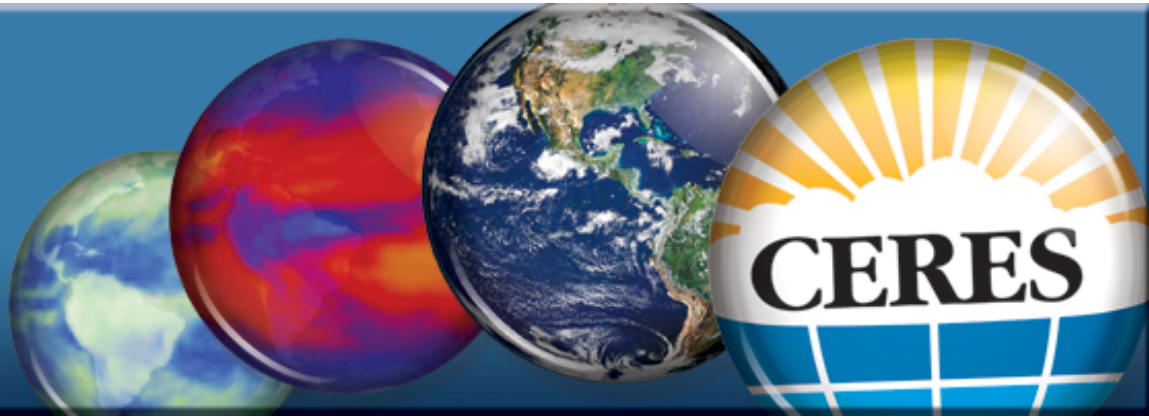
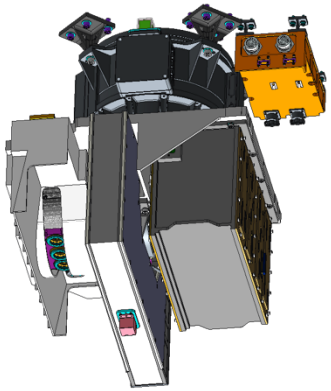
Clouds and the Earth's Radiant Energy System



CERES Flight Model 1 – 6 Instruments and Radiation Budget Instrument (RBI) Status



Susan Thomas, Mohan Shankar

Kory Priestley

CERES Science Team Meeting
NASA LaRC
Hampton, VA
April 26th, 2016

Instrument Working Group

Instrument Operation/I&T

- William Vogler -

- James Bailey -

Christopher Brown

John Butler

Janet Daniels

James Donaldson

William Edmonds

Carol Kelly

B. Mike Tafazoli

Roy Zalameda

Charles Jenkins

Eli Siman-Tov

Data Management

- Denise Cooper -

- Dale Walikainen -

A. Thomas Grepiotis

Mark Timcoe

Jeremie Lande

Dianne Snyder

Science

-Susan Thomas–

Phillip Hess

Mohan Shankar

G. Lou Smith

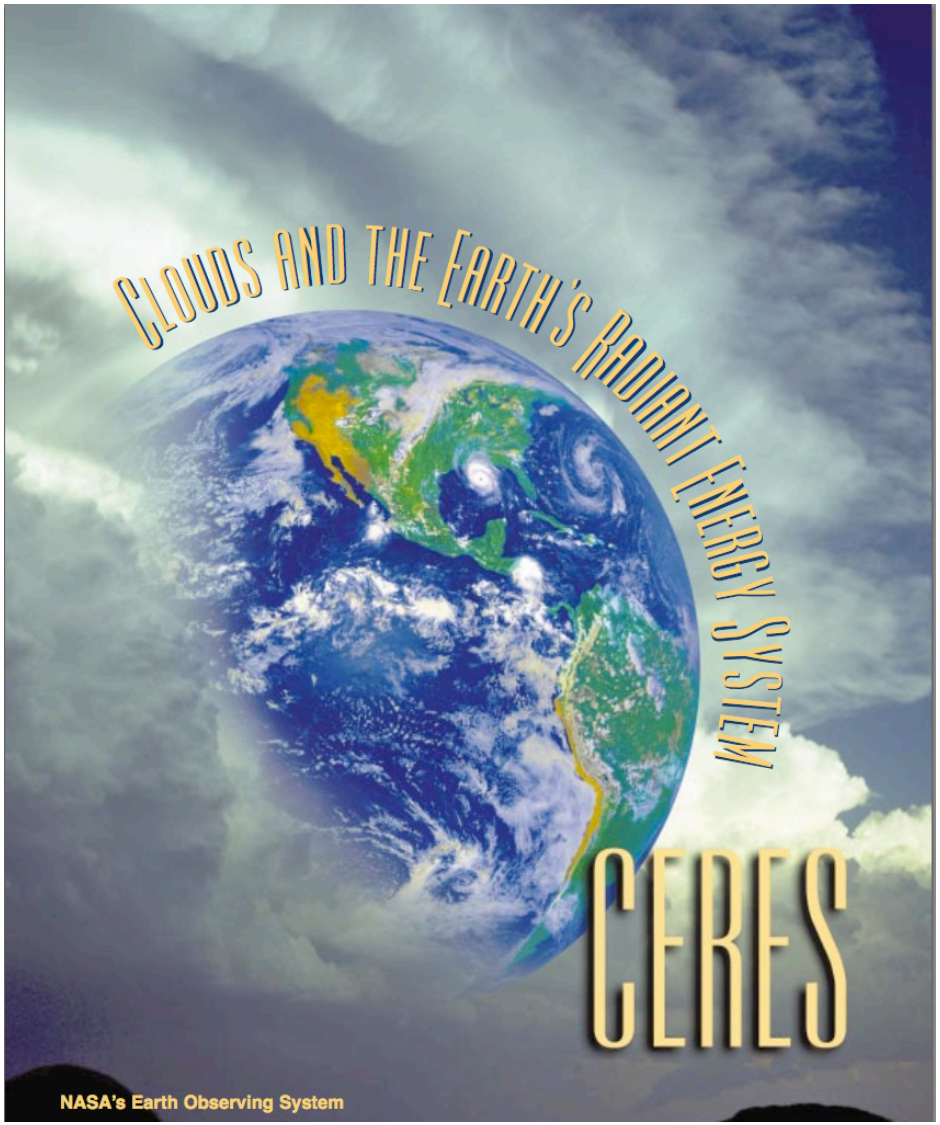
Nathaniel Smith

Nitchie Smith

Z. Peter Szewczyk

Robert Wilson

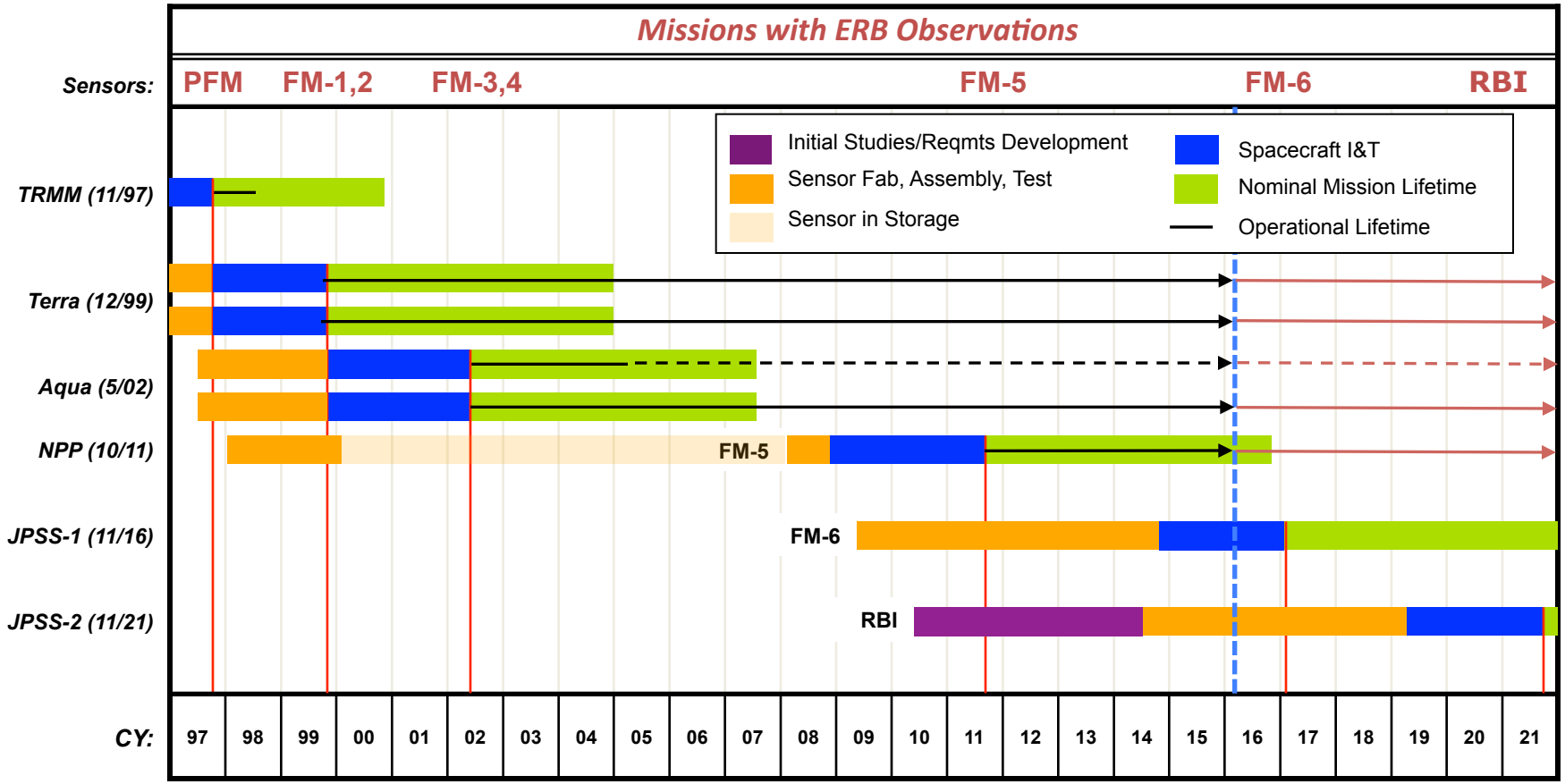
Discussion Topics



- ERB missions Overview
  - Flight history/future
- Instrument Status
  - FM1–4 on Terra/Aqua
  - FM-5 on S-NPP
  - FM-6 on JPSS-1
  - RBI on JPSS-2
- Summary

Climate Data Record Continuity

CERES/RBI Flight Schedule



We now have over 65 years of flight experience with the CERES instruments

CERES Instrument Operations: FM1 - 5

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

Special Inter-comparison campaigns:

On-going:

CERES Terra/FM2 – ScaRAB: April 1 – May 31, 2016

Upcoming:

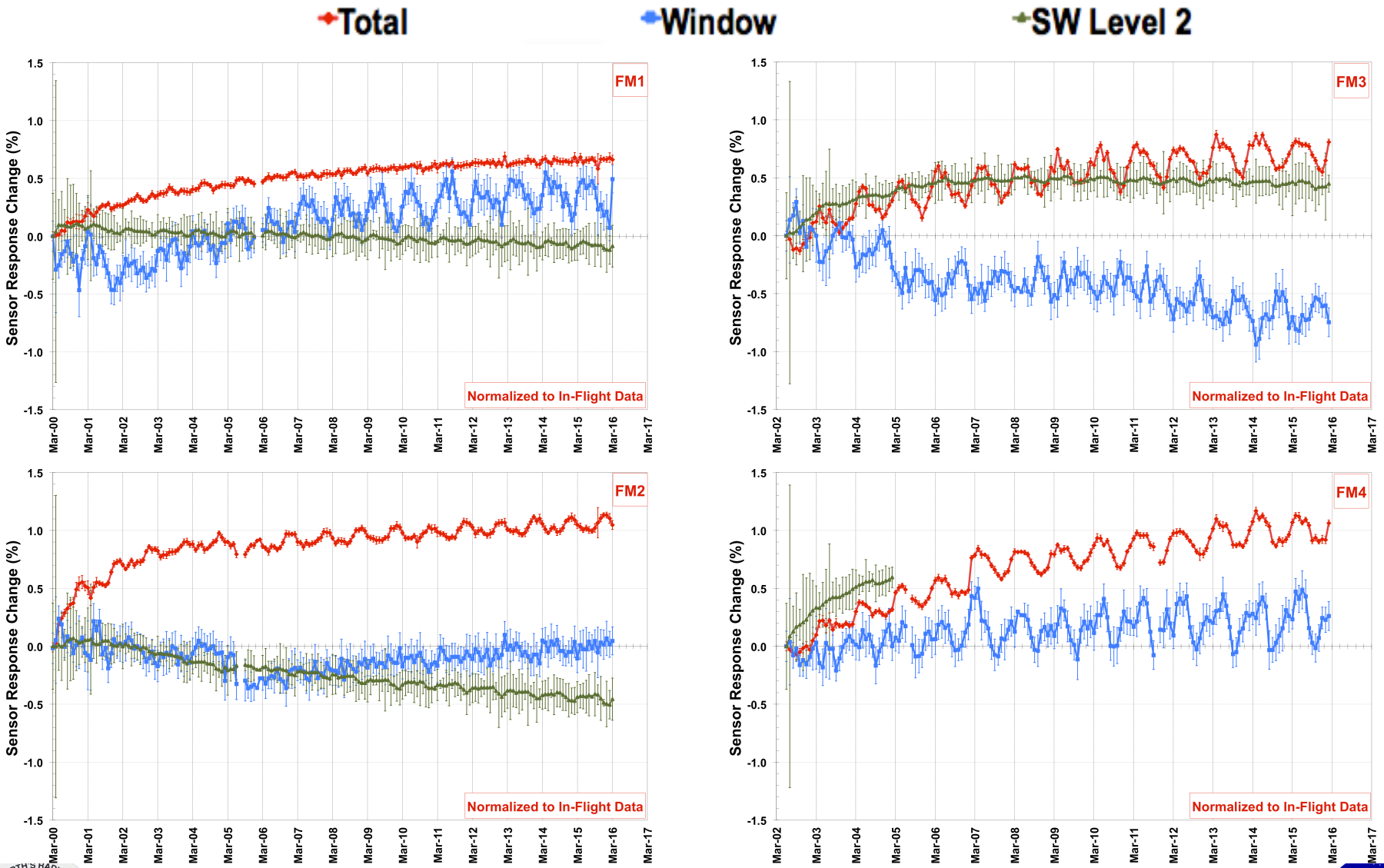
CERES Terra/FM1 – S-NPP/FM5: May 1 – July 31, 2016.

CERES Terra/FM1 – Aqua/FM3: June 1 – 30, 2016

TERRA & AQUA INSTRUMENT STATUS

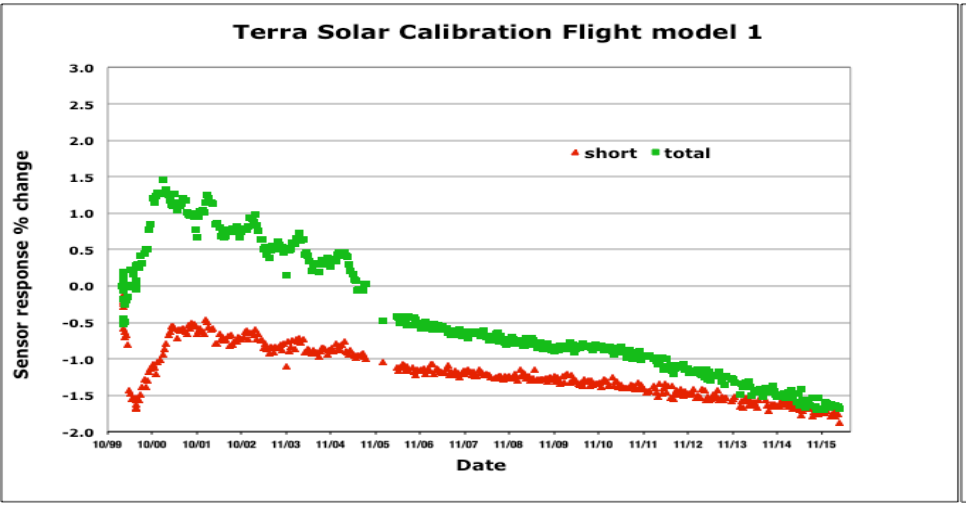
[CERES FM1 – FM4]

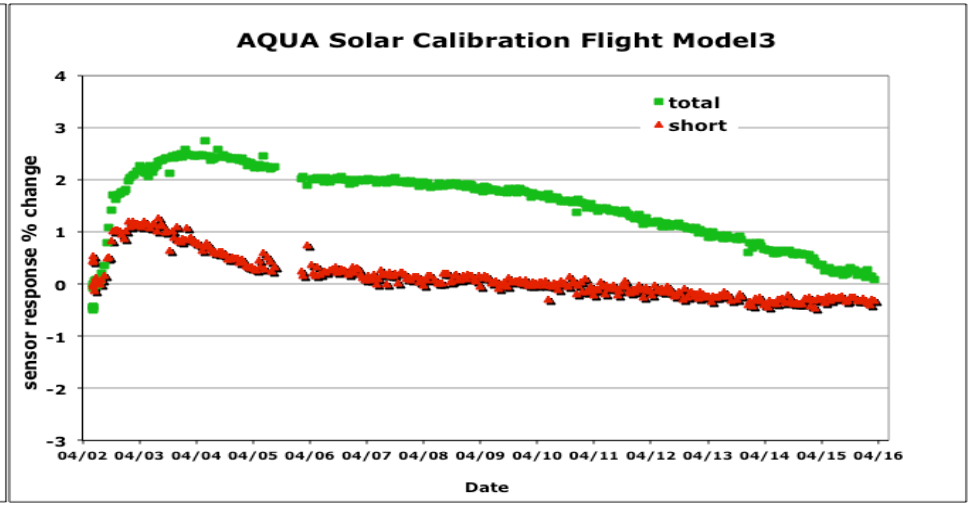
Terra – Aqua Sensor Performance

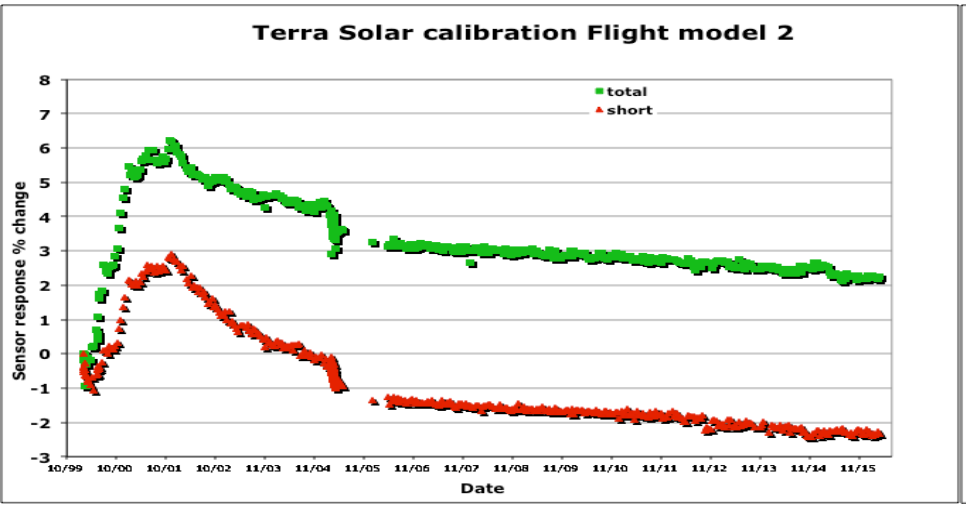


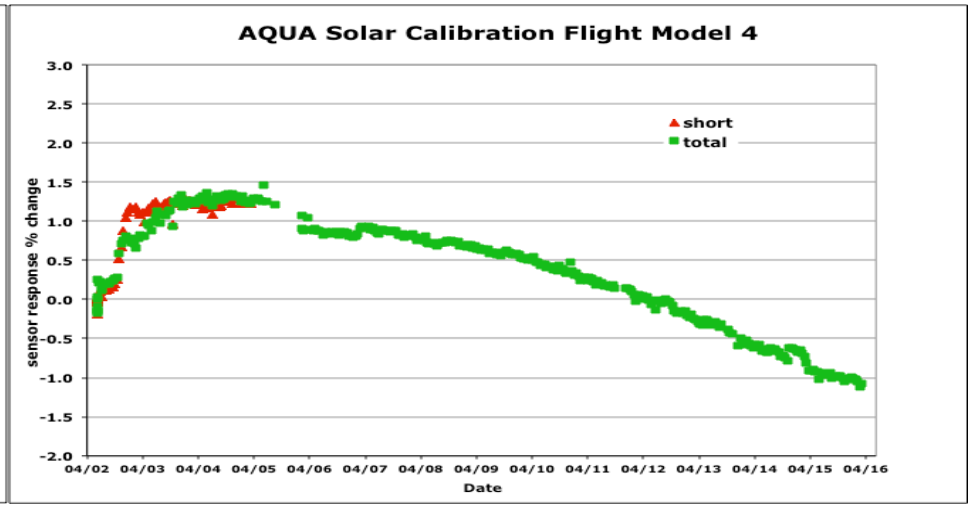
CERES Instrument Working Group

Terra – Aqua Solar Calibration Results

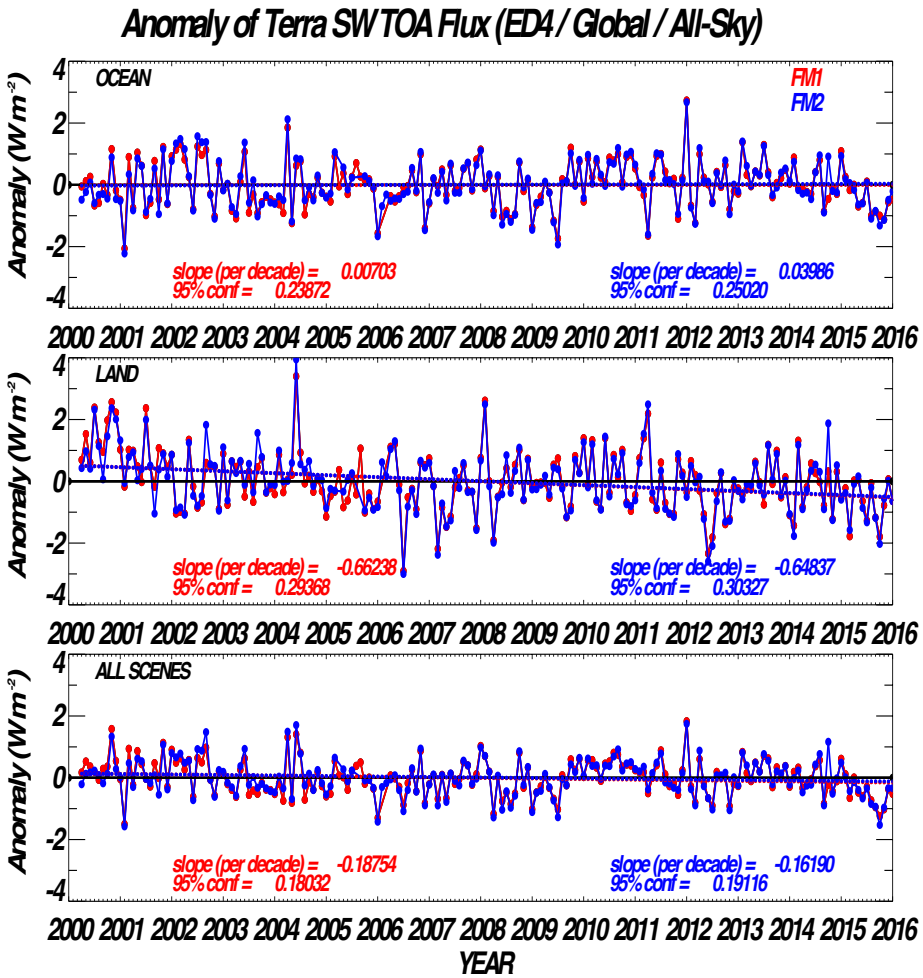


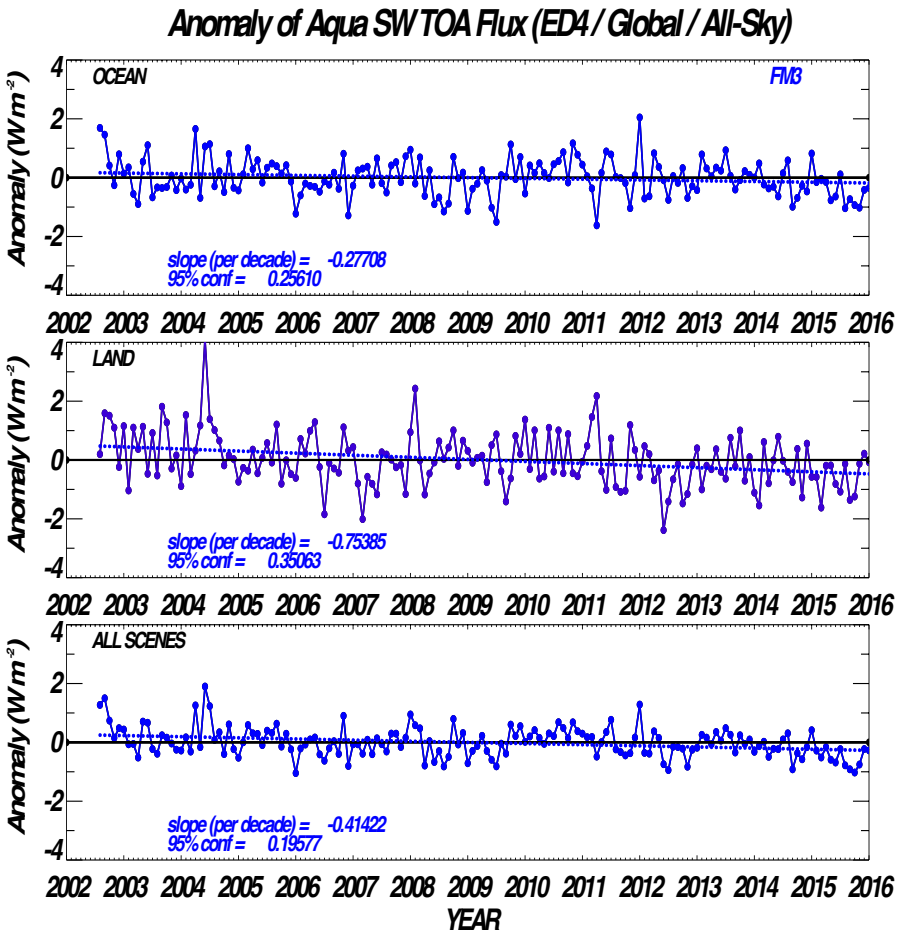






EDITION-4 RESULTS: TERRA & AQUA SW SENSORS

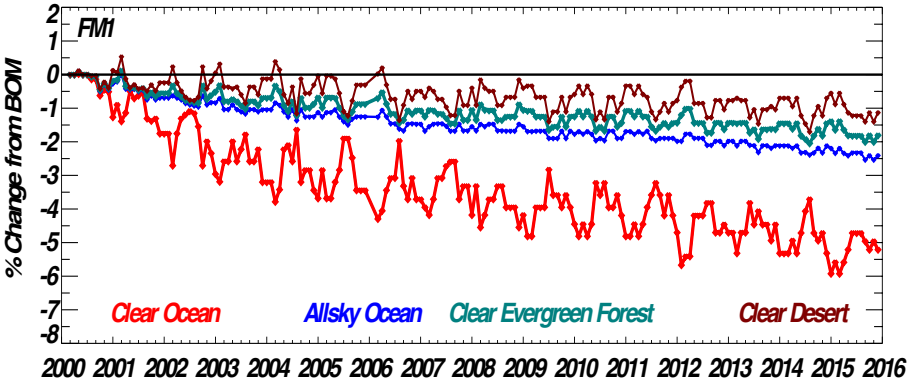




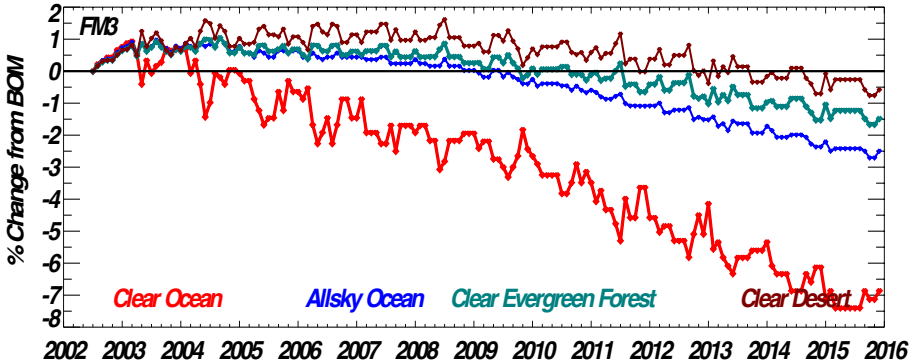
EDITION-4 TERRA/AQUA: SW/TOT SENSOR

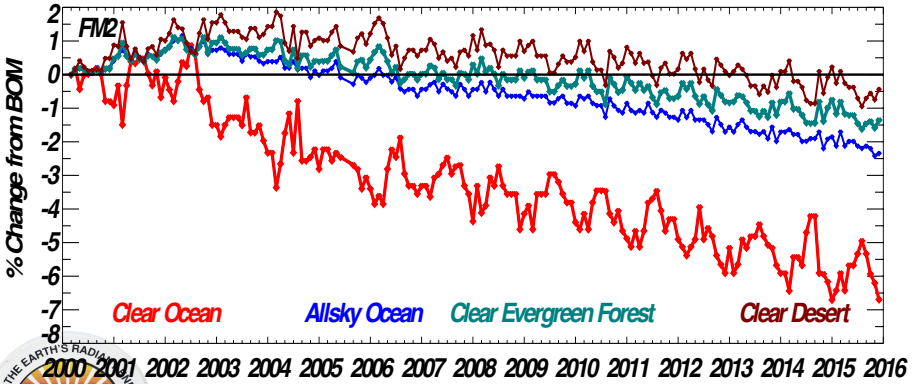
- **Correction to SW/TOT sensor of each instrument is based on the regression between LW(Day-Night) and WN (Day-Night) using Tropical Ocean and Land scenes.**

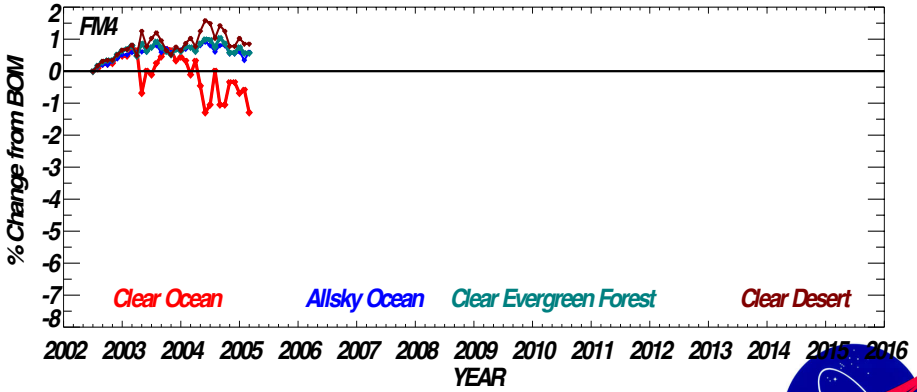
SW/TOT 'Optimal' Throughput Change for Terra (Terra SRF with SCIAMACHY Scene Spectra)



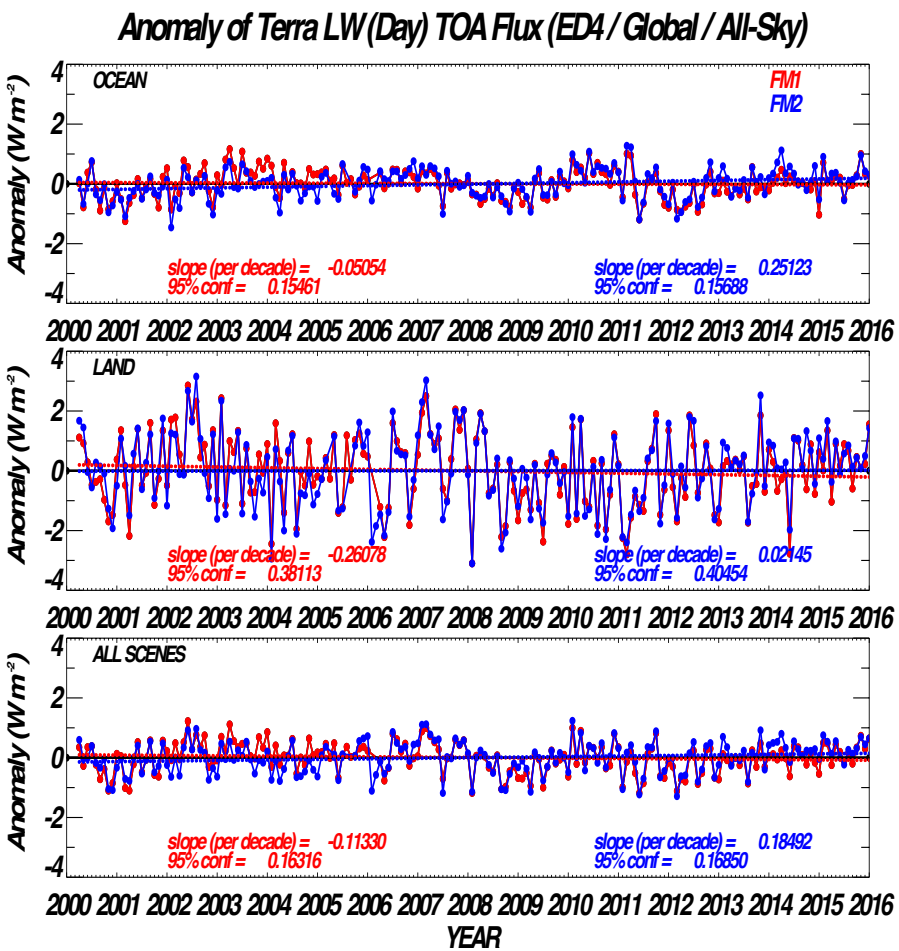
SW/TOT 'Optimal' Throughput Change for Aqua (Aqua SRF with SCIAMACHY Scene Spectra)

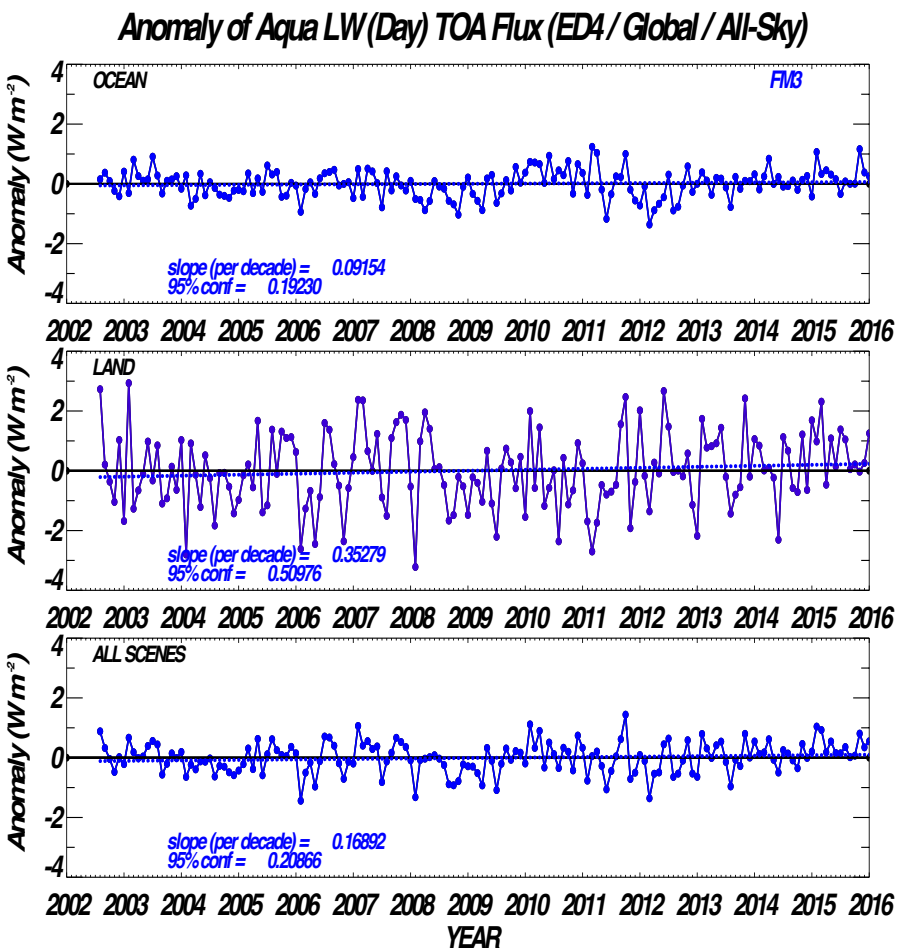






EDITION-4 Results: TERRA & AQUA LW_Day Flux





TERRA/AQUA DATA AVAILABILITY

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

Edition4 Gains and Spectral Response Functions (SRF) :

Terra and Aqua - Start of Mission to December 2015

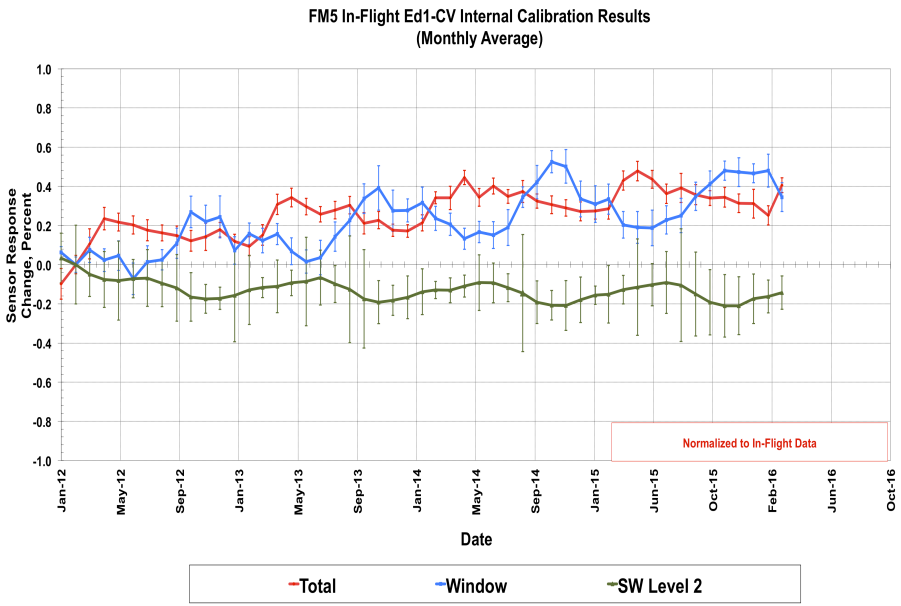
Edition1-CV Data Products (Instrument & ERBE-like):
Start of Mission – March 2016

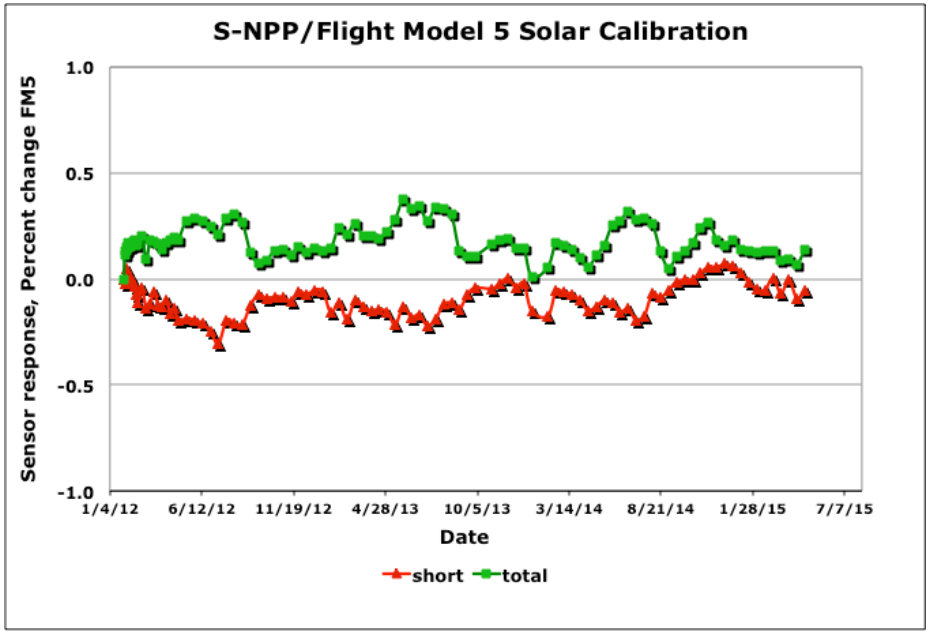
S-NPP/ CERES FM5 INSTRUMENT STATUS

S-NPP/CERES FM5 Instrument Calibration

ICM calibrations show a response increase of 0.4% for Total, 0.5% for Window sensor and a drop of 0.2% in SW sensor.

Sensor response trends from solar calibrations are within +/- 0.5%.

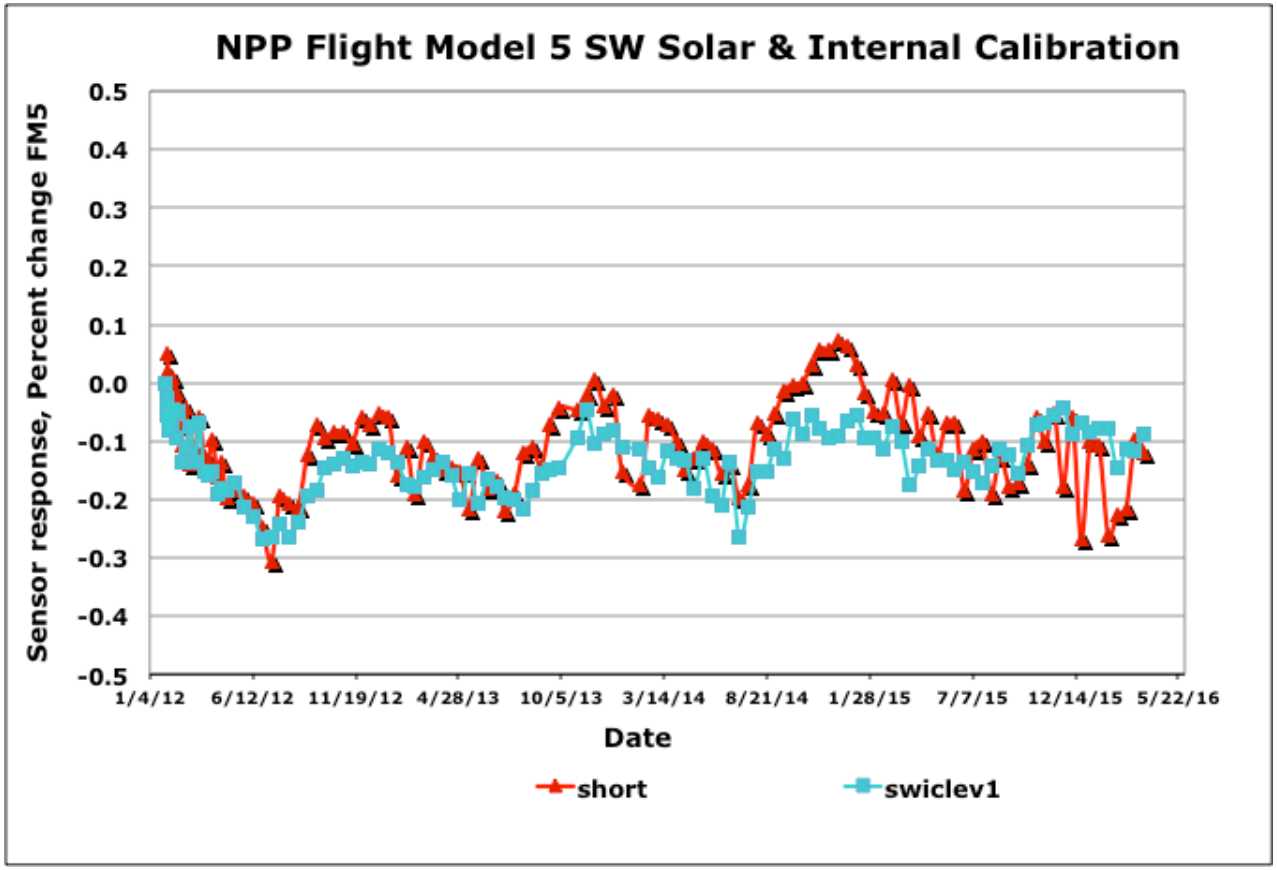




Sensor gain corrections based on ICM calibrations are applied to Edition1 data products.

S-NPP/CERES FM5 Instrument Calibration

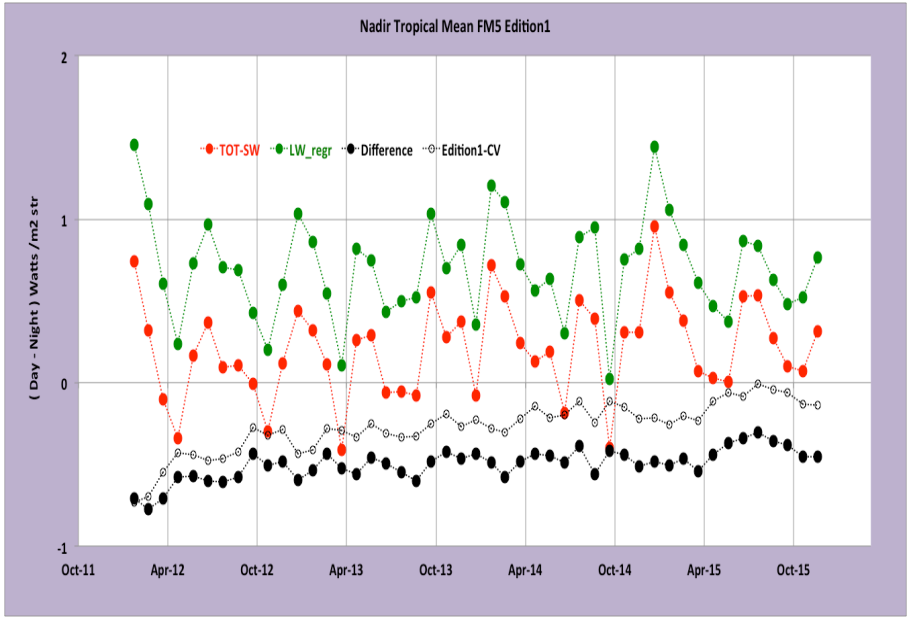
Comparison of calibration results from SWICS and MAM show similar trends in the SW sensor.

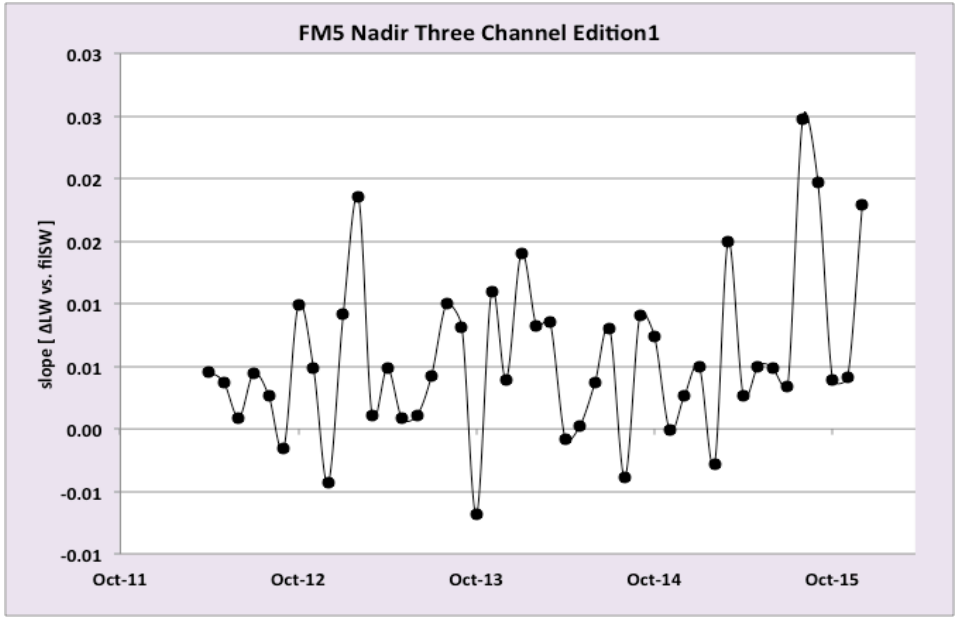


Suomi NPP/CERES FM5 Validation Results

Tropical Mean (TM): Monthly average of LW radiance for Tropical All-sky Ocean in +/- 20 degree latitude band. Day-Night Difference comparison between measured LW and Window measurements highlight changes in SW/TOT channel.

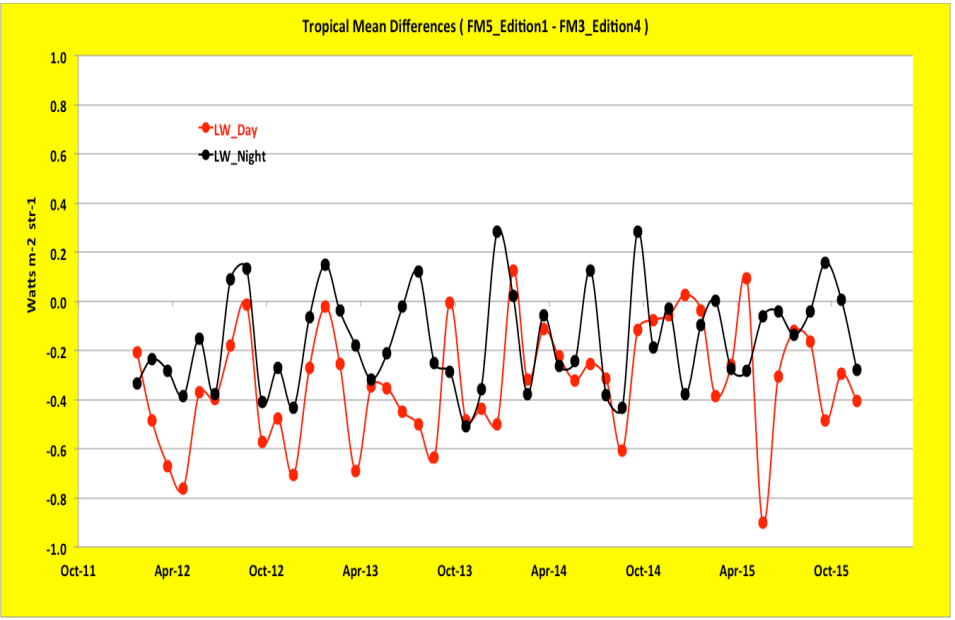
Three Channel comparison use Deep Convective Cloud (DCC) as target. Trend in monthly slope between delta LW and SW measurements.

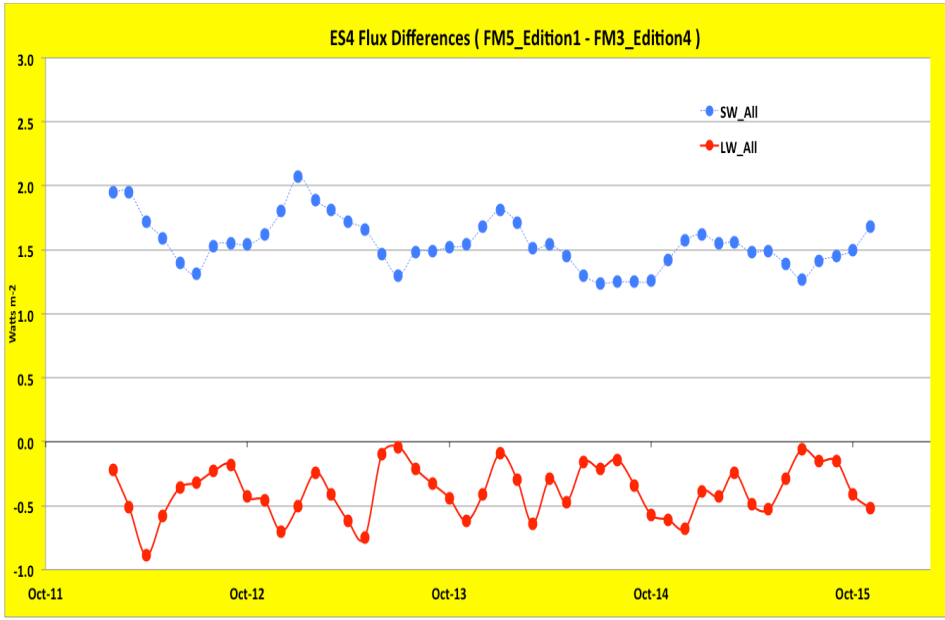




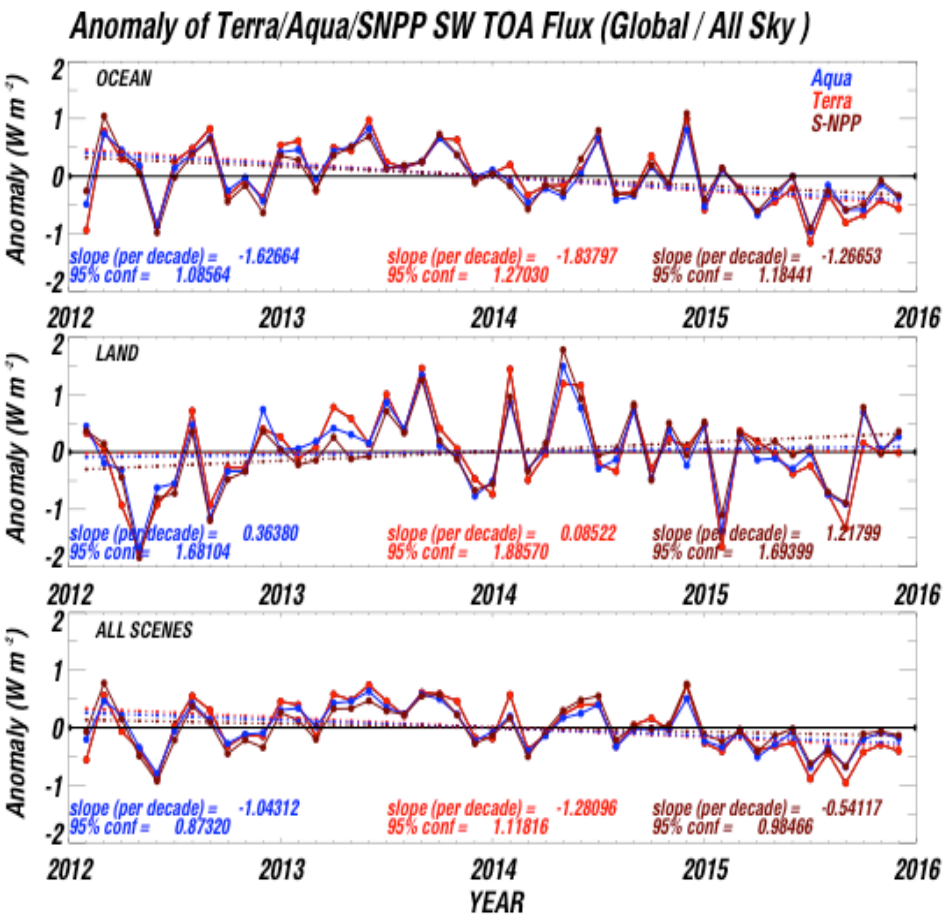
CERES S-NPP/FM5 – Aqua/FM3 Comparison

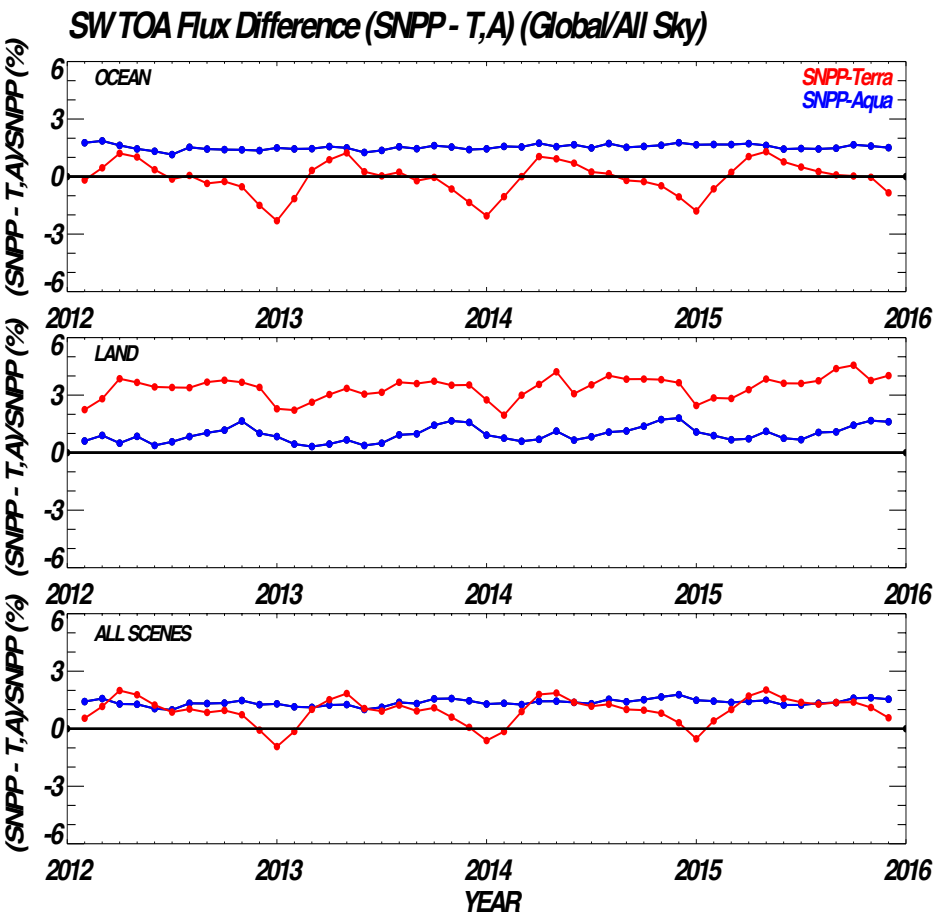
Tropical Mean LW comparisons show stable results.
Global Flux Differences show that CERES FM5 SW measurements are higher and LW measurements lower than FM3 measurements.



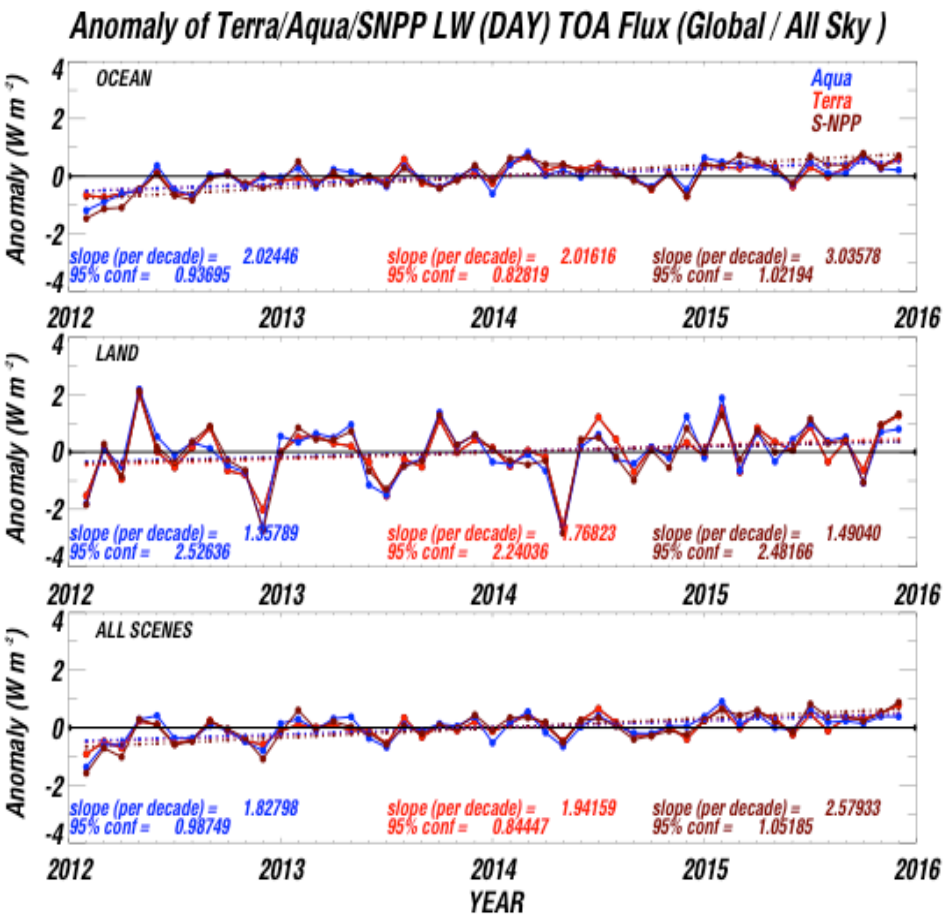


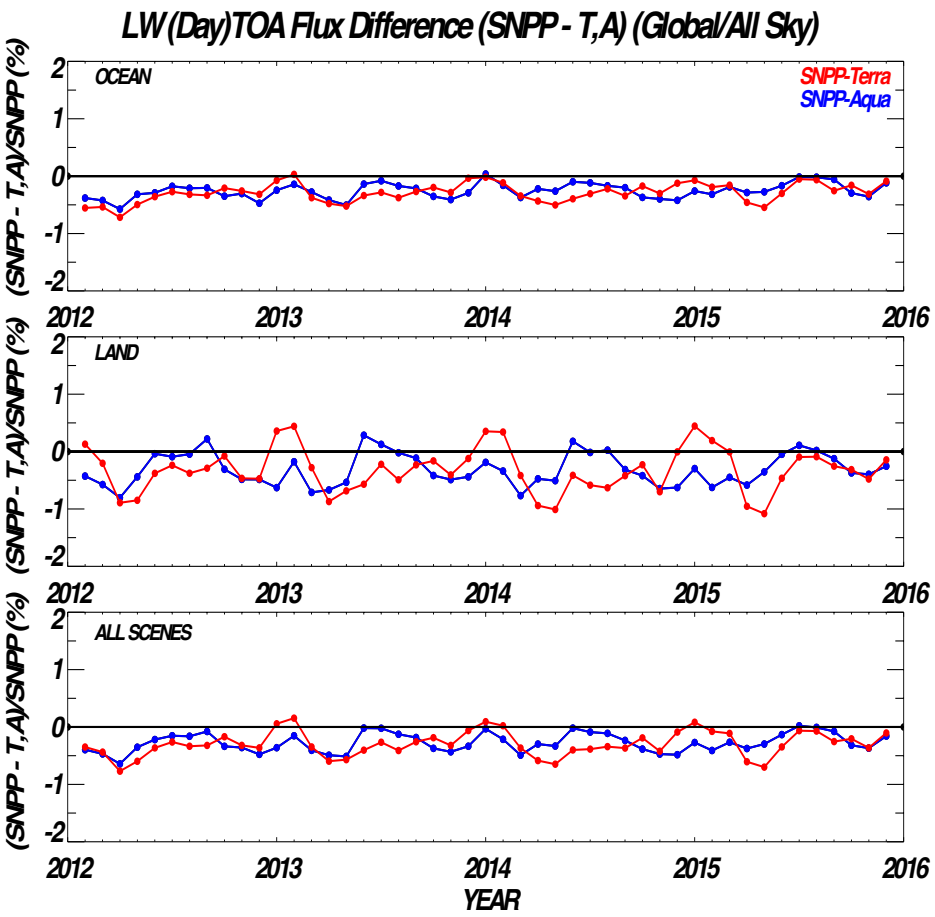
S-NPP/FM5, TERRA & AQUA COMPARE: SW FLUX



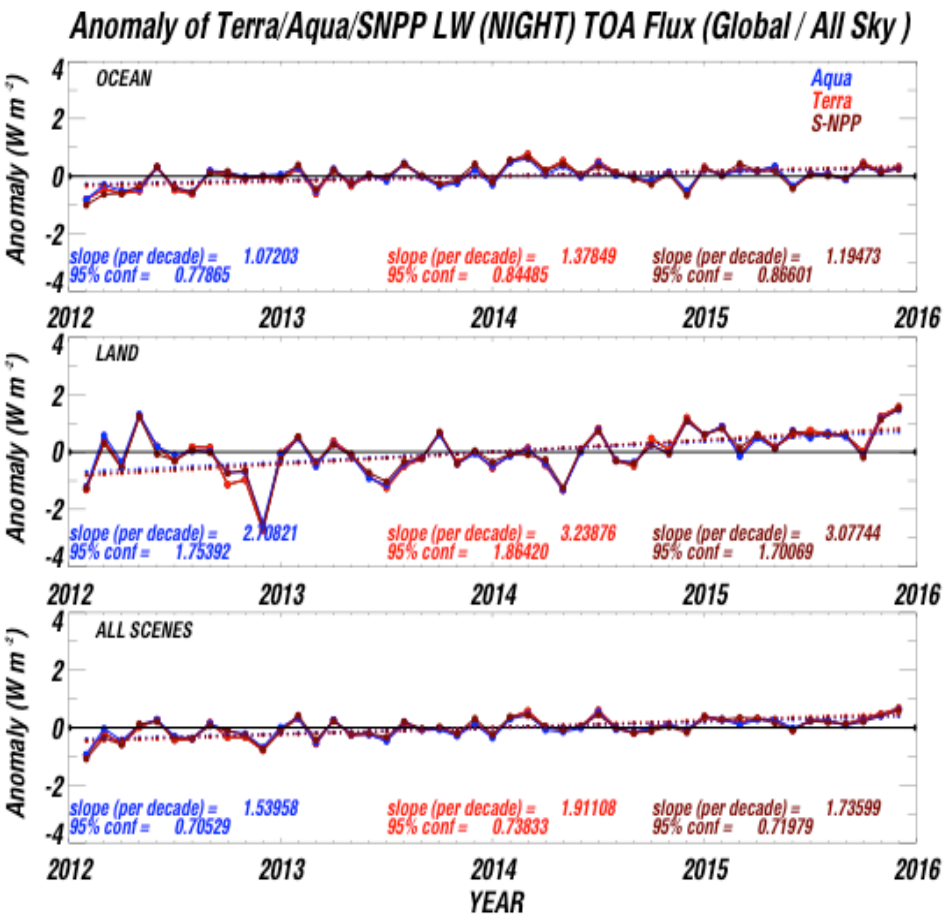


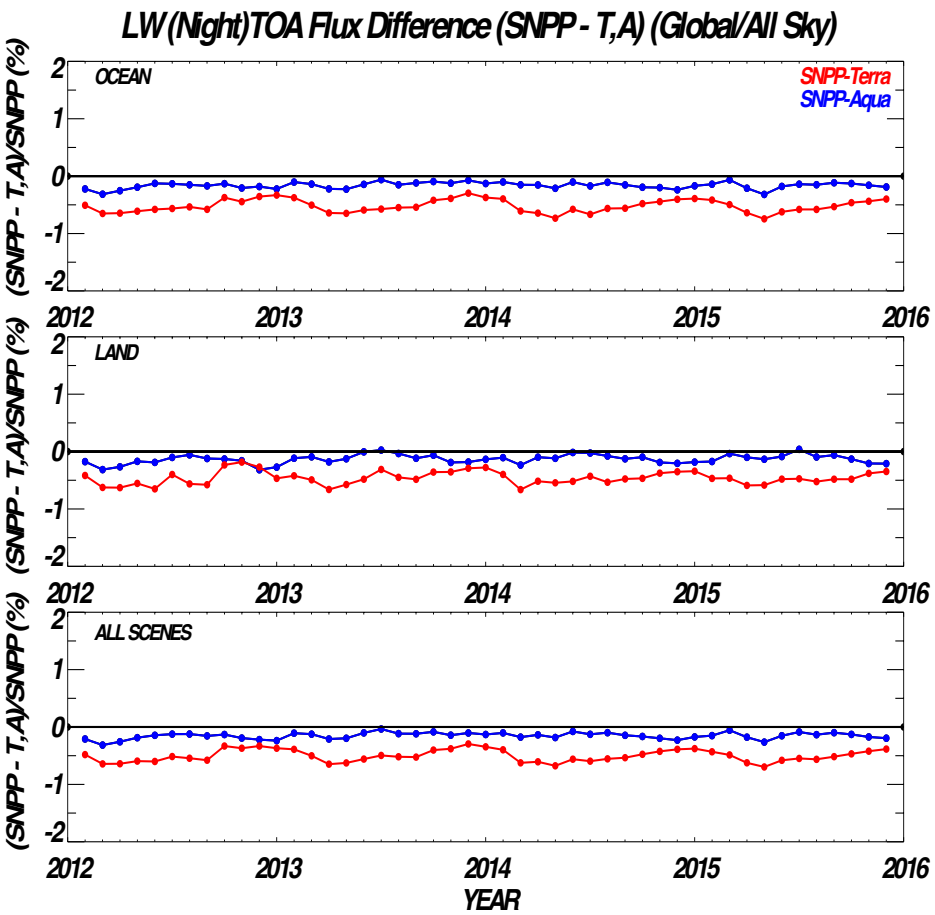
S-NPP/FM5, TERRA & AQUA COMPARE: LW Day





S-NPP/FM5, TERRA & AQUA COMPARE: LW Night





CERES FM5 - FM3 Matched Footprint Comparisons

All-sky 2012/2013/2014/2015
(Rev. 04/19/16)
ΔTime < 1min; ΔRAZ < 10°; ΔVZA <10°

Shown differences are statistically significant

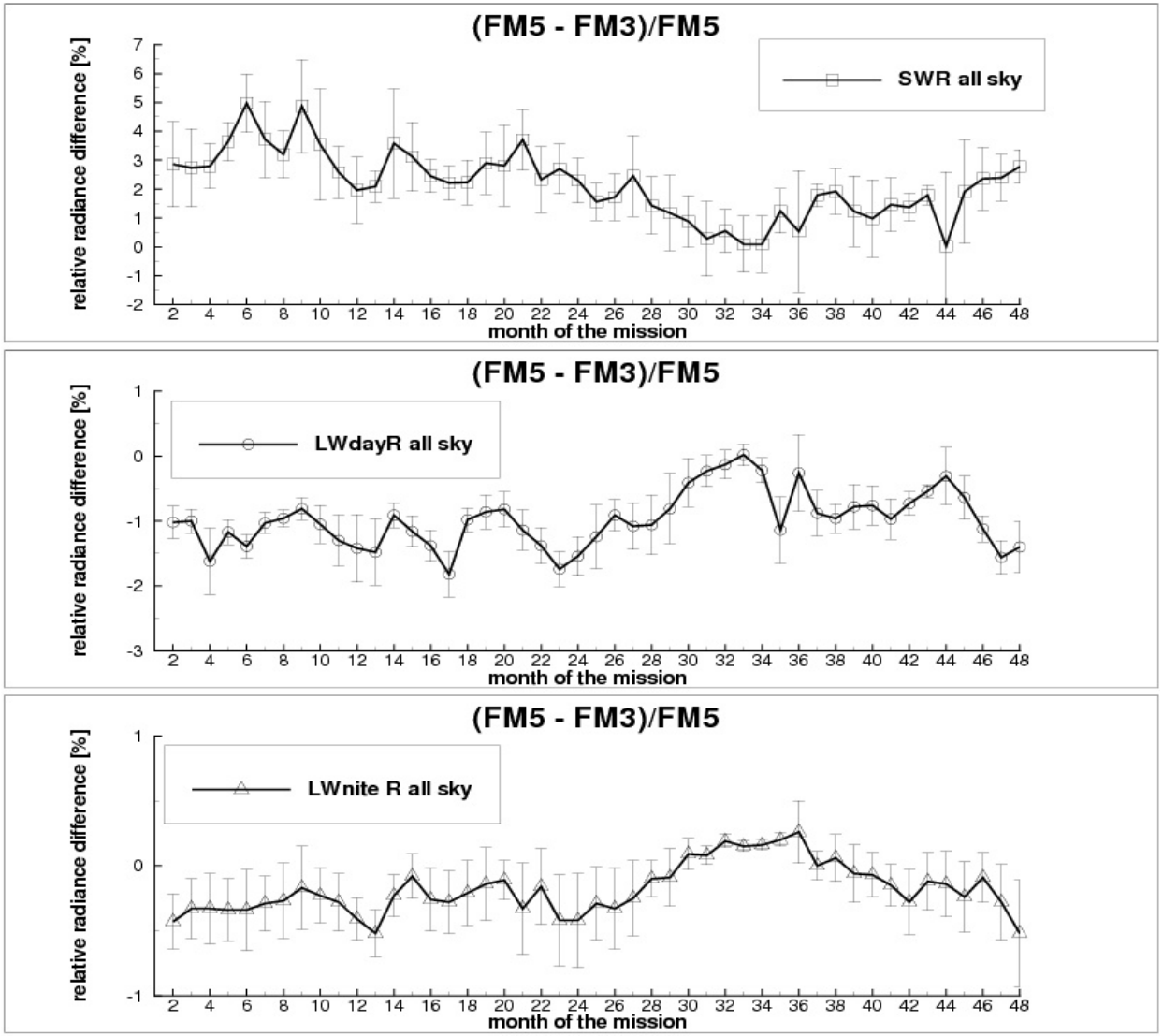
(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	79.1/84.5/77.2/80.6	**3.29 / 2.68 / 1.02/ 1.71**	.40/.31/.35/.35	65/86/91/85
LW daytime	75.7/74.0/76.9/76.6	**-1.13/-1.25/-0.57/-0.87**	.09/.10/.13/.10	69/89/91/85
LW nighttime	66.2/64.9/67.5/65.5	**-0.31/-0.27/0.01/-0.15**	.07/.08/.06/.07	87/105/106/105

- Edition 1 for FM5 and Edition 4 for FM1/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°



Direct compare of FM5 and FM1

All-sky 2012/2013/2014/2015
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	87.0/101.6/111.1/108.6	.81/.93/.86/1.00	.26/.17/.14/.17	64/108/123/139
LW daytime	78.6/76.1/74.8/74.8	-.46 /-.16 /-.81/-.71	.13/.09/.12/.12	68/112/130/141

- 2012 campaign lasted only 6 weeks
  - June 16 – July 31
- 2013/2014/2015 campaigns lasted 3 months
  - May 1 – July 31

FM1 – 5 INSTRUMENT SUMMARY

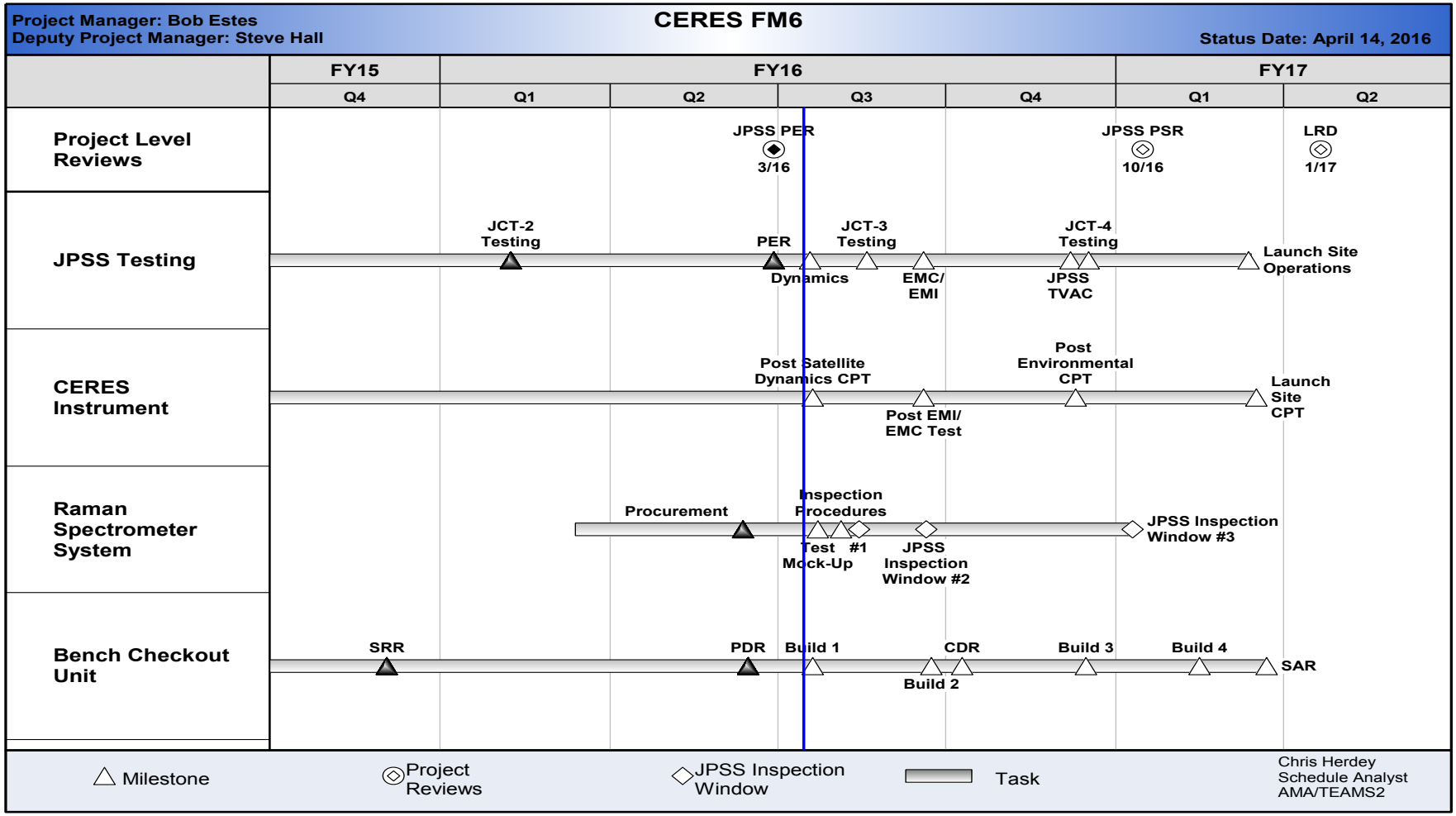
- Validation results from the Edition-4 datasets do not show trends in ocean and land scenes for Terra and Aqua SW and LW-day measurements.
- CERES FM5 calibration results show the performance trends are within expected range. SW sensor results are consistent between SWICS and MAM calibrations.
- S-NPP/FM5, Aqua/FM3 and Terra/FM1 comparisons are performed to evaluate whether there is any observed trends in FM5 measurements.
- The anomaly trends from Terra, Aqua and S-NPP show consistent results.

CERES FM-6

JPSS-1 Satellite I&T Overview

- Ball Aerospace & Technologies Corporation (BATC) in Boulder, CO is the JPSS-1 spacecraft provider and satellite integrator.
- NGST completed first Bench Acceptance Test at BATC in June 2014.
- NASA LaRC personnel perform I&T activities at BATC.
- JPSS coordinate launch operations through NASA KSC
  - Launch will be from Vandenberg AFB, CA - January 2017
  - Launch Vehicle provider: Boeing Delta-2 (same as S-NPP)
- I&T will heavily leverage success accomplished on S-NPP
  - Reuse S-NPP I&T flow & procedures minimizing changes
  - Integrate lessons learned from S-NPP for JPSS-1 I&T

CERES FM6 - Project Schedule



CERES FM-6 Summary

- CERES FM6 is actively marching towards launch, supporting JPSS environmental testing, and preparing for optics inspection

Upcoming Events:

JPSS-1

- May 13-17, 2016 — Joint Confidence Test #3
- May 23-June 19, 2016 — EMC/EMI Test
- June 23-July 2, 2016 — Mission Rehearsal #3

CERES FM6

- May 2-10, 2016 — Optics Inspection Window #1
- May 5, 2016 — Post-Dynamics Test