CERES FLASHFlux Status:

Near-Real Time Surface Radiative Fluxes and Meteorology for Research and Applications

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Outline

- ***Brief introduction***
- ***FLASHFlux V3A: current status***
  - Sample results
  - Ordering web page
- ***FLASHFlux TISA V3A vs CERES SYN1_deg***
- ***Energy Applications Examples***
- ***Publications***
  - SSF paper accepted
  - State of Climate 2012 report published
- ***State of Climate Validation***
- ***Future Plans***
  - Monthly Aerosol to Daily Aerosol
  - Albedo monthly climatology to daily albedo

FLASHFlux Overview

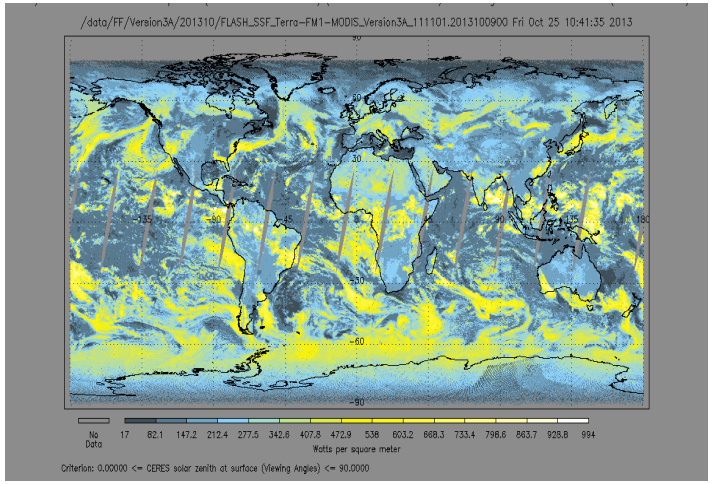
- ***FLASHFLUX = Fast Longwave And SHortwave Radiative Fluxes from CERES and MODIS***

- ***FLASHFlux Objectives***
  - Provide TOA and surface radiative fluxes base on the CERES algorithm within one week of observation for scientific and applied science uses
    - Level 2 – Single Scanner Footprint (SSF) hourly instantaneous for Terra and Aqua in cross-track mode is usually available around 4 days after observation (1/1/2013 – 10/10/2013)
    - Level 3 – Temporal Interpolate and Spatial Averages (TISA) daily gridded that combines Terra and Aqua observations into 1 degree equal angle grid. Available within 7 days after observation (1/1/2013 – 10/10/2013)
  - Conduct scientific investigations and provide for scientific and applied science uses
    - State of the Climate report
    - RETScreen
    - Climate Adaptation Science Investigation
  - Demonstrate processing system pushing data products to research and applications uses
    - Agricultural sector via POWER project: power.larc.nasa.gov
    - Education users accessing the NASA Earth Observatory

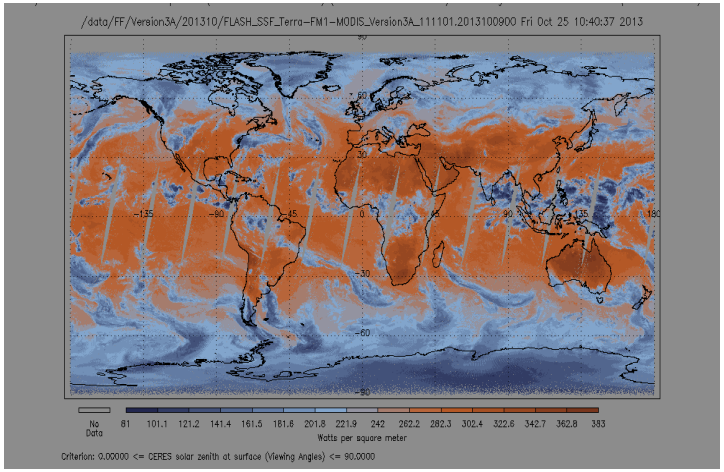
FLASHFlux SSF Data Products (Oct. 9, 2013)

Terra FM1 hourly instantaneous

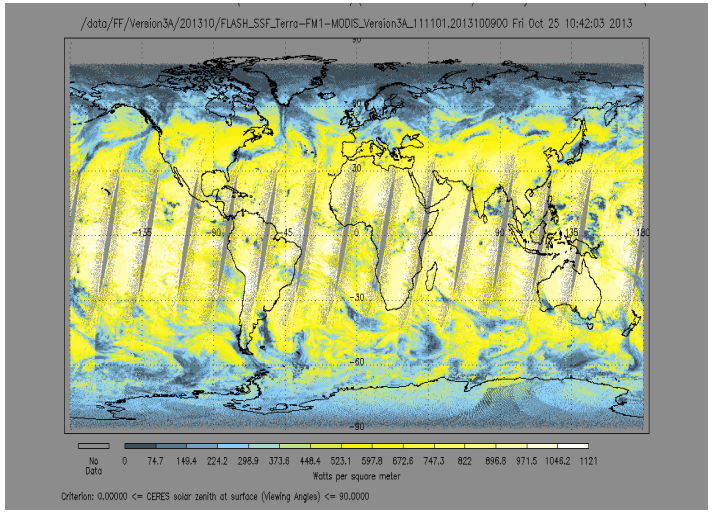
SW TOA



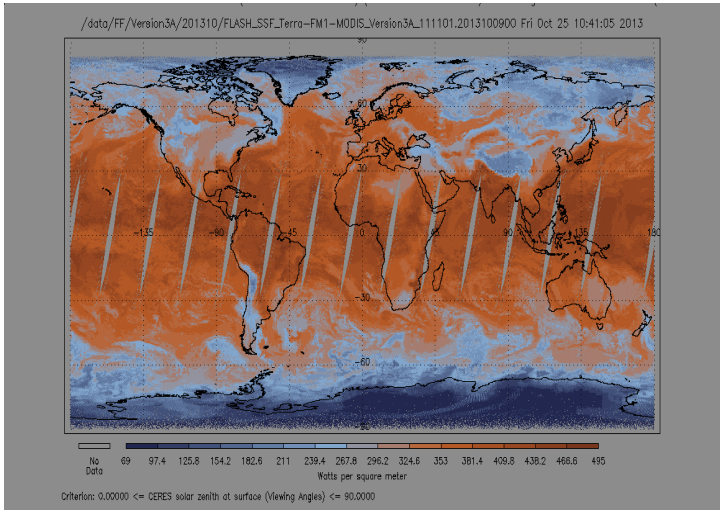
LW TOA



SW Surface



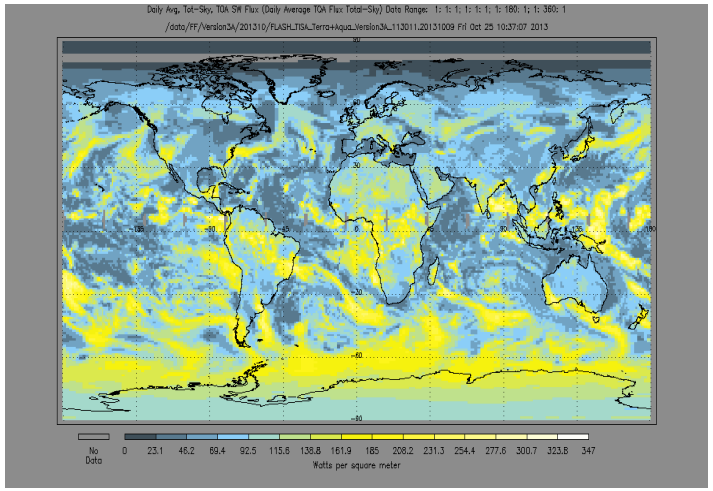
LW Surface



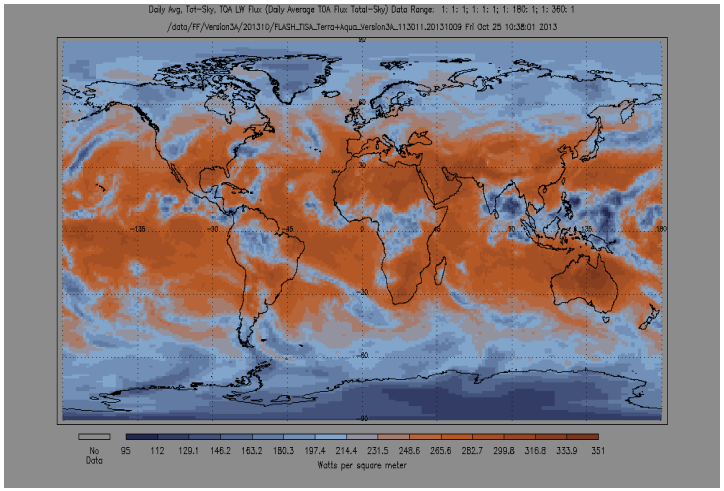
FLASHFlux TISA Data Products (Oct. 9, 2013)

(Terra+Aqua; Daily; 1°x1° resolution)

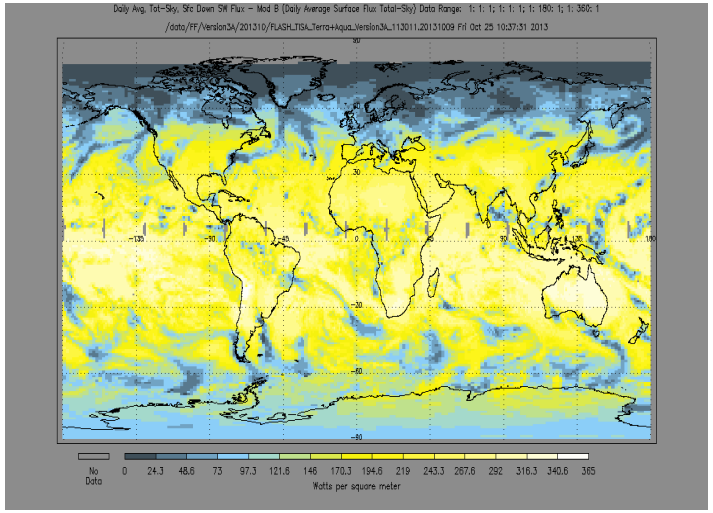
SW TOA



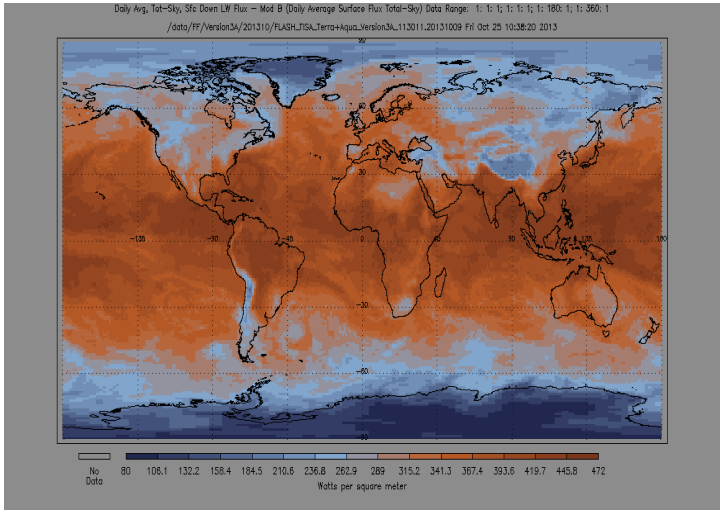
LW TOA



SW Surface



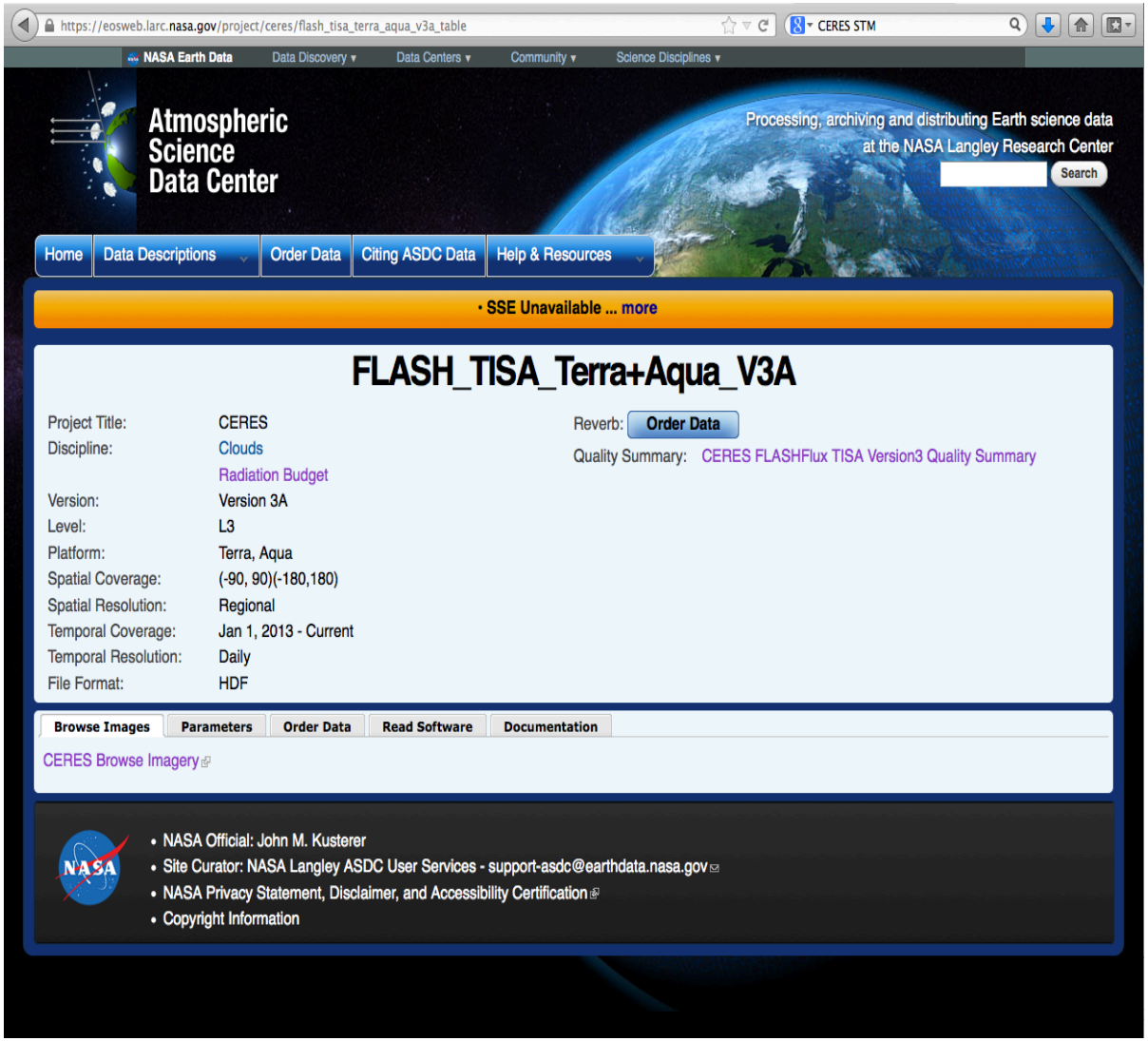
LW Surface



FLASHFlux Data Products

FLASHFlux TISA Version 3A Products (Terra+Aqua; Daily; 1°x1° resolution; Processed through about 10/10/2013)

https://eosweb.larc.nasa.gov/project/ceres/flash_tisa_terra_aqua_v3a_table

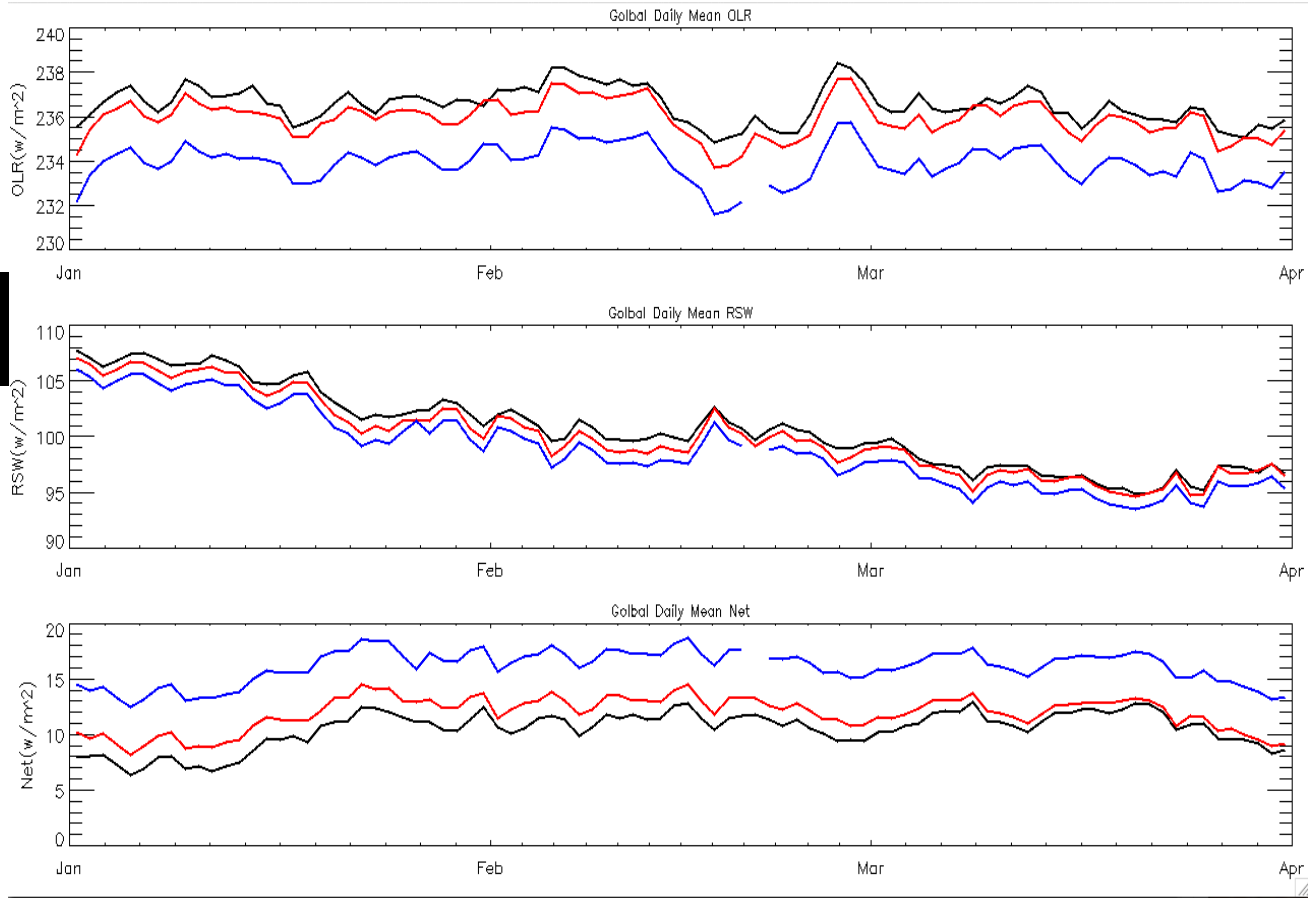


SYN1deg, FF V3A, FF V2H

Daily Global mean of SYN1deg, FF V3A (Current), and FF V2H (Previous)

	SYN 1deg	FF V3A	FF V2H
OLR	236.52	235.92	233.53
RSW	100.68	100.01	95.25
Net	10.47	11.89	13.35

- ***Reduce global mean bias compared to SYN1deg from previous version***
- ***Day to day variability correlate very well***



SYN1deg ***FF V3A (Current)*** ***FF V2H (Previous)***

RETScreen Training Using FF

- ***RETScreen International Tools***
  - RETScreen is a decision support tool for clean energy project analysis and feasibility study
  - RETScreen includes a Performance Plus module that allows for building system monitoring of current system, targeting new performance goals with clean technologies and verifying the savings from implementation of those technologies
  - There are now 65,000+ registered users of the Performance Plus tool
- ***Training Workshops held***
  - RETScreen held several workshops (latest Sept. 2013) on using Performance Plus where data derived from FLASHFlux (through http://power.larc.nasa.gov) was incorporated directly into the training.
  - Several examples were shown and users pulled data from locations as diverse as Arctic circle to Western Africa.

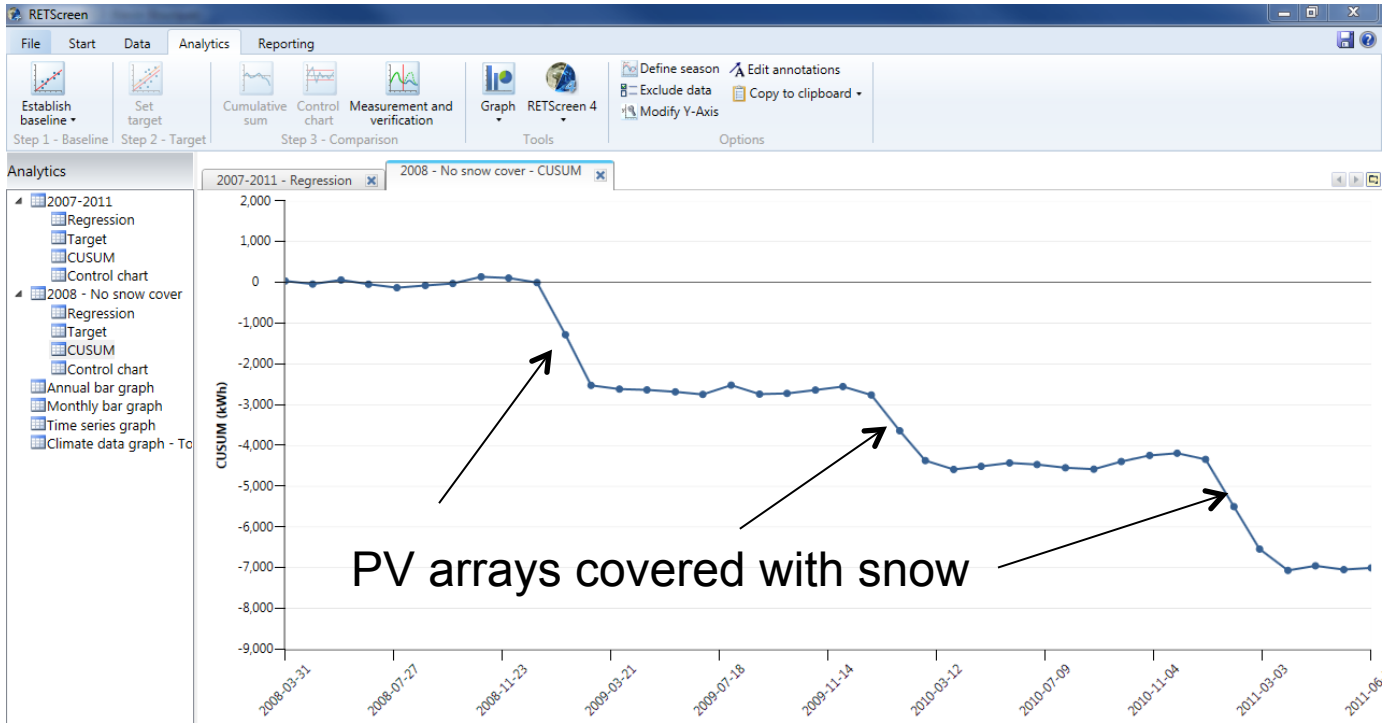
Example: Toronto Photovoltaic Array

Plot shows cumulative performance of system relative to baseline.

Baseline computed using regression of FF solar and system output.

Performance drops correspond to snow covering PV array.

Analysis shows cost of not clearing snow from PV array.



Period	Begin	End	Daily solar radiation - tilted (Fixed - 15.0° - 30.0°) (kWh/m²/d)	Actual Electricity (kWh)	Baseline Predicted (kWh)	Difference (Actual - Baseline) (kWh)	CUSUM (kWh)	Included
4	2008-03-01	2008-03-31	4.18	2,357	2,318	39	39	Yes
5	2008-04-01	2008-04-30	6.00	3,410	3,486	-76	-37	Yes
6	2008-05-01	2008-05-31	5.76	3,534	3,433	101	64	Yes
7	2008-06-01	2008-06-30	5.91	3,317	3,421	-104	-40	Yes
8	2008-07-01	2008-07-31	6.12	3,602	3,687	-85	-125	Yes
9	2008-08-01	2008-08-31	5.84	3,542	3,487	55	-71	Yes
10	2008-09-01	2008-09-30	4.64	2,601	2,553	48	-23	Yes
11	2008-10-01	2008-10-31	3.57	2,049	1,885	164	142	Yes
12	2008-11-01	2008-11-30	2.23	881	911	-30	112	Yes
13	2008-12-01	2008-12-31	1.91	604	716	-112	0	Yes
14	2009-01-01	2009-01-31	3.08	259	1,537	-1,278	-1,278	Yes
15	2009-02-01	2009-02-28	4.60	1,119	2,362	-1,243	-2,521	Yes
16	2009-03-01	2009-03-31	5.06	2,844	2,936	-92	-2,613	Yes
17	2009-04-01	2009-04-30	5.44	3,085	3,104	-19	-2,633	Yes
18	2009-05-01	2009-05-31	6.60	3,976	4,024	-48	-2,680	Yes
19	2009-06-01	2009-06-30	5.99	3,414	3,478	-64	-2,744	Yes

NASA LaRC CASI Analysis

- ***NASA CASI:***
  - NASA has instituted a Climate Adaptation Science Investigation (CASI) team to assess NASA building infrastructure risks to potential changes in climate
  - Part of the assessment is a review of energy performance of buildings under varying meteorological conditions
  - LaRC's team is assessing 4 buildings for team and with the intent to provide tutorial for other centers
  - Analysis uses RETScreen Performance Plus tool with FLASHFlux meteorological inputs and radiative flux outputs.

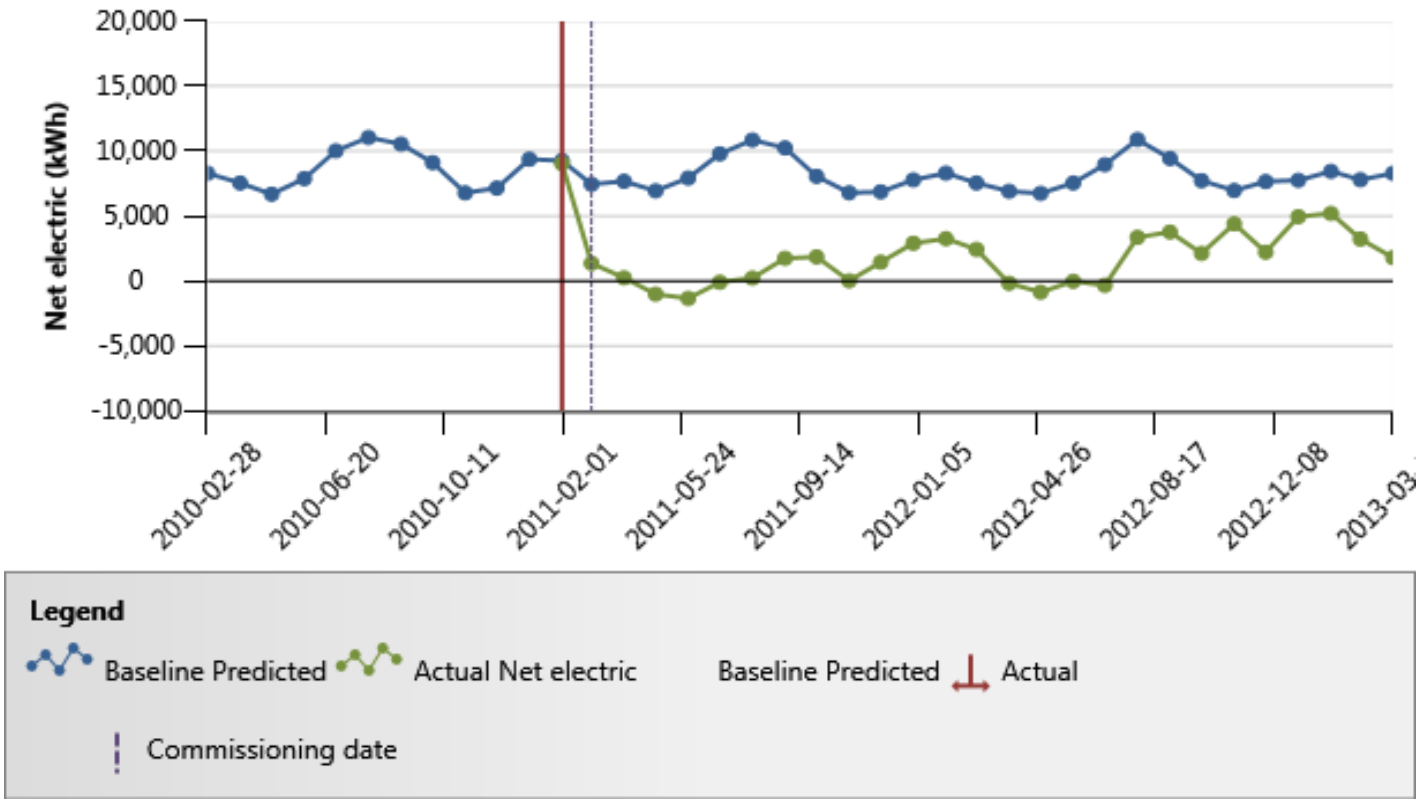
CASI Analysis Case: NASA LaRC Badge and Pass Office

- 39.5 kW Solar Photovoltaic array added to supplement building power in September 2010
- Use Performance Plus and FLASHFlux data to assess savings of new system

CASI Analysis Case: NASA LaRC Badge and Pass Office

Net Electricity usage before and after installation of PV array.

Baseline fit uses temp & other met parameters from GEOS



Note that at first installation building nearing zero energy usage but as offices added and PV degrades additional changes needed to obtain zero energy.

SSF paper Published

The Fast Longwave and Shortwave Flux (FLASHFlux) Data Product: Single Scanner Footprint Fluxes

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Greg R. McGarragh
Colorado State University
Fort Collins, Colorado

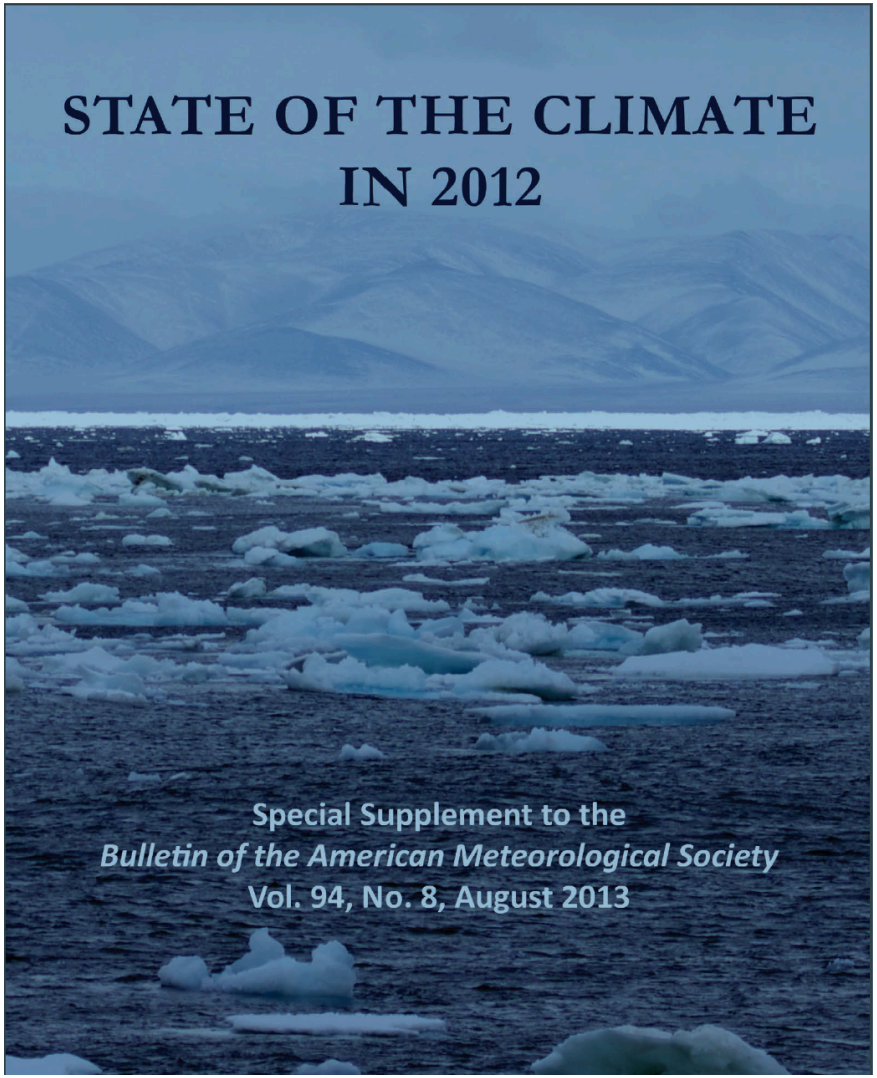
For submission to the
Journal of Applied Meteorology and Climatology

October 2013

Corresponding author address: Dr. David P. Kratz, NASA Langley Research Center, Mail Stop 420, Hampton, VA 23681-2199. *E-mail:* David.P.Kratz@nasa.gov.

- ***Accepted to the Journal of Applied Meteorology and Climatology.***
- ***Highlights the production and validation of the FLASHFlux SSF data product.***
- ***Compares well with CERES SSF data product.***
- ***TISA paper in progress.***

State of the Climate 2012 Published



- ***CERES FLASHFlux contributed to the special annual BAMS report on the "State of the Climate in 2012".***
- ***Issue appeared in Aug. 2013, providing estimates of changes in year to year Global Earth Radiation Budget for the first time.***
- ***These data were extended and normalized relative to the CERES EBAF 2.6r products for this report.***

Revise 2012 Anomaly Analysis

CERES FLASHFlux TOA flux variability for 2012 report:

- FF V2H monthly average annual global TOA normalized to EBAF 2.7 from 7/2011 to 6/2012
- TSI from SORCE instrument
- Global annual average anomalies:

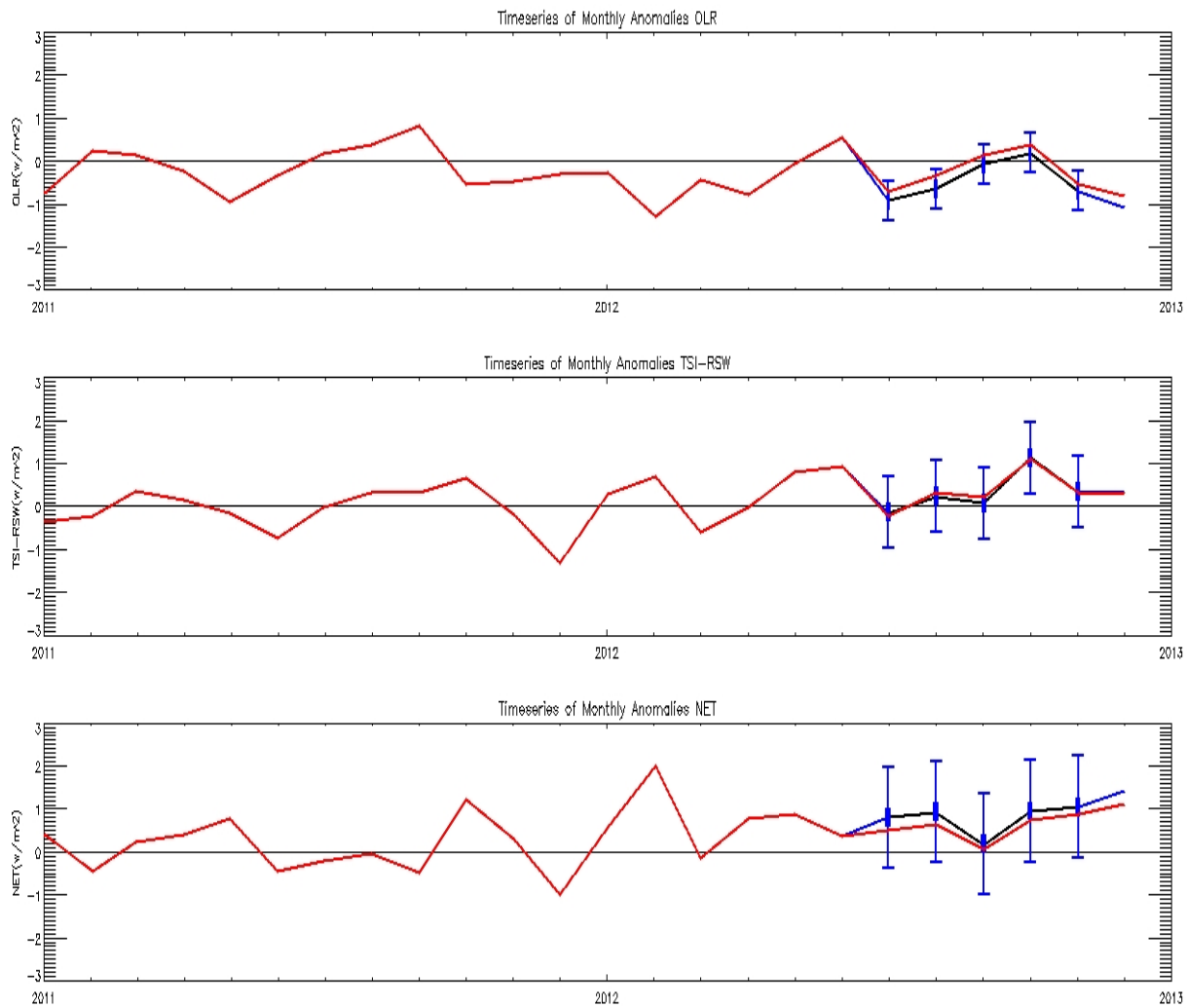
	One year change (2012 minus 2011) (Wm^-2)	2012 anomaly (relative to climatology) (Wm^-2)	Interannual variability (2001 to 2011) (Wm^-2)
OLR	-0.30	-0.50	+/- 0.60
TSI	0.05	0.05	+/- 0.20
RSW	-0.40	-0.30	+/- 0.40
Net	0.75	0.85	+/-0.80

Revise 2012 Anomaly Analysis

- FLASHFlux projection correlates very well to EBAF Ed 2.7.

- 2σ monthly uncertainty of the normalization procedure is ±0.46 Wm^{-2}, ±0.83 Wm^{-2}, and ±1.18 Wm^{-2} for OLR/RSW/Total Net radiation.

- High uncertainty due to 1 year overlap. Projected mean bias error is -0.23 Wm^{-2} , -0.02 Wm^{-2} , and 0.21 Wm^{-2} for OLR/TSI-RSW/Total Net radiation.



EBAF 2.7 FLASHFlux V2H

Future Upgrades and Challenges

- ***FF data products to CERES subsetter***
  - Daily FF TISA TOA and surface fluxes to netCDF format
- ***Continued refinement of algorithms:***
  - Improve near-real time surface albedo to reflect surface condition
  - Aerosols: evaluation FP-IT compared to “Fast-MATCH”
- ***Adapt to MODIS Collection 6 (Ed 4 Clouds)***
- ***Develop FLASHFlux NPP product line (in 2014)***
- ***Improve consistency between CERES algorithms and FLASHFlux (TISA/SYN)***
  - Evaluate using GEO?
  - Adapt special version of TISA for monthly averaged maps
- ***Develop new products and subsets for applications (Solar industry, Agriculture, Building assessment)***

Summary and Conclusions

- ***FLASHFlux 3A***
  - Continuing production and validation
  - Analysis with EBAF 2.7 shows FF global monthly flux anomalies projected 2σ uncertainty to be within 0.12 Wm^{-2}, 0.16 Wm^{-2}, and 0.16 Wm^{-2} for OLR/TSI-RSW/Total Net, respectively.
  - Reprocess at last 6 months of 2012 to provide longer time series with new algorithms and calibration
    - use EBAF 2.7 for normalization for next years SoC

- ***FLASHFlux Applications:***
  - Expanding usage for Energy applications using RETScreen; shows solar and ancillary data accurate enough for energy assessment
  - Also noting expanded usage in building infrastructure risks applications

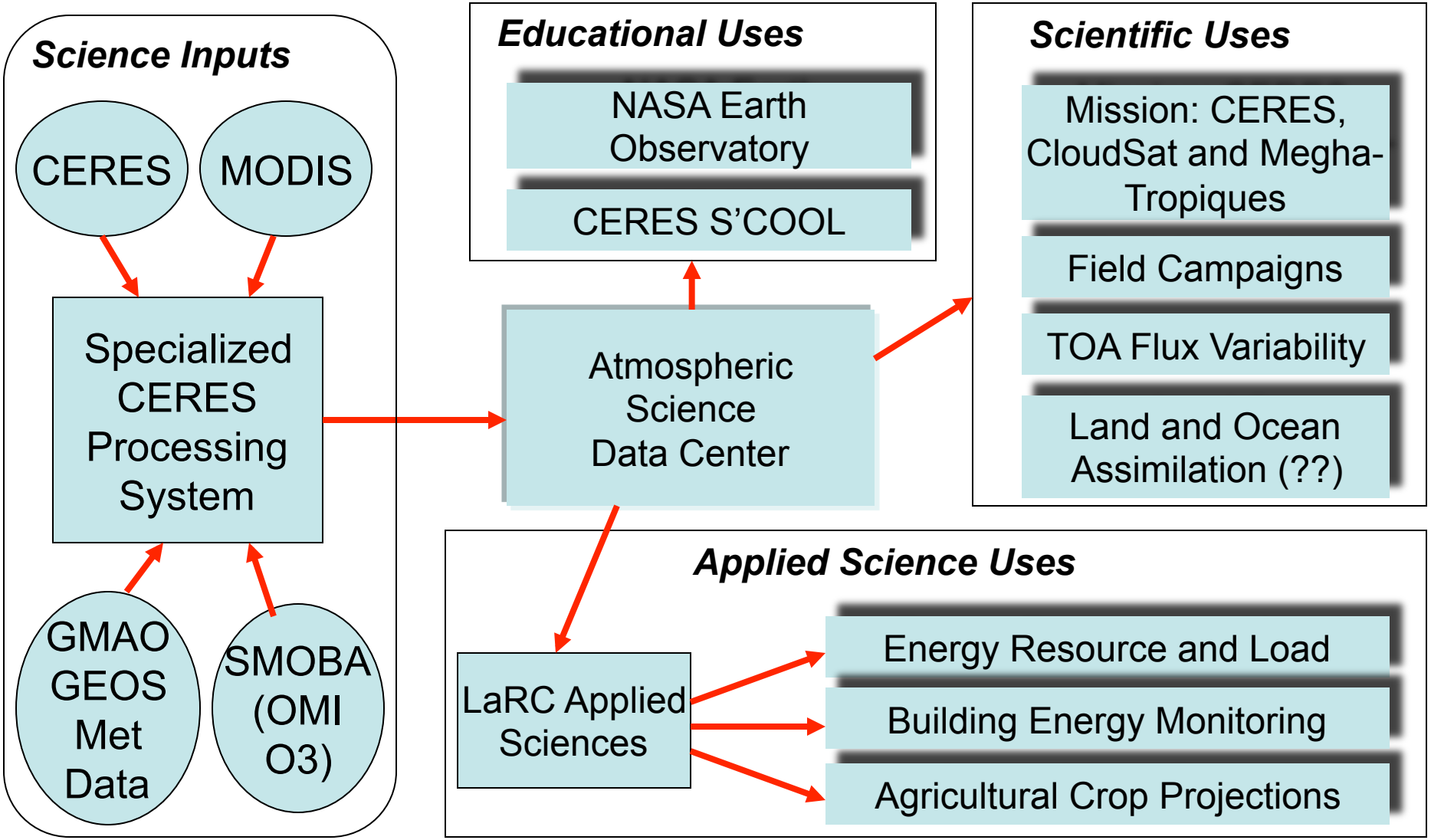
- ***FLASHFlux publications:***
  - SSF accepted; TISA paper next
  - 2012 SoC report published

FLASHFlux Web Sites:

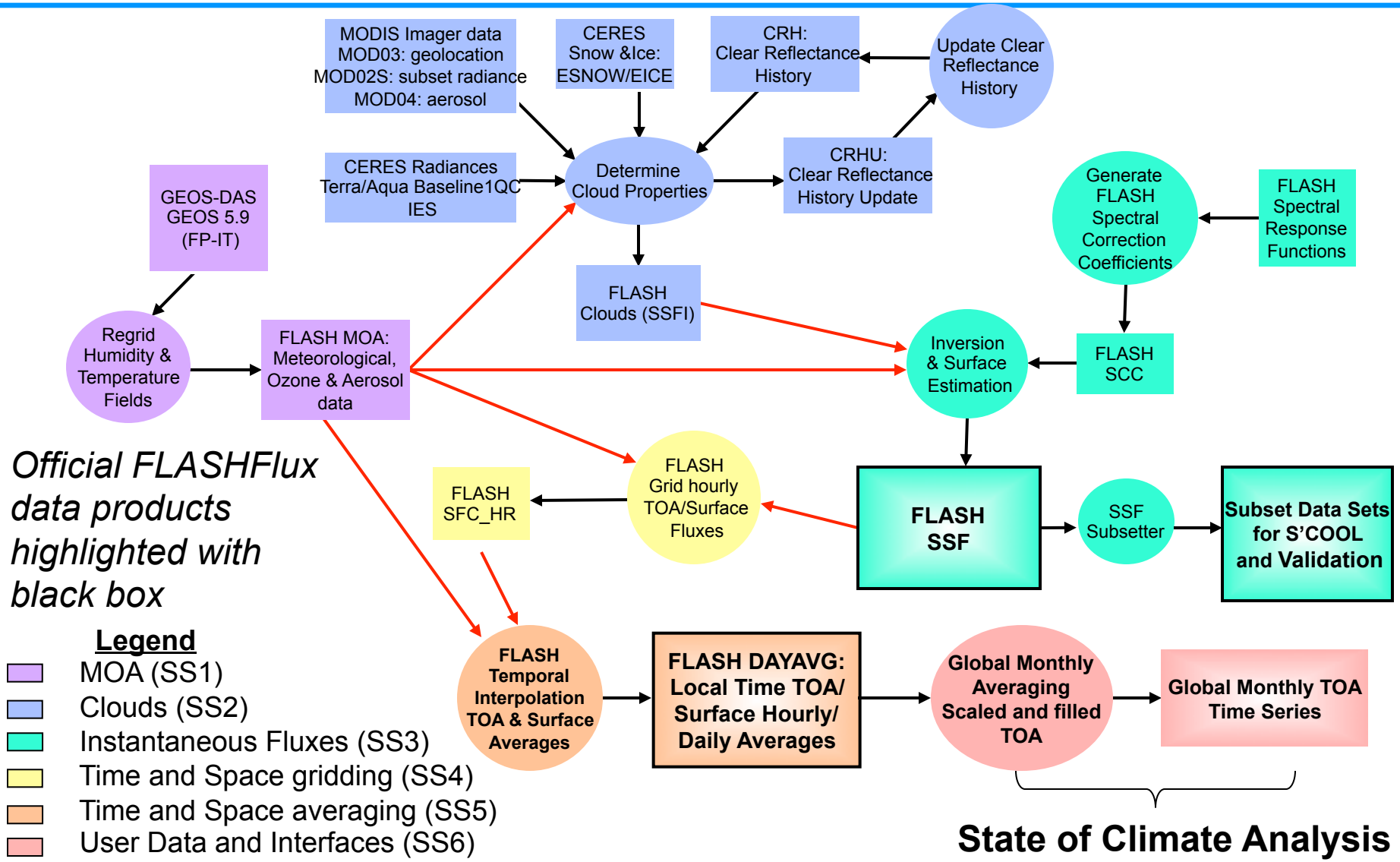
http://flashflux.larc.nasa.gov

Extras

FLASHFLUX: Schematic Mapping to Realized and Potential Uses



FLASHFlux Data Flow (v3A)



Official FLASHFlux data products highlighted with black box

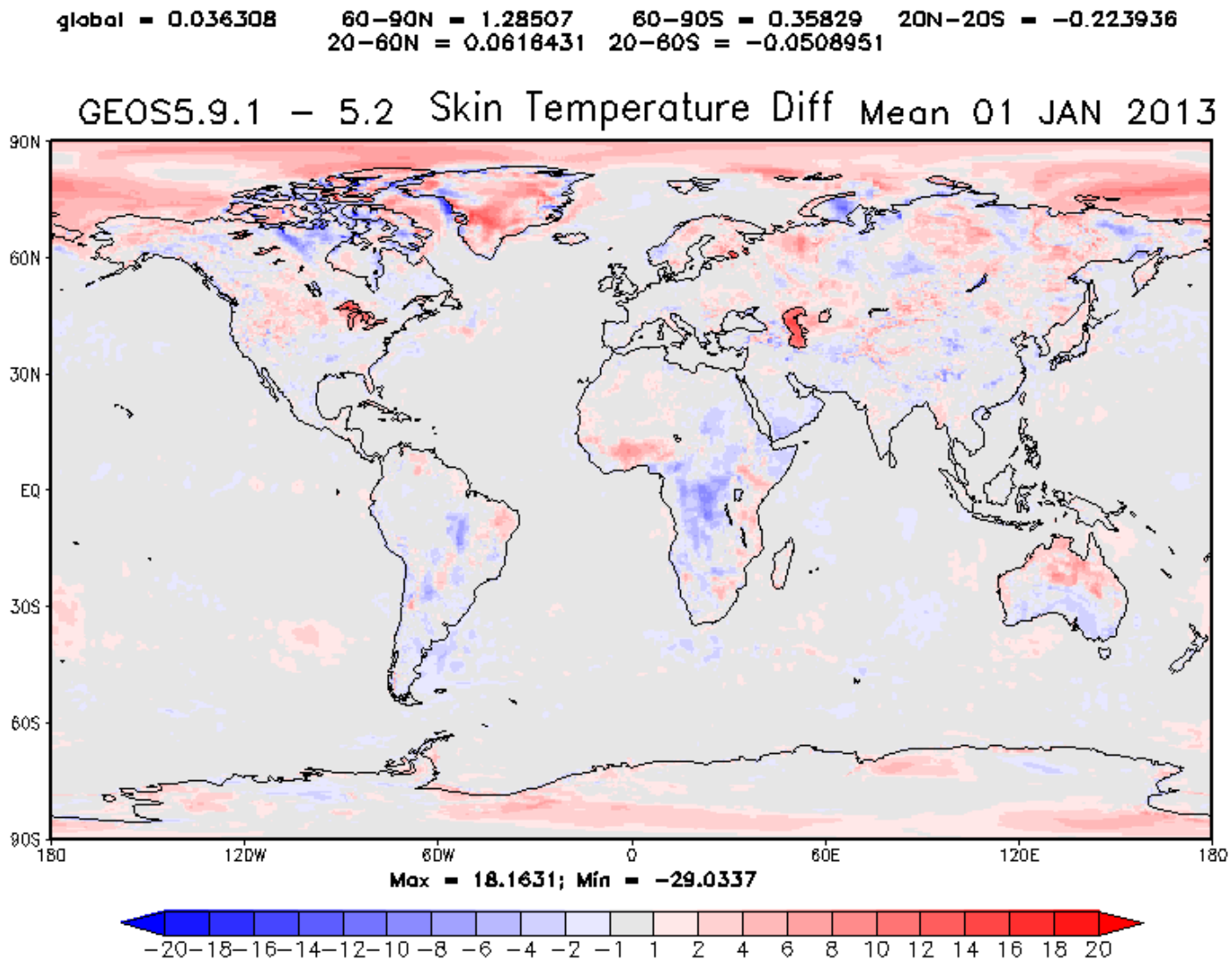
Legend

- MOA (SS1)
- Clouds (SS2)
- Instantaneous Fluxes (SS3)
- Time and Space gridding (SS4)
- Time and Space averaging (SS5)
- User Data and Interfaces (SS6)

GEOS FP-IT

- ***GEOS FP-IT (Forward Processing – Investigative Team)***
  - New GEOS 5.9.1 version replaces operational version GEOS 5.2
    - 0.5^{o} latitude x 0.625^{o} longitude resolution
    - Hourly surface, 3 hourly upper air profile
  - Represents a reprocessed assimilation that is “semi-frozen” with changes before reviewed by the Investigator Team
    - Current being produced from the Jan 1, 2000 to present (3 streams RP-IT1, RP-IT2 and RP-IT3)
    - Production plans to be complete by Fall 2013
- ***Multiple changes from previous versions***
  - Assimilates AIRS radiances among many (HIRS3,4; AMSU-A, B, E; SSM/IS , MHS, IASI, etc. also assimilation GPS)
  - Produces chemistry products such as O3 (SBUV, OMI)
  - Features an aerosol assimilation (AOD MODIS Terra/Aqua)

Upgrade to Inputs: FP-IT



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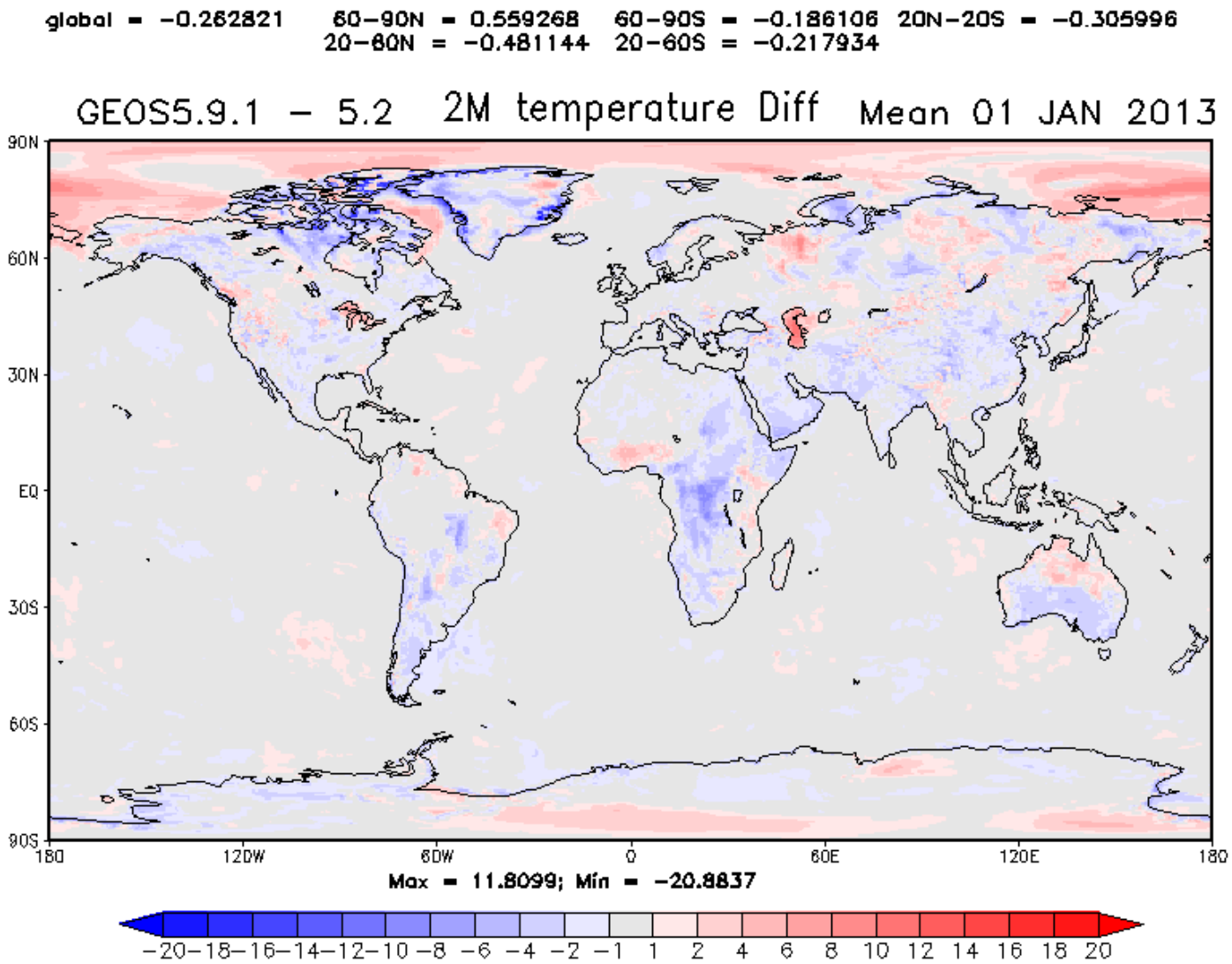

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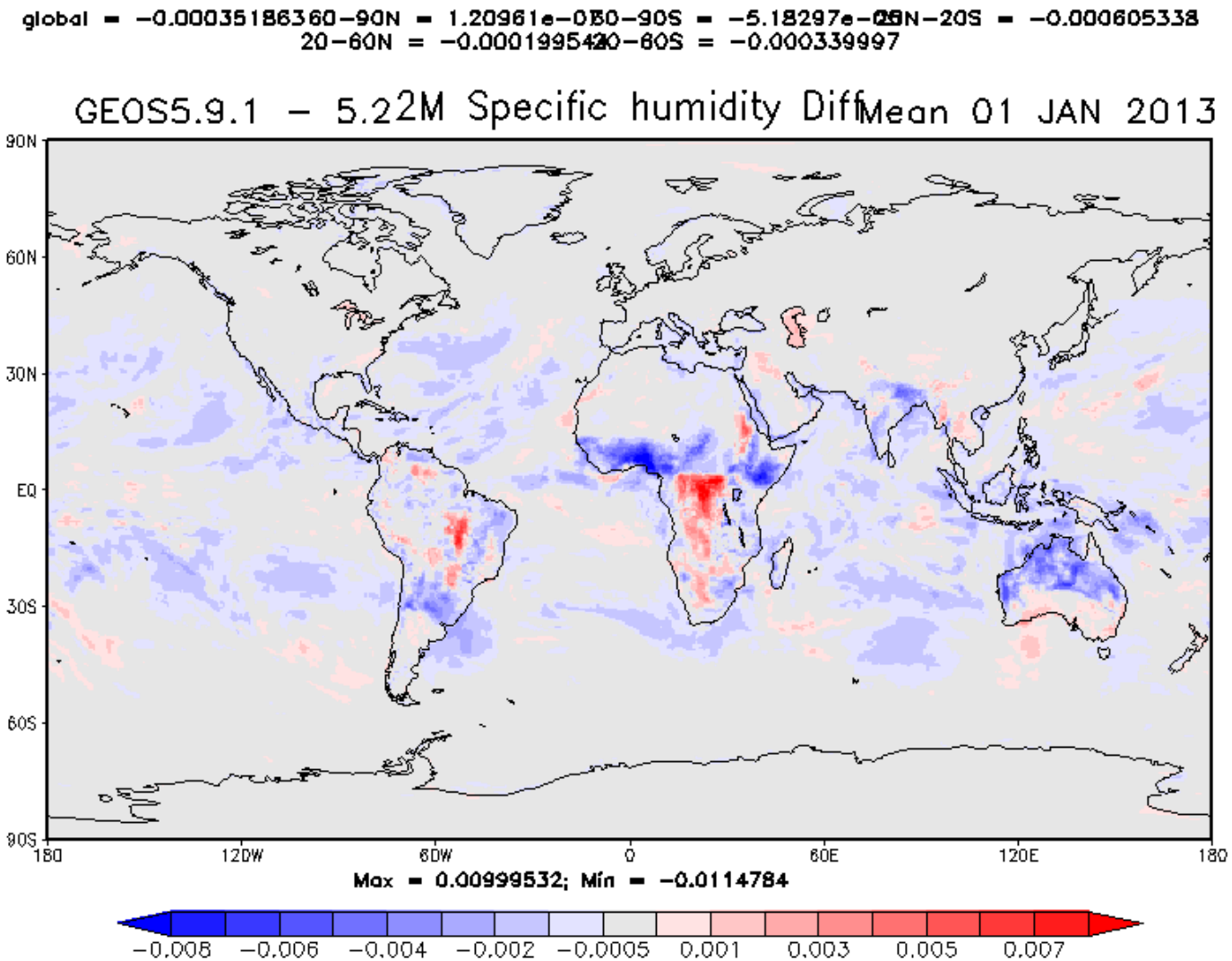
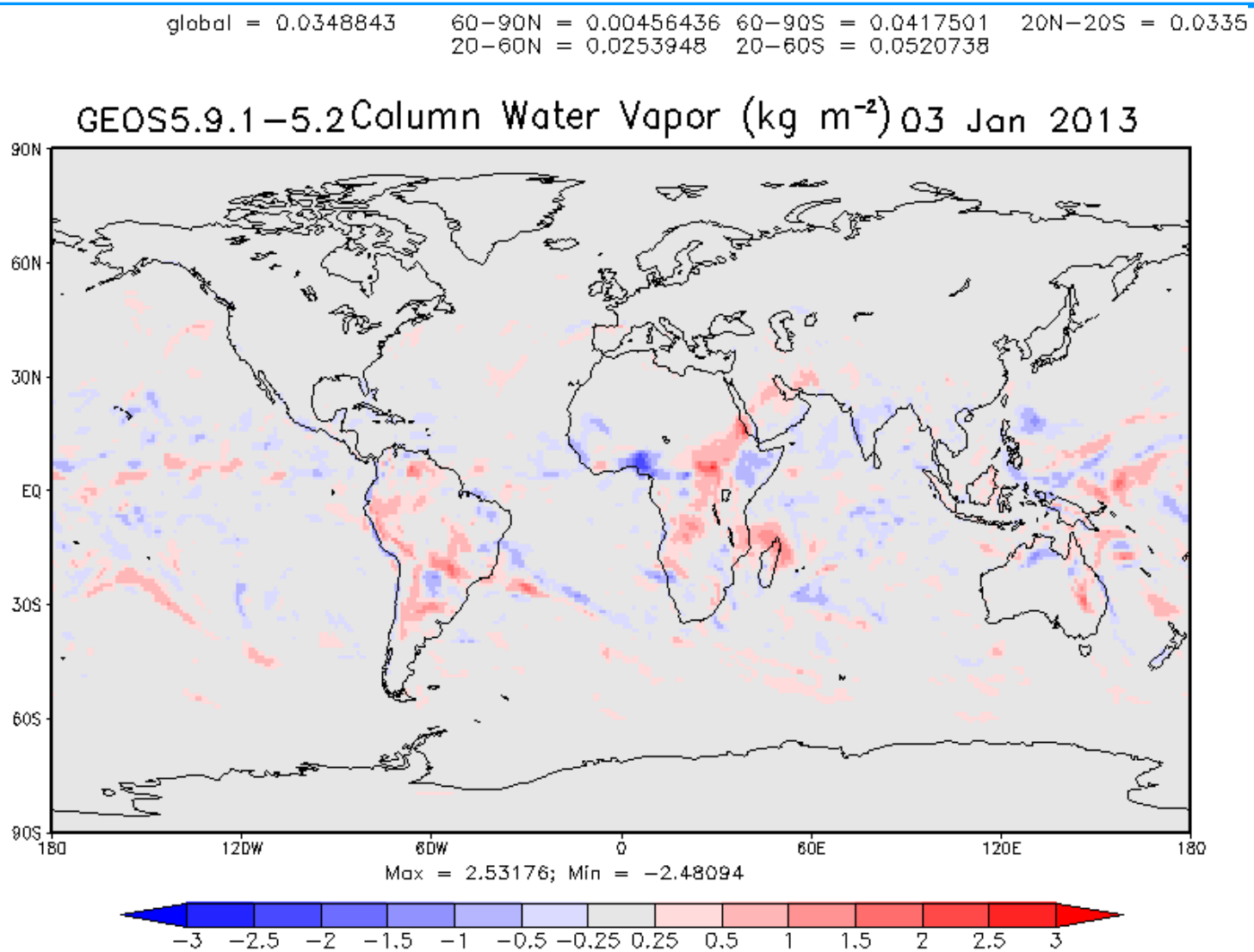
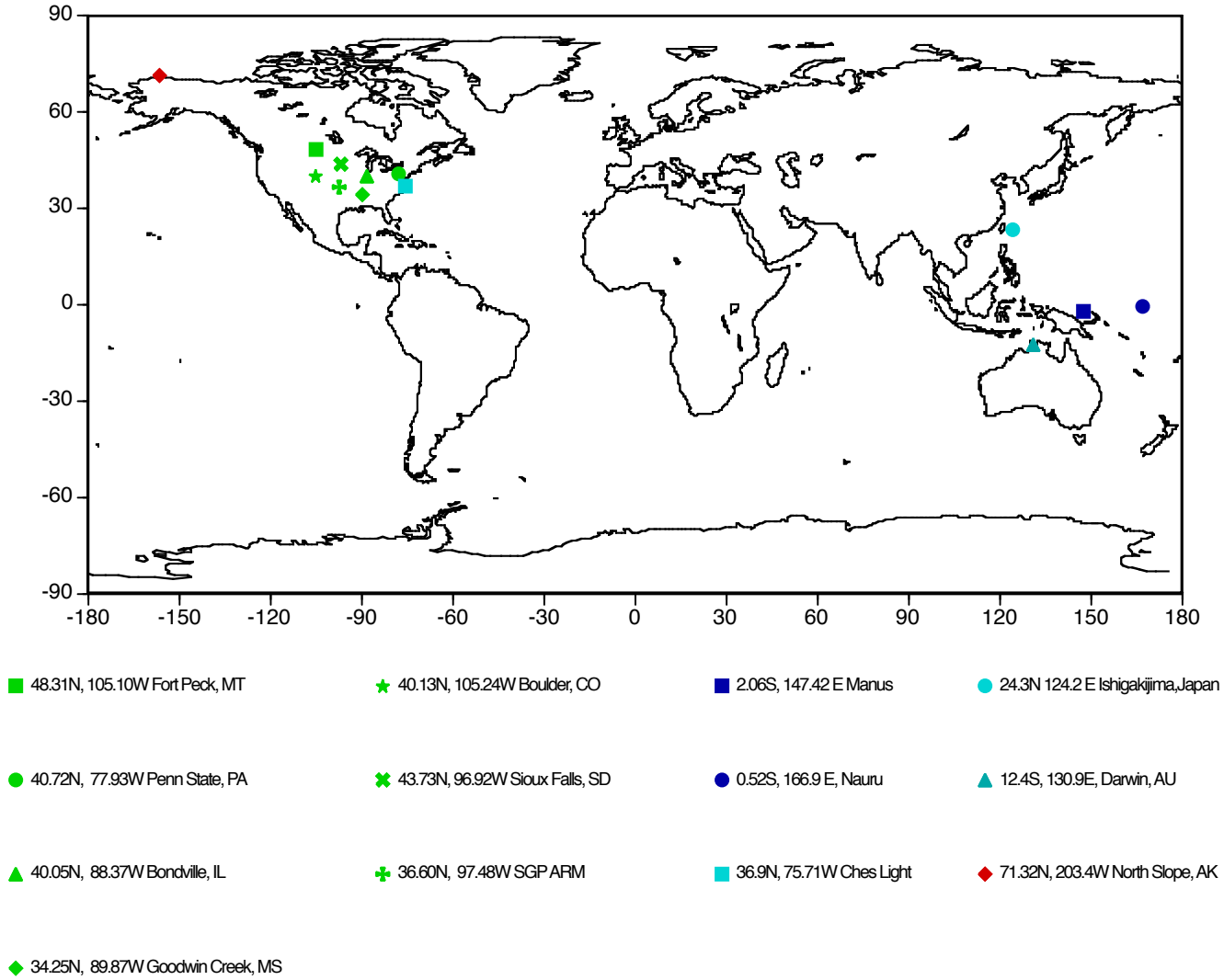


Upgrade to Inputs: FP-IT



Early Surface Flux Validation

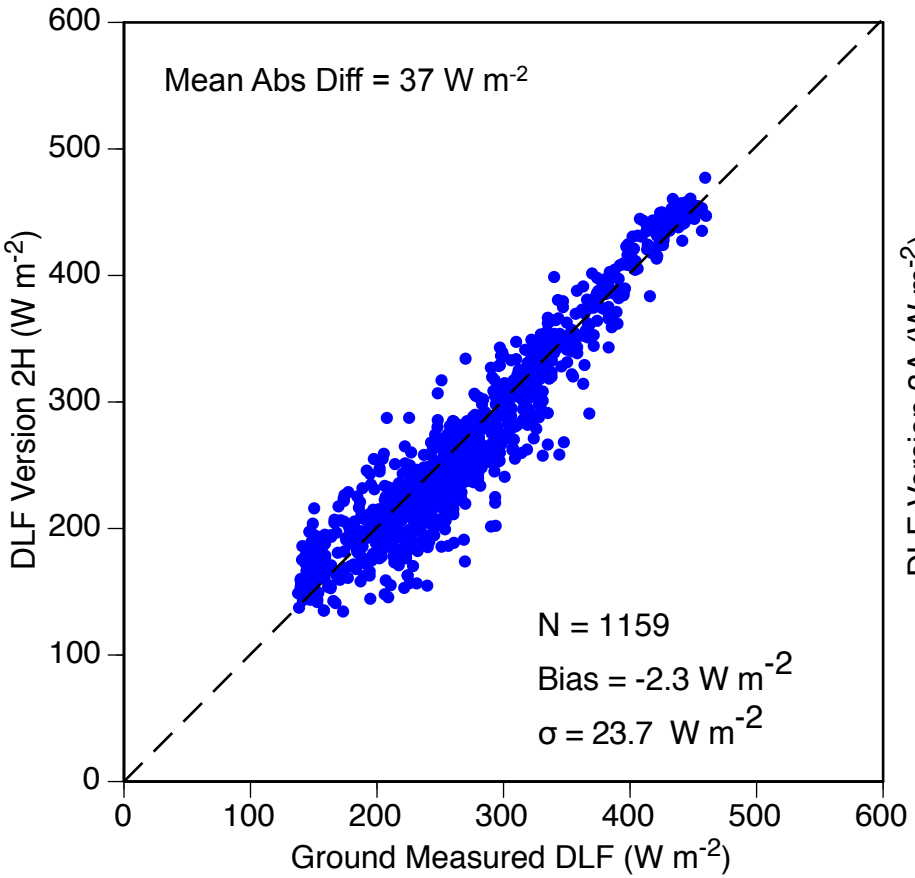
Only SurfRad and a few other sites available for Jan 2013



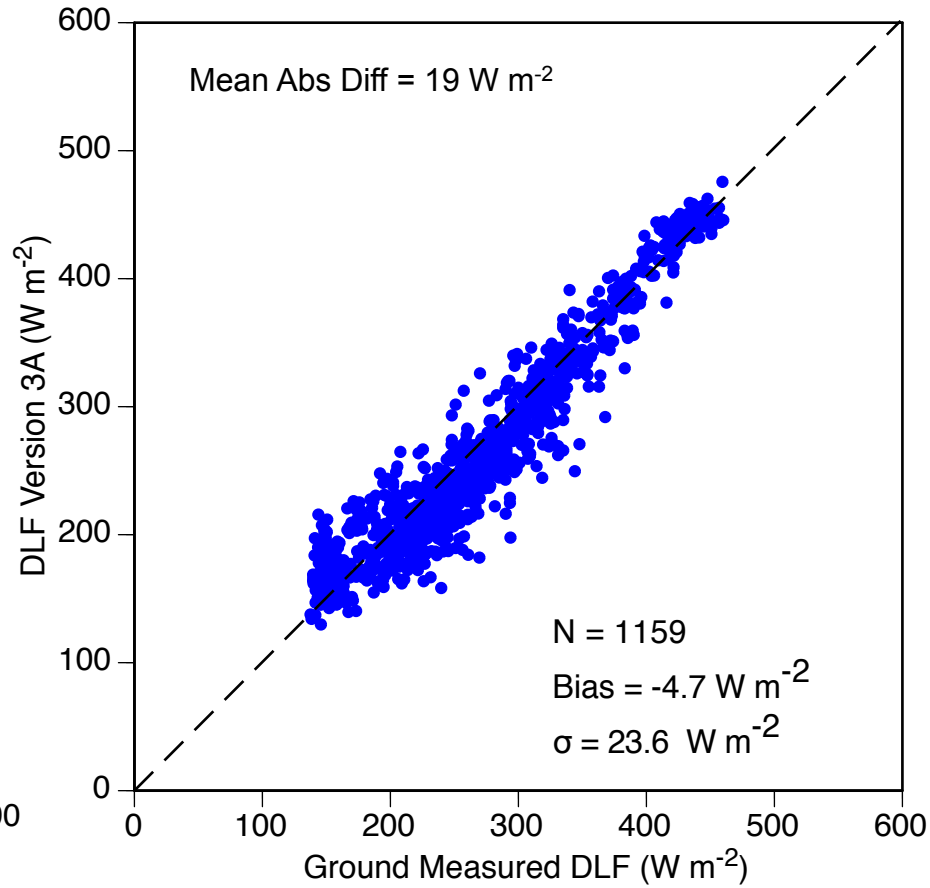
LW SSF Early Validation (Jan 2013)

Terra and Aqua

2H



3A

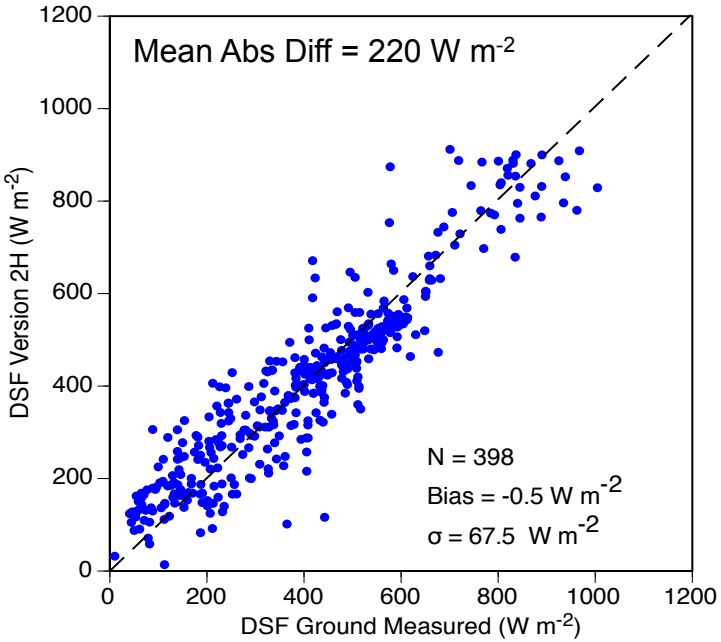


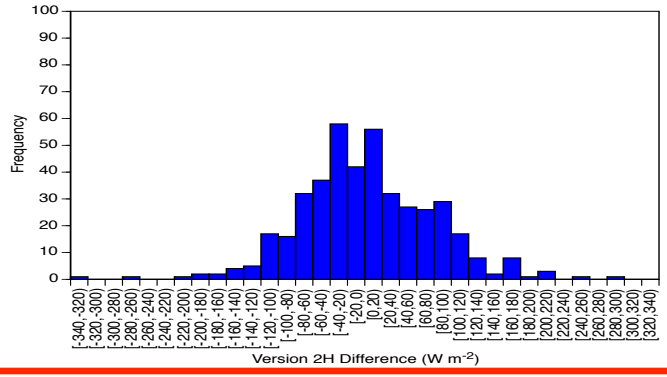
Instantaneous fluxes at overpass times

SW SSF Early Validation (Jan 2013)

Terra and Aqua

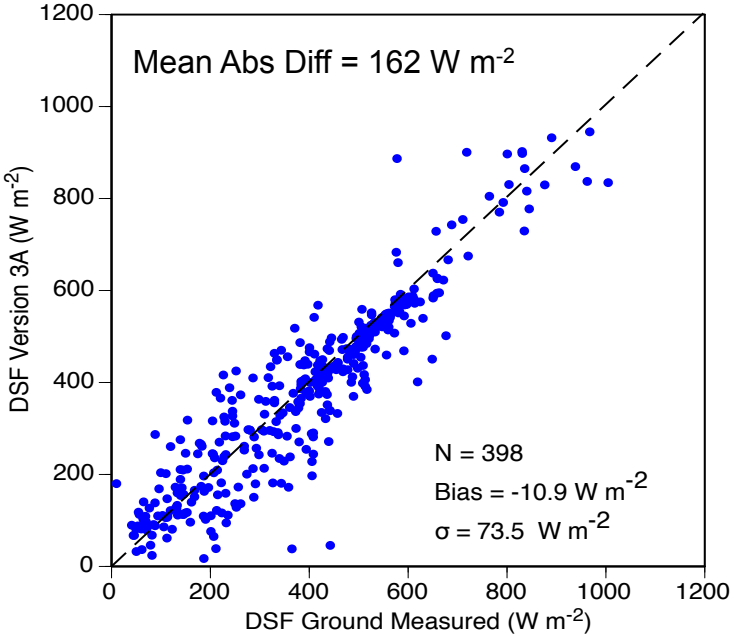
2H

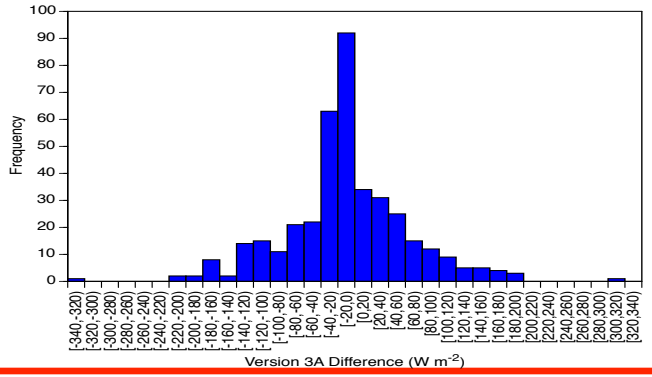




Surface SW flux measure-ments averaged +/- ½ hour overpass time

3A





State of the Climate 2012 Analysis

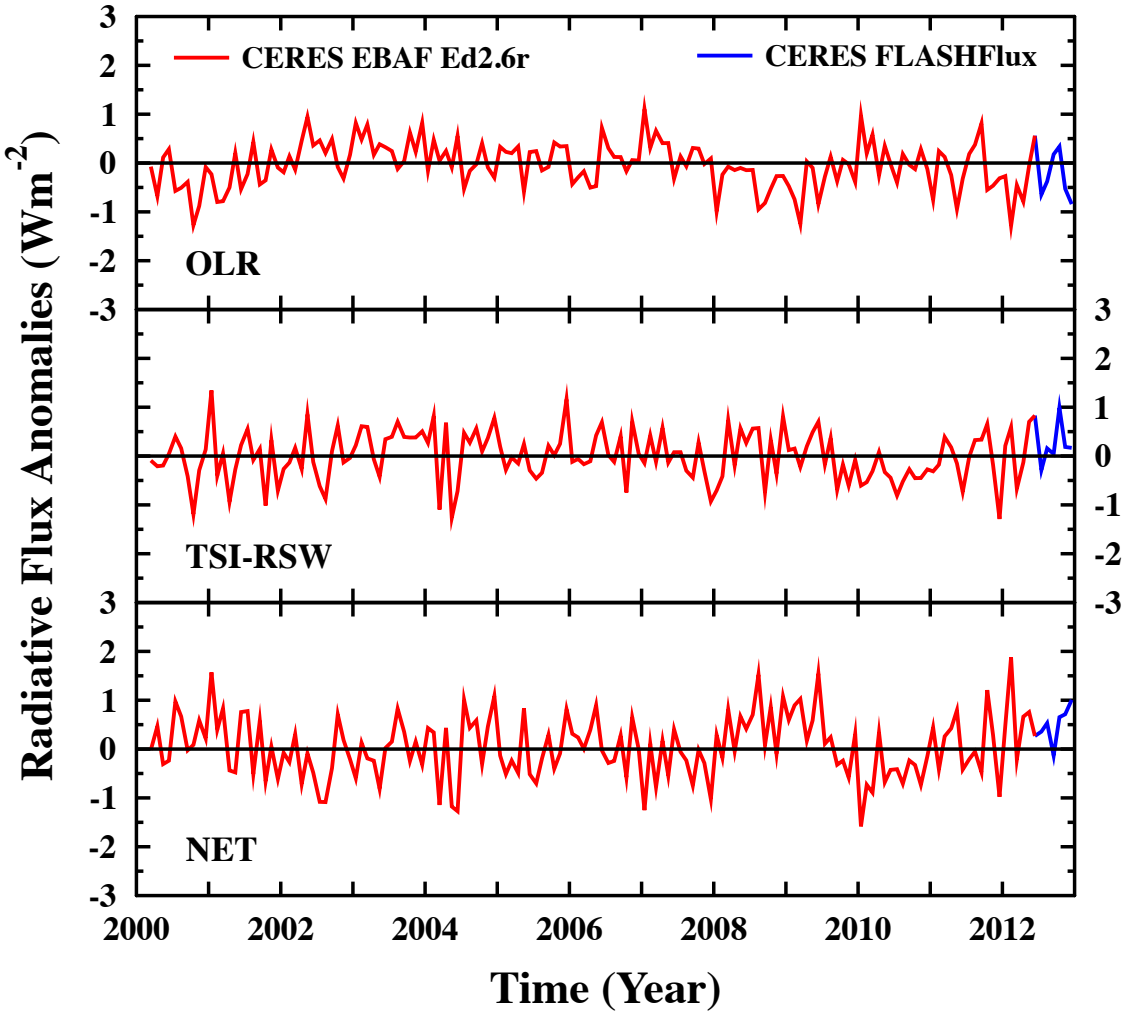
CERES FLASHFlux TOA flux variability for 2011 for BAMS "State of the Climate" report:

- FF monthly average annual global TOA normalized to EBAF from 7/2009 to 6/2012
  - Needed remove trend in calibration difference
- 2 σ monthly uncertainty (W m^{-2}) = ±0.14 Wm^{-2}, ±0.12 Wm^{-2} and ±0.18 Wm^{-2} for OLR/RSW/Total net
- TSI from SORCE instrument
- Global annual average anomalies:

	One year change (2012 minus 2011) (Wm^{-2})	2012 anomaly (relative to climatology) (Wm^{-2})	Interannual variability (2001 to 2011) (Wm^{-2})
OLR	–0.20	–0.35	±0.55
TSI	+0.05	+0.10	±0.20
RSW	–0.25	-0.15	±0.40
Net	+0.50	+0.60	±0.60

State of the Climate 2012 Analysis

- Time series show relatively large fluctuation
- Variability is consistent with NAO phase change



Monitoring and Targeting Case: NASA LaRC Badge and Pass Office

SOUTHERN ENERGY MANAGEMENT
ENERGY EFFICIENCY & SOLAR POWER

Badge and Pass Office Solar Energy Project

ESG ENERGY SYSTEMS GROUP

- Overview
- Current Status
- Weather Conditions

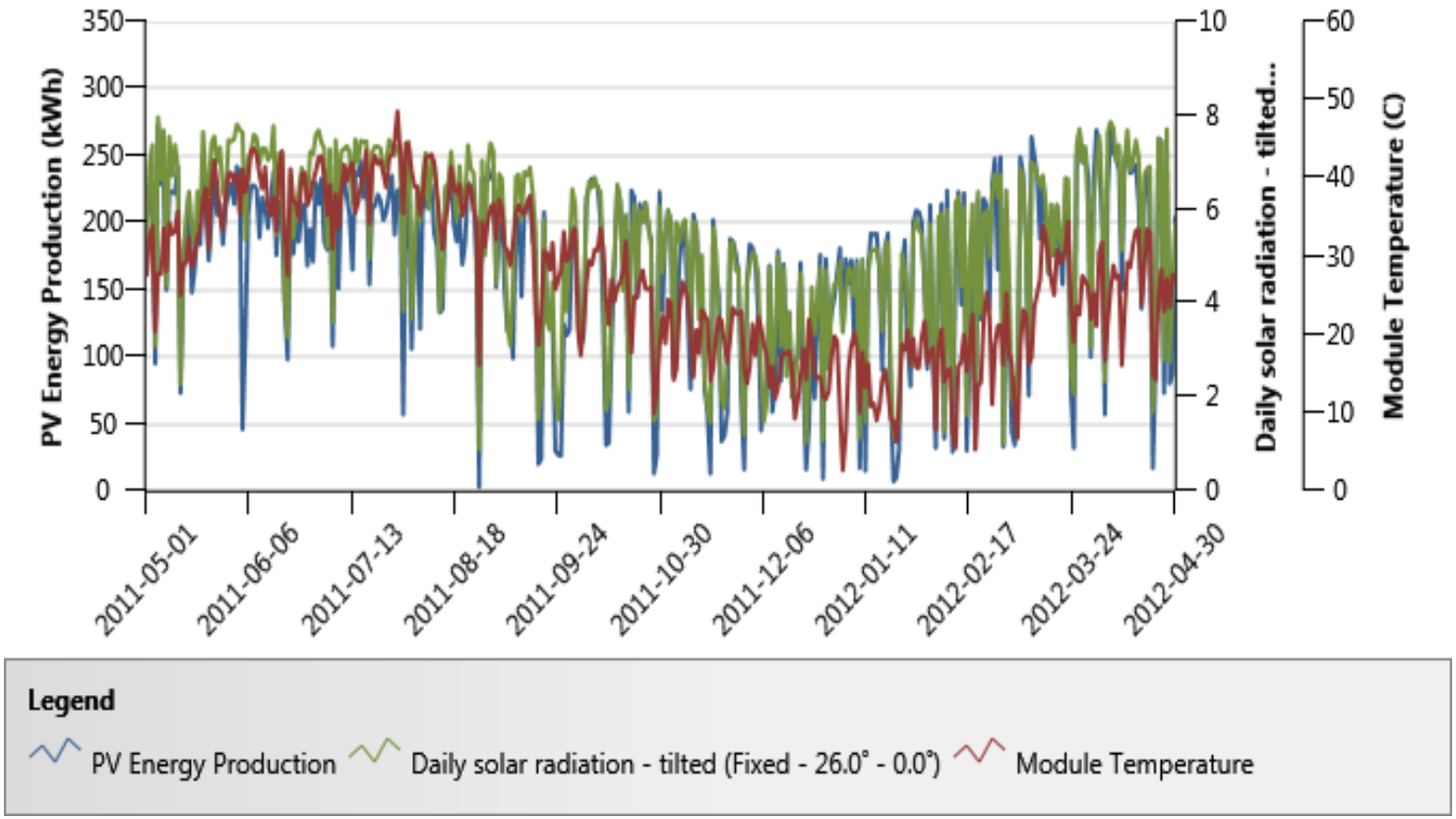
Installed in September 2010, this 39.5 KW ground-mounted solar energy system and will produce around 50,000 kilowatt-hours of electricity each year. The system consists of 168 photovoltaic modules mounted in two arrays located behind the Badge and Pass Office. This project demonstrates the performance of solar energy and the benefit of renewable energy being in our overall energy strategy.

Energy Today	Energy Yesterday	Lifetime Energy
193 kWh	206 kWh	38,035 kWh
Total energy generated by the system today	Total energy generated by the system yesterday	Total energy generated by the system since installation

CASI Analysis Case: NASA LaRC Badge and Pass Office

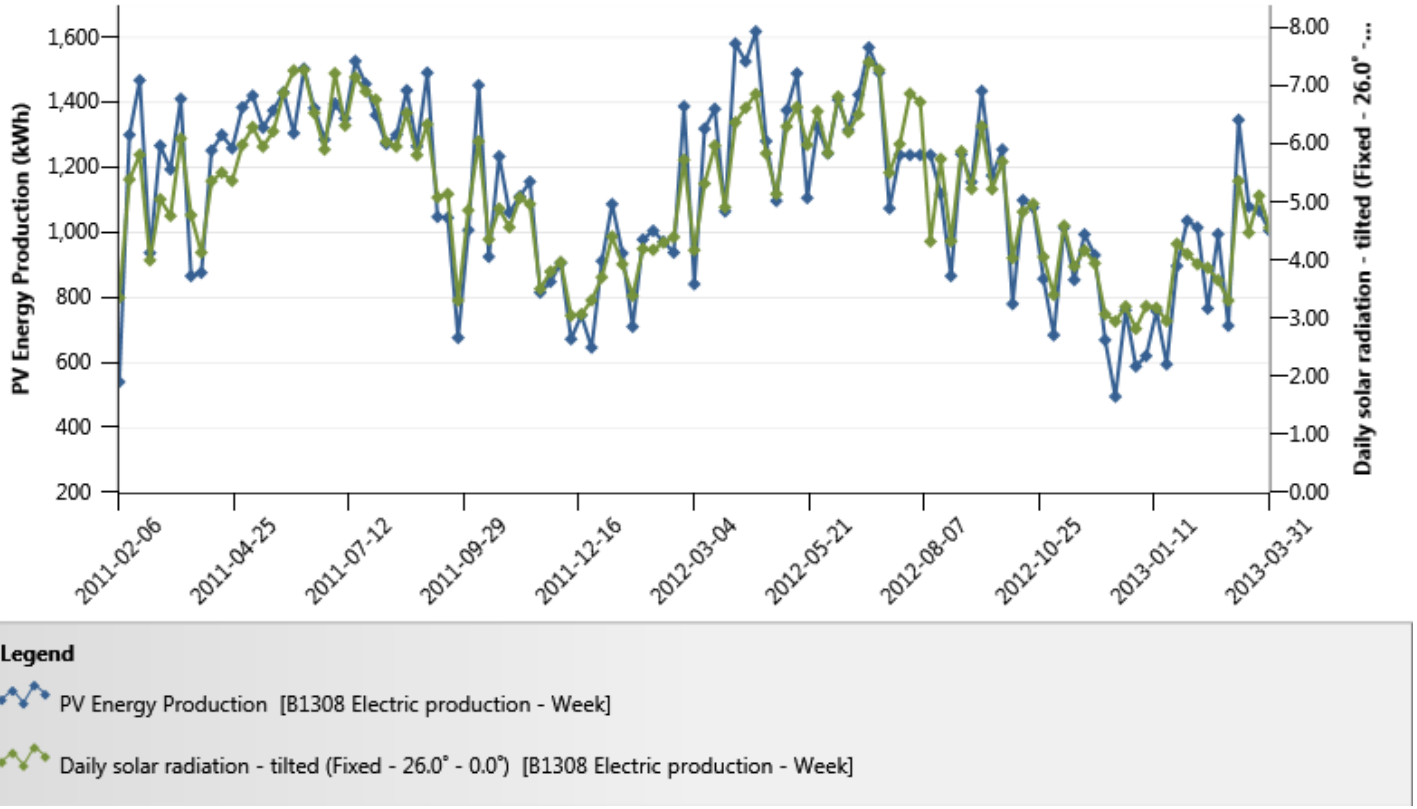
Daily solar irradiance from FF with daily PV energy production for Badge & Pass Office

PV output does depend also on Temp



Monitoring and Targeting Case: NASA LaRC Badge and Pass Office

Solar Panel Elec-trical Output (kWh)



FF 2H daily aver-aged SW fluxes

All points represent weekly average of daily inputs

(Results from RETScreen by Rene Ganoe)

CASI Analysis Case: NASA LaRC Badge and Pass Office

Cumulative sum of the difference between the performance of the PV array the first year after installation compared to subsequent years.

Degradation of energy production typical of PV arrays and is about 3%/year.