

## Applied Physics Laboratory

### What is TIMED and its purpose?

TIMED is an acronym for Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics. The TIMED mission is studying the influences of the sun and humans on the least explored and understood region of Earth's atmosphere – the Mesosphere and Lower Thermosphere/Ionosphere (MLTI). TIMED is focusing on a portion of this region located approximately 40-110 miles (60-180 kilometers) above Earth's surface.

The science objective of the TIMED mission is to understand the MLTI region's basic pressure, temperature and wind that result from the transfer of energy into and out of this region. This mission is helping scientists gain a better understanding of the dynamics of this gateway region and its effects on communications, satellite tracking, spacecraft lifetimes, degradation of spacecraft materials and on spacecraft reentering Earth's atmosphere.

### What will TIMED accomplish that other spacecraft have not?

TIMED is the first mission to conduct a comprehensive global study of this region, including its basic structure and thermal balance, how the mesosphere is coupled to the thermosphere/ionosphere, how the MLTI region is coupled to space and the lower atmosphere below, and how energy is transported vertically and horizontally through this region. The TIMED mission is establishing a baseline against which future studies of changes within this region can be compared and analyzed.

### How does TIMED fit into NASA's overall science program?

The Sun-Earth Connection (SEC) is one of four principal science themes around which missions within NASA's Office of Space Science are organized. The Sun-Earth Connection focuses largely on explaining the physical processes that link the sun and the Earth. TIMED is the first mission within the Solar Terrestrial Probes Program, which falls under the SEC theme. It is investigating one of the Sun-Earth Connection's quests: How does the Earth's upper atmosphere respond to solar inputs?

The Solar Terrestrial Probes Program offers a continuous sequence of flexible, cost-capped missions designed to systematically study the Sun-Earth system. Solar Terrestrial Probes missions focus on studying the sun and the Earth as an integrated system using a blend of in situ and remote-sensing observations, often from multiple platforms.

### Where is the MLTI atmospheric region located, and why is it important to study this region?

The portion of the MLTI (Mesosphere and Lower Thermosphere/Ionosphere) region that TIMED is studying is located approximately 40-110 miles (60-180 kilometers) above Earth's surface. This region is where the sun's energy is first deposited into Earth's environment. The sun's energy can have profound effects on Earth's upper atmospheric regions, particularly during the peak of the sun's 11-year solar cycle when the greatest amounts of its energy are being released. TIMED is focused on understanding and characterizing exactly how the sun interacts with the Earth's environment. It will allow scientists to establish the first-ever baseline of the MLTI region against which future studies of changes within this region can be compared and analyzed.

### Why have studies of this region been limited?

A comprehensive global study of the entire MLTI region has never before been accomplished for several reasons. Ground-based instruments can only see a small portion of the upper atmosphere located over an observation site. It's too high for balloons to reach. Sounding rockets (rockets that fly into the upper atmosphere for just a few minutes before falling back down) can only provide a brief snapshot of the MLTI region's activity near the rocket.

### How will TIMED provide the first-ever global picture of the MLTI region?

The TIMED spacecraft is observing the MLTI region and its basic structure from the spacecraft's 388-mile (625-kilometer) circular orbit around the Earth. Employing advances in remote-sensing technology, the spacecraft's instrument suite is working with a worldwide network of ground-based observation sites to collect information necessary for scientists to test their current understanding of the processes that change the wind and composition in this part of the atmosphere, and determine how energy is absorbed, emitted and transported within the MLTI region.

### How many and what types of instruments are onboard the spacecraft?

TIMED's payload consists of four instruments. The Global Ultraviolet Imager (GUVI) is a spatial-scanning, far-ultraviolet spectrograph designed to globally measure the composition and temperature profiles of the MLTI region, as well as its auroral energy inputs. The Solar Extreme Ultraviolet Experiment (SEE) is comprised of a spectrometer and a suite of photometers designed to measure the solar soft X-rays, extreme-ultraviolet and far-ultraviolet radiation that is deposited into the MLTI region. The TIMED Doppler Interferometer (TIDI) is designed to globally measure the wind and temperature profiles of the MLTI region. And a multichannel radiometer known as SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) is designed to measure heat emitted by the atmosphere over a broad altitude and spectral range, as well as global temperature profiles and sources of atmospheric cooling.

## **Who has access to TIMED data and how is it distributed? How quickly is data made available?**

Data obtained during the TIMED mission is available to the public and accessible through TIMED's Web site (<http://www.timed.jhuapl.edu>).

TIMED's distributed data management approach enables rapid turnaround of data products available for distribution. Total turnaround time – from the spacecraft acquiring data to development of a final product and its distribution online – is within 54 hours. Traditionally, a mission could take up to several days or weeks to get similar products distributed.

## **When, and from where, was the spacecraft launched?**

The TIMED spacecraft was boosted into its 388-mile (625-kilometer) circular orbit around the Earth (inclined 74.1 degrees from the equator) aboard a Delta II 7920-10 launch vehicle from Vandenberg Air Force Base, Calif., on Dec. 7, 2001. The 1,294-pound (587-kilogram) spacecraft rode aboard a Delta II with the Jason-1 spacecraft — a joint project between NASA's Jet Propulsion Laboratory, in Pasadena, Calif., and the U.S. and French space agencies.

## **How long will the mission last?**

The TIMED spacecraft will collect data, while in orbit around the Earth, for two years. An additional two years of data analysis will be supported by TIMED's Mission Operations and Science Data centers, located at The Johns Hopkins University Applied Physics Laboratory in Laurel, Md.

## **What are the mission costs?**

The total cost for TIMED is approximately \$195 million for the spacecraft, its instrument payload and the launch vehicle. An additional \$42 million for ground operations, mission operations and data analysis will be expended during the mission's lifetime.

## **What are the key characteristics of the spacecraft?**

- Mass: 1,294 pounds (587 kilograms)
- Dimensions
  - 8.93 feet (2.72 meters ) high
  - 5.29 feet (1.61 meters) wide (launch configuration)
  - 38.5 feet (11.73 meters) wide (solar arrays deployed)
  - 3.93 feet (1.2 meters) deep
- Power Consumption: 406 watts per orbit
- Data Downlink: 4 megabits per second
- Memory: 5 gigabits
- Attitude
  - Control - Within 0.5 degrees
  - Knowledge - Within 0.03 degrees

## **Who is sponsoring and managing the mission? Who is operating the spacecraft?**

TIMED is sponsored by NASA Headquarters Office of Space Science, Washington, D.C., and managed by the NASA Goddard Space Flight Center's Solar Terrestrial Probes Program Office, Greenbelt, Md. The Johns Hopkins University Applied Physics Laboratory in Laurel, Md., designed, built and is operating the spacecraft and leading the project's science effort during its 2-year, on-orbit mission.

The instrument teams include:

### **GUVI:**

- The Aerospace Corporation, El Segundo, Calif.
- The Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
- University of Alaska's Geophysical Institute, Fairbanks, Ala.
- Southwest Research Institute, San Antonio, TX
- Naval Research Laboratory's E.O. Hulburt Center for Space Research, Washington, D.C.
- Computational Physics, Inc., Fairfax, Va.
- University of Colorado's Cooperative Institute for Research in Environmental Sciences, Boulder, Colo.

### **SABER:**

- Hampton University, Hampton, Va.
- NASA Langley Research Center, Hampton, Va.
- Utah State University, Logan, Utah
- G&A Technical Software Inc., Hampton, Va.
- National Center for Atmospheric Research, Boulder, Colo.
- National Oceanic and Atmospheric Administration's Aeronomy Laboratory, Boulder, Colo.
- Astrophysical Institute of Andalucia (IAA), Granada, Spain
- Air Force Research Laboratory, Hanscom Air Force Base, Mass.
- Naval Research Laboratory, Washington, D.C.
- Stewart Radiance Laboratory, Bedford, Mass.
- British Antarctic Survey, Cambridge, England

**SEE:**

- University of Colorado's Laboratory for Atmospheric and Space Physics, Boulder, Colo.
- High Altitude Observatory at the National Center for Atmospheric Research, Boulder, Colo.
- Hampton University, Hampton, Va.
- Naval Research Laboratory, Washington, D.C.
- Federal Data Corporation at the Jet Propulsion Laboratory, Pasadena, Calif.

**TIDI:**

- National Center for Atmospheric Research, Boulder, Colo.
- University of Michigan, Ann Arbor, Mich.
- National Oceanic and Atmospheric Administration's Space Environment Center, Boulder, Colo.
- Hovemere Limited, Kent, U.K.
- University of California, Berkeley, Calif.
- High Altitude Observatory at the National Center for Atmospheric Research, Boulder, Colo.
- CREES-York University, Toronto, Canada
- Institute of Atmospheric Physics at the Rostock University, Rostock, Germany