CERES CER_SSF_TRMM-PFM-VIRS_Beta2
Data Quality Summary

Investigation:	**CERES**
Data Product:	**Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF)**
Data Set:	**TRMM (Instruments: CERES-PFM, VIRS)**
Data Set Version:	**Beta2**: **These data products are NOT regarded as publishable and will not be maintained in the archives.**

The purpose of this document is to inform users of the accuracy of this data product as determined by the CERES Science Team. This document briefly summarizes key validation results, provides cautions where users might easily misinterpret the data, provides links to further information about the data product, algorithms, and accuracy, and gives information about planned data improvements. This document also automates registration in order to keep users informed of new validation results, cautions, or improved data sets as they become available.

This document is a high-level summary and represents the minimum necessary information for scientific users of this data product.

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Nature of the SSF Product

This document discusses the Single Scanner Footprint (SSF) data set version Beta2 for TRMM. Additional information is in the Description/Abstract Guide. The files in this data product contain one hour of full and partial-Earth view measurements or footprints located in colatitude and longitude at a surface reference level.

The SSF is a unique product for studying the role of clouds, aerosols, and radiation in climate. Each footprint includes reflected shortwave (SW), emitted longwave (LW) and window (WN) radiances from CERES with temporally and spatially coincident imager-based radiances and cloud properties, and meteorological information from the European Centre for Medium-Range Weather Forecasts (ECMWF).

Cloud properties, inferred from the Visible Infrared Scanner (VIRS) imager which flies along with CERES on the TRMM spacecraft, have not changed since Edition1. Top-of-atmosphere (TOA) fluxes derived from the CERES instrument are provided using a draft set of CERES-TRMM Angular Distribution Models (ADMs), called Beta2-TRMM ADMs, based on SSF TRMM Edition1 cloud properties. Surface fluxes are inferred from the TOA fluxes, and the shortwave surface Model B net and downward fluxes are now consistent.

Only CERES footprints with adequate imager coverage are included on the SSF product. Since the VIRS imager can only scan to a maximum viewing zenith angle (VZA) of ~48° this means that only CERES footprints with VZA < 48° are retained on the SSF when CERES is in the crosstrack scan mode. When CERES is scanning in either the Rotating Azimuth Plane (RAP) or the alongtrack scan mode, CERES footprints with VZA > 48° do appear on this product provided they lie within the VIRS swath.

A full list of parameters on the SSF is contained in the CERES Data Product Catalog (PostScript) and a full definition of each parameter is contained in the SSF Collection Guide.

When referring to a CERES data set, please include the satellite name and/or the CERES instrument name, the data set version, and the data product. Multiple files which are identical in all aspects of the filename except for the 6 digit configuration code (see Collection Guide) differ little, if any, scientifically. Users may, therefore, analyze data from the same satellite/instrument, data set version, and data product without regard to configuration code. This data set may be referred to as "CERES TRMM Beta2 SSF."

Cautions and Helpful Hints

There are numerous cautions the CERES Science Team notes regarding the use of CERES-TRMM Beta2 SSF data:

- **These data are NOT regarded as publishable.**

- The geographic location of a CERES flux estimate is at the surface geodetic latitude and longitude of the CERES footprint centroid. On ERBE, all fluxes are located at a geocentric latitude and longitude corresponding to the 30-km level.

- SSF Beta2_TRMM ADMs were constructed without explicitly accounting for the finite thickness of the Earth's atmosphere. Consequently, the reference altitude of the corresponding SSF fluxes depends on scene type (for both SW and LW) and solar zenith angle (SW). On average, the reference level for these fluxes is approximately 28 km for SW and approximately 15 km for LW. The flux on the SSF differs from a flux that accounts for all radiance contributions (including those that don't interact with the surface) at a 17-km reference level by 0.35%.

- Before using SSF parameter values, users should check for CERES default values. (See SSF Collection Guide.) A CERES default value is used when the parameter value is unavailable or considered suspect. SSF-1 through SSF-24 always contain valid parameter values and, therefore, need not be checked for default values. All other parameter values should be checked.

- Users interested in surface type should always examine both "Surface type index" and "Surface type percent coverage." (See SSF Collection Guide.)

- A footprint is recorded in the hourly SSF file that contains its observation time. However, SSF footprints within the file are ordered on alongtrack angle and not on time. The alongtrack angle of the satellite is defined to be 0° at the start of the hour. If the instrument is in the RAP or alongtrack scan mode, then footprints can be prior to this start position and yield a negative alongtrack angle.

- Cloud parameters are saved by cloud layer. Up to two cloud layers may be recorded within a CERES footprint. The layers are floating and will vary from one footprint to another. When there is a single layer within the footprint, it is defined as the lower layer, regardless of its height. A second, or upper, layer is defined only when a footprint contains two unique layers. Within an SSF file, it is possible for the lower layer of one footprint to be much higher than the upper layer of another footprint.

- Within a footprint, the mean pressure value of the lower cloud layer top may be lower than the mean pressure value of the upper cloud layer base.

- Not all footprints have full imager coverage. All footprints have at least 60% imager coverage, defined as adequate. Consult data parameter "Imager percent coverage" (see SSF Collection Guide) to determine actual imager coverage for a footprint. Footprints with VZA greater than 80° and less than 100% imager coverage may be partial Earth-view. Consult data parameter "Radiance and Mode flags" to determine whether the footprint is full Earth-view or not. When the instrument is in the RAP or alongtrack scan mode, there are more footprints with adequate imager coverage and the SSF files are larger.

- There are cases where the cloud properties cannot be determined for an imager pixel that is cloudy at a high confidence level. These pixels are included in the area coverage calculations. The cloud layer areas are proportionately adjusted to reflect the contribution these pixels would have made, but the cloud properties for each layer are not adjusted. The amount of extrapolation can be determined by checking the parameter "cloud property extrapolation over cloud area." (See SSF Collection Guide.)

- Some applications of the SSF data will need to make the distinction between crosstrack, RAP, and alongtrack scan data. Multiple scan modes can occur in the same hour so that bits 8-9 of the data parameter "Radiance and Mode flags" (see SSF Collection Guide) should be examined for each footprint to properly identify the scan mode. If actual azimuth angle is required, examine data parameter "Clock angle of CERES FOV at satellite wrt inertial velocity."

- Night and near-terminator cloud properties - The current method for deriving cloud phase, particle size, and optical depth at night has not been fully tested. It has been implemented primarily to improve the nocturnal determination of cloud effective height for optically thin clouds ($\tau < 5$) and is generally effective at retrieving more accurate cloud heights compared to assuming that all clouds act as blackbody radiators at night (see validation results). Because an accurate optical depth is required to obtain the proper altitude correction, the optical depths for optically thin clouds are probably reasonable.

- Near-terminator cloud amounts - The cloud mask relies heavily on the brightness temperature differences between channels 3 (3.7 µm) and 4 (10.8 µm) for identifying clouds at night (using 3.7 µm emittance) and in the daytime (using 3.7 µm reflectance). The signals differ between night and day for low clouds. For large solar zenith angles (> 80°), the emittance and reflectance signals can cancel each other resulting in low clouds mistaken as clear areas when the cloud temperature is close to or warmer than the clear-sky temperature.

- Heavy aerosols - Aerosols with relatively large optical depths can sometimes be misidentified as clouds over any surface. Thus, in areas known to experience large dust outbreaks, such as large deserts or adjacent ocean areas, caution should be used when interpreting cloud statistics.

- Optical depths over snow - Cloud optical depth is derived from the channel 1 reflectance. Over highly reflective snow areas, the retrieved optical depth is particularly sensitive to small changes in optical depth or to slight variations in the surface reflectance. In general, the optical depths will be overestimated in snow covered regions.

- Multi-layered/mixed-phase cloud properties - An experimental algorithm to detect multi-layered clouds is implemented at the pixel level, but is not available on the SSF. The algorithm requires additional study. Thus, all clouds are treated as single phase, single-layer clouds in the retrievals. Mixed phase cloud pixels are interpreted as either entirely liquid or ice clouds depending on the relative amounts of each phase in the top of a particular cloud. Overlapped ice and water cloud pixels are interpreted in a similar fashion depending on the optical thickness and particle size of the overlying cloud. If it is very thin, the cloud is usually classified as liquid. Thicker ice clouds over liquid clouds are classified as ice. The resulting ice particle size for the thicker clouds should be representative of the ice cloud, but is often too small for the thinner clouds. Mixed phase or overlapped thin-ice-over-thick-water clouds will produce either a liquid water effective radius that is too large for the water droplets in the cloud or too small for the ice crystals in the cloud because the 3.7 µm reflectances for the ice and water particles overlap at the low and high end, respectively. Users will need to use some contextual, temperature, or variability indicators to determine if a particular SSF cloud layer contains both ice and water clouds even if phase index for the footprint is 1 (water) or 2 (ice). Cloud heights for multi-layered clouds will also be in error if the upper cloud deck is optically thin. The retrieved cloud altitude will be between the height of the lower and the upper clouds.

- Visible aerosol optical depth is somewhat high compared with AVHRR (~ 0.03 to 0.05), particularly at large optical thicknesses. This high bias may be the result of cloud contamination, particularly from cirrus clouds. Cirrus clouds absorb at 1.6 µm, but scatter at 0.63 µm. Thus, cirrus should affect aerosol optical depth retrievals more strongly in the visible channel than in the near-IR channel of VIRS. Histograms of aerosol optical depth for large regions of the ocean show more uniform distributions in the near-IR than in the visible, supporting this hypothesis.

- Near-IR aerosol optical depth may have a reflectance calibration or dark albedo correction (thermal leak at 5.2 µm) problem since negative values occur frequently, while they are very rare in visible aerosol optical depth.

- The basic 2nd generation single channel NOAA/NESDIS retrieval algorithm appears to have an artificial dependence on solar zenith angle (SZA), since both AVHRR and VIRS aerosol optical depth values decrease with increasing SZA. Trends also exist with precipitable water and infrared radiance, which are either due to uncorrected absorption by water vapor or real changes in aerosol particle size with relative humidity. Trends exist with wind speed, suggesting that ocean specular reflection or white caps may be artificially elevating aerosol optical depth values. Trends exist with cloud cover, suggesting either weak cloud contamination (possibly from cirrus cloud, as noted above) or from real changes in aerosol properties due to the clouds.

- Visible and near-IR aerosol optical depths are not computed for all clear pixels. (See SSF Collection Guide.)

- Cloud Infrared emissivity values are missing at night and are cut off at 1.0 during the day. Alternately stated, all nighttime cloud IR emissivity values are set to CERES default. Daytime cloud IR emissivity values greater than 1.0 are replaced with CERES default.

- Shortwave Model A surface fluxes are limited to clear-sky footprints. Longwave Model A surface fluxes are also limited to clear-sky footprints. Shortwave Model B and Longwave Model B surface fluxes, however, are available for all-sky.

Accuracy and Validation

Accuracy and validation discussions are organized into sections. Cloud properties, aerosol properties, and spatial matching for the CERES-TRMM Beta2 SSF data set are identical to CERES-TRMM Edition1 SSF. Therefore, the CERES-TRMM Edition1 discussions are relevant and provided as links. Since there have been changes in the computation of TOA fluxes and surface fluxes, those corresponding sections have been updated for CERES-TRMM Beta2.

Please read those sections which correspond to parameters of interest.

- Cloud properties
- Aerosol properties
- Spatial matching of imager properties and broadband radiation
- TOA fluxes
- Surface fluxes

Expected Reprocessing

The CERES Science Team expects to reprocess the SSF data set for TRMM as Edition2 in Fall 2001. The TRMM Edition2 SSF data set will include improved cloud parameters, aerosol optical depths, TOA fluxes and surface fluxes. Edition2 is the last planned reprocessing of the TRMM data.

The TRMM Edition2 reprocessing will use an improved set of ADMs which are based on the Edition2 cloud properties. Accuracy of the fluxes will be improved.

The clear-sky maps will be updated. Results from Edition1 VIRS will be used to improve the characterization of the clear-sky emittance, temperature, and reflectance fields to provide an improved cloud mask, especially over bright desert areas and over land and desert at night.

For Edition2, an improved set of cloud reflectance parameterizations will yield more accurate cloud optical depths.

The Edition2 cloud algorithm improvements will be guided by results of further validation studies. It is expected that a variety of additional types of comparisons will be conducted including references such as microwave liquid water paths over ocean, radiometer-based optical depths from many surface sites, additional ARM sites, and longer time records.

A 3rd generation aerosol retrieval algorithm will be used in CERES-TRMM Edition2. This 3rd generation algorithm uses look-up tables constructed from a modern radiative transfer model, 6S, which incorporates a rough ocean surface reflectance model, a better treatment of atmospheric absorption, and the wide spectral responses of the sensor's channels. The algorithm uses the VIRS channel 1 (0.63) and 2 (1.61) reflectances to select an aerosol size distribution parameter (Angstrom exponent) that is most appropriate for the retrieval of optical depth at that instant in time. If the simultaneous solution cannot be found, then the aerosol retrieval defaults to the 2nd generation type retrieval. The 2nd generation algorithm uses a fixed aerosol microphysical model corresponding to an Angstrom exponent from the middle of the range covered by the 3rd generation algorithm LUTs, and an independent channel retrieval is made from each of the two channel's reflectances. In this case, the retrieved aerosol optical depths may become negative. Even though this algorithm should be more accurate because it adjusts for regional changes in aerosol type, it is still subject to the same calibration and cloud mask uncertainties.

Referencing Data in Journal Articles

These data are NOT for publication.

Feedback

For questions or comments on the CERES Quality Summary, contact the User and Data Services staff at the Atmospheric Science Data Center.

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