Four Years of Terra SSF Fluxes and Clouds

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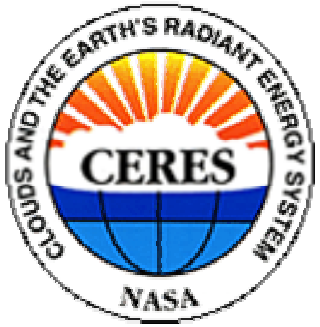

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November 2nd, 2004, 2nd CERES-II STM (Williamsburg)

TOA Flux and Cloud Property Anomaly Time Series

- Apply new CERES Terra ADMs to determine TOA flux from every CERES footprint in CERES SSF product.
- Convert every CERES TOA flux to a 24-h average flux using CERES TRMM directional models (assuming constant meteorology).
- Determine gridded (1°x1° latitude-longitude) monthly mean maps of the following parameters for FM1 and FM2 (separately) for 46 months (March 2000 – December 2003):

SW TOA flux
Cloud Amount (low, middle, high, all)
Cloud Optical Depth (low, middle, high, all)
Aerosol Optical Depth
Snow Fraction

Deseasonalized TOA Flux Anomaly from 2000-2003

- Compute anomaly time series of each variable in a gridbox or a larger region (e.g., tropics, midlatitudes) as follows:

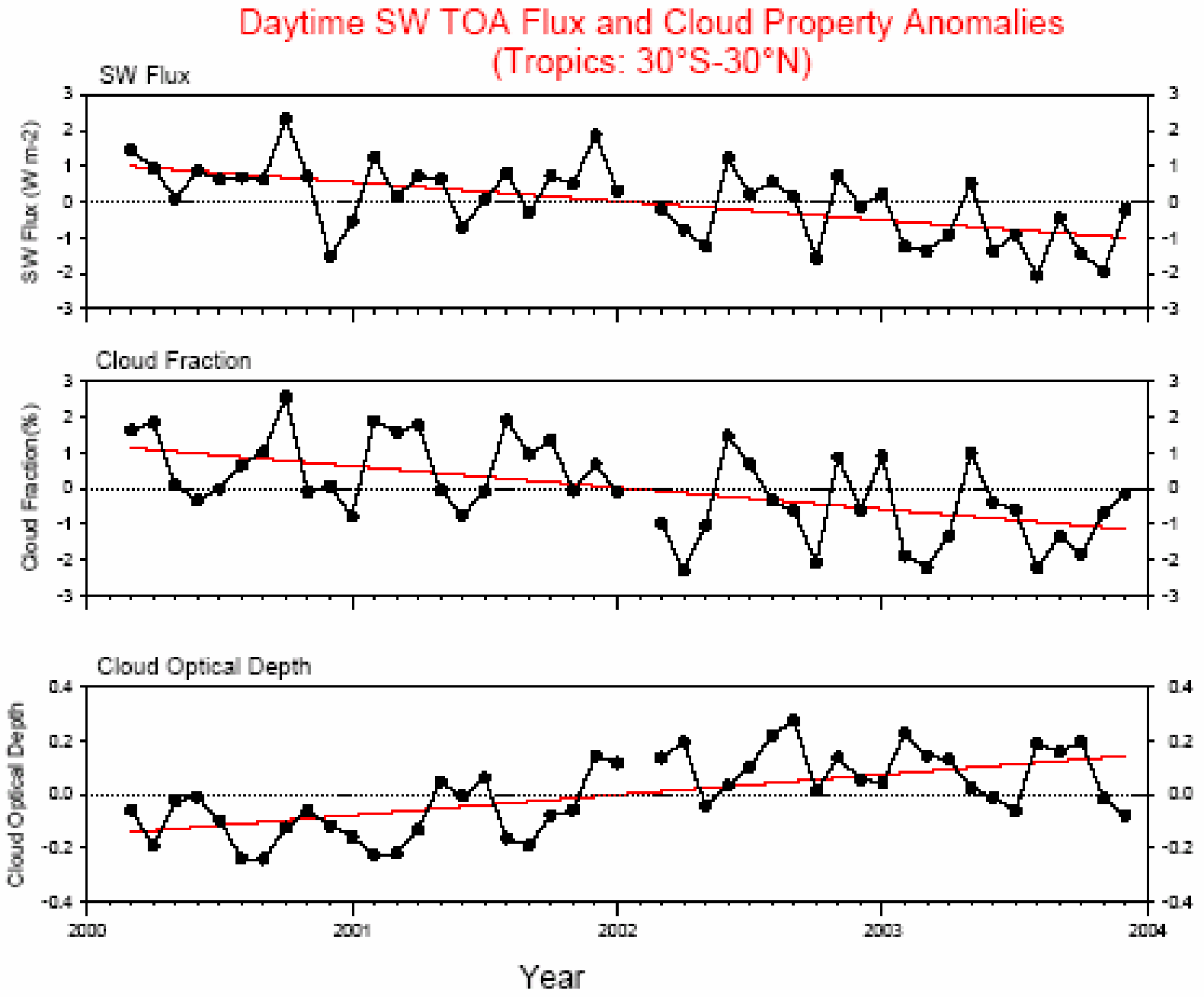
$$\Delta X(yr, mn) = X(yr, mn) - \langle X(mn) \rangle$$

where X(yr, mn) is the monthly mean for month “mn” and year “yr”, and <X(mn)> is the average of all four years for month “mn”.

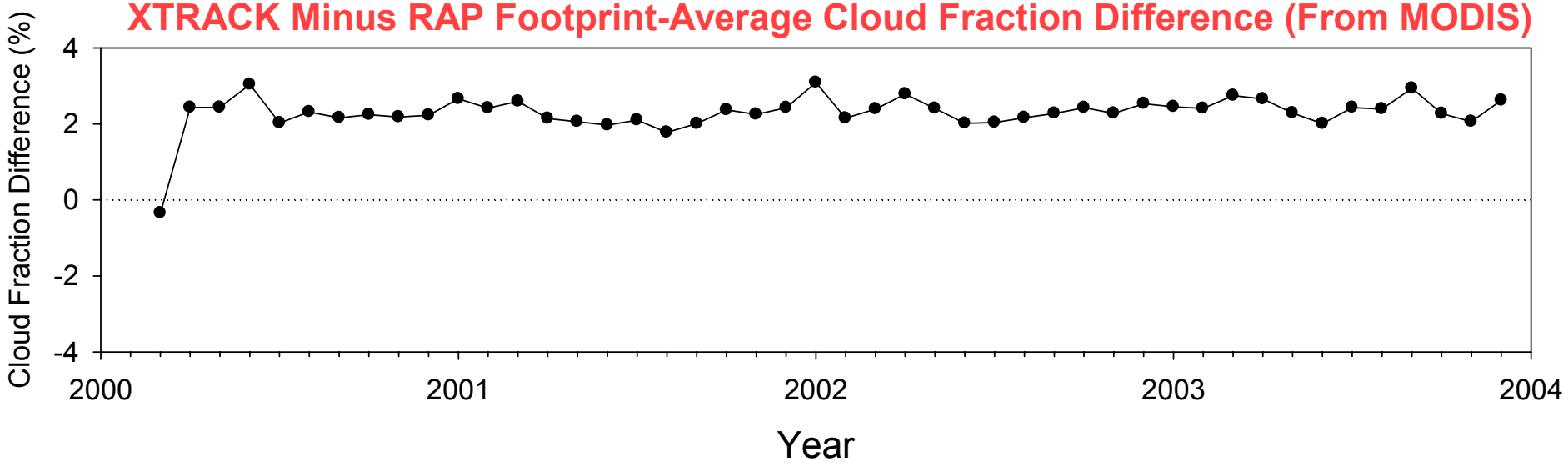
TOA Flux Anomaly Time Series from MODIS Cloud Properties

- Repeat above steps but substitute CERES flux by Fu-Liou RT model flux that uses MODIS cloud properties (cloud phase, cloud amount, cloud optical depth) as input. This approach assumes a black surface.

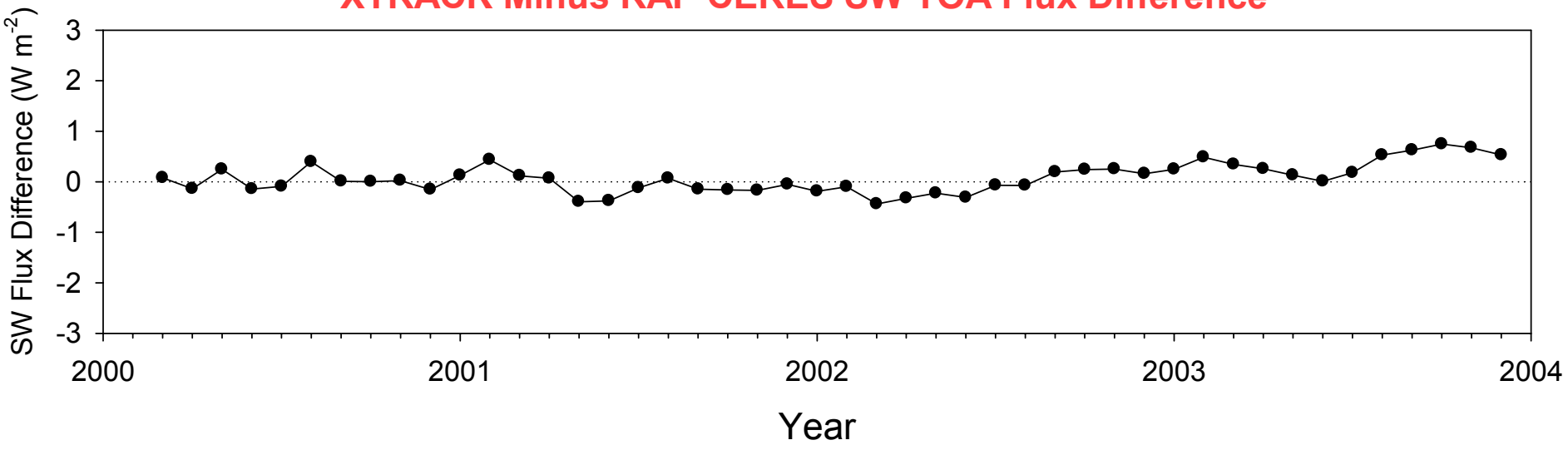
Initial Results for FM2: Incorrect!



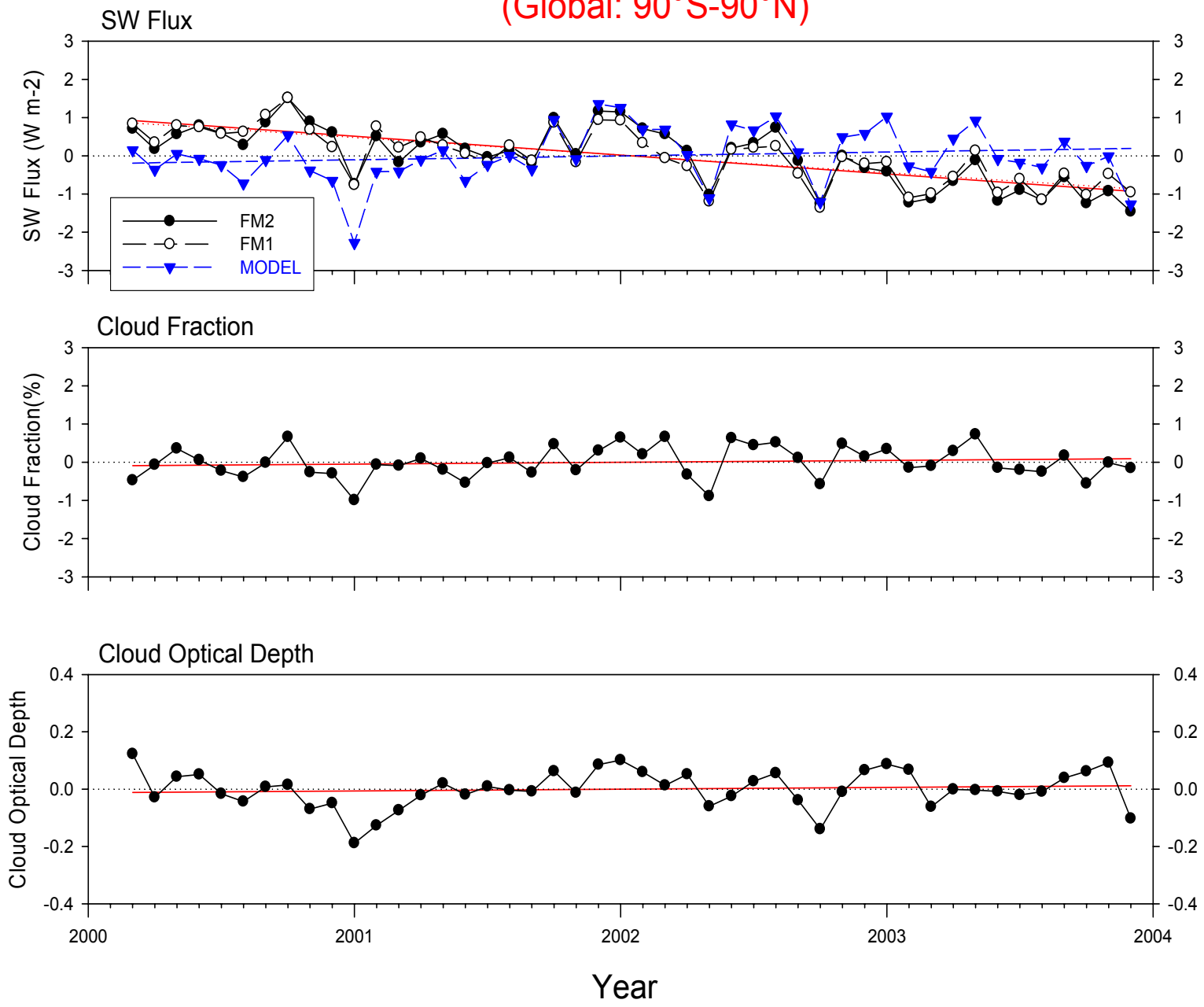
XTRACK Minus RAP Footprint-Average Cloud Fraction Difference (From MODIS)

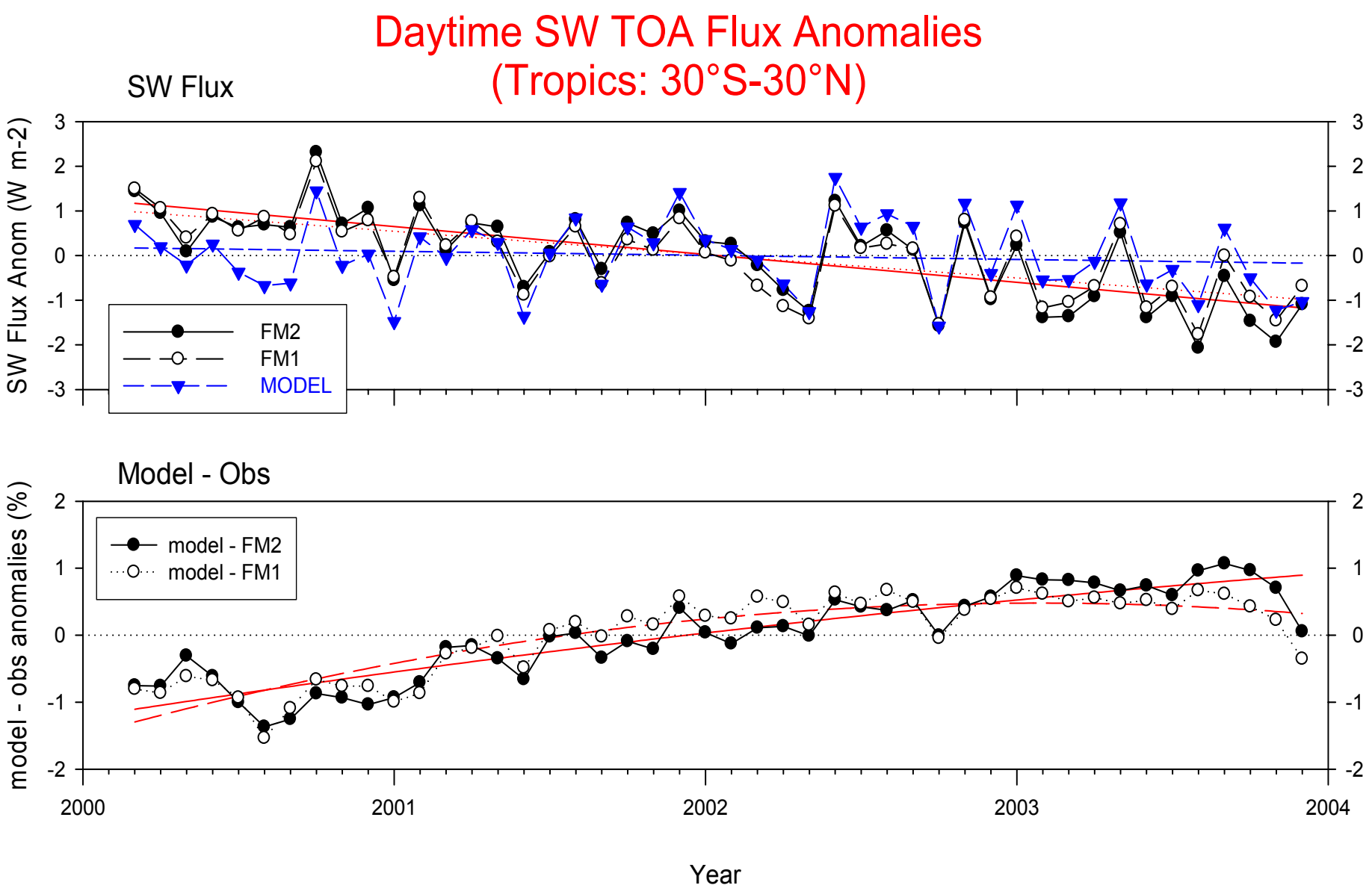


XTRACK Minus RAP CERES SW TOA Flux Difference

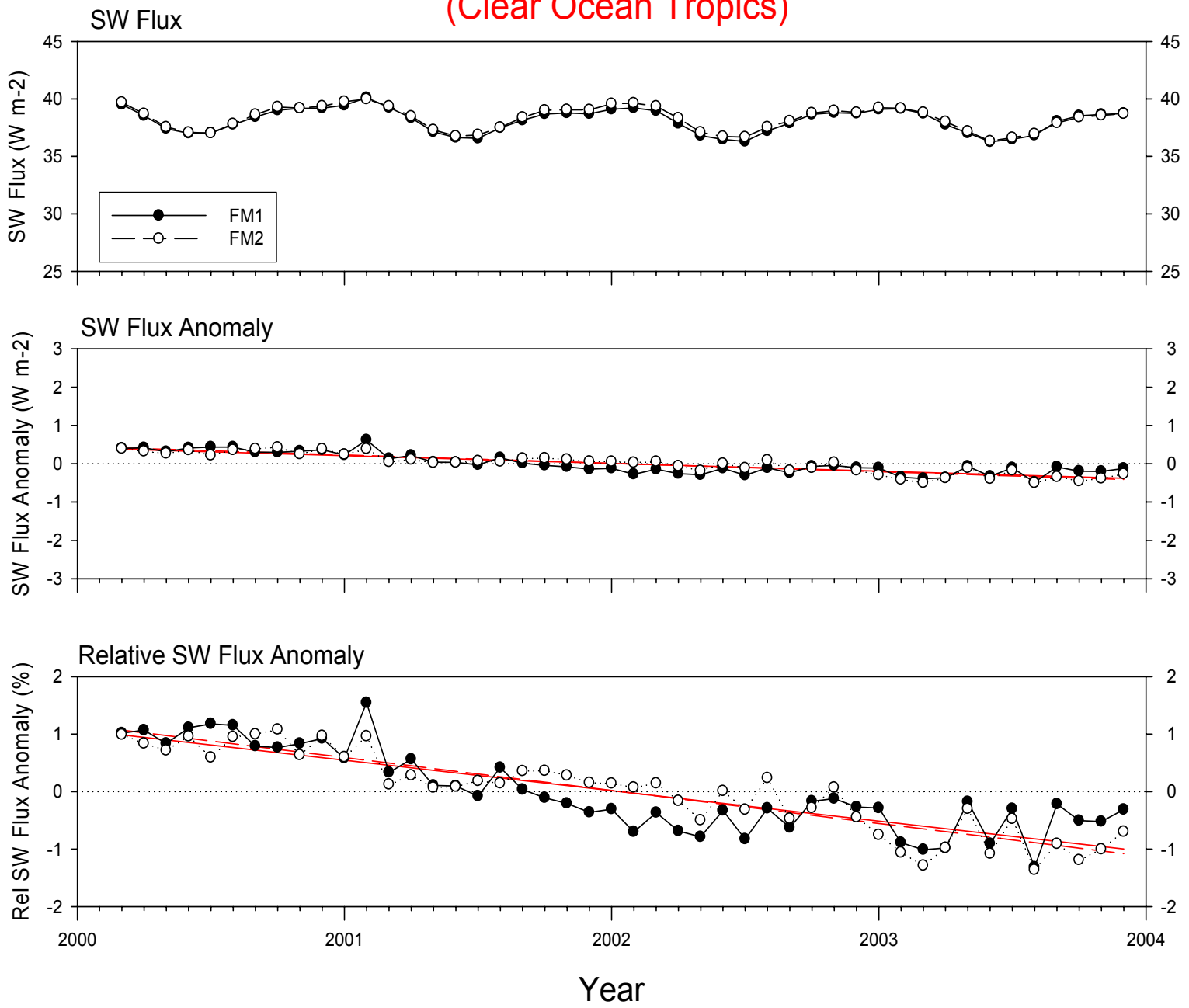


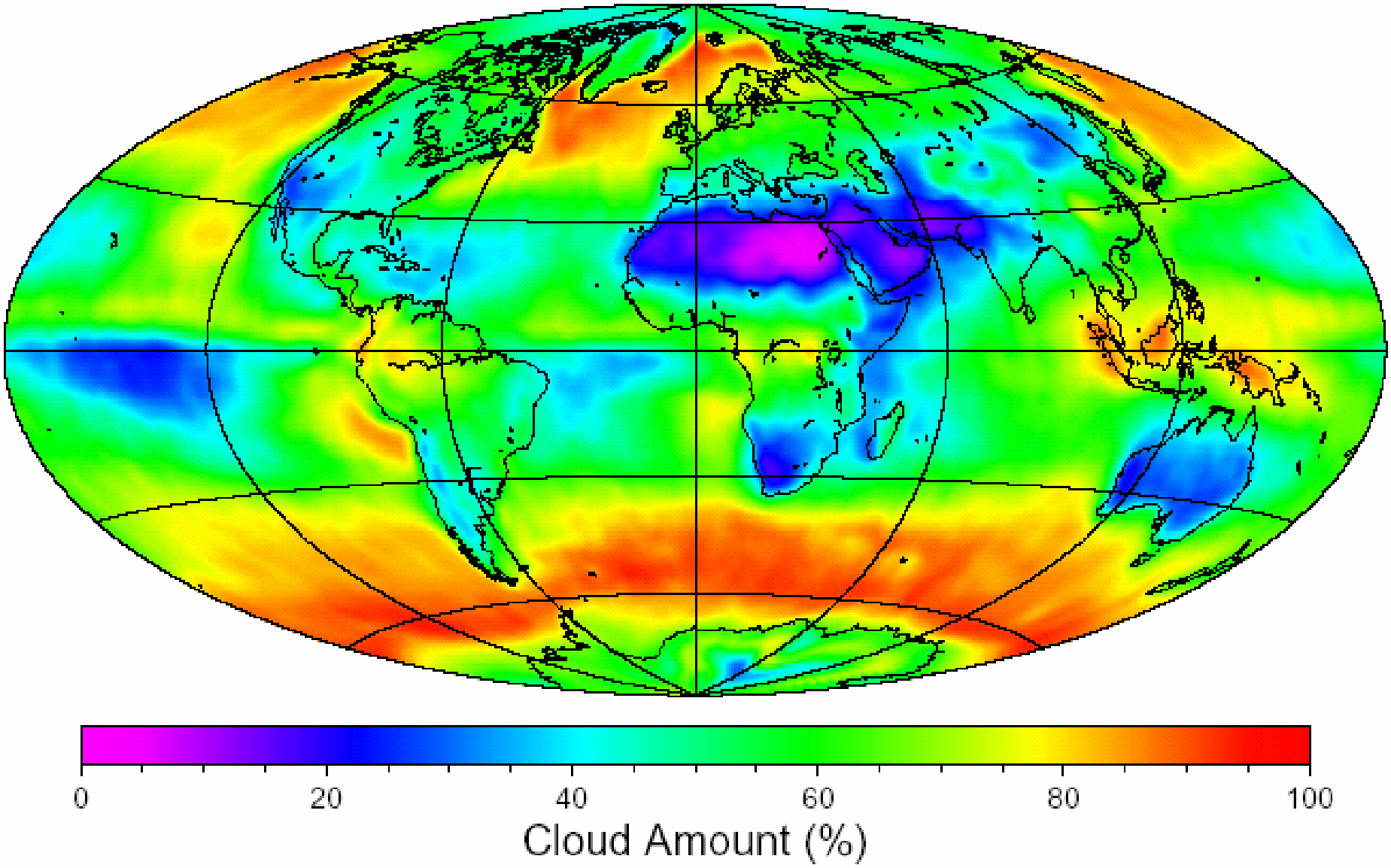
Daytime SW TOA Flux and Cloud Property Anomalies (Global: 90°S-90°N)

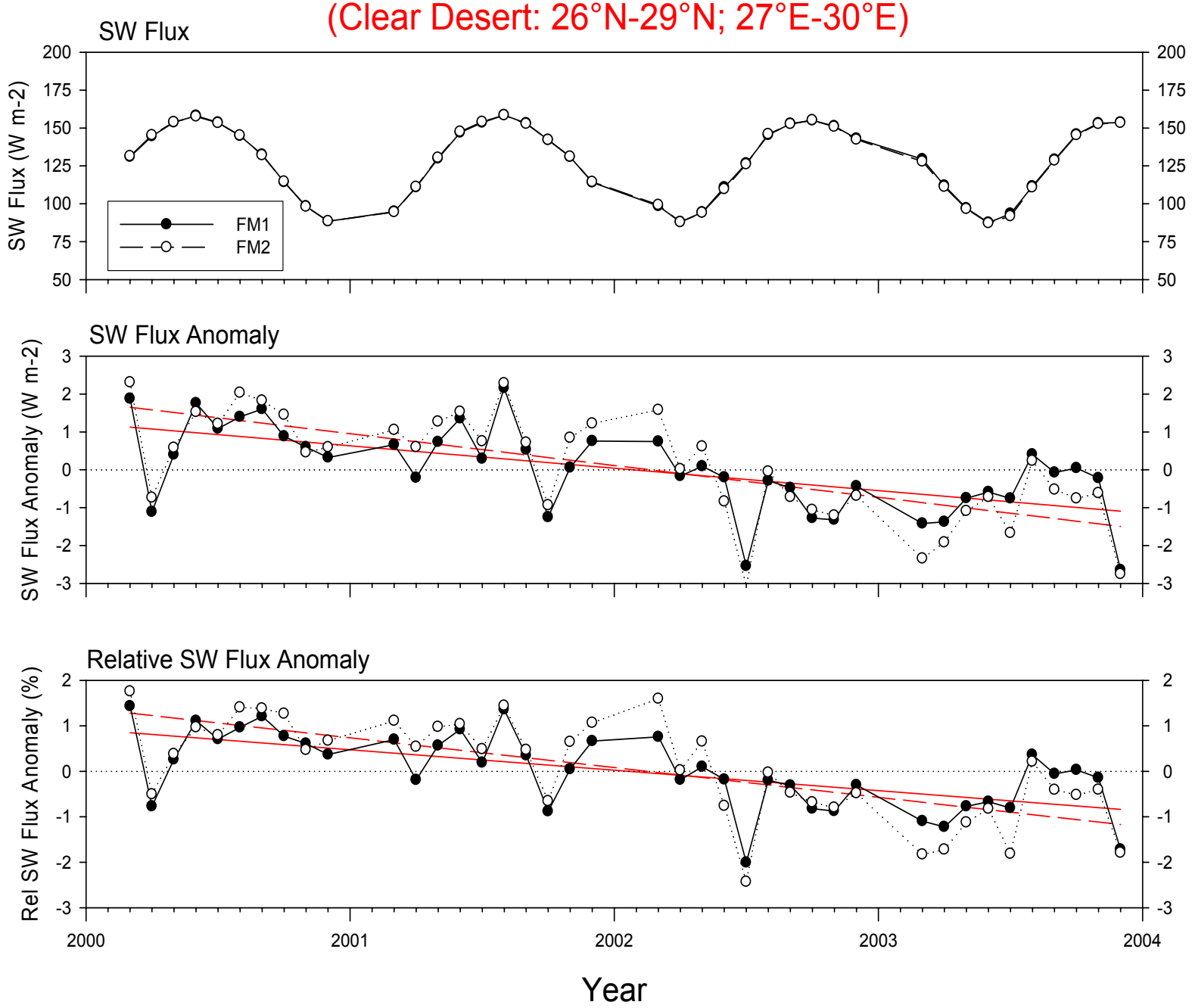


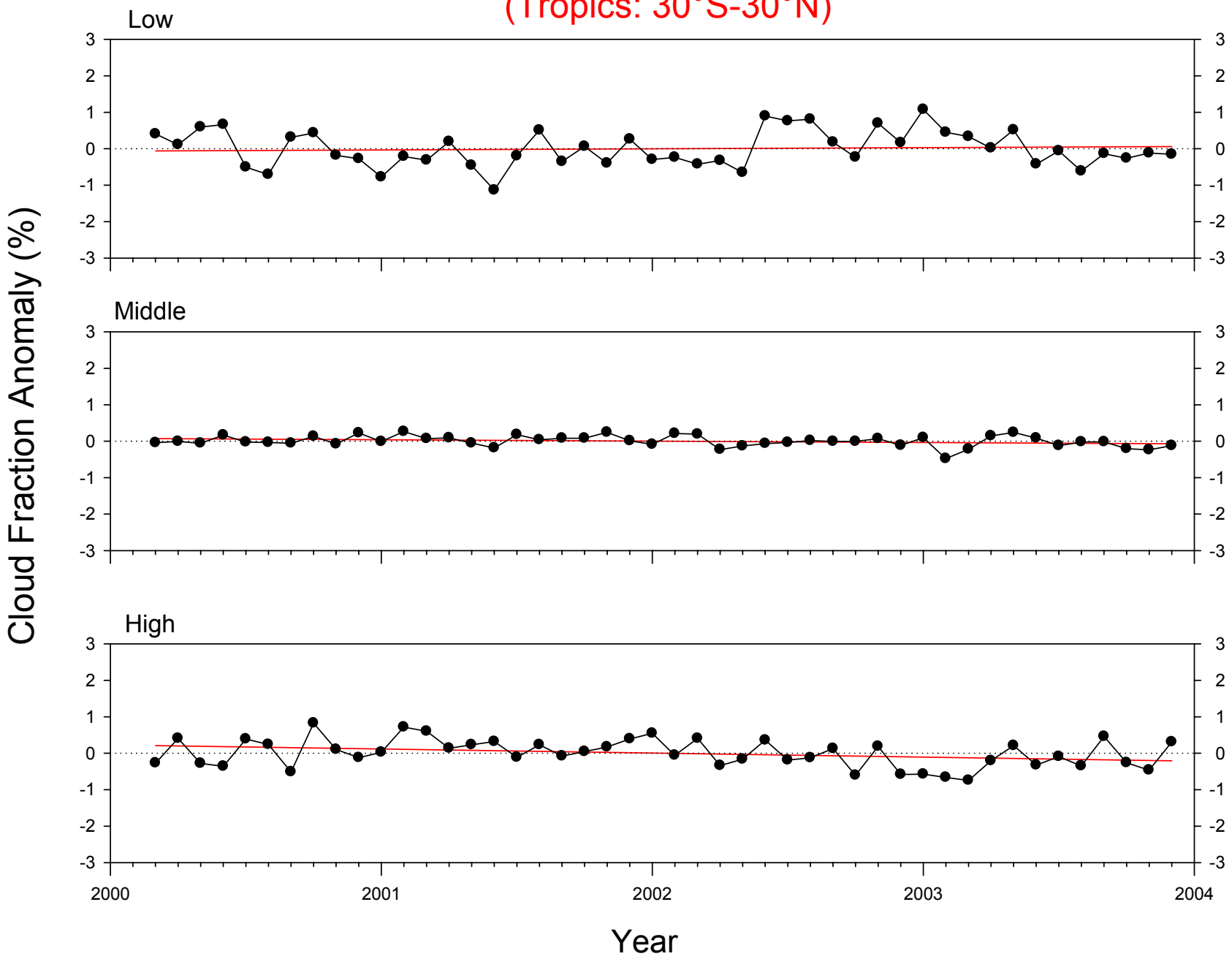

Daytime SW TOA Flux Anomalies
(Tropics: 30°S-30°N)
SW Flux
SW Flux Anom (W m-2)
FM2
FM1
MODEL
Model - Obs
model - obs anomalies (%)
model - FM2
model - FM1
2000
2001
2002
2003
2004
Year

SW TOA Flux Anomalies
(Clear Ocean Tropics)

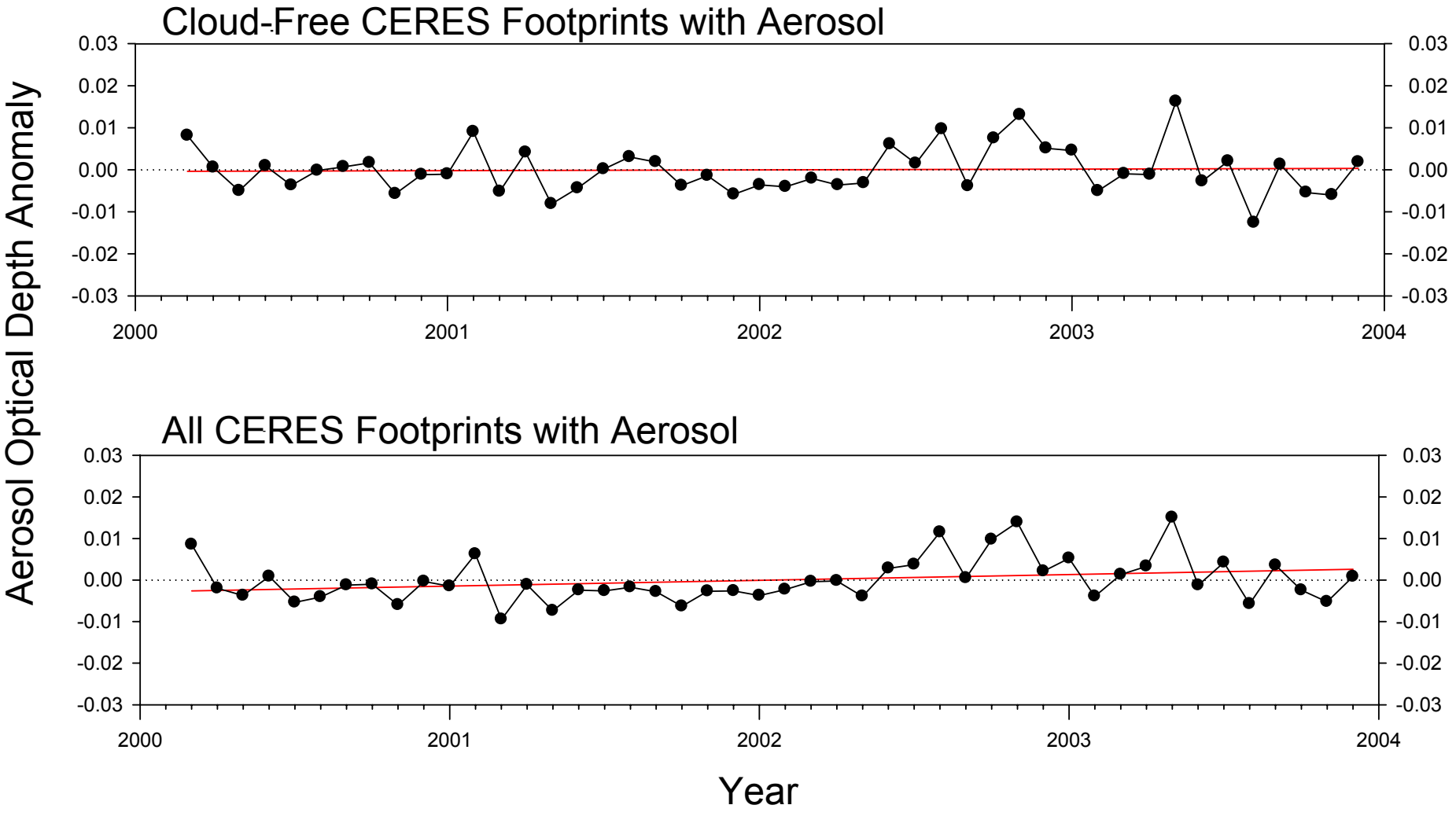



0
20
40
60
80
100
Cloud Amount (%)

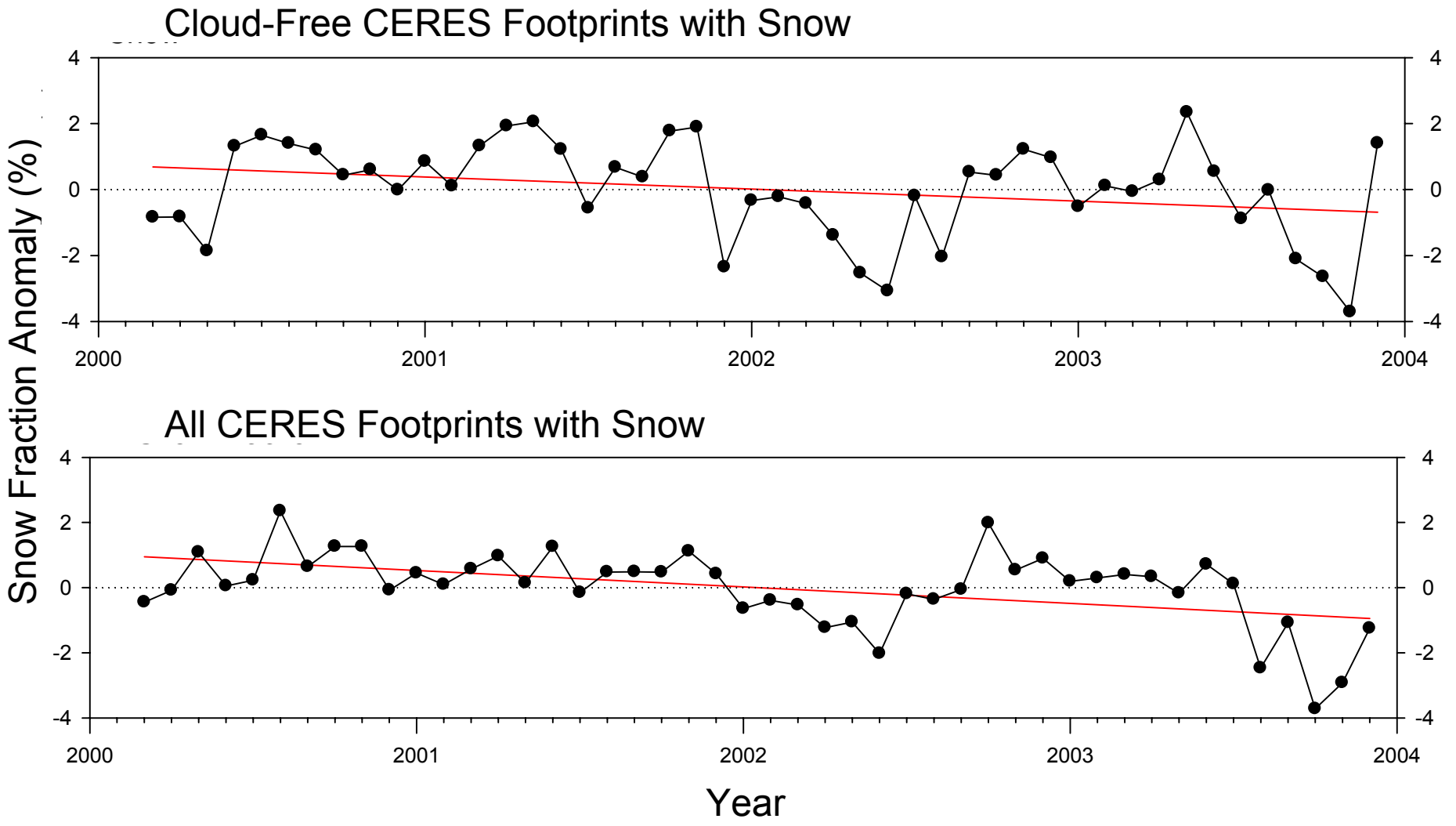

SW TOA Flux Anomalies
(Clear Desert: 26°N-29°N; 27°E-30°E)
SW Flux
SW Flux (W m-2)
200
175
150
125
100
75
50
FM1
FM2
SW Flux Anomaly
SW Flux Anomaly (W m-2)
3
2
1
0
-1
-2
-3
Relative SW Flux Anomaly
Rel SW Flux Anomaly (%)
2
1
0
-1
-2
-3
2000
2001
2002
2003
2004
Year


Daytime Cloud Fraction Anomalies by Cloud Height
(Tropics: 30°S-30°N)
Low
Middle
High
Cloud Fraction Anomaly (%)
3
2
1
0
-1
-2
-3
2000
2001
2002
2003
2004
Year

0.63-μm Aerosol Optical Depth Anomaly (Tropics 0°-30°)



Snow Fraction Anomaly
(Polar 60°-90°)



Overhead Sun Albedo Anomaly Time Series - TROPICS

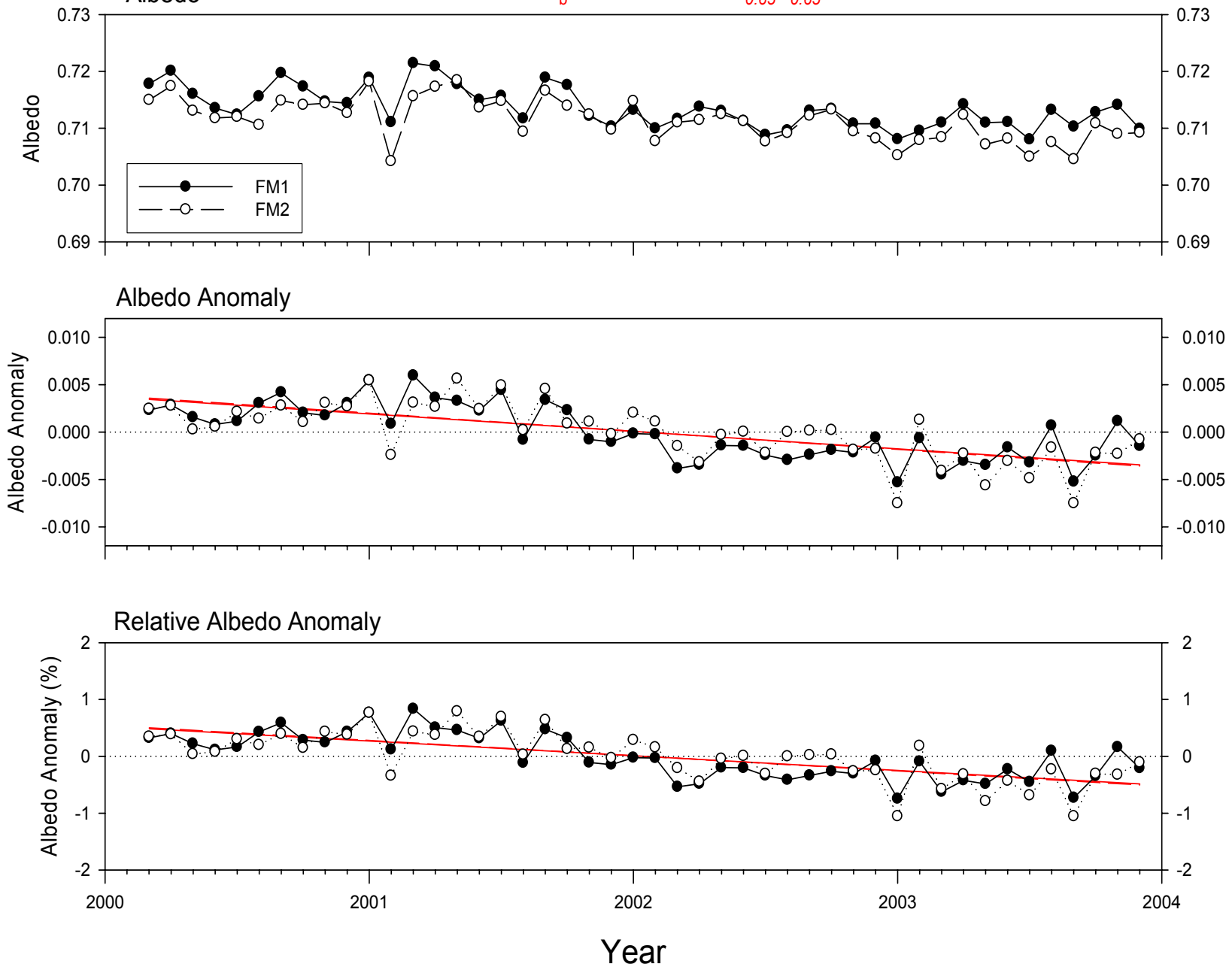
- Apply new CERES Terra ADMs to determine TOA flux from every CERES footprint in CERES SSF product.
- Convert every CERES TOA flux to an overhead sun albedo using CERES TRMM directional models.
- Compute monthly mean overhead sun albedo and anomaly directly from CERES footprint data without gridding data.

1. Deep Convective Clouds: Footprints with:
- 100% cloud amount
- Effective temperature < 205 K
- Cloud optical depth > 10
- Imager radiance dispersion [$\sigma(I)/\langle I\rangle \times 100\%$] < 3%

2. Clear Ocean: Footprints with:
- 100% pixels clear (CERES Cloud Mask)
- 0% Imager sunglint & CERES glint angle > 40°
- Ignatov-Stowe aerosol retrieval over > 50% of CERES FOV

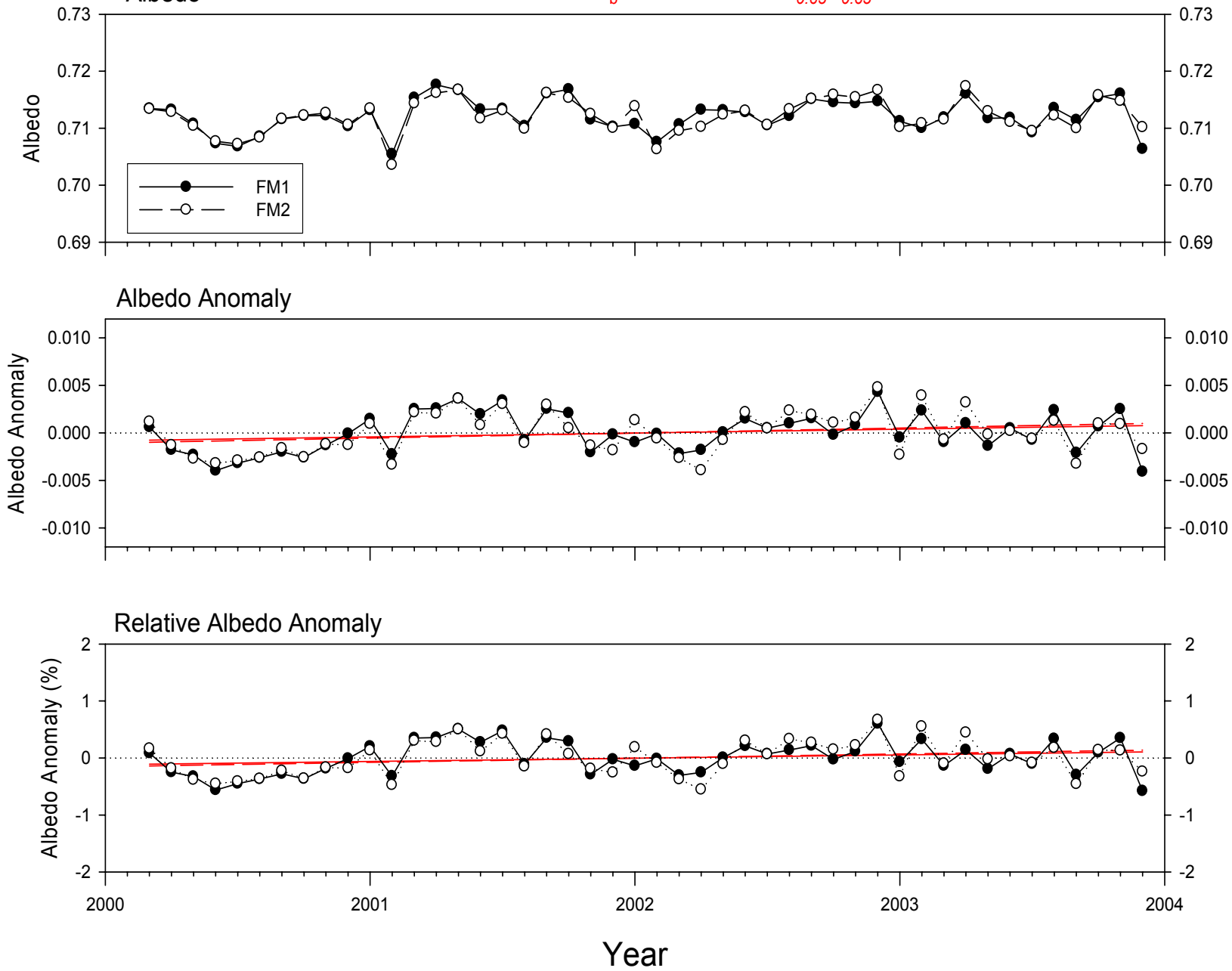
Overhead Sun Albedo Anomalies: CERES

(Deep Conv Clouds: Tropics; $T_b < 205$ K; $f = 1.0$; $\sigma_{0.65}/r_{0.65}$ x 100% < 3%)



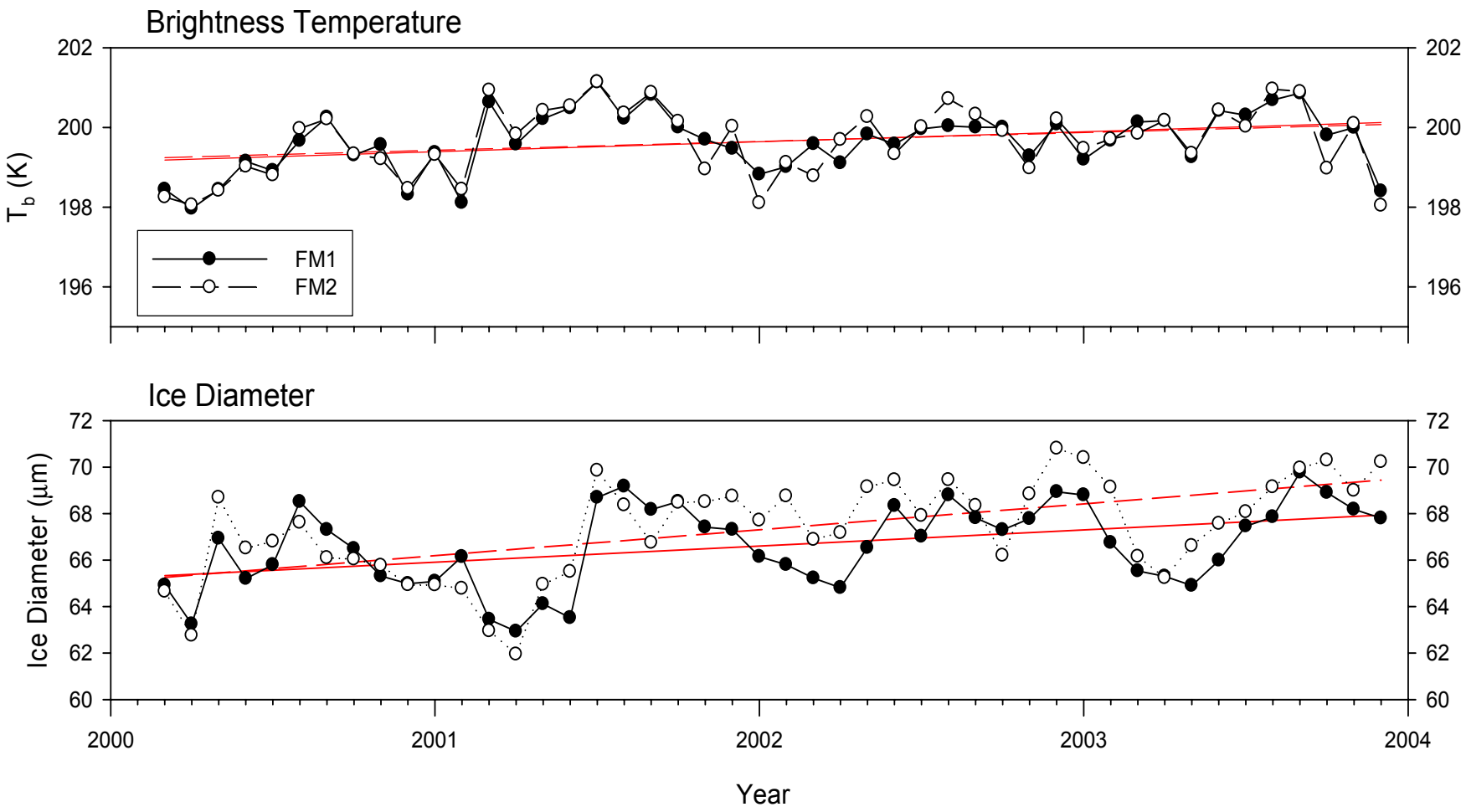
Overhead Sun Albedo Anomalies: MODIS "Broadband"

(Deep Conv Clouds: Tropics; $T_b < 205$ K; $f \approx 1.0$; $\sigma_{0.65}/r_{0.65}$ x 100% < 3%)

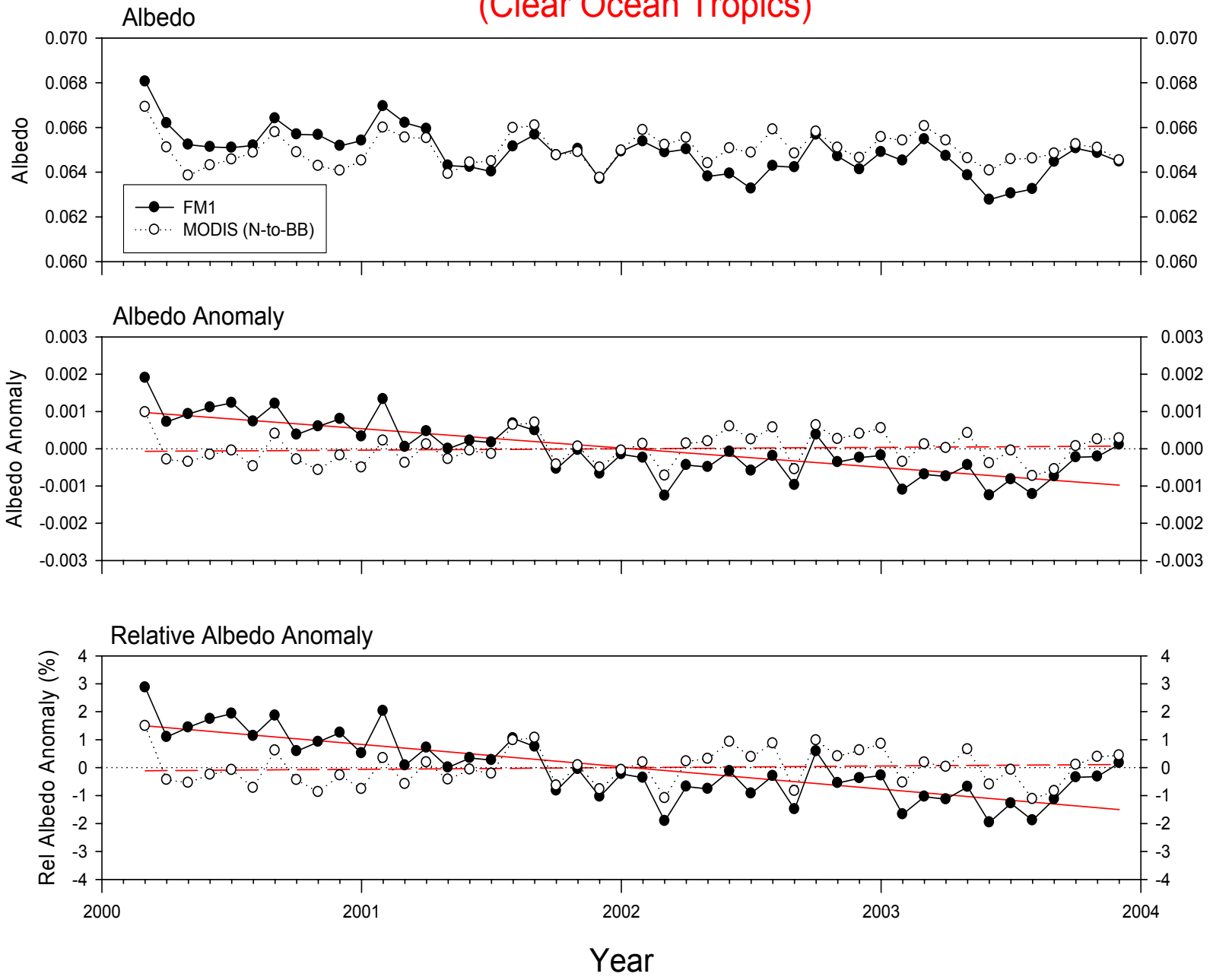


Brightness Temp and Ice Particle Diameter

(Deep Conv Clouds: Tropics; T_b < 205 K; f=1.0; $\sigma_{0.65}/r_{0.65}$ x 100% < 3%)

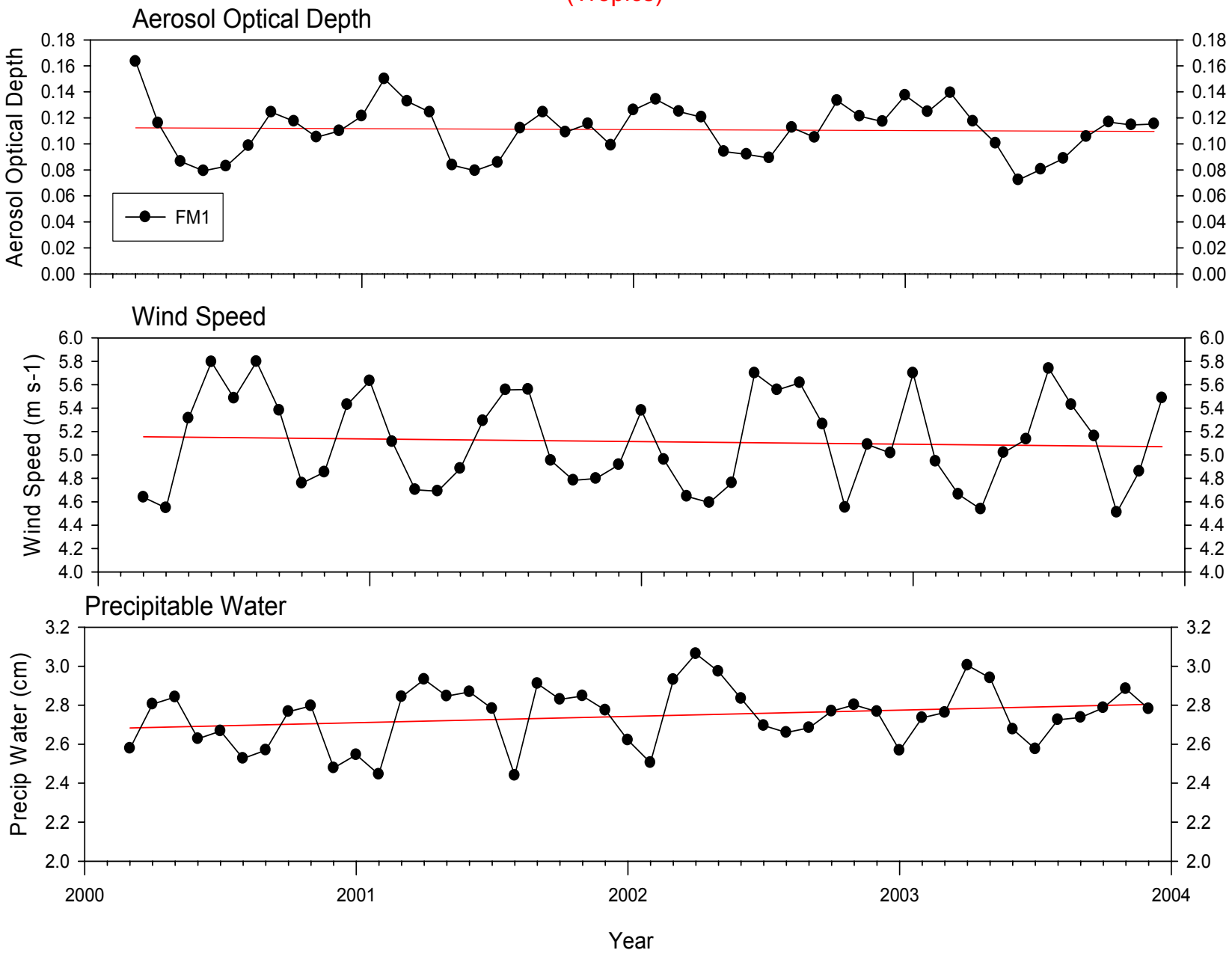


Overhead Sun Albedo Anomalies (Clear Ocean Tropics)



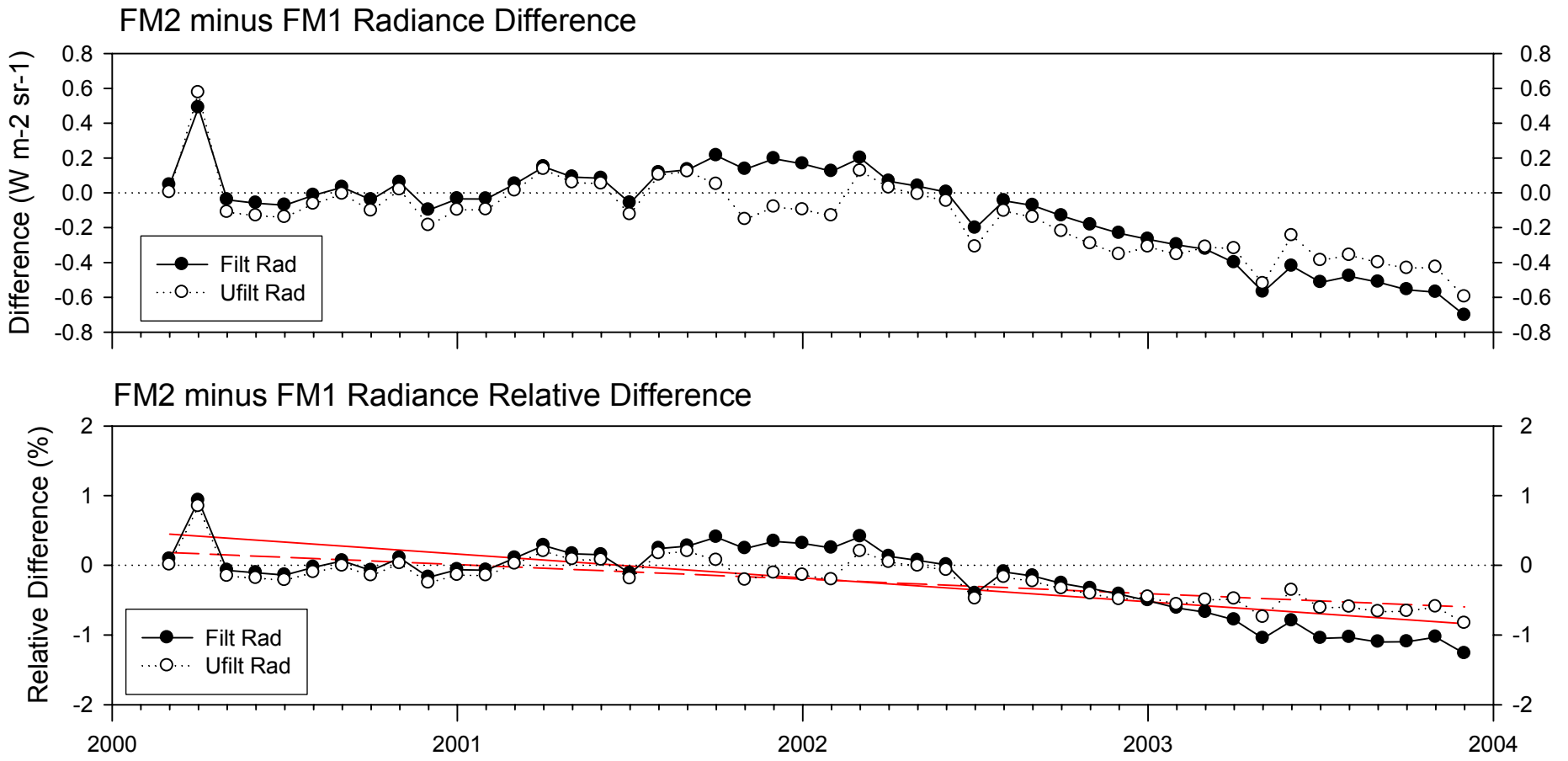
Clear Ocean Properties

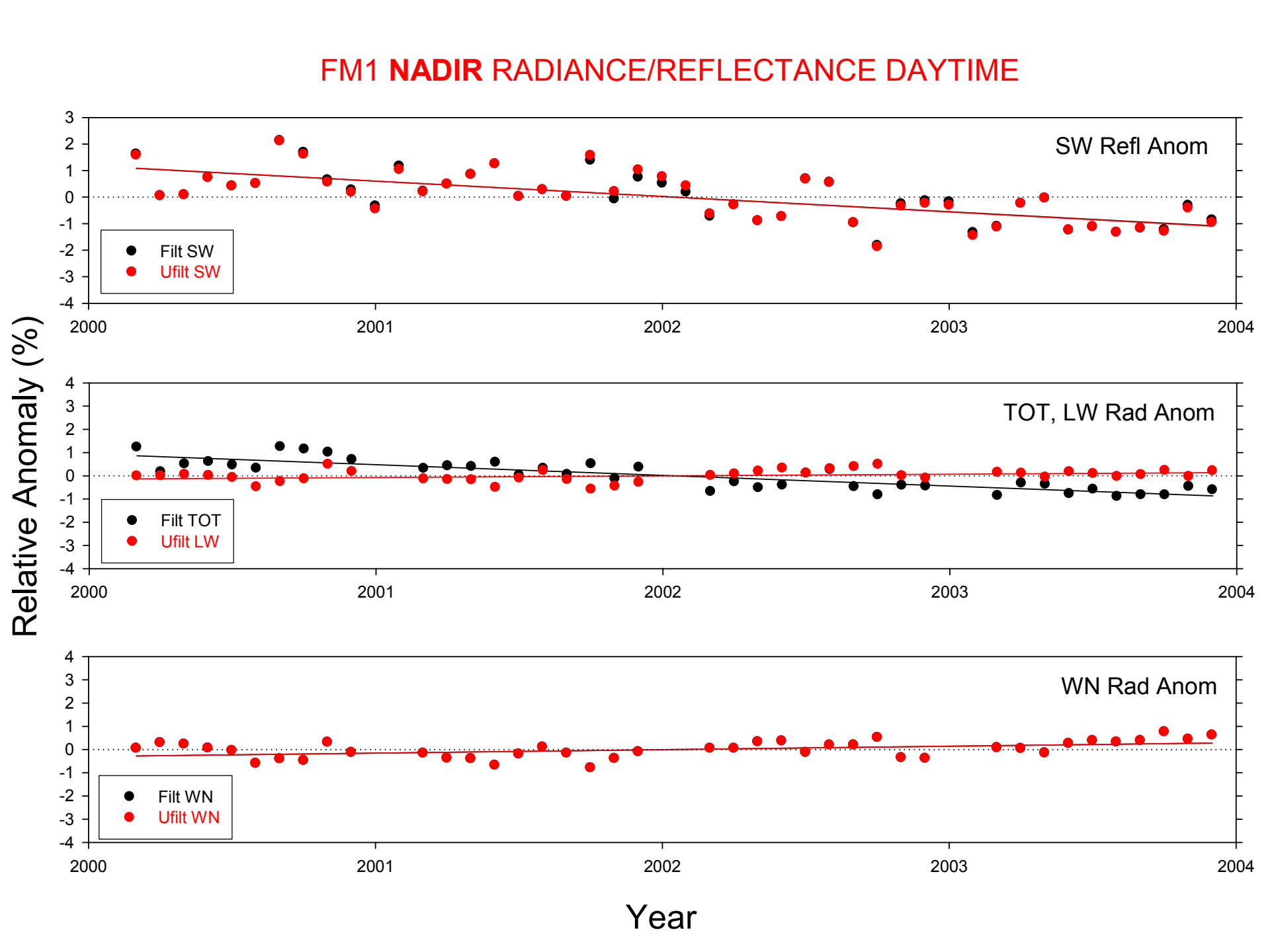
(Tropics)



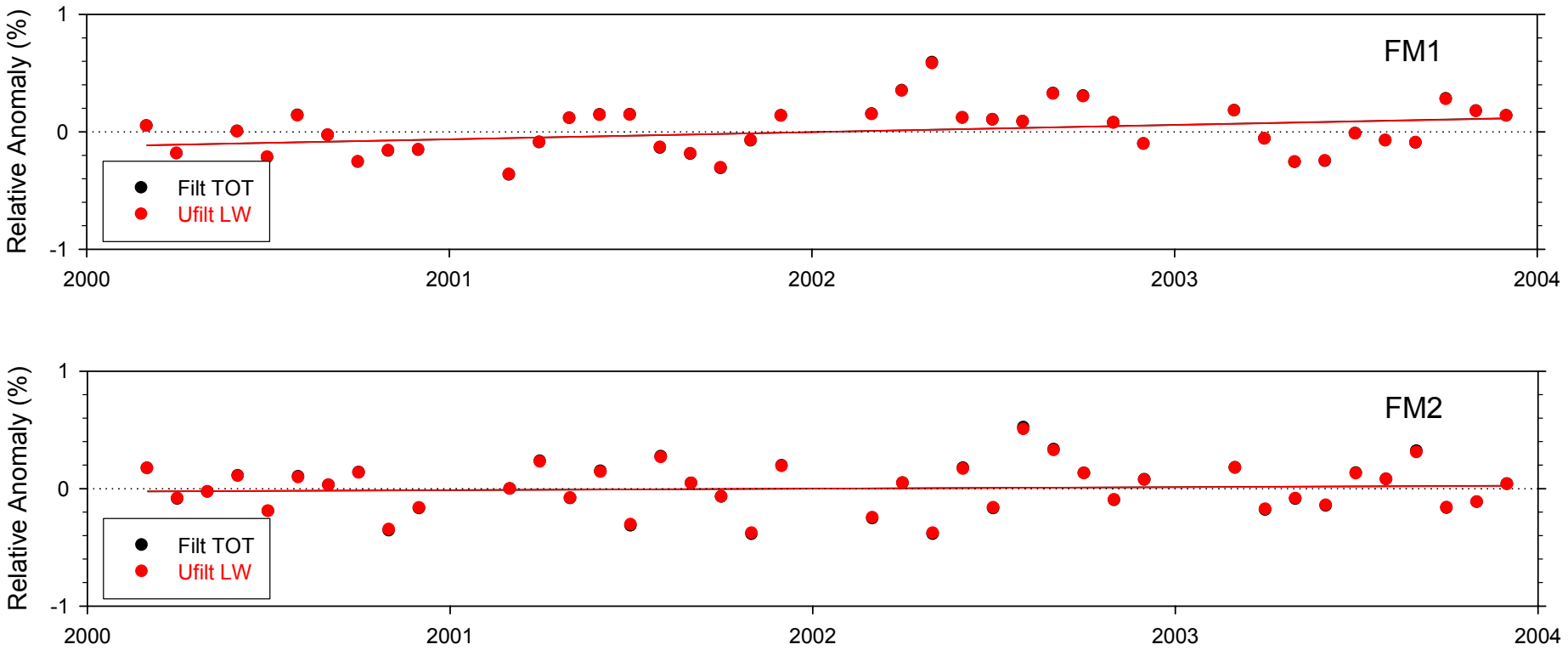
Nadir Radiance Time Series

FM2 Minus FM1 Daytime **Nadir** Filtered and Unfiltered SW Radiance (Global)



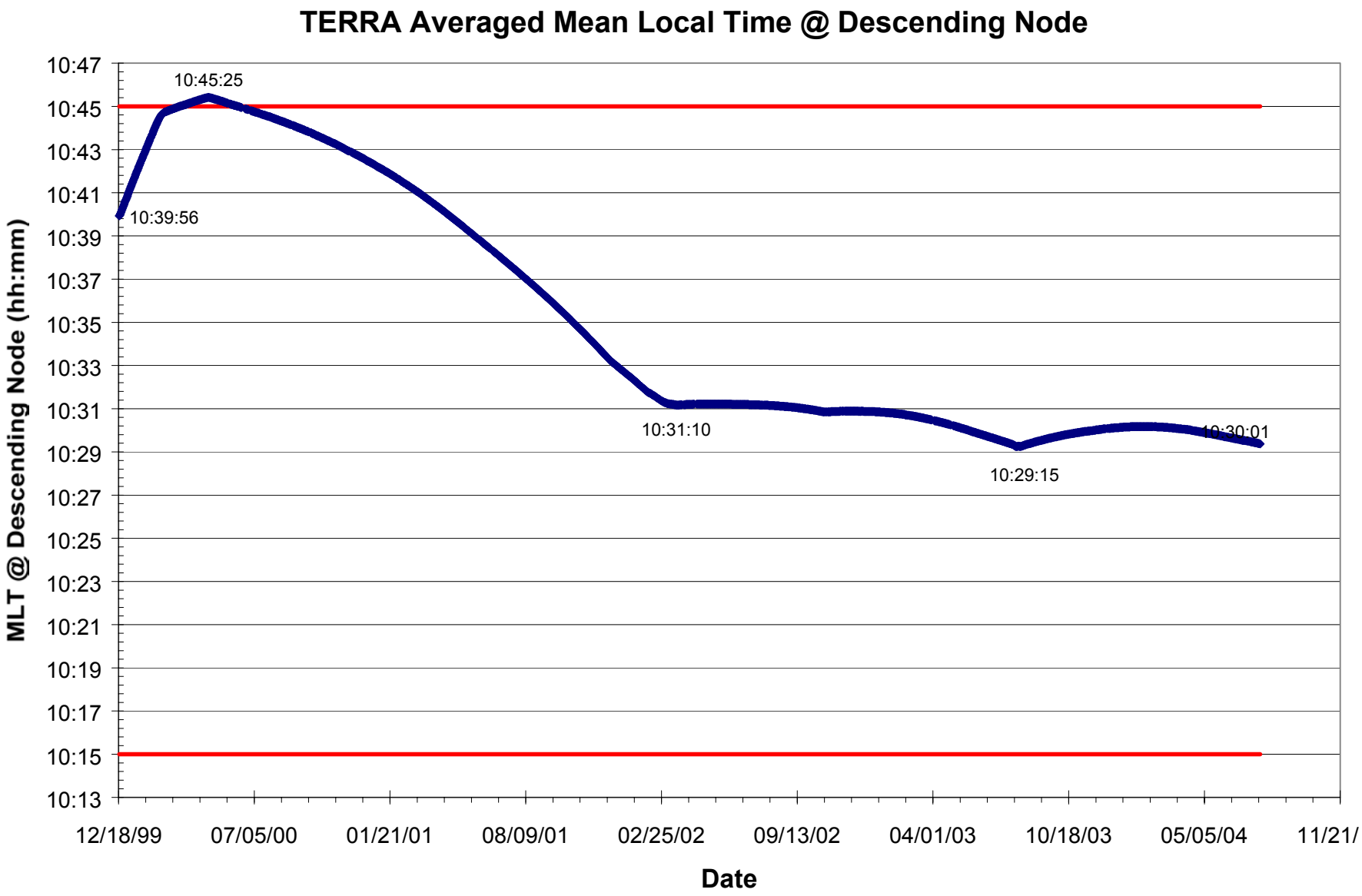

FM1 NADIR RADIANCE/REFLECTANCE DAYTIME
SW Refl Anom
Filt SW
Ufilt SW
TOT, LW Rad Anom
Filt TOT
Ufilt LW
WN Rad Anom
Filt WN
Ufilt WN
Relative Anomaly (%)
Year
2000
2001
2002
2003
2004

TOTAL CHANNEL NADIR RADIANCE AT NIGHT



Summary

- Time-series of cloud properties from SSF data should be stratified by instrument scan mode (XTRACK or RAP) to avoid aliasing results with systematic biases in cloud property retrievals with viewing geometry.
- SW TOA fluxes in both CERES-FM1 and CERES-FM2 decrease by ≈2% between March 2000 and December 2003 for all-sky, clear ocean and clear desert. The decrease is closer to ≈1% for deep convective clouds.
- SW fluxes and cloud properties inferred from MODIS retrievals show no systematic change between March 2000 and December 2003.
- FM1 and FM2 nadir SW radiances are consistent between March 2000 to August 2002. They begin to deviate after Aug 02, and differ by ≈1% by Dec 03 (FM1> FM2).
- No systematic change is observed in global mean daytime and nighttime unfiltered nadir LW and WN radiances over 4 years.


TERRA Averaged Mean Local Time @ Descending Node
MLT @ Descending Node (hh:mm)
10:47
10:45
10:43
10:41
10:39
10:37
10:35
10:33
10:31
10:29
10:27
10:25
10:23
10:21
10:19
10:17
10:15
10:13
10:45:25
10:39:56
10:31:10
10:29:15
10:30:01
12/18/99
07/05/00
01/21/01
08/09/01
02/25/02
09/13/02
04/01/03
10/18/03
05/05/04
11/21/
Date