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Ground validation employing microwave links and sampling uncertainty of GPM

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Accurate and timely surface precipitation measurements are crucial for ground validation of satellite-based precipitation estimates. However, the majority of the land surface of the earth lacks such data, and often the density of gauging networks is even rapidly declining. This development can potentially be counteracted by using received signal level data from the enormous number of microwave links used worldwide in commercial cellular communication networks. Along such links, radio signals propagate from a transmitting antenna at one base station to a receiving antenna at another base station. Rain-induced attenuation and, subsequently, path-averaged rainfall intensity can be retrieved from the signal's attenuation between transmitter and receiver, as has been shown in several studies. Data from a commercial cellular telephone network have already been used to obtain country-wide rainfall maps for the Netherlands, of which some results will be presented to demonstrate the potential for validation of satellite-based precipitation images.

It is important to quantify the effect of revisit time, footprint, and integration time on the quality of the precipitation estimates of satellites such as the Global Precipitation Measurement mission (GPM). This is done by simulating precipitation fields as observed by satellites from a high-quality, gauge-adjusted climatological radar data set of rainfall depths from 1998-2011, and by comparing these fields to this radar data set, which covers the Netherlands, has a temporal resolution of 5 min and a spatial resolution of approximately 6 square kilometers. The bias in the mean and the residual standard deviation of daily rainfall depths are studied as a function of footprint and revisit time. Moreover, insight into the sampling uncertainties of precipitation estimates from satellites, such as the envisaged GPM mission, is also given for a monthly rainfall depth and an extreme daily rainfall depth. This study gives the opportunity to solely quantify sampling uncertainties of satellites. Because a ground-based radar rainfall data set is used for both simulation and validation, representativeness errors between satellite and ground-based observations are not present and measurement errors in satellite observations are not considered as well.