Inter-annual Variations of Tropical Ocean Rainfall—Differences Among Satellite Estimates

Robert Adler, Guojun Gu, Jian-Jian Wang

Accurate estimates of inter-annual variations of tropical ocean rainfall are important to understand phenomena such as the ENSO (El Nino/Southern Oscillation) and relations between temperature variations and rainfall, and for comparison with global models, both reanalyses and climate models. Because much of global precipitation is concentrated over tropical oceans, rainfall variations there on an inter-annual time scale are significant and are related primarily to the El Nino-Southern Oscillation (ENSO) phenomenon and its accompanying SST variations. Understanding the rainfall variations and their relation to the SST variations is important to understand the underlying processes and how well models simulate these variations. From an observational standpoint we are dependent on satellite-based estimates over the open ocean due to the lack of accurate surface-based estimates.

The TRMM/GPM era (1998-2020) is examined in terms of inter-annual patterns and total mean amplitude of tropical ocean rainfall (25N-25S) using a number of well-known precipitation products from TRMM and GPM (both radar and passive microwave-based) and estimates made using passive microwave algorithms applied to SSMI/SSMIS. Also included in the comparison are the blended estimates of V2 and V3 of GPCP (Global Precipitation Climatology Project).

Comparison of these routinely used microwave-based estimates, with different instruments and/or different algorithms, show significant differences among them. The objective here is to examine these differences and provide direction toward the best estimate of the magnitude and evolution of these variations.

Although the patterns of the ENSO rainfall variations are usually similar among the estimates, characteristics related to the amplitudes vary among the estimates:

1) The TRMM/GPM radar-based inter-annual amplitudes are smaller with different evolutions than the PMW (GPROF) estimates from the same satellites;
2) Different PMW algorithms produce different amplitudes, even applied to same instrument (SSMI/SSMIS). Examples here are GPROF (larger) and METH (smaller, used in GPCP).
3) GPROF applied to different instruments provides different amplitudes. GPROF (SSMI/SSMIS) has larger amplitude than GPROF (TMI/GMI), the latter agreeing better with METH (and GPCP).
4) IMERG variations are irregular due to inhomogeneous input data sets.

The different results estimated by the different algorithms/instruments are compared to available inter-annual estimates from water budget analyses as a possible constraining comparison to help arrive at a “best estimate”, which is important for incorporation into frequently used analyses such as GPCP.