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# How accurate are precipitation retrievals from space-borne passive microwave radiometers? – Evaluation of satellite retrieval errors in rain estimates from TMI, AMSR-E, SSM/I, SSMIS, AMSU-B, and MHS over the continental United States

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Precipitation retrievals from space-borne Passive Microwave (PMW) radiometers are the major source in modern satellite-based global rainfall dataset. The error characteristics in these individual retrievals directly affect the merged end products and applications, but have not been systematically studied. In this paper, we undertake a critical investigation of the seasonal and sensor type skill and errors of both in PMW radiometers over the continental United States (CONUS). A high-resolution ground radar-based datasets – NOAA's National Severe Storms Laboratory (NSSL) Q2 radar derived precipitation estimates are used as the ground reference. The high spatial and temporal resolution of the reference data allows near-instantaneous collocation (within 5 minutes) and relatively more precise comparison with the satellite overpasses. We compare precipitation retrievals from twelve satellites, including six imagers (one TMI, AMSR-E, SSM/I and three SSMIS) and six sounders (three AMSU-B and three MHS) against the Q2 radar precipitation. Results show that precipitation retrievals from PMW radiometers exhibit fairly systematic biases depending on season and precipitation intensity, with overestimates in summer at moderate to high precipitation rates and underestimates in winter at low and moderate precipitation rates. This result is also showing in satellite-based multi-sensor precipitation products, indicating the transferring of uncertainties from single sensor input to multi-sensor precipitation estimates. Meanwhile, retrievals from the microwave imagers have notably better performance than those from the microwave sounders. The sounders have higher biases, about two times at small rain rates and two-three times at the moderate to high end rain rates, compared to the imagers. The sounders also have a narrower dynamic range, and higher random errors, which are also detailed in the paper.