NASA Facts

National Aeronautics and
Space Administration

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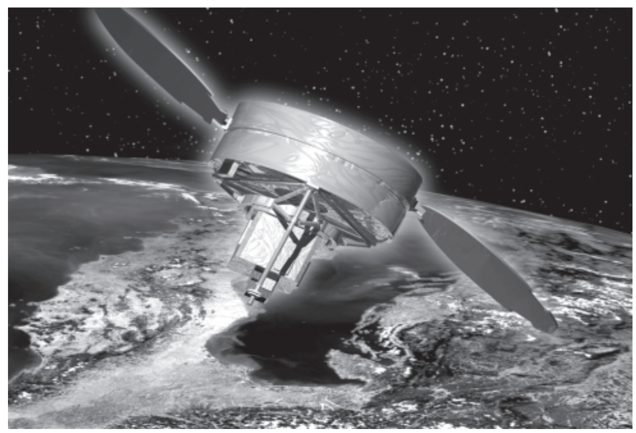
QuikTOMS
Quick Total Ozone Mapping Spectrometer

Introduction

The Total Ozone Mapping Spectrometer (TOMS) is the primary instrument for studying atmospheric ozone on a global scale. National Aeronautics and Space Administration (NASA) scientists use the TOMS instrument to continuously monitor changes of the Antarctic ozone hole, local ozone levels, and global ozone. TOMS also measures sulfur dioxide and ash from large volcanic eruptions, smoke from forest fires and from forest clearing in the tropical rain forests, and the flux of ultraviolet radiation reaching the Earth's surface. The U.S. Federal Aviation Administration (FAA) is using these measurements to prevent aircraft from flying through volcanic ash clouds.

In July 1999, NASA selected Orbital Sciences Corporation (Orbital) to build, launch and operate the Quick Total Ozone Mapping Spectrometer (QuikTOMS), so named since the QuikTOMS effort entailed the construction and launch of a spacecraft in less that two years as compared to traditional missions which take from three to five years. QuikTOMS was procured by NASA's Goddard Space Flight Center's (GSFC) Rapid Spacecraft Development Office (RSDO) and is managed by the GSFC QuikTOMS Project Office.



The QuikTOMS Spacecraft

Ozone Research

Ozone absorbs virtually all of the Sun's radiation in the biologically harmful ultraviolet (UV) wavelength range of 200-310 nanometers (nm). Ultraviolet radiation can cause sunburn and, more seriously, skin cancer, and cataracts. It also damages many other life forms. The decline in global ozone levels, and the discovery of the Antarctic ozone hole, has placed urgent emphasis on monitoring ozone change.

Ozone data must be collected over an extended time period in order to separate human-forced changes from natural atmospheric variations and to help quantify the individual roles of these factors. Maintaining global, carefully calibrated ozone measurements over decades is critical for verifying ozone depletion and the expected ozone recovery. These tasks are central challenges of stratospheric research today.

Atmospheric ozone is controlled by a combination of radiative, chemical and dynamical processes. Ozone plays an important role in these of processes, coupling them in a complex set of feedback mechanisms. Among the factors that affect ozone amounts are variations induced by: (1) atmospheric dynamics (stratospheric weather); (2) solar variations; (3) human produced gases such as chlorofluorocarbons (CFCs) and halons; and (4) volcanic eruptions.

Total Ozone Mapping Spectrometer and Data

TOMS is a second-generation, ozone-sounding instrument derived from the Backscatter Ultraviolet (BUV) Spectrometer flown aboard NASA's Nimbus-4 satellite in 1970. The first TOMS instrument was launched aboard Nimbus 7 in 1978. The Nimbus-7 TOMS operated almost continuously since its launch until its failure in 1993, providing more than 13 years of global, daily maps of total ozone. The Meteor-3 TOMS, ADEOS TOMS and the Earth Probe TOMS followed the Nimbus-7 TOMS. The current operational instrument, Earth Probe TOMS, is approaching its fifth year in orbit and QuikTOMS will replace this aging satellite.

The QuikTOMS instrument will continue these measurements of total ozone. These measurements will allow scientists to separate changes of global ozone caused by natural processes from trends due to CFCs, halons, and other trace gases. For example, theory predicts that long-term variations of the UV output of the Sun will affect total ozone. However, identifying these variations requires data extending over periods longer than a decade. With this information, scientists can begin to predict how human activity affects the environment.

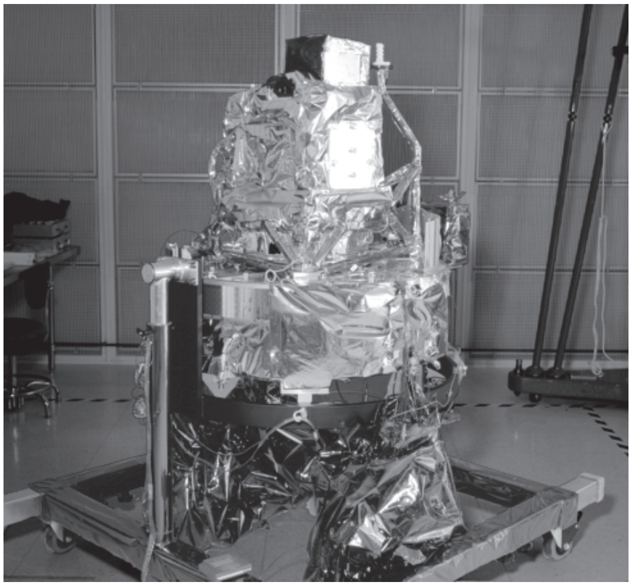
Another important use of TOMS data will be to study changes of biologically active UV radiation that accompanies the decrease of global ozone. The TOMS measurements are used to determine the flux of ultraviolet sunlight at each point on the Earth's surface at wavelengths that affect both plants and animals. TOMS provides the information necessary for estimating biologically active UV radiation at the Earth's surface as a function of location and time of year.

Although the TOMS data will be used primarily to study ozone, the information gained from TOMS will also contribute to volcanic studies. Volcanoes generate sulfur dioxide (SO2) in the Earth's atmosphere and TOMS can map this gas. This gas is rapidly transformed into sulfate aerosols, which may persist in the stratosphere for months to years. Its effects in the stratosphere include the red sunsets that follow major volcanic eruptions, and these effects may be associated with climate change. TOMS data on volcanic eruptions will make valuable contributions to studies in several disciplines, including volcanology, meteorology and atmospheric chemistry.

The TOMS data has many other applications. The total ozone pattern measured by TOMS can be used in studies of severe storms to infer the circulation patterns of the jet stream that strongly affect our weather. TOMS ozone data can also be used for comparison with ground stations, atmospheric correction of ocean color measurements of pigment concentrations, studies of the UV reflectivity of Earth's surface, and development of cloud climatology.

Program History

The first TOMS instrument was launched in October 1978 as part of the package of the Solar Backscattered Ultraviolet and Total Ozone Mapping Spectrometer (SBUV/TOMS) on Nimbus-7, and operated until May 1993. The engineering model of Nimbus-7 TOMS was refur-



The QuikTOMS Spacecraft during thermal vacuum test preparations at Orbital's Environmental Test Facility in Germantown, Maryland.

bished and flown aboard Meteor-3 in August 1991. Meteor-3/TOMS provided critical scientific data until December 1994.

A new series of TOMS instruments was developed to monitor the long-term trend of global total ozone and to continue the study of ozone loss and the Antarctic ozone hole. The first of these, Earth Probe TOMS, was launched aboard Earth Probe (EP) in July 1996, and is still operating. A TOMS instrument was also launched aboard the Japanese ADEOS satellite, in August 1996: and operated until June 1997 when the satellite's solar array failed.

On June 17, 1992, the United States and the Russian Federation signed an agreement concerning cooperation in the exploration and use of outer space for peaceful purposes. In December 1994, NASA and the Russian Space Agency (RSA) signed an agreement to fly a TOMS aboard a Russian Meteor-3M spacecraft. However, because of delays, NASA and RSA agreed to halt cooperation on the mission. In order to meet the critical science window, the primary science objectives of NASA, and the environmental information needs of the international community, QuikTOMS was conceived.

Science Objectives

The primary science objective of NASA's TOMS mission is to continue the ongoing measurements of the Earth's atmospheric ozone begun with Nimbus 7 in 1978 and currently being measured by the NASA Earth Probe (EP)/TOMS mission.

Secondary mission objectives are to: measure ultraviolet absorbing tropospheric aerosols; detect and measure non-absorbing aerosol pollution plumes; estimate surface ultraviolet irradiance and reflectivity; and detect and measure volcanic emissions to assist the U.S. Federal Aviation Administration (FAA).

QuikTOMS Management

NASA Headquarter's Office of Earth Science (OES) manages the overall Earth Explorer and TOMS programs. The Earth Explorers Program Office is responsible for the management of all Earth Explorers Projects assigned to Goddard, which includes the QuikTOMS Project. The QuikTOMS Project Office is responsible for the management of the QuikTOMS mission through definition, development, integration and test, launch and on-orbit checkout.

The TOMS program is managed by NASA's Goddard Space Flight Center, Greenbelt, and is part of NASA's Earth Science Enterprise, a coordinated research effort to study the Earth as a global environmental system.

Mission Operations

QuikTOMS is a free-flying spacecraft with its own orbit adjust subsystem. It will be launched into an intermediate parking orbit, from which it will be raised by a series of orbit-adjust burns, to its operational Sun-synchronous orbit of 500 miles (800km). As soon as the spacecraft separates from the launch vehicle, a preprogrammed sequence of commands will be initiated to deploy the solar arrays and transition the spacecraft to safe mode.

Ground coverage for communications and tracking for the on-orbit phase of the mission will be provided by the Universal Space Network. The NASA Earth Observing System Polar Ground Network will be used for the launch, checkout and orbit raising phases of the mission.

Flight Dynamics and the NASA Integrated Services Network are supplied by the Space Operations Management Organization to support QuikTOMS. They support the launch and on-orbit checkout phase. Orbital Sciences Corporation provides the Mission Control Center, which is located in Dulles, Virginia, and is responsible for the Flight Operations Team that provides spacecraft operations (telemetry, command, and control. The TOMS Science Operations Center, located at the Goddard Space Flight Center in Greenbelt, Md., generates instrument operations plans. The flight operations team integrates instrument plans into the spacecraft operations, captures science data from the mission control center and forwards them to the science center for data processing and generation of data products.

Launch

The QuikTOMS mission will be launched from Vandenberg Air Force Base, Calif., on a commercial Taurus launch vehicle. QuikTOMS is a secondary payload to be flown with the OrbView-4 spacecraft, which is the primary payload. The QuikTOMS secondary payload services are obtained by NASA Kennedy Space Center, Fla., via a contract with the Orbital Launch Services Group. The launch vehicle will fly in an injection orbit of 292 miles (470-km) circular, 97.3° inclination, and at a 10:30 a.m. equator crossing (descending node). Orbital Space Systems Group will provide the spacecraft, which is a Microstar bus, adapted for the TOMS-5 instrument. The TOMS instrument, integrated with the spacecraft, is designated the QuikTOMS observatory.

The mission orbit will be a sun-synchronous, 500 miles (800 km) circular orbit, with a 10:30 a.m. Equator crossing. The spacecraft is designed for a 3-year minimum on-orbit mission lifetime, with sufficient consumables to support a 5-year mission.

The Future

To ensure that ozone data will be available throughout the next decade, NASA will fly an advanced ozone imaging instrument built by the Dutch called Ozone Monitoring Instrument on the Earth Observing System AURA spacecraft, scheduled for launch in 2003.

QuikTOMS satellite data, complemented by aircraft and ground data, provide a better understanding of natural environmental changes to distinguish natural changes from human induced changes. This data, which NASA freely distributes, is essential to humans making informed decisions about their environment.

More information on the QuikTOMS program is available on the QuikTOMS web site at: http://quiktoms.gsfc.nasa.gov

More information and full global maps are available on the TOMS web site at http://toms.gsfc.nasa.gov