Comparison of TOA Fluxes from CERES FLASHFlux and EBAF

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Product Introduction

**EBAF: Energy Balanced and Filled**

- Geostationary-enhanced CERES fluxes adjusted for energy balance at the TOA within the ocean heat storage value.
  

- Produced to meet the needs of the climate modeling community.
- Climate quality fluxes which take upward of six months to prepare.
- Many applications require CERES-like data much sooner while their accuracy requirements are not as stringent.
Product Introduction

• **FLASHFlux**: Fast Longwave and Shortwave Radiative Fluxes

• **Purpose**: Provide CERES-like TOA and surface fluxes on a near real-time basis for use until formal CERES data become available.
  • Devised a speedy stream of the CERES processing system.
  • Produced CERES-like fluxes within 1 week of satellite observations.
  • Accomplished by relaxing some stringent accuracy requirements.
  • Used the first data stream from the instruments (Baseline-1 QC).
  • Processed only cross-track scanner data from both satellites.
  • Used calibration coefficients from the previous CERES processing.

• **Overarching goal**: Capture variability of CERES fluxes even when there are systematic differences so that it can be used to project CERES EBAF fluxes for early applications.

• Scientific, educational and commercial applications: Field experiments, Earth Observatory, S’COOL, Solar Energy and Building industries.

• Compare FLASHFlux with EBAF to assess the quality of the former.
Data Available

- EBAF Edition-2.6r data available as monthly 1°x1° gridded for the March 2000 to December 2011 period.

- FLASHFlux Version-2G data available as daily 1°x1° gridded for January 2009 to December 2011. Averaged to monthly to match EBAF.

- Comparisons made on a monthly average basis for a 36-month period (Jan 2009 – Dec 2011).
Objective

Compare FLASHFlux with EBAF: Quantify the agreement between them

The two fields look very similar but there are small differences.
Objective (continued)

EBAF is the reference field
 FLASHFlux is the test field
Methodology

- Comparison of Statistics (The same 3 used in Taylor diagrams):
  (Taylor, K. E. (2001): JGR, 106, 7183-7193.)

1. Correlation Coefficient ($R$) between the fields:

\[ R = \frac{1}{N} \sum \frac{(f_n - \bar{f})(r_n - \bar{r})}{\sigma_f \sigma_r} \]

where $f$ represents the test variable and $r$ the reference variable. $\sigma_f$ and $\sigma_r$ are their standard deviations. High correlation coeff. demonstrates a correspondence between the spatial patterns.

2. Standard Deviations ($\sigma$) of the two fields:

\[ \sigma_f^2 = \frac{1}{N} \sum (f_n - \bar{f})^2 \quad \text{and} \quad \sigma_r^2 = \frac{1}{N} \sum (r_n - \bar{r})^2 \]

comparable values of standard deviations indicates that range of values in the two fields are comparable.
3. RMS Difference ($E$):

$$E^2 = \frac{1}{N} \sum (f_n - r_n)^2$$

quantifies the difference between the corresponding values in the two datasets but includes the bias between them.

Centered RMS Difference ($E'$):

$$E'^2 = \frac{1}{N} \sum \left[ (f_n - \bar{f}) - (r_n - \bar{r}) \right]^2$$

The two are related as

$$E'^2 = E^2 - \overline{E}^2$$

where $\overline{E} = \left( \bar{f} - \bar{r} \right)$ is the mean bias.

centered RMS removes the effect of mean bias from the RMS.

This can also be represented as:

$$E'^2 = \sigma_f^2 + \sigma_r^2 - 2 \sigma_f \sigma_r R$$
Example Taylor Diagram

\[ E'^2 = \sigma_f^2 + \sigma_r^2 - 2\sigma_f\sigma_r R \]
All-Sky Outgoing Longwave Radiation – 2009-2011

FLASH Mean = 237.05
EBAF Mean = 239.62

Mean Bias (FLASH-EBAF) = -2.57
All-Sky OLR Statistics – 2009-2011

Mean = 0.999

FLASH Mean = 34.39
EBAF Mean = 34.58

Centered RMS = 1.75
RMS Difference = 3.12
All-Sky Reflected Shortwave Radiation – 2009-2011

- EBAF
- FLASH

FLASH Mean = 95.97
EBAF Mean = 99.80
Mean Bias (FLASH-EBAF) = -3.83
All-Sky RSR Statistics – 2009-2011

Mean = 0.998

EBAF S.D.     FLASH S.D.

FLASH Mean = 46.72
EBAF Mean = 47.79

Centered RMS = 2.50
RMS Difference = 4.59
Summary and Concluding Remarks

- CERES-like fluxes available on a near real-time basis.
- Closely capture the variability of the final CERES product.
- Small differences result from the use of older calibration coefficients for FLASHFlux and adjustments made to EBAF.

- Biases:
  - Outgoing LW = -2.57 Wm\(^{-2}\) (-1.1%)
  - Reflected SW = -3.83 Wm\(^{-2}\) (-3.8%)

- Centered RMS Differences:
  - Outgoing LW = ±1.75 Wm\(^{-2}\) (0.7%)
  - Reflected SW = ±2.50 Wm\(^{-2}\) (2.5%)

- Along with other applications these can be used to project CERES fluxes before those become formally available. Done to contribute to the State of the Climate Report.
Back-up Slides
All-Sky Outgoing Longwave Radiation
Taylor Diagram for Monthly Averages

Climate Science Branch, NASA Langley Research Center
Comparison of FLASHFlux and EBAF - Reflected SW Flux for 2009-11

FLASH Mean = 95.97
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Mean Bias (FLASH-EBAF) = -3.83
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Taylor Diagram for Annual Averages