CERES FLASHFlux Working Group: Status & Plans

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

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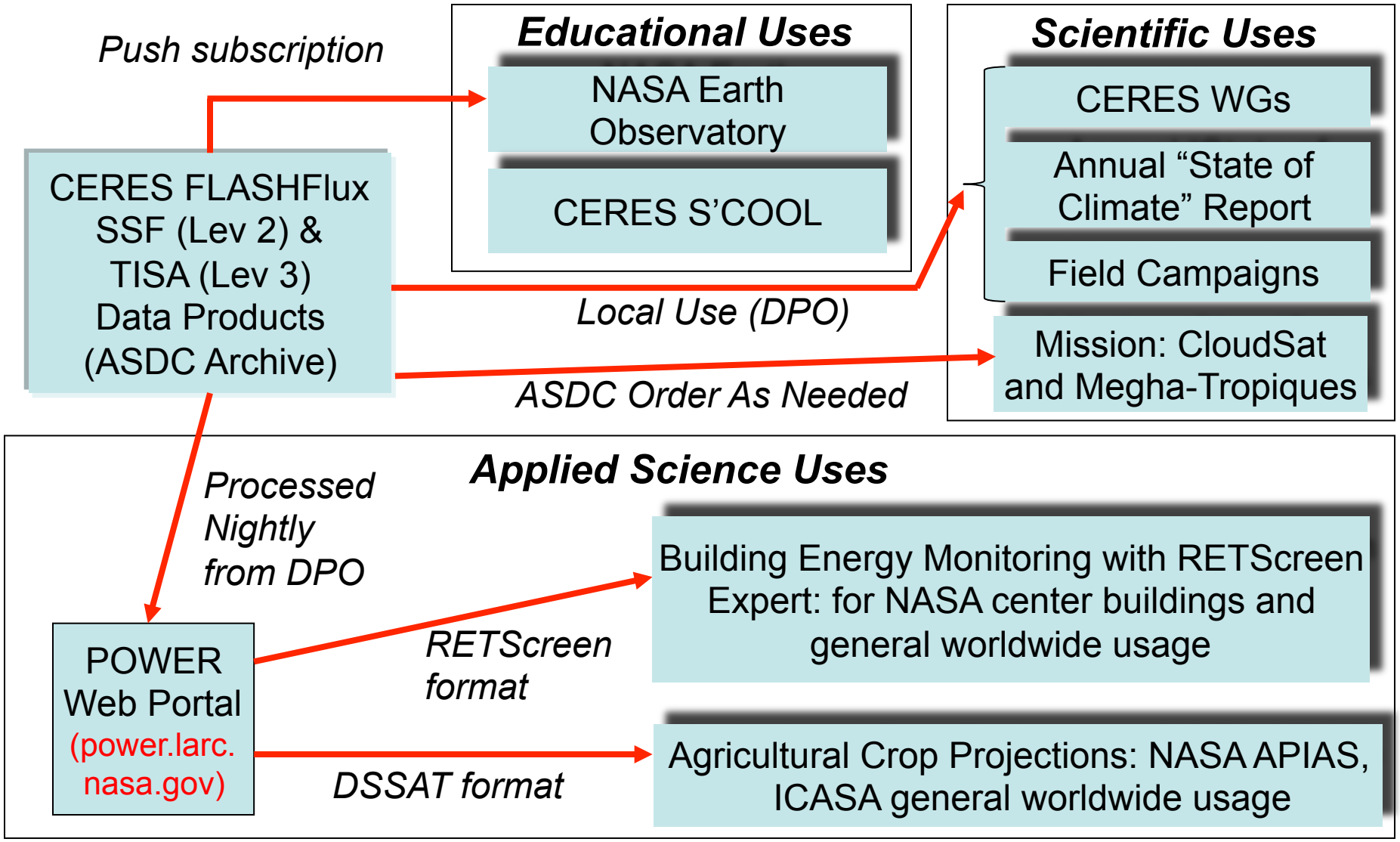
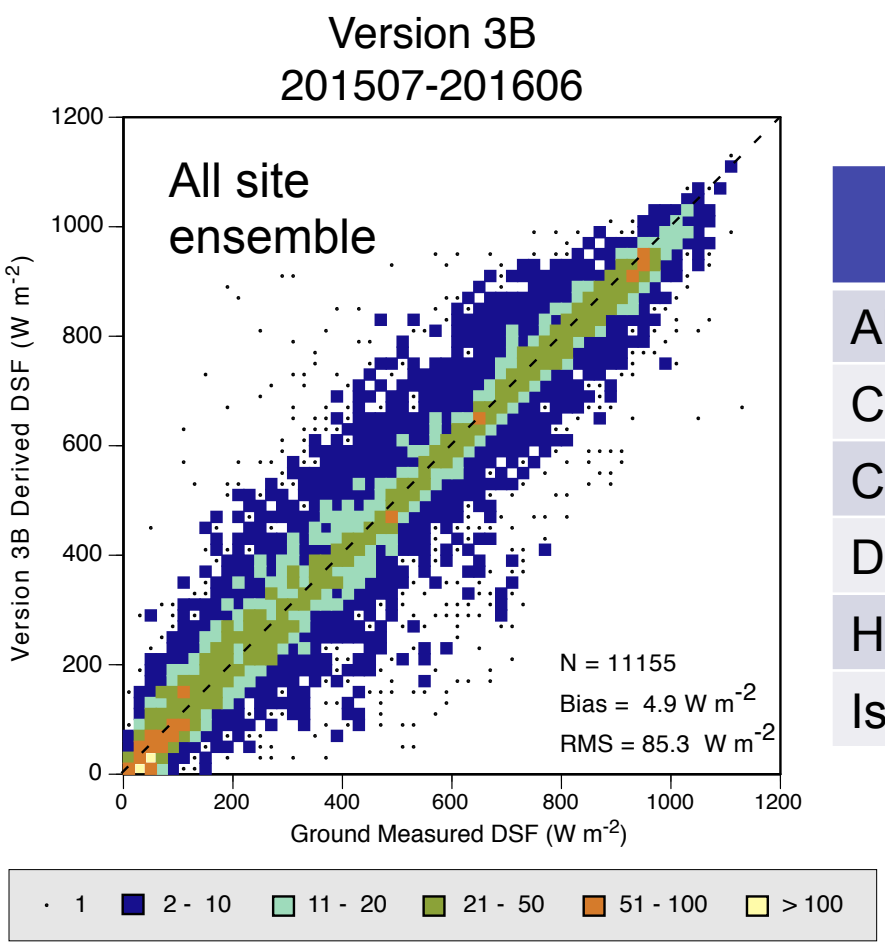
FLASHFLUX: Schematic of Current Uses



FLASHFlux v3B Status

- ***Continuing production with v3B (since August 2014)***
  - FLASHFlux SSF available via CERES subsetter and ASDC 4-5 days latency
  - FLASHFlux TISA available via CERES subsetter, ASDC and specialized formats through POWER web portal (power.larc.nasa.gov) 5-6 days latency
- ***Version 3B Validation***
  - Processed and compared to latest validation from BSRN, ARM & buoy
- ***Flux Anomalies from the 2015-2016 (El Nino+)***
  - "State of Climate 2015" published
  - Anomaly time series for global and Pacific regions => tomorrow's talk
- ***Applied Science Usage: Expansion to GIS***
  - Agricultural and Energy usage showed continued growth since May (550+ users, 73,000+ orders per, 10+ GB per month) => New web site coming
  - Expanded efforts to serve CERES using GIS tools for FLASHFlux and SYN1Deg; New web services being developed
  - Data sets now available via OPeNDAP

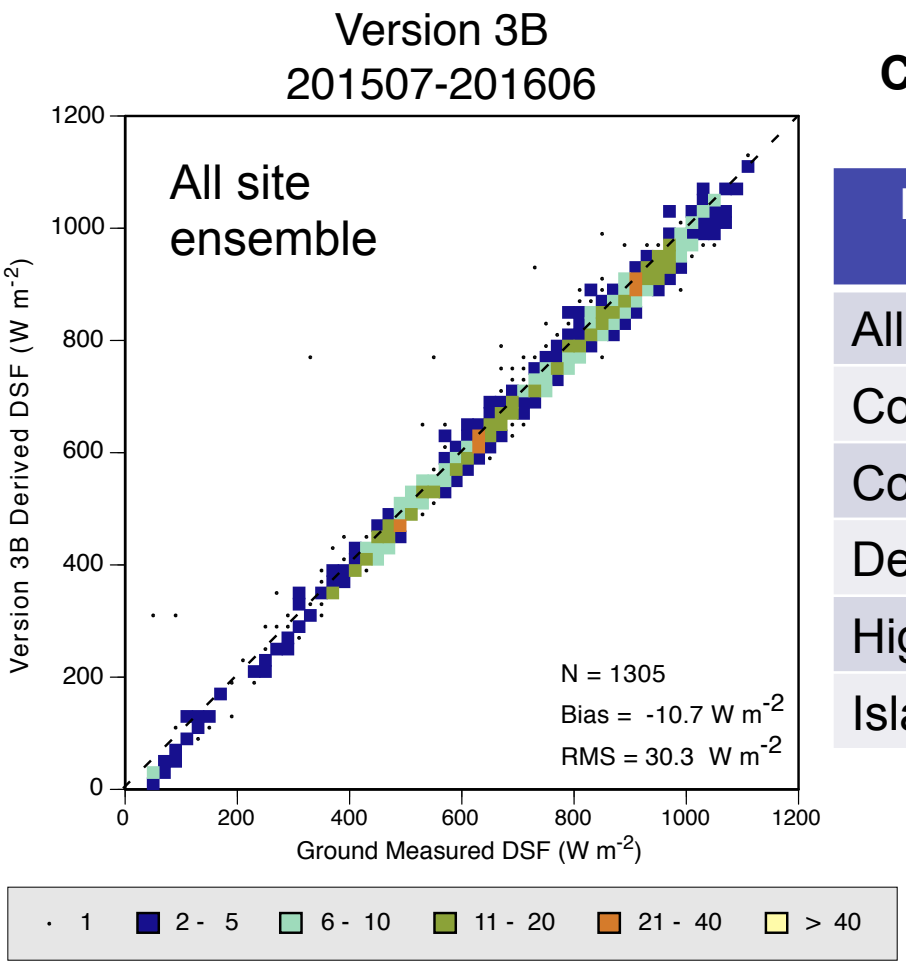
SSF SW Validation: 7/2015 – 6/2016



Aqua & Terra SSF Comparison
All-Sky (BSRN only; hour averages)

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N	r^2
All Obs	4.9	85.3	11155	0.92
Continental	14.4	79.7	3379	0.92
Coastal	12.6	87.5	3892	0.90
Desert	-1.2	65.5	960	0.91
High Latitude	-29.7	93.5	2118	0.77
Island	26.0	94.8	806	0.82

SSF SW Validation: 7/2015 – 6/2016

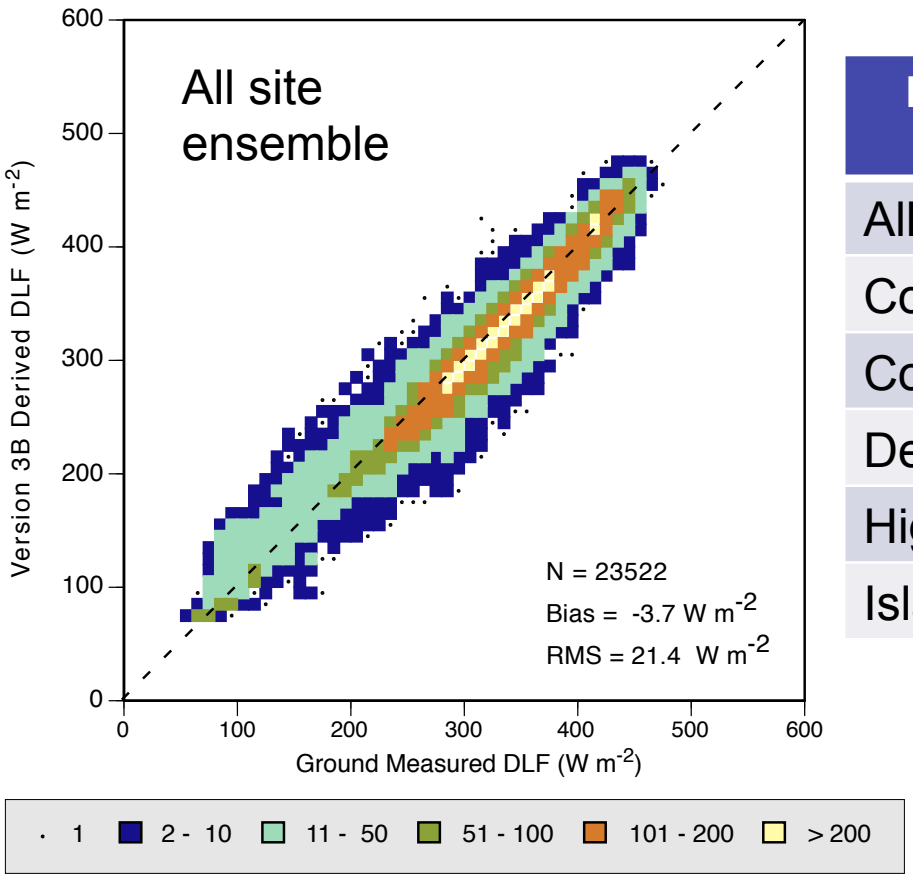


Aqua & Terra SSF Comparison
Clear-Sky (BSRN only; minute averages)

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N	r^2
All Obs	-10.7	30.3	1305	0.99
Continental	-8.4	35.5	523	0.97
Coastal	-16.4	26.6	168	0.99
Desert	-8.1	24.9	406	0.98
High Latitude	-19.9	22.4	173	1.00
Island	-1.5	48.2	35	0.88

SSF LW Validation: 7/2015 – 6/2016

Version 3B
201507-201606

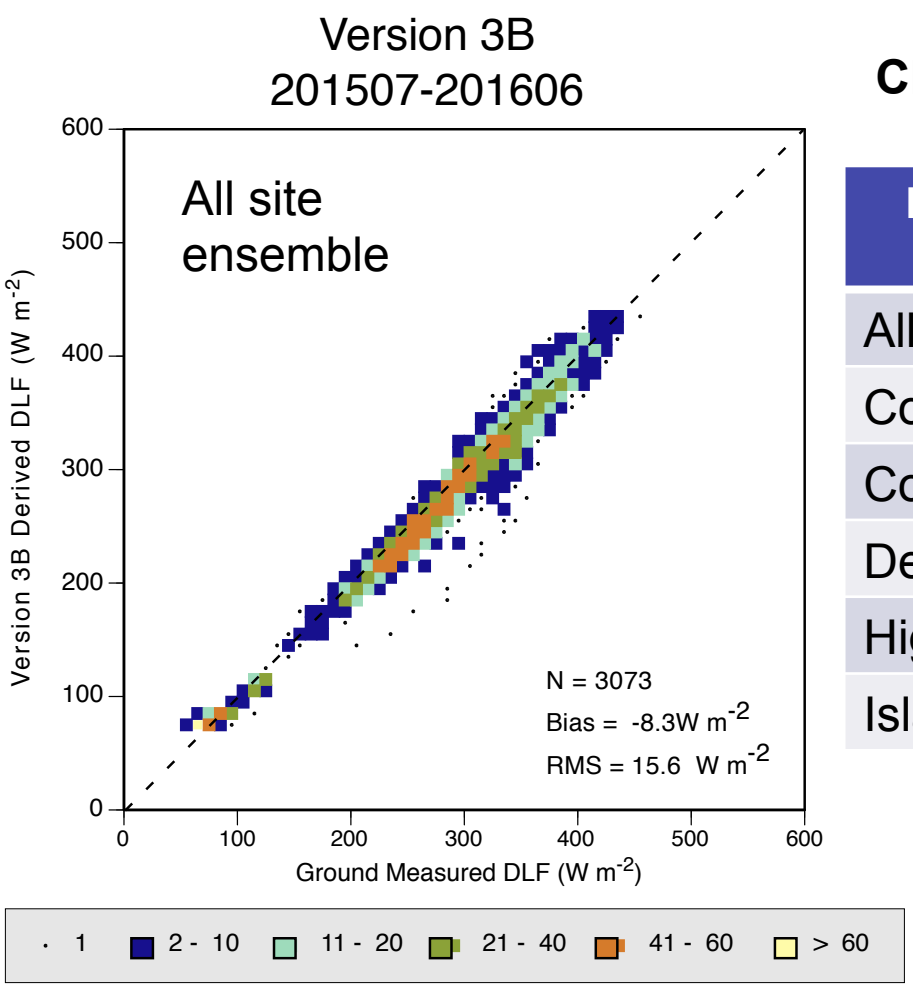


Aqua & Terra SSF Comparison
All-Sky (BSRN only; minute averages)

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N	r^2
All Obs	-3.7	21.4	23522	0.94
Continental	-7.0	19.6	6817	0.91
Coastal	-3.8	19.3	7735	0.89
Desert	-5.3	22.3	1869	0.85
High Latitude	0.8	27.1	5480	0.74
Island	-2.9	14.4	1621	0.87

FLASHFlux uses the GMAO FPIT NRT operational analysis

SSF LW Validation: 7/2015 – 6/2016



Aqua & Terra SSF Comparison
Clear-Sky (BSRN only; minute averages)

Ensemble Type	Bias (W m^{-2})	RMS (W m^{-2})	N	r^2
All Obs	-8.3	15.6	3073	0.98
Continental	-8.6	15.1	1413	0.96
Coastal	-7.3	13.6	503	0.96
Desert	-13.2	20.7	678	0.90
High Latitude	-1.1	9.2	412	0.97
Island	-5.7	14.4	67	0.87

FLASHFlux uses the GMAO FPIT NRT operational analysis

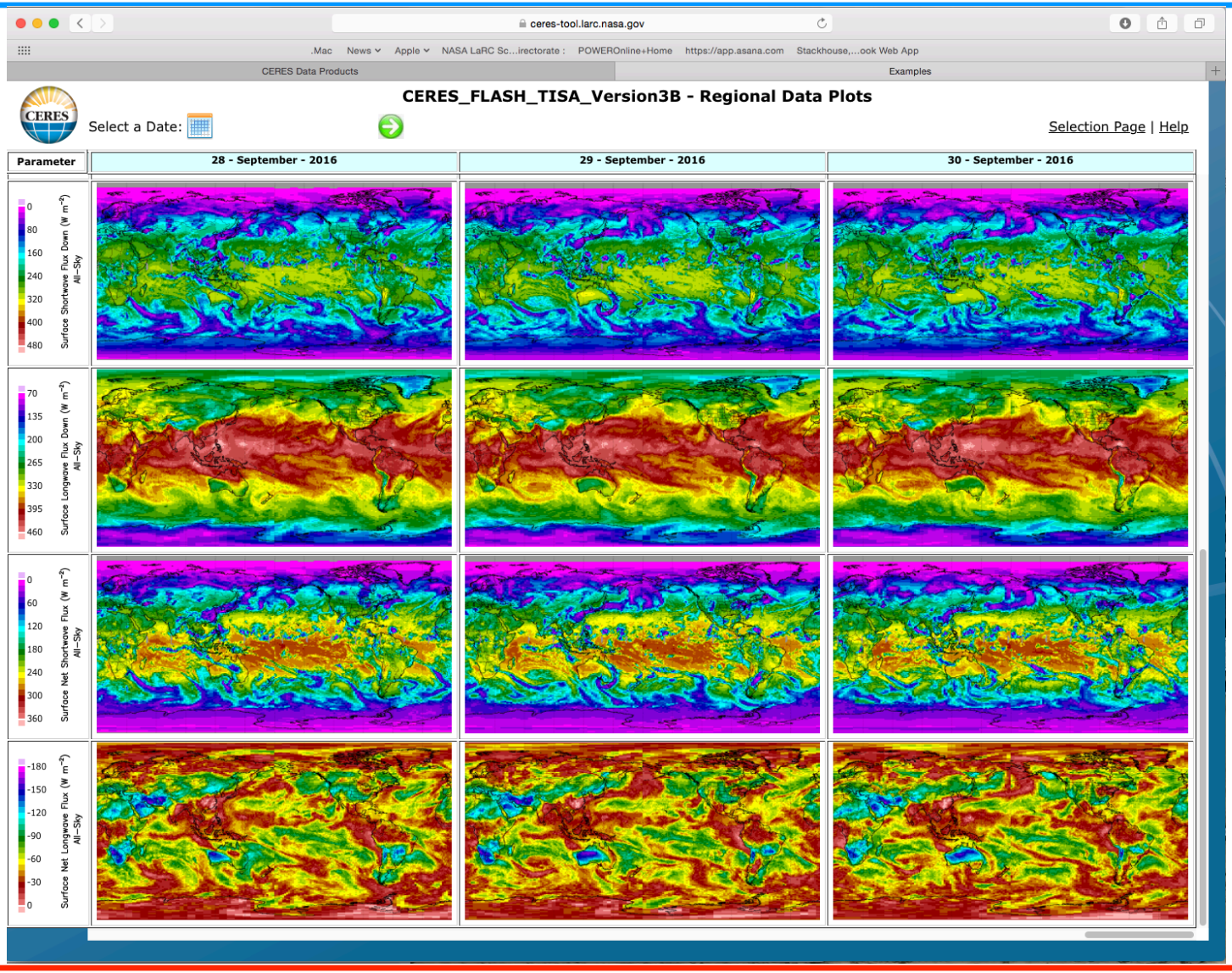
FLASHFlux TISA Available Via Subsetter

SW Down

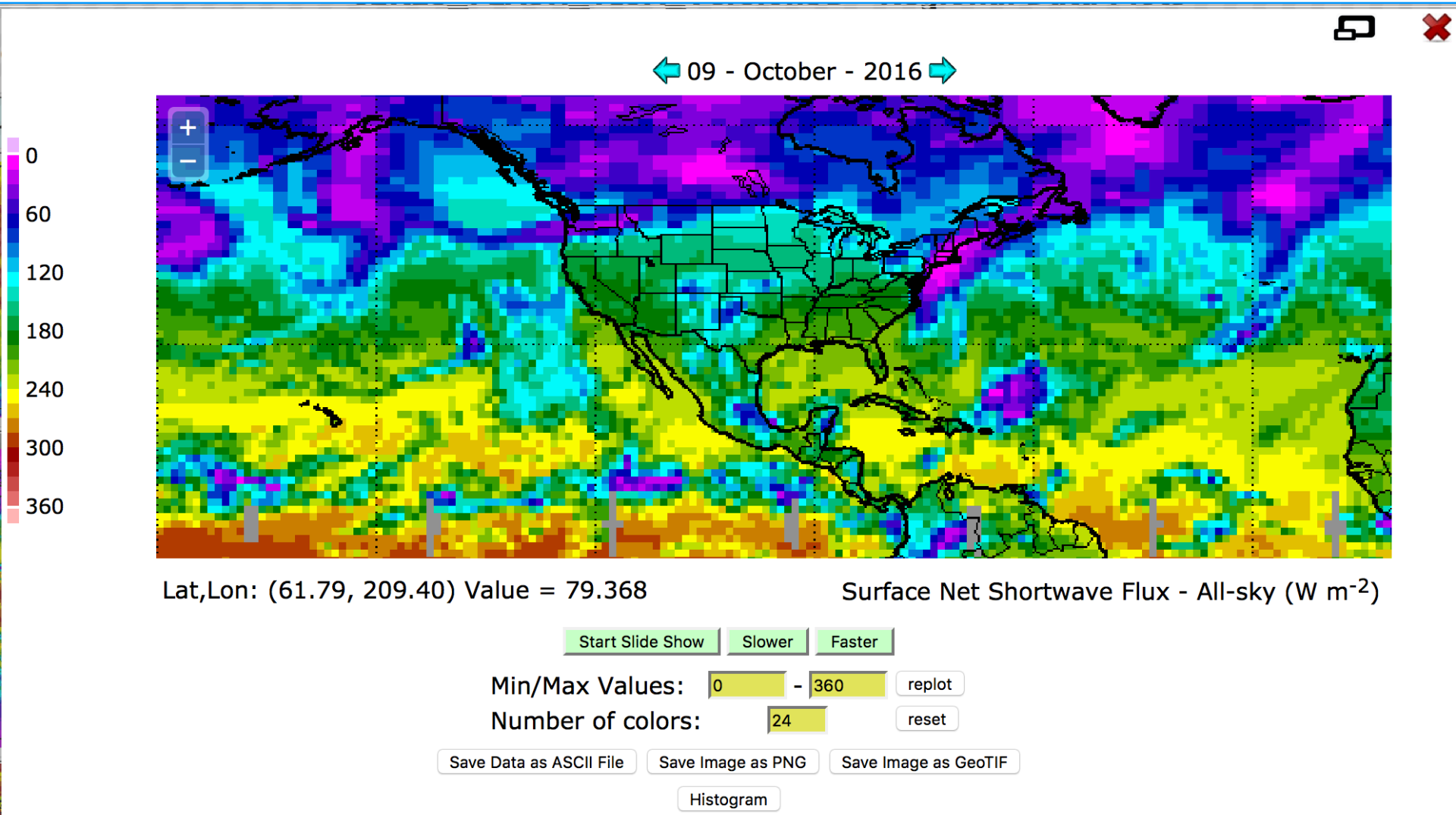
LW Down

Net SW

Net LW

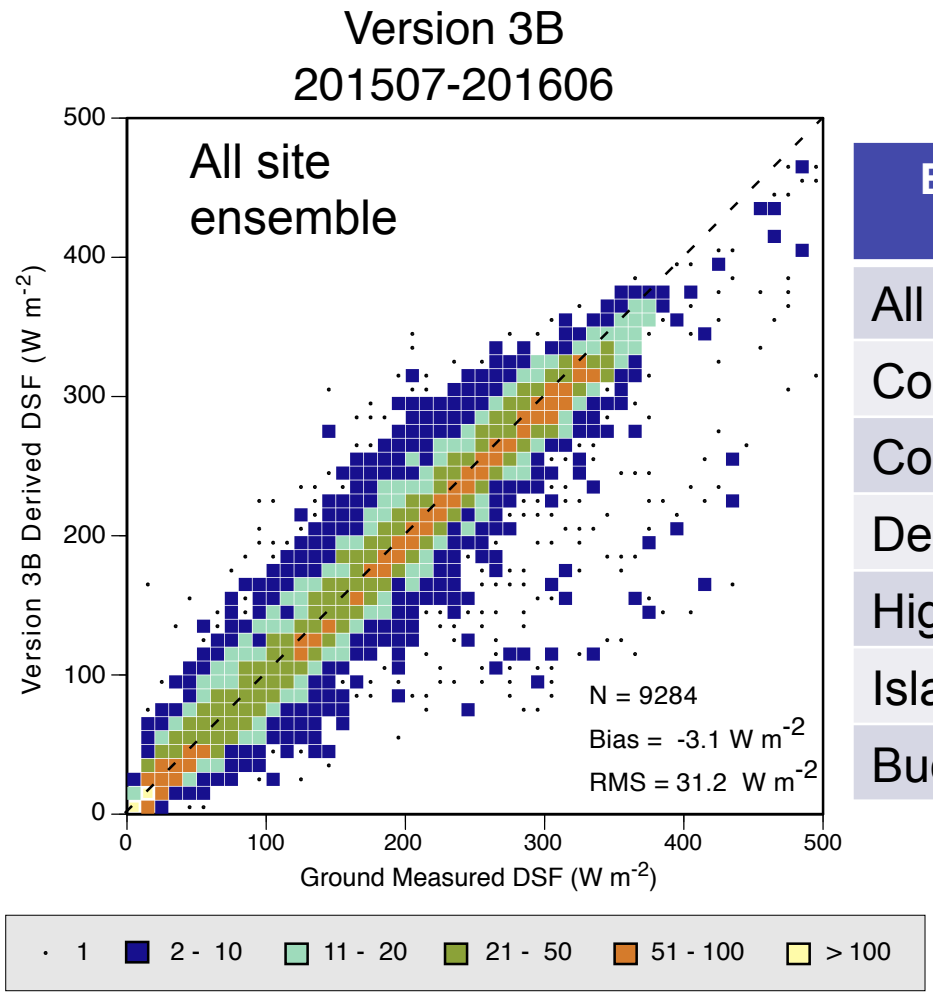


FLASHFlux TISA Via Subsetter



Time series of fluxes following Hurricane Matthew

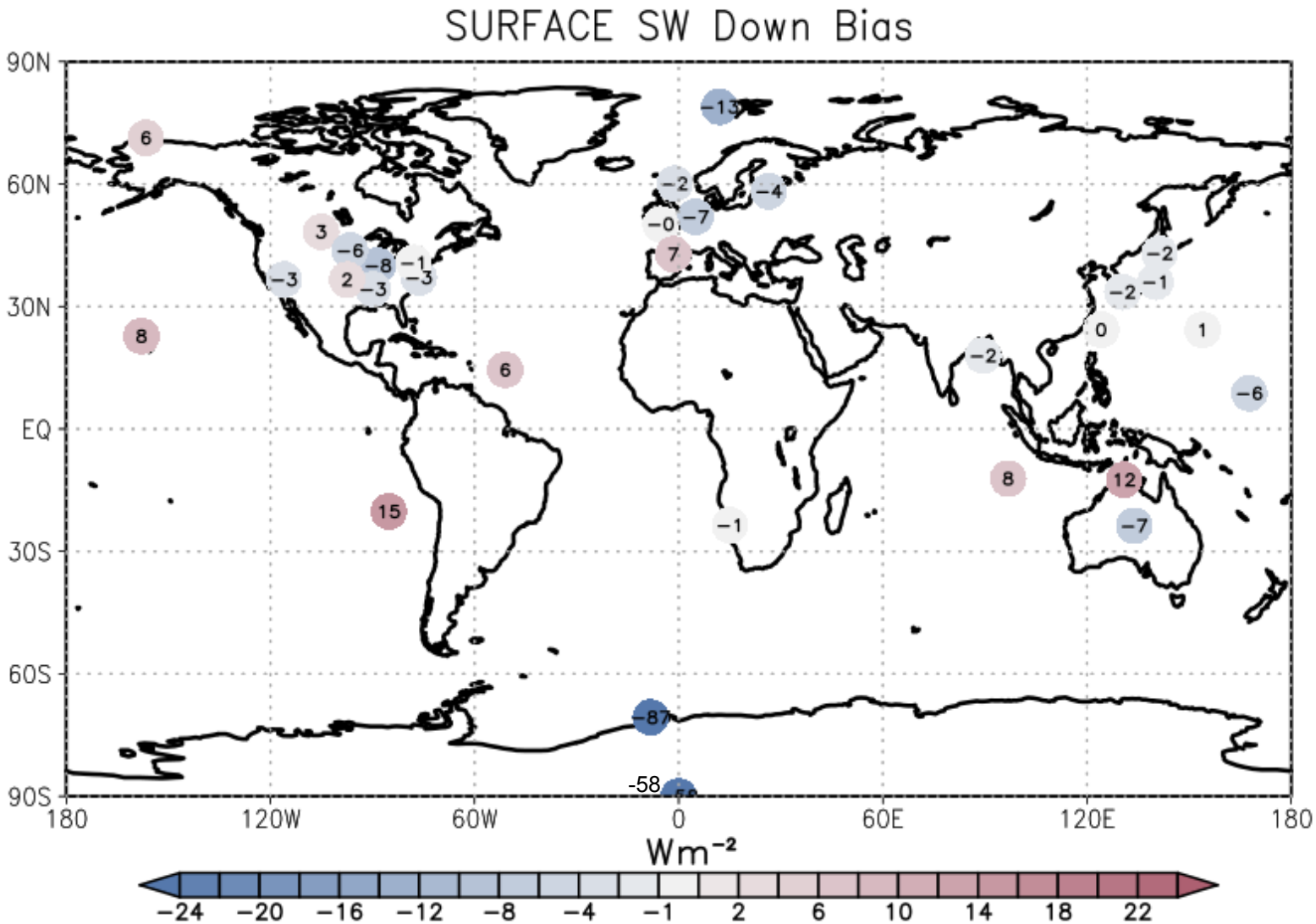
TISA SW Validation: 7/2015– 6/2016



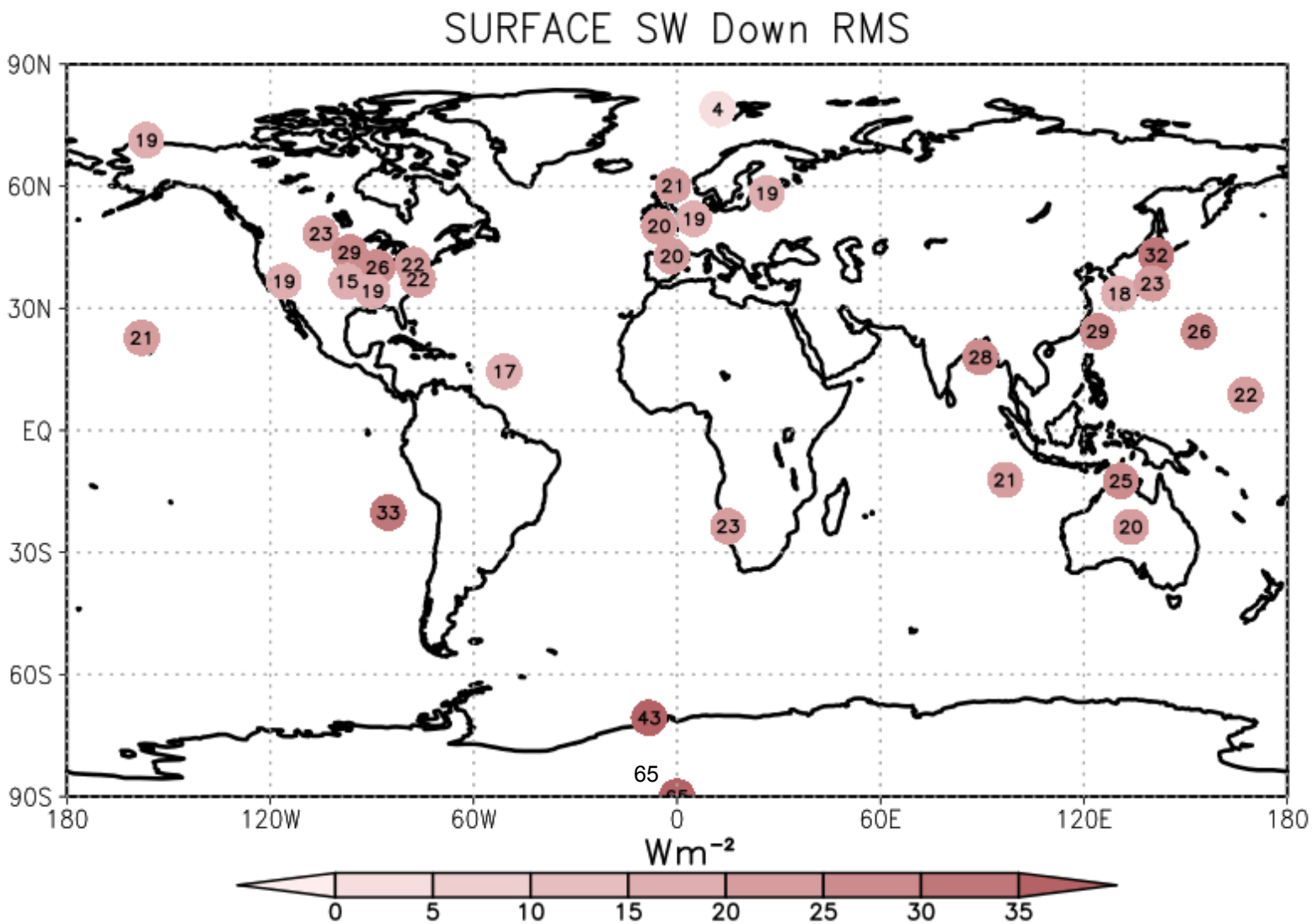
Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N	r^2
All Obs	-3.1	31.2	9284	0.91
Continental	-1.6	24.0	2625	0.94
Coastal	-1.8	24.9	3355	0.93
Desert	-2.9	22.6	902	0.93
High Latitude	-49.3	85.5	481	0.78
Island	-0.5	25.0	835	0.86
Buoy	8.0	29.2	1086	0.83

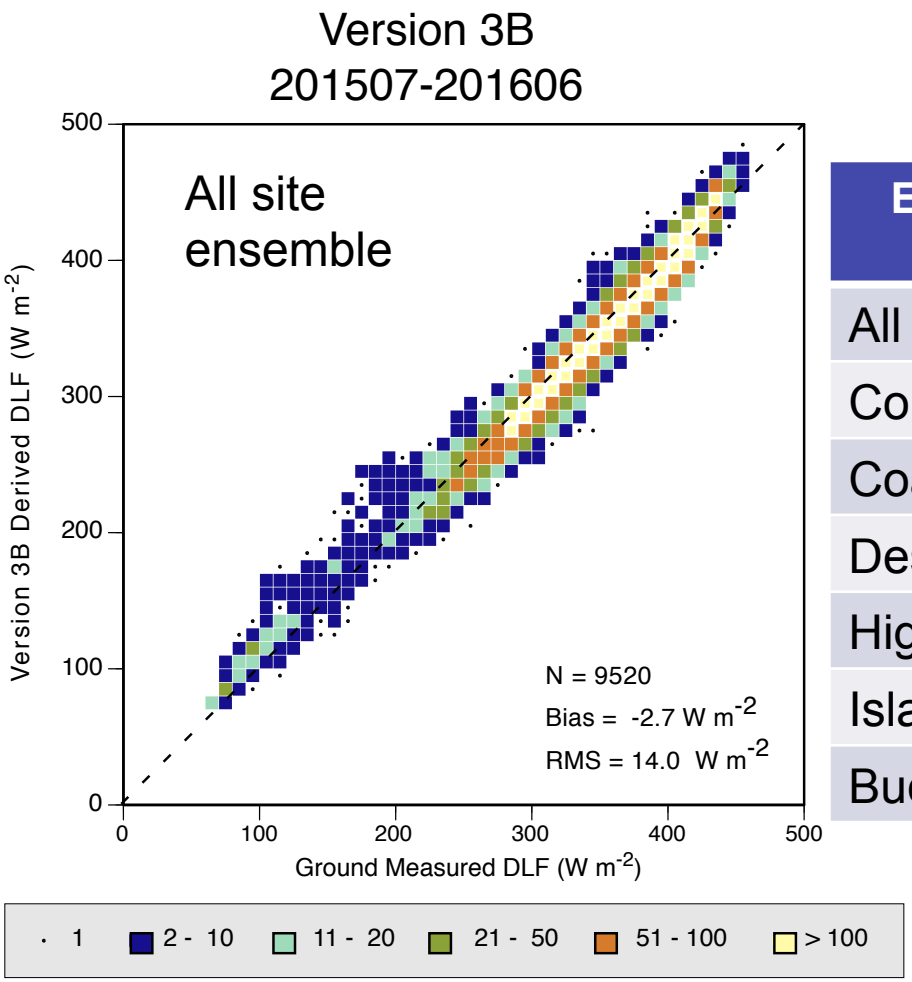
TISA SW Validation: 7/2015 –6/2016



TISA SW Validation: 7/2015 –6/2016



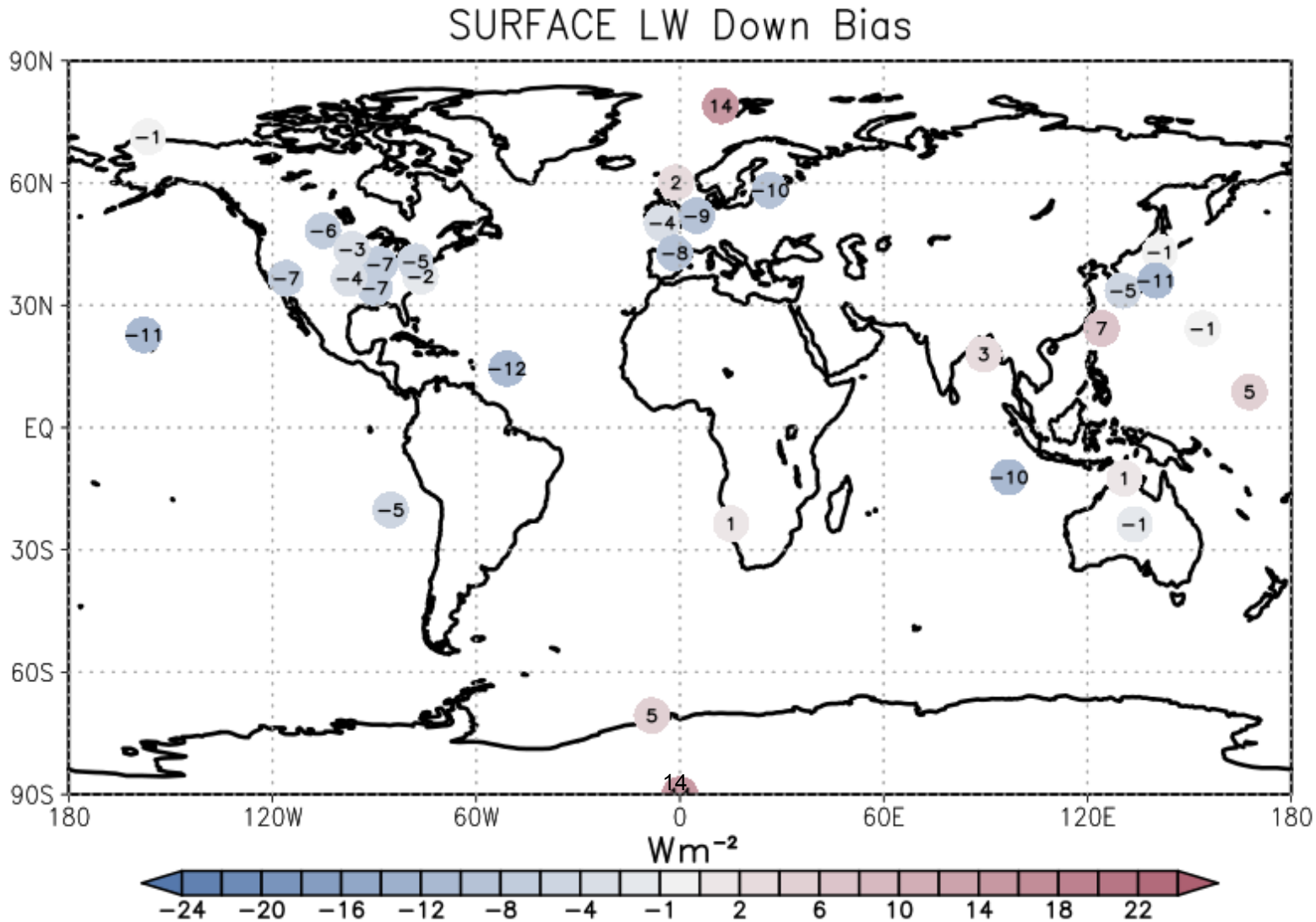
Recent LW Validation: 7/2015 –6/2016



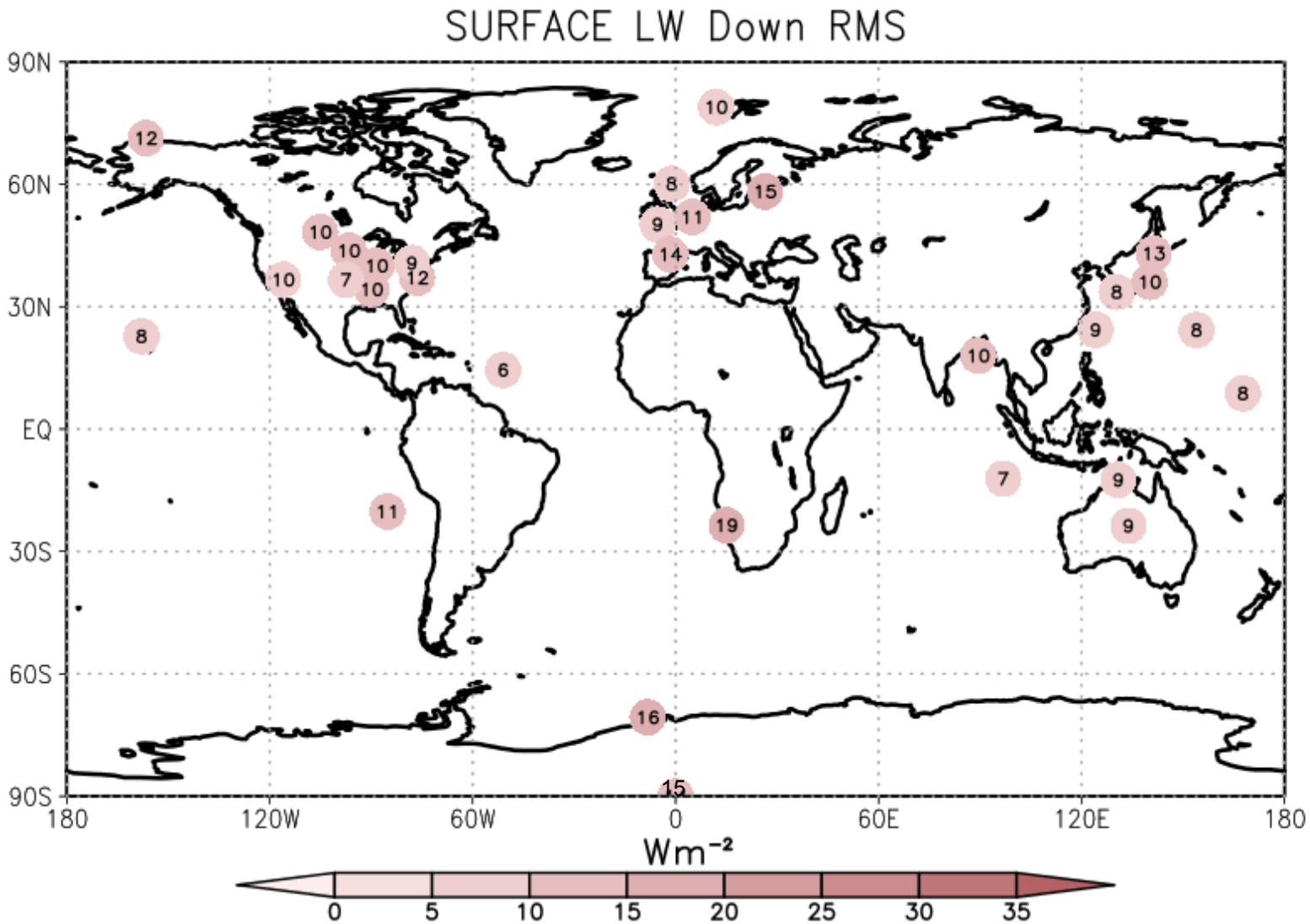
Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N	r^2
All Obs	-2.7	14.0	9520	0.97
Continental	-6.2	13.3	2562	0.96
Coastal	-2.2	12.2	3289	0.95
Desert	-2.7	16.5	886	0.91
High Latitude	8.9	20.8	825	0.94
Island	-0.2	10.9	819	0.87
Buoy	-6.5	13.7	1078	0.85

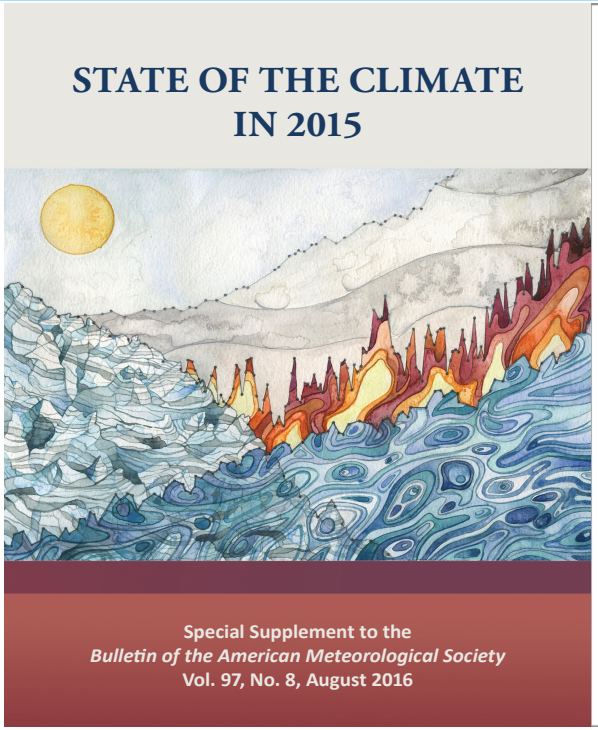
Recent LW Validation: 7/2015 –6/2016

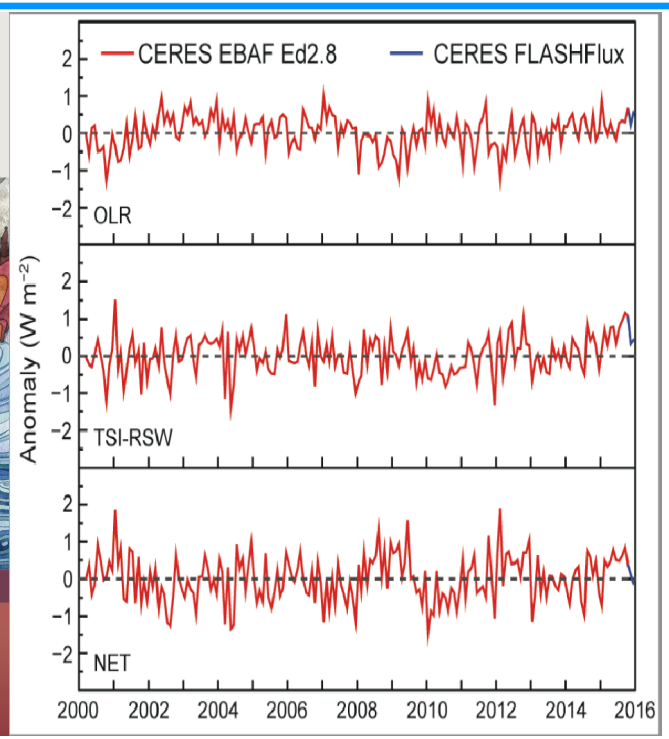


Recent LW Validation: 7/2015 –6/2016



State of Climate 2015 Results





Global monthly mean deseasonalized anomalies produced by merging datasets from CERES EBAF TOA Ed2.8 and CERES FLASHFlux product. The FLASHFlux data have been normalized to the EBAF data using TOA fluxes from both datasets for the six-year period from January 2009 through December 2014.

	Global-annual Mean Difference (2015 minus 2013) ($W\ m^{-2}$)	Global-annual Mean Difference (2015 minus 2014) ($W\ m^{-2}$)	2015 Anomaly (relative to climatology) ($W\ m^{-2}$)	Interannual variability (2001 to 2014) ($W\ m^{-2}$)
OLR	+0.30	+0.15	+0.30	±0.50
TSI	+0.05	+0.05	+0.10	±0.20
RSW	−0.75	−0.45	−0.55	±0.40
Net	+0.50	+0.40	+0.35	±0.65

The 2015 Reflected Shortwave anomaly is 0.15 Wm^{-2} larger than 2-sigma Interannual variability (2001 to 2014).

Stackhouse et al., 2016: Earth Radiation Budget [in "State of the Climate in 2015"]. *BAMS*, 97 (8), S37-S38.

State of Climate 2015 Results

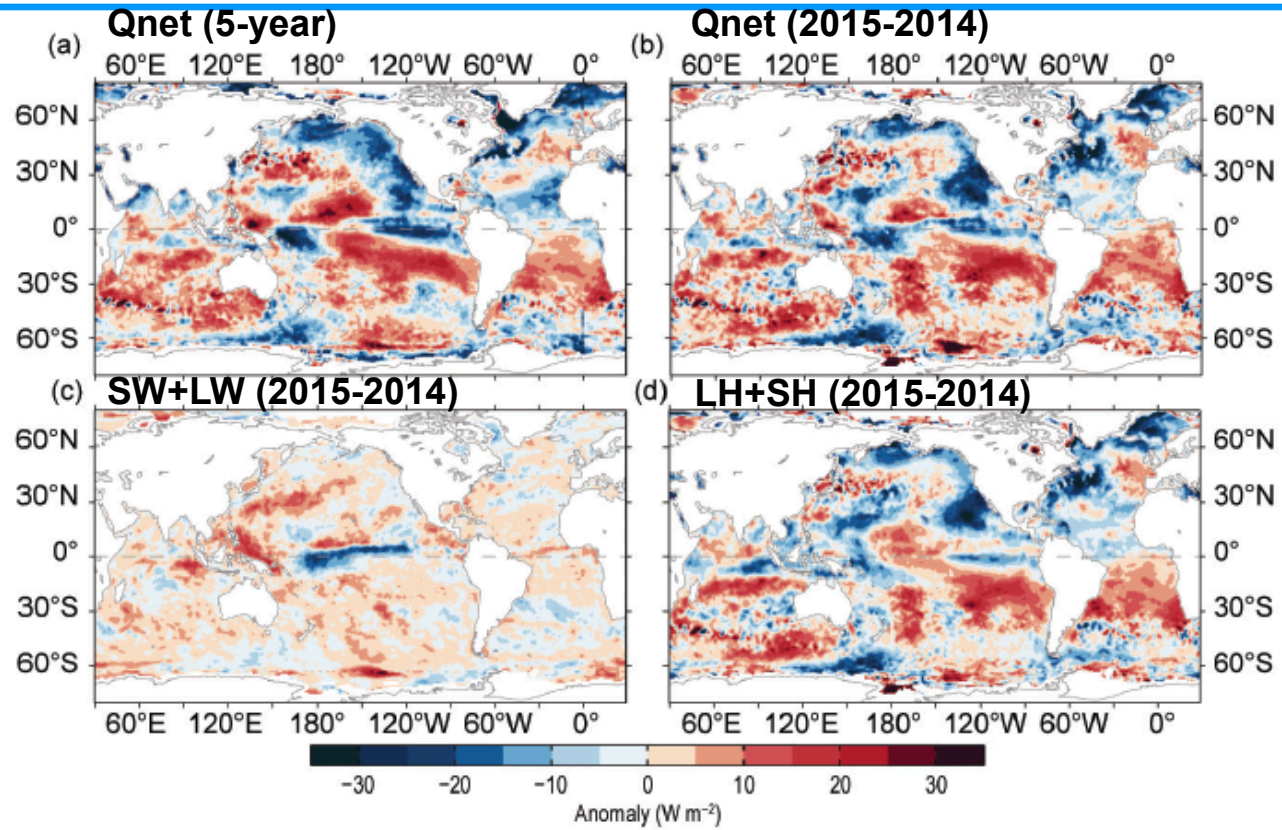
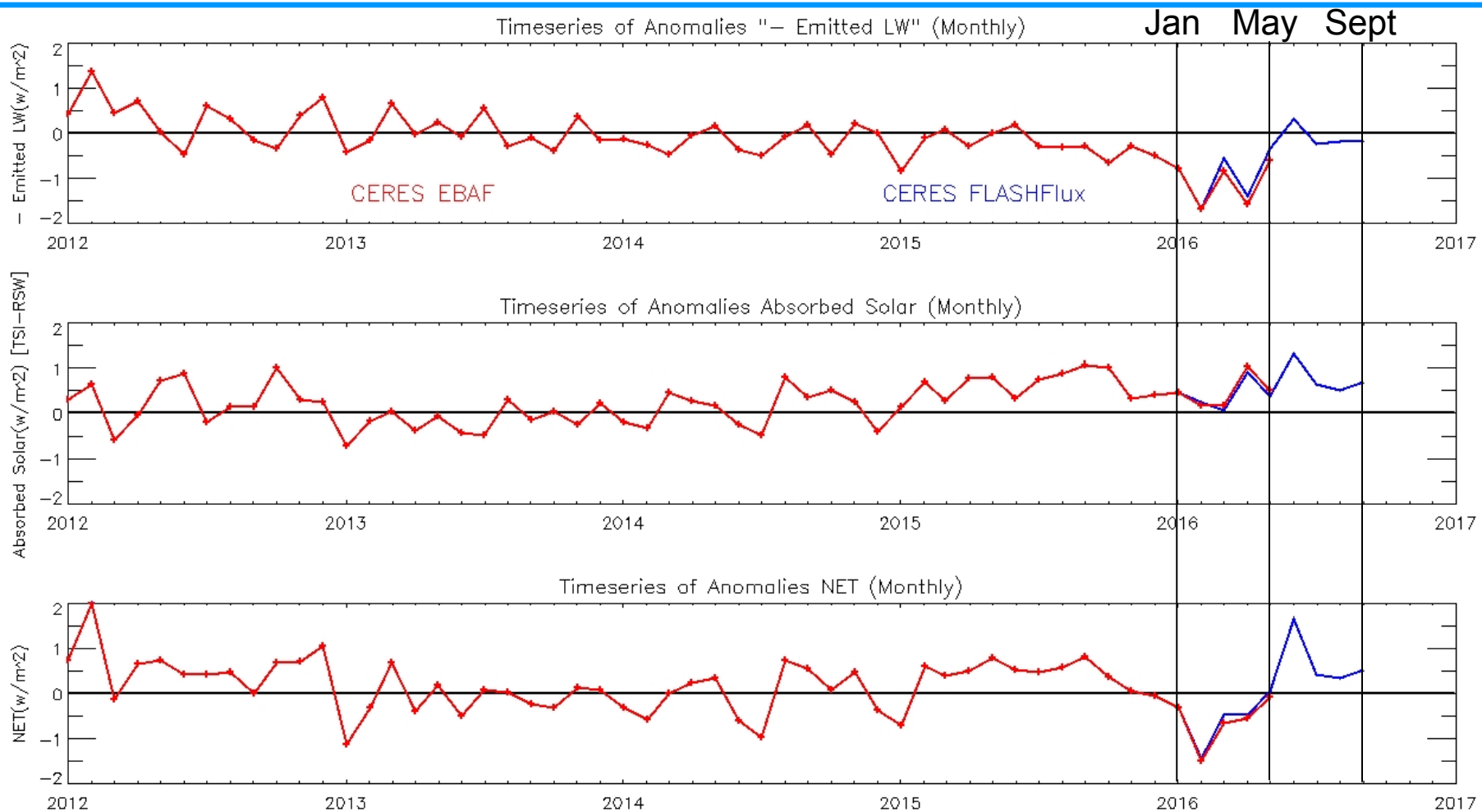


Fig. 3.11. (a) Surface heat flux (Q_{net}) anomalies for 2015 relative to a 5-year (2010–14) mean. Positive values denote ocean heat gain. Panels (b), (c), and (d) are the 2015–2014 anomaly tendencies for Q_{net}, surface radiation (SW+LW), and turbulent heat fluxes (LH+SH), respectively. Positive anomalies denote that the ocean gained more heat in 2015 than in 2014. LH+SH are produced by the OAFlux high-resolution satellite-based analysis, and SW+LW by the NASA FLASHFlux project.

Yu et al., 2016: Earth Radiation Budget [in "State of the Climate in 2015"]. *BAMS*, 97 (8), S74-S80.

WHOI OAflux Latent & Sensible Heat fluxes + CERES FLASHFlux year-to-year difference for radiative fluxes

Extending Deseasonalized Anomalies



Globally averaged EBAF and normalized FLASHFlux deseasonalized monthly anomalies relative to EBAF climatology extended to September 2016.

Enhancing Data Discovery Points

DATA ACCESS VIEWER

Download, Interact, analyze and visualize data in a responsive web mapping application on desktop and mobile platforms.

WEB DATA SERVICES

Consume data into your applications and code using ArcGIS Image Services, Web Mapping Services, REST API, OPeNDAP.

WEB PROCESSING SERVICES

Utilize our ArcGIS GeoProcessing Services and/or OGC Web Processing Services for direct access and analysis of data.

DOWNLOADABLE TOOLS & CODE

Download the POWER ArcGIS Toolbox and ArcGIS Raster Function Templates for analytical and data accessibility capabilities.

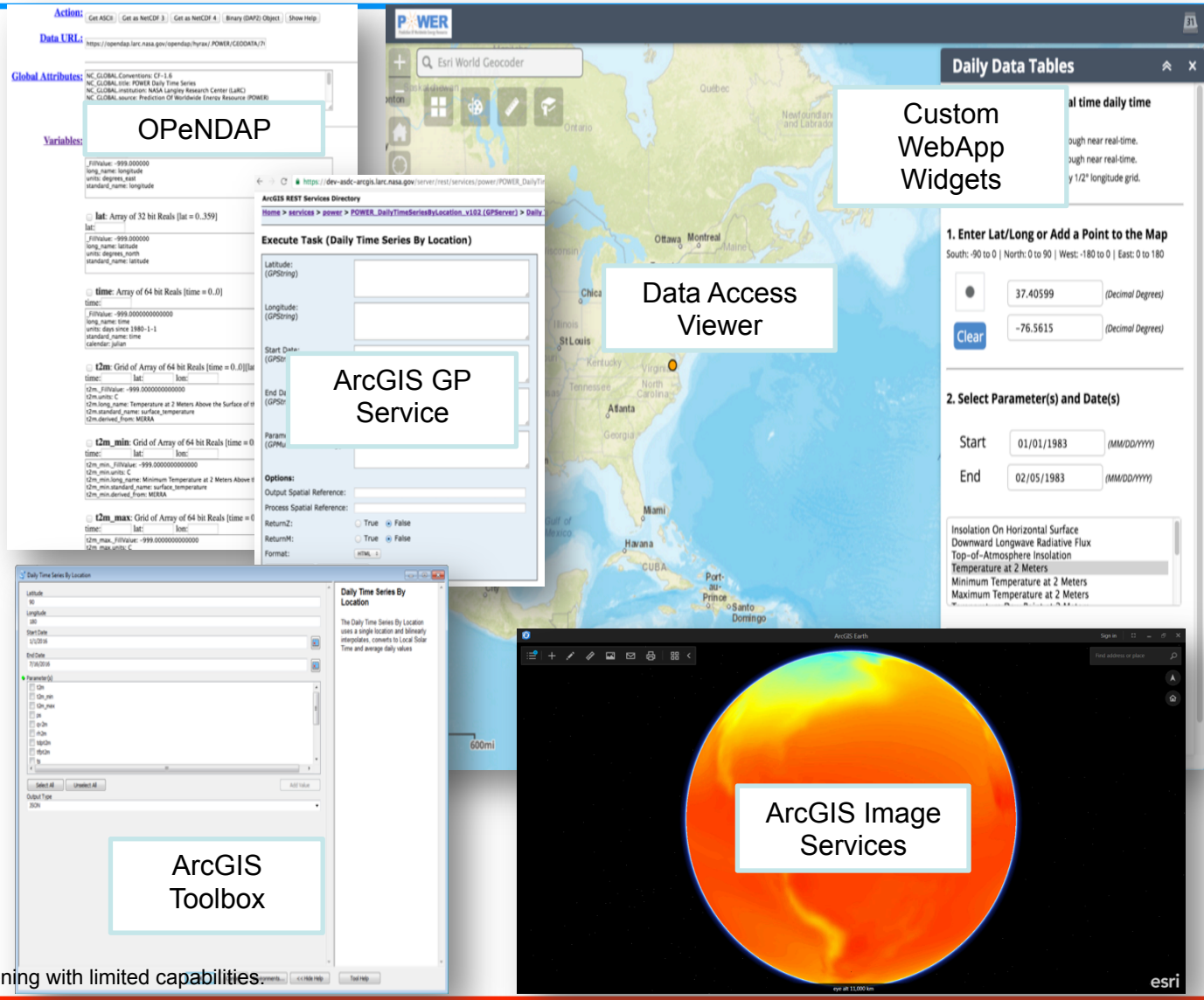
POWER Website serves as a platform for discovery of multiple data access points

Website is a Responsive Platform for Desktop, Tablet, and Smartphone

Enhancing Data Access Points

POWER
Prediction Of Worldwide Energy Resource

- ***Data Access Viewer****
- ***Web Data Services***
  - ArcGIS Image Services
  - OGC Web Map Services
  - OPeNDAP*
- ***Web Processing Services***
  - ArcGIS GP Services*
  - OGC Web Processing Services
- ***Downloadable Tools/ Code***
  - ArcGIS Toolbox*
  - ArcGIS Raster Function Templates
  - ArcGIS Custom WebApp Builder Widgets



*Items to be initially released in POWER soft opening with limited capabilities.

Enabling Data Usage Applications

Visualization & Analysis

- Panoply
  - NetCDF, OPeNDAP
- Esri ArcGIS Suite
  - NetCDF, OPeNDAP, ArcGIS Image Services, ArcGIS GP Services, ArcGIS Toolbox, GeoTIFF, Shapefile
- MatLab
  - Netcdf, OPeNDAP, GeoTiff
- QGIS
  - OGC Web Map Service, OGC Web Process Service, GeoTIFF
- DSSAT
  - ICASA
- HDFView
  - NetCDF
- Microsoft Office
  - CSV, ASCII
- R Statistics
  - NetCDF, CSV
- ERDAS Imagine
  - NetCDf, GeoTiff

POWER
Prediction Of Worldwide Energy Resource

Programming

- Python
  - Esri ArcGIS for Python API, ArcGIS Image Service REST Endpoint, ArcGIS Toolbox Functions, OPeNDAP, ArcGIS GP Services, JSON, CSV, Shapefile, GeoTIFF, NetCDF
- JavaScript
  - Esri ArcGIS For JavaScript API, ArcGIS Image Services, ArcGIS GP Services, JSON, CSV
- Microsoft .NET
  - ArcGIS Runtime SDK for .NET, ArcGIS Image Services, ArcGIS GP Services, JSON, CSV

Progress Toward CERES GIS Support

Folder: ceres

https://dev-asdc-arcgis.larc.nasa.gov/server/rest/services/ceres

ArcGIS REST Services Directory

Home > **services** > **ceres**

JSON | SOAP

Published CERES SYN1DEG Image Services In Development Environment

Folder: ceres

Current Version: 10.4

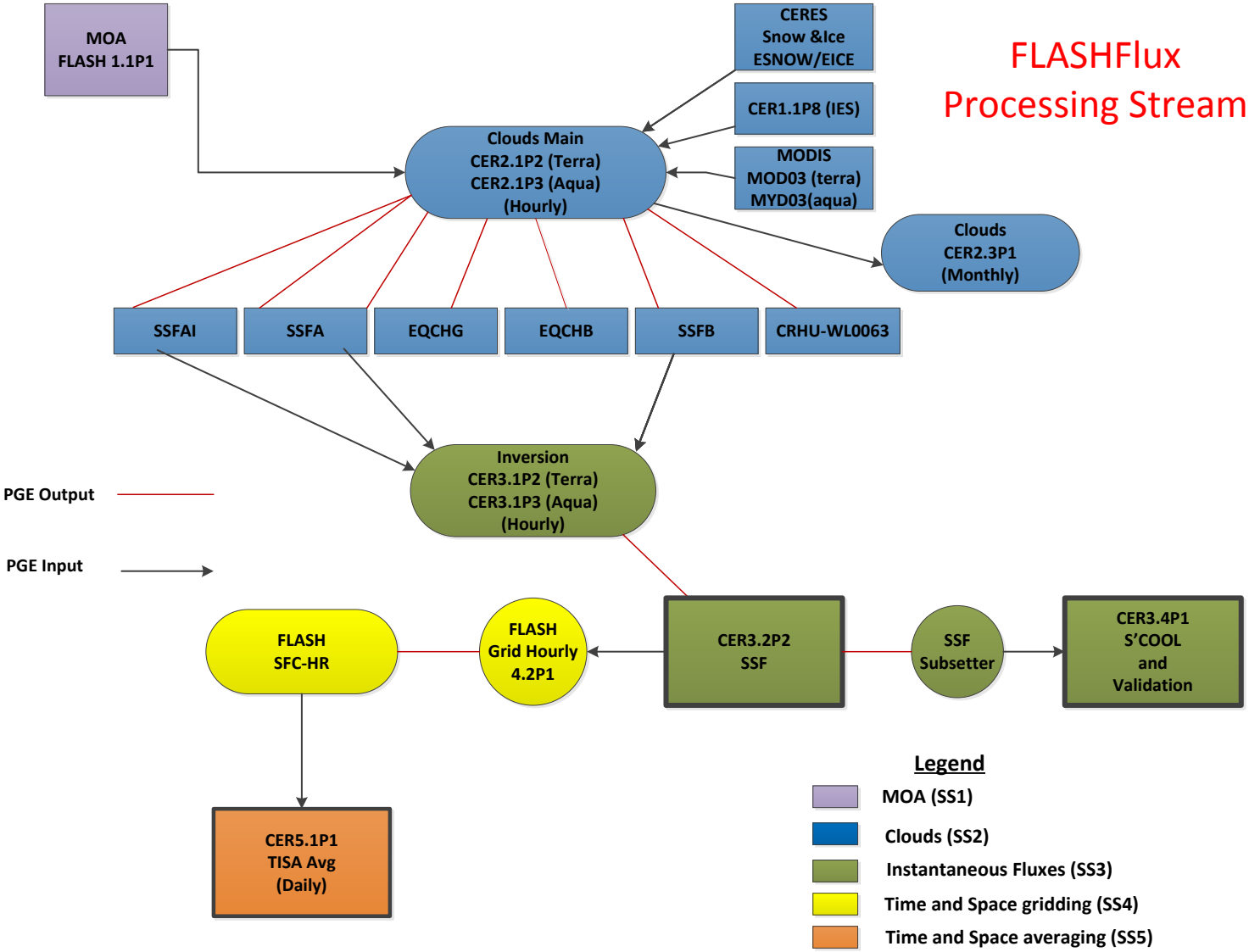
View Footprints In: ArcGIS Online map viewer

Services:

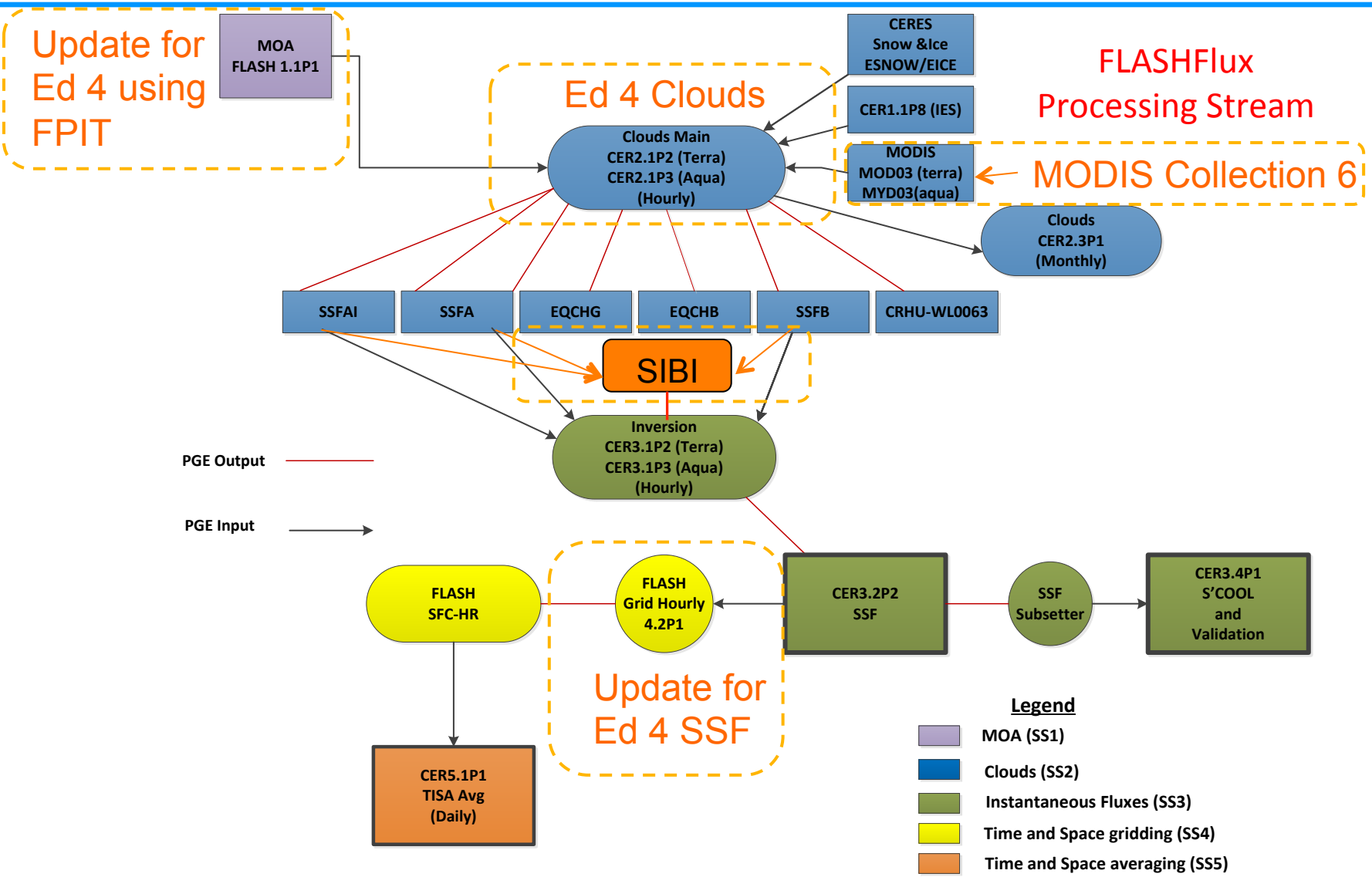
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_lw_down_all_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_sw_down_all_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_sfc_comp_sw_down_clr_daily (ImageServer)
- ceres/arcgis_arcgis_CERES_SYN1degDayEd3A_toa_comp_sw_down_all_daily (ImageServer)

Supported Interfaces: REST SOAP Sitemap Geo Sitemap

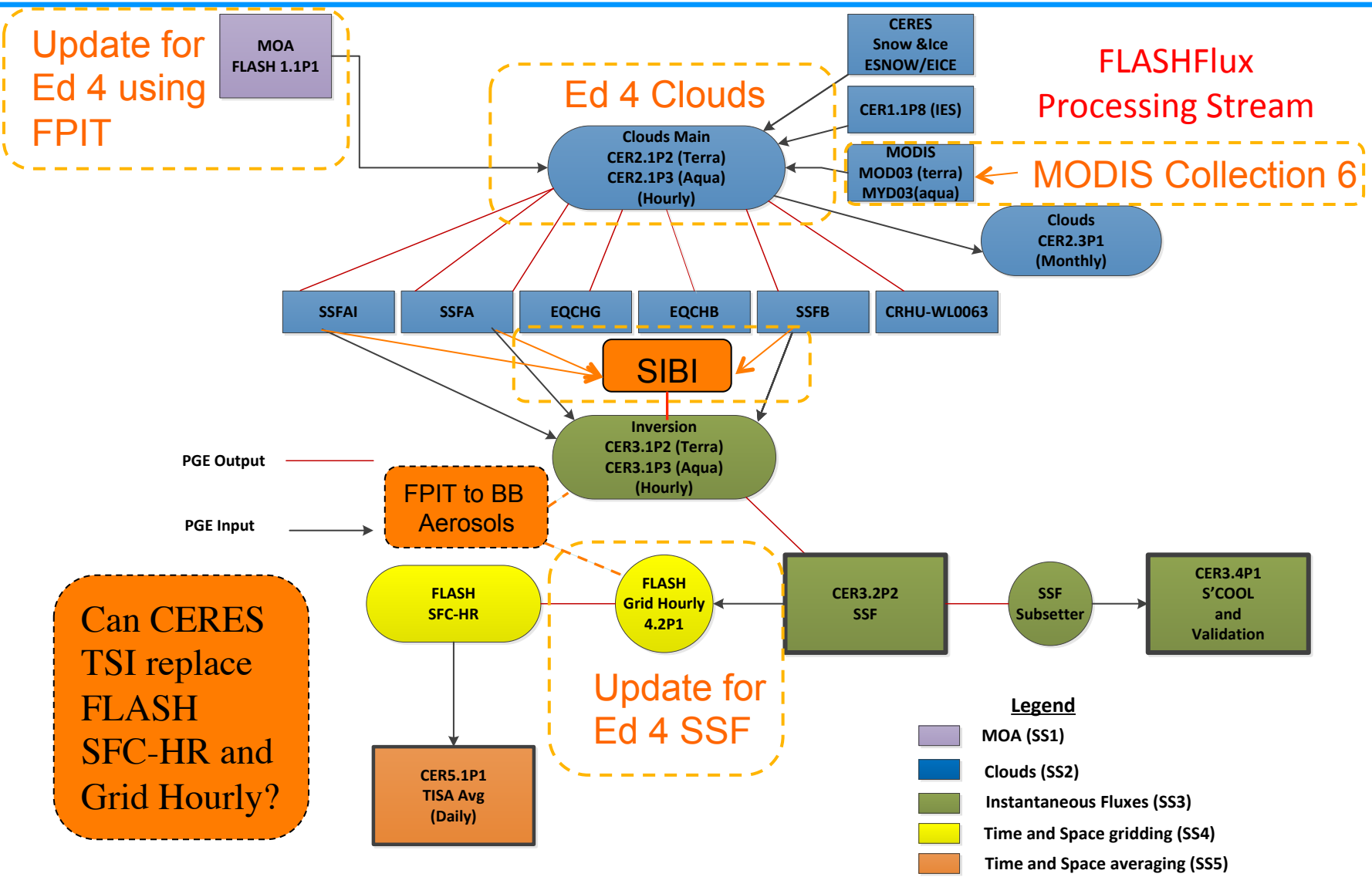
Current v3B Production System



Planned v4A Production System (Jan '17)



FF Future Production System



Summary and Conclusions

- ***FLASHFlux 3B***
  - Continuing production and validation for v3B; surface site validation
  - 2015-2016 El Nino related anomalies extended
- ***FLASHFlux Applications:***
  - Continued growth of usage of FLASHFlux through POWER project
  - Developing new web site featuring GIS tools for CERES/FF/POWER and with ASDC to raise discoverability and accessibility
- ***FLASHFlux publications:***
  - 2015 SotC reports published
  - Future papers: FLASHFlux TISA applications & NASA Energy
- ***Future Versions***
  - Developing v4A by migrated CERES Ed 4 Clouds (collection 6) and Inversion; must adapt current FF TISA => operational by January '17
  - Longer-term Upgrades (Spring '17):
    - Adopt FTIP aerosol assimilation
    - Assess & adapt CERES TSI to FLASHFlux TISA

FLASHFlux Web Sites:

http://flashflux.larc.nasa.gov

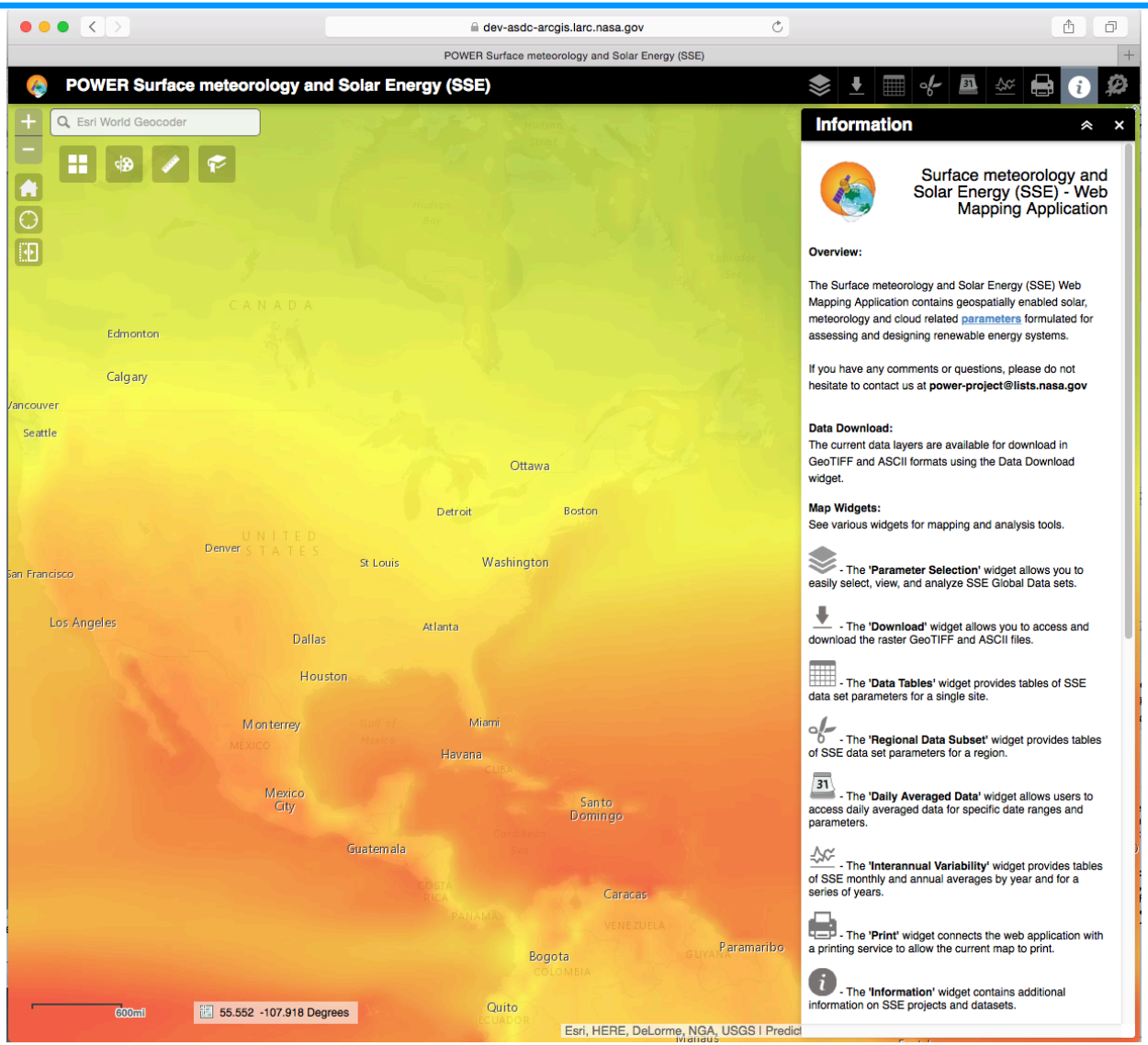
Extras

FLASHFlux Near Future Updates

- **Upgrade to CERES Ed 4 subsystems underway**
  - Meteorological input migration from GEOS 5.9.1 to 5.12.4 => the replacement of FP-IT
  - Upgrade Ed 4 Clouds with MODIS Collection 6 inputs
  - Upgrade to Ed 4 Inversion
  - Upgrade to FF TISA to support Ed 4 formatted inputs
- **Advance Web based GIS services**
  - New POWER web site to enhance data access and usage with GIS web and image services
  - Migrate FLASHFlux datasets to POWER and eventually EBAF/ SYN1Deg
- **Build Compatibility with CERES TSI**
  - Assess & adapt CERES TSI for FLASHFlux global fluxes
  - Build capability for GEO processing

SSE-GIS Beta v1.0.3

- Nearing public release of SSE-GIS
- Provides users an opportunity interact with time series data sets of energy related data sets using web based GIS services from ESRI
- Services are hosted from ASDC servers
- Users can display maps, work with multiple layers, obtain data tables and geotiff files of the parameters



Using ArcGIS To Enhance Applied Science Usage of Data Products

GEOPLATFORM.gov

DATA.GOV

Enhancing Applied Science Usage with ArcGIS

ArcGIS Capabilities

- High quality viewing (Desktop/ Mobile) and printing
- Data Extraction/Subsetting => Python code to support a variety of data formats from ASCII, to .netCDF, to geoTIF
- Simultaneous Dataset Visualization (Swiping)
- Temporal Visualization (time slider)
- Custom Color Ramps
- Pixel/Attribute Value Identification at Selected Location
- Python code to support computation of on-the-fly parameter computation

Technologies

- Esri ArcGIS Server & Portal
- OPeNDAP
- PostgreSQL & PostGIS

Connectivity

- Climate.gov
- GEOSS (AIP-8)

Progress Toward CERES GIS Support

- Published four CERES SYN1DEG ArcGIS Image Services in ***the development environment***. Allows users to 1) access the data via a REST endpoint/protocols, via JSON REST response, 2) utilize online web mapping application development tools via the ArcGIS API for JavaScript, 3) consume the services directly into ArcGIS Desktop and custom applications for further visualization and analysis.
- Data served directly from the CERES SYN1Deg Native NetCDFs:
  - SFC COMP LW DOWN ALL DAILY
  - SFC COMP SW DOWN ALL DAILY
  - SFC COMP SW DOWN CLR DAILY
  - TOA COMP SW DOWN ALL DAILY
- The 2 systems purchased by CERES have had systems software installed and are integrated into the WebRA production environment. Each server has 2 Intel Xeon E5-2643 v3 Processors (20M cache, 3.40 Ghz, 6 cores), 2.4TB of storage, 256 GB RAM (DDR4-2133MHz).
- A process was developed for integrating the machines into the production architecture for dedicated hosting of geospatial web services for CERES data products.
- These systems will be added to the ArcGIS cluster for dedicated hosting of CERES data product geospatial web services.

Progress Toward CERES GIS Support

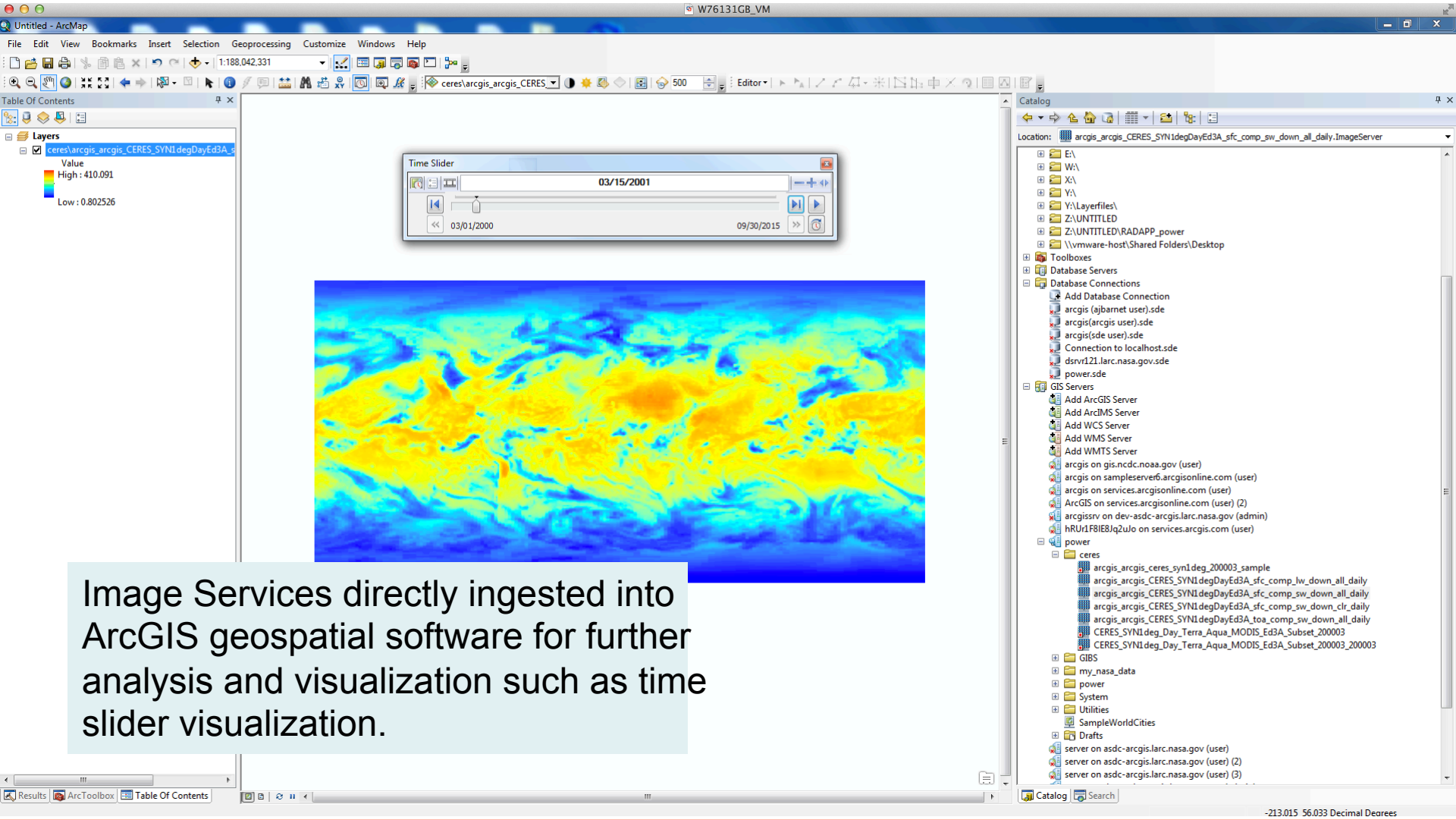


Image Services directly ingested into ArcGIS geospatial software for further analysis and visualization such as time slider visualization.