FLASHFlux Working Group Status: Operations with GEOS-IT and moving to GEO

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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 .

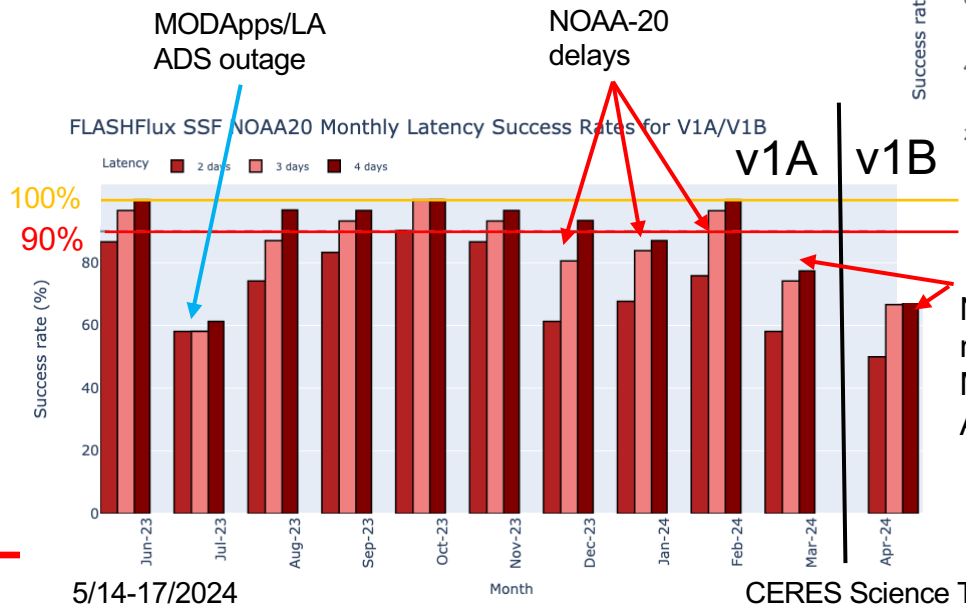
FLASHFlux Operational Status

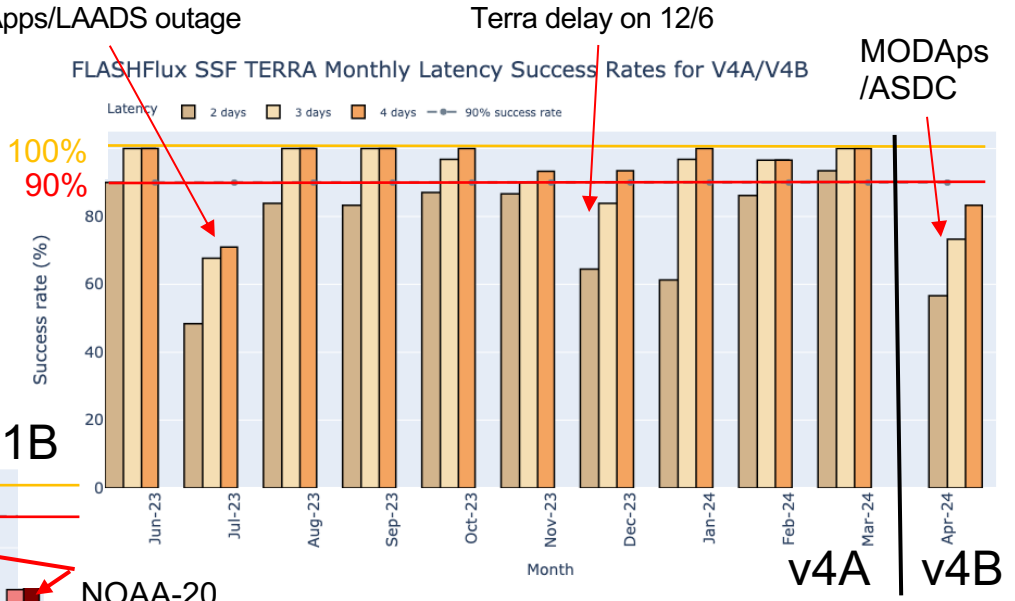
- ***FF Production System Updates:***
  - Continuing FF SSF production, now with GEOS-IT:
    - Terra V4B SSF (since April 1, 2024)
    - NOAA-20 V1B SSF (since April 1, 2024)
  - TISA (Terra+NOAA-20, V4C) operational with GEOS-IT since April 1, 2024
- ***FF Production status:***
  - Current Status:
    - SSF Terra (V4B): 5/12/24; SSF NOAA-20 (V1B): 5/12/24
    - TISA V4C (Terra+NOAA-20): 5/10/24 (processed back to 10/1/23)
  - Updated calibration coefficients received & promoted as cc change effective 4/1/24
- ***Important Activities since last CERES Meetings:***
  - Promoted to operations production with GEOS-IT (still performing quality assessments)
  - Investigated production environment updates/data quality issues
  - Investigating data quality due NOAA-20 orbit repositioning
  - Developing new footprint flux algorithms utilizing a NN/ML approach
  - Developing a new TISA that is more compatible with CERES TISA (SYN1Deg) which requires operational processing of GEO data

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

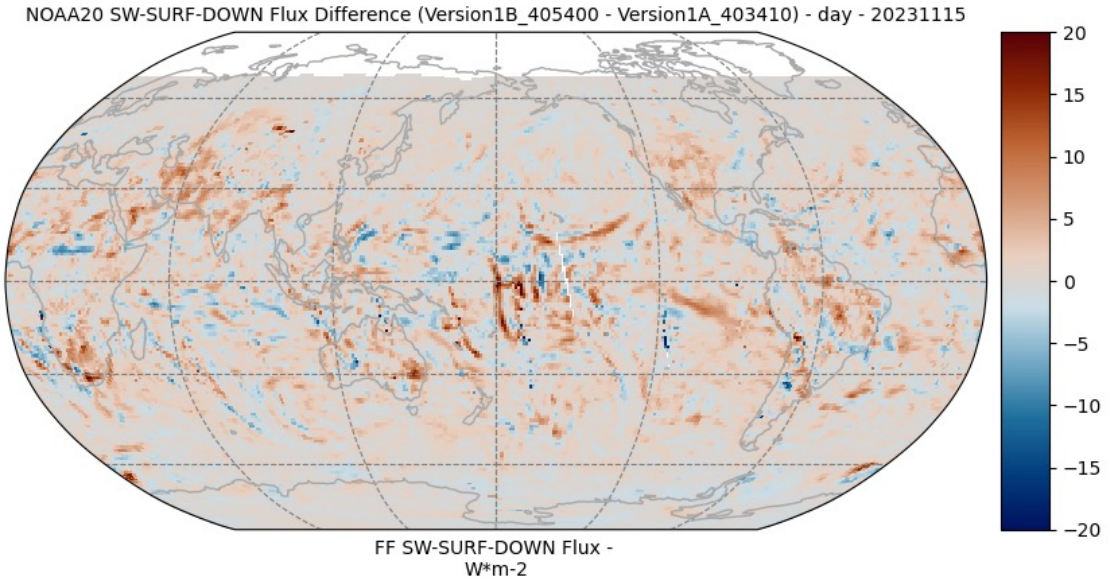


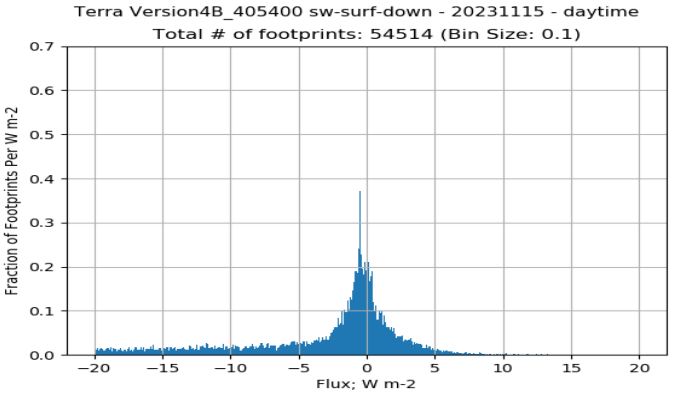


Latency for April 2024:
Terra SSF: < 90% even at 4 days
NOAA-20 SSF: < 70% even at 4 days

Assessing Transition to GEOS-IT: Surface SW Down

SW Surface Down: NOAA-20 Daytime (11/15/2023)



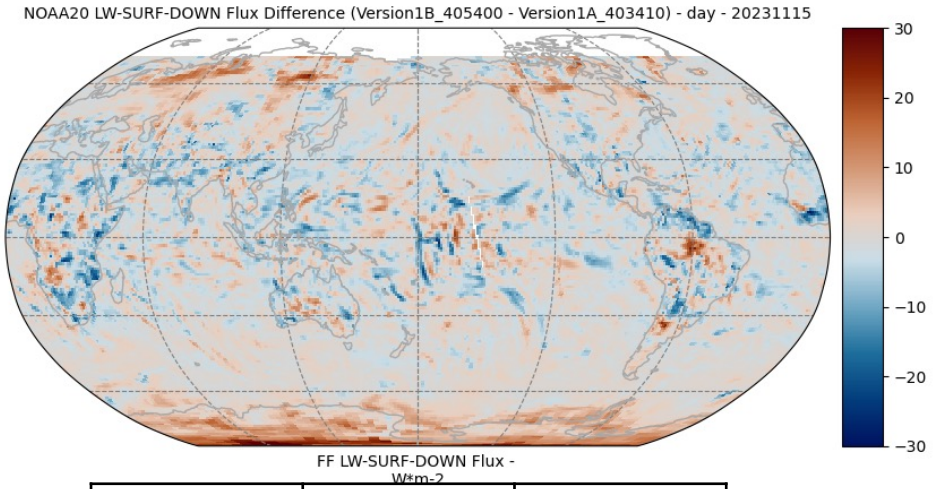


Global Stats	Difference	Standard Deviation
11/15/23	0.793	2.523
11/30/23	0.582	2.578
12/02/23	0.557	2.524
12/15/23	0.632	2.625

Assessing Transition to GEOS-IT: Surface LW Down

LW Surf Down: NOAA-20 Daytime (11/15/2023)

	GLOBAL		Land		Ocean	
Units: W*m-2	Mean Diff	SD	Mean Diff	SD	Mean Diff	SD
Global Avg	-0.4787	4.2827	0.3466	4.9742	-0.9497	3.7521
60-90 deg N	1.6986	4.4569	1.9966	5.0581	-0.5925	4.1015
30-60 deg N	-0.3235	3.3275	0.0839	3.495	-0.8851	2.9921
0-30 deg N	-1.9294	5.0258	-1.4847	4.4929	-2.1621	4.4202
0-30 deg S	-1.0178	4.5001	-0.9372	5.1372	-1.0484	4.233
30-60 deg S	-0.0952	2.3087	-0.5719	3.4048	-0.0542	2.184
60-90 deg S	4.0887	4.8331	5.7303	5.056	1.3792	2.8163

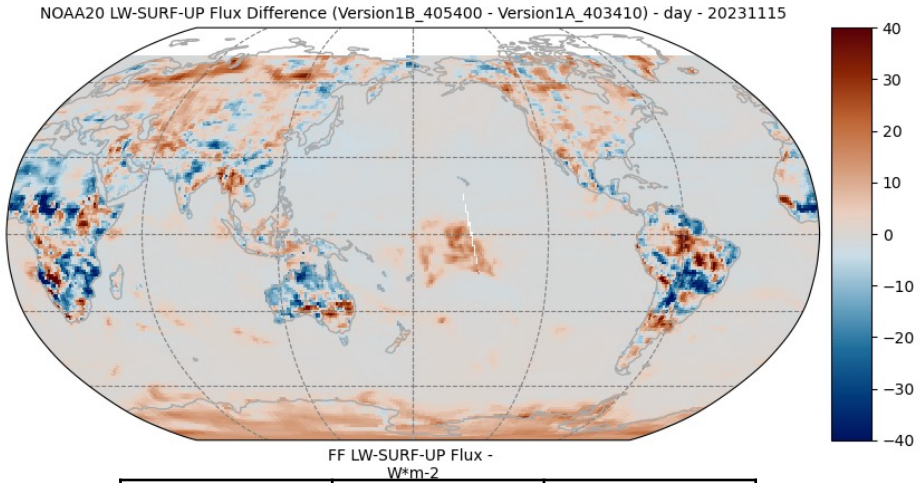


Global Stats	Difference	Standard Deviation
11/15/23	-0.479	4.283
11/30/23	-0.184	4.339
12/02/23	-0.233	4.378
12/15/23	-0.504	4.093

Assessing Transition to GEOS-IT: Surface LW Up

LW Surf Up: NOAA-20 Daytime (11/15/2023)

	GLOBAL		Land		Ocean	
Units: W*m-2	Mean Diff	SD	Mean Diff	SS	Mean Diff	SD
Global Avg	-0.0249	6.8454	1.2158	7.4886	-0.733	6.3418
60-90 deg N	3.1857	6.9795	3.6934	8.156	-0.7179	7.2343
30-60 deg N	0.4514	5.0409	1.2357	5.3201	-0.6296	4.4054
0-30 deg N	-1.8189	8.1774	-0.877	4.9099	-2.3118	7.8026
0-30 deg S	-0.7664	8.7536	-0.7688	11.0538	-0.7655	7.7036
30-60 deg S	0.3569	3.3134	-0.0907	6.2193	0.3955	2.9285
60-90 deg S	5.051	5.0699	6.9646	5.0675	1.8924	3.1179



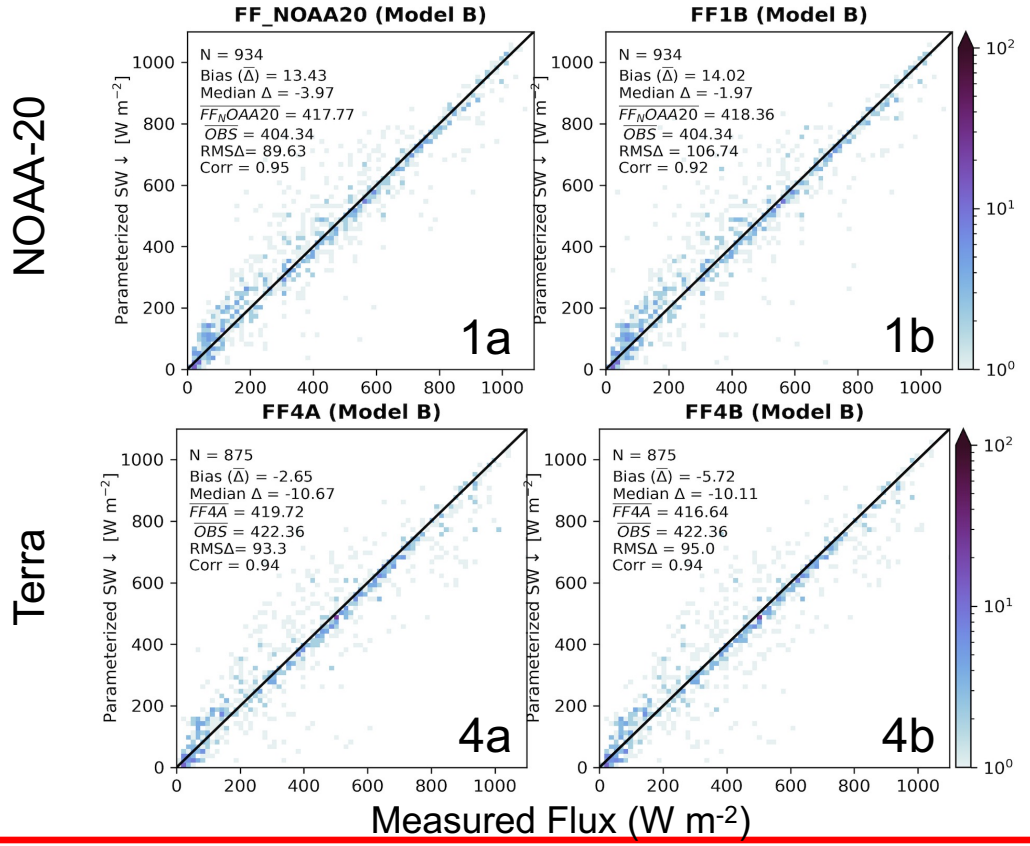
Global Stats	Difference	Standard Deviation
11/15/23	-0.025	6.845
11/30/23	0.019	6.907
12/02/23	-0.115	6.835
12/15/23	-0.197	6.303

FF SSF SW Flux Validation: 10/2023-12/2023

Overpass SW flux validation with BSRN measurements:

- Left FLASHFlux SSF with previous version (w/ FP-IT)
- Right FLASHFlux SSF (Current Version w/ GEOS-IT)
- Top NOAA-20, Bottom Terra

- SW fluxes Bias/RMS worse with GEOS-IT; Terra more consistent
- SW NOAA-20 has much larger biases than Terra
  - NOAA-20: bias < 4%, 27%
  - Terra: bias < -2%, 23%

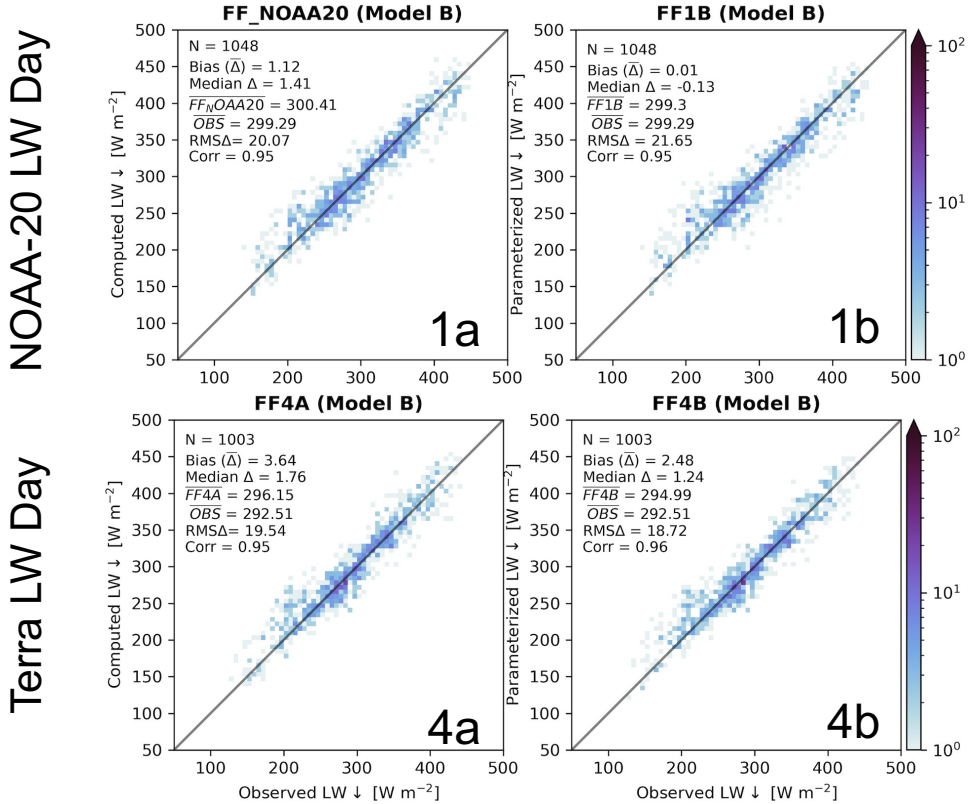


FF SSF LW Flux Day Validation: 10/2023-12/2023

Overpass LW daytime flux validation with BSRN measurements:

- Left FLASHFlux SSF Previous Version (with FP-IT)
- Right FLASHFlux SSF Current Version: (with GEOS-IT)
- Top NOAA-20, Bottom Terra

FLASHFlux LW Daytime NOAA-20 and Terra radiative fluxes show consistency between FP-IT/GEOS-IT: biases < 1%; RMS's < 7%

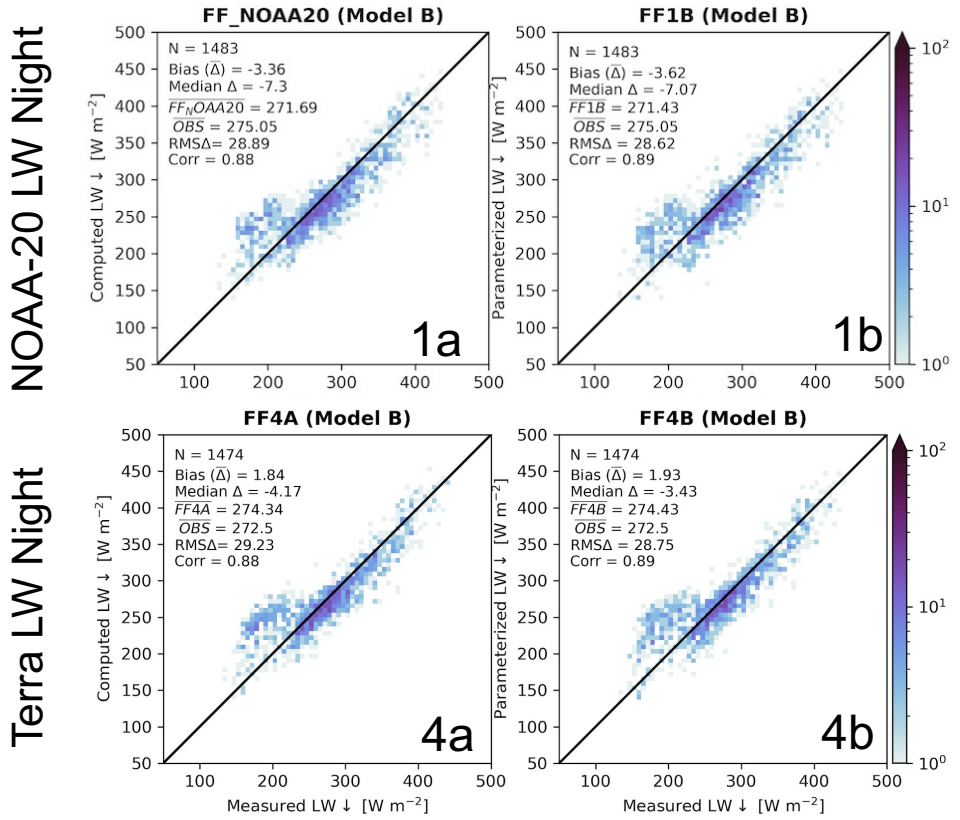


FF SSF LW Flux Night Validation: 10/2023-12/2023

Overpass LW daytime flux validation with BSRN measurements:

- Left FLASHFlux SSF Previous Version (with FP-IT)
- Right FLASHFlux SSF Current Version: (with GEOS-IT)
- Top NOAA-20, Bottom Terra

FLASHFlux LW Daytime NOAA-20 and Terra radiative fluxes show consistency between FP-IT/GEOS-IT: biases < 1%; RMS's < 11%



SSF Flux Algorithm Updates: NN SW & LW

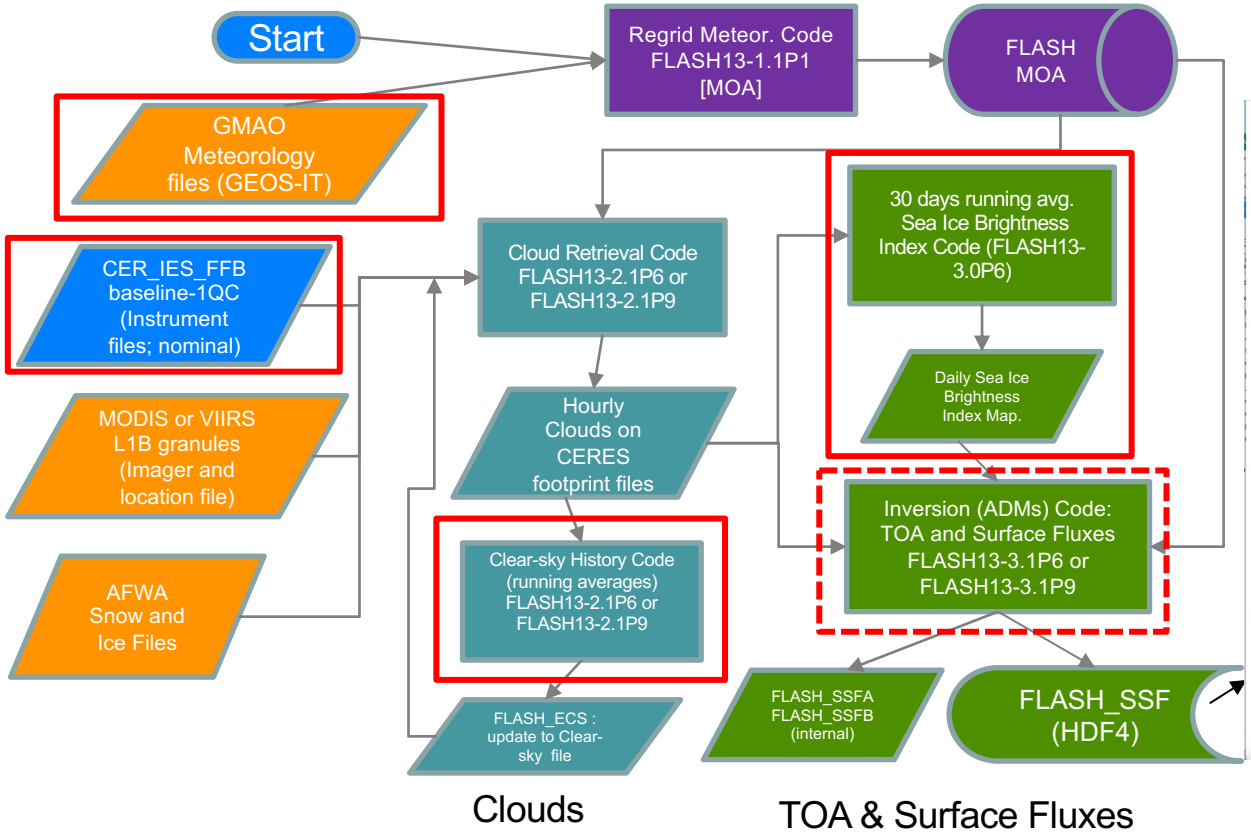
Justification:

- FF footprint fluxes have been used both scientifically and for applications
- Current LPSA/LPLA algorithms older methods, hard to update; separate from Fu/Liou

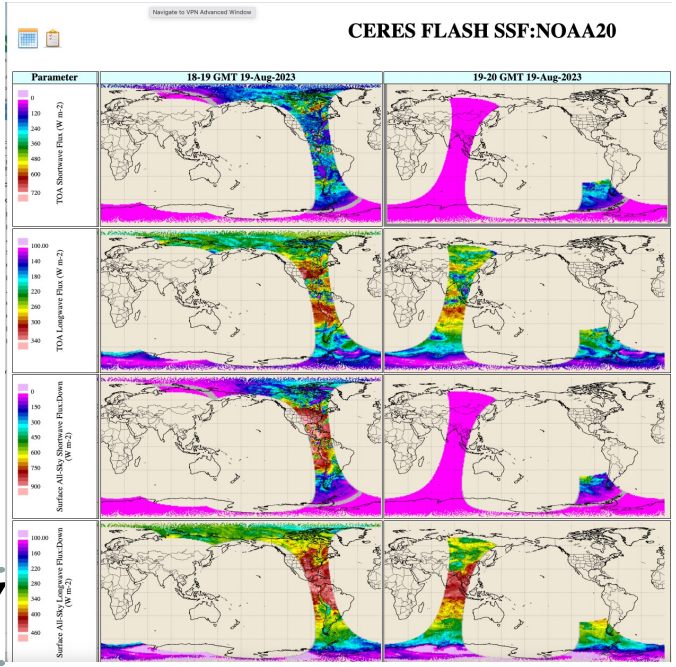
Objectives:

- Use NN/ML methods to devise algorithms that approximate FF; given key inputs available in from MOA and Inversion
  - Using CRS Ed1 used for training since uses full Fu/Liou RT
- Ran numerous tests on optimizing both training data sets and parameters
- Ran 2 months from the following year; evaluated against surface observations
- Some additional changes to the LW may be needed
- Experiments and results reviewed in Jay Garg's presentation

FLASHFlux SSF Data Flow



Sample Data from 8/19/23

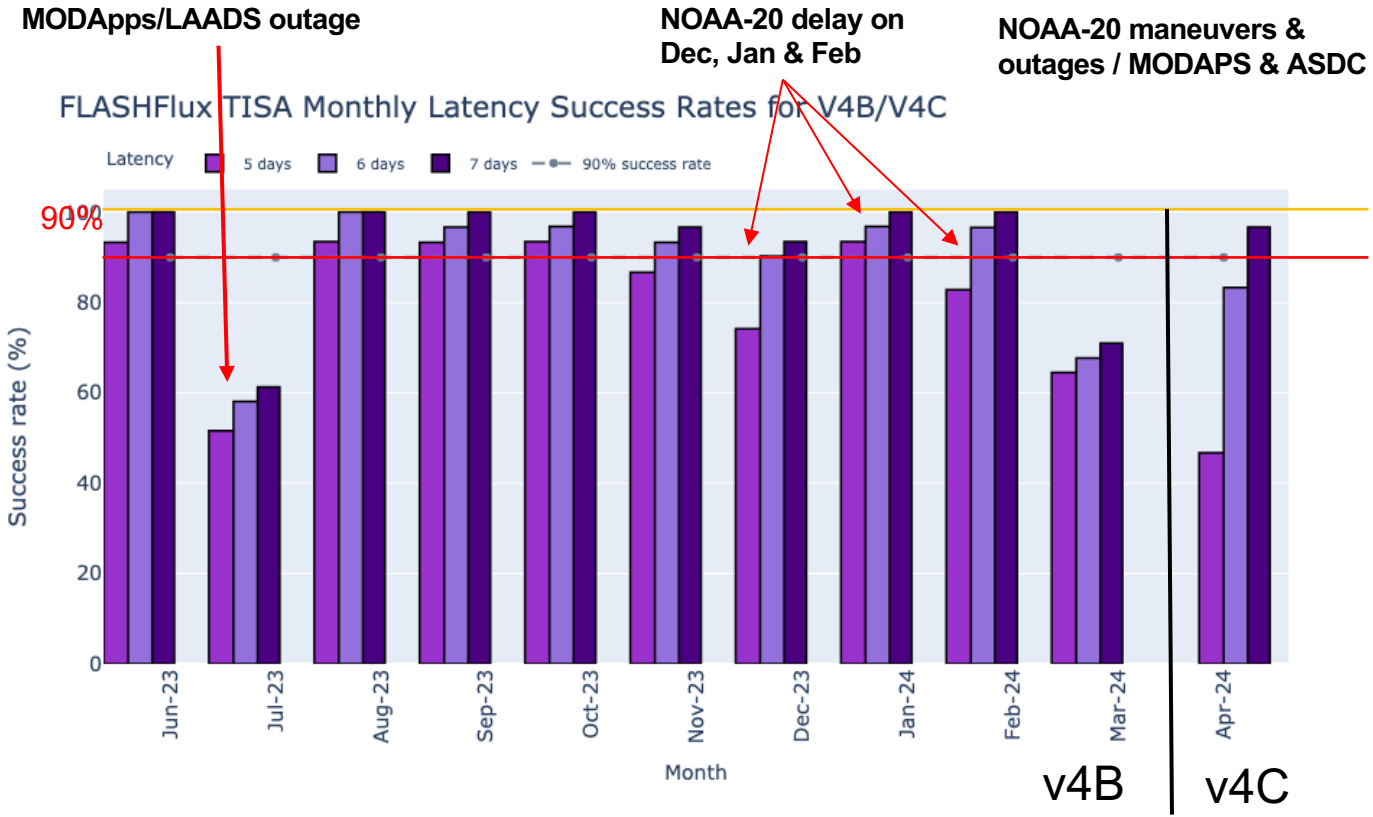


FLASHFlux TISA: Latency Statistics (v4B/v4C)

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

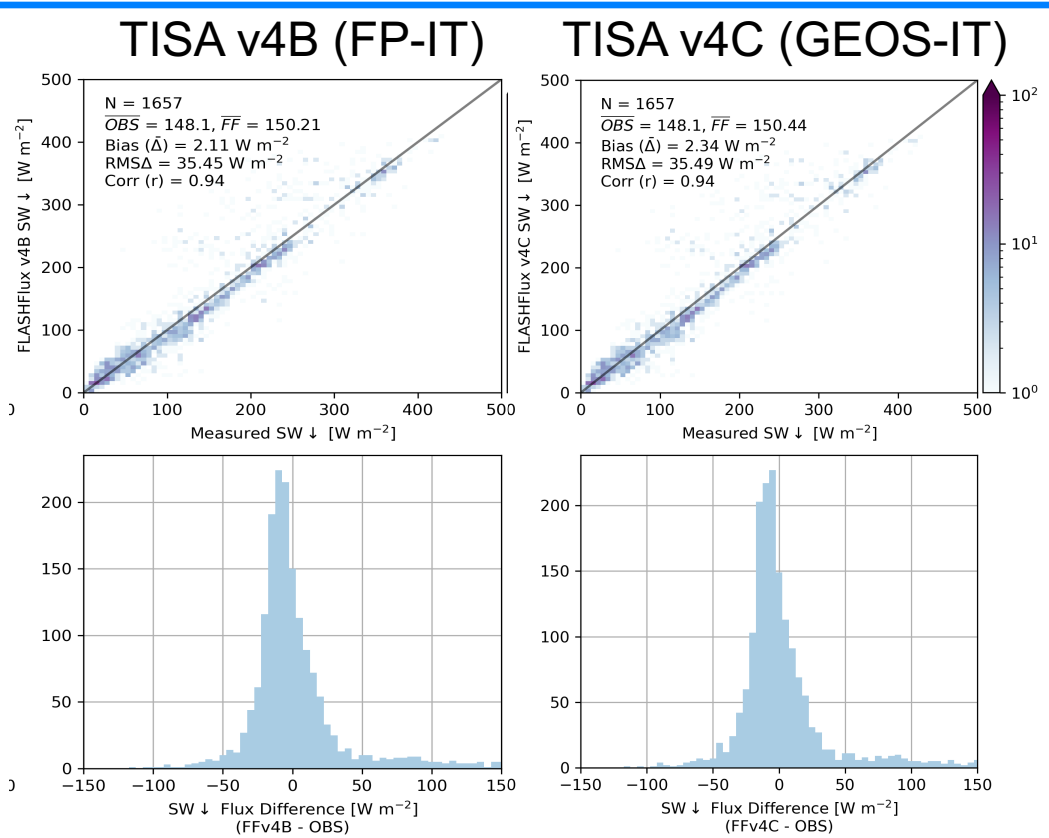
v4B began production in March 2023

February 2024 showed about >95% by day 6 (able to deliver all data by day 7).



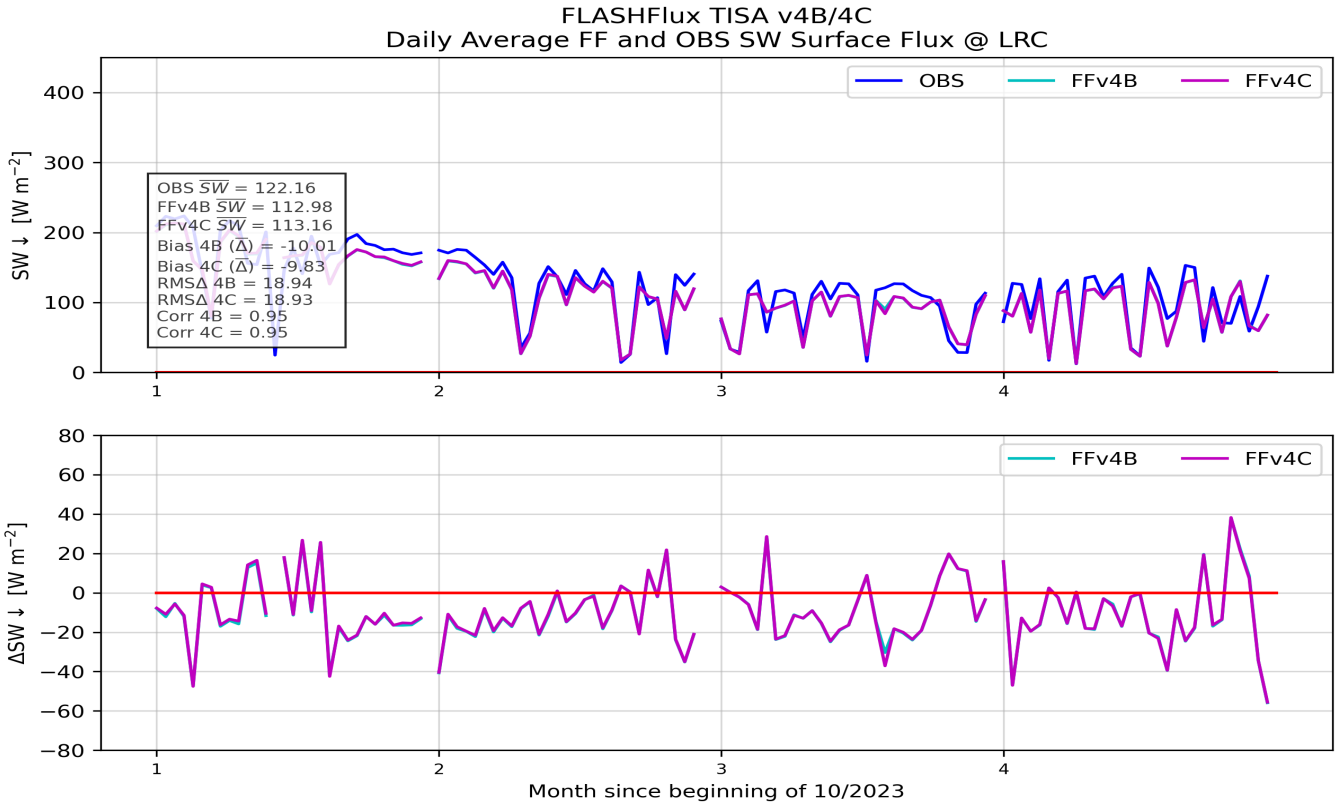
FLASHFlux TISA Validation: SW Surface Fluxes

- Ensemble FLASHFlux Version4B vs 4C SW Daily Average Comparisons to Surface Measurements (10/2023-1/2024)
- SW fluxes show very consistent statistical quality relative to surface measurements:
  - Bias Diff: < 1.6%
  - RMS Diff: < 24%
- Histograms show peaked, relatively symmetric distributions, median bias is negative for SW



Time Series Validation: SW

- Example time series comparison against SW measurements from the LRC site
- Here negative bias is evident, but that varies site to site
- There is now discernable difference between 4B and 4C

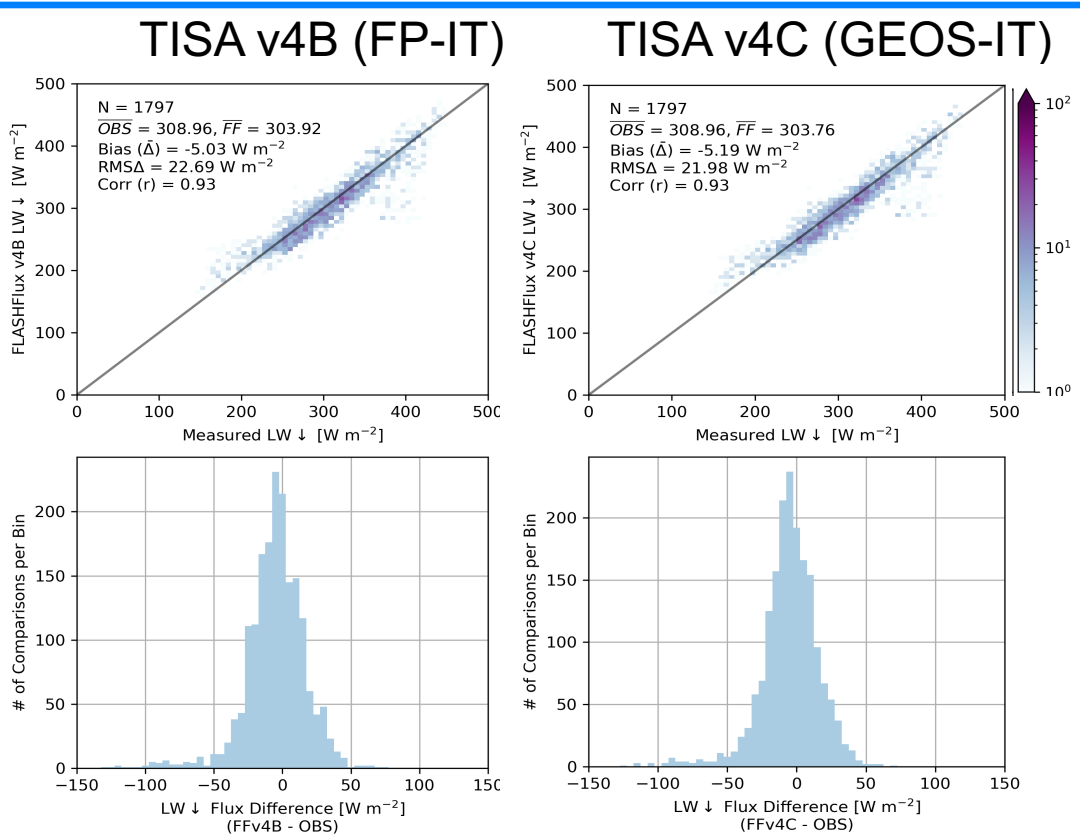


FLASHFlux TISA Validation: LW Surface Fluxes

- Ensemble FLASHFlux Version4B vs 4C LW Daily Average Comparisons to Surface Measurements (10/2023-1/2024)

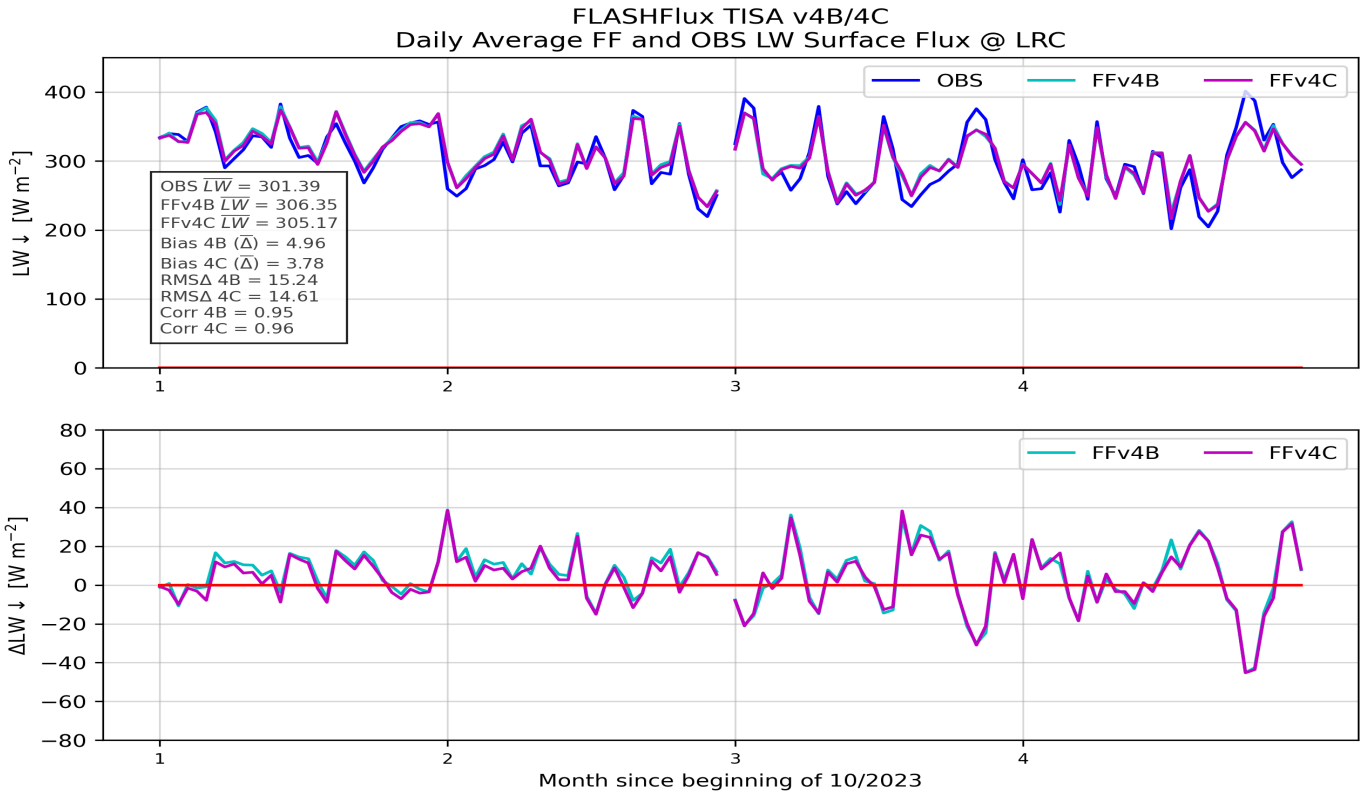
- LW fluxes show very consistent statistical quality relative to surface measurements:
  - Bias Diff: < -1.7
  - RMS Diff: < 7.4%

- Histograms show peaked, relatively symmetric distributions, median bias is negative for LW; slightly improved negative shoulder



Time Series Validation: LW

- Example time series comparison against SW measurements from the LRC site
- Some day-to-day variability in differences; similar to other sites
- v4C (GEOS-IT) is slightly better at that this site; similar to other sites



FLASHFlux TISA Application: Updated Anomalies

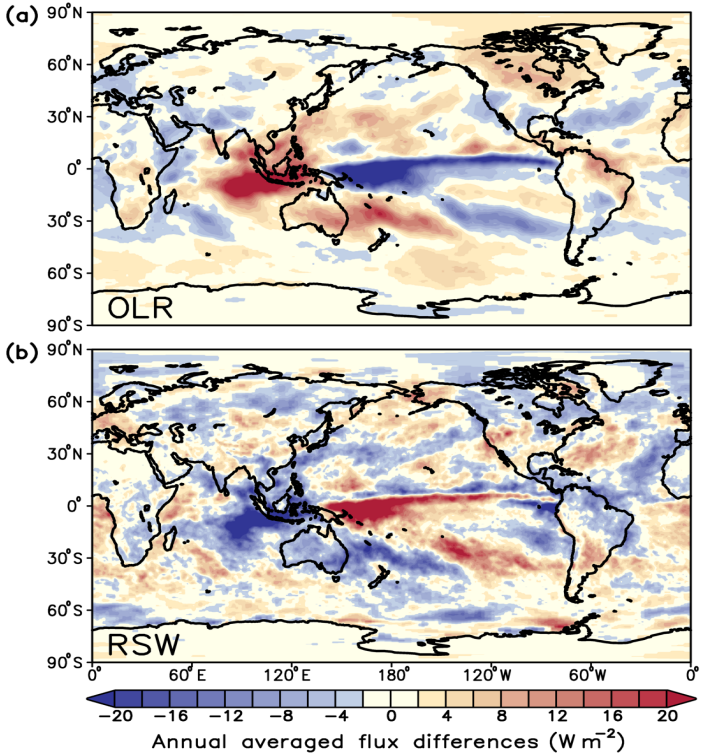


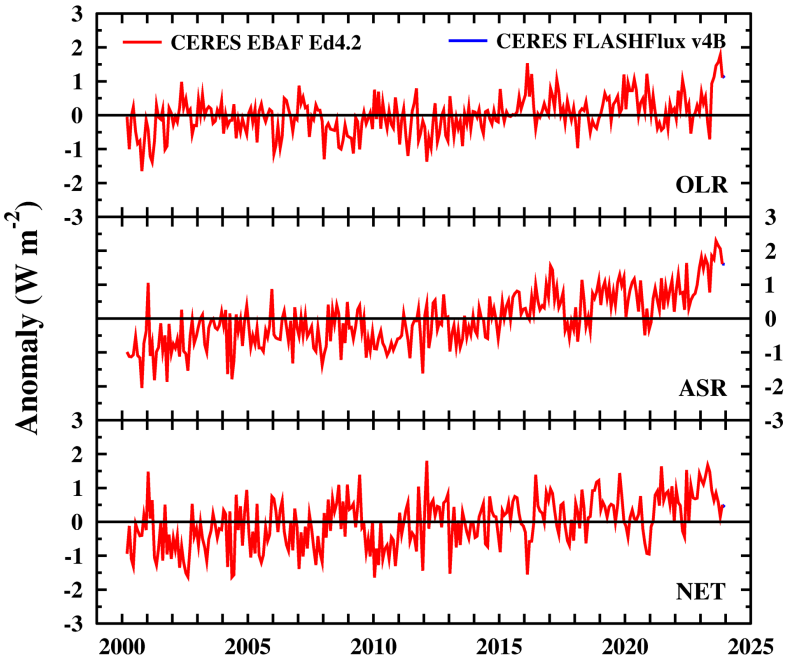
Table 2.f.1.1. *Global annual mean TOA radiative flux changes between 2022 and 2023, the 2023 global annual mean radiative flux anomalies relative to their corresponding 2001–22 mean climatological values, and the 2-sigma interannual variabilities of the 2001–22 global annual mean fluxes (all units in W m^{-2}) for the outgoing longwave radiation (OLR), total solar irradiance (TSI), reflected shortwave (RSW), absorbed solar radiation (ASR, determined from TSI-RSW) and total net fluxes. All flux values have been rounded to the nearest 0.05 W m^{-2} and only balance to that level of significance.*

	One Year Change (2023 minus 2022) (W m^{-2})	2023 Anomaly (Relative to Climatology) (W m^{-2})	Climatological Mean (2001–22) (W m^{-2})	Interannual Variability (2001–22) (W m^{-2})
OLR	+0.60	+0.85	240.35	±0.65
TSI	+0.10	+0.25	340.20	±0.15
RSW	−0.80	−1.50	99.00	±1.05
ASR	+0.90	+1.75	241.20	±1.05
Net	+0.30	+0.90	0.85	±0.85

Stackhouse *et al.*, 2024, submitted to BAMS

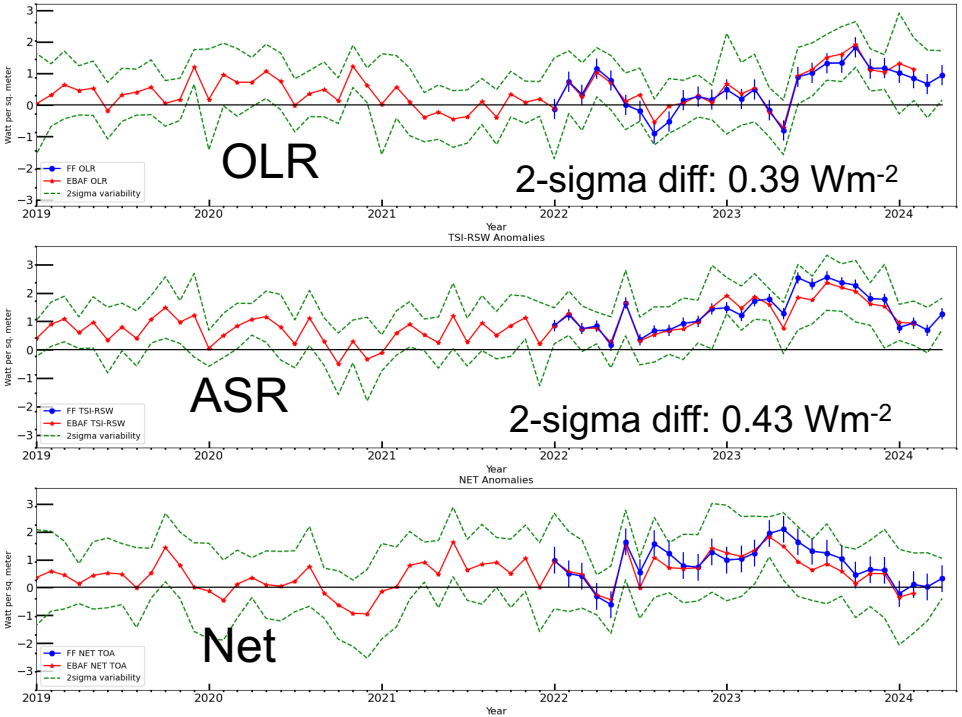
FLASHFlux TISA Application: Updated TOA Anomalies

TOA Flux Anomalies (through 2023)



Stackhouse *et al.*, 2024, submitted to BAMS

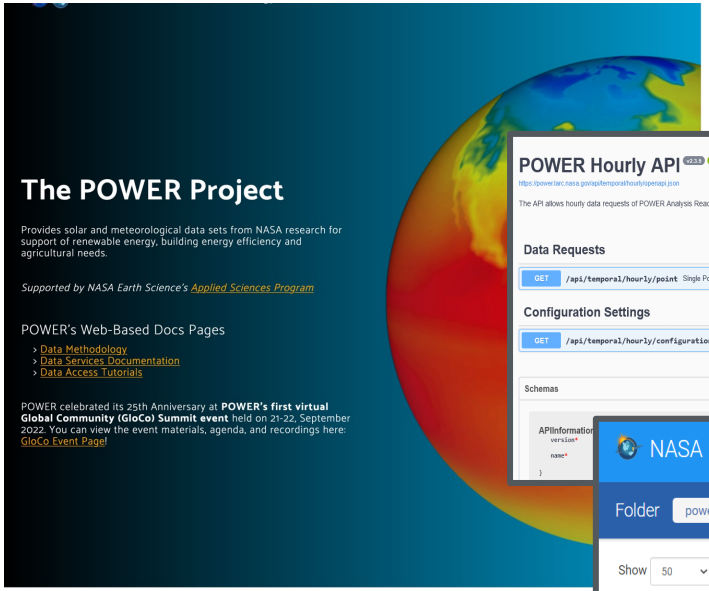
TOA Flux Anomalies (updated through 4/24)

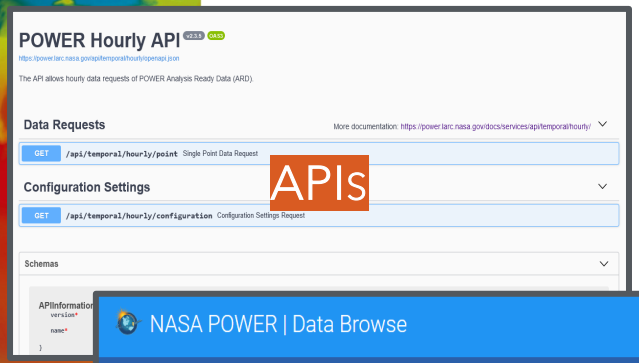


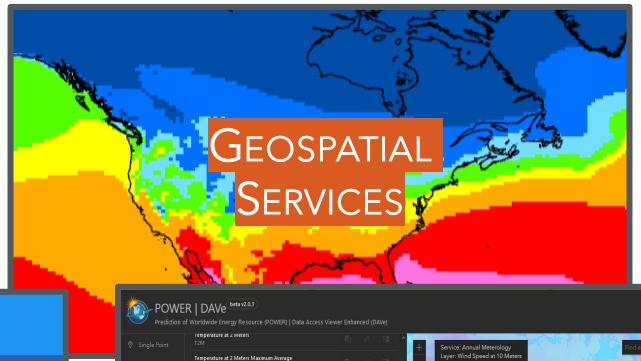
Includes TISA 4B/4C transition

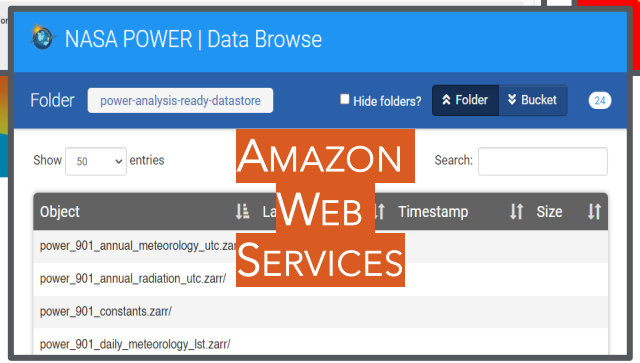
FLASHFlux TISA Application: Accessibility Through POWER

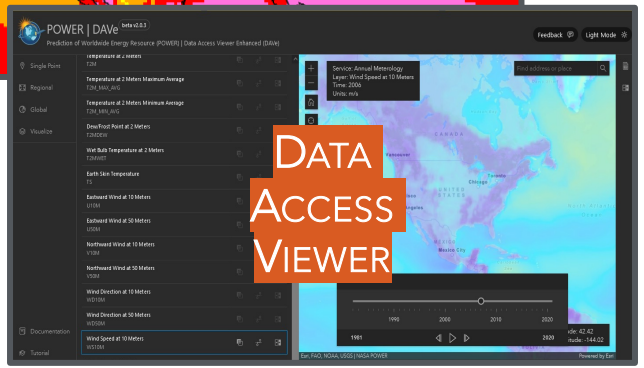
Different users require different ways to access the same data











https://power.larc.nasa.gov

Creating **trusted, value-added, easy-to-use** Application Ready Data & **Services**

FLASHFlux TISA Application via POWER Web Services Portal (2022/08/01 to 2023/07/31)

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

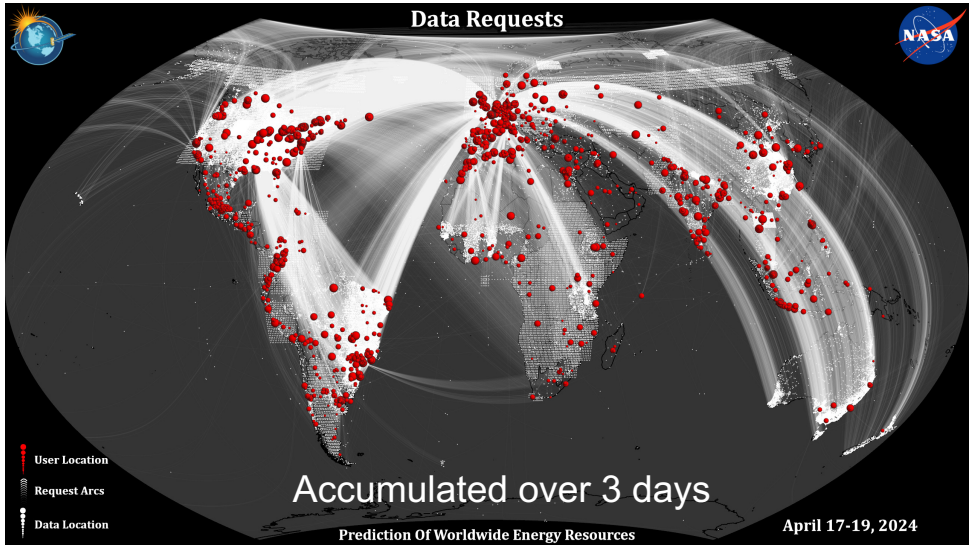
	Total	Monthly	Avg. Last 3 Months
Unique Users IPs	~51.9 K (16%)	~5.6 K (18%)	~4.8 K (19%)
Requests	~48.0 M (32%)	~4.0 M (32%)	~4.1 M (33%)

CERES Data Orders Delivered via POWER including SYN1Deg and FLASHFlux data

	Total	Monthly	Avg. Last 3 Months
Unique Users IPs	~149.8 K (47%)	~15.0 K (47%)	~16.2 K (48%)
Requests	~ 75.9 M (51%)	~6.3 M (51%)	~5.6 M (45%)

(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.



FF users increased by about ~40% since last report

Total FF+ SYN1Deg users 14% since last report

CERES TISA Application via POWER: User Story

Urban Solar

Urban Solar manufactures solar power systems and LED lightning solutions for transit, transportation, parking lots, pathways, and general illumination applications. Their philosophy is good lightning allows people to feel safe in outdoor spaces.

- Urban Solar uses CERES data through POWER's API to retrieve minimum solar irradiance and to calculate the power generated by solar arrays.
- Data provides specifications to manufacture and place solar power systems and LED lightning solutions.
- NRT used to monitor performance

TISA Flux Algorithm Updates: Incorporating GEO

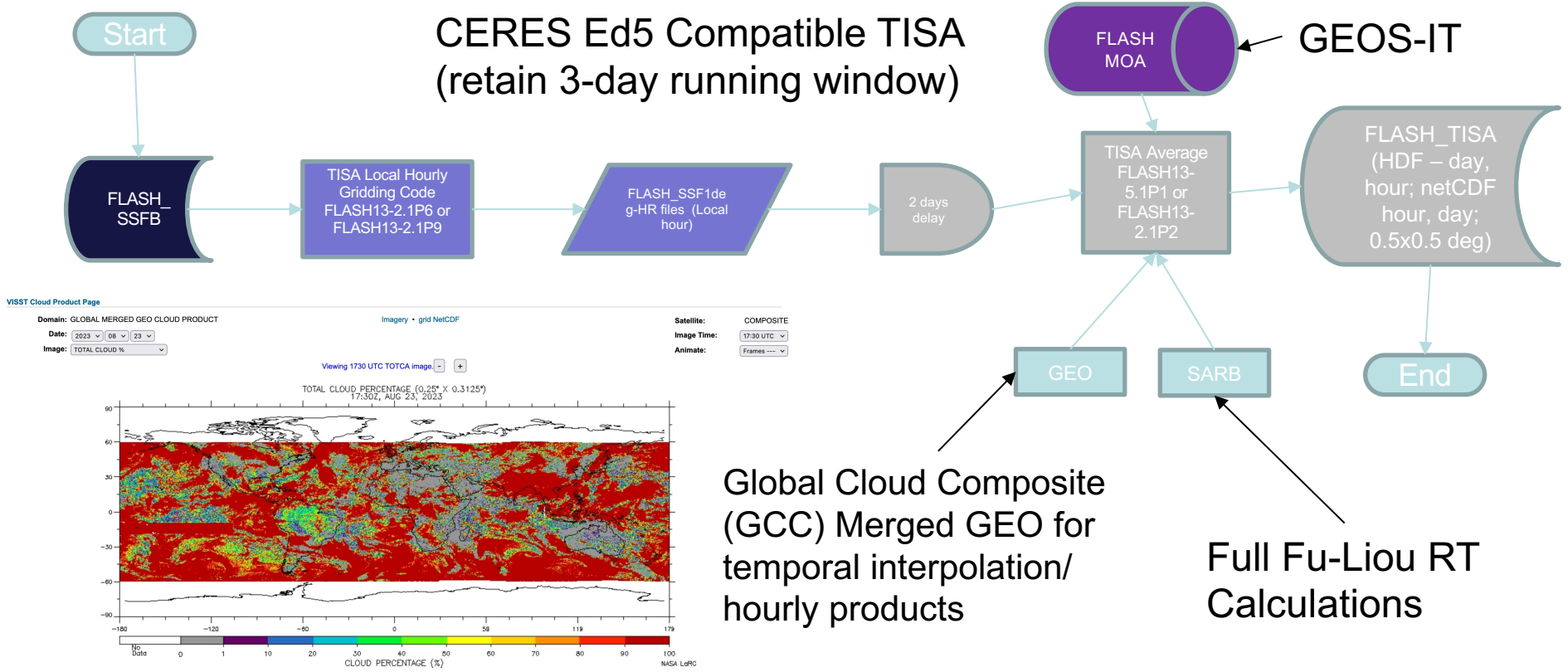
Justification:

- Aqua and Terra are drifting and will be turned off
- Currently have replaced Aqua with NOAA-20, but still using Terra
- Once TERRA is turned off, there will be no morning, evening samples for the diurnal models to estimate the daily averages; the primary product
- Concurrently, users are asking for hourly flux data at lower latency to be more consistent with the SYN1Deg hourly products
- If the GEO that CERES already processes for the SYN1Deg can be processed within the latency, then this provides the extra samples needed to improve daily and also provides the opportunity to provide CERES consistent fluxes at the hourly temporal resolution at lower latency.

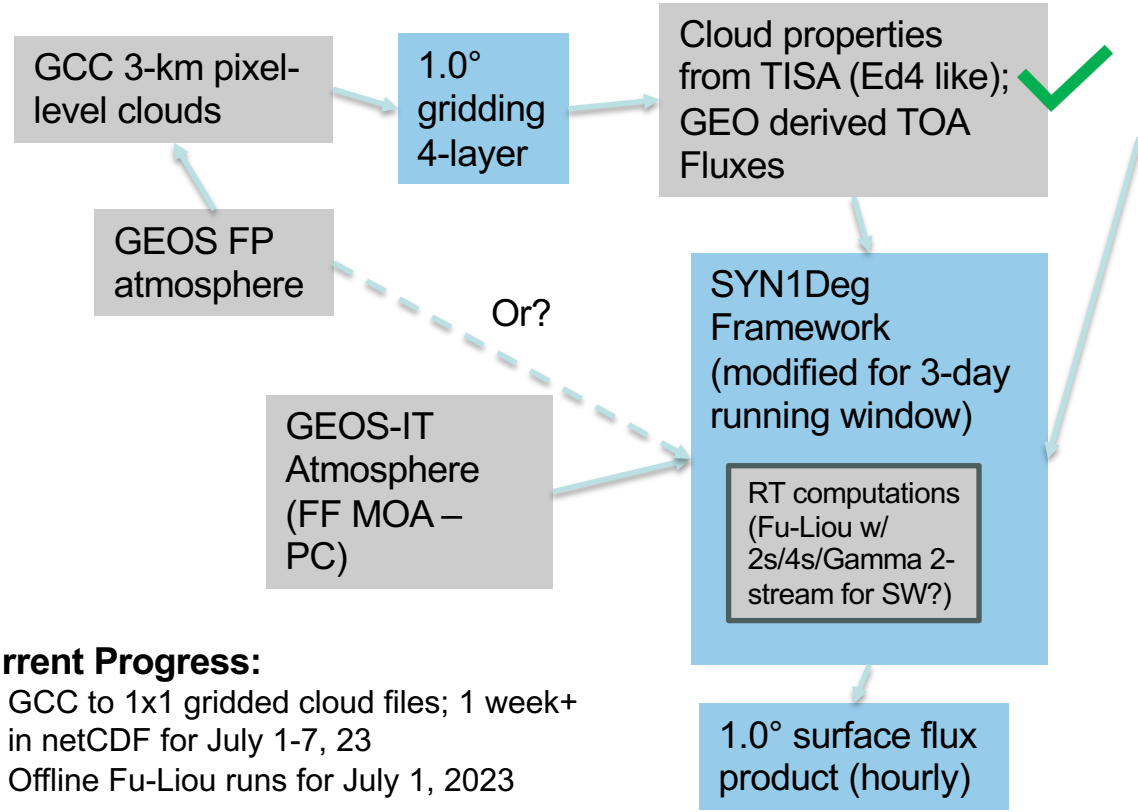
Objectives:

- Work with SatCORP/Clouds group and the TSI group to develop a new lower latency pipeline to enable the production of fluxes more consistent with CERES SYN1Deg
- Leverages SatCORP groups existing work and automated QC
- Leverages TSI group's objective to restructure CERES production code for Ed5

Future FLASHFlux TISA Data Flow: Adding GEO



Adding GEO to FF TISA: SatCORPS GCC into FLASHFlux



Current Progress:

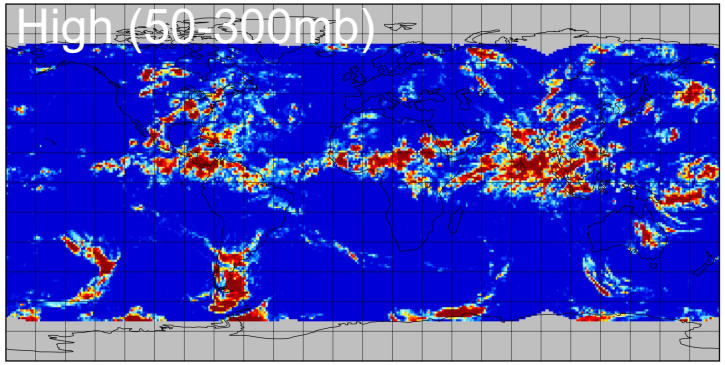
1. GCC to 1x1 gridded cloud files; 1 week+ in netCDF for July 1-7, 23
2. Offline Fu-Liou runs for July 1, 2023

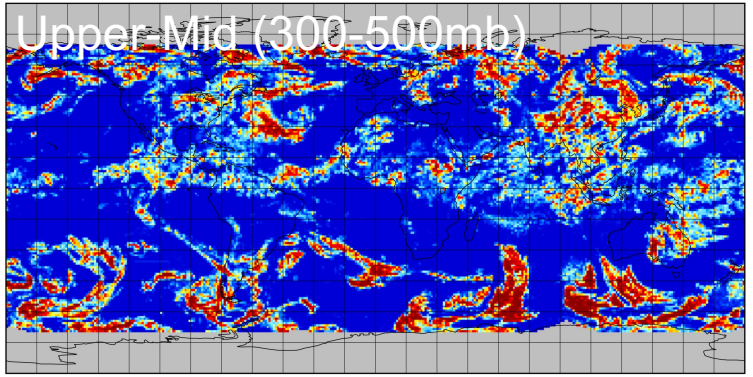
Progress:

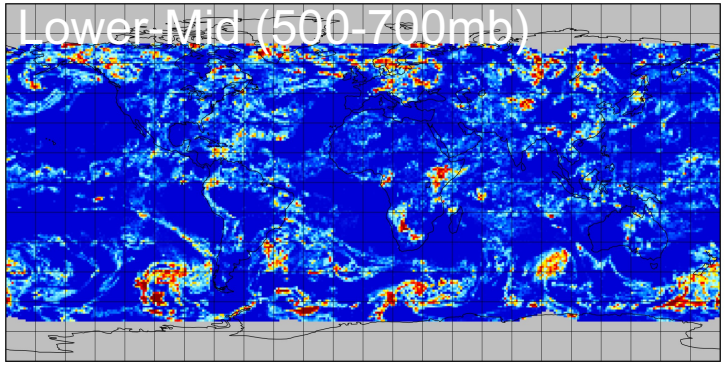
1. Completed cloud gridding code – targeting Ed4 clouds (4 layers) since code exists. **Done**
2. Align all inputs to correct data structures: **ongoing**
3. Configure SYN1Deg like code with 3-day running window, global by hour; determine options for running F/L: **ongoing**
4. Assess GEOS-FP vs GEOS-IT

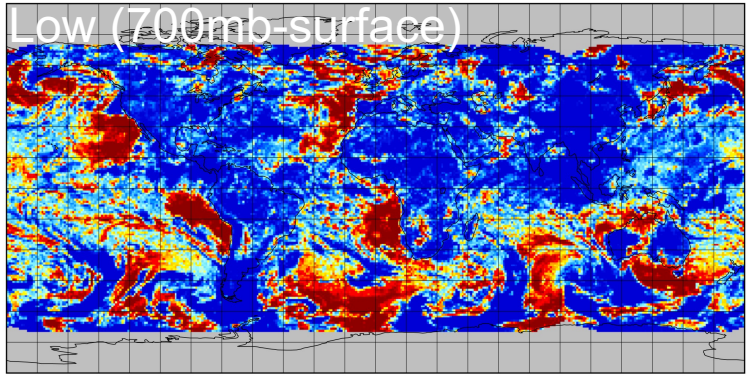
Adding GEO to FF TISA: Gridded GCC Cloud Properties

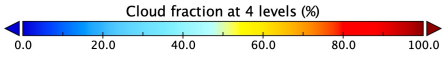
From Global Cloud Composite, Gridded Cloud Fraction at 1^0 X 1^0, Hour 1 of 24, 7/2/23

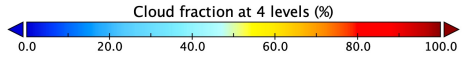










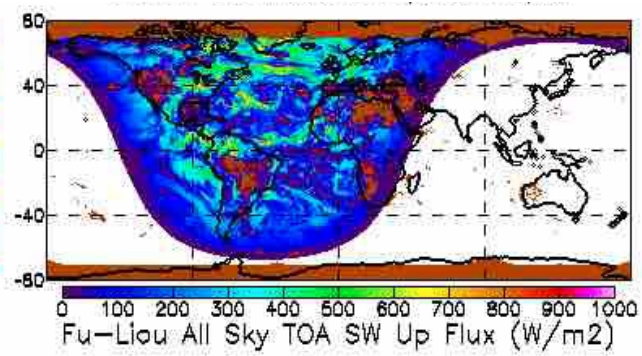


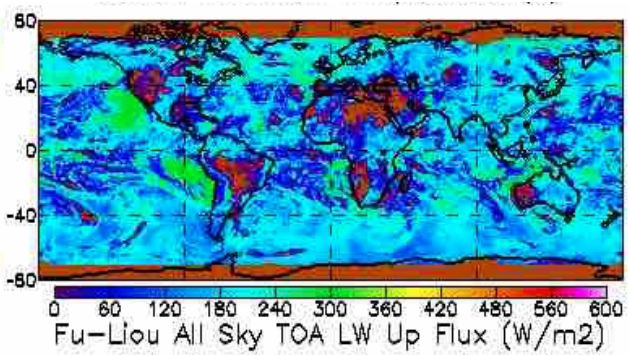
Arun Gopalan

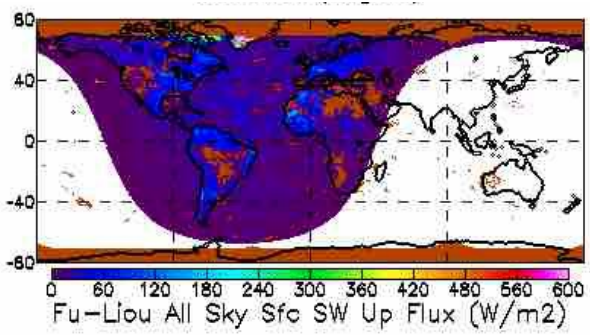
Adding GEO to FF TISA: Offline 1st Fluxes

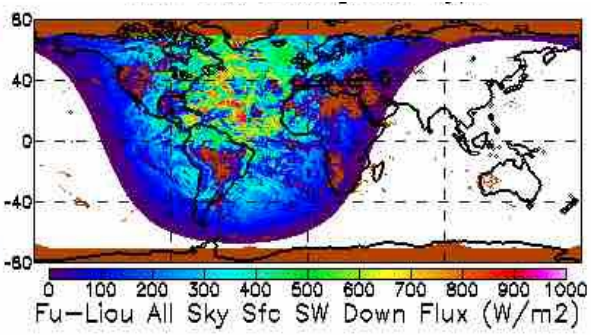
Offline runs will be compared to SARB-like runs

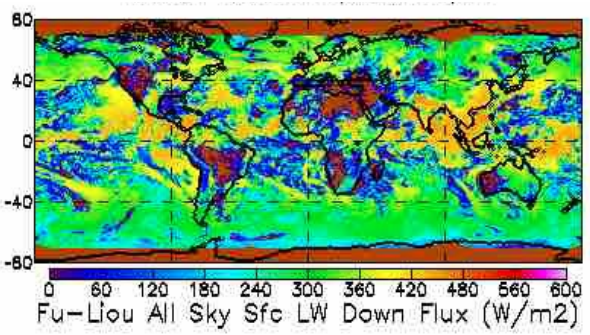
July 1, 2023
15 UT











Fu-Lung Chang

FLASHFlux Summary

- ***Production with SSF for Terra (v4b), NOAA-20 (1b) and TISA (v4C) Continues***
  - FF NOAA-20 V1B SSF (5/12/24) and Terra V4B (5/12/24) with GEOS-IT
  - TISA V4C Terra/NOAA-20 through 5/10; latency goals not met due to various issues
  - New FF Gain+Spectral coefficients beginning Apr 1st, 2024.
- ***Validation and Assessment Relative to BSRN/Buoy***
  - CERES and FLASHFlux SSF through Dec 2023; SW biases larger; GEOS-IT min impact
  - TISA v4C daily averages through Oct-Jan 2023 (4 months); low biases; some LW improved
- ***FLASHFlux Modernization and Updates***
  - ML based algorithms for future FF SSF data products: Goal Operational Oct 2024
  - Migrate configuration to NOAA-20 + GCC GEO & F/L Fluxes: Goal Operational Jan 2025
- ***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: ~150K unique IPs; > 76M orders; orders >33% FF
  - 2023 BAMS State of the Climate TOA Flux reports submitted

FLASHFlux Web Sites & Acknowledgments

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

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

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Extras