FLASHFlux Working Group Status: Transition to NOAA-20 and Future Upgrades

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CERES FLASHFlux Overview

- ***FLASHFlux Overview***
  - Uses CERES based production system through inversion (w/ quarterly calibration updates projected forward)
  - Running 3-day TISA utilizing morning and afternoon orbiters
- ***FLASHFlux Latency Objectives***
  - SSF products within 3-4 days
  - Global 1x1 daily averages from FF TISA; goal: 5-7 days latency
- ***FLASHFlux Uses***
  - Primarily used for applied science and education (i.e., POWER and Globe Clouds)
  - Supports also QC for selected missions (e.g., NOAA NESDIS)
  - TOA gridded fluxes; normalized to TOA EBAF for annual “State of the Climate” assessments .

FLASHFlux Operational Status

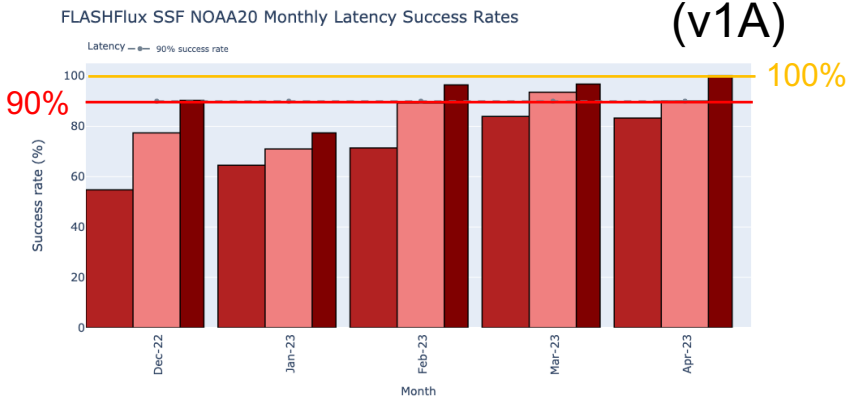
- ***FF Production System Updates:***
  - Began NOAA-20 FLASHFlux SSF (v1A; 3/1/23 back to 10/1/22)
  - Transitioned TISA from Terra+Aqua to Terra+NOAA-20 (v4B; processed back to 11/1/23)
- ***FF Production status:***
  - Current Status:
    - SSF Terra: 5/4/22; SSF Aqua: 3/31/23 (stopped on March 31)
    - SSF NOAA-20: began 3/1/23; currently 5/4/23 (processed back to 10/1/22)
    - TISA (Terra+NOAA-20): 5/2/23
  - Updated calibration coefficients received; promoted as cc change effective 4/1/23

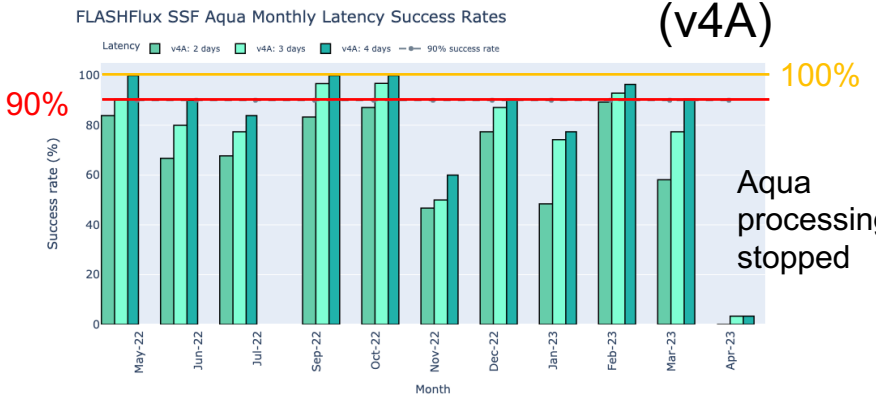
FLASHFlux SSF Latency Assessment

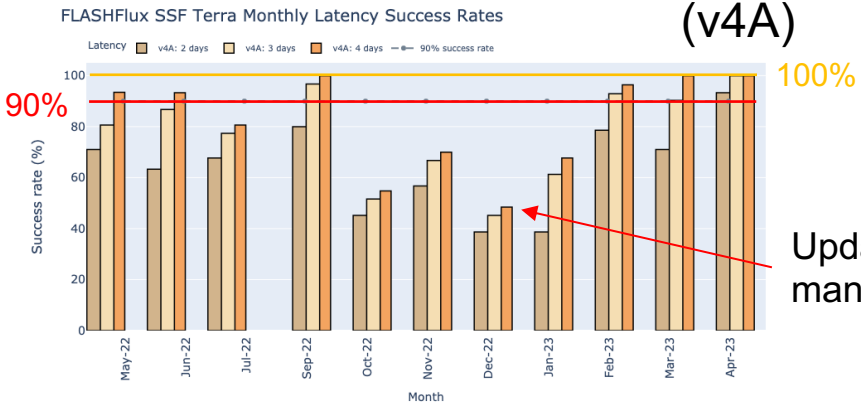
Success rate (%) of time data archived within 2, 3, or 4 days of observation

Lags due to: maneuvers/satellite issues, ASDC updates/outages, ASDC Dropbox/Darkhorse, GSFC LAADS and/or SIPS

SSF utilized for operational satellite algorithm comparisons (i.e., NOAA GOES ABI); Applications like Solar Irradiance Forecasting and Educational applications like GLOBE Clouds.



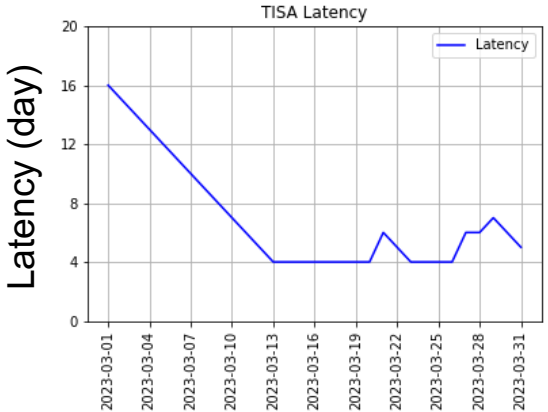


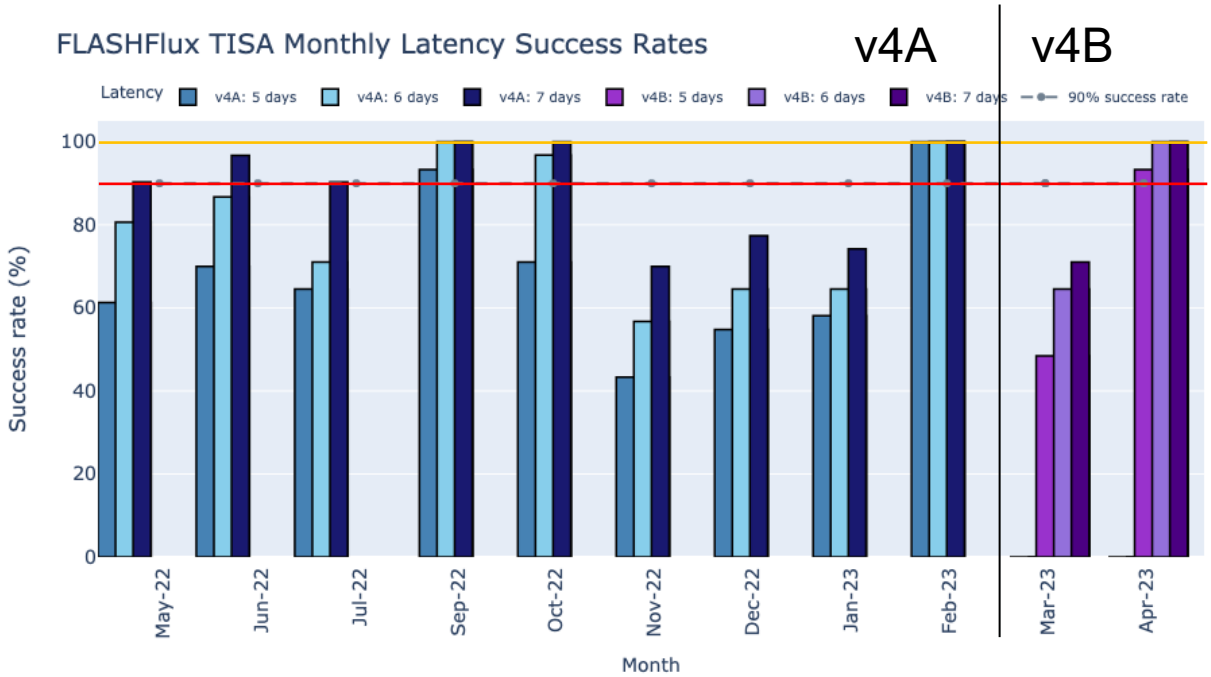


TISA Latency Statistics (v4A/v4B)

v4A success rates for TISA to be archive in 5, 6 or 7 days after observation

v4B began production in March 2023





FLASHFlux Data Delivery via POWER Web Services Portal (2022/05/01 to 2023/04/30)

CERES Data Orders Delivered via POWER < 3 weeks latency (FLASHFlux Data)

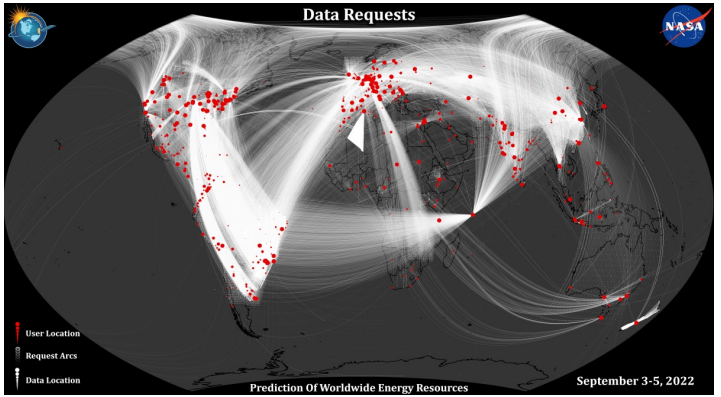
	Total	Monthly	Avg. Last 3 Months
Unique Users IPs	~30.8 K (12%)	~3.2 K (13%)	~4.1 K (13%)
Requests	~28.8 M (26%)	~2.4 M (25%)	~3.2 M (31%)

CERES Data Orders Delivered via POWER including SYN1Deg and FLASHFlux data

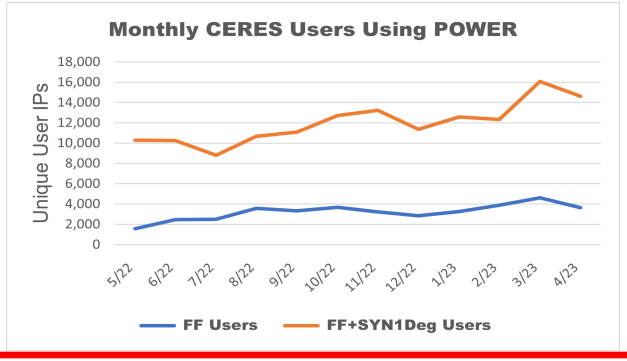
	Total	Monthly	Avg. Last 3 Months
Unique Users IPs	~123.6 K (50%)	~12 K (49%)	~14.3 K (46%)
Requests	~ 66.9 M (59%)	~5.58 M (59%)	~5.14 M (50%)

(includes SYN1Deg from Sep 2001 through latest month released)

Dot density map showing locations of users (red) and data request locations (white). Brighter colors show larger frequency at that location.



Accu-mulated over 3 days



Total FF+ SYN1Deg users 50-60% increase

FF users ~2X during last year

FF SSF SW Flux Validation: 01/2019-12/2022

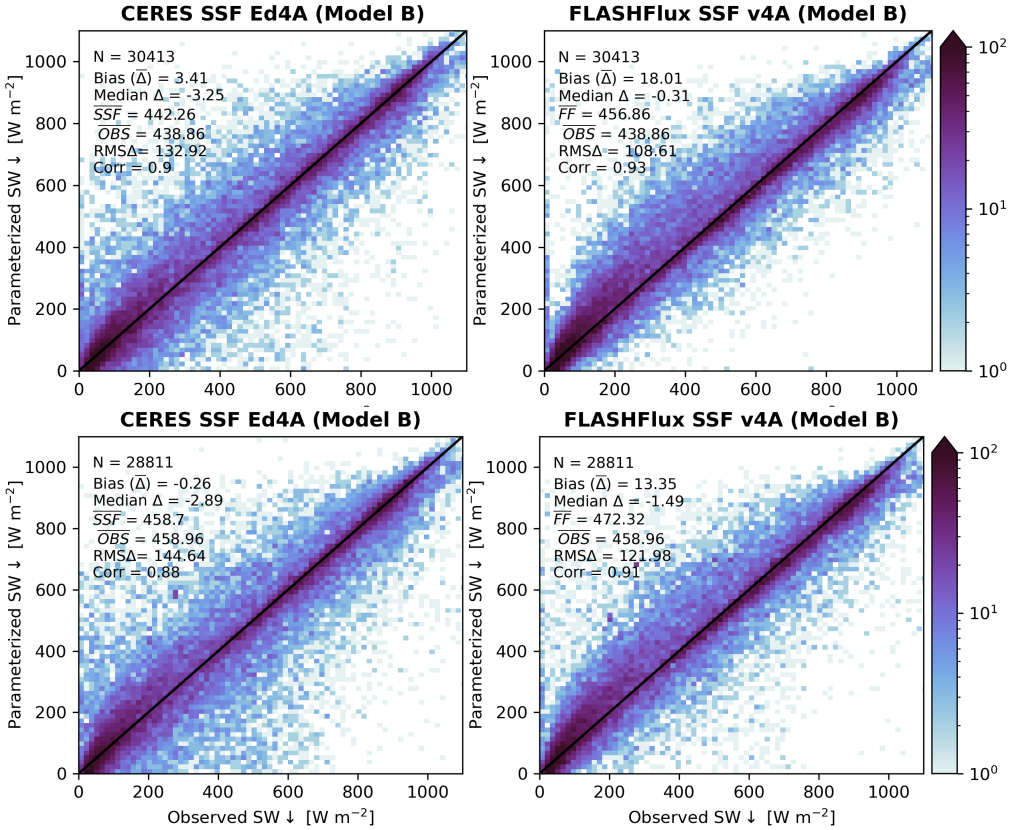
Overpass SW flux validation with BSRN measurements:

- Left CERES SSF (Model B)
- Right FLASHFlux SSF (Model B)
- Top Aqua, Bottom Terra

Both FLASHFlux SW Aqua and Terra radiative fluxes show larger bias but better RMS than CERES SSF (both biases < 5%; RMS < 27%)

SW Aqua

SW Terra

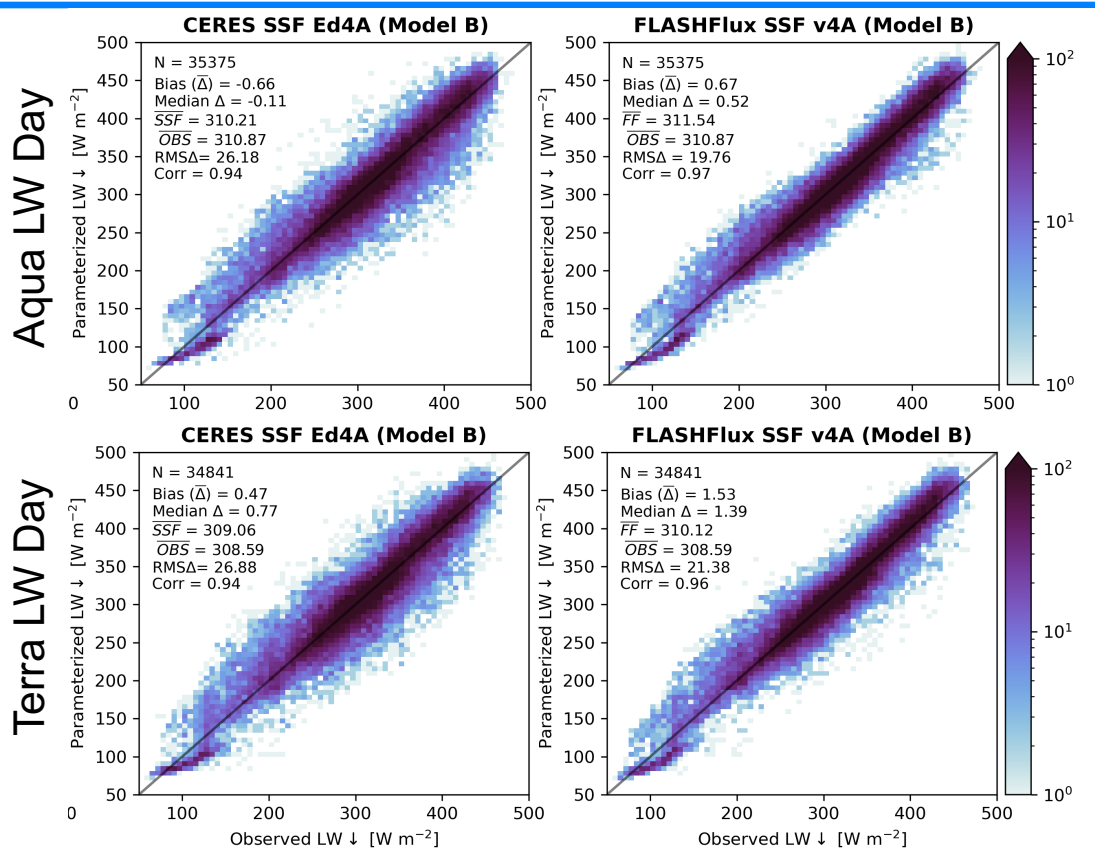


FF SSF LW Flux Validation: 01/2019-12/2022

Overpass LW daytime flux validation with BSRN measurements:

- Left CERES SSF (Model B)
- Right FLASHFlux SSF (Model B)
- Top Aqua, Bottom Terra

Both FLASHFlux SW Aqua and Terra radiative fluxes show equivalent biases but FF a better RMS than CERES SSF (both biases < 1%; RMS's < 7%)



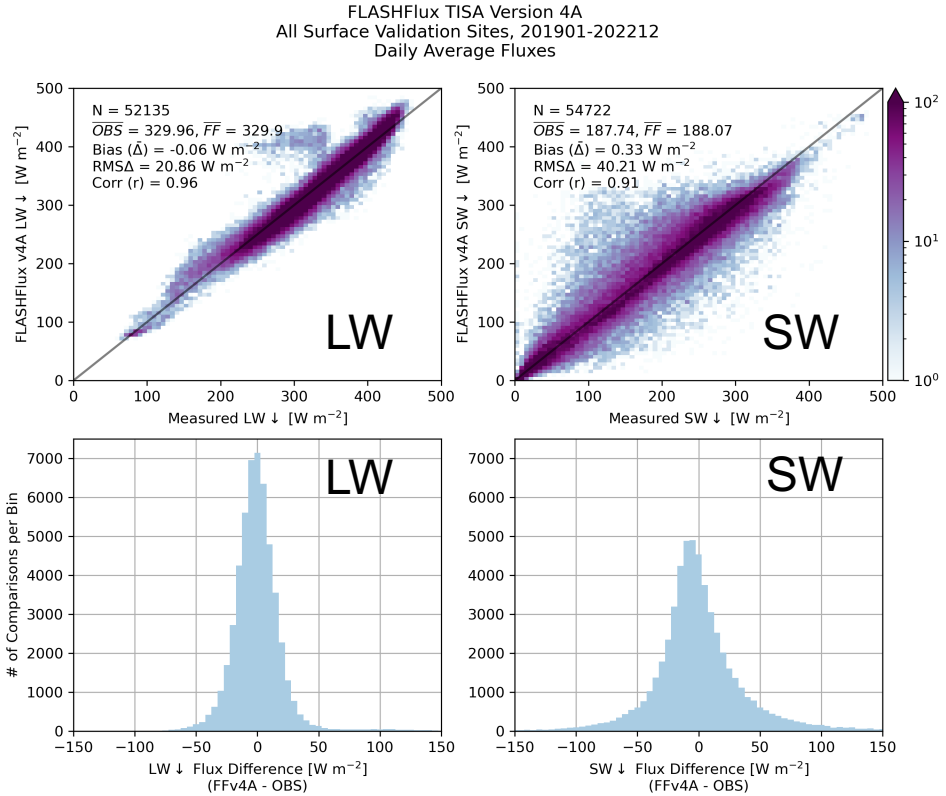
FLASHFlux TISA Validation: Surface Fluxes

Ensemble FLASHFlux Version4A LW and SW Daily Average Comparisons to Surface Measurements (01/2019-12/2022)

LW: Bias -0.01 W m^{-2} (<< 1%)
RMS 20.9 W m^{-2} (~7%)

SW: Bias 0.3 W m^{-2} (<< 1%)
RMS 40.2 W m^{-2} (~22%)

Histograms show peaked, relatively symmetric distributions, median bias is negative for LW, positive for SW



Assessing FLASHFlux with NOAA-20 (FM-6)

FF NOAA-20 (v1A) began operations 10/1/22

FF TISA Terra+NOAA20 (v4B) began operations 3/10/23

SSF Validation: CERES Ed4 vs FF v4B

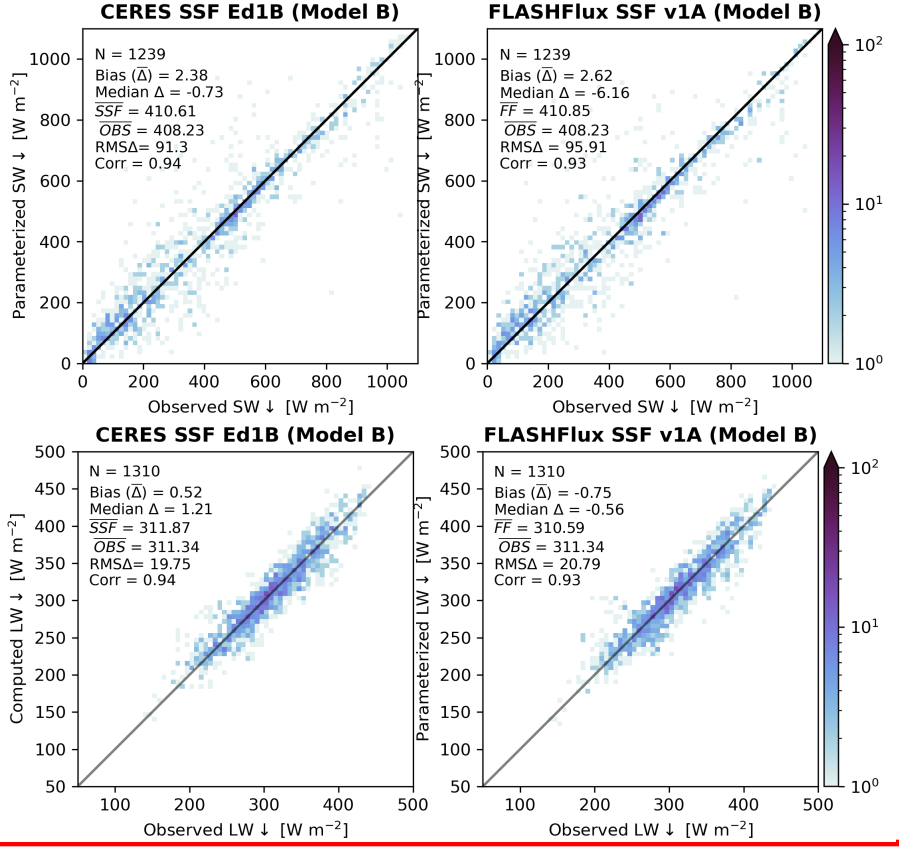
NOAA-20 SSF Surface SW between CERES SSF Ed1B and FF SSF v1A (Oct – Dec 2022)

SW

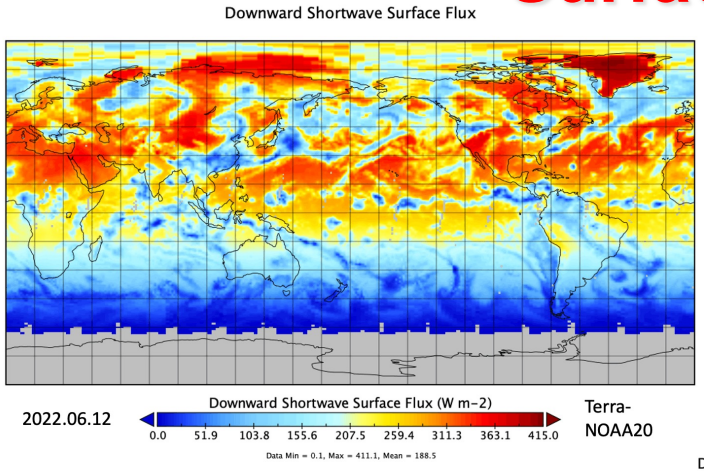
- SW downwelling fluxes show very similar statistics with RMS ~22-23%

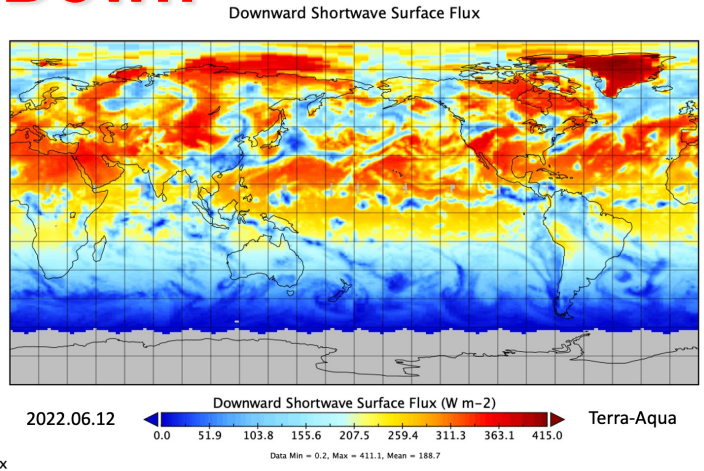
- LW downwelling fluxes very similar with RMS <7%

LW

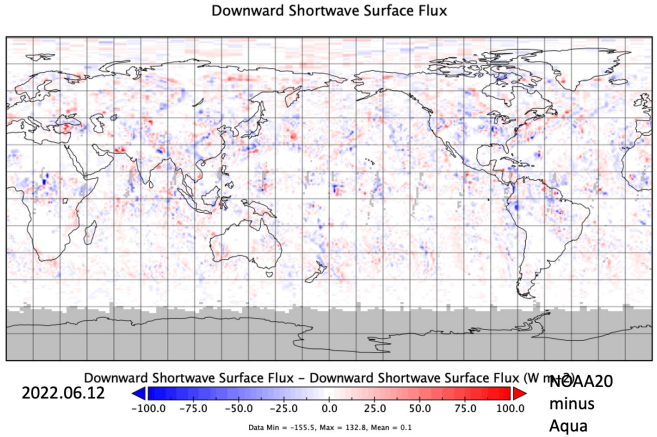


Surface SW Down





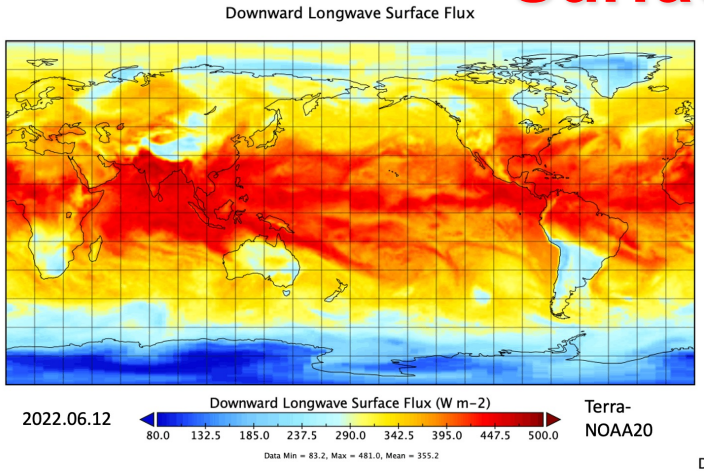
NOAA20 + Terra



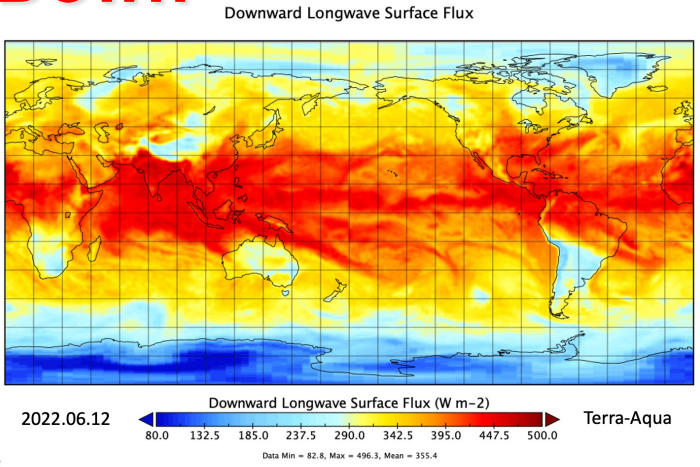
Aqua + Terra

Differences Terra-NOAA20 minus Terra-Aqua

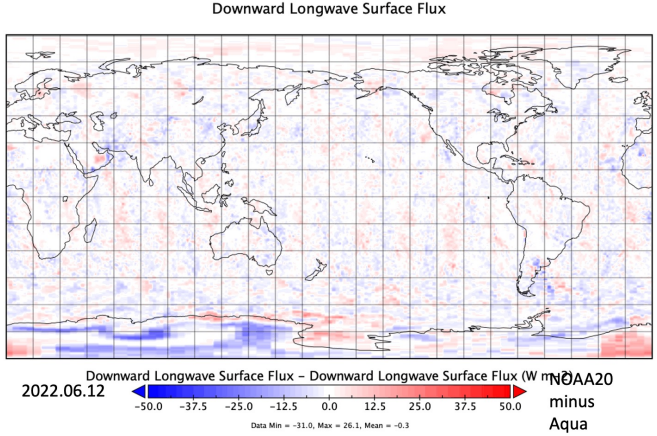
Surface LW Down



NOAA20 + Terra



Aqua + Terra



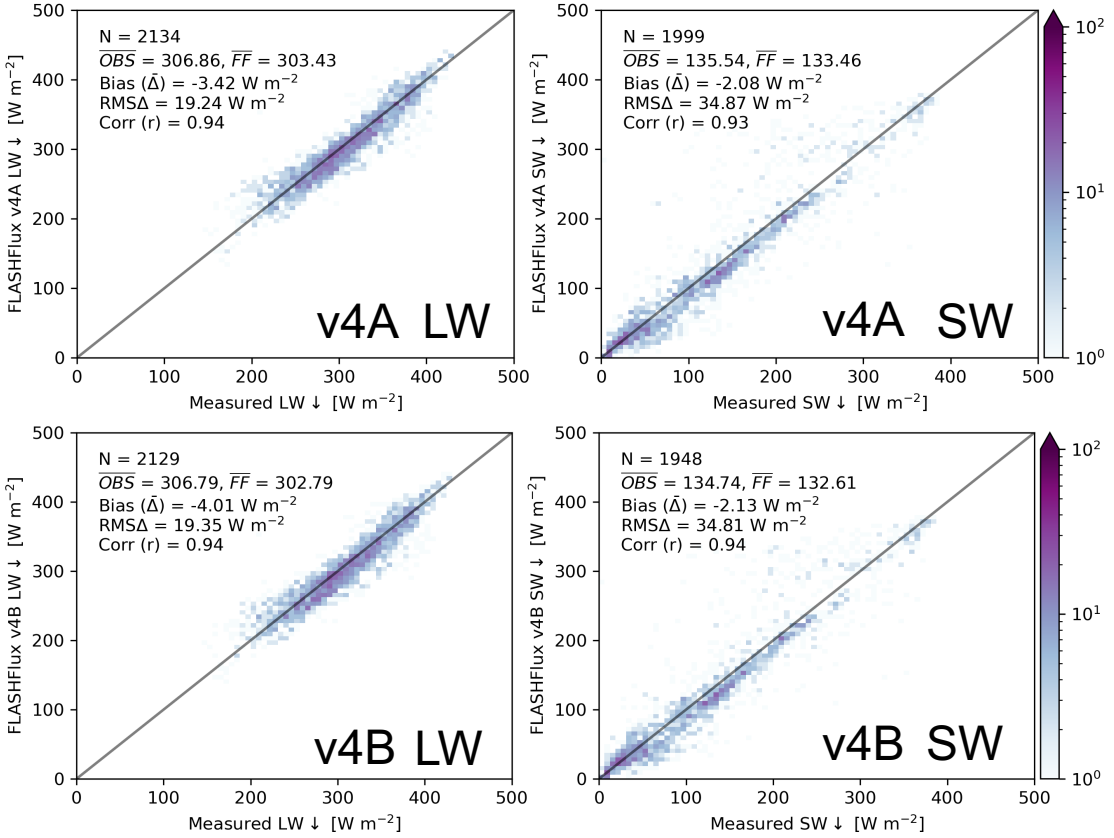
Differences Terra-NOAA20 minus Terra-Aqua

FLASHFlux TISA Validation: V4A vs V4B

Comparison Daily Averaged Surface LW (left) and SW (right) of v4A (top) and v4B (bottom) (Oct – Dec 2022)

Both downwelling fluxes show very similar statistics between v4A and v4B:

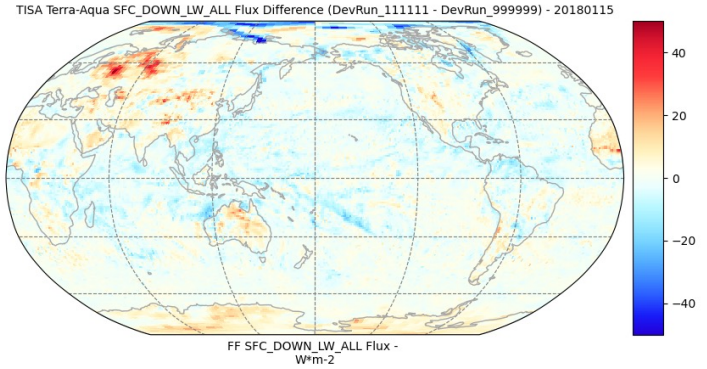
- LW RMS's: ~6%
- SW RMS's: ~25%



Assessing GEOS-IT:
All-Sky Surf LW Down Differences (Jan, Jun 15, 2018)

Jan All-Sky Surf LW Down (w/ GEOS-IT – FP-IT)

Units: W m^{-2}



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.2022	5.007	3.3027
60-90N	-0.6161	8.9421	5.545
30-60N	0.8929	5.5597	3.5622
0-30N	-1.3146	4.5707	3.255
0-30S	-1.0147	4.5295	3.3025
30-60S	0.3348	2.684	1.8724
60-90S	2.9375	3.8006	2.9726

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	1.0896	5.8561	4.2557
60-90N	2.1292	6.1036	4.1667
30-60N	2.7896	5.99	4.0231
0-30N	0.5619	6.0614	4.7003
0-30S	-0.0866	5.6067	4.2508
30-60S	1.4698	4.3045	3.3297
60-90S	1.9914	2.8992	2.0752

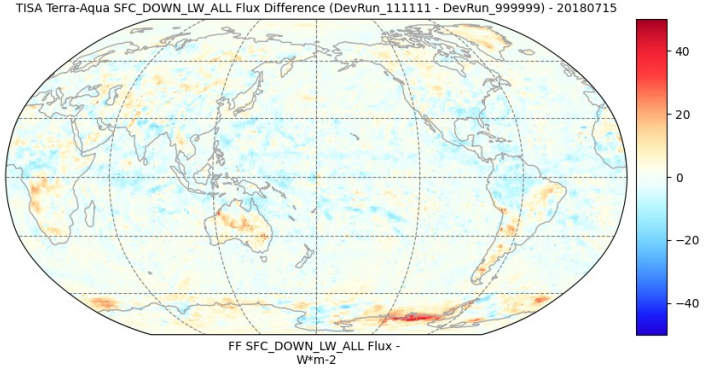
Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-1.0672	3.3112	2.4463
60-90N	0.1668	2.0783	1.4767
30-60N	-1.2261	2.8224	2.1052
0-30N	-2.3038	3.1116	2.3095
0-30S	-1.3694	3.9864	2.9847
30-60S	0.2371	2.4718	1.741
60-90S	0.5652	1.4897	1.1012

Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	1.3466	8.1657	5.2576
60-90N	-1.1343	9.7683	6.3311
30-60N	1.9059	7.0955	4.7145
0-30N	--	--	--
0-30S	--	--	--
30-60S	--	--	--
60-90S	4.8224	4.0603	3.2039

July All-Sky Surf LW Down (w/ GEOS-IT – FP-IT)



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.2574	4.1239	2.8615
60-90N	0.9618	3.1469	2.2283
30-60N	-0.0383	3.5326	2.5815
0-30N	-1.7314	3.7796	2.817
0-30S	-0.6223	4.3731	3.0701
30-60S	0.2173	2.532	1.7782
60-90S	3.4908	6.5413	4.4537

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.2018	4.8701	3.6308
60-90N	0.8823	3.2476	2.3917
30-60N	0.1595	4.1189	3.1417
0-30N	-1.3231	4.751	3.6562
0-30S	1.079	6.1544	4.7405
30-60S	1.9123	4.2945	3.2095
60-90S	4.7377	5.3338	3.9246

Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.9301	2.934	2.1847
60-90N	-0.023	1.5748	1.0871
30-60N	-0.3037	2.5253	1.8315
0-30N	-1.9465	3.1282	2.3705
0-30S	-1.2713	3.232	2.4018
30-60S	0.028	2.1429	1.6073
60-90S	1.007	1.9178	1.3973

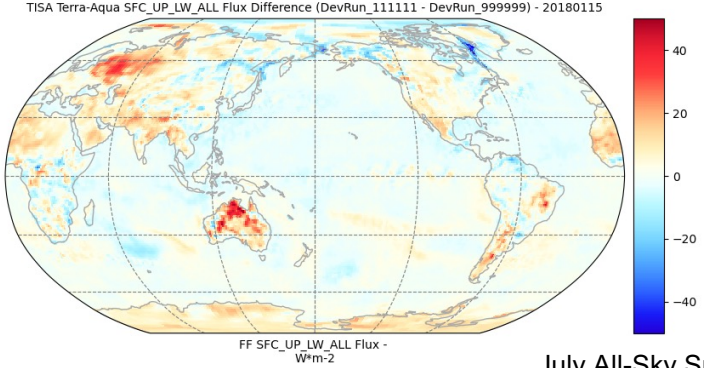
Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	3.1215	6.2475	4.2442
60-90N	1.6497	3.3818	2.3853
30-60N	0.2578	4.4484	3.6579
0-30N	--	--	--
0-30S	--	--	--
30-60S	1.9391	5.2355	3.6273
60-90S	3.6415	6.8675	4.6902

Assessing GEOS-IT:
All-Sky Surf LW Up Differences (Jan, Jun 15, 2018)

Jan All-Sky Surf LW Up (w/ GEOS-IT – FP-IT)

Units: W m^{-2}



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.7063	5.781	3.7996
60-90N	-0.259	8.6218	6.131
30-60N	1.1119	6.606	4.6927
0-30N	-0.0823	5.4453	3.7099
0-30S	0.7684	5.726	3.3114
30-60S	0.5183	3.4994	2.2664
60-90S	3.9171	4.7563	3.9886

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	3.6851	8.1257	6.1329
60-90N	3.0366	7.1518	5.276
30-60N	4.3661	7.177	5.3213
0-30N	3.5397	7.7693	6.404
0-30S	3.2538	9.7663	6.9855
30-60S	4.2934	7.2743	5.6802
60-90S	3.0629	4.4838	3.1943

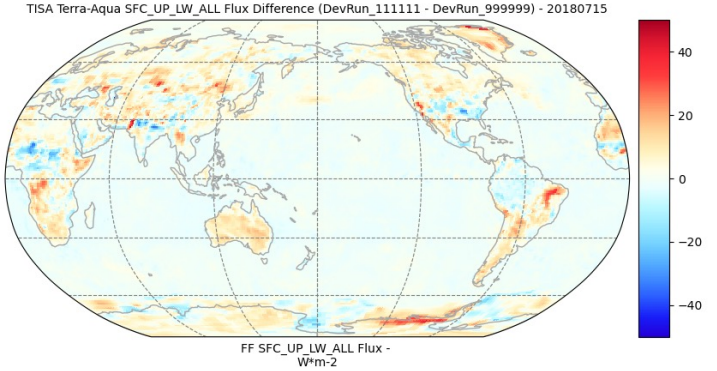
Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.7706	2.4263	1.8183
60-90N	-0.8166	2.157	1.3181
30-60N	-1.9873	1.7319	1.2351
0-30N	-1.9916	1.697	1.1981
0-30S	-0.1794	2.3799	1.8121
30-60S	0.1928	2.7212	1.9231
60-90S	0.3398	1.4318	1.1518

Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	2.0713	8.5242	6.363
60-90N	-0.552	9.1823	6.8356
30-60N	1.9016	8.454	6.2583
0-30N	--	--	--
0-30S	--	--	--
30-60S	--	--	--
60-90S	6.7714	4.4966	3.6579

July All-Sky Surf LW Up (w/ GEOS-IT – FP-IT)



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.4558	4.8404	3.124
60-90N	2.6394	4.4932	3.1847
30-60N	2.1239	5.3822	3.7888
0-30N	-0.6762	4.6533	2.457
0-30S	-0.0877	4.6375	2.8057
30-60S	-0.5363	2.2672	1.1776
60-90S	2.6195	7.0734	5.2586

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	2.5901	6.9393	5.1399
60-90N	2.8004	4.305	3.2776
30-60N	3.3341	6.6321	4.829
0-30N	0.4513	7.6833	5.3946
0-30S	3.7198	7.4844	6.1353
30-60S	3.454	4.9894	4.2688
60-90S	4.0499	6.5	4.9848

Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.9836	1.3433	0.9172
60-90N	0.6914	1.6645	1.1771
30-60N	0.5105	2.1131	1.6092
0-30N	-1.2703	0.9657	0.7409
0-30S	-1.5402	0.8372	0.6215
30-60S	-0.9322	0.9449	0.7003
60-90S	-0.3856	0.8113	0.5746

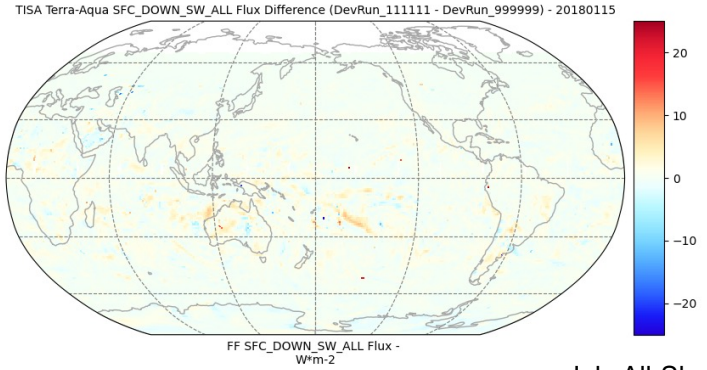
Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	2.8504	6.9813	5.0604
60-90N	3.3105	5.5042	3.7406
30-60N	3.4584	5.058	4.403
0-30N	--	--	--
0-30S	--	--	--
30-60S	-0.5793	7.022	5.1913
60-90S	2.8197	7.3907	5.5166

Assessing GEOS-IT:
All-Sky Surf SW Down Differences (Jan, Jun 15, 2018)

Jan All-Sky Surf SW Down (w/ GEOS-IT – FP-IT)

Units: W m^{-2}



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.3256	1.2395	0.6406
60-90N	0.0069	0.104	0.0559
30-60N	0.0906	0.5979	0.2957
0-30N	0.3564	1.3674	0.6076
0-30S	0.6011	1.6551	0.9283
30-60S	0.3453	0.9664	0.6055
60-90S	-0.1186	0.7356	0.5311

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.3892	1.4859	0.7375
60-90N	0.0224	0.1725	0.0886
30-60N	0.1038	0.5725	0.3273
0-30N	0.3553	1.1154	0.7458
0-30S	0.7061	2.2209	0.9846
30-60S	0.638	1.8765	1.0129
60-90S	-0.0323	0.6355	0.4463

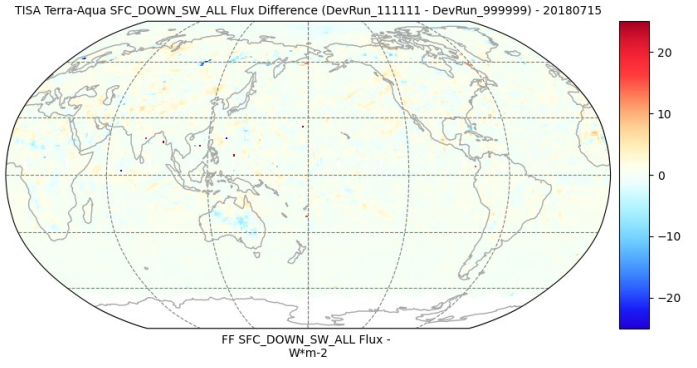
Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.3686	1.1725	0.6223
60-90N	0.0064	0.0643	0.0433
30-60N	0.1675	0.3832	0.2686
0-30N	0.3566	1.4832	0.535
0-30S	0.5611	1.378	0.9057
30-60S	0.3201	0.8386	0.5641
60-90S	0.0455	0.4541	0.3335

Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	-0.1166	0.7924	0.3992
60-90N	0.0047	0.0957	0.0535
30-60N	-0.0629	0.8574	0.28
0-30N	--	--	--
0-30S	--	--	--
30-60S	--	--	--
60-90S	-0.2578	0.8872	0.6803

July All-Sky Surf SW Down (w/ GEOS-IT – FP-IT)



Global Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.3463	1.3742	0.6158
60-90N	0.2525	1.4276	0.8214
30-60N	0.5452	1.1358	0.7648
0-30N	0.3732	2.1917	0.726
0-30S	0.3601	0.864	0.5889
30-60S	0.1551	0.3576	0.2343
60-90S	-0.0103	0.2188	0.0727

Land Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.4401	1.2656	0.8032
60-90N	0.3522	1.6706	0.9287
30-60N	0.6271	1.2434	0.851
0-30N	0.4247	1.2375	0.7941
0-30S	0.292	1.135	0.7551
30-60S	0.1985	0.672	0.4263
60-90S	-0.0241	0.1411	0.0741

Ocean Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.3111	1.4428	0.5094
60-90N	0.2302	0.8498	0.5164
30-60N	0.4303	0.9533	0.631
0-30N	0.3459	2.5569	0.687
0-30S	0.3861	0.7331	0.5279
30-60S	0.1525	0.3094	0.2145
60-90S	0.0183	0.0868	0.0572

Snow/Ice Statistics

Diff Stats	Mean	StdDev	Mean Abs Difference
Global	0.0499	0.8537	0.5145
60-90N	0.0523	0.9926	0.7184
30-60N	2.2652	1.8424	1.3928
0-30N	--	--	--
0-30S	--	--	--
30-60S	0.0127	0.3117	0.1875
60-90S	-0.0246	0.272	0.0822

FLASHFlux Future Production Strategy

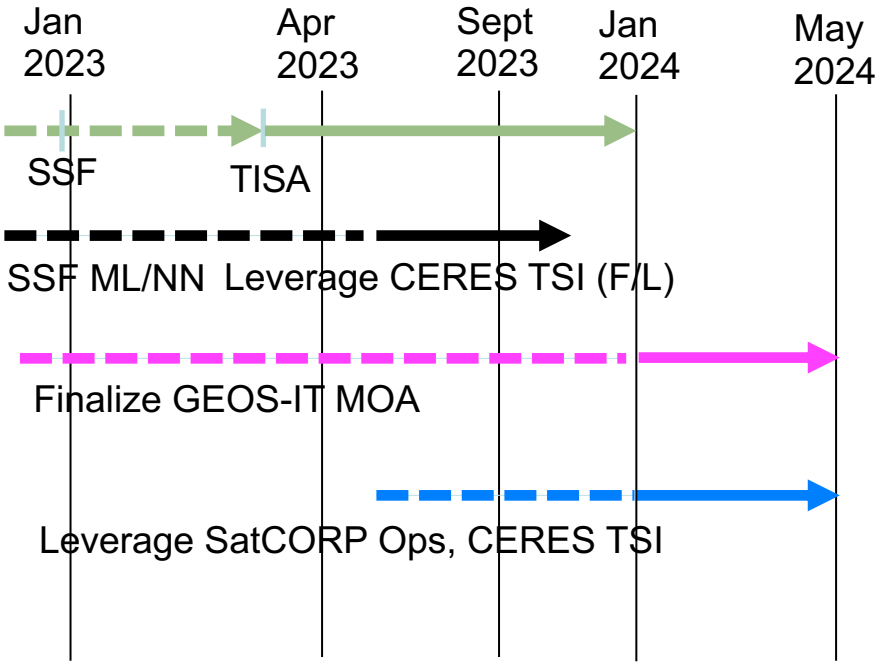
- Both Terra and Aqua are scheduled to be turned off in 2023; production system must be modernized and adjusted to continue production
- Current Plan:

FF NOAA-20 to Operations for SSF (v1A) and add to TISA (v4B)

Upgrade SSF/TISA RT algorithms

Update to GEOS-IT (Evaluate aerosols)

Processing GEO for FF (replace lost morning orbit)



FLASHFlux Summary

- ***Production with NOAA-20 SSF and TISA v4B Begun***
  - Operational FF NOAA-20 v1A SSF (11/1/22) and TISA v4B (since Jan 1, 2019); Aqua SSF ceased 3/31/23
  - SSF Terra/NOAA-20 through 5/4; TISA through 5/2
  - New FF Gain+Spectral coefficients beginning April 1st, 2023.
- ***Validation and Assessment***
  - FLASHFlux SSF surface fluxes relative to BSRN for 01/2019 through 12/2022
  - TISA Daily averages relative to BSRN for Jan 2019 through Dec 2022 (48 months)
- ***FLASHFlux Modernization and Updates***
  - NOAA-20 SSF data product; Goal Nov 2022; completed
  - Terra+NOAA-20 TISA data product; Goal Mar 2023; completed
  - New GEOS-IT sample data; first cut comparisons to FP-IT (still assessing); Goal Apr 2023; done
  - ML non-linear Tree based algorithms for future FF SSF data products; Goal Oct 2023
  - Migrate configuration to NOAA-20 + GEO/GEOS-1 (leveraging Ed5 TSI); Goal Dec 2023
- ***FLASHFlux Information & Data Provision Through ...***
  - CERES web site and subsetter both SSF and TISA, ASDC (via EarthData) and POWER
    - FF+Syn1 POWER Distribution in last year: ~124K unique IPs; > 64M orders; orders >44% low latency
  - 2022 BAMS State of the Climate TOA Flux reports submitted

FLASHFlux Web Sites

https://ceres.larc.nasa.gov/data/#fast-longwave-and-shortwave-flux-flashflux

Data also served through
https://power.nasa.gov