NASA Facts

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Tropical Rainfall Measuring Mission

Improving the Accuracy of Estimating Climate Change

Scientists often design controlled experiments in a laboratory when they want to better understand a process. Atmospheric scientists have quite a challenge designing these types of experiments as it is very difficult to simulate real processes that control weather and climate in a laboratory.

One solution to this problem is to develop atmospheric models of weather and climate systems. These models are sets of mathematical equations representing the relationships that govern what is happening in the atmospheric system. The complexity of these weather/climatic models require the use of advanced supercomputer technology. Sophisticated weather/climate models in use today combine characteristics of the land, sea, and air. These so-called "coupled models" are useful to the scientist trying to understand climate processes. It is this type of model that benefits greatly from NASA's new Tropical Rainfall Measuring Mission (TRMM).

Climate is the average weather for a given location over a years-long period of time. It is known that three-fourths of weather-producing energy comes from the heat exchanges involved in rainfall processes. It is also known that the majority of the world's rain falls in the tropical regions of the Earth. This means that modeling weather and climate processes should include proper understanding of the processes that produce tropical rainfall. The vastness of the tropics makes it difficult to thoroughly study tropical rainfall from the ground. Furthermore, a great majority of the tropics is ocean. A space-based perspective from TRMM gives scientists the thoroughness needed for global modeling efforts.

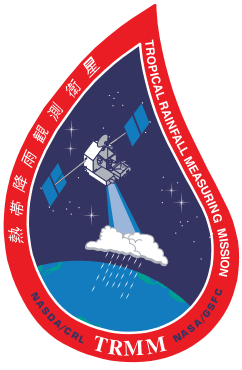
TRMM will carry a suite of instruments to measure rainfall. This "flying rain gauge" will carry microwave instruments that measure radiation emitted from water substances or scattered from ice in clouds. These signals can be converted to rainfall amounts. A precipitation radar similar in principle to the radars used by evening weathercasters or airport control towers will be flown in space for the first time. It will provide information on how much rain is falling at each level in the atmosphere. TRMM provides better coverage than ground-based efforts in terms of when and where it is raining in the tropics, as well as the variation of rainfall by height.

How will TRMM improve climate modeling efforts? In order for a model to produce a forecast or prediction of a future atmospheric state, it needs data on what is happening now. This data has traditionally come from measure-

ments taken from weather balloons, surface weather stations, and satellites. The basic initial data for most models diagnose temperature, moisture, pressure, and the wind flow. For a cake recipe, if the measurements are correct and the ingredients are fresh, there is a good chance the cake will taste great. This is also true of model output. The model will perform even better if it is constantly receiving updates on what the atmospheric/climate state is like. In other words, the model will perform much better if it is given not just a "snapshot" of what is occurring at the initial time, but what is continuing to occur in the continuously changing weather/climate system.

TRMM offers scientists improved input data for climate models as well as validation data for model output. TRMM's ability to resolve the space and time characteristics of a tropical rainfall system is critical to proper depiction of the "what is happening now" requirement of the model's initial conditions. TRMM's ability to measure rainfall variations with height provides information on evaporation and condensation processes. It is these processes that serve as the "fuel supply" for the rainfall system itself and the global weather "energy supply." By improving the resolution of energy sources in the tropics, understanding of pressure and wind patterns that govern global weather and climate will also improve (ultimately resulting in improved climate change predictions). TRMM rainfall estimates will also serve as validation for model-produced rainfall amounts. This is critical since a model may predict drought or flood conditions in an isolated region. This prediction means nothing if it is not substantiated or refuted with observations—observations that TRMM will provide.

Visit the TRMM Homepage at
http://trmm.gsfc.nasa.gov



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