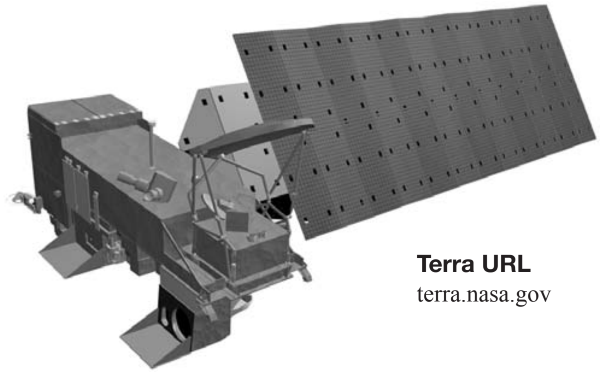
Terra



Terra URL
terra.nasa.gov

Key Terra Facts

Joint with Japan and Canada

Orbit:
Type: Near-polar, sun-synchronous
Equatorial Crossing: 10:30 a.m.
Altitude: 705 km
Inclination: 98.1°
Period: 98.88 minutes
Repeat Cycle: 16 days

Dimensions: 2.7 m × 3.3 m × 6.8 m

Mass: 5,190 kg

Power: 2,530 W

Design Life: 6 years

Summary

The Terra (formerly called EOS AM-1) satellite is the flagship of NASA's Earth Science Missions. Terra is the first EOS (Earth Observing System) platform and provides global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another.

Instruments

- Clouds and the Earth's Radiant Energy System (CERES; two copies)
- Multi-angle Imaging SpectroRadiometer (MISR)
- Moderate Resolution Imaging Spectroradiometer (MODIS)
- Measurements of Pollution in The Troposphere (MOPITT)
- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

Points of Contact

- *Terra Project Scientist:* Marc Imhoff, NASA Goddard Space Flight Center
- *Terra Deputy Project Scientist:* Si-Chee Tsay, NASA Goddard Space Flight Center

Other Key Personnel

- *Terra Program Scientist:* Garik Gutman, NASA Headquarters
- *Terra Program Executive:* Lou Schuster, NASA Headquarters

Mission Type

Earth Observing System (EOS) Systematic Measurements

Launch

- *Date and Location:* December 18, 1999, from Vandenberg Air Force Base, California
- *Vehicle:* Atlas Centaur IIAS expendable launch vehicle

Relevant Science Focus Areas

(see NASA's Earth Science Program section)

- Atmospheric Composition
- Carbon Cycle, Ecosystems, and Biogeochemistry
- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycles
- Weather

Related Applications

(see Applied Science Program section)

- Agricultural Efficiency
- Air Quality
- Carbon Management
- Coastal Management
- Disaster Management
- Ecological Forecasting
- Energy Management
- Homeland Security
- Invasive Species
- Public Health
- Water Management

Terra Science Goals

- Provide the first global and seasonal measurements of the Earth system, including such critical functions as biological productivity of the land and oceans, snow and ice, surface temperature, clouds, water vapor, and land cover.

- Improve our ability to detect human impacts on the Earth system and climate, identify the 'fingerprint' of human activity on climate, and predict climate change by using the new global observations in climate models.

- Help develop technologies for disaster prediction, characterization, and risk reduction from wildfires, volcanoes, floods, and droughts.

- Start long-term monitoring of global climate change and environmental change.

Terra Mission Background

The Terra mission provides comprehensive global measurements for quantitatively monitoring Earth's land, oceans, and atmosphere. Terra, along with other EOS spacecraft (Landsat 7, Aqua, and ICESat) acquires many of the measurements required to advance understanding of the Earth system. Terra flies in a near-polar, sun-synchronous orbit that descends across the equator in the morning. After launch in December 1999, Terra's equator crossing time was changed from around 10:45 a.m. local time to 10:30 a.m. ± 5 minutes after a series of inclination maneuvers. This crossing time is expected to be maintained for the rest of the mission.

Terra's orbit follows the Worldwide Reference System, as do the orbits of Landsat 7 (USGS), Earth Observing-1 (EO-1, NASA), and Satelite de Aplicaciones Cientificas-C (SAC-C, Argentina Comisión Nacional para el Ahorro de Energia [CONAE]), all crossing the equator within 30 minutes of each other. These four spacecraft compose the 'Morning Constellation,' thus facilitating joint use of Terra data and the data from its companion missions. The Aqua spacecraft, launched in May 2002, flies in an ascending orbit with a 1:30 p.m. equatorial crossing time, which enables study of diurnal variability with the MODIS and CERES instruments on both Terra and Aqua. For additional information about the Terra spacecraft and links to each of its five instruments, the reader is invited to visit the Terra Project Science homepage at: terra.nasa.gov.

Each Terra instrument was developed under the supervision of a science team that also provides algorithms for analysis of the data and derivation of Earth-system measurements. The science teams validate these products and use them in scientific investigations. Terra has five complementary scientific instruments: ASTER for close-up land studies, CERES for a broad view of long- and shortwave radiation, MOPITT for studies of pollution, MISR for bidirectional-reflectance studies of clouds, aerosol, and land features, and MODIS for global analysis of land, ocean, and atmosphere properties and their interactions. The MODIS and CERES

Terra Instruments

ASTER
Advanced Spaceborne Thermal Emission and Reflection Radiometer

A 3-radiometer sensor package with three vis/near-IR, six shortwave, and 5 thermal-infrared channels with 15, 30, and 90-m resolution, respectively, and a 60-km swath. Provided by the Japanese Ministry of Economy, Trade, and Industry (METI), designed to make detailed maps of land surface temperature, emissivity, reflectance and elevation.

CERES
Clouds and the Earth's Radiant Energy System

A 3-channel, broadband radiometer (0.3 to > 100 μm, 0.3–5 μm, 8–12 μm) designed to measure major elements of the Earth's radiation balance.

MISR
Multi-angle Imaging SpectroRadiometer

A 36-channel instrument; nine pushbroom cameras with discrete view angles (to ±70°) in four spectral bands (0.443–0.865 m) with resolutions of 275 m to 1.1 km, designed to measure clouds, aerosols and vegetation cover.

MODIS
Moderate Resolution Imaging Spectroradiometer

A 36-band spectroradiometer measuring visible and infrared radiation (0.4–14.5 μm with spatial resolutions of 250 m, 500 m, and 1 km at nadir) for derivation of products ranging from land vegetation and ocean chlorophyll fluorescence to cloud and aerosol properties, fire occurrence, snow cover on land, and sea ice in the oceans.

MOPITT
Measurements of Pollution in The Troposphere

An 8-channel cross-track-scanning gas-correlation radiometer operating at three wavelengths (2.2, 2.3, and 4.7 μm), designed to measure carbon monoxide and methane in the atmosphere.

instruments extend the measurements of their heritage sensors—the Advanced Very High Resolution Radiometer (AVHRR), the Coastal Zone Color Scanner (CZCS), and the Earth Radiation Budget Experiment (ERBE)—but with a higher quality of calibration and characterization.

Over the course of the mission, Terra's MODIS and MOPITT instruments have experienced some anomalies. The MODIS instrument power supply and scientific formatting equipment experienced problems in 2001 and 2002, respectively, and were switched to redundant units. MOPITT experienced the loss of four of its channels in 2001, resulting in a reduction of carbon monoxide profiling capability. Despite these problems MOPITT is acquiring science data for both carbon monoxide and methane. ASTER, MISR, and CERES have operated throughout the mission with no significant problems.

The amount of downloaded data from Terra's instruments is about 195 Gb of Level 0 data each day, which represents about 850 terabytes when processed to higher-level science products. Currently, the majority of planned Terra science products are available through the EOS Data Gateway. At this point in the mission, most products are calibrated and validated and have been given the label of 'validated' data. This means that a data product has been evaluated and quality checked and is considered ready for routine scientific research uses. Nonetheless, validation research is continuing throughout the lifetime of the Terra mission, and it is reasonable to expect that Terra data products will continue to be improved over time. For the latest information on the status and availability of data from Terra (and similarly for other EOS missions), see: eosdatainfo.gsfc.nasa.gov/terra.

Early in the Terra mission, instrument-team scientists called for a series of on-orbit pitch-over maneuvers to allow Terra's instruments to view cold deep space or the sunlit lunar surface. Data from the deep-space maneuvers were required to enable CERES to confirm offsets for its longwave-radiation measurements and enable MODIS to adequately characterize response as a function of mirror scan angle. ASTER, MISR, and MODIS science teams desired measurements of the lunar surface for radiometric calibration purposes. The maneuver required a reverse pitch during eclipse (spacecraft night) within about 33 minutes.

The first Terra deep-space calibration maneuver was successfully performed on March 26, 2003, followed by an identical and flawless maneuver with the moon in the viewing plane of the instruments on April 14, 2003. NASA's EO-1 Advanced Land Imager (ALI) and Hyperion instruments and OrbView's Sea-Viewing Wide Field-of-view Sensor (SeaWiFS) acquired data of the moon around the time of Terra's maneuver. Intercomparisons with these instruments are planned. Analysis of the measurements from the deep space and lunar maneuvers are currently underway, and final results may lead to a plan for a third maneuver.

Through satellite and other observations, the scientific community now has unprecedented quantitative data sets to study Earth as a system and answer the questions of how is Earth changing and how will humans be affected by these changes. Terra, as the flagship observatory for NASA's Earth Observing System, is contributing valuable new data, leading to new insights about the Earth system.

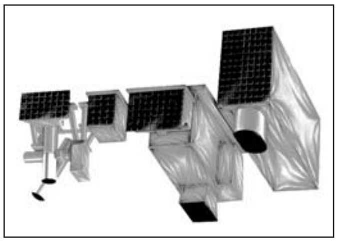
Terra Partners

The Terra Project Office, located at NASA GSFC, manages Terra development. GSFC was responsible for the development of the satellite and the development and operation of the ground operations system. Spacecraft operations are performed at a Mission Operations Center at GSFC.

ASTER

Advanced Spaceborne Thermal Emission and Reflection Radiometer

ASTER Background



ASTER is a facility instrument provided for the Terra platform by Japan's Ministry of Economy, Trade and Industry (METI). It provides high-spatial-resolution (15- to 90-m) multispectral images of Earth's surface and clouds in order to better understand the physical processes that affect climate change. While MODIS and MISR monitor many of the same variables globally, and on a daily basis, ASTER provides data at a scale that can be directly related to detailed physical processes. These data bridge the gap between field observations and data acquired by MODIS and MISR, and between process models and climate and/or forecast models. ASTER data are also used for long-term monitoring of local and regional changes on Earth's surface, which either lead to, or are in response to, global climate change, e.g., land use, deforestation, desertification, lake and playa water-level changes, and other changes in vegetation communities, glacial movement, and volcanic processes.

Clouds are one of the most important variables in the global climate system. With its high spatial resolution, broad spectral coverage, and stereo capability, ASTER provides essential measurements of cloud amount, type, spatial distribution, morphology, and radiative properties.

ASTER provides radiative (brightness) temperature, and the multispectral thermal infrared (TIR) data can be used to derive surface kinetic temperature and spectral emissivity. Radiative temperature is an element in the surface heat balance. Surface kinetic temperature can be used to determine elements of surface-process models, sensible heat flux, latent heat flux, and ground heat conduction. Surface temperatures are also related to thermophysical properties (such as thermal inertia), vegetation health, soil moisture, temporal land classification, e.g., wet vs. dry, vegetated vs. bare soil, and evapotranspiration.

ASTER operates in three visible and near-infrared (VNIR) channels between 0.5 and 0.9 µm, with 15-m resolution; six shortwave infrared (SWIR) channels between 1.6 and 2.43 µm, with 30-m resolution; and five TIR channels between 8 and 12 µm, with 90-m resolution. The instrument acquires data over a 60-km swath whose center is pointable cross-track ±8.55° in the SWIR and TIR, with the VNIR pointable out to ±24°. An additional VNIR telescope (aft pointing) covers the wavelength range of Channel 3. By combining these data with those for Channel 3, stereo views can be created, with a base-to-height ratio of 0.6. ASTER's pointing capabilities are such that any point on the globe is accessible at least once every 16 days in all 14 bands and, on average, every 4 days in the three VNIR channels.

ASTER data products exploit combinations of VNIR, SWIR, and TIR for cloud studies, surface mapping, soil and geologic

Key ASTER Facts

Japan provided the instrument, which provides high-resolution images of the land surface, water, ice, and clouds and has same-orbit stereo capability.

Heritage: Japanese Earth Resources Satellite-1 (JERS-1), Optical Sensor (OPS), and Landsat

Instrument Type: Multispectral imaging radiometer for reflected and emitted radiation measurements of the Earth's surface

Absolute Radiometric Accuracy: 4% in VNIR and SWIR bands

Absolute Temperature Accuracy: 3 K in 200–240 K range, 2 K in 240–270 K range, 1 K in 270–340 K range, and 2 K in 340–370 K range for TIR bands

Swath: 60 km at nadir; swath center is pointable cross-track, ±106 km for SWIR and TIR, and ± 314 km for VNIR

Spatial Resolution: VNIR (0.5–0.9 µm), 15 m [stereo (0.7–0.9 µm), 15 m horizontal, 25 m vertical]; SWIR (1.6–2.43 µm), 30 m; TIR (8–12 µm), 90 m

Dimensions:

- VNIR: 57.9 cm × 65.1 cm × 83.2 cm
- SWIR: 72.3 cm × 134 cm × 90.6 cm
- TIR: 73 cm × 183 cm × 110 cm
- Common Signal Processor (CSP)/VEL (electronics): 33.4 cm × 54 cm × 31.5 cm
- Master Power Supply (electronics): 30 cm × 50 cm × 32 cm

Mass: 421 kg

Duty Cycle: 8% (VNIR and SWIR, daylight only), 16% (TIR)

Power: 463 W (average), 646 W (peak)

Data Rate: 8.3 Mbps (average), 89.2 Mbps (peak)

Thermal Control: 80 K Stirling-cycle coolers, heaters, cold-plate/capillary-pumped loop, and radiators

Thermal Operating Range: 10–28° C

Field of View (FOV) (all pointing is near nadir, except VNIR has both nadir and 27.6° backward from nadir): VNIR: 6.09° (nadir), 5.19° (backward), SWIR and TIR: 4.9°

Instrument IFOV: VNIR: 21.5 µrad (nadir), 18.6 µrad (backward), SWIR: 42.6 µrad (nadir), TIR: 128 µrad (nadir) studies, volcano monitoring, and surface temperature, emissivity, and reflectivity determination. VNIR and SWIR bands are used for investigation of land-use patterns and vegetation, VNIR and TIR combinations for the study of coral reefs and glaciers, and VNIR for digital elevation models (DEMs). TIR channels are used for study of evapotranspiration and land and ocean temperature. The stereoscopic capability yields local surface DEMs and allows observations of local topography, cloud structure, volcanic plumes, and glacial changes.

ASTER URL

asterweb.jpl.nasa.gov

Japan ASTER Science Team Leader

Hiroji Tsu, Geological Society of Japan

U.S. ASTER Science Team Leader

Michael Abrams, NASA Jet Propulsion Laboratory/California Institute of Technology

CERES

Clouds and the Earth's Radiant Energy System

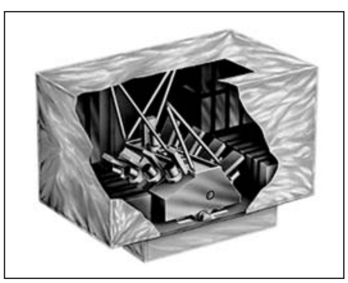
The CERES instrument is described in the Aqua section.

MISR

Multi-angle Imaging SpectroRadiometer

Provides top-of-atmosphere bidirectional reflectances and albedos, cloud-top heights and cloud-tracked winds, cloud classifiers and masks, aerosol optical depths and particle properties, surface bidirectional reflectances, albedos, leaf-area index, and fractional absorbed photosynthetically active radiation.

MISR Background



MISR routinely provides multiple-angle, continuous-sunlight coverage of Earth with moderately high spatial resolution. The instrument obtains multi-directional observations of each scene within a time scale of minutes, thereby under almost identical atmospheric conditions. MISR uses nine individual CCD-based pushbroom cameras to observe Earth at nine discrete view angles: one at nadir, plus eight other symmetrical views at 26.1°, 45.6°, 60.0°, and 70.5°

Key ASTER Facts *(cont.)*

Spectral Range: 14 multispectral bands from visible through thermal infrared

Direct Readout: No

Prime Contractor: NEC (systems integration, VNIR, and Common Signal Processor)

Subcontractors: MELCO (SWIR and cryocooler), Fujitsu (TIR and cryocooler), and Hitachi (master power supply)

Key MISR Facts

Built by the NASA Jet Propulsion Laboratory

Heritage: Galileo, Wide-Field/Planetary Camera

Instruments: Nine charge-coupled device (CCD) cameras fixed at nine viewing angles out to 70.5° at the Earth's surface, forward and afterward of nadir, including nadir

Spectral Bands: Four spectral bands discriminated via filters bonded to the CCDs

Swath: 380 km viewed in common by all nine cameras

Spatial Sampling: 275 m, 550 m, or 1.1 km, selectable in-flight

Repeat Cycle: Global coverage in 9 days

Dimensions: 0.9 m × 0.9 m × 1.3 m

Mass: 149 kg

Duty Cycle: 50%

Power: 83 W (average), 131 W (peak)

Thermal Control: Passive cooling and active temperature stabilization

Thermal Operating Range: 0–10° C

FOV: ±60° (along-track) × ±15° (cross-track)

Data Rate: 3.3 Mbps (orbit average), 9.0 Mbps (peak)

Direct Broadcast: No

forward and aftward of nadir. Images at each angle are obtained in four spectral bands centered at 446, 558, 672, and 866 nm. Each of the 36 instrument data channels (4 spectral bands × 9 cameras) is individually commandable to provide ground sampling of 275 m, 550 m, or 1.1 km. The common swath width of all 9 MISR cameras is about 380 km, providing global multi-angle coverage of the entire Earth in nine days at the equator, and 2 days at the poles. The instrument design and calibration strategies maintain absolute radiometric uncertainty to ±4%. This is met through the bimonthly use of an onboard calibrator and annual field calibration exercises that make use of surface measurements and data from the MISR airborne simulator, AirMISR.

MISR images are acquired in two observing modes: Global and Local. Global Mode provides continuous planet-wide observations, with all of the nadir channels and the red band of all of the off-nadir cameras operating at 275-m resolution and everything else operating at 1.1-km resolution. Local Mode provides data at 275-m resolution in all spectral bands and all cameras for selected 380-km × 300-km regions. In addition to data products providing radiometrically calibrated and geo-rectified images, Global Mode data are used to generate the standard Level 2 Top-of-Atmosphere (TOA)/Cloud Products and Aerosol and Surface Products. Level 3 monthly, seasonal, and annual summary products are generated from Level 1 and Level 2 inputs.

The purpose of the TOA/Cloud Product suite is to enable study, on a global basis, of the use of remotely sensed radiances for inferring cloud properties and albedos, taking into account the effects of cloud-field heterogeneity, altitude, and three-dimensional morphology on the solar radiance and irradiance reflected to space. These products also provide angular signature and stereoscopic cloud identifiers that are particularly useful over challenging areas such as snow- and ice-covered surfaces. The aerosol parameters contained within the Aerosol and Surface Products enable study, on a global basis, of the magnitude and natural variability in space and time of sunlight absorption and scattering by different aerosol types over many kinds of surfaces, including bright-desert source regions. These products also provide atmospheric correction inputs for surface-imaging data acquired by MISR and other instruments that are simultaneously viewing the same portion of the Earth. The surface parameters within the Aerosol and Surface Product are designed to enable improved measures of land-surface characteristics, using bidirectional and hemispherical reflectances to distinguish surface texture and to take into account canopy structure in retrieving global leaf-area index and fractional absorbed photosynthetically active radiation.

MISR URL

www-misr.jpl.nasa.gov/

MISR Principal Investigator

David J. Diner, NASA Jet Propulsion Laboratory/ California Institute of Technology

MODIS

Moderate Resolution Imaging Spectroradiometer

The MODIS instrument is described in the Aqua section.

MOPITT

Measurements of Pollution in The Troposphere

Uses pressure modulation and length modulation to obtain carbon monoxide (CO) concentrations with three independent pieces of information represented by values on seven pressure levels, as well as CO and methane (CH_4) columns.

MOPITT Background

The MOPITT experiment is provided under a Memorandum of Understanding with the Canadian Space Agency (CSA). MOPITT measures emitted and reflected infrared radiance in the atmospheric column which, when analyzed, permits retrieval of tropospheric CO profiles and total column amounts of CO and CH_4.

Both CO and CH_4 are produced by biomass systems, oceans, and human activities. CO is intimately connected with the hydroxyl radical (OH) chemical cycle in the troposphere and moves both vertically and horizontally within the troposphere. CH_4 is a greenhouse gas and is increasing on an annual basis. MOPITT measurements allow studies of the global and temporal distributions that drive energy budget and source/sink studies. Since human activities have a significant influence on both CO and CH_4 concentrations, a better understanding of the role of these constituents is essential to understanding anthropogenic effects on the environment.

MOPITT operates on the principle of correlation spectroscopy, i.e., spectral selection of radiation emission or absorption by a gas, using a sample of the same gas as a filter. The instrument modulates sample-gas density by changing the length or the pressure of the gas sample in the optical path of the instrument. This modulation changes the absorption profile in the spectral lines of the gas in the cell as observed by a detector. The modulated-gas sample acts as an optical filter, which selectively picks out the parts of the atmospheric absorption lines of that gas in the atmosphere. The detector thus observes a signal highly correlated with the abundance of the sample gas in the atmosphere.

Atmospheric sounding and column CO are mapped by using thermal and reflected solar channels in the regions of 4.7 and 2.3 µm, respectively. Column CO and CH_4 are measured using solar channels viewed through modulation cells to sense solar radiation reflected from the surface. The solar channels are duplicated in the instrument at different correlation-cell pressures, to allow a failure in one channel without compromising the column measurement.

MOPITT is designed as a scanning instrument. The field of 4 pixels, aligned along the direction of motion, and each 1.8° (or 22 km at nadir) on a side, is scanned through a cross-track scan angle of 26.1°, or 29 pixels, to give a swath width of 640 km. This swath leaves gaps in coverage between successive orbits using the nominal 705-km altitude and 98.2° inclination orbit.

MOPITT was launched on the Terra spacecraft on December 18, 1999, and was activated in March 2000. Performance to May 2001 was excellent, at which point a problem with the detector cooling system degraded the instrument performance somewhat. However, data are still being obtained by the instrument, and studies have shown that the performance has only been slightly degraded throughout most of the measurement region. MOPITT data for CO have been taken and processed regularly for the entire mission.

The data products include CO soundings, which are retrieved with 10% accuracy provided by up to three independent pieces of information and are represented by values on seven pressure levels between 0 and 14 km. These soundings are taken at laterally scanned sampled locations with 22-km horizontal resolution.

MOPITT CO data for the first 5 years of the MOPITT mission (March 2000 through May 2005) have been released as validated. Problems were discovered with some ancillary data beginning in June 2005, and as of early 2006 the data from June 2005 onward are being reprocessed with an updated algorithm.

MOPITT URLs

University of Toronto
www.atmosp.physics.utoronto.ca/MOPITT/home.html

National Center for Atmospheric Research
www.eos.ucar.edu/mopitt/

MOPITT Principal Investigator

James Drummond, University of Toronto, Canada

Key MOPITT Facts

Joint with Canada

Heritage: Measurement of Air Pollution from Satellites (MAPS), Pressure Modulator Radiometer (PMR), Stratospheric and Mesospheric Sounder (SAMS), and Improved Stratospheric and Mesospheric Sounder (ISAMS) instruments

Instrument Type: Eight-channel radiometer

CO Concentration Accuracy: 10%

CH_4 Column Abundance Accuracy: 1%

Swath: 640 km (29 fields of view)

Spatial Resolution (each pixel): 22 km × 22 km (at nadir)

Dimensions: 115 cm × 93 cm × 57 cm (stowed), 115 cm × 105 cm × 71 cm (deployed)

Mass: 192 kg

Power: 250 W (average), 260 W (peak)

Duty Cycle: 100%

Data Rate: 28 kbps

Thermal Control: 80 K Stirling-cycle cooler, capillary-pumped cold plate and passive radiation

Thermal Operating Range: 25° C (instrument), 100 K (detectors)

Instrument IFOV: 22 km across track, 88 km along track (1.8° × 7.2° × 4° pixels)

Spectral Range: Correlation spectroscopy utilizing both pressure- and length-modulated gas cells, with detectors at 2.3, 2.4, and 4.7 µm

Direct Broadcast: No; Rapid Response processing available

Prime Contractor: COM DEV

The Canadian Space Agency provided the instrument

Terra References

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Diner, D. J., J. C. Beckert, G. W. Bothwell, and J. I. Rodriguez, 2002: Performance of the MISR instrument during its first 20 months in Earth orbit. *IEEE Trans. Geosci. Remote Sens.*, **40**, 1449–1466.

Also see the collection of 17 MISR-related papers in the Special Section on MISR, 2002: *IEEE Trans. Geosci. Remote Sens.*, **40**.

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See CERES and MODIS references in the Aqua section.

Terra Data Products

For more information about the data products please see the *EOS Data Products Handbook*, Volume 1 (revised January 2004) available at: eos.nasa.gov/eos_homepage/for_scientists/data_products/. Future updates regarding data products and data availability should be available through the URLs provided in the instrument sections.

Product Name or Grouping	Processing Level	Coverage	Spatial/Temporal Characteristics
ASTER *Data Set Start Date: March 8, 2000*			
Reconstructed, Unprocessed Instrument Data	1A	Regional up to 780 60 km × 60 km scenes per day (daytime for all channels, daytime and nighttime TIR channels, nighttime SWIR and TIR channels for volcano observation)	15 m (VNIR), 30 m (SWIR), 90 m (TIR)
Registered Radiance at Sensor	1B	Regional up to 310 60 km × 60 km scenes per day (daytime and nighttime)	15 m (VNIR), 30 m (SWIR), 90 m (TIR)
Brightness Temperature at Sensor	2	Regional up to 70 64 km × 60 km scenes per day (daytime and nighttime)	90 m
Browse Data-Decorrelation Stretch Product	2	Regional, three images available per scene	15 m (VNIR), 30 m (SWIR), 90 m (TIR)
Surface Reflectance and Surface Radiance	2	16 days required for global coverage; 70 scenes per day	15 m (VNIR), 30 m (SWIR), 90 m (TIR)
Digital Elevation Models (DEMs)	3	Global	30 m
Polar Surface and Cloud Classification Product	4	Regional (poleward from 60° N or S)	30 m over 60 km × 60 km scenes
Surface Emissivity and Surface Kinetic Temperature	2	Regional, land surface	90 m
CERES *Data Set Start Date: February 25, 2000*			
Bi-Directional Scans Product	0,1	Global	20 km at nadir/0.01 second
ERBE-like Instantaneous TOA Estimates	2	Global	20 km at nadir/0.01 second
ERBE-like Monthly Regional Averages (ES-9) and ERBE-like Monthly Geographical Averages (ES-4)	3	Global	2.5°, 5.0°, 10.0°, region and zone, global/monthly (by day and hour)
Single Scanner TOA/ Surface Fluxes and Clouds	2	Global	20 km at nadir/0.01 second
Clouds and Radiative Swath	2	Global	20 km at nadir/0.01 second
Monthly Gridded Radiative Fluxes and Clouds	3	Global	1° region/hour

Terra Data Products

Product Name or Grouping	Processing Level	Coverage	Spatial/Temporal Characteristics
CERES			
Synoptic Radiative Fluxes and Clouds	3	Global	1° region/ 3-hour, month
Average (AVG) (used for the CERES Monthly Regional Radiative Fluxes and Clouds data product); Zonal Average (ZAVG) (used for the CERES Monthly Zonal and Global Radiative Fluxes and Clouds data product)	3	Global	1° region, 1° zone, global/month
Monthly Gridded TOA/Surface Fluxes and Clouds	3	Global	1° region/hour
Monthly TOA/Surface Averages	3	Global	1° region/month
MISR *Data Set Start Date: February 24, 2000*			
Reformatted Annotated Product	1A	Global, daytime; 378-km swath width (nadir), 413-km swath width (off nadir), providing global coverage in 9 days	Spatial sampling of the nadir-viewing camera, 250 m (cross-track) × 275 m (along track); spatial sampling of the 8 off-nadir cameras, 275 m × 275 m. Onboard averaging up to 1.1 km is selectable by ground command.
Radiometric Product	1B1	Global, daytime; 378-km swath width (nadir), 413-km swath width (off nadir), providing global coverage in 9 days	Spatial sampling of the nadir-viewing camera, 250 m (cross-track) × 275 m (along track); spatial sampling of the 8 off-nadir cameras, 275 m × 275 m. Onboard averaging up to 1.1 km is selectable by ground command.
Geo-rectified Radiance Product	1B2	Global, daytime; 378-km swath width (nadir), 413-km swath width (off nadir), providing global coverage in in 9 days	Resampled data, provided on a 275-m × 275-m Space Oblique Mercator grid in certain channels and a 1.1-km × 1.1-km grid in the remaining channels, as established by the instrument observing configuration
Ancillary Geographic Product	1B2	Global, one time only	1.1 km for most surface classification, elevation, and latitude-longitude parameters, 17.6 km for coarse-resolution elevation information
Ancillary Radiometric Product	1B1	N/A, generated periodically	Radiometric calibration coefficients per pixel
Top of Atmosphere (TOA)/ Cloud Product	2, 3	Global, daytime; 9-day for global repeat coverage	1.1, 2.2, 17.6, 35.2, and 70.4-km sampling (various parameters)/ 9-day for global coverage at Level 2; monthly and seasonal globally gridded products at Level 3
Aerosol and Surface Product	2, 3	Global, daytime	1.1, 17.6, and 70.4-km sampling (various parameters)/9-day for global coverage at Level 2; monthly and seasonal globally gridded products at Level 3

Terra Data Products

Product Name or Grouping	Processing Level	Coverage	Spatial/Temporal Characteristics
MISR			
Aerosol Climatology Product	2, 3	N/A, one-time only, with infrequent updates	Contains aerosol particle and mixture microphysical properties
MODIS *Data Set Start Date: February 24, 2000*			
Level 1B Calibrated, Geolocated Radiances	1B	Global	0.25, 0.5, and 1 km/daily (daytime and nighttime)
Geolocation Data Set	1B	Global	1 km /daily (daytime and nighttime)
Aerosol Product	2	Global over oceans, nearly global over land	10 km/daily daytime
Total Precipitable Water	2	Global	Varies with retrieval technique; 1 km near-infrared/daylight only, and 5 km infrared/day and night
Cloud Product	2	Global	1 or 5 km/once or twice per day (varies with parameter)
Atmospheric Profiles	2	Global, clear-sky only	5 km/daily (daytime and nighttime)
Atmosphere Level 2 Joint Product (select subset)	2	Global	5 or 10 km/once or twice per day (varies with parameter)
Atmosphere Level 3 Joint Product	3	Global	1.0° latitude-longitude equal-angle grid/daily, 8-day, and monthly
Cloud Mask	2	Global	250 m and 1 km/daily
Surface Reflectance; Atmospheric Correction Algorithm Products	2	Global land surface	500 m, 0.05°, and 0.25°/daily
Snow Cover	2, 3	Global, daytime	500 m, 0.05°, and 0.25°/daily; 500 m 0.05°/8-day; 0.05°/monthly
Land Surface Temperature (LST) and Emissivity	2, 3	Global land surface	1 km, 5 km/daily; 1 km/8-day
Land Cover/Land Cover Dynamics	3	Global, clear-sky only	1 km and 0.05°/yearly
Vegetation Indices	3	Global land surface	250 m, 500 m, 1 km/16-day; 1 km/monthly
BRDF/Albedo	3	Global land surface	1 km, 0.05°/16-day
Land Cover Change and Conversion	3, 4	Global, daytime	250 m, 500 m/96-day, yearly

Terra Data Products

Product Name or Grouping	Processing Level	Coverage	Spatial/Temporal Characteristics
MODIS			
Thermal Anomalies/Fire	2, 3	Global, daytime/nighttime	Swath (nominally 1-km) (Level 2); 1 km/daily, 8-day (Level 3)
Leaf Area Index (LAI) and Fraction of Photosynthetically Active Radiation (FPAR)	4	Global	1 km/8-day
Net Photosynthesis and Net Primary Production	4	Global	1 km/8-day, yearly
Sea Surface Temperature (11 μm, day and night; 4 μm, night)	2, 3	Global ocean surface, clear-sky only	1 km/daily (Level 2); 4 km, 9 km/daily, 8-day, monthly, yearly (Level 3)
Sea Ice Cover and Ice-Surface Temperature	2, 3	Global, daytime and nighttime over nonequatorial ocean	1 km, 0.05°/daily
Terra MODIS ocean color products are not available at the time of printing (May 2006); see the ocean color webpage (oceancolor.gsfc.nasa.gov) for up-to-date information regarding the availability of these products.			
MOPITT *Data Set Start Date: March 3, 2000*			
Geolocated Radiances	1B	Global	650-km swath centered at nadir; interlaced crosstrack scan of 4 pixels, each 22 km × 22 km at nadir
CO Profile, CO Column, and CH_4 Column Data	2	Global	CO profiles and column amounts: 22 km at nadir with some degradation depending on cloud clearing and pixel average/daily CH_4 retrievals: currently unavailable
Data Assimilation System (DAS)			
Time-Averaged Single-Level Cloud Quantities	4	Global	1.25° × 1° lon-lat grid (288 × 181 grid points), 8 times/file: 01.30, 04.30, 07.30, 10.30, 13.30, 16.30, 19.30, and 22.30 UTC; 3-hour average centered at the timestamp
Time-Averaged Near Surface and Vertically-Integrated Quantities	4	Global	1.25° × 1° lon-lat grid (288 × 181 grid points), 8 times/file: 01.30, 04.30, 07.30, 10.30, 13.30, 16.30, 19.30, and 22.30 UTC; 3-hour average centered at the timestamp
Time-Averaged 2-Dimensional Surface Data	4	Global	1.25° × 1° lon-lat grid (288 × 181 grid points), 8 times/file: 01.30, 04.30, 07.30, 10.30, 13.30, 16.30, 19.30, and 22.30 UTC; 3-hour average centered at the timestamp
Time-Averaged Surface and Top-of-Atmosphere Stresses	4	Global	1.25° × 1° lon-lat grid (288 × 181 grid points), 8 times/file: 01.30, 04.30, 07.30, 10.30, 13.30, 16.30, 19.30, and 22.30 UTC; 3-hour average centered at the timestamp

Terra Data Products

Product Name or Grouping	Processing Level	Coverage	Spatial/Temporal Characteristics
Data Assimilation System (DAS)			
Time-Averaged 3-Dimensional Cloud Quantities	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (360 × 181 × 36 grid points), 4 times/file 03, 09, 15, and 21 UTC; 6-hour average centered at the timestamp
Time-Averaged 3-Dimensional Wind Tendency Fields	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (360 × 181 × 36 grid points), 4 times/file 03, 09, 15, and 21 UTC; 6-hour average centered at the timestamp
Time-Averaged 3-Dimensional Moisture Tendency Fields	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (360 × 181 × 36 grid points), 4 times/file 03, 09, 15, and 21 UTC; 6-hour average centered at the timestamp
Total Column Ozone	4	Global	2.5° × 2.0° lon-lat grid (144 × 91 grid points), 8 times/file: 00, 03, 06, 09, 12, 15, 18, and 21 UTC; instantaneous data, valid at the timestamp
Instantaneous Near Surface and Vertically-Integrated State Variables	4	Global	1.25° × 1° lon-lat grid (360 × 181 grid points), 8 times/file: 00, 03, 06, 09, 12, 15, 18, and 21 UTC; instantaneous data, valid at the timestamp
Ozone Mixing Ratio	4	Global	2.5° × 2.0° lon-lat grid, 36 pressure levels in the vertical (144 × 91 × 36 grid points), 4 times/file: 00, 06,12, and 18 UTC; instantaneous data, valid at the timestamp
Instantaneous 3-Dimensional State Variables	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (288 × 181 × 36 grid points), 4 times/file: 00, 06,12, and 18 UTC; instantaneous data, valid at the timestamp
Time-Averaged 3-Dimensional Temperature-Tendency Fields	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (288 × 181 × 36 grid points), 4 times/file: 03, 09,15, and 21 UTC; 6-hour average centered at the timestamp
Time-Averaged 3-Dimensional Eddy-Diffusivity and Cloud Max Flux Fields	4	Global	1.25° × 1° lon-lat grid, 36 pressure levels in the vertical (288 × 181 × 36 grid points), 4 times/file: 03, 09,15, and 21 UTC; 6-hour average centered at the timestamp

Terra Data Products