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Space-borne measurements of cloud optical thickness and drop size in rain formation process

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The cloud feedback problem is one of the largest uncertainties in climate studies because cloud formation and dissipation are complicated processes. Clouds have mutual relations to aerosols and precipitation. Increases in aerosol concentrations result in a decreased drop size and modify the cloud radiative forcing. Decreased drop size may also suppress precipitation, which also influences the cloud radiative forcing because cloud amount is controlled by precipitation significantly. A study on clouds-precipitation interaction is, therefore, critical to improve our understanding of the cloud feedback problem. Despite extensive studies on cloud-precipitation interactions, our understanding is very limited because of their complex nature.

We examined how cloud optical thickness relates to precipitation by a combined use of the Precipitation Radar and the Visible and Infrared Scanner (VIRS) onboard the Tropical Rainfall Measuring Mission. Although there are considerable scatters between cloud optical thickness and rain rate, cloud optical thickness was found to increases with rain rate on average. The tendency to increase was mostly due to increases in liquid water path and depended on rain rate. For fixed values of liquid water path, there were no significant dependences of cloud optical thickness on rain rate for strong rain. Whereas, cloud optical thickness was found to decrease with rain rate for weak rain. In particular, significant differences of optical thickness were found between non-precipitating clouds and precipitating clouds: smaller cloud optical thickness was observed for precipitating clouds.Detailed analysis shows that dispersion of cloud drop size was found in the rain formation process, which may relate to broadening in the shape of drop size spectra. The broadened size distribution leads to the decreases in the cloud optical thickness for precipitating clouds This study related to the changes in cloud optical thickness associated with rain formation process can improve our understanding of cloud feedback problem in climate.