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Impact of SST and water vapor on cloud properties of warm rain systems

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Many climate models suggest that an enhanced hydrologic cycle will result from projected temperature increases. How the hydrologic cycle will respond has been the subject of many studies, most of them focusing on changes to deep convection and their cirrus production. However, our research, along with other recent studies, suggests that warm rainfall systems may show an appreciable response to surface temperature increases. Warm rain systems are prevalent throughout the Tropics and are an important element of the tropical hydrologic cycle and radiation balance. Recent studies suggest that precipitation efficiency in these clouds increases with increasing sea surface temperature (SST). These warm rainfall systems contribute not only to the total tropical rainfall and the radiation budget, but also serve to moisten and precondition the environment for deep convection. A change in these systems could have important implications for the hydrologic cycle in climate change scenarios.

Tropical Rainfall Measuring Mission (TRMM) satellite measurements are used in conjunction with the Atmospheric Infrared Sounder (AIRS) to investigate the relationship between clouds, precipitation, water vapor and the underlying SST. TRMM Visible and Infrared Scanner (VIRS) and TRMM Microwave Imager (TMI) measurements are combined to retrieve the shortwave effective radius, which gives information about the size of the particles at the top of the cloud, and microwave effective radius, which provides a column-average estimate of cloud drop size. In a precipitating warm cloud, the microwave effective radius is expected to be larger than shortwave effective radius since the larger precipitation-sized drops at the base of the cloud will dominate the microwave retrieval. In an enhanced precipitation efficiency scenario, we expect the microwave effective radius to grow with increasing SST since the larger particles would precipitate more efficiently than smaller droplets. Cloud effective radii have been analyzed with TMI-derived SST and AIRS water vapor retrievals to investigate the role of SST and water vapor in cloud top and column-averaged effective radius to determine if a dependency exists. This study provides further information on the link between SST, water vapor and warm rain clouds.