A Status Update for FLASHFlux and SOFA working groups including Data Usage Highlights from new POWER portal

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Surface-Only Flux SSF Products

- CERES SSF includes several Surface–Only Flux Algorithms (SOFA) to compute SW and LW surface fluxes at footprint resolution

- The SOFA algorithms include (Kratz et al., 2010):

		Model A	Model B	Model C
SW	Clear	Li et al. (1993)	LPSA (Gupta et al. 2001)	--
	All-Sky	--	LPSA (Gupta et al. 2001)	--
LW	Clear	Inamdar and Ramanathan (1997)	LPLA (Gupta et al. 1992, 2010)	Zhou-Cess (Zhou et al., 2007)
	All-Sky	--	LPLA (Gupta et al. 1992, 2010)	Zhou-Cess (Zhou et al., 2007)

LPSA/LPLA = Langley Parameterized SW/LW Algorithm

- The SOFA group actively updates and validates these data products

Ed4 LP (Model B) Surface-Only Flux Algorithms

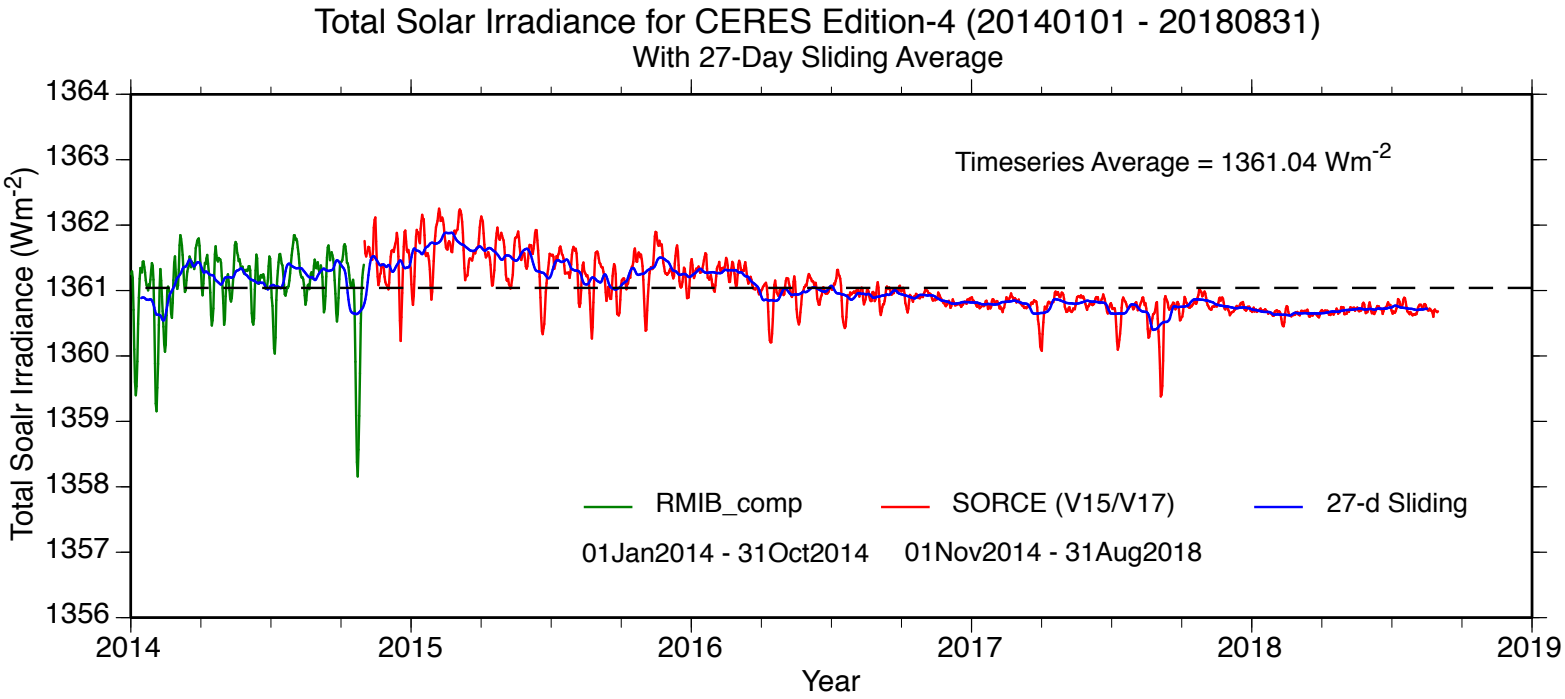
- ***Systematic improvements to LPSA (SW Model B) Model For Ed4:***
  - Key Input changes include TOA albedo map and aerosol properties using monthly and daily MATCH/OPAC datasets
  - Key algorithm changes include Rayleigh scattering formulation and revised cloud transmission formula
- ***Systematic improvements to LPLA (LW Model B) Model For Ed4:***
  - Key algorithm changes include lapse rate/ inversion strength constrained to +/- 10K/100hPa (e.g., Gupta et al. (2010)).
- ***SOFA group Ed4 editing paper including updated descriptions and validation results***

Update summary for LPSA and LPLA algorithms for Ed4A

Dataset	CERES 2B	CERES 4A
Clear-Sky TOA albedo Terra	48 month ERBE	70 month Terra
Clear-Sky TOA albedo Aqua	46 month Terra	70 month Terra
Clear-Sky Surf. albedo	46 month Terra	70 month Terra
TOA to Surface albedo transfer	Instantaneous	Monthly average
Spec. Corr. Coef.	CERES 2B	CERES 4A
Cos (sza) dependence of Surface Flux	LPSA	Briegleb-type
Cloud Algorithm Terra	Terra Ed2	Terra/Aqua Ed4
Cloud Algorithm Aqua	Aqua Ed2	Terra/Aqua Ed4
SW aerosol dataset	WCP-55	MATCH/OPAC
Rayleigh Treatment	Original LPSA	Bodhaine et al (1999), JAOT.
Ozone Range Check	0 to 500 DU	0 to 800 DU
Twilight cutoff		New
Cloud transmission empirical coefficient	0.80	0.75
LW high temperature surface correction	No	Maximum Lapse Rate 10K/100hPa
LW Inversion correction	No	Maximum Inversion Strength -10K/100hPa

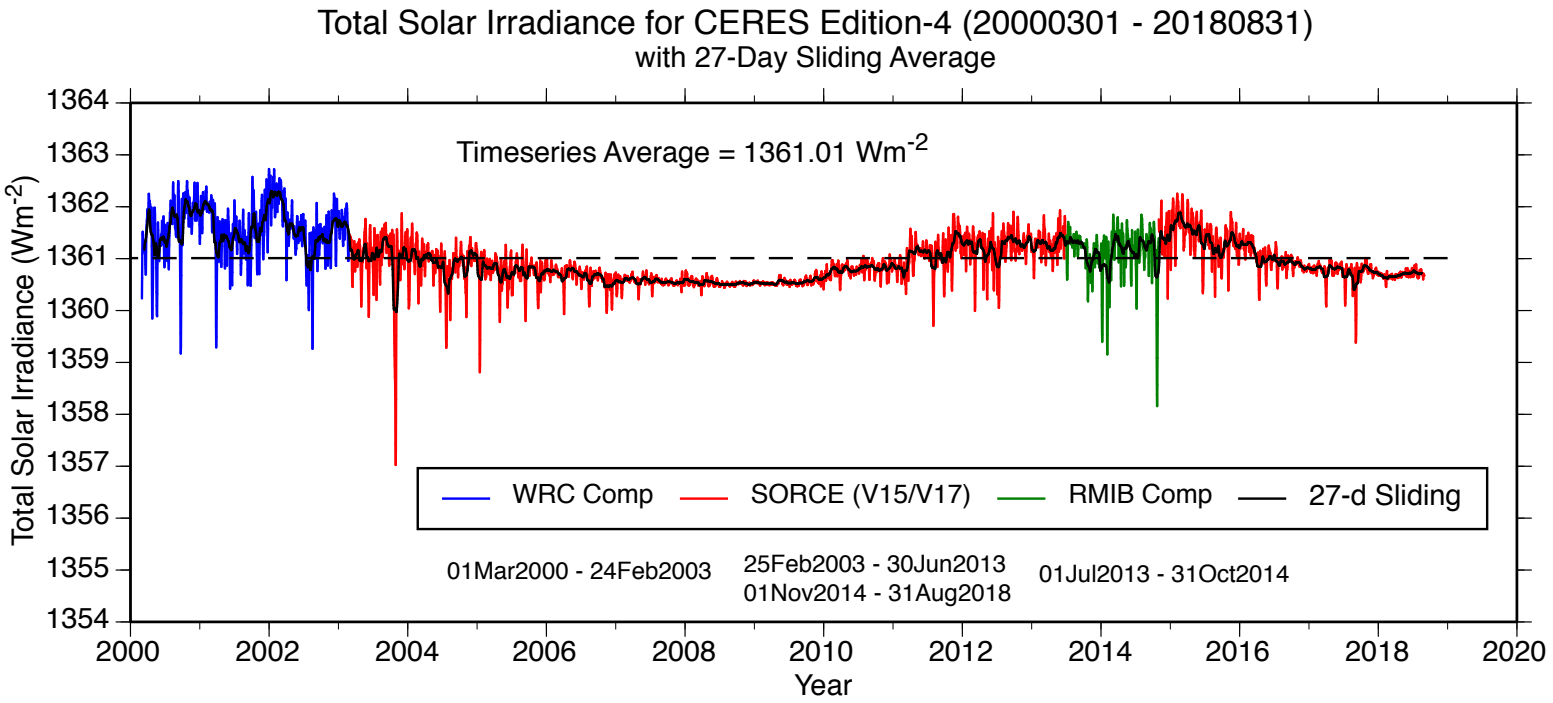
TSI Updates For CERES Processing

- Regular updates to TSI from SORCE continue



TSI Updates For CERES Processing

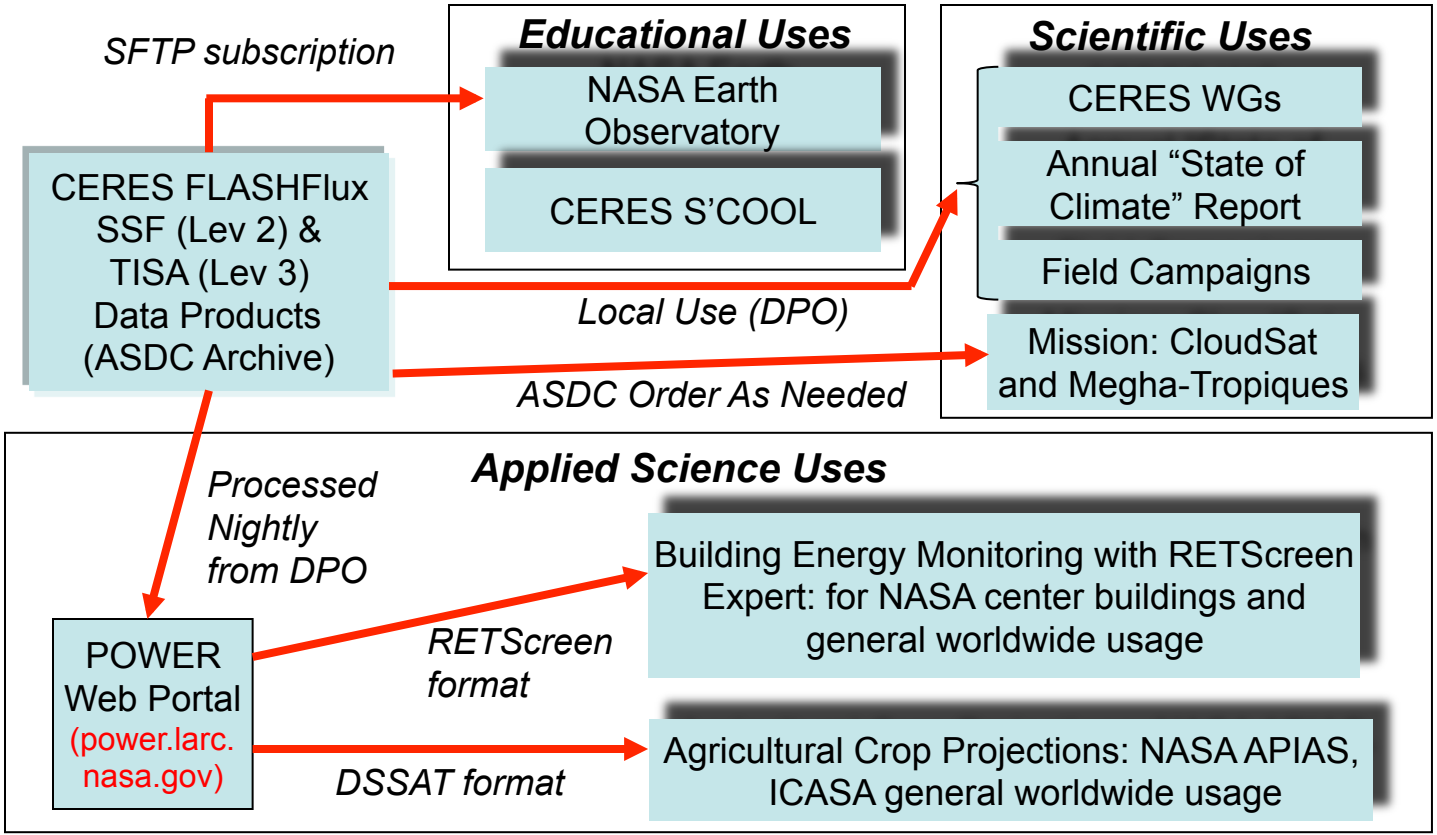
- Regular updates to TSI from SORCE continue
- Now nearly 18 ½ years
- Expecting TSIS from ISS soon (end of Sept.??)



CERES FLASHFlux Overview

- ***FLASHFlux Overview***
  - Uses CERES based production system through inversion
  - Most recent calibration projected forward
  - LPSA/LPLA SOFA algorithms for surface fluxes
- ***FLASHFlux Objectives***
  - SSF products within 4 days
  - Global 1x1 daily averages from a FF TISA (uses a running 3-day average); goal: 6-7 days latency
- ***FLASHFlux Usages***
  - Primarily used for applied science and education
  - Supports also QC for selected missions
  - TOA gridded fluxes; normalized to TOA EBAF for annual “State of the Climate” assessments.

FLASHFLUX: Schematic of Current Uses

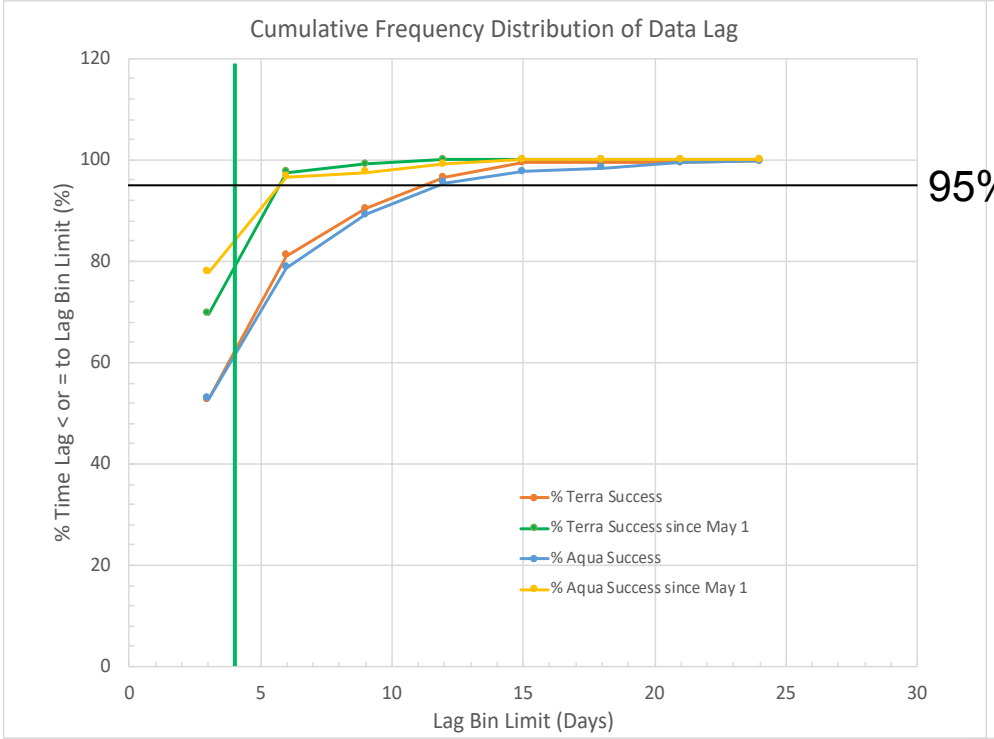


FLASHFlux v3C Status

- ***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***
  - Development towards V4A => V4A through FLASHFlux SSF being tested (uses MC6.1)
  - V3C vs 4A SSF; SW algorithm updates being evaluated
  - Finalizing V4A TISA modifications (consistent with Ed 4)
- ***FLASHFlux Data Provision Through POWER:***
  - New POWER web portal released
  - Usage Examples from US and World
  - Early user metrics

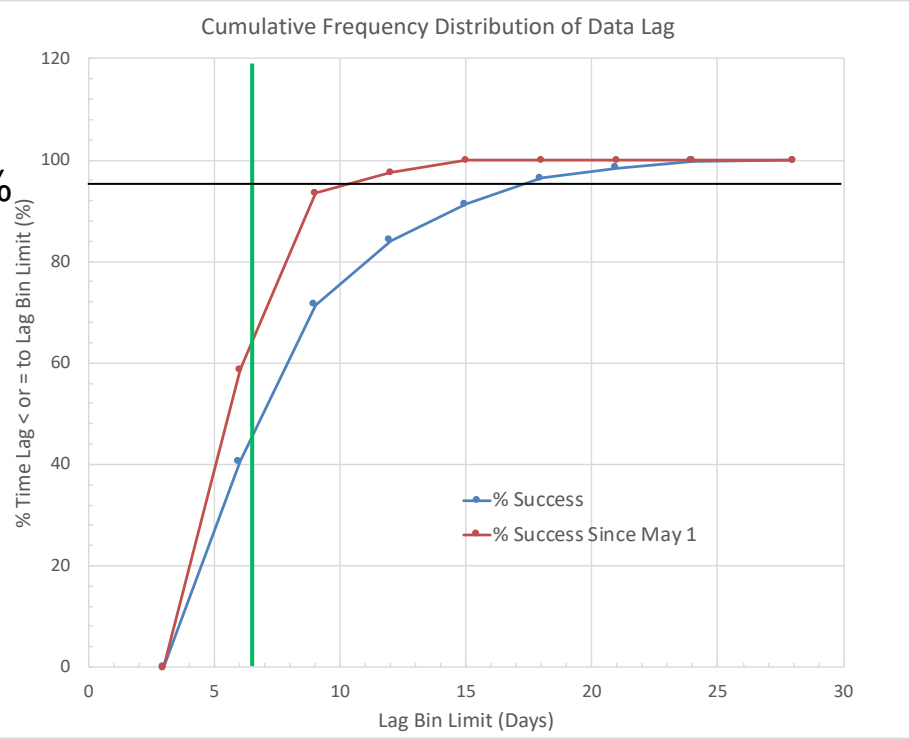
FLASHFlux Latency Success

FF SSF Goal: 4-day latency

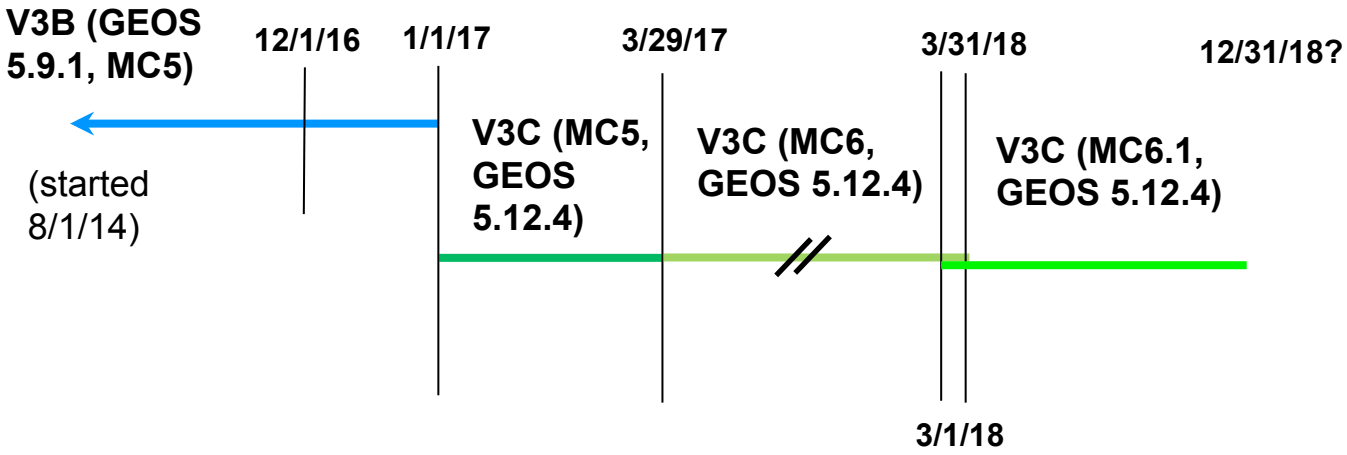


95%

FF TISA Goal: 6-day latency



Current FLASHFlux Versions

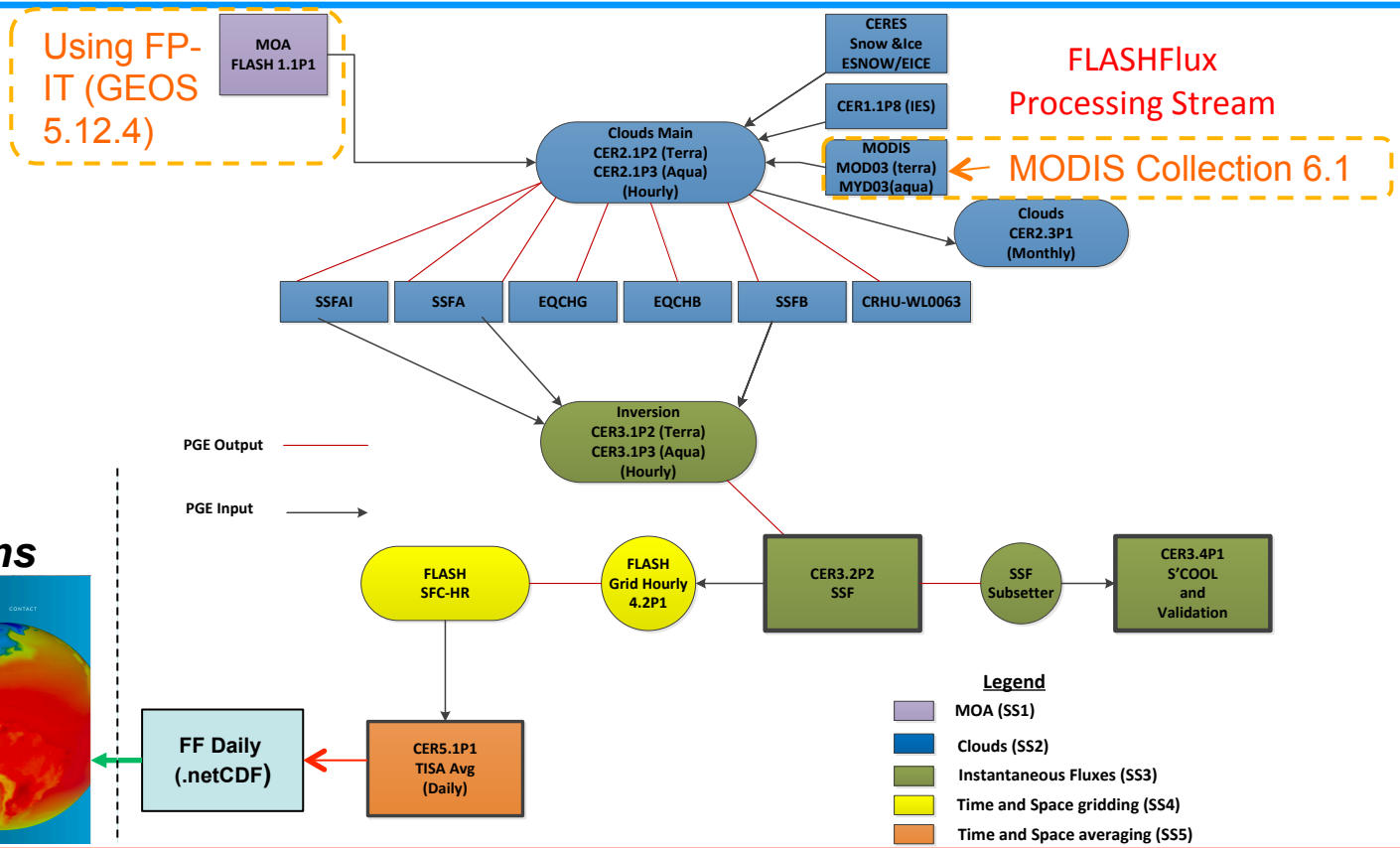


Transitioned from MODIS Collection 6 to 6.1

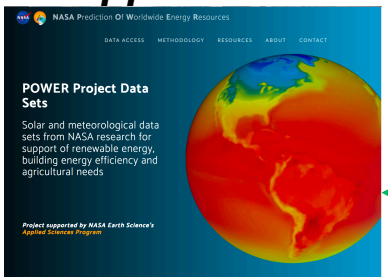
MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

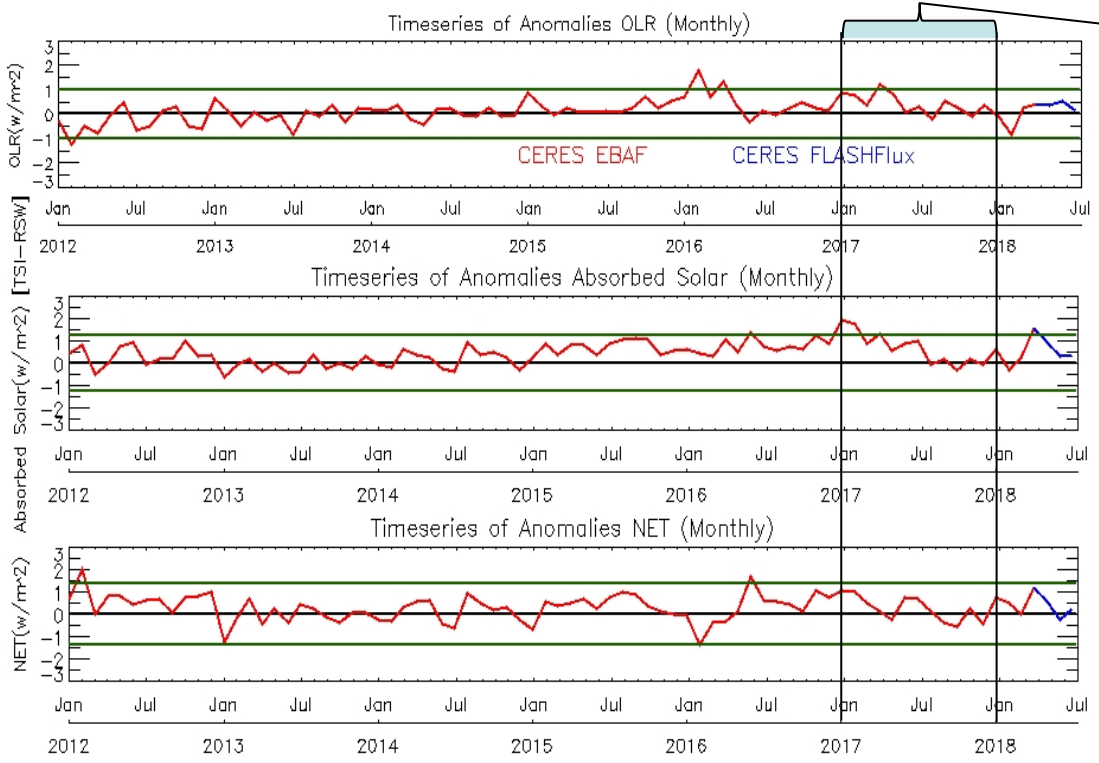
Current v3C Production System



POWER Applications



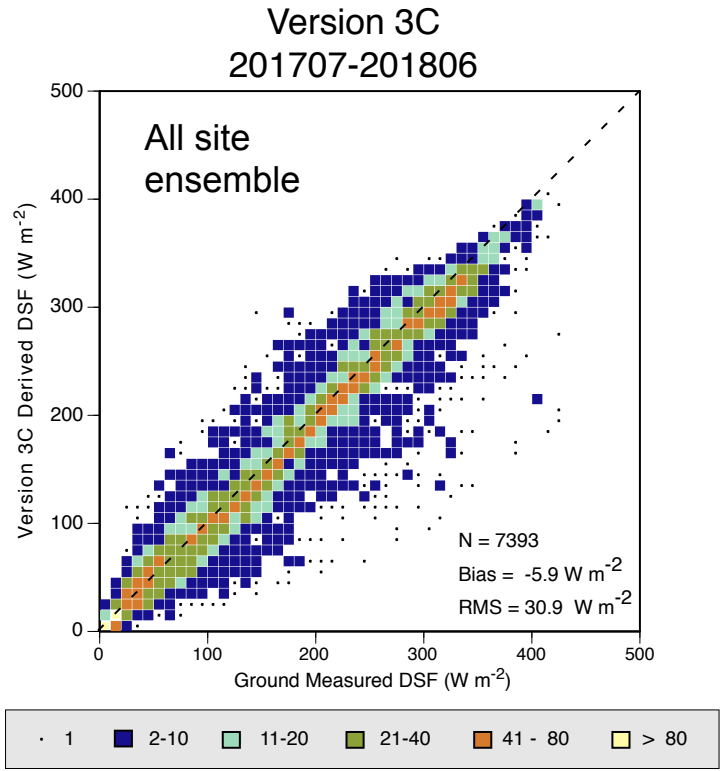
Updated Global Anomaly Time Series



"State of the Climate 2017"
(Wong et al, August 2018)

	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}) (2-sigma)
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

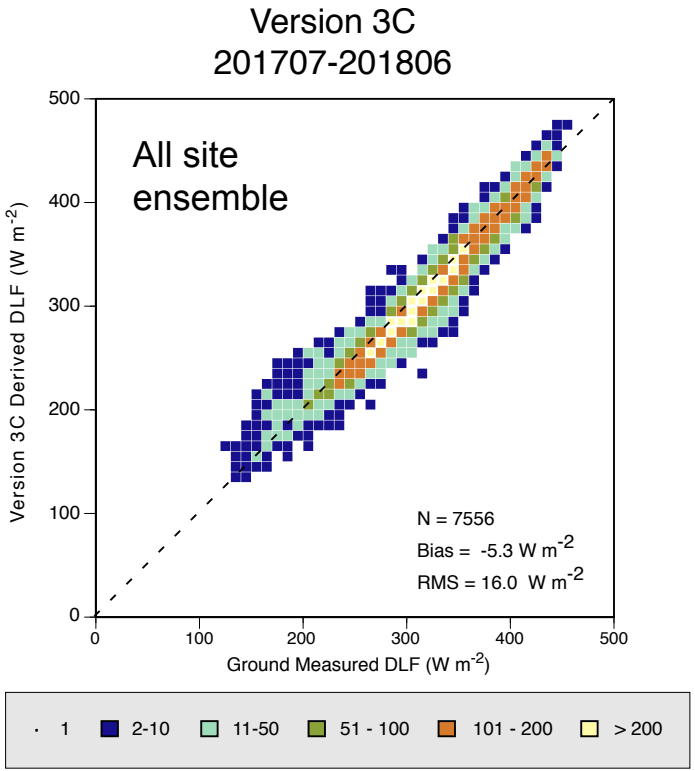
Recent SW Validation: 7/2017– 6/2018



Daily Averaged TISA Comparison

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N
All Obs	-5.9	31.0	7393
Continental	-5.6	28.6	4053
Coastal	-3.7	23.5	1210
Desert	-3.4	23.4	1241
High Latitude	-28.2	60.2	751
Island	13.0	32.0	318

Recent LW Validation: 7/2017 –6/2018



Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-5.3	16.0	7556
Continental	-8.3	15.9	3986
Coastal	-3.1	13.2	1191
Desert	-5.4	13.7	1221
High Latitude	5.6	20.0	838
Island	-3.9	11.7	320

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

- **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

POWER (v1, GIS): From Data Source to User, Flexible and Scalable

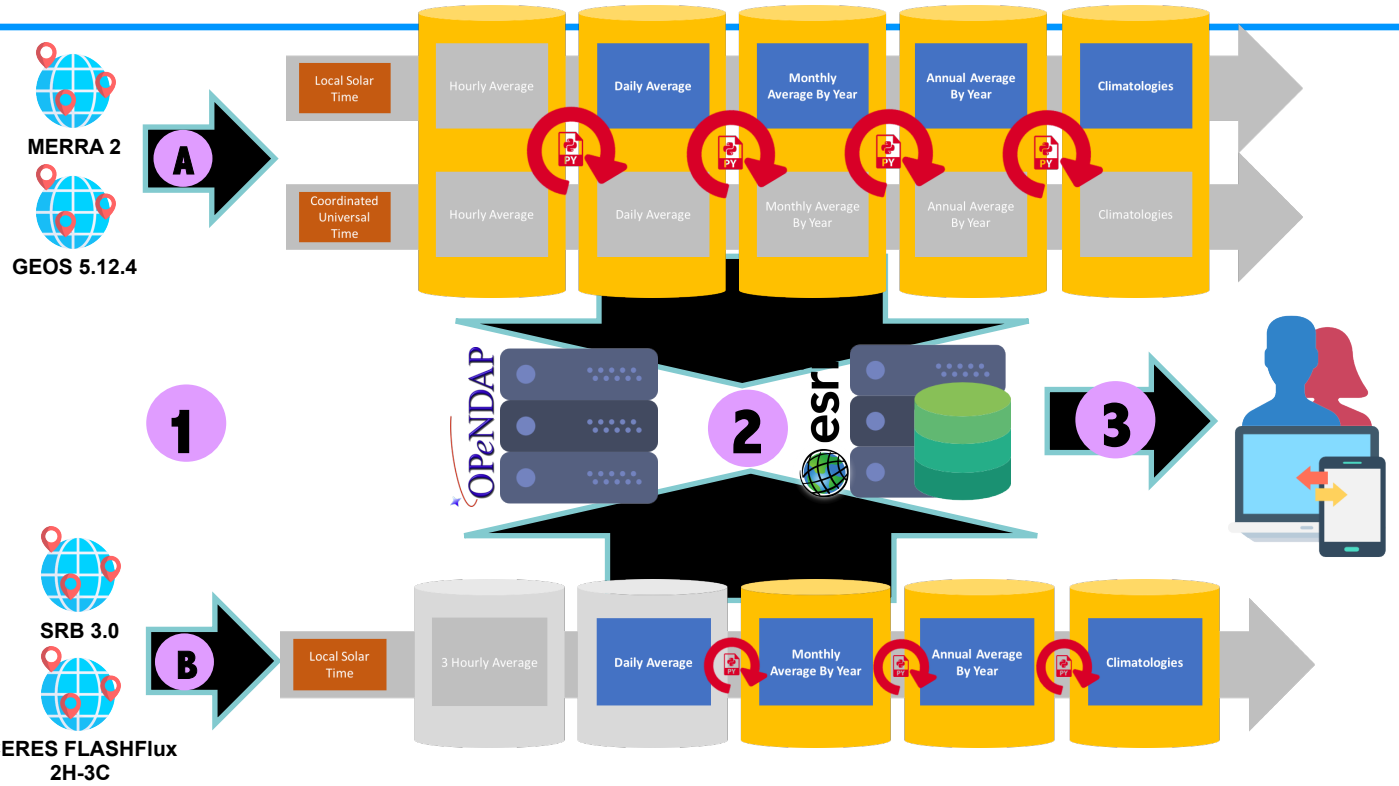
1

A Native meteorological model data is ingested and processed on a recurring cycle and stored.

B Native solar model data is ingested on a recurring cycle and averages greater than daily are processed and stored.

2 Data is served to users via Custom Python API utilizing OPeNDAP and Esri ArcGIS Server (Image Services).

3 Users can access the data in commercial and custom applications via Desktop, Tablet and smartphone technologies.



Native Gridded Model Data | Data Not Distributed* | Data Distributed | Data Stored | Recurring Python Scripts | Server with Enterprise GeoDatabase | Web Server | Users Access On Responsive Platform

* Data may become available in future depending on resources and user requirements.

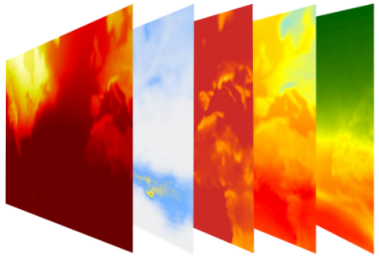
Icons Source: http://www.flaticon.com (Creative Commons 3.0)

POWER (v1, GIS): Three Main Data Accessibility Options

Data Access Viewer

Responsive web mapping application providing data subsetting, charting, and visualization tools in an easy-to-use interface.

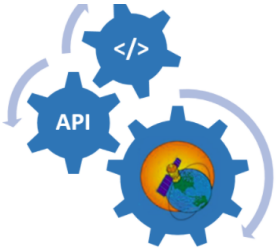
POWER DATA ACCESS VIEWER



ArcGIS Image Services

GIS-Ready Time-Enabled ArcGIS Image Services for mapping, visualization, and spatial analysis.

POWER DATA ACCESS VIEWER



POWER API Integration

Access the POWER data holdings through your own custom scripts and scalable applications.

POWER API DOCUMENTATION

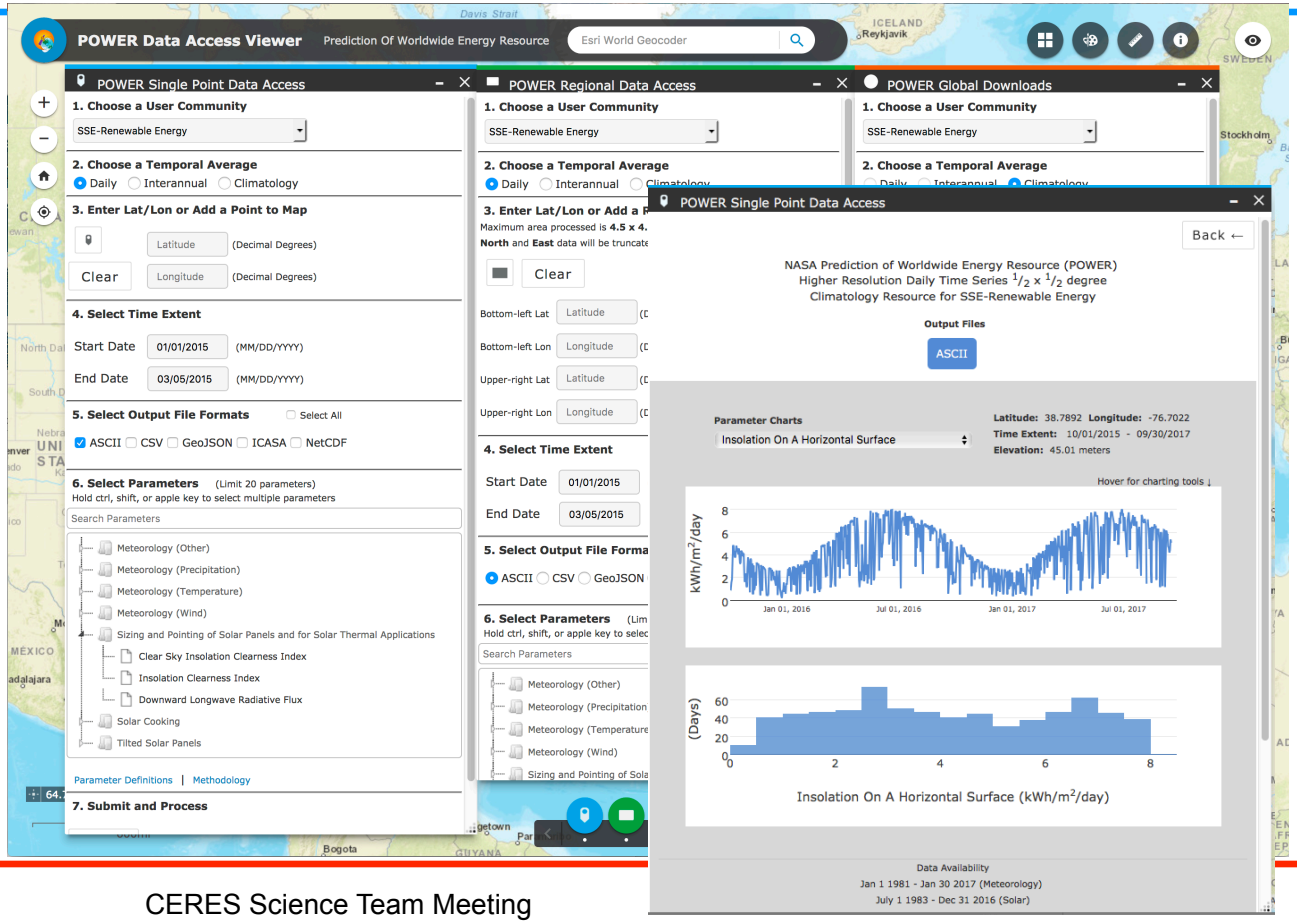
POWER (v1, GIS): Interactive Data Access Viewer

Graphical Data Access

- ½ x ½ deg; within 5-7 days of obs
- multiple parameters from FLASHFlux, GMAO, etc. available
- parameters arranged by application community (i.e., renewable energy, buildings, agroclimatology)
- Multiple data output formats

Four Applications :

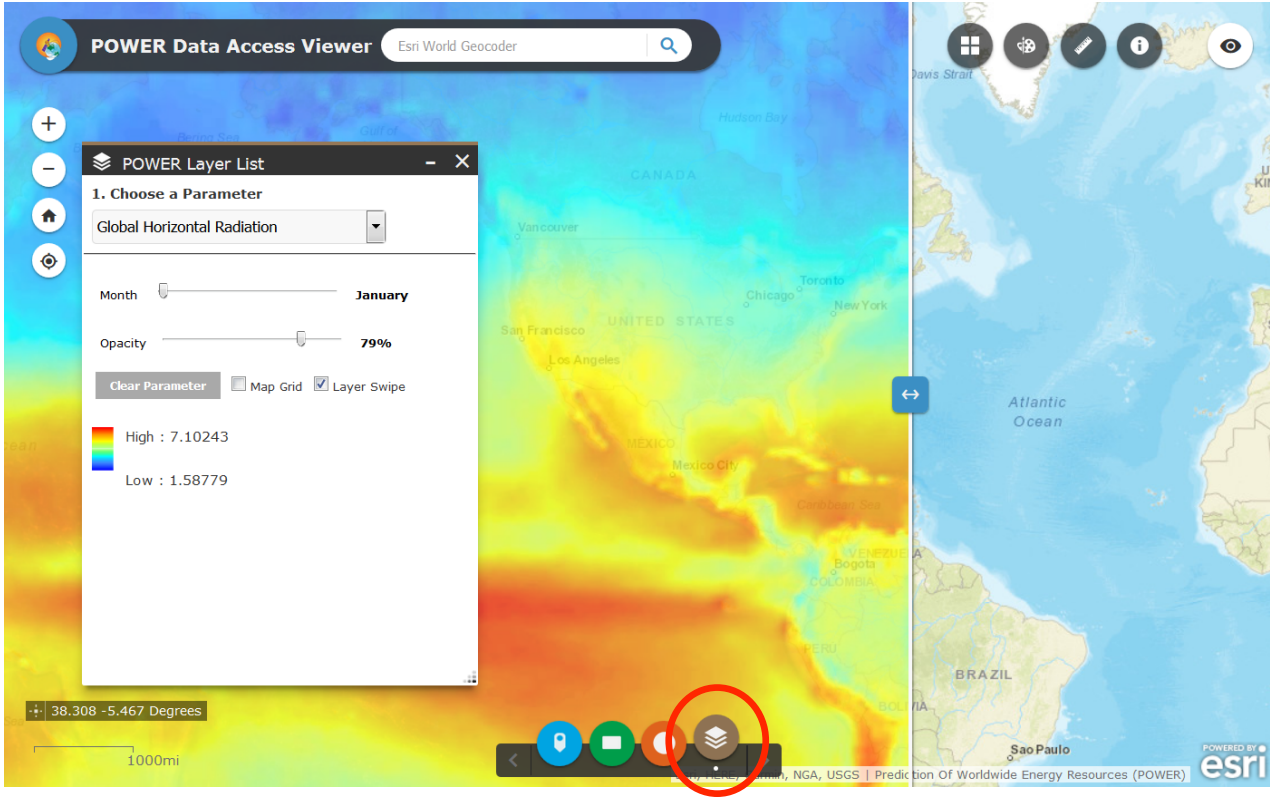
- Time series at a single point (daily, monthly, up to 30 years*)
- Regional times series (limited area)
- Global climatology (30 year*)
- Layer List (Image Services)



POWER (v8, GIS): ArcGIS Image Services

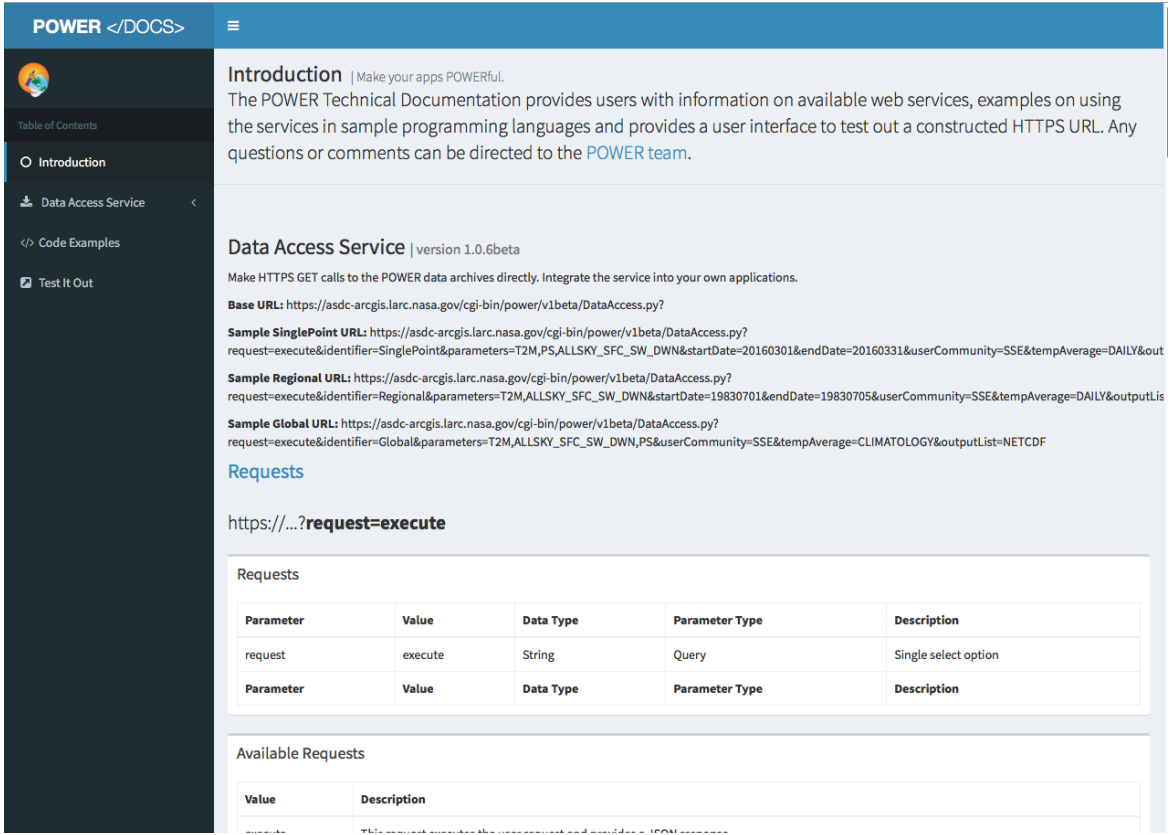
Image Services

1. Migrated current SSE-GIS capabilities (see https://asdc-arcgis.larc.nasa.gov/sse/
2. OGC compliant (opensource)
3. Includes all available parameters for climatological values (ability to click a location and obtain data values)
4. Background maps with support for image tools
5. Time series slider and swiping tools, etc.
6. To Do: implement more services, allow for time series, add on-the-fly



POWER (v8, GIS): Accessing Data with API Service

- Complete instructions to setup up URL based data access (API using OPeNDAP)
- Provide immediate access to the data parameters and time periods required
- Returned file formatted for general software (Excel, GRaDs, MatLab) or customized script/coding for Decision Support Tools (RETScreen, HOMER)



POWER Connects to RETScreen

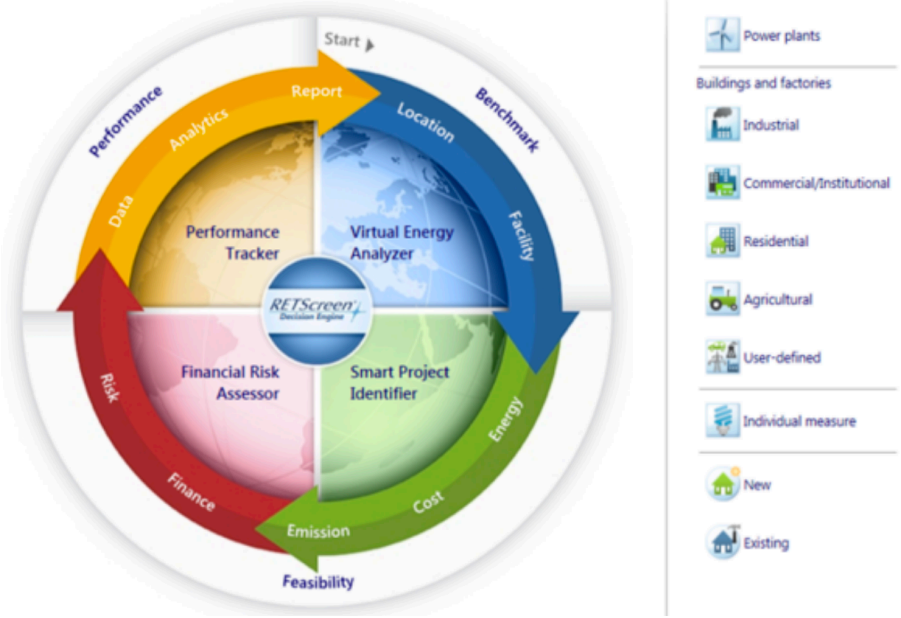
RETScreen Clean Energy Management Software

World's leading clean energy decision-making software

- Benchmark, feasibility, performance and portfolio analysis
- Energy efficiency, heating and cooling, power generation and cogeneration
- Renewable energy and fossil fuels
- Residential and commercial/institutional buildings and industrial facilities
- 36 languages covering 2/3rds world's population

Empowering cleaner energy decisions worldwide

- 575,000+ users in all countries, growing at 50,000+ new users per year
- 1,100+ universities & colleges also use for teaching & research



- Well over $8 billion in direct user savings since 1998

Next generation, *RETScreen Expert*, released September 2018 with updated NASA POWER interface

Example Uses of FF Data Distributed Through POWER

- *3M Company manages 11 facilities using RETScreen and POWER (CERES FLASHFlux) data: "The NASA datasets we use are critical to our energy analysis since they are used as major variables that predict our energy use."*
- *Renewable energy engineers use daily solar irradiance to assess performance of multiple solar systems for clients of RETScreen users in Ottawa region (e.g., others include MIT, Lockheed Martin, Corning, Johnson Controls)*
- *Hawaii Department of Education implementing program to use RETScreen at all education buildings/schools*
- *Ontario Schools including Niagara district using RETScreen (https://www.linkedin.com/pulse/school-board-energy-managers-lead-way-gregory-j-leng)*

District School Board of Niagara's Main Office

POWER Web Site Usage Statistics

POWER Data Access Viewer - PROD
All Web Site Data

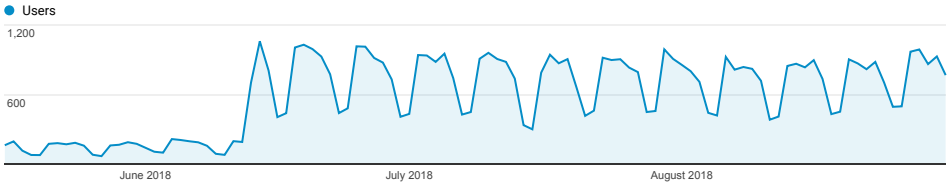
GO TO REPORT

Audience Overview

All Users
100.00% Users

May 16, 2018 - Aug 31, 2018

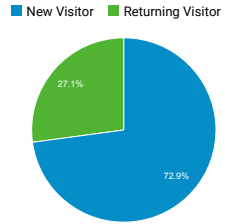
Overview

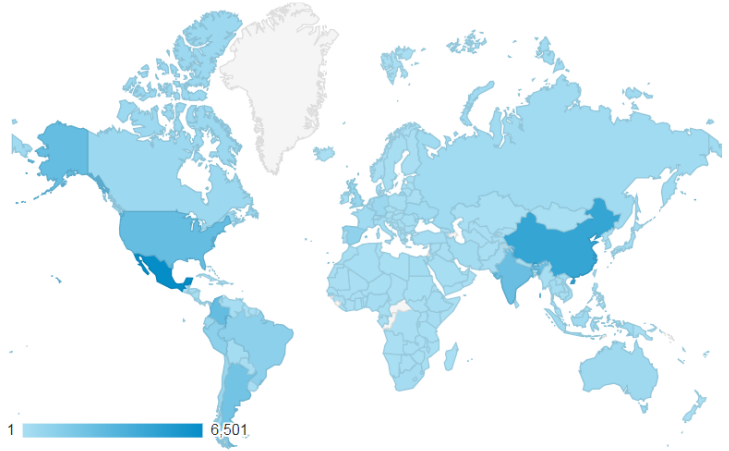


Users	New Users	Sessions
39,114	37,487	82,065

Number of Sessions per User	Pageviews	Pages / Session
2.10	248,484	3.03

Avg. Session Duration	Bounce Rate
00:08:21	33.07%

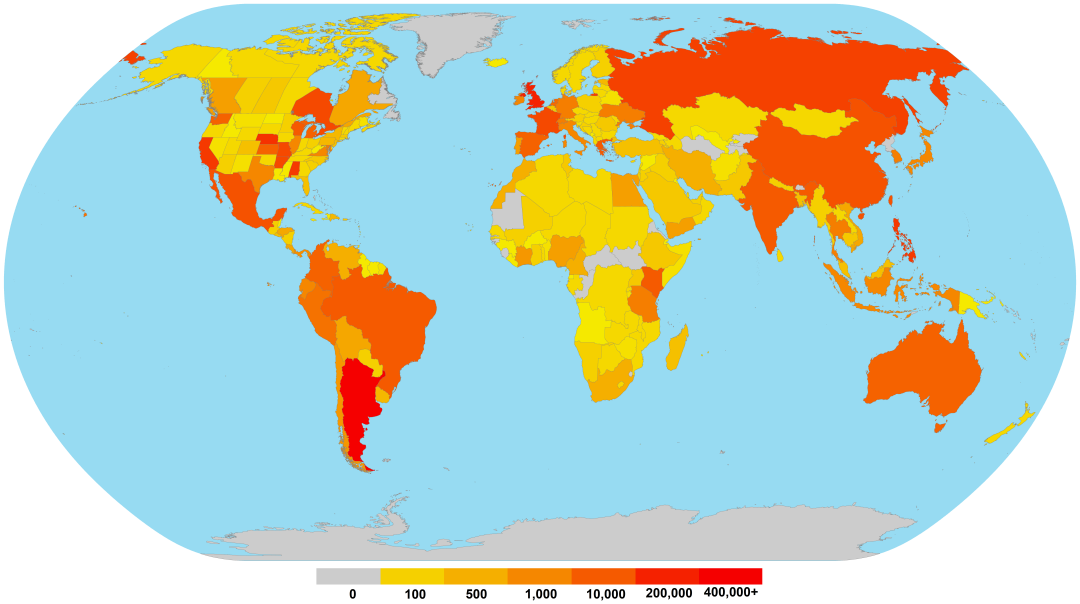




Country		Acquisition			Behavior		
		Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration
		39,114 % of Total: 100.00% (39,114)	37,659 % of Total: 100.46% (37,487)	82,065 % of Total: 100.00% (82,065)	33.07% Avg for View: 33.07% (0.00%)	3.03 Avg for View: 3.03 (0.00%)	00:08:21 Avg for View: 00:08:21 (0.00%)
1.	Mexico	6,501 (16.80%)	6,411 (17.02%)	15,839 (19.30%)	29.52%	3.38	00:08:15
2.	China	4,600 (11.89%)	4,496 (11.94%)	9,407 (11.46%)	35.47%	3.87	00:08:31
3.	Colombia	2,762 (7.14%)	2,728 (7.24%)	6,016 (7.33%)	31.30%	4.00	00:09:00
4.	United States	2,731 (7.06%)	2,595 (6.89%)	5,288 (6.44%)	40.37%	1.81	00:05:54
5.	India	2,579 (6.66%)	2,552 (6.78%)	5,697 (6.94%)	30.21%	3.48	00:07:54

POWER User Metrics Since Release

POWER Data Requests May 16, 2018 to August 31, 2018



POWER Data Request Metrics
(POWER-GIS v1 on-line May 16, 2018)

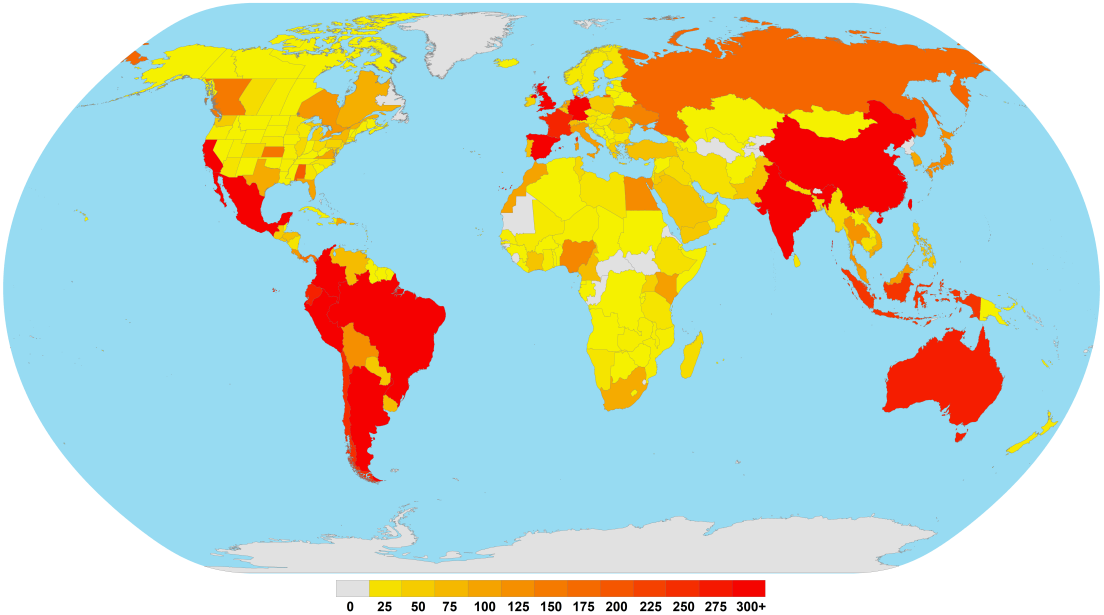
Month	Unique Users	Data Requests	Effective Volume (Gb)
May+	1,074	148,090	87
June	4,787	695,524	412
July	7,688	310,585	234
August	7,985	519,756	673
Total	**19,706***	**1,673,955**	**1,407.09**
% Using FLASHFlux	71.3%	64.6%	14%

+ Includes only May 16 – May 31

** Excludes returning users in multiple months*

POWER Data Usage Metrics Since Release

POWER Unique Users May 16, 2018 to August 31, 2018



POWER Data Monthly Average Metrics
(POWER-GIS v1 on-line May 16, 2018)

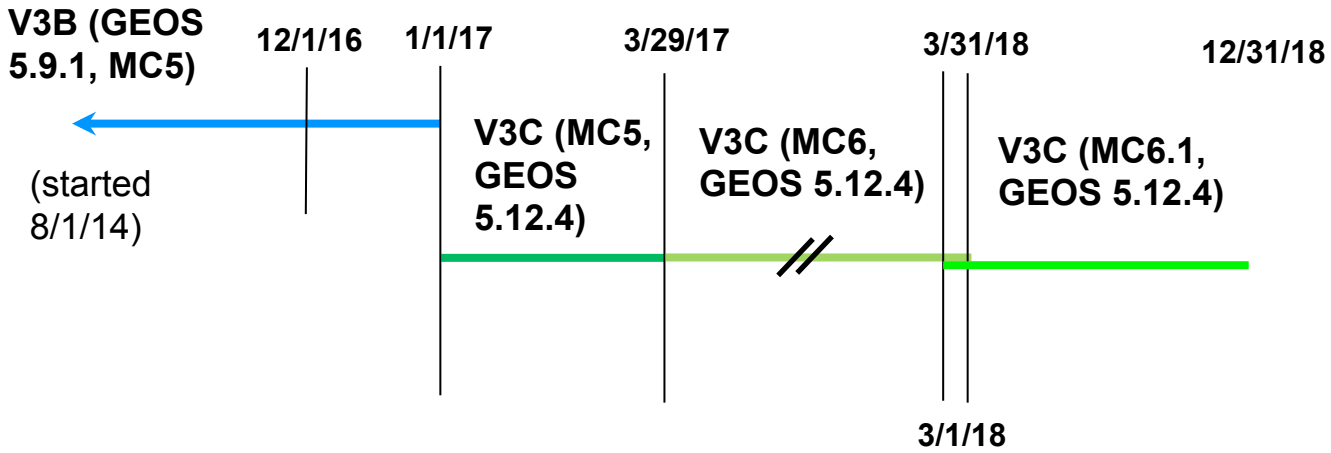
Acquisition Type	Unique Users	Data Requests	Effective Volume (Gb)
API	463	393,510	257
ArcGIS	--[a]	7,642	0.001
DAV	5,556	30,475	121
OPeNDAP	14	13,368	0.9
RETScreen	28[b]	10,705	9.4
Total	**5,977**	**455,700**	**388.22**
FLASHFlux	***4,288***	***299,861***	***55.2***
% FLASHFlux	***71.7%***	***65.8%***	***14%***

[a] *Currently untrackable;*
[b] *Old RETScreen version users not counted*

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 w/ MC 6.1 calibration (current work)	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	Modified SW surface algorithm (current work)	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 1/1/19	None
Validation Results	1/1/17 – 6/30/18	---	---

Moving to FLASHFlux Ed4A



MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

Under development and testing

1/1/19

V4A (CERES Ed 4, MC6.1, GMAO 5.12.4)

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

FLASH SFC-HR

FLASH Grid Hourly 4.2P1

CER3.2P2 SSF

SSF Subsetter

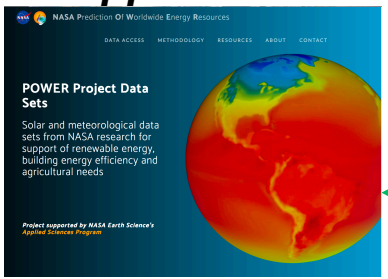
CER3.4P1 S'COOL and Validation

Update for Ed 4 SSF

CER5.1P1 TISA Avg (Daily)

FF Daily (.netCDF)

POWER Applications



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***
  - Made 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 released on May 16, 2018
  - 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 published
  - Future papers: SOFA SSF and 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 October ‘18
  - Longer-term Upgrades (Fall ‘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