

Earth Radiation Budget Experiment (ERBE) Langley ASDC Project Document



Summary:

This document briefly describes the ERBE Project. It lists all data products that are currently archived at the Langley ASDC as well as information concerning the satellites, instruments, and references. User's Guides have been provided by the ERBE Team. All documents can be obtained by contacting the [Langley ASDC User and Data Services](#).

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1. Project/Campaign Overview:

Name of Project/Campaign:

Earth Radiation Budget Experiment, ERBE

Project/Campaign Introduction:

The objectives of the Earth Radiation Budget Experiment (ERBE) are:

- To determine, for a minimum of 1 year, the monthly average radiation budget on regional, zonal, and global scales.
- To determine the equator-to-pole energy transport gradient.
- To determine the average diurnal variation of the radiation budget on a regional and monthly scale.

Project/Campaign Mission Objectives:

The goal of the Earth Radiation Budget Experiment is to produce monthly averages of longwave and shortwave radiation parameters on the Earth at regional to global scales. Preflight mission analysis lead to a three-spacecraft system to provide the geographic and temporal sampling required to meet this goal. Three nearly identical sets of instruments were built and launched on three separate spacecraft. These instruments differ principally in the spacecraft interface electronics and in the field-of-view limiters for the nonscanner instruments required because of differences in the spacecraft orbit altitudes.

The ERBS spacecraft was launched by Space Shuttle Challenger in October 1984 and was the first spacecraft to carry ERBE instruments into orbit. ERBS was designed and built by Ball Aerospace Systems under contract to NASA Goddard Space Flight Center (GSFC), and ERBS was the first spacecraft dedicated to NASA science experiments to be launched by the Space Shuttle. ERBS carries the Stratospheric Aerosols and Gas Experiment II (SAGE II) in addition to the ERBE instruments. The Payload Operation and Control Center (POCC) at GSFC directs operations of the ERBS spacecraft and the ERBE and SAGE II instruments, employing both ground stations and the Tracking and Data Relay Satellite System (TDRSS) network. Spacecraft and instrument telemetry data are received at GSFC where the data are processed by the Information Processing Division that provides ERBE and SAGE II experiment data to the NASA Langley Research Center (LaRC).

The second and third spacecraft launched with ERBE instruments are Television Infrared Radiometer Orbiting Satellite (TIROS) N-class spacecraft, which are part of the NOAA operational meteorological satellite series. The NOAA-9 and NOAA-10 spacecraft were launched in December 1984 and September 1986, respectively. The NOAA spacecraft include other instruments, such as the Advanced Very High Resolution Radiometer (AVHRR) and the High-Resolution Infrared Radiometer Sounder (HIRS), which provide NOAA with data for near-real-time weather forecasting. Both spacecraft are in nearly Sun-synchronous orbits. At launch equator-crossing times for the NOAA-9 and



NOAA-10 orbits were 1420 UT (ascending) and 1930 UT (descending), respectively, where UT denotes universal time. The Satellite Operations and Control Center (SOCC) at the National Environmental Satellite and Data Information Service (NESDIS) operates the NOAA spacecrafts. NOAA provides telemetry data and generates ERBE data for LaRC.

NASA tracks the ERBS spacecraft, and the North American Aerospace Defense Command (NORAD) tracks the NOAA spacecraft. The tracking data are provided to GSFC where orbit ephemeris data are calculated for all three spacecraft and provided (on either magnetic tape or via Internet file transfer) to LaRC.

Discipline(s):

Atmospheric Sciences, Radiation Sciences

Geographic Region(s):

NOAA-9 and NOAA-10 provide global coverage and the ERBS satellite provides coverage between 60.00 degrees north and south latitude.

Detailed Project/Campaign Description:

The Earth Radiation Budget Experiment (ERBE) is a multi-satellite system designed to measure the Earth's radiation budget. The ERBE instruments fly on a mid-inclination National Aeronautics and Space Administration (NASA) satellite (Earth Radiation Budget Satellite (ERBS)) and two sun-synchronous National Oceanic and Atmospheric Administration (NOAA) satellites (NOAA-9 and NOAA-10). Each satellite carries both a scanner and a nonscanner instrument package.

The scanner instrument package contains three detectors to measure shortwave (0.2 to 5 microns), longwave (5 to 50 microns) and total waveband radiation (.2 to 50 microns). Each detector normally scans the Earth perpendicular to the satellite groundtrack from horizon-to-horizon. The detectors are thermistors which use space views on every scan as a reference point to guard against drift. They are located at the focal point of a f/1.84 Cassegrain telescope, whose aluminum-coated mirrors have been overcoated to enhance ultraviolet reflectivity. The total channel has no filter and so absorbs all wavelengths. The shortwave channel has a fused silica filter which transmits only shortwave radiation. The longwave channel has a multilayer filter on a diamond substrate to reject shortwave energy and accept longwave. To enhance the spectral flatness of the detectors, each thermistor chip is coated with a thin layer of black paint. The effective field of view of the scanner is 3 degrees.

The nonscanner instrument package contains four Earth-viewing channels and a solar monitor. The Earth-viewing channels have two spatial resolutions: a horizon-to-horizon view of the Earth, and a field-of-view limited to about 1,000 km in diameter. The former are called the wide field-of-view (WFOV) and the latter the medium field-of-view (MFOV) channels. For each of the two fields of view, there is a total spectral channel which is sensitive to all wavelengths and a shortwave channel which uses a high purity, fused silica filter dome to transmit only the shortwave radiation from 0.2 to 5 microns. The solar monitor is a direct descendant of the Solar Maximum Mission's Active Cavity Radiometer Irradiance Monitor detector. Because of the concern for spectral flatness and high accuracy, all five of the channels on the nonscanner package are active cavity radiometers.

2. Data Availability:

Data Type(s):

The Earth Radiation Budget Experiment data are archived in two different formats, native format (NAT), which is defined by the ERBE Data Management Team (DMT), and Hierarchical Data Format (HDF).

The following data sets are in native format, as indicated by the "_NAT" ending:

- ERBE_S10N_WFV_NF_NAT
- ERBE_S10N_WFV_SF_NAT
- ERBE_S10_MFOV_NF_NAT
- ERBE_S10_MFOV_SF_NAT
- ERBE_S10_WFOV_NF_NAT
- ERBE_S10_WFOV_SF_NAT
- ERBE_S4N_NAT
- ERBE_S4_NAT
- ERBE_S7_NAT
- ERBE_S8_NAT
- ERBE_S9_NAT



Documentation of the native format can be found in User's Guides produced by the ERBE DMT as well as in the on-line data set guides provided by the Langley ASDC. Software to read the native format data is available or being developed.

The following data sets are in HDF:

- ERBE_S4G_MFOV_NF
- ERBE_S4G_WFOV_NF_N10
- ERBE_S4G_MFOV_NF_ZG
- ERBE_S4G_MFOV_SF
- ERBE_S4G_MFOV_SF_ZG
- ERBE_S4G_SC_2.5
- ERBE_S4G_SC_NEST10
- ERBE_S4G_SC_NEST5
- ERBE_S4G_SC_ZG
- ERBE_S4G_WFOV_NF
- ERBE_S4G_WFOV_NF_N10
- ERBE_S4G_WFOV_NF_ZG
- ERBE_S4G_WFOV_SF
- ERBE_S4G_WFOV_SF_ZG
- ERBE_S4GN_WFOV_NF
- ERBE_S4GN_WFV_NF_N10
- ERBE_S4GN_WFOV_NF_ZG
- ERBE_S4GN_WFOV_SF
- ERBE_S4GN_WFOV_SF_ZG

The Hierarchical Data Format is a multi-object file format for the transfer of graphical and numerical data between machines. The design of this format allows self-definition of data content and easy extensibility for future enhancements or compatibility with other standard formats.

There is read software available to read the non-scanner S-4G data sets and another to read the scanner S-4G data sets. The S-4GN read program allows the user to read the S-4GN data sets as well as the non-scanner S-4G data sets. All of these read programs can be obtained from the Langley ASDC. Each of these programs is available in both the C and Fortran programming languages.

In order to compile and run the read software, you will need to obtain the HDF libraries. These libraries are in the public domain and are available from the National Center for Supercomputing Applications (NCSA) via FTP (<ftp.ncsa.uiuc.edu> or 128.174.20.50).

Input/Output Media:

Data were transitioned to the Langley ASDC via 9-track tapes, optical platters, and electronic means.

Proprietary Status:

This data is free for public use.

2.4 Description of Data Sets:

S-7

The S-7 contains 4-second averaged non-scanner measurements and 32-second estimates of the longwave and shortwave flux at the top of the atmosphere. All the data are ordered chronologically for one month and one spacecraft. There is one available S-7 data set, see below.

S-7 Data Set

Data Set Name	Data Set Long Name
ERBE_S7_NAT	Earth Radiation Budget Experiment (ERBE) S-7 Monthly Medium-Wide Data Tape in Native (NAT) Format

S-8

The Processed Archival Tape (PAT) contains ERBE scanner and non-scanner radiometric measurements, their location and viewing angles at the top of the atmosphere, and estimates of the flux based on these measurements for one day and one satellite. All of the data are ordered chronologically and divided into 16-second records. There is one available S-8 data set, see below.

S-8 Data Set

Data Set Name	Data Set Long Name
ERBE_S8_NAT	Earth Radiation Budget Experiment (ERBE) S-8 Processed Archival Tape (PAT) in Native (NAT) Format

S-9

The S-9 contains regional hourly and daily monthly averages as well as the actual individual hour box data. The S-9 contains 2.5-degree resolution data from the scanner instrument and is available as a combination of all operational spacecraft. There may be three to eight S-9 files per month depending upon the number of operational instruments for a given month. The scanner data for each region observed during a month are collected into a 32 x 25 matrix representing days and hours of the month; monthly(day), monthly(hour), daily, and monthly hourly averages, are determined for each region. There is one available S-9 data set, see below.

S-9 Data Set

Data Set Name	Data Set Long Name
ERBE_S9_NAT	Earth Radiation Budget Experiment (ERBE) S-9 Scanner Radiant Flux and Albedo in Native (NAT) Format

S-10

The S-10 contains regional hourly and daily monthly averages as well as the actual individual hour box data. Medium field-of-view data are available as a combination of the ERBS and NOAA-9 spacecraft. One data file is produced per month, containing values represented in scaled 16-bit integers. Below is a list of all available S-10 data sets.

S-10 Data Sets

Data Set Name	Data Set Long Name
ERBE_S10_MFOV_NF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 Nonscanner Medium Field of View (MFOV) Numerical Filter (NF) Radiant Flux and Albedo in Native (NAT) Format
ERBE_S10_MFOV_SF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 Nonscanner Medium Field of View (MFOV) Shape Factor (SF) Radiant Flux and Albedo in Native (NAT) Format
ERBE_S10_MFOV_NF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 Nonscanner Medium Field of View (MFOV) Numerical Filter (NF) Radiant Flux and Albedo in Native (NAT) Format
ERBE_S10_MFOV_SF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 Nonscanner Medium Field of View (MFOV) Shape Factor (SF) Radiant Flux and Albedo in Native (NAT) Format

S-10N

The S-10N contains the same science information arranged in the same order as S-10 but with some differences in processing algorithms and data format. The data set, S-10N consists of nonscanner data processed without scene identification information from the scanner instrument and with the numerical filter cross-track enhancement technique.

S-10N Data Sets

Data Set Name	Data Set Long Name
ERBE_S10N_WFV_NF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 (Nonscanner-only) Wide Field of View (WFOV) Numerical Filter (NF) Radiant Flux and Albedo in Native (NAT) Format
ERBE_S10N_WFV_SF_NAT	Earth Radiation Budget Experiment (ERBE) S-10 (Nonscanner-only)



S-4

The Earth Radiation Budget Experiment Level 3 Regional, Zonal, and Global Averages Product (S-4) is arranged on a regional basis and contains radiant fluxes (longwave, shortwave, net), albedo, and solar incidence. S-4 contains the following scanner data: 2.5-degree regional averages; 2.5-degree nested to 5.0-degree regional averages; 5.0-degree nested to 10.0-degree regional averages; 2.5-degree, 5.0-degree, and 10.0-degree zonal averages; and global averages. S-4 also contains the following numerical filter nonscanner data: 5.0-degree medium and wide field-of-view regional averages, 5.0-degree nested to 10.0-degree regional averages, 5.0-degree and 10.0-degree medium and wide field-of-view zonal averages, and medium and wide field-of-view global averages. In addition S-4 contains the following shape factor nonscanner data: 10.0-degree regional, zonal, and global averages for both medium and wide field-of-view. There is one available S-4 data set, see below.

S-4 Data Set

Data Set Name	Data Set Long Name
ERBE_S4_NAT	Earth Radiation Budget Experiment (ERBE) S-4 (Scanner and Nonscanner) Regional, Global, and Zonal Averages of Radiant Flux and Albedo in Native (NAT) Format

S-4N

The Earth Radiation Budget Experiment Level 3 Nonscanner Regional, Zonal, and Global Averages Product (S-4N) is arranged on a regional basis and contains radiant fluxes (longwave, shortwave, net), albedo, and solar incidence. S-4N contains the following numerical filter nonscanner data: 5.0-degree wide field-of-view regional averages, 5.0-degree nested to 10.0-degree regional averages, 5.0-degree and 10.0-degree wide field-of-view zonal averages, and wide field-of-view global averages. S-4N also contains the following shape factor nonscanner data: 10.0-degree regional, zonal, and global averages for wide field-of-view. There is one available S-4N data set, see below.

S-4N Data Set

Data Set Name	Data Set Long Name
ERBE_S4N_NAT	Earth Radiation Budget Experiment (ERBE) S-4N (Nonscanner-only) Regional, Global, and Zonal Averages of Radiant Flux and albedo in Native (NAT) Format

S-4G

The Earth Radiation Budget Experiment Level 3 Regional, Zonal, and Global Gridded Averages Product (S-4G) is S-4 data organized on a regional basis and contains radiant fluxes (longwave, shortwave, net), albedo, and solar incidence in HDF. Below is a list of all available S-4G data sets.

S-4G Data Sets

Data Set Name	Data Set Long Name
ERBE_S4G_SC_2.5	Earth Radiation Budget Experiment (ERBE) S-4G Scanner (SC) 2.5 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_SC_NEST5	Earth Radiation Budget Experiment (ERBE) S-4G Scanner (SC) 2.5 degree Nested to 5 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_SC_NEST10	Earth Radiation Budget Experiment (ERBE) S-4G Scanner (SC) 5 degree Nested to 10 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_SC_ZG	Earth Radiation Budget Experiment (ERBE) S-4G Scanner (SC) 2.5, 5.0, and 10.0 degree Zonal and Global Regional Averages in Hierarchical Data Format
ERBE_S4G_MFOV_NF	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner



	Medium Field of View (MFOV) Numerical Filter (NF) 5 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_MFOV_NF_N10	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Medium Field of View (MFOV) Numerical Filter (NF) 5 degree Nested to 10 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_MFOV_NF_ZG	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Medium Field of View (MFOV) Numerical Filter (NF) Zonal and Global Averages in Hierarchical Data Format
ERBE_S4G_MFOV_SF	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Medium Field of View (MFOV) Shape Factor (SF) 10 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_MFOV_SF_ZG	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Medium Field of View (MFOV) Shape Factor (SF) Zonal and Global Averages in Hierarchical Data Format
ERBE_S4G_WFOV_NF	Earth Radiation Budget Experiment (ERBE) S-4G Wide Field of View (WFOV) Numerical Filter (NF) 5 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_WFOV_NF_N10	Earth Radiation Budget Experiment (ERBE) S-4G Wide Field of View (WFOV) Numerical Filter (NF) 5 degree Nested to 10.0 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_WFOV_NF_ZG	Earth Radiation Budget Experiment (ERBE) S-4G Wide Field of View (WFOV) Numerical Filter (NF) 5 degree and 10.0 degree Zonal and Global Averages in Hierarchical Data Format
ERBE_S4G_WFOV_SF	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Wide Field of View (WFOV) Shape Factor (SF) 10.0 degree Regional Averages in Hierarchical Data Format
ERBE_S4G_WFOV_SF_ZG	Earth Radiation Budget Experiment (ERBE) S-4G Nonscanner Wide Field of View (WFOV) Shape Factor (SF) 10.0 degree Zonal and Global Averages in Hierarchical Data Format

S-4GN

The Earth Radiation Budget Experiment Level 3 Nonscanner Regional, Zonal, and Global Gridded Averages Product (S-4GN) is S-4N data organized by parameter and contains radiant fluxes (longwave, shortwave, net), albedo, and solar incidence in HDF. Below is a list of all available S-4GN data sets.

S-4GN Data Sets

Data Set Name	Data Set Long Name
ERBE_S4GN_WFV_NF	Earth Radiation Budget Experiment (ERBE) S-4GN (Nonscanner-only) Wide Field of View (WFOV) Numerical Filter (NF) 5 degree Regional Averages in Hierarchical Data Format
ERBE_S4GN_WFV_NF_N10	Earth Radiation Budget Experiment (ERBE) S-4GN (Nonscanner-only) Wide Field of View (WFOV) Numerical Filter (NF) 5 degree Nested to 10.0 degree Regional Averages in Hierarchical Data Format
ERBE_S4GN_WFV_NF_ZG	Earth Radiation Budget Experiment (ERBE) S-4GN (Nonscanner-only) Wide Field of View (WFOV) Numerical Filter (NF) 5 degree and 10.0 degree Zonal and Global Averages in Hierarchical Data Format
ERBE_S4GN_WFV_SF	Earth Radiation Budget Experiment (ERBE) S-4GN (Nonscanner-only) Wide Field of View (WFOV) Shape Factor (SF) 10 degree Regional Averages in Hierarchical Data Format
ERBE_S4GN_WFV_SF_ZG	Earth Radiation Budget Experiment (ERBE) S-4GN (Nonscanner-only) Wide Field of View (WFOV) Shape Factor (SF) 10 degree Zonal and Global Averages in Hierarchical Data Format

TSI

The Total Solar Irradiance from the ERBS Satellite contains total solar irradiance data that were collected every two weeks from the solar monitor. Each granule consists of six months of data and are in ASCII format.

3. Data Access:

Data Center Location:

Langley ASDC User and Data Services Office
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

Contact Information:

Dr. Takmeng Wong, Physical Scientist
NASA Langley Research Center
Mail Stop 420
Hampton, Virginia 23681-2199
Telephone: (757) 864-5607
FAX: (757) 864-7996
E-mail: takmeng.wong@nasa.gov

Associated Costs:

There is no cost for obtaining this data.

4. Principal Investigator Information:

Investigator(s) Name and Title:

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5. Submitting Investigator Information:

Investigator(s) Name and Title:

Dr. Bruce R. Barkstrom, ERBE Principal Investigator
NASA Langley Research Center
Hampton, Virginia 23681

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7. Glossary and Acronyms:

[EOSDIS Acronyms](#) (PDF).

Albedo



The ratio of shortwave radiant flux to the integrated solar incidence, where zero (0.0) represents total absorption, and one (1.0) represents total reflectance.

Nadir

That point on the celestial sphere vertically below the observer, or 180 degrees from the zenith.

Radiance

The radiant flux per unit solid angle per unit of projected area of the source; usual unit is the watt per square meter per steradian. Also known as steradiancy.

Radiant Flux

The time rate of flow of radiant energy.

Solar Incidence

Total energy per unit area impinging on the earth from the sun.

Zenith

That point on the celestial sphere vertically above the observer.

ASDC - Atmospheric Science Data Center

AVHRR - Advanced Very High Resolution Radiometer

DAAC - Distributed Active Archive Center

DMT - Data Management Team

EOSDIS - Earth Observing System Data and Information System

ERBE - Earth Radiation Budget Experiment

ERBS - Earth Radiation Budget Satellite

FTP - File Transfer Protocol

GSFC - Goddard Space Flight Center

HDF - Hierarchical Data Format

HIRS - High-Resolution Infrared Radiometer Sounder

LaRC - Langley Research Center

MFOV - Medium Field-Of-View

NASA - National Aeronautics and Space Administration

NESDIS - National Environmental Satellite and Data Information Service

NOAA - National Oceanic and Atmospheric Administration

NOAA-10 - National Oceanic and Atmospheric Administration operational weather monitoring satellite, number 10

NOAA-9 - National Oceanic and Atmospheric Administration operational weather monitoring satellite, number 9

NORAD - North American Aerospace Defense Command

POCC - Payload Operation and Control Center

SAGE II - Stratospheric Aerosols and Gas Experiment II

SOCC - Satellite Operations and Control Center

TDRSS - Tracking and Data Relay Satellite System

TIROS - Television Infrared Radiometer Orbiting Satellite

WFOV - Wide Field-Of-View

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