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Observed Influence on the Tropical Atmospheric Water Cycle

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Observed Influence of SST on the Tropical Atmospheric Water Cycle

Abstract

The objective of this paper is to improve our understanding of the relationships between the atmospheric water cycle variables, using a new synergistic data set of instantaneous spaceborne observations. This data set consists of five years (May 2012 to April 2016) of relative humidity profiles from the Megha-Tropiques satellite, collocated with cloud and precipitation from the CALIPSO and CloudSat satellites. The data is gridded on a 1° × 1° spatial resolution, collocated once daily (1.30 pm LT) and partitioned into atmospheric circulation regimes, as well as cloud phase and opacity categories and precipitating/non-precipitating scenes. The results show that all SST bins are dominated by non-precipitating cloud objects, but highlight that convective precipitation only occurs for SSTs above 299 K, whilst stratiform precipitation from liquid clouds can be present down to 291 K. In extreme ascending situations, when the atmosphere contains an ice cloud (dominant mode: 72 %), different behaviors are seen below and above the 299 K SST threshold – often referred to and discussed in several previous papers as the threshold for the onset of deep convection and/or a runaway greenhouse effect: (i) Below 299 K, the atmosphere is fully overcast with opaque clouds, whilst above 299 K, the opaque cover decreases and favors more thin clouds. (ii) As the SST passes over the 299 K threshold, the moist RH rises from the near-surface layer to the free troposphere. (iii) In the mid-troposphere, precipitating scenes are moister than its non-precipitating counterparts, but drier in the PBL and at the tropopause level. Further discussions will treat the contrasts between extreme ascending and descending regimes, under which conditions the different sub regimes dominate, as well as the signature of the El Niño period and its impact on the relationships between the atmospheric water cycle variables.