NASA Facts

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

AC 301 286-8955

FS-1998-05-010-GSFC

Tropical Rainfall Measuring Mission

Why We Study Tropical Rainfall

Anyone who has wilted outside on a steamy, hot summer day knows the Sun's power to generate heat and energy. Its intensity might even lead some to believe that it provides all of the power needed to influence Earth's weather and climate. It doesn't—at least not directly.

Earth's climate is affected in part by complex interactions between the Sun and the planet's vast expanse of ocean waters. Understanding their dynamics, and the subsequent formation of water vapor, clouds, rainfall and the release of "latent heat" high into the atmosphere, which then affects global atmospheric circulation, are central to understanding the climate system. For this reason, Earth scientists study ocean storms and measure rainfall.

NASA's Tropical Rainfall Measuring Mission (TRMM) is a link in that understanding. Meteorologists have studied rainfall patterns over the land for more than 20 years using ground-based radar, special aircraft instruments and weather ground stations. Now, for the first time with TRMM, they are able to make extremely precise measurements of rainfall over the ocean, where conventional ground-based instruments cannot see.

This is especially important because two-thirds of the world's global rain falls in tropical areas, and three-fourths of weather-producing energy comes from the heat exchanges involved in the rainfall process. Until now, information on the intensity and amount of rainfall over much of the tropics was incomplete.

For scientists, the research isn't a matter of mere academic interest. Understanding rainfall and its variability is crucial to understanding and predicting global climate change. Is our planet getting warmer due to increased levels of carbon dioxide and other greenhouse gases in the atmosphere? Is the threat real? Computer models that predict the future climate still differ in some very substantial ways, with some models predicting little or no warming, while others predict temperature increases that would substantially alter our way of life. With more data and a better understanding of the current climate system—driven by the complex interplay of water vapor, clouds, rainfall and the release of energy after it rains—scientists are hopeful that they will be able to definitively say. In fact, the U.S. Global Change Research Program classifies understanding the role of clouds and the Earth's energy budget as its highest priority.

The Climate Machine

It all begins with the Sun. One-fourth of Earth's energy comes directly from the Sun. The other three-fourths are transferred to the atmosphere when warm tropical ocean waters, which the Sun originally heated, evaporate to form huge equatorial cloud clusters that form a belt along the equator as evidenced by satellite photos.

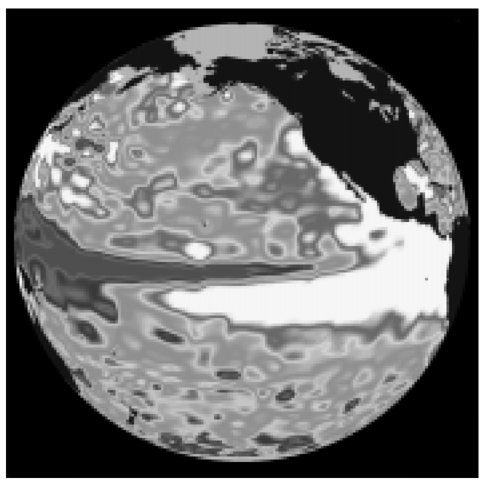
Upon cooling, the vapor condenses into clouds and forms raindrops. When rain falls, the heat originally used to evaporate the water from the Earth's surface is released high into the atmosphere and flows to both poles. Although the latent heat can't be seen or measured directly, rainfall, which is the product of the release, can be measured.

The latent heat then affects Earth's atmospheric circulation and contributes to the weather patterns observed around the globe. Averaged over the entire Earth, the heating released by precipitation is about five times greater than that produced by variations in surface heating. In other words, tropical rainfall—working in conjunction with the Sun—drives Earth's climate machine.

As of late 1997, measurements of the global distribution of rainfall at the Earth's surface had uncertainties of about 50 percent. Unless scientists can better define the amount of rainfall and the energy released when rain occurs, they stand little chance of putting the climate models through the rigorous tests needed to determine whether in fact carbon dioxide and other greenhouse gases in the atmosphere are warming up the planet.

El Niño: How Warm Ocean Waters Affect Global Weather

Throughout 1997-1998, television weathercasters devoted at least a few minutes each day to El Niño, and the latest onslaught of drenching rains that led to mud slides in California, fish die-offs off the coast of Peru and the early onset of allergy season for people sensitive to tree and grass pollen and molds. They had much to talk about. It was one of the stronger El Niño events on record.



The warm water pool (white area) as seen from the TOPEX/Poseidon satellite on November 10, 1997

El Niño-related weather, in addition to making vivid television footage during evening broadcasts, illustrates how tropical oceans can affect weather patterns around the globe and shows how scientists can predict climate change months in advance.

With help from NASA's Tropical Rainfall Measuring Mission (TRMM), those forecasts are expected to improve. Designed to act as an orbiting rain gauge to measure rainfall amounts, TRMM has gathered buckets full of precise data on increased rainfall amounts related to the 1997-1998 El Niño event. The rainfall data is vital to researchers. Each time it rains, energy is released high into the atmosphere. The amount and direction of this energy determines, among other things, the change from non El Niño to El Niño conditions.

The phenomenon, which means "Christ Child" because of its onset in late December, affects short-term climate variability. During an El Niño event, drier-than-normal weather is experienced in Indonesia and Australia, heavier-than-normal rainfall in South America, and warmer-than-normal winters in the northwestern region of the United States and excessive rainfall in the Gulf Coast states.

These weather changes happen because a large mass of warm ocean water usually confined to the western Pacific moves eastward. As the warm water evaporates, towering cumulus clouds form, getting their fuel from the warm ocean waters below. Once the moisture-laden air is saturated and the vapor that it contains condenses, rain is produced. Earth's atmospheric circulation, affected by the release of latent heat, carries these moisture-heavy clouds to land, where the climatic effects, as evidenced by the last few months, can be disastrous.