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New Metrics to Quantify Spatial and Temporal Characteristics of Precipitation Using 20-years TRMM-GPM Data for Evaluating Climate Models

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Precipitation is a highly complex, multiscale entity in the global weather and climate system. It is affected by both global and local circulations over a wide range of time scales from hours to weeks and beyond. It is also an important measure of the water and energy cycle in climate models. To better understand the physical processes controlling precipitation in climate models, we need to evaluate precipitation not only in terms of its global climatological distribution but also multiscale variability in time and space.

This study presents a new set of metrics to quantify characteristics of global precipitation using 20-years the TRMM-GPM Multisatellite Precipitation Analysis (TMPA) data from June 1998 to May 2018 over the global tropics-midlatitudes (50°S – 50°N) with 3-hourly and 0.25-degree resolutions. We developed a method to identify large-scale precipitation objects (LPOs) using a temporal-spatial filter and then track the LPOs in time, namely the Large-scale Precipitation Tracking systems (LPTs) as described in Kerns and Chen (2016, 2020, JGR-Atmos). The most unique feature of this method is that it can distinguish large-scale precipitation organized by, for example, monsoons and the Madden-Julian Oscillation (MJO), from that of mesoscale and synoptic scale weather systems, as well as those relatively stationary local topographically and diurnally forced precipitation. The new precipitation metrics based on the satellite observation are used to evaluate climate models. Early results show that most models overproduce precipitation over land in non-LPTs and underestimate large-scale precipitation (LPTs) over the oceans compared with the observations. For example, the MJO contributes up to 40-50% of the observed annual precipitation over the Indo-Pacific warm pool region, which are usually much less in the models because of models' inability to represent the MJO dynamics. Furthermore, the spatial variability of precipitation associated with ENSO is more pronounced in the observations than models.