Net Surface Flux Budget Over Tropical Oceans Estimated From the Tropical Rainfall Measuring Mission (TRMM)

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Abstract

Energy exchanges between the atmosphere and oceans involve several complicated processes: shortwave (SW) and longwave (LW) radiative processes, sea surface turbulent latent heat and sensible heat transports, and raid induced sensible heat fluxes. This study investigates these flux components over tropical oceans (30°N to 30°S) using data collected from the Tropical Rainfall Measuring Mission (TRMM) which is equipped with five sensors: Visible and Infrared Scanner (VIRS), Clouds and Earth's Radiant Energy System (CERES), TRMM Microwave Imager (TMI), Precipitation Radar (PR), and Lighting Imaging Sensor (LIS). The data from VIRS, CERES, and TMI instruments are used in this study. The LW and SW net fluxes are estimated by the CERES project with and accuracy of ~2 and ~3W/m^2 at the top of atmosphere and ~8 and ~15W/m^2 at sea surfaces, respectively.

The turbulent latent and sensible heat fluxes from oceans to the atmosphere are calculated from TMI retrievals of near sea surface wind speeds, air humidity, and temperature using bulk formulae derived from Tropical Ocean Global Atmosphere (TOGA) Coupled Ocean-Atmosphere Response Experiment (COARE). The latent and sensible heat fluxes have been compared to those of the Goddard Satellite-bases Surface Turbulent Fluxes version 2 (GSSTF-2) product derived from Special Sensor Microwave/Image (SSM/I) data collected by Defense Meteorological Satellite Program (DMSP) satellites. The results show that the monthly average differences for the whole tropical oceans range from –7 to 2W/m^2 and –6 to -8W/m^2 for latent heat and sensible heat for the first eight months of 1998. The sensible heat fluxes from TMI are lower than those from GSSTF-2 across all compared latitudes, which may be due to a positive bias of 7W/m^2 in the GSSTF-2. The TRMM satellite derived turbulent fluxes are about 1.9W/m^2 and 1.64W/m^2 lower for latent heat and sensible heat fluxes when comparing with in-situ ship measurements. Rain droplets are the condensation of vapor into water or ice at the upper troposphere. They are usually cooler than sea surface temperature, therefore have cooling effects on the surface. The rain induced sensible heat fluxes are estimated from the TMI rainfall Profiling data.

Combining all these fluxes, the zonal average Net Surface Fluxes (NSF) from oceans to the atmosphere varies from –100 to 100W/m^2 over tropical oceans. From the equator toward 30° the NSF stays at approximate 100W/m^2 in the summer hemisphere and gradually drops from 100 to –100W/m^2 in the winter hemisphere. The positive tropical total NSF is generally balanced by ocean heat storage in term of mixing layer temperature change, the loss of fluxes in higher latitudes, and oceanic vertical heat transports.