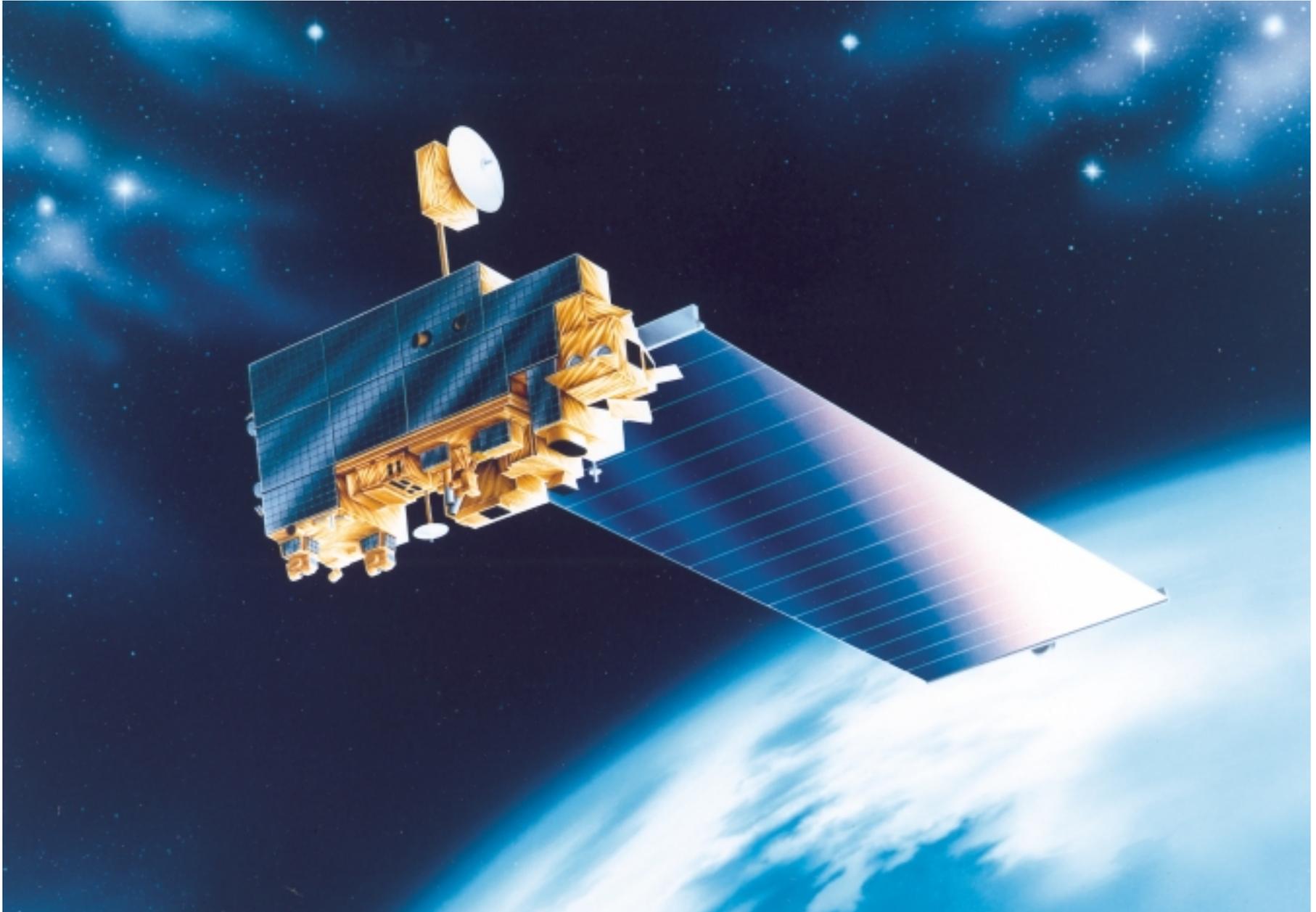




National Aeronautics and
Space Administration

Goddard Space Flight Center

Terra





Earth System Science

Beginning in the 1960s, NASA pioneered the study of the atmosphere from the unique perspective of space. These early efforts have matured to the point where it is now possible to study the Earth as a global system. Earth System Science is the integration of many scientific disciplines. The research seeks the understanding of the entire planet, its integral parts and how their interactions function. Through this research, scientists are beginning to better understand short-term weather phenomena that are connective in nature. Long-term weather forecasting is a challenge that needs more data collection, trend analysis, and a clearer understanding of the interactions between the Earth's physical and biological systems. Earth's climate has evolved in the past and continues to evolve today. These changes span a wide spectrum of space and time. More immediate effects of our changing climate can be seen in altered weather patterns—such as the effects of El Niño. Though we are just recently beginning to understand more about El Niño, our current lack of understanding of these changes diminishes our ability to respond—both before and after the event. NASA's Earth Observing System (EOS) will help us to understand how the Earth's complex systems of air, land, water and life are linked.

What is Terra?

NASA's commitment to studying the Earth as a global system continues with the Terra spacecraft (formerly known as the Earth Observing System AM-1) and represents a key contribution by NASA to the U.S. Global Change Research Program. Terra is the first of several EOS spacecraft and will observe the Earth's continents, oceans and atmosphere with five state-of-the-art instruments achieving measurement capability and accuracy never flown before. This comprehensive approach enables scientists to study the interactions among these three components of the Earth system, which determine the cycling of water and nutrients on Earth.

Terra will simultaneously study clouds, water vapor, small particles in the atmosphere called aerosols, trace gases, land surface and oceanic properties, as well as the interaction between them and their effect on the Earth's energy budget and climate. Moreover, Terra also will observe changes in the Earth's radiation energy budget, together with measurements of changes in land/ocean surface, and interactions with the atmosphere through exchanges of energy, carbon and water. Clearly comprehending these interactive processes is essential to understanding global climate change.

Mission Facts

A polar-orbiting spacecraft, Terra was launched on December 18, 1999 aboard an Atlas Centaur IAS expendable launch vehicle from Vandenberg Air Force Base, California. NASA's Kennedy Space Center, Florida, is responsible for launch operations and NASA's Glenn Research Center, Cleveland, is responsible for the Atlas launch vehicle under a contract with Lockheed Martin Astronautics, Denver.

Terra is orbiting the Earth in sync with the Sun, with its path over the ground descending across the equator at approximately 10:30 a.m. everyday—hence the original term "AM." A morning observation minimizes the time in which clouds obscure the land surface—optimizing observing time. Mornings over land typically have clear skies whereas the mornings over the oceans are more often cloudy. Terra is orbiting at an inclination of 98 degrees to the equator and at a mean altitude of 705 kilometers (380 nautical miles). Terra is followed by the Aqua (formerly "PM") spacecraft, launched on May 4, 2002. Aqua is flying in an ascending orbit with a 1:30 p.m. equatorial crossing time.

Terra is a joint project between the United States, Japan and Canada. The U.S. provided the spacecraft and three instruments—the Clouds and the Earth's Radiant Energy System (CERES), the Multi-Angle Imaging Spectroradiometer (MISR) and the Moderate Resolution Imaging Spectroradiometer (MODIS). The Japanese Ministry of International Trade and Industry provided the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The Canadian Space Agency/University of Toronto provided an instrument called the Measurements of Pollution In The Troposphere (MOPITT) instrument.

NASA's Goddard Space Flight Center, Greenbelt, Maryland, provided the spacecraft data interface system or "bus" and one instrument (MODIS). In addition, Goddard managed the integration and testing of the spacecraft, is operating the Terra via the Tracking and Data Relay Satellite System, and receives, processes, and disseminates science data through the Earth Observing System Data and Information System (EOSDIS). EOS is managed by Goddard for NASA's Earth Science Enterprise, Washington, D.C. MISR was provided by NASA's Jet Propulsion Laboratory, Pasadena, California, and the two CERES instruments were provided by NASA's Langley Research Center, Hampton, Virginia. Integration and test of the spacecraft was performed by Lockheed Martin under Goddard management.

The EOS series of spacecraft is the cornerstone of NASA's Earth Science Enterprise (<http://earth.nasa.gov>), a long-term research effort to study the Earth's land, oceans, air, ice and life as a total system.

For more information on EOS, access the EOS Project Science Office Homepage at: <http://eos.nasa.gov>.

For further information on Terra, access the Terra Project Homepage at: <http://terra.nasa.gov>.

FOR THE CLASSROOM GRADE LEVEL: 6-9

The purpose of this activity is to verify the statements: "A morning observation minimizes the time in which clouds obscure the land surface — optimizing observing time. Mornings over land typically have clear skies whereas mornings over the ocean are more often cloudy."

MATERIALS:

- 2 aluminum pie pans with clear plastic covers
- 2 goose neck desk lamps
- 2 - 100 watt light bulbs
- water (room temperature)
- moist soil to fill one pie pan

PROCEDURE:

1. Fill one pie pan to the top with water. (do not cover)
2. Fill the other pie pan to the top with moist soil. (do not cover)
3. Place the lamps at an equal distance from the pans.
4. Turn on the lamps for 3-5 minutes to heat the soil and water.
5. Turn off the lamps.
6. Hold a plastic cover about 10cm above each pie pan.
7. Observe and record which pie pan has more condensation on its cover.
8. Wipe the covers dry and wait 5 minutes. Repeat #6.
9. Observe and record which pie pan has more condensation on its cover.

QUESTIONS:

- Which pan created more condensation?
- Which pan represents more cloud formation?
- In step #8, is heat loss faster over land or water?
- Is observation over land more viable in the morning?

EXTENSIONS:

- Use dry soil or soil with vegetation.