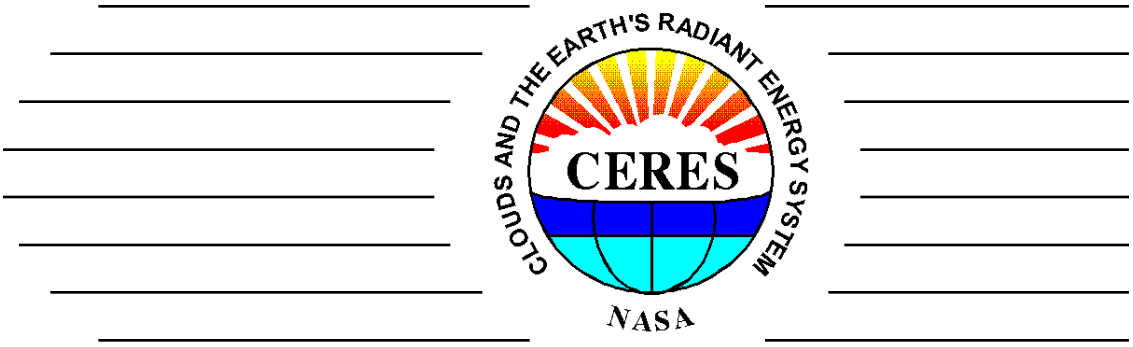
CERES Instrument Cal/Val Report



Kory J. Priestley
Robert Lee, Susan Thomas,
Aiman Al-Hajjah, Robert Wilson, Pete Spence, Ed Kizer,
Peter Szewczyk, Phil Hess, Joey Escuadra, Denise Cooper

26th CERES Science Team Meeting
Williamsburg, VA
May 14, 2002

NASA Langley Research
Atm

OS -AQUA

02:54:

May 04

Vandenbe

Aqua Mission Status

05/ 04	Launch
	CERES Instruments to SURVIVAL Mode
	CERES Instruments Deployed
05 / 07	CEA & CEF first power on; SAFE Mode
05 / 10	S/C demo Delta-V Yaw maneuver
	Activate X-Band com system
	SSR partitioning for Science Data
	Enable CERES 1553 science data transactions
	First dump of SSR with Science Data Partitioning
05 / 11	S/C Delta-V demo 30 sec **burn**
05 / 12	AMSU-A1, -A2 Power On & Functional Test
05 / 13	First Delta-V ascent **burn**
05 / 14	HSB power on & Functional Test
05 / 16	Begin CERES Activation and Functional Tests
05 / 21	Second Ascent **burn**
05 / 24	Third Ascent **burn**
05 / 27	Fourth Ascent **burn**
05 / 30	Fifth Ascent **burn**
06 / 08	Final Ascent **burn**; mission orbit
06 / 09	***CERES covers open***
07 / 10	***Deep Space Pitch-over maneuver***

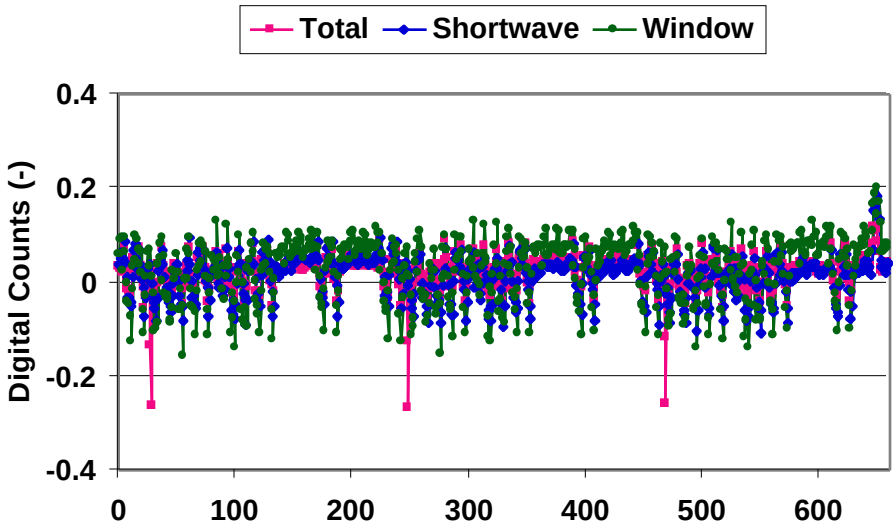
Aqua Mission Status

Launch Configuration (CERES Stowed)

Mission Configuration (CERES Deployed)

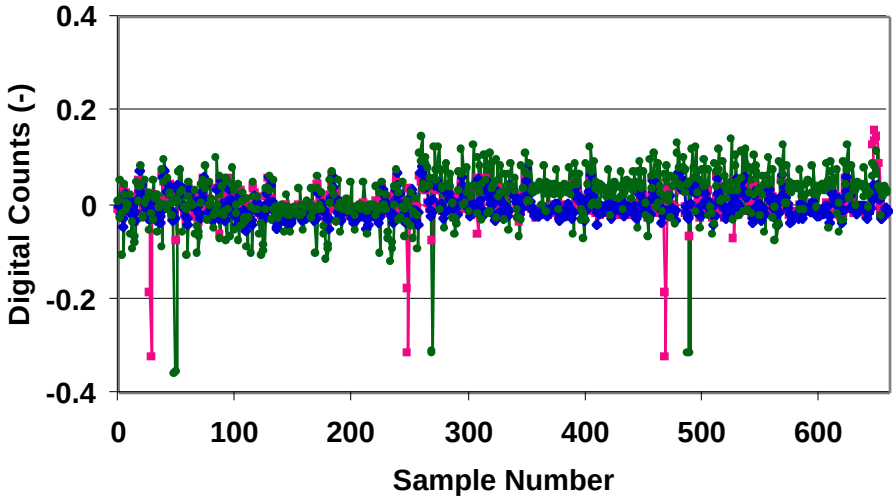
Initial Aqua Science Data

Stow Mode Diagnostic Data



FM-3

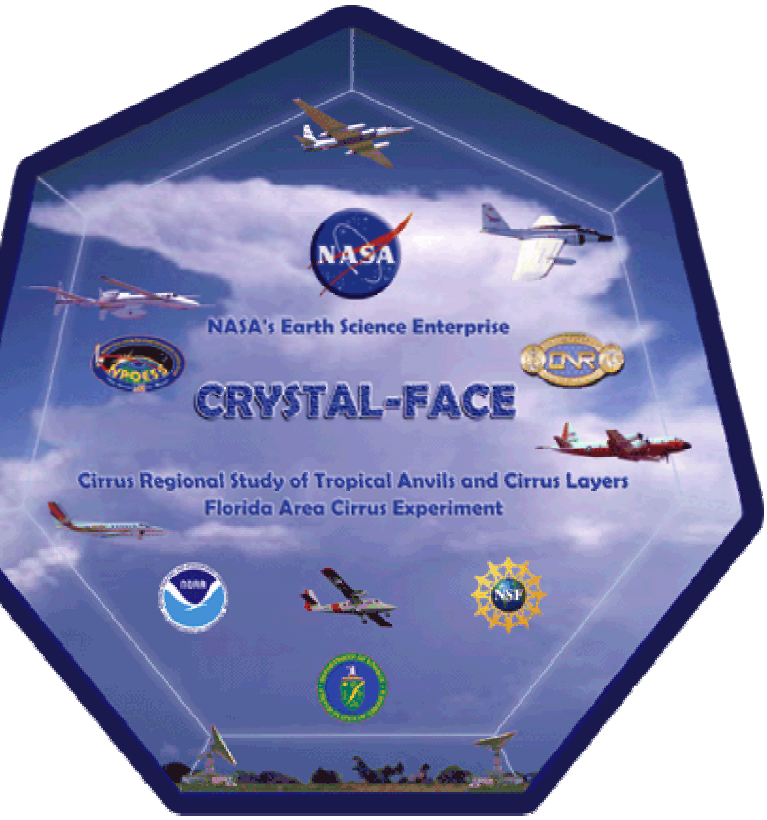
No Measurable change from
Pre-flight noise measureme



FM-4

1 count ~.5 w/m^2

Upcoming Instrument Activities



Crystal-Face experiment will occur during July

CERES will provide coverage on a daily basis.

Preferred platform is the Aqua S/C,

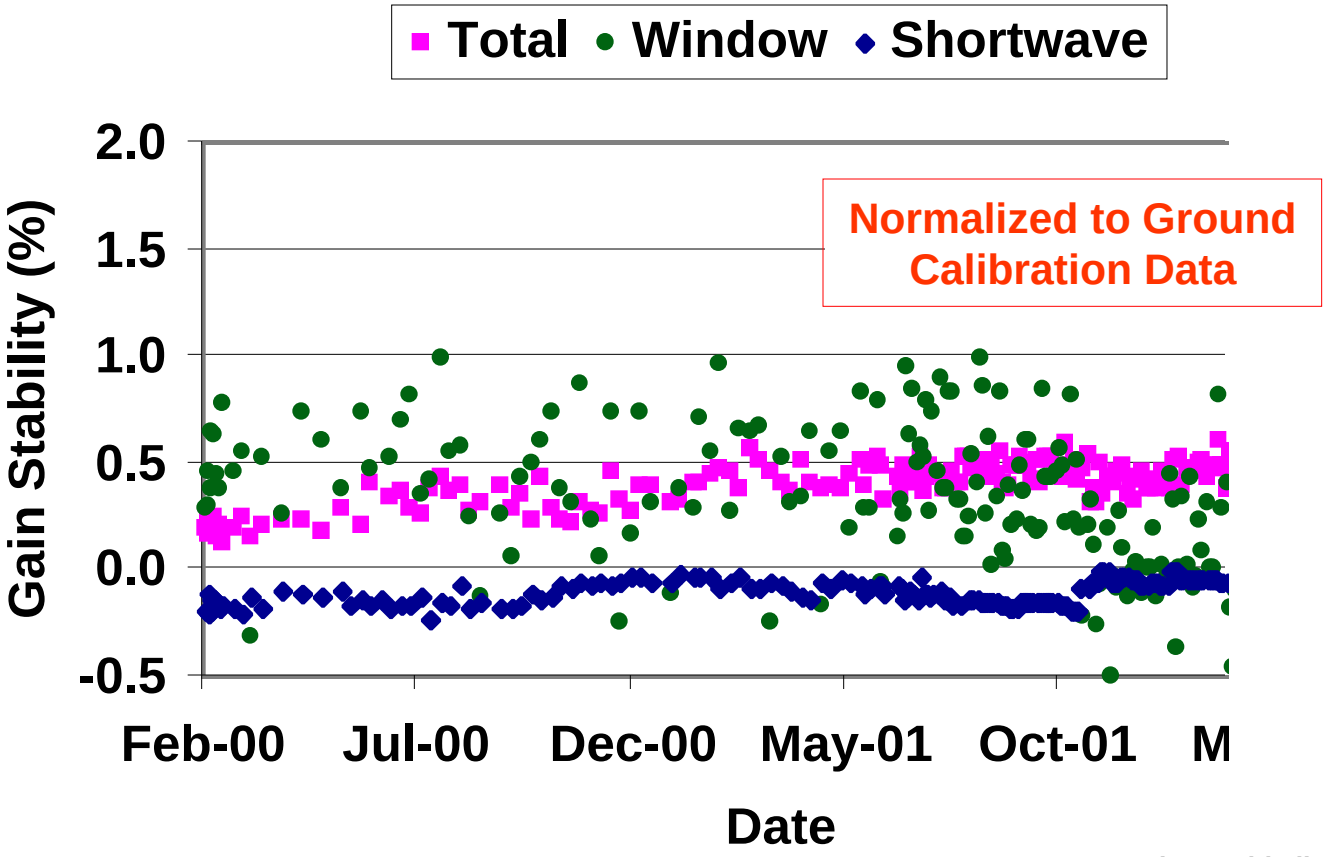
Will depend on S/C performance over next 30 d

CERES/TERRA will provide coverage.

Test runs to be completed in June.

Terra/Flight Model 1
Lifetime Radiometric Stability

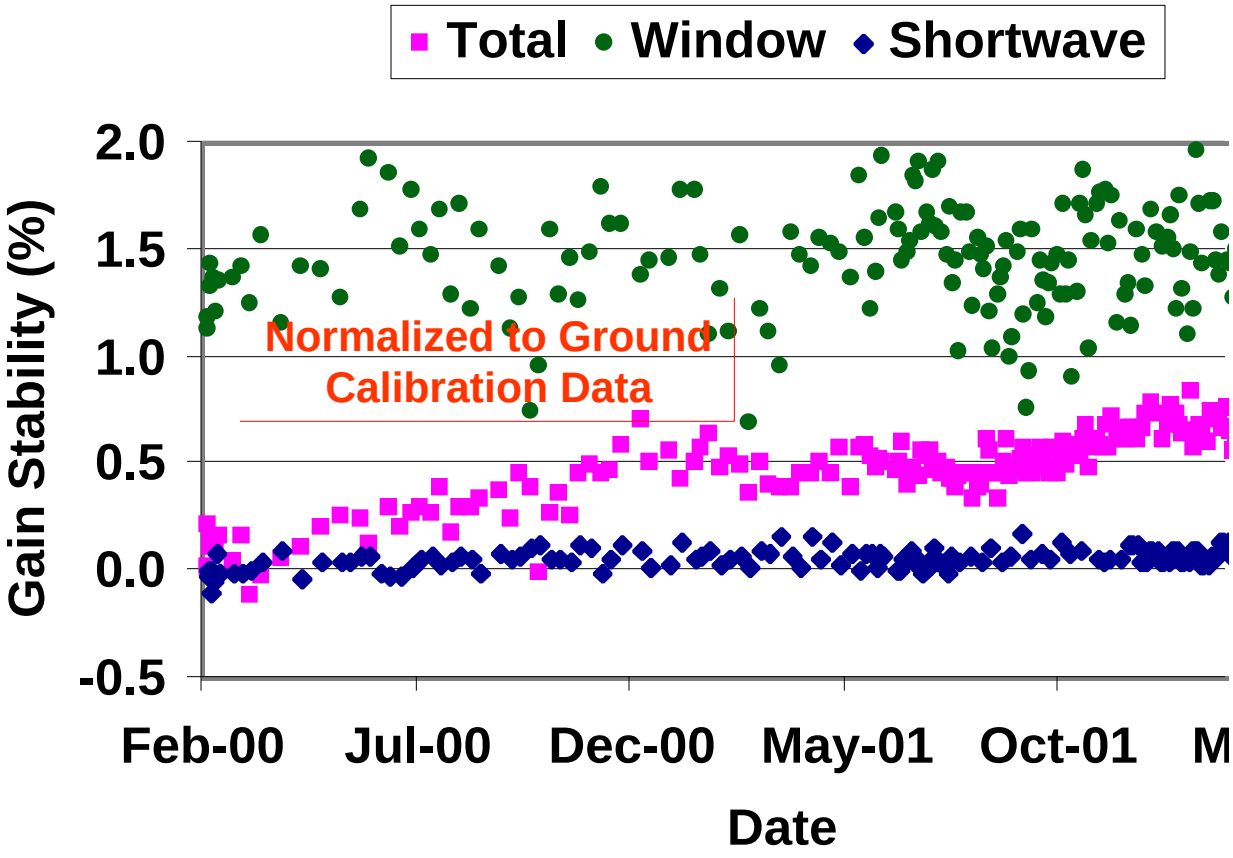
Determined with the Internal Calibration Module



Aiman Al-hajjah, Susan Thoma

Terra/Flight Model 2
Lifetime Radiometric Stability

Determined with the Internal Calibration Module



Internal/Solar Calibrations Key Results

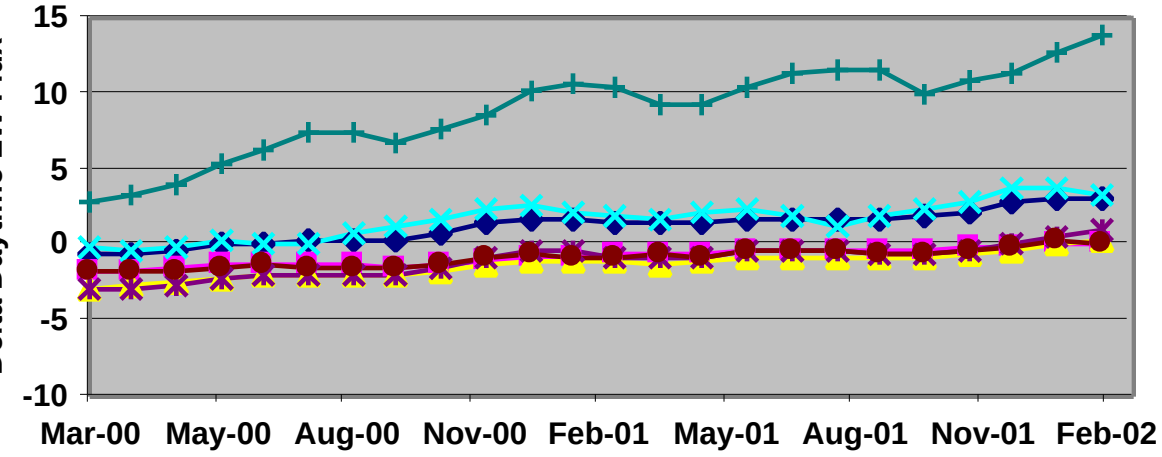
- Ground to Flight Calibration Stability
  - Determined with Internal Calibration Module
    - TOT: 0.20 and 0.12% for FM1 and FM2
    - WN: 0.48 and 1.3% for FM1 and FM2
    - SW: -0.16 and <0.1% for FM1 and FM2

- On-Orbit Calibration Stability (%/year)
  - Internal Calibration Module
    - TOT: 0.20* and **0.26*** %/yr for FM1 and FM2
    - WN: -0.05 and 0.07 %/yr for FM1 and FM2
    - SW: 0.04* and 0.03* %/yr for FM1 and FM2
      - * statistically significant
      - All internal calibrations have been executed in daytime portion of orbit
  - Solar Calibrations
    - Terra MAM's have continued to drift with time and results are suspect

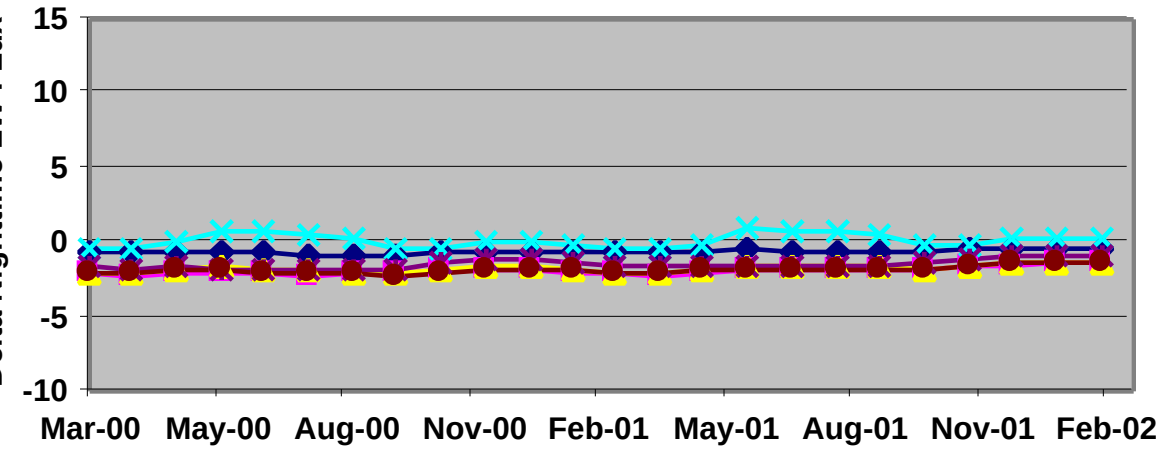
Co-located Nadir Flux Comparisons

(FM2 minus FM1)

Edition 1 Data Products

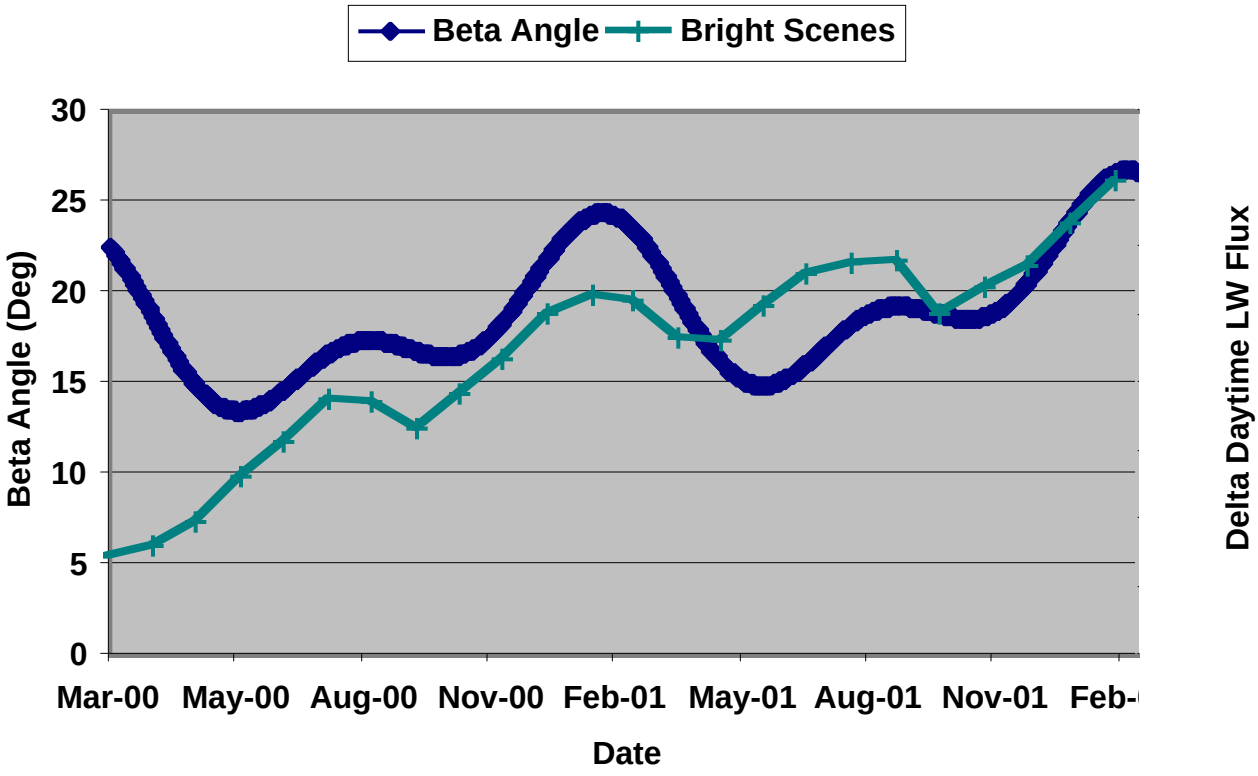


LW Daytime



LW Nighttime

Beta Angle Dependence



There exists a beta angle dependence for one of the two SW Channels.

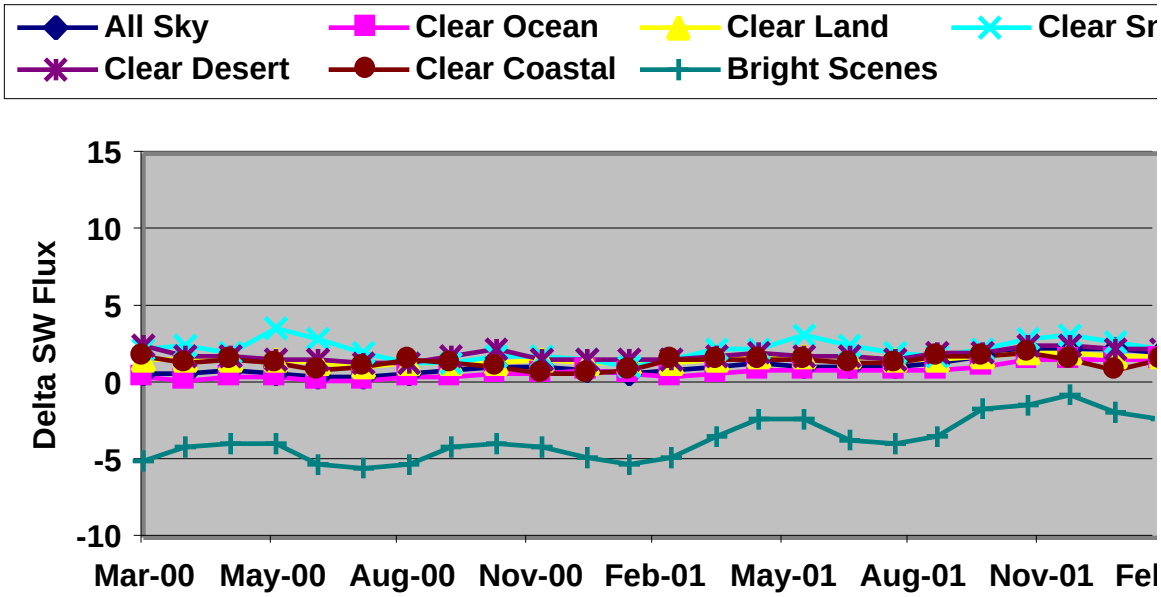
Suspect FM-2 is the culprit, analysis not yet complete.

Dependence will NOT be removed in Edition 2 BDS Data Products.

Co-located Nadir Flux Comparisons

(FM2 minus FM1)

Edition 1 Data Products

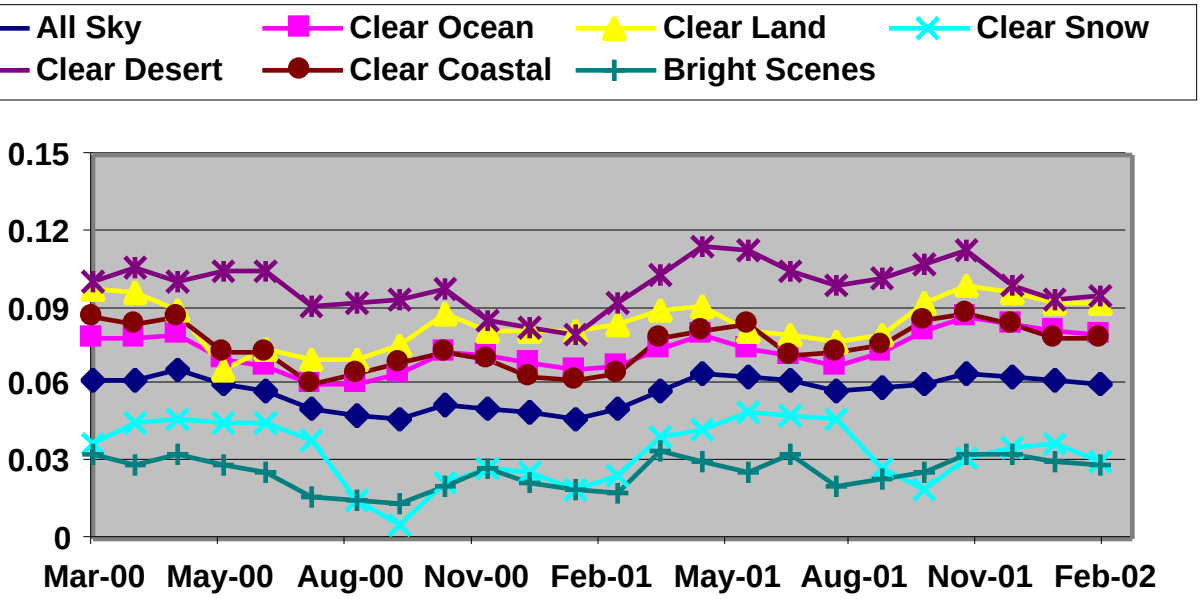


Increasing difference in Daytime LW is caused primarily by the SW portion of the FM-2 Total Channel

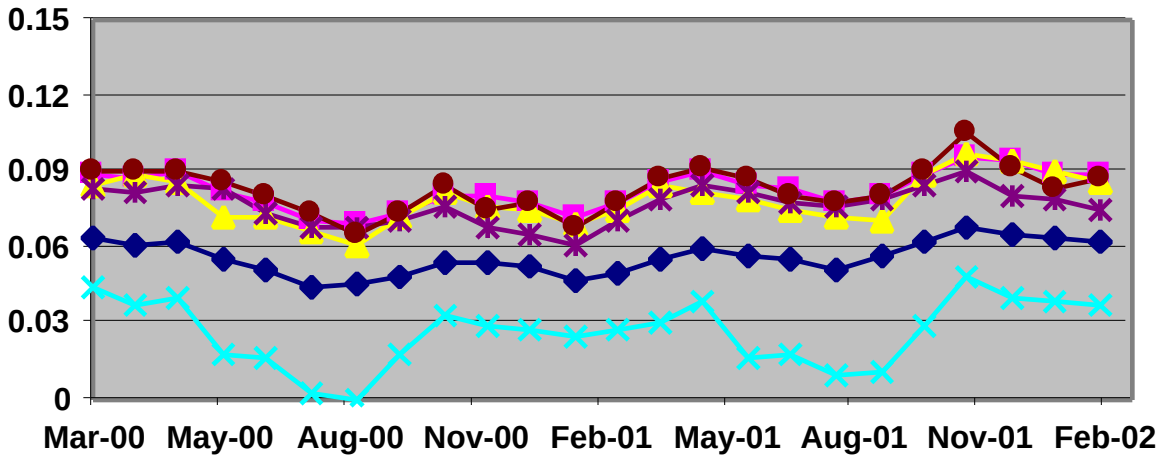
Co-located Nadir Flux Comparisons

(FM2 minus FM1)

Edition 1 Data Products



WN Daytime

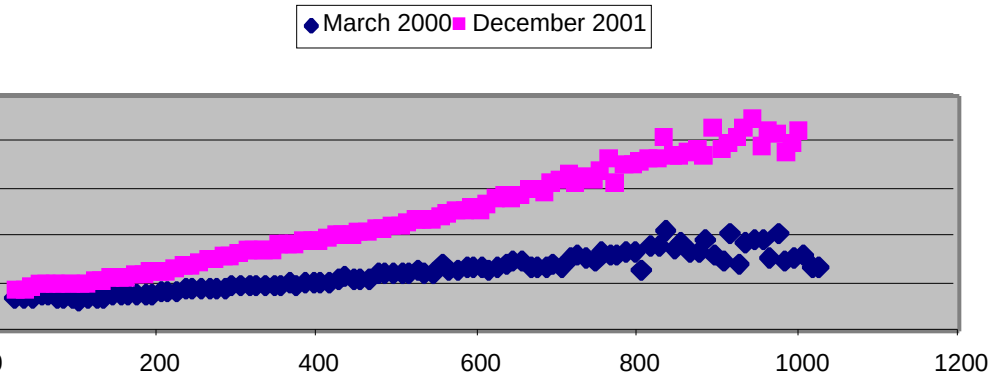


WN Nighttime

Co-located Nadir Flux Comparisons

(FM2 minus FM1)

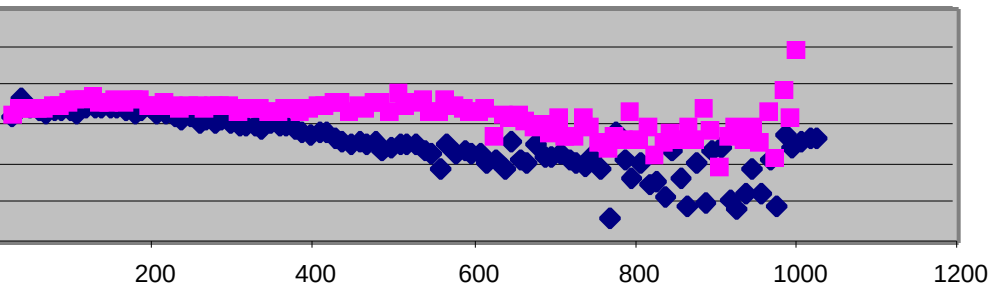
Edition1 Data Products



LW Flux

Growth in ΔLW_{day} is correlated to S

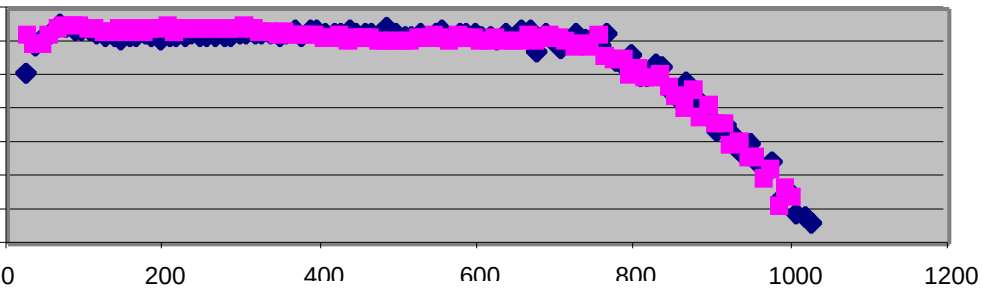
From 3-channel intercomparison w the changes are in FM-2.



SW Flux

Relative agreement is a function of

Drift of ~0.4%/yr beginning in May '



WN Radiance

FM1 WN radiance grows with SW

Consistent with a SW leak at the 0.1

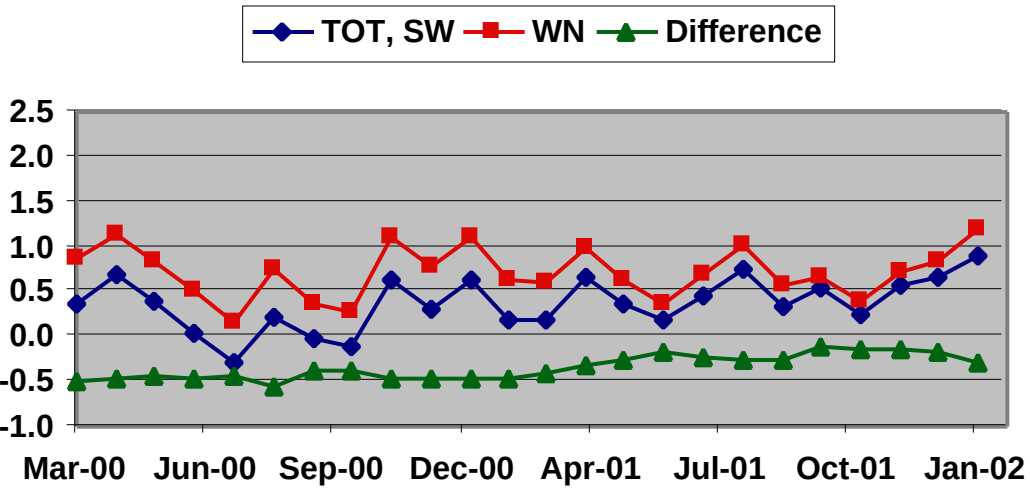
3-channel Intercomparison verifies

Invariant with time

Tropical Mean Self Consistency

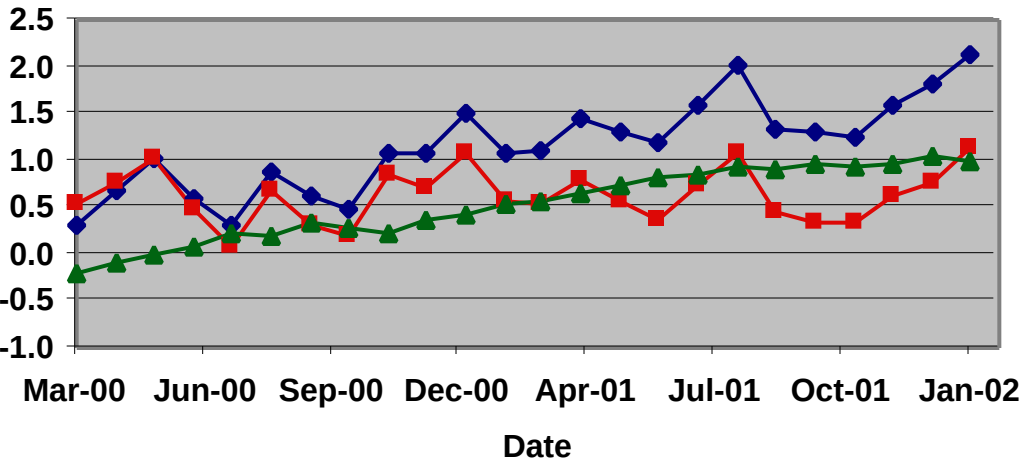
Tropical Ocean, All Sky

Edition 1 Data Products



FM-1

**Apparent drift in the
SW channel beginnin
April 2001.**



FM-2

**Significant drift in the
portion of TOT chann**

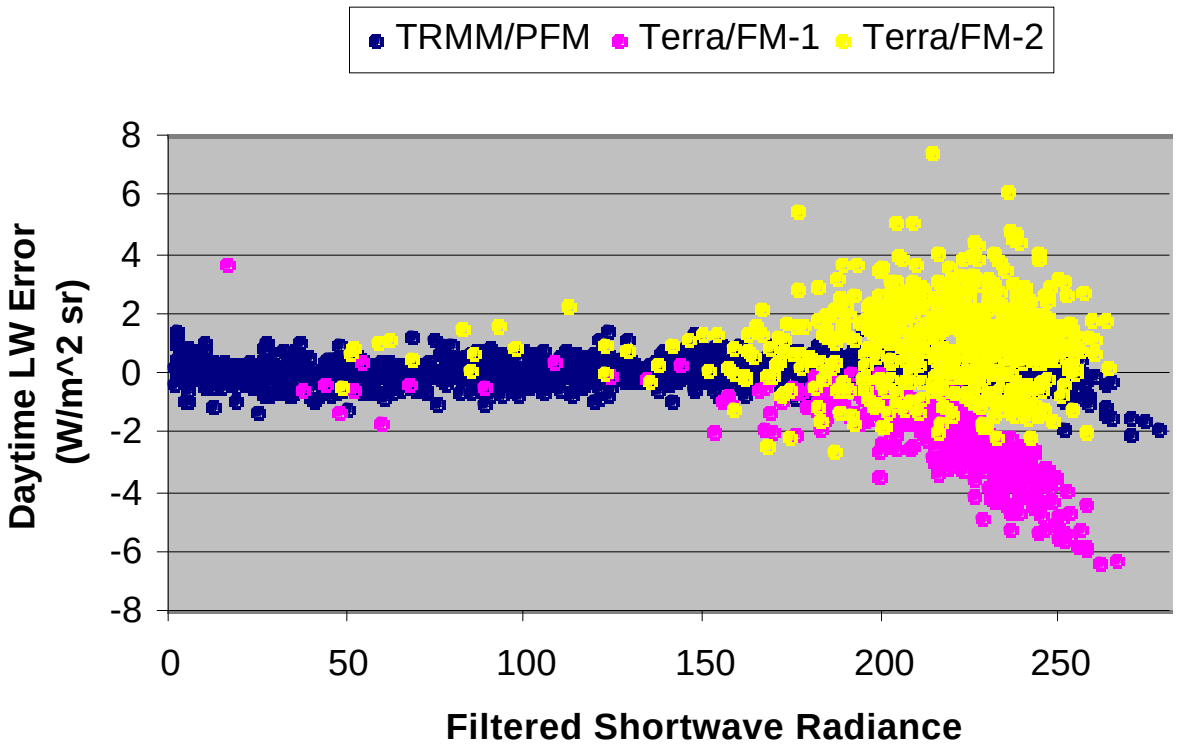
Direct Comparison / Tropical Mean Key Results

Direct Comparison

- Relative Differences
  - WN radiances: FM1 < FM2 by 1.0%, no relative drift
    - FM1 has a SW leak of ~0.1%
  - SW radiances: FM1 < FM2 by 0.33% (Globally)
    - Clear Ocean FM2 > FM1 by ~1.9%
    - Bright Clouds FM1 > FM2 by ~0.7%
  - Nighttime LW: FM1 > FM2 by 0.3%, no relative drift
  - Daytime LW: Relative Growth of FM2 Daytime LW measurements of ~1.0%/yr since launch

3-Channel Deep Convection Results

March - December 2000



Daytime LW Error = (Total $_{day}$ – SW $_{day}$) – (C_1*WN $_{day}$ + C_2)

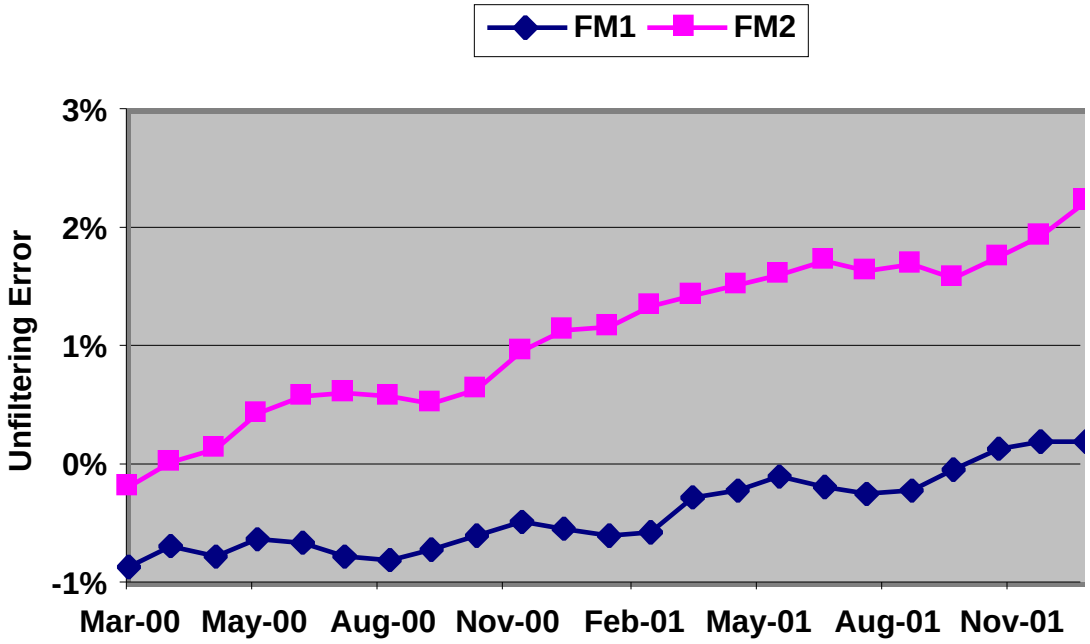
Where C_1 and C_2 are found by regressing the Unfiltered WN against the unfiltered Total channel at night.

Non-linearity in FM1 is due to SW leak in WN channel

Three Channel Inter-Comparison

Using Deep Convective Clouds

Edition 1 Data Products



SW portion of the FM2 Total channel, and the FM1 SW channel are changing with time.

3-Channel Intercomparison Key Results

- FM-1
  - Time varying inconsistency in FM-1 Total Channel (total change ~1.0%)
  - Structure in Daytime LW Error is due to WN channel SW leak
    - Direct Comparison suggests error is in the SW channel
- FM-2
  - Time varying inconsistency in FM-2 Total channel (total change ~2.7%)
    - Direct Comparison suggests error is in the SW portion of the Total Channel

rra Validation Effort / Executive Summa

March, 2000 – March, 2002

- Ground to Flight calibration stability is better than 0.3% for TOT and SW channels
- WN channel calibrations shifted from ground to flight, FM-1 by 0.48%, FM-2 by 1.3%
  - FM-2 WN radiances > FM-1 WN radiances by ~0.9%
  - Insufficient settling time allowed during ground cal's (Possible FM-2 delamination)
  - FM-1 WN channel has apparent SW leak of ~0.1%
  - No measurable drift in WN channels over mission lifetime (I.e. <0.1%)
- SW channel radiance measurements consistent at the 0.3% level between FM-1 and FM-2 globally averaged (I.e. FM-2 > FM-1)
  - Apparent mix of bias and gain errors (possibly spectral in nature) yields scene dependence
    - Clear Ocean FM-2 > FM-1 by ~1.9%
    - Bright Clouds FM-1 > FM-2 by ~0.7%
  - Stability better than 0.12 and 0.08 % per year based on SWICS lamps
  - Direct Comparison and Tropical Mean studies suggest larger instabilities (0.5% level)
- FM-1 day and nighttime LW (I.e. total channel) radiances are stable to better than 0.25% over the first 24 months
- FM-2 daytime LW radiances demonstrate a slow increase of ~1%/year
- FM-2 nighttime radiances appear stable with no measurable drift
  - Physics not yet completely understood

Edition 2 BDS and ERBE-Like Products: Drift Removal Methodology

fts are modeled as originating from either of 2 physical entities…..

Radiometric Gain Change

- ✓ **Wavelength independent change in sensor responsivity**
- ✓ **Corrections implemented in Count Conversion algorithm (SS1)**

Spectral Response Change

- ✓ **Wavelength dependent change in sensor absorptivity**
- ✓ **Corrections implemented in Spectral Unfiltering algorithms (SS2)**

Updated Radiometric Gains and Spectral Response Functions will be generated on a monthly basis and will be implemented on either a daily (Gains) or monthly (Spectral) interpolated basis.

Instrument Group has completed preliminary reprocessing runs which correct the drift in the FM-2 Total channel.

lition 2 BDS, IES, ES8 Processing Strate

Data product generation requires 2 steps

(1) Process “Baseline-1” BDS and ES8 using baseline radiometric gains spectral correction coefficients (SCC’s)

- **Production strategy “Baseline-1”, not available to public**
- **Generates BDS, ES8 (no IES) to perform monthly Validation Studies**

(2) Process “Edition 2” using updated radiometric gains (BDS) and Spec Correction Coefficients (ES8). Gains and SCC’s derived monthly

- **Production strategy “Edition 2”, available to public**
- **Generates BDS, ES8, IES**

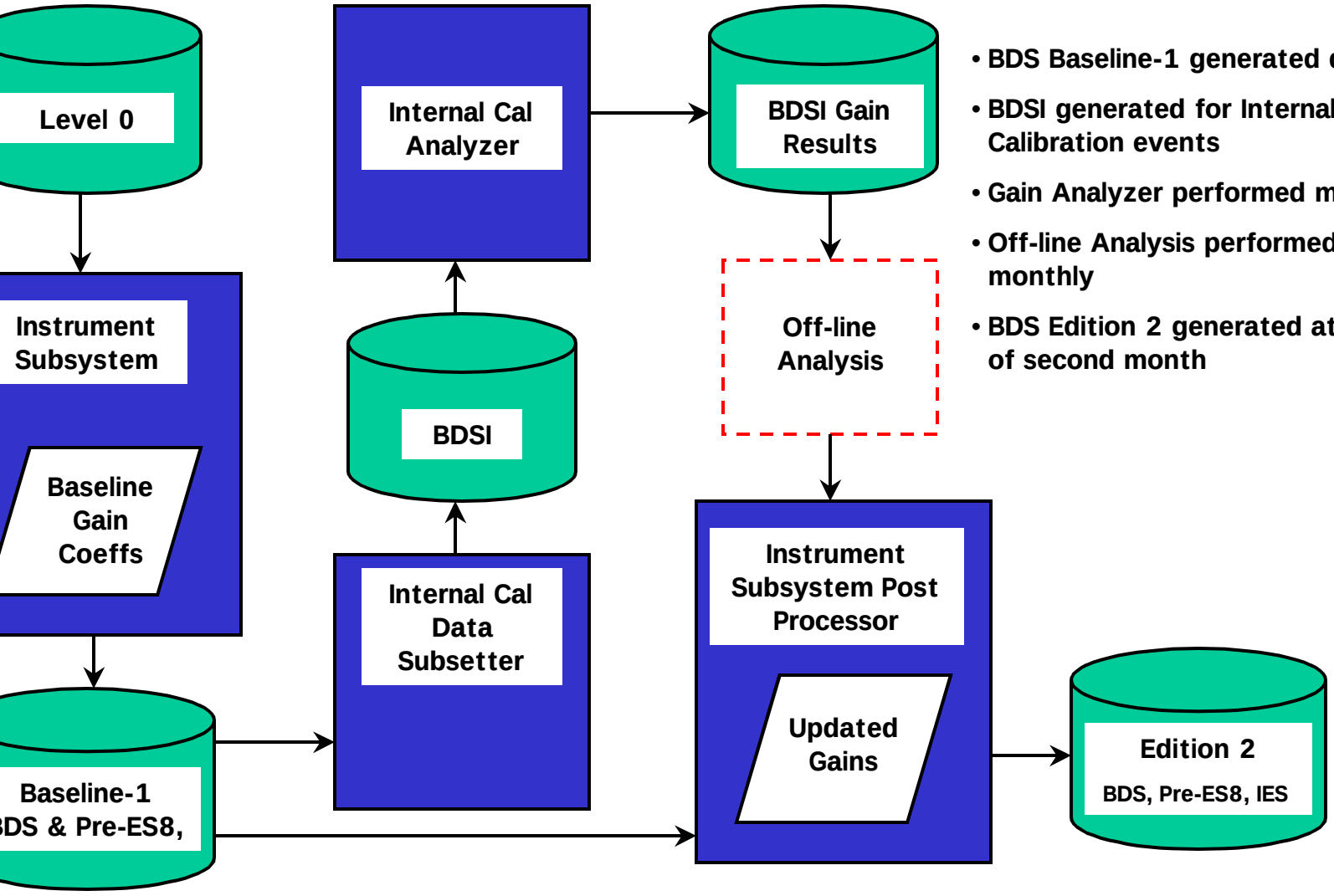
Data reduction and off-line analyses using baseline data is required

Edition 2 products delayed approx. 2 months

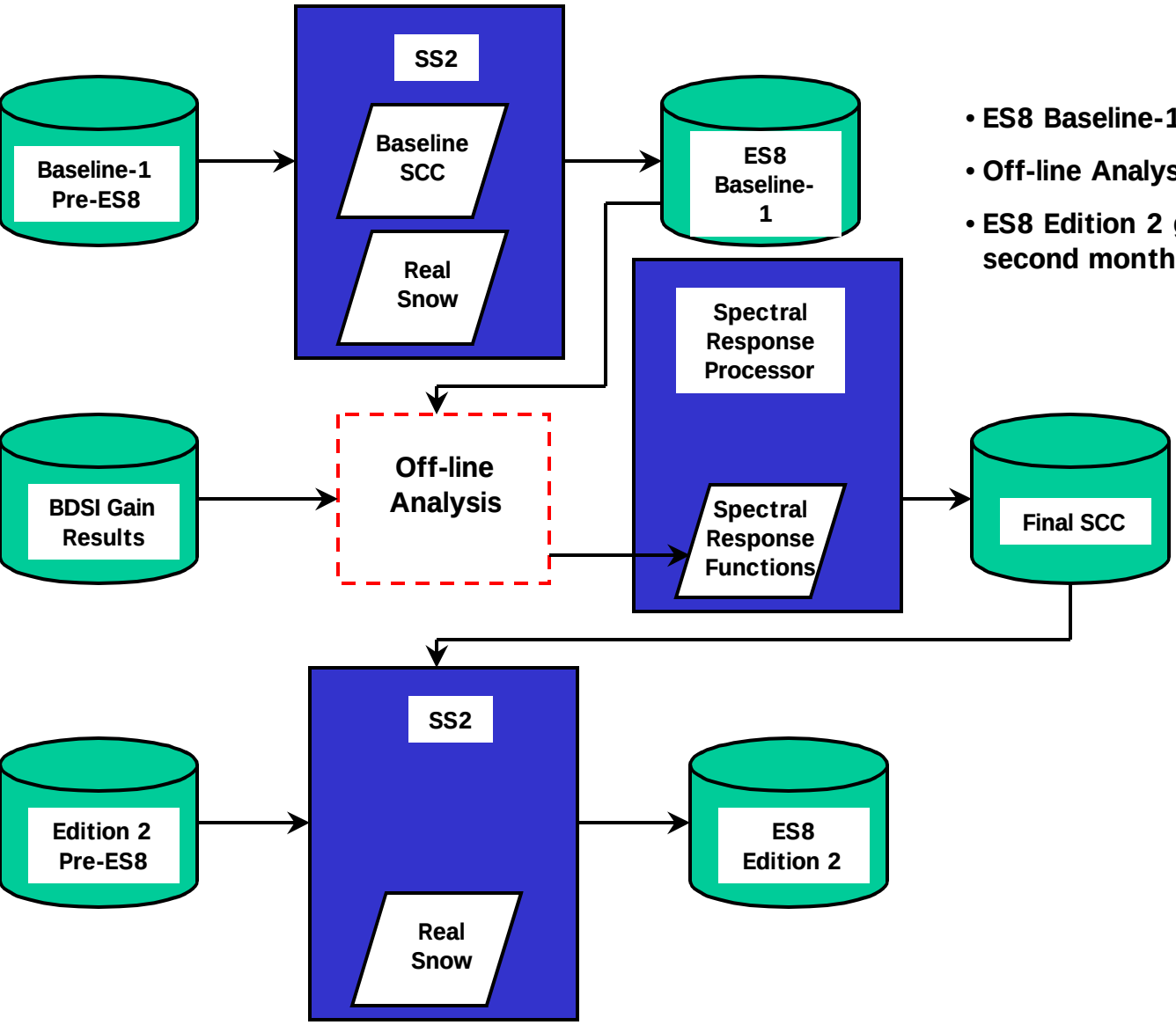
Goal is to remove > 80% of the instrument drifts without waiting for long term data sets for reprocessing

Edition 2 BDS Production Strategy

Implementing Radiometric Gain Updates



Edition 2 ES8 Production Strategy



- ES8 Baseline-1 generated monthly
- Off-line Analysis performed monthl
- ES8 Edition 2 generated at end of second month

Edition 2 BDS and ERBE-Like Products: Preliminary Results

trument Group has completed preliminary reprocessing runs which correct the drift in the FM-2 Total channel.

Radiometric Gain Change

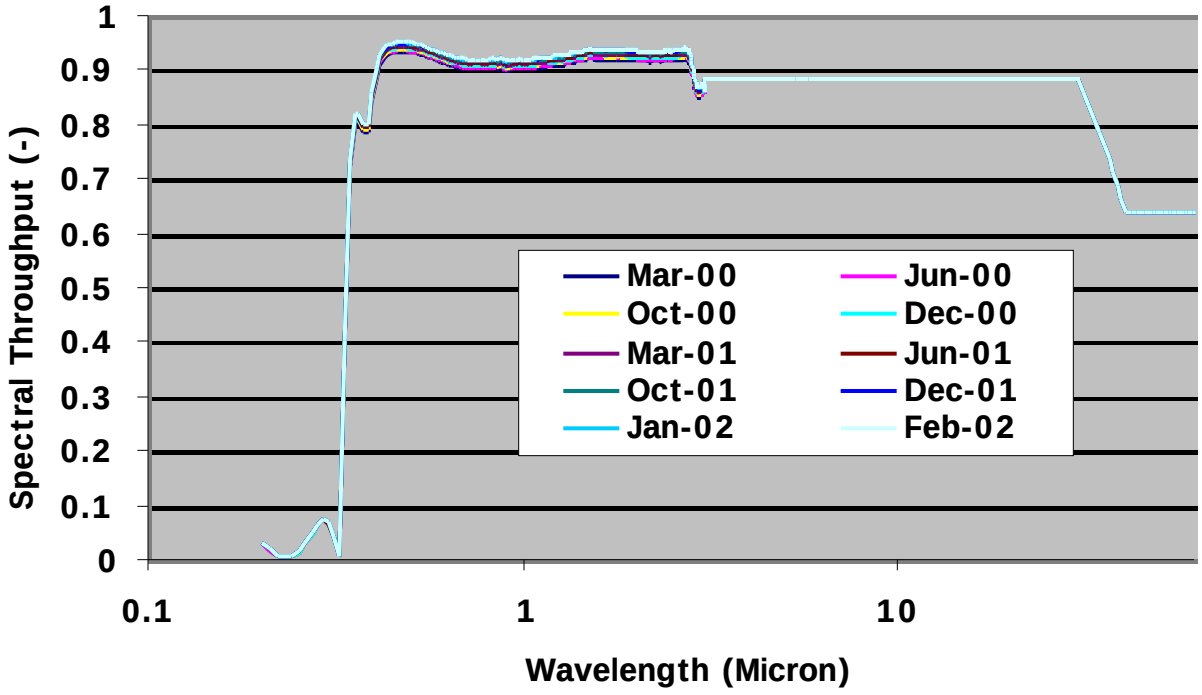
- ✓ **Modeled as a linear 0.6% increase in responsivity over the first 25 months of data collected.**

Edition 2 BDS and ERBE-Like Products: Preliminary Results

trument Group has completed preliminary reprocessing runs which correct the drift in the FM-2 Total channel.

Spectral Response Change

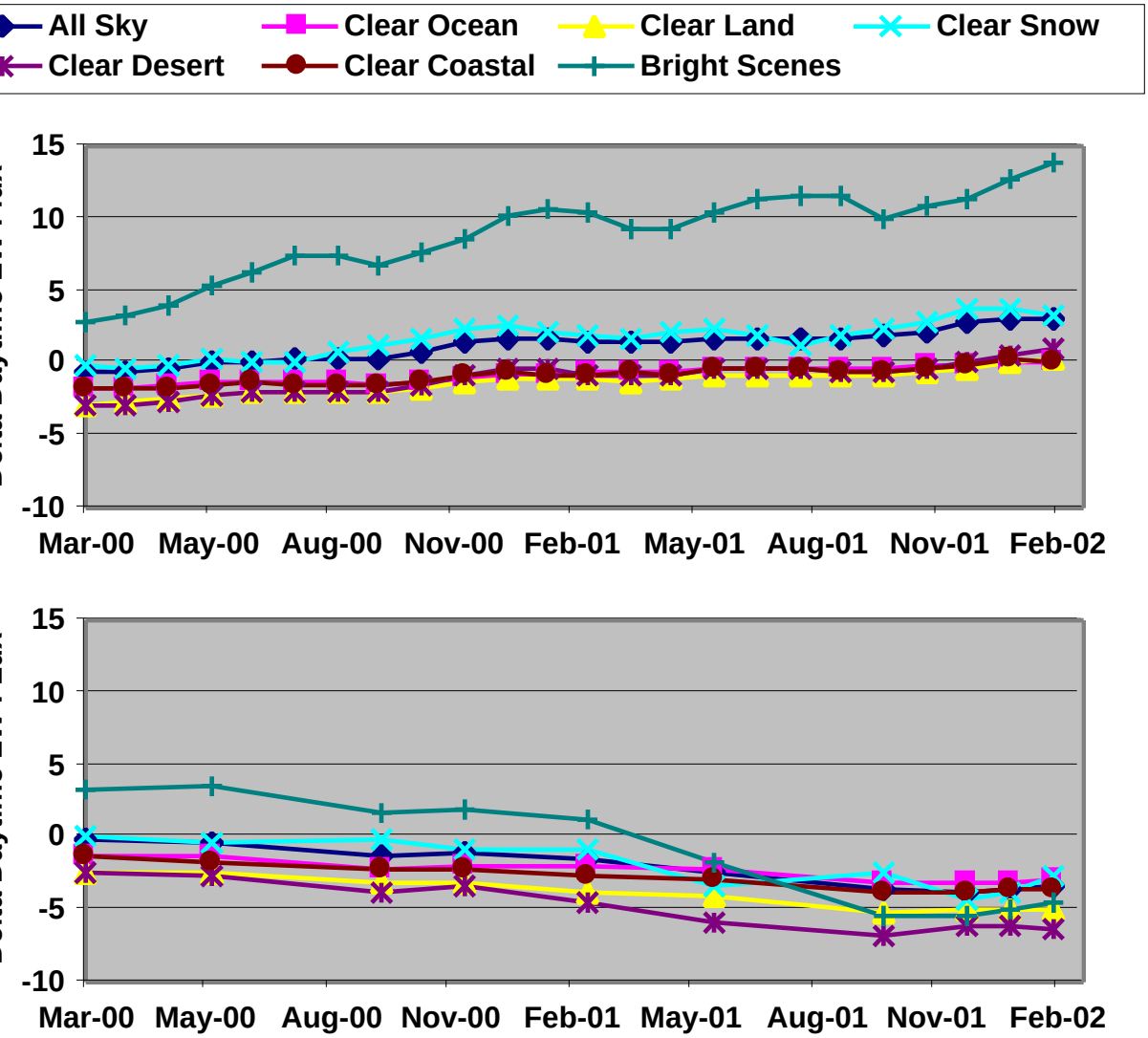
- ✓ **Modeled as a linear 2.0% increase in the spectral throughput of th SW portion of the FM-2 Total channel (I.e. 0.2 - 3.0 microns) over t first 25 months of data collected.**



Co-located Nadir Flux Comparisons

(FM2 minus FM1)

LW Daytime Flux



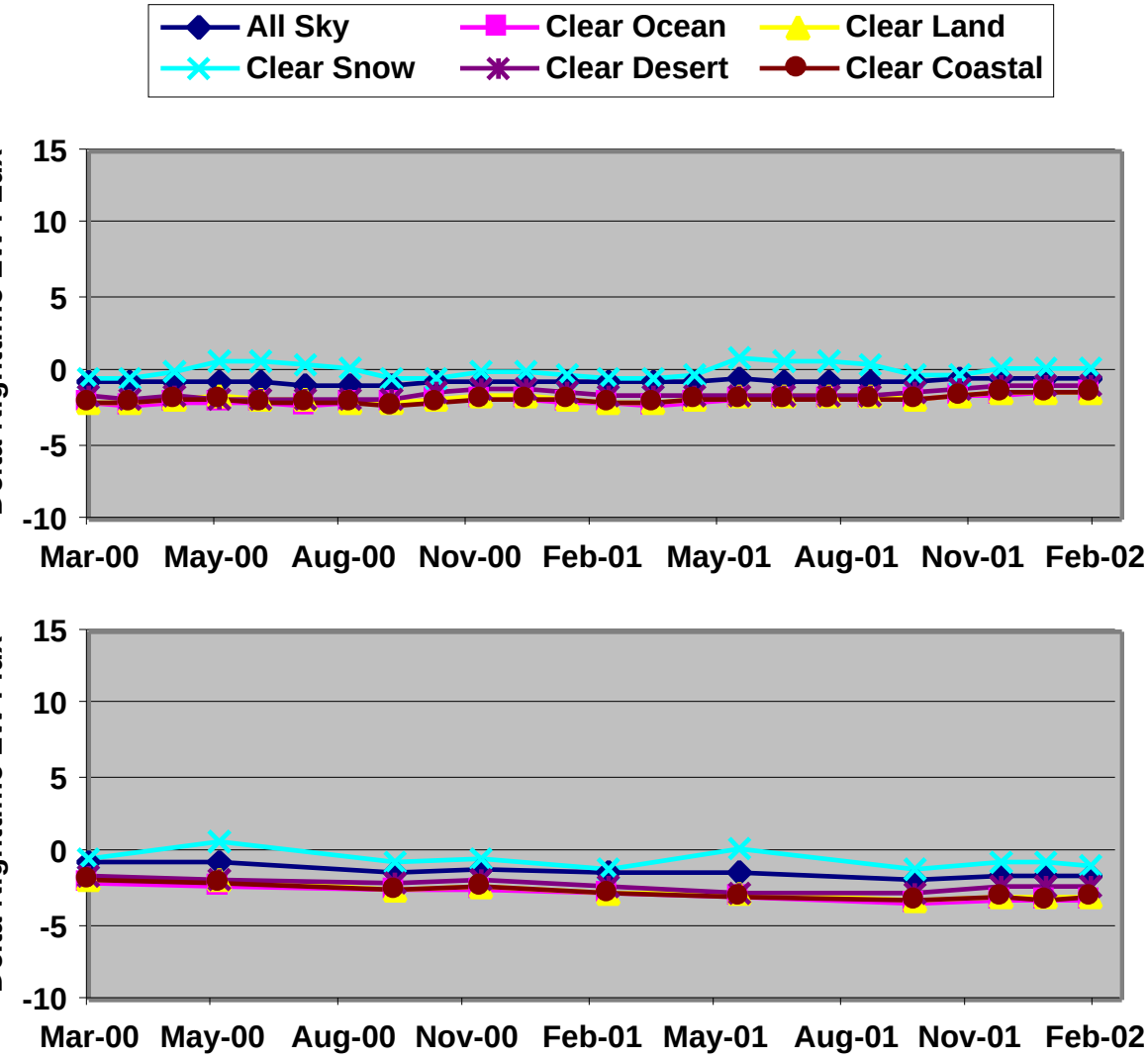
Edition 1

Prelim. Editio

Co-located Nadir Flux Comparisons

(FM2 minus FM1)

LW Nighttime Flux



Edition 1

Prelim. Editio

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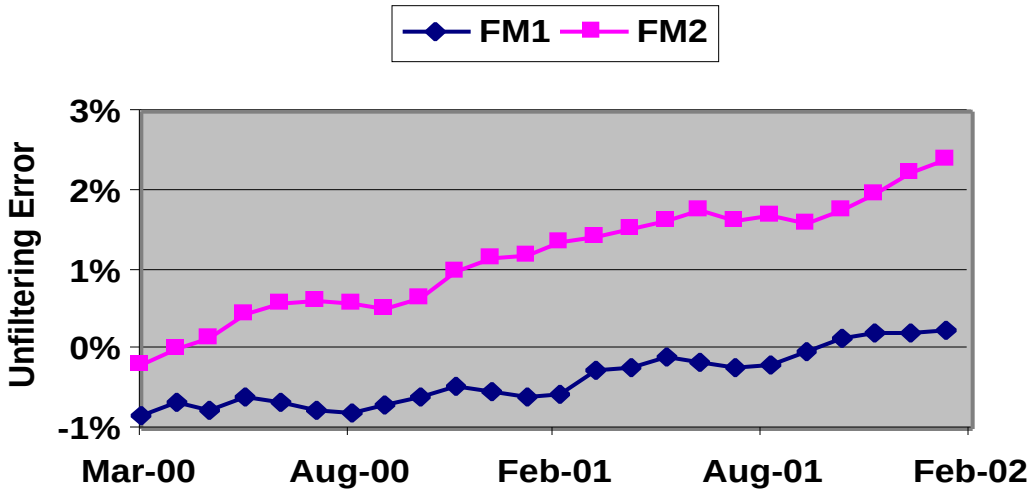
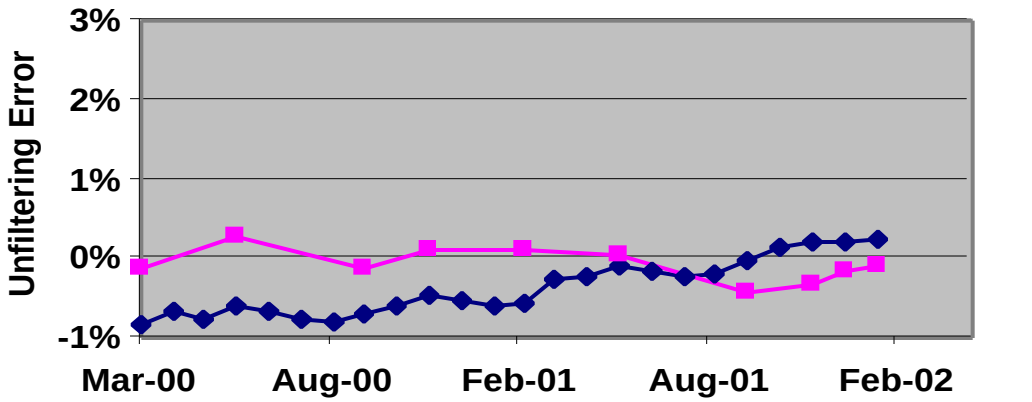
Using Deep Convective Clouds



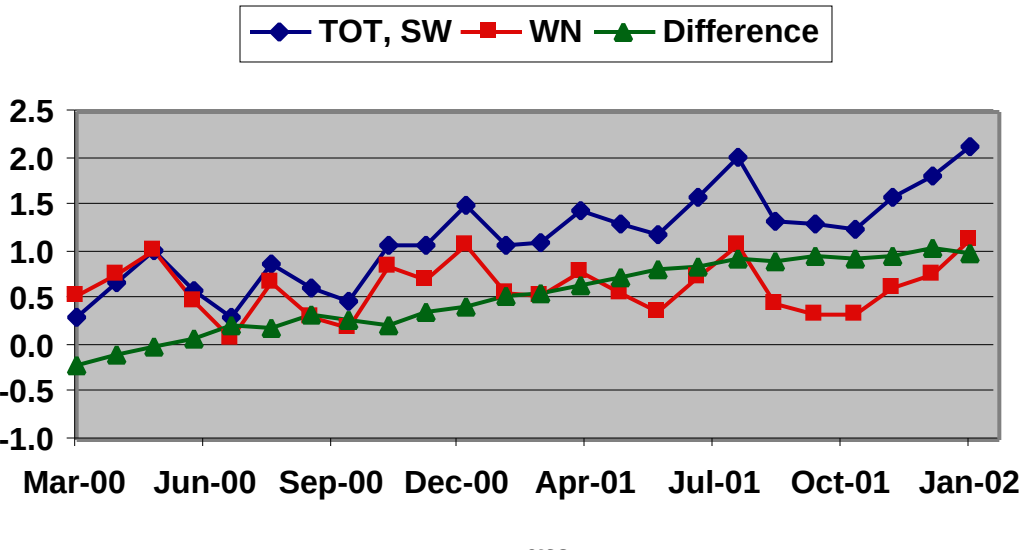
Edition 1



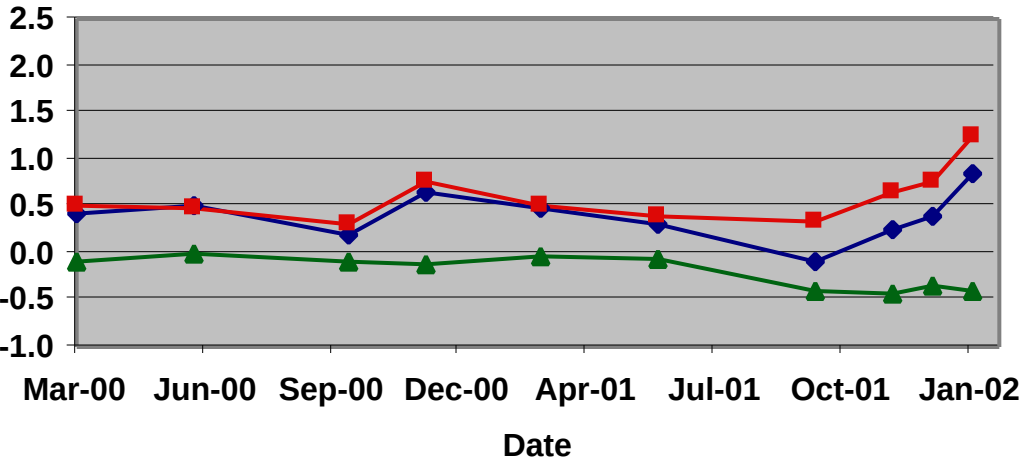
Prelim. Edition 2

Tropical Mean Self Consistency

Tropical Ocean, All Sky



Edition 1



Edition 2

Instrument Cal/Val Summary

Aqua:

No significant anomalies from spacecraft or instruments

CERES will open contamination covers on ~June 9, and thus begin operational data collectio

Deep Space Pitch-over maneuver scheduled for mid-July

Terra:

Deep Space Pitch-over maneuver not yet executed

Edition 2 BDS and ERBE-like products will be publicly available by the end of June.

Edition 2 will:

- Account for pre to post launch gain changes as measured by the Internal Calibra Modules.
- Reduce by a factor of 2 to 10 uncertainties in the TOA fluxes due to time varying radiometric gain or spectral response function changes.
  - For example, errors in FM-2 daytime LW for Deep Convective clouds will be reduced from ~12 W/m^2 to ~1 W/m^2

Edition 2 will not:

- Correct noise due to beta angle dependence
- Incorporate scan dependent offset measurements from Deep Space Pitch-over