CERES FM1 – FM5 Instrument Status

Susan Thomas
CERES Instrument Working Group Team

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Hampton Virginia
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CERES Instrument Operations

All CERES Instruments (FM1 – FM5) on Terra, Aqua and S-NPP are operating nominally in cross-track mode.

Special Inter-comparison campaigns:

Terra/CERES FM2 – GERB: Dec 1 – 31, 2014

Terra/CERES FM2 – ScaRaB: March 22 – May 31, 2015

CERES Terra/FM1 – Aqua/FM3: June 1 – 30, '15

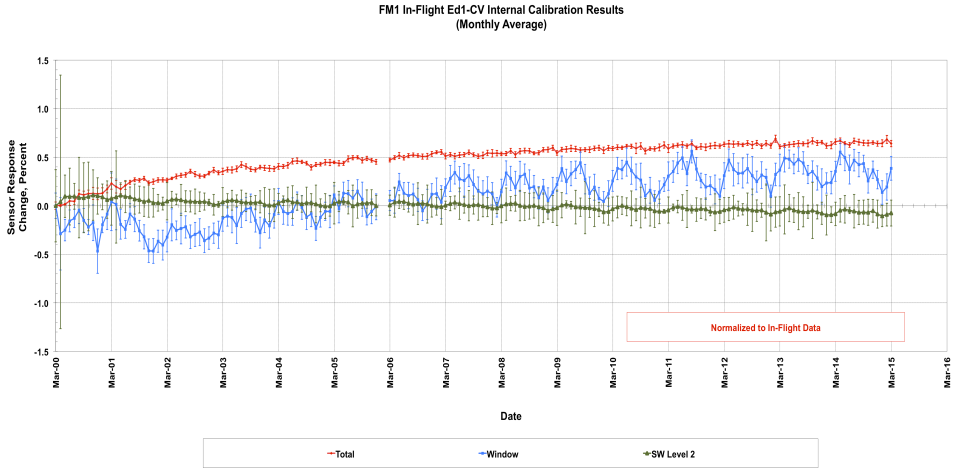
CERES Terra/FM1 – S-NPP/FM5: May 1 – July 31, '15.

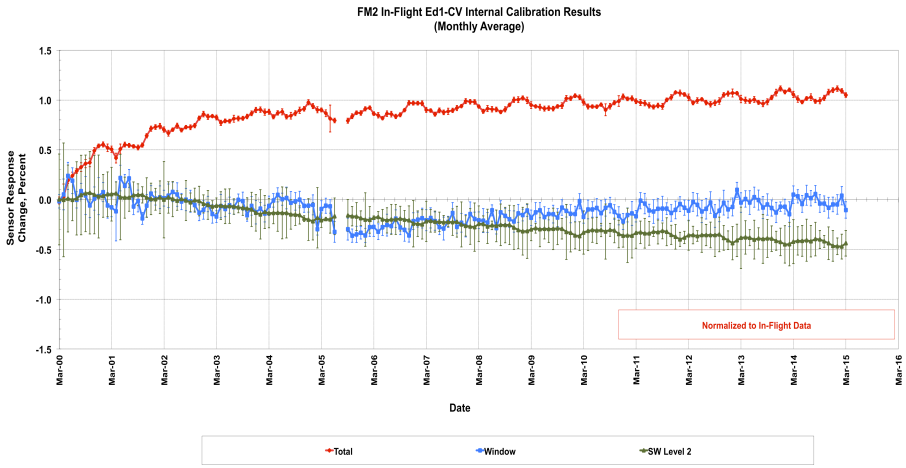
Terra/CERES FM2 – GERB: June 1 – 30, 2015

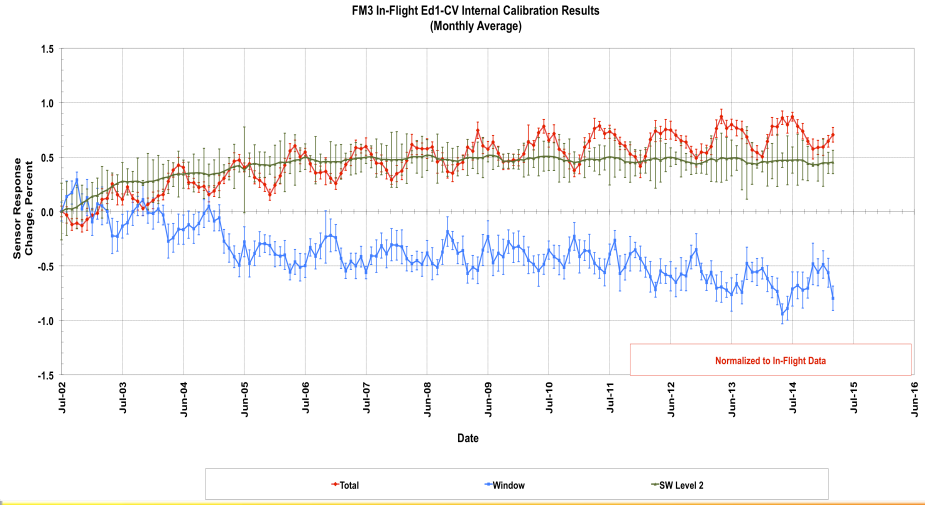
TERRA & AQUA INSTRUMENT STATUS

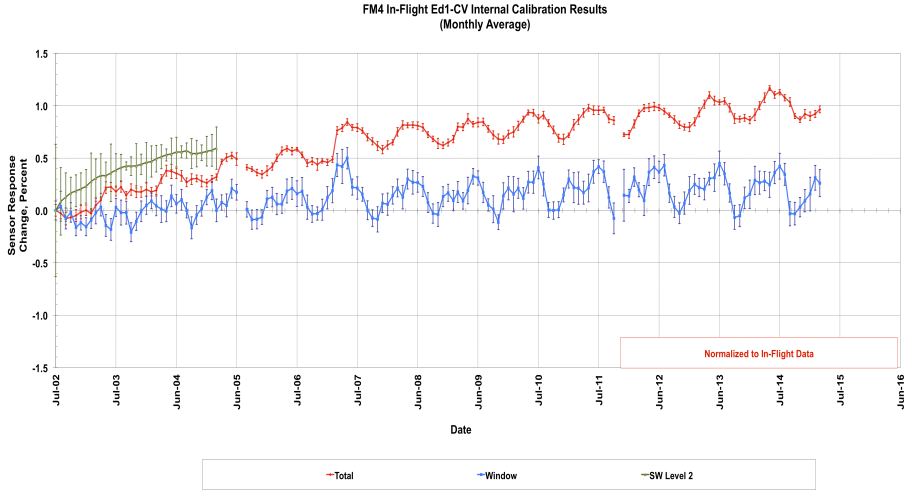
[CERES FM1 – FM4]

Terra – Aqua Sensor Performance



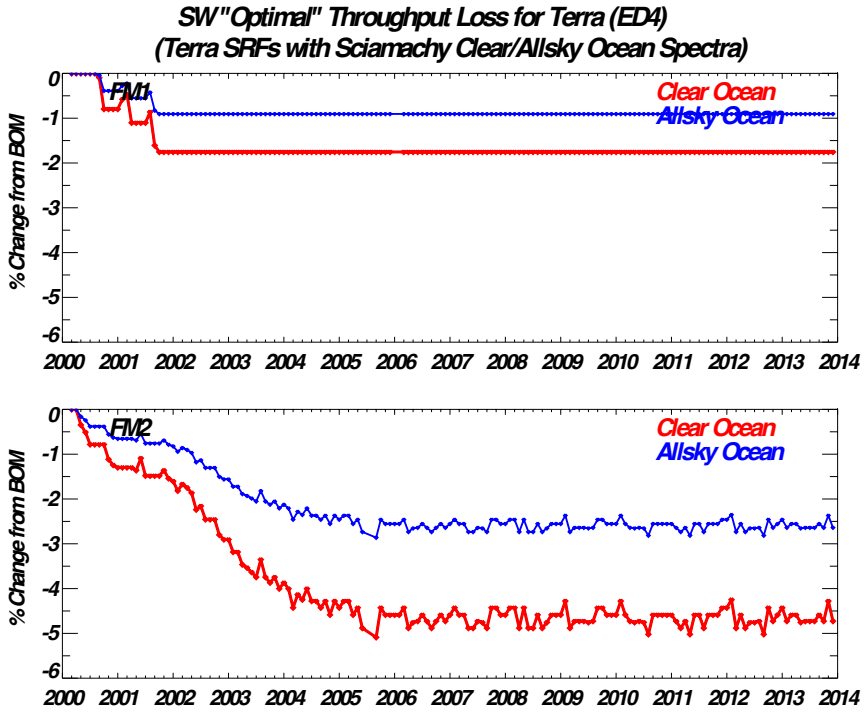




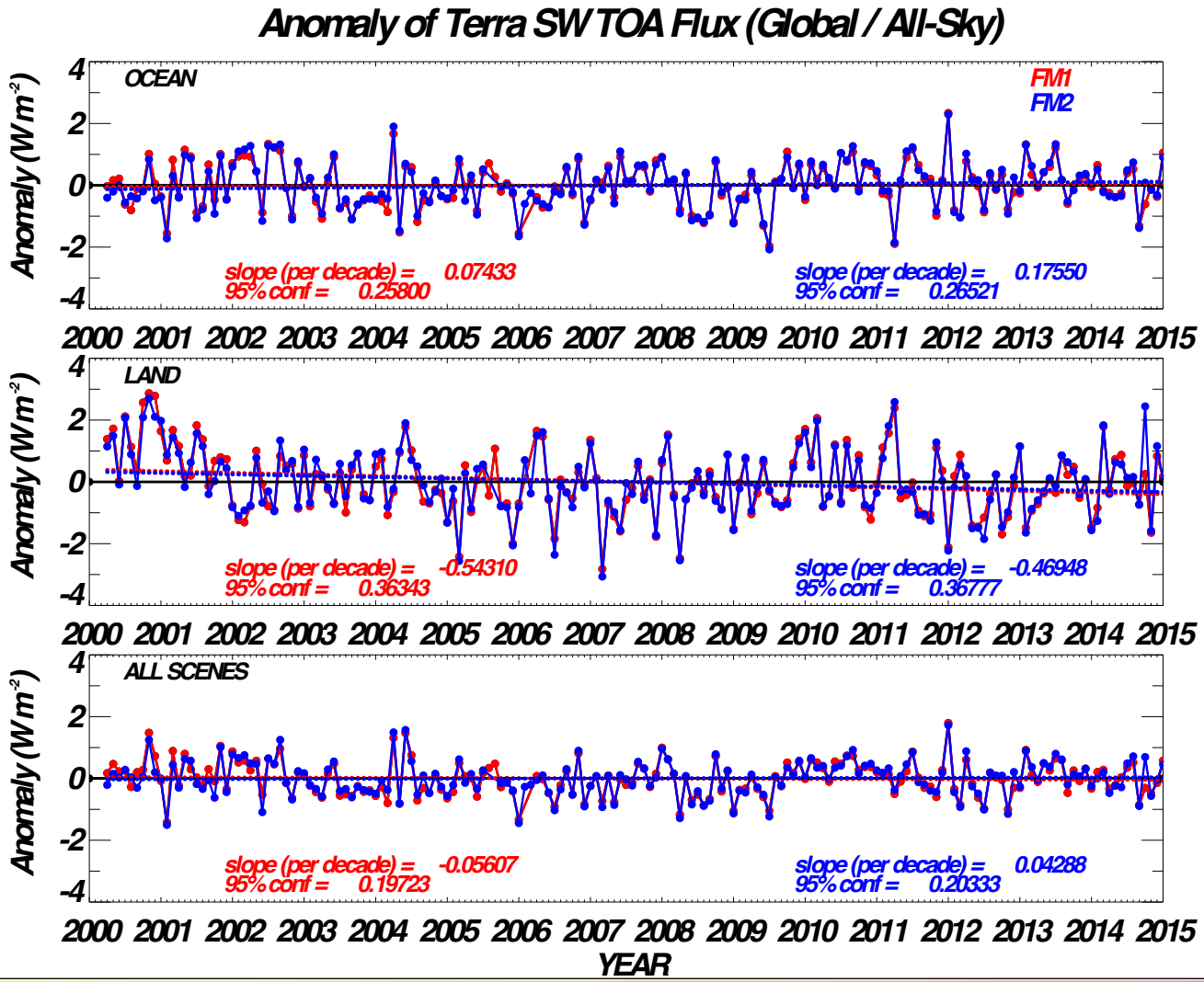


TERRA/AQUA EDITION-4

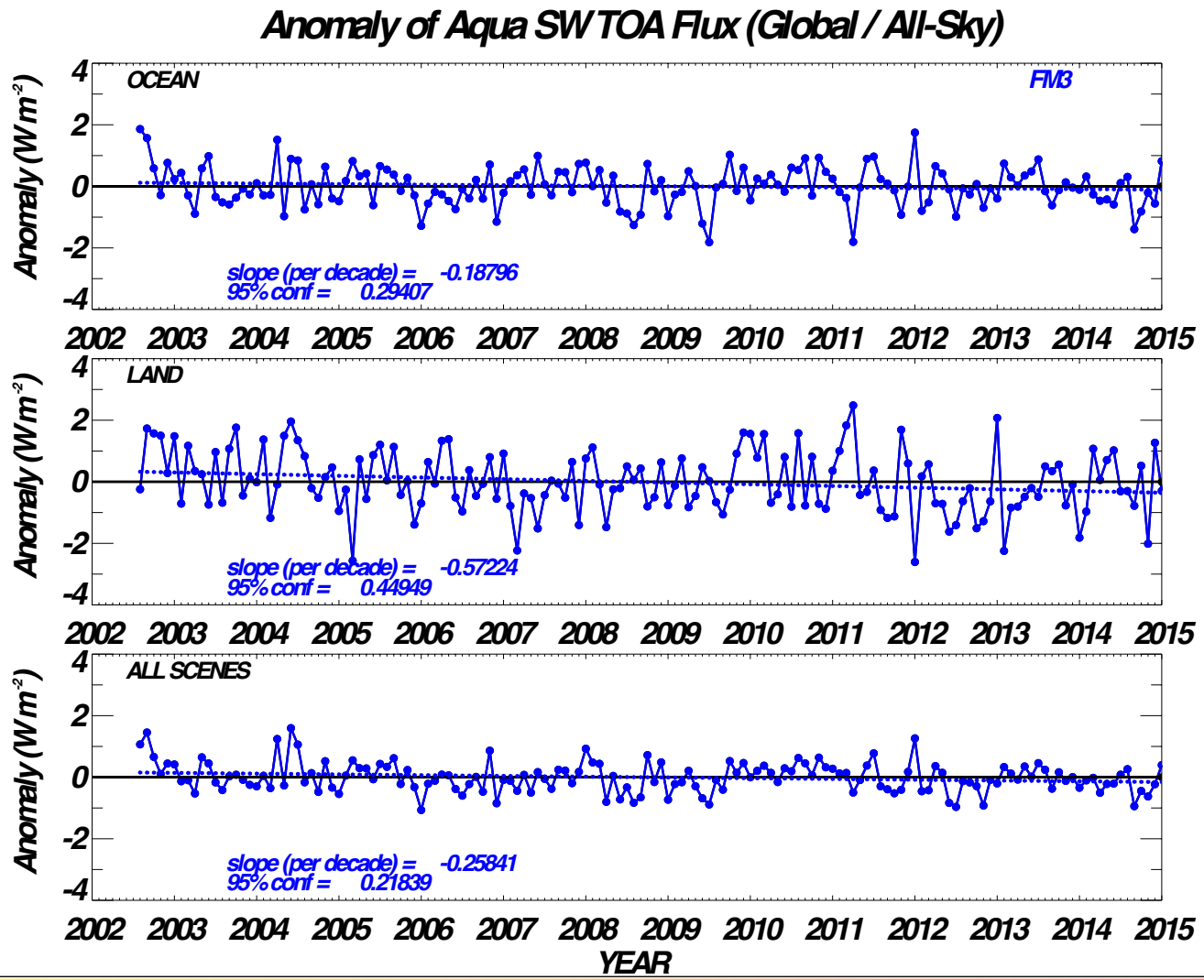
- **The SW sensor Spectral Response Function (SRF) for the instrument operating in RAPS mode is corrected based on the functional form:** $D(\lambda) = [1 - e^{-\alpha\lambda}]$



EDITION-4 VALIDATION: TERRA SW SENSORS



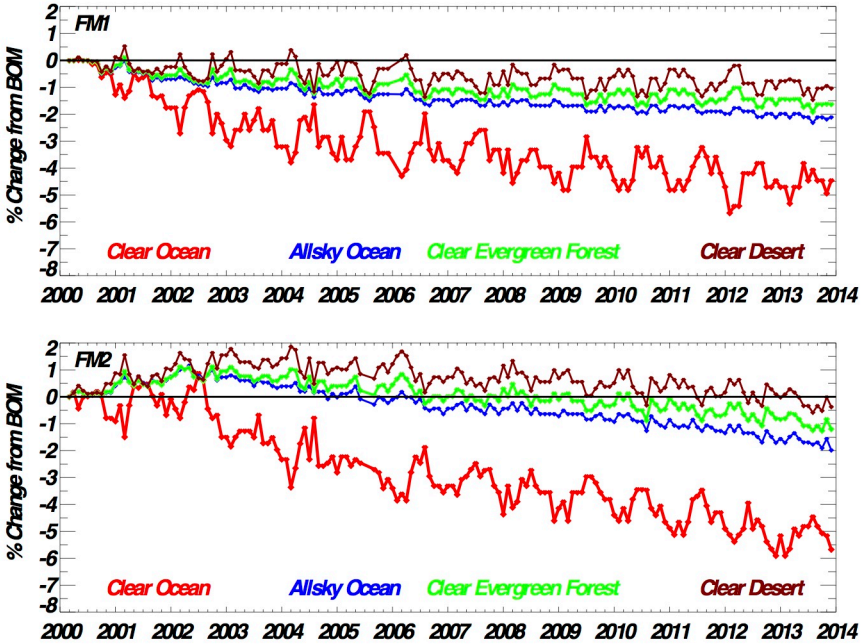
EDITION-4 VALIDATION: AQUA/FM3 SW SENSOR



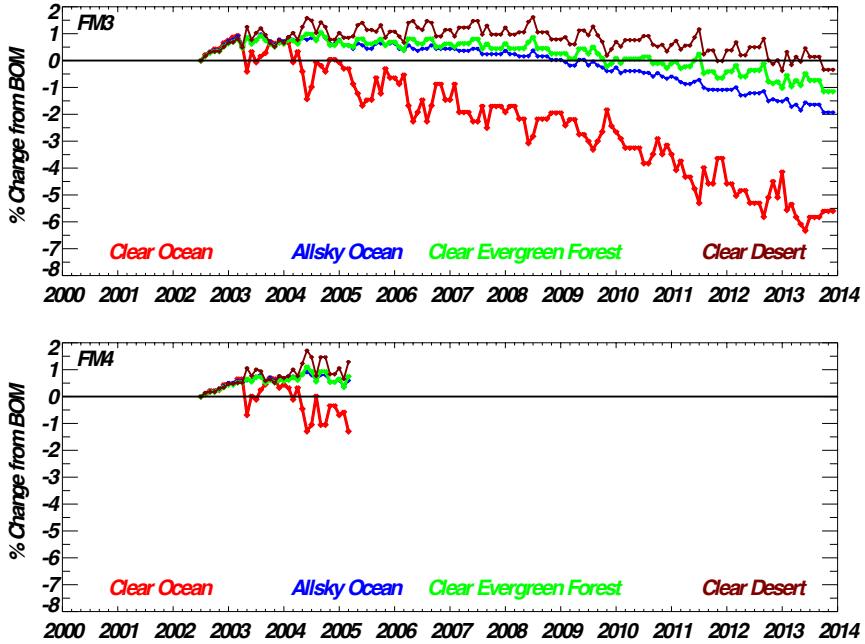
EDITION-4 TERRA/AQUA: SW/TOT SENSOR

- **Correction to SW/TOT sensor is based on the regression between LW(Day-Night) and WN (Day-Night) using Tropical Ocean and Land scenes. The corrections applied to SW/TOT SRF is of the functional form:** $D(\lambda) = [1 - e^{-\alpha\lambda}] + \beta$

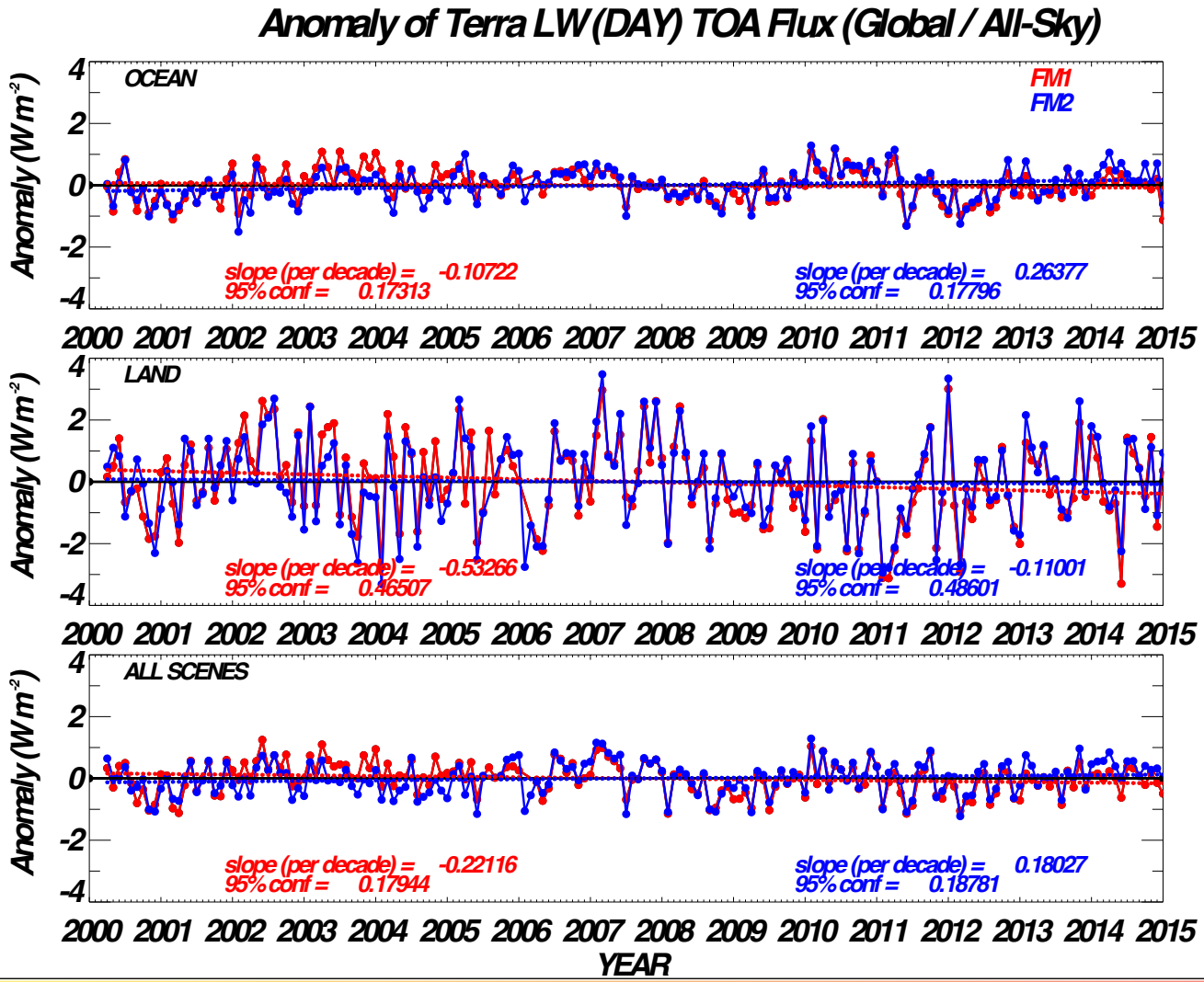
SW/TOT 'Optimal' Throughput Change for Terra (Terra SRF with Schiamachy Scene Spectra)



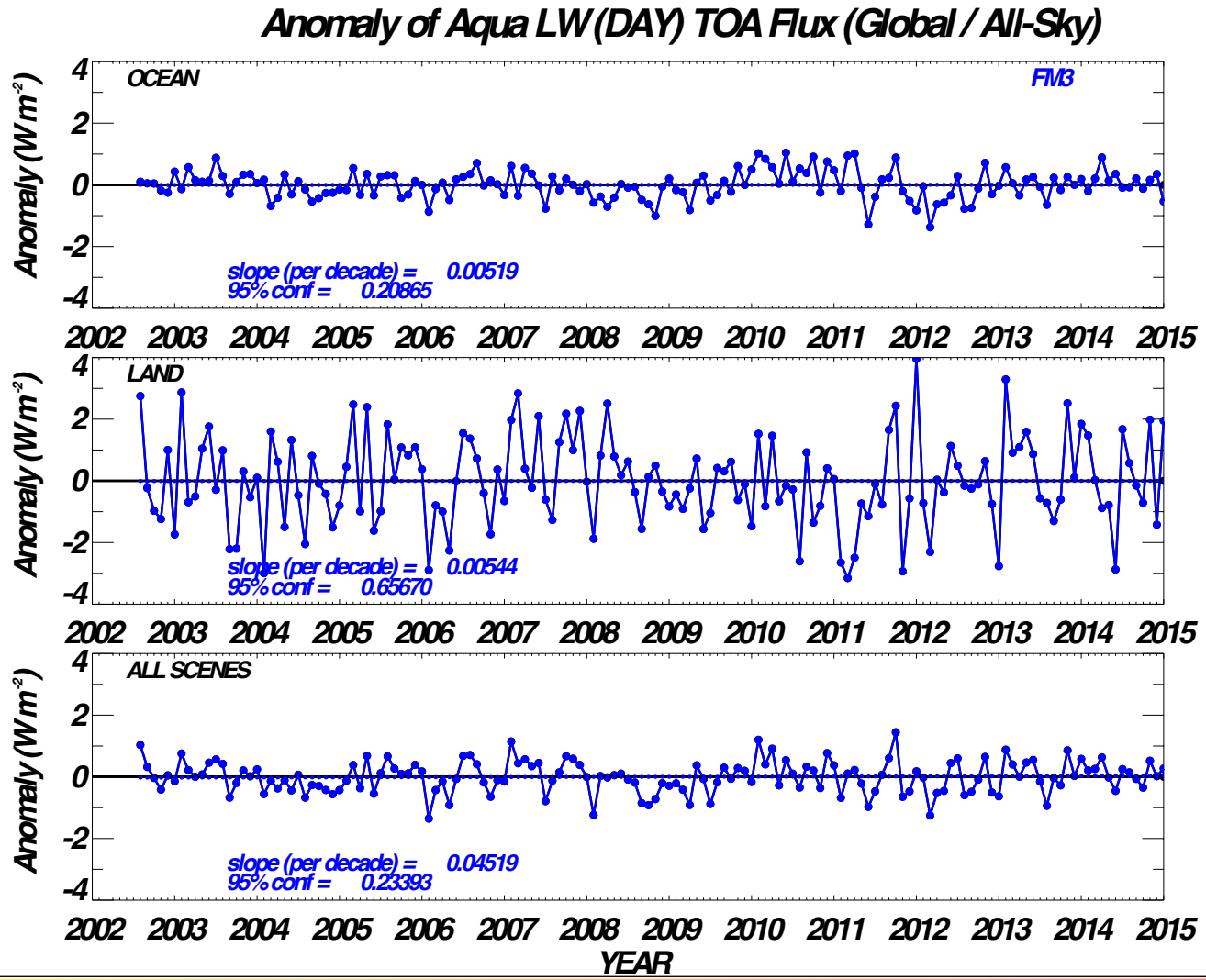
SW/TOT 'Optimal' Throughput Change for Aqua (Aqua SRF with Schiamachy Scene Spectra)



EDITION-4 VALIDATION: TERRA LW-DAY



EDITION-4 VALIDATION: AQUA/FM3 LW-DAY



TERRA/AQUA DATA AVAILABILITY

Edition3 Gains and Spectral Response Functions (SRF) :
Start of Mission – January 2015

Edition4 Gains and Spectral Response Functions (SRF) :

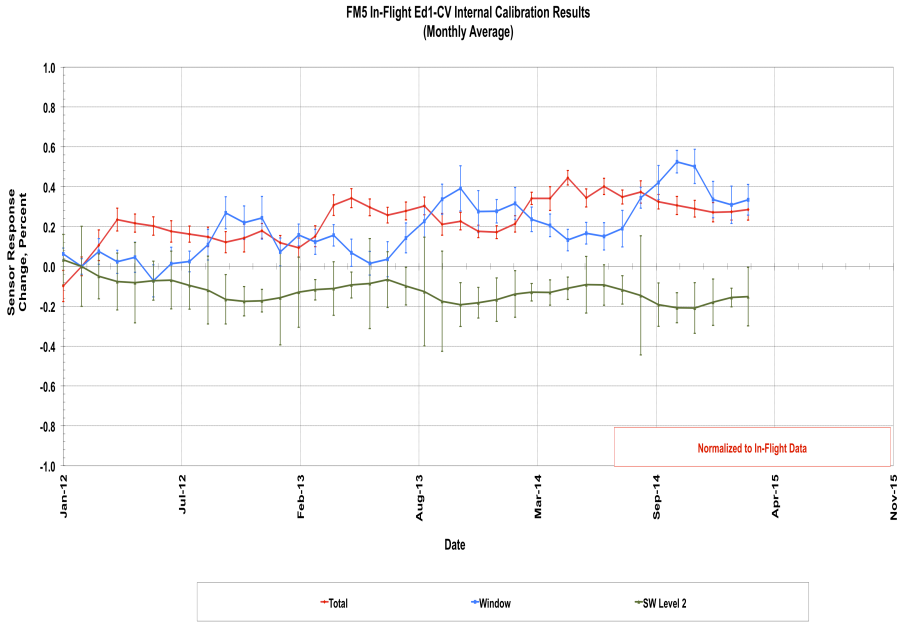
Terra and Aqua - Start of Mission to Dec 2014

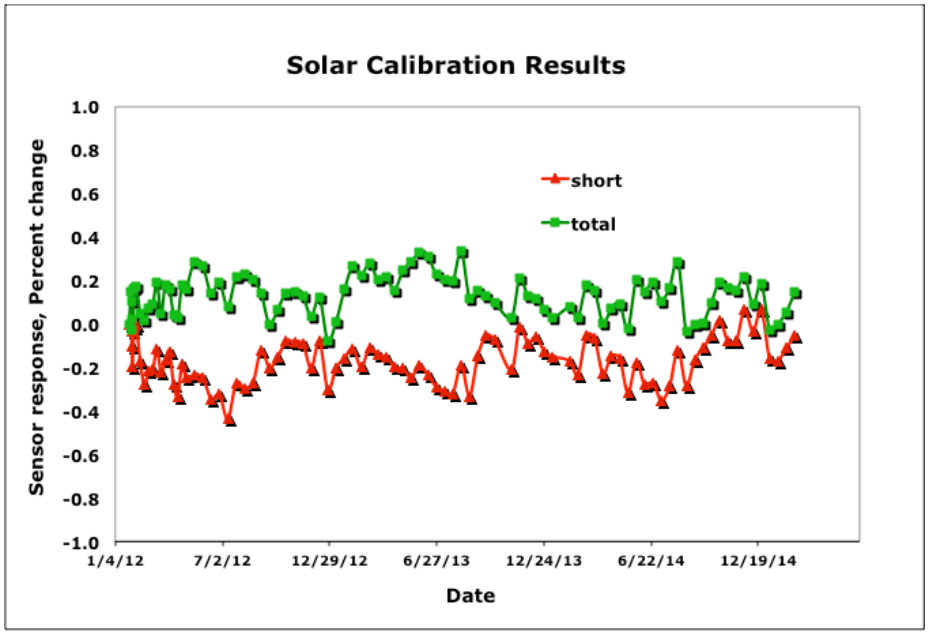
Edition1-CV Data Products (Instrument & ERBE-like):
Start of Mission – March 2015

Suomi-NPP/ CERES FM5 INSTRUMENT STATUS

S-NPP/CERES FM5 Instrument Calibration

The internal and solar calibration results show the instrument on-orbit performance are within the expected range.





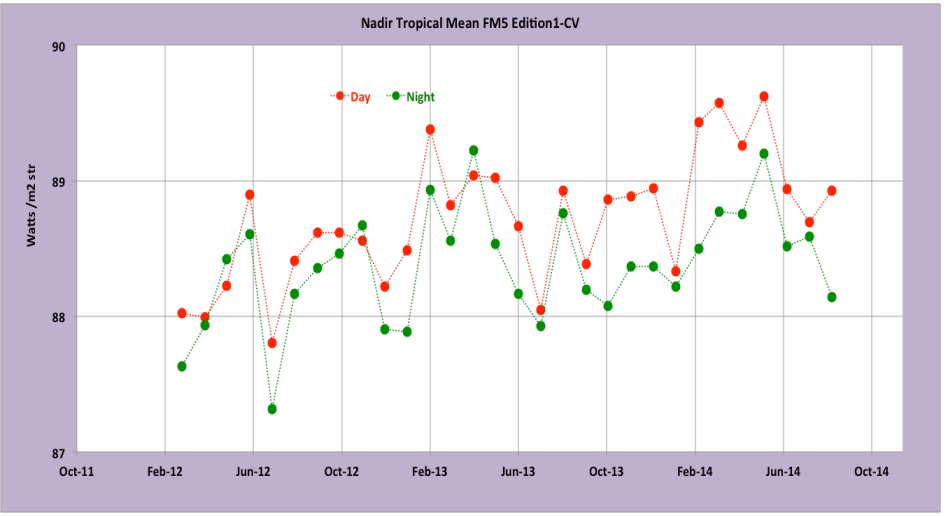
Sensor gain corrections based on ICM calibrations are applied to Edition1 data products.

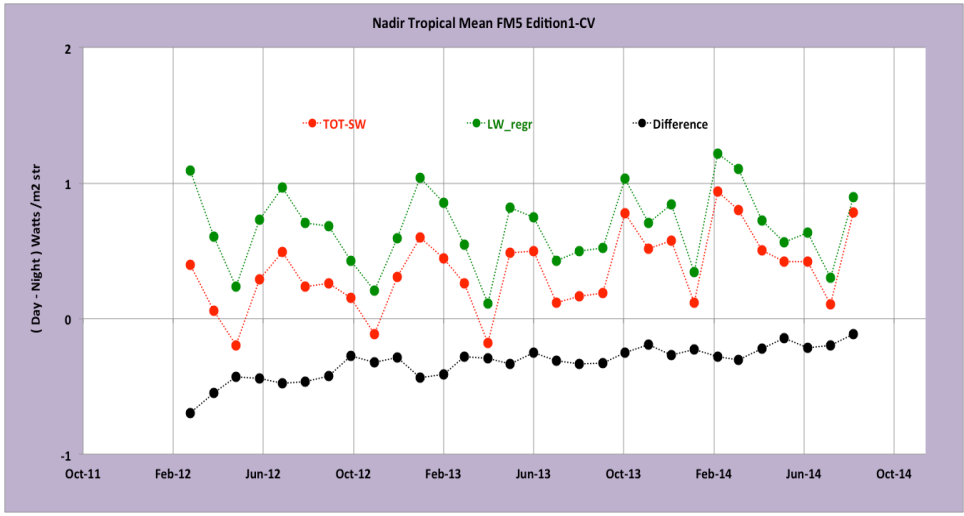
Suomi NPP/CERES FM5 Validation: Tropical Mean

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

TM Day-Night Difference (DN) is derived from the measured LW radiances and LW value derived from the Window channel.

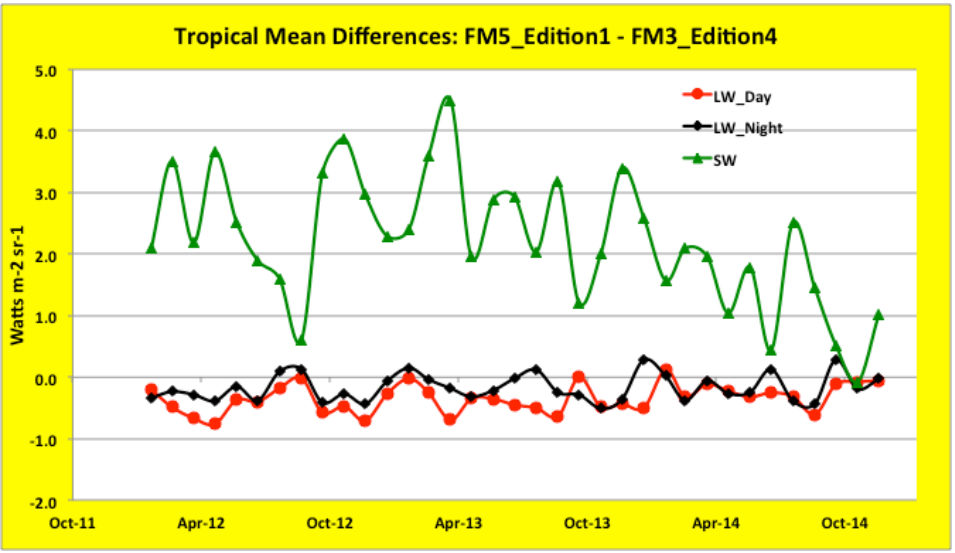
Difference in the DN value is monitored to evaluate any changes that may occur in the shortwave region of the total sensor.

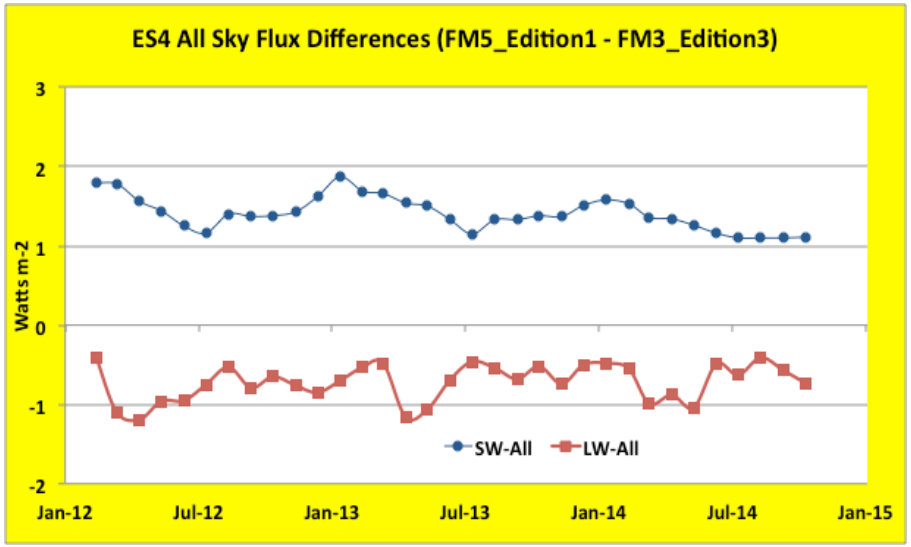




CERES S-NPP/FM5 – Aqua/FM3 Comparison

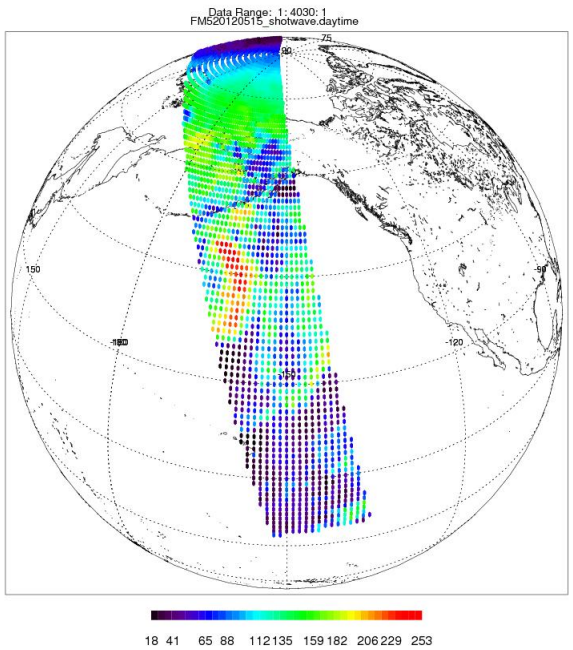
Tropical Mean Radiance Differences and the Global Flux Differences show that CERES FM5 SW measurements are higher than the corresponding CERES FM3 SW measurements.



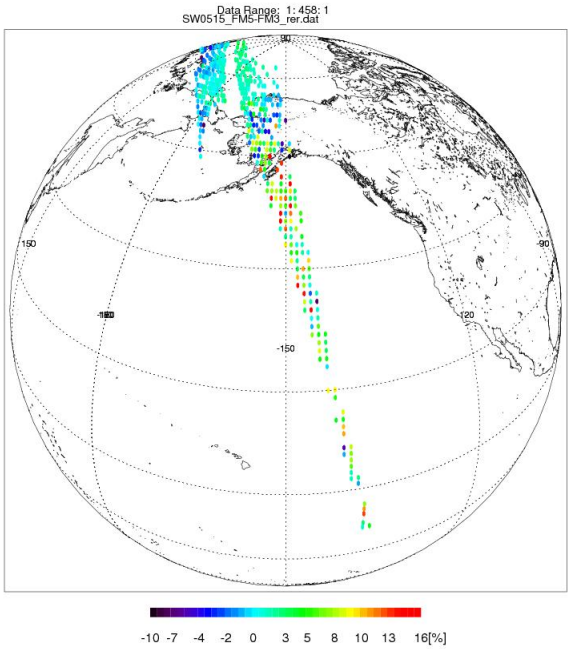


CERES FM5 - FM3 Matched Footprint Comparisons

NPP and Aqua Simultaneous Observation occur every 64 hours and last ~20 minutes with views about 20 seconds apart. Comparison based on 1° x1° grid averages with relative VZA <15 deg and RAZ < 10 deg. Each grid has 20 -25 footprints.



Averaged unfiltered radiance for 1°×1°grid



Relative difference for each matched 1°×1°grid

Direct compare of FM5 and FM3

All-sky 2012/2013/2014
ΔTime < 1min

Shown differences are statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	78.2/82.8/77.6	**3.41 / 2.50 / 0.81**	0.44/0.43/0.50	67/87/90
LW daytime	76.0/74.5/77.8	**-1.36 / -1.21 / 0.76**	0.11/0.12/0.12	68/88/90
LW nighttime	67.6/65.7/69.0	**-0.47 / -0.23 / 0.11**	0.12/0.11/0.08	86/101/100

- Edition 1 for FM5 and Edition 4 for FM1/FM3 are used
- Shown differences are computed as “average of differences” to avoid error cancellation

Direct compare of FM5 and FM3

Clear Ocean 2012/2013/2014
ΔTime < 1min

Only longwave differences for 2014 are not statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	27.3/26.3/25.3	**11.13 / 8.57 / 4.17**	1.32/1.66/1.35	48/57/66
LW daytime	89.6/87.8/90.0	**-1.07 / -0.67 / 0.07**	0.14/0.17/0.11	53/64/67
LW nighttime	92.5/92.5/92.6	**-1.01 / -0.91 / -0.07**	0.16/0.17/0.11	47/46/53

Direct compare of FM5 and FM1

All-sky 2012/2013/2014
ΔTime < 5min

Shown differences are statistically significant

(FM5-FM1)/ FM5	FM5 radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	87.0/101.6/111.1	0.81 / 0.93 / 0.86	0.26/0.17/0.14	64/108/123
LW daytime	78.6/76.1/74.8	-0.46 / -0.16 / -0.81	0.13/0.09/0.12	68/112/130

- 2012 campaign lasted only 6 weeks
  - June 16 – July 31
- 2013/2014 campaigns lasted 3 months
  - May 1 – July 31

SUMMARY

- CERES FM5 gains for Edition1 processing were delivered and are currently under production.
- FM5 – FM3 SW radiances comparisons show FM5 is higher than the FM3 measurements, with differences decreasing in 2014.
- Instrument Gain and Spectral Response Functions for the Edition3 and Edition4 processing were delivered through Jan 2015 and Dec 2014 respectively.
- Validation studies have shown that the trend for ocean and land scenes in Terra and Aqua SW and LW-day measurements was corrected in Edition-4 products.

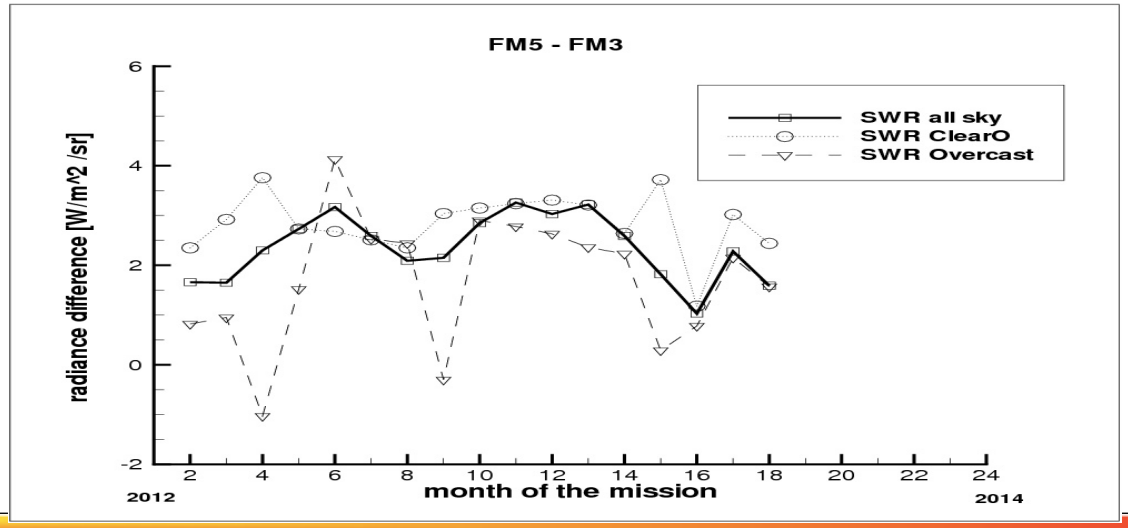
BACK UP SLIDES

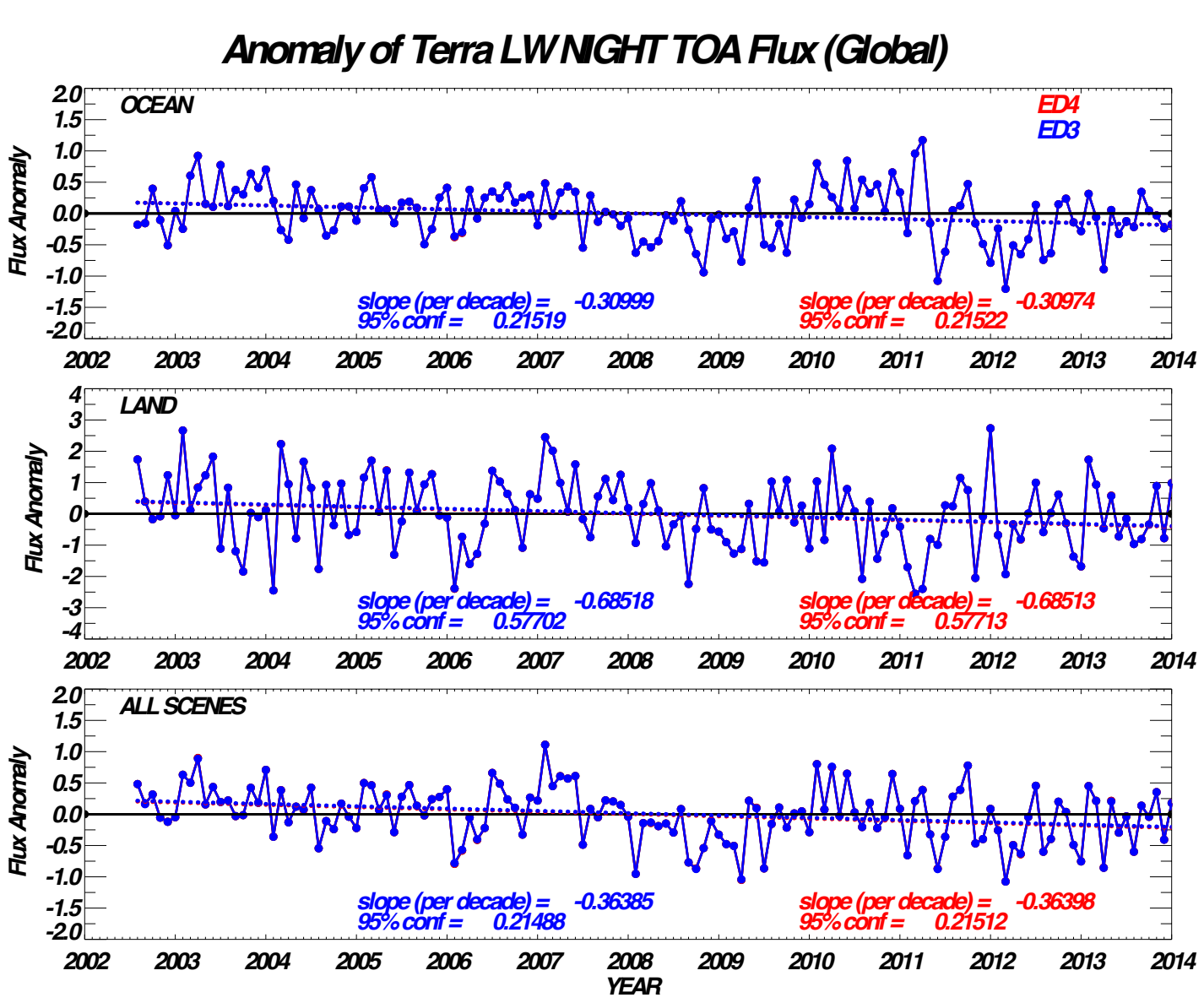
CERES FM5 - FM3 Matched Footprint Comparisons

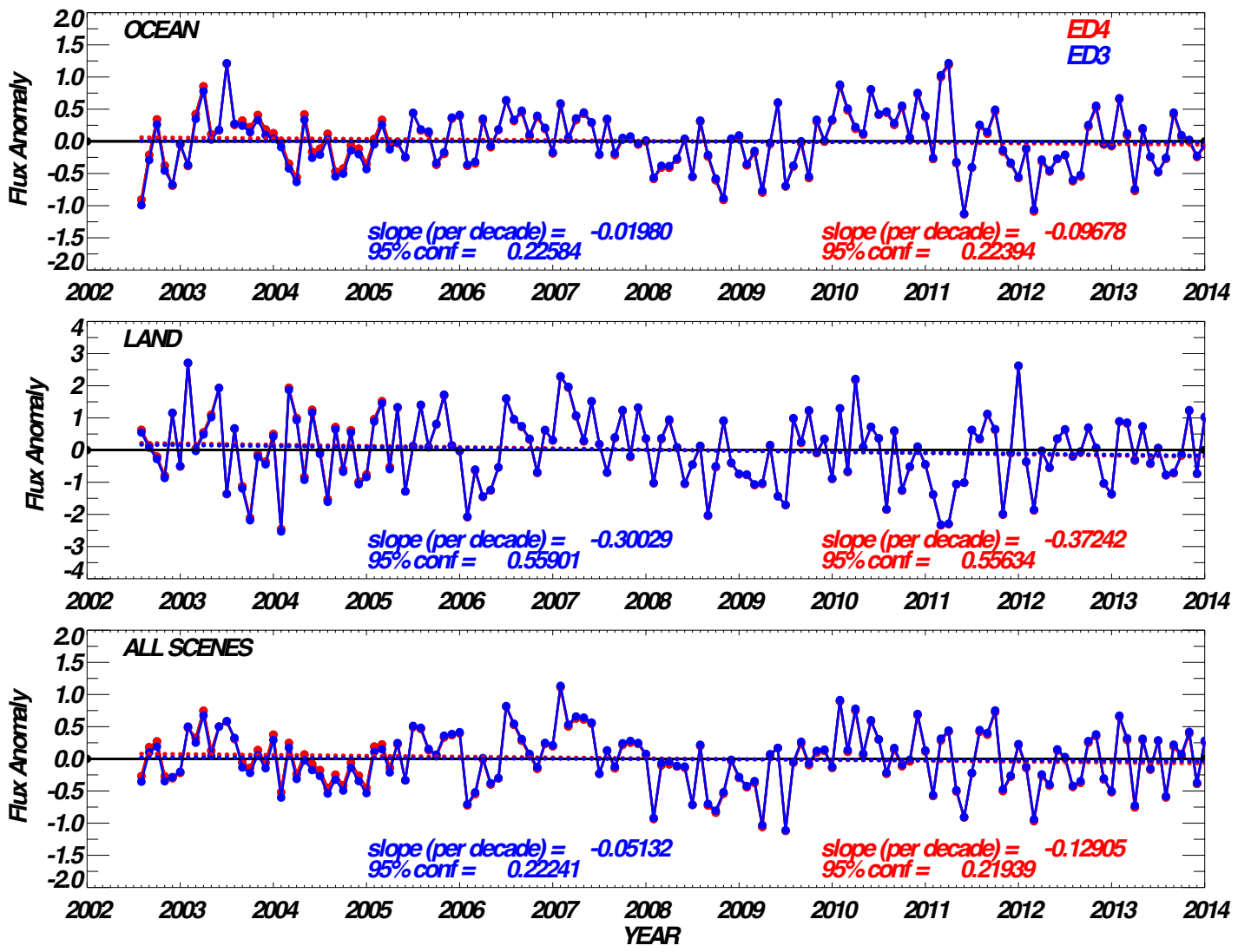
All-sky Results: February 2012 – April 2013; First repeat cycle of 432 days

(FM5-FM3)/FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	**79.10**	**3.15**	**0.45**	**99**
LW daytime	**75.04**	**-1.66**	**0.13**	**100**
LW nighttime	**66.78**	**-0.51**	**0.10**	**121**

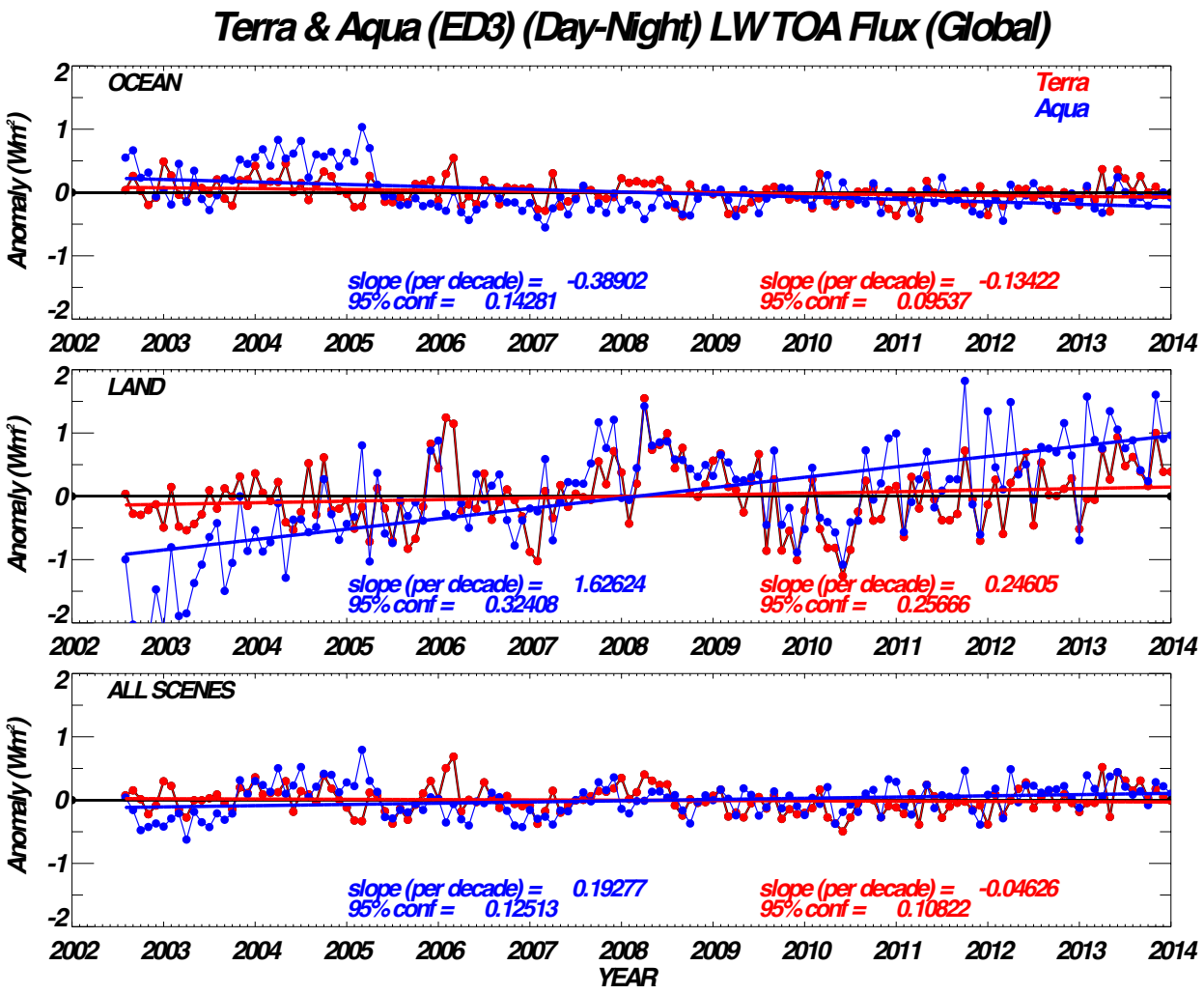
Monthly SW differences



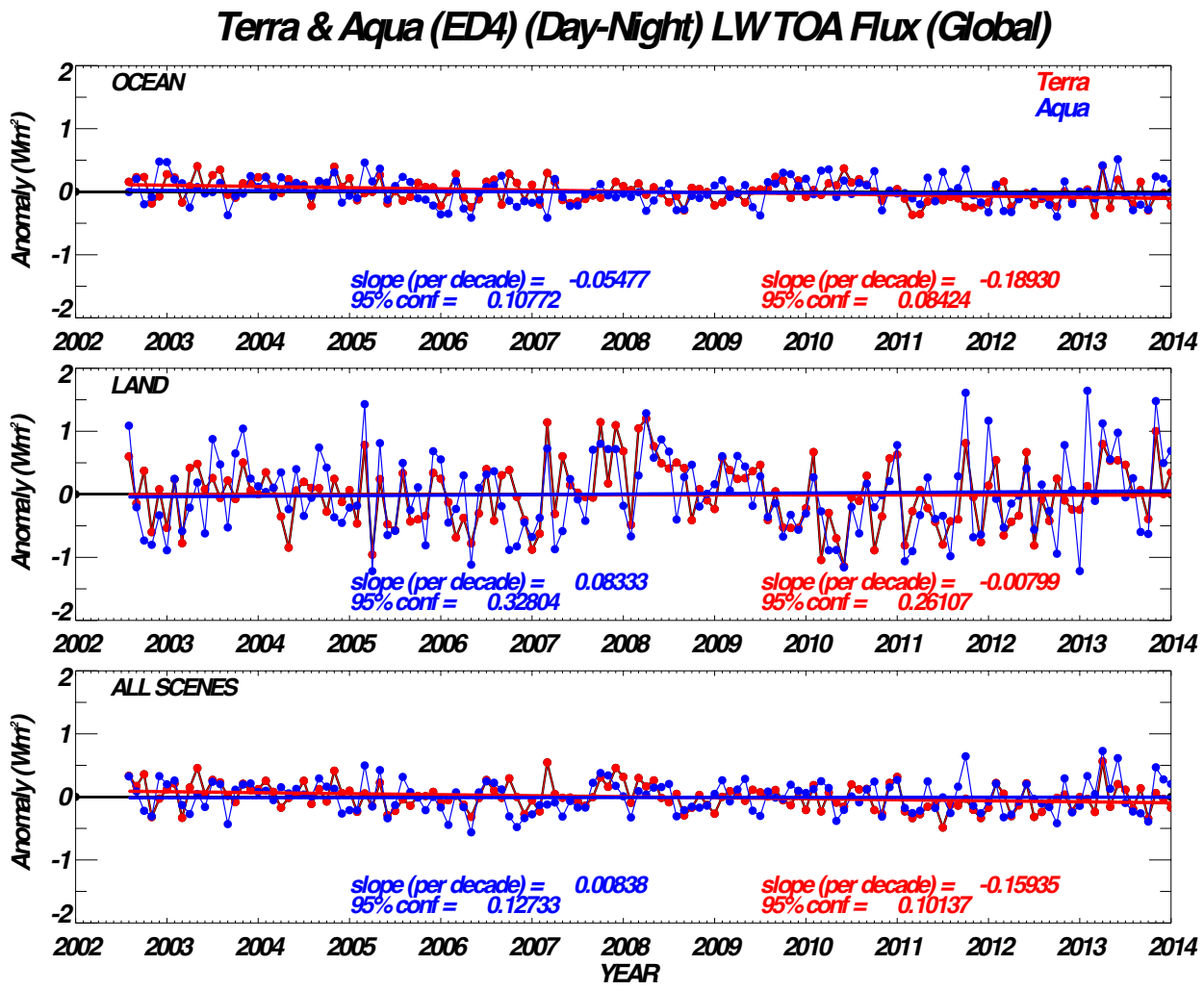

Anomaly of Terra LW NIGHT TOA Flux (Global)
OCEAN
ED4
ED3
Flux Anomaly
slope (per decade) = -0.30999
95% conf = 0.21519
slope (per decade) = -0.30974
95% conf = 0.21522
LAND
slope (per decade) = -0.68518
95% conf = 0.57702
slope (per decade) = -0.68513
95% conf = 0.57713
ALL SCENES
slope (per decade) = -0.36385
95% conf = 0.21488
slope (per decade) = -0.36398
95% conf = 0.21512
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
YEAR


Anomaly of Aqua LW NIGHT TOA Flux (Global)
OCEAN
ED4
ED3
Flux Anomaly
slope (per decade) = -0.01980
95% conf = 0.22584
slope (per decade) = -0.09678
95% conf = 0.22394
LAND
slope (per decade) = -0.30029
95% conf = 0.55901
slope (per decade) = -0.37242
95% conf = 0.55634
ALL SCENES
slope (per decade) = -0.05132
95% conf = 0.22241
slope (per decade) = -0.12905
95% conf = 0.21939
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
YEAR

TERRA/AQUA EDITION-3 VALIDATION



TERRA/AQUA EDITION-4 VALIDATION



Direct compare of FM5 and FM1

Overcast 2012/2013/2014
ΔTime < 5min

SW differences for 2012/2013 are statistically significant

(FM5-FM1)/ FM5	FM5 radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	140.6/148.2/144.0	0.18 / 0.79 / 0.67	0.49/0.28/0.24	25/53/74
LW daytime	67.5/66.4/66.4	-0.59 / -0.10 / -0.96	0.36/0.20/0.20	32/66/85

Direct compare of FM5 and FM1

Clear Land 2012/2013/2014
ΔTime < 5min

Shown differences are not statistically significant

(FM5-FM1)/ FM5	FM5 radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	39.3/40.5/38.7	1.40 / 1.34 / 0.49	1.57/1.63/0.87	23/23/17
LW daytime	90.4/89.2/88.8	0.16 / 0.23 / 0.22	0.22/0.17/0.24	28/30/27