Clouds and the Earth's Radiant Energy System (CERES) Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF) Data Set Abstract

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Data Set Description:

The Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF) product contains one hour of instantaneous Clouds and the Earth's Radiant Energy System (CERES) data for a single scanner instrument. The SSF combines instantaneous CERES data with scene information from a higher-resolution imager such as Visible/Infrared Scanner (VIRS) on TRMM, Moderate-Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua, or Visible Infrared Imaging Radiometer Suite (VIIRS) on Suomi-National Polar-orbiting Partnership (NPP). Scene identification and cloud properties are defined at the higher imager resolution and these data are averaged over the larger CERES footprint.

The SSF product includes:

- Time and Position (Sun, satellite footprint)
- Viewing geometry
- Surface information
- Scene identification
- Radiometric data (total, shortwave, window)
- Unfiltered radiances (shortwave, longwave, window)
- Top-of-Atmosphere (TOA) and surface fluxes (shortwave, longwave, window)
- Full footprint area parameters (imager coverage, wind, temperature, humidity, extrapolation)
- Clear area parameters (clear amount, aerosol)
- Cloud area parameters for up to 2 layers (cloud amount, height, temperature, pressure, optical depth, emissivity, and water path and particle size for both water phases)
- Imager radiance statistics (full footprint, clear, cloudy, layers)
- MODIS land aerosol (starting with Edition1A Terra, **not** available for TRMM, VIIRS land aerosol on NPP)
- MODIS ocean aerosol (starting with Edition1A Terra, **not** available for TRMM, VIIRS ocean aerosol on NPP)

CERES footprints which fall outside of the imager swath do not appear on the SSF data product. The maximum VIRS viewing zenith angle is ~48°, and the maximum MODIS viewing zenith angle is ~65°. The imager swath restriction does not apply to the CERES ES-8 product which contains a full set of CERES footprints.

Additional information about the format and content of the SSF can be found in the CERES Data Products Catalog. A detailed description of the SSF can be found in the SSF Collection Guide. Data set specific information can be found in the associated Quality Summary.

Summary of Changes:

The CERES Data Management Team and the Atmospheric Science Data Center (ASDC) at Langley use a Sampling Strategy, a Production Strategy, and a Configuration Code (CCode) to track versions of CERES primary data products. In general, minor reprocessing changes are tracked by increasing the Configuration Code while major reprocessing changes result in a new Production Strategy. The Sampling Strategy identifies the satellite and instruments which acquired the data in the product.

A summary of changes made to the CERES SSF product is shown in the following tables. Please note that Field of View (FOV) and footprint are used interchangeably.

Modification History for: NPP | Aqua | Terra | TRMM

Modification History of the CERES NPP SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
NPP-FM5-Edition1A[4]	100101	Aug 2015	• Fixed an error that was not selecting imager pixels at certain view zenith angles. For even packets, sample numbers between 190 and 212 and between 476 and 498 are dropped. For odd packets, sample numbers between 131 and 155 and between 533 and 547 are dropped. • Captured VIIRS scan lines that were being dropped as granules varied from 4 to 6 minutes. • Include both land and ocean pixels in calculating aerosol variables. • Imager aerosol percent coverage for land and ocean are calculated. • Use imager derived skin temperature when grater than 10 degrees over MOA value. • Ported to IBM PPC 7 hardware.
NPP-FM5-Edition1A[4]	100100	Oct 2014	• The NPP processing variations began with an Aqua/Terra Edition4A baseline. • Modified cloud mask to use VIIRS imager radiance bands and produce consistent results with baseline. • Improved daytime polar cloud mask. • Increased nighttime tropical ocean thin cirrus cloud detection. • Improved twilight and nighttime polar cloud detection with reduced twilight stripping and nighttime speckling resulting in more low clouds and thin cirrus. • Replaced cloud mask tests using 6.7 and 13.3 µm channels with test using available VIIRS channels. • Modified cloud retrieval algorithms to function with the VIIRS imager radiance bands to produce consistent results. • Removed conversion of optical depth from 3.7 to 0.6 µm. • Corrected thick cloud top height correction. • Modified code to process imager data at 8 (pixel) by 2 (scan) resolution. • Converted VIIRS AOT to correspond to MODIS AOT by weighting with logarithm of wavelength at 0.469, 0.645, 0.859, 1.64, and 2.13 µm. • Provided 1.24 radiance from reflectance. • Replaced CO_2 channel algorithm for retrieval of cirrus cloud top heights, pressure, and temperature. • Eliminated all multilayer cloud retrieval over snow and ice covered surfaces. • Implemented imager wavelength selection consistent with available VIIRS channels. • Implemented Correlated K-Distribution's coefficients for VIIRS bands: 3.7 (I4), 11 (M15), 12 (M16), 1.6 (M10), and 1.24 (M8) µm. • Implemented clear sky directional and bidirectional models for both snow free and snow surfaces at 1.6 µm. • Updated clear sky overhead albedo for 1.6 µm. • Resolved VIIRS bowtie deletion issue. • Used new liquid water (Hong) ice (Yang) reflectance model at I1, I3, I4, and M8. • Removed conversion of optical depth from 3.7 to 0.6 µm. • Corrected thick cloud top height correction.

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Modification History of the CERES NPP SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
			• Implemented O2 transmittance for 0.6 µm.
Availability: (1) not available; (2) restricted to CERES analysts; (3) restricted to CERES Science Team and analysts; (4) public			

Modification History for: NPP | Aqua | Terra | TRMM

Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
Aqua-FM3-MODIS_Edition4A[4] Aqua-FM4-MODIS_Edition4A[4]	400402 400403	Oct 2014	• Improved TOA fluxes with updated Edition4A ADMs used for both Terra and Aqua. • Improved surface model fluxes with use of Edition4 MATCH aerosol daily files. • Improved solar insolation from combined SORCE-RMIB dataset. • Used Edition4 CERES gains and SRFs. • Used clouds data from the Beta2-Ed4 SSF. • Processing on the AMI-x86 system.
Aqua-FM3-MODIS_Beta2-Ed4[1] Aqua-FM4-MODIS_Beta2-Ed4[1]	400401	Mar 2013	• Improved cloud height determination with lapse rate modified profiles.
Aqua-FM3-MODIS_Beta1-Ed4[1] Aqua-FM4-MODIS_Beta1-Ed4[1]	400400	Aug 2012	• Additional variables were added and others dropped. SSF_ID is 119. • Ice particle size is now reported as generalized effective radius instead of effective diameter. • Updated daytime nonpolar cloud mask for better sun-glint detection, better dust and low cloud discrimination (ratio of 1.24/0.65), high-elevated deserts, snow detection, and improved thin cirrus and coastal clouds detections. • Modified daytime mask over tropical ocean for heavy dust and low cloud test in presence of sunglint. • Updated nighttime non-polar cloud mask improving thin cirrus and low cloud detection, increased cloud detection over ocean and desert (reduced 3.75-11 STD from 2 to 1.5K). • Updated daytime polar cloud mask improved ice clouds, snow surface, clear land, and cirrus detection. Added clear-snow overwrite, clear strong, and clear weak using snow, ice and IGBP maps and spectral test. • Updated nighttime polar cloud mask with improved cloud detection. Changed the cloud test over super cold plateau. Added MODIS clear-sky restore tests. • Improve twilight polar test be reducing brightness temperature difference and reflectance thresholds. • Implemented a daily moving transition definition between polar and non-polar during the summer season. • Corrected cloud optical depth for upper-layer clouds. • Corrected particle size retrieval in SIST (nighttime) at large and small limit. • Standardized on 1.24 µm imager channel for microphysical properties. • Improved MODIS correlated k-distribution for 1.24 µm. • Implemented new particle size algorithms for 1.24 and 2.13 µm over daytime non-polar regions. • Implemented water and ice cloud absorption at 1.24 µm. • Implemented Ping Yang ice model for 0.6, 1.24, 2.13, and 3.7

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Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
			μm with roughness = 1.
			• Implemented algorithm that include CO_2 slicing for optically thick clouds to calculate optical depth using 1.24 μm over daytime polar region.
			• Implemented an IR algorithm to be applied for no VISST retrieval or thin cirrus clouds without an ice solution.
			• Improved daytime cloud phase algorithm to prevent supercool clouds being classified as ice and thin cirrus as water.
			• Corrected a bug that when starting with very cold clouds, it did not transition to water even as temperature was warm enough.
			• Improved nighttime cloud phase algorithm to reduce misidentification.
			• Always use predicted clear sky reflectance during cloud retrieval instead of observations when exceeding 10 percent of pixels.
			• Changed to use SIST algorithm during twilight instead of LBTM and multispectral daytime analysis.
			• Modified VISST effective temperature to use CO_2 effective temperature (cloud top adjusted) for ice clouds.
			• Implemented over-shooting top algorithm to mask pixels that are higher than tropopause. VISST cloud retrieval now calculates an actual cloud height and properties.
			• Implemented a new ice cloud thickness algorithm based on CERES-CALIPSO-CloudSat-MODIS results.
			• Implemented algorithm to check cloud retrieval properties to determine if their actually aerosol only.
			• Revised look-up tables for emissivity, reflectivity, and transmission. Increased range of valid brightness temperature and conversion between effective ice radius and diameter.
			• Revised the CO_2 algorithm to enhance cirrus cloud-top height retrieval and repaired false-detection and 13.3 μm stripping.
			• Improved the multilayer algorithm to remove daytime false detection and nighttime no retrieval.
			• Improved the multilayer optical depth and cloud macro-physical properties.
			• Corrected the CEM CO_2 cloud fraction
			• Implemented 1.24 μm snow-free directional model and Kriebel BDRF for each surface and hybrid snow-covered BDRF,
			• Implemented Jin's clear sky (snow-free) ocean reflectance model for .24, 1.6, and 2.13 μm including using water vapor and ozone absorption from MOA.
			• Added snow-free clear sky overhead sun-albedo maps at 1.24 μm and updated for 0.6, 1.6, and 2.13 μm.
			• Added snow-covered clear sky overhead sun-albedo maps at 1.24 μm.
			• Implemented 3.7 μm nighttime calibration correction.
			• Implemented an algorithm to remove stripping in brightness temperature difference in 3.7 and 11 at night.
			• Removed the supervised classifier (UAH) based upon a back-propagation neural network.
			• Stopped including CERES footprints with 0 percent imager coverage or no valid CERES radiances.
			• Reclassify imager pixels with no cloud fraction as clear if high probability of glint and difference between clear sky and 11 μm brightness temperature is small.
			• When MODIS aerosol scans in a granule is inconsistent with the geolocation, the aerosol file is skipped.
			• Eliminate use of Radiometric Scale Factors.

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Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
			• Use LASP SORCE TSI variable Solar Constant data instead of 1365. • Updated Surface Model B algorithm • Use MATCH data when MODIS aerosol is not available in Surface Model B. • Port code from magneto to AMI.
Aqua-FM3-MODIS_Edition3A[4] Aqua-FM4-MODIS_Ed3A-NoSW[4]	303303 303304 303305 304305	May 2013	• Removed extra input footprint that did not have corresponding Edition3 IES data.
Aqua-FM3-MODIS_Edition3A[4] Aqua-FM4-MODIS_Ed3A-NoSW[4]	300301	Oct 2011	• Provided error handling when 0.65 MODIS imager channel was not available.
Aqua-FM3-MODIS_Edition3A[4] Aqua-FM4-MODIS_Edition3A[4] Aqua-FM4-MODIS_Ed3A-NoSW[4]	300300, 301300, 302300, 303300	Jan 2011	• Created new PGE to read and IES file for input as well as an existing SSF, MOA and Spectral Calibration Coefficients. • Installed updated algorithms for surface models LWA and LWB using a constrained near-surface air temperature. • Applied Radiometric Scaling Factor. • Twilight fix applied. • SSF ID set to 1117 • 300300 – Edition2B SSF used as input. • 301300 – Edition2C SSF used as input. • 302300 – Edition2D SSF used as input. • 303300 – Edition1-CV SSF used as input
Aqua-FM3-MODIS_Edition2D[4] Aqua-FM4-MODIS_Ed2D-NoSW[4]	035041	Jul 2010	• Software recompile to operate on IBM hardware with SUSE linux. • Uninitialized parameters were initialized and some bounds problems corrected. (CERES Fluxes SSF-38 through SSF-49 and cloud properties SSF-82 through SSF-114) • Software recompile to use interface to GMAO G5-CERES MOA data. (CERES Fluxes SSF-38 through SSF-49, MOA parameters SSF-57 through SSF-62, and clouds mask and properties SSF-66, SSF-81, SSF-116, SSF-117, SSF-82 through SSF-114) • Modified to handle higher surface pressure from G5-CERES. (cloud mask and properties SSF-82 through SSF-114). • Modified to handle reprocessed radiation MODIS granules with different scan numbers than the geolocation file. (CERES Fluxes SSF-38 through SSF-49 and all imager based parameters SSF-60 through SSF-160). • SSF ID set to 1117.
Aqua-FM3-MODIS_Ed2C-MOD-C4-Land-IGBP[4] Aqua-FM4-MODIS_Ed2C-MOD-C4-Land-IGBP[4]	034040	Jun 2009	• The variable MODIS derived IGBP map was used instead of the fixed map used in climate data sets. • SSF ID set to 1117.
Aqua-FM3-MODIS_Edition2C[4] Aqua-FM4-MODIS_Edition2C[4] Aqua-FM4-MODIS_Ed2C-NoSW[4]	034040	Sep 2008	• Software recompile to support MODIS Collection 5. • SSF ID set to 1117.
Aqua-FM3-MODIS_Edition2B[4] Aqua-FM4-MODIS_Edition2B[4]	034039	Jun 2007	• SW Surface Flux Model B module was modified to switch back from MATCH broadband to Match GFDL aerosols. The following SSF SDSs will vary: SSF-46 and SSF-48. • Software recompile to support upgrade to Toolkit version 5.2.12. • SSF ID set to 1117.
Aqua-FM3-MODIS_Edition2A[4]	032037	Feb 2006	• SW Surface Flux Model A module was modified to switch from

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Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
Aqua-FM4-MODIS_Edition2A[4]			Match GFDL to MATCH aerosols at 550 nm. The following SSF SDSs will vary: SSF-38, SSF-41 and SSF-44. • SW Surface Flux Model B module was modified to switch from Match GFDL to MATCH broadband aerosols. The following SSF SDSs will vary: SSF-46 and SSF-48. • LW Surface Flux Model B module was modified to correct cloud pressure calculations. The following SSF SDSs will vary: SSF-39, SSF-47 and SSF-49. • SSF ID set to 1117.

Aqua-FM3-MODIS_Edition1B[4]
 Aqua-FM4-MODIS_Edition1B[4]
	029033
	 030034
		Jan 2005	• Cloud Phase Algorithm was modified to have a more accurate cloud phase selection. The following SSF SDSs will vary SSF-82 through SSF-114.
			• Water content map is re-generated to change defaults to zeros over Antarctica region. The following SSF SDSs will vary: SSF-25, SSF-66, SSF-81, SSF-116, SSF-117, SSF-82 through SSF-114.
			• The problem over polar/non-polar transition ocean areas (mostly occurred in Sea of Okhotsk and Hudson Bay in Terra-MODIS_Edition2-QC) is resolved by having a fix ocean albedo over non-polar region. SSF SDSs: SSF-66, SSF-81, SSF-116, SSF-117, SSF-82 through SSF-114 will vary over the transition ocean areas.
			• 12 months of clear sky start-up maps are re-created for 0.6 µm and 2.1 µm respectively. Clear sky maps are the inputs for all algorithms, therefore the new maps will influence many SSF SDSs (mostly SSF-66, SSF-81, SSF-116, SSF-117,SSF-82 through SSF-114) to some degrees.
			• The following summaries the changes in CERES mask algorithm, which will affect SSF SDSs: SSF-66, SSF-81, SSF-116, and SSF-117.
			  o Daytime non-polar:
			    – Consolidated the Terra and Aqua daytime cloud mask into one set for easier maintenance and higher efficiency.
			    – Implemented the new daytime thin Cirrus detection tests over land and desert using MODIS 1.38, 8.55 - 11, 11 - 12 tests and the MOA precipitable water. It significantly improved the thin Ci detection over land. Daytime
			    – CERES cloud mask structure has been changed.
			    – In C3_land tests, improved the low clouds tests and the dark snow detection at high latitudes, smoothed the transition regions.
			  o Daytime polar:
			    – Improved both Aqua and Terra mini-mask for a better classification of the TBD pixels.
			    – Reorganized and cleaned up the Aqua and Terra masks.
			  o Twilight polar:
			    – Improved the twilight Aqua and Terra cloud and snow detection for a smoother transition between polar and non-polar.
			• When VISST algorithm returns no cloud retrieval, LBTM algorithm is applied. This modification will improve SSF SDSs: SSF-82 through SSF-114.
			• CERES Overlapping Algorithm was implemented. None of SSF SDS is affected.
			• Clouds QC structure is modified to include histograms for several cloud properties. None of SSF SDS is affected.
			• Footprints influenced by a solar eclipse will be removed from the file.

Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
			• The Surface type percent coverage (SSF-25) land coverage is reduced based on the water content map. The reduced area is added to the ocean areal coverage.
			• The Snow/Ice percent coverage from vis albedo (SSF-30) now includes permanent snow.
			• The GRing module was modified to use correct coordinates for the no footprint case. A GRing that covers the entire globe was added.
			• Aqua dynamic Spectral Correction Coefficients were used.
			• Terra Edition2B ADMs were used.
			• SSF ID set to 1117.
Aqua-FM4-MODIS_Edition1A[1] Aqua-FM4-MODIS_Edition1A[1]	029032	Dec 2004	• Incorrect Spectral correction coefficients used in creating Aqua-FM4-MODIS_Edition1A.
Aqua-FM3-MODIS_Beta2[4] Aqua-FM4-MODIS_Beta2[4]	027030	Mar 2004	• All footprints with a viewing zenith greater than or equal to 63 degrees are included in the SSF. When the viewing zenith angle is less than 63 degrees and the packet number is even, then only footprints with an even value Scan sample number are placed in the SSF. When the viewing zenith angle is less than 63 degrees and the packet number is odd, then only footprints with an odd value Scan sample number are placed in the SSF.
			• All PSF weighted imager parameters on the SSF (SSF-24 through SSF-26, SSF-30, SSF-54, SSF-64 through SSF-78, SSF-81 through SSF-113, and SSF-131) will be obtained using only imager pixels from every 2nd scanline and every 4th pixel (2x4) and a new point spread function.
			• The Surface type percent coverage (SSF-25) sea ice areal coverage is reduced based on the ice fraction reported on the microwave ice map. The reduced area is added to the ocean areal coverage.
			• ADM geo (SSF-30) now contains the percent snow or ice for polar region based on the overhead-sun albedo from CRH 0.6 µm map updated from the day before. The threshold over ocean is equal to the average IGBP type overhead sun albedo plus 3-sigma. The threshold over land IGBP types is its average overhead sun albedo plus 2-sigma.
			• The Radiance and Mode flags (SSF-34) will identify when the footprint was under a solar eclipse.
			• CERES ADM types and TOA fluxes-upward (SSF-27 through SSF-29 and SSF-38 through SSF-41) will be derived using the new Terra Edition2A ADMs.
			• Notes on General Procedures (SSF-64) only footprints that have Stowe aerosol calculated on them are flagged as using the second generation algorithm.
			• Total aerosol A optical depths (SSF-73 and SSF-74) will use satellite specific solar constants as provided by Dr. Ignatov to determine reflectance. The radiance channel for clear air optical depth using the Stowe algorithm was made selectable based on satellite. For Aqua, it will be 0.6 and 2.13.

			• Clear, Clear/layer/overlap, All subpixel clear, All subpixel overcast cloud area percent coverage (SSF-66, SSF-81, SSF-116, and SSF-117) will vary due to
			  o Added skin T restriction for Tlim test: (T > 270K)
			  o Daytime Polar:
			    – Added restriction to Cold Cloud Test, avoid calling Super Cold Plateau clouds.
			    – Added thin cirrus clouds detection. Tuned various thresholds to improve the results.
			    – Added mini-mask for TBD pixels, no more TBD in

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Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product

			CERES daytime mask.
			 o Nighttime Polar:
			   − All the improvements in the Terra Edition 2 (SCCR467).
			   − Filter out the bad T3.7 data (T3.7 > 300K)
			 o Daytime non-polar:
			   − Added sun-glint probability dependent T3-T4 thresholds in SunGlintTest.
			   − Improved smoke detection over ocean.
			   − Added a snow test region flag to avoid "tropic snow"
			 o Special cloud detection tests over super cold plateau for night and twilight.
			 o Welch mask will no longer be used when CERES mask in undetermined over polar region during daytime.
			 o Welch mask will no longer be used when CERES mask in undetermined over polar region during daytime.
			 o The polar mask is no longer applied in nonpolar regions where skin temperature is less than 270 K.
			 o The imager pixel will not have an undetermined cloud fraction anymore.
			 • Cloudy Footprint Area SDS (SSF-82 through SSF-114) will be improved because over snow-ice non-elevated land, where an inversion cloud height was calculated from GEOS lapse rate, the MOA skin temperature used in calculations was replaced by the daily averaged MOA air surface temperature. Cloud thickness and clouds top emissivity calculations now uses cloud phase instead of cloud temperature. Footprint Imager Radiance Statistics (SSF-118 through SSF-131) for daytime footprints contain radiance for 2.13 micrometer.
			 • The Percentage of CERES FOV with MODIS land and ocean aerosol (SSF-132 and SSF-146) was corrected to represent the true coverage instead of anything over 1 percent being reported as 100 percent.
			 • PSF-wtd MOD04 corrected optical depths land, effective optical depth average ocean, and optical depth small average ocean (SSF-136 through SSF-138 and SSF-150 through SSF-159) now have an upper limit of 5.0.
			 • Aqua dynamic Spectral Correction Coefficients were used.
			 • Terra Edition2A ADMs were used.
			 • SSF ID set to 1117.

Aqua-FM4-MODIS_Beta1[3]	025027	May 2003	• The Aqua processing variations began with a Terra Edition1A baseline. • Clear, Clear/layer/overlap, All subpixel clear, All subpixel overcast cloud area percent coverage (SSF-66, SSF-81, SSF-116, and SSF-117) will vary due to o New start-up maps for 2.1 µm albedo and 2.1 µm albedo standard deviation were implemented. o The Kriebel Bidirectional model for 2.1 µm was implemented. o Both sub-Arctic summer and sub-Arctic winter snow reflectance models for 2.1 µm were implemented. o Welch mask will no longer be used when CERES mask in undetermined over polar region during daytime. o 2.1 µm daytime polar cloud mask used. Improved polar nighttime and non-polar daytime CERES mask • Cloudy Footprint Area SDS (SSF-82 through SSF-114) will be improved because o The 2.1 µm cloud model used in polar regions was

Modification History of the CERES Aqua SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on Aqua SSF Product
			implemented so that the NoVis cloud retrieval algorithm automatically uses the 2.13 µm cloud model.
			○ The observed 1.6 µm reflectance and clear sky predicted 1.6 µm reflectance were replaced by 2.1 µm observed reflectance and clear sky predicted 2.1 µm reflectance respectively.
			• PSF-wtd MOD04 dust weighting factor land (SSF-135) is filled with default values.
			• Mean and Stddev of imager radiances (SSF-118 through SSF-129) contain the same radiance channels as used for Terra.
			• Static Aqua spectral correction coefficients were used. Terra Edition1A ADMs were used.
			• SSF ID set to 1117.
Availability: (1) not available; (2) restricted to CERES analysts; (3) restricted to CERES Science Team and analysts; (4) public			

Modification History for: NPP | Aqua | Terra | TRMM

Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
Terra-FM1-MODIS_Edition4A[4] Terra-FM2-MODIS_Edition4A[4]	400402 400403	Oct 2014	• Update the MATCH aerosol daily file from Edition2 to the Edition4 netCDF files. • Update the SORCE TSI ancillary file to a combined SORCE-RMIB ancillary file. • Update the ADM software and ancillary files from the Edition2/3 versions to Edition4. • Use Edition4 CERES gains and SRFs. • Processing on the AMI-x86 system. • Clouds data from the Beta2-Ed4 SSF are used. • Edition4 gains and spectral responses are used.
Terra-FM1-MODIS_Beta2-Ed4[1] Terra-FM2-MODIS_Beta2-Ed4[1]	400401	Mar 2013	• Use lapse rate modified profiles for cloud height determination.
Terra-FM1-MODIS_Beta1-Ed4[1] Terra-FM2-MODIS_Beta1-Ed4[1]	400400	Aug 2012	• Additional variables were added and others dropped. SSF_ID is 119. • Ice particle size is now reported as generalized effective radius instead of effective diameter. • Updated daytime nonpolar cloud mask for better sun-glint detection, better dust and low cloud discrimination (ratio of 1.24/0.65), high-elevated deserts, snow detection, and improved thin cirrus and coastal clouds detections. • Modified daytime mask over tropical ocean for heavy dust and low cloud test in presence of sunglint. • Updated nighttime non-polar cloud mask improving thin cirrus and low cloud detection, increased cloud detection over ocean and desert (reduced 3.75-11 STD from 2 to 1.5K). • Updated daytime polar cloud mask improved ice clouds, snow surface, clear land, and cirrus detection. Added clear-snow overwrite, clear strong, and clear weak using snow, ice and IGBP maps and spectral test. • Updated nighttime polar cloud mask with improved cloud detection. Changed the cloud test over super cold plateau. Added MODIS clear-sky restore tests.

Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
			• Improve twilight polar test be reducing brightness temperature difference and reflectance thresholds.
			• Implemented a daily moving transition definition between polar and non-polar during the summer season.
			• Corrected cloud optical depth for upper-layer clouds.
			• Corrected particle size retrieval in SIST (nighttime) at large and small limit.
			• The MODIS imager calibration was adjust to be consistent with Aqua MODIS.
			• Standardized on 1.24 µm imager channel for microphysical properties.
			• Improved MODIS correlated k-distribution for 1.24 µm.
			• Implemented new particle size algorithms for 1.24 and 2.13 µm over daytime non-polar regions.
			• Implemented water and ice cloud absorption at 1.24 µm.
			• Implemented Ping Yang ice model for 0.6, 1.24, 2.13, and 3.7 µm with roughness = 1.
			• Implemented algorithm that include CO_2 slicing for optically thick clouds to calculate optical depth using 1.24 µm over daytime polar region.
			• Implemented an IR algorithm to be applied for no VISST retrieval or thin cirrus clouds without an ice solution.
			• Improved daytime cloud phase algorithm to prevent supercool clouds being classified as ice and thin cirrus as water.
			• Corrected a bug that when starting with very cold clouds, it did not transition to water even as temperature was warm enough.
			• Improved nighttime cloud phase algorithm to reduce misidentification.
			• Always use predicted clear sky reflectance during cloud retrieval instead of observations when exceeding 10 percent of pixels.
			• Changed to use SIST algorithm during twilight instead of LBTM and multispectral daytime analysis.
			• Modified VISST effective temperature to use CO_2 effective temperature (cloud top adjusted) for ice clouds.
			• Implemented over-shooting top algorithm to mask pixels that are higher than tropopause. VISST cloud retrieval now calculates an actual cloud height and properties.
			• Implemented a new ice cloud thickness algorithm based on CERES-CALIPSO-CloudSat-MODIS results.
			• Implemented algorithm to check cloud retrieval properties to determine if their actually aerosol only.
			• Revised look-up tables for emissivity, reflectivity, and transmission. Increased range of valid brightness temperature and conversion between effective ice radius and diameter.
			• Revised the CO_2 algorithm to enhance cirrus cloud-top height retrieval and repaired false-detection and 13.3 µm stripping.
			• Improved the multilayer algorithm to remove daytime false detection and nighttime no retrieval.
			• Improved the multilayer optical depth and cloud macro-physical properties.
			• Corrected the CEM CO_2 cloud fraction
			• Implemented 1.24 µm snow-free directional model and Kriebel BDRF for each surface and hybrid snow-covered BDRF,
			• Implemented Jin's clear sky (snow-free) ocean reflectance model for .24, 1.6, and 2.13 µm including using water vapor and ozone absorption from MOA.
			• Added snow-free clear sky overhead sun-albedo maps at 1.24

Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
			µm and updated for 0.6, 1.6, and 2.13 µm.
			• Added snow-covered clear sky overhead sun-albedo maps at 1.24 µm.
			• Implemented 3.7 µm nighttime calibration correction.
			• Implemented an algorithm to remove stripping in brightness temperature difference in 3.7 and 11 at night.
			• Removed the supervised classifier (UAH) based upon a back-propagation neural network.
			• Stopped including CERES footprints with 0 percent imager coverage or no valid CERES radiances.
			• Reclassify imager pixels with no cloud fraction as clear if high probability of glint and difference between clear sky and 11 µm brightness temperature is small.
			• When MODIS aerosol scans in a granule is inconsistent with the geolocation, the aerosol file is skipped.
			• Eliminate use of Radiometric Scale Factors.
			• Use LASP SORCE TSI variable Solar Constant data instead of 1365.
			• Updated Surface Model B algorithm
			• Use MATCH data when MODIS aerosol is not available in Surface Model B.
			• Port code from magneto to AMI.
Terra-FM1-MODIS_Edition3A[4] Terra-FM2-MODIS_Edition3A[4]	303303 303304 303305 304305	May 2013	• Removed extra input footprint that did not have corresponding Edition3 IES data.
Terra-FM1-MODIS_Edition3A[4] Terra-FM2-MODIS_Edition3A[4]	300301	Oct 2011	• Provided error handling when 0.65 MODIS imager channel was not available.
Terra-FM1-MODIS_Edition3A[4] Terra-FM2-MODIS_Edition3A[4]	300300, 301300, 302300 303300	Jan 2011	• Created new PGE to read and IES file for input as well as an existing SSF, MOA and Spectral Calibration Coefficients. • Installed updated algorithms for surface models LWA and LWB using a constrained near-surface air temperature. • Applied Radiometric Scaling Factor. • Twilight fix applied. • SSF ID set to 1117. • 300300 – Edition2B SSF used as input. • 301300 – Edition2C SSF used as input. • 302300 – Edition2D SSF used as input. • 303300 – Edition1-CV SSF used as input
Terra-FM1-MODIS_Edition2G[4] Terra-FM2-MODIS_Edition2G[4]	028035	May 2010	• Software recompile to use interface to GMAO G5-CERES MOA data. (CERES Fluxes SSF-38 through SSF-49, MOA parameters SSF-57 through SSF-62, and clouds mask and properties SSF-66, SSF-81, SSF-116, SSF-117, SSF-82 through SSF-114). • SSF ID set to 1117.
Terra-FM1-MODIS_Edition2F[4] Terra-FM2-MODIS_Edition2F[4]	027033	Sep 2008	• Software recompile to support MODIS Collection 5. • SSF ID set to 1117.

Terra-FM1-MODIS_Edition2B[4] Terra-FM2-MODIS_Edition2B[4]	026030	Nov 2004	• Terra Edition2B ADMs are used.
			• Name changes in SSF SDS:
			  o ADMGEO changed to Snow/ice percent coverage clear-sky overhead-sun vis albedo (SSF-30).
			  o CERES WN ADM type for inversion process changed to Cloud classification (SSF-29).
			• SSF ID remains 1117

Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product

Terra-FM1-MODIS_Edition2A[4]
Terra-FM2-MODIS_Edition2A[4]
	025029,
	026029
		Feb 2004	• Terra Edition2 ADMs are used.
			• The Aqua processing variations began with a Terra Edition1A baseline.
			• All footprints with a viewing zenith greater than or equal to 63 degrees are included in the SSF. When the viewing zenith angle is less than 63 degrees and the packet number is even, then only footprints with an even value Scan sample number are placed in the SSF. When the viewing zenith angle is less than 63 degrees and the packet number is odd, then only footprints with an odd value Scan sample number are placed in the SSF.
			• All PSF weighted imager parameters on the SSF (SSF-24 through SSF-26, SSF-30, SSF-54, SSF-64 through SSF-78, SSF-81 through SSF-113, and SSF-131) will be obtained using only imager pixels from every 2nd scanline and every 4th pixel (2x4) and a new point spread function.
			• Clear, Clear/layer/overlap, All subpixel clear, All subpixel overcast cloud area percent coverage (SSF-66, SSF-81, SSF-116, and SSF-117) will vary due to
			  o New start-up maps for 2.1 μm albedo and 2.1 μm albedo standard deviation were implemented.
			  o The Kriebel Bidirectional model for 2.1 μm was implemented.
			  o Both sub-Arctic summer and sub-Arctic winter snow reflectance models for 2.1 μm were implemented.
			  o Welch mask will no longer be used when CERES mask in undetermined over polar region during daytime.
			  o 2.1 μm daytime polar cloud mask used.
			  o Improved polar nighttime and non-polar daytime CERES mask.
			• Cloudy Footprint Area SDS (SSF-82 through SSF-114) will be improved because
			  o The 2.1 μm cloud model used in polar regions was implemented so that the NoVis cloud retrieval algorithm automatically uses the 2.13 μm cloud model.
			  o The observed 1.6 μm reflectance and clear sky predicted 1.6 μm reflectance were replaced by 2.1 μm observed reflectance and clear sky predicted 2.1 μm reflectance respectively.
			• PSF-wtd MOD04 dust weighting factor land (SSF-135) is filled with default values.
			• Mean and Stddev of imager radiances (SSF-118 through SSF-129) contain the same radiance channels as used for Terra.
			• SSF ID set to 1117.

Terra-FM1-MODIS_Beta5[3] Terra-FM2-MODIS_Beta5[3]	024027	Nov 2003	• This SSF product contains Edition1A cloud parameters and new fluxes using Beta5 Terra ADMs. • SW Model B surface flux algorithm was modified to correct the cloud temperature parameter used to compute the SW surface flux. • LW Model A surface flux algorithm was modified to use the MOA surface temperature. • LW Model B surface flux algorithm was modified to use the MOA surface temperature. • SSF ID set to 1117.
Terra-FM1-MODIS_Edition1A[4] Terra-FM2-MODIS_Edition1A[4]	024025	Oct 2002	• The 1.6 micrometer imager radiance values are saved for all footprints with CERES solar zenith <= 90 degrees. • Cloud Phase Algorithm was modified to correctly classify cloud phase for thin cirrus cases. • The CERESmask was updated to improve cloud detection over strong sunglint ocean (sunglint probability > 40%) to reduce false clouds. Over sunglint ocean, the clear sky standard deviation of

Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
			the brightness temperature difference between 3.7 µm and 11 µm was changed from a constant number (2.5K) to 0.0255K*sunglint_probability + 2.45K. • The extinction ratios and single scattering albedos were updated. • SW Model A surface flux algorithm was modified to retrieve the GFDL aerosol parameters from the correct hemisphere. • SSF ID set to 1117.
Terra-FM1-MODIS_Beta4[3] Terra-FM2-MODIS_Beta4[3] Terra-FM1-MODIS_Beta4-overARM[3] Terra-FM2-MODIS_Beta4-overARM[3]	022020	Jun 2002	• TRMM Edition2B ADMs were updated for snow. • SW TOA flux algorithm was updated to apply earth-sun distance correction to unfiltered SW radiance in the SW flux calculation for snow and the default SW ADM type was set to 592. • LW model A Surface algorithm module: Effective pressure (used to compute air temp) now computed based on ocean/land and surface pressure (previously based on tropics/extra-tropics). New sets of coefficients for Land (no longer split based on tropics/extra-tropics). • Aerosol correction removed from SW model B surface flux algorithm. • Cloud retrieval model for 1.6µm was changed to higher angle resolutions. • Cloud retrieval models for 3.7µm were changed to higher angle resolutions. • CERES Mask algorithm was updated. The updates include: a. Clear sky night time. b. Polar daytime mask. c. Polar nighttime mask. d. CERES non_polar night time. • The twilight definition was changed for solar zenith angle range from 82.0-87.5 degrees to 82.0-88.5 degrees. Improved version of MODIS classifier. • New IR cloud phase algorithm. • Updated overlapping algorithm. • Spectral correction algorithm modified to use dynamic Spectral Correction Coefficients based on instrument gains. Combined NSDC and NESDIS snow/ice maps used as input. • Aerosol A algorithm has been changed to process each channel independently (single-channel) using the input tables from the third-generation algorithm. • SSF ID remains 117.
Terra-FM1-MODIS_Beta3[3] Terra-FM2-MODIS_Beta3[3]	020018	Apr 2002	• Clear sky snow and ice reflectance models and albedo models for 0.6µm, 1.6µm and 3.7µm changed to higher angle resolutions. • Clear sky, snow and ice reflectance models and albedo models updated for 0.6µm at TOA, 1.6µm and 3.7µm at surface. • The Cloud Phase Algorithm modified for a better cloud detection, especially for thin cirrus clouds. • A MODIS 3.7µm calibration implemented. This calibration includes Response-Function-Weighted wavelength and VIRS radiance normalization. • The CERES mask algorithm (including polar mask algorithm) re-tuned based on the 3.7µm calibration. • The Relative Azimuth was changed from CERES to the imager for the Stowe aerosol optical thickness calculation. Over polar regions and over snow-ice surfaces, the NoVis algorithm was turned on. • Welch MODIS classifier implemented. • Monthly clear sky start-up maps for Terra used.

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
			• Additional Vgroups and SDSs containing the MODIS Aerosol parameters are on the SSF HDF files. There are 14 land and 15 ocean parameters. • TRMM Edition 2B SW, LW, and WN ADMs are used. • SW Model A and SW Model B use GFDL climatology to compute aerosol optical depth. • LW Model A Air Temperature at 950mb was replaced with air temperature at effective pressure. The effective pressure was computed based on FOV location (tropics/extra tropics) and surface pressure. Parameter name remained temp950mb even though contents changed. • SSF ID remains 117.
Terra-FM1-MODIS_Beta3-overARM[3] Terra-FM2-MODIS_Beta3-overARM[3]	021019		•
Terra-FM1-MODIS_Beta2[4] Terra-FM2-MODIS_Beta2[4] Terra-FM1-MODIS_Beta2-overARM[4] Terra-FM2-MODIS_Beta2-overARM[4]	019016	Jan 2002	• Using updated MOA interface to correct end-of-year access problem. • SSF ID remains 117.
Terra-FM1-MODIS_Beta2[4] Terra-FM2-MODIS_Beta2[4] Terra-FM1-MODIS_Beta2-overCLAMS[4] Terra-FM2-MODIS_Beta2-overCLAMS[4] Terra-FM1-MODIS_Beta2-overARM[4] Terra-FM2-MODIS_Beta2-overARM[4]	019015	Dec 2001	• Edition2_TRMM ADMs used to invert data to surface Added MODIS Welch classifier. • Added preliminary polar nighttime mask. • Expanded imager viewing zenith bins in the QC report to support MODIS angles beyond 50 degrees. This corrects the bogus cloud detection problem found in Beta1. • SW and LW Model A surface fluxes only computed for FOVs for which clear coverage exceeds 99.9%. • SSF ID remains 117.
Terra-FM1-MODIS_Beta1[4] Terra-FM2-MODIS_Beta1[4] Terra-FM1-MODIS_Beta1-overARM[4] Terra-FM2-MODIS_Beta1-overARM[4]	016013	Sep 2001	• All footprints with one or more pixels of imager coverage included in SSF. • Implemented MODIS Correlated K calculation. • Implemented 1.6 micron/ NoViS cloud property retrieval Improved 1.6 micron clear sky prediction over snow/ice Updated CERES Polar Mask Algorithm. • MODIS radiance channels for footprint statistics are selected based on solar zenith angle and day of the month Beta2_TRMM ADMs are used for all-sky fluxes; SW ADMs are based on renormalized optical depths for all Terra viewing angles. • Metadata G-rings do not specify individual hourly swaths. • SSF ID remains 117.
Terra-FM1-MODIS_Alpha[1] Terra-FM2-MODIS_Alpha[1]	012009	May 2001	• Nighttime IR emissivities computed. • Terra (FM1, FM2) Aerosol A parameters set to CERES default MODIS 3.7 micron calibration correction. • MODIS version of Correlated K algorithm. • Polar Mask added. • IR emissivity range changed from 0..1 to 0..2. • MODIS input subsetted to 2x2 sampling (every other pixel on every other scanline). • Cloud fraction change due to an adjustment of the brightness temperature clear sky stddev based on imager viewing zenith angle.

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Modification History of the CERES Terra SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the Terra SSF Product
			• SSF ID remains 117.
Availability: (1) not available; (2) restricted to CERES analysts; (3) restricted to CERES Science Team and analysts; (4) public			

Modification History for: NPP | Aqua | Terra | TRMM

Modification History of the CERES TRMM SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
TRMM-PFM-VIRS_Edition2B[4] TRMM-PFM-VIRS_Edition2B-TransOps[4]	021018	Jun 2002	• TRMM Edition2B ADMs were updated for snow. • SW TOA flux algorithm updated to apply earth-sun distance correction to unfiltered SW radiance in the SW flux calculation for snow. • LW model A Surface algorithm module: Effective pressure (used to compute air temp) now computed based on ocean/land and surface pressure (previously based on tropics/extra-tropics). New sets of coefficients for Land (no longer split based on tropics/extra-tropics). • The SW Model B surface flux algorithm no longer uses GFDL climatology to compute optical depth. • The Model A algorithm for CERES downward/net SW surface fluxes corrected to include the GFDL aerosol correction and process only for clear-sky. • Aerosol A algorithm has been changed to process each channel independently (single-channel) using the input tables from the third-generation algorithm. • SSF ID remains 117.
TRMM-PFM-VIRS_Edition2-VIRSonly[4] TRMM-PFM-VIRS_Edition2A-TransOps[4]	019016	Jan 2002	• Aerosol A optical depth calculation corrected to use imager relative azimuth. • Using updated MOA interface to correct end-of-year access problem. • SSF ID remains 117.
TRMM-PFM-VIRS_Edition2-VIRSonly[4]	019015	Dec 2001	• CERES instrument is powered off (no CERES measurements are available). • CERES geolocation generated by simulating CERES crosstrack scan mode. • Cloud algorithms have not changed (still Edition2). • Aerosol A algorithm has not changed (still using 3rd generation algorithm where possible). • Updated SW model B surface flux algorithm. • All TOA fluxes and most surface fluxes set to CERES default. • SSF ID remains 117.
TRMM-PFM-VIRS_Edition2A[4]	018014	Oct 2001	• Edition2_TRMM ADMs used for all-sky fluxes. • Actual G-rings placed in metadata. • New Cloud property parameterizations to resolve optical depth problems. • VIRS 1.6 micron radiance correction based on detector temperature. • Cloud subcategory propagated onto FOV when property retrieval failed; coverage added to Notes on cloud algorithms • Aerosol A algorithm modified to use 3rd generation where possible; flag added to Notes on cloud algorithms. • "Reclassified" clear over land/desert where WN exceeds threshold; coverage added to Notes on cloud algorithms. • "bad data" coverage added to Notes on general procedures. • WN channel unfiltered radiance and flux no longer per micron. • Modified LW model B and SW model B surface flux algorithms.

Modification History of the CERES TRMM SSF Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
			• SSF ID remains 117.
TRMM-PFM-VIRS_Edition2-QC[3]	014011	Jul 2001	• All footprints with one or more pixels of imager coverage included in SSF. • Beta2_TRMM ADMs used for all-sky fluxes. When ADM not available, flux and ADMtype are set to CERES default. • New Cloud property parameterizations to resolve optical depth problems. • VIRS 1.6 micron radiance correction based on detector temperature. • Cloud subcategory propagated onto FOV when property retrieval failed; coverage added to "Notes on cloud algorithms". • Aerosol A algorithm modified to use 3rd generation where possible; flag added to "Notes on cloud algorithms" • "Reclassified" clear over land/desert where WN exceeds threshold; coverage added to "Notes on cloud algorithms". • "bad data" coverage added to "Notes on general procedures". • WN channel unfiltered radiance and flux no longer per micron Modified LW model B surface flux algorithm. • SSF ID remains 117.
TRMM-PFM-VIRS_Beta2[4]	013010	Jun 2001	• Cloud properties, aerosol properties, and spatial matching identical to TRMM-PFM-VIRS_Edition1. • Clear and cloudy TOA fluxes available. • ADMs updated to Beta2_TRMM ADMs supplemented with VIRS12B. • Units altered for parameters CERES WN radiance - upwards, CERES WN TOA flux - upwards, and CERES downward WN surface flux - Model A. • SW surface - Model B downward and net fluxes consistent and available for clear and cloudy sky. • SSF ID remains 117.
TRMM-PFM-VIRS_Edition1[4] TRMM-PFM-VIRS_Subset-Edition1[4]	011008	Dec 2000	• N2O absorption added to Correlated K calculation. • Surface emissivity maps improved. • 0.6 micron model improved. • TISA night time cloud retrieval added. • 1.6 micron ratio model modified. • CERES mask algorithm improved. • Aerosol A algorithm processes each channel independently (single-channel) with updated tables for the spectral responses for 0.66 and 1.6 micrometer MODIS channels. • SSF ID remains 117.
TRMM-PFM-VIRS_ValR5[1] TRMM-PFM-VIRS_Subset-ValR5[1]	010008	Nov 2000	• Vgroups added to hdf file; Vgroups map to parameter groupings. • SSF_Header Vdata updated (Added Beta angle). • Added SSF FOV parameters Column averaged relative humidity, Cloud property extrapolation over cloudy region, Cloud-mask clear-strong percent coverage, Cloud-mask clear-weak percent coverage, Cloud-mask percent coverage supplement, Aerosol A supplements 1-4, Mean water particle radius for cloud layer (1.6), Mean ice particle effective diameter for cloud layer (1.6), and Mean cloud particle phase for cloud layer (1.6). • Deleted SSF FOV parameters: Colatitude of CERES FOV at TOA, Longitude of CERES FOV at TOA, CERES spectral albedo, Shadowed imager pixels percent coverage, Imager sun glint percent coverage, Imager-based fire percent coverage, Area percent coverage for cloud layer, and Stddev of cloud particle phase for cloud layer. • Other SSF FOV parameter updates include: parameter names

Modification History of the CERES TRMM SSF Product

| Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
			adjusted, clear and cloudy percent coverage data types switched to 32-bit real.
			• MOA input generated from ECMWF data. Using MOA ozone information.
			• VIRS Release 5 imager data used as input.
			• CRH startup maps replaced (corrects problem over tundra ecosystems).
			• Surface emissivity maps replaced (now based on ECMWF/AVHRR 1986 data).
			• CERES calibration adjustment to 1.6 micron VIRS radiances.
			• Most adjustments to imager radiances included in SSF imager radiance statistics.
			• Nighttime cloud algorithm added.
			• Polar snow and ice cloud mask added.
			• Potential cloud layer overlap algorithm added.
			• Correction to twilight drop in cloud fraction.
			• New Welch algorithm incorporated.
			• CERES Cloud Mask (improvements in sunglint areas, added shadowed algorithm) updated. Mask decision tree uses Welch results as needed.
			• Added code to handle saturation of 3.75 channel.
			• Added reflectance calculation for 3.75 channel.
			• VISST algorithm modified to accommodate new science algorithms. New models for 3.7 channel ice and water phases. Handles cloud inversions.
			• Particle size calculation adjusted.
			• Aerosol optical depth calculations use 2x2 pixel uniformity test for channel 1 reflectance and land/water map on 10 minute grid.
			• Keep cloudy FOVs with limited or no cloud property coverage; extrapolate layer coverages and properties where possible.
			• Single broadband surface albedo and surface emissivity calculation for FOV (previously calculated for every pixel).
			• New Slope Intercept Spectral Correction algorithm and coefficients to unfilter CERES radiances.
			• ADMs updated to VIRS12B.
			• TOA fluxes referenced at surface.
			• Only FOVs which are 99.90 or more clear have valid CERES flux values. All others CERES derived flux values set to CERES default.
			• SSF ID set to 117.
TRMM-PFM-VIRS_ValidationR4[1]	009006 009007	Jul 1999	• Partial Earth FOVs added.
			• G-Ring expanded to better define data.
			• Cloud mask TLim test modified (pressure level temperature for determining cloud/no cloud threshold).
			• CRH startup maps in southern hemisphere adjusted Correlated K profile derivation algorithms improved.
			• Algorithms computing total aerosol optical depth at 0.6 microns and at 1.6 microns allow negative values.
			• Coefficients applied to WN channel to determine SW thermal adjustment updated.
			• SSF ID remains 113.
TRMM-PFM-VIRS_ValidationR3[1]	008002	Mar 1999	• HDF SSF format updated - each parameter is a separate SDS VIRS Release 4 imager data used as input.
			• "Note for cloud layer" contains strong cloud, weak cloud, and sunglint from cloud assessments.
			• "Notes on cloud algorithms" contains strong clear and weak clear

Modification History of the CERES TRMM SSF Product

| Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the SSF Product
			assessments.
			• Visible optical depth no longer logarithmically averaged. Corresponding parameters now Mean logarithm of visible optical depth for cloud layer and Stddev of logarithm of visible optical depth for cloud layer.
			• VIRS based direction models used.
			• Correlated K profile derivation improved.
			• VINT phase determination algorithm improved.
			• Cloud mask improvements.
			• CRH startup maps improved for 0.6 albedo, 1.6 albedo, ratio of 1.6 to 0.6 reference, and 10.8 brightness temperature Low cloud detection improved.
			• VIRS 1.6 micron channel thermal leak correction made before computing Total aerosol optical depth at 1.6 microns in clear area.
			• Imager-based aerosol percent coverage and associated flag modified.
			• Algorithms for computing Percentiles of visible optical depth for cloud layer and Percentiles of IR emissivity for cloud layer expanded.
			• VIRS12A Angular Direction Model used to invert radiances to fluxes.
			• Missing microwave precipitable water corrected – microwave values properly flagged on MOA and copied onto SSF.
			• SSF ID set to 113.
TRMM-PFM-VIRS_ValidationR2[1] TRMM-PFM-VIRS_ValR2-NL[1]	005000	Jul 1998	• CERES mask within VINT algorithm improved • CRH start-up maps and emissivity maps improved. • SSF ID remains 112.
TRMM-PFM-VIRS_ValidationR2 [1]	004000	May 1998	• Geocentric/geodetic issues resolved. • Window channel units to "per micron". • Full Julian date replaces fractional Julian day. • Calibration corrections to VIRS version 1 data. • Cloud mask and cloud properties improved - additional tests added. • Correlated K algorithm modified. • Bilinear interpolation of MOA data within Clouds. • Viewing zenith cutoff increased from 76.2 to 80.0 deg. • Revised spectral correction coefficients. • SSF ID set to 112.
TRMM-PFM-VIRS_ValidationR1 [1]	000003	Mar 1998	• First software delivery to process 1 month of data.
Availability: (1) not available; (2) restricted to CERES analysts; (3) restricted to CERES Science Team and analysts; (4) public			

Examples of Data:

The sample images for clear area percent coverage depict one hour, or one granule, of SSF data. The sample images for SW unfiltered radiance and SW TOA flux depict an area over northeast Africa (Egypt) and illustrate the CERES crosstrack scan pattern. Two sets of images are provided to illustrate the similarities and differences between TRMM Edition1 SSF and TRMM Edition2A SSF. In TRMM Edition1 SSF, only clear footprints have fluxes associated with them. In the other SSF data sets, TOA fluxes are not limited to clear footprints.
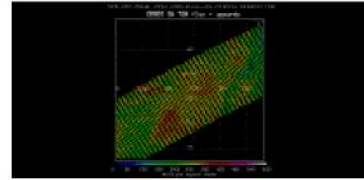
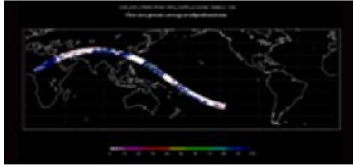TRMM Edition2A
Clear Area Percent Coverage
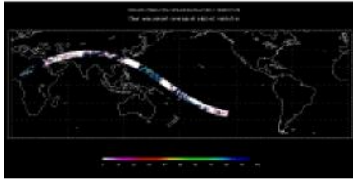
TRMM Edition2A
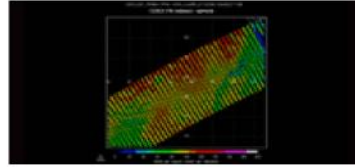CERES SW Unfiltered Radiance
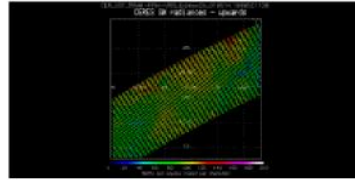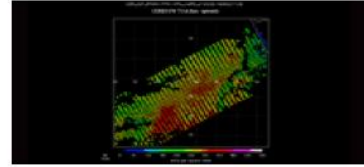

TRMM Edition2A
CERES SW TOA Flux

TRMM Edition1
Clear Area Percent Coverage

TRMM Edition1
CERES SW Unfiltered Radiance

TRMM Edition1
CERES SW TOA Flux

Daily instrument operation summaries are available from CERES Operations in Orbit.

References:

The CERES Team has gone to considerable trouble to remove major errors and to verify the quality and accuracy of these data. Please provide a reference to the following paper when you publish scientific results with the CERES data:

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