CERES/MODIS/MISR/SeaWiFS/Earthshine SW Trend Comparisons

Norman G. Loeb

Hampton University/NASA Langley Research Center

Hampton, VA

Contributors: W. Sun, K. Loukachine, W. F. Miller, W. Su, B. A. Wielicki

November 1st, 2005, CERES STM (Hampton, VA)

CLIMATE DATA RECORDS (SOME REQUIREMENTS)

1) Long-term records of cloud and radiation measurements to separate sampling noise and natural variability from real changes.

2) Calibration stability

3) Algorithm Stability (includes input data sets)

4) Independent measurements and methodologies

OBSERVATIONS

Terra:

- 64 months (March 2000 – June 2006) of CERES Ed2B_rev1 Single Scanner Foorprint (SSF).

- Selected days from new merged CERES-MODIS-MISR multiangle dataset.

Aqua:

- 32 months (August 2002 – March 2005) of CERES Ed2A_rev1 Single Scanner Foorprint (SSF).

SeaWiFS:

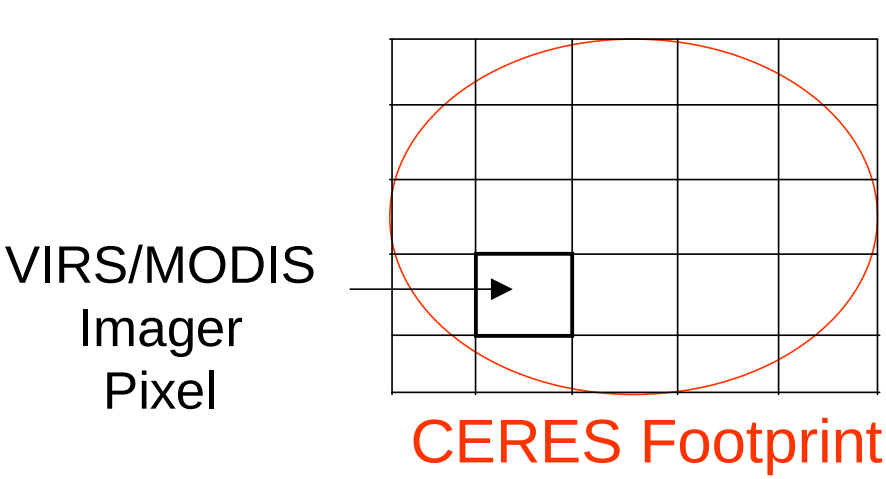
- Photosynthetically Active Radiation (PAR) retrievals for March 2000 – June 2004

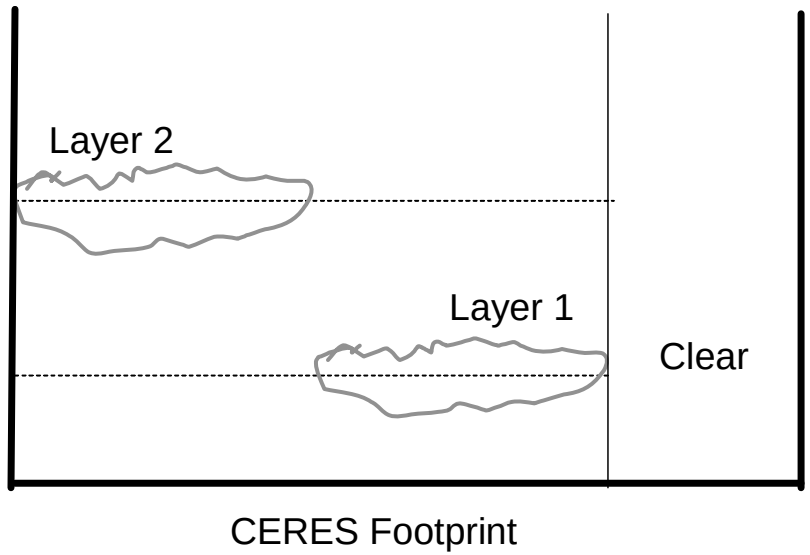
Earthshine: Published results between 2000 – 2003.

CERES Single Scanner Footprint (SSF) Product

- Coincident CERES radiances and imager-based cloud and aerosol properties (including MOD04 and NOAA-NESDIS aerosol products).
- Use VIRS (TRMM) or MODIS (Terra, Aqua) to determine the following parameters in up to 2 cloud layers over every CERES FOV:

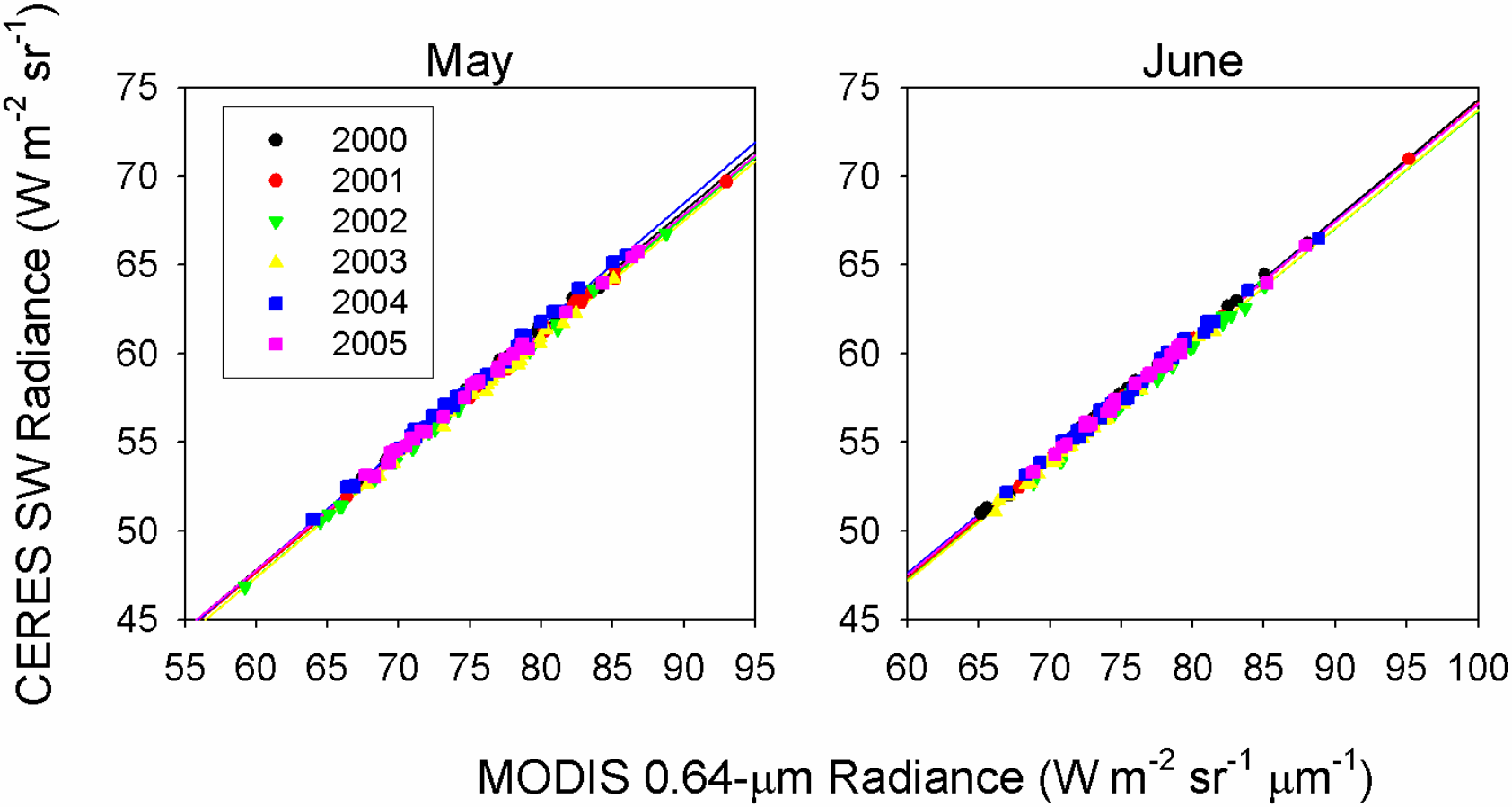
Macrophysical: Fractional coverage, Height, Radiating Temperature, Pressure
Microphysical : Phase, Optical Depth, Particle Size, Water Path
Clear Area : Albedo, Skin Temperature, Aerosol optical depth, Emissivity

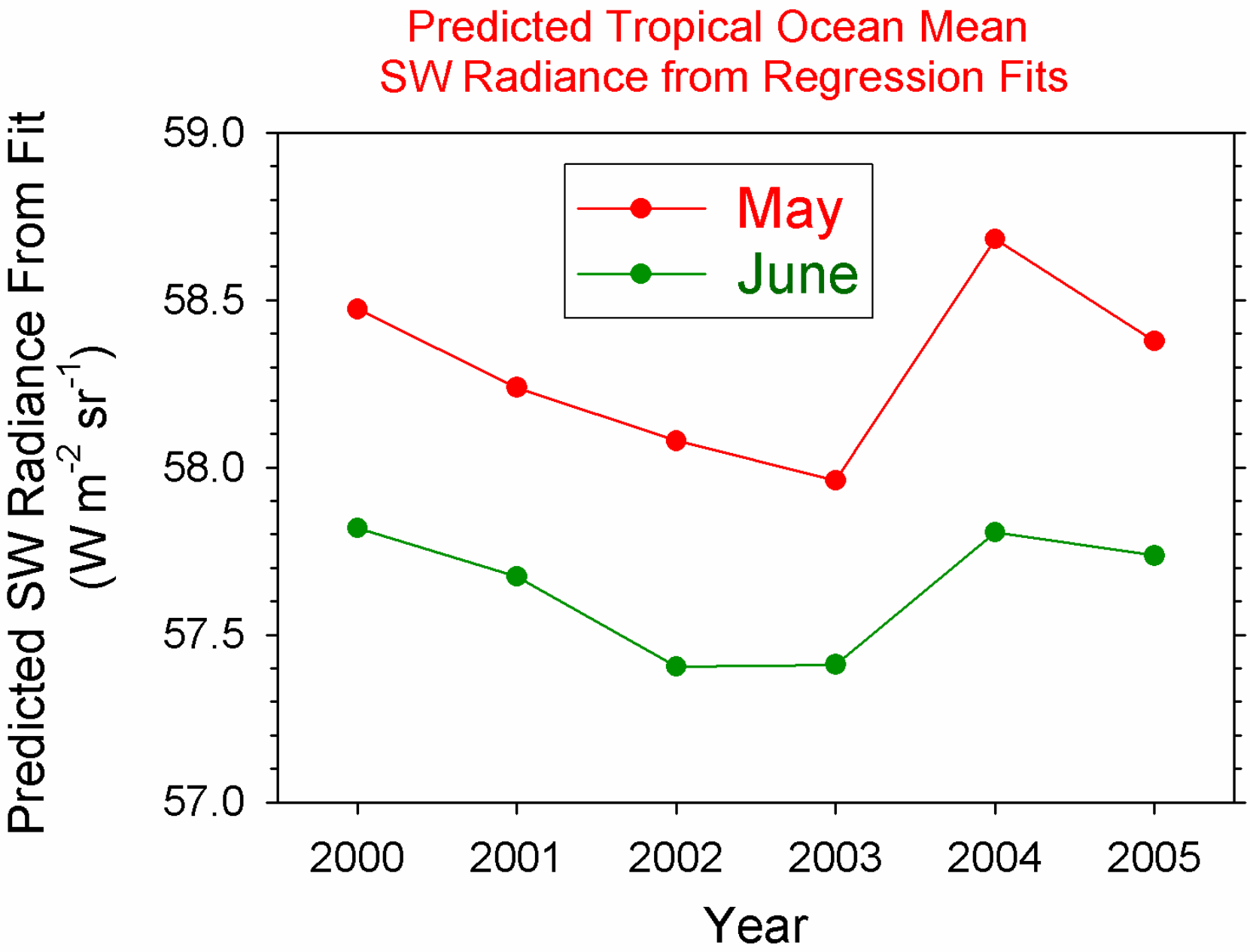


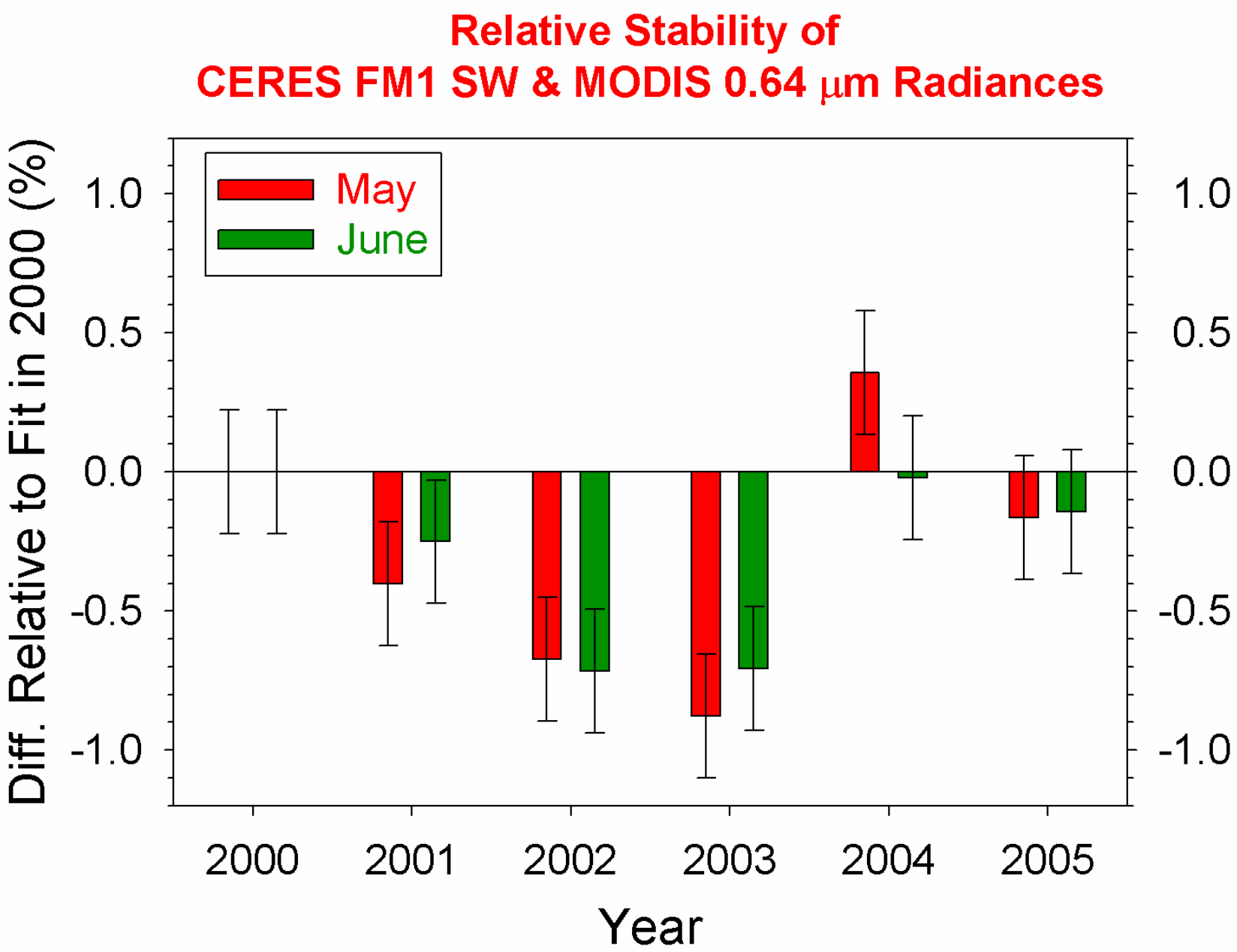


Relative Stability of CERES & MODIS

CERES FM1 vs MODIS Daily Mean Nadir Radiance Comparison
(Ocean; 30°S-30°N; θ ≤ 10°)



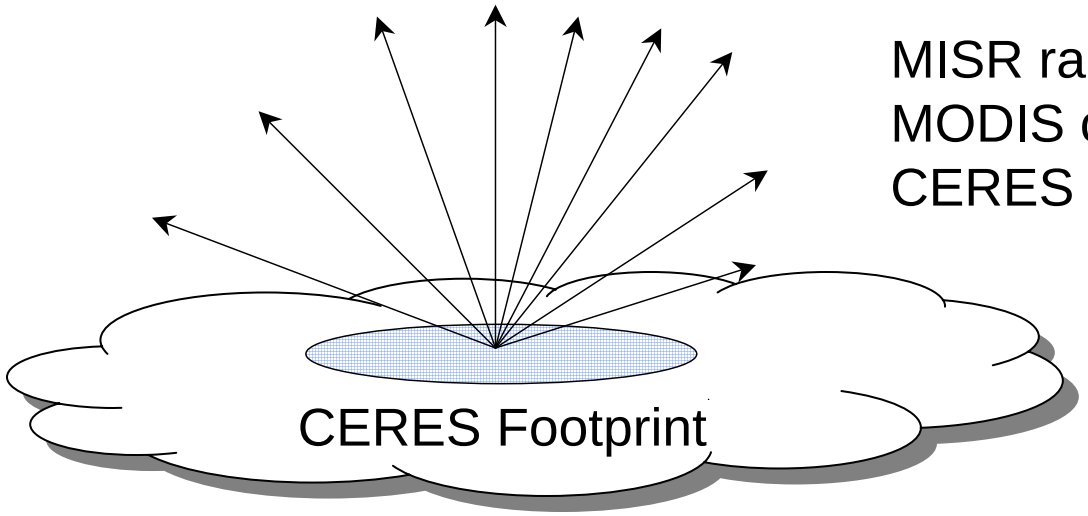

Predicted Tropical Ocean Mean
SW Radiance from Regression Fits
Predicted SW Radiance From Fit
(W m-2 sr-1)
59.0
58.5
58.0
57.5
57.0
May
June
2000
2001
2002
2003
2004
2005
Year


Relative Stability of
CERES FM1 SW & MODIS 0.64 μm Radiances
May
June
Diff. Relative to Fit in 2000 (%)
1.0
0.5
0.0
-0.5
-1.0
2000
2001
2002
2003
2004
2005
Year

Relative Stability of MISR & MODIS

NEW MERGED CERES-MISR-MODIS DATASET

CERES and MISR teams are working together to produce the first merged CERES-MISR-MODIS dataset.

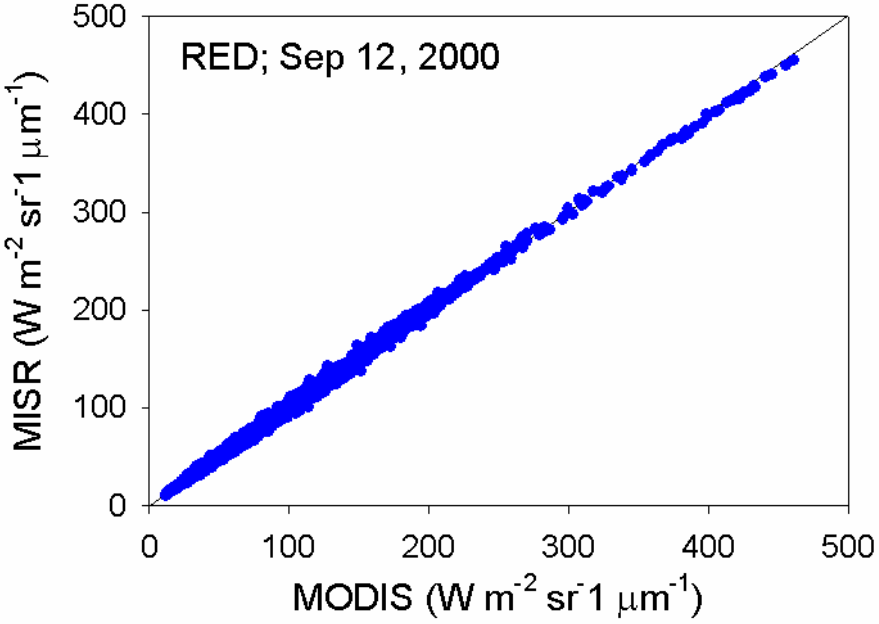


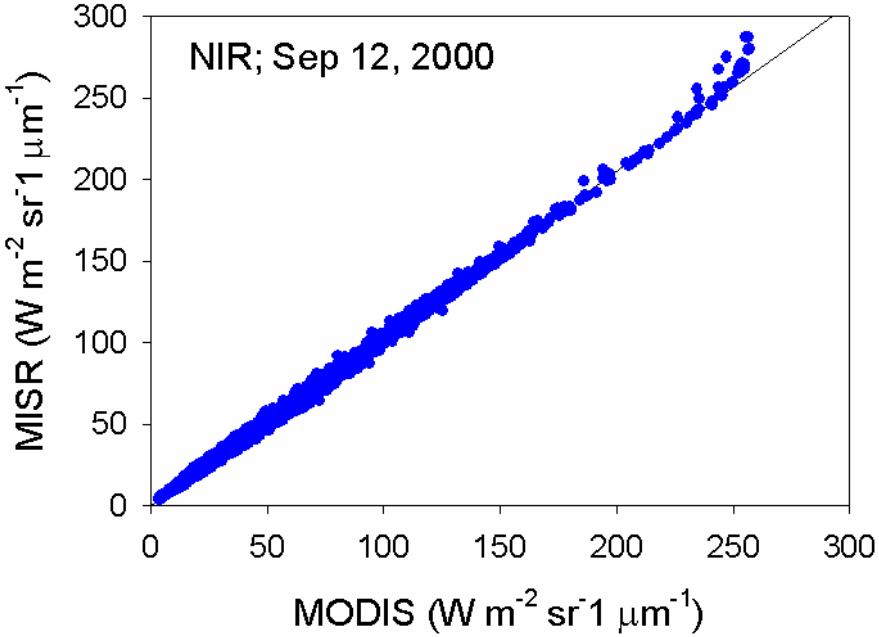
MISR radiances
MODIS clouds and aerosols
CERES radiances and fluxes

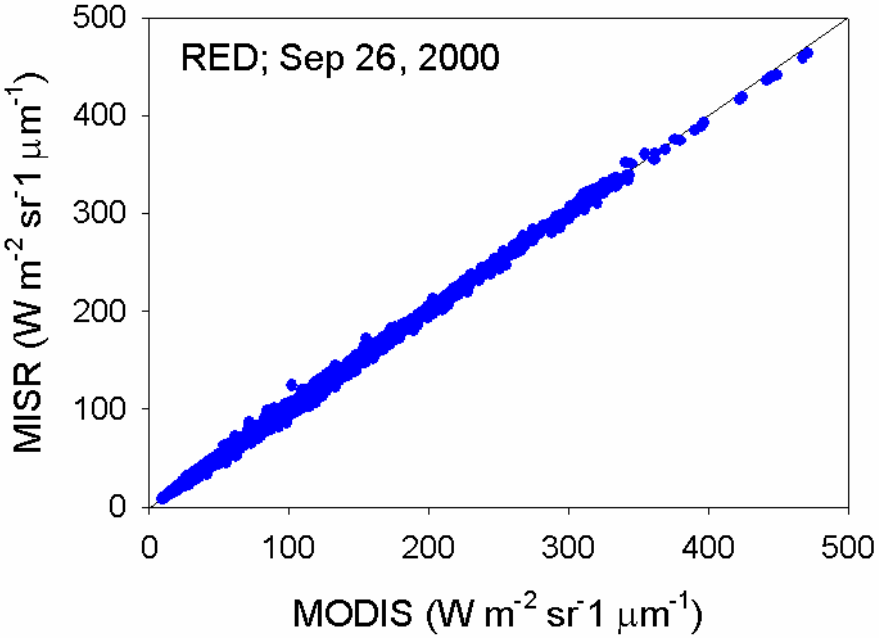
Contains all CERES-MODIS parameters on the CERES SSF product and all available MISR radiances (9 angles and 4 channels) averaged over every CERES footprint.

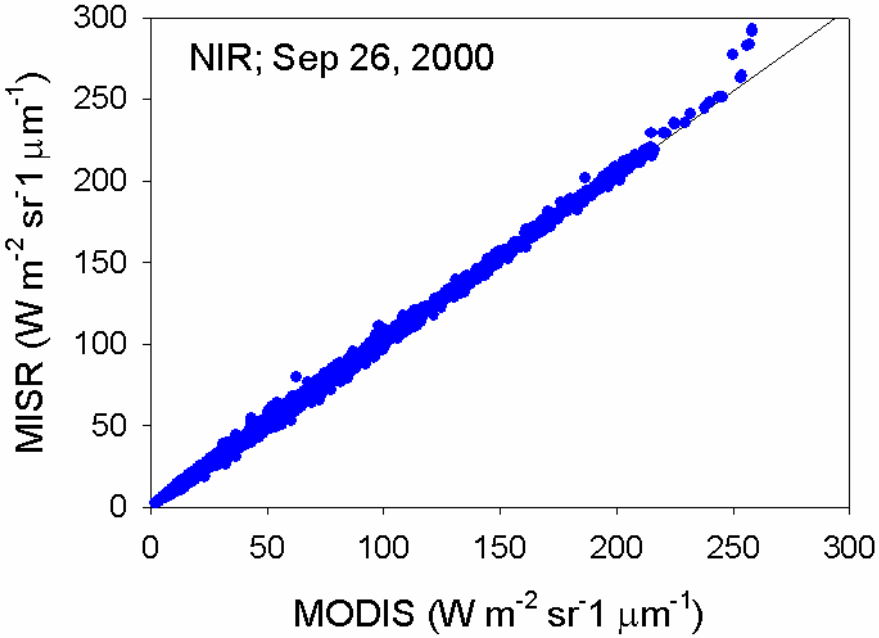
⇒ Can be extended to include other MISR and MODIS derived parameters

MISR vs MODIS Radiances (2000)

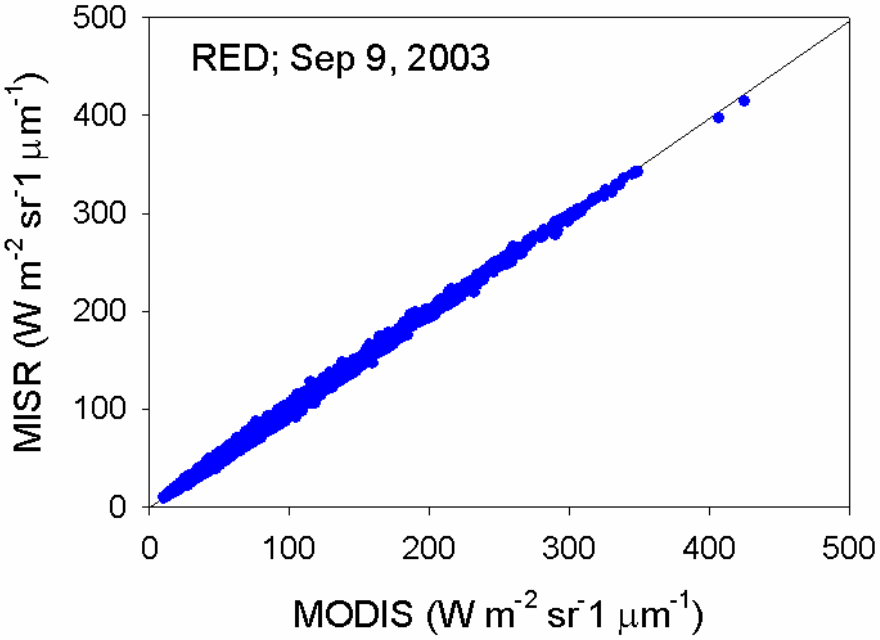


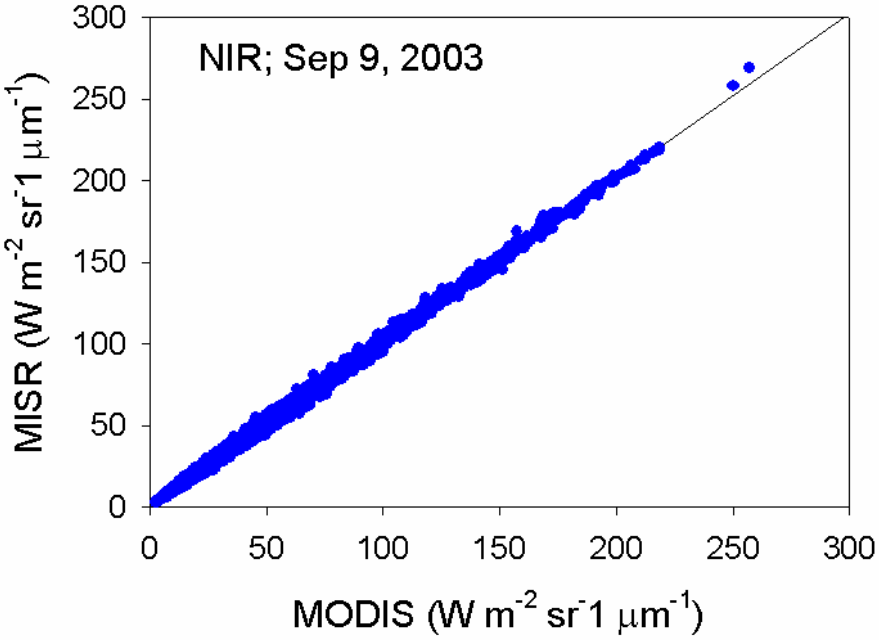


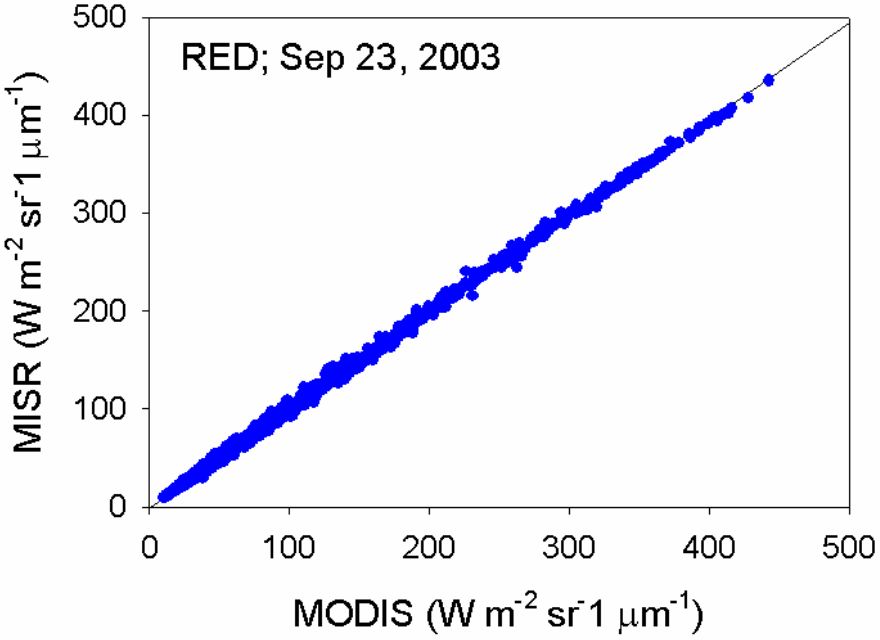


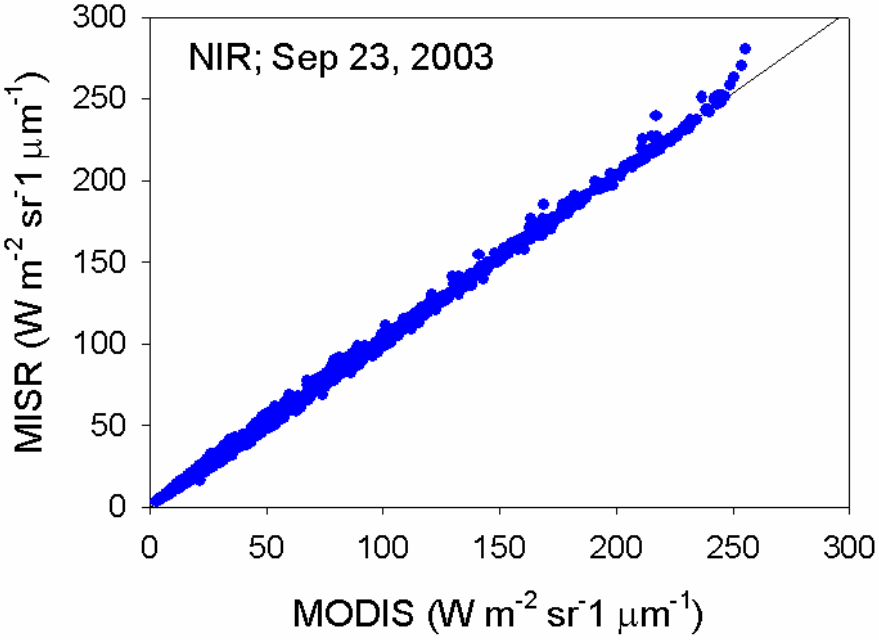


MISR vs MODIS Radiances (2003)









Predicted MISR radiance from MISR-MODIS Regressions: (W m^{-2} sr^{-1} μm^{-1})

	RED	NIR
Sep 12, 2000	76.708	47.703
Sep 26, 2000	76.618	47.722
Sep 9, 2003	75.913	47.336
Sep 23, 2003	75.873	47.582

Radiance Rel. Diff. (%)

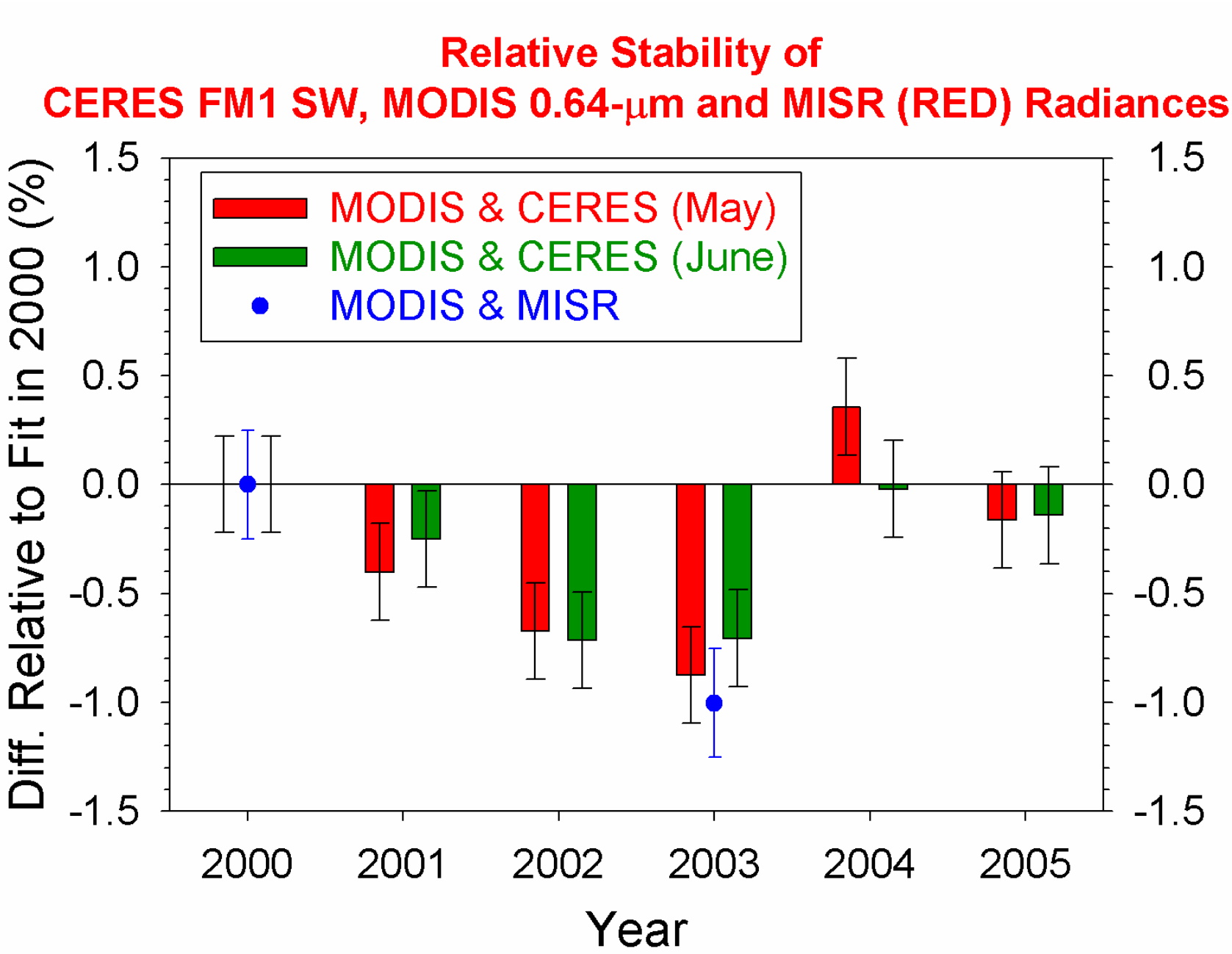
	RED	NIR
09/09/03 – 09/12/00	-1.036	-0.768
09/23/03 – 09/26/00	-0.972	-0.294
09/23/03 – 09/12/00	-1.089	-0.810
09/09/03 – 09/26/00	-0.920	-0.253
Mean	**-1.004 ± 0.24**	**-0.530 ± 0.30**

Predicted MISR radiance from MISR-MODIS Red band Regressions:

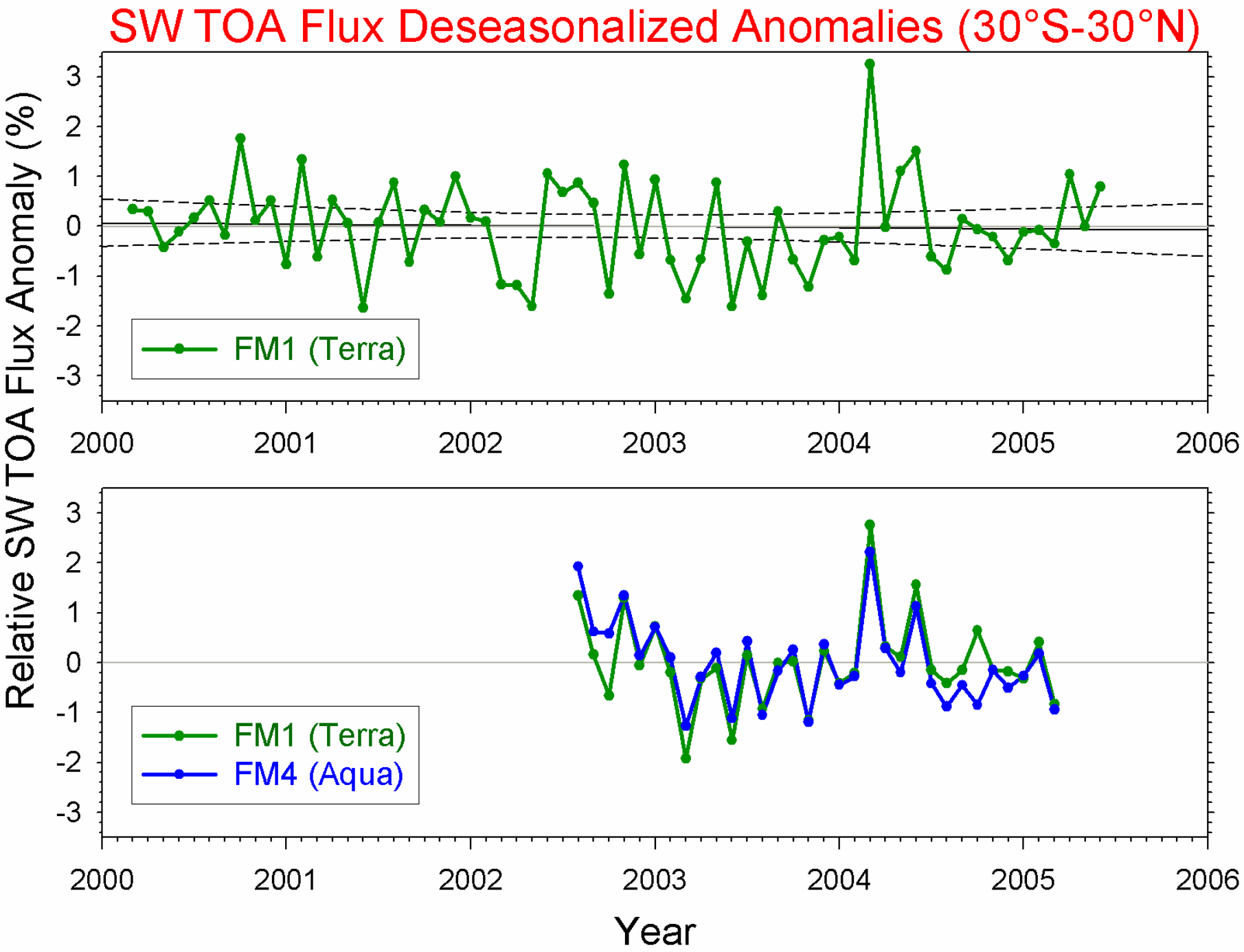
O3	Sep 12, 2000	Sep 26, 2000	Sep 9, 2003	Sep 23, 2003
220-240	63.53	63.41	62.85	62.51
240-260	73.06	72.86	72.27	72.38
260-280	85.44	85.14	84.39	84.41

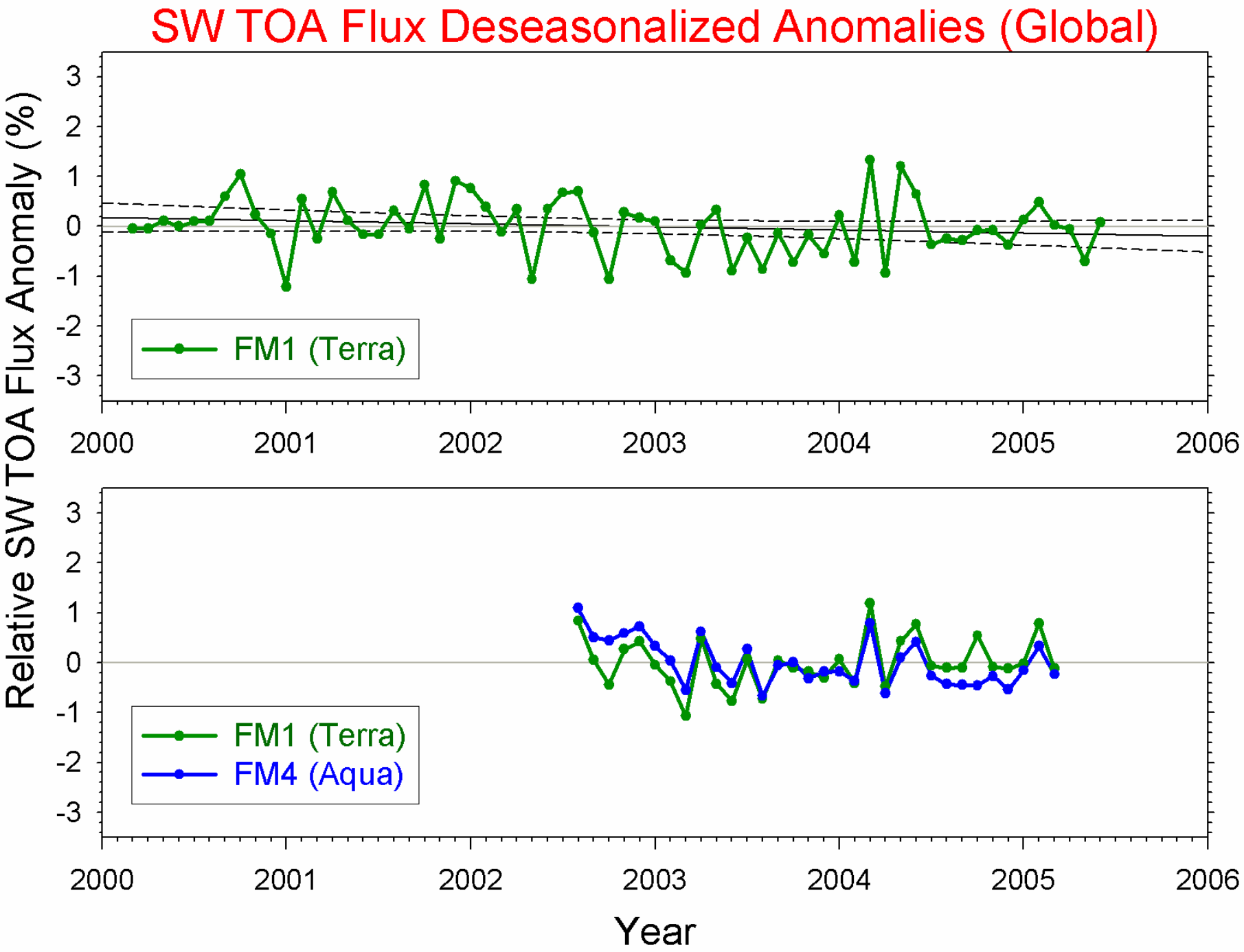
Radiance Rel. Diff. (%)

	220-240	240-260	260-280
09/09/03 – 09/12/00	-1.070	-1.081	-1.229
09/23/03 – 09/26/00	-1.419	-0.659	-0.857
09/23/03 – 09/12/00	-1.606	-0.931	-1.206
09/09/03 – 09/26/00	-0.883	-0.810	-0.881
Mean	**-1.25**	**-0.87**	**-1.04**

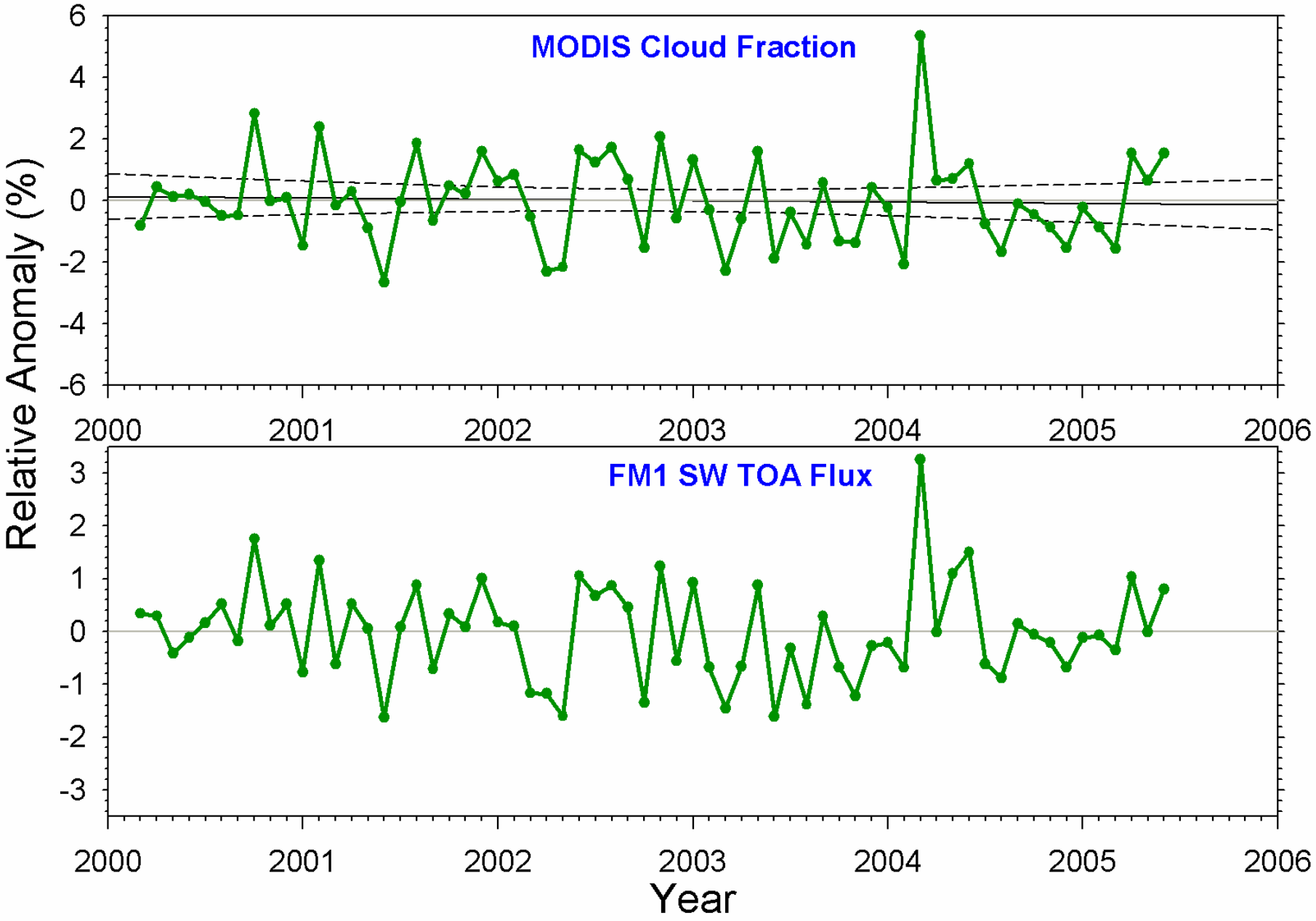

Relative Stability of
CERES FM1 SW, MODIS 0.64-μm and MISR (RED) Radiances
MODIS & CERES (May)
MODIS & CERES (June)
MODIS & MISR
Diff. Relative to Fit in 2000 (%)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
2000
2001
2002
2003
2004
2005
Year

CERES Terra and Aqua Deseasonalized Anomalies

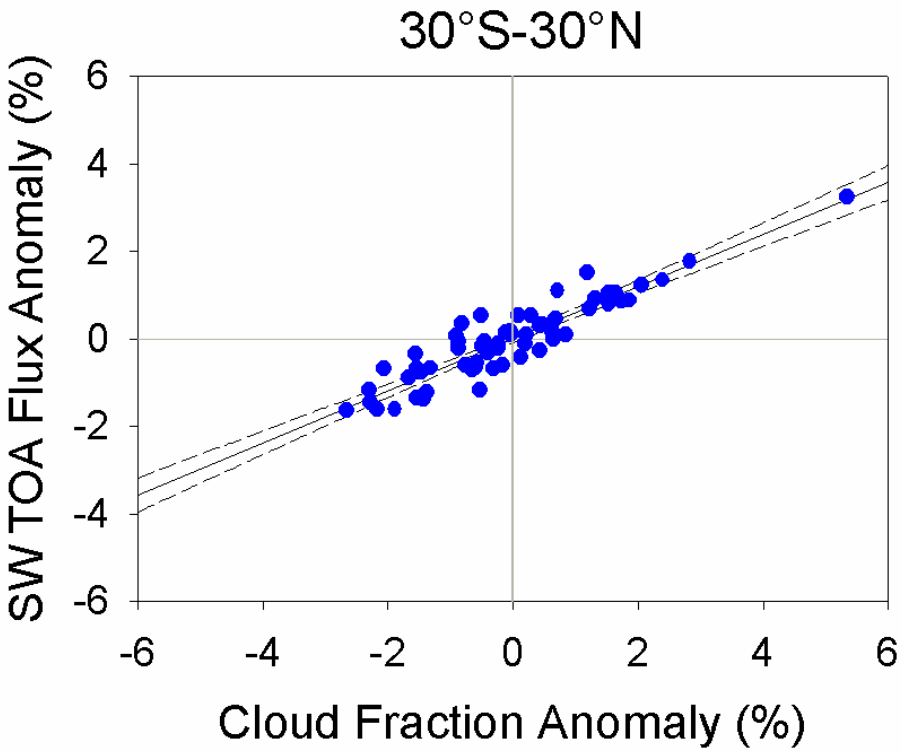

SW TOA Flux Deseasonalized Anomalies (30°S-30°N)
Relative SW TOA Flux Anomaly (%)
3
2
1
0
-1
-2
-3
FM1 (Terra)
2000
2001
2002
2003
2004
2005
2006
FM1 (Terra)
FM4 (Aqua)
Year


SW TOA Flux Deseasonalized Anomalies (Global)
Relative SW TOA Flux Anomaly (%)
3
2
1
0
-1
-2
-3
FM1 (Terra)
2000
2001
2002
2003
2004
2005
2006
FM1 (Terra)
FM4 (Aqua)
Year

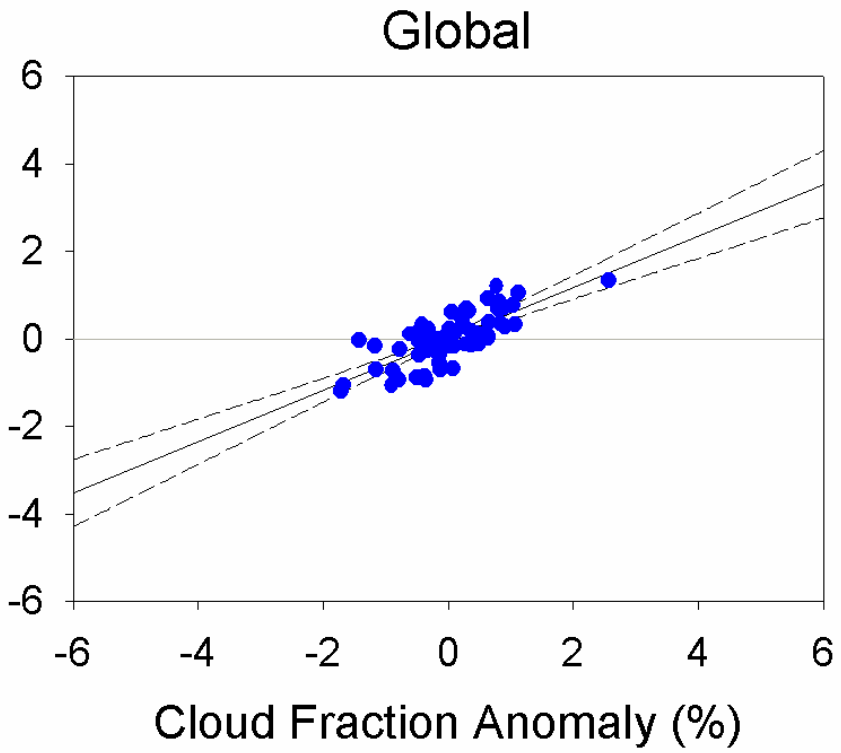
Cloud Fraction & SW Flux Deseasonalized Anomalies (30°S-30°N)



CERES FM1 SW TOA Flux Anomaly vs MODIS Cloud Fraction Anomaly



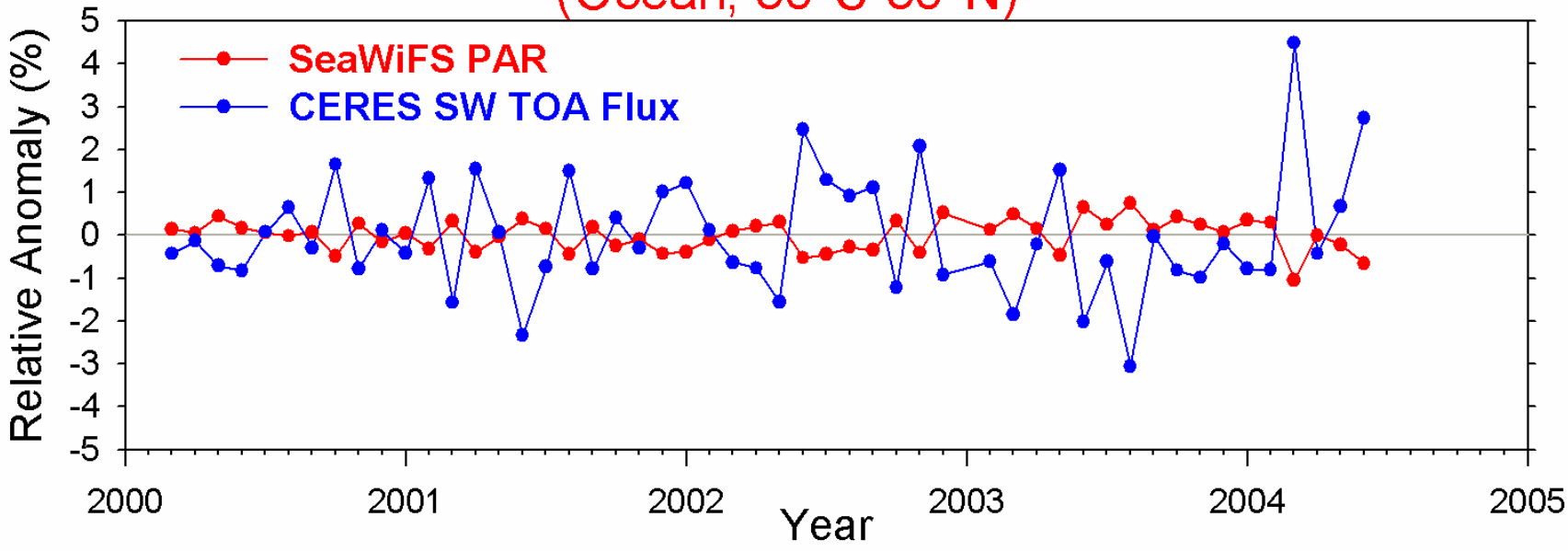
a0 = -1.56e-7
a1 = 0.594
r² = 0.85

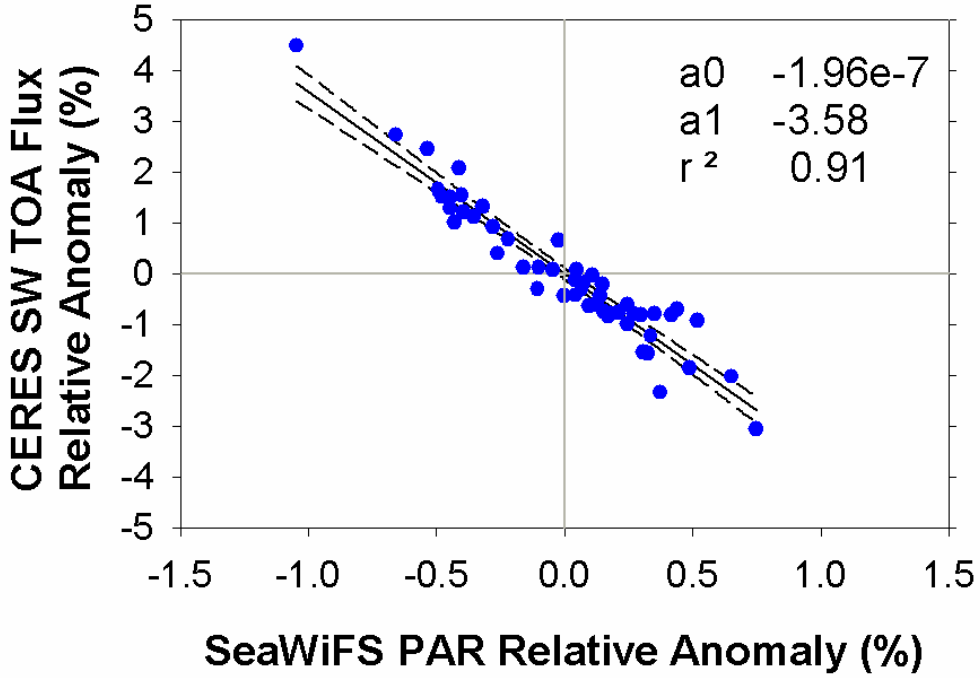


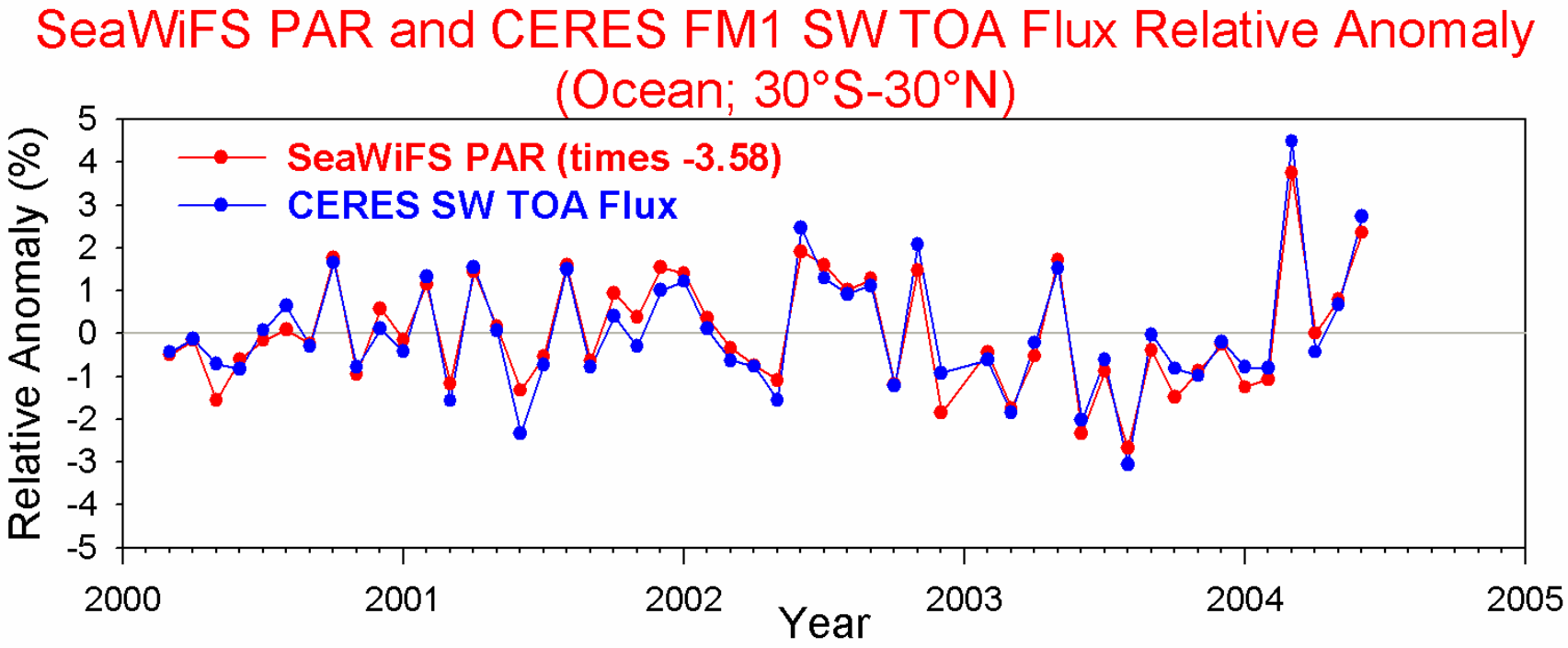
a0 = 1.84e-7
a1 = 0.589
r² = 0.58

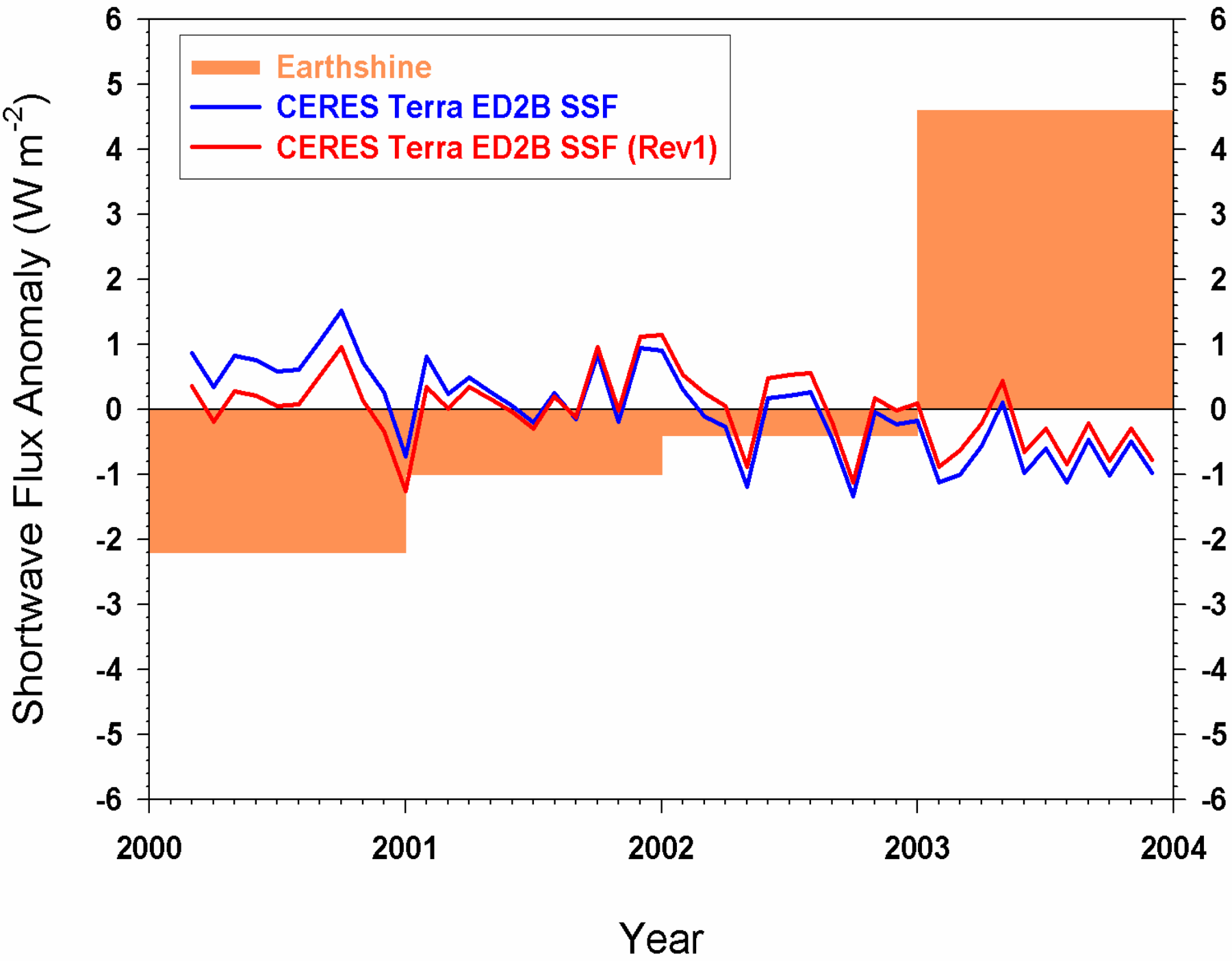
CERES & SeaWiFS Deseasonalized Anomalies

SeaWiFS PAR and CERES FM1 SW TOA Flux Relative Anomaly (Ocean; 30°S-30°N)






SeaWiFS PAR and CERES FM1 SW TOA Flux Relative Anomaly
(Ocean; 30°S-30°N)
SeaWiFS PAR (times -3.58)
CERES SW TOA Flux
Relative Anomaly (%)
5
4
3
2
1
0
-1
-2
-3
-4
-5
2000
2001
2002
2003
2004
2005
Year


Earthshine
CERES Terra ED2B SSF
CERES Terra ED2B SSF (Rev1)
Shortwave Flux Anomaly (W m-2)
Year
6
5
4
3
2
1
0
-1
-2
-3
-4
-5
-6
2000
2001
2002
2003
2004

CONCLUSIONS

- The CERES, MISR, MODIS and SeaWiFS instruments are well characterized with unprecedented calibration stability (relative consistency within 1% in 5 years).

- CERES relative anomalies are remarkably consitent with those from SeaWiFS.

- No statistically significant trend in SW TOA flux is observed between March 2000 and June 2005.

- Variability in SW TOA flux and cloud fraction is much more pronounced in tropics than global.