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Uncertainty of Global Total Precipitable Water Trends from Passive Microwave Radiometers and Active GNSS Radio Occultation over Oceans under Clear and Cloudy Skies

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Water vapor (WV) is one of the most important greenhouse gases in the atmosphere. The vertical temperature and moisture distributions above, within, and below clouds are critical for understanding cloud and water vapor feedbacks, which are still one of the largest uncertainties in climate sensitivity studies. Passive microwave (MW) radiometers are among the very few satellite missions that are able to provide long-term (more than 25 years) all- weather time series of water vapor measurements using a similar satellite sensors and retrieval techniques. Recently a new version of daily ocean products mapped to 0.25 degree grid from SSM/I and similar satellite-borne microwave radiometers including SSMIS, AMSR, AMSR-E, WindSat, and TMI are released by Remote Sensing Sytem (RSS). The quality of the climate observations obtained from microwave radiometers were needed to be quantified. The Global Positioning System (GPS) Radio Occultation (RO) is an active remote sensing technique, which is complementary with the passive microwave and infrared sounders and microwave imagers. Because GPS RO data are not sensitive to clouds and precipitation, GPS RO derived water vapour products are very useful to identify the possible Total Precipitable Water (TPW) biases retrieved from measurements of passive microwave sounders and imagers under different meteorological conditions (i.e. clear, cloudy, non-precipitation/cloudy and precipitation/cloudy). In this study, we use GPS RO derived TPW data products to quantify the accuracy of TPW under cloudy conditions over oceans. Results show that the mean microwave (MW) radiometer - COSMIC TPW differences range from 0.06-0.18 mm for clear skies, 0.79-0.96 mm for cloudy skies, 0.46-0.49 mm for cloudy but non-precipitation conditions, and 1.64-1.88 mm for precipitation conditions. The trend using all COSMIC observations collocated with MW pixels is 1.79 mm/decade, with a 95% confidence interval of (0.96, 2.63), which is in close agreement with the trend estimated by all MW observations (1.78 mm/decade with a 95% confidence interval of 0.94, 2.62).