Four Years of Terra SSF Fluxes and Revision1 Adjustments

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BACKGROUND

- CERES shows a ≈2 W m^{-2} decrease in SW flux between 2000 and 2004.

- We believe that part of this change is caused by spectral darkening of the optics when in RAP mode.

- Kory Priestley and Grant Matthews have produced adjustment factors to account for the spectral darkening of the optics (CERES ED2_Rev1).

- CERES data users interested in long-term SW TOA flux changes can apply the ED2_Rev1 adjustment factors directly to the archived CERES ED2 data.

- These changes will be included in CERES ED3 data products (expected in 2006-2007).

OBJECTIVE

- Demonstrate how the CERES ED2_Rev1 adjustment factors affect four-year changes in monthly mean ED2 SW TOA fluxes.

DATA

- 46 months of SW TOA fluxes derived from the CERES FM1 and FM2 ED2B Single Scanner Foorprint (SSF) product.

24-h Monthly Mean SW TOA Fluxes from Instantaneous CERES SSF ED2B Data

- Apply CERES Terra ADMs to determine SW TOA flux from every CERES footprint in CERES ED2B SSF product.

- Convert every CERES TOA flux to a 24-h average flux using CERES TRMM diurnal albedo models (assume constant meteorology).

- Determine gridded (1°x1° latitude-longitude) monthly mean maps of SW TOA Flux (similar to SRBAVG nongeo)

Deseasonalized TOA Flux Anomaly from 2000-2003

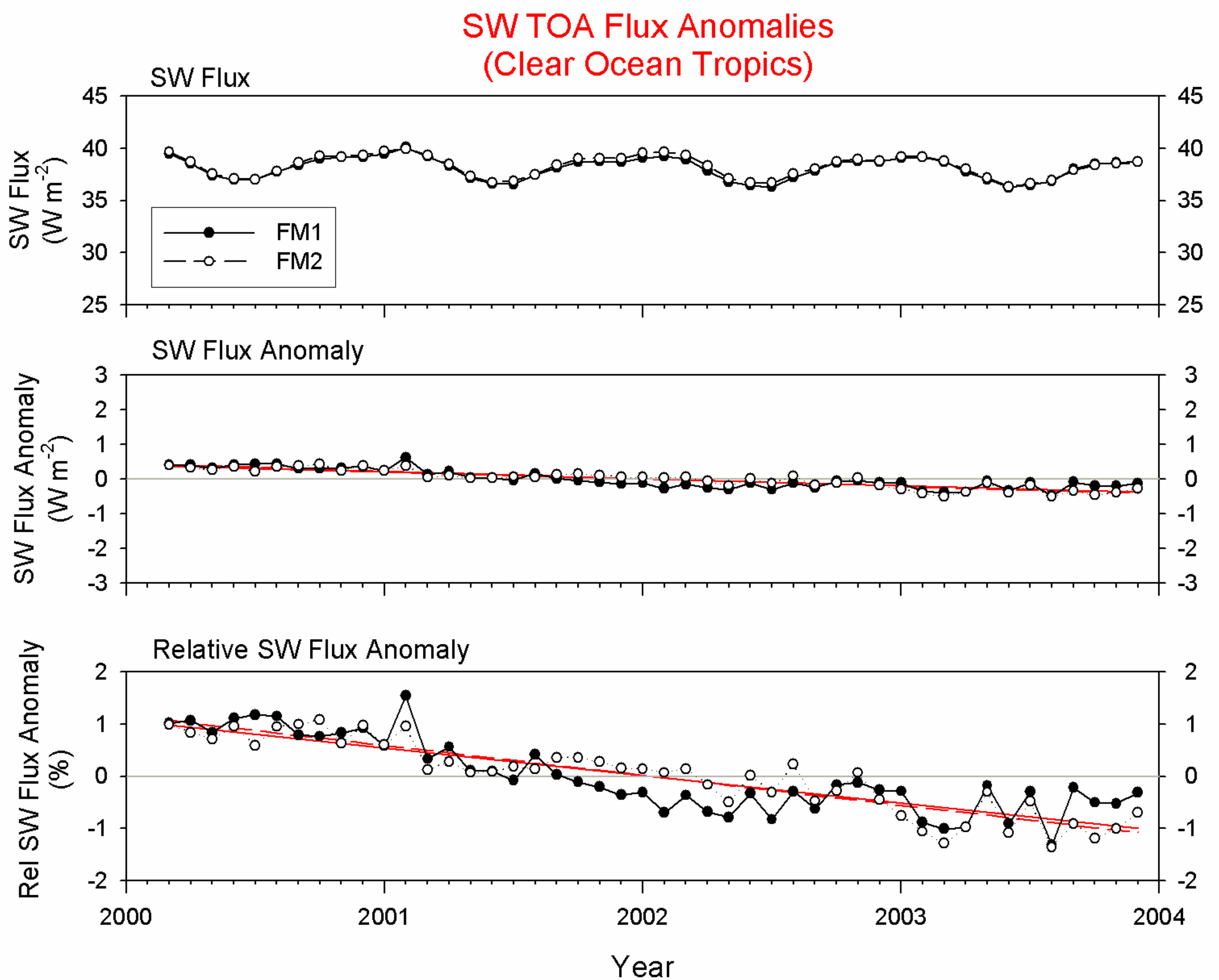
- Compute anomaly time series as follows:

$$\Delta X(yr, mn) = X(yr, mn) - <X(mn)>$$

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

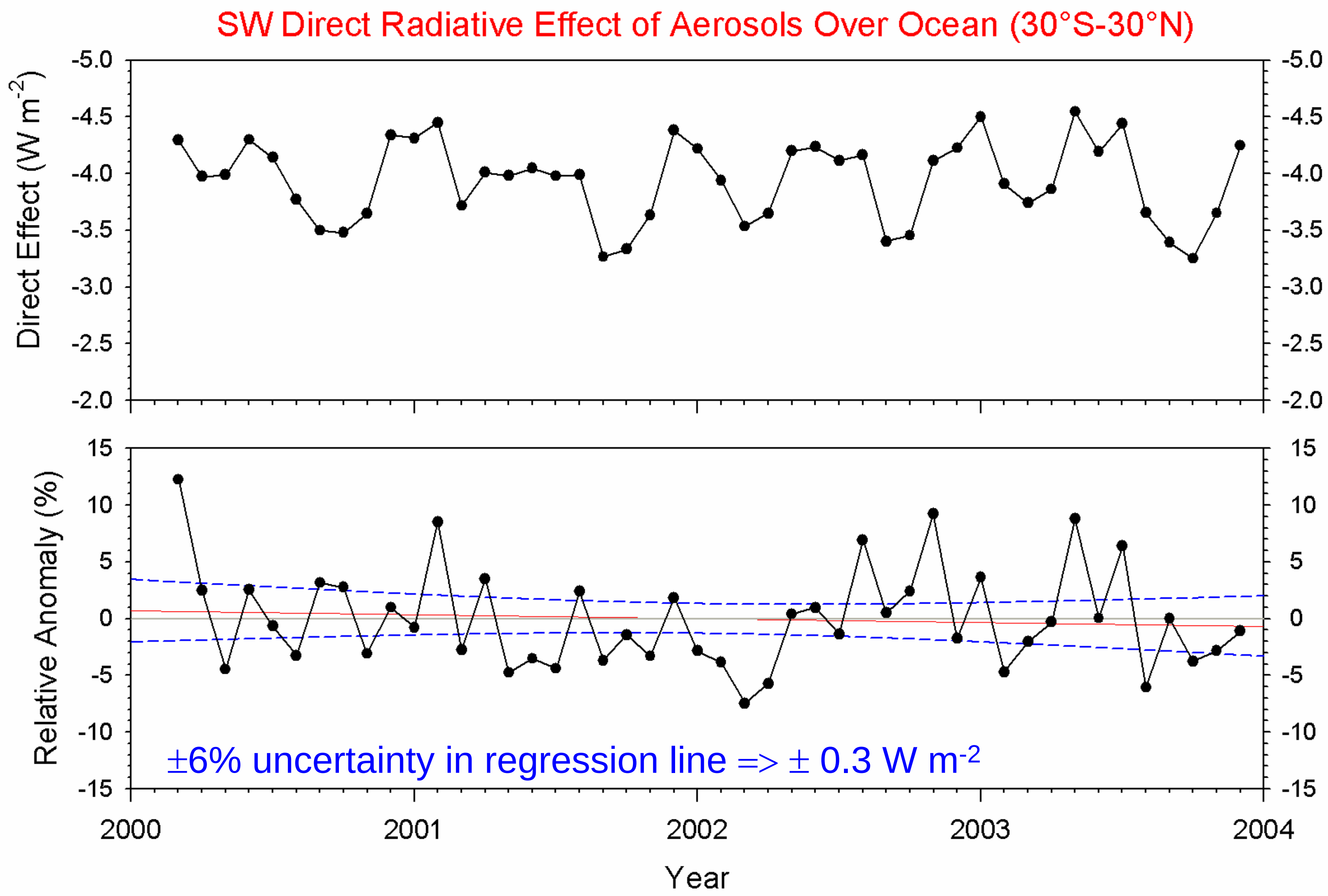
Scene Types Considered

- Clear Ocean (30S-30N)
- All-Sky (90S-90N)
- Clear Desert (26°N-29°N; 27°-30°E)
- Deep Convective Clouds


SW TOA Flux Anomalies
(Clear Ocean Tropics)
SW Flux
SW Flux (W m-2)
FM1
FM2
SW Flux Anomaly
SW Flux Anomaly (W m-2)
Relative SW Flux Anomaly
Rel SW Flux Anomaly (%)
2000
2001
2002
2003
2004
Year

Clear Ocean Constraint

Is a clear-sky ocean SW TOA flux change of 2% over 4 years possible given the variability in aerosol direct radiative effect?



Clear Ocean Constraint

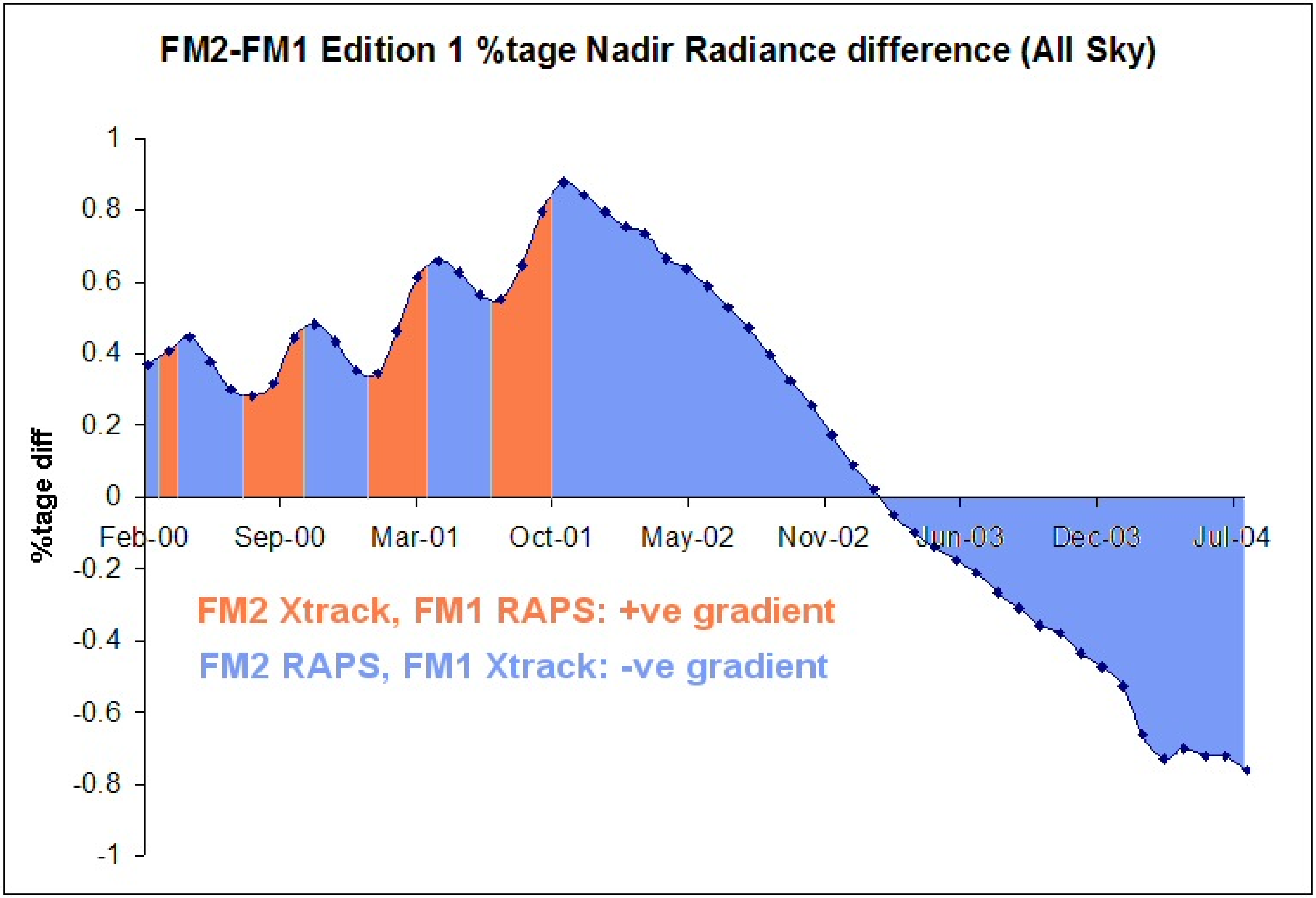
- The uncertainty in aerosol direct radiative effect change over 4 years is ±6% or ± 0.3 W m^{-2}

- Typical clear ocean TOA flux ~ 40 W m^{-2}

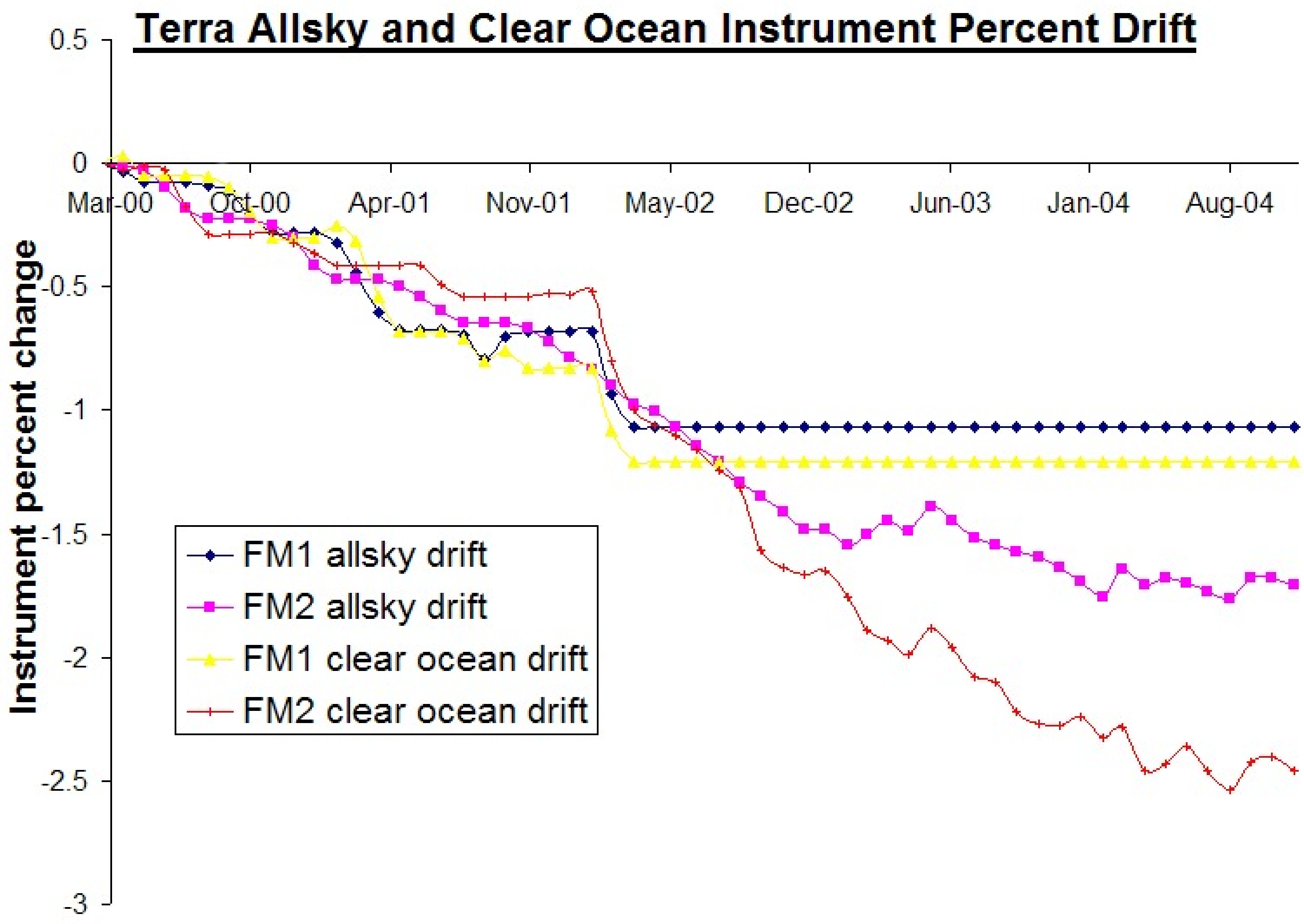
⇒ Maximum expected change in clear ocean SW TOA flux from by aerosol variability alone is:

±0.3 / 40 x 100% = ± 0.75% (over 4 years)

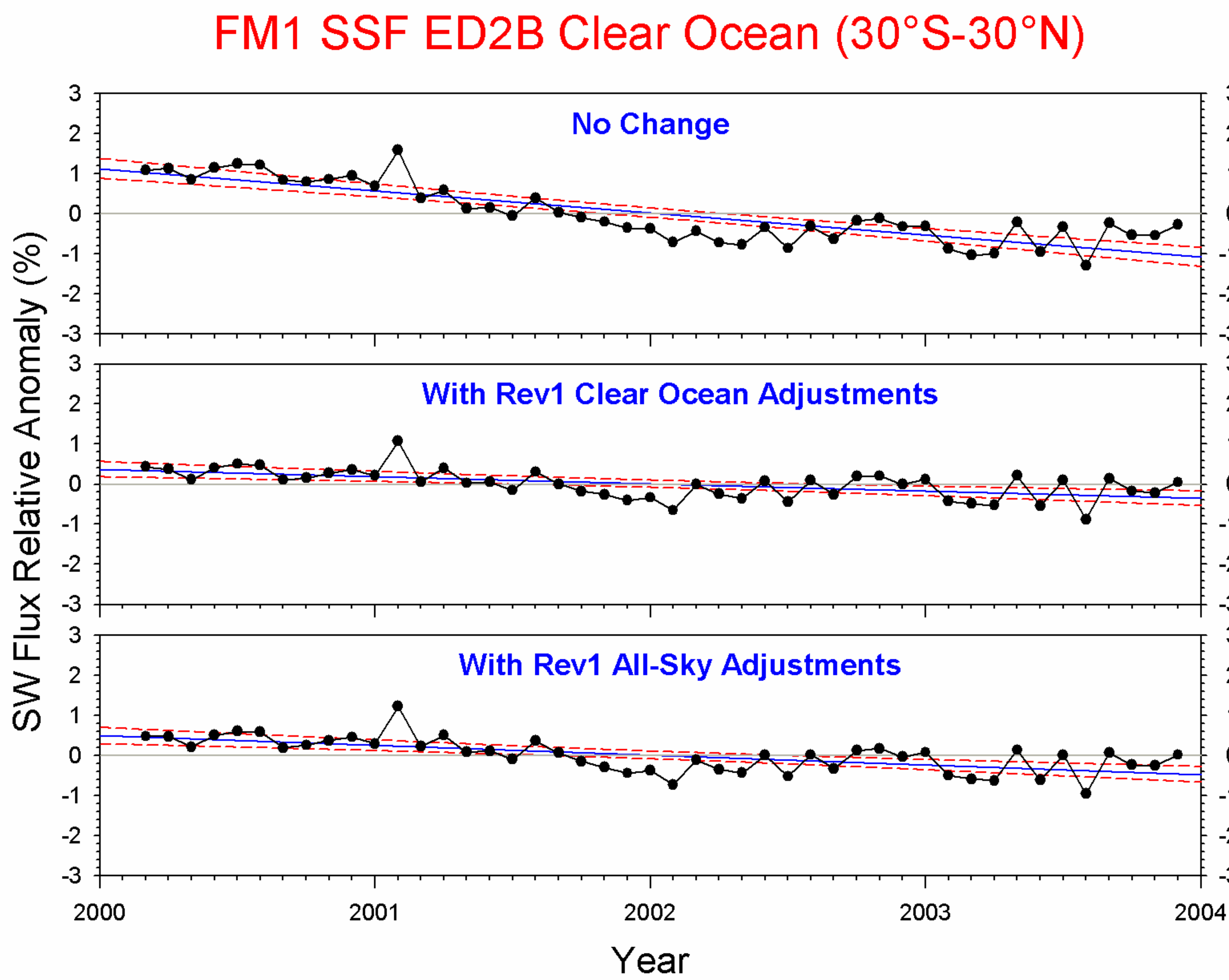
2% change in clear ocean TOA flux exceeds the expected natural variability due to aerosol variations.
=> unphysical



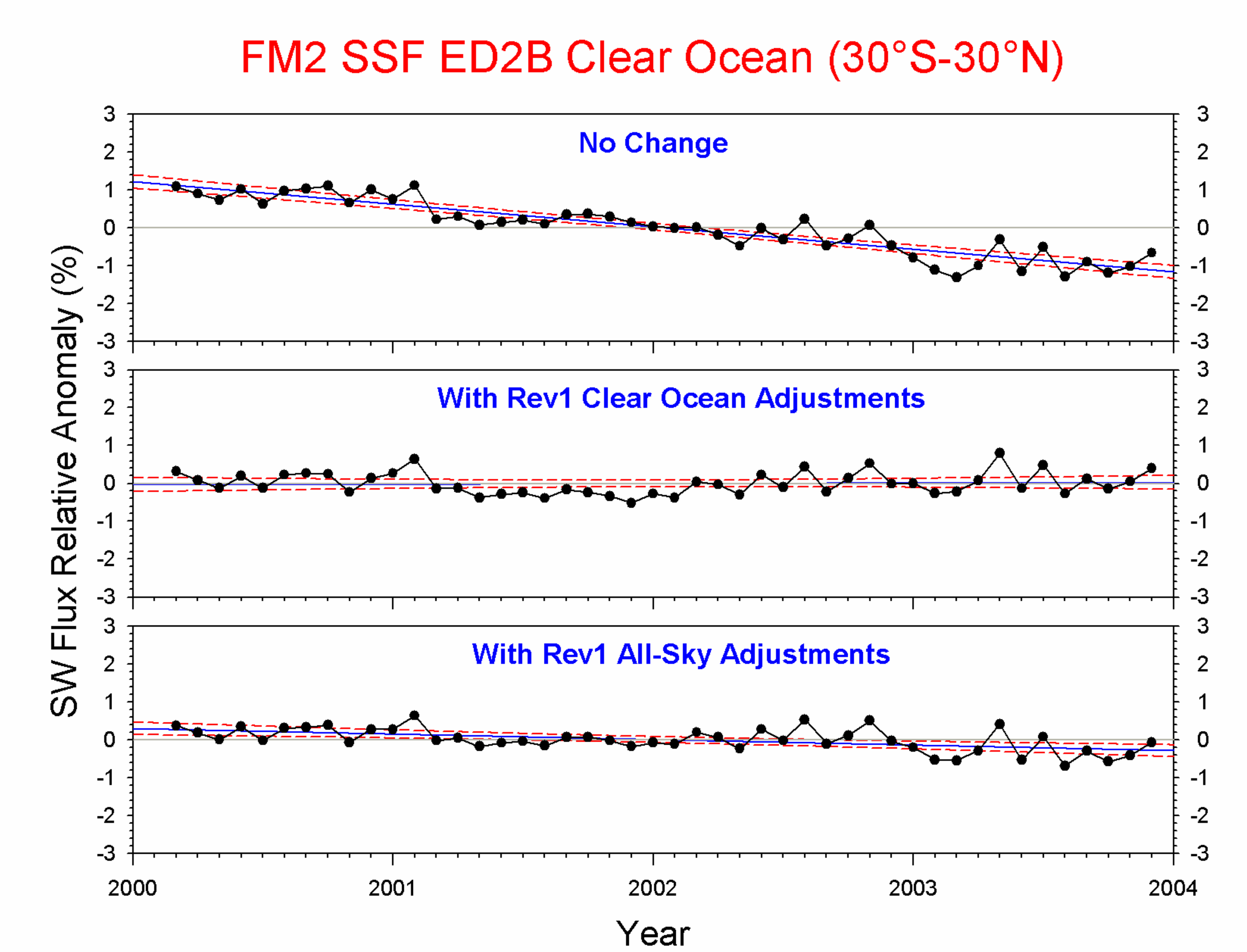
The change in the nadir radiance difference between FM2 and FM1 correlates extremely well with instrument scan mode.

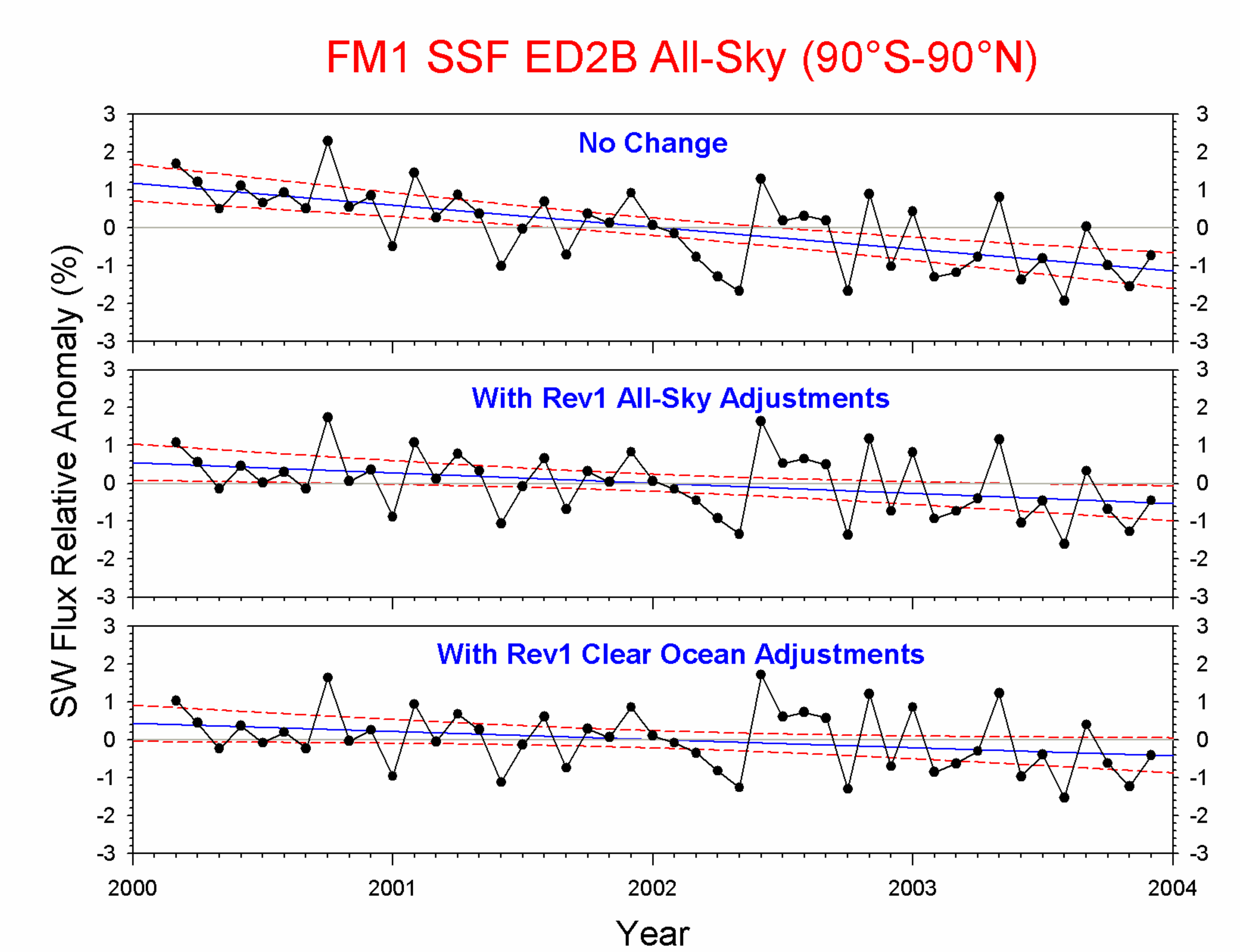


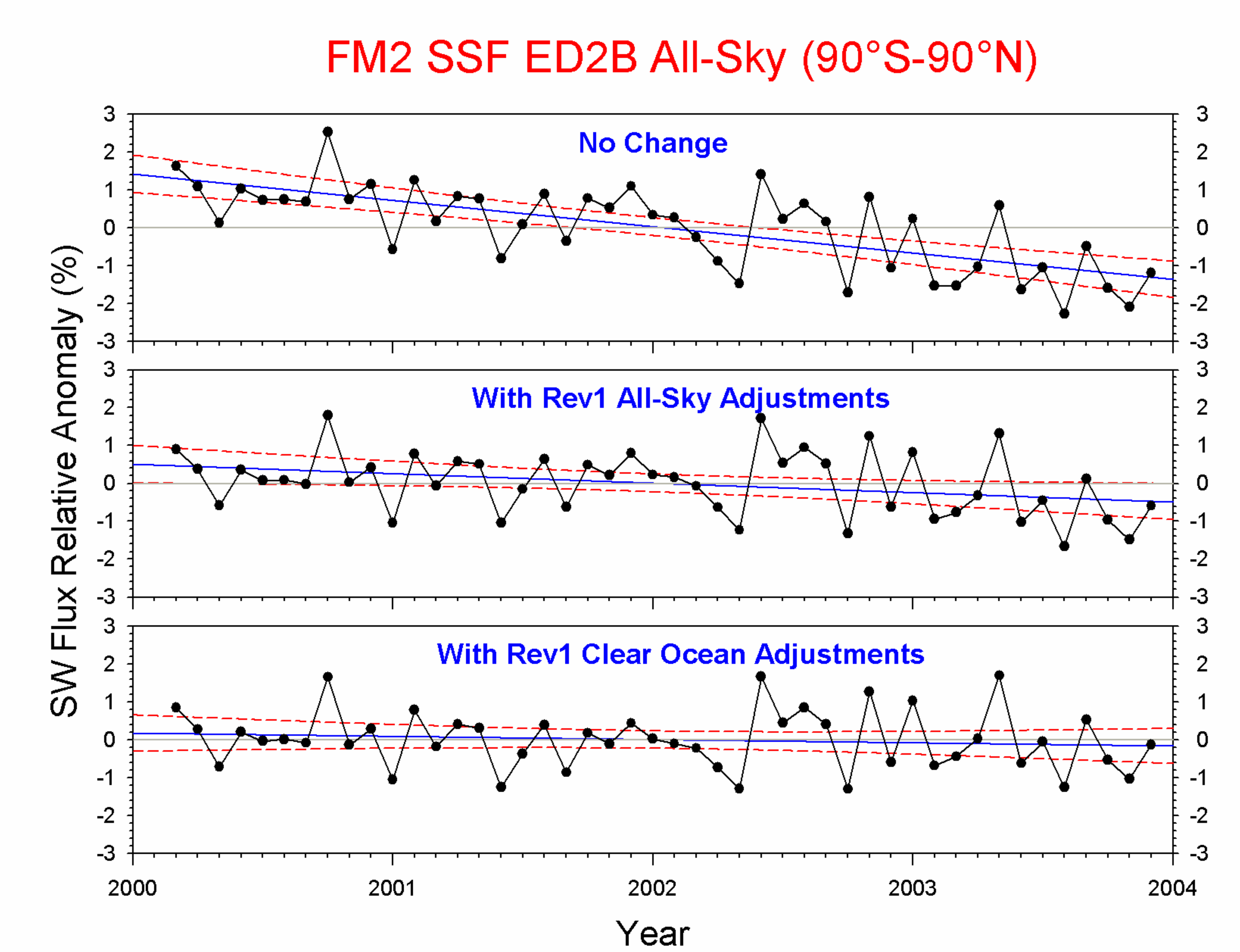
Assuming the Xtrack instrument does not degrade, derive the calibration change specific to each instrument.



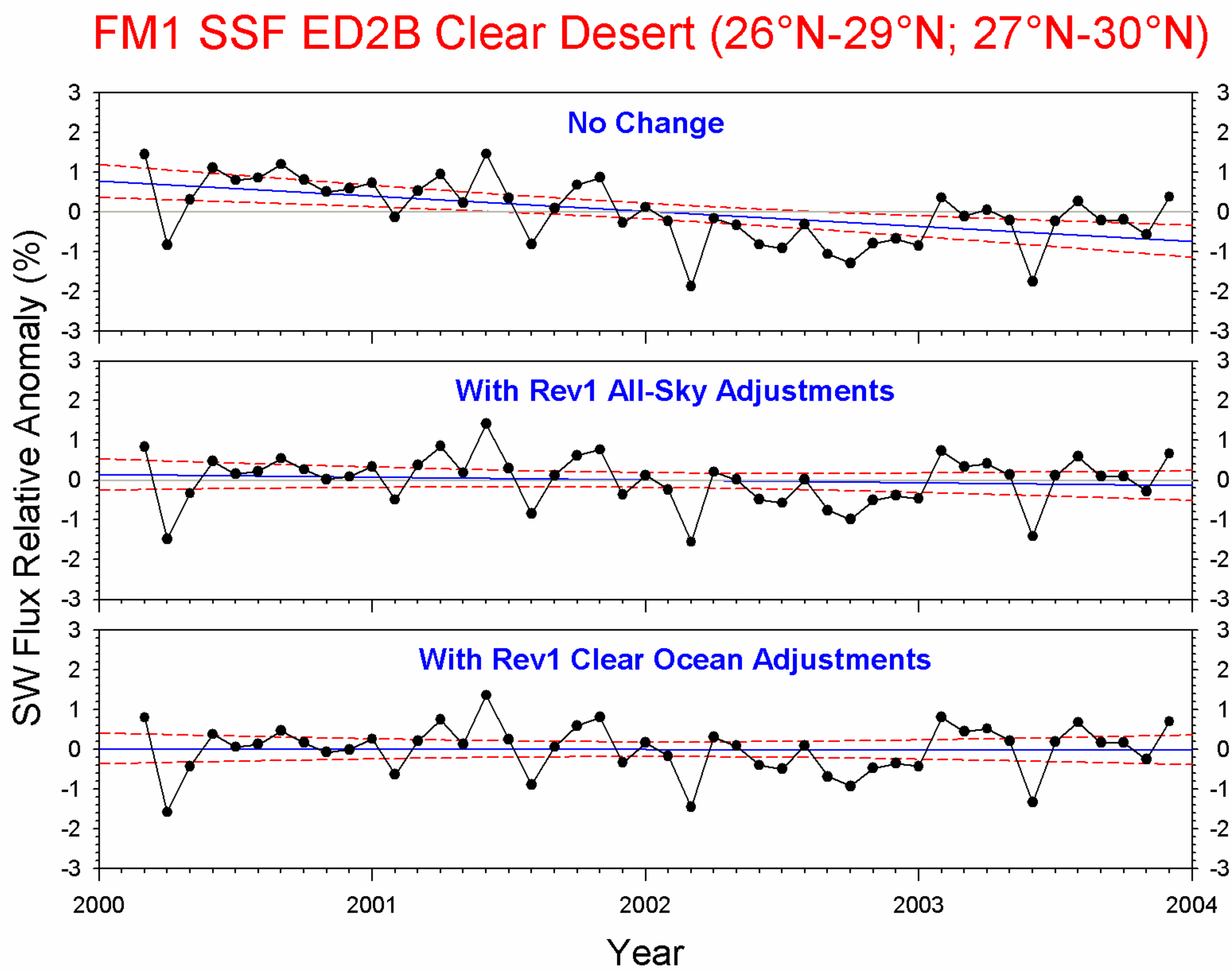
FM1 SSF ED2B Clear Ocean (30°S-30°N)
No Change
With Rev1 Clear Ocean Adjustments
With Rev1 All-Sky Adjustments
SW Flux Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3


FM2 SSF ED2B Clear Ocean (30°S-30°N)
No Change
With Rev1 Clear Ocean Adjustments
With Rev1 All-Sky Adjustments
SW Flux Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3

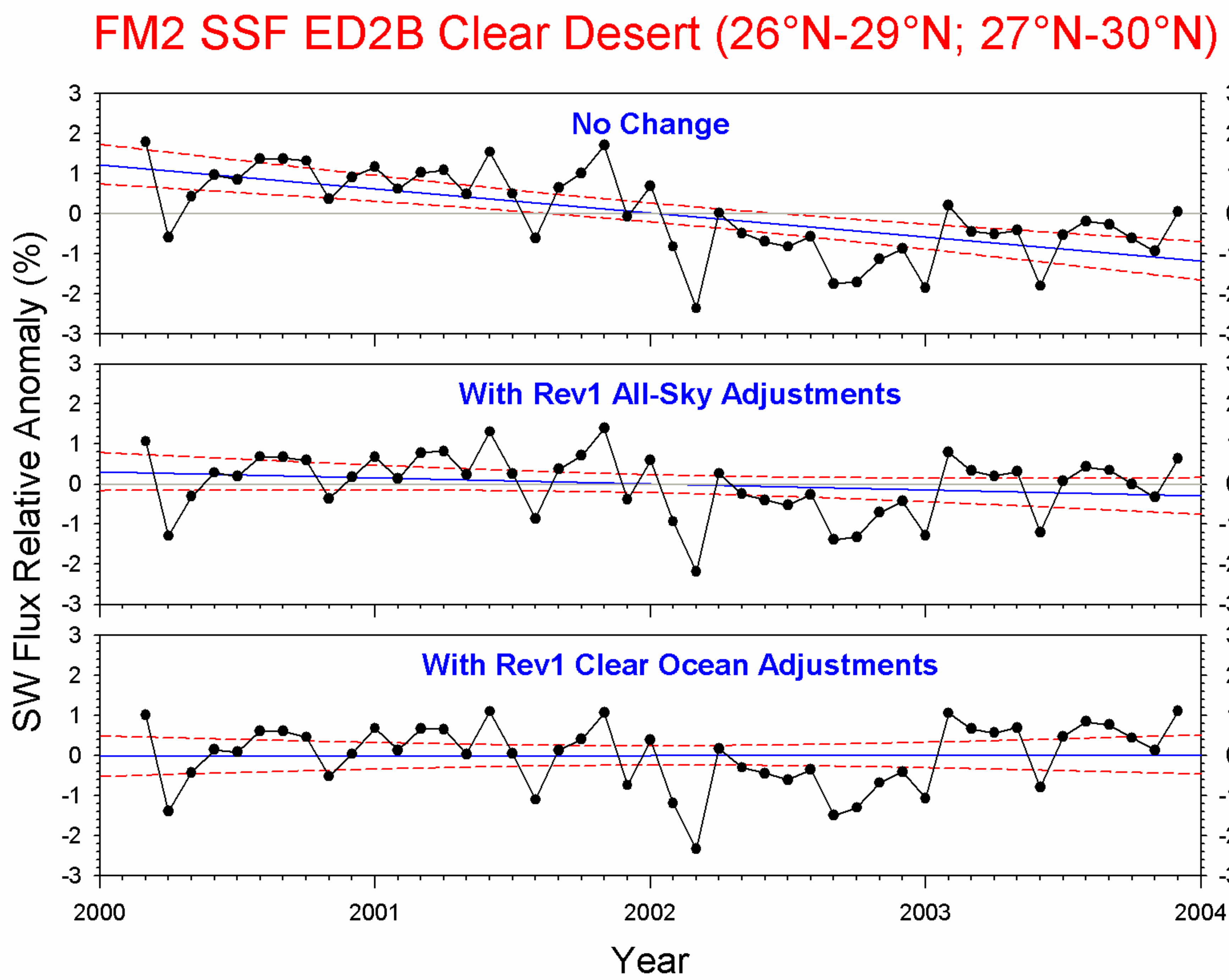

FM1 SSF ED2B All-Sky (90°S-90°N)
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
SW Flux Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3



FM2 SSF ED2B All-Sky (90°S-90°N)
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
SW Flux Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3



FM1 SSF ED2B Clear Desert (26°N-29°N; 27°N-30°N)
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
SW Flux Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3



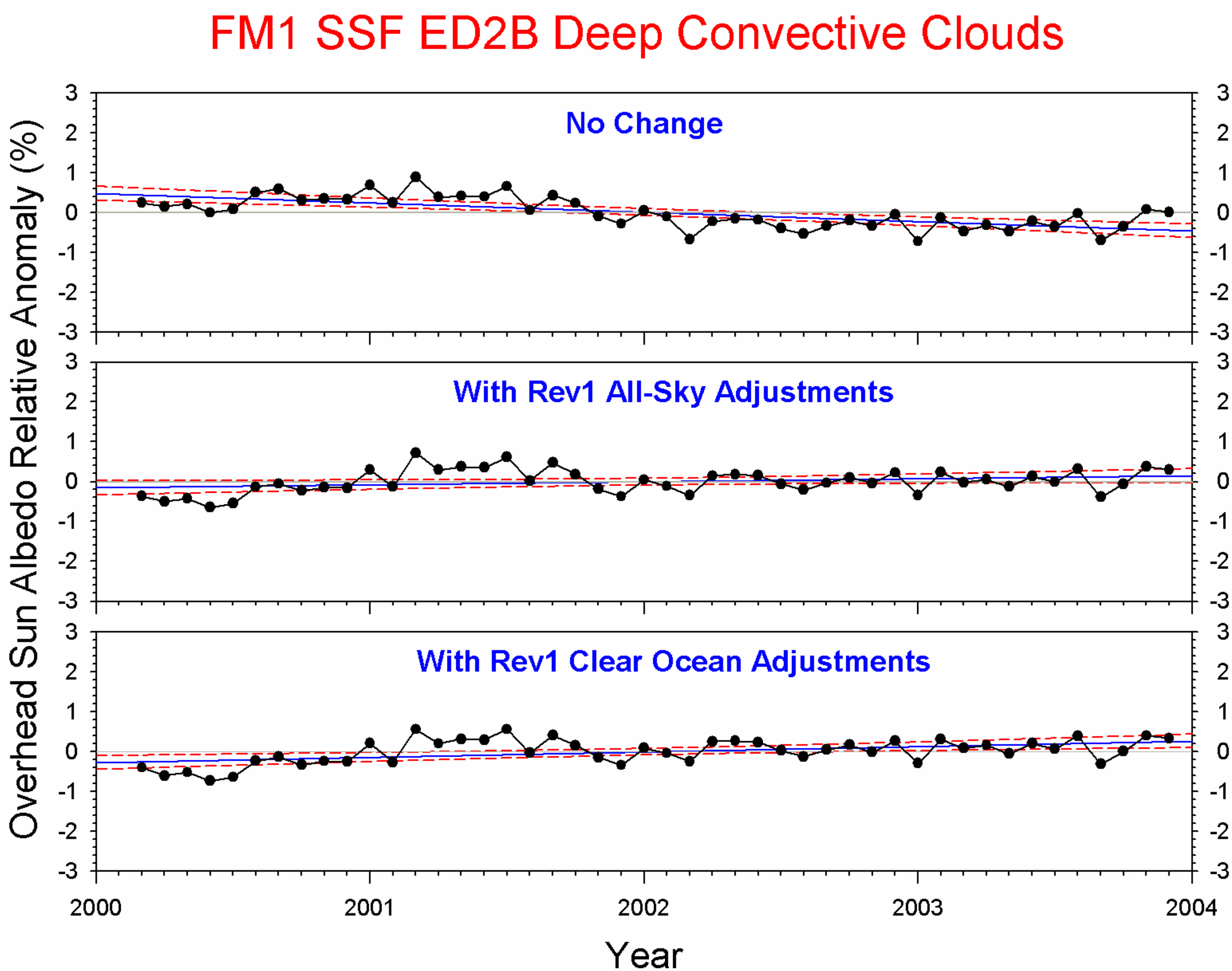
FM2 SSF ED2B Clear Desert (26°N-29°N; 27°N-30°N)
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
SW Flux Relative Anomaly (%)
3
2
1
0
-1
-2
-3
2000
2001
2002
2003
2004
Year

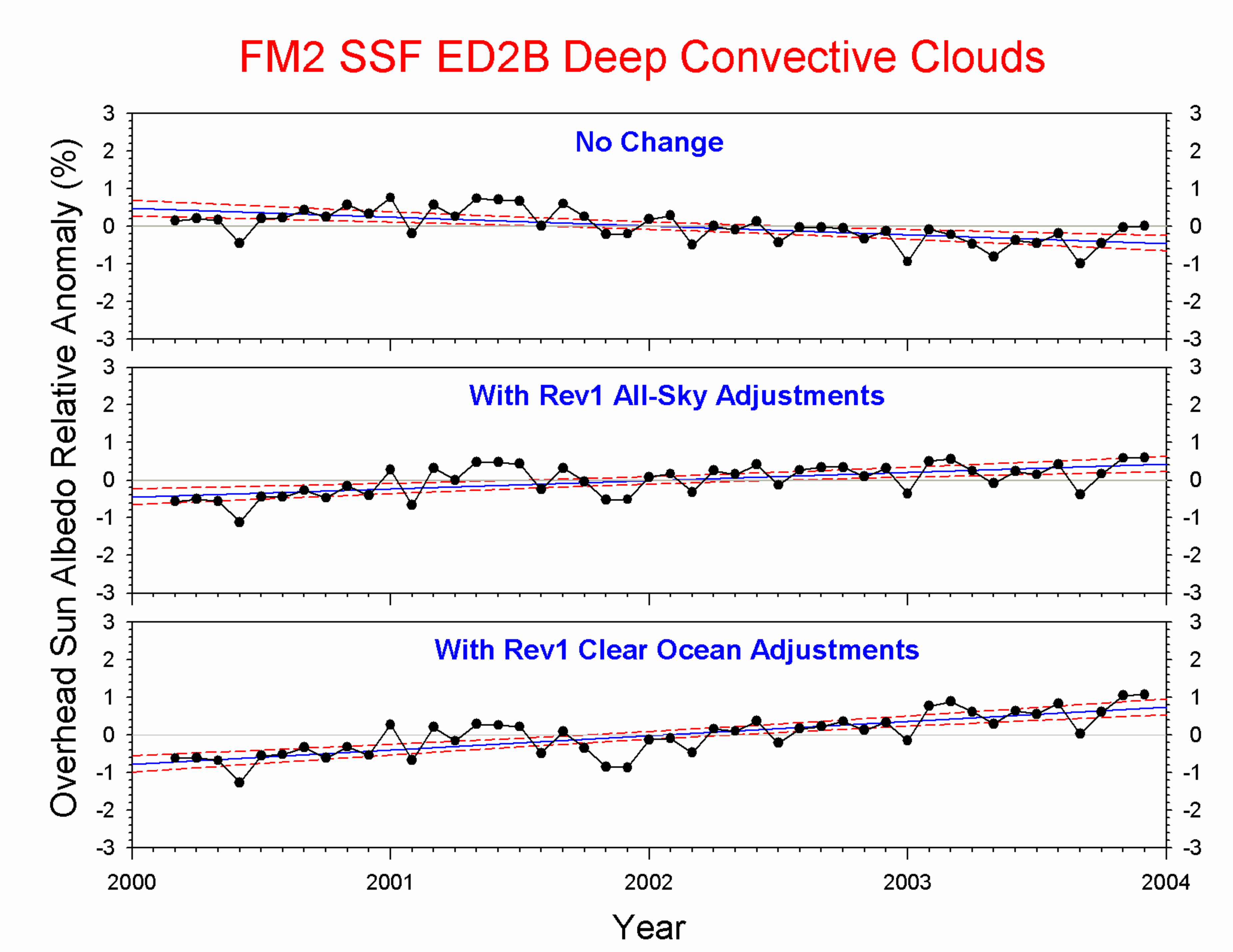
Deep Convective Cloud Overhead Sun Albedo Anomaly Time Series

- Apply 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.

Deep Convective Clouds: Footprints with:

- 100% cloud amount
- Effective temperature < 205 K
- Cloud optical depth > 10
- Imager radiance dispersion $[\sigma(I) / \langle I \rangle \times 100\%] < 3\%$


FM1 SSF ED2B Deep Convective Clouds
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
Overhead Sun Albedo Relative Anomaly (%)
Year
3
2
1
0
-1
-2
-3
2000
2001
2002
2003
2004



FM2 SSF ED2B Deep Convective Clouds
No Change
With Rev1 All-Sky Adjustments
With Rev1 Clear Ocean Adjustments
Overhead Sun Albedo Relative Anomaly (%)
Year
2000
2001
2002
2003
2004
3
2
1
0
-1
-2
-3

SUMMARY

- CERES shows a ≈2% decrease in SW TOA flux between 2000 and 2004 that is partly due to spectral darkening of the optics when in RAP mode.
- Assuming this change only affects CERES when in RAP mode, adjustment factors that rely only on RAP minus FAP nadir radiance differences were derived for CERES ED2 data (⇒ ED2_Rev1).
- For global all-sky SW TOA fluxes, approximately half of the 2% decrease is accounted for by this adjustment. The remaining 1% is likely a real change in global SW TOA flux.
- The uncertainty in the 4-year SW TOA flux change is 0.5% after applying the ED2_Rev1 adjustment.

- For clear ocean and desert, the decrease in SW flux is < 0.5% after the adjustment is applied.

- For deep convective clouds, the adjustment over-compensates for the spectral darkening of the optics (extreme case).

- A far more rigorous account of the spectral changes will be provided in the ED3 release of CERES.

- In the meantime, users interested in longer term SW TOA flux changes are encouraged to directly apply the ED2_Rev1 adjustment factors to the ED2 data.