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

Paul Stackhouse and David P. Kratz (NASA LaRC)

PC Sawaengphokhai, Shashi Gupta and Anne Wilber (SSAI)

POWER Team: Bradley MacPherson (Booz-Allen-Hamilton)

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

SOFA Update

- ***Paper published:***

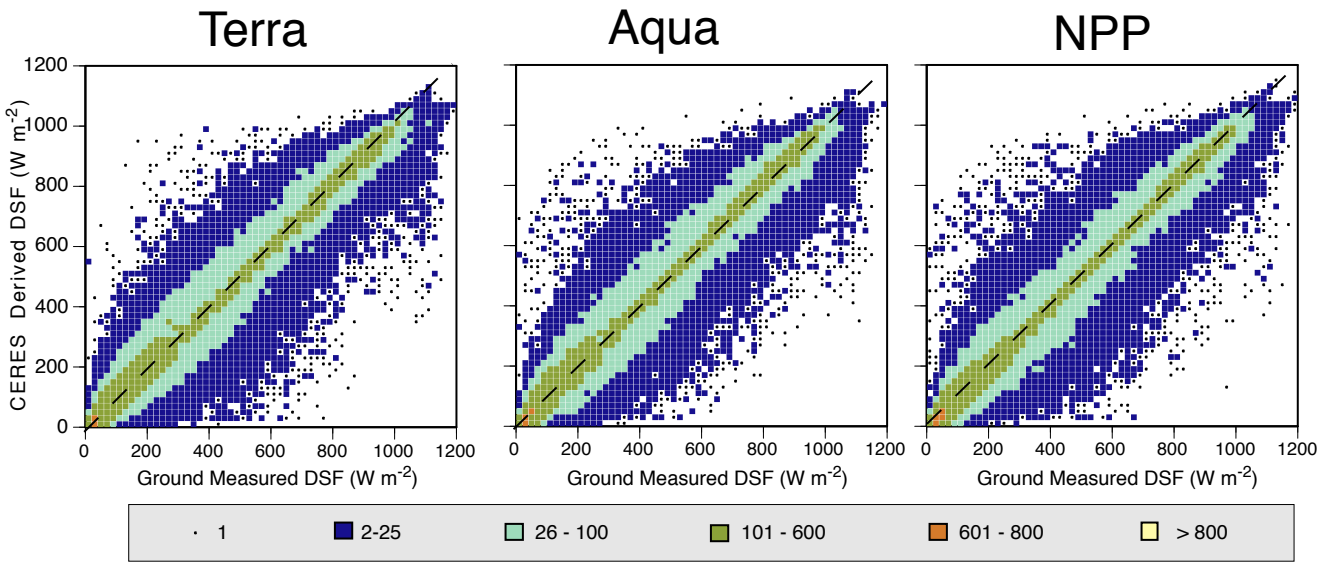
  Kratz, D. P., Gupta, S. K., Wilber, A. C., & Sothcott, V. E. (2020). Validation of the CERES Edition-4A Surface-Only Flux Algorithms. Journal of Applied Meteorology and Climatology, 59(2), 281–295. https://doi.org/10.1175/JAMC-D-19-0068.1

- ***Testing begun on NOAA-20:***
  - Initial SOFA Model B (LPSA/LPLA) results look consistent with the results from NPP, Terra and Aqua
  - Model A LW requires WN channel which is not present.
  - Currently waiting for a full set of data to provide validation results.

- ***Validation Continued on Terra, Aqua and NPP***
  - SSF SOFA Model B SW/LW validation shows low biases and consistent RMS between 3 instruments

All-sky Surface Downward Shortwave Flux Model B

201201 - 201911



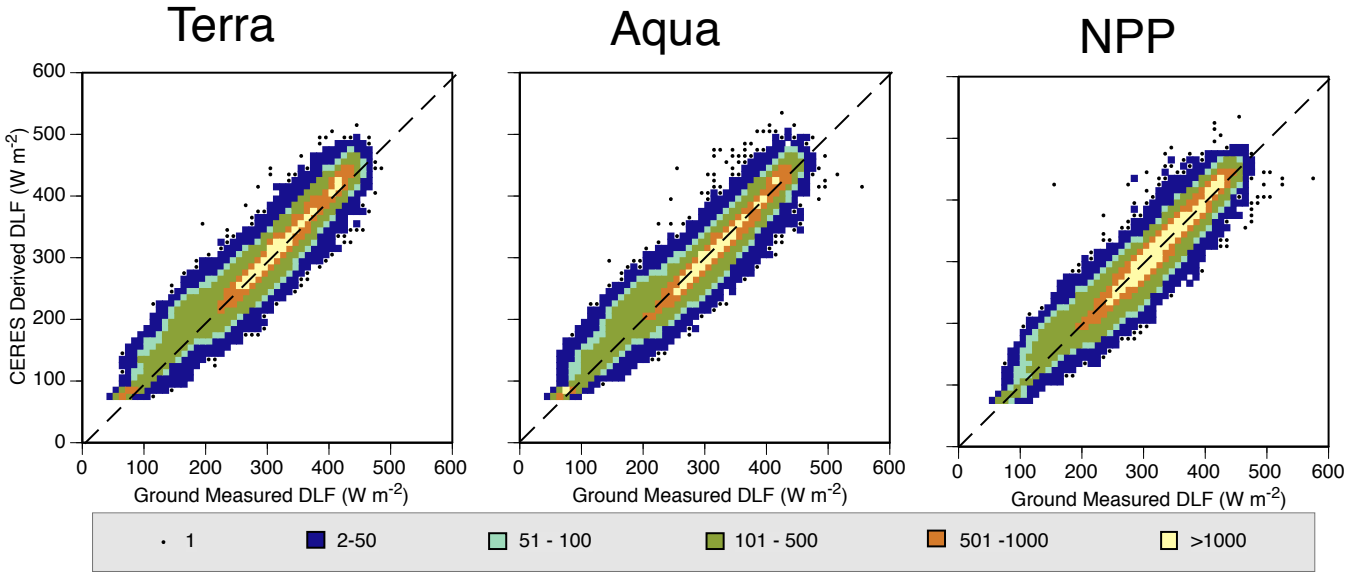
N = 72984
Bias = -4.3 W m^{-2}
RMS = 93.0 W m^{-2}

N = 73319
Bias = 0.8 W m^{-2}
RMS = 94.3 W m^{-2}

N = 68136
Bias = -1.4 W m^{-2}
RMS = 98.8 W m^{-2}

All-sky Surface Downward Longwave Flux Model B

201201 - 201911



Terra	Aqua	NPP
N = 133770	N = 135065	N = 165811
Bias = 0.5 W m^{-2}	Bias = 0.3 W m^{-2}	Bias = -2.3 W m^{-2}
RMS = 22.4 W m^{-2}	RMS = 22.8 W m^{-2}	RMS = 22.5 W m^{-2}

CERES FLASHFlux Overview

- ***FLASHFlux Overview***
  - Uses CERES based production system through inversion
  - Periodic calibration updates projected forward; running 3-day TISA
  - LPSA/LPLA SOFA algorithms for surface fluxes
- ***FLASHFlux Objectives***
  - SSF products within 4 days
  - Global 1x1 daily averages from 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 (most recent report revised Mar. 2020).

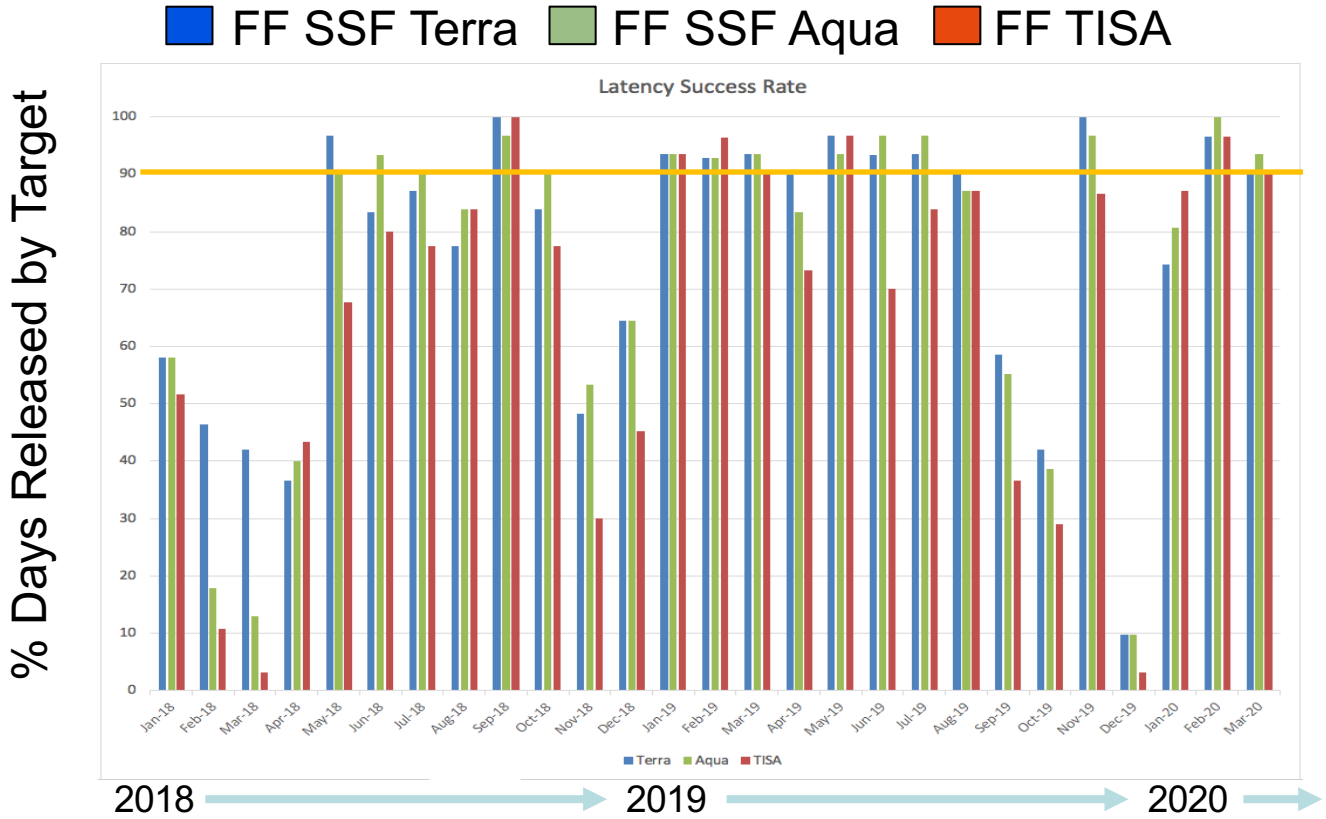
FLASHFlux v3C Status

- ***Production with v3C (MODIS C5/C6/C6.1) (since Jan 1, 2017)***
  - 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
  - Maintaining v3C processing; latency is improved after Dec 2019
- ***Current Activities***
  - FF v4A SSF and TISA delivered in Jan/Feb. 2020.
  - Processing FLASHFlux SSF V4A from Dec. 1, 2018 through present (uses MC6.1); applying calibration from June 2019
  - Evaluating v3C, 4A, and CERES Ed4 SSF
  - Plan to continue production for v3C for 2020 while production adapted to FF v4A; transition TBD
- ***FLASHFlux Information & Data Provision Through ...***
  - New CERES web site and subsetter both SSF and TISA; ASDC (via EarthData)
  - SSF data to NOAA NESDIS, Globe-Clouds
  - TISA data to POWER Energy/Ag web portal

CERES FLASHFlux Latency Status

- FF SSF Success Target = data release within 4 days
- FF TISA Success Target = data released within 6 days
- Recovery from power outage in 12/09
- Last 2 months > 90% SSF & TISA success

75% of daily solar irradiance users request low latency



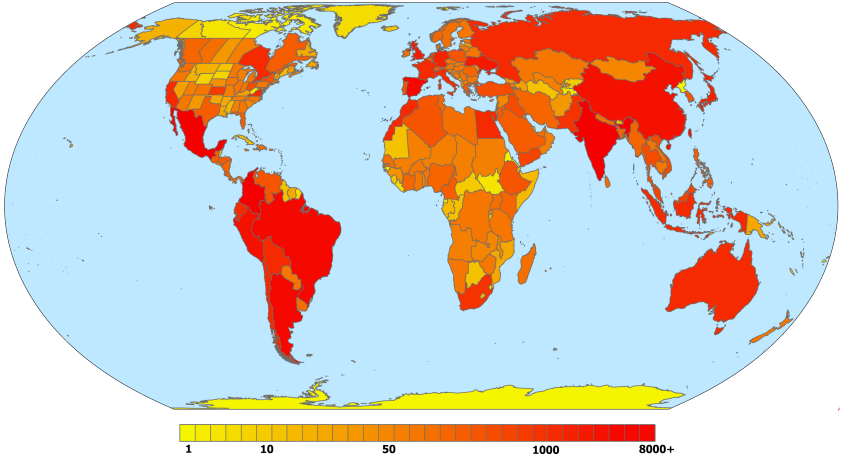
FLASHFlux to POWER Metrics

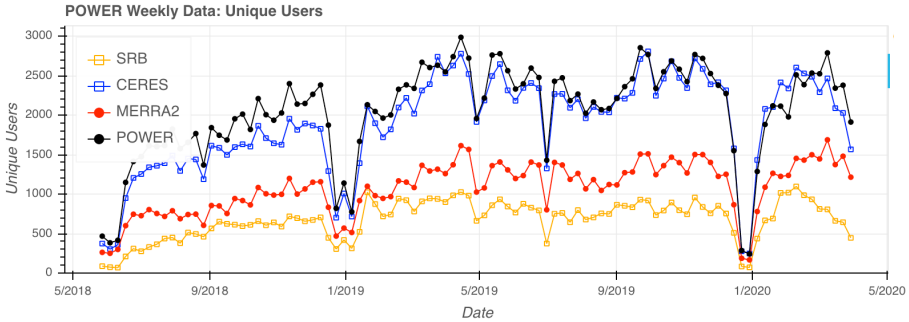
CERES FLASHFlux Usage Metrics through POWER (2019/03/01 to 2020/03/31)

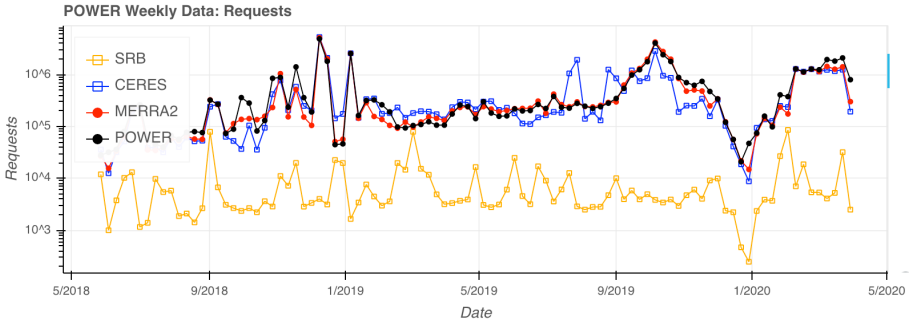
	Total	Monthly
Unique Users IPs	96,910	7,454
Requests	28,816,773	2,216,675
Latency < 2 Weeks %	59.8%	59.8%*

*Low latency was not available for most of Dec 2019/ Jan 2020 due to outage; typically ~75%

POWER User Locations March 2019 – March 2020

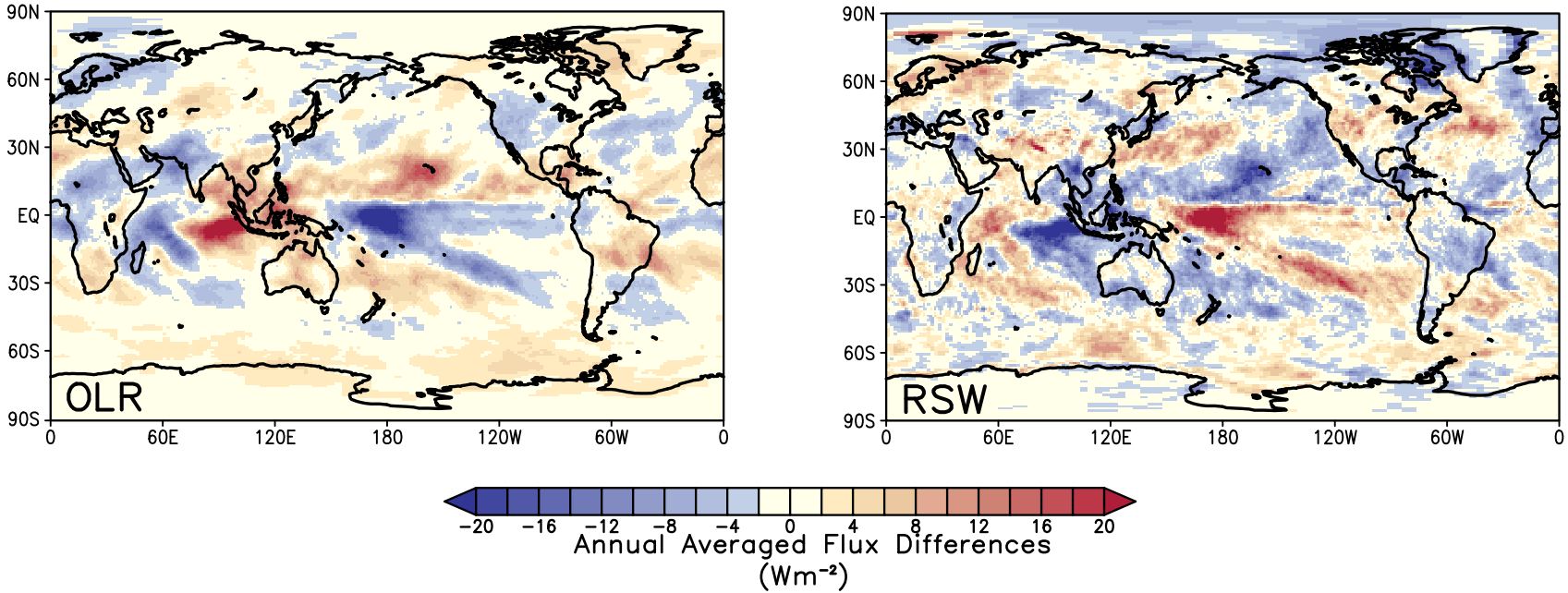






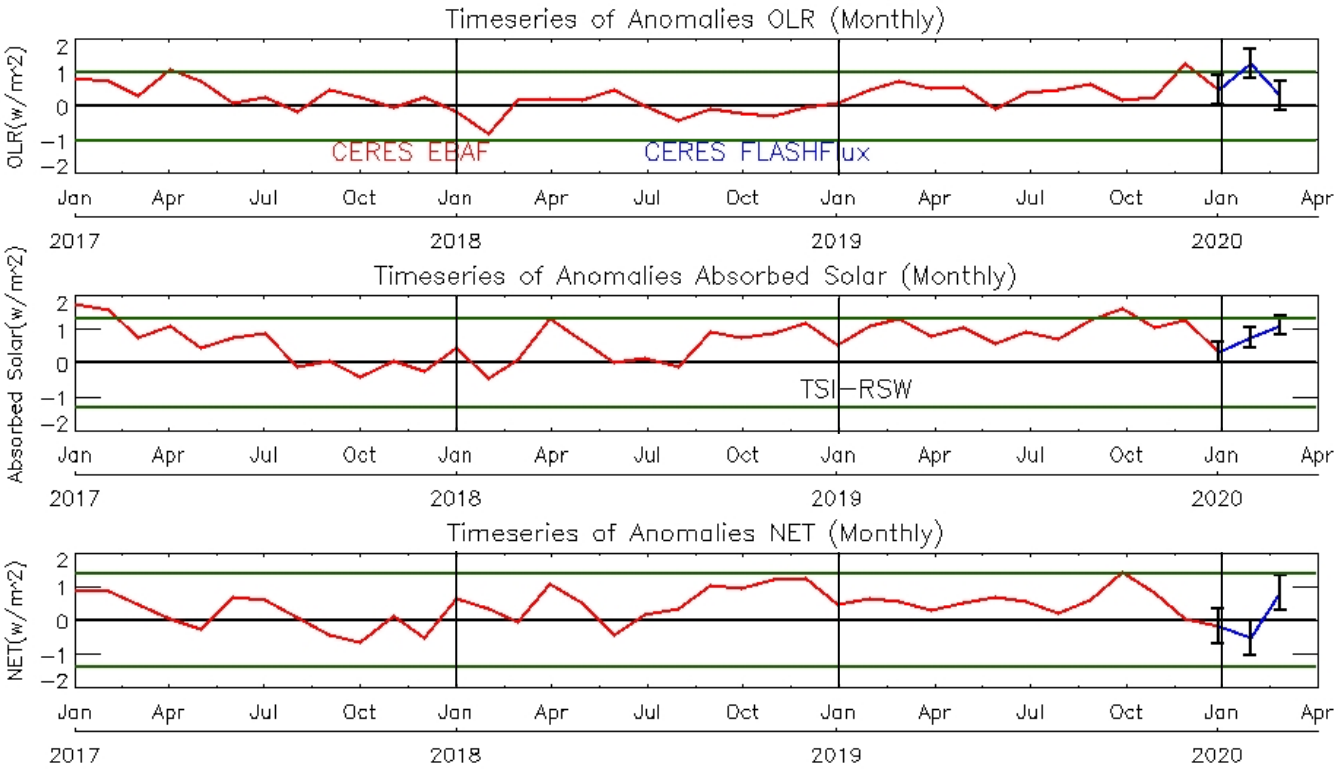
Annual Average Differences (2019 – 2018)

Transition from La Nina in 2018 in to weak El Nino in 2019

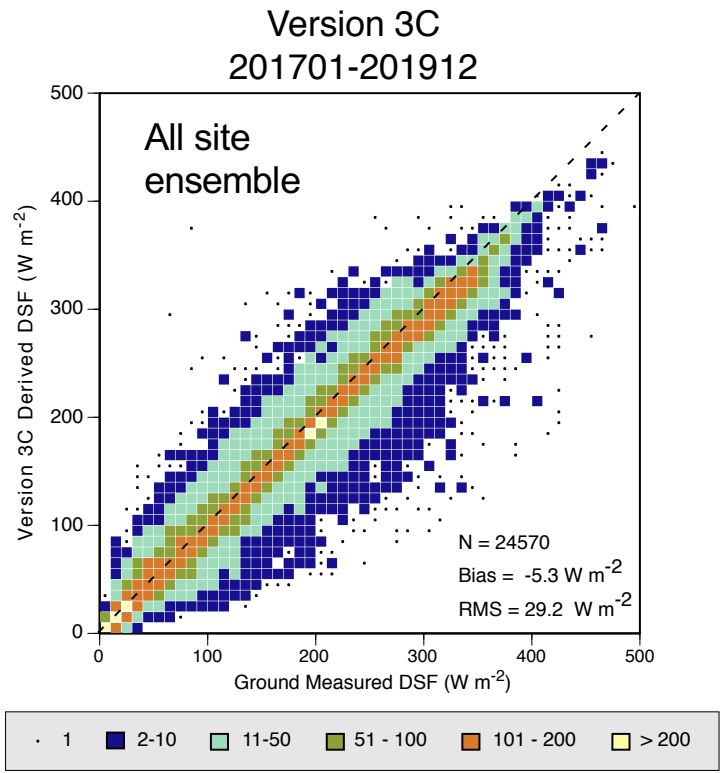


TOA Anomaly Time Series for State of the Climate

- OLR anomalies jump back up > 1.0 W m^{-2} (2-sigma)
- Net RSW (absorbed SW) anomalies remain +0.8 to 1.6 W m^{-2}
- Subtraction gives Total Net that reduces from +1.2 to -0.1 W m^{-2} in December 2019; rebounds nearly 1 W m^{-2} by Mar. 2020.



Recent SW Validation: 1/2017– 12/2019

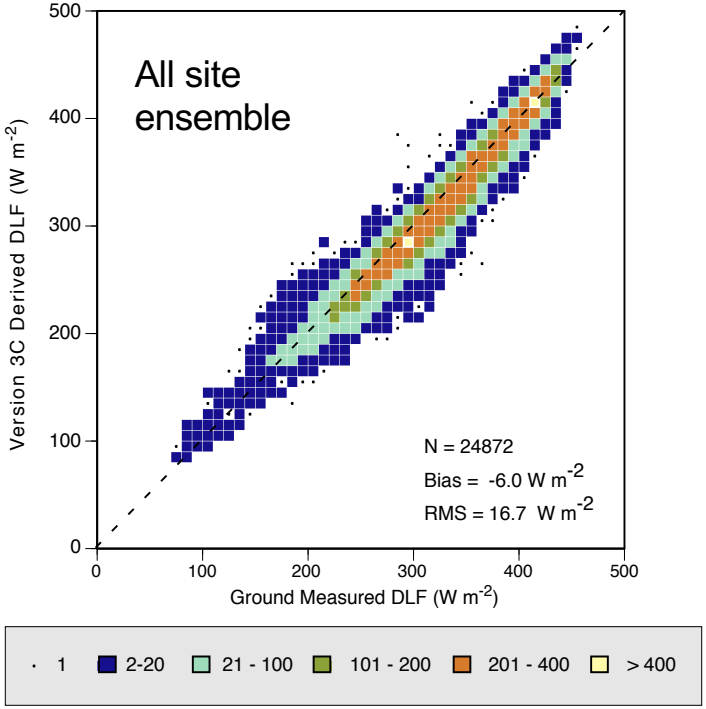


Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-5.3	29.2	24570
Continental	-5.1	28.2	12913
Coastal	-3.8	24.2	4935
Desert	-6.1	21.9	3086
High Latitude	-19.6	51.0	1982
Island	6.5	26.4	1654

Recent LW Validation: 1/2017 –12/2019

Version 3C
201701-201912



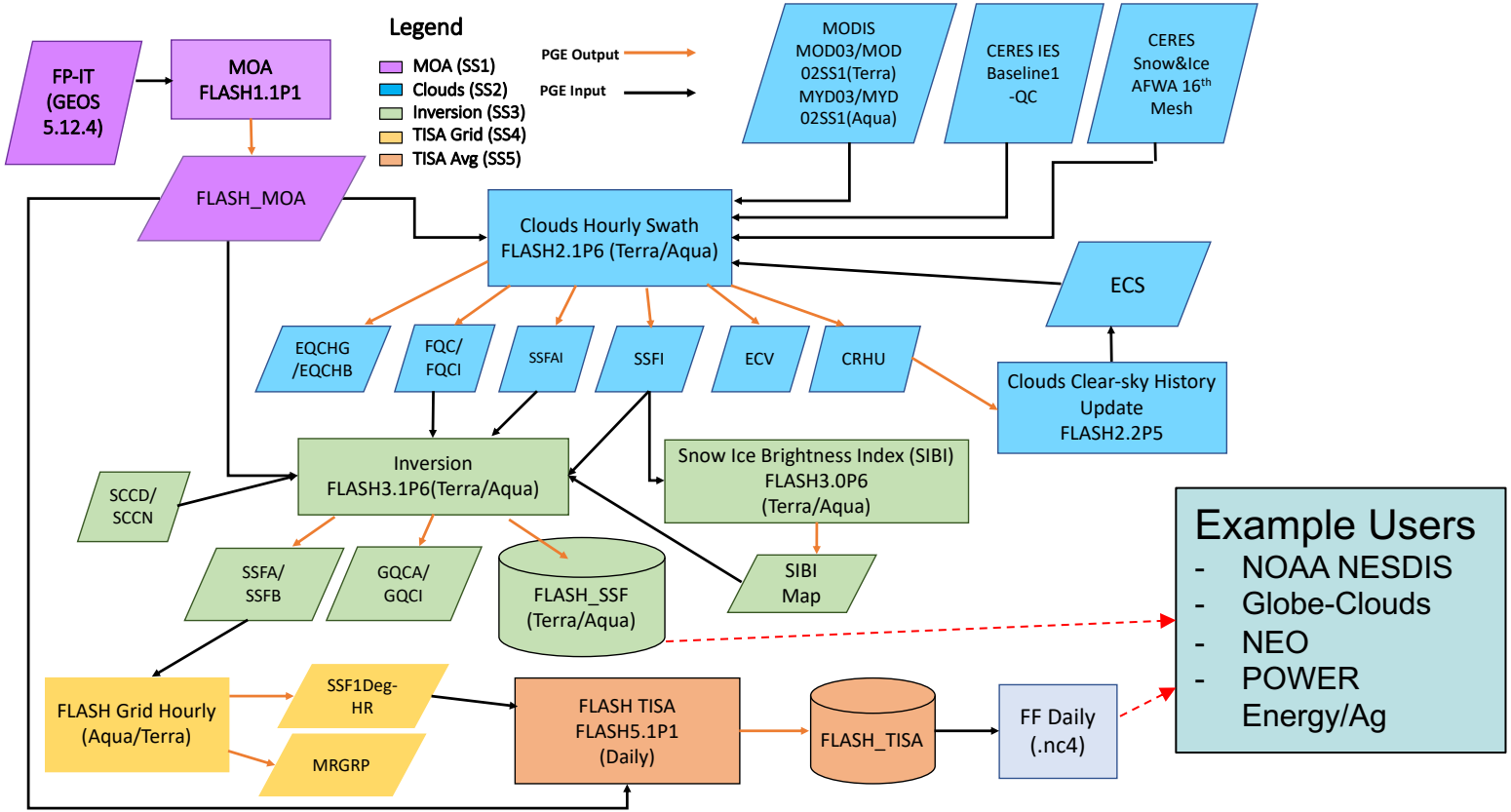
Daily Averaged TISA Comparison

Ensemble Type	Bias ($W\ m^{-2}$)	RMS ($W\ m^{-2}$)	N
All Obs	-6.0	16.7	24872
Continental	-9.6	18.0	12620
Coastal	-3.0	12.4	4921
Desert	-7.2	16.4	3015
High Latitude	4.0	20.7	2657
Island	-1.8	10.3	1659

FLASHFlux Data Flow (Version 4A)

Key Changes:

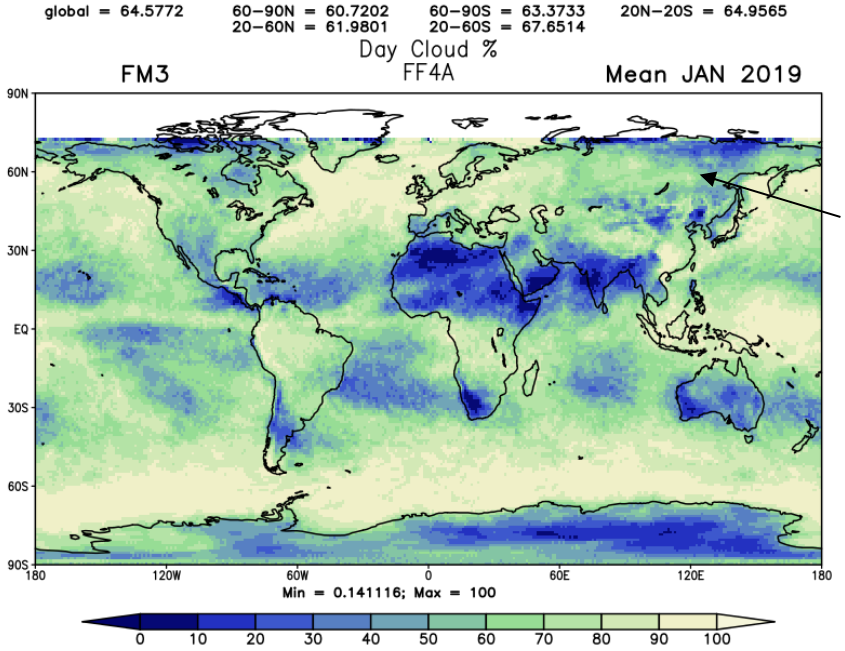
- Clouds Ed4
- SIBI Map: running 30-day maps
- Ed4 Inversion
- Globe-Clouds to read SSF instead of subsetter
- SW Model B (LPSA)
- FF Daily added to PGE



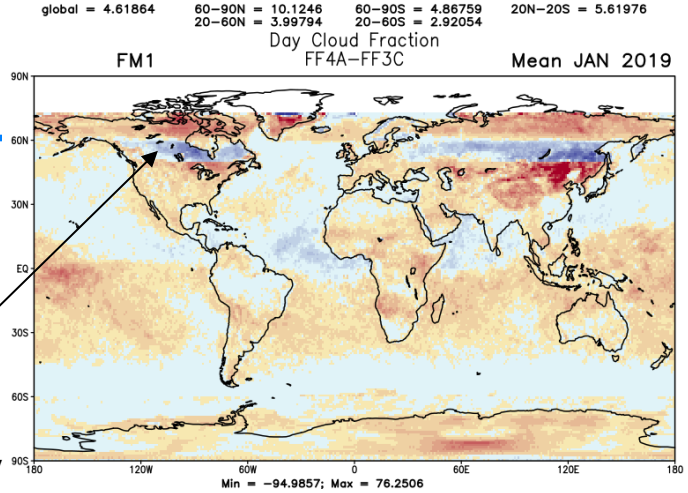
Example FF Version 4A SSF Terra Results

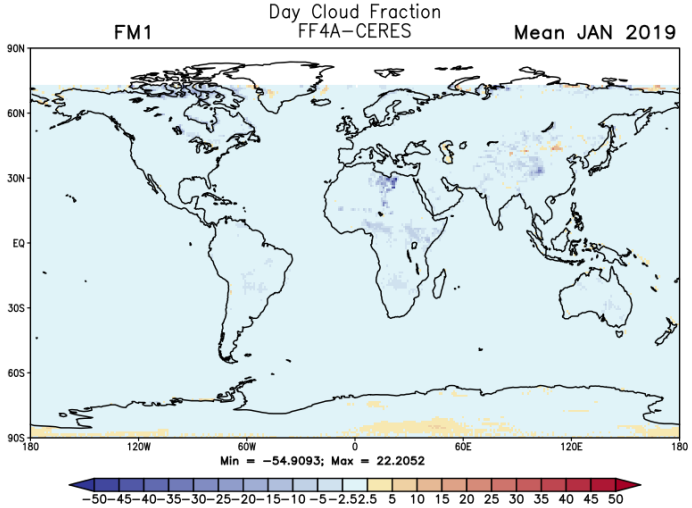
	Meteorology	Clouds	Ice/snow	SIBI map	Aerosols
FLASHFlux 4A	GEOS 5.9.12	CERES Ed4	1/16 mesh	Running monthly mean	MATCH climatology from MODIS 5 (Years 2000-2005)
FLASHFlux 3C	GEOS 5.9.12	CERES Ed2-like	1/16 mesh	No SIBI used	MATCH climatology from MODIS 5 (Years 2000-2005)
CERES 4A	GEOS 5.4	CERES Ed4	1/8 mesh	Calendar monthly mean	MATCH daily from MODIS 6.1

Terra Daytime Cloud Fraction Differences (Jan 2019)



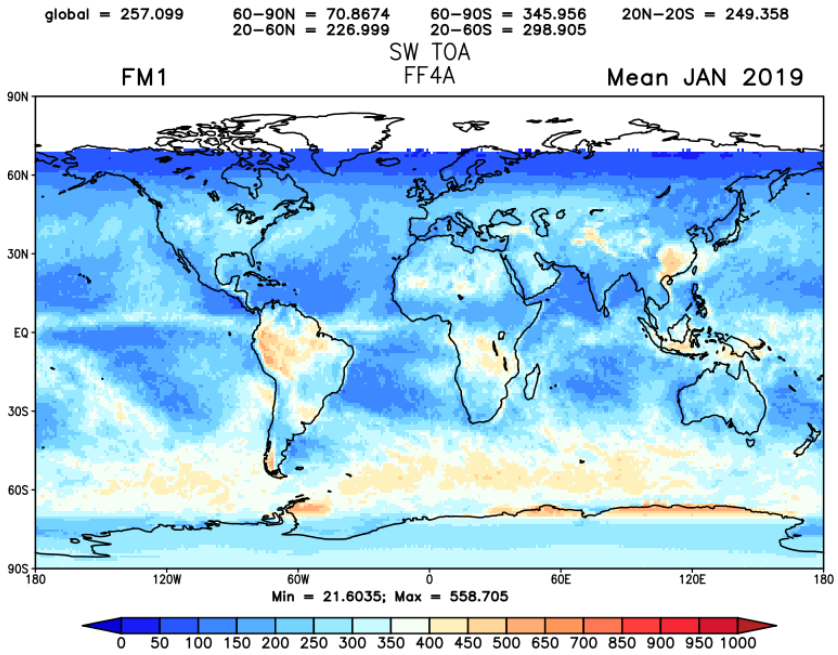
Ed2 Cloud Discontinuity eliminated

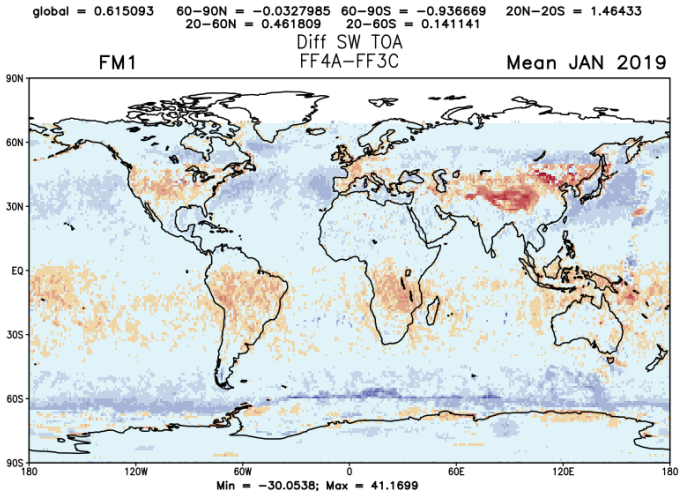


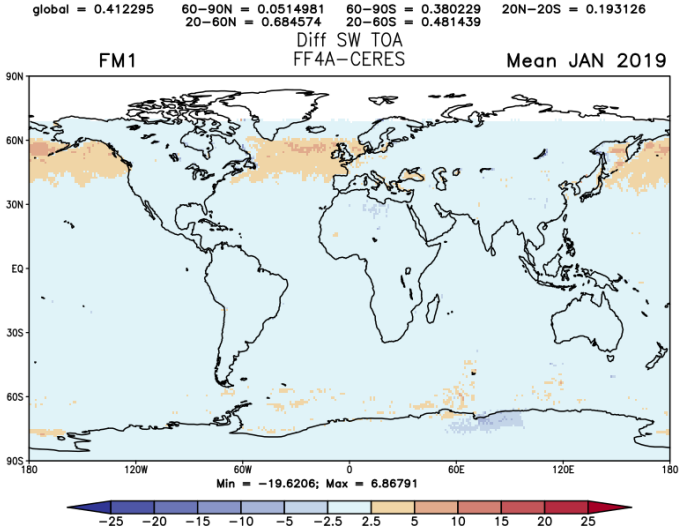


FF v4A consistent cloud mask with CERES Ed4A

Terra TOA SW Flux Differences (Jan 2019)

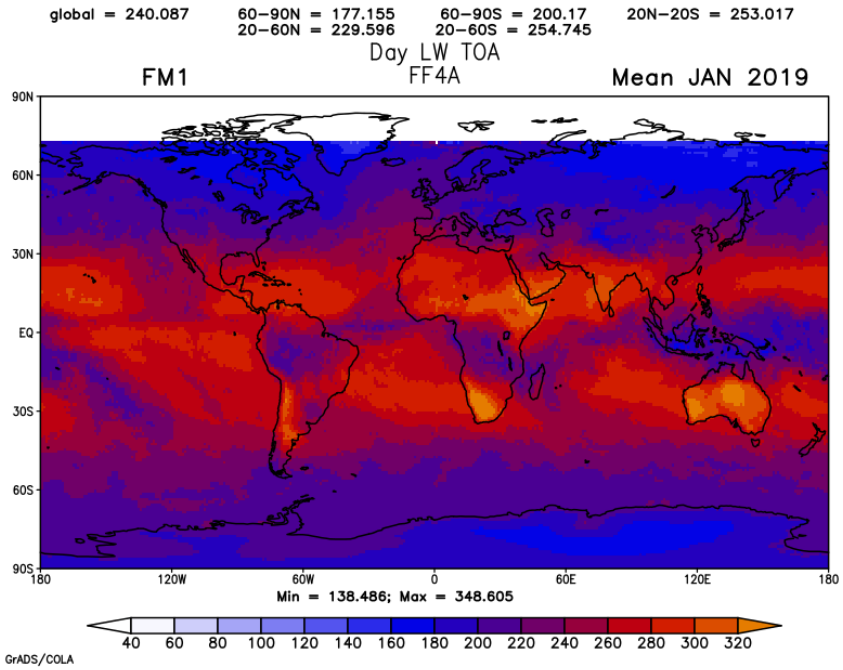


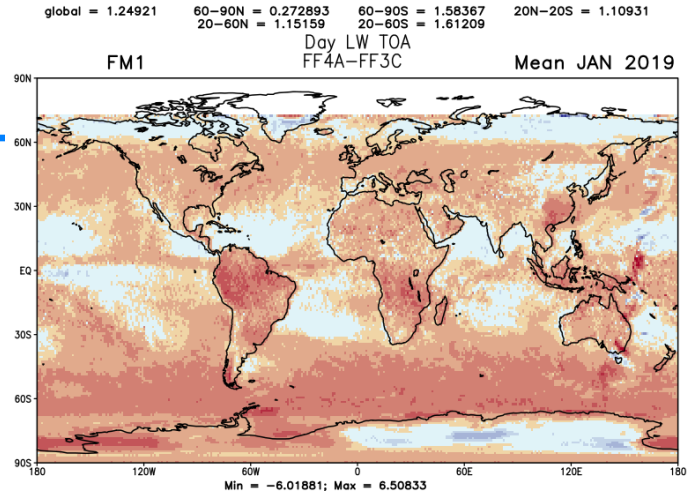


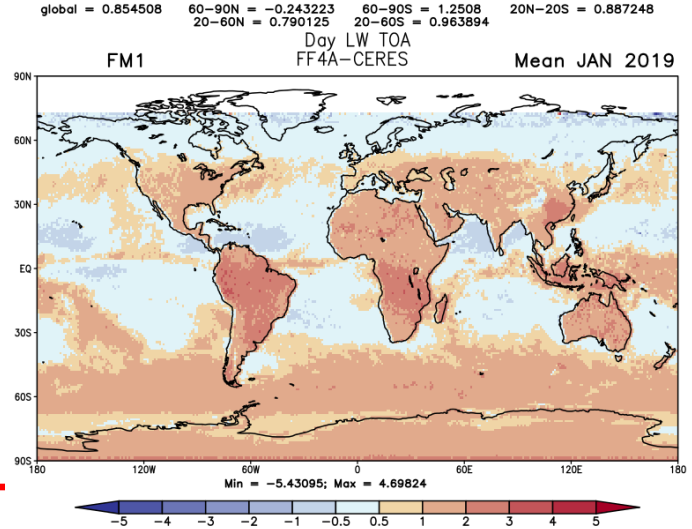


Global relative difference ~+0.16%

Terra TOA Daytime LW Flux Differences (Jan 2019)

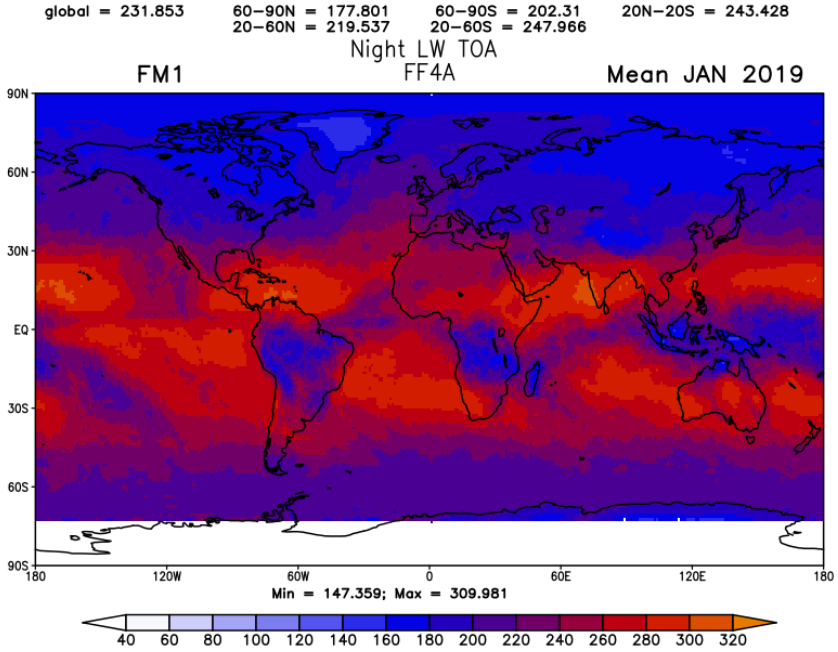


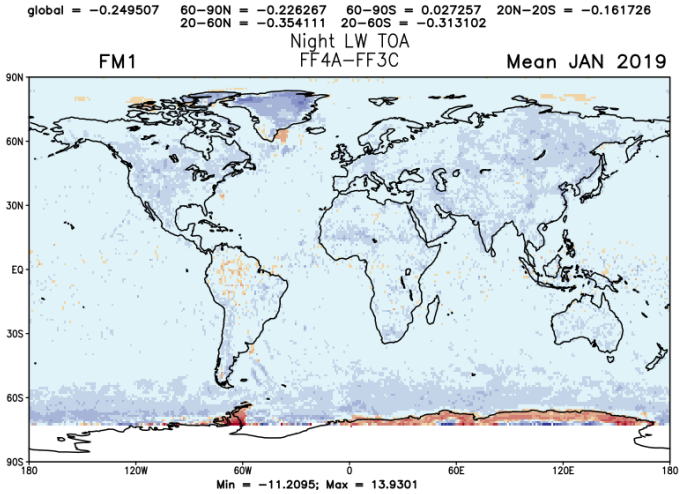


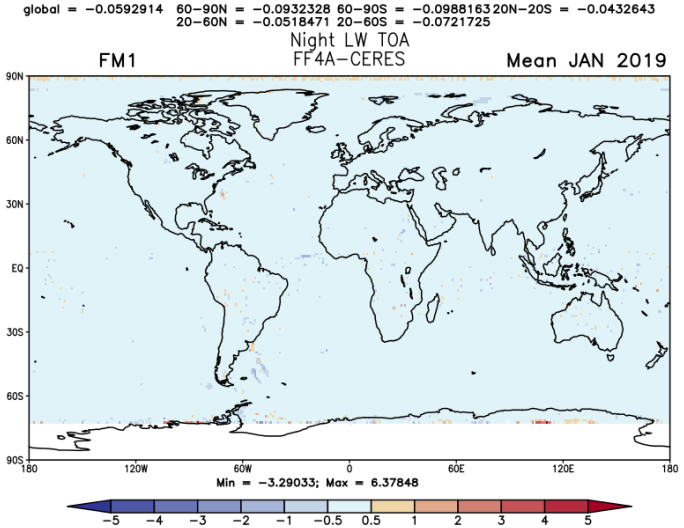


Global relative difference ~+0.38%

Terra TOA Nighttime LW Flux Differences (Jan 2019)



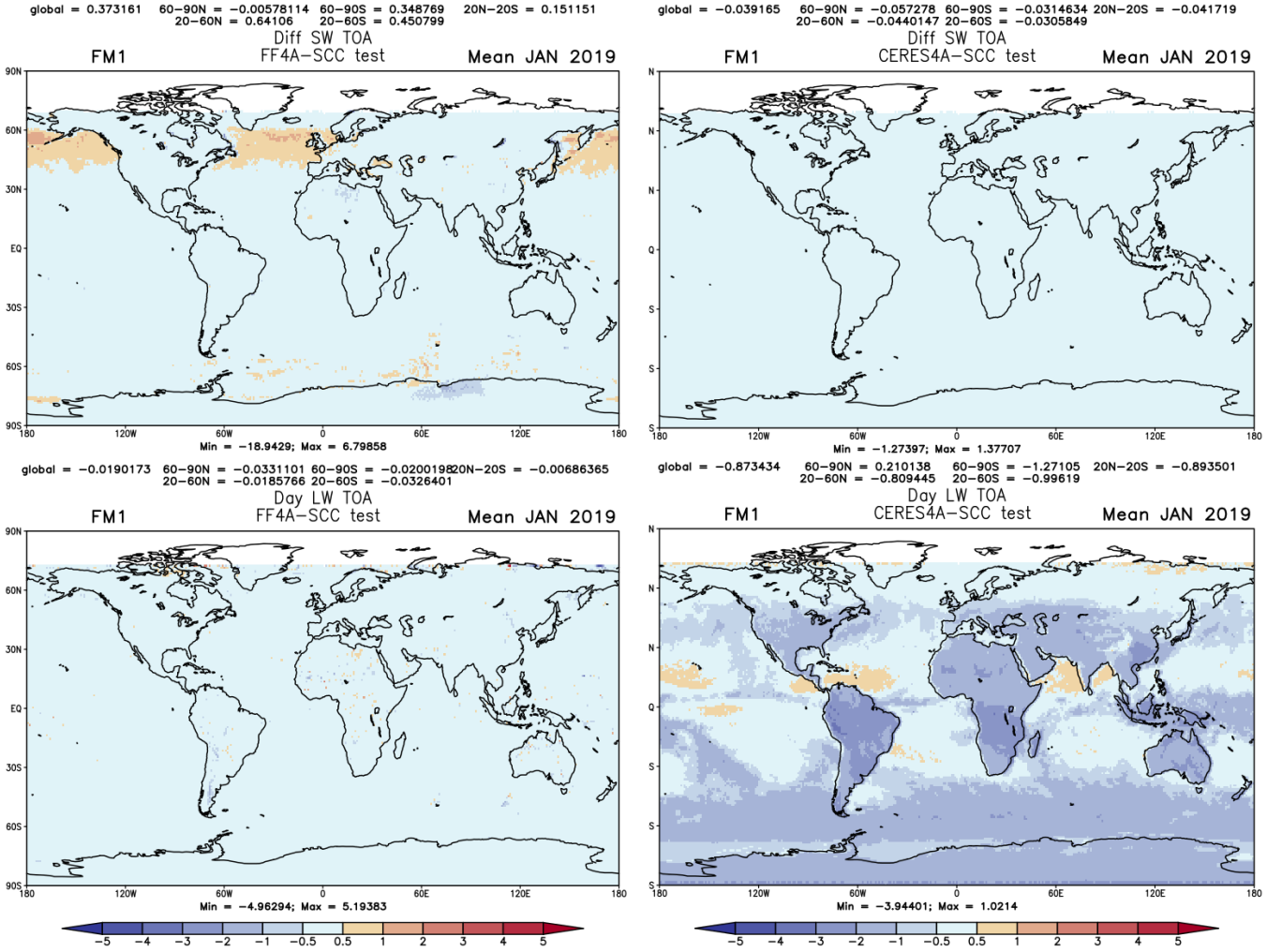




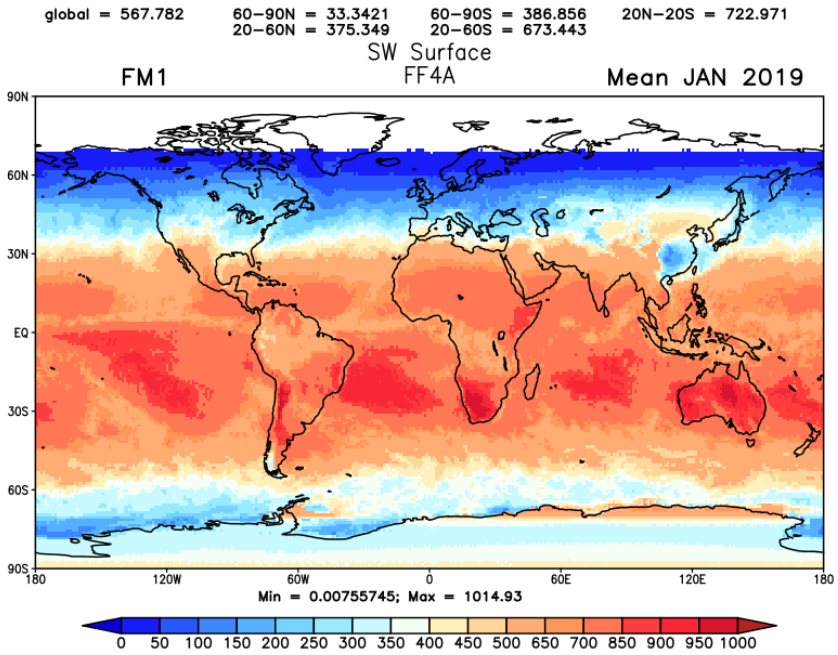
Global relative difference ~-0.03%

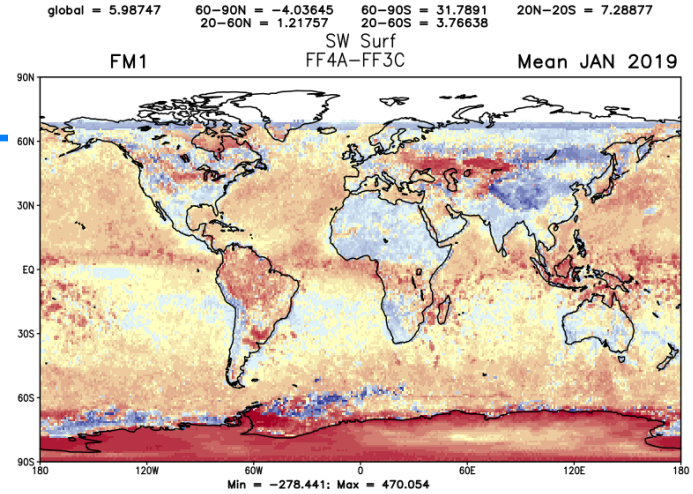
Spectral Calibration Testing:

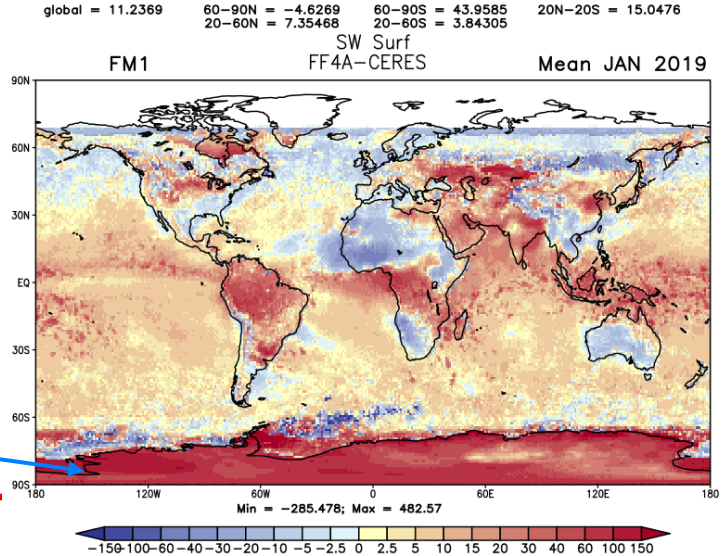
- Runs generated from special FF calibration from June 2019
- Compare FF4A, CERES Ed4 and special SCC run using Ed4 inputs and FF SCC
- SW TOA differences due to FF vs CERES implementation
- LW TOA @day due to calibration coefficients



Terra Surface SW Flux Differences (Jan 2019)



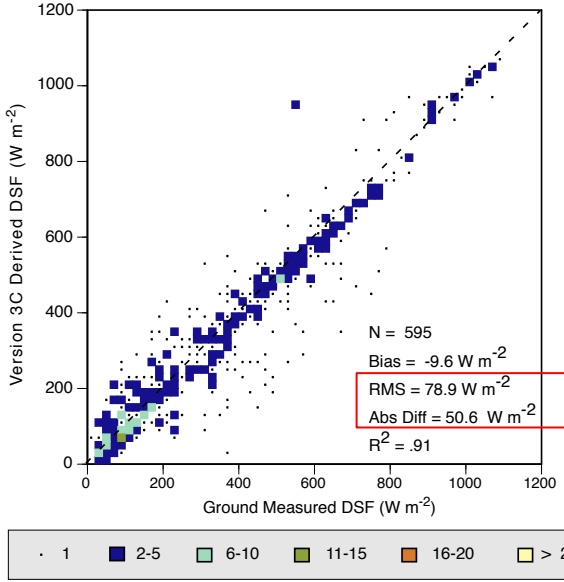




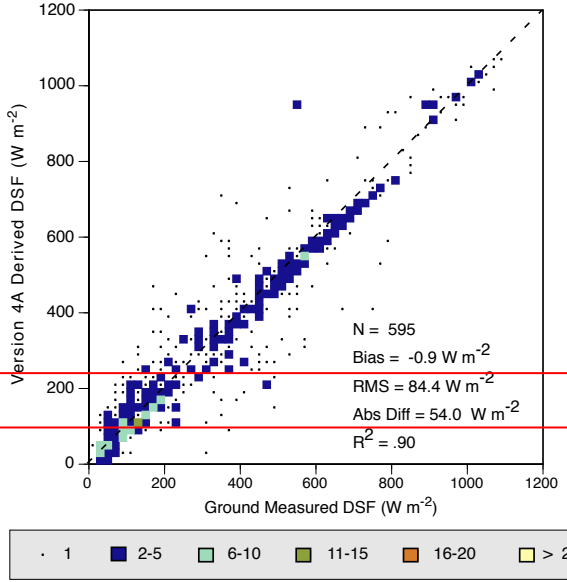
Revised alternate algorithm over snow/ice

Terra Surface SW Flux Differences (Jan 2019)

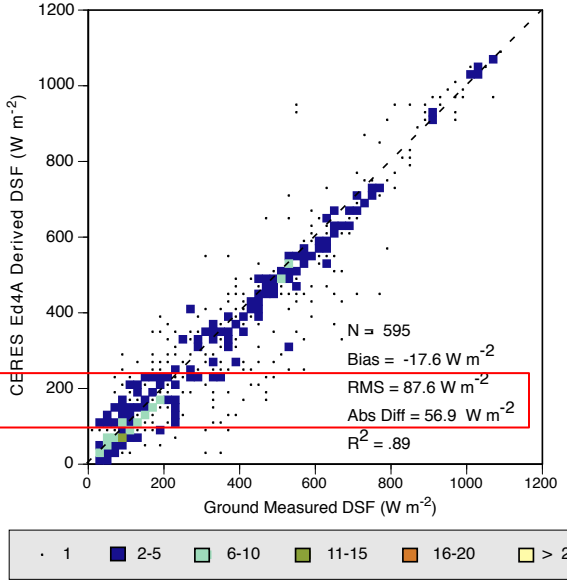
Ensemble
FLASHFlux V3C
201901
Terra



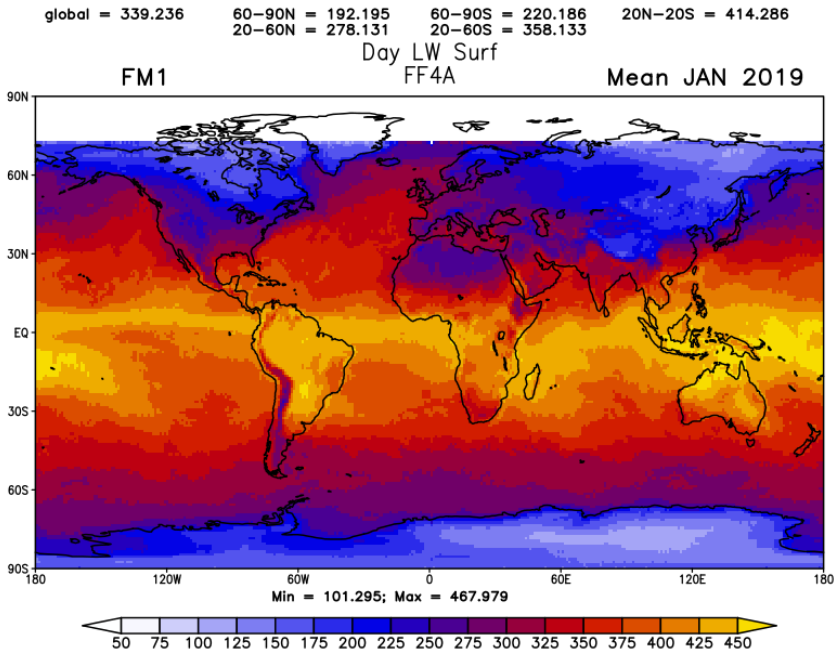
Ensemble
FLASHFlux V4A
201901
Terra

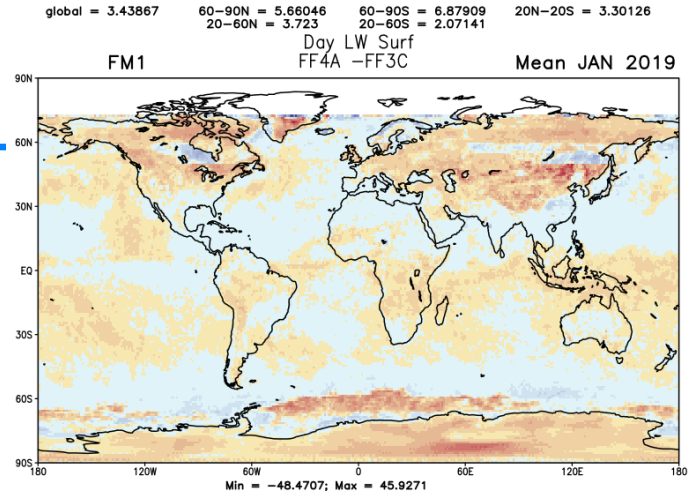


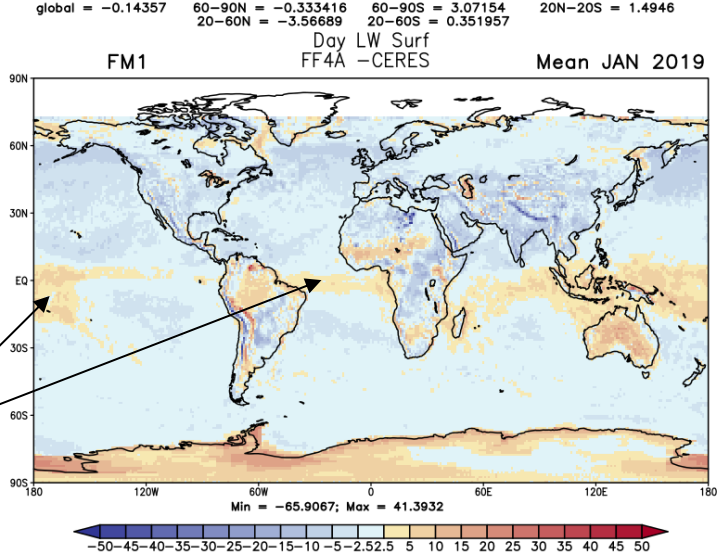
Ensemble
CERES Ed4A
201901
Terra



Terra TOA Daytime LW Flux Differences (Jan 2019)

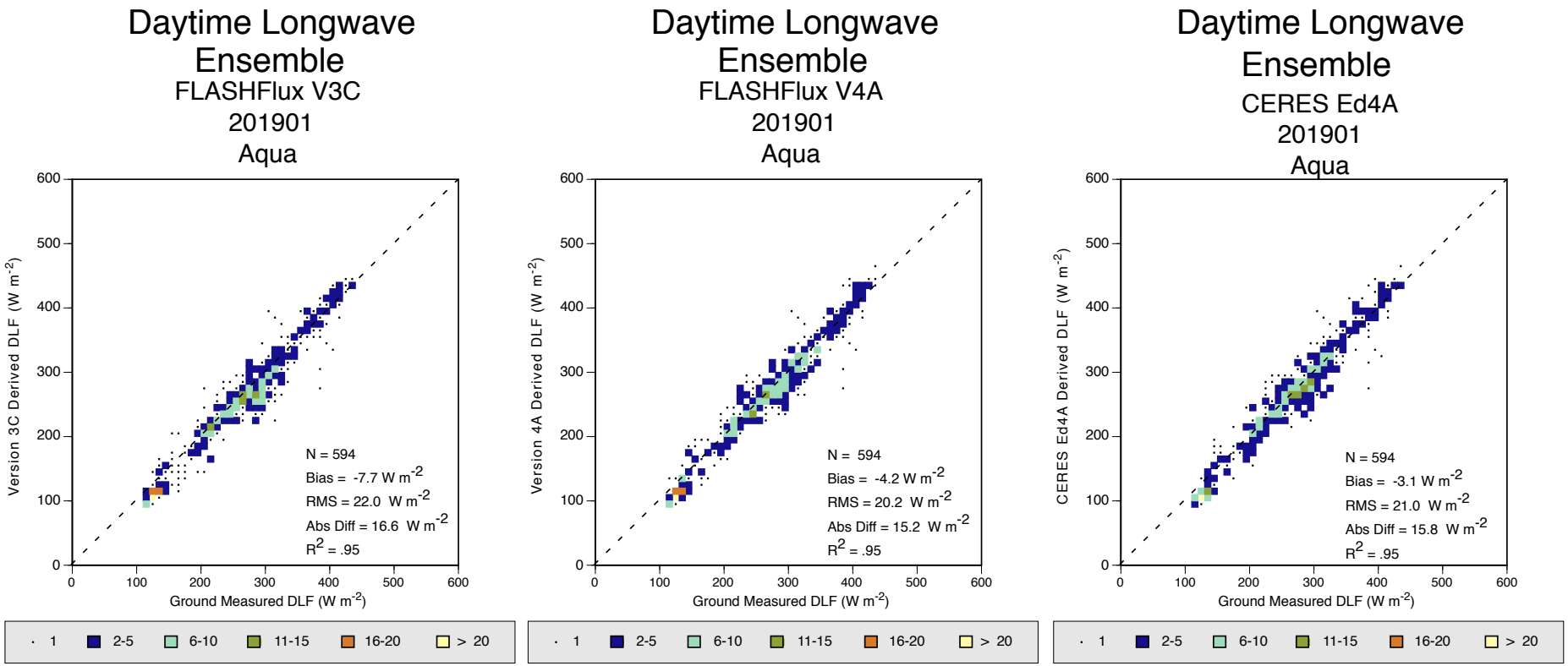




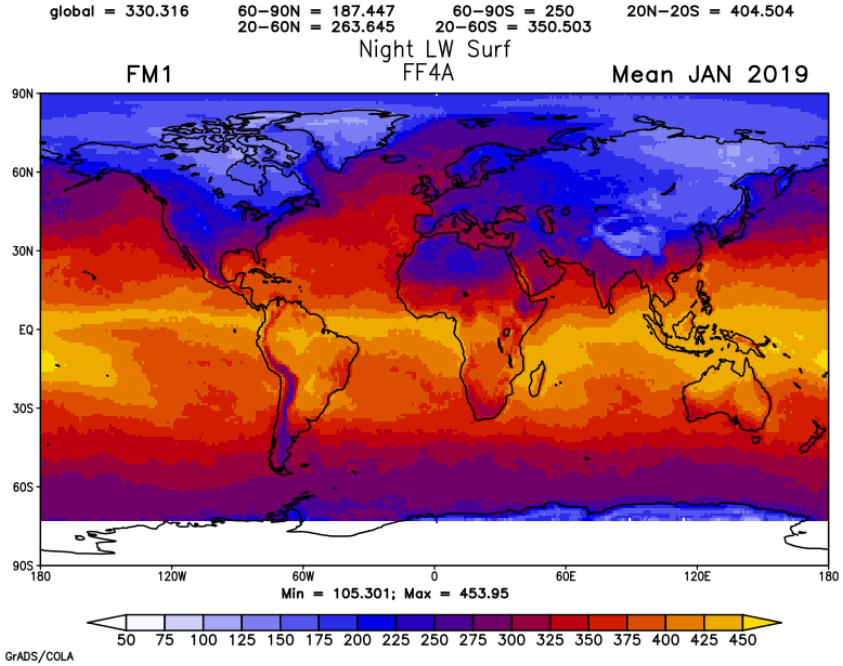


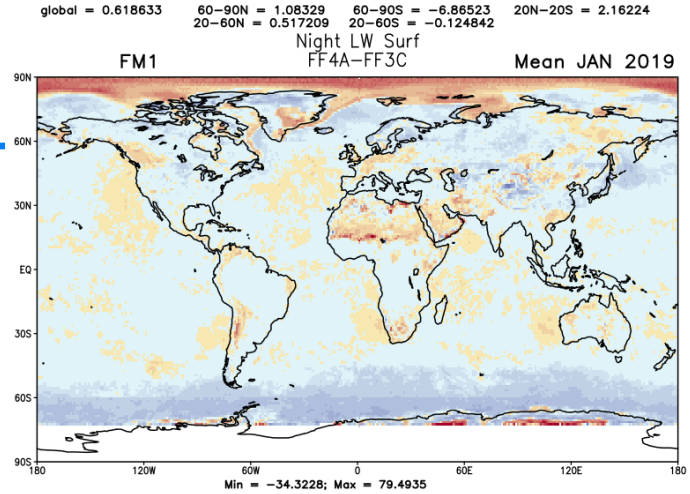
Differences due to water vapor inputs

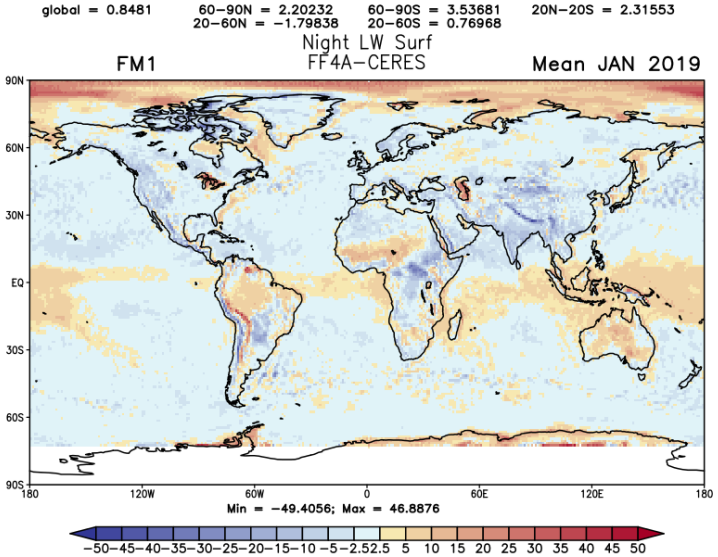
Terra Surface Daytime LW Flux Differences (Jan 2019)



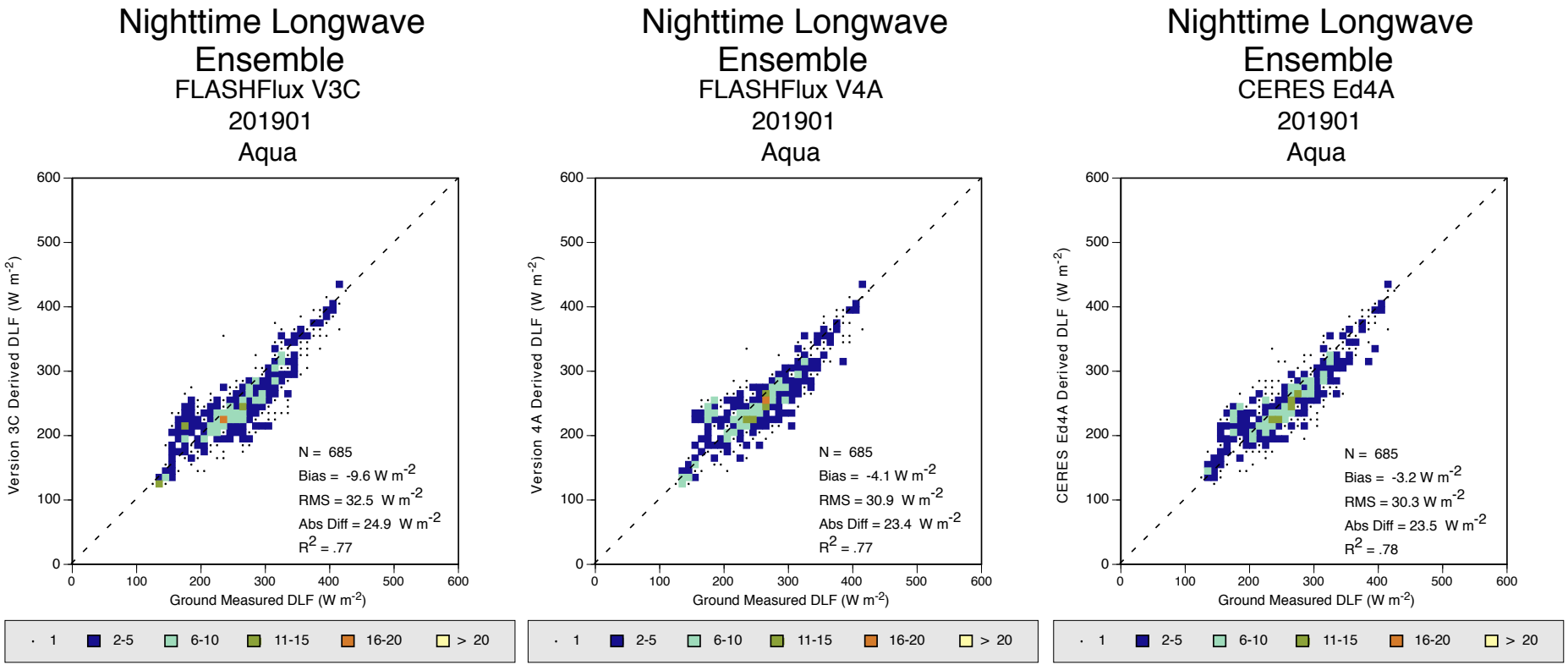
Terra TOA Nighttime LW Flux Differences (Jan 2019)



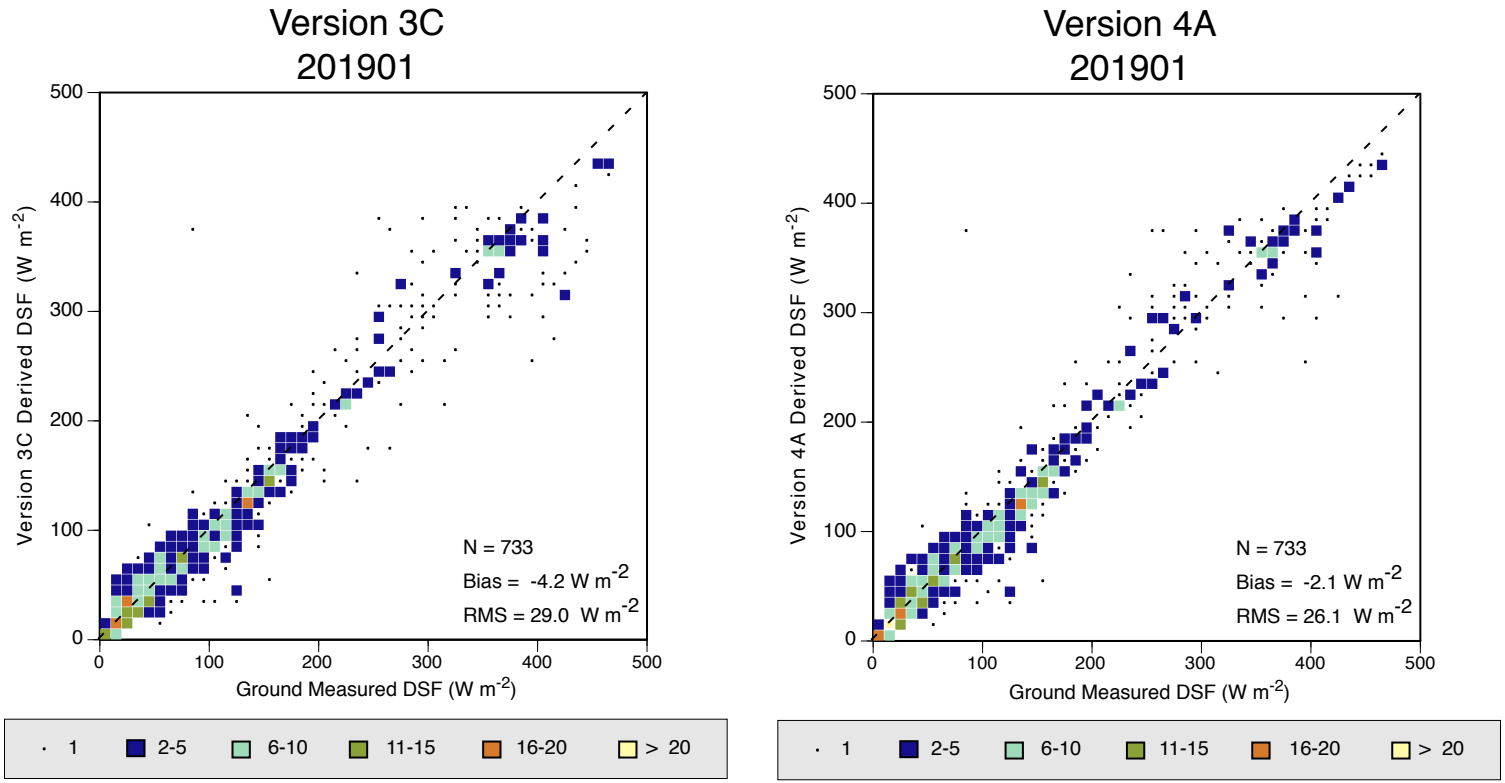




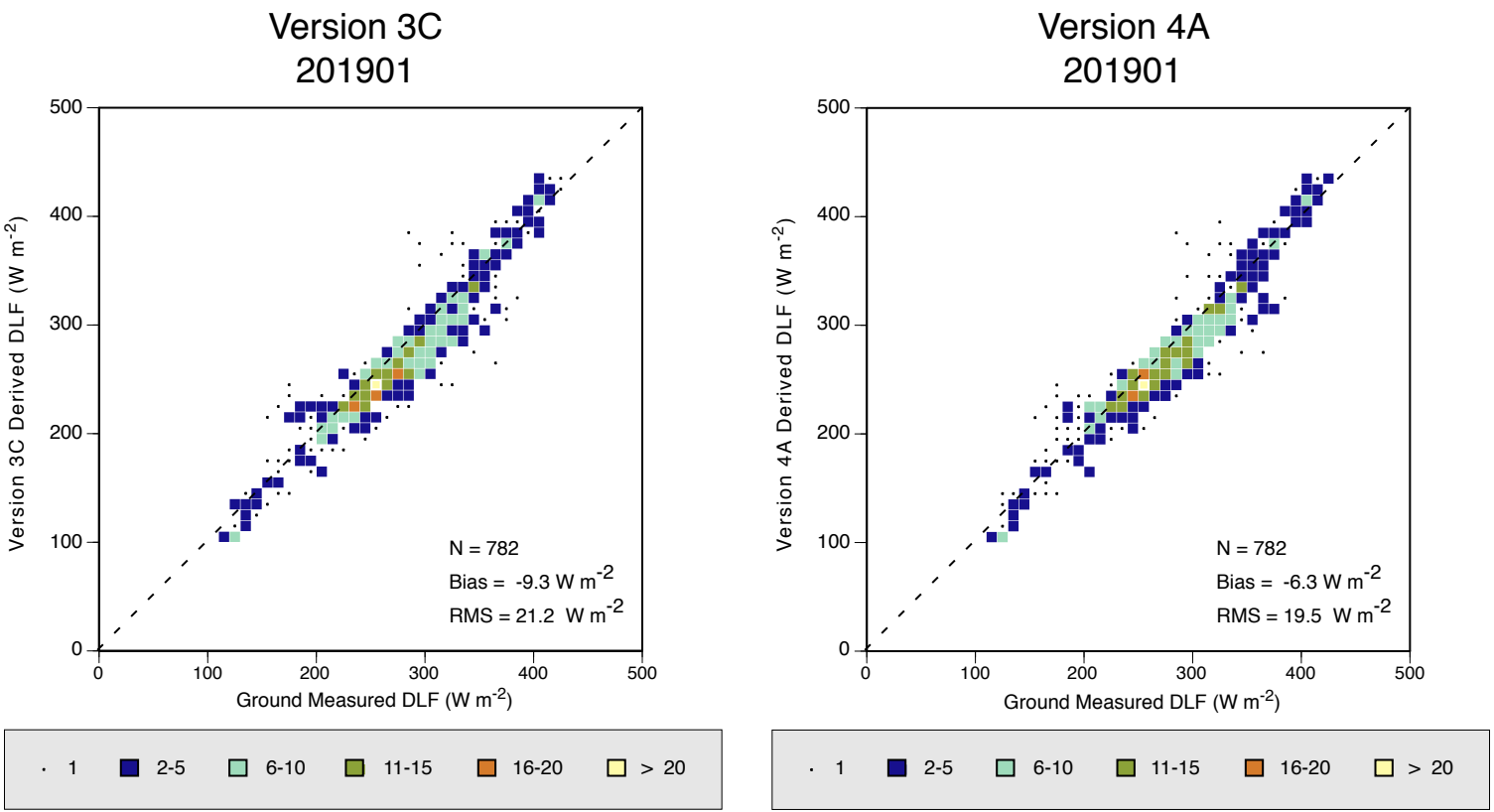
Terra Surface Nighttime LW Flux Differences (Jan 2019)



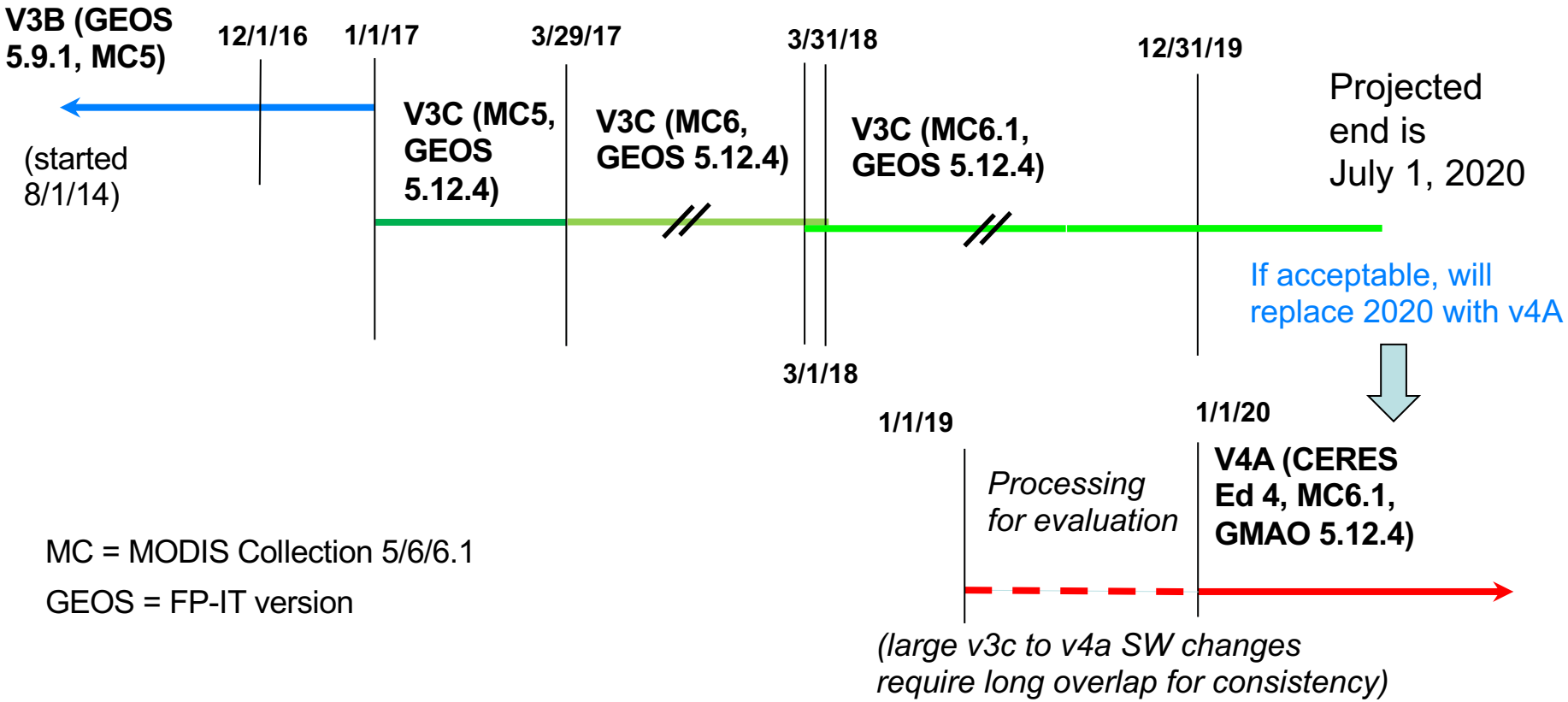
FF Version 4A TISA Results: Surf SW Down



FF Version 4A TISA Results: Surf LW Down



FLASHFlux V4A Transition Plans



MC = MODIS Collection 5/6/6.1

GEOS = FP-IT version

Longer-Term Future: Moving FLASHFlux Toward V5A

Attribute	FF v3C (MC6)	FF v4A	FF v4B	FF v5A
Baseline 1QC	Previous (Terra, Aqua)	Calibration Update Cycle (Terra, Aqua)	Calibration Update Cycle (Terra?, Aqua)	Calibration Update Cycle (N20, GEO)
GEOS FP-IT input	GEOS 5.12.4	GEOS 5.12.4	GEOS new version	GEOS new version
MOA	Ed 4 compatible	Ed 4 compatible	Ed 4 compatible	Ed 5(?) compatible
MODIS	Collection 6	Collection 6.1	Collection 6.1	Collection 7(?)
Clouds	Ed 2	Ed 4 w/ MC 6.1 calibration	Ed 4	Ed 4
SIBi (Snow/ICE Brightness Index)	No	Yes	Yes	Yes
Inversion (improved ADMs)	Ed 2	Ed 4	Ed 4	Ed 4
Aerosols	MATCH climatology	MATCH climatology	GEOS new version or updated MATCH	GEOS new version or updated MATCH
Flux Algorithm	Unchanged	Modified SW surface algorithm	A0, Ap adjustments; new clear-sky TOA & surface albedos (current work)	Updated or new algorithms(?)
TISA	Ed 2	Compatible w/ Ed 4 (current work)	Compatible w/ Ed 4 (custom CERES TSI?)	Compatible w/ Ed 5(?) (custom CERES TSI?)
Data Processed	March 28 - present	Planned to begin 1/1/19	None	None
Validation Results	1/1/17 – 12/31/19	1/1/2019 – 12/31/20?	1/1/2020 - ??	1/1/2020 - ??

Summary and Conclusions

- ***SOFA Group***
  - SOFA Ed4 paper revisions published; validation updated Terra, Aqua, NPP; new N20
- ***FLASHFlux 3C and 4A progress***
  - Continued 3C processing; operational version
  - Version4A compatible with CERES Ed 4; uses MODIS Collection 6.1
  - Version4A now processing beginning from Dec 1, 2019, now in April 2020
  - SSF comparisons show good agreement at TOA; calibration and angle differences at TOA
  - SSF surface fluxes show significant changes; especially over ice, still evaluating
  - ***Goal: FF v4A operational in July 2019 for transition to new year; begin data 1/1/20***
- ***FLASHFlux Applications:***
  - Datasets continuing being supplied and distributed through POWER web services; latency much improved after Jan recovery
  - CERES FF ordering past year ~100,000 unique ISP; nearly 30M orders; most low latency
- ***FLASHFlux Publications:***
  - 2019 SotC report submitted

FLASHFlux Web Sites:

https://flashflux.larc.nasa.gov

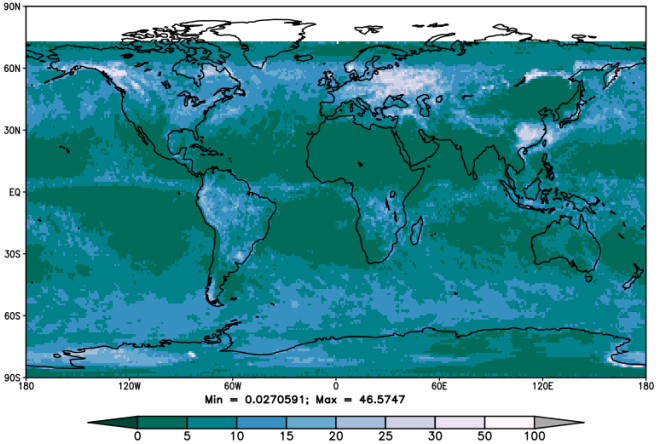
https://power.nasa.gov & https://power.nasa.gov

Extras

global = 7.11554 60–90N = 7.75053 60–90S = 7.75858 20N–20S = 5.46575
20–60N = 9.19332 20–60S = 6.91761

Cloud Optical Depth

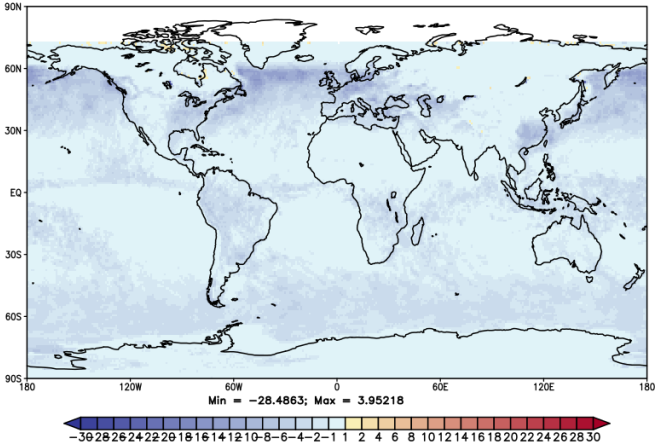
FM3 FF4A Mean JAN 2019



global = −1.46525 60–90N = −0.164059 60–90S = −0.829616 20N–20S = −1.17656
20–60N = −2.36021 20–60S = −1.33376

Cloud Optical Depth

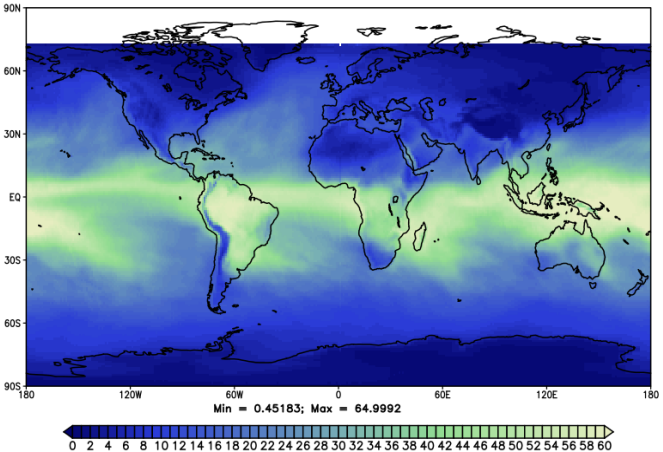
FM3 FF4A–CERES Mean JAN 2019



global = 23.9929 60–90N = 3.31894 60–90S = 4.84092 20N–20S = 42.3239
20–60N = 9.90391 20–60S = 22.6097

Day Precipitable H2O (kg m^{-2})

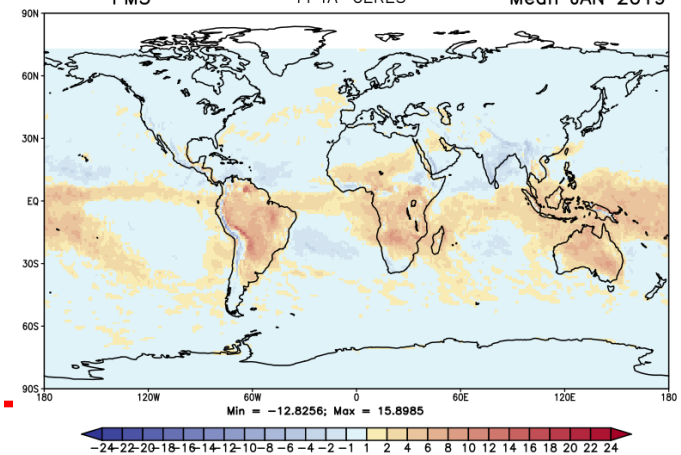
FM3 FF4A Mean JAN 2019



global = 1.18604 60–90N = 0.0456595 60–90S = 0.360053 20N–20S = 2.45457
20–60N = 0.0872846 20–60S = 1.03646

Day Precipitable H2O (kg m^{-2})

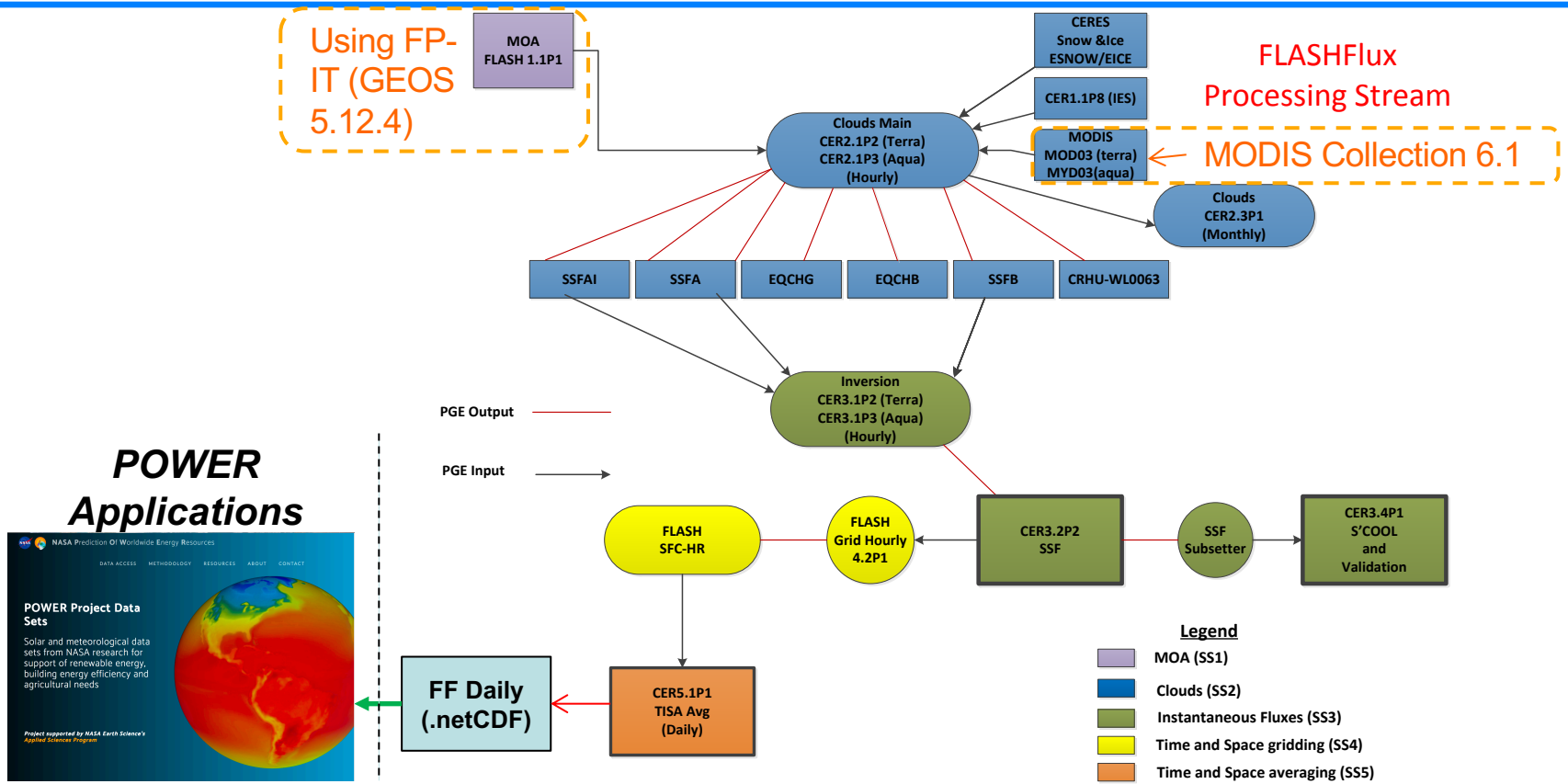
FM3 FF4A–CERES Mean JAN 2019



Near Future: Transition FLASHFlux V4A

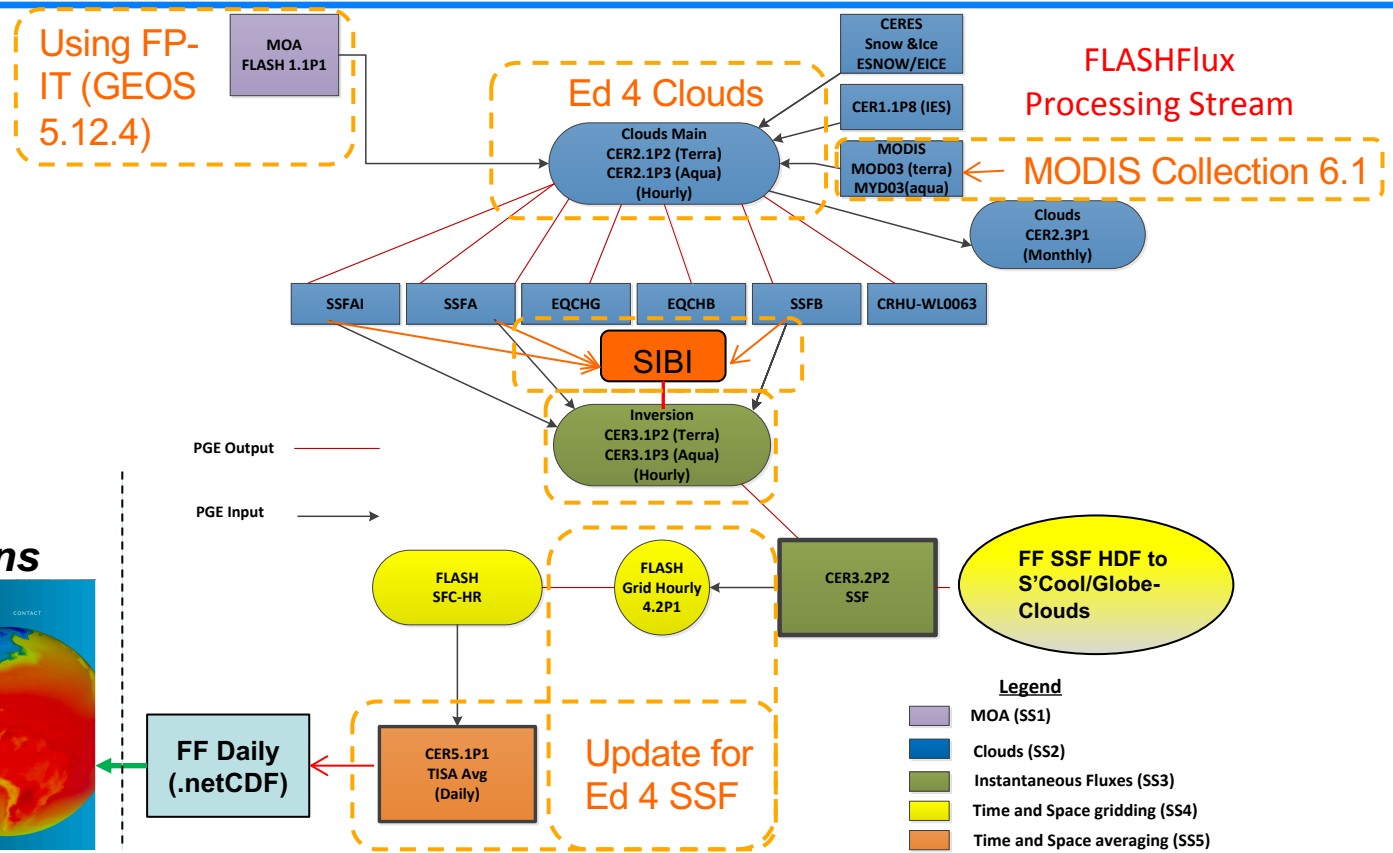
Attribute	FF v3C (MC6)	FF v4A
Baseline 1QC	Previous	New calibration
GEOS FP-IT input	GEOS 5.12.4	GEOS 5.12.4
MOA	Ed 4 compatible	Ed 4 compatible
MODIS	Collection 6	Collection 6.1
Clouds	Ed 2	Ed 4 w/ MC 6.1 calibration (current work)
SIBi (Snow/ICE Brightness Index)	No	Yes
Inversion (improved ADMs)	Ed 2	Ed 4
Aerosols	MATCH climatology	MATCH climatology
Flux Algorithms	Unchanged	Modified SW surface algorithm (current work)
TISA	Ed 2	Compatible w/ Ed 4 (current work)
Data Processed	March 28 - present	Planned to begin 1/1/19
Validation Results	1/1/17 – 6/30/18	---

Current v3C Production System



New v4A Production System

Initial data date Jan 1, 2019



POWER Applications