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A Precipitation Climatology using Satellite Remote Sensing and Water Cycle Constraints

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Passive microwave satellite data records have finally reached critical lengths that provide unparalleled climate monitoring capability. In particular, if we are to monitor and understand regional climate changes, the use of satellite data are necessary for much of the planet where in situ observations are infrequent or absent. Using passive microwave data we provide a precipitation climatology and integrate our activities with the NASA Precipitation Measurement Mission (PMM) and the NASA Energy and Water Cycle Study (NEWS). We obtain geophysical retrievals over the ocean using our Unified Microwave Ocean Retrieval Algorithm (UMORA), which simultaneously retrieves sea surface temperature, surface wind speed, columnar water vapor, columnar cloud liquid water, and surface rain rate from a variety of passive microwave radiometers including SSMI (F08, F10, F11, F13, F14, F15), SSMIS (F16, F17), TMI on TRMM, AMSR (Aqua and Midori-II), and WindSat. In addition to the retrieval algorithm, the other critical component to obtaining a quality precipitation climatology is an accurate radiometer intercalibration at the brightness temperature level. We have spent a great deal of effort intercalibrating the SSM/I series of radiometers. In the most recent version, the SSM/I have been intercalibrated to a precision of 0.1 K and the other sensors have been adjusted to match the SSM/I time series.

We are using passive microwave observations to make climatologies of areal precipitation over ocean basins. Our results indicate surprisingly consistent evaporation ratios (ratio of evaporation to precipitation) over large ocean basins. The ratios are around 1.2, meaning that over sufficiently large areas of ocean, evaporation is about 20% larger than precipitation – with the excess finding its way onto land via atmospheric rivers. These results are very different than previous satellite-based estimates, which show great variability from basin to basin. Our results may be due to a number of factors: consistent climate-quality winds used in calculating evaporation, careful intercalibration of satellite sensors for rain retrievals, our attempts to estimate the frozen precipitation contribution to the water cycle, removing the small but significant diurnal cycle from the satellite rain retrievals, and careful screening of land versus ocean pixels. We will present an uncertainty analysis providing bounds on our evaporation ratio estimates, and discuss the relationship between the evaporation ratio and the basin size. We will also discuss our evaporation ratio results in relation to salinity measurements, which highlight differences between the tropics and subtropics as well as the Atlantic versus Pacific basins. Our results could potentially provide an important constraint to understanding recent climate change and possibly even predicting future climate changes.