

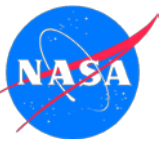
# **CERES FLASHFlux Status:**

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

***Paul Stackhouse, David P. Kratz, and  
Takmeng Wong, (NASA LaRC)***

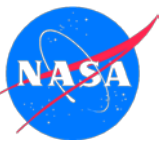
***Shashi Gupta, Parnchai Sawaengphokhai  
and Anne Wilber (SSAI)***

***Lindsay Parker and the  
Atmospheric Science Data Center Team  
(SSAI)***



# FLASHFlux Overview

- ***FLASHFLUX = Fast Longwave And Shortwave Radiative Fluxes from CERES and MODIS***
- ***FLASHFlux Objectives***
  - Compute radiative fluxes from CERES and MODIS observations from both Terra and Aqua within one week of measurement (currently available within 4 days)
  - Global gridded and time averaged radiative flux and meteorological data sets using both Terra and Aqua when available (currently available within 6 days)
  - Conduct scientific investigations and provide for scientific and applied science uses
  - Demonstrate processing system pushing data products to research and applications uses



# FLASHFLUX: Schematic Mapping to Realized and Potential Uses

## *Science Inputs*

CERES

MODIS

Specialized  
CERES  
Processing  
System

GMAO  
GEOS  
Met  
Data

SMOBA  
(OMI  
O3)

## *Educational Uses*

NASA Earth  
Observatory

CERES S'COOL

## *Scientific Uses*

Mission: CERES,  
CloudSat and Megha-  
Tropiques

Field Campaigns

TOA Flux Variability

Land and Ocean  
Assimilation (??)

Atmospheric  
Science  
Data Center

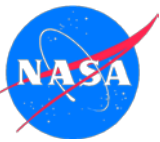
## *Applied Science Uses*

LaRC Applied  
Sciences

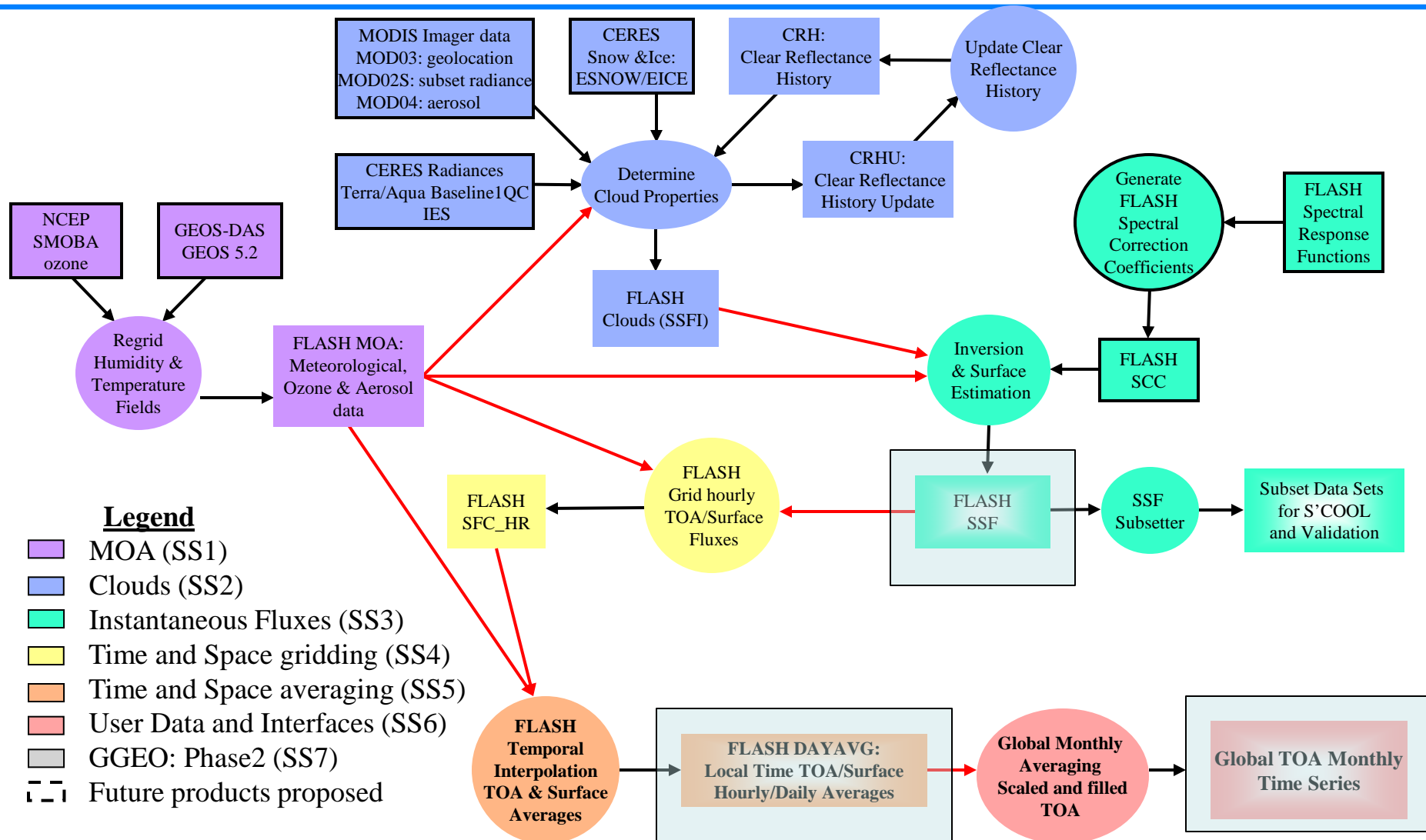
Energy Resource and Load

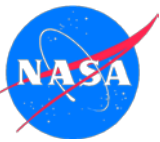
Building Energy Monitoring

Agricultural Crop Projections



# FLASHFlux Data Flow (v2G)





# FLASHFlux SSF Data Products

***CERES-like Single Scanner Footprint (SSF)  
(Terra and Aqua overpasses; 30 km nadir;  
Processed through near 4/25/2012)***

Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF): One hour of instantaneous FLASHFlux data for a single scanner instrument.				
Select Parameters: Cloud Properties, TOA Fluxes, Surface (Radiative) Fluxes, Unfiltered Radiances, Filtered Radiances, OLR, Surface Types.				
Spacecraft	Data Set Name (Select name to order)	Temporal Coverage (Hourly)	Documentation	Sample Software
Aqua	<a href="#">FLASH SSF Aqua-FM3-MODIS Version2G</a>	Jan 1, 2009 - Dec 31, 2011	<a href="#">Data Quality Summary FLASH SSF Version2</a>   <a href="#">CERES SSF Data Products Catalog R4V1</a> (PDF)	<a href="#">Readme R4-555</a>   <a href="#">Read Package R4-555 (C)</a> .
	<a href="#">FLASH SSF Aqua-FM3-MODIS Version2H</a>	Jan 1, 2012 - current		
Terra	<a href="#">FLASH SSF Terra-FM1-MODIS Version2G</a>	Jan 1, 2009 - Dec 31, 2011		
	<a href="#">FLASH SSF Terra-FM1-MODIS Version2H</a>	Jan 1, 2012 - Current		

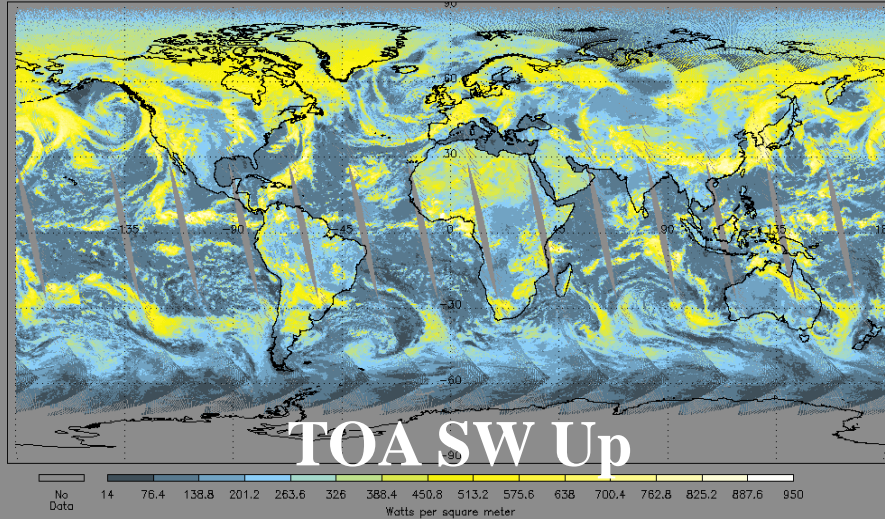
Difference between 2G and 2H is the transition from  
the old the SGI Warlock to AMI-P  
(gained 1 day end to end in production)



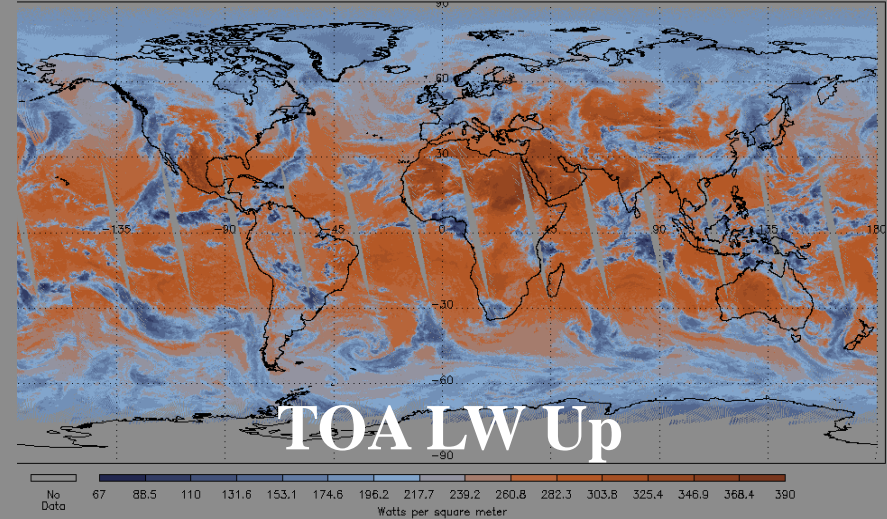


# Overpass Footprint Resolution Products (Aqua Daytime Composite, Apr 25, 2012).

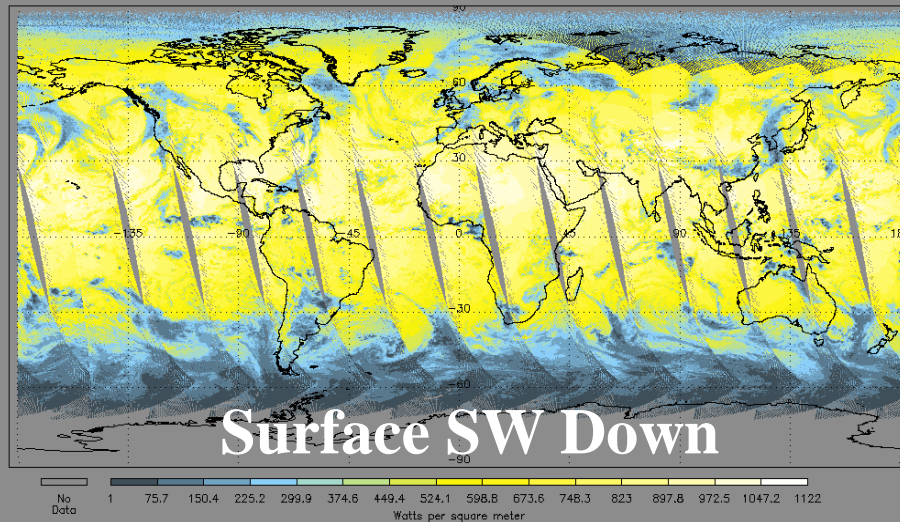
/data/FLASHFlux/SSF/Aqua-FM3-MODIS\_Version2H/FLASH\_SSF\_Aqua-FM3-MODIS\_Version2H\_009018.2012042500 Mon Apr 30 12:16:45 2012



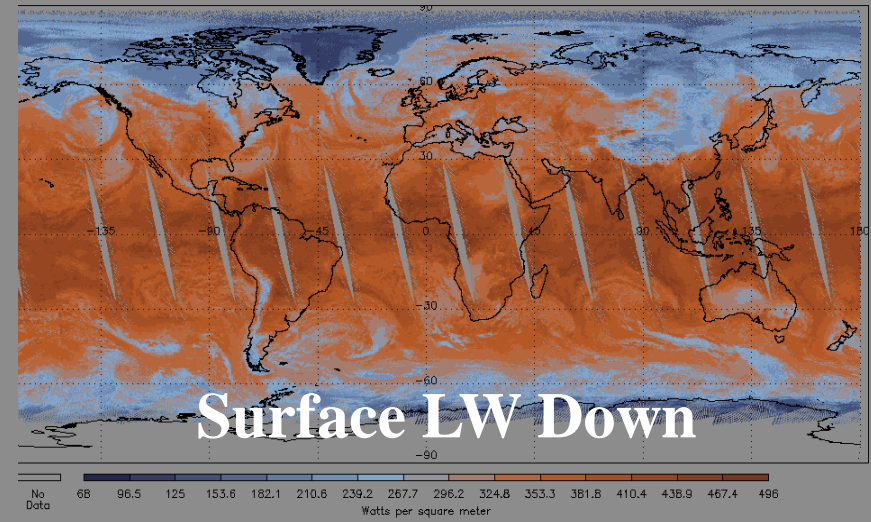
ASHFlux/SSF/Aqua-FM3-MODIS\_Version2H/FLASH\_SSF\_Aqua-FM3-MODIS\_Version2H\_009018.2012042500 Mon Apr 30 12:13:10 2012



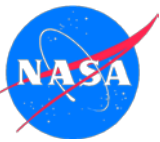
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ASHFlux/SSF/Aqua-FM3-MODIS\_Version2H/FLASH\_SSF\_Aqua-FM3-MODIS\_Version2H\_009018.2012042500 Mon Apr 30 12:14:31 2012

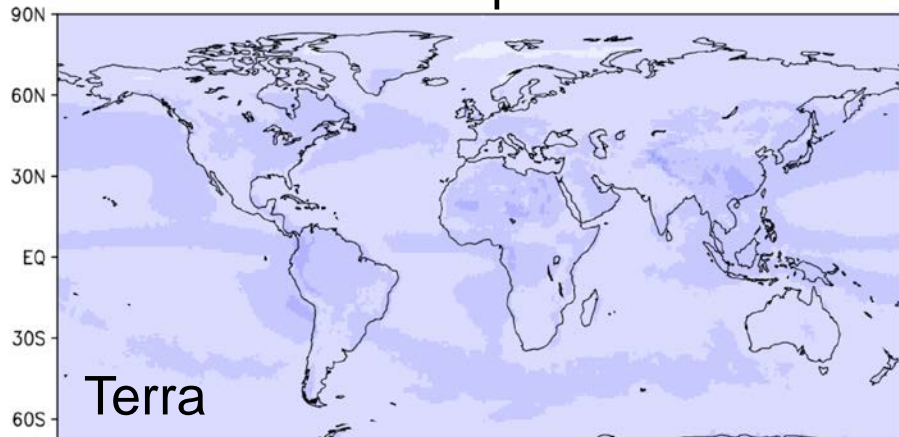




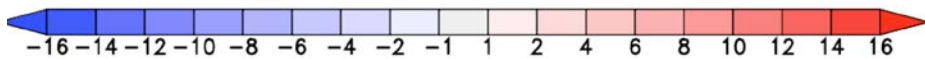
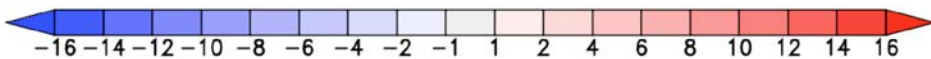
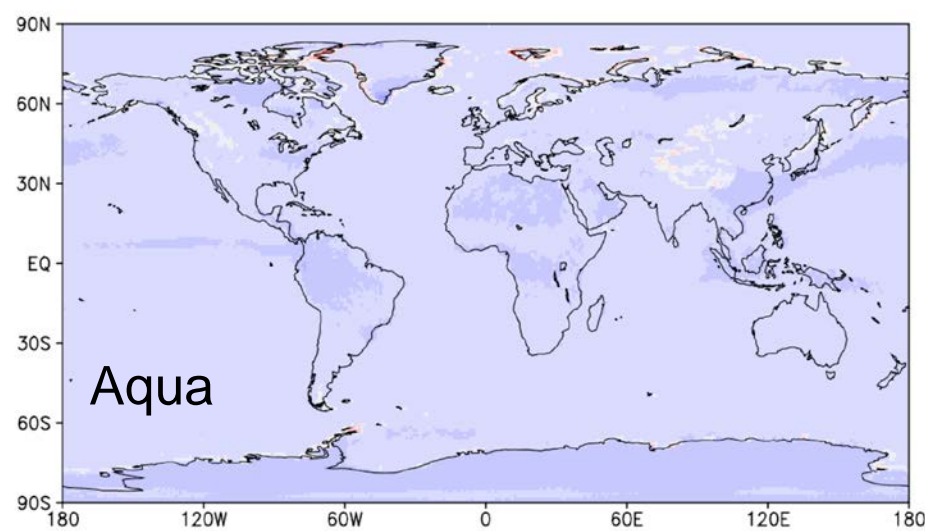
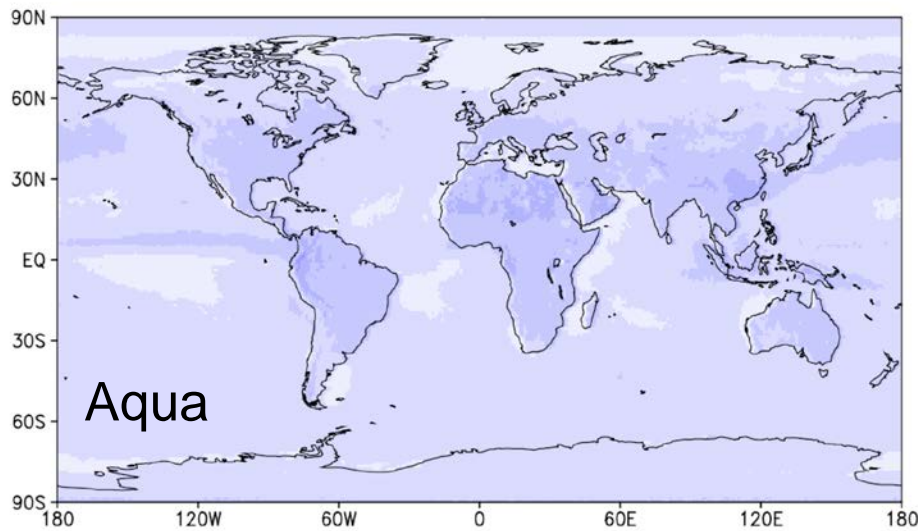
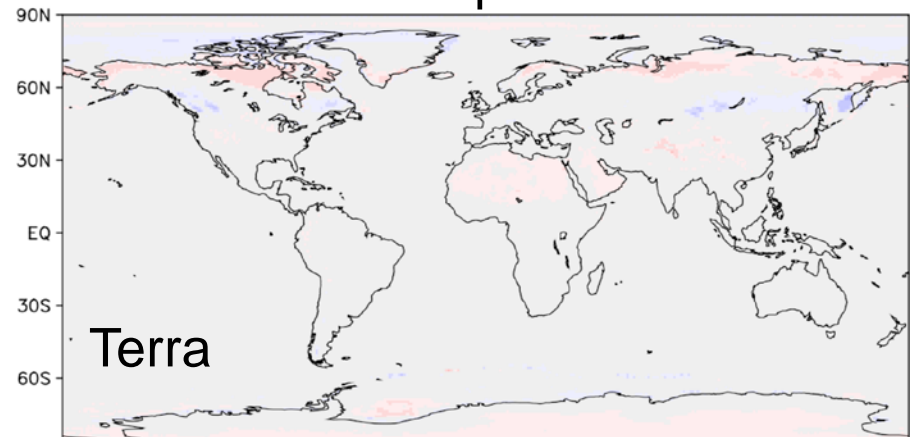


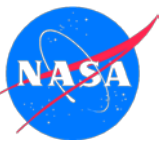
# FLASHFlux SSF Validation: TOA FF 2G – CERES Ed 3

TOA LW Up Difference



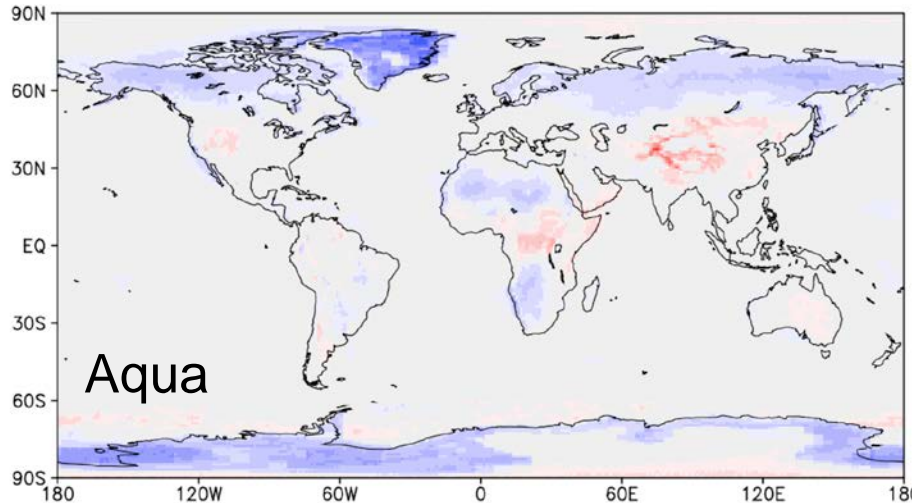
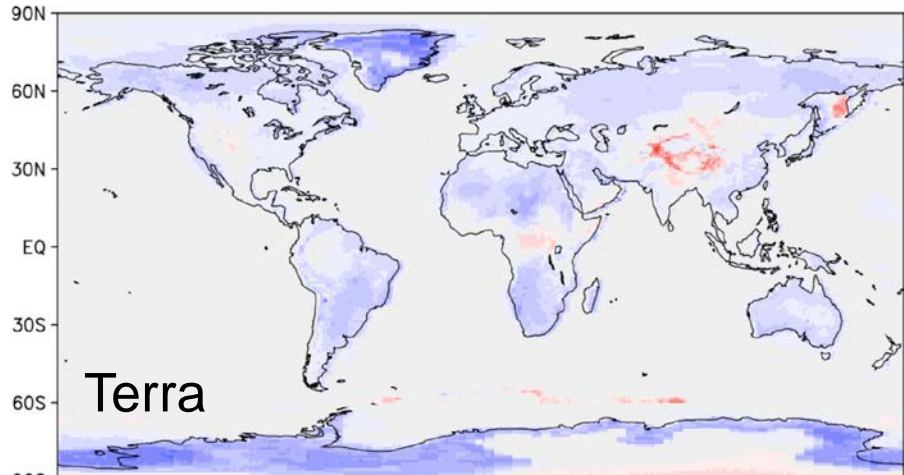
TOA SW Up Difference



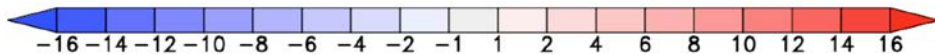
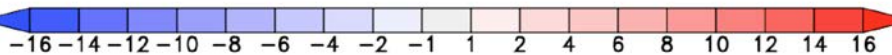
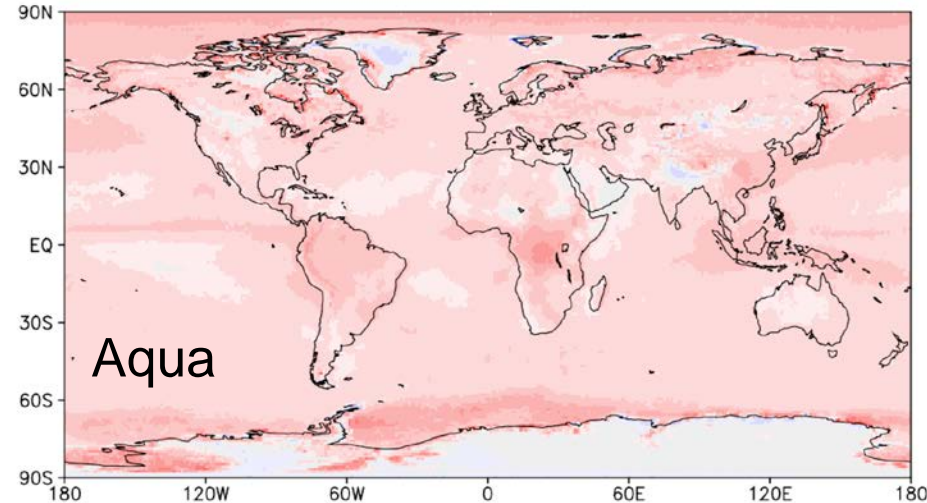
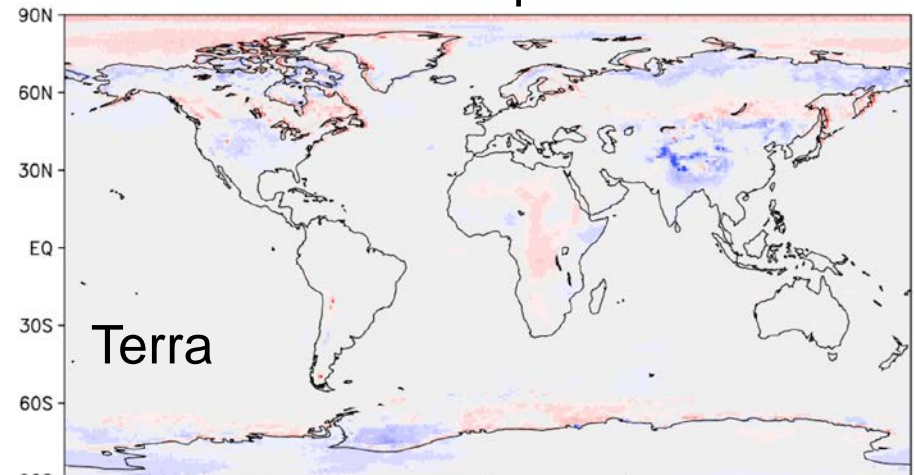


# FLASHFlux SSF Validation: Surface FF 2G – CERES Ed 3

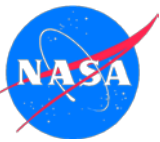
Surface LW Down Difference



Surface LW Up Difference



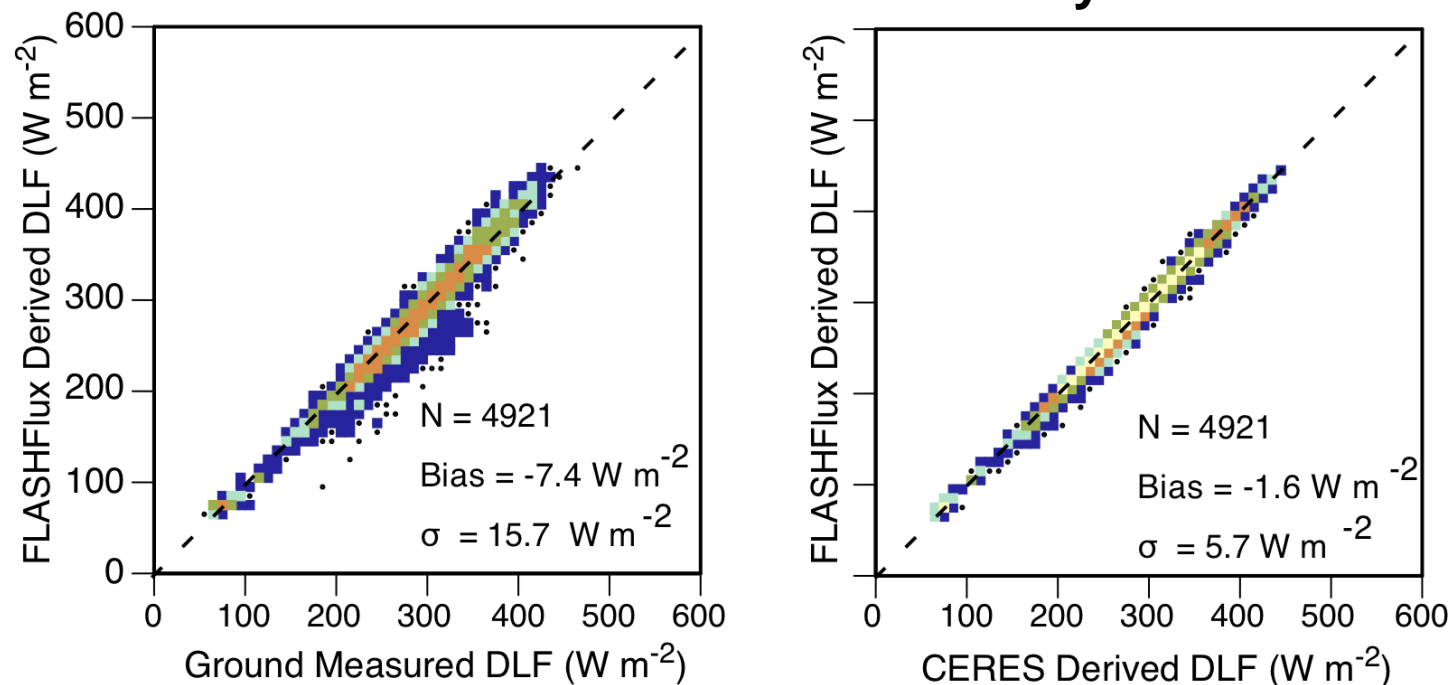




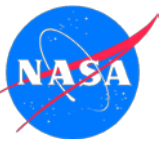
# FLASHFlux SSF Validation

*Overpass validation against BSRN (including SURFRAD and ARM measurements) from Jan 2009 - Dec 2010*

## Surface LW Down Clear-sky



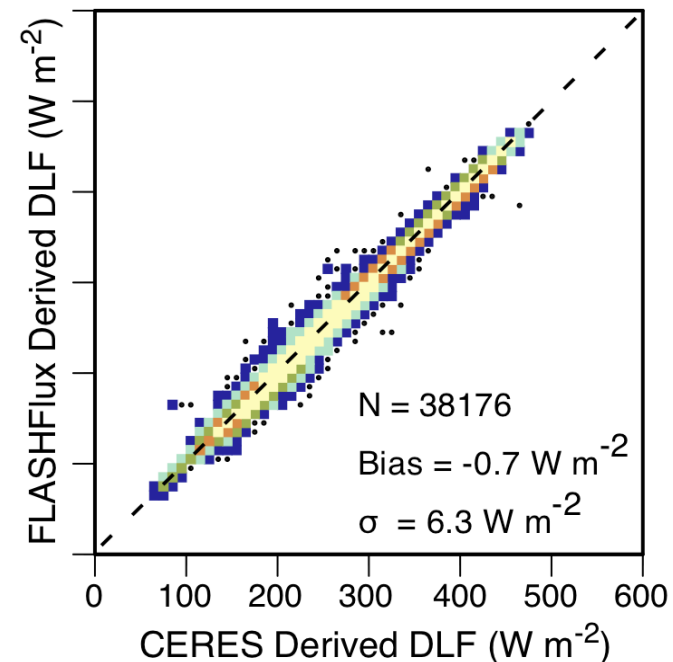
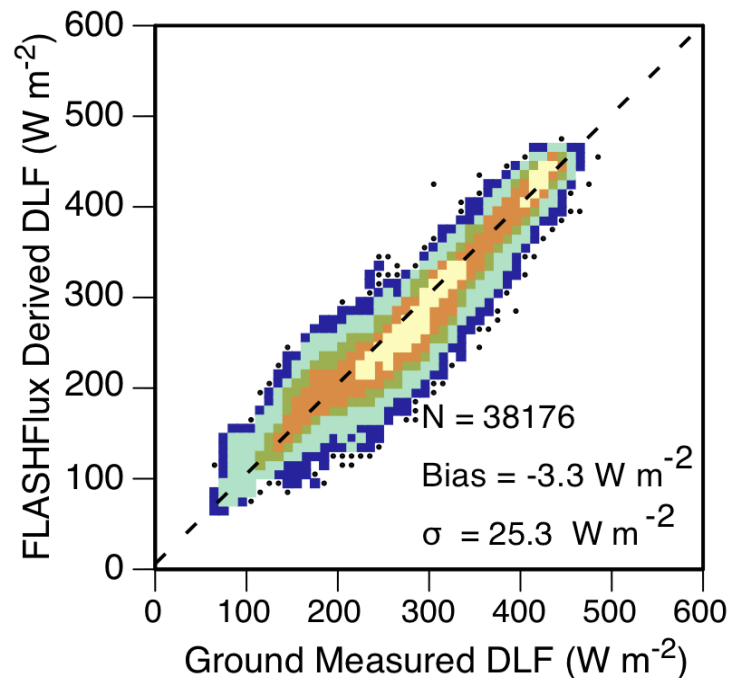
• 1    ■ 2 - 10    ■ 11 - 20    ■ 21 - 50    ■ 51 - 100    ■ > 100



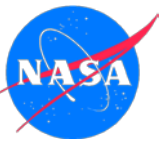
# FLASHFlux SSF Validation

*Overpass validation against BSRN (including SURFRAD and ARM measurements) from Jan 2009 - Dec 2010*

## Surface LW Down Cloudy-sky



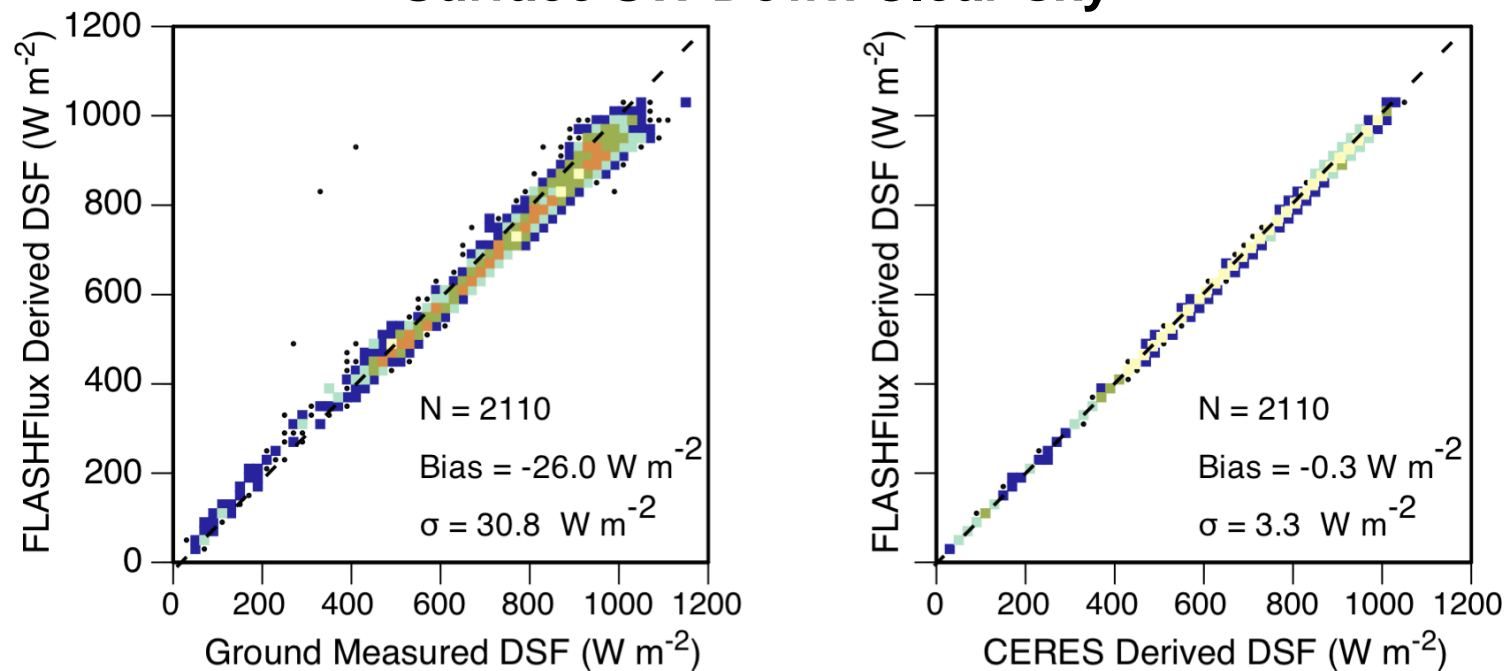
• 1    ■ 2 - 10    ■ 11 - 50    ■ 51 - 100    ■ 101 - 200    ■ > 200



# FLASHFlux SSF Validation

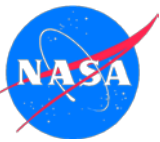
*Overpass validation against BSRN (including SURFRAD and ARM measurements) from Jan 2009 - Dec 2010*

## Surface SW Down Clear-sky



• 1    ■ 2 - 5    ■ 6 - 10    ■ 11 - 20    ■ 21 - 30    ■ > 30

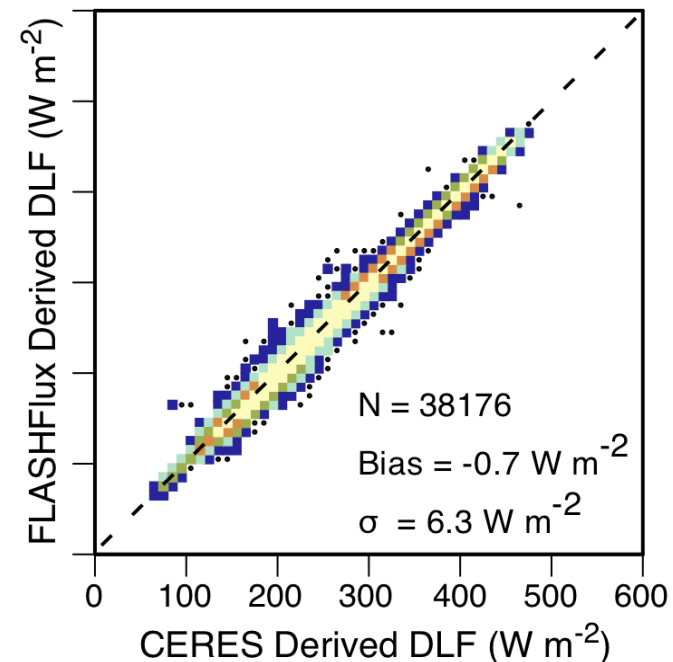
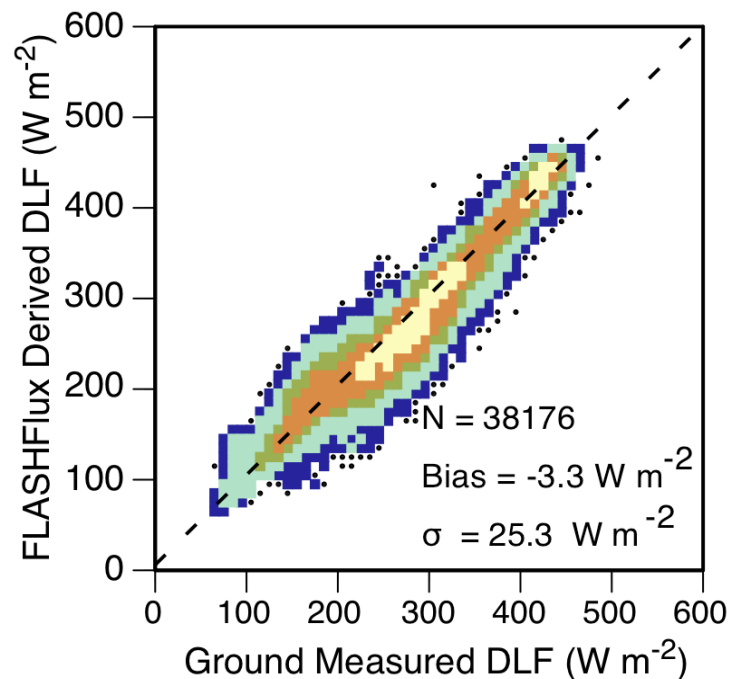




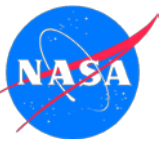
# FLASHFlux SSF Validation

*Overpass validation against BSRN (including SURFRAD and ARM measurements) from Jan 2009 - Dec 2010*

## Surface SW Down Cloudy-sky



• 1    ■ 2 - 10    ■ 11 - 50    ■ 51 - 100    ■ 101 - 200    ■ > 200



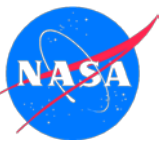
# FLASHFlux Data Products

***FLASHFlux Gridded and Temporally  
Averaged Data Products  
(Terra+Aqua; Hourly/Daily; 1°x1° resolution;  
Processed through about 4/23/2012)***

**Daily Gridded Single Satellite TOA and Surfaces/Clouds data in HDF (TISA):  
One day of averaged FLASHFlux data for available scanner instruments.**

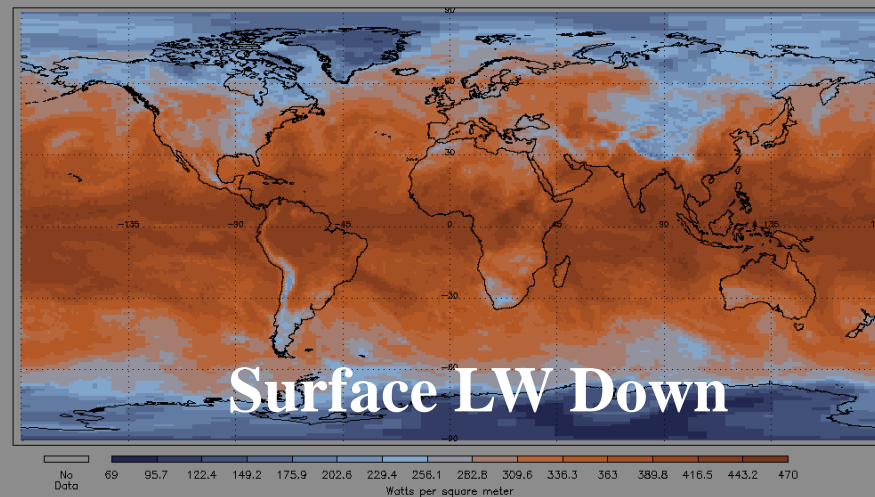
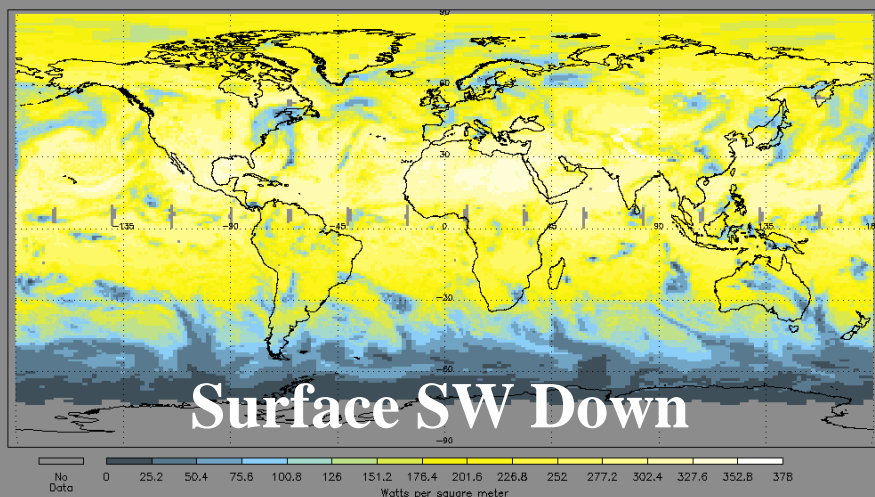
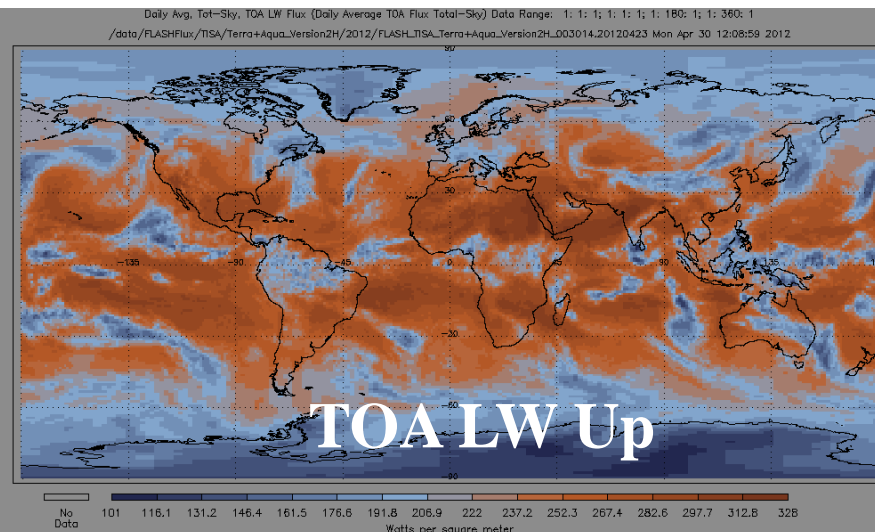
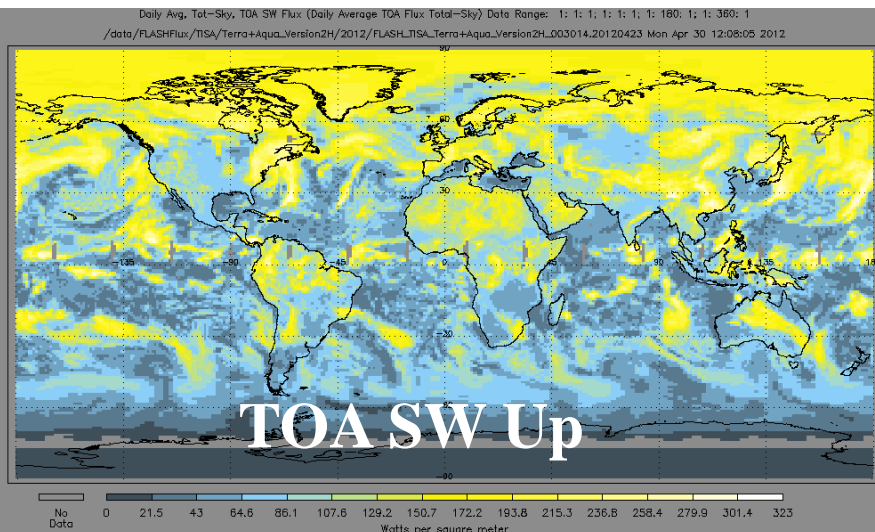
**Select Parameters:** Cloud Properties, TOA Fluxes, Surface (Radiative) Fluxes, OLR, Surface Types. ([Complete Parameter List](#))

Spacecraft	Data Set Name (Select name to order)	Temporal Coverage (Daily)	Documentation	Sample Software
Terra + Aqua	<a href="#">FLASH TISA Terra+Aqua Version2G</a>	Jan 1, 2009 - Dec 31, 2011	<a href="#">Data Quality Summary FLASH TISA Version2</a>	<a href="#">Readme R1V1  </a> <a href="#">Read Package R1V1 (C).</a>
	<a href="#">FLASH TISA Terra+Aqua Version2H</a>	Jan 1, 2012 - current		



# ***FLASHFlux Gridded and Temporally Averaged Data Products (Apr. 23, 2012)***

## ***(Terra+Aqua; Daily; 1°x1° resolution)***





# Global Averaged TOA Flux Estimates

## STATE OF THE CLIMATE IN 2010

J. Blunden, D. S. Arndt, and M. O. Baringer, Eds.

Associate Eds. K. M. Willett, A. J. Dolman, B. D. Hall, P. W. Thorne, J. M. Levy, H. J. Diamond,  
J. Richter-Menge, M. Jeffries, R. L. Fogt, L. A. Vincent, and J. M. Renwick



Special Supplement to the  
Bulletin of the American Meteorological Society  
Vol. 92, No. 6, June 2011

- *CERES FLASHFlux contributed to the special annual BAMS report on the “State of the Climate in 2010”.*
- *Issue appeared in Aug. 2011, providing estimates of changes in year to year Global Earth Radiation Budget for the first time.*
- *These data have now been extended and used longer overlap with CERES EBAF products.*

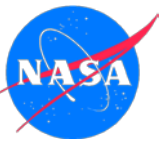


# State of the Climate 2011

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

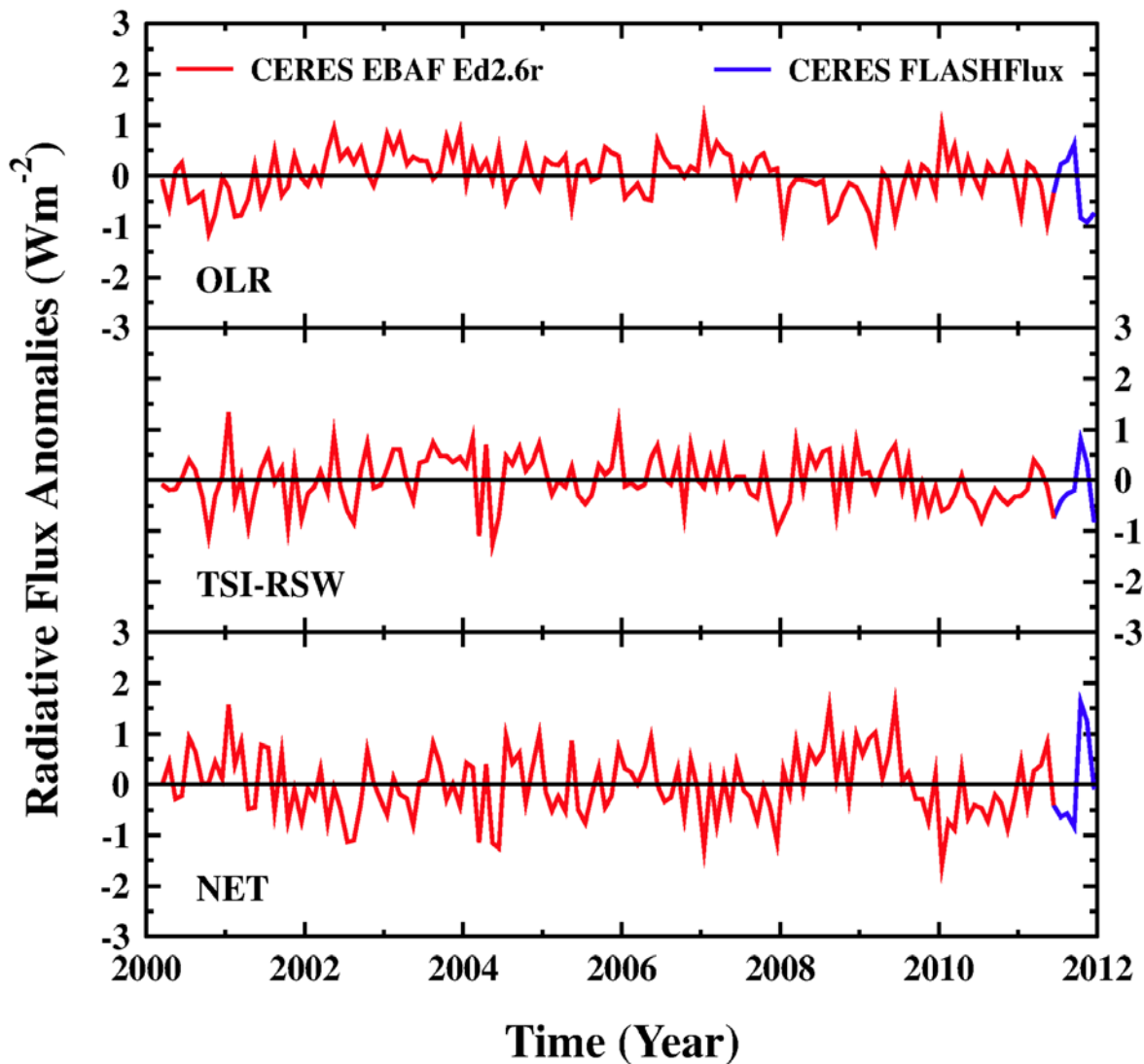
- FF monthly average annual global TOA normalized to EBAF from 3/2007 to 2/2011
- $2\sigma$  monthly uncertainty ( $\text{W m}^{-2}$ ) =  $\pm 0.2/0.1/0.15$  for OLR/RSW/Total net
- TSI from SORCE instrument
- Global annual average anomalies:

	One year change (2011 minus 2010)	2011 anomaly (relative to climatology)	Inter-annual variability (2001 to 2011)
OLR	-0.45	-0.30	$\pm 0.55$
TSI	+0.05	+0.05	$\pm 0.20$
RSW	-0.20	+0.15	$\pm 0.40$
Net	+0.70	+0.20	$\pm 0.65$

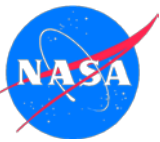


# State of the Climate 2011

- Time series show relatively large fluctuation
- AIRS OLR shows consistent variability
- Variability is consistent with NAO phase change







# Monitoring and Targeting Case: NASA LaRC Badge and Pass Office



## Badge and Pass Office Solar Energy Project



Overview

Current Status

Weather Conditions

Installed in September 2010, this 39.5 KW ground-mounted solar energy system 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



193  
kWh

Total energy generated by the system today

### Energy Yesterday



206  
kWh

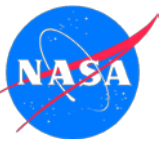
Total energy generated by the system yesterday

### Lifetime Energy



38,035  
kWh

Total energy generated by the system since installation



# Energy Monitoring with RETScreen Plus

Objective: Enable “users to monitor, analyze and report key energy performance data to facility operators, managers and senior decision-makers.”

Usage:

1. Determine & obtain building energy and meteorological information for any location in world
2. Use multivariate analysis to determine system performance as a function of meteorological variability
3. Monitoring building energy performance for system changes, target higher efficiency and reporting verification

RETScreen - NASA Langley Solar System

File Start Data Analytics Reporting

Resources naturelles Canada Natural Resources Canada

Canada

RETScreen Plus

Clean Energy Project Analysis Software

Project information [See project database](#)

Project name: NASA Langley Solar System

Project location: Hampton, VA USA

Prepared for: NASA

Prepared by: Paul Stackhouse

Show settings

RETScreen - Climate database

Country - region: United States of America

Province / State: Virginia

Climate data location: Newport News

Latitude: 37.1 °N

Longitude: -76.5 °E

Elevation: 16 m

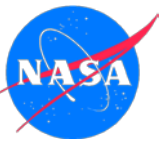
Heating design temperature: -5.1 °C

Cooling design temperature: 33.1 °C

Earth temperature amplitude: 18.7 °C

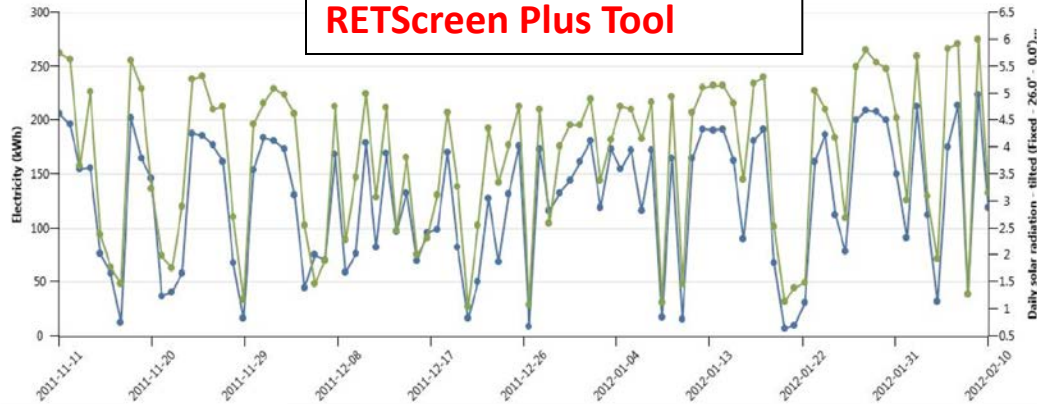
Source: Ground, Ground, NASA

Month	Air temperature °C	Relative humidity %	Daily solar radiation - horizontal kWh/m <sup>2</sup> /d	Atmospheric pressure kPa	Wind speed m/s	Earth temperature °C	Heating degree-days 18 °C °C-d	Cooling degree-days 10 °C °C-d
January	4.2	66.9%	2.22	101.6	3.9	2.5	428	0
February	5.6	66.5%	2.97	101.6	4.0	4.5	347	0
March	9.3	64.3%	3.89	101.4	4.4	8.7	270	0
April	14.3	66.0%	5.04	101.2	4.3	14.9	111	129
May	19.0	71.8%	5.59	101.2	3.9	20.4	0	279
June	23.6	73.9%	5.89	101.2	3.7	24.6	0	408
July	26.2	74.4%	5.73	101.2	3.6	26.2	0	502
August	25.1	76.9%	5.29	101.3	3.5	24.9	0	468
September	21.7	77.3%	4.32	101.4	3.5	21.5	0	351
October	15.8	75.4%	3.36	101.6	3.4	15.7	68	180
November	11.1	71.0%	2.46	101.6	3.7	10.1	207	33
December	6.2	68.0%	1.95	101.7	3.8	4.4	366	0
Annual	15.2	71.1%	4.06	101.4	3.8	14.9	1,797	2,350
Source	Ground	Ground	Ground	NASA	Ground	NASA	Ground	Ground
Measured at					10 m	0		



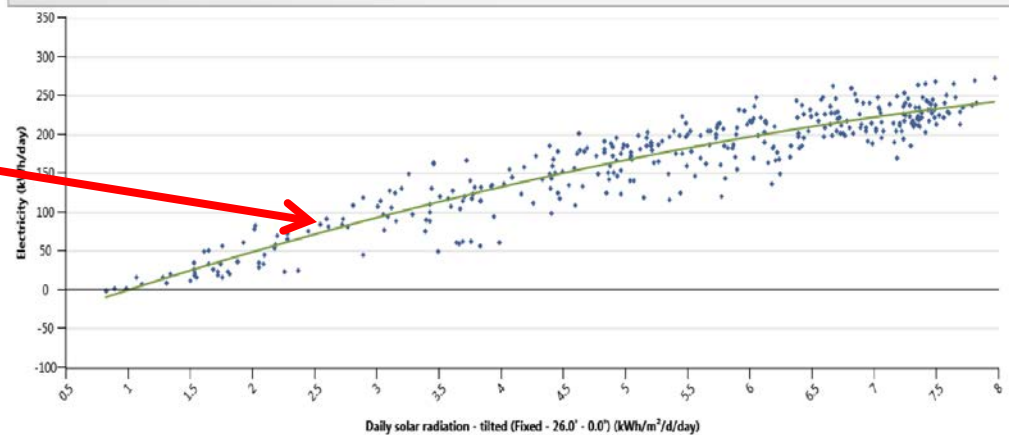
# Monitoring and Targeting Case 1: NASA LaRC Badge and Pass Office

RETScreen Plus Tool

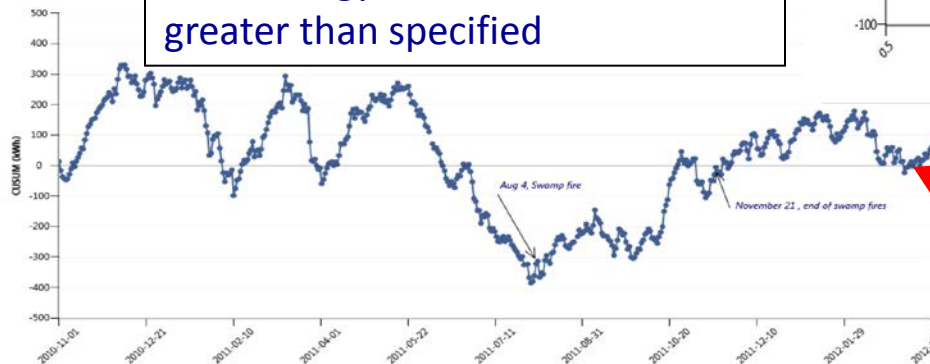


**Step 1:** LaRC based CERES FLASHFlux project surface solar flux (blue) vs. Solar Panel Electrical Output (green) gives excellent correlation.

**Step 2:** Regression relationship defines the system as a function of available solar energy

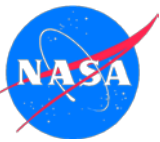


Total Energy = 59,000 kWhr, 18% greater than specified



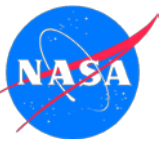
**Step 3:** Cumulative differences in output relative to system function shows noise but performance steady.





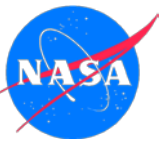
# Current Upgrades for FF v3a

- ***Deliver SCC consistent with CERES Ed 3***
- ***Prepare for new operational reanalysis from GMAO:***
  - GEOS 5.7.2 now operational; split into two streams
  - FP1: Resolution  $0.25^\circ$  lat x  $0.3125^\circ$  lon, new levels
    - Changed more frequently
  - FP2: Resolution  $0.5^\circ$  lat x  $0.625^\circ$  (or  $2/3^\circ$ ) lon
    - Changed by user community consent
    - Will be back processed through 2000 (will include AIRS and soon NPP)
- ***Deliver new algorithm changes:***
  - CERES Ed 4 upgrades to the models
    - SW: Rayleigh scattering revision and MATCH aerosols
    - LW: high surface temperature and inversion corrections
  - Ozone from GEOS
- ***Data product subsetting => CERES and ASDC***



# Future Upgrades and Challenges

- ***Continued refinement of algorithms:***
  - SW: Cloudy-sky transmission formula
- ***Improve near-real time albedos and aerosols***
  - MATCH too late; another strategy needed
- ***Adapt to MODIS Collection 6***
- ***Deliver and test GEO version of CERES TISA to:***
  - Estimate all-sky/clear-sky TOA and Surface fluxes
  - Provide monthly averaged maps
- ***Improve consistency between CERES algorithms and FLASHFlux (TISA/SYN)***
- ***Develop new products and subsets => parameterizations for the applications like solar industry***



# Summary and Conclusions

- ***FLASHFlux Operational and ...***

- Producing global TOA/surface cloud products and radiative fluxes within 1 week after Terra/Aqua overpass
  - SSF products for both Terra and Aqua now used by CloudSat, CERES Science Team, Megha-Tropiques and S'COOL
  - TISA products providing 1°x1° global hourly/daily fluxes for Terra+Aqua data shown accurate for scientific analysis (e.g., TOA Global averages), energy (load forecasting & building monitoring) and agricultural use (e.g. crop modeling).
- Has large potential for considerably more usage in both science (i.e., data analysis and assimilation) and applied sciences (energy, agriculture and other applications)

- ***FLASHFlux Is Working Towards ...***

- Delivering new improvements in SCC, inputs and algorithms
- Increasing data accessibility with subsetting
- Surface flux anomalies by increasing consistency with CERES algorithms; new data products and parameters.



## **FLASHFlux Web Sites:**

**<http://flashflux.larc.nasa.gov>**

***[http://eosweb.larc.nasa.gov/  
PRODOCS/flashflux/  
table\\_flashflux.html](http://eosweb.larc.nasa.gov/PRODOCS/flashflux/table_flashflux.html)***





# Extras

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