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Tropical Rainfall Measuring Mission

Heat Transport and Global Atmospheric Circulation

The U.S. - Japanese Tropical Rainfall Measuring Mission (TRMM) is a spaceborne remote sensing spacecraft that is expected to provide significant insights into the nature of the heat engine that drives our atmospheric circulation. For the first time, a satellite will be capable of not only characterizing the rain that hits the ground, but also telling us what happens to the rain on its journey from the cloud to the ground. We know that at certain altitudes, rain drops form through the condensation of water vapor dust, and sometimes these raindrops evaporate. Whenever condensation takes place, latent (meaning stored) heat is released into the atmosphere, and conversely whenever evaporation takes place, latent heat is removed from the atmosphere. A simple example of the latent heat released due to condensation can be seen on a cold can of soda on a hot summer day. The drops of water appear on the can because the thin layer of air surrounding the can is being cooled such that all the water vapor in this layer is condensed out. Latent heat is given off since the water has gone from a more “active” molecular state to a less active state (vapor to liquid). A simple example of the latent heat removed due to evaporation can be illustrated each time you get out of the shower. You feel cool because the water on your skin is evapo rating, causing the thin layer of air just about the surface of your skin to cool (since latent heat is being removed).

Using TRMM, scientists will be able to measure the latent heat associated with condensation and evaporation processes on a global scale. Vertical patterns of latent heat will be measured from heights of 50,000 ft down to the surface of the Earth, the height equivalent of 2.5 Mt. Everest’s or 51 Empire State Buildings! If scientists can acquire quantitative data about the vertical patterns of latent heating, they can apply this information to climate models to calculate the effects of heating on the global circulation of the atmosphere. Most of the heat that enters the atmosphere in this fashion is supplied by events taking place in Earth’s tropics and subtropics, the regions to be covered by the orbit of the TRMM observatory.

The first “big picture” view of atmospheric circulation was proposed by George Hadley in 1736. Hadley’s basic concept was that warm air rises in the vicinity of the equator, where the most heating from the sun occurs, and then moves away from the Earth’s surface in both hemispheres. The air then returns to the surface at about 30 degrees latitude, and returns to the equatorial region via winds near the surface called Trade Winds. This gave us the picture of two "Hadley" cells, one in each hemisphere.

Another "big picture" view of atmospheric circulation is attributed to Sir Gilbert Walker, who discovered the southern oscillation in 1924. Walker found a seesaw variation in surface air pressure between the eastern and western tropical Pacific. This variation in surface pressure causes the easterly trade winds to slow down when the pressure is higher to the west or lower to the east. Consequently, conditions for the onset of the El Niño phenomenon are put into place. Because of the apparent connection between El Niño and the southern oscillation, scientists often refer to this phenomena as an ENSO event.

The pictures of atmospheric circulation supplied by Hadley and Walker are certainly good starting points for understanding global circulation patterns. But, in actuality, the atmosphere is far more complicated than is suggested by those idealizations. Hence, observations from the new orbiting observatory, TRMM, are expected to take atmospheric scientists to the next step on their journey to unraveling these mysteries. Scientists are not content to stay with such a simplified view of the atmosphere, which would give us little insight to changes that may be forthcoming. If quantitative predictions of disruptions in the basic patterns of weather and climate are desired, not only for El Niños but also, for example, hurricane tracking and frequency, then we must seek the added information that a mission such as TRMM will supply.

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