Improving the CERES Derivation of SW TOA Broadband Fluxes from GEO Narrowband Radiances with the Anticipation of the Next Generation GEO Sensors

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CERES monthly averaged datasets
CERES provides the climate community 3 types of monthly averaged datasets and are available at the following web site.
http://ceres.larc.nasa.gov/order_data.php

1) EBAF – Monthly and climatological averages of TOA and surface clear-sky (spatially complete) fluxes, all-sky fluxes, and cloud radiative effect (CRE), where the TOA net flux is constrained to the ocean heat storage term (0.58Wm⁻²). These fluxes are appropriate for climate model comparisons, since the net balance is not tied to the CERES calibration and surface fluxes are consistent with the TOA fluxes. These fluxes are diurnally complete.
2) SSFlog – CERES single satellite monthly and daily averaged TOA fluxes and MODIS cloud properties using constant meteorology at the time of the CERES measurement. These fluxes are not diurnally complete and should not be used when comparing to other Terra or Aqua datasets.
3) SYNlog – CERES monthly and daily averaged combined Terra and Aqua satellite fluxes and MODIS cloud properties with 3-hourly 5-satellite geostationary derived broadband fluxes and cloud properties. The geostationary derived broadband fluxes are used to infer the flux in between the CERES observations on either Terra (0:30) or Aqua (1:30pm) satellites. These fluxes are diurnally complete, but do contain some residual geostationary artifacts. The geostationary derived broadband fluxes are carefully normalized to the CERES fluxes to maintain the CERES instrument calibration and remove artifacts.

Background
1) CERES has used 15 GEO satellites over the last 12 years. Each one has a unique spectral response function. The older GEOs have mainly broadband functions, whereas the newer and future imagers will resemble the MODIS channels.
2) The GEO radiances need to be converted into broadband radiances in the CERES processing to estimate the diurnal flux in between CERES measurements.
3) These must be a function of surface, cloud and angle, since each of these has a very different spectral signature.

GEO visible inter-calibration with MODIS
1) Linearly regress coincident ray-matched or bore-sighted GEO visible counts and MODIS 0.65µm radiances to obtain monthly gains.
2) Track the monthly gains over time to determine GEO degradation

GEO narrowband to broadband models
1) Compute, using DISORT, the GEO and MODIS/VIRS reflectances as a function of angles, cloud and surface properties. Use a linear regression of reflectance pairs based on optical depth to convert GEO reflectance to MODIS/VIRS reflectance
2) Compute the linear regression of MODIS/VIRS and CERES observed coincident reflectance pairs as a function of angles, cloud and surface properties.

GEO visible narrowband radiancie to SW TOA flux conversion Edition2 methodology
The GEO radiances are converted broadband fluxes using a 6-step process.
1) The GEO visible radiances are inter-calibrated against Terra-MODIS 0.65µm calibration, since they have no onboard calibration.
2) The GEO visible and IR radiances are used to compute GEO cloud properties. These cloud properties will select the correct broadband to broadband and angular directional model (ADM) factors.
3) The GEO visible radiances are converted to equivalent MODIS 0.65µm radiances using DISORT as a function of angle and cloud properties.
4) The GEO equivalent MODIS 0.65µm radiances are converted to CERES-like broadband radiances using empirical model based on coincident MODIS 0.65 µm and CERES radiances using CERES SIF or footprint dataset.
5) The GEO broadband radiances are converted to fluxes using the same CERES angular directional models that CERES instrument radiances use.
6) The GEO derived broadband fluxes are then normalized regionally by regressing the GEO and CERES coincident fluxes over to maintain the CERES instrument calibration. This removes most regional, angular, cloud property dependent GEO SWTOA flux artifacts.

GEO derived broadband regional flux normalization
Using a moving 5°x5° latitude by longitude domain linearly regress all of the coincident GEO and CERES SW TOA 2°x2° regional fluxes within an 1.5 hour.
This ensures that most dependencies are not biased as a function of angles, region or cloud properties.

Future Work (Edition 4)
1) Instead of using a 2-step GEO visible narrowband to CERES broadband SW TOA flux conversion, eliminate the GEO equivalent MODIS 0.65µm conversion step and directly convert using DISORT theoretical radiances. Also use all available visible channels on the new GEO sensors.
2) Retrieve 5 channel GEO cloud properties rather than 2-channel, taking advantage of the new multi-channel GEO imagers.
3) Use hourly GEO data, eliminating the need for temporal interpolation in between CERES and 3-hourly GEO fluxes.
4) Use both GEO IR and WV channels to convert to broadband LW fluxes.