2.5 Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF)

EOSDIS Product Code: CER11

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 or Moderate-Resolution Imaging Spectroradiometer (MODIS) on Terra and Aqua. Scene identification and cloud properties are defined at the higher imager resolution and these data are averaged over the larger CERES footprint.

For each CERES footprint, the SSF contains the number of cloud layers and for each layer the cloud amount, height, temperature, pressure, optical depth, emissivity, ice and liquid water path, and water particle size. The SSF also contains the CERES filtered radiances for the total, shortwave (SW), and window (WN) channels and the unfiltered SW, longwave (LW), and WN radiances. The SW, LW, and WN radiances at spacecraft altitude are converted to Top-of-the-Atmosphere (TOA) fluxes based on the imager defined scene. These TOA fluxes are used to estimate surface fluxes.

Only footprints with adequate imager coverage are included on the SSF which is much less than the full set of footprints on the CERES ES-8 product. The number of possible footprints on an SSF depends on the elevation scan mode, azimuth scan mode, and height of the satellite. Since elevation and azimuth scan modes are programmable, the range on the number of footprints in an SSF product has been set to the largest possible range, namely 0 .. 360000 as shown in Table 2.5-2. A smaller number of footprints is used in SSF sizing estimates, namely the estimated maximum number of TRMM full Earth-view footprints per hour given a normal elevation scan and an along-track azimuth scan. Accounting for the need for adequate imager coverage, the actual number of footprints is expected to be even smaller. This reduction of footprints due to lack of imager coverage is very evident when CERES is operating in a cross-track azimuth scan mode. A complete listing of parameters for this data product can be found in Tables 2.5-3 to Table 2.5-13.

A more detailed listing of the data parameters for this product can be found in the SSF Collection Guide: http://asd-www.larc.nasa.gov/ceres/collect_guide/list.html (Reference 3).

Level: 2
Frequency: 1/Hour
Configuration Code: 013010 and greater

Time Interval Covered
  File: 1 Hour
  Record: 1/100-Second

Portion of Globe Covered
  File: Satellite Swath
  Record: 1 CERES Footprint

Portion of Atmosphere Covered
  File: Surface to TOA

SSF Metadata

SSF metadata includes the CERES Baseline Header Metadata and CERES_metadata Vdata, which are listed in Appendix B. The SSF product-specific metadata parameters are listed in Table 2.5-1 and the SSF_Header parameters are listed in Table 2.5-2.

Table 2.5-1. SSF Product-specific Metadata

Item	Parameter Name	Units	Range	Data Type
1	PercentCrosstrackFOV	N/A	0.0 .. 100.0	32-bit real
2	PercentRapsFOV	N/A	0.0 .. 100.0	32-bit real
3	PercentOtherFOV	N/A	0.0 .. 100.0	32-bit real

Table 2.5-2. SSF_Header (1 of 2)

Item	Description	Units	Range	Elements	Bytes/ Elem
SSF-H1	SSF ID	N/A	117	1	4
SSF-H2	Character name of CERES instrument	N/A	ASCII string	1	4
SSF-H3	Day and time at hour start	N/A	ASCII string	1	28
SSF-H4	Character name of satellite	N/A	ASCII string	1	4
SSF-H5	Character name of high resolution imager instrument	N/A	ASCII string	1	8
SSF-H6	Number of imager channels	N/A	1 .. 20	1	4
SSF-H7	Central wavelengths of imager channels	µm	0.4 .. 15.0	20	4
SSF-H8	Earth-Sun distance at hour start	AU	0.98 .. 1.02	1	4
SSF-H9	Beta angle	deg	-90 .. 90	1	4
SSF-H10	Colatitude of subsatellite point at surface at hour start	deg	0 .. 180	1	4
SSF-H11	Longitude of subsatellite point at surface at hour start	deg	0 .. 360	1	4
SSF-H12	Colatitude of subsatellite point at surface at hour end	deg	0 .. 180	1	4
SSF-H13	Longitude of subsatellite point at surface at hour end	deg	0 .. 360	1	4
SSF-H14	Along-track angle of satellite at hour end	deg	0 .. 330	1	4
SSF-H15	Number of footprints in SSF product	N/A	0 .. 360000	1	4
SSF-H16	Subsystem 4.1 identification string	N/A	ASCII string	1	128
SSF-H17	Subsystem 4.2 identification string	N/A	ASCII string	1	128
SSF-H18	Subsystem 4.3 identification string	N/A	ASCII string	1	128
SSF-H19	Subsystem 4.4 identification string	N/A	ASCII string	1	128
SSF-H20	Subsystem 4.5 identification string	N/A	ASCII string	1	128

Table 2.5-2. SSF_Header (2 of 2)

Item	Description	Units	Range	Elements	Bytes/ Elem
SSF-H21	Subsystem 4.6 identification string	N/A	ASCII string	1	128
SSF-H22	IES production date and time	N/A	ASCII string	1	24
SSF-H23	MOA production date and time	N/A	ASCII string	1	24
SSF-H24	SSF production date and time	N/A	ASCII string	1	24

SSF Scientific Data Sets

The SSF contains 131 Scientific Data Sets (SDS) which are parameter collections of along-track ordered footprints where the first dimension corresponds to the number of footprints; the last dimension corresponds to the number of parameters; and the middle dimension, if rank 3, corresponds to the number of elements in each parameter array. This ordering is used by the C programming language and most HDF viewers. In FORTRAN, the dimensions are reversed such that the number of footprints becomes the last dimension and the first dimension is the number of parameters in the SDS. The SDSs are divided into tables which map to Vgroups of the same name. Table 2.5-3 to Table 2.5-13 summarize the contents of each Vgroup and SDS contained within the SSF file.

(Note: the dimension n in the following tables is the number of footprints processed: Assuming n = 245475 for sizing)

Table 2.5-3. Time and Position

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-1	Time of observation	day	2440000.. 2480000	n	64-bit real	1.87
SSF-2	Radius of satellite from center of Earth at observation	km	6000 .. 8000	n	64-bit real	1.87
SSF-3	X component of satellite inertial velocity	km sec^{-1}	-10 .. 10	n	64-bit real	1.87
SSF-4	Y component of satellite inertial velocity	km sec^{-1}	-10 .. 10	n	64-bit real	1.87
SSF-5	Z component of satellite inertial velocity	km sec^{-1}	-10 .. 10	n	64-bit real	1.87
SSF-6	Colatitude of subsatellite point at surface at observation	deg	0 .. 180	n	32-bit real	0.94
SSF-7	Longitude of subsatellite point at surface at observation	deg	0 .. 360	n	32-bit real	0.94
SSF-8	Colatitude of subsolar point at surface at observation	deg	0 .. 180	n	32-bit real	0.94
SSF-9	Longitude of subsolar point at surface at observation	deg	0 .. 360	n	32-bit real	0.94

Table 2.5-3. Time and Position

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-10	Colatitude of CERES FOV at surface	deg	0 .. 180	n	32-bit real	0.94
SSF-11	Longitude of CERES FOV at surface	deg	0 .. 360	n	32-bit real	0.94
SSF-12	Scan sample number	N/A	1 .. 660	n	16-bit integer	0.47
SSF-13	Packet number	N/A	0 .. 13100	n	16-bit integer	0.47
SSF-14	Cone angle of CERES FOV at satellite	deg	0 .. 90	n	32-bit real	0.94
SSF-15	Clock angle of CERES FOV at satellite wrt inertial velocity	deg	0 .. 360	n	32-bit real	0.94
SSF-16	Rate of change of cone angle	deg sec^{-1}	-300 .. 300	n	32-bit real	0.94
SSF-17	Rate of change of clock angle	deg sec^{-1}	-20 .. 20	n	32-bit real	0.94
SSF-18	Along-track angle of CERES FOV at surface	deg	-30 .. 330	n	32-bit real	0.94
SSF-19	Cross-track angle of CERES FOV at surface	deg	-90 .. 90	n	32-bit real	0.94

Table 2.5-4. Viewing Angles

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-20	CERES viewing zenith at surface	deg	0 .. 90	n	32-bit real	0.94
SSF-21	CERES solar zenith at surface	deg	0 .. 180	n	32-bit real	0.94
SSF-22	CERES relative azimuth at surface	deg	0 .. 360	n	32-bit real	0.94
SSF-23	CERES viewing azimuth at surface wrt North	deg	0 .. 360	n	32-bit real	0.94

Table 2.5-5. Surface Map

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-24	Altitude of surface above sea level	m	-1000 .. 10000	n	32-bit real	0.94
SSF-25	Surface type index	N/A	1 .. 20	n x 8	16-bit integer	3.75
SSF-26	Surface type percent coverage	N/A	0 .. 100	n x 8	16-bit integer	3.75

Table 2.5-6. Scene Type

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-27	CERES SW ADM type for inversion process	N/A	0 .. 5000	n	16-bit integer	0.47
SSF-28	CERES LW ADM type for inversion process	N/A	0 .. 5000	n	16-bit integer	0.47
SSF-29	CERES WN ADM type for inversion process	N/A	0 .. 5000	n	16-bit integer	0.47
SSF-30	ADM geo (TBD)	N/A	-32767 .. 32766	n	16-bit integer	0.47

Table 2.5-7. Filtered Radiances

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-31	CERES TOT filtered radiance - upwards	$W\ m^{-2}\ sr^{-1}$	0 .. 700	n	32-bit real	0.94
SSF-32	CERES SW filtered radiance - upwards	$W\ m^{-2}\ sr^{-1}$	-10 .. 510	n	32-bit real	0.94
SSF-33	CERES WN filtered radiance - upwards	$W\ m^{-2}\ sr^{-1} \mu m^{-1}$	0 .. 15	n	32-bit real	0.94
SSF-34	Radiance and Mode flags	N/A	0 .. (2**31)-1	n	32-bit integer	0.94

Table 2.5-8. Unfiltered Radiances

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-35	CERES SW radiance - upwards	$W\ m^{-2}\ sr^{-1}$	-10 .. 510	n	32-bit real	0.94
SSF-36	CERES LW radiance - upwards	$W\ m^{-2}\ sr^{-1}$	0 .. 200	n	32-bit real	0.94
SSF-37	CERES WN radiance - upwards	$W\ m^{-2}\ sr^{-1}$	0 .. 60	n	32-bit real	0.94

Table 2.5-9. TOA and Surface Fluxes

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-38	CERES SW TOA flux - upwards	W m^{-2}	0 .. 1400	n	32-bit real	0.94
SSF-39	CERES LW TOA flux - upwards	W m^{-2}	0 .. 500	n	32-bit real	0.94
SSF-40	CERES WN TOA flux - upwards	W m^{-2}	0 .. 200	n	32-bit real	0.94
SSF-41	CERES downward SW surface flux - Model A	W m^{-2}	0 .. 1400	n	32-bit real	0.94
SSF-42	CERES downward LW surface flux - Model A	W m^{-2}	0 .. 700	n	32-bit real	0.94
SSF-43	CERES downward WN surface flux - Model A	W m^{-2}	0 .. 250	n	32-bit real	0.94
SSF-44	CERES net SW surface flux - Model A	W m^{-2}	0 .. 1400	n	32-bit real	0.94
SSF-45	CERES net LW surface flux - Model A	W m^{-2}	-250 .. 50	n	32-bit real	0.94
SSF-46	CERES downward SW surface flux - Model B	W m^{-2}	0 .. 1400	n	32-bit real	0.94
SSF-47	CERES downward LW surface flux - Model B	W m^{-2}	0 .. 700	n	32-bit real	0.94
SSF-48	CERES net SW surface flux - Model B	W m^{-2}	0 .. 1400	n	32-bit real	0.94
SSF-49	CERES net LW surface flux - Model B	W m^{-2}	-250 .. 50	n	32-bit real	0.94
SSF-50	CERES broadband surface albedo	N/A	0 .. 1	n	32-bit real	0.94
SSF-51	CERES LW surface emissivity	N/A	0 .. 1	n	32-bit real	0.94
SSF-52	CERES WN surface emissivity	N/A	0 .. 1	n	32-bit real	0.94

Table 2.5-10. Full Footprint Area (1 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-53	Number of imager pixels in CERES FOV	N/A	0 .. 32766	n	16-bit integer	0.47
SSF-54	Imager percent coverage	N/A	0 .. 100	n	16-bit integer	0.47
SSF-55	Imager viewing zenith over CERES FOV	deg	0 .. 90	n	32-bit real	0.94
SSF-56	Imager relative azimuth over CERES FOV	deg	0 .. 360	n	32-bit real	0.94

Table 2.5-10. Full Footprint Area (2 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-57	Surface wind - U-vector	m sec^{-1}	-100 .. 100	n	32-bit real	0.94
SSF-58	Surface wind - V-vector	m sec^{-1}	-100 .. 100	n	32-bit real	0.94
SSF-59	Surface skin temperature	K	175 .. 375	n	32-bit real	0.94
SSF-60	Column averaged relative humidity	N/A	0 .. 100	n	32-bit real	0.94
SSF-61	Precipitable water	cm	0.001 .. 10	n	32-bit real	0.94
SSF-62	Flag - Source of precipitable water	N/A	0 .. 120	n	16-bit integer	0.47
SSF-63	Cloud property extrapolation over cloudy area	N/A	0 .. 100	n	16-bit integer	0.47
SSF-64	Notes on general procedure	N/A	0 .. 32766	n	16-bit integer	0.47
SSF-65	Notes on cloud algorithms	N/A	0 .. 32766	n	16-bit integer	0.47

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Table 2.5-11. Clear Footprint Area (1 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-66	Clear area percent coverage at subpixel resolution	N/A	0 .. 100	n	32-bit real	0.94
SSF-67	Cloud-mask clear-strong percent coverage	N/A	0 .. 100	n	16-bit integer	0.47
SSF-68	Cloud-mask clear-weak percent coverage	N/A	0 .. 100	n	16-bit integer	0.47
SSF-69	Cloud-mask snow/ice percent coverage	N/A	0 .. 100	n	16-bit integer	0.47
SSF-70	Cloud-mask aerosol B percent coverage	N/A	0 .. 100	n	16-bit integer	0.47
SSF-71	Flag - Type of aerosol B	N/A	0 .. 9999	n	16-bit integer	0.47
SSF-72	Cloud-mask percent coverage supplement	N/A	0 .. 32766	n	16-bit integer	0.47
SSF-73	Total aerosol A optical depth - visible	N/A	-1 .. 5	n	32-bit real	0.94
SSF-74	Total aerosol A optical depth - near IR	N/A	-1 .. 5	n	32-bit real	0.94
SSF-75	Aerosol A supplement 1	N/A	-1000 .. 1000	n	32-bit real	0.94
SSF-76	Aerosol A supplement 2	N/A	-1000 .. 1000	n	32-bit real	0.94
SSF-77	Aerosol A supplement 3	N/A	-1000 .. 1000	n	32-bit real	0.94
SSF-78	Aerosol A supplement 4	N/A	-1000 .. 1000	n	32-bit real	0.94
SSF-79	Imager-based surface skin temperature	K	175 .. 375	n	32-bit real	0.94

Table 2.5-11. Clear Footprint Area (2 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-80	Vertical temperature change	K	-30 .. 90	n	32-bit real	0.94

Table 2.5-12. Cloudy Footprint Area (1 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-81	Clear/layer/overlap percent coverages	N/A	0 .. 100	n x 4	32-bit real	3.74
SSF-82	Note for cloud layer	N/A	0 .. (2**31)-1	n x 2	32-bit integer	1.87
SSF-83	Mean visible optical depth for cloud layer	N/A	0 .. 400	n x 2	32-bit real	1.87
SSF-84	Stddev of visible optical depth for cloud layer	N/A	0 .. 300	n x 2	32-bit real	1.87
SSF-85	Mean logarithm of visible optical depth for cloud layer	N/A	-6 .. 6	n x 2	32-bit real	1.87
SSF-86	Stddev of logarithm of visible optical depth for cloud layer	N/A	0 .. 6	n x 2	32-bit real	1.87
SSF-87	Mean cloud infrared emissivity for cloud layer	N/A	0 .. 2	n x 2	32-bit real	1.87
SSF-88	Stddev of cloud infrared emissivity for cloud layer	N/A	0 .. 2	n x 2	32-bit real	1.87
SSF-89	Mean liquid water path for cloud layer (3.7)	g m^{-2}	0 .. 10000	n x 2	32-bit real	1.87
SSF-90	Stddev of liquid water path for cloud layer (3.7)	g m^{-2}	0 .. 8000	n x 2	32-bit real	1.87
SSF-91	Mean ice water path for cloud layer (3.7)	g m^{-2}	0 .. 10000	n x 2	32-bit real	1.87
SSF-92	Stddev of ice water path for cloud layer (3.7)	g m^{-2}	0 .. 8000	n x 2	32-bit real	1.87
SSF-93	Mean cloud top pressure for cloud layer	hPa	0 .. 1100	n x 2	32-bit real	1.87
SSF-94	Stddev of cloud top pressure for cloud layer	hPa	0 .. 600	n x 2	32-bit real	1.87
SSF-95	Mean cloud effective pressure for cloud layer	hPa	0 .. 1100	n x 2	32-bit real	1.87
SSF-96	Stddev of cloud effective pressure for cloud layer	hPa	0 .. 500	n x 2	32-bit real	1.87

Table 2.5-12. Cloudy Footprint Area (2 of 2)

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-97	Mean cloud effective temperature for cloud layer	K	100 .. 350	n x 2	32-bit real	1.87
SSF-98	Stddev of cloud effective temperature for cloud layer	K	0 .. 150	n x 2	32-bit real	1.87
SSF-99	Mean cloud effective height for cloud layer	km	0 .. 20	n x 2	32-bit real	1.87
SSF-100	Stddev of cloud effective height for cloud layer	km	0 .. 12	n x 2	32-bit real	1.87
SSF-101	Mean cloud base pressure for cloud layer	hPa	0 .. 1100	n x 2	32-bit real	1.87
SSF-102	Stddev of cloud base pressure for cloud layer	hPa	0 .. 600	n x 2	32-bit real	1.87
SSF-103	Mean water particle radius for cloud layer (3.7)	µm	0 .. 40	n x 2	32-bit real	1.87
SSF-104	Stddev of water particle radius for cloud layer (3.7)	µm	0 .. 20	n x 2	32-bit real	1.87
SSF-105	Mean ice particle effective diameter for cloud layer (3.7)	µm	0 .. 300	n x 2	32-bit real	1.87
SSF-106	Stddev of ice particle effective diameter for cloud layer (3.7)	µm	0 .. 200	n x 2	32-bit real	1.87
SSF-107	Mean cloud particle phase for cloud layer (3.7)	N/A	1 .. 2	n x 2	32-bit real	1.87
SSF-108	Mean water particle radius for cloud layer (1.6)	µm	0 .. 40	n x 2	32-bit real	1.87
SSF-109	Mean ice particle effective diameter for cloud layer (1.6)	µm	0 .. 300	n x 2	32-bit real	1.87
SSF-110	Mean cloud particle phase for cloud layer (1.6)	N/A	1 .. 2	n x 2	32-bit real	1.87
SSF-111	Mean vertical aspect ratio for cloud layer (TBD)	N/A	0 .. 20	n x 2	32-bit real	1.87
SSF-112	Stddev of vertical aspect ratio for cloud layer (TBD)	N/A	0 .. 15	n x 2	32-bit real	1.87
SSF-113	Percentiles of visible optical depth for cloud layer	N/A	0 .. 400	n x 13 x 2	32-bit real	24.35
SSF-114	Percentiles of IR emissivity for cloud layer	N/A	0 .. 2	n x 13 x 2	32-bit real	24.35

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Table 2.5-13. Footprint Imager Radiance Statistics

Item	SDS Name (Parameter Name)	Units	Range	Dimen-sions	Data Type	Maximum Hourly Size (MB)
SSF-115	Imager channel central wavelength	µm	0.4 .. 15.0	n x 5	32-bit real	4.68
SSF-116	All subpixel clear area percent coverage	N/A	0 .. 100	n	32-bit real	0.94
SSF-117	All subpixel overcast cloud area percent coverage	N/A	0 ..100	n	32-bit real	0.94
SSF-118	Mean imager radiances over clear area	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-119	Stddev of imager radiances over clear area	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68
SSF-120	Mean imager radiances over over-cast cloud area	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-121	Stddev of imager radiances over overcast cloud area	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68
SSF-122	Mean imager radiances over full CERES FOV	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-123	Stddev of imager radiances over full CERES FOV	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68
SSF-124	5th percentile of imager radiances over full CERES FOV	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-125	95th percentile of imager radiances over full CERES FOV	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-126	Mean imager radiances over cloud layer 1 (no overlap)	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-127	Stddev of imager radiances over cloud layer 1 (no overlap)	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68
SSF-128	Mean imager radiances over cloud layer 2 (no overlap)	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-129	Stddev of imager radiances over cloud layer 2 (no overlap)	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68
SSF-130	Mean imager radiances over cloud layer 1 and 2 overlap	W m^{-2} sr^{-1} μm^{-1}	-1000 .. 1000	n x 5	32-bit real	4.68
SSF-131	Stddev of imager radiances over cloud layer 1 and 2 overlap	W m^{-2} sr^{-1} μm^{-1}	0 .. 1000	n x 5	32-bit real	4.68

Estimated GigaBytes / Day: 6.1