Clouds and the Earth's Radiant Energy System (CERES) ERBE-like Monthly Regional Averages (ES-9) Data Set Abstract

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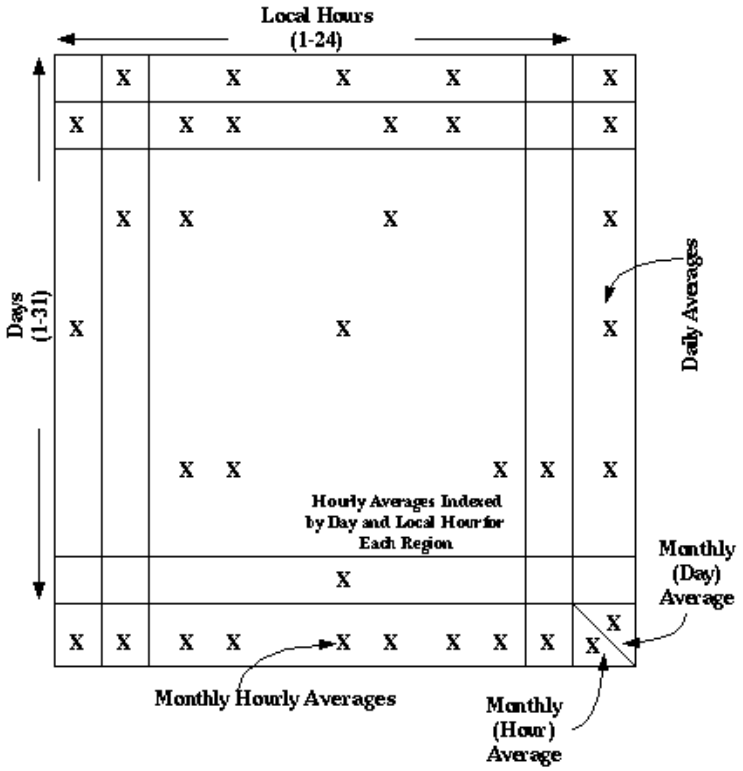
Data Set Description:

The ERBE-like Monthly Regional Averages (ES-9) product contains a month of space and time averaged Clouds and the Earth's Radiant Energy System (CERES) data for a single scanner instrument. The ES-9 is also produced for combinations of scanner instruments. All instantaneous shortwave and longwave fluxes at the Top-of-the-Atmosphere (TOA) from the CERES ES-8 product for a month are sorted by 2.5-degree spatial regions, by day number, and by the local hour of observation. The mean of the instantaneous fluxes for a given region-day- hour bin is determined and recorded on the ES-9 along with other flux statistics and scene information. For each region, the daily average flux is estimated from an algorithm that uses the available hourly data, scene identification data, and diurnal models. This algorithm is "like" the algorithm used for the Earth Radiation Budget Experiment (ERBE). The ES-9 also contains hourly average fluxes for the month and an overall monthly average for each region. These average fluxes are given for both clear-sky and total-sky scenes.

The ES-9 archival data product is created as an HDF file with Scientific Data Sets (SDS) which contain data for each 2.5-degree region observed during a month. There are 10,368 possible regions; a given region is viewed by the scanner several times as the spacecraft passes overhead. For each region, data are stored for each hour that is viewed by the CERES scanner during the month. SDS data include the mean estimates of shortwave and longwave radiant flux at the TOA, the standard deviations of these estimates, the maximum and minimum estimate, and scene information or cloud condition. Similar parameters are determined for those scanner measurements that are identified as clear-sky areas. In addition to the hourbox data, Daily, Monthly Hourly, and monthly averages are also stored (see figure below).



The ES-9 contains Scientific Data Sets written as six HDF vgroups:

1. Regional Summary Data
2. Monthly (Day) Averages
3. Monthly (Hour) Averages
4. Daily Averages
5. Monthly Hourly Averages
6. Hourbox Data (hourly averages indexed by day and local hour for each region)

The Regional Summary Data vgroup contains information such as region number, geographic scene type, and cloud cover for each of the possible 10,368 2.5-deg regions on the ES-9 product. The remaining vgroups contain clear-sky and total-sky parameters such as solar incidence, net radiant flux, longwave flux, shortwave flux, and albedo.

Additional information about the format and content of the ES-9 can be found in the CERES Data Products Catalog. Details concerning the science parameters and how they are calculated can be found in the CERES Algorithm Theoretical Basis Document for Subsystem 3.0 and in the ES-9 Collection Guide.

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 archival 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(s) and instrument(s) which acquired the data in the product.

A summary of changes made to the ES-9 HDF product is shown in the following table.

Modification History for: NPP | Aqua | Terra | TRMM | Terra+Aqua | TRMM+Terra

Modification History of the CERES ES-9 NPP Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
NPP-FM5_Edition1 (3)	100103	Dec 2013	• First application of time-varying gains to FM5 data. • Initiated by instrument PGE update using this CCode.
NPP-FM5_Edition1-CV (3)	300303	Aug 2013	• No science impact. • Reprocessed entire FM5 data set due to spikes detected in initial Instrument data (BDS), which translated into fill values in downstream products. • Fixed by Instrument PGE update using this CCode.
NPP-FM5_Edition1-CV (3)	300301	Sep 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
NPP-FM5_Edition1-CV (3)	300300	Sep 2012	• Initial delivery.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Modification History for: NPP | Aqua | Terra | TRMM | Terra+Aqua | TRMM+Terra

Modification History of the CERES ES-9 Aqua Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Aqua-Xtrk_Edition4 (3)	400403	Nov 2013	• Uses new set of Spectral Correction Coefficients similar to Edition3's.
Aqua-Xtrk_Edition3 (3)	300303	Aug 2013	• No science impact. • Reprocessed data from 201210 due to incorrect scan time initialization detected in initial C++ Instrument data stream (BDS). • Fixed by Instrument PGE update using this CCode.
Aqua-Xtrk_Edition3 (3)	300301	Nov 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
Aqua-Xtrk_Edition3 (3)	300300	Nov 2011	• Uses new set of Aqua channel-degradation-corrected Edition3 EID6s and CXDRs from subsystem 2.0. • Processes only data that is in cross-track scan mode on day-to-day basis, selecting the Aqua instrument for each day based on the daily Aqua x-track database.
Aqua-FM3_Edition1-CV (3)	300303	Aug 2013	• No science impact. • Extension of 300301 data set following upstream Instrument PGE update (see NPP-FM5_Edition1-CV entry above with this CCode).
Aqua-FM3_Edition1-CV (3)	300301	Sep 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
Aqua-FM3_Edition1-CV (3)	300300	Nov 2011	• No science impact. • Migration of software to IBM P6 platform.
Aqua-FM3_Edition2 (3) Aqua-FM4_Edition2 (3) Aqua-FM3_Edition1-CV (3)	025033	Oct 2010	• No science impact. • Migration of software to IBM P4 platform.

Modification History of the CERES ES-9 Aqua Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Aqua-FM4_Edition1-CV (3)			
Aqua-FM3_Edition1-CV (3) Aqua-FM4_Edition1-CV (3)	024030	Apr 2006	• No science impact. • Reprocessed to use all available input.
Aqua-FM3_Edition1-CV (3) Aqua-FM4_Edition1-CV (3)	024029	Apr 2006	• Eliminated data affected by Solar Heating.
Aqua-FM3_Edition1 (3) Aqua-FM4_Edition1 (3)	024026	Mar 2005	• Instrument Subsystem code changes result in less radiances processed. The worst case is 1.5% less records for a day and 0.1% for a month compared with 024025 processing.
Aqua-FM3_Edition2 (3) Aqua-FM4_Edition2 (3)	024025	Jun 2004	• (FM3) Corrected SW part of Total Channel spectral response. • (FM4) Corrected SW part of Total Channel spectral response.
Aqua-FM3_Edition1 (3) Aqua-FM4_Edition1 (3)	024025	May 2004	• No science impact.
Aqua-FM3_Edition2 (3) Aqua-FM4_Edition2 (3)	024024	Feb 2004	• Instrument calibaration update for both FM3 and FM4 instruments. • (FM3) Corrected SW part of Total Channel spectral response. • (FM4) Corrected SW part of Total Channel spectral response.
Aqua-FM3_Edition1 (3) Aqua-FM4_Edition1 (3)	024024	Feb 2004	• Instrument calibaration update for both FM3 and FM4 instruments.
Aqua-FM3_Edition1 (3) Aqua-FM4_Edition1 (3)	023023	Sep 2003	• No science impact.
Aqua-FM3_Edition1 (3) Aqua-FM4_Edition1 (3)	023022	Aug 2003	• Release of Aqua Edition1.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Modification History for: NPP | Aqua | Terra | TRMM | Terra+Aqua | TRMM+Terra

Modification History of the CERES ES-9 Terra Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Terra-Xtrk_Edition4 (3)	400403	Nov 2013	• Uses new set of Spectral Correction Coefficients similar to Edition3's except for the TOT channel offset: instead of being in the spectral response function, it was put back into the gain.
Terra-Xtrk_Edition3 (3)	300303	Aug 2013	• No science impact. • Reprocessed data from 201210 due to incorrect scan time initialization detected in initial C++ Instrument data stream (BDS). • Fixed by Instrument PGE update using this CCode.
Terra-Xtrk_Edition3 (3)	300301	Nov 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
Terra-Xtrk_Edition3 (3)	300300	Nov 2011	• Uses new set of Terra ch annel-degradation-corrected Edition3 EID6s and CXDRs from subsystem 2.0. Processes only data that is in cross-track scan mode on day-to-day basis, selecting the Terra instrument for each day based on the daily Terra x-track database.

Modification History of the CERES ES-9 Terra Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	300303	Aug 2013	• No science impact. • Extension of 300301 data set following upstream Instrument PGE update (see NPP-FM5_Edition1-CV entry above with this CCode).
Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	300301	Sep 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	300300	Nov 2011	• No science impact. • Migration of software to IBM P6 platform.
Terra-FM1_Edition2 [3] Terra-FM2_Edition2 [3] Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	025033	Oct 2010	• No science impact. • Migration of software to IBM P4 platform.
Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	024030	Apr 2006	• No science impact. • Reprocessed to use all available input.
Terra-FM1_Edition1-CV [3] Terra-FM2_Edition1-CV [3]	024029	Apr 2006	• Eliminated data affected by Solar Heating.
Terra-FM1_Edition2 [3] Terra-FM2_Edition2 [3]	024026	Mar 2005	• Instrument Subsystem code changes result in less radiances processed. The worst case is 1.5% less records for a day and 0.1% for a month compared with 024025 processing. • Linerally dropped FM2's SW channel spectral response by 0.25% from Dec03 level. Each month Jan04 to Nov04 has a 0.25%/11 drop from the preceeding month.
Terra-FM1_Edition1 [3] Terra-FM2_Edition1 [3]	024026	Mar 2005	• Instrument Subsystem code changes result in less radiances processed. The worst case is 1.5% less records for a day and 0.1% for a month compared with 024025 processing.
Terra-FM1_Edition1 [3] Terra-FM2_Edition1 [3] Terra-FM1_Edition2 [3] Terra-FM2_Edition2 [3]	024025	May 2004	• No science impact.
Terra-FM1_Edition1 [3] Terra-FM2_Edition1 [3]	024024	Feb 2004	• No science impact.
Terra-FM1_Edition2 [3] Terra-FM2_Edition2 [3]	023023	Sep 2003	• (FM2) Corrected SW Channel spectral response.
Terra-FM1_Edition1 [3] Terra-FM2_Edition1 [3]	023023	Sep 2003	• No science impact.
FM1+FM2_Edition1 [2]	023022	Jul 2003	• No science impact.
Terra-FM1_Edition2 [2] Terra-FM2_Edition2 [2]	023021	Jul 2003	• (FM2) Corrected SW Channel spectral response.
Terra-FM1_Edition1 [3] Terra-FM2_Edition1 [3]	023021	Jul 2003	• No science impact.

Modification History of the CERES ES-9 Terra Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Terra-FM1_Edition2 (3) Terra-FM2_Edition2 (3) FM1+FM2_Edition2 (3)	021020	Sep 2002	• Instrument calibration updates for both FM1 and FM2 instruments. Snow map algorithm correction. • Recovery of missing Edition1 data. • (FM1) Corrected SW part of Total Channel spectral response. • (FM2) Corrected SW part of Total Channel spectral response.
Terra-FM1_Edition2 (3) Terra-FM2_Edition2 (3)	021019	Aug 2002	• Instrument calibration updates for both FM1 and FM2 instruments. Snow map algorithm correction. • (FM1) Corrected SW part of Total Channel spectral response (FM1) Corrected SW Channel spectral response. • (FM2) Corrected SW part of Total Channel spectral response.
Terra-FM1_Edition1 (3) Terra-FM2_Edition1 (3) FM1+FM2_Edition1 (3)	021019	Aug 2002	• Instrument calibration updates for both FM1 and FM2 instruments. • Recovery of missing Edition1 data. • Snow map algorithm correction.
Terra-FM1_Edition1 (3) Terra-FM2_Edition1 (3) FM1+FM2_Edition1 (3)	019018	Nov 2001	• No science impact.
Terra-FM1_Edition1 (2) Terra-FM2_Edition1 (2) FM1+FM2_Edition1 (2)	018016	Apr 2001	• Applied HDF Compression.
Terra-FM1_Edition1 (3) Terra-FM2_Edition1 (3) FM1+FM2_Edition1 (3)	017015	Nov 2000	• Release of Terra Edition1. • Slope/intercept Spectral Correction code updated to apply 2nd order polynomial fits for the window channel and for shortwave cloudy cases, and to perform interpolation of unfiltered radiances. • Provided new day and night spectral correction coefficients for FM1 and FM2.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Modification History for: NPP | Aqua | Terra | TRMM | Terra+Aqua | TRMM+Terra

Modification History of the CERES ES-9 TRMM Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
TRMM-PFM_Edition2 (3)	021019	Aug 2002	• Snow map algorithm correction. • Recovery of missing Edition1 data.
TRMM-PFM_Edition2 (3)	019018	Nov 2001	• No science impact.
TRMM-PFM_Edition1 (2)	016014	Sep 2000	• No science impact.

Modification History of the CERES ES-9 TRMM Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
TRMM-PFM_Edition2 (2)	015013	Apr 2000	• Change Spectral Correction Algorithm to use slope intercept method. • Change LW TOA flux upper limit from 400 W/m^2 to 450 W/m^2. • New structure for ES-9 HDF products. Also, changed from HDF-EOS to HDF. • Modified slope intercept method (2nd (+) order curve fit) used in the Spectral Correction Algorithm. • New day & night Spectral Correction Coefficients for PFM, FM1, & FM2.
TRMM-PFM_Edition2 (2)	014012	Mar 2000	• No science impact.
TRMM-PFM_Edition1 (3)	009001	Oct 1998	• Both crosstrack and rotating azimuth measurements included in monthly averages.
TRMM-PFM_Edition1 (2)	008000	Aug 1998	• Changed HDF parameter names.
TRMM-PFM_Edition1 (2)	007000	Jun 1998	• Began generating ES-9 HDF product.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Modification History for: NPP | Aqua | Terra | TRMM | Terra+Aqua | TRMM+Terra

Modification History of the CERES ES-9 Terra+Aqua Archival Product

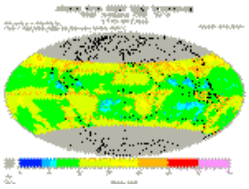
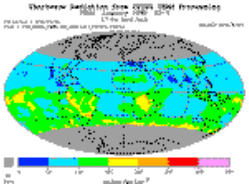
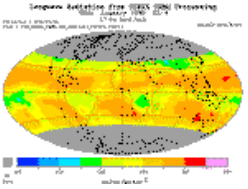
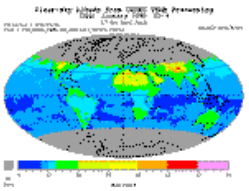
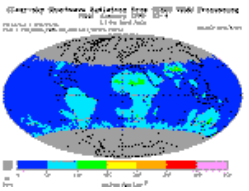
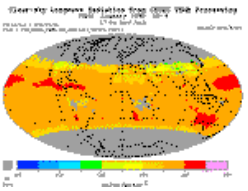
Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
Terra+Aqua_Edition4 (3)	400403	Nov 2013	• Uses new set of Spectral Correction Coefficients similar to Edition3's except for Terra's TOT channel offsets: instead of being in the spectral responses, they were put back into the gains.
Terra+Aqua_Edition3 (3)	300303	Aug 2013	• No science impact. • Reprocessed data from 201210 due to incorrect scan time initialization detected in initial C++ Instrument data stream (BDS). • Fixed by Instrument PGE update using this CCode.
Terra+Aqua_Edition3 (3)	300301	Aug 2012	• No science impact. • Migration of software to IBM P6 and x86 platforms.
Terra+Aqua_Edition3 (3)	300300	Nov 2011	• Uses new set of Terra and Aqua channel-degradation-corrected Edition3 DES9s from3.1P1.
FM1+FM3_Edition2 (3) FM1+FM4_Edition2 (3)	024025	Jun 2004	• (FM3) Corrected SW part of Total Channel spectral response • (FM4) Corrected SW part of Total Channel spectral response
FM1+FM3_Edition2 (3) FM1+FM4_Edition2 (3)	024024	Feb 2004	• (FM3) Corrected SW part of Total Channel spectral response • (FM4) Corrected SW part of Total Channel spectral response
FM1+FM2+FM3+FM4_Edition1 (3)	023023	Sep 2003	• No science impact.
FM1+FM2+FM3+FM4_Edition1 (3)	023022	Aug 2003	• No science impact.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Modification History of the CERES ES-9 TRMM+Terra Archival Product

Sampling Strategy and Production Strategy	CCode	Available at ASDC	Impact on the ES-9 Product
PFM+FM1_Edition2 (3) PFM+FM2_Edition2 (3) PFM+FM1+FM2_Edition2 (3)	021020	Sep 2002	• Instrument calibration updates for both FM1 and FM2 instruments. • Snow map algorithm correction. • Recovery of missing Edition1 data.
PFM+FM1_Edition1 (3) PFM+FM2_Edition1 (3) PFM+FM1+FM2_Edition1 (3)	019018	Nov 2001	• No science impact.
PFM+FM1_Edition1 (3) PFM+FM2_Edition1 (3) PFM+FM1+FM2_Edition1 (3)	017015	Nov 2000	• New slope/intercept spectral correction coefficients for PFM. Slope/intercept Spectral Correction code updated to apply 2nd order polynomial fits for the window channel and for shortwave cloudy cases, and to perform interpolation of unfiltered radiances. • Provided new day and night spectral correction coefficients for FM1 and FM2.
Availability: (1) Validation version only available to CERES analysts; (2) restricted to CERES Science Team; (3) public			

Examples of Data:

At the present time there are no graphics available over the Web for the ES-9 product; however, the six quality control images (gif files) that are generated and made available on the Web for the ES-4 product are representative of the ES-9. Examples of albedo, shortwave, and longwave (clear-sky and total-sky for each) images from the January 1998 ES-4 TRMM data set follow.

	Albedo	Shortwave	Longwave
All-Sky			
Clear-Sky			

Additional images and ancillary data sets (such as Directional Models) are available from the CERES ERBE-like Data Validation - Public Page.

References:

1. Clouds and the Earth's Radiant Energy System (CERES) Data Management System Software Requirements Document, ERBE-like Inversion to Instantaneous TOA Fluxes (Subsystem 2.0), Release 1 Version 1, November 1994.

2. Clouds and the Earth's Radiant Energy System (CERES) Data Management System Software Requirements Document, ERBE-like Averaging to Monthly TOA Fluxes (Subsystem 3.0), Release 1 Version 1, January 1995.

3. Smith, G.L.; Green, R. N.; Raschke, E.; Avis, L. M.; Suttles, J. T.; Wielicki, B. A., and Davies, R.: Inversion Methods for Satellite Studies of the Earth's Radiation Budget: Development of Algorithms for the ERBE Mission. Reviews of Geophysics, Vol. 24, No. 2, pp. 407-421, May 1986.

4. Clouds and the Earth's Radiant Energy System (CERES) Algorithm Theoretical Basis Document, ERBE-like Inversion to Instantaneous TOA Fluxes (Subsystem 2.0), Rel. 2.2, June 2, 1997.

5. ERBE Data Management System Reference Manual, Volume V(a) and V(b) (PDF), Inversion, August 1987.

6. Clouds and the Earth's Radiant Energy System (CERES) Algorithm Theoretical Basis Document, ERBE-like Averaging to Monthly TOA Fluxes (Subsystem 3.0), Rel. 2.2, June 2, 1997.

7. ERBE Data Management System Reference Manual, Volume VI (PDF), Daily Data Base, Monthly Time/Space Averaging, November 1986.

8. Clouds and the Earth's Radiant Energy System (CERES) Data Management System Data Products Catalog.

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10. Clouds and the Earth's Radiant Energy System (CERES) Algorithm Theoretical Basis Document, Instrument Geolocate and Calibrate Earth Radiances (Subsystem 1.0), Release 2.2, June 1997.

11. Brooks, D. R.; Harrison, E. F.; Minnis, P.; Suttles, J. T., and Kandel, R. S.: Development of Algorithms for Understanding the Temporal and Spatial Variability of the Earth's Radiation Balance. Reviews of Geophysics, Vol. 24, pp. 422-438, May 1986.

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13. Brooks, D. R. and P. Minnis, "Comparison of Longwave Diurnal Models Applied to Simulations of the Earth Radiation Budget Experiment," Journal of Climate and Applied Meteorology, 23, 155-160, 1984.

14. Clouds and the Earth's Radiant Energy System (CERES) Validation Plan, ERBE-like Averaging to Monthly TOA Fluxes (Subsystem 3.0), Release 3.0, February 1999.

Contact Information:

Investigator(s) Name and Title	Technical Contact(s)	Data Center
Norman G. Loeb CERES Interdisciplinary Principal Investigator E-mail: norman.g.loeb@nasa.gov Telephone: (757) 864-5688	Takmeng Wong Atmospheric Sciences Competency Mail Stop 420 NASA Langley Research Center Hampton, Virginia 23681-2199 USA Telephone: (757) 864-5607 FAX: (757) 864-8197 E-mail: takmeng.wong@nasa.gov	User and Data Services Office Atmospheric Science Data Center NASA Langley Research Center Mail Stop 157D Hampton, Virginia 23681-2199 USA Telephone: (757) 864-8656 FAX: (757) 864-8807 E-mail: support-asdc@earthdata.nasa.gov URL: http://eosweb.larc.nasa.gov

Acknowledgement:

The requested form of acknowledgment for any publication in which these data are used is:

"These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center."

The Langley Data Center requests a reprint of any published papers or reports or a brief description of other uses (e.g., posters, oral presentations, etc.) of data that we have distributed. This will help the Data Center determine the use of data distributed, which is helpful in optimizing product development. It also helps us to keep our product related references current.

Reference:

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:

Wielicki, B. A., B. R. Barkstrom, E. F. Harrison, R. B. Lee III, G. L. Smith, and J. E. Cooper, "Clouds and the Earth's Radiant Energy System (CERES): An Earth Observing System Experiment," *Bull. Amer. Meteor. Soc.*, **77**, 853-868, 1996.

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ASDC Help Desk: Phone (757) 864-8656; E-mail support-asdc@earthdata.nasa.gov