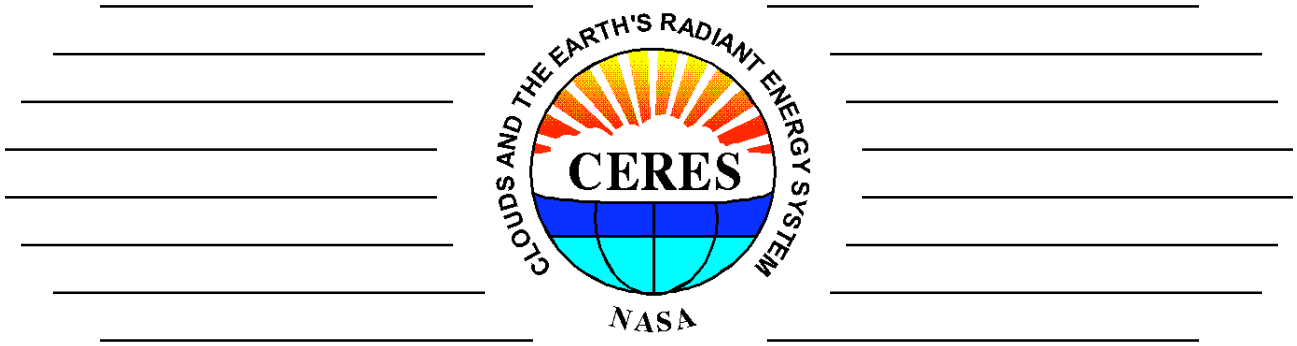
Terra/Aqua Instrument and ERBE-Like Calibration Status Report



Kory J. Priestley
Robert Lee, Susan Thomas, Grant Matthews
Robert Wilson, Pete Spence, Ed Kizer, Peter Szewczyk
Phil Hess, Denise Cooper, Dale Walikainen,

CERES Science Team Meeting
Williamsburg, VA
Novenber 2-4, 2004

NASA Langley Research Center
Atmospheric SCIENCES

Agenda

- **Project Status**
  - **Operational Status**
  - **Engineering Status**
- **Cal/Val Report**
  - **Terra on-orbit performance**
  - **Aqua on-orbit performance**

CERES Terra/Aqua Health & Status

To date, the CERES Terra/Aqua instruments are functioning nominally…

All temperatures and voltages remain within limits

No discernable or alarming trends.

Spacecraft	Instruments	Launch	Science Initiation	Collected Data (Months)
TRMM	PFM	11/97	1/98	9
Terra	FM1, FM2	12/99	3/00	56 +
Aqua	FM3, FM4	5/02	6/02	29 +
?	FM5	?	?	?

Aqua pitchover maneuver tentatively scheduled for Fall 2004.

CERES Terra/Aqua Diagnostic Operations

9 Special Diagnostic Operations to date in 2004…

Date	Instruments	Requestor	Purpose
2/1	FM1,FM2,FM3,FM4	CERES IWG	Quarterly Diagnostic
5/1	FM1,FM2,FM3,FM4	CERES IWG	Quarterly Diagnostic
8/1	FM1,FM2,FM3,FM4	CERES IWG	Quarterly Diagnostic
8/27	FM2	Grant Matthews	2nd TC Patches
9/30	FM2	CERES IWG	FM2 Quick Look Patch
9/30	FM4	CERES IWG	FM4 WN Bridge Balance Patch
10/5	FM3	CERES IWG	Time Stamp Memory Patch
10/15	FM4	CERES IWG	Time Stamp Memory Patch
11/1	FM1,FM2,FM3,FM4	CERES IWG	Quarterly Diagnostic
TBD	FM4	CERES IWG	Independent Bridge Balance

CERES Terra/Aqua Diagnostic Operations

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10/5	FM3	CERES IWG	Time Stamp Memory Patch
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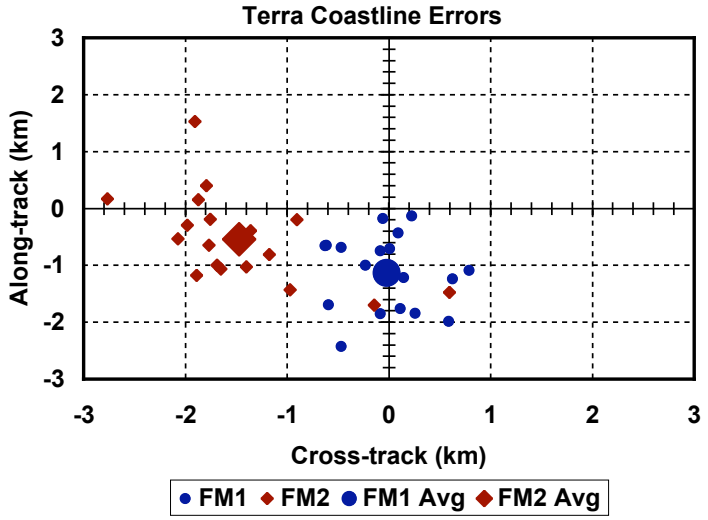
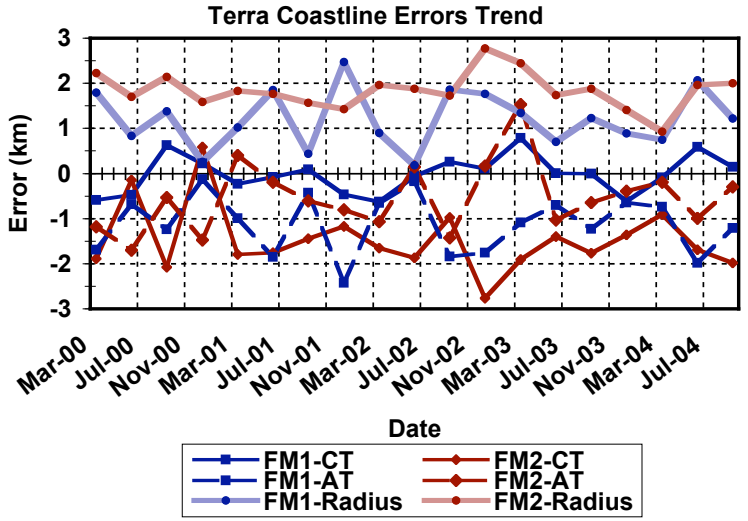
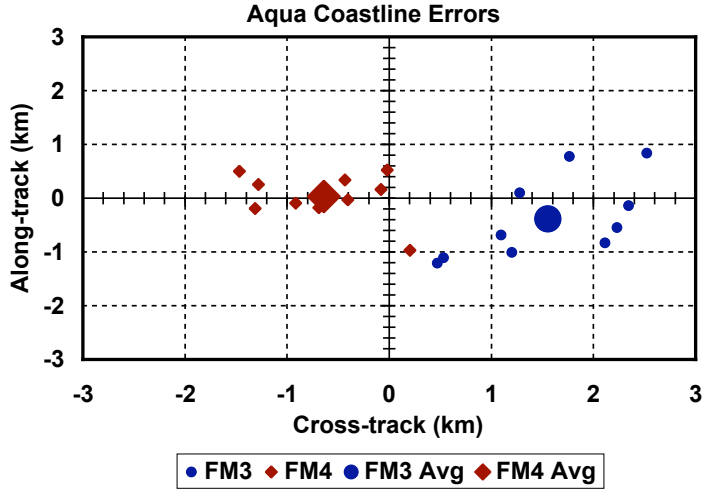
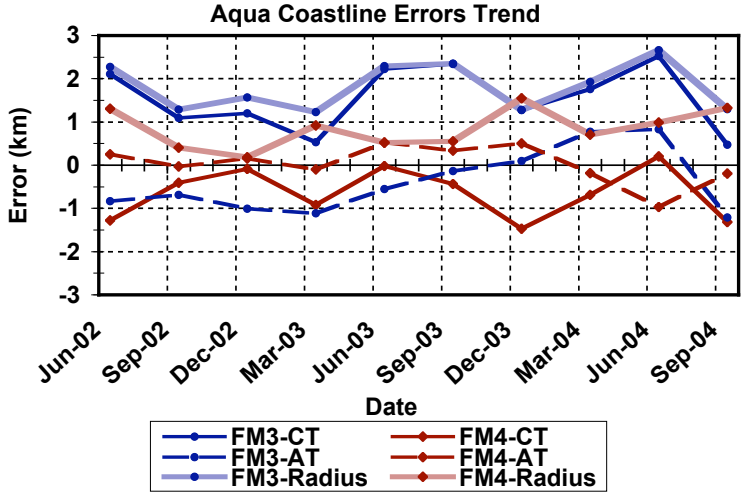
Pointing Knowledge - Coastline Detection

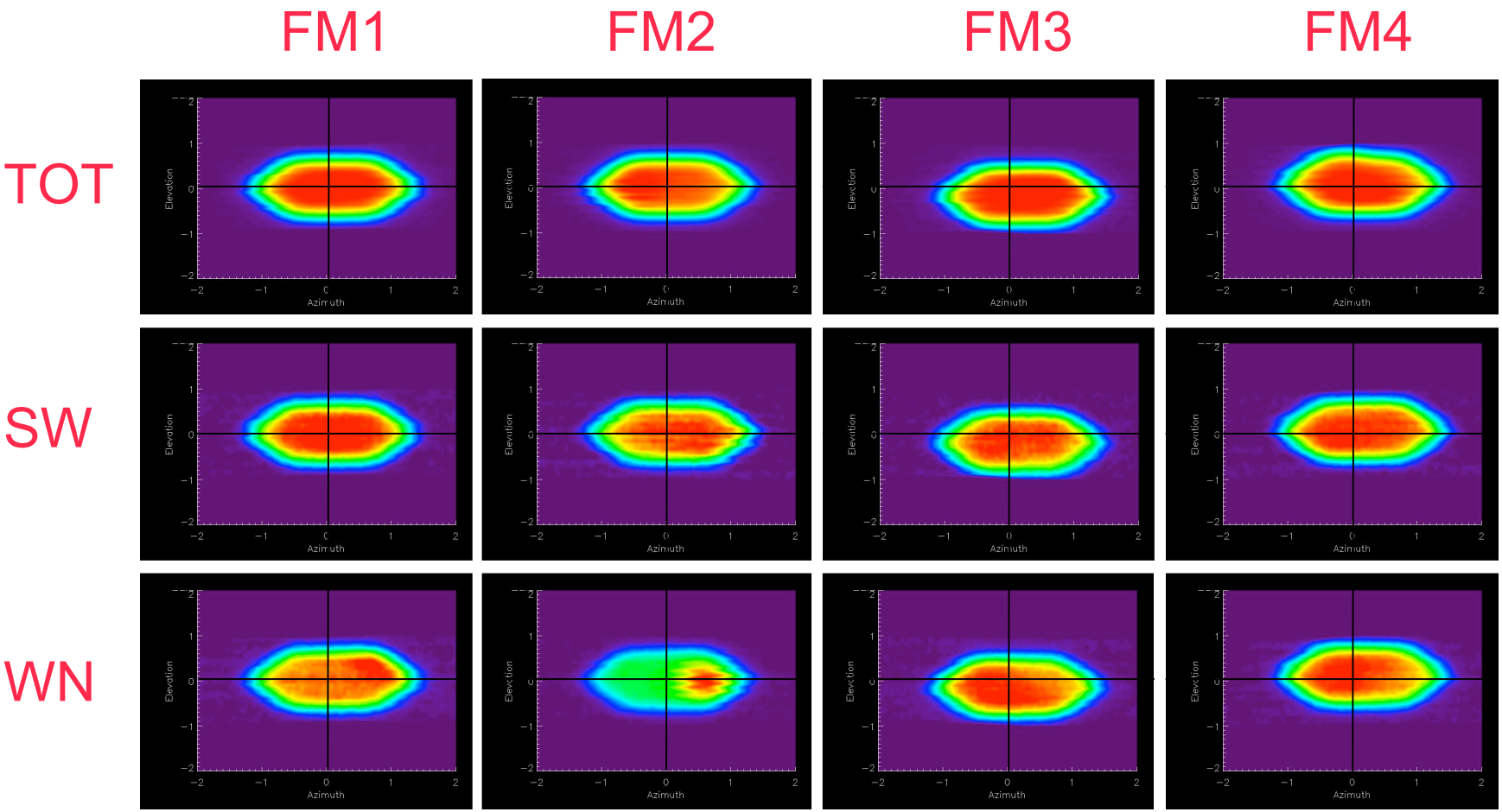








Lunar Scan Results - CERES Optical Transfer Function



Note: Each Plot is on a 4-deg x 4-deg grid

CERES Terra/Aqua Science Operations

14 special Science Operations to date in 2004…

Date	Instruments	Requestor	Purpose
1/1 - 1/5	FM2	GIST	CERES-GERB Intercompare
1/29 - 2/19	FM2	Norman Loeb	Solar Principle Plane
2/5 - 2/7	FM1,FM2,FM3,FM4	Bob Lee	Lunar Scan
2/9 - 2/12	FM2, FM3	Ernesto Lopez	Valencia Anchor Station
4/4 - 4/6	FM1,FM2,FM3,FM4	Bob Lee	Lunar Phase Scan
5/4 - 5/5	FM1,FM2,FM3,FM4	Bob Lee	Lunar Eclipse Scan
6/5 - 6/6	FM2,FM3	CERES IWG	Greenland Intercomparison
6/7 - 7/7	FM1,FM4	CERES IWG	Greenland Intercomaprison
6/10 - 7/6	FM2	GIST	CERES-GERB Intercompare
7/19 - 8/1	FM2	Norman Loeb	Desert ADM Scans
8/19	FM2	Michel Viollier	True Along-Track Scan
8/26 - 9/6	FM2,FM3	Jim Haywood	Aeronet Ocean Tower Scans
9/27 -29	FM1,FM2,FM3,FM4	Bob Lee	Lunar Phase Scans
10/27 - 10/28	FM1,FM2,FM3,FM4	Bob Lee	Lunar Eclipse Scans
TBD	FM2	Michel Viollier	True Along-Track Scans
TBD	FM2	GIST	CERES-GERB Intercompare

CERES Terra/Aqua Science Operations

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TBD	FM2	GIST	CERES-GERB Intercompare

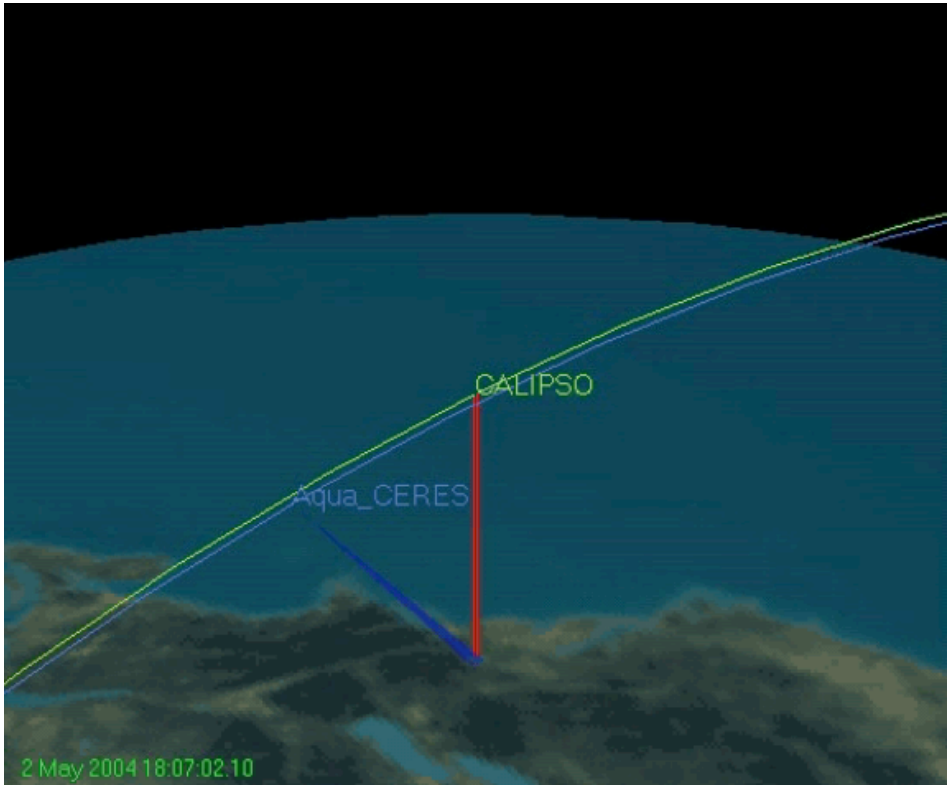
Operational Coverage Request

http://asd-www.larc.nasa.gov/Instrument/operations.html

CERES - CALIPSO Matched Operations

Calipso is scheduled to launch in July, 2005….

Desire exists to co-locate Calipso lidar and CERES measurements…



BDS and ERBE-Like Production Strategy

Edition1 - Static Algorithms and coefficients - baseline product used in cal/val protocol

Edition2 - Utilizes temporally varying coefficients to correct for traceable radiometric drift

Edition2 products lag Edition1 by a minimum of 4 months

Drifts 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.**

  Corrections delivered for the first 45 and 25 months of Terra and Aqua data.

CERES BDS and ERBE-Like Product Status

Spacecraft	Product	Version	Available	Months Processed
TRMM	BDS	Edition1	Yes	1/98 - 8/98 , 3/00
	ERBE-Like	Edition1	Yes	1/98 - 8/98 , 3/00
		Edition2	Yes	1/98 - 8/98 , 3/00
Terra	BDS	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 12/03
	ERBE-like	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 - 12/03
Aqua	BDS	Edition1	Yes	6/02 - present
		Edition2	Yes	6/02 - 7/04
	ERBE-like	Edition1	Yes	6/02 - present
		Edition2	Yes	6/02 - 7/04

CERES BDS Radiometric Inputs

		Radiometric Gain Values		Radiometric Gain Temporal Variation		WN Channel
Spacecraft	Version	Ground	In-Flight	Static	Varying	SW Correction
TRMM	Ed1	X		X		
	Ed2	-	-	-	-	-
Terra	Ed1	X		X		After 3/04
	Ed2		X		X	After 3/04
Aqua	Ed1		X	X		After 3/04
	Ed2		X		X	X

CERES Science Team strongly urges data users to utilize Edition2 BDS and ERBE-Like products in their studies

All Editions of SSF and higher products utilize BDS Ed2 inputs

CERES ERBE-Like Radiometric Inputs

		Spectral Response Values		Spectral Response Temporal Variation	
Spacecraft	Version	Ground	In-Flight	Static	Varying
TRMM	Ed1	X		X	
	Ed2		X	X	
Terra	Ed1		X	X	
	Ed2		X		X
Aqua	Ed1		X	X	
	Ed2		X		X

CERES Science Team strongly urges data users to utilize Edition2 BDS and ERBE-Like products in their studies

All Editions of SSF and higher products utilize ES-8 Ed2 inputs

CERES Terra/Aqua Cal/Val Status

Terra SW TOA fluxes decrease between March 2000 and December 2003

- **~2% for all-sky, clear ocean and clear desert**
- **~1% for deep convective clouds.**
- **Existing Cal\Val studies suggest instrument is radiometrically stable**

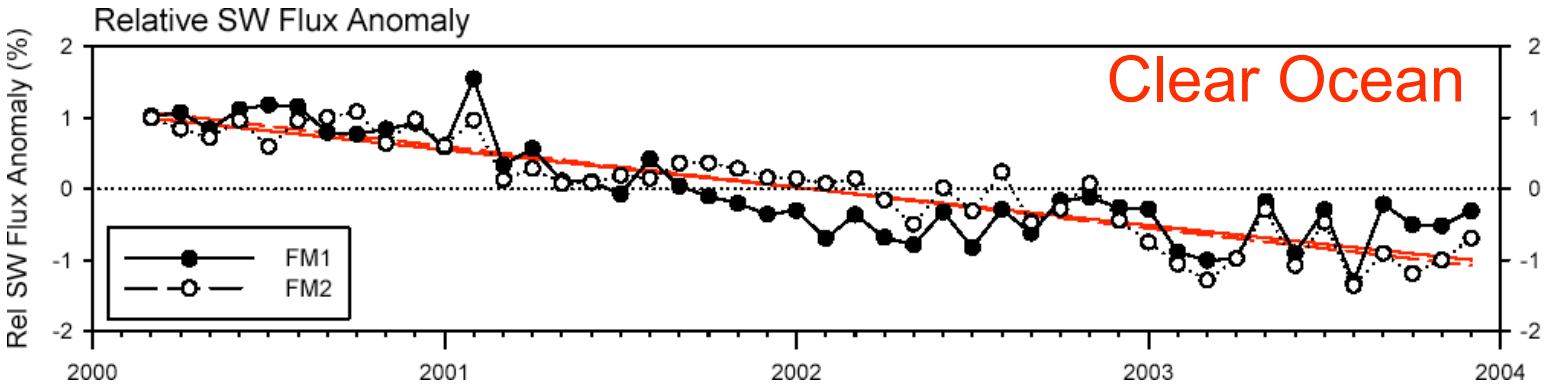
Near Term Work:

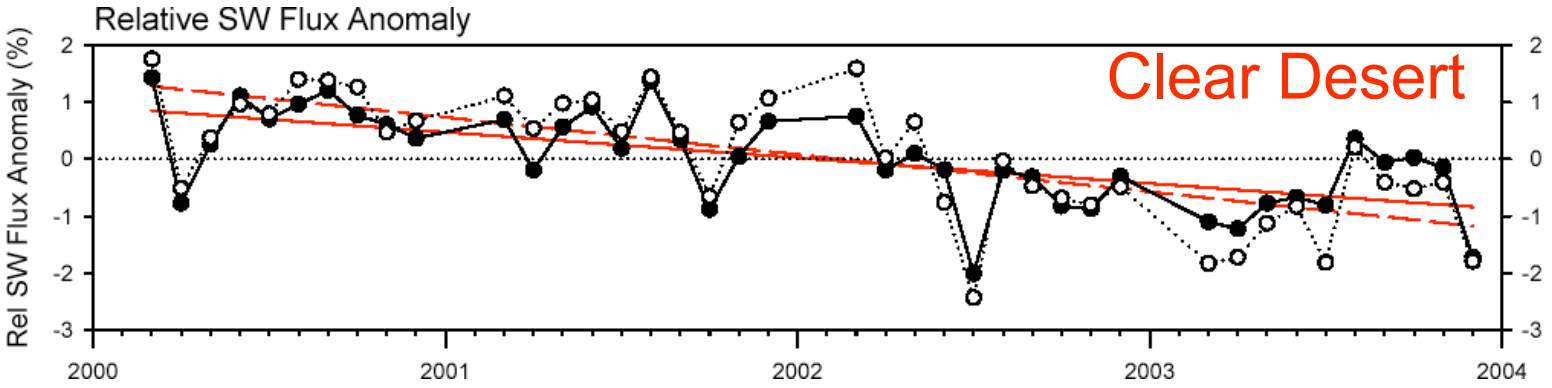
- **SW Calibration - FM4 Ground to Flight Shift (8%)**
- **WN correlation with SW scene brightness**

Long Term Work:

- **MAM Redesign**

CERES SSF SW TOA Flux Anomaly





Executive Summary

- All Diagnostic/Housekeeping data is nominal…
  - Gimbal Friction measurements stable
  - Pointing stable
  - No significant voltage or temperature trends

- Cal/Val Protocol demonstrates radiometric stability of the Ed2 data products of…. (units are in %/yr)

	Terra		Aqua	
	FM1	FM2	FM3	FM4
LWday	.125	.125	<.1	<.1
LWnight	<.1	<.1	<.1	<.1
SW	.2	.2	<.1	<.1
WN	<.1	<.1	.125	.125

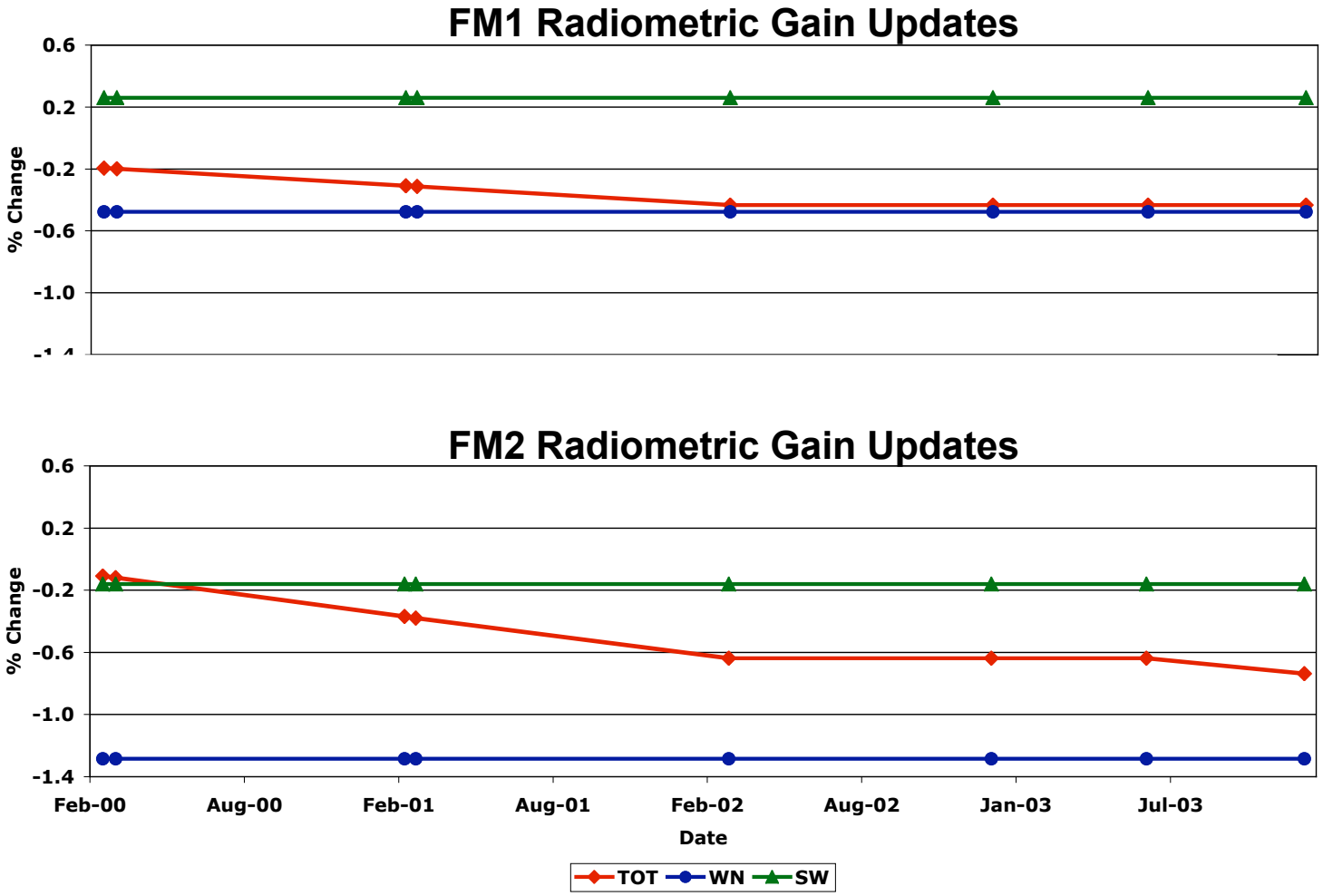
CERES Gain/Spectral Change Summary

		Channel Gain (%)			Channel Spectral Response (%)				TOA Flux (W/m^2)		
Spacecraft		TOT	WN	SW	SW	WN	SW/ TOT	LW/ TOT	SW	LWDay	LWNight
Terra	FM1	.35	-	-	-	-	.45	-	-	1.1	.65
	FM2	.40	-	-	.40	-	2.6	-	.4	3.6	1.0
Aqua	FM3	.45	-	.50	-	-	1.4	-	.5	1.6	1.1
	FM4	.30	-	.70	-	-	1.2	-	.7	1.6	.75

1. All values are maximum on-orbit changes
2. Ground to flight shifts are accounted for separately
3. SW/TOT < 3.0 microns, LW/TOT > 3.0 microns
4. TOA Flux values are all-sky global averages

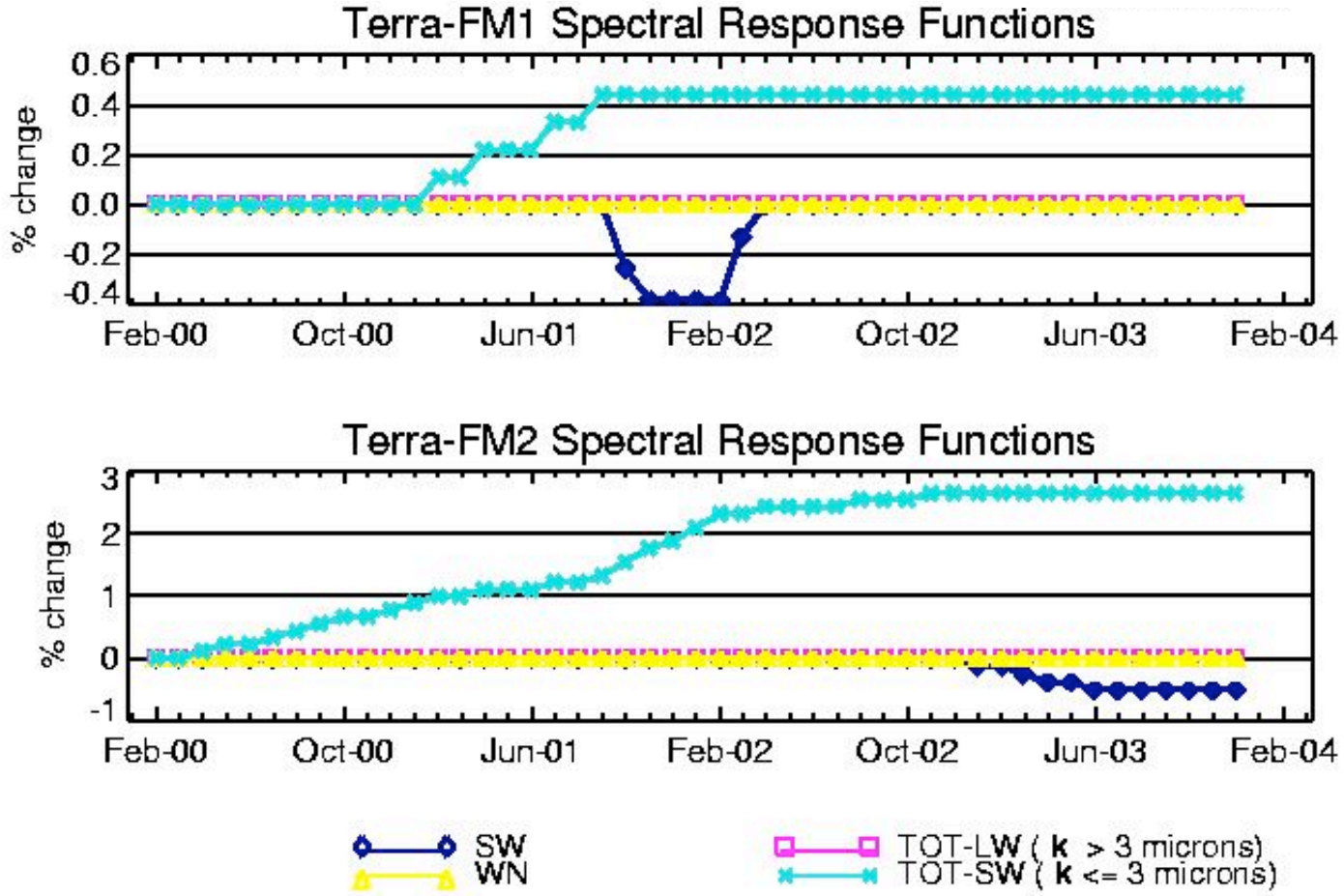
CERES Terra Edition2 Gain Updates

Normalized to Ground Calibration Data



CERES Terra Edition2 Spectral Updates

Normalized to Ground Calibration Data



CERES Aqua Edition2 Gain Updates

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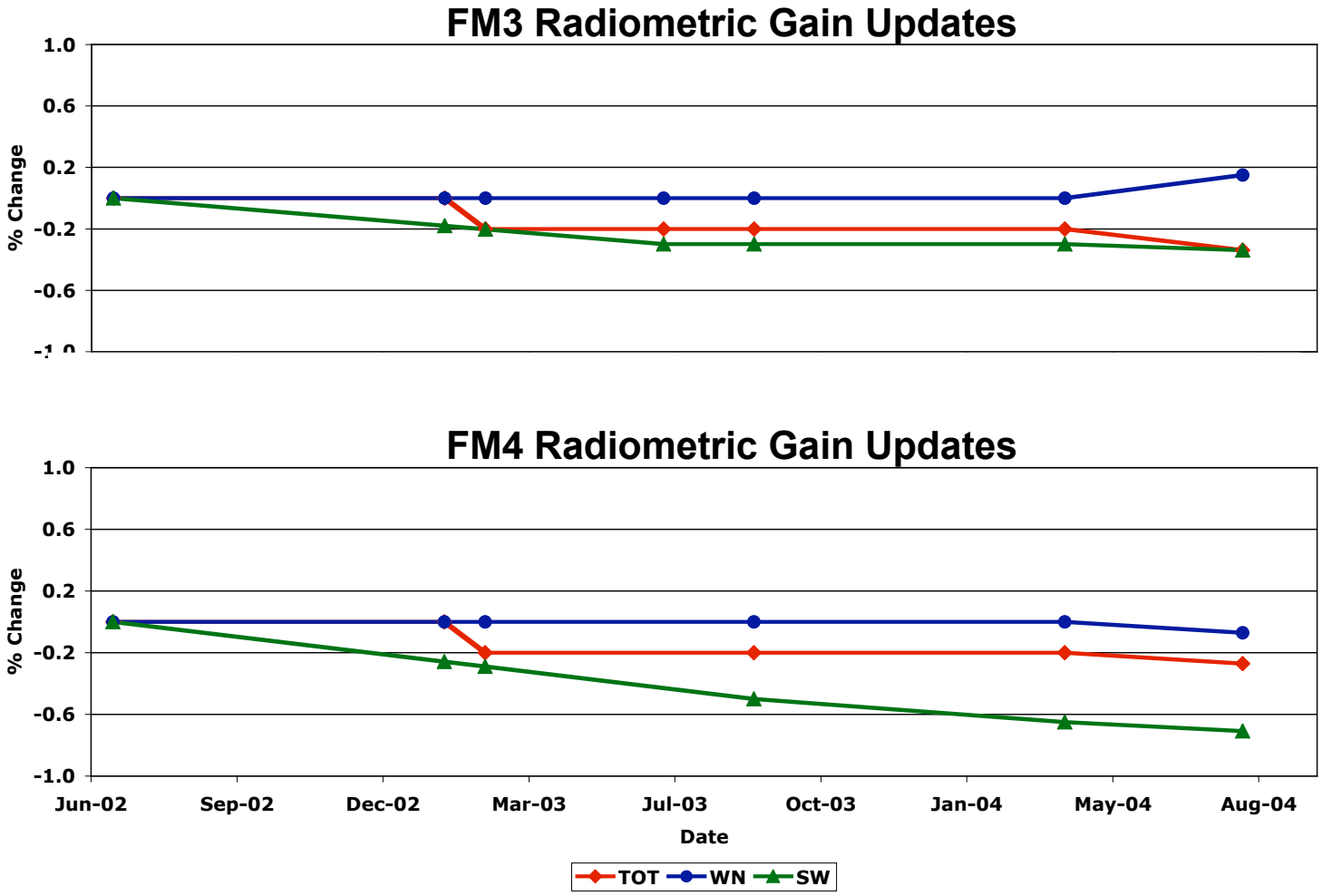
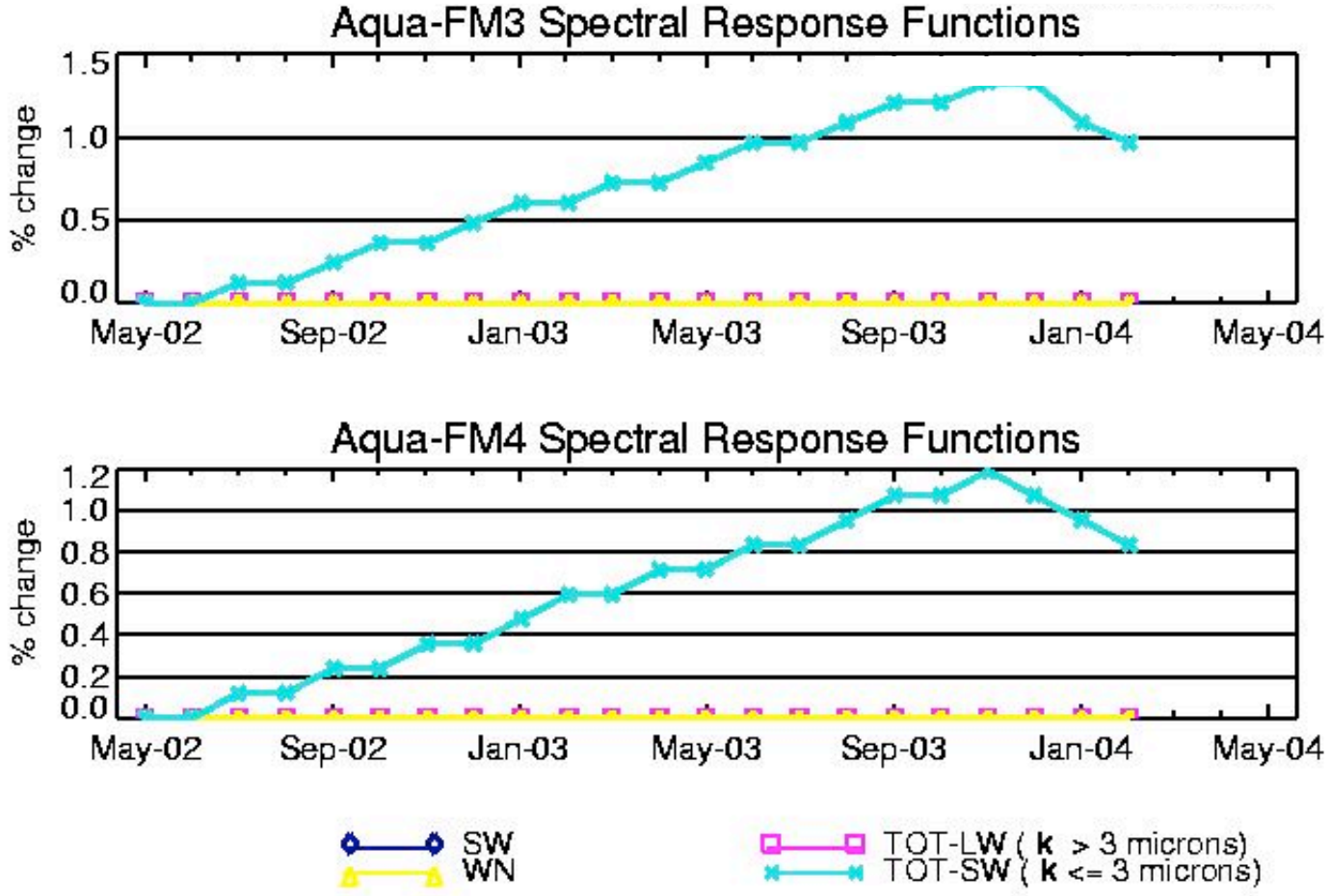


CERES Aqua Edition2 Spectral Updates

Normalized to Ground Calibration Data



CERES Instrument Radiometric Validation Activities

		Product	Spatial Scale	Temporal Scale	Metric	Spectral Band
On-Board	Internal BB	Filtered Radiance	N/A	N/A	Absolute Stability	TOT, WN
	Internal Lamp	Filtered Radiance	N/A	N/A	Absolute Stability	SW
	Solar	Filtered Radiance	N/A	N/A	Relative Stability	TOT, SW
Vicarious	Theoretical Line-by-Line	Filtered Radiance	> 20 Km	Instantaneous	Inter-Channel Theoretical Agreement	TOT, WN
	Unfiltering Algorithm Theoretical Validation	N/A	N/A	N/A	N/A	TOT, SW, WN
	Inter-satellite (Direct Comparison)	Unfiltered Radiance	1-deg Grid	1 per crossing	Inter-Instrument Agreement, Stability	TOT, SW, WN
	Globally Matched Pixels (Direct Comparison)	Unfiltered Radiance	Pixel to Pixel	Daily	Inter-Instrument Agreement	TOT, SW, WN
	Tropical Mean (Geographical Average)	Unfiltered Radiance	20N – 20S	Monthly	Inter-Channel Agreement, Stability	TOT, WN
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

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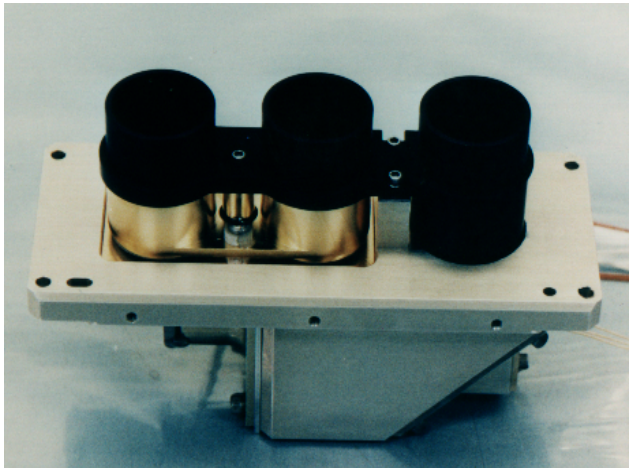
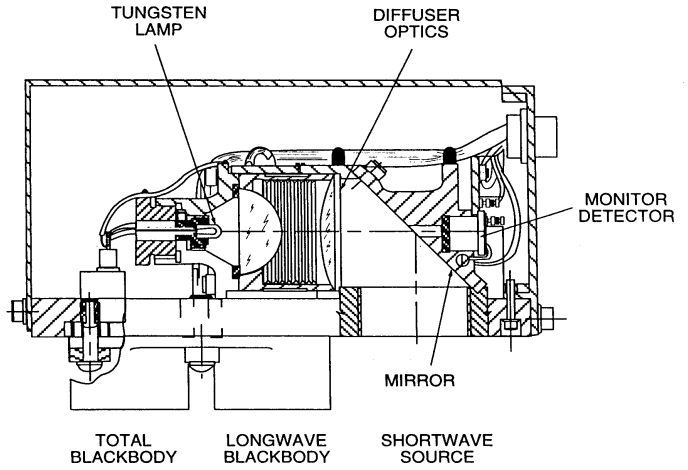
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

CERES Onboard Calibration Sources

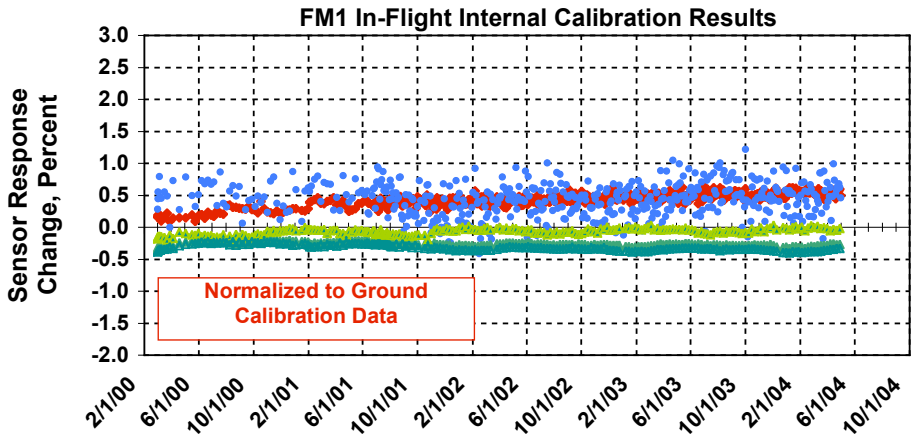
Internal Calibration Module (ICM)

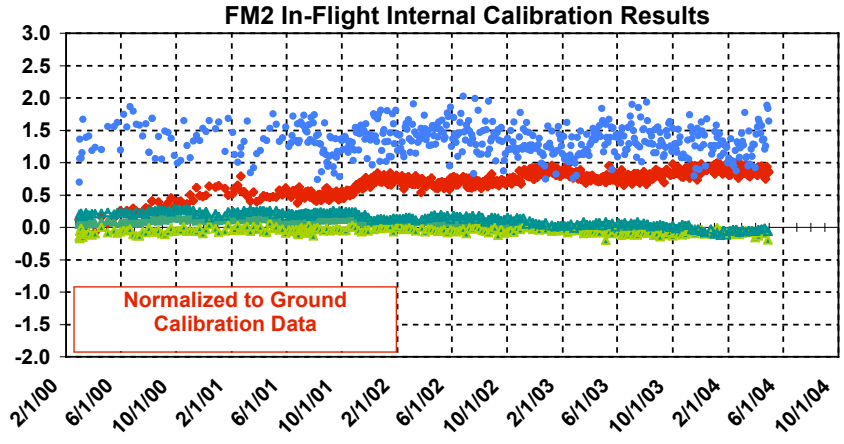
- ICM Provides 3 unique radiance levels for the SW and LW sources
- Blackbodies for the Total and Window channels
- Temperature knowledge obtained via Platinum Resistance Thermometers
- Quartz-halogen tungsten lamp for the Shortwave channel (2100, 1900, 1700 K spectrums)
- SiPd independently monitors lamp output
- Acceptance testing for lamps includes burn-in period of ~80 hours to screen for stability
- Narrow and broadband radiant intensity measurements are performed prior to acceptance
- Design specification is +-0.5% stability over 5-year mission

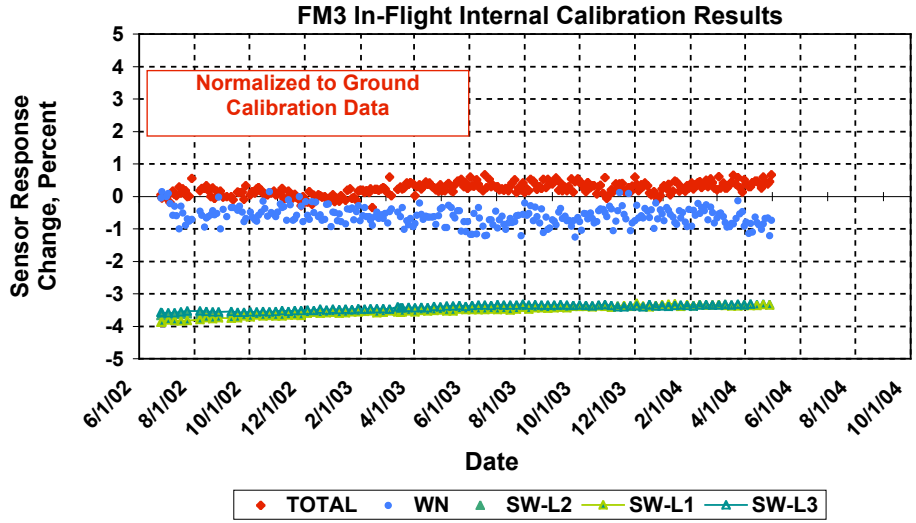


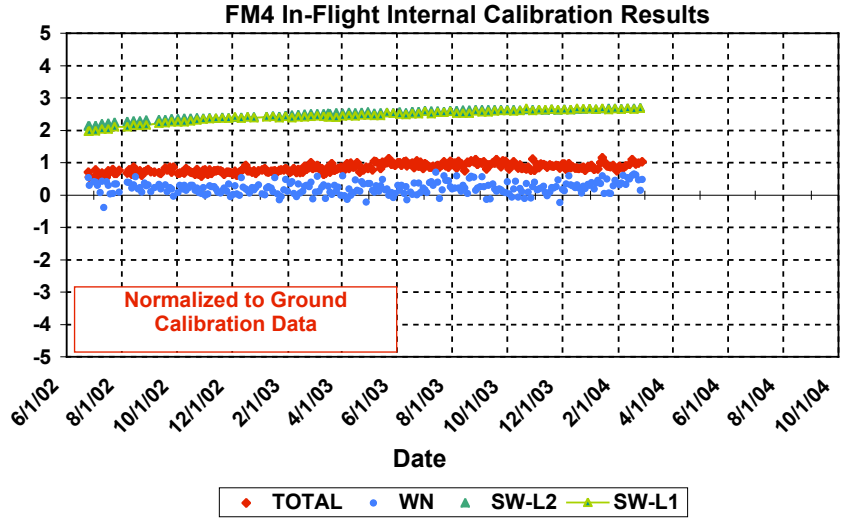


CERES Internal Calibration Results

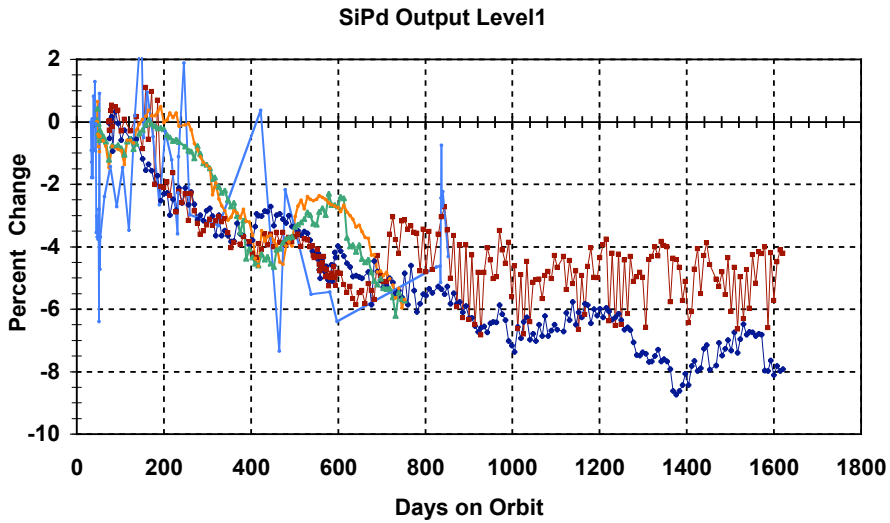


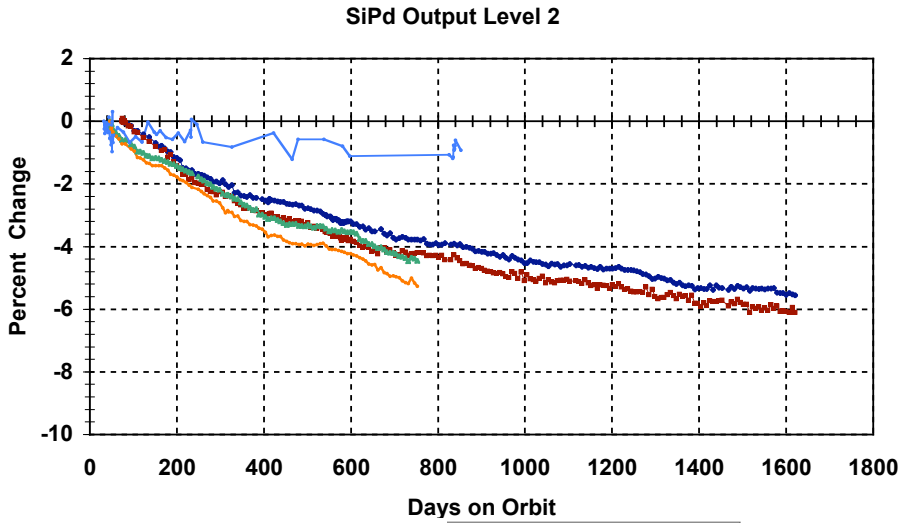


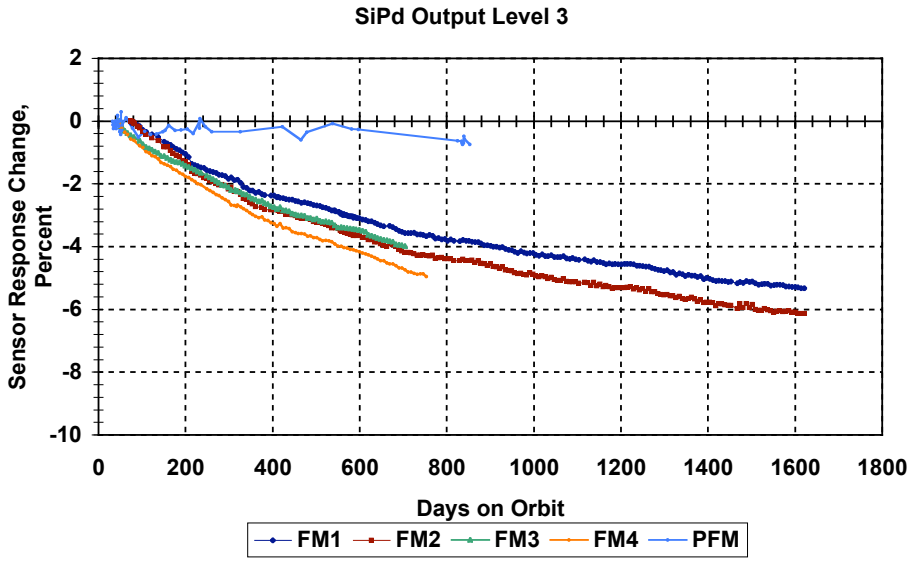




CERES SWICS SiPD Results







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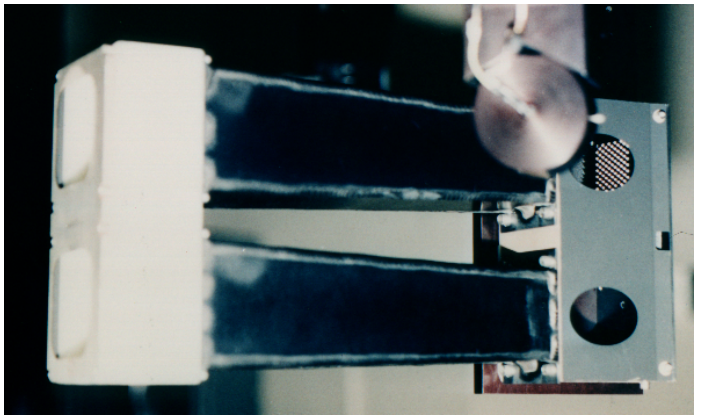
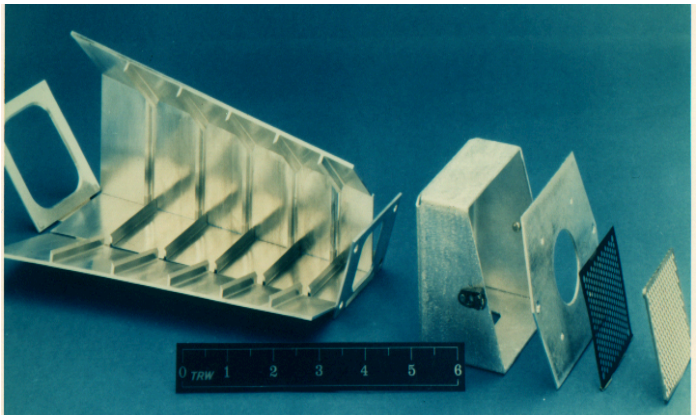
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

CERES Solar Calibration

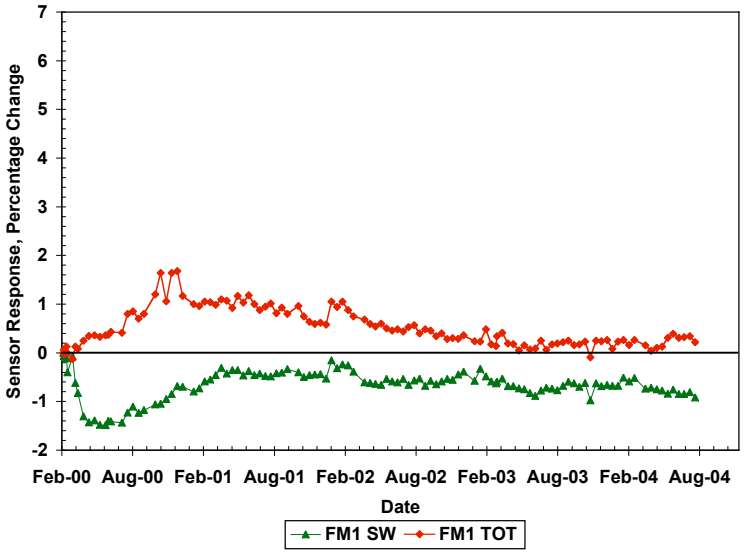
Mirror Attenuator Mosaic (MAM)

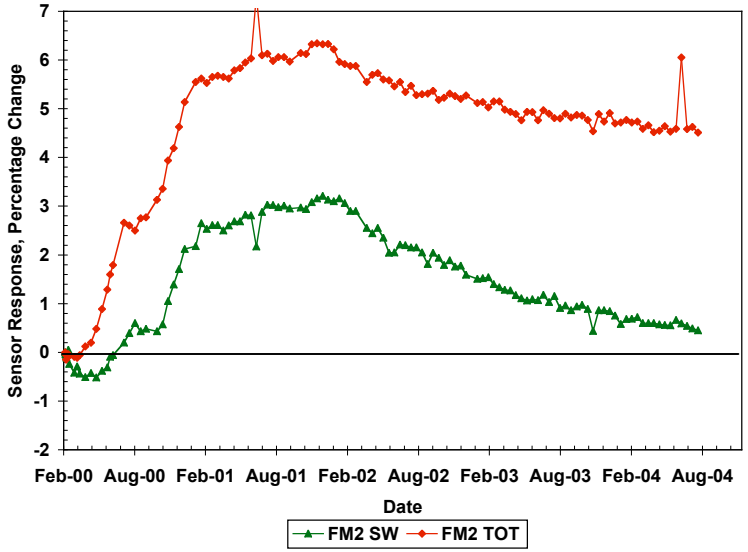
- Solar Diffuser plate attenuates direct solar view
- MAM is a Nickel substrate with Aluminum coated spherical cavities or divots
- Provides a Relative calibration of the Shortwave channel and the SW portion of the Total channel
- Solar Cal results to date are suspect due to large initial drift in MAM surface reflectances…

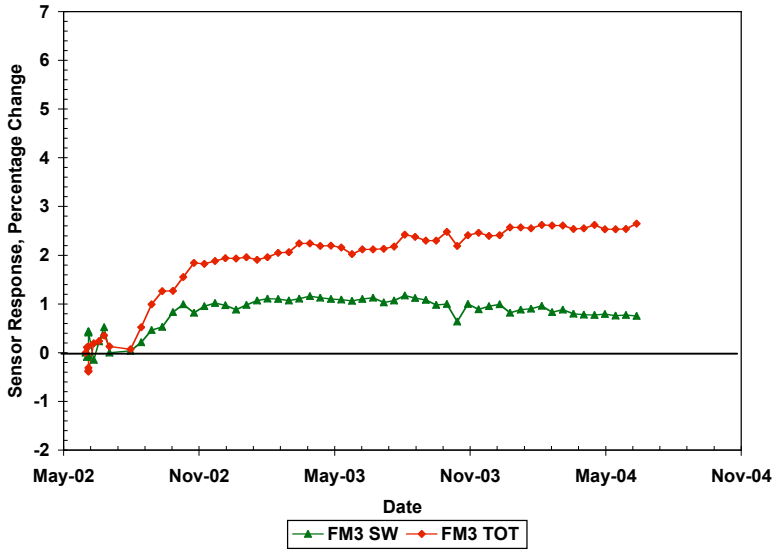


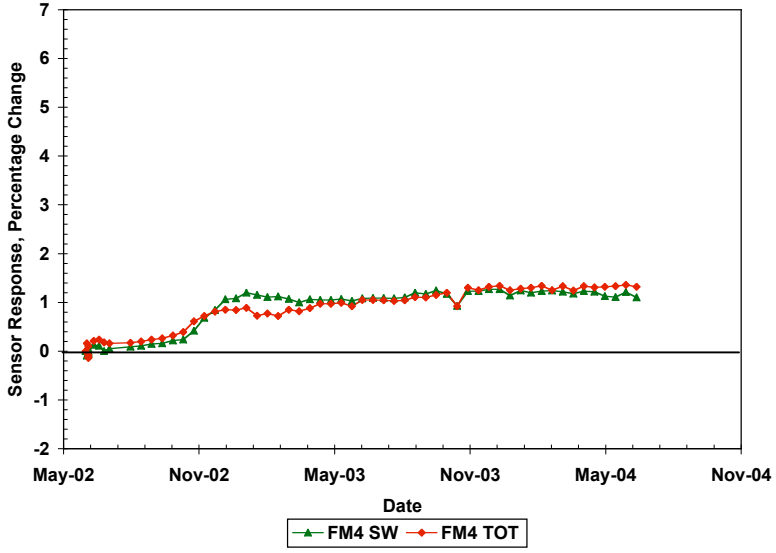


CERES Solar Calibration Results

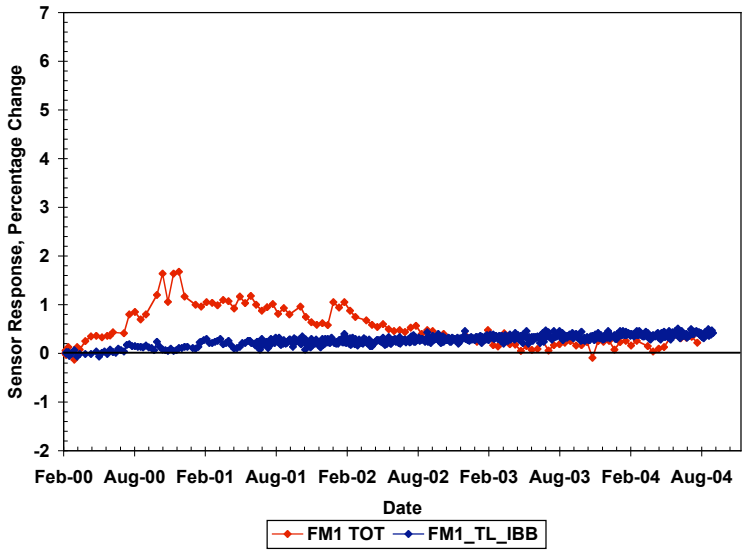


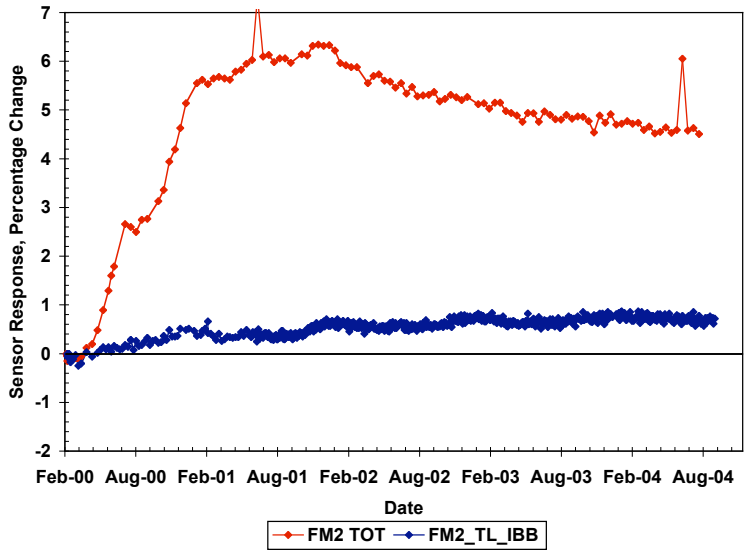


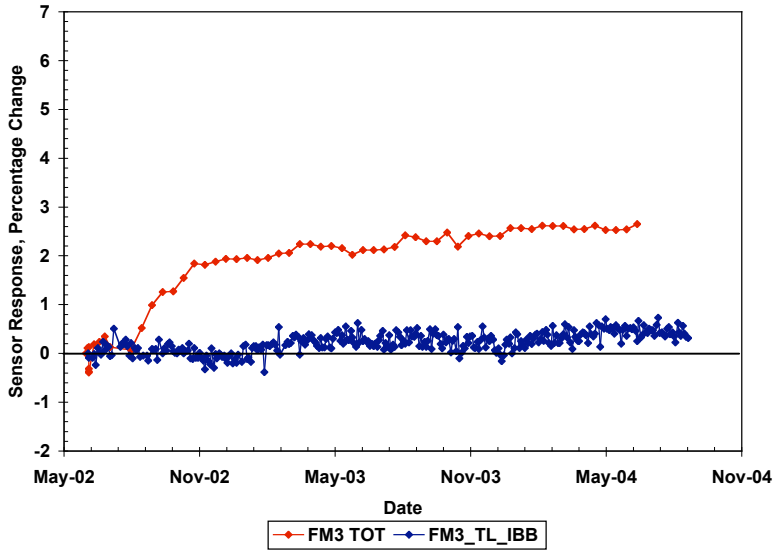


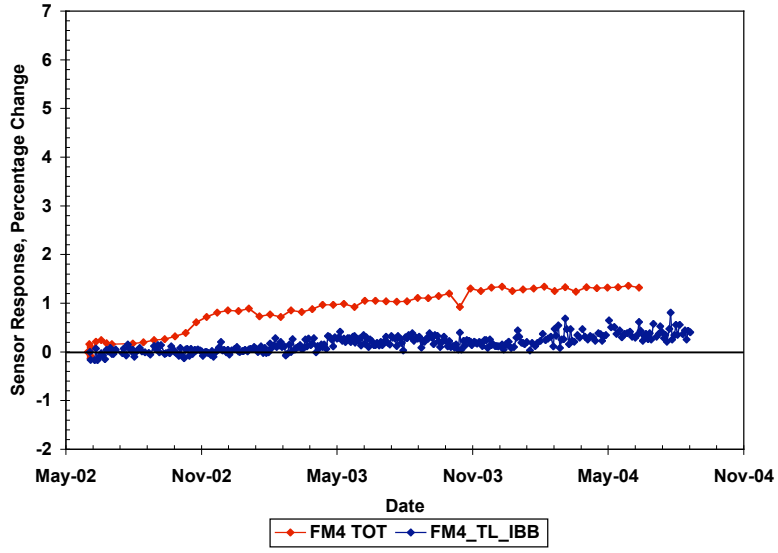


Comparison of Solar and IBB Cal Results

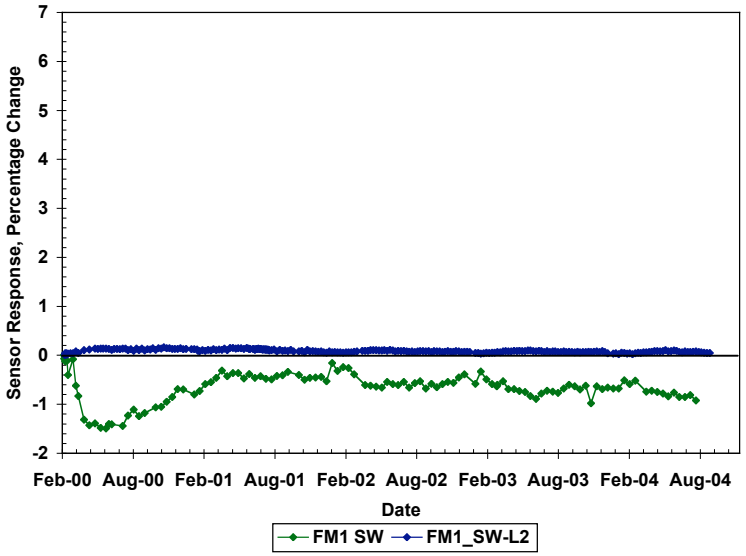


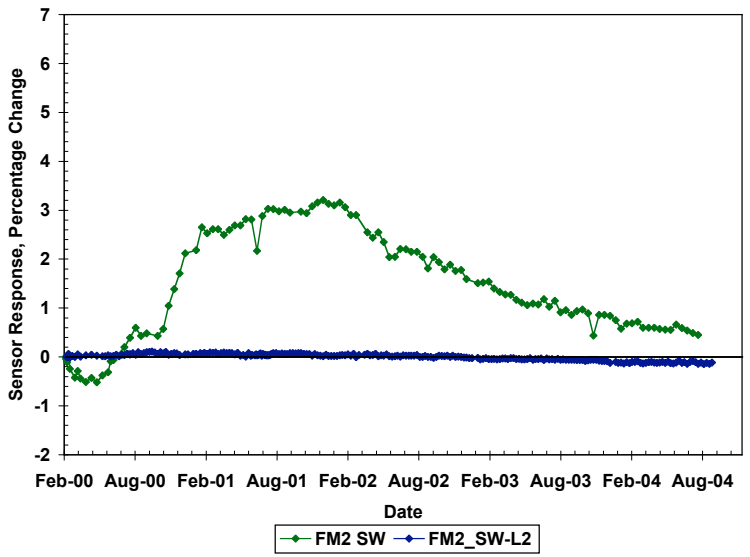


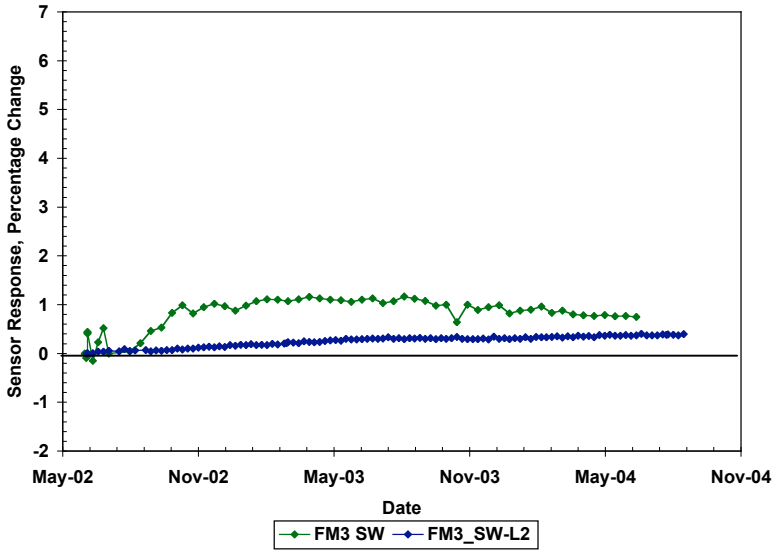


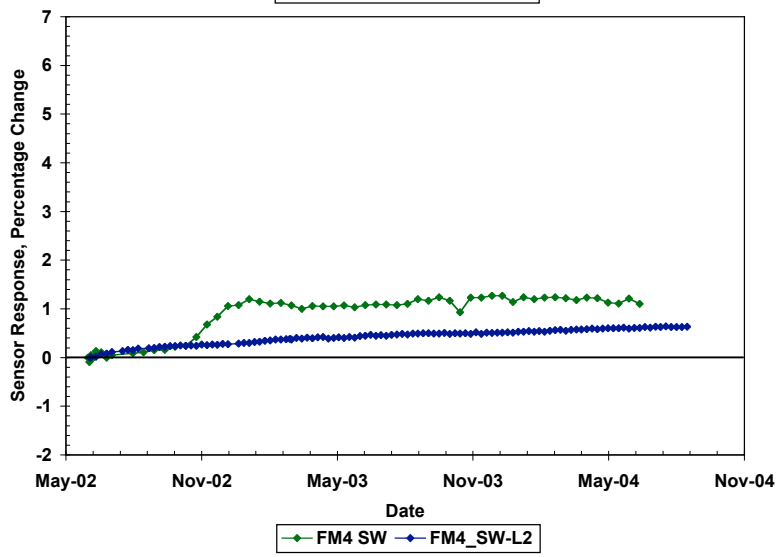


Comparison of Solar and SWICS Cal Results









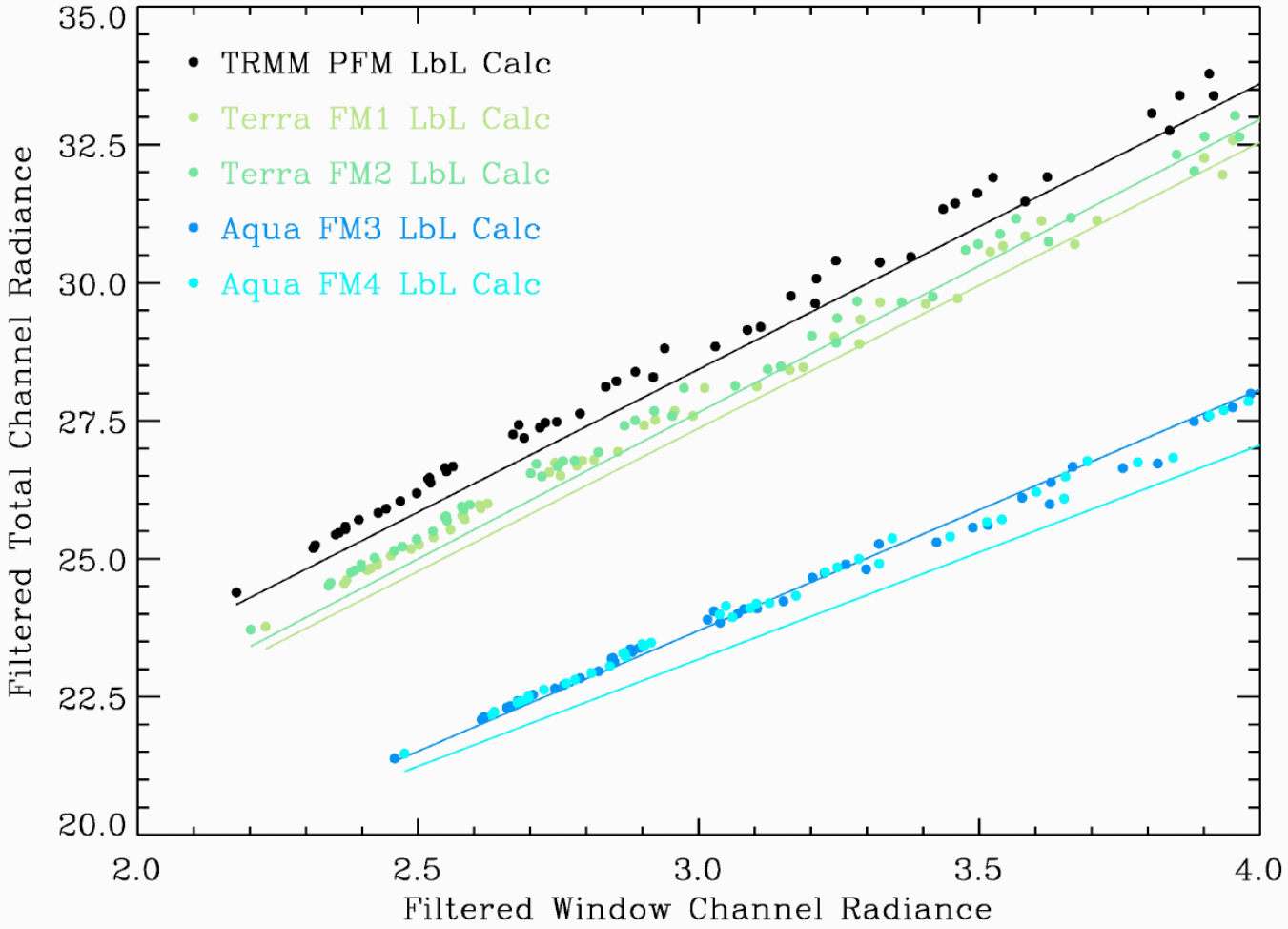
CERES Instrument Radiometric Validation Activities

		Product	Spatial Scale	Temporal Scale	Metric	Spectral Band
On-Board	Internal BB	Filtered Radiance	N/A	N/A	Absolute Stability	TOT, WN
	Internal Lamp	Filtered Radiance	N/A	N/A	Absolute Stability	SW
	Solar	Filtered Radiance	N/A	N/A	Relative Stability	TOT, SW
Vicarious	Theoretical Line-by-Line	Filtered Radiance	> 20 Km	Instantaneous	Inter-Channel Theoretical Agreement	TOT, WN
	Unfiltering Algorithm Theoretical Validation	N/A	N/A	N/A	N/A	TOT, SW, WN
	Inter-satellite (Direct Comparison)	Unfiltered Radiance	1-deg Grid	1 per crossing	Inter-Instrument Agreement, Stability	TOT, SW, WN
	Globally Matched Pixels (Direct Comparison)	Unfiltered Radiance	Pixel to Pixel	Daily	Inter-Instrument Agreement	TOT, SW, WN
	Tropical Mean (Geographical Average)	Unfiltered Radiance	20N – 20S	Monthly	Inter-Channel Agreement, Stability	TOT, WN
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

Line by Line Radiative Transfer Code Comparison

Nighttime Deep Convective Cloud Data

Edition 2



CERES Instrument Radiometric Validation Activities

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On-Board	Internal BB	Filtered Radiance	N/A	N/A	Absolute Stability	TOT, WN
	Internal Lamp	Filtered Radiance	N/A	N/A	Absolute Stability	SW
	Solar	Filtered Radiance	N/A	N/A	Relative Stability	TOT, SW
Vicarious	Theoretical Line-by-Line	Filtered Radiance	> 20 Km	Instantaneous	Inter-Channel Theoretical Agreement	TOT, WN
	Unfiltering Algorithm Theoretical Validation	N/A	N/A	N/A	N/A	TOT, SW, WN
	Inter-satellite (Direct Comparison)	Unfiltered Radiance	1-deg Grid	1 per crossing	Inter-Instrument Agreement, Stability	TOT, SW, WN
	Globally Matched Pixels (Direct Comparison)	Unfiltered Radiance	Pixel to Pixel	Daily	Inter-Instrument Agreement	TOT, SW, WN
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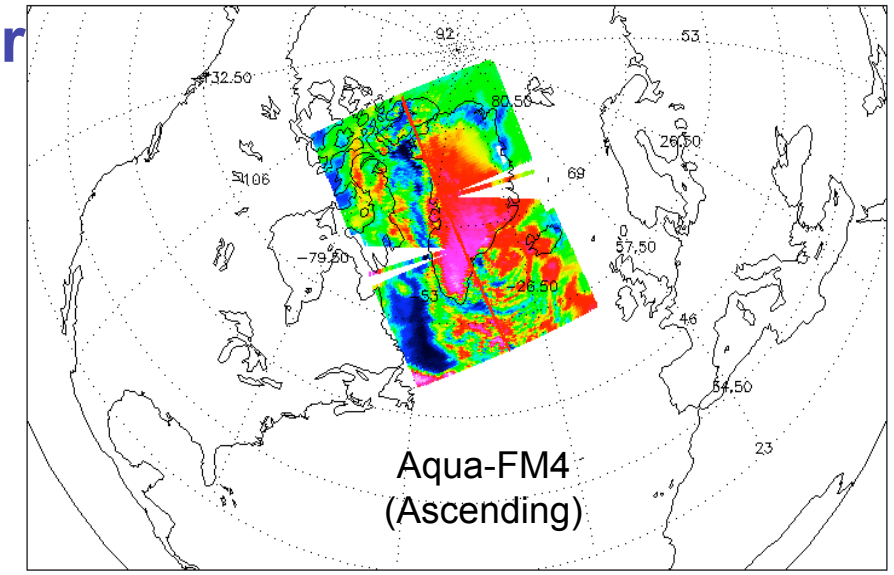
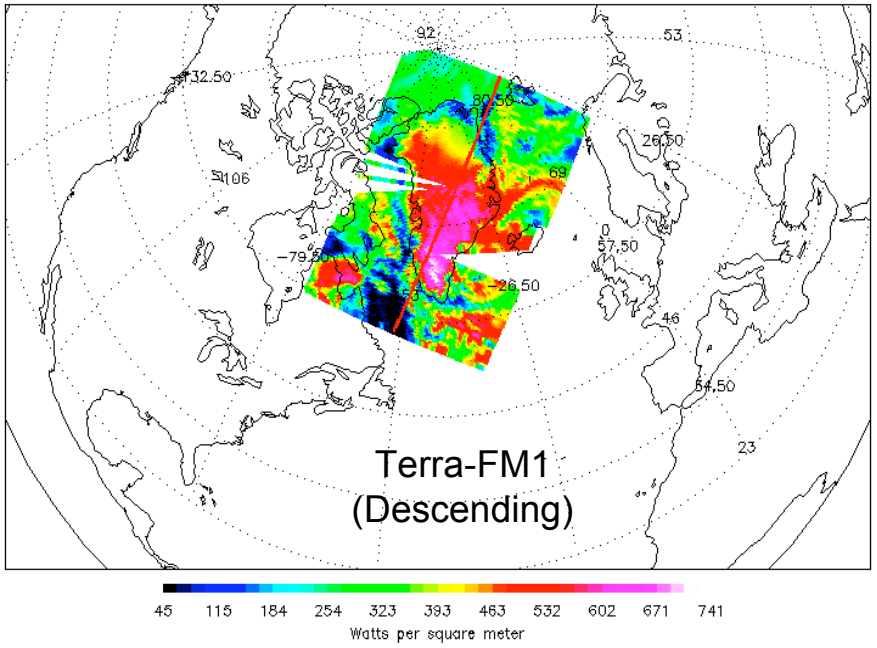
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

Terra/aqua Inter-Calibration Over Greenland





Strategy

- **FM1 and FM4 instruments were utilized**
- **Orbits intersect at 69.5 deg**
- **Temporal matching <15 mins**
- **VZA matched within 10 deg**
- **Scan planes set orthog. to principal plane**
- **Data collected for 5-deg lat. Swath**
- **About 90 sec of data per orbit**

Campaigns

- **07/04-08/22, 2002**
  - **600 orbital crossings**
- **06/13 - 06/29, 2003**
  - **250 orbital crossings**
- **06/07 - 07/07, 2004**
  - **200 orbital crossings**

Terra/Aqua Zonal Inter-Calibration

Direct Comparison of radiances

- **Difference of averages**

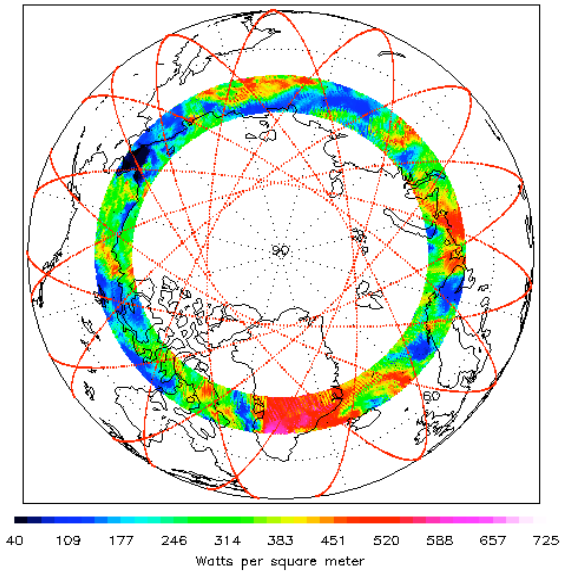
Spatial noise dominates

- **Averaging over 1° x 1° grid-boxes**
- **At least 20 footprints or 75% of area covered**

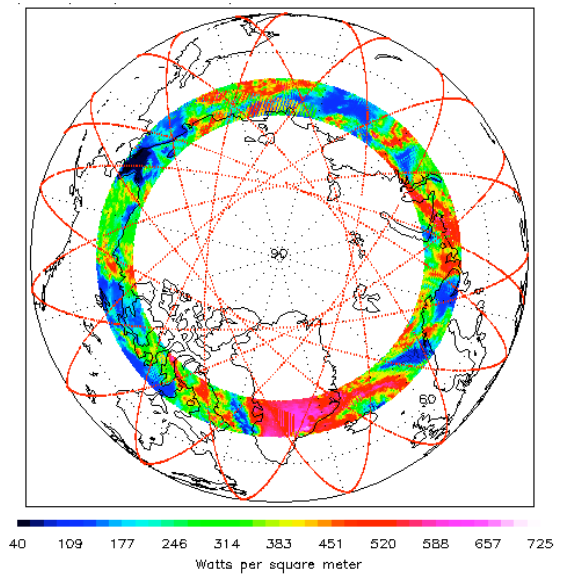
Matching Geometry

- **10° tolerance for viewing zenith angles**
- **20° tolerance for relative azimuth for SW**

Terra-FM1
(Descending)



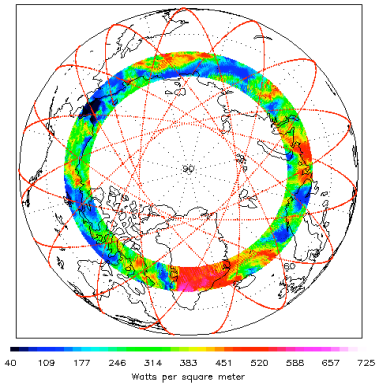
Aqua-FM4
(Ascending)



Terra/Aqua Intercalibration

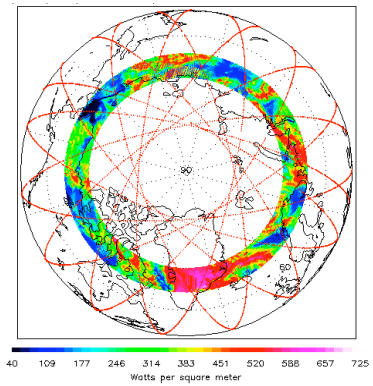
FM1 and FM4 Zonal Comparison

Edition1
2002



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



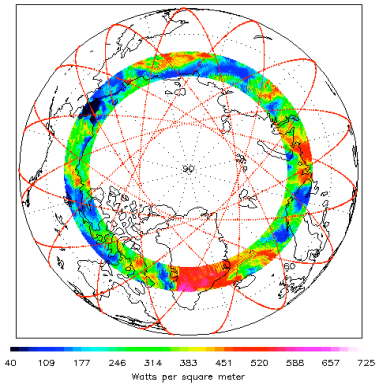
	Mean	Abs Diff	% Diff	$\Delta\sigma$	n	α-test
SW	88.6	-0.36	-0.4	0.74	508	0.08
LW_{day}	76.7	0.54	0.7	0.18	508	0.02
LW_{night}	55.1	0.06	0.1	0.10	527	0.01
WN_{day}	5.5	0.05	0.9	0.03	508	0.00
WN_{night}	3.0	0.03	1.0	0.01	527	0.00

All units in $W/m^2/sr$ **Mean = FM4**
Diff = FM4 - FM1
Data Products: **FM1 - Edition2**
FM4 - Edition1

Terra/Aqua Intercalibration

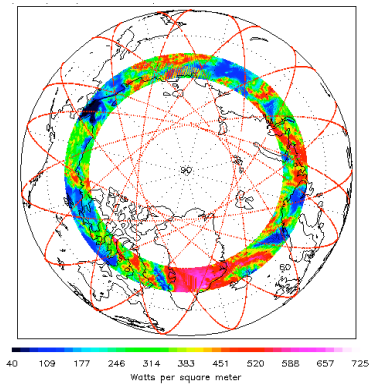
FM1 and FM4 Zonal Comparison

Edition1
2003



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



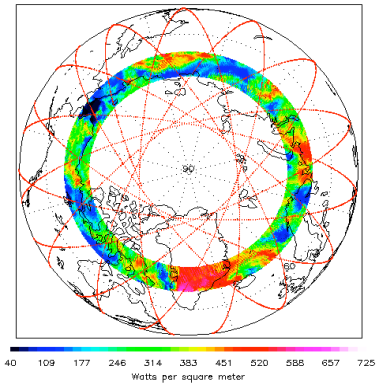
	Mean	Abs Diff	% Diff	$\Delta\sigma$	n	α-test
SW	92.5	-0.56	-0.6	0.69	236	0.1
LW_{day}	78.4	1.48	1.9	0.31	236	0.1
LW_{night}	55.8	0.13	0.2	0.10	242	0.00
WN_{day}	5.6	0.04	0.7	0.03	236	0.01
WN_{night}	3.1	0.03	0.9	0.01	242	0.01

All units in $W/m^2/sr$ **Mean = FM4**
Diff = FM4 - FM1
Data Products: **FM1 - Edition2**
FM4 - Edition1

Terra/Aqua Intercalibration

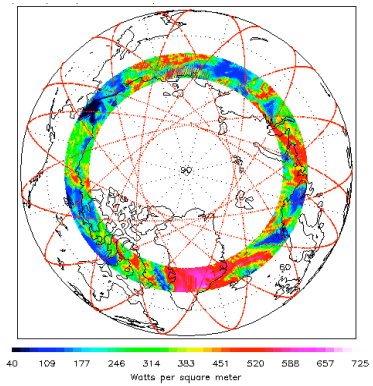
FM1 and FM4 Zonal Comparison

Edition2
2002



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



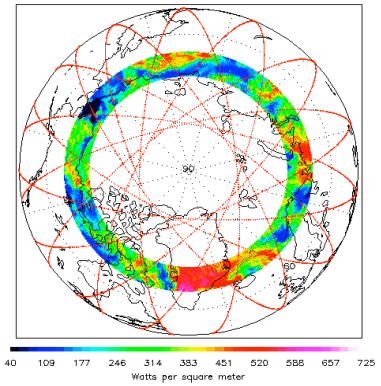
	Mean	Abs Diff	% Diff	$\Delta\sigma$	n	α-test
SW	93.0	-0.33	-0.4	0.77	346	0.1
LW_{day}	77.2	0.43	0.6	0.19	346	0.02
LW_{night}	55.1	0.07	0.1	0.10	344	0.01
WN_{day}	5.6	0.05	0.9	0.03	346	0.00
WN_{night}	3.0	0.03	1.0	0.01	344	0.00

All units in $W/m^2/sr$ **Mean = FM4**
Diff = FM4 - FM1
Data Products: **FM1 - Edition2**
FM4 - Edition2

Terra/Aqua Intercalibration

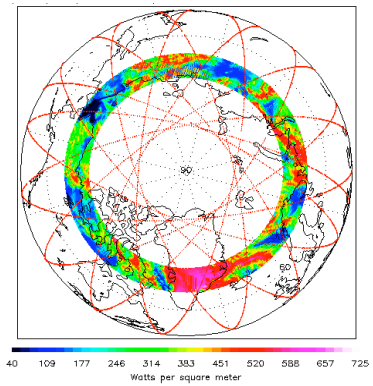
FM1 and FM4 Zonal Comparison

Edition2
2003



Terra-FM1
(Descending)

Aqua-FM4
(Ascending)



	Mean	Abs Diff	% Diff	$\Delta\sigma$	n	α-test
SW	92.3	-0.86	-0.9	0.71	234	0.1
LW_{day}	77.7	0.69	0.9	0.19	234	0.1
LW_{night}	55.7	0.03	0.1	0.10	240	0.00
WN_{day}	5.6	0.04	0.7	0.02	234	0.1
WN_{night}	3.1	0.03	0.9	0.01	240	0.1

All units in $W/m^2/sr$ **Mean = FM4**

Diff = FM4 - FM1

Data Products: **FM1 - Edition2**

FM4 - Edition2

CERES Instrument Radiometric Validation Activities

		Product	Spatial Scale	Temporal Scale	Metric	Spectral Band
On-Board	Internal BB	Filtered Radiance	N/A	N/A	Absolute Stability	TOT, WN
	Internal Lamp	Filtered Radiance	N/A	N/A	Absolute Stability	SW
	Solar	Filtered Radiance	N/A	N/A	Relative Stability	TOT, SW
Vicarious	Theoretical Line-by-Line	Filtered Radiance	> 20 Km	Instantaneous	Inter-Channel Theoretical Agreement	TOT, WN
	Unfiltering Algorithm Theoretical Validation	N/A	N/A	N/A	N/A	TOT, SW, WN
	Inter-satellite (Direct Comparison)	Unfiltered Radiance	1-deg Grid	1 per crossing	Inter-Instrument Agreement, Stability	TOT, SW, WN
	Globally Matched Pixels (Direct Comparison)	Unfiltered Radiance	Pixel to Pixel	Daily	Inter-Instrument Agreement	TOT, SW, WN
	Tropical Mean (Geographical Average)	Unfiltered Radiance	20N – 20S	Monthly	Inter-Channel Agreement, Stability	TOT, WN
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

Direct Comparison of Nadir Radiance Measurements

Two CERES instruments on a common platform allows for a unique validation opportunity…..

Direct Comparison of simultaneous Nadir measurements

Each CERES/Terra instrument views nadir every 3.3 seconds

Thus, we obtain nearly simultaneous measurements of the same geo-location ($\Delta t < 3.3$ seconds)….

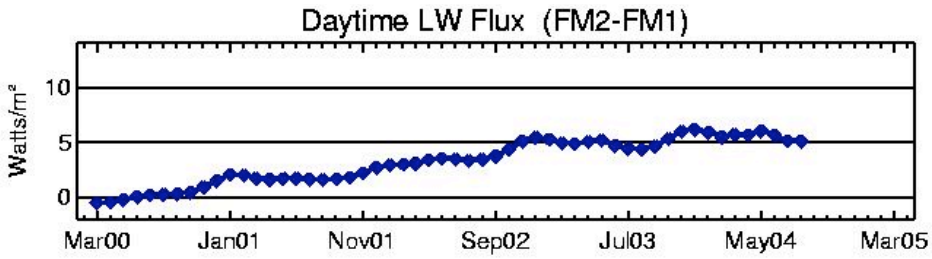
Spatial, angular, and temporal sampling issues are virtually eliminated.

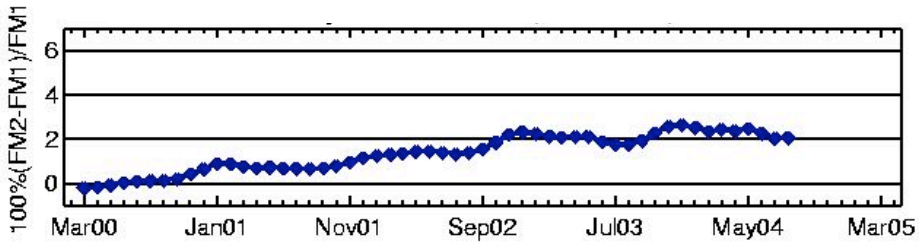
26,000 co-located (but not independent) measurements in a given day, provides a very rigorous statistical tool.

Results can be discretized by scene type to enhance the analysis.

Terra FM1 - FM2 Nadir Self Consistency
Daytime LW Flux

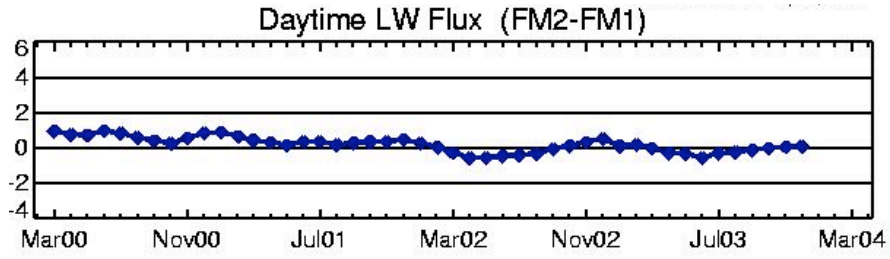
Edition 1

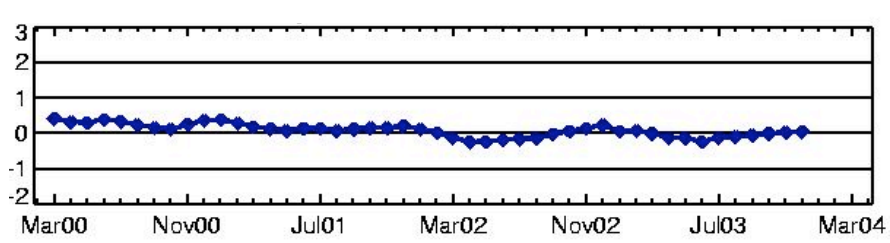




[FM1 Average] = 239.2

Edition 2



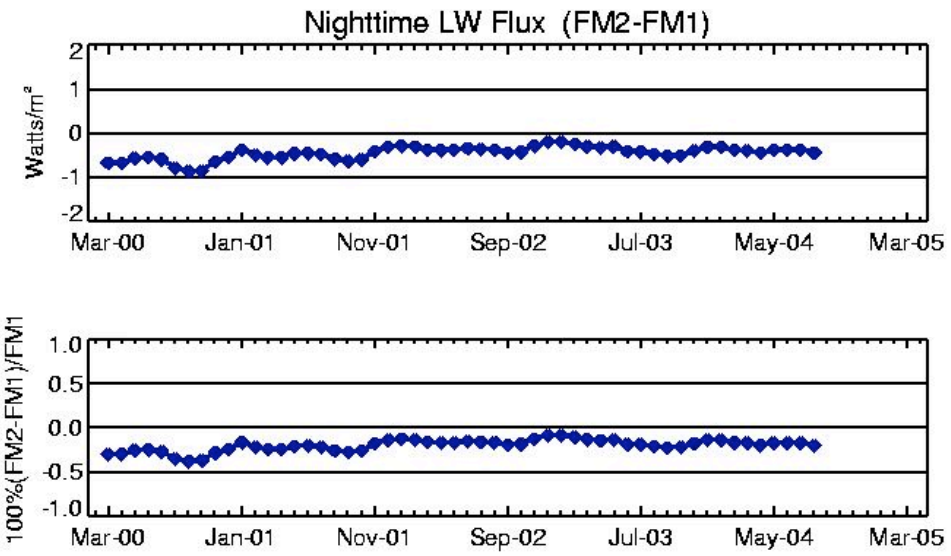


[FM1 Average] = 236.9

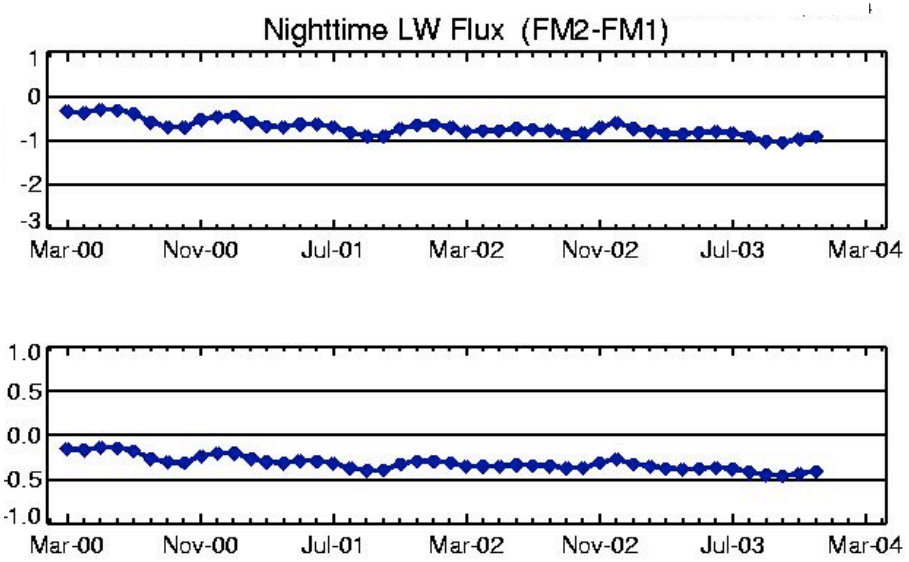
Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
2.5	**6**	**.5**	**1**

Terra FM1 - FM2 Nadir Self Consistency
Nighttime LW Flux

Edition 1



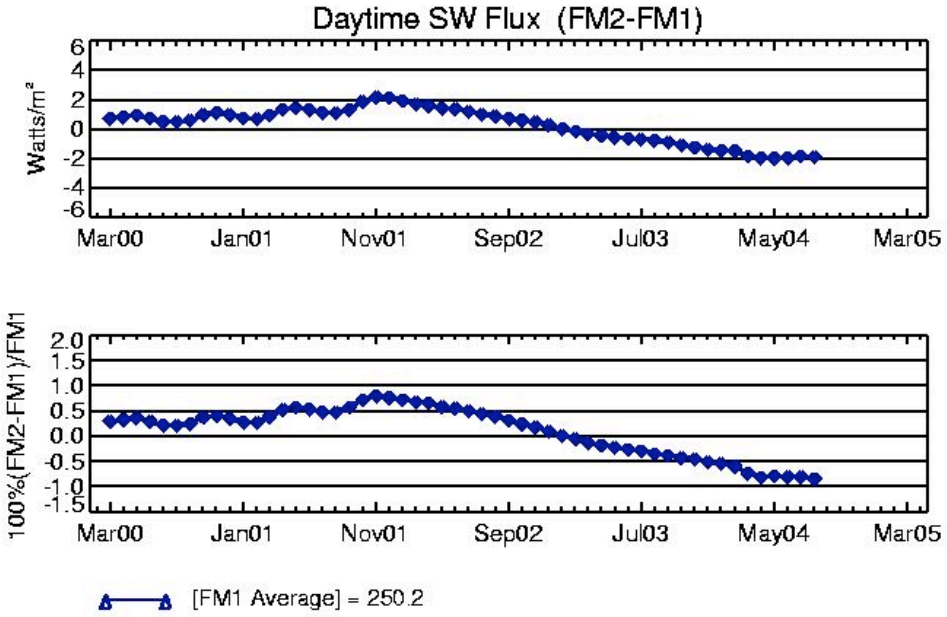
Edition 2



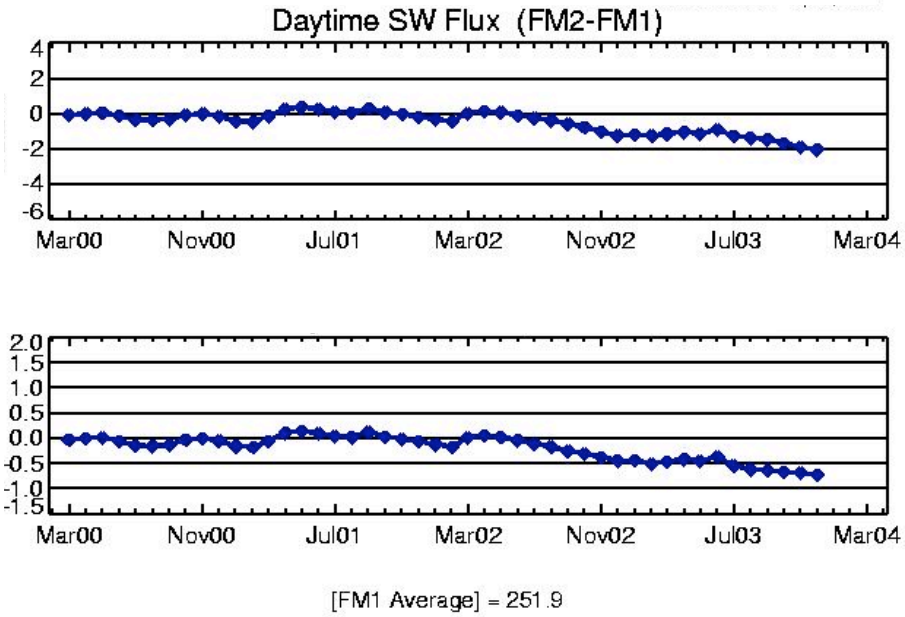
Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
.3	**.5**	**.3**	**.8**

Terra FM1 - FM2 Nadir Self Consistency
SW Flux

Edition 1



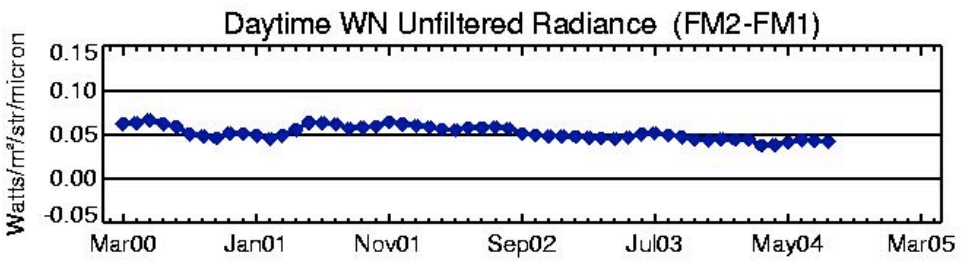
Edition 2

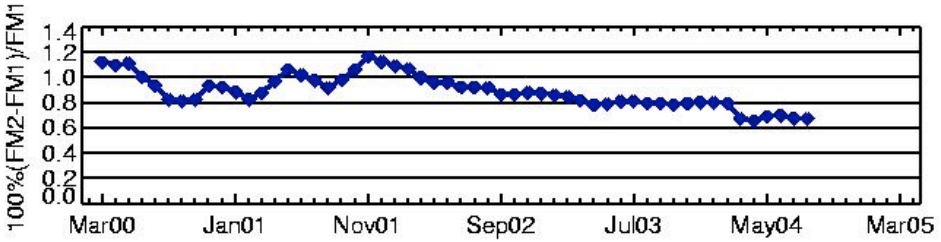


Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
1.8	**4**	**.9**	**2**

Terra FM1 - FM2 Nadir Self Consistency
Daytime WN Flux

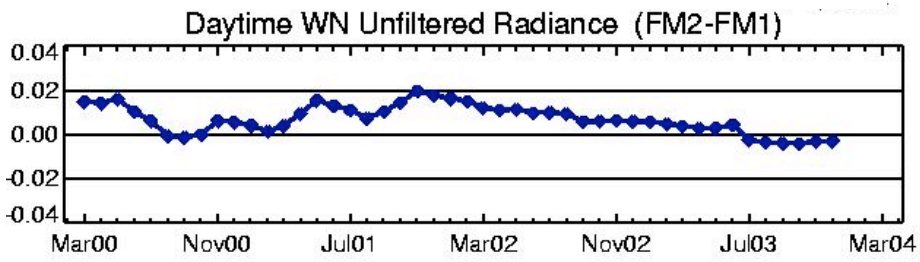
Edition 1

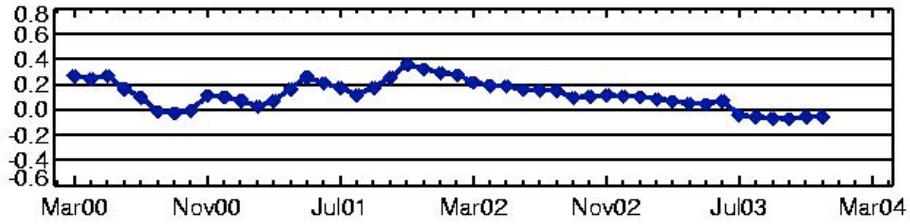




[FM1 Average] = 5.8

Edition 2



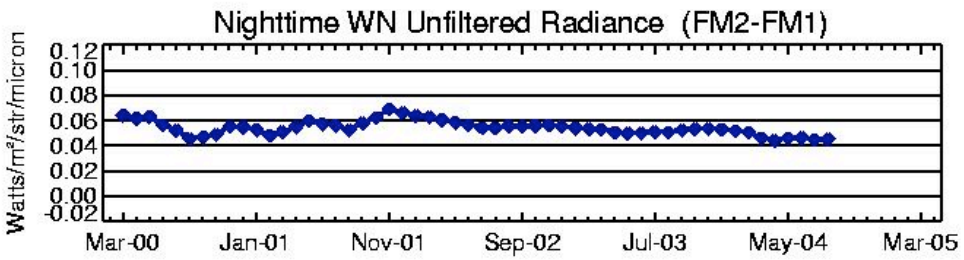


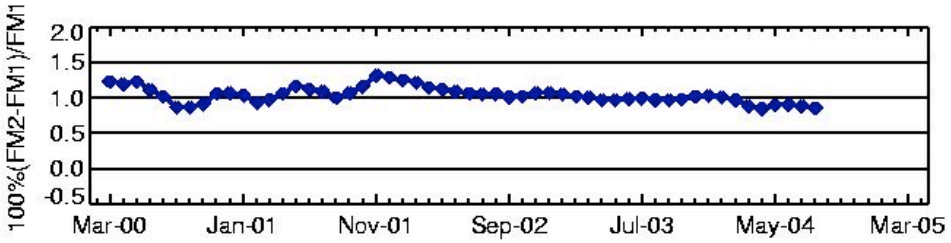
[FM1 Average] = 5.8

Relative Stability			
Edition 1		Edition 2	
%	W/m²sr-μm	%	W/m²sr-μm
.3	**.03**	**.3**	**.03**

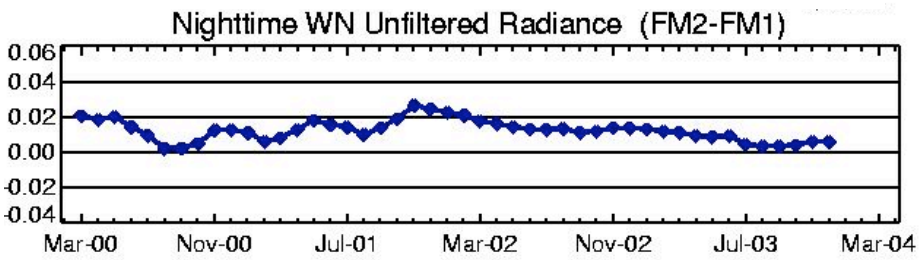
Terra FM1 - FM2 Nadir Self Consistency
Nighttime WN Flux

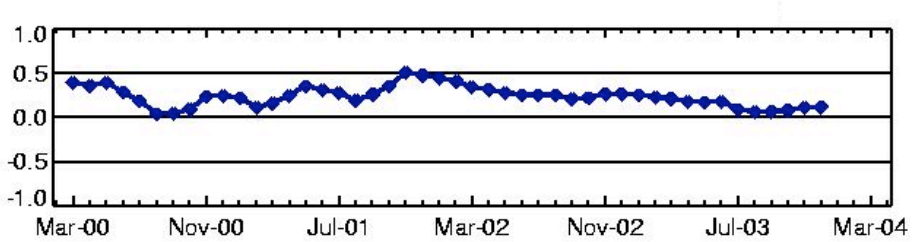
Edition 1





Edition 2

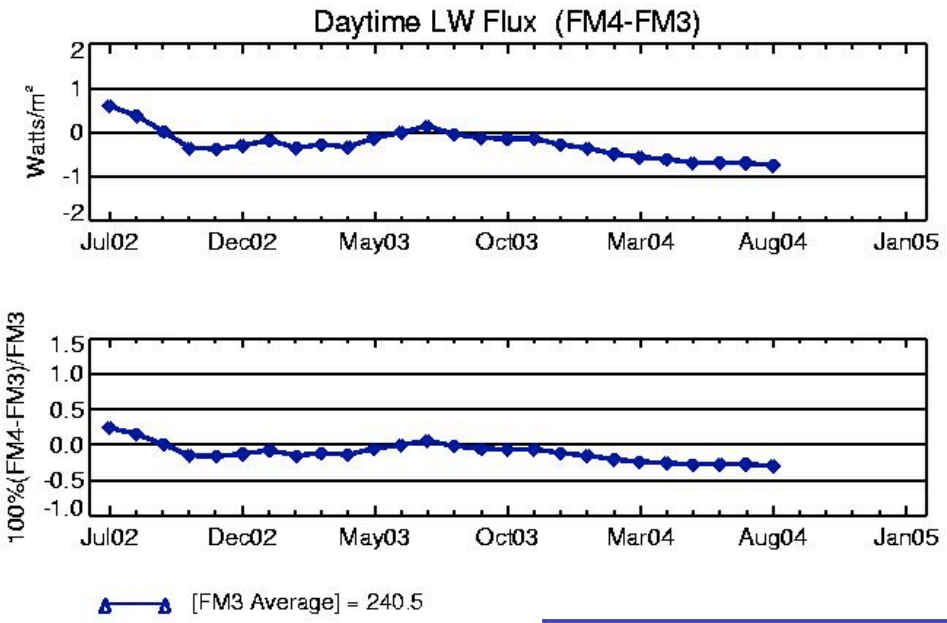




Relative Stability			
Edition 1		Edition 2	
%	W/m²sr-μm	%	W/m²sr-μm
.2	**.02**	**.2**	**.02**

Aqua FM3 - FM4 Nadir Self Consistency
Daytime LW Flux

Edition 1



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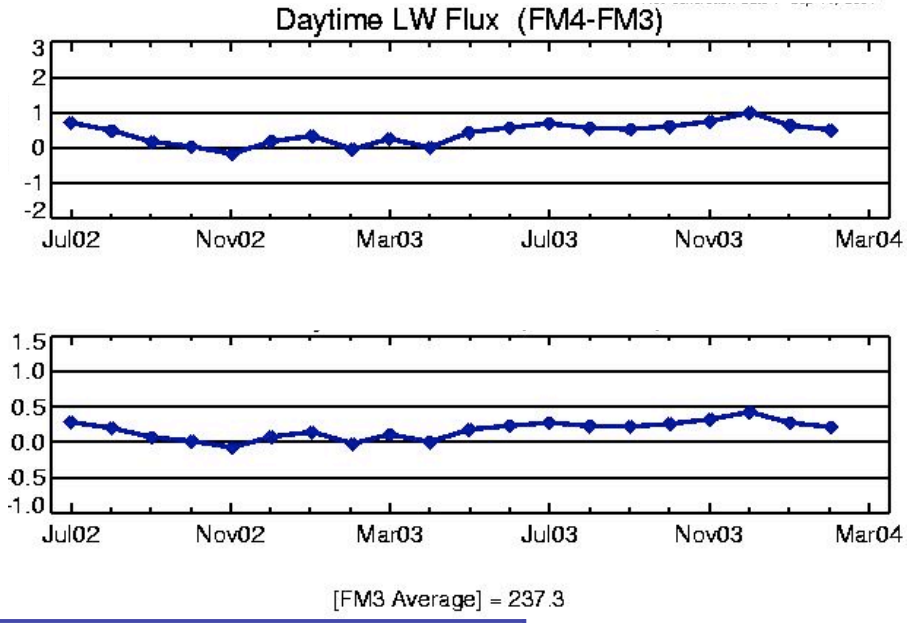
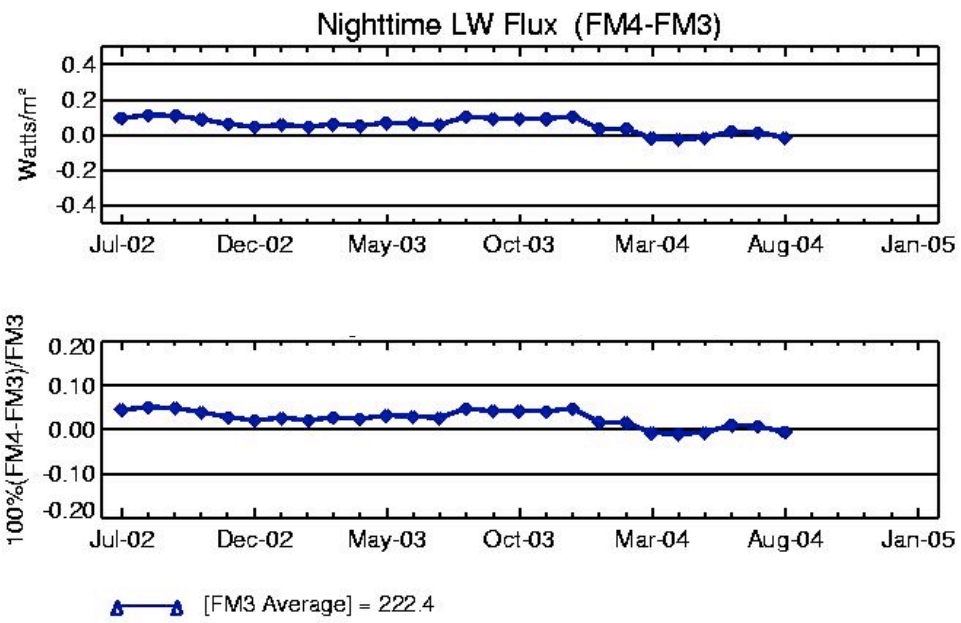


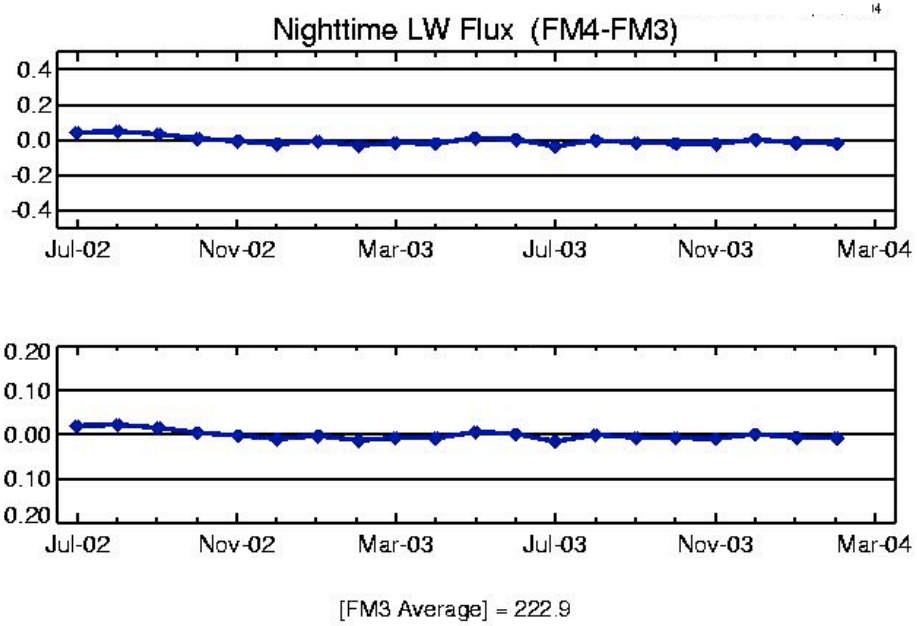
Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
.8	**1.8**	**.1**	**.25**

Aqua FM3 - FM4 Nadir Self Consistency
Nighttime LW Flux

Edition 1



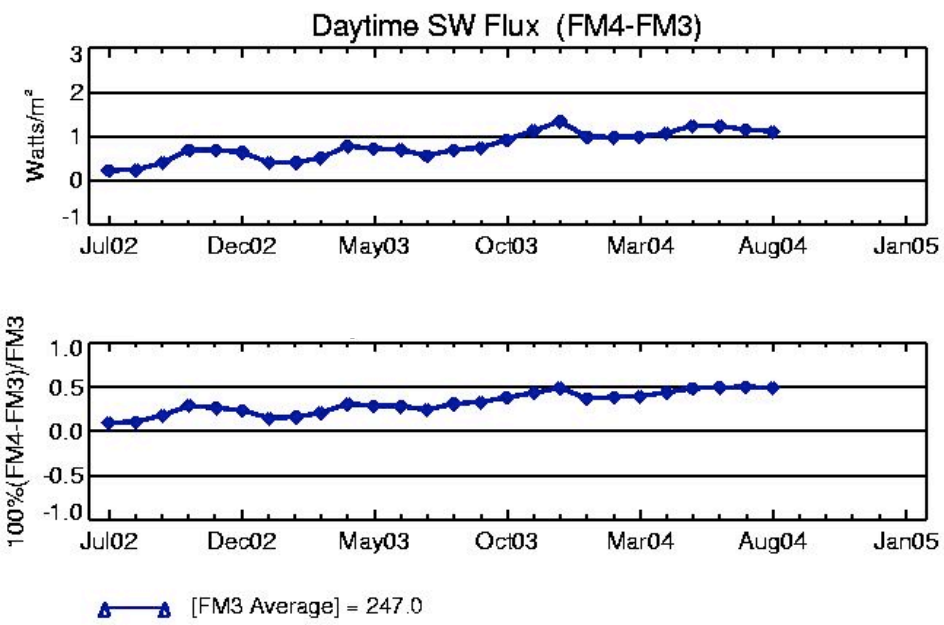
Edition 2



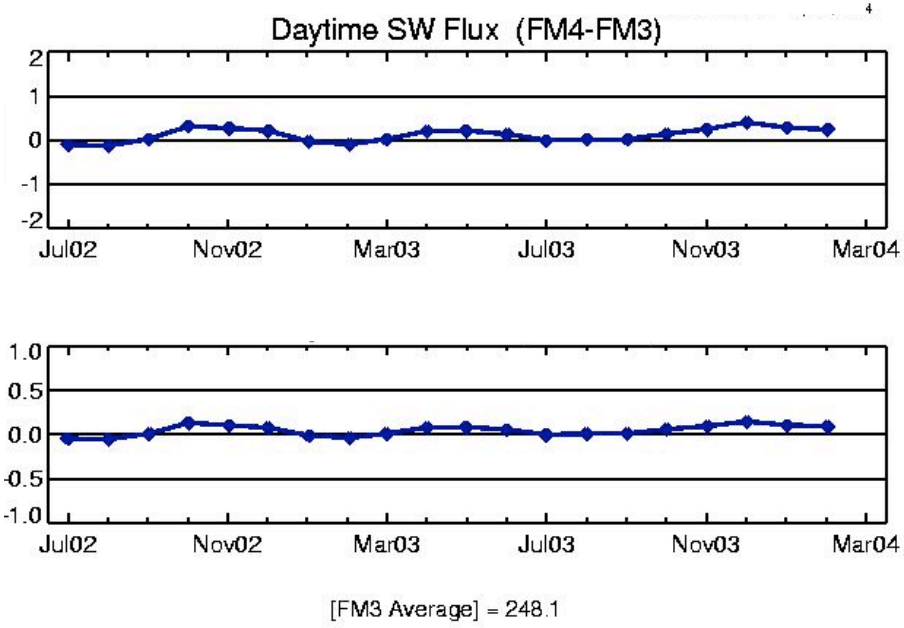
Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
.05	**.1**	**.02**	**.05**

Aqua FM3 - FM4 Nadir Self Consistency
SW Flux

Edition 1



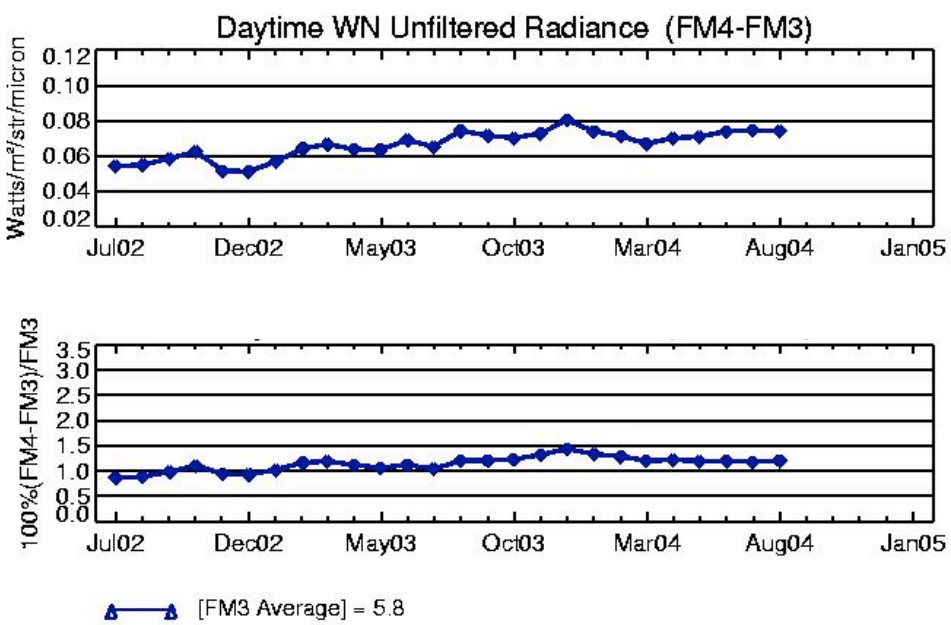
Edition 2



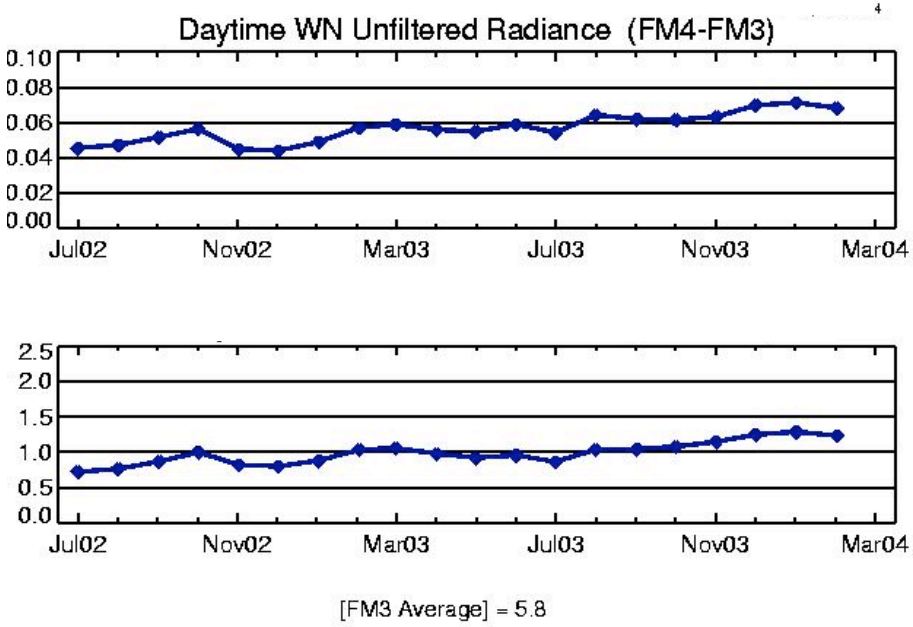
Relative Stability			
Edition 1		Edition 2	
%	W/m²sr	%	W/m²sr
.5	**1**	**.1**	**.2**

Aqua FM3 - FM4 Nadir Self Consistency
Daytime WN Flux

Edition 1



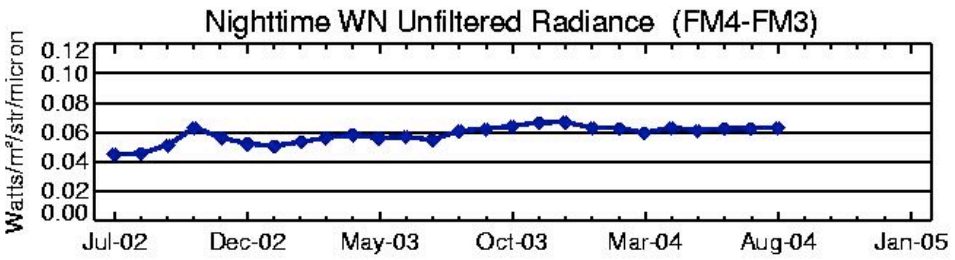
Edition 2

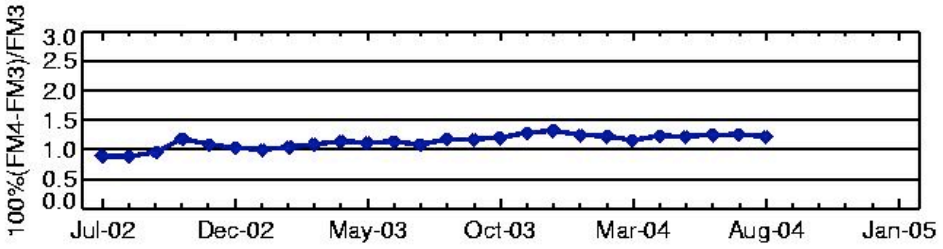


Relative Stability			
Edition 1		Edition 2	
%	W/m²sr-μm	%	W/m²sr-μm
.25	**.02**	**.2**	**.01**

Aqua FM3 - FM4 Nadir Self Consistency
Nighttime WN Flux

Edition 1





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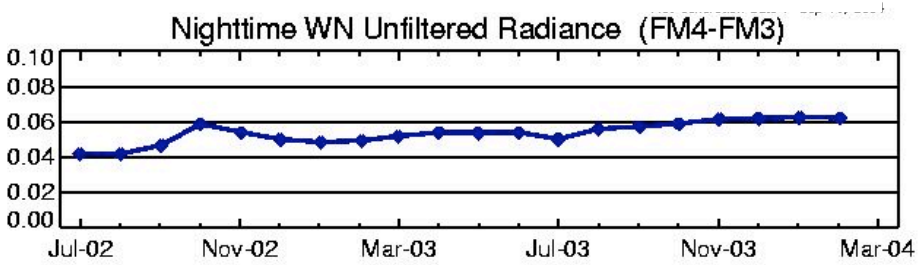
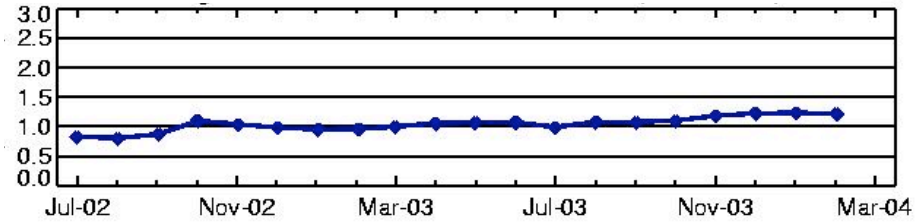




Relative Stability			
Edition 1		Edition 2	
%	W/m²sr-μm	%	W/m²sr-μm
.25	**.02**	**.25**	**.02**

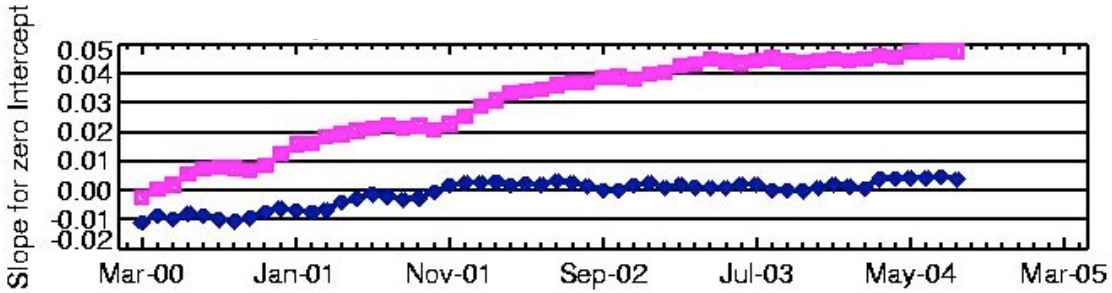
CERES Instrument Radiometric Validation Activities

		Product	Spatial Scale	Temporal Scale	Metric	Spectral Band
On-Board	Internal BB	Filtered Radiance	N/A	N/A	Absolute Stability	TOT, WN
	Internal Lamp	Filtered Radiance	N/A	N/A	Absolute Stability	SW
	Solar	Filtered Radiance	N/A	N/A	Relative Stability	TOT, SW
Vicarious	Theoretical Line-by-Line	Filtered Radiance	> 20 Km	Instantaneous	Inter-Channel Theoretical Agreement	TOT, WN
	Unfiltering Algorithm Theoretical Validation	N/A	N/A	N/A	N/A	TOT, SW, WN
	Inter-satellite (Direct Comparison)	Unfiltered Radiance	1-deg Grid	1 per crossing	Inter-Instrument Agreement, Stability	TOT, SW, WN
	Globally Matched Pixels (Direct Comparison)	Unfiltered Radiance	Pixel to Pixel	Daily	Inter-Instrument Agreement	TOT, SW, WN
	Tropical Mean (Geographical Average)	Unfiltered Radiance	20N – 20S	Monthly	Inter-Channel Agreement, Stability	TOT, WN
	DCC Albedo	Unfiltered Radiance	>40 Km	Monthly	Inter-Instrument agreement, Stability	SW
	DCC 3-channel	Unfiltered Radiance	>100 Km	Monthly	Inter-Channel consistency, stability	TOT, SW
	TIme Space Averaging	Fluxes	Global	Monthly	Inter-Instrument Agreement	LW, SW
	Lunar Radiance Measurements	Filtered Radiance	Sub Pixel	Quarterly	Inter-Instrument Agreement	LW, SW, WN

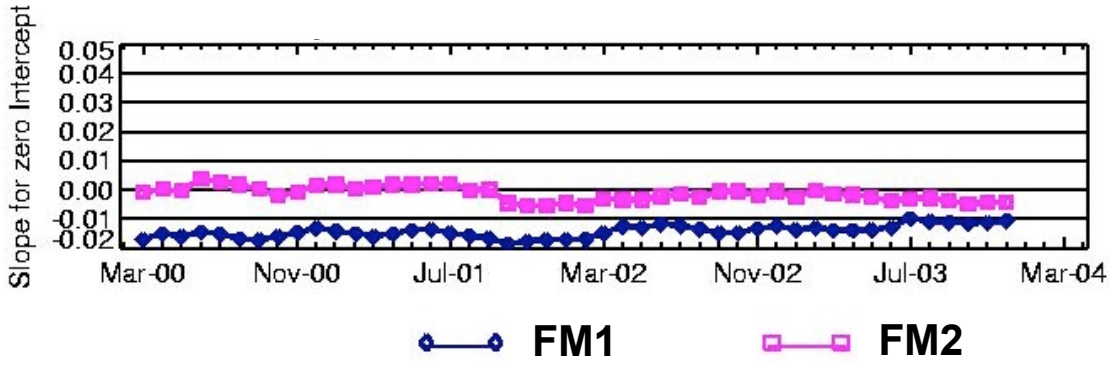
Deep Convective Cloud 3-Channel Intercomparison

Terra

Relative Unfiltering Errors (%) of SW and SW/TOT channels



Edition 1

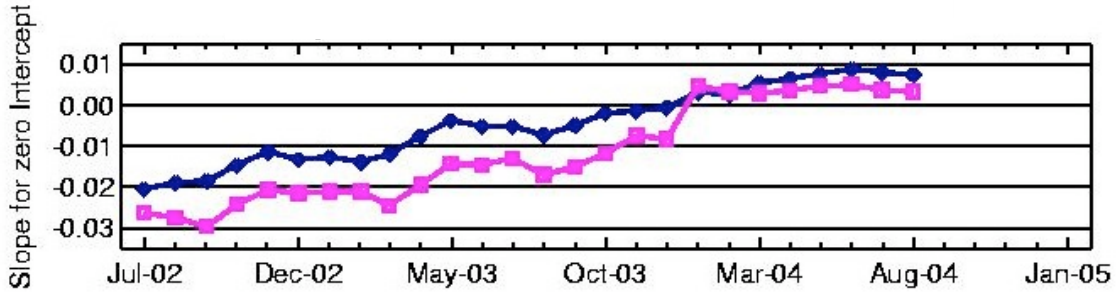


Edition 2

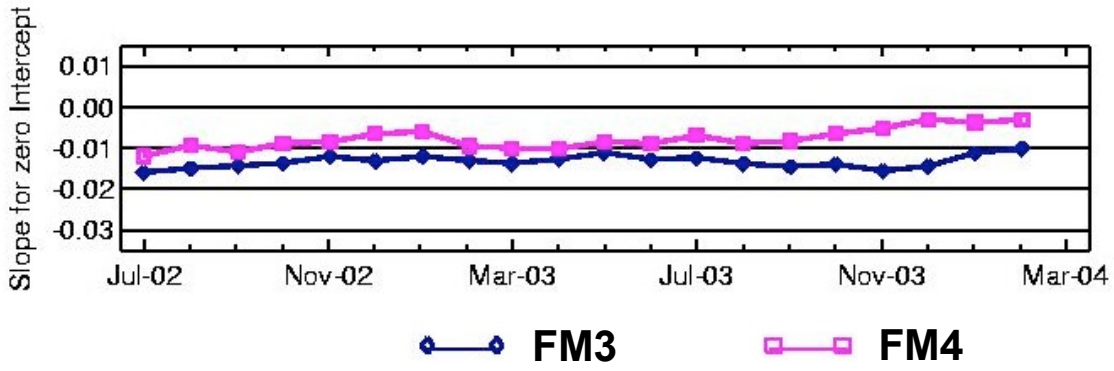
Deep Convective Cloud 3-Channel Intercomparison

Aqua

Relative Unfiltering Errors (%) of SW and SW/TOT channels



Edition 1



Edition 2

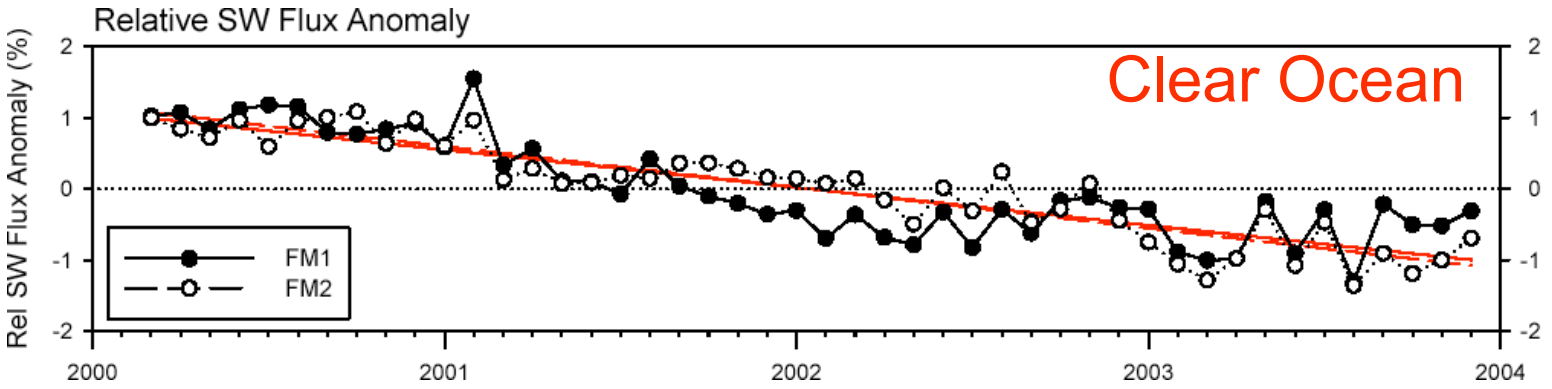
Executive Summary

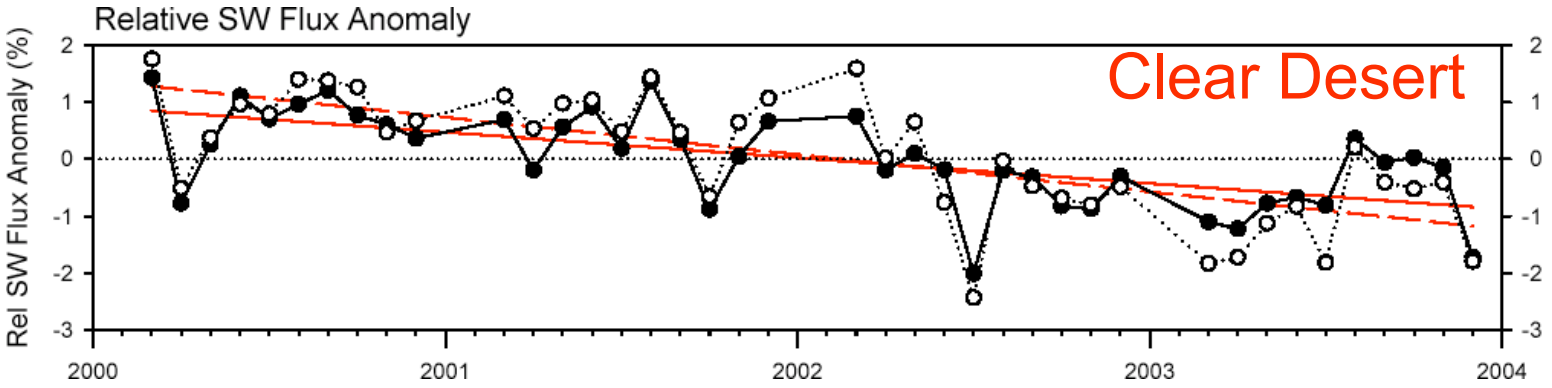
- All Diagnostic/Housekeeping data is nominal…
  - Gimbal Friction measurements stable
  - Pointing stable
  - No significant voltage or temperature trends

- Cal/Val Protocol demonstrates radiometric stability of the Ed2 data products of…. (units are in %/yr)

	Terra		Aqua	
	FM1	FM2	FM3	FM4
LWday	.125	.125	<.1	<.1
LWnight	<.1	<.1	<.1	<.1
SW	.2	.2	<.1	<.1
WN	<.1	<.1	.125	.125

CERES SSF SW TOA Flux Anomaly





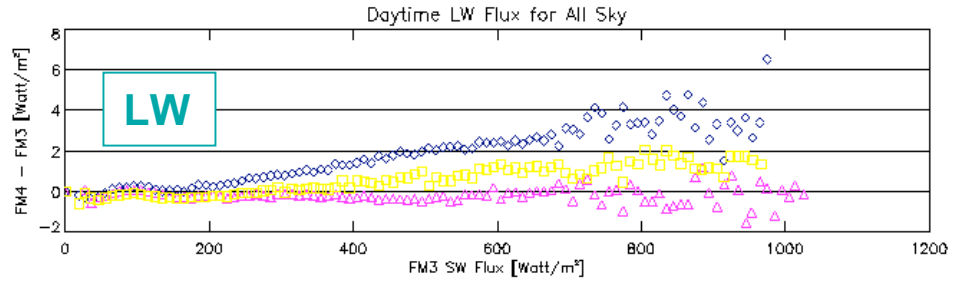
CERES Aqua Edition1 Gain Updates

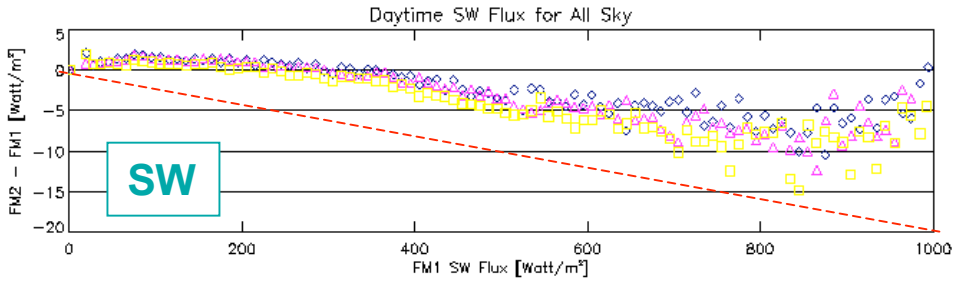
Normalized to Ground Calibration Data

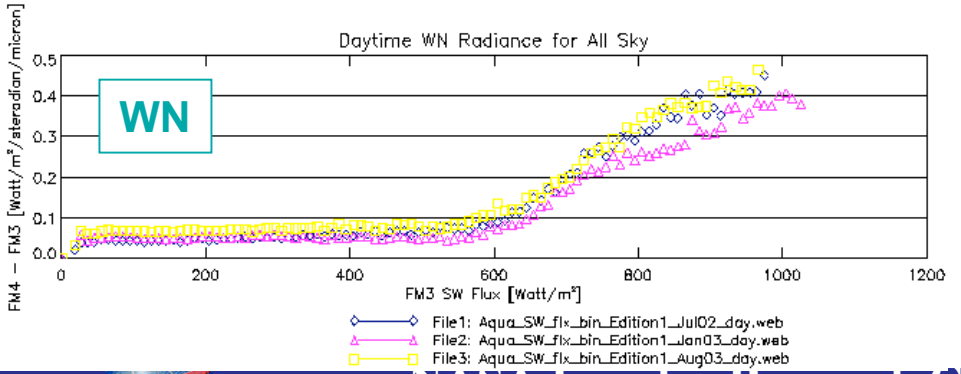
Aqua Binned Flux Comparison

LW, SW, and WN Radiances

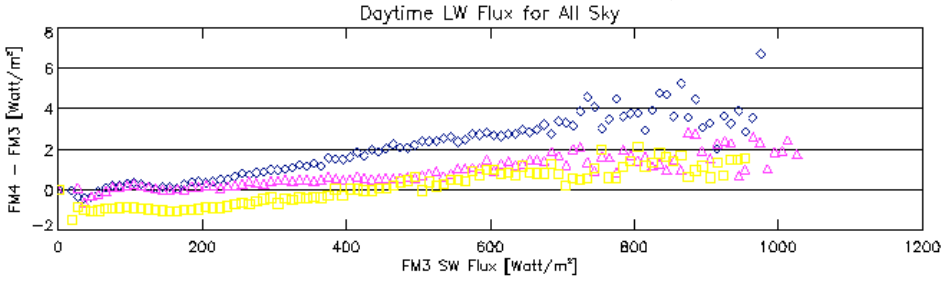
Edition 1

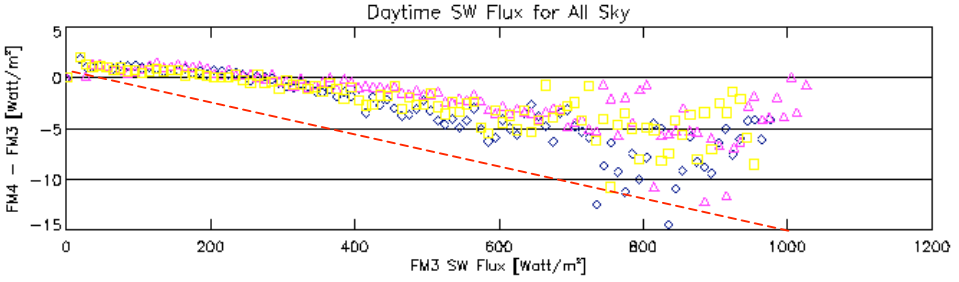


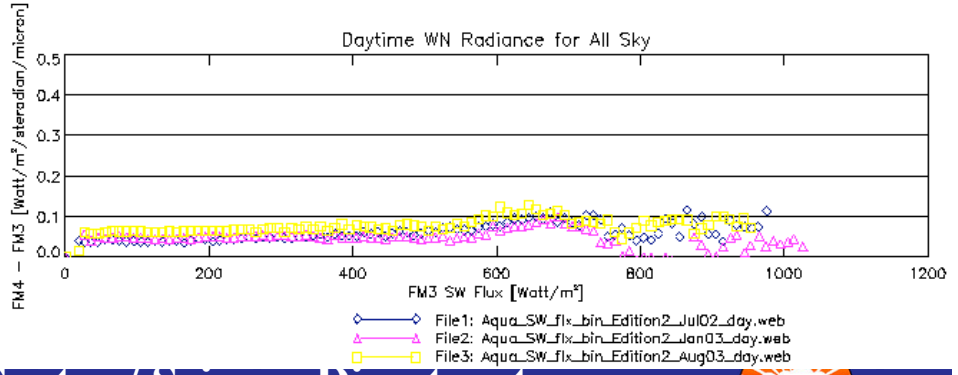




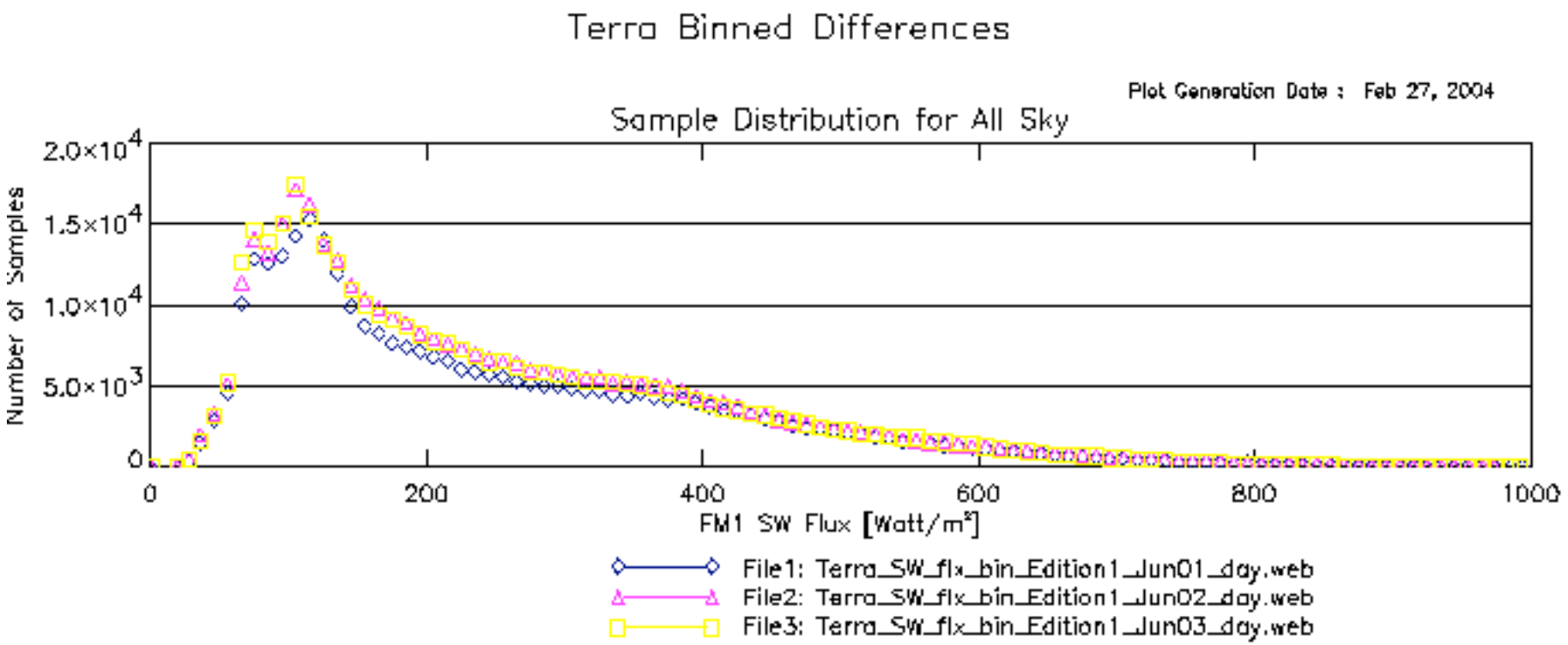
Edition 2







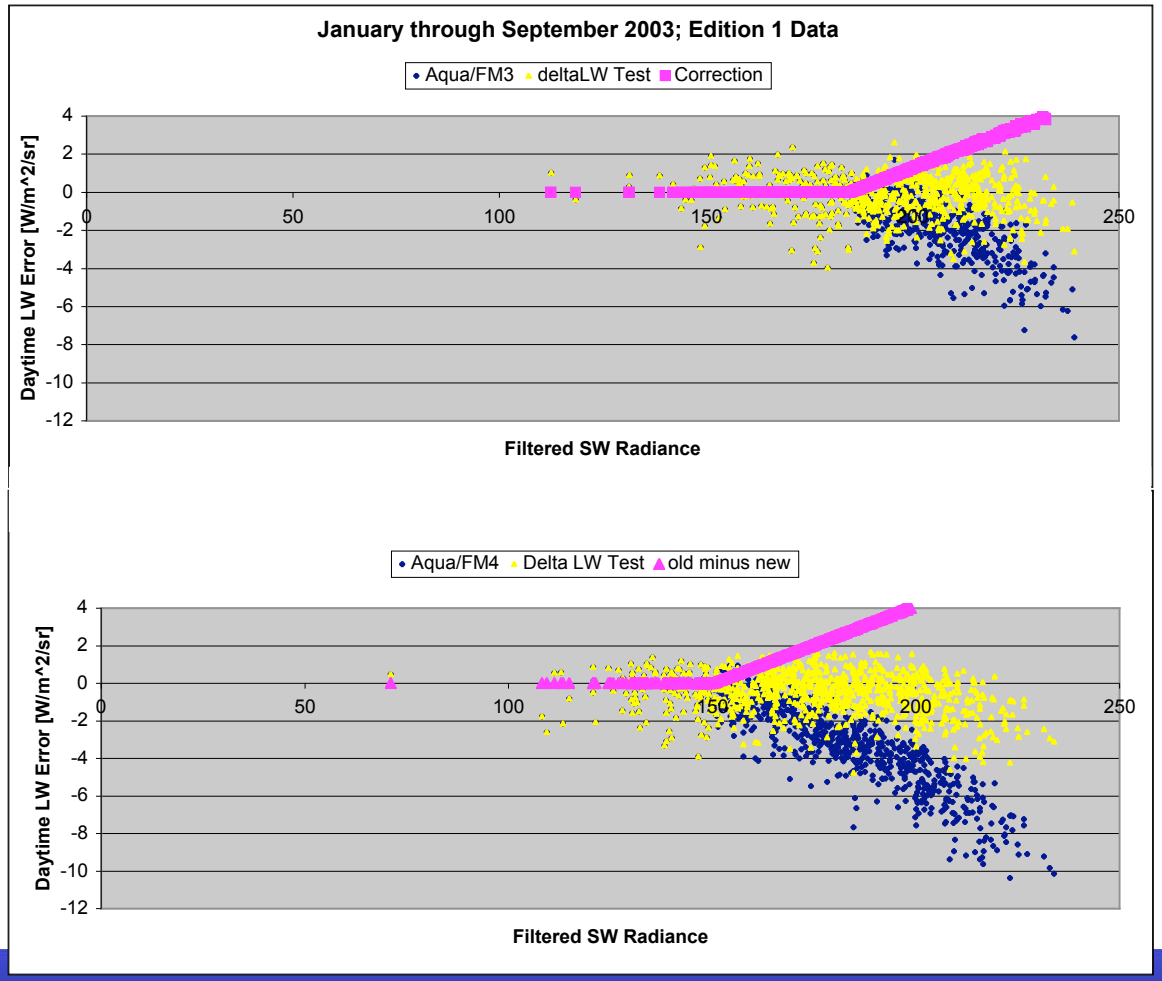
Binned Flux Comparison Footprint Distribution



Aqua Three Channel Inter-Comparison

WN Channel SW sensitivity correction

Edition1 data



CERES Cal/Val Summary

Terra/Aqua

- All radiometric goals have been met or exceeded in Edition2 products
- Edition2 BDS and ERBE-like products available through 6/03
- Rigoruous validation protocol has removed on orbit radiometric transients
- Still some residual correlation with SW (scene brightness)
- WN channel SW sensitivity has been accounted for in…
  - Aqua Edition2 Data Products (All)
  - Terra Edition2 Data Products from 7/03 onward
- Unprecedented stability levels of ~0.1%/yr for CERES climate record

INSTRUMENT WORKING GROUP

CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM

Introduction | Activities | Documentation | Operations | Production | Data | Personnel

ACTIVITIES

Choose from one of the links below:

Ground Calibration

Deep Space Calibration

Validation

Field Campaigns:

CLAMS CRYSTAL-FACE INDOEX
LaRC-ULDB GERB Aerosols
Terra/Aqua Intercalibration
Solar Principal Plane Scans (PPS)

Event Calendar: 2003

NASA LaRC

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Last Updated: Tue Apr 29 13:03:55 2003
Web Curator: Phil Hess (p.c.hess@larc.nasa.gov)
Responsible NASA Official: Kory Priestley (k.j.priestley@larc.nasa.gov)

CERES Home Page

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Introduction
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ACTIVITIES
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Deep Space Calibration
Validation
Field Campaigns:
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CRYSTAL-FACE
INDOEX
LaRC-ULDB
GERB
Aerosols
Terra/Aqua Intercalibration
Solar Principal Plane Scans (PPS)
Event Calendar:
2003
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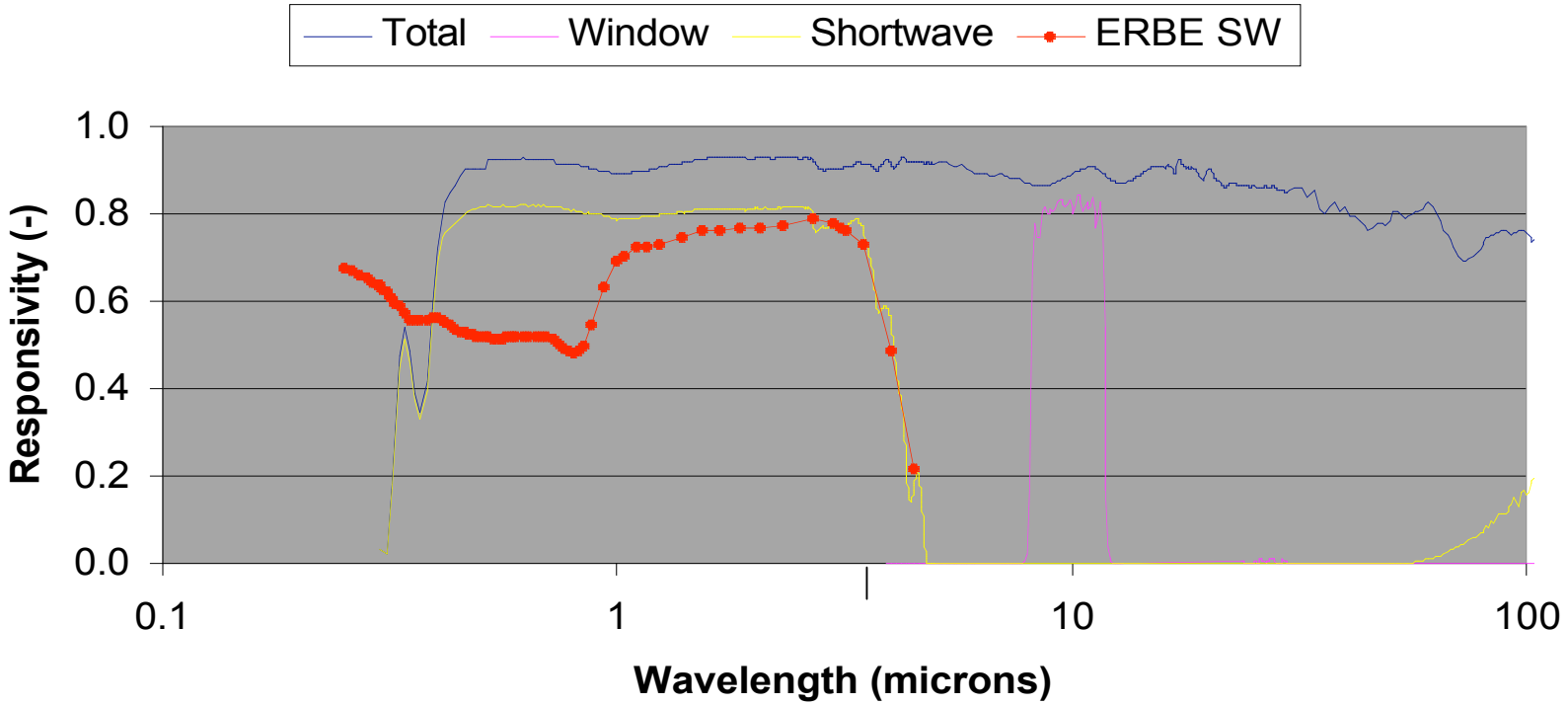
Last Updated: Tue Apr 29 13:03:55 2003
Web Curator: Phil Hess (p.c.hess@larc.nasa.gov)
Responsible NASA Official: Kory Priestley (k.j.priestley@larc.nasa.gov)
CERES Home Page

CERES Spectral Response Function

TRMM/PFM Edition1 Data Products



Note: LW_{DAY} = Total - Shortwave