Earth Radiation Budget Experiment (ERBE) Overview

Background

The radiation budget represents the balance between incoming energy from the Sun and outgoing thermal (longwave) and reflected (shortwave) energy from the Earth. In the 1970's, NASA recognized the importance of improving our understanding of the radiation budget and its effects on the Earth's climate. Langley Research Center was charged with developing a new generation of instrumentation to make accurate regional and global measurements of the components of the radiation budget. The Goddard Space Flight Center built the Earth Radiation Budget Satellite (ERBS) which carried the first ERBE instruments. ERBS was deployed from the Space Shuttle Challenger in October 1984 by NASA Astronaut Sally Ride and launched into a 57 degree inclination precessing orbit with a period of approximately 72 days. In addition to the ERBE scanning and nonscanning instruments, the satellite also carried the Stratospheric Aerosol Gas Experiment (SAGE II). ERBE instruments were also launched on two National Oceanic and Atmospheric Administration weather monitoring satellites, the NOAA-9 satellite in January 1985 and the NOAA-10 satellite in October 1986.

Science Team

An international team of scientists was selected from proposals to an Announcement of Opportunity in 1978 to participate in the design and development of ERBE. Dr Bruce Barkstrom, of the Radiation Sciences Branch of Langley's Atmospheric Sciences Competency, was selected as the ERBE Principal Investigator. He led the team through 30 meetings to guide the development of the instrumentation and the ground processing software for analyzing the data, including algorithm development and data validation activities.

Instrument Development

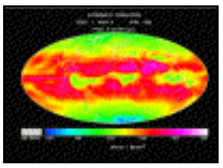
Langley formed a team of electronic, thermal, and mechanical experts to develop the ERBE instruments. Led by Jack Cooper, Experiment Manager, and Glenn Taylor, Instrument Manager, this team developed the specifications for two types of instruments. TRW, of Redondo Beach, California, was selected to build the instruments, calibrate them in a unique thermal/vacuum radiometric calibration facility, and help integrate the instruments with the ERBS and NOAA satellite platforms.

- **Scanner**

  The scanner instrument contains three detectors (total, longwave, and shortwave) which normally operate in a cross-track mode, scanning from above the horizon, down across the Earth disk, through nadir, continuing across the other Earth limb up through space to the internal blackbody. In-flight, the instrument is normally calibrated internally at 2-week intervals. The scanning detectors consist of one Total wavelength thermistor bolometer, one Long wavelength thermistor bolometer, and one Short wavelength thermistor bolometer.

  The total detector measures radiation in the 0.2-50.0 micron wavelength band, the longwave detector measures radiation in the 0.5-50.0 micron wavelength band, and the shortwave detector measures radiation in the 0.2-5.0 micron band.

  The ERBS scanner was operational for more than five years. This representative sample of ERBS scanner measurements shows a surface map of the Earth's surface with the regional time and space averaged longwave fluxes for the ERBS for April 1985.

  view full sample

- **Nonscanner**

  There are five detectors within the nonscanner instrument: one measures the total energy from the Sun, two measure the shortwave and total energy from the entire Earth disk, and two measure the shortwave and total energy from a medium resolution area beneath the satellite. Four detectors normally operate in a nadir (Earth) staring mode. The fifth detector (the solar monitor) is used only for solar calibration measurements. In-flight, the instrument is normally calibrated internally at 2-week intervals.

  The nonscanner detectors consist of:

  - Wide Field-Of-View (WFOV) Detectors:
    - One Total (wavelength) active cavity radiometer (ACR)
    - One Short (wavelength) ACR
  - The Medium Field-Of-View (MFOV) Detectors:
    - One Total (wavelength) ACR
    - One Short (wavelength) ACR

- The Solar Monitor Detector:
  - One Solar active cavity pyrheliometer

The total detectors measure radiation in the 0.2-50.0 micron wavelength band, and the shortwave detectors measure radiation in the 0.2-5.0 micron band. The solar monitor is sensitive to all incident irradiance.

The ERBS nonscanner instrument remained fully operational for more than eight years. An eight year nonscanner history of ERBS WFOV measurements shows the long-term trends of the Earth's emitted and reflected radiant energy over this period of time.

Data Management System Development

The ERBE Data Management Team was formed to design and develop the ground data processing system based on algorithms from the Science Team. Jim Kibler, Head of the Data Management Office in Langley's Atmospheric Sciences Competency, led the team through three iterative releases of the system to be ready for processing at the first launch. The system design included several subsystems to produce archival science products for study by the science community:

- Telemetry - Process data from NOAA and GSFC to a common format, interpret the instrument and spacecraft housekeeping data, and analyze instrument commands and in-orbit environment.
- Ephemeris - Analyze orbit position data from GSFC for each of the three satellite platforms.
- Merge/Count Conversion - Combine telemetry and ephemeris data to produce Earth location geometry and convert radiometric counts produced by the instruments into satellite-altitude radiances.
- Inversion - Identify the scene viewed by the instruments and interpret the measurements at the top of the Earth's atmosphere using shape factor and numerical filter inversion techniques.
- Daily and Monthly Time/Space Averaging - Convert from time-ordered to regionally-accessible data sets and apply diurnal models to estimate hourly, daily, and monthly averages of radiation budget components.
- Data Products - Generate well-documented science archival products in an easily accessible format.

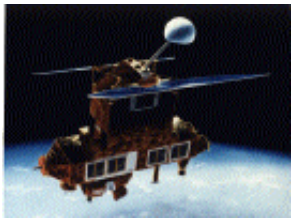
Data Archival and Access

Since the ERBS launch in 1984, the ERBE Project has been validating the instrument results and producing data products for use by the science community. These products range from instantaneous time-sequenced instrument measurements to monthly-averaged regional, zonal, and global estimates of radiation budget parameters:

- S-2 Solar Incidence
- S-4 Regional, Zonal, and Global Averages
- S-4G Regional, Zonal, and Global Gridded Averages
- S-7 Medium-Wide Field of View Nonscanner Data
- S-8 Instantaneous Scanner and Nonscanner Data
- S-9 Scanner Earth Radiant Flux and Albedo
- S-10 Nonscanner Earth Radiant Flux and Albedo

These data products and programs for reading the data are available from the Langley Distributed Active Archive Center (Atmospheric Science Data Center).

Related Links and Images

Related Links	ERBS Satellite	ERBE Scanner	ERBE Nonscanner
• CERES ERBE-like Subsystems Home Page • ERBE References (PDF)	 view full satellite image	 view full scanner image	 view full nonscanner image