Fact Sheet

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-2199

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CERES: Understanding the Earth's Clouds and Climate

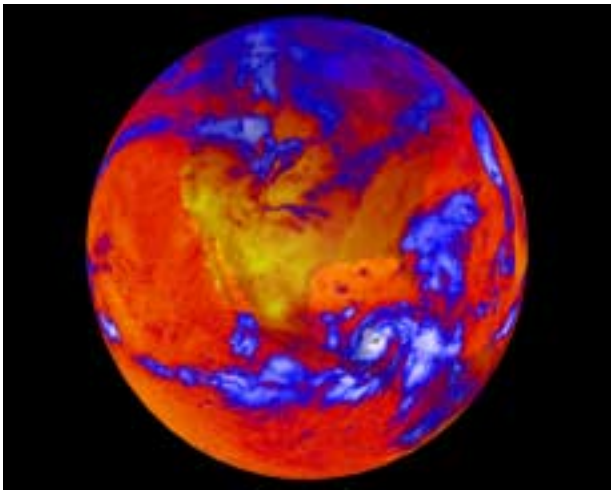
The Clouds and the Earth's Radiant Energy System (CERES) instrument is one of several scheduled to launch aboard the Earth Observing System's (EOS) Aqua spacecraft in 2002. Scientists will use observations from the CERES instrument to study the energy exchanged between the Sun; the Earth's atmosphere, surface and clouds; and outer space.

The CERES Aqua instruments will be the fourth and fifth CERES instruments in orbit. NASA launched the first CERES instrument aboard the Tropical Rainfall Measuring Mission satellite or TRMM in November 1997. Results of the TRMM mission show that the first CERES provided better measurement capabilities than any previous satellite instrument of its kind. Two other CERES instruments are currently orbiting the Earth on the EOS Terra spacecraft, launched in late 1999. Early CERES Terra results give new insights into the effects of clouds on climate and how the climate system changes from decade to decade. Two CERES instruments on each of the Terra and Aqua spacecraft will provide global coverage of energy radiated and reflected from the Earth. Scientists will use measurements from both satellites' orbits to improve observations of the daily cycle of radiated energy.

NASA Langley Research Center manages the CERES mission. Langley's highly successful Earth Radiation Budget Experiment (ERBE) provided the foundation for the design of the CERES instrument. ERBE used three satellites to provide global energy measurements from 1984 through the 1990s. The TRW Space & Electronics Group in Redondo Beach, Calif., built all six CERES instruments.

What CERES Will Measure

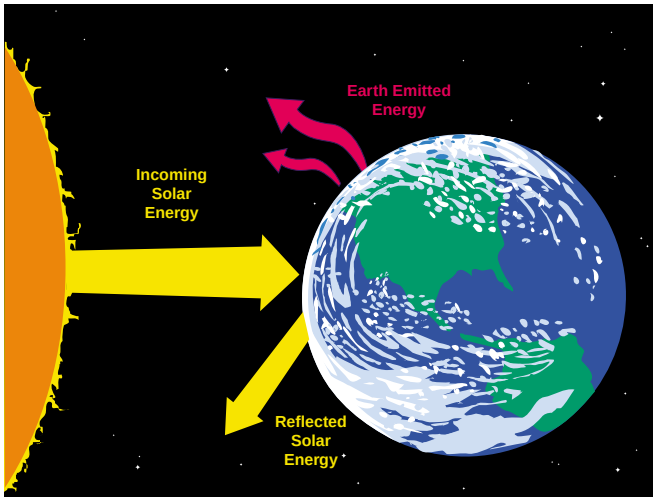
CERES will measure the energy at the top of the atmosphere, as well as estimate energy levels in the atmosphere and at the Earth's surface. Using information from very high resolution cloud imaging instruments on the same spacecraft, CERES also will determine cloud properties, including altitude, thickness, and the size of the cloud particles. All of these measurements are critical for advancing the understanding of the Earth's total climate system and the accuracy of climate prediction models.



CERES detects low (blue and white) to high (yellow) amounts of emitted heat.

Balancing the Earth's Energy Budget

The balance between Earth's incoming and outgoing energy controls daily weather and climate (long-term weather patterns). Sunlight or solar energy is the planet's only incoming energy source. Heat emitted from and sunlight reflected by the Earth's surface, atmosphere and clouds make up the planet's outgoing energy. Scientists have been working for decades to understand this critical energy balance, called the Earth's "energy budget."



Earth's radiation budget is the balance between incoming and outgoing energy.

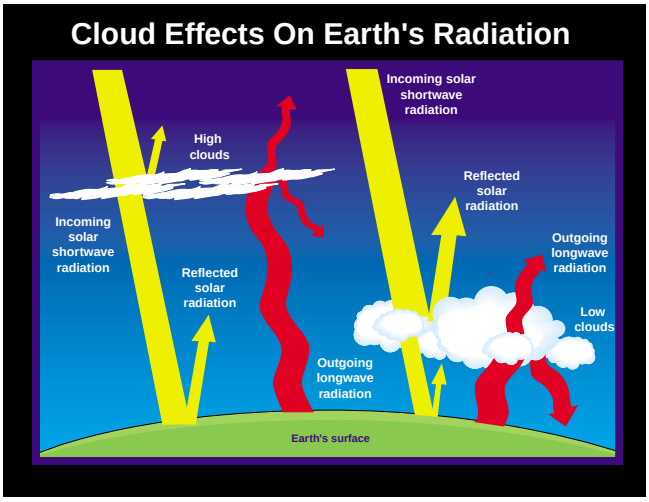
The energy received from the Sun is at short wavelengths, while the energy emitted by the surface of the Earth, the atmosphere and clouds is at long wavelengths. Greenhouse gases in the atmosphere absorb the long wavelength energy or heat emitted by the Earth. Increases in the amounts of greenhouse gases produced by both natural processes or human activities can lead to a warming of the Earth's surface. Such changes may, in turn, alter the planet's daily weather and climate.

Clouds and small particles in the atmosphere called aerosols also reflect some sunlight back into space. Major sources of aerosols include windblown dust, emissions from the burning of fossil fuels, such as gasoline, and the burning of forests and agricultural fields.

Cloud Effects

One of the most intriguing questions facing climate modelers today is how clouds affect the Earth's climate and vice versa. The U.S. Global Change Research Program classifies understanding the role of clouds and the Earth's energy budget as one of its highest scientific priorities. Understanding cloud effects requires a detailed knowledge of how clouds absorb and reflect sunlight, as well as how they absorb and re-emit outgoing heat emitted by the planet. For example, low, thick clouds primarily reflect incoming solar energy back to space causing cooling. Thin, high clouds, however, primarily trap outgoing heat and produce warming. To date, satellite studies have found that clouds have an overall cooling effect on the Earth.

Analyses of satellite data also indicate that clouds which form over water are very different from clouds which form over land. These differences affect the way clouds reflect sunlight back into space and how much heat emitted from the Earth the clouds absorb and re-emit. For example, over the equator in the eastern Pacific Ocean during El Niño events, there is a significant decrease in the amount of energy emitted by the Earth due to increased cloudiness. El Niño events occur when portions of the eastern Pacific Ocean become considerably warmer than normal, causing an increase in cloudiness over the region. These changes can affect weather patterns around the world.



Water Vapor Effects

Water vapor in the atmosphere also impacts our daily weather and climate, though scientists are only beginning to understand how this complex mechanism works. Water vapor acts like a greenhouse gas and absorbs outgoing heat to warm the Earth. Because water vapor also condenses to make clouds, additional water vapor in the atmosphere also may increase the amount of clouds.

Future Missions

One additional CERES instrument is available to fill the gap between Aqua and the next generation of highly accurate Earth radiation budget measurements. These observations are expected to be made on the National Polar-orbiting Operational Environmental Satellite System (NPOESS) starting around 2010. To continue the 22-year record of global energy measurements, the next CERES mission should launch in 2007.

Educational Outreach

As a CERES instrument passes overhead, students worldwide are observing clouds and then sending their observations to NASA Langley's Atmospheric Sciences Data Center (ASDC). At the ASDC, scientists store data for further analysis by the CERES science team. The student observations are part of a global educational outreach program called the Students' Cloud Observations On-Line (S'COOL) project. Since the project began five years ago, S'COOL has reached over 1,000 schools in all 50 states and 57 other countries on five continents.

Commercial Applications

CERES supports commercial applications by providing data about weather and sunlight at the Earth's surface for the renewable energy industry via an innovative Web site (http://eosweb.larc.nasa.gov/sse/). The Surface Meteorology and Solar Energy Project maintains the site. In the first three years of operation, the number of registered users of the Web site, including major energy companies, financial institutions and federal agencies, has grown to over 2,000 from nearly 100 countries. With 35,000 hits per month since January 2001, SSE is the most accessed Web site at the ASDC.

For more CERES information, please contact:

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Also, see the CERES Home Page:
http://asd-www.larc.nasa.gov/ceres/ASDceres.html

Or

NASA Langley's Atmospheric Sciences Home Page:
http://asd-www.larc.nasa.gov/ASDhomepage.html