A Status Update for the FLASHFlux Working Group

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Tonya Davenport and Fenny Wang and the Atmospheric Science Data Center Team (SSAI)
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 Latency Objectives**
  – SSF products within 4 days
  – Global 1x1 daily averages from FF TISA; goal: 6-7 days latency

• **FLASHFlux Usages**
  – 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 (most recent update through August 2021).
v4A operational in Sep 2020 (delays due to Aqua outage)

Success rate % of time < 3 (dark/thick bar) or 4 days (lighter/thinner bar)

Terra had 7 months at or exceed 90% of days at 4 day latency; Aqua had 5

Lags due to: maneuvers/ satellite issues, ASDC updates/outages

SSF utilized by GLOBE Clouds; occasional satellite algorithm comparisons (i.e., NOAA GOES ABI)
CERES FLASHFlux SSF 4A

**Inputs**

CERES FF SSF Ver 4A-like
but using specialized combined
Gain & Spectral Calibration
Coefficients;
geolocated FOVs, etc.

GEOS 5.12.4 (FP-IT)
$T(z), p(z), q(z), O_3(z), T_s$

MODIS
cloud properties (Ed4)

MATCH
climatological AOD

IGBP surface type

Surface albedo climatological
map (clear from TERRA SSF)

**Outputs**

CERES derived
SW↑ & LW↑ fluxes
(ADM radiance to flux)

Parameterized Broadband Surface Fluxes:
e.g., “Model B” - All-Sky
Langley Parameterized Longwave Algorithm
Langley Parameterized Shortwave Algorithm

Instantaneous broadband
fluxes at the TOA

Instantaneous broadband
fluxes at the Surface for all-sky and clear (no clouds)

SW up, net; LW up, net

Surface

~20-50 km

CERES Footprint / FOV
Terra, Aqua, S-NPP, NOAA-20
CERES Cloud Radiative Swath (CRS, Beta version)

**Inputs**

- **CERES SSF Ed4A**
  - geolocated FOVs, etc.

- **GEOS 5.4.1**
  - $T(z)$, $p(z)$, $q(z)$, $O_3(z)$
  - surface wind speed

- **MODIS**
  - cloud properties (Ed4)
  - spectral albedo
  - land temp (clear)
  - AOD (sometimes)

- **MATCH**
  - hourly aerosol profiles & AOD

- **IGBP**
  - surface type

  - surface albedo history map (cloudy)

**Outputs**

- **Langley Fu-Liou Radiative Transfer Model**
  - TOA
  - 70 mb
  - 200 mb
  - 500 mb
  - 850 mb

- **SW**
  - 2-stream SW

- **LW**
  - 2-stream LW

- **SW direct + diffuse PAR, UV fluxes**

- **~2,300,000 FOV calculations / day**

- **No longer tuning to the CERES TOA flux (as in Ed 2)**

**CERES Cloud Radiative Swath (CRS, Beta version)**

**Outputs**

- **Arbitrary output levels**
  - TOA
  - 70 mb
  - 200 mb
  - 500 mb
  - 850 mb

- **Surface**

- **~20-50 km**

- **Outputs**
  - instantaneous vertical profiles (6 levels) of broadband fluxes + spectrally-resolved fluxes at the surface and TOA

- **Arbitrary output levels**
  - 4-stream SW
  - 2-stream LW

- **LW : 12 bands**
  - SW : 14 bands
  - (surface, all-sky)

- **SW direct + diffuse PAR, UV fluxes**

- **~2,300,000 FOV calculations / day**

- **No longer tuning to the CERES TOA flux (as in Ed 2)**
• Aqua SSF validation for CRS, Ed4A and FF for surface SW down
• CRS consistent outperforms, note RMS differences
• New FF polar flux parameterization appears to explain increased scatter (although works better for TISA)
• Continuing assessment
Terra SSF validation for CRS, Ed4A and FF for surface daytime LW down
• Much more consistent than SW, but CRS still has lowest RMS
• Similar results for night-time but larger scatter
• Polar fluxes and show interesting relationships
LW Validation vs BSRN Fluxes: CRS and SSF

- Terra SSF validation for CRS, Ed4A and FF for surface daytime LW down
- Much more consistent than SW, but CRS still has lowest RMS
- Similar results for night-time but larger scatter
- Polar fluxes and show interesting relationships
v4A operational in Sep 2020

Success rate % of time < 6 (dark blue) or 7 days (light blue)

7 of 12 months reached 90% of days at 7 day latency

Lags due to: maneuvers, ASDC updates/outages

TISA delivered to POWER Web Services Suite

90%
• Anomalies relative to July 2005 to June 2015

• Green lines show +/- 2 sigma for each climatological month

• FF Normalized using overlap period begin Jan 2015 and April 2021

• Error bars denoted uncertainty derived from the overlap analysis
FLASHFlux Data Delivery via POWER Web Services Portal (2020/10/01 to 2021/09/30)

All CERES Orders Delivered via POWER

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique Users IPs</td>
<td>~94.8 K</td>
<td>~8,992</td>
</tr>
<tr>
<td>Requests</td>
<td>~35.3 M</td>
<td>~2.95 M</td>
</tr>
</tbody>
</table>

(includes SYN1Deg from Jan 2001 through latest month released)

FLASHFlux Low Latency Orders Delivered via POWER

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Monthly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique Users IPs</td>
<td>~28.3 K</td>
<td>~2,712</td>
</tr>
<tr>
<td>Requests</td>
<td>~23.1 M</td>
<td>~1.92 M</td>
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Dot density map showing locations of users (red) and data request locations (white). Brighter colors show larger frequency at that location.

10/12-14/2021 CERES Science Team Meeting
Ensemble FLASHFlux LW and SW Daily Average Comparisons to BSRN Measurements (1/2019-6/2021)

LW: Bias -1.5 W m\(^{-2}\)  
RMS 16.7 W m\(^{-2}\)

SW: Bias 0.3 W m\(^{-2}\)  
RMS 38.5 W m\(^{-2}\)

Histograms show peaked, relatively symmetric distributions, median bias is negative bias for SW, LW
### FLASHFlux TISA Validation:
**BSRN and Ocean Buoy Fluxes**

FLASHFlux v4A TISA Daily Average Fluxes (1/2019 – 6/2021)

<table>
<thead>
<tr>
<th>Region Type</th>
<th>LW Bias</th>
<th>LW RMS</th>
<th># LW Pairs</th>
<th>SW Bias</th>
<th>SW RMS</th>
<th># SW Pairs</th>
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<tr>
<td>All Ensemble</td>
<td>-1.5</td>
<td>16.7</td>
<td>28,683</td>
<td>0.3</td>
<td>38.5</td>
<td>32,233</td>
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<tr>
<td>Coastal</td>
<td>-0.2</td>
<td>15.7</td>
<td>6369</td>
<td>-1.3</td>
<td>37.0</td>
<td>6164</td>
</tr>
<tr>
<td>Desert</td>
<td>-8.5</td>
<td>19.9</td>
<td>2301</td>
<td>-12.3</td>
<td>28.3</td>
<td>2283</td>
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<tr>
<td>Island</td>
<td>6.1</td>
<td>14.7</td>
<td>1935</td>
<td>19.5</td>
<td>47.4</td>
<td>1895</td>
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<tr>
<td>Continental</td>
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<td>18.0</td>
<td>10053</td>
<td>-4.0</td>
<td>40.3</td>
<td>10002</td>
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<tr>
<td>Polar</td>
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<td>48.4</td>
<td>2028</td>
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<td>Ocean buoys</td>
<td>1.0</td>
<td>12.4</td>
<td>5036</td>
<td>6.7</td>
<td>35.7</td>
<td>9861</td>
</tr>
</tbody>
</table>
FF Time Series (Goodwin Creek)

FLASHFlux TISA Version 4A
Daily Average FFv4A and OBS Surface Flux @ GCR

FLASHFlux TISA Version 4A
Daily Average Surface Flux Δ(FFv4A - OBS) @ GCR

10/12-14/2021

CERES Science Team Meeting
FF Time Series (Desert Rock)

FLASHFlux TISA Version 4A
Daily Average FFv4A and OBS Surface Flux @ DRA

FLASHFlux TISA Version 4A
Daily Average Surface Flux Δ(FFv4A - OBS) @ DRA

10/12-14/2021
CERES Science Team Meeting
Initial GEOS-IT vs FP-IT Comparisons: PW

GEOS-IT: Mon Avg Precipitable Water (kg m\(^{-2}\))

Global Average : 0.141 kg m\(^{-2}\)

GEOS-IT – FP-IT: Mon Avg Prec Water (kg m\(^{-2}\))

Global Average : -0.10 K

January 2018

Global Average : 0.02 K

July 2018

CERES Science Team Meeting

10/12-14/2021
Initial GEOS-IT vs FP-IT Comparisons: Tskin

GEOS-IT – FP-IT: Monthly Average T 2m (K)

Global Average:
+0.53 K

GEOS-IT – FP-IT: Mon Ave Diurnal Range T 2m (K)

Jan 2018

Global Average:
1.72 K

July 2018
Initial GEOS-IT vs FP-IT Comparisons: Tskin

GEOS-IT – FP-IT: Monthly Average Ts (K)

Global Average : 1.52 K

GEOS-IT – FP-IT: Mon Ave Diurnal Range Ts (K)

Jan 2018

Global Average : -0.04 K

July 2018

GEOS-IT – FP-IT Differences: Tskin

Global Average : 1.52 K

Jan 2018

Global Average : -0.04 K

July 2018
FLASHFlux Summary

• **Production with v4A Begun (since Aug 1, 2020)**
  – Operational FF v4A SSF and TISA v4A (since Jan 1, 2019): SSF Terra/Aqua through 10/9; TISA through 10/7 (delays in September due to maneuver and missing snow/ice maps all resolved)
  – New FF Gain+Spectral coefficients beginning Oct 1

• **Validation and Assessment**
  – SSF relative to CRS (Beta), CERES Ed4A SSF (SOFA) and FF and BSRN
  – TISA Daily averages relative to BSRN for Jan 2019 through June 2021 (30 months)

• **FLASHFlux Modernization and Updates**
  – Migration to CERES CATALYST for future production managing (also see Katie’s talk)
  – Evaluating ML based algorithms for future FF SSF data products
  – New GEOS-IT sample data; first cut comparisons to FP-IT (diurnal cycle Ts and T2m changes)
  – NOAA-20 path tested through inversion; upgrading TISA to accommodate

• **FLASHFlux Information & Data Provision Through ...**
  – Daily and monthly data available in internal subsetter; internal team web site
  – CERES web site and subsetter both SSF and TISA, ASDC (via EarthData) and POWER
    • POWER Distribution in last year: ~94,800 unique IPs; > 35M orders; orders >65% low latency
  – 2020 BAMS State of the Climate TOA Flux report published
FLASHFlux Web Sites
now moved to under CERES page

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

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