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Characteristics of Tropical Cloud Regimes and Their Associated Radiative Effects from CloudSat/CALIPSO Satellite Products

Abstract

By utilizing comprehensive cloud information provided by CloudSat/CALIPSO satellite products, this study aims to investigate large-scale variability of various cloud types and analyze their impacts on climatological energy budget, based on 10 years of active observations from 2007 to 2016.

Through the cloud classification products, the three-dimensional relative frequency reveals that most cloud types follow the migration of Intertropical Convergence Zones (ITCZs), except for stratocumulus clouds, which are confined to region characterized by large-scale subsidence, such as cold pool and subtropical area. Additionally, cloud features such as diurnal cycles and seasonal variations are examined. For the diunal cycles, most cloud types are prevalent at daytime, while cirrus occurs more frequently at night, and cumulonimbus clouds exhibit strong regional dependence. In terms of seasonal variation, most cloud types align with the expansion of ITCZ, whereas stratocumulus clouds display opposite patterns.

Regarding the flux and heating rate dataset, which show good agreement with collocated observations from the Cloud and Earth's Radiant Energy System (CERES), atmospheric cloud radiative effects (ACRE) for distinct cloud types are derived and their coupled relations to occurrence frequency are also identified using singular value decomposition (SVD) method. Low clouds are found to induce cooling within cold pool region, while high clouds contribute to heating within ITCZs. Finally, supplementary information from the CERES products is incorporated to extend the analysis to longer time scales.

Keywords

Cloud Radiative Effects (CRE)

CloudSat/CALIPSO