TISA Working Group Update

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OUTLINE

• FluxbyCloudType (FBCT) Product, **Moguo Sun**
  – The FBCT product description
  – FBCT-monthly and daily products
  – Validation and Beta tester results
  – Public Release

• TISA
  – Ed5 TISA/Flashflux/SARB framework
  – GEO daily gain monitoring
Ed5 flowchart
CERES processing editions

• Ed2
  - CERES-only (SSF1deg), CERES+GEO (SYN1deg), and SARB tuned fluxes all in one product package (SRBAVG/ZAVG/AVG)
  - CERES-only fluxes not dependent on GEO or SARB and held up by GEO and SARB
  - SARB-tuned fluxes dependent on GEO broadband fluxes

• Ed4
  - SSF1deg product is the CERES-only and release soon after release of SSF
  - SYN1deg product contains both the CERES+GEO and SARB tuned fluxes

• Ed5
  - Remove the Tuned SARB fluxes from SYN1deg to allow SARB and TISA to improve in parallel and remove the contingency of TISA for the SARB release

• Ed5 TISA/SARB/FlashFLUX framework
Ed5 TISA/SARB/FlashFLUX requirements

• **FlashFLUX**
  - requires **local** 3-day (months) processing and run daily
  - Incorporate the GEO Fu-Liou computed fluxes
  - Migrate to same code as CERES, To facilitate new inputs of NPP, NOAA-20, and GEO clouds and fluxes into FlashFLUX processing

• **TISA**
  - Run GEO NB to BB and computed fluxes at the instantaneous gridded level, allows flexibility to change the cloud/atmosphere/channel radiance parameters, rather than drag parameters through the entire TISA code at the regional processing module
  - Each SW flux will be assigned a directional model, This facilitates nearly the same TISA code to temporally interpolate and to average fluxes for SSF1deg and SYN1deg, lite, and Flashflux.

• **SARB**
  - Remove tuned fluxes, removes contingency of GEO derived fluxes
  - Computed fluxes to be run daily, rather than by monthly-zonal processing, for efficiency
  - Computed fluxes to be run for single GEOs to facilitate quick validation of surface fluxes.
Ed5 flowchart

Sensor pixel level/native resolution
- GEO image pixel level radiance and clouds (sensor instantaneous netCDF)
- (CERES/Flash) Source specific spatial resolution: atmospheric profile (GEOS5/FPIT), aerosol, snow maps
- SSF footprint clouds/fluxes
- Validation Source specific spatial resolution: GERB

Sensor instantaneous common grid
- Instantaneous gridded GEO cloud/rad (sensor daily gridded netCDF)
- MOA
  - Aerosol
  - Snow map
  - Gridded Daily files
- Instantaneous gridded SSF cloud/fluxes (sensor daily gridded netCDF)
- GEO module fluxes
- SAR module fluxes
- Instantaneous GEO gridded cloud/TOA/computed flux (sensor daily gridded netCDF)
- Processed daily

Processing direction
Ed5 flowchart

Instantaneous Common grid
- Instantaneous GEO gridded cloud
  TOA/computed flux (sensor daily gridded netCDF)
  - Apply GEO flux normalization factors
- Instantaneous gridded SSF cloud/fluxes

Input Selection
- Sensor & parameter
  global compositing
  - Terra/Aqua/NPP/N20 (SSF1deg)
  - CERES-Terra+Aqua
    (SSF1deg lite)
  - Terra+Aqua+GEO
    (SYN1deg) (lite)
  - Clouds - CLDTYPHIST
  - Terra/Aqua - FBCT
  - GEO-only (validation)

Time-step selection
- Time-step selection
  - Temporal resolution
    Hourly, 30’, 3-hour
  - GMT for CERES
  - local time for Flash
- PC/Tau stratification

Common grid and timestep
- global time-step
  TOA/SFC/clouds map (daily netCDF)

Processed daily

Processing direction

NASA Langley Research Center / Atmospheric Sciences
Ed5 flowchart

Common grid and timestep
- Convert timestep maps into regional-timestep
- Temporally average daily, monthly, month-hour
- Bypass: CldTYPHIST, FBCT
- CERES-monthly processing FlashFLUX 3-day processing
- Processed daily

Regional-timestep
- Temporally interpolate clouds, TOA fluxes
- Compute fluxes for missing time steps
- Compute tuned fluxes for all time steps (option)

Convert timestep maps into temporal resolution output
- Zonal and global averaging
- Write out SSF1deg, SYN1deg_lite, CldTypHist, FlashFLUX, hourly/daily/monthly netcdf files

Hourly/daily/monthly regional

Global time-step TOA/SFC/clouds map (daily netCDF)
L1B daily monitoring
First of all, usually there are no sensor event logs, GEO L1B never reprocessed.

I praise NOAA efforts to provide this web page to the remote sensing community.

A new calibration algorithm was operationally implemented to reduce the VNIR striping observed since in-orbit. This implementation was accomplished with two steps: the first step was the upload of the new detector non-linearity (Q) LUT for B01/B02/B03 on 01/17/2018 and the second step was to implement the new algorithm using Q-scaling on 02/07/2018. This new algorithm resulted in significant reduce in striping at B01/B02/B03 and slight change in the VNIR radiometric calibration accuracy. No change in B05 striping.

All the G16 VNIR bands experienced a unexpected large jump (>10%) after the GS software update (DO.07.02) on 04/08/2019. An unknown origin of the gain were used after this GS update. On 04/09/2019 the previous solar cal gain values derived with DO.07 using the 03/26 solar cal. data were re-applied to generate L1B data. Visible striping can be observed in the G16 L1B images during this abnormal period.

https://www.star.nesdis.noaa.gov/GOESCal/goes_SatelliteAnomalies.php
GEO/MODIS ATO ray-matching calibration algorithm

• Find within 15 minute coincident GOES-16 and Aqua-MODIS 50-km ray-matched radiances over all-sky ocean
• Apply spectral band adjustment factor
• Linearly regress through the space count the ray-matched radiances to obtain the monthly gain factor
• Linearly regress (2nd order) the monthly gain factors to obtain the calibration coefficients over time.
CERES Ed4 calibration methodology validation

- The ATO-RM is the primary calibration method, the other 3 methods are used to validate the primary method.
- All methods independently transfer the Aqua-MODIS calibration standard.
- The 4 method mean timeline gains are within 0.6%.

CERES Edition 4 calibration website: https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?mnemonic=CALIB-ED4

Realtime GEO calibration website: https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?mnemonic=CALIB-UPRT

ATO ray-matching daily monitoring, Jan 2019

Use Terra, Aqua, NPP and N20 ray-matches to increase sampling

GOES-16/Terra-MODIS
Jan 2019, all MODIS & VIIRS

# = 23K

ATO-RM detected the Jan 17-20, 2019 anomalies

GOES-16/Terra-MODIS daily gains
Jan 2019, all MODIS & VIIRS

SE = 0.8%

± 2.5%
The daily gain standard error is 1.0%, all daily gain departures > 3% are considered L1B anomalies.

Only two false positives exceeded ±3%, after filtering 9% of all days.

Known L1B anomalies from NOAA GOES-16 web page.

Known ch2 calibration gain 6.2% adjustment from NOAA G16 event log page.
DCC invariant target (IT) calibration algorithm

- DCC is a statistical approach that assumes that the collective tropical DCC reflectance is invariant.
- DCC pixels are identified as BT<205K, SZA<40°, VZA<40°, VIS<3% and IR<1K.
- Apply DCC BRDF, which in this case is a very small adjustment.
- The DCC pixels are compiled into a monthly probability density functions (PDFs) and the PDF mode DCC radiance is tracked over time. For wavelengths<1µm use the mode statistic, >1µm then mean
The DCC-IT looks promising to detect daily calibration anomalies.

Use 4 times as many GEO images per day to increase sampling.
GOES-16 daily DCC-IT gain monitoring

- DCC-IT was able to detect Jan 18-22, 2019, & April 8-9 GOES-16 L1B calibration anomalies
- DCC-IT was also able to predict the April 23, 2019 GOES-16 L1B calibration adjustment
- DCC-IT 3 sigma is ±2.1%

Band = 0.65 μm

Use the previous 30 days as the baseline for ±3% sigma threshold
Conclusions

• Edition 5 code re-architecture
  – One overarching framework that facilitates TISA, SARB, and FlashFLUSH products and validation efforts

• TISA code review
  – Based on a TISA library model, where shared subroutines among products remains consistent
  – Ed5 codes will be validated against Ed4 output

• A new GEO daily calibration monitoring system has been developed
Ed2 flowchart

CERES

SFC-Terra → SFC-Aqua → GEO1deg 5-satellites

CERES/GEO normalization factors

- Terra+Aqua CERES-only fluxes
- Normalized CERES+3-hourly GEO hourly fluxes
- Apply Fu-Liou to obtain surface/atm fluxes
- Then compute tune fluxes based on CERES/GEO fluxes

Products:
- SYN -> 3-hourly
- SRBAVG -> monthly
- ZAVG -> zonal, global

FlashFlux

SFC-Terra → SFC-Aqua

Daily gridded processing, Flash codes

- Temporal interpolation to hourly
- Hourly surface flux parameterizations
- Daily averaging
- Daily TOA/SFC fluxes

• The CERES-only product, which is not being updated, must wait for TISA and SARB
• SARB must wait for TISA for TOA fluxes of the CERES+GEO product to begin improving tuned computed fluxes.
Ed4 flowchart

CERES

SSF1deg-Terra → Terra-only
SSF1deg-Aqua → Aqua-only
GEO1deg 5-satellites → CERES/GEO normalization factors

Normalized 1-hourr GEO + CERES hourly fluxes
Computed surface/atm fluxes
Compute tuned (to CERES/GEO) fluxes

Products:
SSF1deg-day/month

FlashFlux

SSF1deg-Terra → Daily TOA/SFC fluxes
SSF1deg-Aqua

Temporal interpolation to hourly
Hourly surface flux parameterizations
Daily averaging

Products:
SSF1deg-day/month

- The CERES-only product released near real-time
- SARB must wait for TISA for TOA fluxes of the CERES+GEO product to begin improving tuned computed fluxes.
GEO derived broadband fluxes

- The CERES project relies on geostationary (GEO) derived broadband fluxes to infer the regional diurnal cycle in between Terra (10:30AM) and Aqua (1:30PM) CERES measurements.
- The GEO broadband (BB) fluxes are derived from the narrowband (NB) channel imager radiances and associated cloud properties to select the appropriate NB to BB and angular directional models (ADMs) based on scene selection.
- The GEO imager radiances are calibrated against Aqua-MODIS to ensure consistent clouds.
- The GEO imager derived broadband fluxes are normalized against the CERES instrument observations to maintain temporal stability in the SYN1deg product.
  - The climate quality CERES EBAF-*monthly* TOA fluxes have mostly mitigated all known GEO artifacts.
- The GEO imager L1B radiances occasionally show daily anomalies, which can vary up to 10%.
  - Need to be mitigated to avoid impacting the GEO BB fluxes in the CERES BB SYN1deg (*hourly*) dataset.