CERES Time-Interpolated TOA Fluxes, Clouds and Aerosols (SSF1deg-Day)

The SSF1deg-Day product provides daily mean CERES-observed top-of-atmosphere (TOA) radiative fluxes and coincident MODIS-derived cloud and aerosol properties based on the SSF Level 2 measurements. First, each parameter is spatially gridded into a 1° nested grid. Second, the parameters are temporally interpolated between the times of the CERES observations to produce a complete 1-hourly time series for the month. The SSF1deg TOA fluxes are temporally interpolated using the assumption of constant meteorological conditions. For longwave fluxes over oceans and snow/ice surfaces, linear interpolation is used, whereas over land, the daytime heating is estimated using a half-sine curve centered on noon. For shortwave fluxes, empirical diurnal albedo models defined as a function of solar zenith angle and based on cloud and surface conditions are used. The cloud properties are linearly interpolated in time for each layer and are weighted by cloud fraction to compute the total cloud properties. Only clear-sky CERES footprints, which have cloud fractions less than 0.1%, are used to compute the clear-sky parameters. If no regional clear-sky footprints are observed over the month, all clear-sky parameters are set to default. Daily means are calculated using the combination of hourly observed and temporally interpolated parameters for days containing at least one CERES observation.

The SSF1deg-Day product contains these daily mean parameters at the 1°–regional spatial scale:

- All-sky and clear-sky radiative shortwave (SW), longwave (LW), window-channel (WN) and net fluxes at TOA
- Total and 4-layered cloud properties for day/night (24-hour) and daytime only
- Auxiliary parameters, such as aerosol optical depths, skin temperature, and precipitable water, that are used as input to process the CERES fluxes
- Solar incoming flux

The SSF1deg products are processed separately for each satellite. Although Terra and Aqua have two CERES instruments each, only the instrument in cross-track mode on each satellite is used.

The product data file is written in HDF and is organized by Vgroups containing collections of science parameters written as Scientific Data Sets (SDSs). Each file contains data for one month.

More information about the CERES products can be obtained on the CERES subsetter ordering web page (http://ceres.larc.nasa.gov/order_data.php).

Level: 3
Frequency: 1/Month
Portion of Atmosphere Covered: TOA

Time Interval Covered:
File: 1 Month

Portion of Globe Covered:
File: Entire Globe
Record: 1.0-Degree Regions

Product Version:

TRMM: N/A
Terra: Edition3A, Edition4A
Aqua: Edition3A, Edition4A
NPP: Edition1A

SSF1deg-Day Definition

Table 1 summarizes the overall structure of the SSF1deg-Day HDF file. The HDF file contains metadata in the form of file attributes and a Vdata structure, Vgroups of Scientific Data Sets (SDSs), and dimension scales.

Table 1. SSF1deg-Day HDF structure summary.

Name	Description
CERES Baseline Header Metadata	Table B-1
CERES_metadata Vdata	Table B-2
SSF1deg-Day Product-specific Metadata	Table 2
Vgroups of SDSs	Table 5 through Table 13
Dimension Scales	Table 29

SSF1deg-Day Metadata

Metadata for the SSF1deg-Day product is contained in three components of the HDF file: two file attributes named coremetadata and archivemetadata and one Vdata structure named CERES_metadata. The information contained in these three components is listed in Appendix B. Metadata that is specific to the SSF1deg-Day product is listed in Table 2; it may be found within the coremetadata attribute.

Table 2. SSF1deg-Day product-specific metadata.

Item	Parameter Name	Units	Range	Data Type
1	identifier_product_doi	N/A	N/A	string

SSF1deg-Day Dimensions

Regional (1° latitude x 1° longitude) SDSs are three-dimensional day/latitude/longitude arrays of daily means for the month with Ndayx180x360 elements, where Nday is the number of days in a given month (ranging from 28 to 31). The day index indicates the day of the month. The values of the latitude and longitude indices are shown in Table 3. Cloud parameter SDSs have an additional dimension indicating cloud layer and have 5xNdayx180x360 elements. Values of the cloud layer index are shown in Table 4. There are no zonal or global means in the SSF1deg-Day product.

Table 3. Definitions of the latitude and longitude dimensions for the CERES equal-angle 1° latitude by 1° longitude grid.

Dimension	Size	Definition
latitude	180	Index #1 is at 89.5°N and #180 is at 89.5°S.
longitude	360	Index #1 is at 179.5°W and #360 is at 179.5°E.

Table 4. Definition of the cloud_layer dimension.

Cloud_layer index	Cloud Layer	Pressure layer (hPa)
1	High	50-300
2	Upper Mid	300-500
3	Lower Mid	500-700
4	Low	700-Surface
5	Total	50 - Surface

Daily Regional Scientific Data Sets

The tables contained in this section list all daily regional mean parameters in the file. The daily regional mean Scientific Data Sets (SDS) are divided into Vgroups; these Vgroups and their corresponding tables of SDSs are listed in Table 5. All SDS tables include the SDS index, SDS name, long name, data type, units, data range, and the number of elements for each SDS.

Regional (1° latitude x 1° longitude) SDSs are three-dimensional day/latitude/longitude arrays of daily means for the month with Ndayx180x360 elements, where Nday is the number of days in a given month (ranging from 28 to 31). The day index indicates the day of the month. The values of the latitude and longitude indices are shown in Table 3. Cloud parameter SDSs have an additional dimension indicating cloud layer and have 5xNdayx180x360 elements. Values of the cloud layer index are shown in Table 4.

Table 5. List of the Vgroups contained in the SSF1deg-Day product

Vgroup Number	Vgroup Name	SDS Table	Number of SDSs
0	Regional_Information	Table 6	3
1	CERES_TOA_Fluxes	Table 7	11
2	Meteorological_Variables	Table 8	9
3	CERES_MODIS_Cloud_Layer_Properties_24Hour_Averages	Table 9	25
4	CERES_MODIS_Cloud_Layer_Properties_Daylight_Only_Averages	Table 10	25
5	MODIS_Land_Aerosols	Table 11	2
6	MODIS_Ocean_Aerosols	Table 12	2
7	Number_of_Observations	Table 13	4

Table 6. Regional_Information

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
0	sfc_altitude	Altitude of Surface Above Sea Level	32-bit real	m	-1000 .. 10000	Ndayx180x360
1	ocean_coverage	Ocean Percent Coverage	32-bit real	%	0 .. 100	Ndayx180x360
2	snow_ice_coverage	Snow/Ice Percent Coverage	32-bit real	%	0 .. 100	Ndayx180x360

Table 7. CERES_TOA_Fluxes

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
3	clr_toa_sw	CERES Clear-Sky TOA SW Flux	32-bit real	W m^{-2}	0 .. 1400	Ndayx180x360
4	clr_toa_lw	CERES Clear-Sky TOA LW Flux	32-bit real	W m^{-2}	0 .. 500	Ndayx180x360
5	clr_toa_wn	CERES Clear-Sky TOA WN Flux	32-bit real	W m^{-2}	0 .. 200	Ndayx180x360
6	clr_toa_net	CERES Clear-Sky TOA Net Flux	32-bit real	W m^{-2}	-400 .. 400	Ndayx180x360
7	clr_toa_alb	CERES Clear-Sky TOA Albedo	32-bit real	N/A	0 .. 1	Ndayx180x360
8	all_toa_sw	CERES All-Sky TOA SW Flux	32-bit real	W m^{-2}	0 .. 1400	Ndayx180x360
9	all_toa_lw	CERES All-Sky TOA LW Flux	32-bit real	W m^{-2}	0 .. 500	Ndayx180x360
10	all_toa_wn	CERES All-Sky TOA WN Flux	32-bit real	W m^{-2}	0 .. 200	Ndayx180x360
11	all_toa_net	CERES All-Sky TOA Net Flux	32-bit real	W m^{-2}	-400 .. 400	Ndayx180x360
12	all_toa_alb	CERES All-Sky TOA Albedo	32-bit real	N/A	0 .. 1	Ndayx180x360
13	toa_sw_insol	TOA SW Insolation	32-bit real	W m^{-2}	0 .. 1400	Ndayx180x360

Table 8. Meteorological_Variables

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
14	sfc_wind_speed	Surface Wind Speed	32-bit real	m s^{-1}	0 .. 100	Ndayx180x360
15	sfc_skin_temp	Surface Skin Temperature	32-bit real	K	175 .. 375	Ndayx180x360
16	sfc_press	Surface Pressure	32-bit real	hPa	0 .. 1100	Ndayx180x360
17	sfc_750_temp_diff	Surface Minus 750 mb Air Temperature Difference	32-bit real	K	-200 .. 200	Ndayx180x360
18	estim_inversion_strength	Estimated Inversion Strength	32-bit real	K	-200 .. 200	Ndayx180x360
19	750_sfc_pot_temp_diff	750 mb Minus Surface Air Potential Temperature Difference	32-bit real	K	-200 .. 200	Ndayx180x360
20	pw	Precipitable Water	32-bit real	cm	0 .. 10	Ndayx180x360

Table 8. Meteorological_Variables

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
21	cld_msk_clr_strong_coverage	Cloud-mask Clear-Strong Percent Coverage	32-bit real	%	0 .. 100	Ndayx180x360
22	cld_msk_clr_weak_coverage	Cloud-mask Clear-Weak Percent Coverage	32-bit real	%	0 .. 100	Ndayx180x360

Table 9. CERES_MODIS_Cloud_Layer_Properties_24Hour_Averages

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
23	cld_amount	Cloud Amount - Total	32-bit real	%	0 .. 100	5xNdayx180x360
24	cld_amount_liq	Cloud Amount - Liquid	32-bit real	%	0 .. 100	5xNdayx180x360
25	cld_amount_ice	Cloud Amount - Ice	32-bit real	%	0 .. 100	5xNdayx180x360
26	cld_od	Cloud Visible Optical Depth (from 3.7 µm particle size retrieval)	32-bit real	N/A	0 .. 400	5xNdayx180x360
27	cld_od_linavg	Cloud Visible Optical Depth (linear averaged, from 3.7 µm particle size retrieval)	32-bit real	N/A	0 .. 400	5xNdayx180x360
28	cld_ir_emiss	Cloud Infrared Emissivity	32-bit real	N/A	0 .. 2	5xNdayx180x360
29	cld_lwp	Cloud Liquid Water Path (from 3.7 µm particle size retrieval)	32-bit real	g m^{-2}	0 .. 10000	5xNdayx180x360
30	cld_iwp	Cloud Ice Water Path (from 3.7 µm particle size retrieval)	32-bit real	g m^{-2}	0 .. 10000	5xNdayx180x360
31	cld_top_press	Cloud Top Pressure	32-bit real	hPa	0 .. 1100	5xNdayx180x360
32	cld_top_temp	Cloud Top Temperature	32-bit real	K	100 .. 350	5xNdayx180x360
33	cld_top_hgt	Cloud Top Height	32-bit real	km	0 .. 20	5xNdayx180x360
34	cld_eff_press	Cloud Effective Pressure	32-bit real	hPa	0 .. 1100	5xNdayx180x360
35	cld_eff_temp	Cloud Effective Temperature	32-bit real	K	100 .. 350	5xNdayx180x360
36	cld_eff_hgt	Cloud Effective Height	32-bit real	km	0 .. 20	5xNdayx180x360
37	cld_base_press	Cloud Base Pressure	32-bit real	hPa	0 .. 1100	5xNdayx180x360
38	cld_base_temp	Cloud Base Temperature	32-bit real	K	100 .. 350	5xNdayx180x360

Table 9. CERES_MODIS_Cloud_Layer_Properties_24Hour_Averages

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
39	cld_liq_radius_37um	Cloud Liquid Particle Radius (from 3.7 µm particle size retrieval)	32-bit real	µm	0 .. 40	5xNdayx180x360
40	cld_ice_radius_37um	Cloud Ice Particle General Effective Radius (from 3.7 µm particle size retrieval)	32-bit real	µm	0 .. 300	5xNdayx180x360
41	cld_phase_37um	Cloud Particle Phase (from 3.7 µm particle size retrieval)	32-bit real	N/A	1 .. 2	5xNdayx180x360
42	cld_liq_radius_12um	Cloud Liquid Particle Radius (from 1.2 µm particle size retrieval)	32-bit real	µm	0 .. 40	5xNdayx180x360
43	cld_ice_radius_12um	Cloud Ice Particle General Effective Radius (from 1.2 µm particle size retrieval)	32-bit real	µm	0 .. 300	5xNdayx180x360
44	cld_od_12um	Cloud Visible Optical Depth (from 1.2 µm particle size retrieval)	32-bit real	N/A	0 .. 400	5xNdayx180x360
45	cld_liq_radius_21um	Cloud Liquid Particle Radius (from 2.1 µm particle size retrieval)	32-bit real	µm	0 .. 40	5xNdayx180x360
46	cld_ice_radius_21um	Cloud Ice Particle General Effective Radius (from 2.1 µm particle size retrieval)	32-bit real	µm	0 .. 300	5xNdayx180x360
47	cld_od_21um	Cloud Visible Optical Depth (from 2.1 µm particle size retrieval)	32-bit real	N/A	0 .. 400	5xNdayx180x360

Table 10. CERES_MODIS_Cloud_Layer_Properties_Daylight_Only_Averages

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
48	cld_amount_day	Cloud Amount - Total - Daylight Only	32-bit real	%	0 .. 100	5xNdayx180x360
49	cld_amount_liq_day	Cloud Amount - Liquid - Daylight Only	32-bit real	%	0 .. 100	5xNdayx180x360
50	cld_amount_ice_day	Cloud Amount - Ice - Daylight Only	32-bit real	%	0 .. 100	5xNdayx180x360
51	cld_od_day	Cloud Visible Optical Depth (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	N/A	0 .. 400	5xNdayx180x360
52	cld_od_linavg_day	Cloud Visible Optical Depth (linear averaged, from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	N/A	0 .. 400	5xNdayx180x360
53	cld_ir_emiss_day	Cloud Infrared Emissivity - Daylight Only	32-bit real	N/A	0 .. 2	5xNdayx180x360
54	cld_lwp_day	Cloud Liquid Water Path (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	g m^{-2}	0 .. 10000	5xNdayx180x360
55	cld_iwp_day	Cloud Ice Water Path (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	g m^{-2}	0 .. 10000	5xNdayx180x360
56	cld_top_press_day	Cloud Top Pressure - Daylight Only	32-bit real	hPa	0 .. 1100	5xNdayx180x360

Table 10. CERES_MODIS_Cloud_Layer_Properties_Daylight_Only_Averages

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
57	cld_top_temp_day	Cloud Top Temperature - Daylight Only	32-bit real	K	100 .. 350	5xNdayx180x360
58	cld_top_hgt_day	Cloud Top Height - Daylight Only	32-bit real	km	0 .. 20	5xNdayx180x360
59	cld_eff_press_day	Cloud Effective Pressure - Daylight Only	32-bit real	hPa	0 .. 1100	5xNdayx180x360
60	cld_eff_temp_day	Cloud Effective Temperature - Daylight Only	32-bit real	K	100 .. 350	5xNdayx180x360
61	cld_eff_hgt_day	Cloud Effective Height - Daylight Only	32-bit real	km	0 .. 20	5xNdayx180x360
62	cld_base_press_day	Cloud Base Pressure - Daylight Only	32-bit real	hPa	0 .. 1100	5xNdayx180x360
63	cld_base_temp_day	Cloud Base Temperature - Daylight Only	32-bit real	K	100 .. 350	5xNdayx180x360
64	cld_liq_radius_37um_day	Cloud Liquid Particle Radius (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 40	5xNdayx180x360
65	cld_ice_radius_37um_day	Cloud Ice Particle General Effective Radius (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 300	5xNdayx180x360
66	cld_phase_37um_day	Cloud Particle Phase (from 3.7 µm particle size retrieval) - Daylight Only	32-bit real	N/A	1 .. 2	5xNdayx180x360
67	cld_liq_radius_12um_day	Cloud Liquid Particle Radius (from 1.2 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 40	5xNdayx180x360
68	cld_ice_radius_12um_day	Cloud Ice Particle General Effective Radius (from 1.2 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 300	5xNdayx180x360
69	cld_od_12um_day	Cloud Visible Optical Depth (from 1.2 µm particle size retrieval) - Daylight Only	32-bit real	N/A	0 .. 400	5xNdayx180x360
70	cld_liq_radius_21um_day	Cloud Liquid Particle Radius (from 2.1 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 40	5xNdayx180x360
71	cld_ice_radius_21um_day	Cloud Ice Particle General Effective Radius (from 2.1 µm particle size retrieval) - Daylight Only	32-bit real	µm	0 .. 300	5xNdayx180x360
72	cld_od_21um_day	Cloud Visible Optical Depth (from 2.1 µm particle size retrieval) - Daylight Only	32-bit real	N/A	0 .. 400	5xNdayx180x360

Table 11. MODIS_Land_Aerosols

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
73	aod_land	PSF-weighted MOD04 Corrected Optical Depth Land (0.550 µm)	32-bit real	N/A	0 .. 5	Ndayx180x360

Table 11. MODIS_Land_Aerosols

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
74	deep_blue_aod_land	PSF-weighted MOD04 Deep Blue Aerosol Optical Depth Land (0.550 µm)	32-bit real	N/A	0 .. 5	Ndayx180x360

Table 12. MODIS_Ocean_Aerosols

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
75	aod_ocean	PSF-weighted MOD04 Effective Optical Depth Average Ocean (0.550 µm)	32-bit real	N/A	0 .. 5	Ndayx180x360
76	aod_small_ocean	PSF-weighted MOD04 Optical Depth Small Average Ocean (0.550 µm)	32-bit real	N/A	0 .. 5	Ndayx180x360

Table 13. Number_of_Observations

SDS Index	SDS Name	Long Name	Data Type	Units	Range	Number of Elements
77	num_sw_obs	Number of CERES SW Observations	32-bit integer	N/A	0 .. 24	Ndayx180x360
78	num_lw_obs	Number of CERES LW Observations	32-bit integer	N/A	0 .. 24	Ndayx180x360
79	num_clr_sw_obs	Number of CERES Clear-Sky SW Observations	32-bit integer	N/A	0 .. 24	Ndayx180x360
80	num_clr_lw_obs	Number of CERES Clear-Sky LW Observations	32-bit integer	N/A	0 .. 24	Ndayx180x360

SSF1deg-Day Dimension Scales

Table 14 lists the dimension scales of the SDS arrays in the HDF file. Each dimension scale variable corresponds to one dimension and has the same name and size as that dimension. The dimension scales store the index values belonging to each dimension and have information like the other SDSs in the file.

Table 14. Dimension Scale Information

SDS Index	Dimension Name	Long Name	Data Type	Units	Range	Number of Elements
81	longitude	Longitude	32-bit real	degrees_east	N/A	360
82	latitude	Latitude	32-bit real	degrees_north	N/A	180
83	day_of_month	Day of the Month	32-bit integer	N/A	N/A	28-31
84	cloud_layer	Index of Cloud Layers Stratified by Pressure	32-bit integer	N/A	N/A	5

File Size: ~850 MB
Number of Regional Parameters: 81

SSF1deg-Day Revision Record

The product Revision Record contains information pertaining to approved section changes. The table lists the date the Software Configuration Change Request (SCCR) was approved, the Release and Version Number, the SCCR number, a short description of the revision, and the revised sections.

SSF1deg-Day Revision Record

SCCR Approval Date	Release/ Version Number	SCCR Number	Description of Revision	Section(s) Affected
09/30/2015 (Ed3) 04/18/2017 (Ed4 & Ed1-NPP)	R5V1	1086(Ed3) 1177(Ed4 & Ed1-NPP)	• Initial version of this document.	All