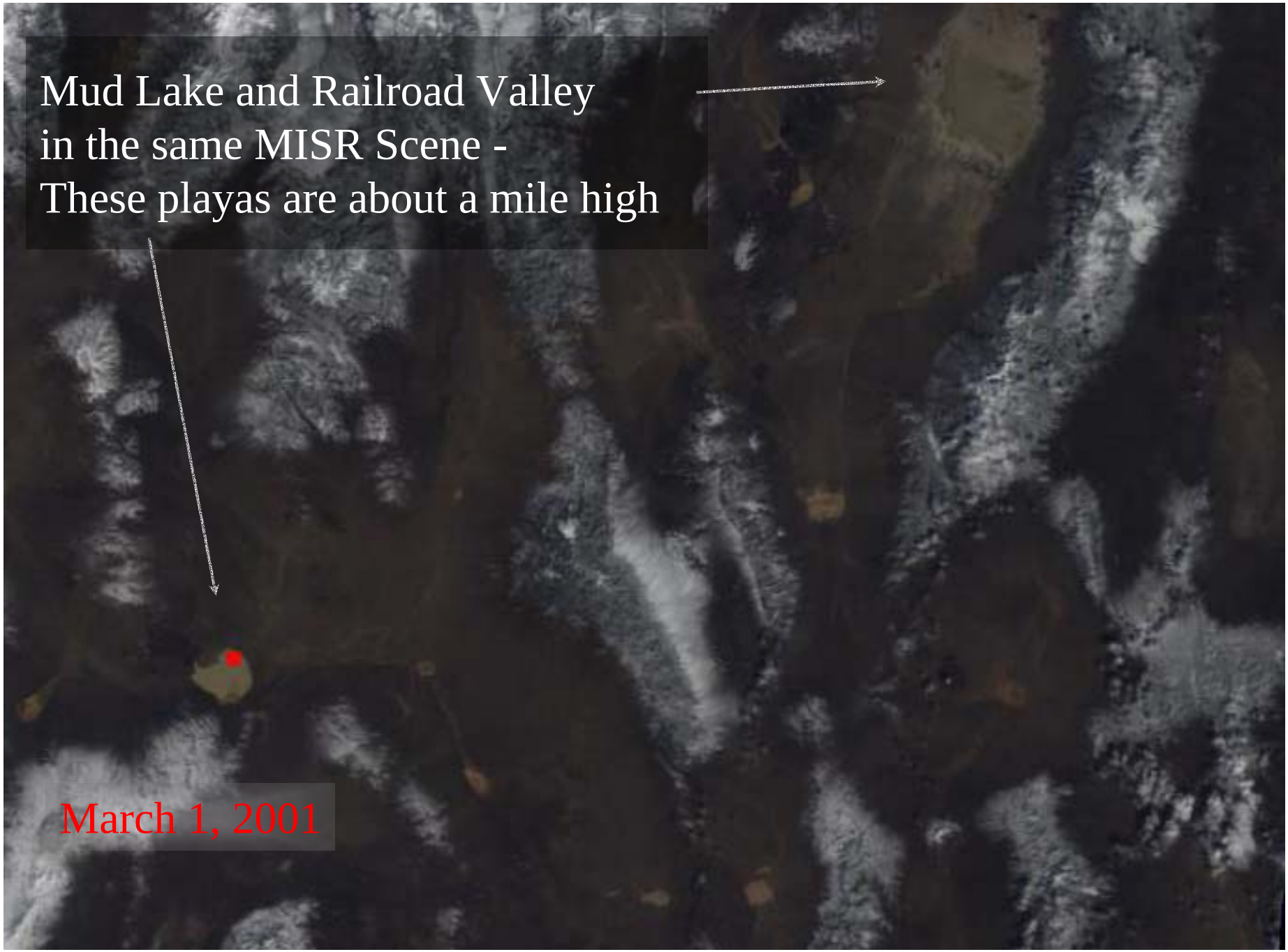
Does specular component of playa reflectance create seasonal reflectance functions, due to variation in solar zenith?

MISR observations, shown on the following pages, demonstrate that the reflectance is stable over time.

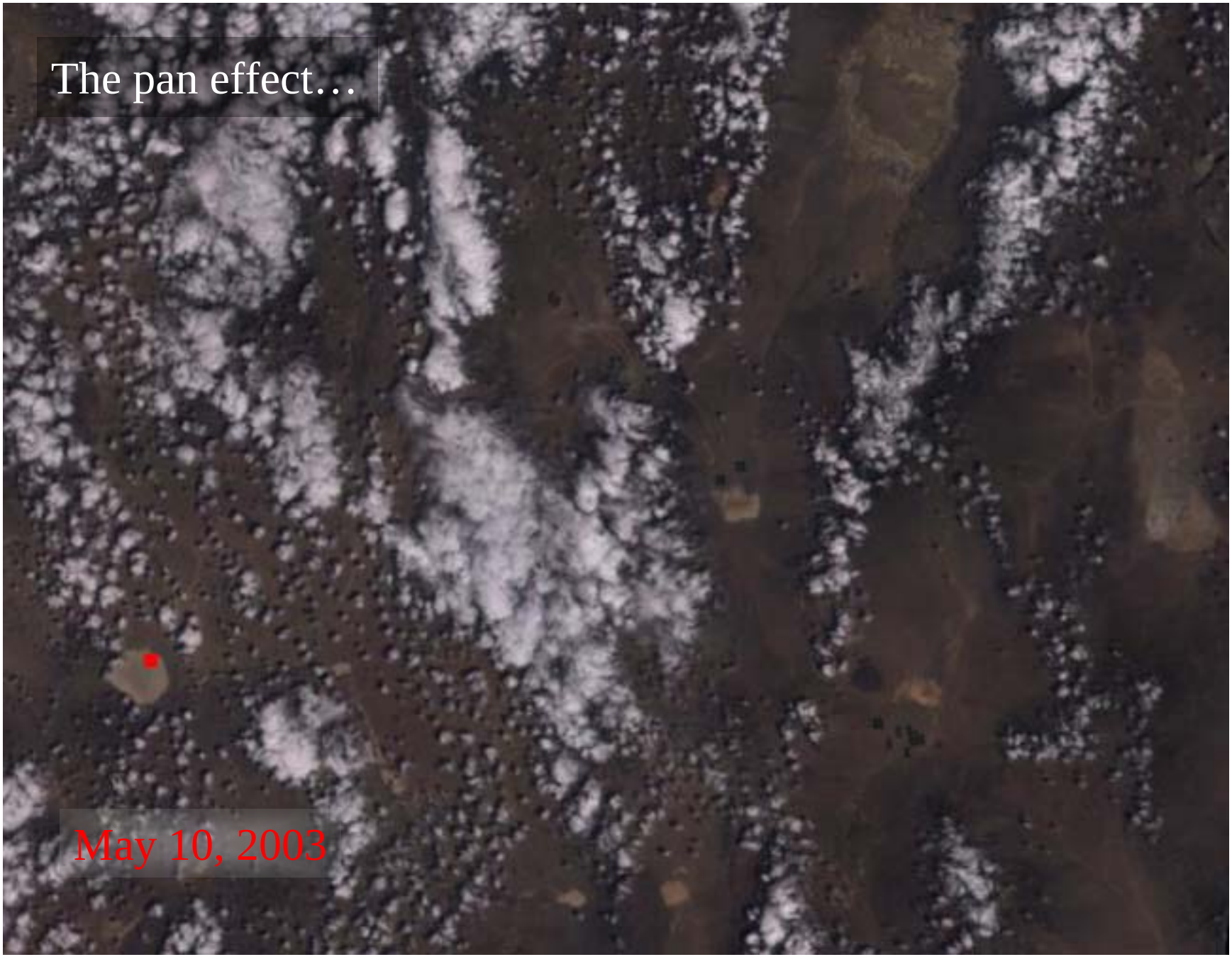


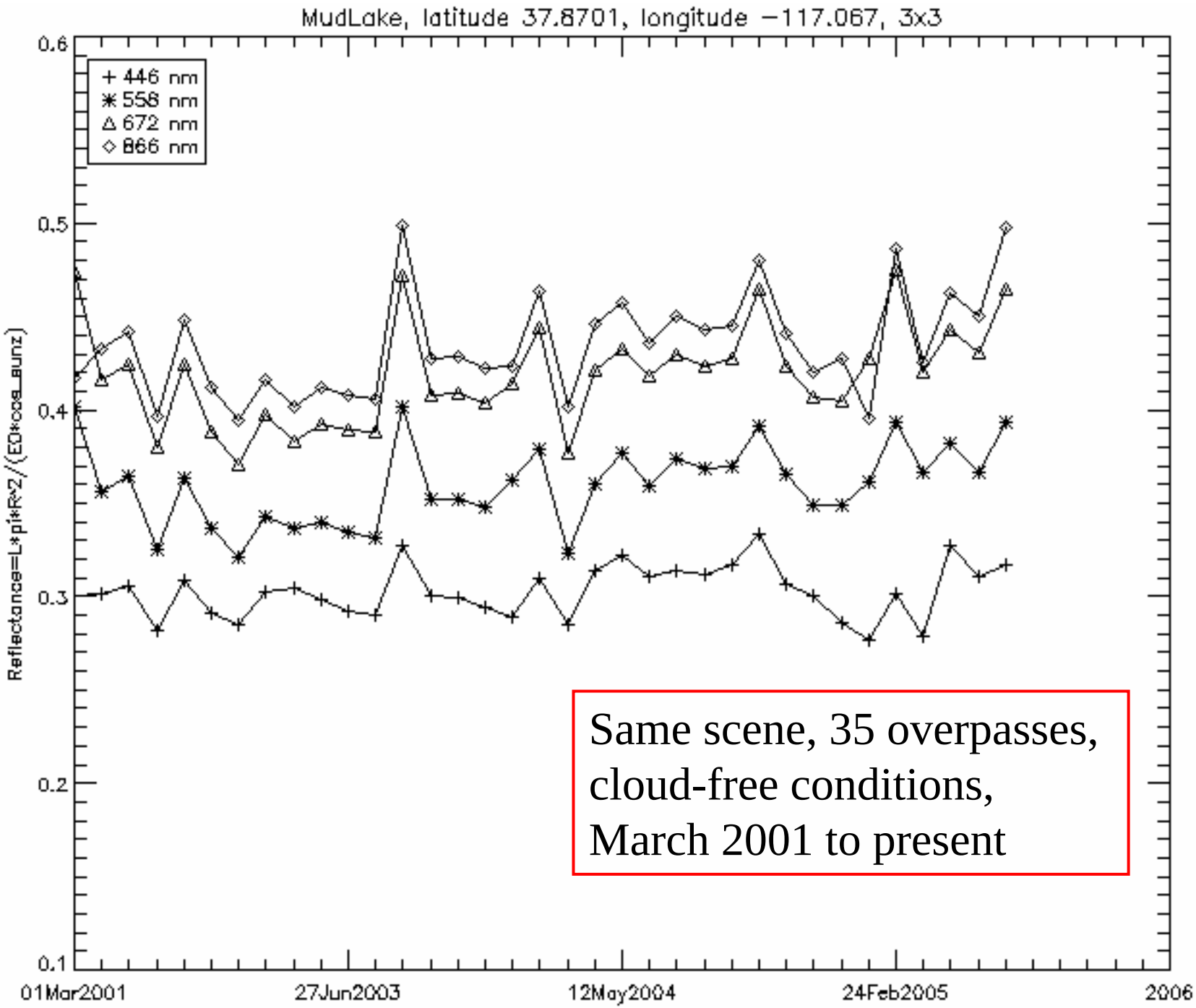
PARABOLA measured BRF Railroad Valley 2003 results

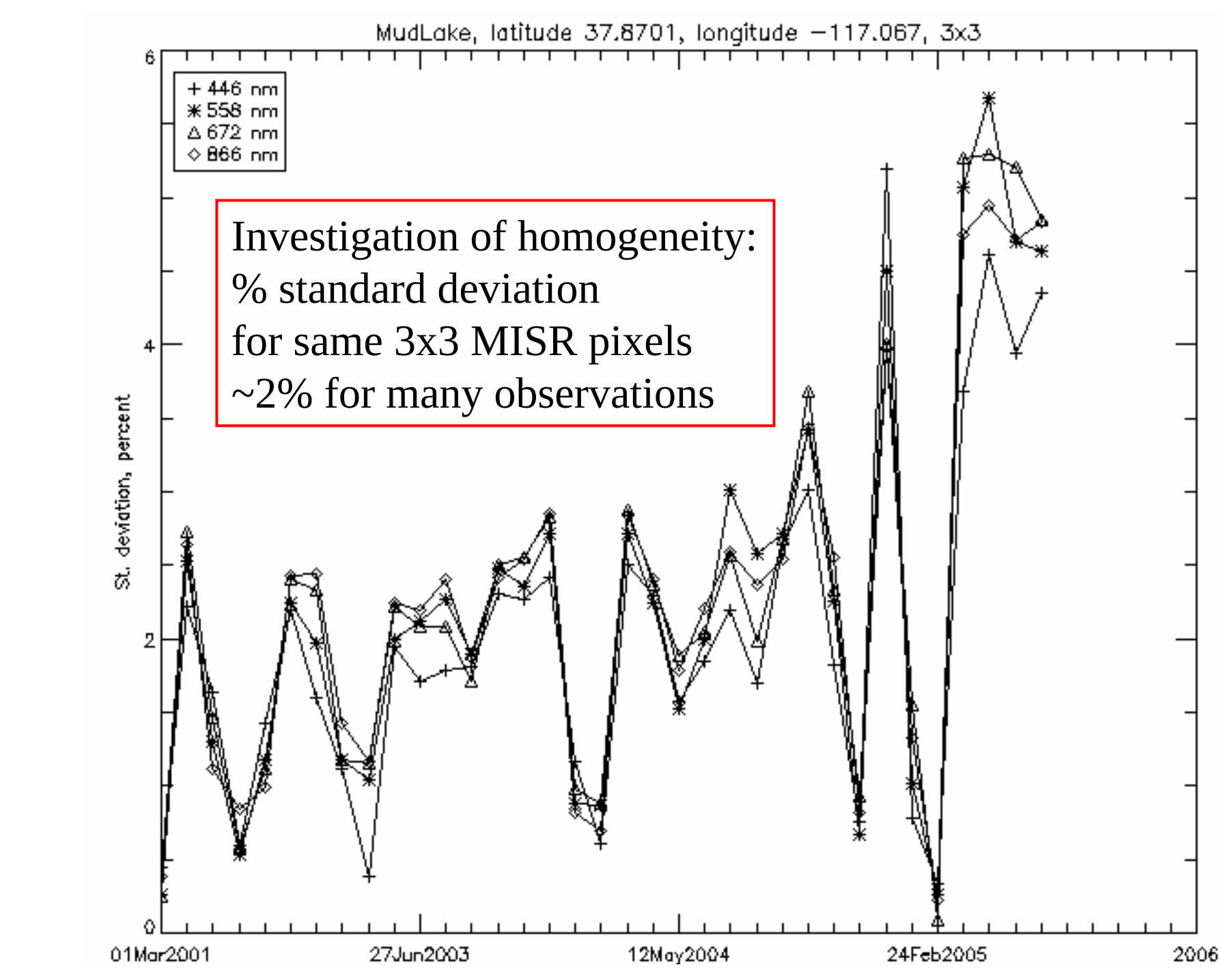
- Bi-directional reflectance factor (BRF) at 441, 533, 551, 650, 861, and 948 nm, sun zenith angle of 24.42°. Forward scattering lobe is noted.
- PARABOLA (in-situ) and AirMISR (20 km) are unique tools used for the validation of MISR's off-nadir radiometry.

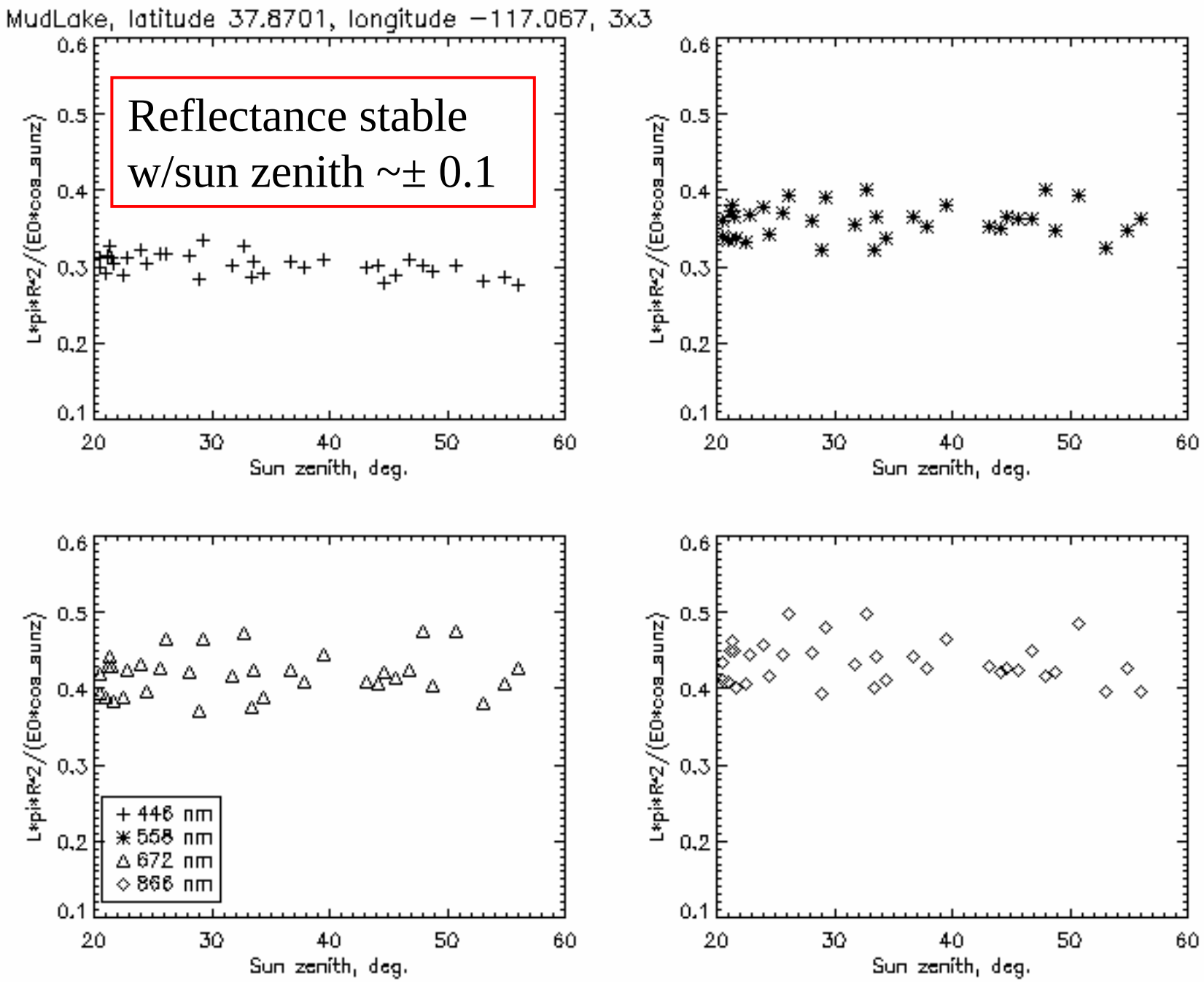

Mud Lake and Railroad Valley
in the same MISR Scene -
These playas are about a mile high
March 1, 2001

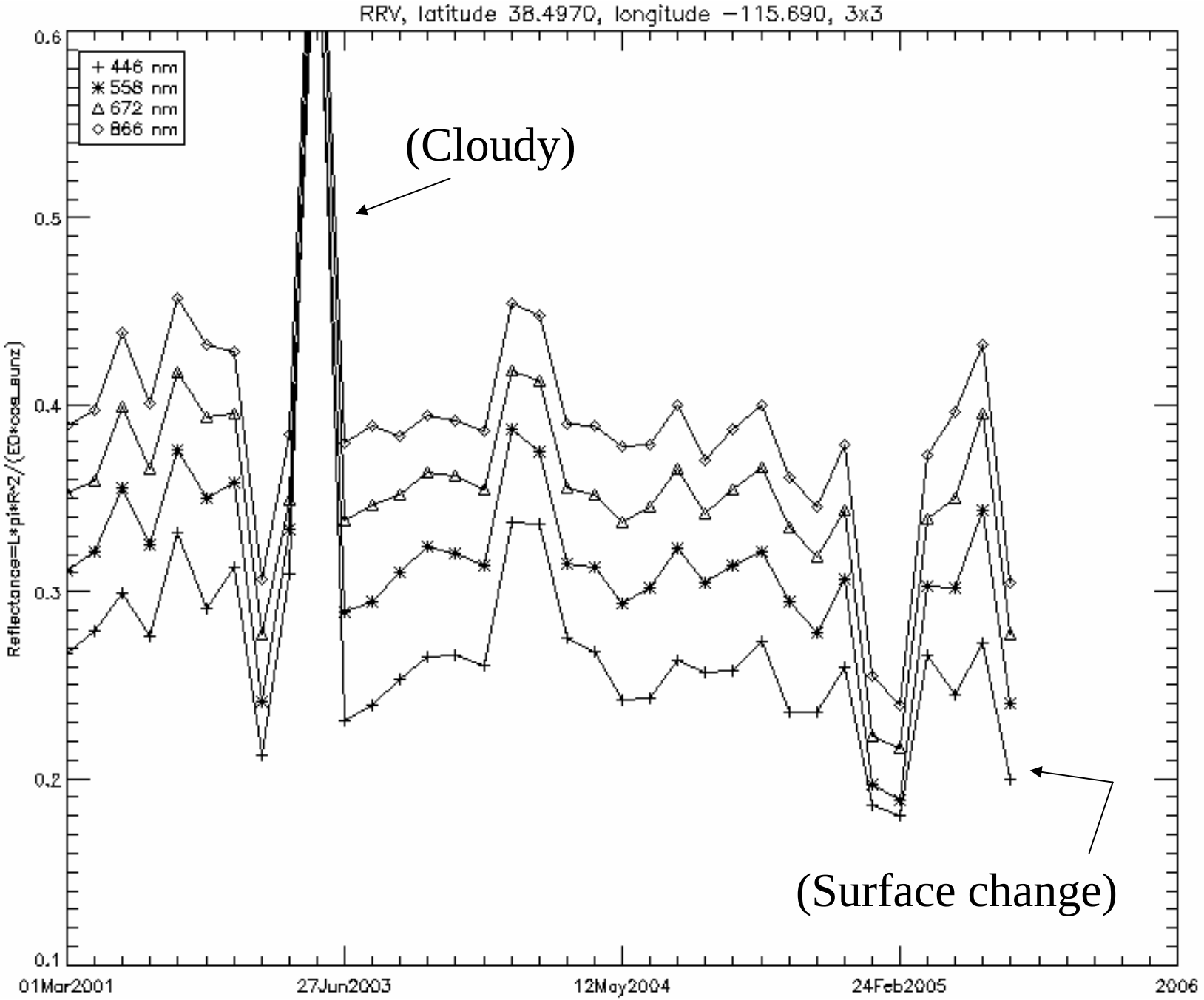

There is some seasonal variability…
February 6, 2004

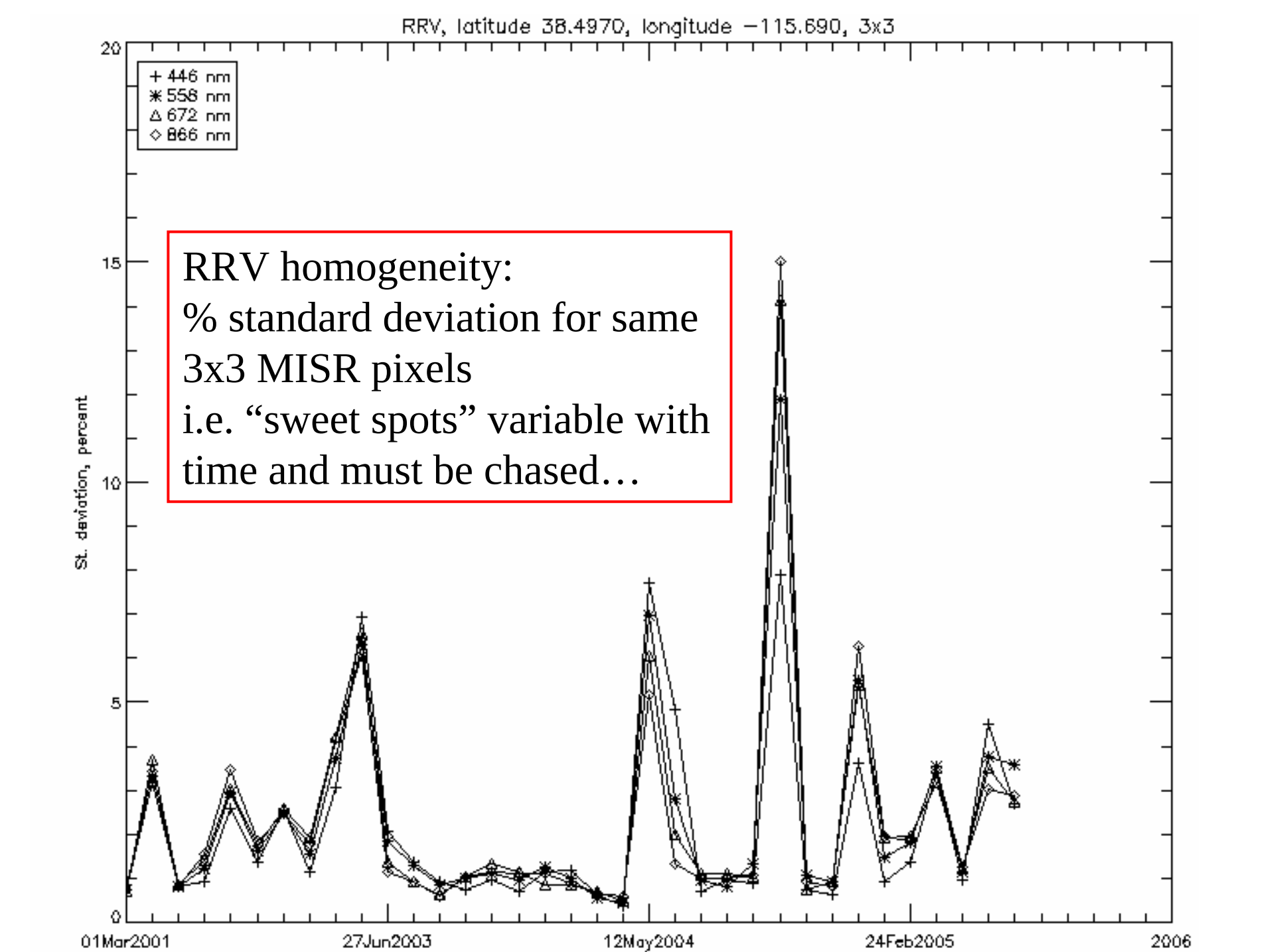

The pan effect…
May 10, 2003

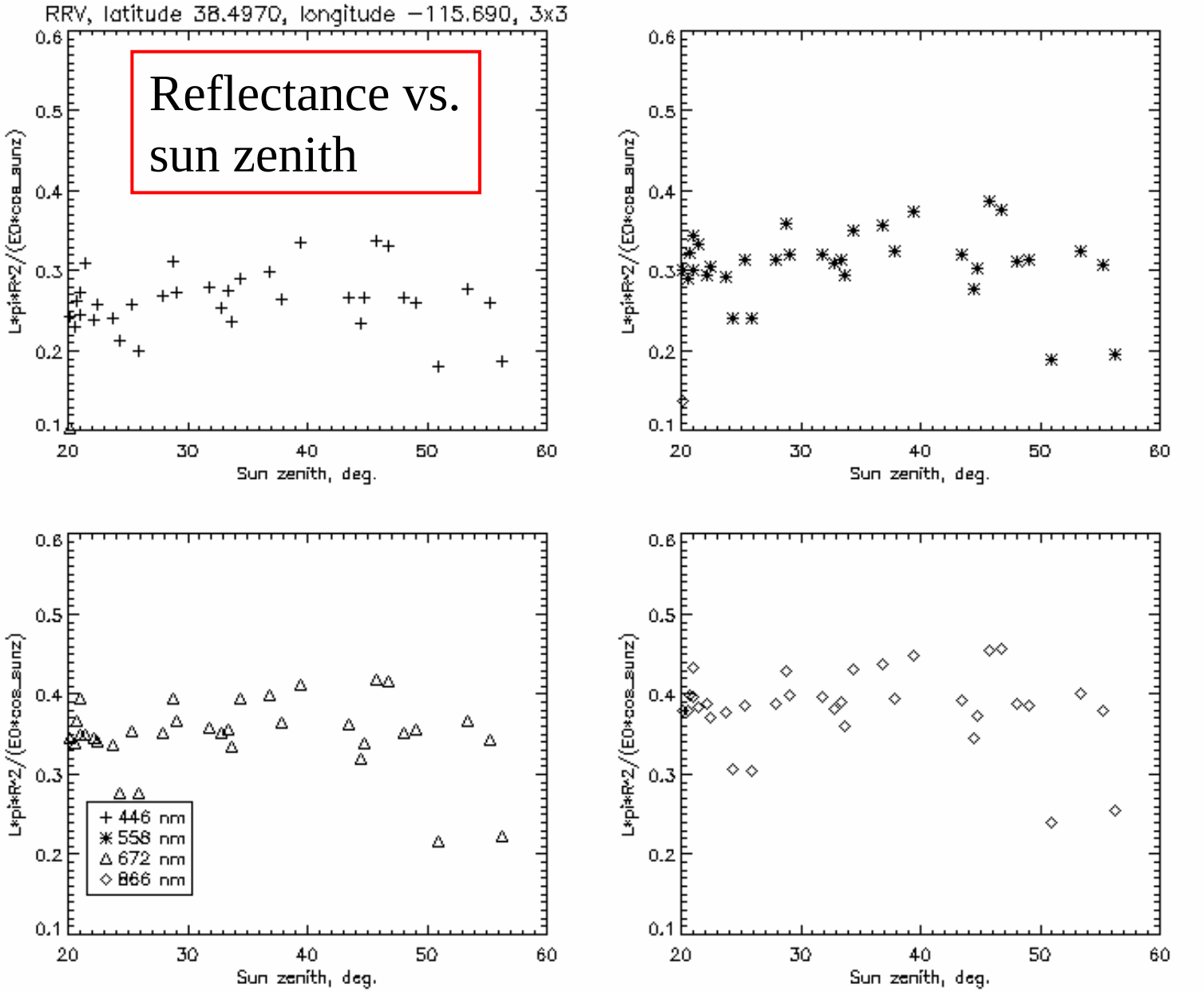

MudLake, latitude 37.8701, longitude −117.067, 3x3
+ 446 nm
* 558 nm
△ 672 nm
◇ 866 nm
Reflectance=L*pi*R^2/(E0*cos_sunz)
0.6
0.5
0.4
0.3
0.2
0.1
01Mar2001
27Jun2003
12May2004
24Feb2005
2006
Same scene, 35 overpasses,
cloud-free conditions,
March 2001 to present


MudLake, latitude 37.8701, longitude −117.067, 3x3
+ 446 nm
* 558 nm
△ 672 nm
◇ 866 nm
Investigation of homogeneity:
% standard deviation
for same 3x3 MISR pixels
~2% for many observations
St. deviation, percent
0
2
4
6
01Mar2001
27Jun2003
12May2004
24Feb2005
2006

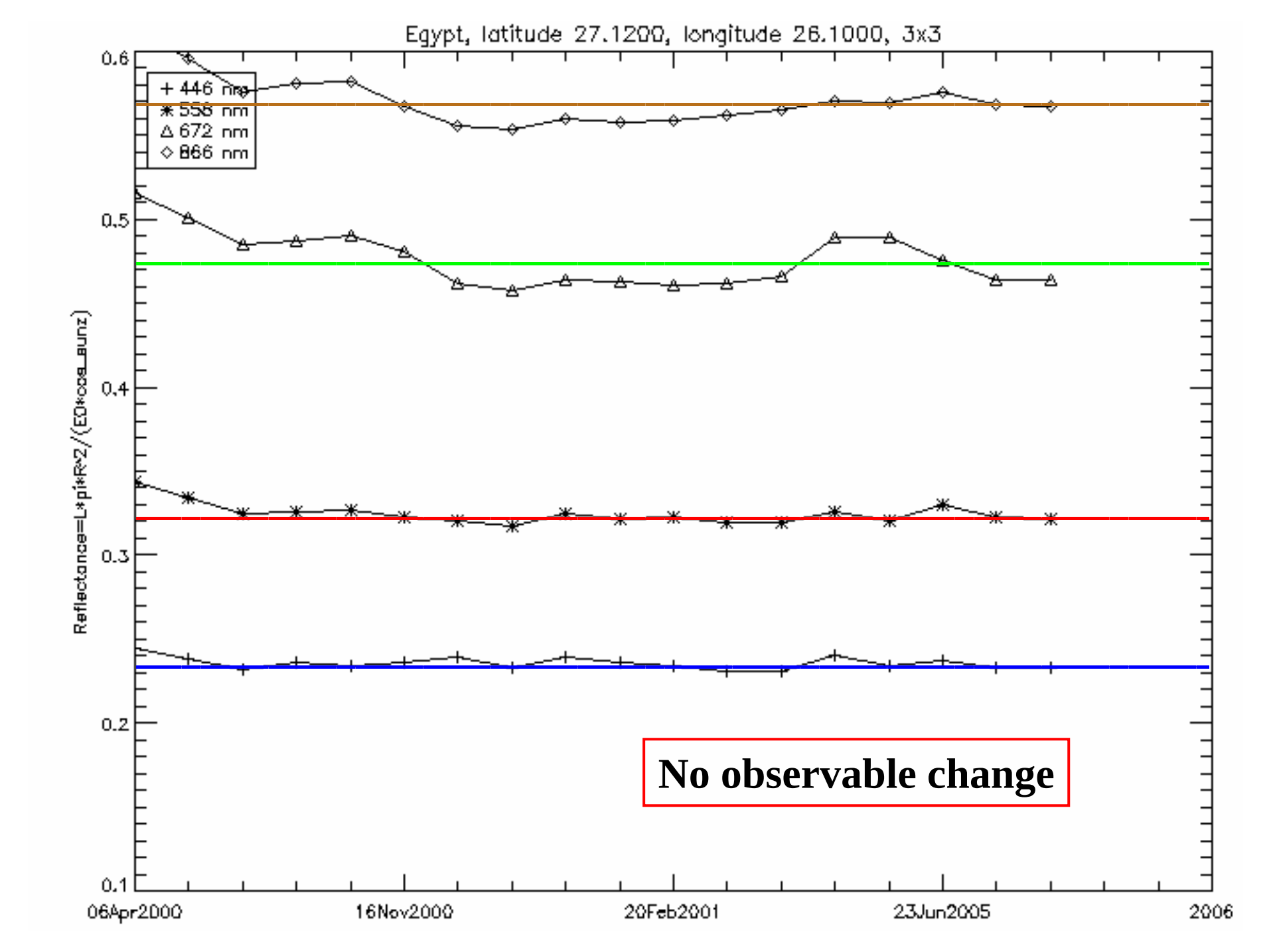

MudLake, latitude 37.8701, longitude −117.067, 3x3
Reflectance stable w/sun zenith ~± 0.1
L*pi*R^2/(E0*cos_sunz)
Sun zenith, deg.
446 nm
558 nm
672 nm
866 nm

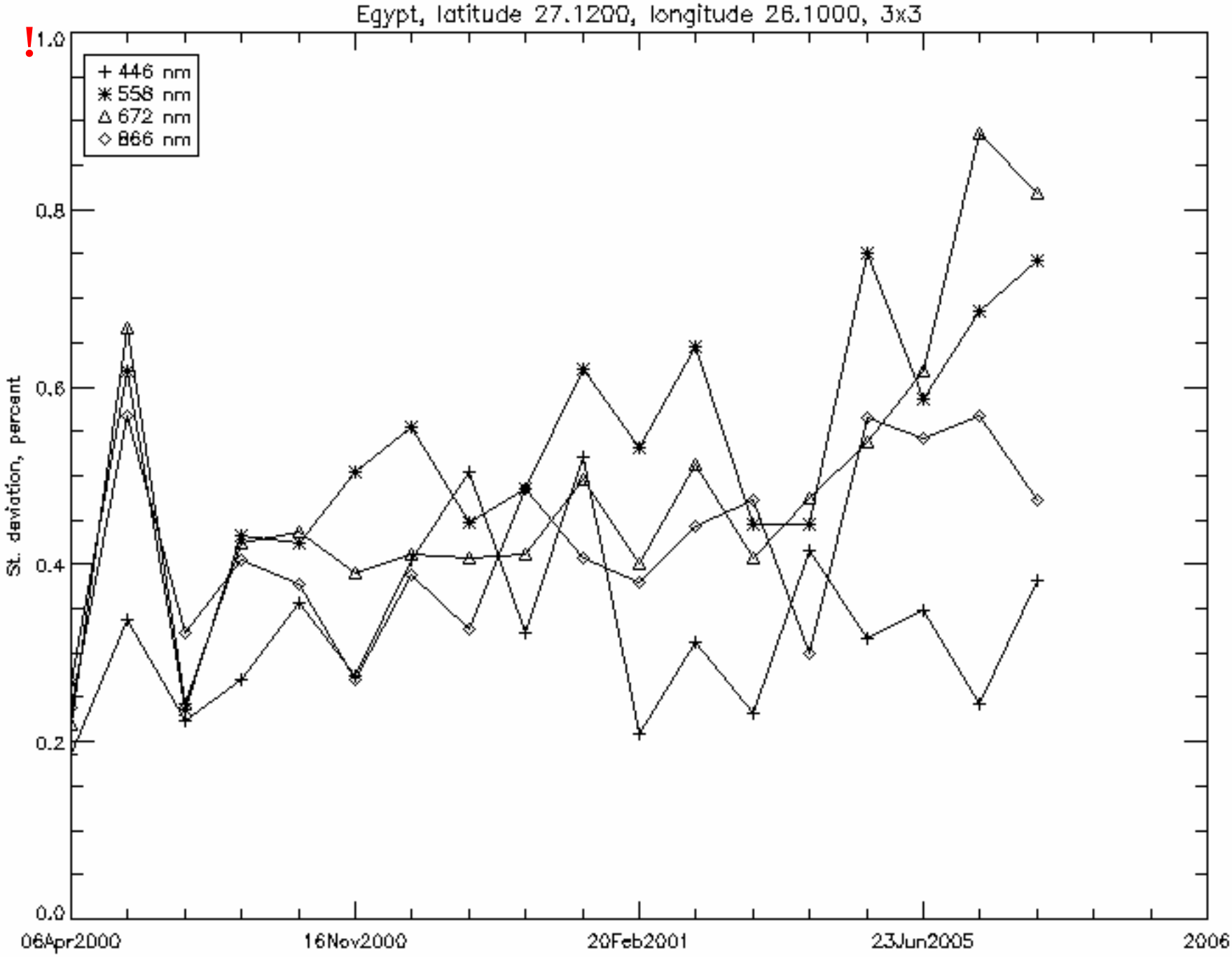

RRV, latitude 38.4970, longitude −115.690, 3x3
+ 446 nm
* 558 nm
△ 672 nm
◇ 866 nm
(Cloudy)
(Surface change)
Reflectance=L*pi*R^2/(E0*cos_sunz)
0.6
0.5
0.4
0.3
0.2
0.1
01Mar2001
27Jun2003
12May2004
24Feb2005
2006

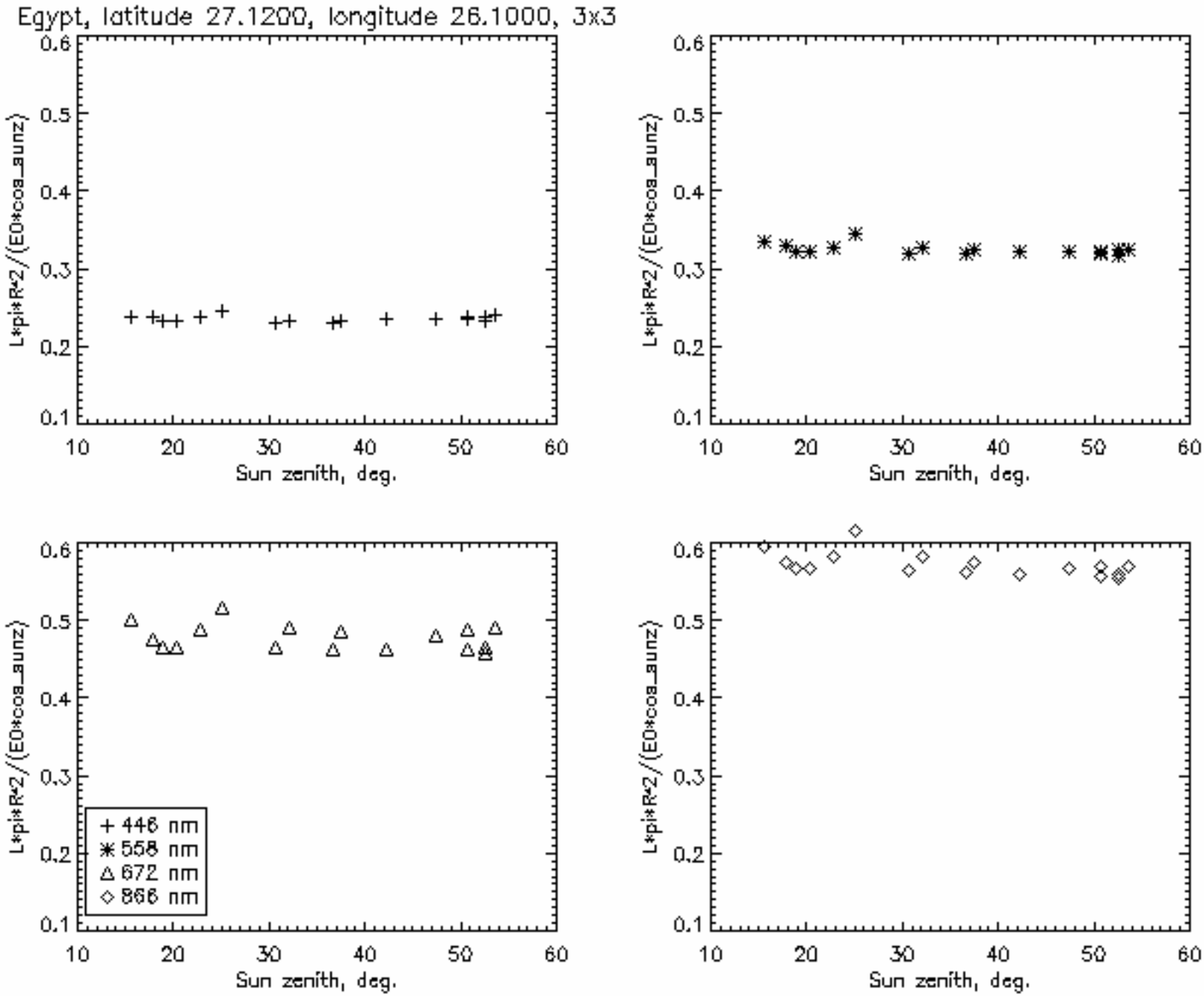

RRV, latitude 38.4970, longitude −115.690, 3x3
+ 446 nm
✳ 558 nm
△ 672 nm
◇ 866 nm
St. deviation, percent
0
5
10
15
20
01Mar2001
27Jun2003
12May2004
24Feb2005
2006
RRV homogeneity:
% standard deviation for same 3x3 MISR pixels
i.e. “sweet spots” variable with time and must be chased…


RRV, latitude 38.4970, longitude −115.690, 3x3
Reflectance vs. sun zenith
L*pi*R^2/(E0*cos_sunz)
Sun zenith, deg.
446 nm
558 nm
672 nm
866 nm


July 9, 2005
Egypt_1 (27.12 N, 26.1 E)
Area shown is ~ 150 in extent


Egypt, latitude 27.1200, longitude 26.1000, 3x3
+ 446 nm
* 556 nm
△ 672 nm
◇ 866 nm
Reflectance=L*pi*R^2/(E0*cos_sunz)
0.6
0.5
0.4
0.3
0.2
0.1
06Apr2000
16Nov2000
20Feb2001
23Jun2005
2006
No observable change


Egypt, latitude 27.1200, longitude 26.1000, 3x3
+ 446 nm
* 558 nm
△ 672 nm
◇ 866 nm
St. deviation, percent
1.0
0.8
0.6
0.4
0.2
0.0
06Apr2000
16Nov2000
20Feb2001
23Jun2005
2006


Egypt, latitude 27.1200, longitude 26.1000, 3x3
L*pi*R^2/(E0*cos_sunz)
Sun zenith, deg.
446 nm
558 nm
672 nm
866 nm

MISR An (nadir-viewing) camera
July 2, 2005

•Lines indicate Nellis AFB boundary.
•Symbols indicate boundaries of ASD data acquisition.

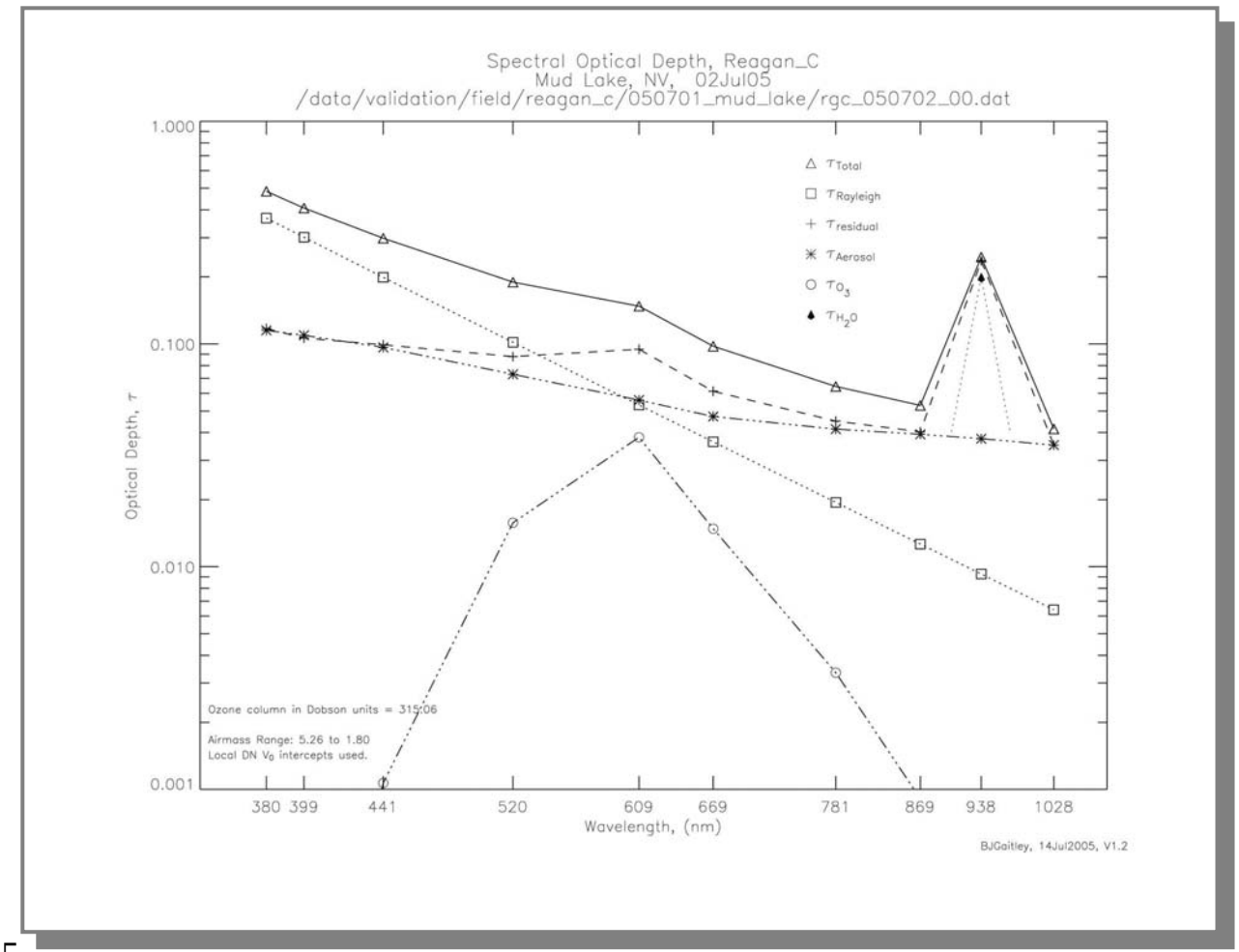
Surface reflectance measurements

ASD measurement summary

Standard_Set Wavelength	Mean HDRF	St Dev HDRF	Upper HDRF	Lower HDRF	% Relative Deviation
400.00	0.2871	0.0097	0.2968	0.2775	3.3610
450.00	0.3540	0.0126	0.3666	0.3414	3.5640
500.00	0.3960	0.0143	0.4103	0.3818	3.6061
550.00	0.4540	0.0172	0.4713	0.4368	3.7940
600.00	0.4988	0.0197	0.5185	0.4791	3.9472
650.00	0.5115	0.0197	0.5312	0.4919	3.8486
700.00	0.5244	0.0203	0.5447	0.5041	3.8758
750.00	0.5332	0.0204	0.5536	0.5128	3.8326
800.00	0.5358	0.0202	0.5560	0.5156	3.7694
850.00	0.5291	0.0196	0.5487	0.5096	3.6951
900.00	0.5198	0.0190	0.5388	0.5008	3.6589
950.00	0.5137	0.0187	0.5324	0.4950	3.6368
1000.00	0.5138	0.0178	0.5316	0.4959	3.4742

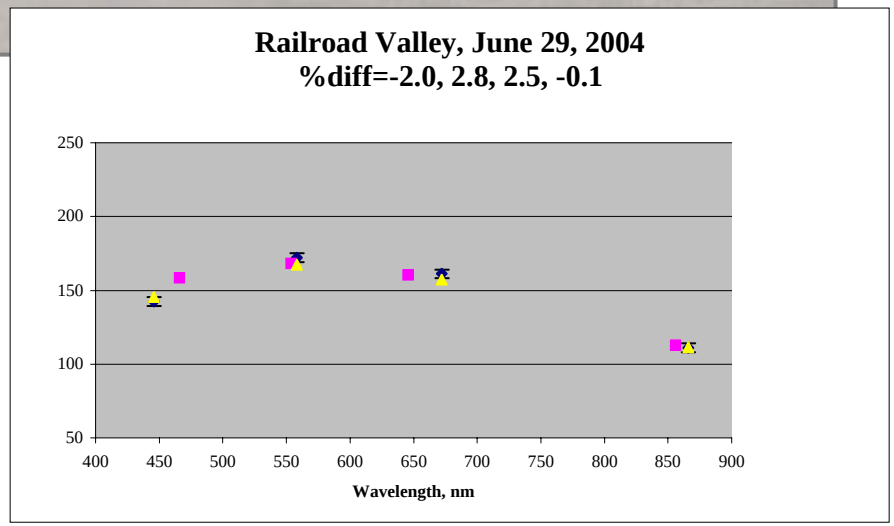
Above: ASD acquires hyperspectral measurements of surface. Data are ratioed to output while viewing a Spectralon reflectance standard.

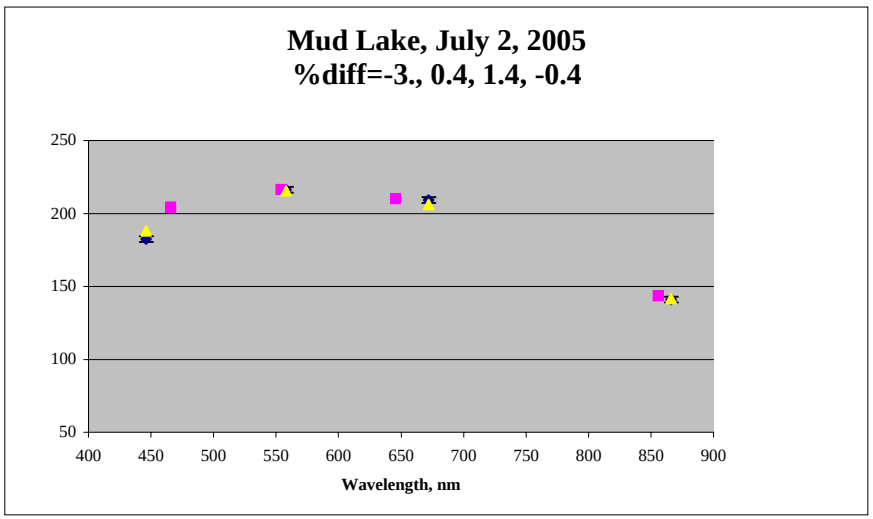
Atmospheric characterization

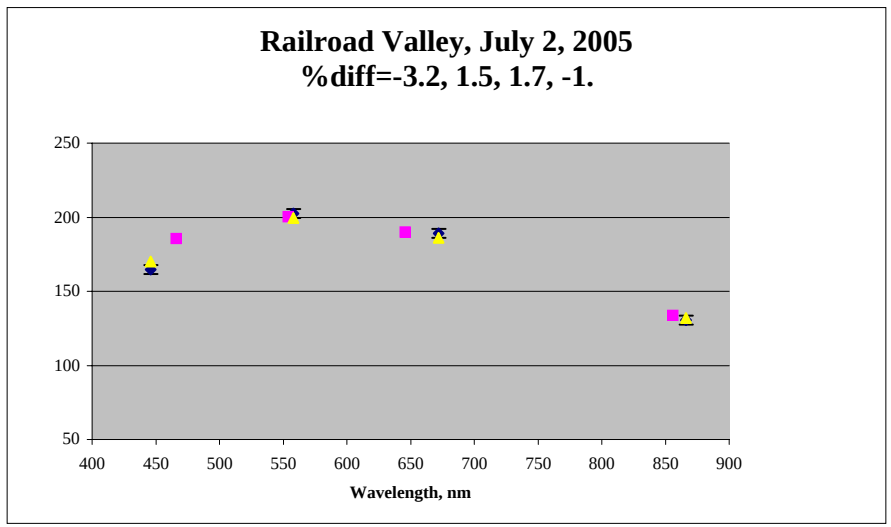


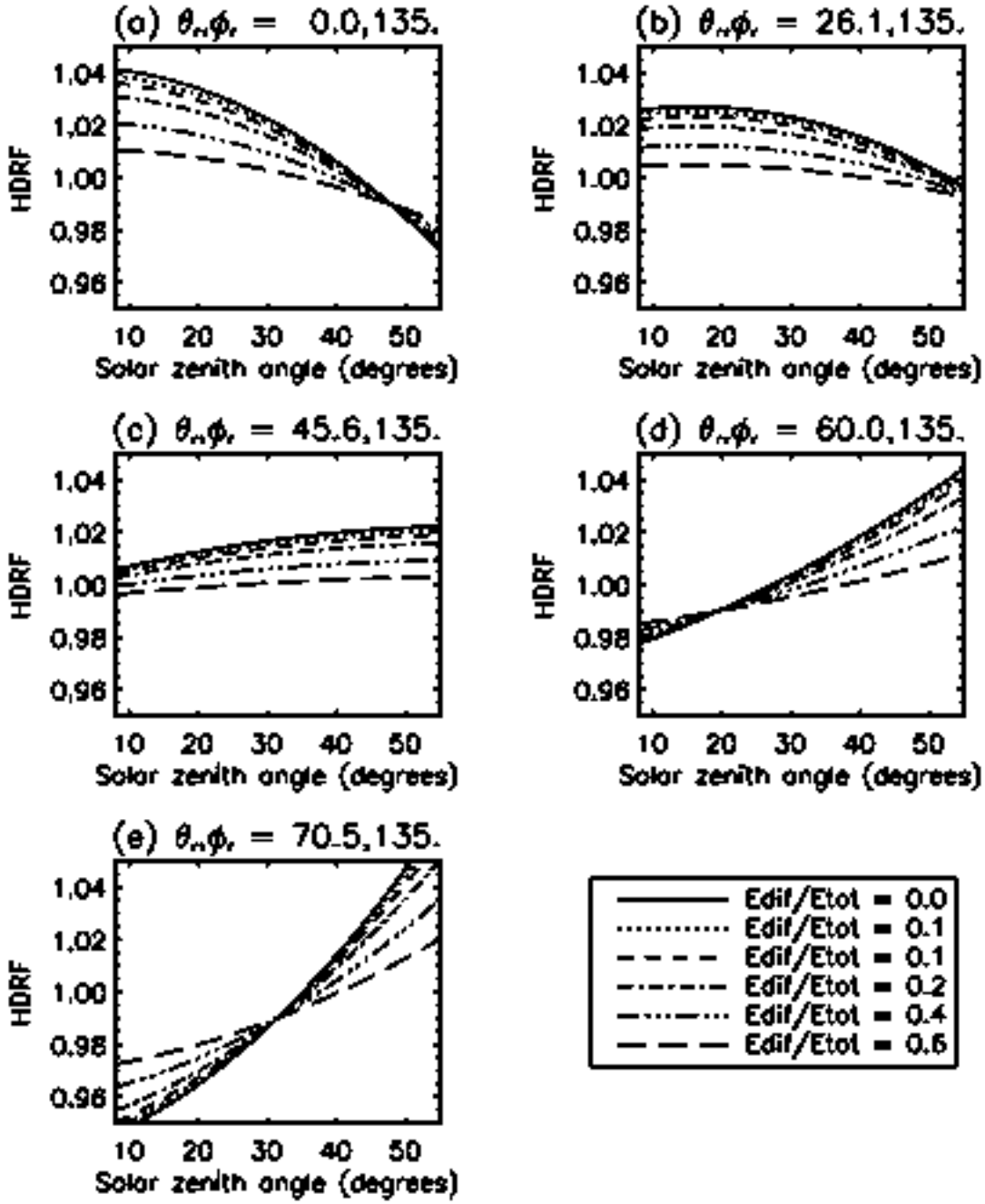
Spectralon BRF

MISR-MODIS comparison, 2004(top) and 2005 (bottom)
%diff=(misr-modis)*100/modis









Plots show the change in hemispheric-diffuse reflectance (HDRF) with atmospheric conditions, for the 5 MISR view angles

Lines show the Spectralon bi-directional reflectance (BRF), with no diffuse illumination

<u>July 2, 2005 conditions</u>

- Edif/Etot ~ 0.2 at 550 nm
- Solar zenith 23°
- From (a) we see the error in assumint Spectralon HDRF =BRF is 1-2% for the MISR nadir camera

Summary

•The MISR instrument continues to degrade at a constant rate, with a total degradation of 10% following 5 years on-orbit

•MODIS cross-comparison studies and Egypt_1 observations suggests that the MISR on-board calibrator continues to adjust calibration coefficients to maintain calibration accuracy at 3-5%.

•2005 vicarious calibration anomalous - warm-up time/ spectral calibration of surface radiometer under investigation

VC Campaign Lessons Learned

- Two playas, two different orbits better chances for “Golden Day” in season
- Mobile lab - operator comfort - ability to repair and recover
- Enthusiastic student help and on-going contact with their advisors
- Verify data before leaving site
- Detailed field notes which capture ad-hoc field methods
- Flexible and overlapping power systems
- Instrument automation - real-time operation updates, “songs”
- Dedicated field team - consistent equipment cognizance
- Documentation of instrument operation, methodology & science drivers
- End-to-end participation of cal/val team members
- Consensus on operations before deployment, including what-if scenarios
- Satellite telephone - coordinating airborne overflights - crew safety
- Mobile Internet access: http://www.apccorp.net/flyawaymobile.htm
- Field crew SOP: If it's clear, collect data!