CERES FM1 – FM5 Instrument Status

Susan Thomas
CERES Instrument Working Group Team

CERES Science Team Meeting
Marriott at City Center
Newport News, VA
May 1, 2012

Instrument Working Group Personnel

Science

- Susan Thomas -

Audra Bullock

Janet Daniels

Phillip Hess

Suzanne Maddock

Mohan Shankar

Nathaniel Smith

Nitchie Smith

Peter Szewczyk

Robert Wilson

Data Management

- Denise Cooper -

- Dale Walikainen -

Thomas Grepiotis

Nelson Hillyer

Jeremie Lande

Dianne Snyder

Richard Spivak

Mark Timcoe

Mission Operations

- Bill Vogler -

- James Bailey -

Christopher Brown

John Butler

William Edmonds

Mike Tafazoli

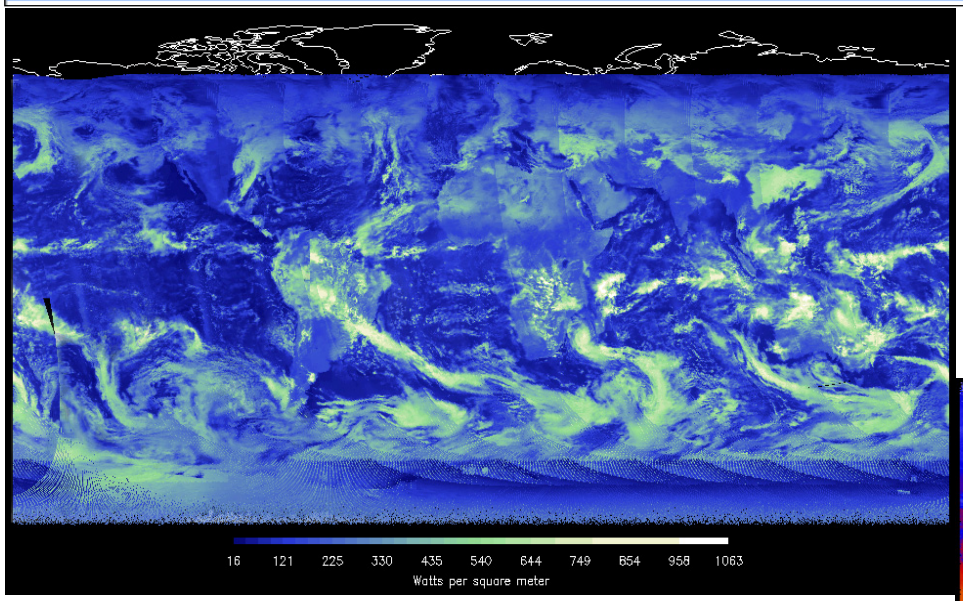
Kelly Teague

Roy Zalameda

Suomi NPP Launch

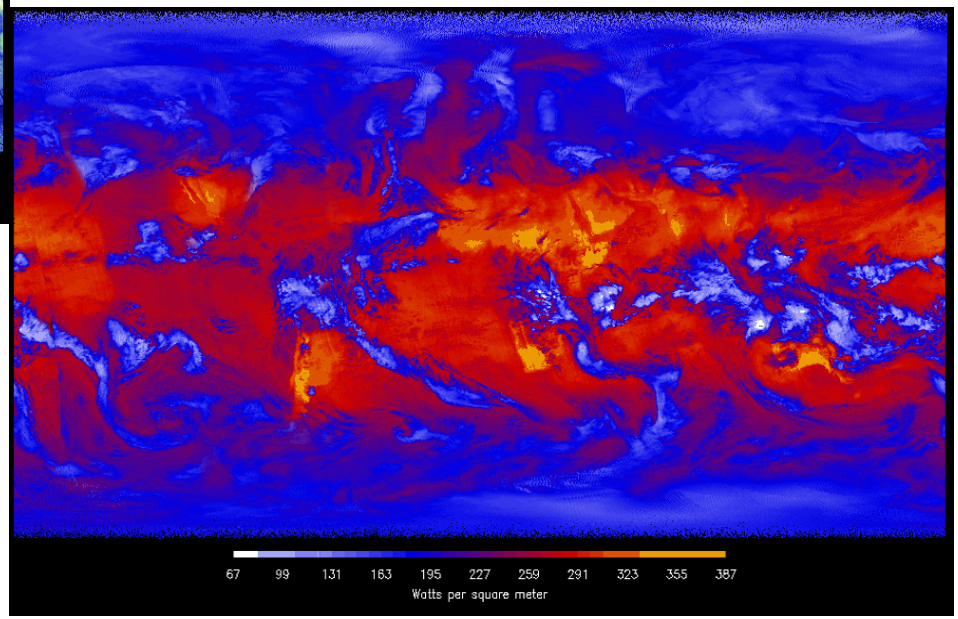
CERES Flight Model 5 (FM5) was launched on Suomi NPP Spacecraft at 2:48 AM PDT on October 28, 2011

Suomi NPP/CERES FM5 First Images



SHORTWAVE FLUX

LONGWAVE FLUX

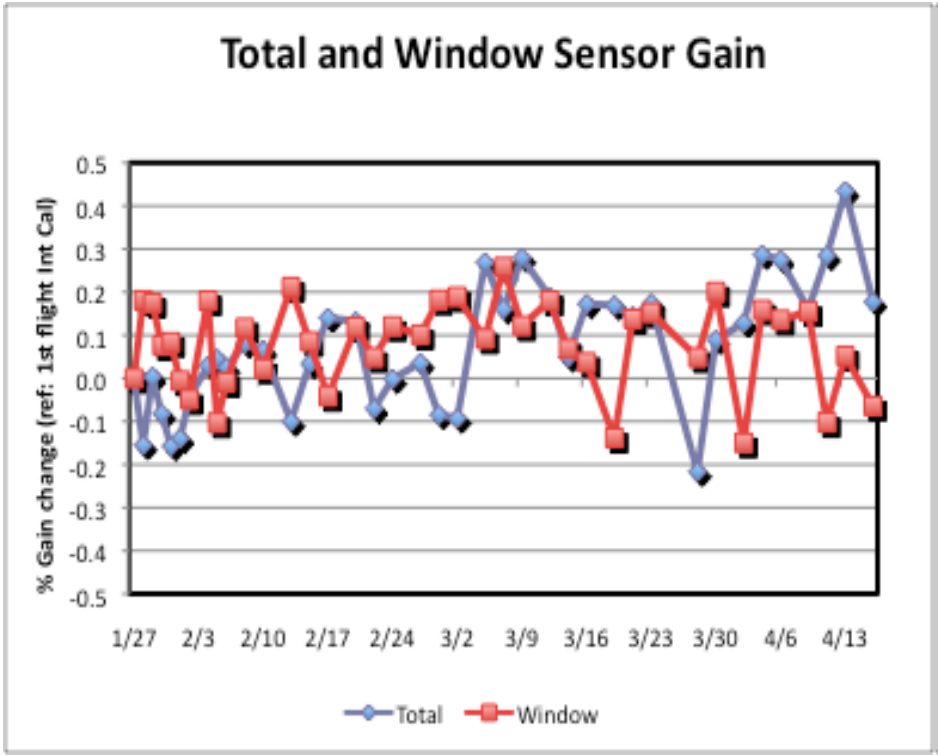


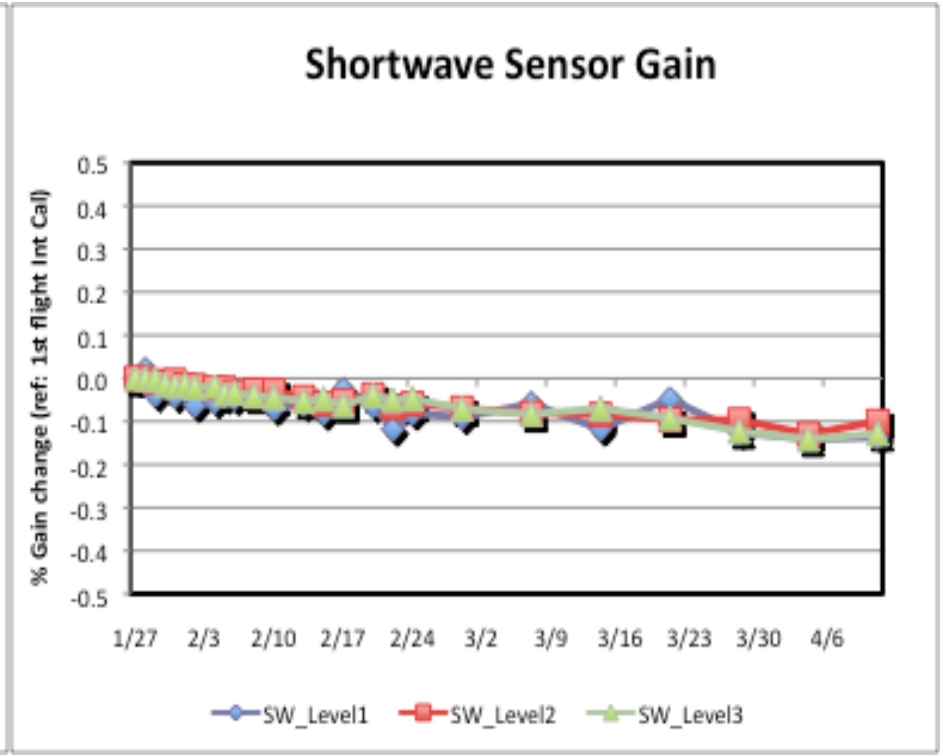
Suomi NPP/CERES FM5 Operations

NPP Spacecraft Launch – October 28, 2011
CERES Power On – November 9, 2011
Covers Closed Instrument Ops – Nov 9, 2011 – Jan 25, 2012
Calibration using ICM Sources – Nov 10, 2011 – Feb 8, 2012
CERES Main and MAM Cover Open – January 26, 2012
MAM Conditioning Operation – Jan 28 – 29, 2012 (22 orbits)
CERES Solar MAM Calibration – January 28, 2012
Spacecraft YAW Maneuver – Feb 17 – 18, 2012
Spacecraft Pitch Back Maneuver – February 20, 2012
NPP LEO&A Period End – March 7, 2012

Suomi NPP/CERES FM5 ICM Calibrations

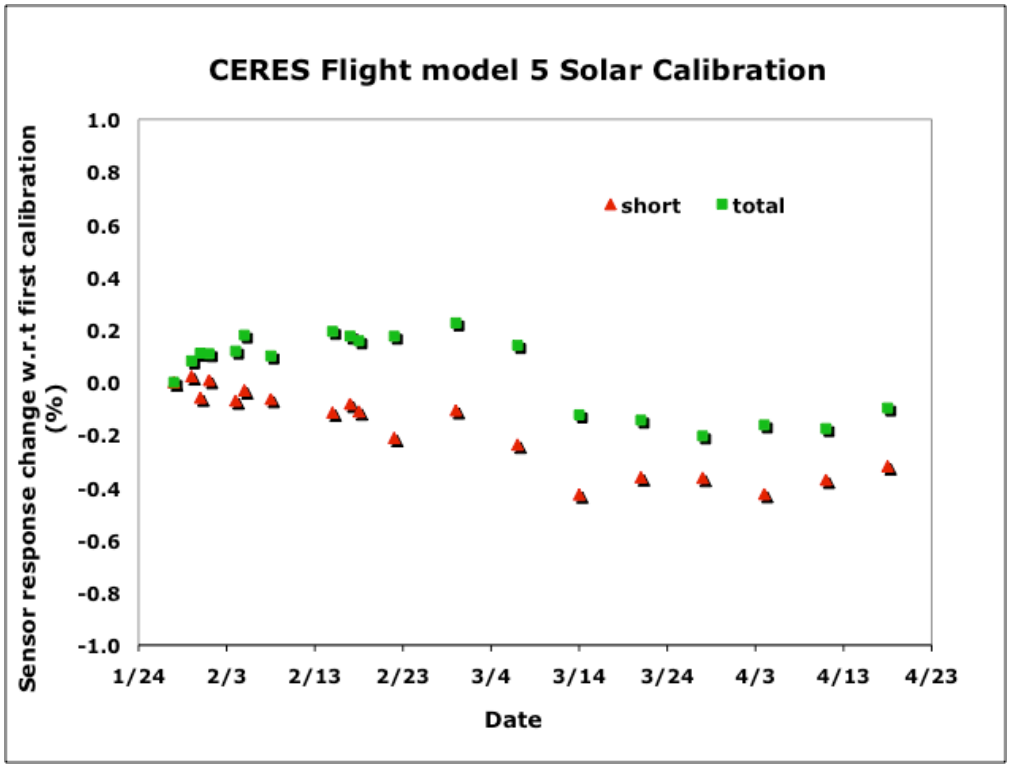
The performance of CERES sensors are within the expected range - +/- 0.5%

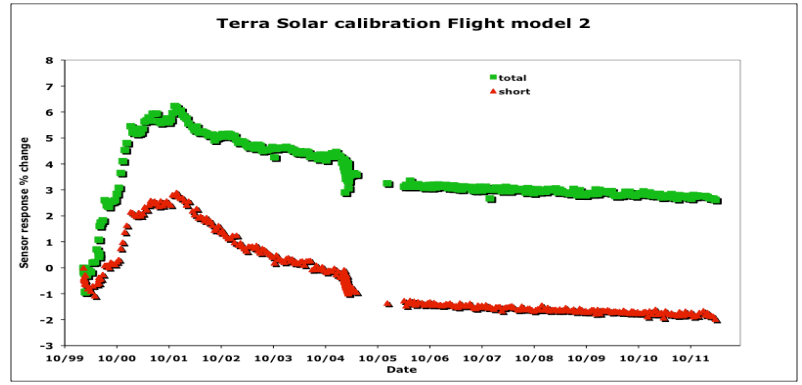


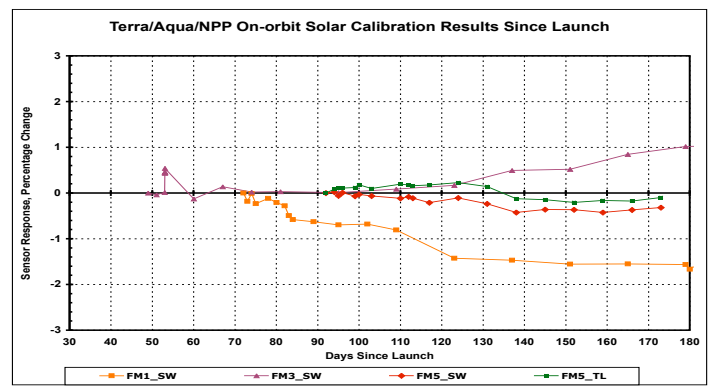


Suomi NPP/CERES FM5 Solar Calibrations

- Total and SW sensor results and the MAM performance are within the expected range of +/- 1%





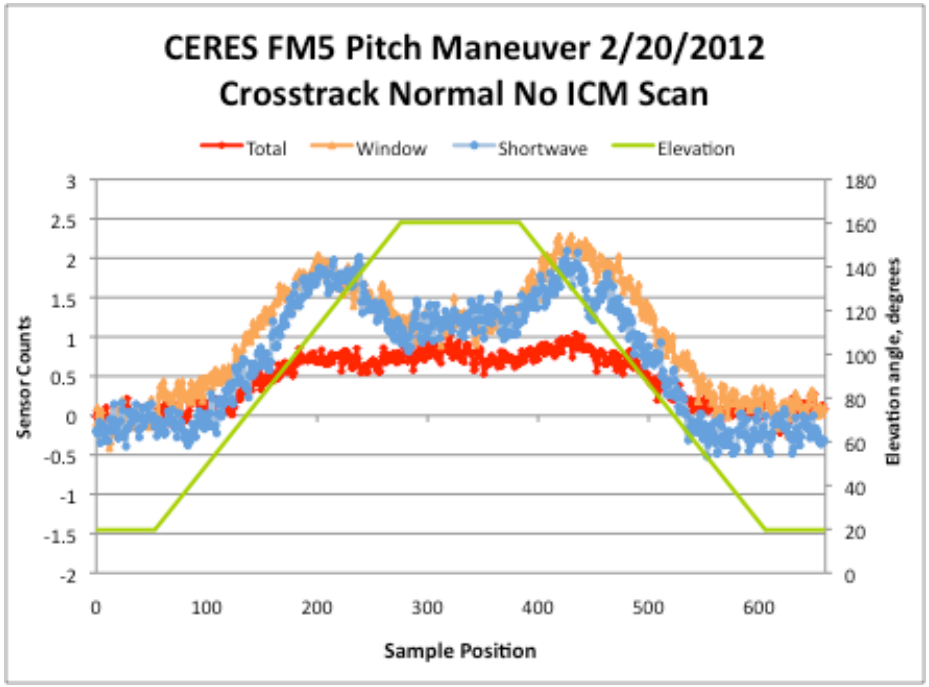


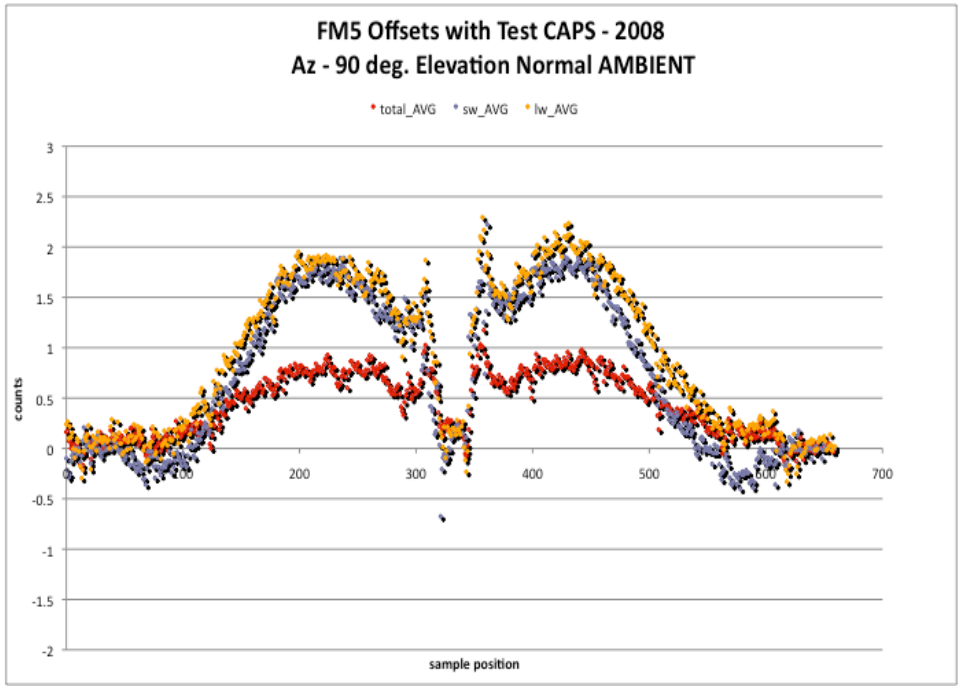
Suomi NPP/CERES FM5 Pitch Back Maneuver

- Spacecraft Pitch Back Maneuver was carried out on Feb 20, 2012 18:15 – 18:59 (44 minutes)
- CERES data was collected for 5 scan modes
  - Normal Crosstrack Scan
  - Normal Scan without ICM view
  - NADIR Scan
  - Double Nadir Scan
  - Short Scan
- Scan Offsets for the Earth viewing Elevation positions were calculated.

Suomi NPP/CERES FM5 Pitch Back Maneuver

The sensor offsets are similar in magnitude to pre-launch ground calibration results.

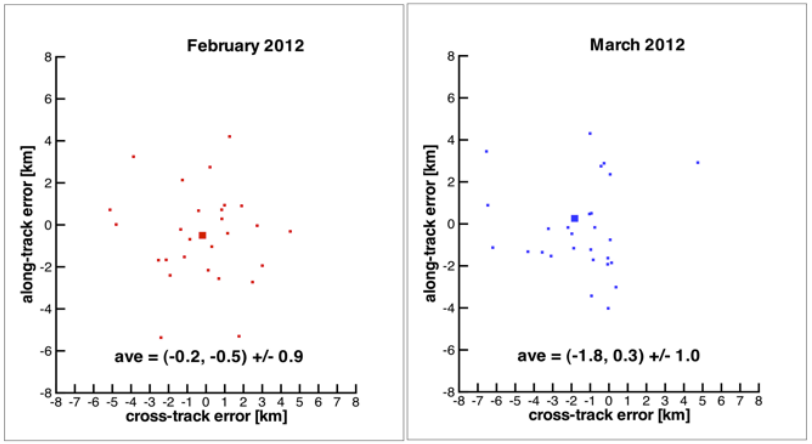




CERES FM5 Geolocation Validation

Coastline Detection Algorithm:

- Detect clear sky hot/cold radiance gradients provided by land-water boundaries (coastlines) during limb to limb scan.
- Determine corresponding geodetic coordinates at the inflection point.
- Compare with the coastline CIA map
- Calculate the along-track and cross-track errors.



Error in Pointing Accuracy is estimated at < 10% of a footprint size.
Preliminary results show consistency with other CERES instruments.

CERES FM5 Validations – Flux Comparison

Comparison of FM5 LW and SW Flux Average (Feb & March 2012) with CERES FM1- FM3 [Ed1-CV]

	FM5 Wm-2	FM1 Wm-2	FM5-FM1 (%)	FM2 Wm-2	FM5-FM2 (%)	FM3 Wm-2	FM5-FM3 (%)
LW	236.01	237.73	-0.72	240.5	-1.87	237.32	-0.55
SW	100.59	97.185	3.5	96.22	4.55	97.23	3.46

CERES FM5 Validations

Tropical Mean: Average of All-sky tropical ocean(20ºN-20ºS)
Longwave (night) radiance measurement

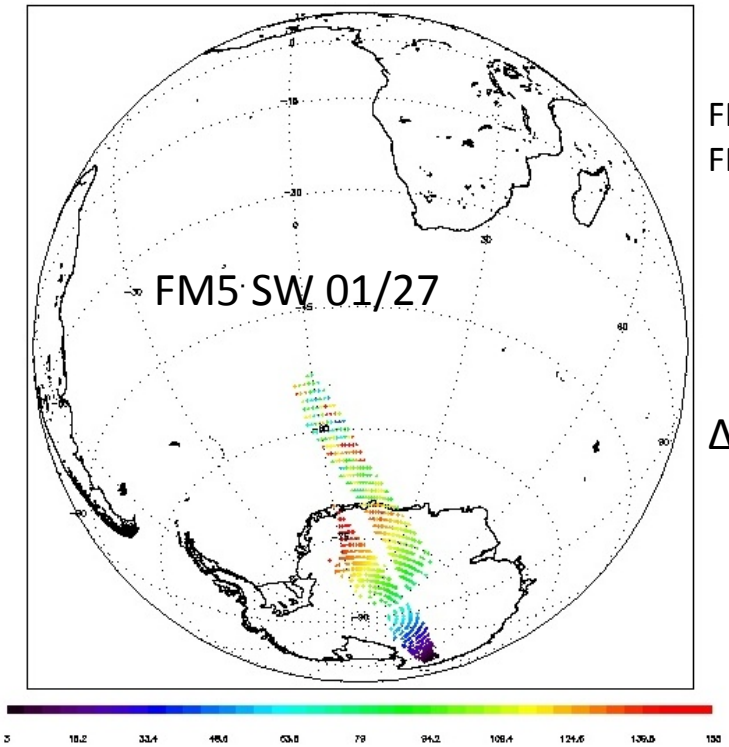
FM5 LW (night) Radiance average for Feb & March 2012 comparison with CERES FM1- FM3

	FM5 Wm-2sr-1	FM1 Wm-2sr-1	FM5-FM1 (%)	FM2 Wm-2sr-1	FM5-FM2 (%)	FM3 Wm-2sr-1	FM5-FM3 (%)
LW-night (Ed1-CV)	87.606	88.421	-0.92	88.114	-0.58	88.432	-0.93
LW-night (Ed3-Gain)	87.606	87.894	-0.33	87.454	0.17	87.93	-0.37

CERES FM5 (NPP) –FM3 (Aqua) Comparisons

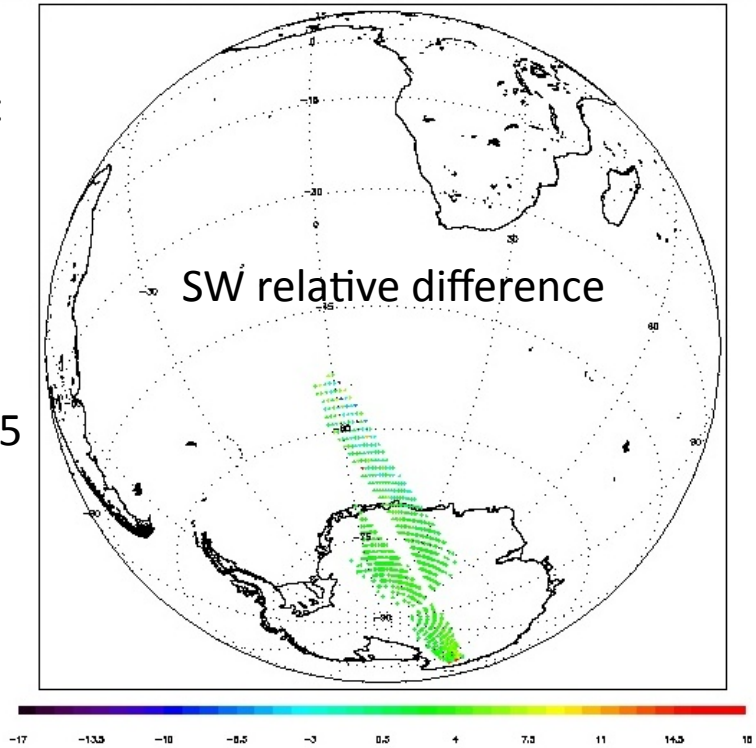
- NPP and Aqua Simultaneous Observation Opportunities occur every 64 hours and last ~20minutes with views < 15 sec apart.
- Comparison based on gridded 1° x1^o averages with relative VZA <5 deg and RAZ < 1 deg.
- 34 orbital crossing opportunities (8 in Tropics, 11 in Polar regions, 15 mid-latitudes) during Feb – April, 2012.

CERES FM5 (NPP) –FM3 (Aqua) Comparisons



FM5 – Baseline1-QC
FM3 – Ed1-CV

ΔSW ≅ 3% ± 0.15



(1) FM5 reads higher in SW, lower in LW
(2) Differences on par with changes from Ed1 to Ed3 for FM3

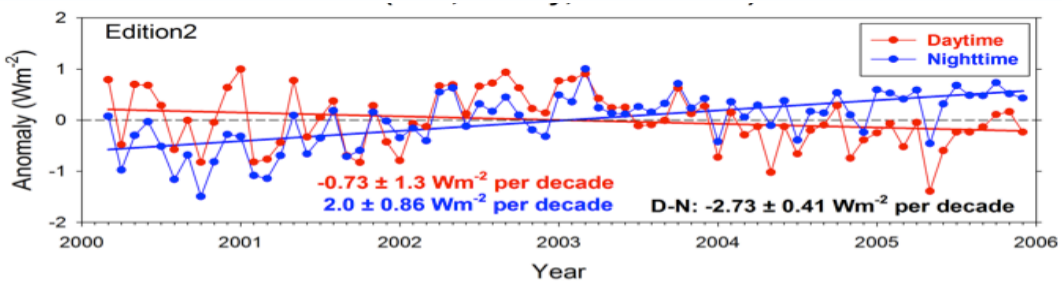
TERRA & AQUA INSTRUMENT STATUS

[CERES FM1 – FM4]

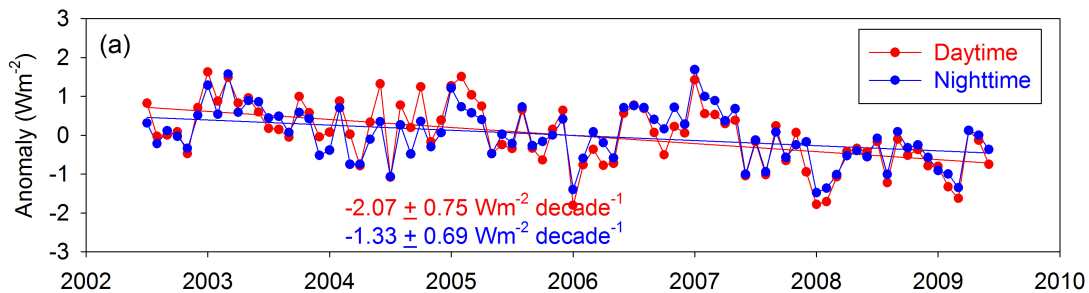
TERRA/AQUA DATA AVAILABILITY

Spacecraft	Product	Version	Available	Months Processed
Terra	BDS	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 – 8/10
		Editon3	Yes	2/00 – 5/11
		Edition3	Testing	6/11 – 12/11
	ERBE-like	Edition1	Yes	2/00 - present
		Edition2	Yes	2/00 – 8/10
		Editon3	Yes	2/00 – 5/11
		Edition3	Testing	6/11 – 12/11
Aqua	BDS	Edition1	Yes	6/02 - present
		Edition2	Yes	6/02 – 8/10
		Editon3	Yes	2/00 – 5/11
		Edition3	Testing	6/11 – 12/11
	ERBE-like	Edition1	Yes	6/02 - present
		Edition2	Yes	6/02 – 8/10
		Editon3	Yes	2/00 – 5/11
		Edition3	Testing	6/11 – 12/11

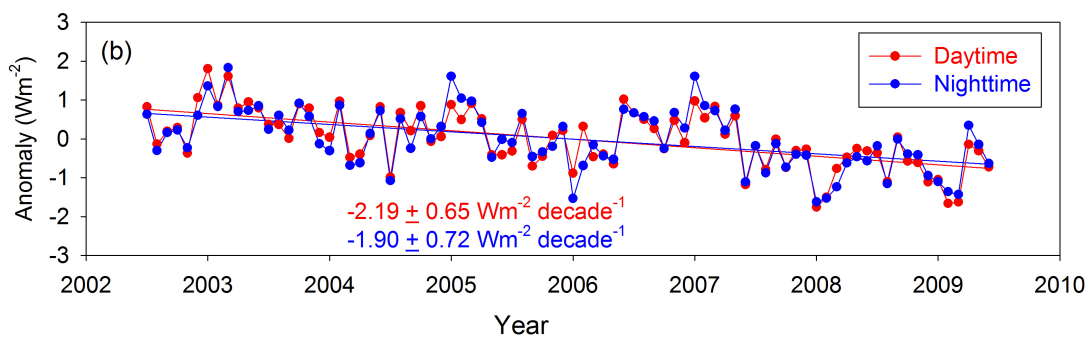
TERRA/AQUA EDITION COMPARISON



LW TOA Flux Anomaly
Global All-sky
FM1 Edition2

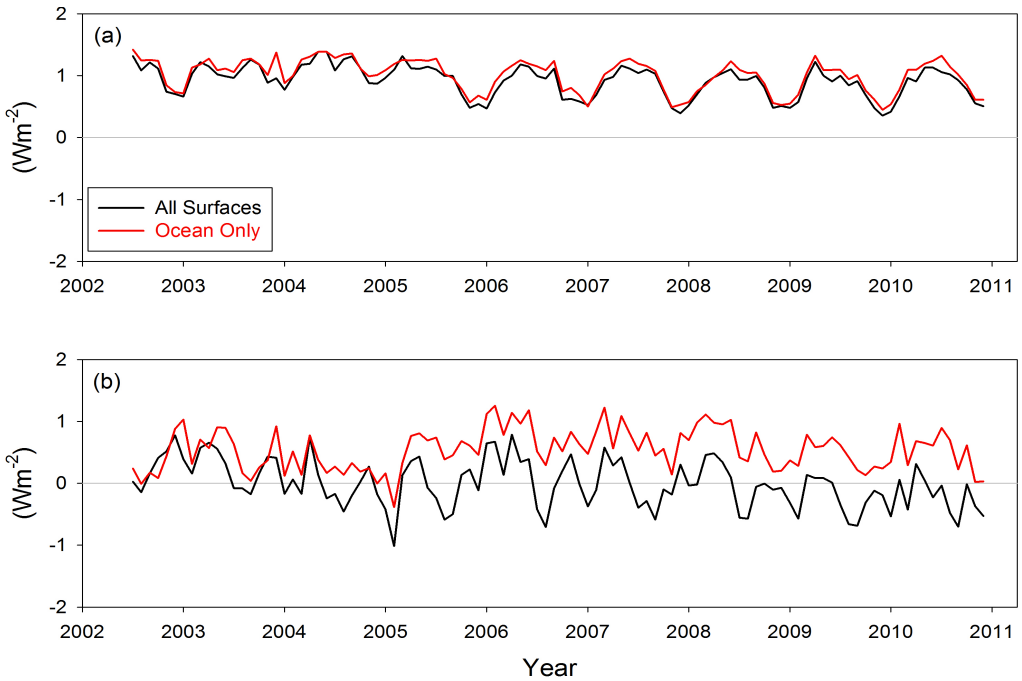


AQUA Crosstrack
Edition3
30ºN -30ºS



TERRA Crosstrack
Edition3
30ºN -30ºS

TERRA/AQUA EDITION-3 LW Comparison



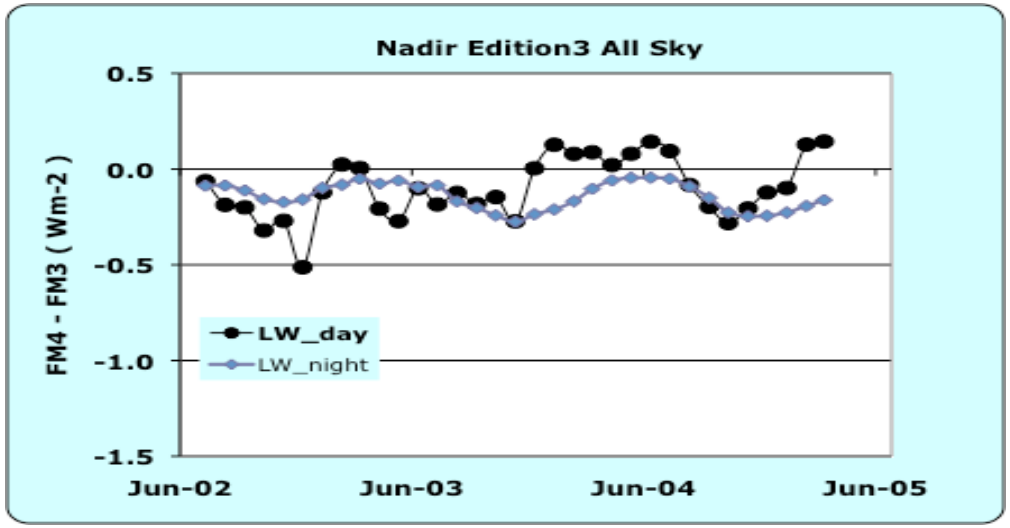
Terra minus Aqua all-sky LW TOA flux difference for (a) nighttime and (b) daytime over 60°S-60°N based on the SSF1deg-lite_Ed2.5 product.

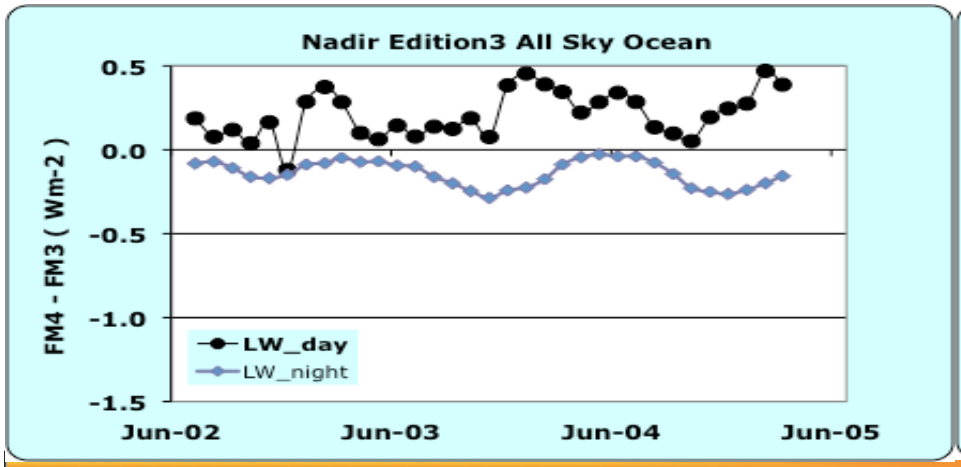
Daytime Ocean-Only result show a bias in the trend at April 2005.

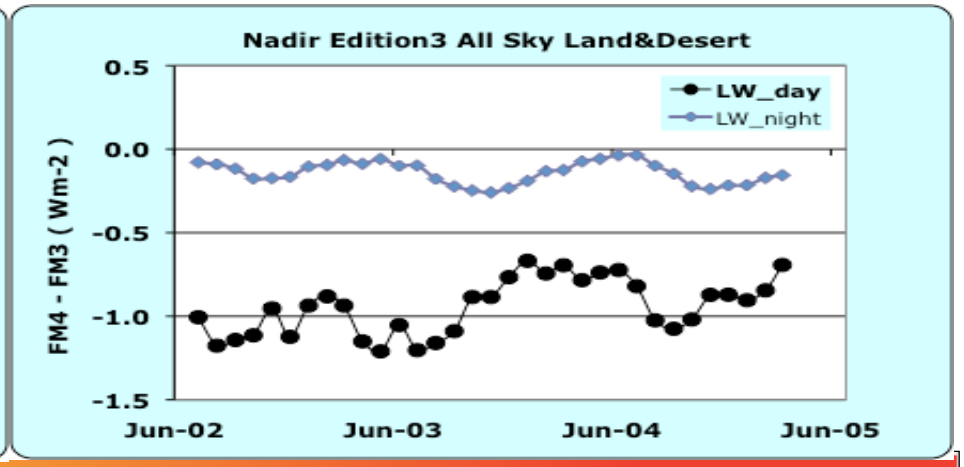
TERRA-AQUA EDITION-3 LW Comparison

Aqua FM4-FM3
Direct Compare

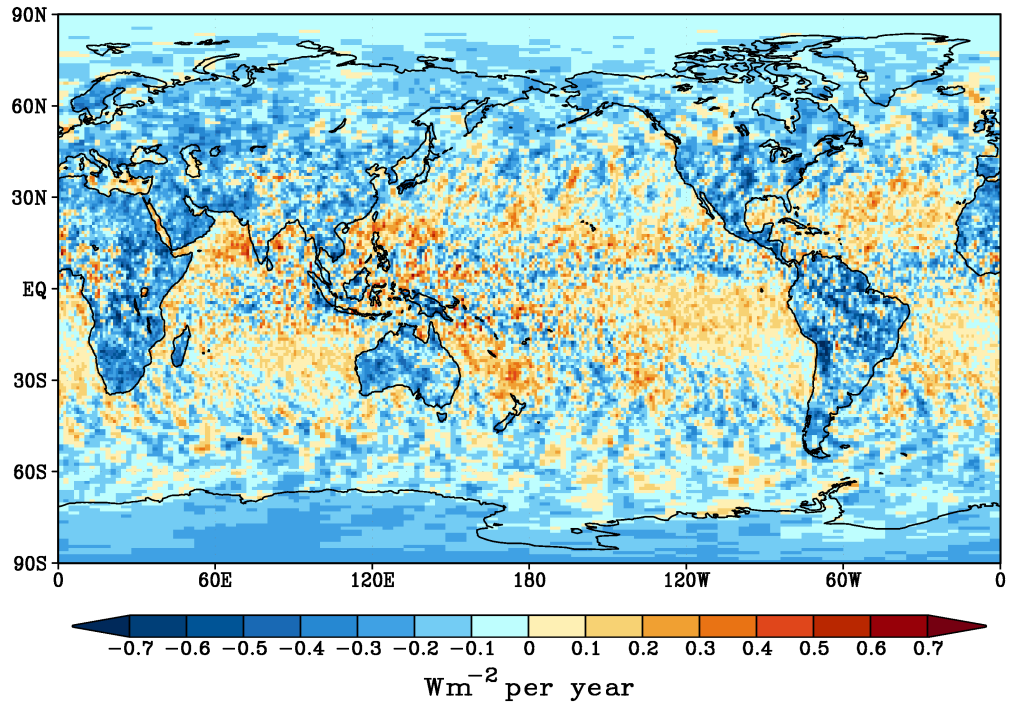
ERBE-Like ES8
Nadir Dataset







TERRA/AQUA EDITION-3 DATA

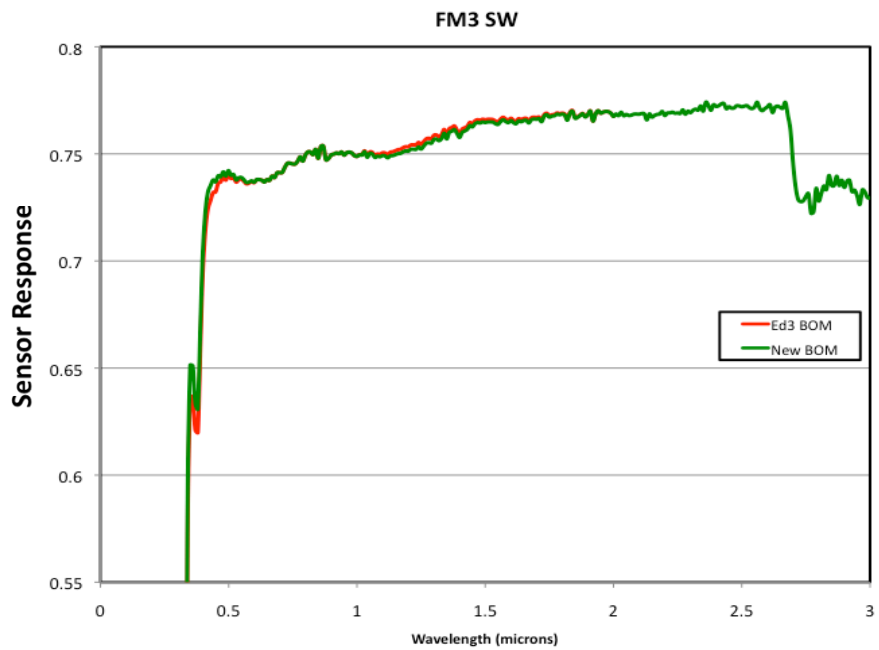


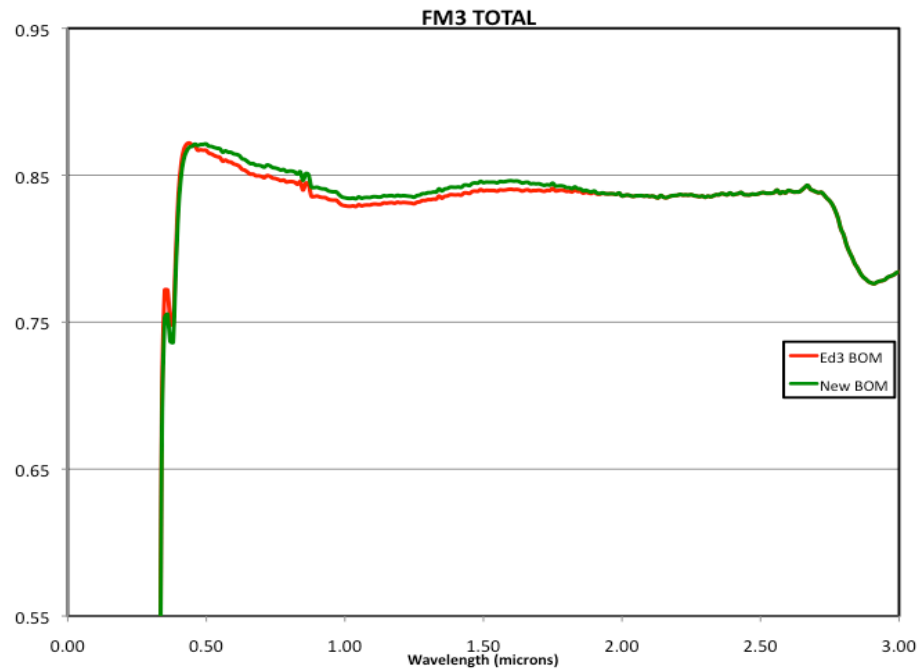
Slope of Terra minus Aqua all-sky LW TOA flux anomalies for July 2002-June 2009 from SSF1deg-lite_Ed2.5. (Units: Wm^{-2} per year)

Negative trend over the Land and a positive trend over Ocean region

AQUA Beginning-Of-Mission SRF

The Beginning-of-Mission (BOM) Spectral Response Functions (SRF) for the Aqua Instruments (FM3 and FM4) were evaluated.
Ground Calibration measurement noise for shortwave (<2 microns) characterization using narrow band filters was assessed to estimate it's impact on the SRF.





AQUA Beginning of Mission Flux Comparison

ERBE-like ES8 NADIR Matched Footprint Comparison

SW Flux

	All Sky Flux (W/m²)			All Ocean Flux (W/m²)			All Land Flux (W/m²)			
SRF	FM3	FM4	Diff%	FM3	FM4	Diff%	FM3	FM4	Diff%	Disp
Ed3 BOM	236.65	235.94	**-0.30**	207.68	206.95	**-0.35**	284.06	283.48	**-0.21**	**-0.14**
New BOM	235.97	236.06	**0.04**	206.37	206.34	**-0.01**	283.83	284.12	**0.10**	**-0.11**

LW-day Flux

	All Sky Flux (W/m²)			All Ocean Flux (W/m²)			All Land Flux (W/m²)			
SRF	FM3	FM4	Diff%	FM3	FM4	Diff%	FM3	FM4	Diff%	Disp
Ed3 BOM	247.36	247.44	**0.03**	243.63	243.86	**0.09**	269.87	269.18	**-0.25**	**0.34**
New BOM	247.33	247.45	**0.05**	243.98	244.12	**0.06**	268.61	268.54	**-0.03**	**0.09**

Diff%= (FM4-FM3/FM4)*100

Disp= Ocn%-Land%

AQUA Beginning of Mission Radiance Comparison

SSF - ES8 NADIR Matched Footprint Comparison

SW Radiance

	All Sky Flux (W/m²/sr)			All Ocean Flux (W/m²/sr)			All Land Flux (W/m²/sr)			
SRF	**FM3**	**FM4**	**Diff %**	**FM3**	**FM4**	**Diff%**	**FM3**	**FM4**	**Diff%**	**Disp**
Ed3 BOM	66.46	66.25	**-0.31**	55.62	55.35	**-0.48**	90.21	90.11	**-0.11**	**-0.37**
New BOM	66.26	66.25	**-0.01**	55.43	55.35	**-0.14**	90.01	90.11	**0.11**	**-0.25**

LW-day Radiance

	All Sky Flux (W/m²/sr)			All Ocean Flux (W/m²/sr)			All Land Flux (W/m²/sr)			
SRF	**FM3**	**FM4**	**Diff %**	**FM3**	**FM4**	**Diff%**	**FM3**	**FM4**	**Diff%**	**Disp**
Ed3 BOM	82.13	82.11	**-0.02**	81.38	81.40	**0.02**	93.13	92.79	**-0.37**	**0.39**
New BOM	82.10	82.11	**0.01**	81.41	81.40	**-0.01**	92.90	92.79	**-0.12**	**0.11**

Diff%= (FM4-FM3/FM4)*100

Disp= Ocn%-Land%

CERES Inter-Comparison Campaigns

- CERES Terra/FM1 – NPP/CERES FM5

  Planning stage for June 2012

  Minor plane scanning with 1 orbital crossing/day of 2 minute duration

- CERES Terra/FM1 – Aqua/FM3

  Planned for June 2012

  Minor plane scanning with 15 orbital crossing/day

- CERES Terra/FM2 – ScaRaB

  On-going: April 18 – End of May, 2012

  Comparison of matched radiance averages over 1° × 1° grid

  Temporal difference within 7.5 minutes

- CERES Terra/FM2 – GERB

  Planning stage for June 2011

SUMMARY

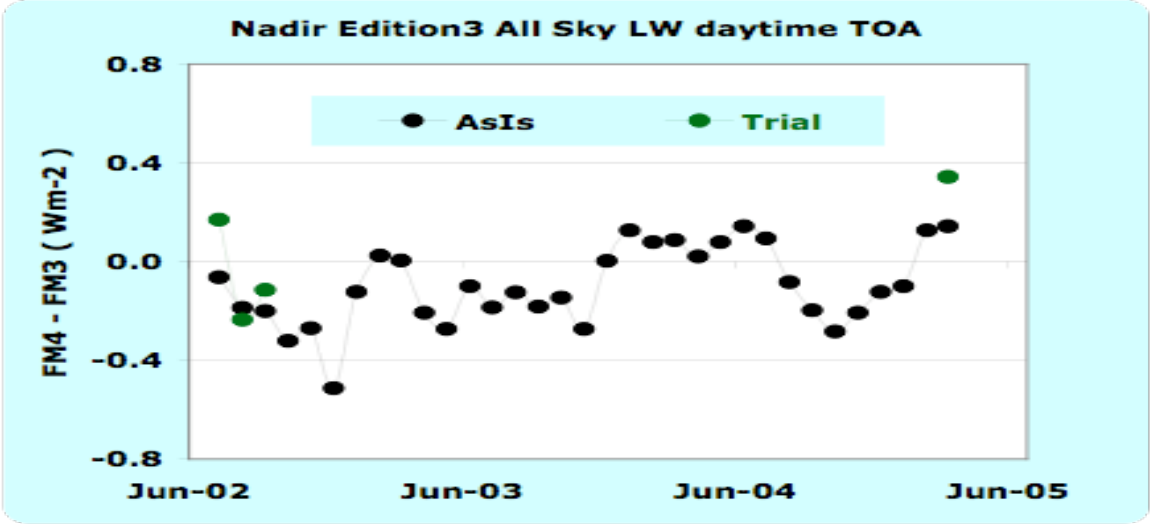
- Suomi NPP/ CERES FM5 Instrument completed all planned activities during LEO&A period and the sensor performance is within expected range based on initial calibration/validation results.
- Investigation of AQUA/TERRA Edition-3 LW-day measurement trends is on-going.
- The scene dispersion on Aqua Edition-3 LW-day results is addressed through the Beginning of Mission SRF.
- Several inter-instrument comparison campaigns (Aqua-Terra, Terra-NPP, CERES-GERB, CERES-ScaRAB) are planned during April –June, 2012.

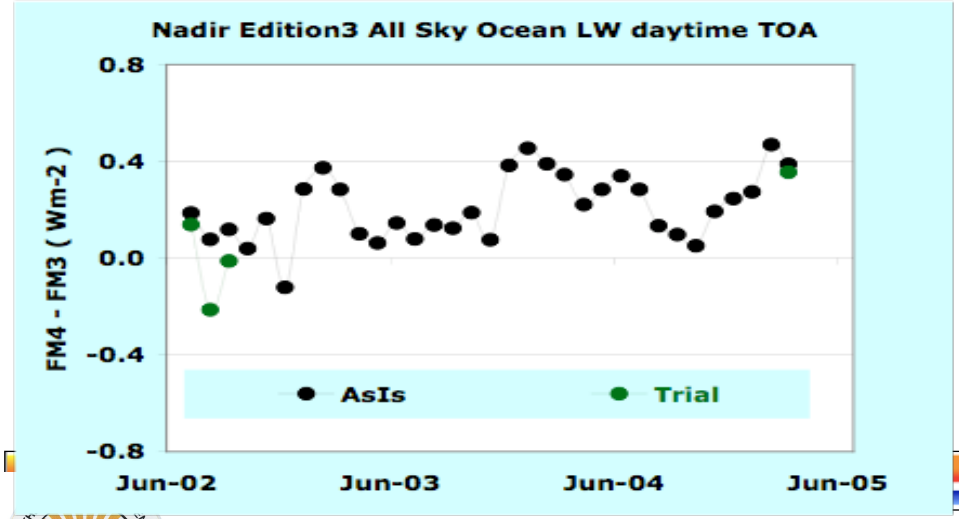
BACK-UP SLIDES

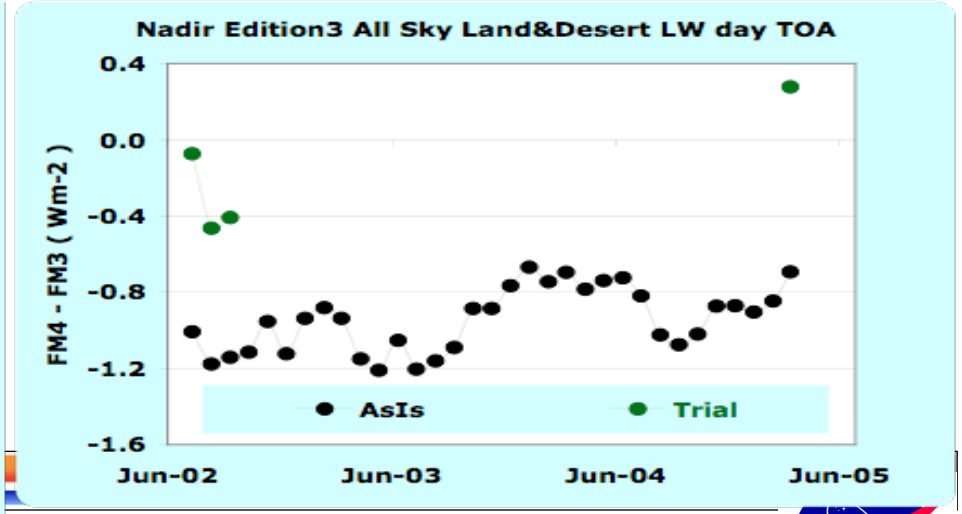
AQUA EDITION-3/NEW BOM LW-day Comparison

Aqua FM4-FM3
Direct Compare

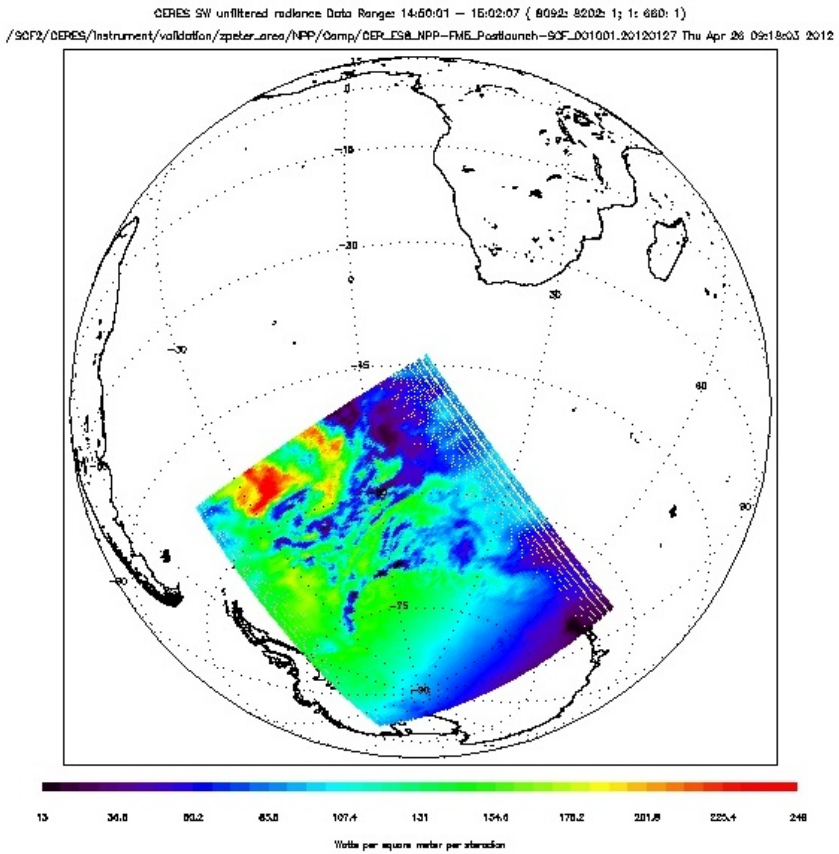
ERBE-Like ES8
Nadir Dataset

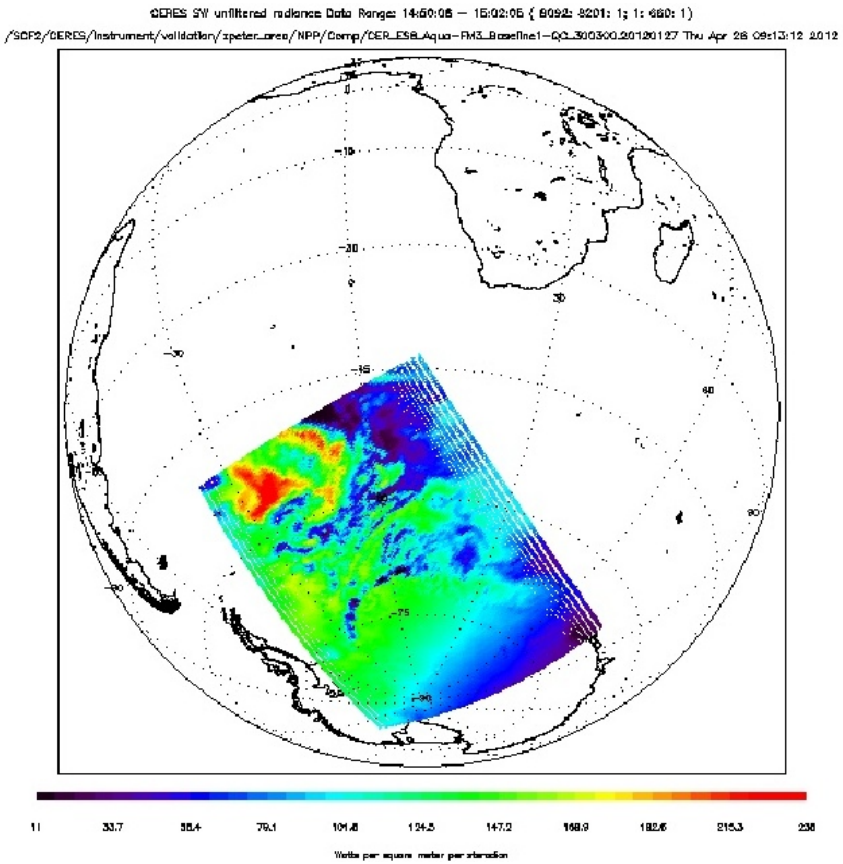






FM5/FM3 comparison region





SW

ERBE-Like

All Sky Flux (W/m²)				
SRF	**FM3**	**FM4**	**Diff**	**Diff%**
Ed3 BOM	236.65	235.94	-0.71	**-0.30**
New BOM	235.97	236.06	0.09	**0.04**

All Ocean Flux (W/m²)				
Ed3 BOM	207.68	206.95	-0.73	**-0.35**
New BOM	206.37	206.34	-0.03	**-0.01**

All Land Flux (W/m²)					Disp
Ed3 BOM	284.06	283.48	-0.58	**-0.21**	**-0.14**
New BOM	283.83	284.12	0.29	**0.10**	**-0.11**

Matched ES8-SSF

All Sky Radiance (W/m²/sr)				
SRF	**FM3**	**FM4**	**Diff**	**Diff%**
Ed3 BOM	66.46	66.25	-0.20	**-0.31**
New BOM	66.26	66.25	-0.01	**-0.01**

Diff%= (FM4-FM3/FM4)*100

All Ocean Radiance (W/m²/sr)				
Ed3 BOM	55.62	55.35	-0.27	**-0.48**
New BOM	55.43	55.35	-0.08	**-0.14**

Disp= Ocn%-Land%

All Land Radiance (W/m²/sr)					Disp
Ed3 BOM	90.21	90.11	-0.10	**-0.11**	**-0.37**
New BOM	90.01	90.11	0.10	**0.11**	**-0.25**

LW Day

All Sky Flux (W/m²)				
SRF	**FM3**	**FM4**	**Diff**	**Diff%**
Ed3 BOM	247.36	247.44	0.08	**0.03**
New BOM	247.33	247.45	0.13	**0.05**

All Ocean Flux (W/m²)				
Ed3 BOM	243.63	243.86	0.23	**0.09**
New BOM	243.98	244.12	0.14	**0.06**

All Land Flux (W/m²)					Disp
Ed3 BOM	269.87	269.18	-0.69	**-0.25**	**0.34**
New BOM	268.61	268.54	-0.07	**-0.03**	**0.09**

All Sky Radiance (W/m²/sr)				
SRF	**FM3**	**FM4**	**Diff**	**Diff%**
Ed3 BOM	82.13	82.11	-0.02	**-0.02**
New BOM	82.10	82.11	0.01	**0.01**

All Ocean Radiance (W/m²/sr)				
Ed3 BOM	81.38	81.40	0.02	**0.02**
New BOM	81.41	81.40	-0.01	**-0.01**

All Land Radiance (W/m²/sr)					Disp
Ed3 BOM	93.13	92.79	-0.34	**-0.37**	**0.39**
New BOM	92.90	92.79	-0.11	**-0.12**	**0.11**