NASA Facts

National Aeronautics and
Space Administration

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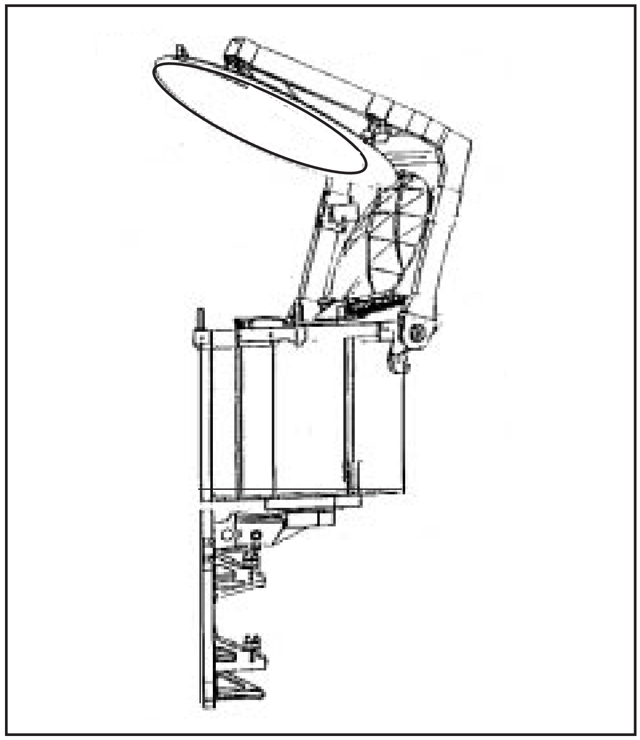
AC 301 286-8955

FS-1997(10)-023-GSFC

Tropical Rainfall Measuring Mission's TRMM Microwave Imager

The Tropical Rainfall Measuring Mission's (TRMM) Microwave Imager (TMI) is a passive microwave sensor designed to provide quantitative rainfall information over a wide swath under the TRMM satellite. By carefully measuring the minute amounts of microwave energy emitted by the Earth and its atmosphere, TMI will be able to quantify the water vapor, the cloud water, and the rainfall intensity in the atmosphere. It is a relatively small instrument that consumes little power. This, combined with the wide swath and the good, quantitative information regarding rainfall make TMI the "workhorse" of the rain-measuring package on Tropical Rainfall Measuring Mission.



TMI instrument with antenna deployed

Improving on History

TMI is not a new instrument. It is based on the design of the highly successful Special Sensor Microwave/Imager (SSM/I) which has been flying continuously on Defense Meteorological Satellites since 1987.

The TMI measures the intensity of radiation at five separate frequencies: 10.7, 19.4, 21.3, 37, 85.5 GHz. These frequencies are similar to those of the SSM/I, except that TMI has the additional 10.7 GHz channel designed to provide a more-linear response for the high rainfall rates common in tropical rainfall. The other main improvement that is expected from TMI is due to the improved ground resolution. This improvement, however, is not the result of any instrument improvements, but rather a function of the lower altitude of TRMM

218 miles (350 kilometers) compared to 537 miles (860 kilometers) of SSM/I). TMI has a 487 mile (780-kilometer) wide swath on the surface.

The higher resolution of TMI on TRMM, as well as the additional 10.7 GHz frequency, will make TMI a better instrument than its predecessors. The additional information supplied by the Precipitation Radar will further help to improve algorithms. The improved rainfall products over a wide swath will serve both TRMM as well as the continuing measurements being made by the SSM/I and future radiometers scheduled to fly on the NASA's EOS-PM and the Japanese ADEOS-II satellites.

Measuring Rainfall with Microwaves

Calculating rainfall rates from TMI requires some fairly complicated calculations. The basis of these calculations is in Planck's radiation law, which describes how much energy a body radiates given its temperature. Water surfaces such as oceans and lakes have an additional property which is very important. The surfaces emit only about one half the microwave energy specified by Planck's law and therefore appear to have only about half the real temperature of the surface. Water surfaces therefore look very "cold" to a passive microwave radiometer. Raindrops on the other hand, appear to have a temperature that equal their real temperature. They appear warm to a passive microwave radiometer and therefore offer a contrast against "cold" water surfaces. The more raindrops, the warmer the whole scene appears, and research over the last three decades now make it possible to obtain fairly accurate rainfall rates based on the temperature of the microwave scene.

Land is very different from oceans in terms of the emitted microwave radiation, appearing to have about 90 percent of its real temperature. In this case, there is little contrast to observe the "warm" raindrops. Certain properties of rainfall, however, still can be inferred. The high frequency microwaves (85.5 GHz) measured by TMI are strongly scattered by ice present in many raining clouds. This reduces the microwave signal at the satellite and offers a contrast against the warm land background.

TRMM is NASA's first mission dedicated to observing and understanding the tropical rainfall and how this rainfall affects the global climate. It is a joint mission with the National Space Development Agency of Japan. The primary instruments for measuring precipitation are the Precipitation Radar, the TMI, and the Visible and Infrared Scanner. Additionally, TRMM will carry the Lightning Imaging Sensor and the Clouds and the Earth's Radiant Energy System Instrument. These instruments can all function individually or in combination with one another.

TRMM is part of NASA's Mission to Planet Earth, a long-term, coordinated research effort to study the Earth as a global system.

More information on TMI is available via the Internet at:

http://trmm.gsfc.nasa.gov