CERES FLASHFlux Status: Progress toward Version 4A and New GIS-enabled Web Site

Low Latency Surface Radiative Fluxes and Meteorological Parameters for Research and Applications

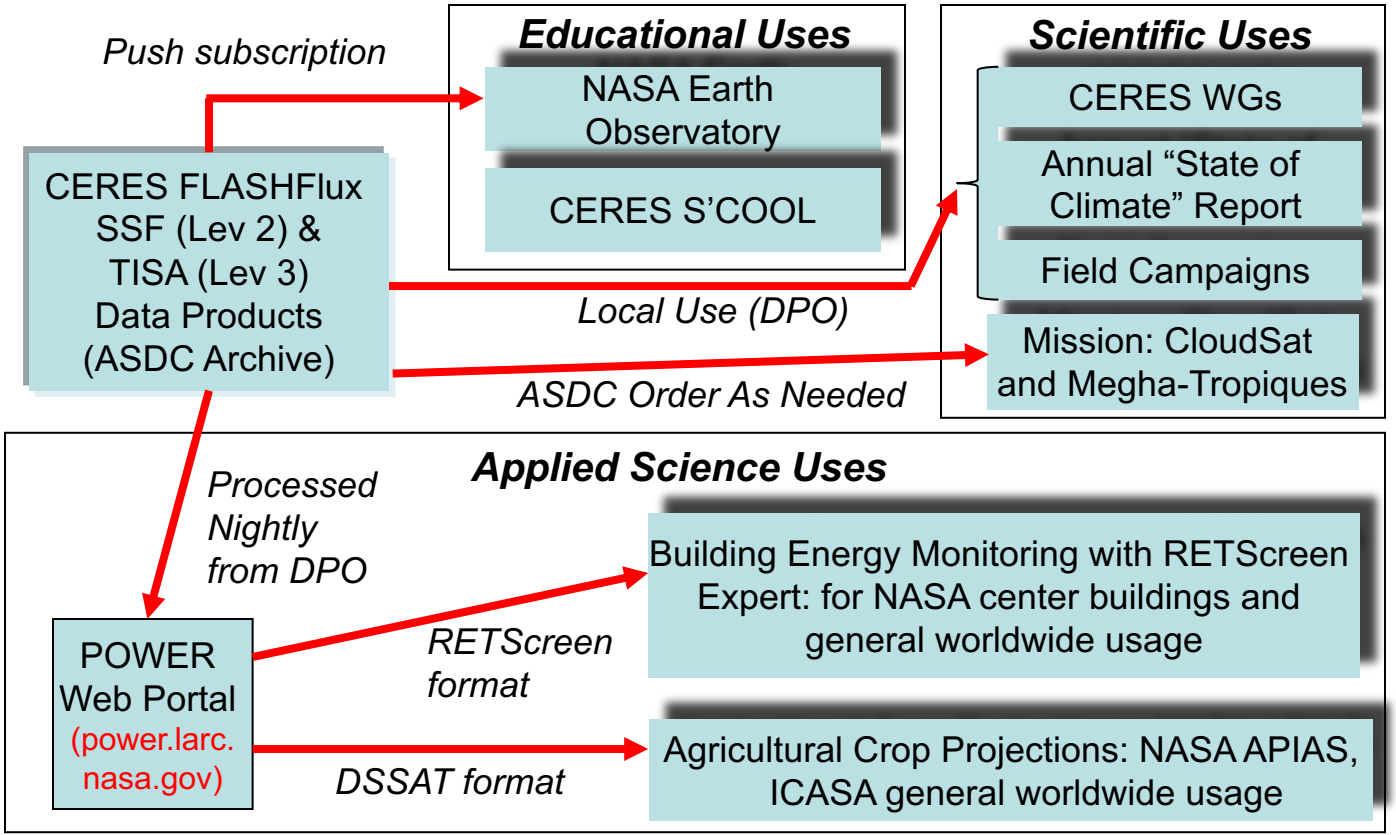
Paul Stackhouse, David P. Kratz, and Takmeng Wong, (NASA LaRC)

PC Sawaengphokhai, Shashi Gupta and Anne Wilber (SSAI)

POWER Team: Jason Barnett, Tyler Bristow, and Bradley MacPherson (Booz-Allen-Hamilton); David Westberg and James Hoell, (SSAI)

Tonya Davenport and Fenny Wang and the Atmospheric Science Data Center Team (SSAI)

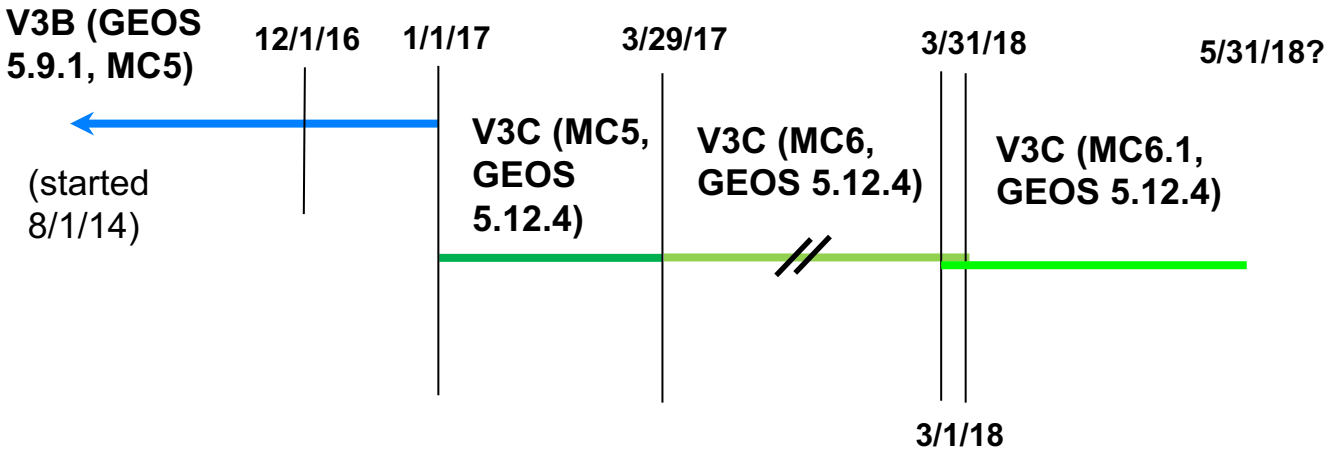
FLASHFLUX: Schematic of Current Uses



FLASHFlux v3C Status

- ***Production with v3C (MODIS C5/C6/C6.1) (since Jan 1, 2017)***
  - Now uses FP-IT (GEOS 5.12.4) and MODIS Collection 6.1 (after March 1, 2018)
  - FLASHFlux TISA available via CERES subsetter, ASDC and specialized formats through POWER web portal (power.larc.nasa.gov) 5-6 days latency
  - Plan to continue production for 2018 while production adapted to FF v4A
- ***Current Activities***
  - V3B v V3C and MODIS Coll. 5/6/6.1 differences evaluated; MC 6/6.1 shown here
  - Validation for v3C-MC6, v3C-MC6.1, v4A
  - Development towards V4A => V4A through FLASHflux SSF being tested (uses MC6.1)
- ***FLASHFlux Data Provision Through POWER:***
  - New POWER web portal in beta within days of release
  - Leverages OPeNDAP with both direct API and GIS-based Data Access Viewer
  - Multiple output formats supported => parameters aimed to specific usages
  - Hourly CERES SYN1Deg used for Canadian solar resource map and time series data supplied to partner performing building energy analysis

Current FLASHFlux Versions

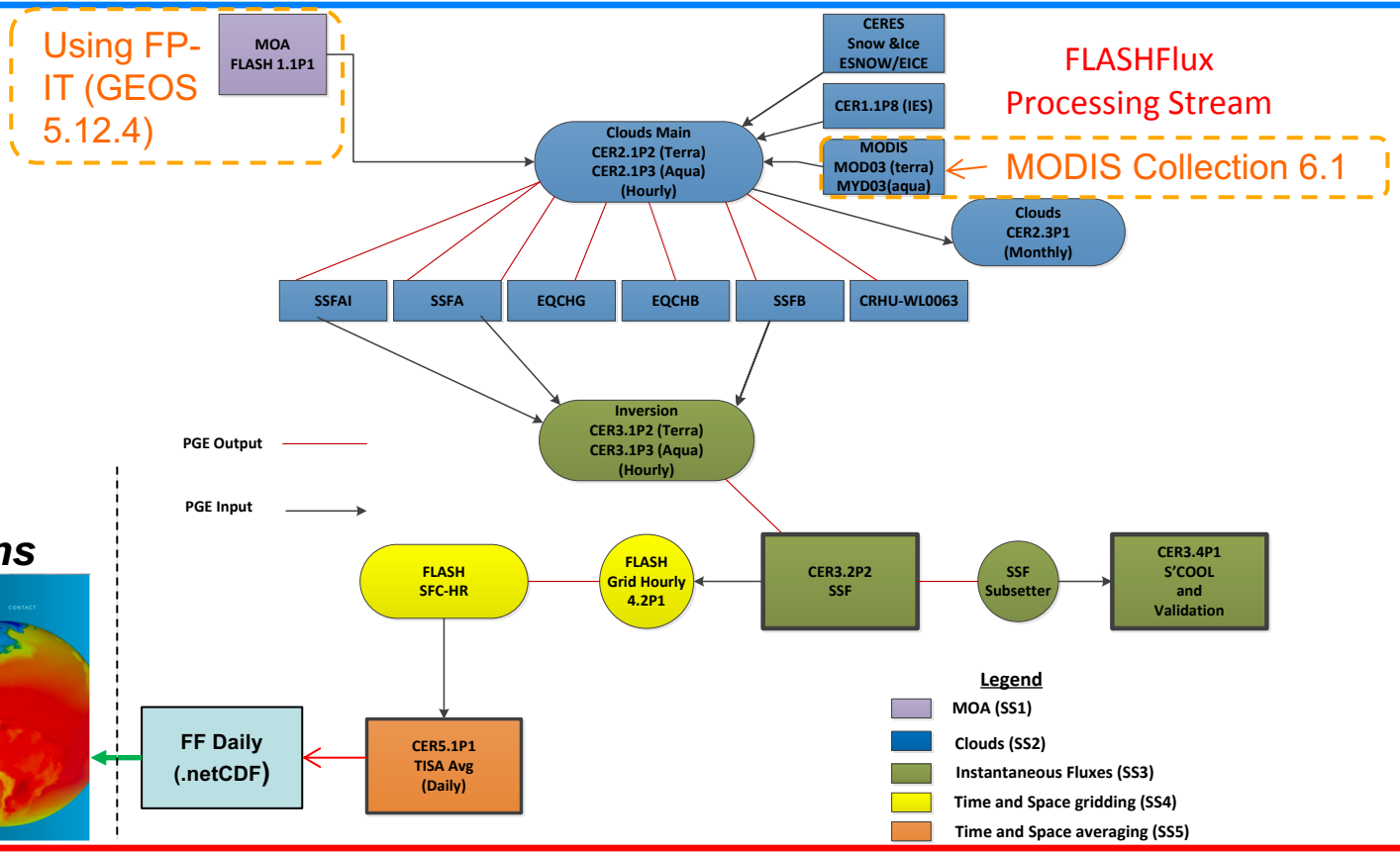


Transitioned from MODIS Collection 6 to 6.1

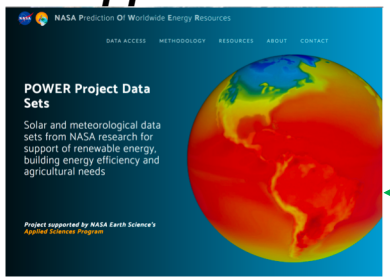
MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

Current v3C Production System



POWER Applications



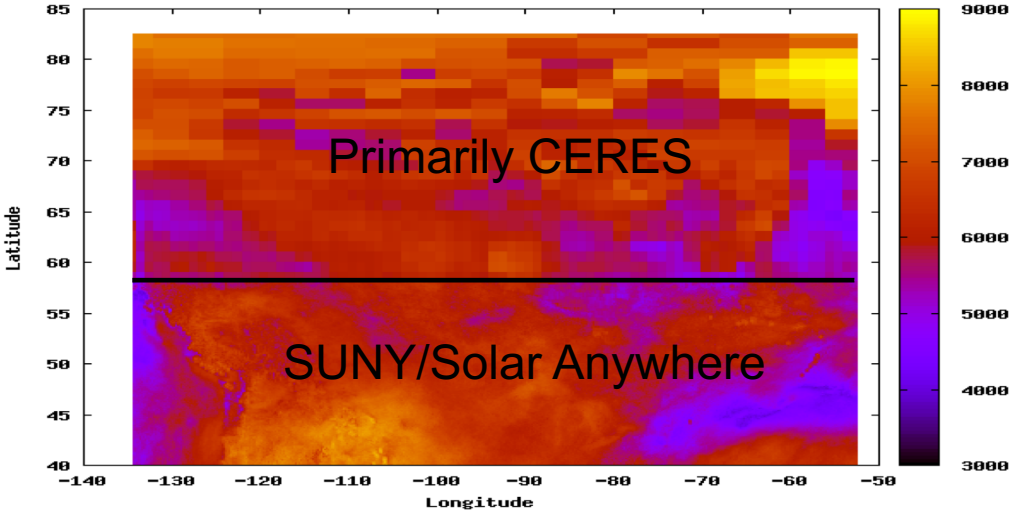
POWER New (GIS) Featuring FLASHFlux Fluxes (https://power.larc.nasa.gov/new)

- **Using ArcGIS architecture** to geospatially enable entire POWER data archive for access to growing Applied Science users.
- **Increased spatial/temporal resolutions**:
  - Features CERES FLASHFLUX for Solar & GMAO MERRA-2/GEOS 5.12.4 for meteorological parameters
  - Mapped to ½ x ½ spatial resolution, Low latency Daily Time Series, 30 Year Climatological Averages
- ***Complete API service (data order using URL)***
  - allows for data to be repeatedly requested using a script or from within a user analysis program
- ***Interactive Data Access Viewer and ArcGIS Image Services***
  - User selection of location, parameters
  - Output formats ASCII, CSV, geoJSON, NetCDF4, ICASA, GeoTiff

New CERES Application Highlights

- ***SYN1Deg hourly SW used for Canadian Solar Resource Maps***
  - Natural Resources Canada commission Dr. Richard Perez (SUNY-Albany) to develop new hourly solar resource for Canada. His algorithm uses GEO and cuts off at 58° N.
  - CERES SYN1Deg blended with his product to develop the new resource maps that are still under refinement and assessment
- ***SYN1Deg hourly SW used for building energy modeling project***
  - POWER team processed and delivered SYN1Deg 15 year time series data for selected locations
  - Data will be used to evaluate building energy models

Preliminary Map:
Solar Irradiance for June 2006



Units: W-hr m^{-2} day^{-1}

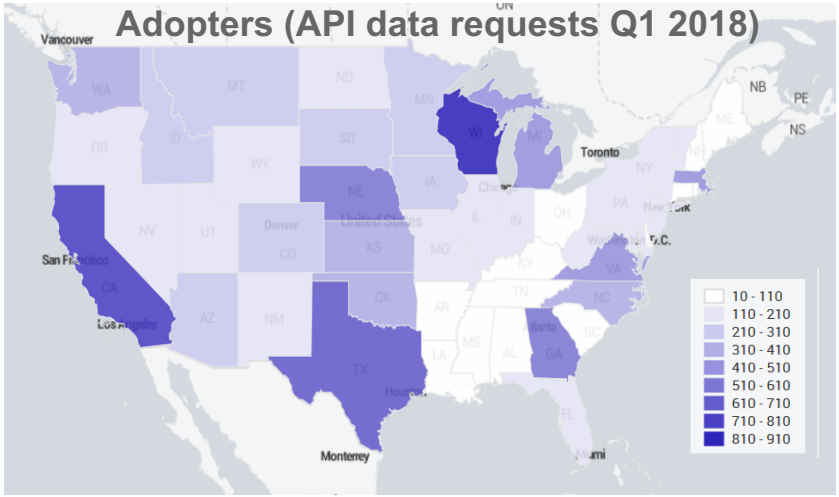
RETScreen/POWER Applied Science Benefits the U.S.

- *Michigan: University of Michigan uses RETScreen to monitor building energy efficiency and greenhouse gas emission (uses POWER low latency data product streams from the GMAO and CERES FLASHFlux) (https://www.linkedin.com/pulse/universities-colleges-reduce-carbon-gregory-j-leng/)*

- *Alaska: U.S. Department of Agriculture Analyzes Wood Heating in Alaska with RETScreen (uses POWER daily long-term time series data product streams from the GMAO and CERES FLASHFlux) (https://www.fs.fed.us/pnw/pubs/pnw_gtr924.pdf)*

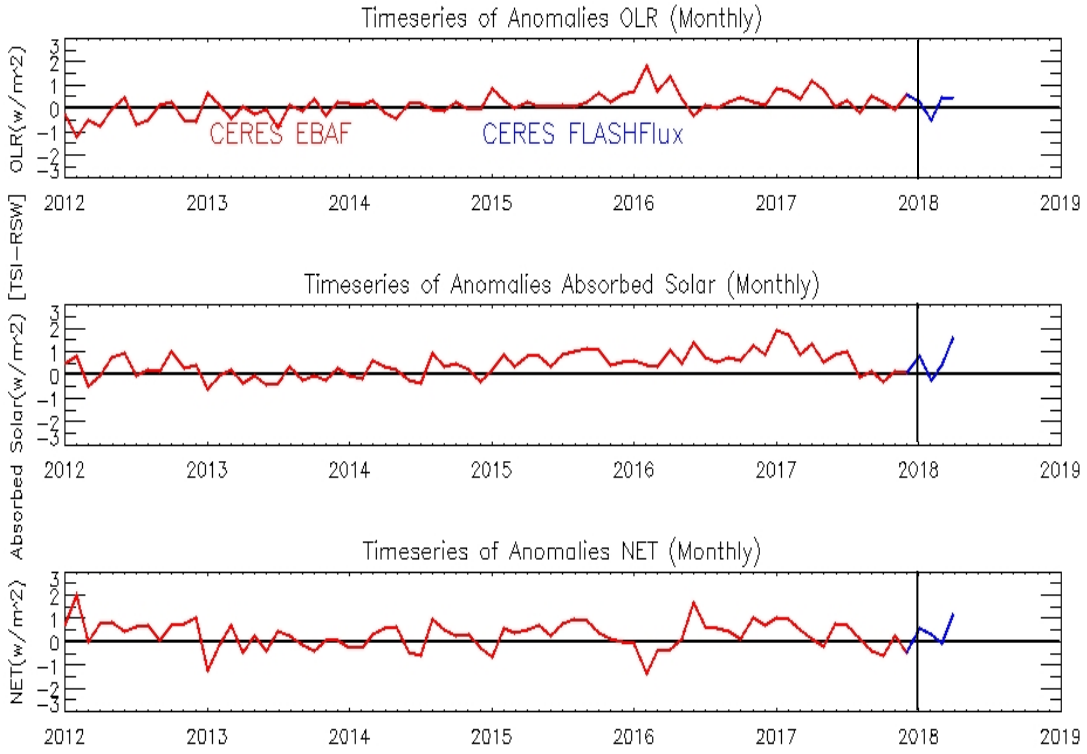
- *Massachusetts and Minnesota: RETScreen used to developed renewable energy heating and cooling scenarios for policy incentive programs including solar hot water heating, biomass heat and advanced heat pump technologies (uses POWER/SSE climatology data from GEWEX SRB, CERES, GMAO). (http://www.mass.gov/eea/docs/doer/pub-info/heating-and-cooling-in-aps.pdf; http://mn.gov/commerce-stat/pdfs/value-solar-heating-cooling.pdf)*

US Distribution of Early POWER-GIS Beta Adopters (API data requests Q1 2018)



- *Wisconsin: RETScreen is used extensively for the State's Focus on Energy solar hot water incentive program for businesses. Potential projects are evaluated for savings using RETScreen (uses POWER/SSE climatology data from GEWEX SRB, CERES, GMAO). Other state uses include educational (https://aefis.wisc.edu/index.cfm/page/AefisCourse.ABETSyllabusForm?courseid=848) and feasibility analysis (https://psc.wi.gov/Pages/Programs/OEI.aspx/docview.asp).*

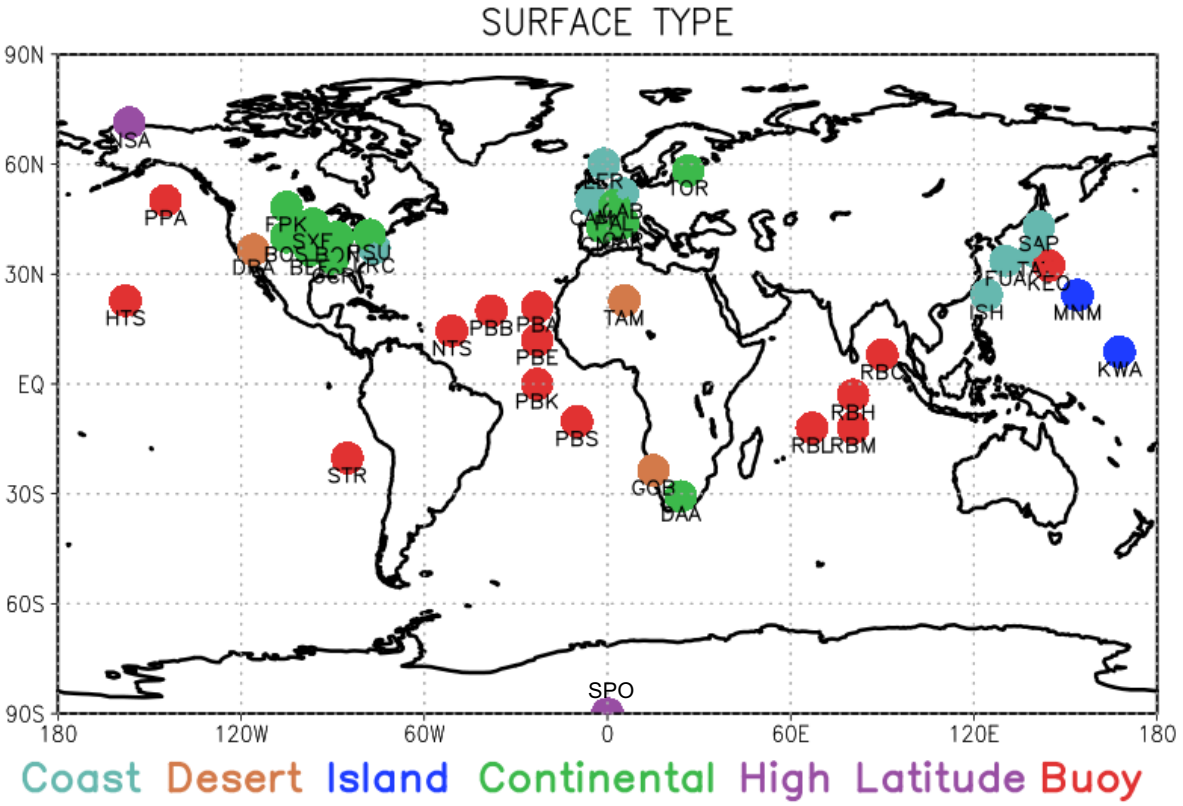
Updated Global Anomaly Time Series



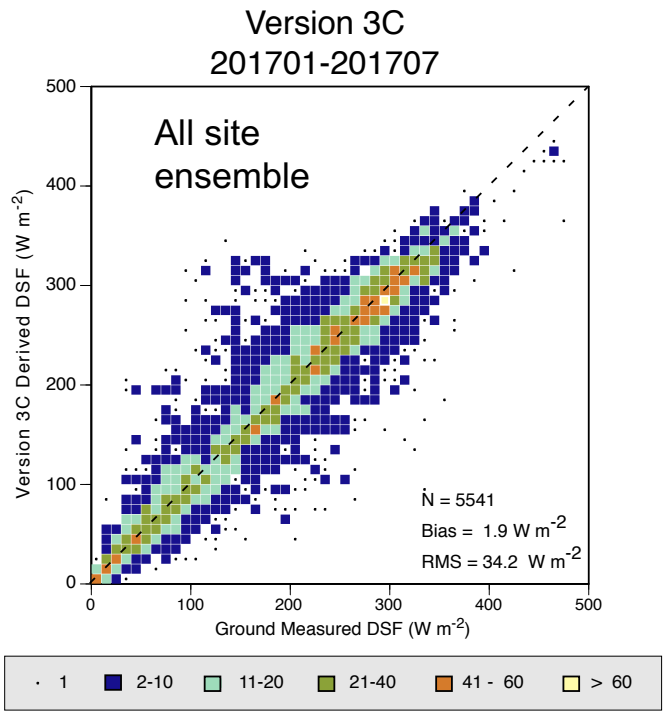
"State of the Climate 2017"

	Global-annual Mean Difference (2017 minus 2016) (W m^{-2})	2017 Anomaly (relative to Clima-tology) (W m^{-2})	Inter-annual variabil-ity (2001 to 2016) (W m^{-2})
OLR	+0.00	+0.50	±0.60
TSI	-0.10	-0.10	±0.15
RSW	-0.05	-0.80	±0.80
Net	+0.05	+0.20	±0.75

Validation Sites 1/2017 –7/2017



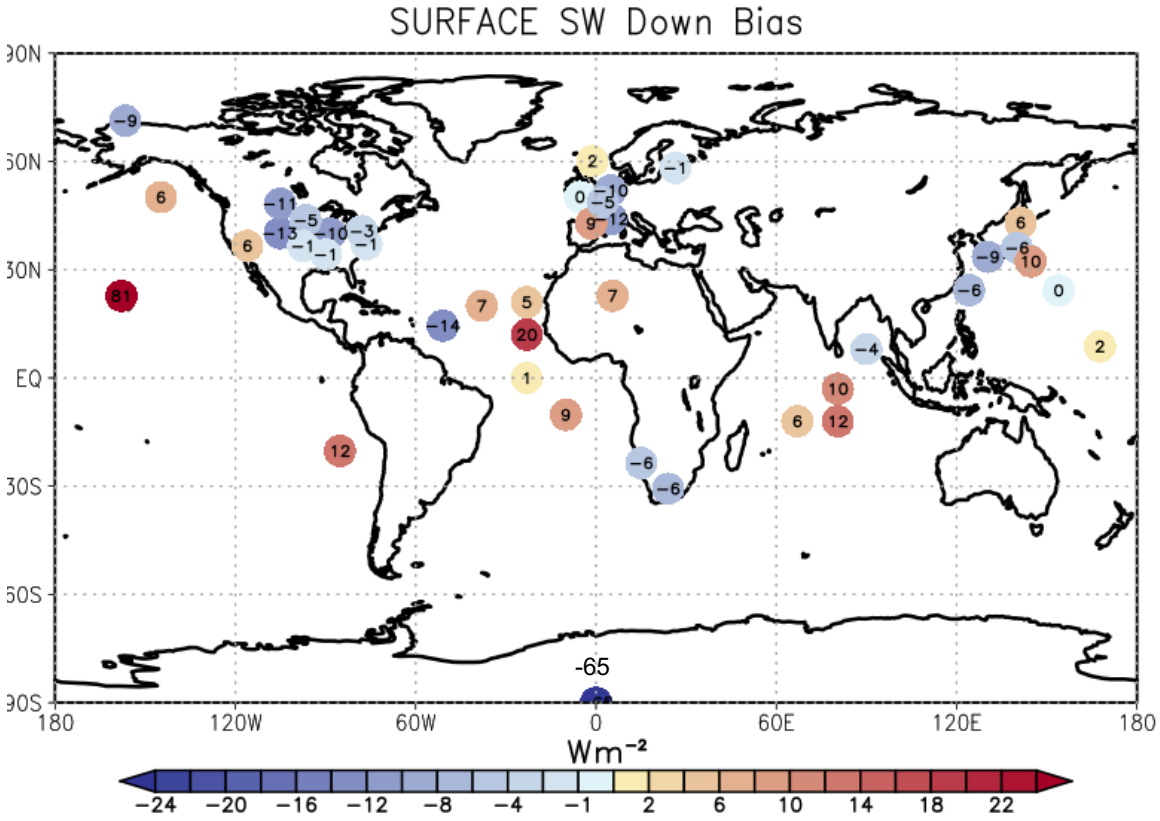
Recent SW Validation: 1/2017– 7/2017



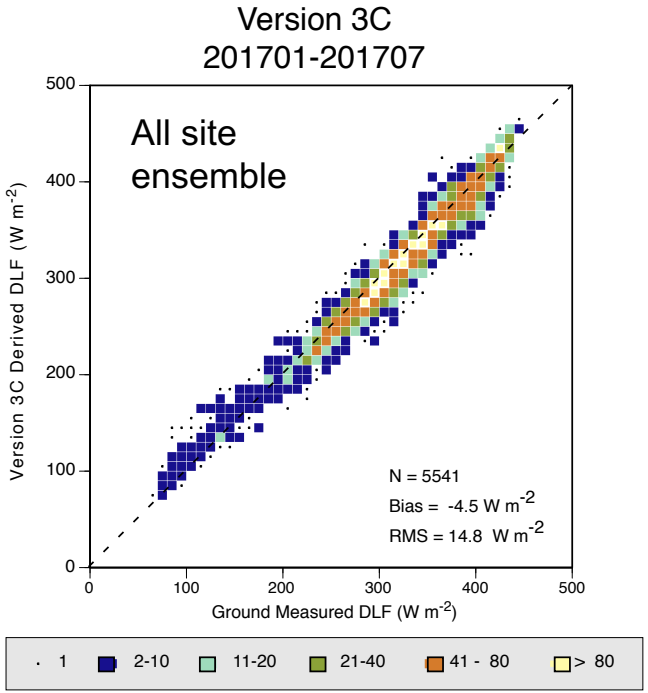
Daily Averaged TISA Comparison

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	0.9	34.2	6319
Continental	-5.8	28.4	1890
Coastal	-3.1	28.5	1474
Desert	2.4	24.4	570
High Latitude	-30.8	57.4	179
Island	1.1	22.4	349
Buoy	13.6	43.9	1857

Recent SW Validation: 1/2017 –7/2017



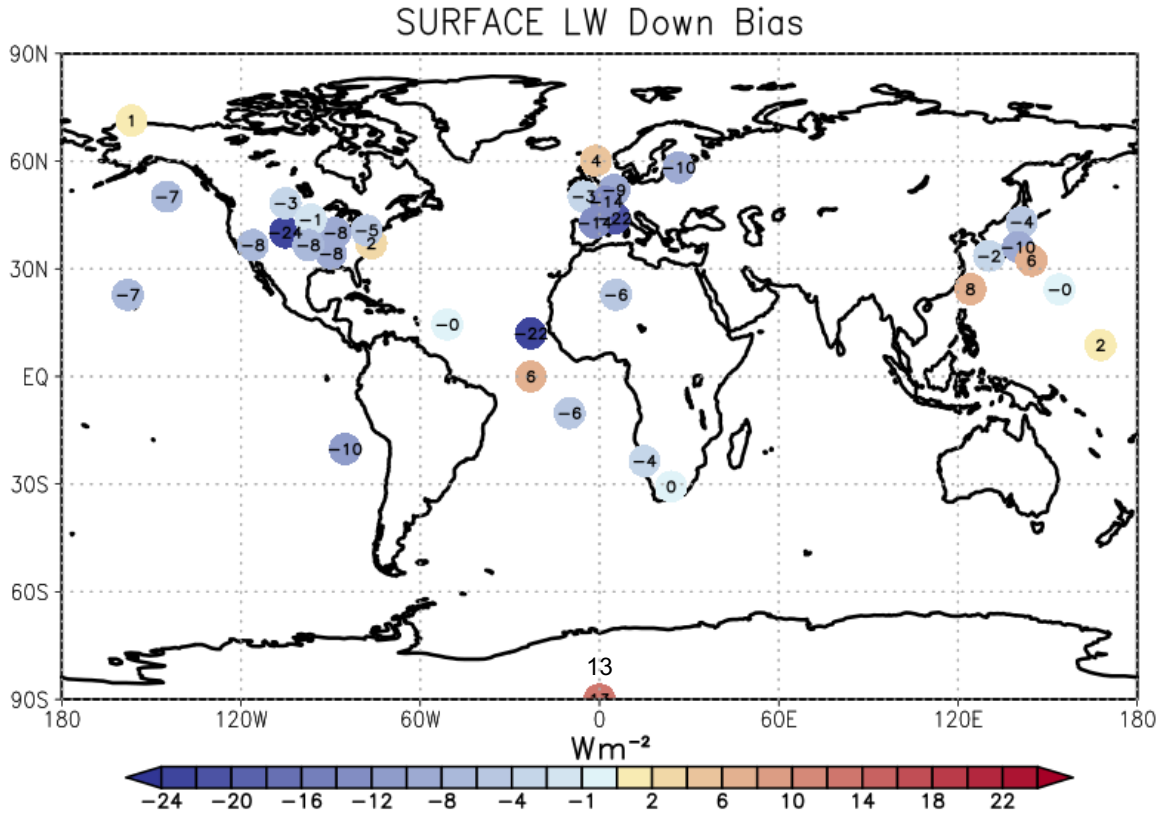
Recent LW Validation: 1/2017 –7/2017



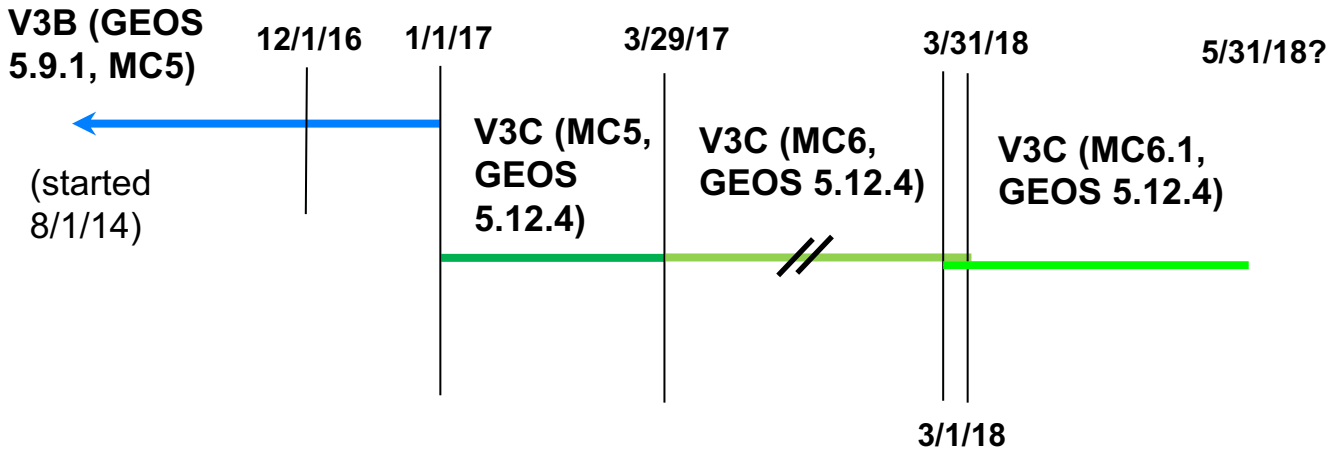
Daily Averaged TISA Comparison

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	-4.5	14.8	5541
Continental	-9.0	16.0	1849
Coastal	-1.8	12.2	1475
Desert	-5.6	14.4	563
High Latitude	7.4	17.8	323
Island	0.5	9.2	350
Buoy	-5.4	16.6	981

Recent LW Validation: 1/2017 –7/2017



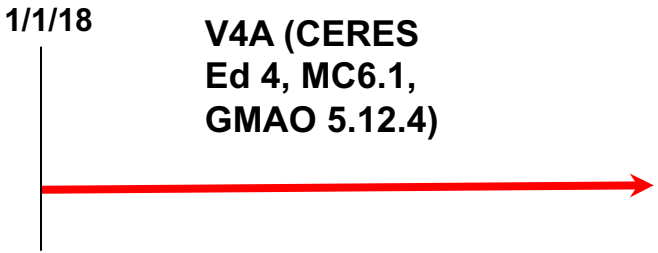
Moving to FLASHFlux Ed4A



MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

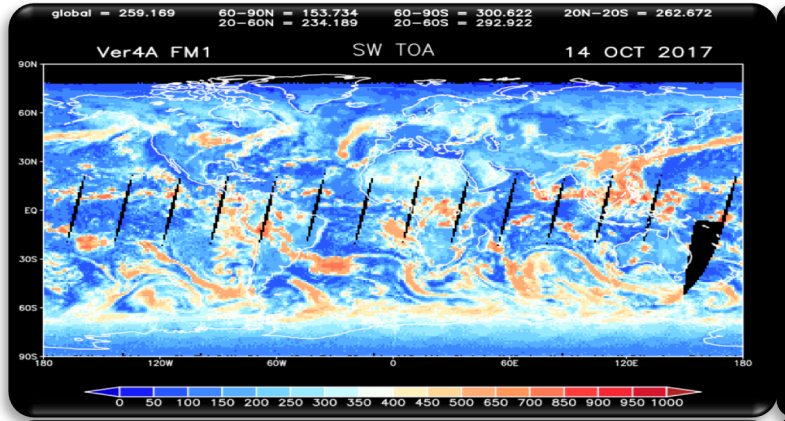
Under development and testing

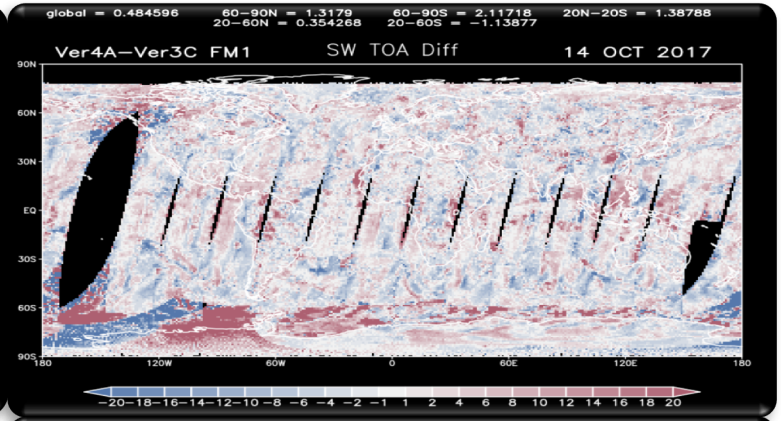


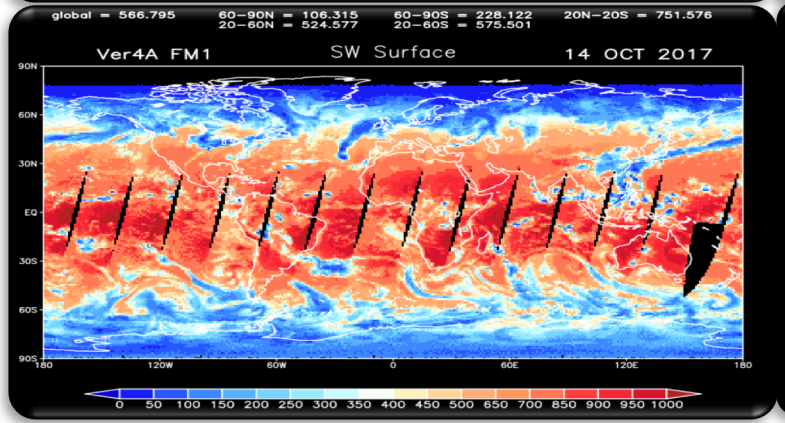
Near Future: Moving FLASHFlux Toward V4

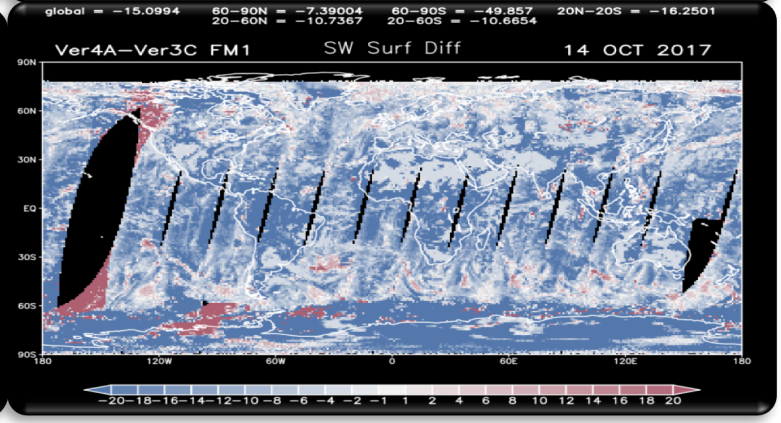
Attribute	FF v3C (MC6)	FF v4A	FF v4B
Baseline 1QC	Previous	New calibration	New calibration
GEOS FP-IT input	GEOS 5.12.4	GEOS 5.12.4	GEOS 5.12.4
MOA	Ed 4 compatible	Ed 4 compatible	Ed 4 compatible
MODIS	Collection 6	Collection 6.1	Collection 6.1
Clouds	Ed 2	Ed 4	Ed 4
SIBi (Snow/ICE Brightness Index)	No	Yes	Yes
Inversion (improved ADMs)	Ed 2	Ed 4	Ed 4
Aerosols	MATCH climatology	MATCH climatology	GEOS 5.12.4
Flux Algorithms	Unchanged	Unchanged	A0, Ap adjustments; new clear-sky TOA & surface albedos (current work)
TISA	Ed 2	Compatible w/ Ed 4 (current work)	Compatible w/ Ed 4 (custom CERES TSI?)
Data Processed	March 28 - present	Planned to begin 1/1/18	None
Validation Results	1/1/17 – 7/31/17	---	---

CERES Terra Daily Convolved SSF v4A

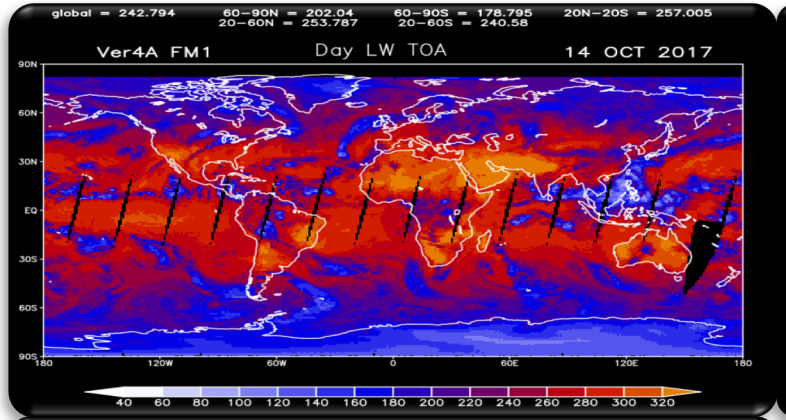


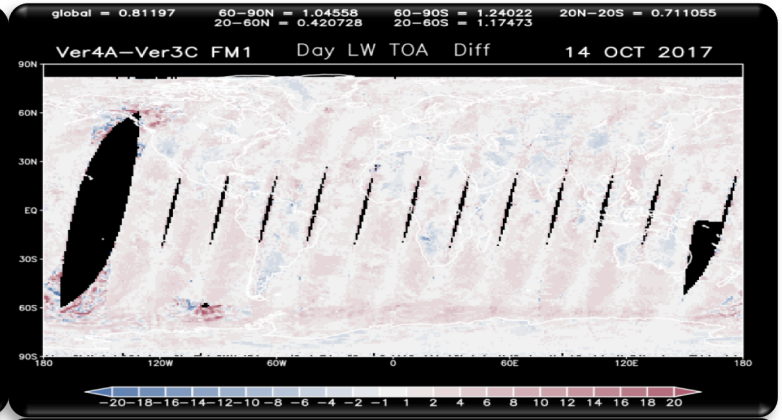


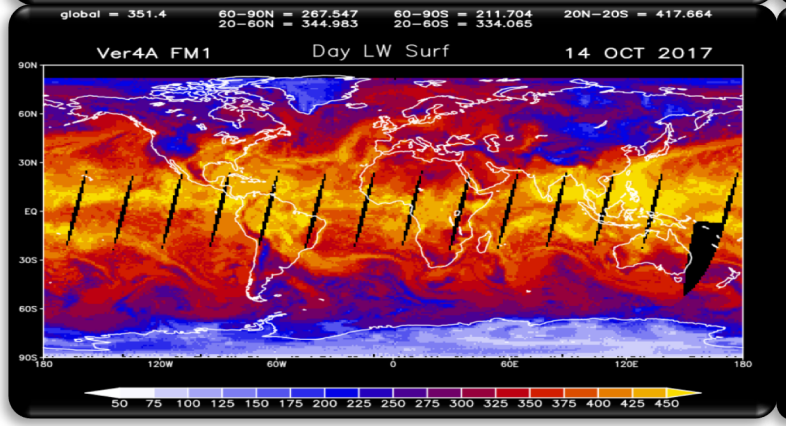


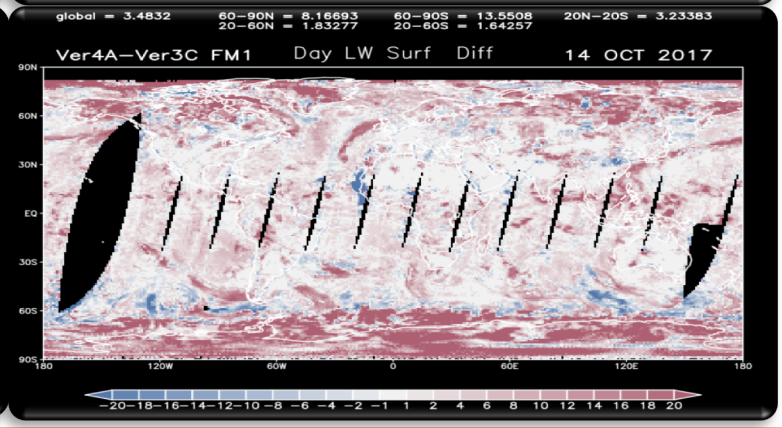


CERES Terra Daily Convolved SSF v4A

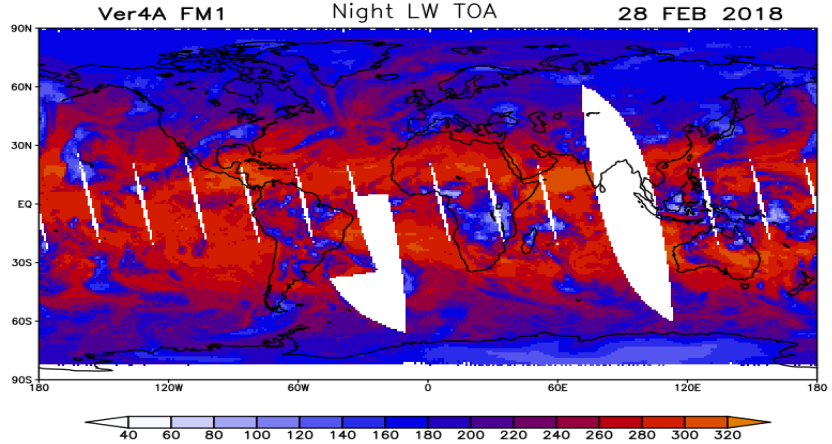


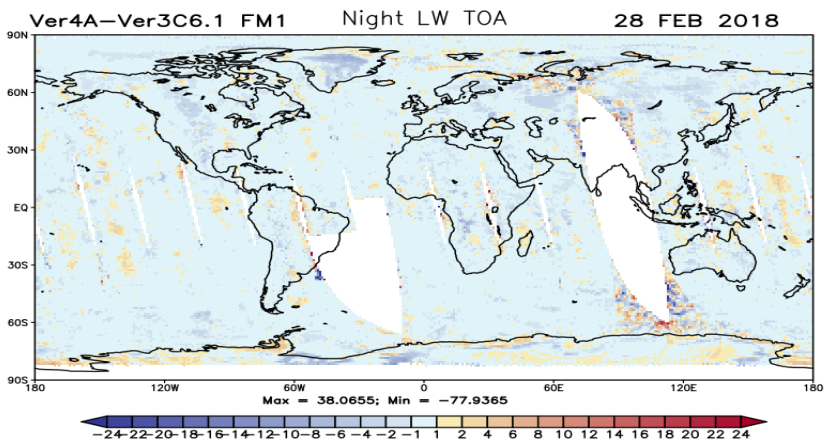


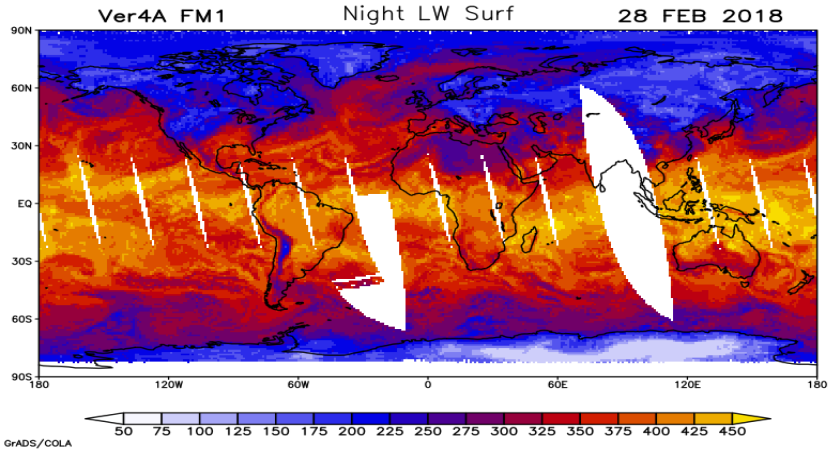


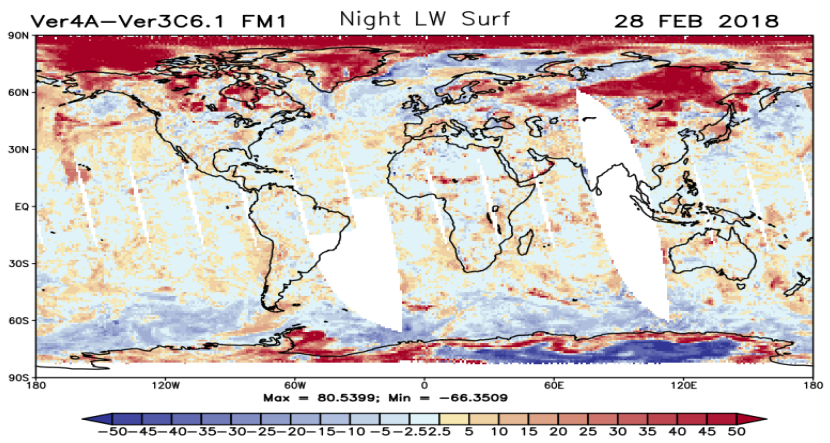


CERES Terra Daily Convolved SSF v4A – V3C (MC6.1)









GrADS/COLA

Planned v4A Production System

Update for Ed 4 using FPIT

MOA FLASH 1.1P1

Ed 4 Clouds

CERES Snow &Ice ESNOW/EICE

CER1.1P8 (IES)

Clouds Main CER2.1P2 (Terra) CER2.1P3 (Aqua) (Hourly)

MODIS MOD03 (terra) MYD03(aqua)

FLASHFlux Processing Stream

MODIS Collection 6.1

Clouds CER2.3P1 (Monthly)

SSFAI | SSFA | EQCHG | EQCHB | SSFB | CRHU-WL0063

SIBI

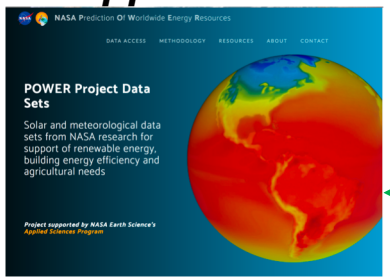
Inversion CER3.1P2 (Terra) CER3.1P3 (Aqua) (Hourly)

Initial data date Jan 1, 2018

PGE Output

PGE Input

POWER Applications



FLASH SFC-HR

FLASH Grid Hourly 4.2P1

CER3.2P2 SSF

SSF Subsetter

CER3.4P1 S'COOL and Validation

Update for Ed 4 SSF

FF Daily (.netCDF)

CER5.1P1 TISA Avg (Daily)

Legend

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

Summary and Conclusions

- ***FLASHFlux 3C and 4A progress***
  - Transition from v3C (MODIS C6) to v3C MODIS 6.1
  - Developing v4A compatible with CERES Ed 4; will use to MODIS Collection 6.1
  - Evaluating changes to SW MODEL B
- ***FLASHFlux Applications:***
  - New web site featuring GIS tools for CERES/FF/POWER and with ASDC to raise discoverability and accessibility scheduled for release this week!
  - Institutional RETScreen Expert licenses will result in continual usage in large number of US and Canada federal buildings (Johnson Controls), state facilities (HI, MI) and universities (UM, Auburn, Purdue) and corporation facilities (3M)
- ***FLASHFlux publications:***
  - 2017 SotC report submitted
  - Future papers: FLASHFlux TISA applications including energy
- ***Future Versions***
  - Developing v4A by migrating CERES Ed 4 Clouds (collection 6.1) and Inversion; must adapt current FF TISA => target June ‘18
  - Longer-term Upgrades (Summer ‘18): Refine SW Model B, Assess & adapt CERES TSI to FLASHFlux TISA, Assess FPIT aerosol assimilation; NPP SSF

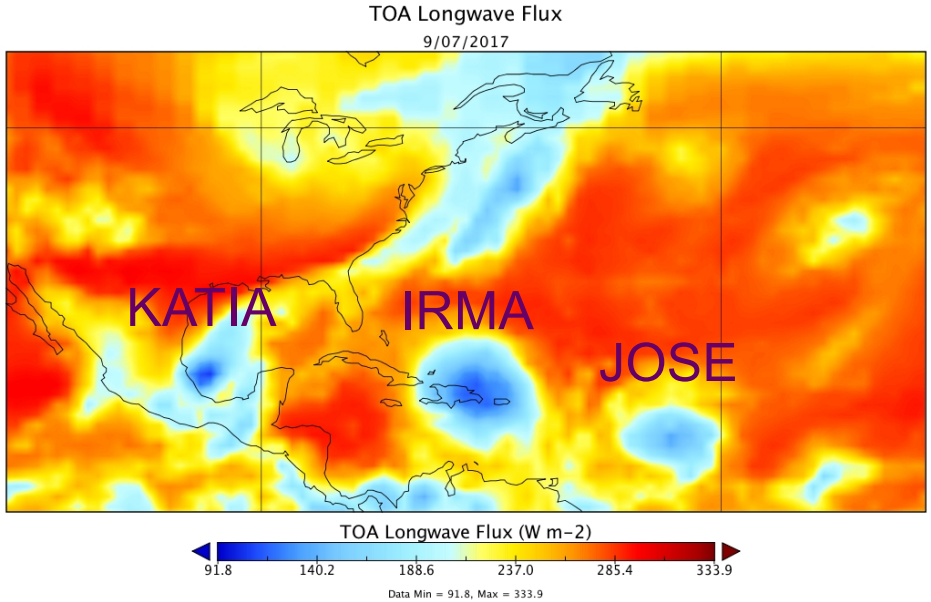
FLASHFlux Web Sites:

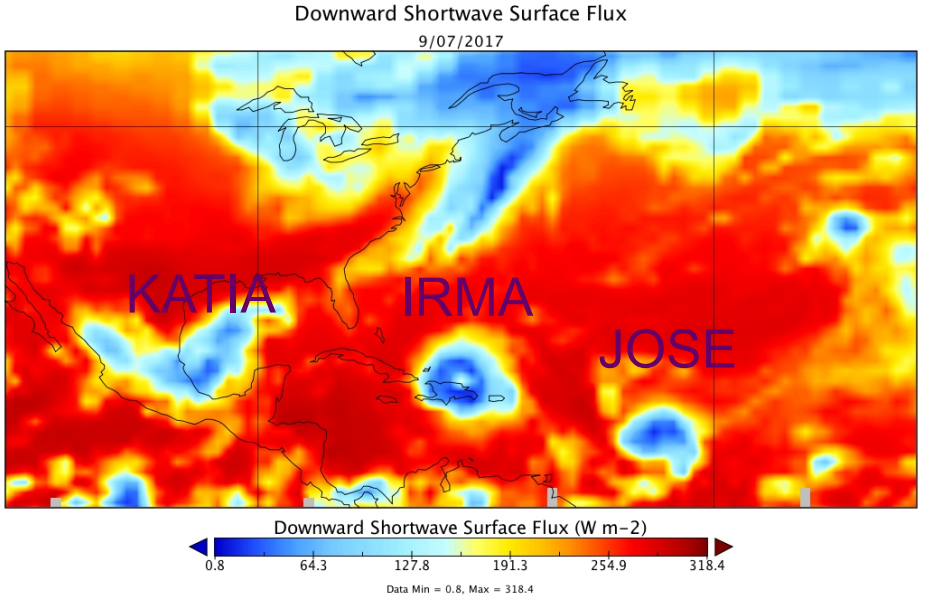
https://flashflux.larc.nasa.gov

https://power.nasa.gov & https://power.nasa.gov/new (in Beta)

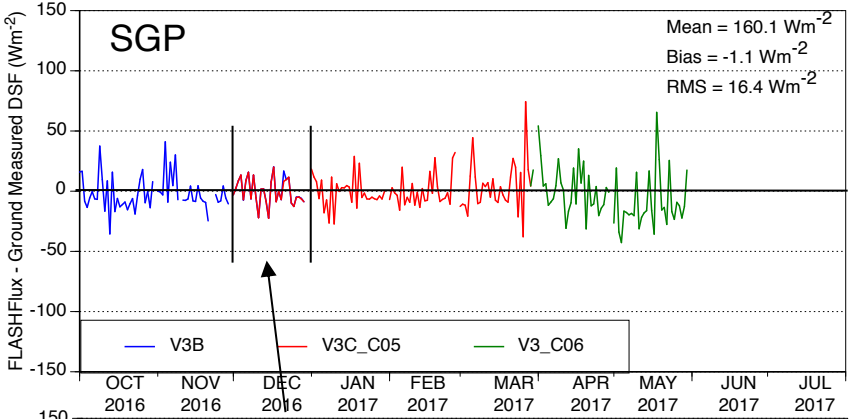
Extras

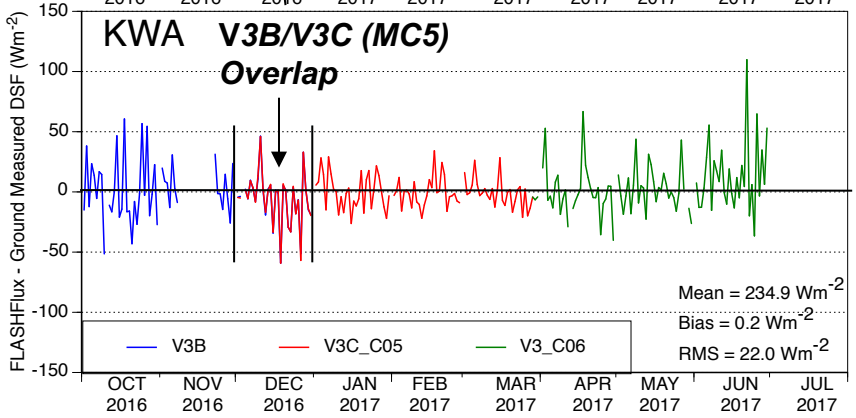
Daily Time Series: Hurricanes Irma, Jose and Katia

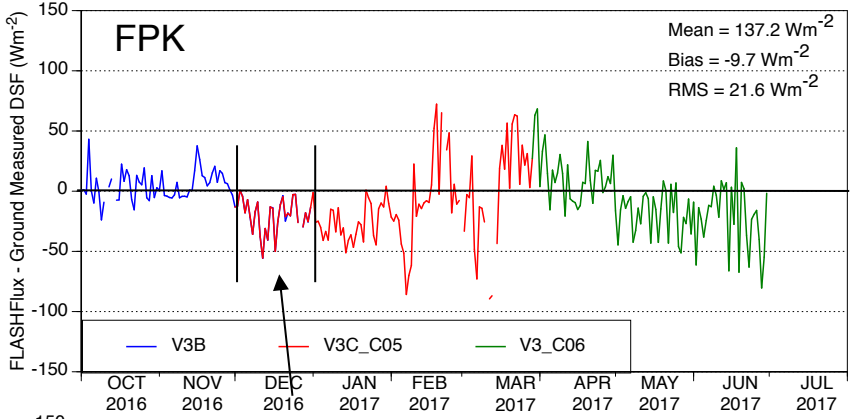


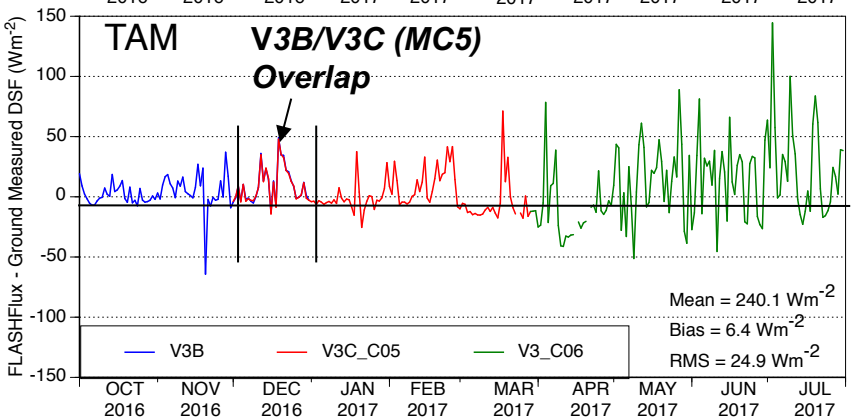


Multi-Version Difference Time Series: SW









Multi-Version Difference Time Series: LW