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Sampling uncertainties of precipitation estimates from satellites using a climatological radar rainfall data set

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Satellites provide precipitation estimates over large areas and often for areas where no or few rainfall observations are available, such as oceans and developing countries. The launch of new satellites, such as the Global Precipitation Measurement (GPM) mission, will result in precipitation estimates over the tropics and mid-latitudes with a revisit time or sampling time interval of 3 hours and a horizontal resolution of 4-5 km, the footprint.

It is important to quantify the effect of revisit time, footprint and integration time on the quality of the precipitation estimates. This can be done by simulating satellite precipitation images from rain gauges or ground-based weather radar data. The number of rain gauges is often too small to obtain accurate areal rainfall depths, especially for subdaily integration times. In contrast, radar data give precipitation estimates over large areas with high spatial and temporal resolutions. Nevertheless, radar data may suffer from several (sources of) errors, and long-term, high-quality radar rainfall data sets with a large number of possible rainfall levels are often not available.

Two adjustment methods, which use rain gauge data from two networks, were combined to obtain a high-quality radar rainfall data set suitable for hydrological and climatological applications. This 11-year data set (1998-2008) has a temporal resolution of 5 min and covers the entire land surface of the Netherlands (35500 km^2). Recent studies show that this data set is suitable to derive probability distributions of extreme areal rainfall.

Satellite rainfall depths are simulated from this climatological radar rainfall data set for revisit times of 15 min to 24 hours, integration times of 1 hour to 1 month, and footprints of approximately 25 to 1500 km^2 and the entire land surface of the Netherlands (35500 km^2). These characteristics are representative for satellite missions such as GPM or Meteosat Second Generation (MSG).

For instance, a revisit time of 3 hours and an integration time of 24 hours means that 8 5-min radar rainfall accumulation images are used to compute a 24-hour simulated satellite rainfall depth for a chosen footprint. Subsequently, the simulated satellite rainfall depths are verified against the radar rainfall data set, the ground-truth, having a revisit time of 5 min and the same footprint. Because the same data set is used for both simulation as well as verification, errors can be solely attributed to sampling uncertainties. Verification results are shown for different combinations of revisit time, integration time and footprint. For instance, a spatial verification is given by comparing monthly rainfall depths. Seasonal dependence in sampling uncertainties is studied, which is possible owing to the long radar rainfall data set.