CERES FM1 – FM5 Instrument Status

Susan Thomas
CERES Instrument Working Group Team

CERES Science Team Meeting
University of Washington
Seattle, WA
September 1 - 3, 2015

Instrument Working Group

Instrument Operation/I&T

- William Vogler -

- James Bailey -

Christopher Brown

John Butler

William Edmonds

Carol Kelly

B. Mike Tafazoli

Roy Zalameda

Data Management

- Denise Cooper -

- Dale Walikainen -

Thomas Grepiotis

Mark Timcoe

Jeremie Lande

Dianne Snyder

Science

-Susan Thomas–

Janet Daniels

Phillip Hess

Mohan Shankar

G. Lou Smith

Nathaniel Smith

Nitchie Smith

Z. Peter Szewczyk

Robert Wilson

CERES Instrument Operations

CERES Instruments, Flight Models 1- 5 (FM1 – FM5) are primarily in Cross-Track mode of operation.

Special Inter-comparison campaigns:

CERES Terra/FM1 – Aqua/FM3: June 1 – 30, 2015

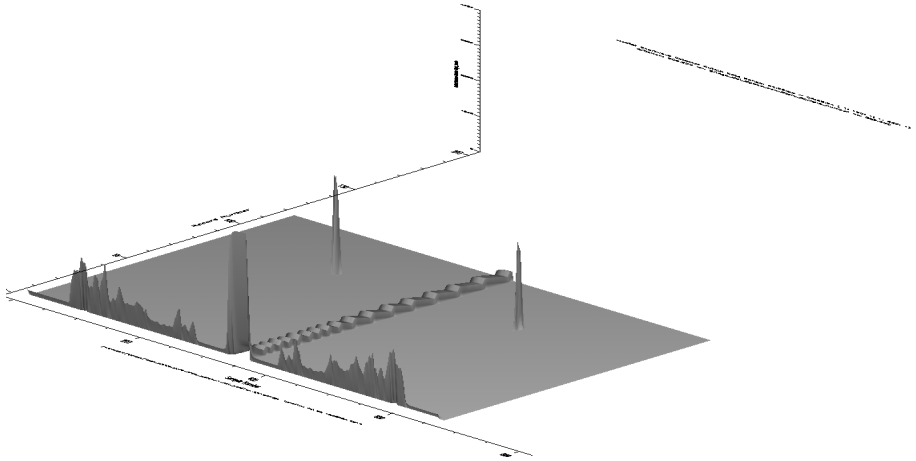
CERES Terra/FM1 – S-NPP/FM5: May 1 – July 31, 2015.

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

CERES FM5 Glint Evaluation:

Started July 23, 2015

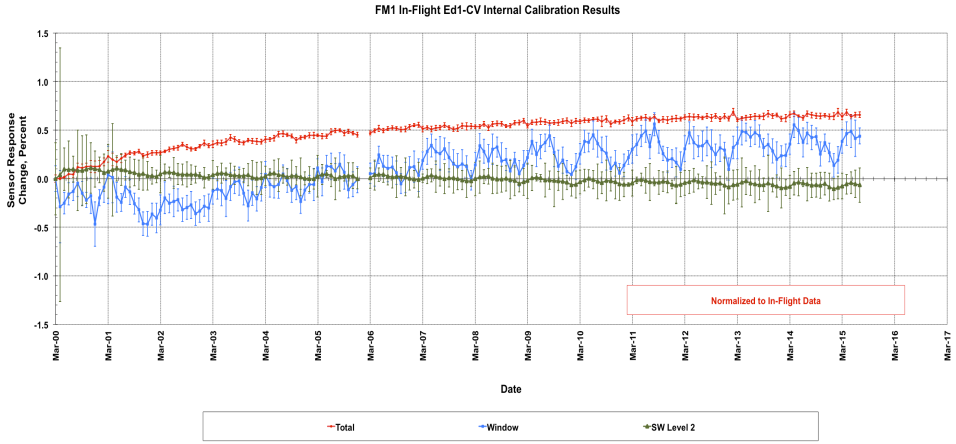
Set up to increase the dynamic range of measurement window.

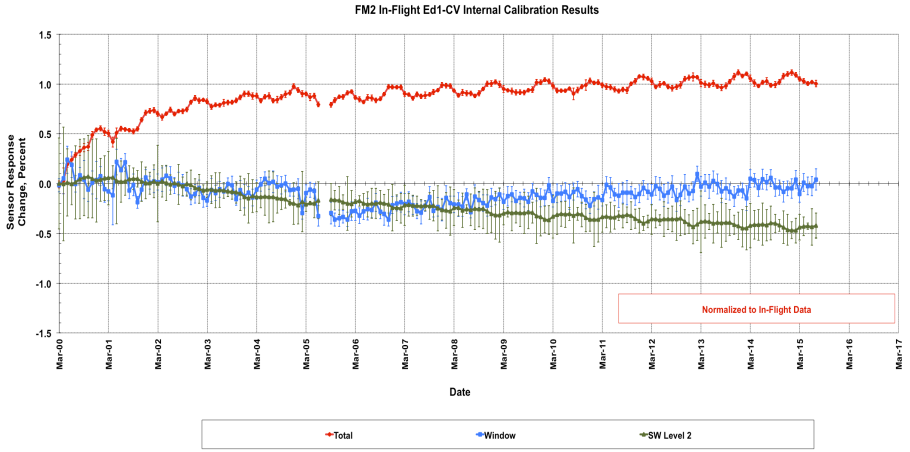


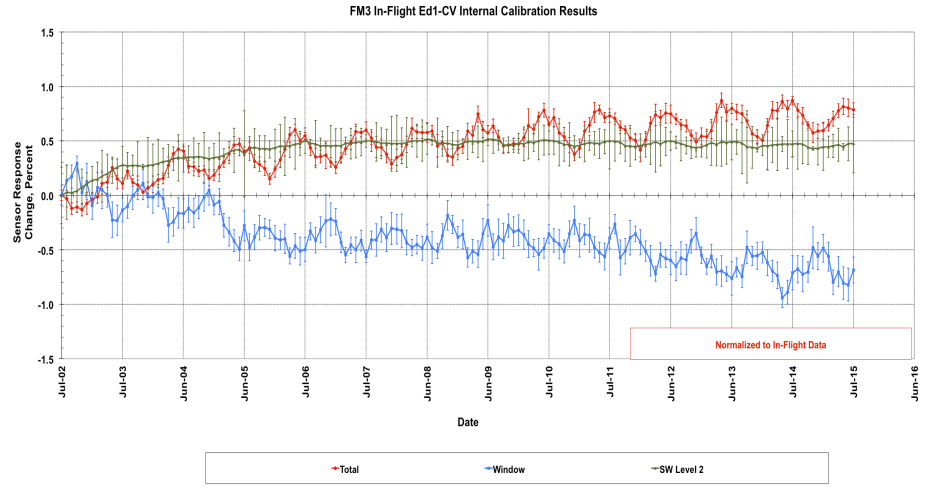
TERRA & AQUA INSTRUMENT STATUS

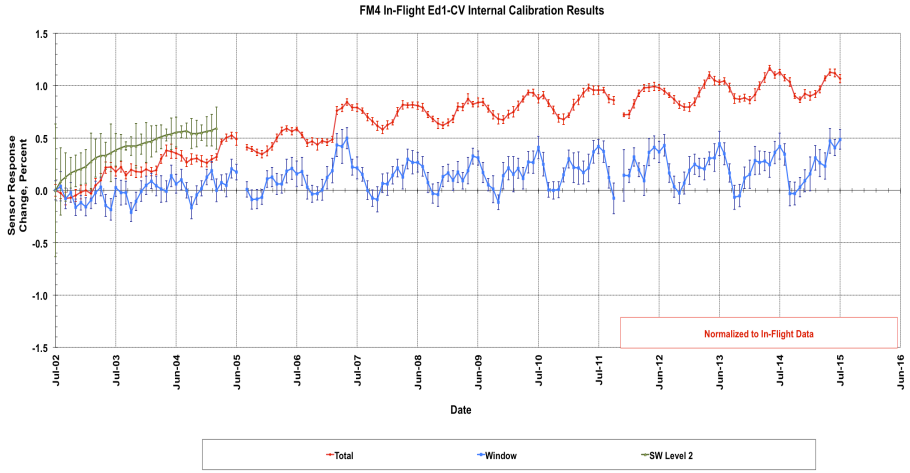
[CERES FM1 – FM4]

Terra – Aqua Sensor Performance

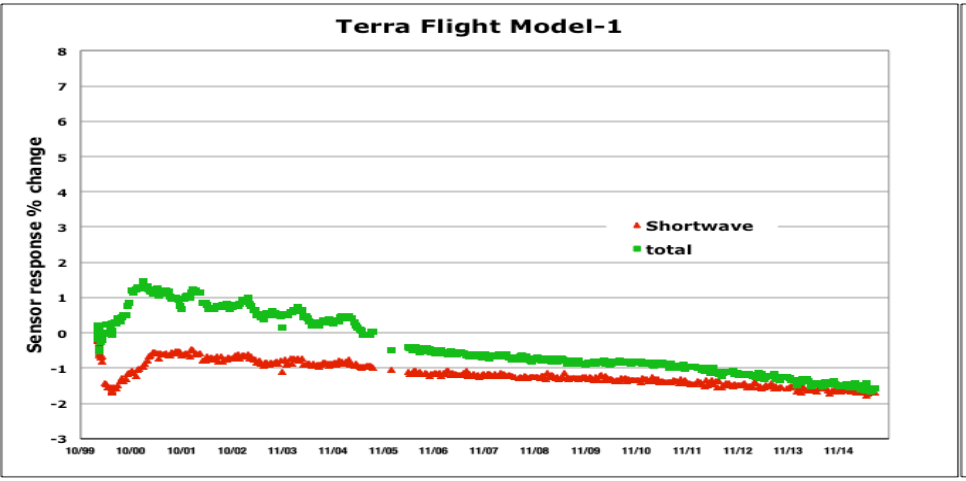


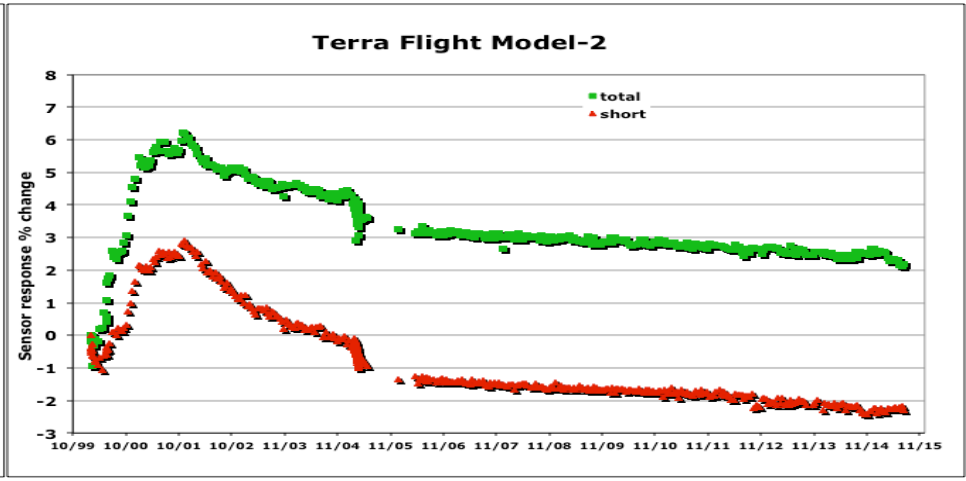


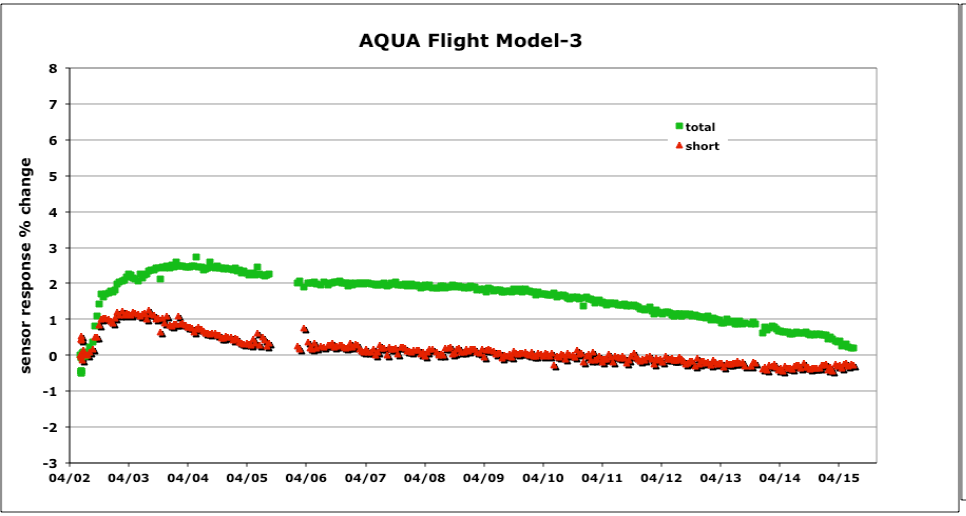


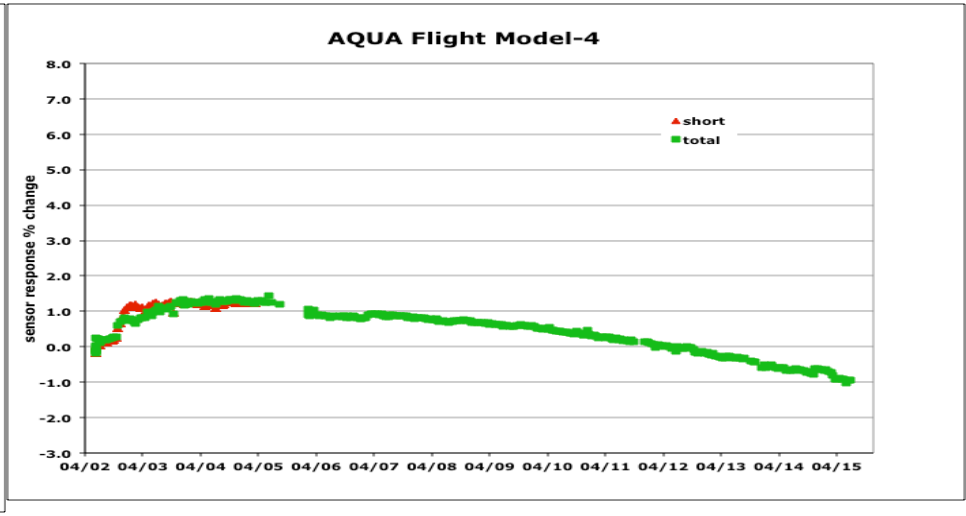


Terra – Aqua Solar Calibration Results







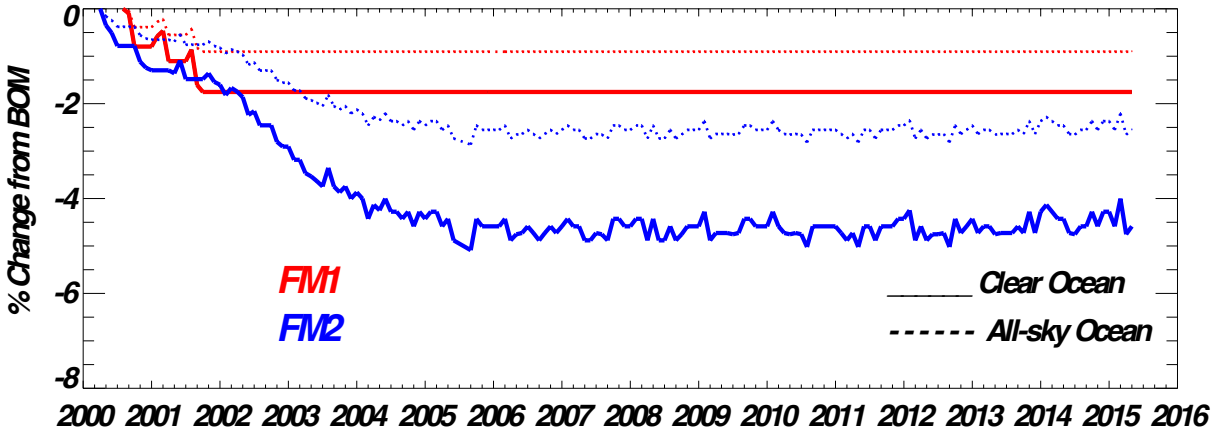


TERRA/AQUA EDITION-4: SW SENSOR

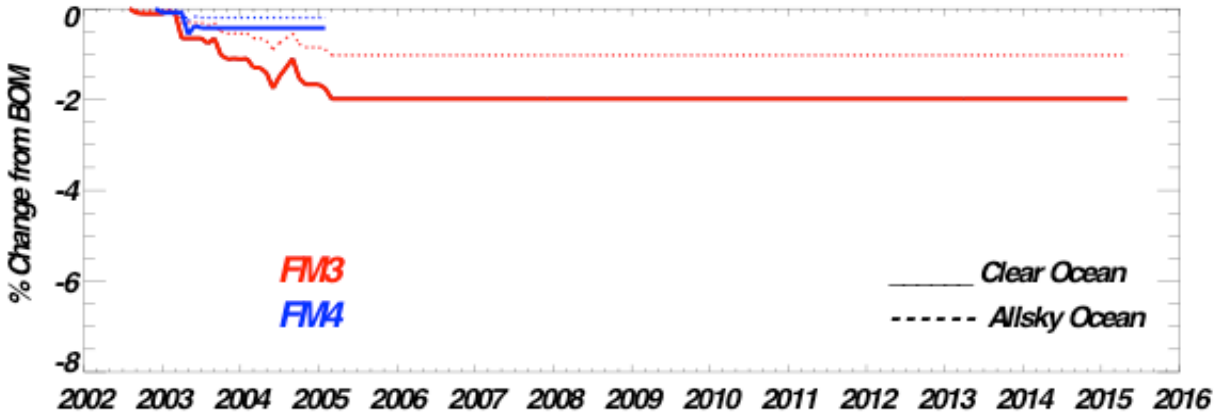
The SW sensor Spectral Response Function (SRF) correction is applied based on the Nadir comparison of Clear Ocean SW measurement from two instruments on same spacecraft. The correction is applied to SRF for the instrument operating in RAPS mode.

SW 'Optimal' Throughput Change calculated with SCIAMACHY Clear/All Ocean Spectra

TERRA

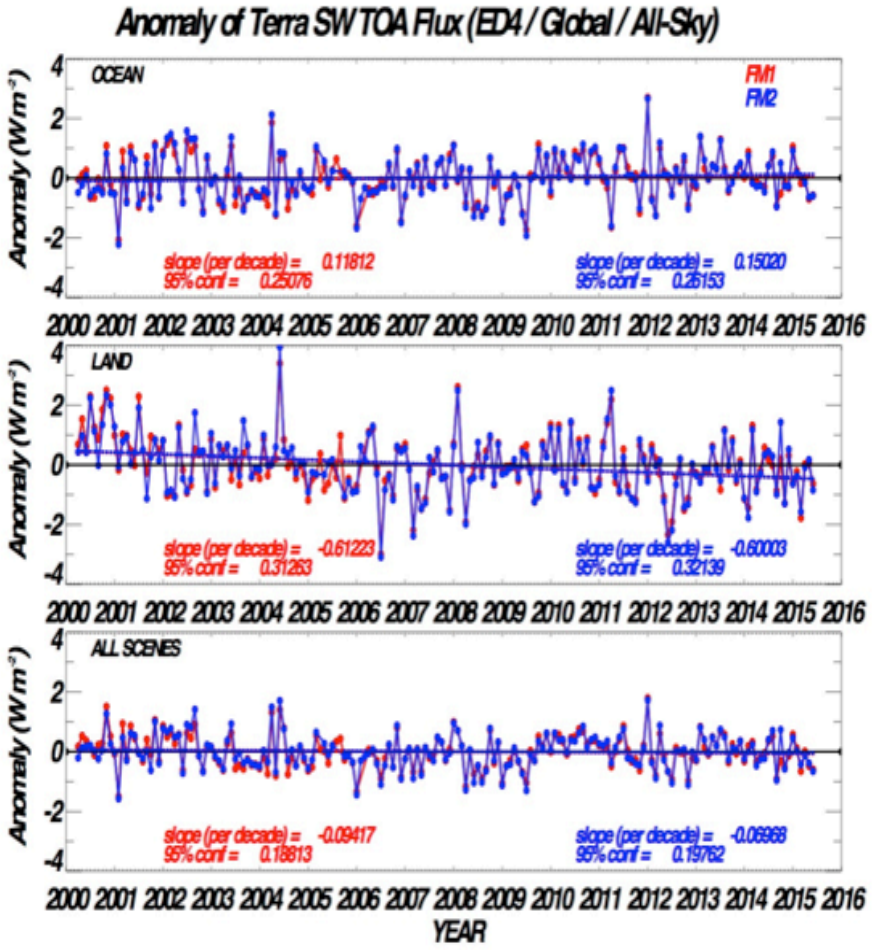


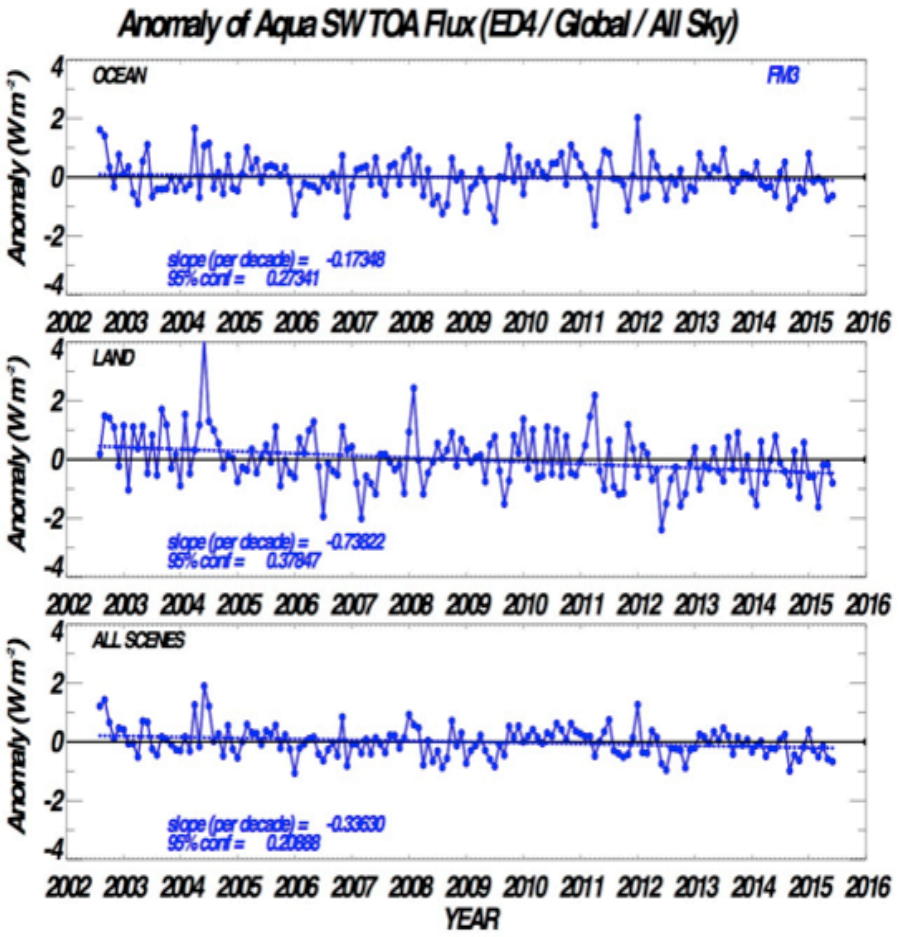
AQUA



CERES Instrument Working Group

EDITION-4 RESULTS: TERRA & AQUA SW SENSORS

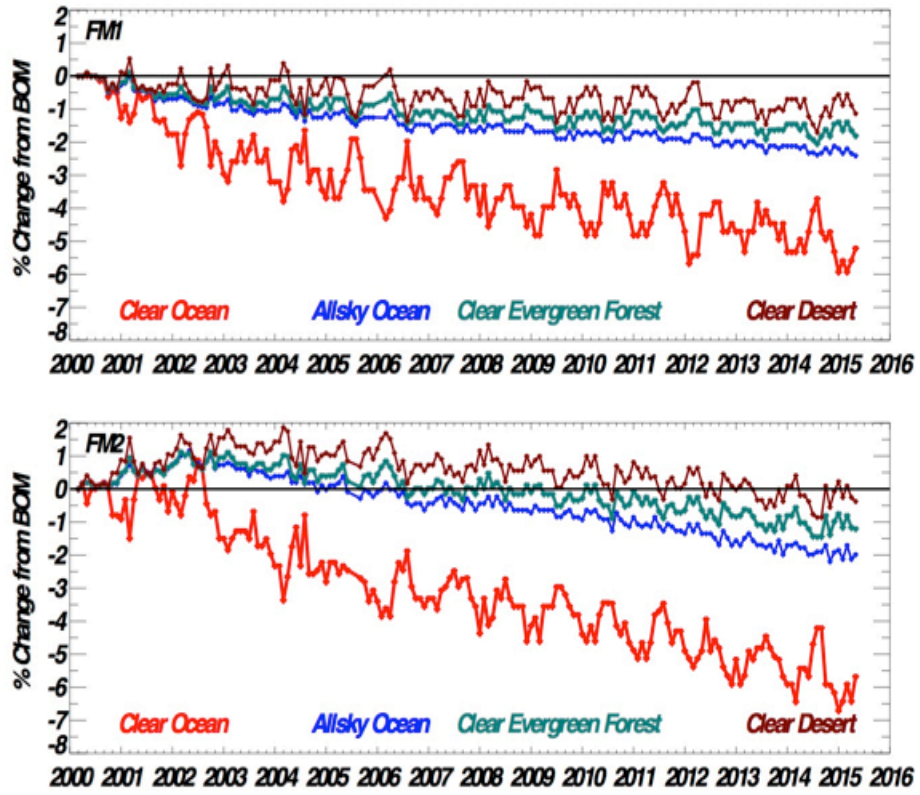




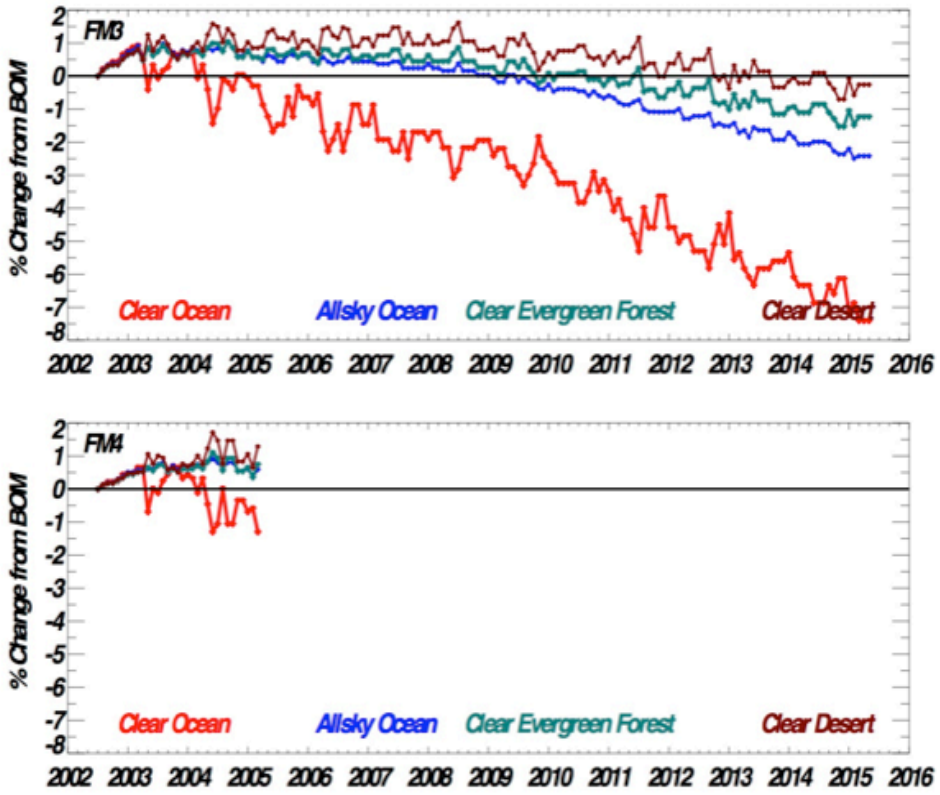
EDITION-4 TERRA/AQUA: SW/TOT SENSOR

- **Correction to SW/TOT sensor of each instrument is based on the regression between LW(Day-Night) and WN (Day-Night) using Tropical Ocean and Land scenes.**

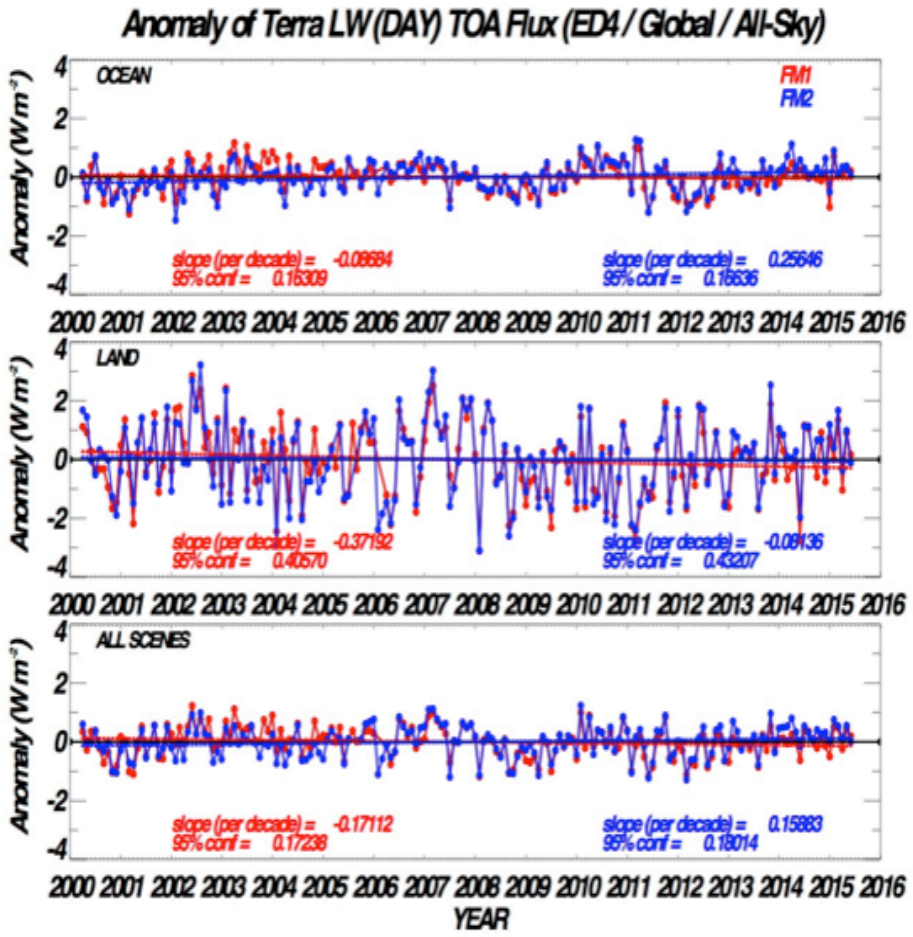
SW/TOT 'Optimal' Throughput Change for Terra (Terra SRF with SCIAMACHY Scene Spectra)

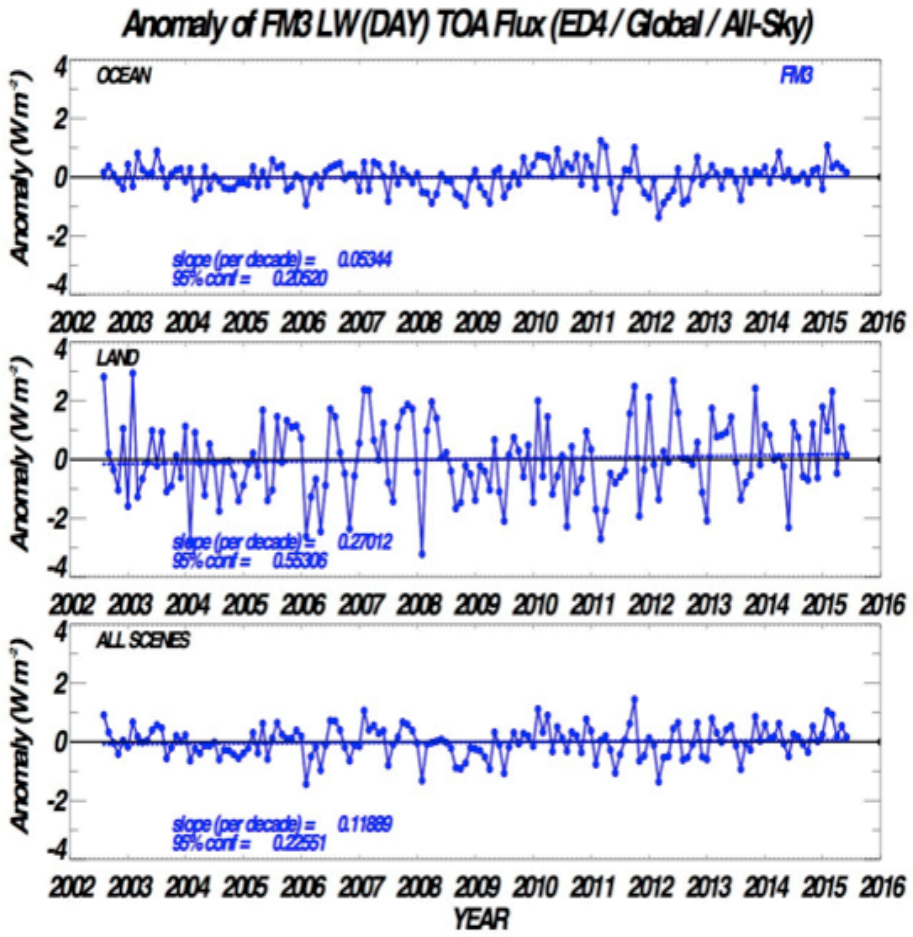


SW/TOT 'Optimal' Throughput Change for Aqua (Aqua SRF with SCIAMACHY Scene Spectra)

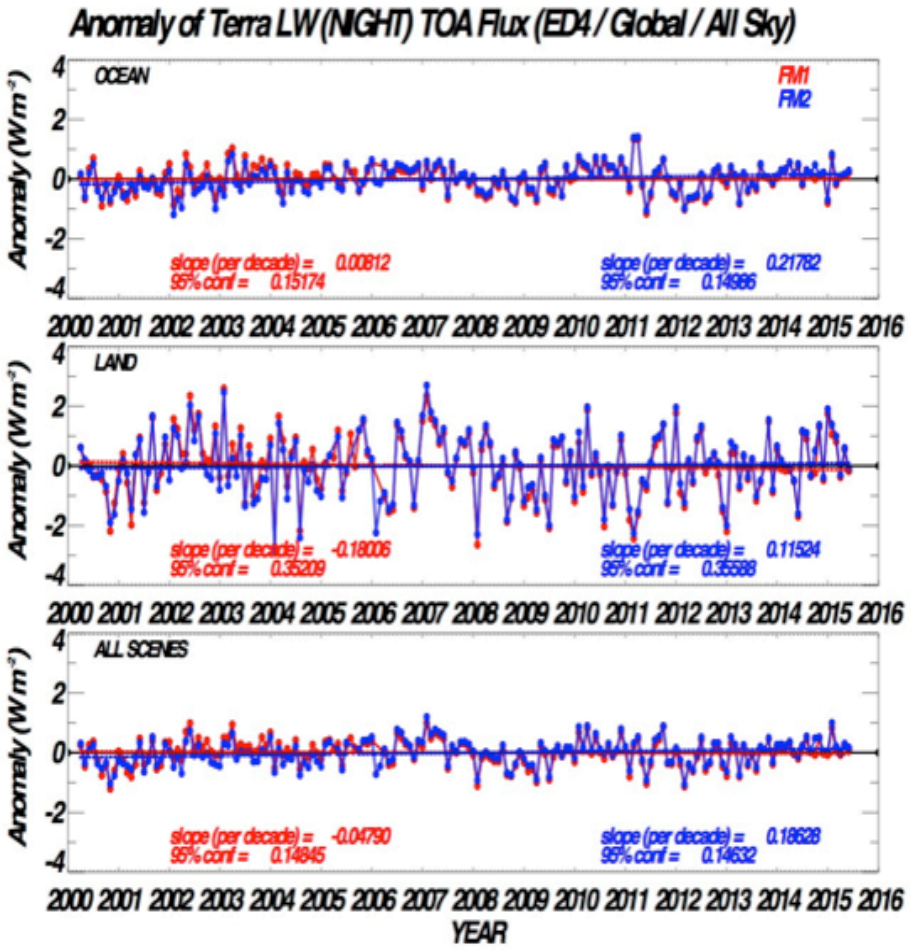


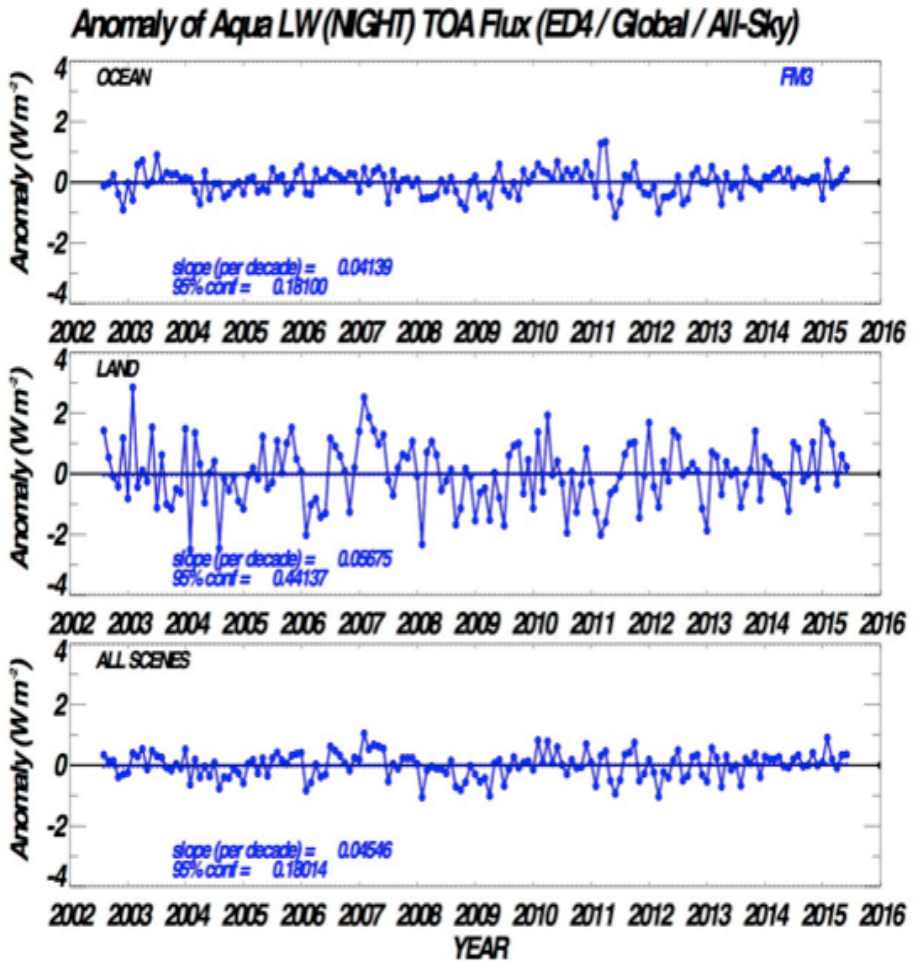
EDITION-4 Results: TERRA & AQUA LW_Day Flux



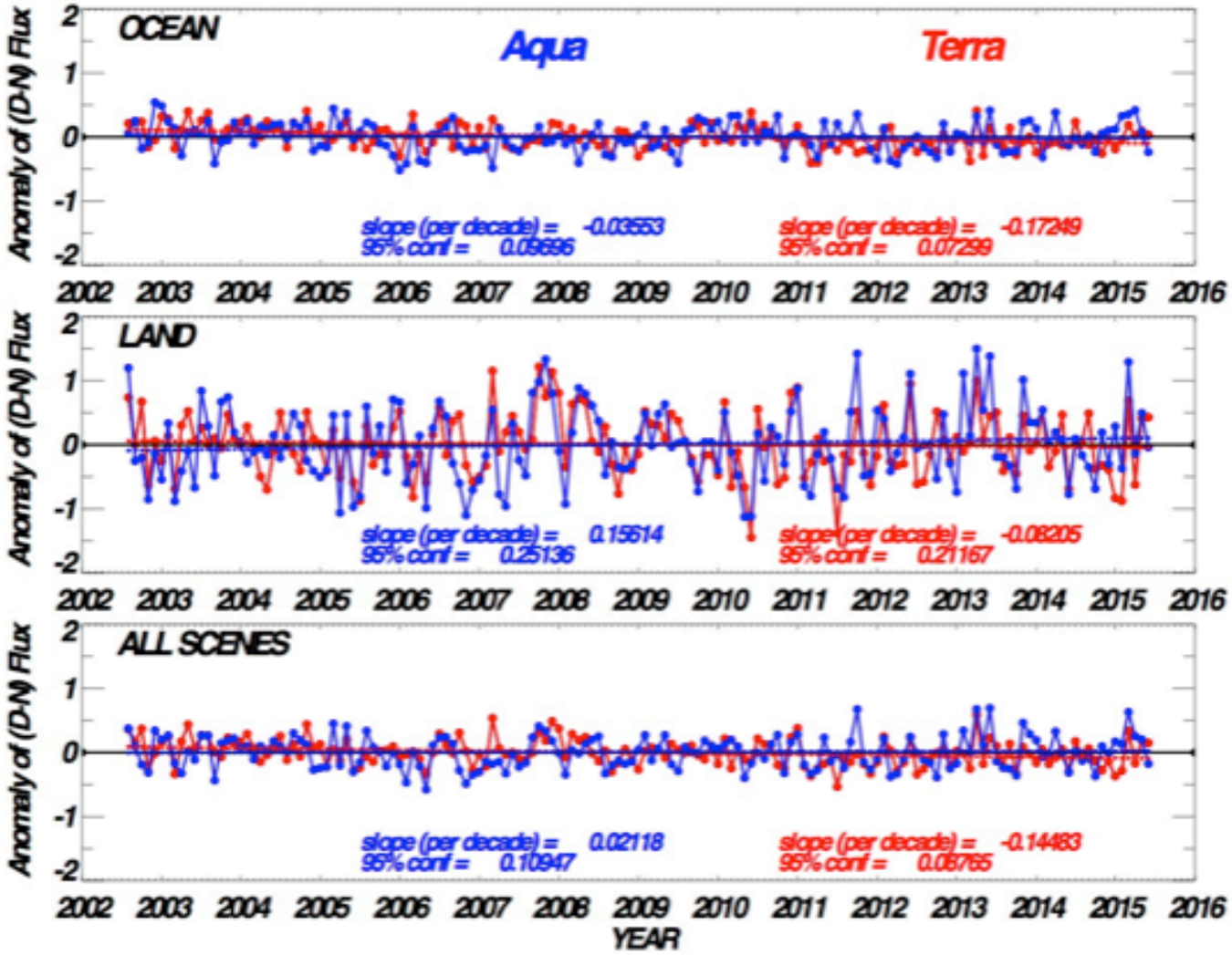


EDITION-4 Results: TERRA & AQUA LW_Night Flux





TERRA and AQUA (Day-Night) LW TOA Flux



TERRA/AQUA DATA AVAILABILITY

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

Edition4 Gains and Spectral Response Functions (SRF) :

Terra and Aqua - Start of Mission to Dec 2014

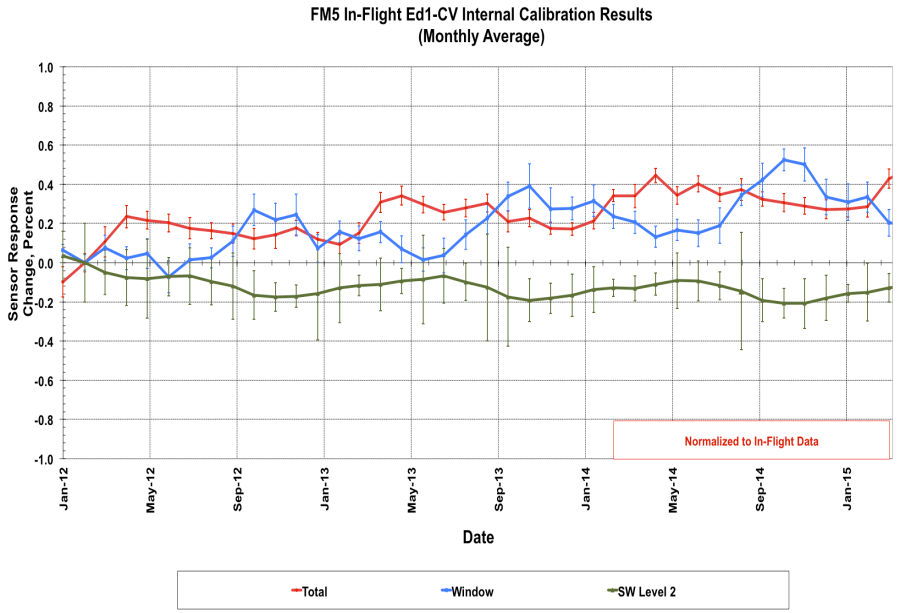
Edition1-CV Data Products (Instrument & ERBE-like):
Start of Mission – July 2015

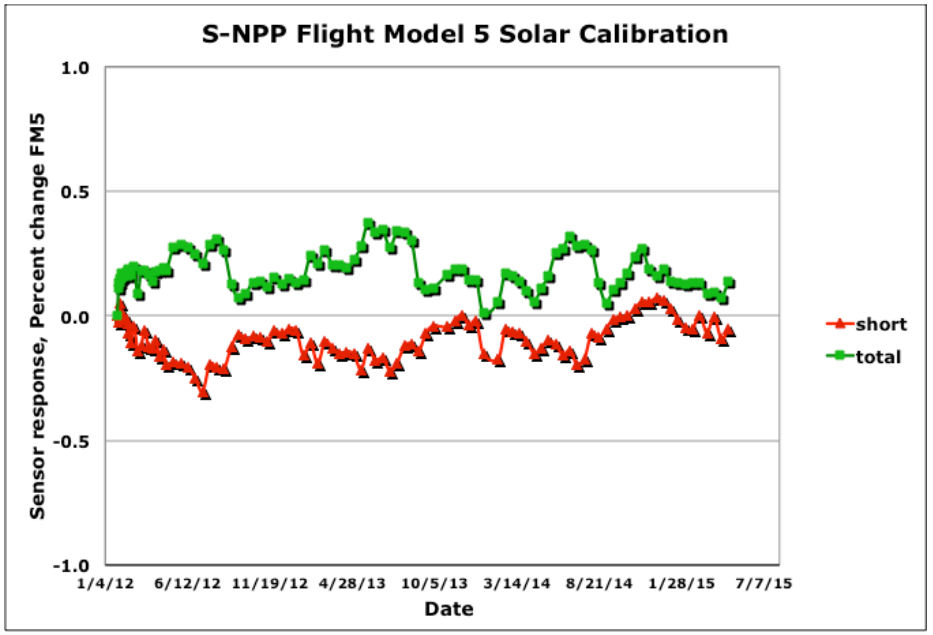
Suomi-NPP/ CERES FM5 INSTRUMENT STATUS

S-NPP/CERES FM5 Instrument Calibration

ICM calibrations show a response increase of 0.4% for Total and Window sensors and a drop of 0.2% in SW sensor.

Solar calibration results do not show discernable trends.



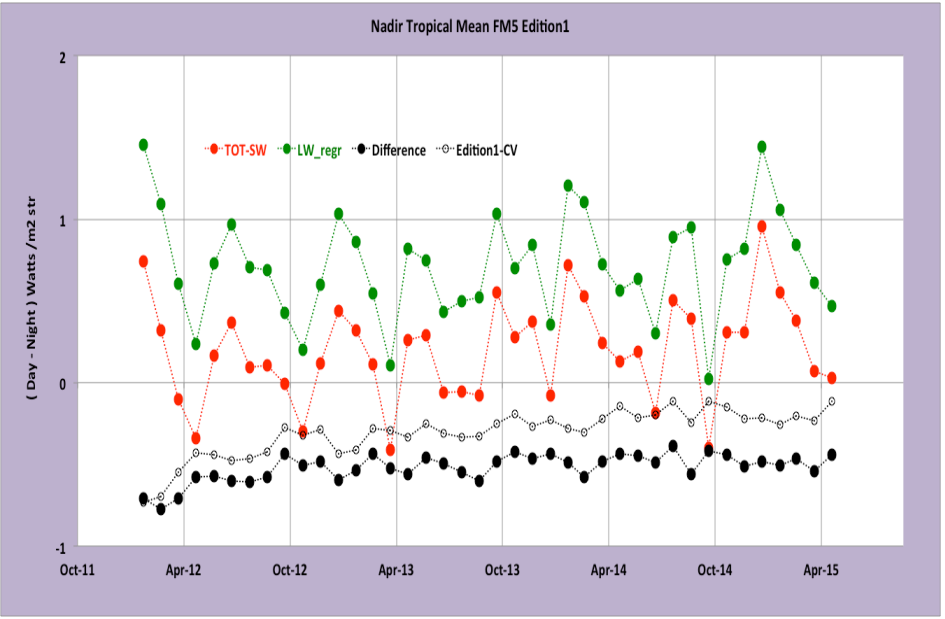


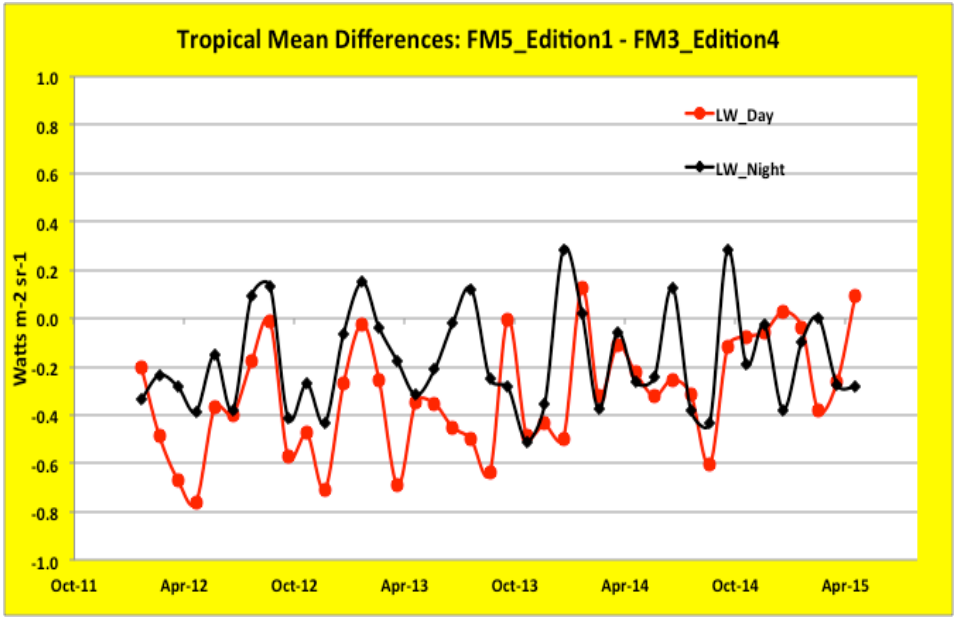
Sensor gain corrections based on ICM calibrations are applied to Edition1 data products.

Suomi NPP/CERES FM5 Validation: Tropical Mean

Tropical Mean (TM) is the monthly average of LW radiances for the Tropical All-sky Ocean in the +/- 20 degree latitude band.

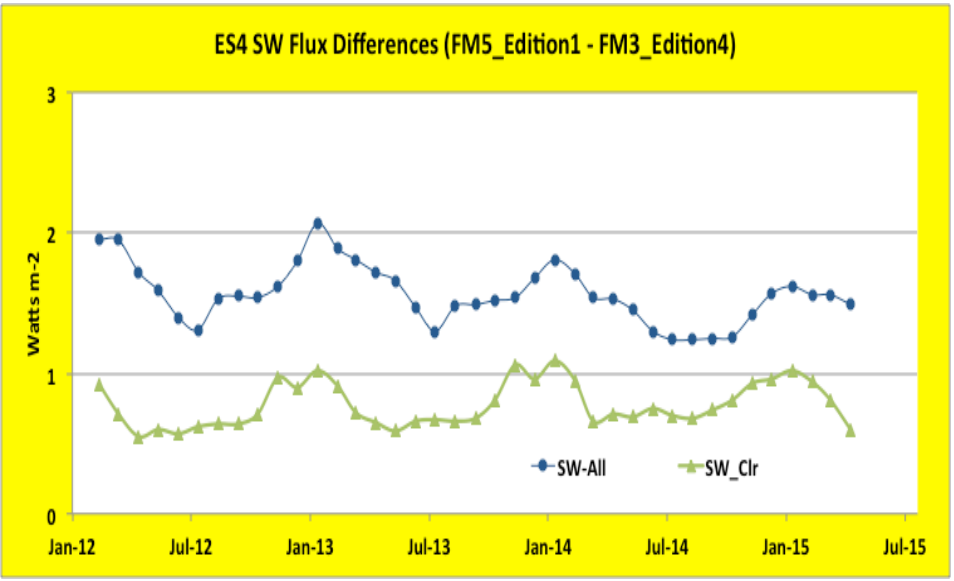
Day-Night Difference comparison between measured LW and Window channel measurements highlight changes in SW/TOT channel.

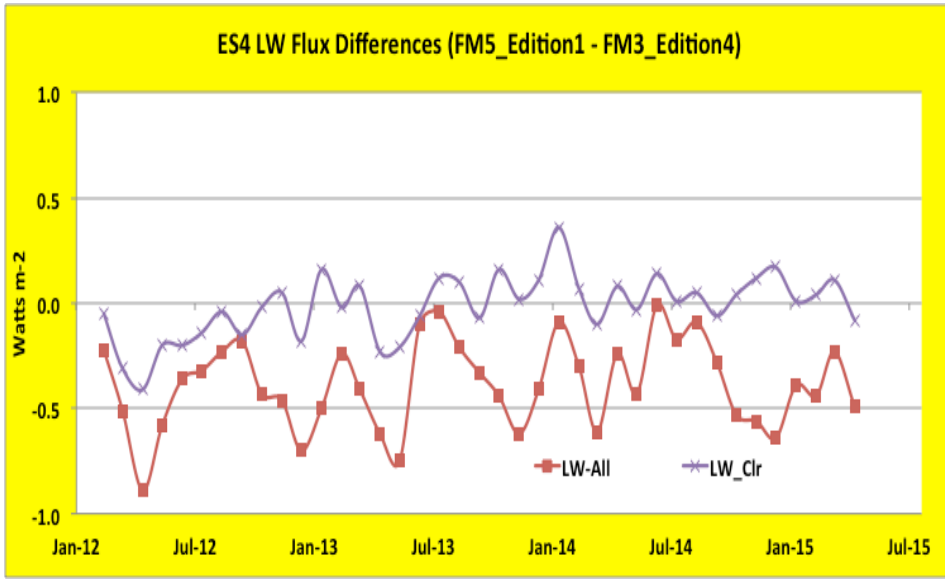




CERES S-NPP/FM5 – Aqua/FM3 Comparison

Global Flux Differences show that CERES FM5 SW measurements are higher and LW measurements lower than the corresponding CERES FM3 measurements.





CERES FM5 - FM3 Matched Footprint Comparisons

All-sky 2012/2013/2014

ΔTime < 1min; ΔRAZ < 10°; ΔVZA < 10°

Only LWN difference for 2014 is not statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	79.5/84.0/77.2	**3.35 / 2.70 / 1.02**	0.40/0.33/0.35	63/79/91
LW daytime	75.9/74.2/76.9	**-1.14 / -1.23 / -0.57**	0.09/0.10/0.13	67/82/91
LW nighttime	67.0/64.7/67.5	**-0.32 / -0.26 / 0.01**	0.09/0.08/0.06	86/98/106

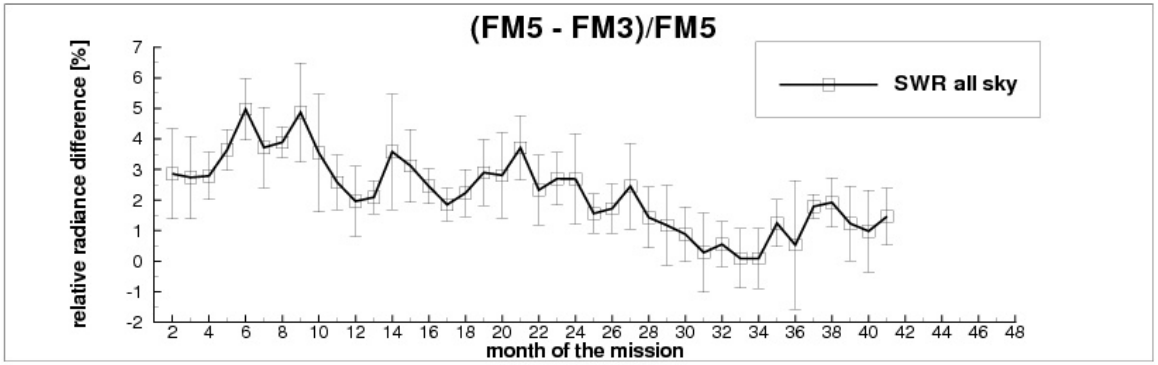
- Edition 1 for FM5 and Edition 4 for FM3 are used
- Shown differences are computed as "average of differences" to avoid error cancellation

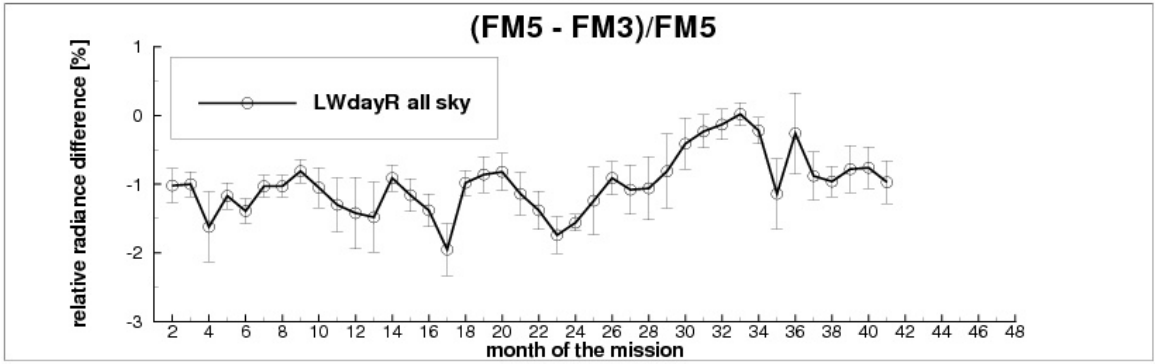
CERES FM5 – FM3 All-sky Monthly Difference

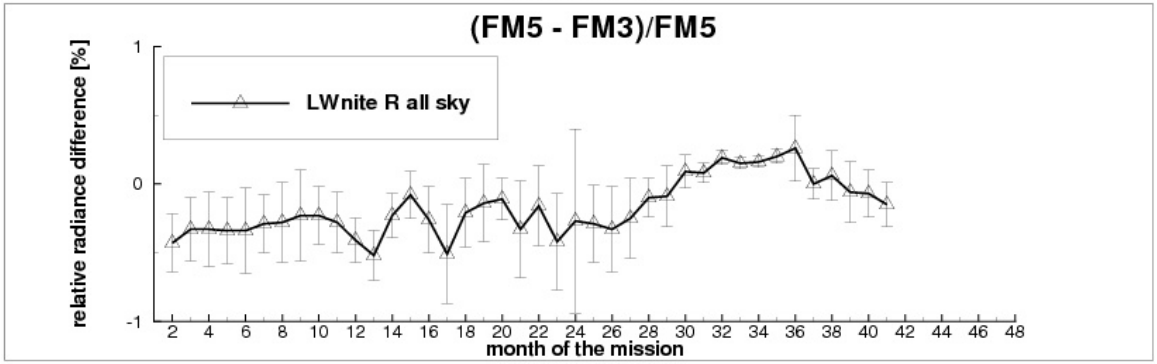
ΔTime < 1min;
ΔRAZ < 10°;
ΔVZA < 10°;

{VZA} = 23°

None of the monthly SW differences is statistically significant







CERES FM5 – FM3 NADIR DWELL COMPARISON

FM5 and FM3 use a nadir dwell scan profile for Matched Site Targeting

$\Delta T < 5$ minutes; lat < 0.5°, lon < 0.25°

VZA < 0.2°

13 Nadir Dwell Datasets in 2013-2014

Ocean and Land Scenes

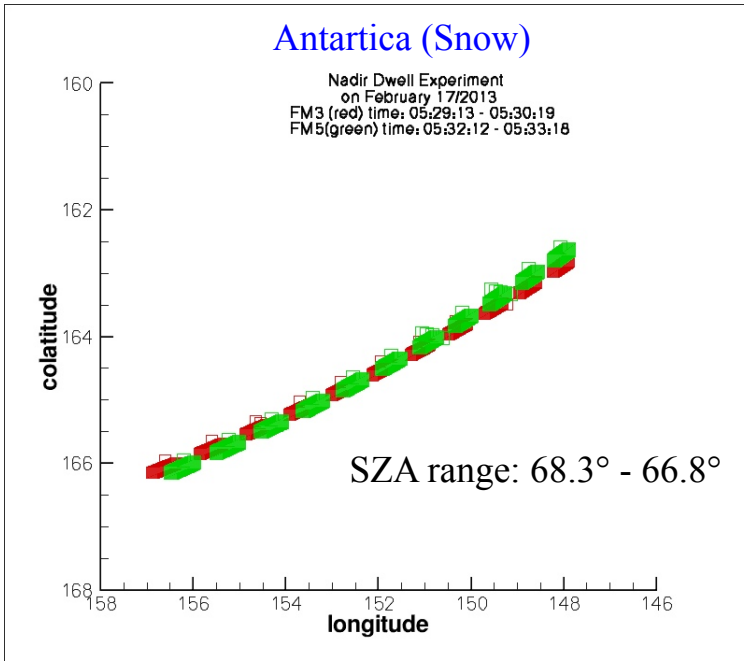
Day and Night Measurements

SW Measurements

FM5 higher than FM3.

LW Measurements – Clear Sky

FM5 is same as FM3 (within uncertainty)



Z. P. Szewczyk will give a detailed evaluation of this study in Co-I Report.

SUMMARY

- Validation results from the Edition-4 datasets have shown that the trends in ocean and land scenes for Terra and Aqua SW and LW-day measurements were corrected.
- CERES FM5 calibration results show the sensor performance trends are within expected range. Gain changes based on ICM calibrations applied to Edition1 dataset.
- Evaluation continuing on FM5–FM3 SW radiances differences.

BACK UP SLIDES

CERES FM5 - FM3 Matched Footprint Comparison

Clear Ocean 2012/2013/2014

ΔTime < 1min; ΔRAZ < 10°; ΔVZA < 10°

Shown differences are statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	27.1/26.6/24.8	**9.90 / 8.95 / 3.56**	1.58/1.95/0.85	29/33/64
LW daytime	90.4/89.3/89.8	**-0.70 / -0.66 / -0.13**	0.09/0.12/0.11	48/50/66
LW nighttime	92.9/93.9/91.9	**-0.53 / -0.64 / -0.24**	0.14/0.15/0.11	40/39/58

CERES FM5 - FM3 Matched Footprint Comparison

Overcast 2012/2013/2014

ΔTime < 1min; ΔRAZ < 10°; ΔVZA < 10°

Shown differences are statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	111.9/106.8/112.6	**1.66 / 1.56 / 0.60**	0.48/0.39/0.31	45/67/83
LW daytime	62.2/63.3/62.6	**-1.41 / -1.40 / -0.79**	0.21/0.17/0.19	62/74/84
LW nighttime	56.5/56.5/57.2	**-0.14 / -0.12 / 0.18**	0.08/0.10/0.07	83/93/102