



**NOAA Satellite and Information Service
Deep Space Climate Observatory (DSCOVR)
NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY ADVANCED RADIOMETER (NISTAR)**

Background

NISTAR is a cavity radiometer designed to measure the absolute, spectrally integrated irradiance reflected and emitted from the entire sunlit face of the Earth, as viewed from an orbit around the Lagrangian point 1 (L1)—neutral gravity point between Earth and the sun. This position offers a unique continuous view of the “Earth at noon.”

Solar irradiance is the power of electromagnetic radiation (radiative flux, measured in Watts) from the sun per unit area incident on the Earth’s surface. Because Earth is not an isotropically reflecting object, the uneven distribution of land, ocean and ice on the surface and the continually changing cloud cover, vegetation, ice and snow make modeling the radiant energy emitted and reflected by Earth difficult. Nevertheless, we can accurately measure radiances over a critical angle range important for understanding Earth’s total radiant flux. NISTAR will be the first instrument capable of providing continual measurements over this angle range for the entire Earth.

NISTAR was designed and built between 1999 and 2001 by Ball Aerospace and Technology Corporation and the NIST Optical Technology Division, in conjunction with the Scripps Institute of Oceanography and NASA, as part of the DSCOVR mission. The instrument consists of four detectors, three electrical-substitution active cavity radiometers and a photodiode, and several band-defining optical filters that can be used with any of the detectors.

In 2010 and 2013, the NISTAR instrument was calibrated against a portable version of the NIST SIRCUS (Spectral Irradiance and Radiance Responsivity Calibrations using Uniform Sources) facility.

Benefits

The energy balance measurement and accuracy of the measurement will improve our understanding of the effects of changes to Earth’s radiation budget caused by human activities and natural phenomena. This information can be used for climate science applications.

The data collected by NISTAR on Earth’s albedo, incoming short- and long-wave radiation, and outgoing long-wave radiation has never been measured from this position before. DSCOVR’s location at the L1 observing position permits long integration times because no scanning is required. Radiometric accuracy of 0.1–1.5% (varies with band) is expected, which is up to a 10-fold improvement in accuracy over current Earth-orbiting satellite data.

NISTAR Instrument-at-a-Glance

Purpose: Measures the absolute irradiance over a broad spectrum of the entire sunlit face of Earth.

Instrument Contractor: Ball Aerospace, Boulder, Colo. with the NIST Optical Technology Division in Gaithersburg, Md.

Key Specs:

Coverage:

UV to IR: 0.2–100 μm

UV to near IR: 0.2–4 μm

Near IR: 0.7–4 μm

Photodiode: 0.3–1 μm

Accuracy: 0.1–1.5%

Swath: FOV of 1 $^{\circ}$, full disk image

Website:

<http://www.nesdis.noaa.gov/DSCOVR/spacecraft.html>

“NISTAR uses active cavity radiometers that absorb all of the incident radiation in internal cavities and monitor the heater currents necessary to maintain the cavity at a constant measured temperature, thus determining the incident energy,” said Adam Szabo, DSCOVR Project Scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. “Recent ground recalibration of this instrument indicates that better than the required 1% absolute accuracy will be achieved.”

From the L1 vantage point, NISTAR, along with its companion imaging spectrometer, the Enhanced Polychromatic Imaging Camera (EPIC), will have a continuous “big picture” view of the illuminated Earth. Earth-orbiting satellites, in contrast, alternate between “day time” and “night time” views.

Key Measurements

The goal of NISTAR is to measure the Earth’s energy balance and radiation budget (solar input and Earth reflection and radiation into space) at high accuracy.

The NISTAR instrument includes four detectors: three active-cavity electrical substitution radiometers and one silicon photodiode channel to measure reflected ultraviolet, visible and infrared solar irradiance. NISTAR measures the absolute irradiance integrated over the entire sunlit face of Earth in four broadband channels minute-by-minute. The four channels are as follows:

- 1) An ultraviolet to far infrared (0.2–100 μm) channel to measure total radiant power in UV, visible and infrared wavelengths emerging from Earth
- 2) A solar (0.2–4 μm) channel to measure reflected solar radiance in UV, visible and near infrared wavelengths
- 3) A near infrared (0.7–4 μm) channel to measure reflected IR solar radiation
- 4) Photodiode (0.3–1 μm) channel for monitoring radiometer filter elements (i.e., channel for on-board calibration reference)

NISTAR has a field of view (FOV) of 1° , sufficient to see and image the full Earth disk which has a FOV of approximately 0.5° as seen from L1. The photodiode channel has been included in order to obtain a faster time series (< 1 s) than what can be obtained by the cavity radiometers. The channel is used to provide for the tracking stability of the filters, to verify co-alignment of NISTAR and EPIC, and to continuously observe the solar reflected broadband radiation from Earth with high temporal resolution.