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Statistical properties of rain rates in Mid Norway as seen by a vertically looking Micro Rain Radar (MRR)

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The background for this study is the need of a reference dataset with high temporal resolution that can be used for describing the statistics of precipitation intensities in Norway. The specific needs of the authors of this paper were challenges related to catchment hydrology like (i) precipitation estimation from C-band radars, (ii) parameterization of stochastic precipitation simulators and for (iii) increasing our understanding of hydrological processes related to infiltration. Recent measurement technologies that can be used for this purpose solve is either optical precipitation sensors (disdrometers) or micro rain radars (MRR). They both measure precipitation intensities down to 0.01 mm/h with 1 minute time resolution whereas a tipping bucket rain gauge would need an intensity of 6.0 mm/h for registering one pulse within one specific minute. The aim of this study was to provide basic description of statistical properties of rainfall rates in Norway. To fulfill this aim we answered the following questions: (i) What is the distribution of precipitation intensities? (ii) How much does different precipitation intensities contribute to total precipitation? (iii) For which temporal resolution are the bucket gauges appropriate to use? (iv) What is typical correlation length for precipitation? (v) What are the characteristics of precipitation intermittency? We used a MRR radar located in Trondheim, Norway, that sampled average precipitation with one minute resolution. The results show that precipitation intensities below 0.1 mm/h contributes little to the total precipitation and might be treated as zero precipitation. The Kappa-4 distribution gives the best fit to the observed precipitation intensities. Intensities less than 1.76 mm/h contributes to 50 % of the total precipitation volume, and 88% of the total volume has intensities lower than 6.0 mm/h that is the resolution of the tipping bucket sensor for detecting precipitation within one specific minute. The tipping bucket sensor is sufficient if we are interested in hourly or daily data. For higher time resolutions, high resolution recording instruments are needed. For extreme precipitation intensities, however, the tipping bucket sensor is appropriate. For intensities around 100 mm/h the resolution is at 5% of the measured values and contributes to a measurement uncertainty. The scanning frequency of the C-band radars in Norway is now 7.5 minutes, but was 15 minutes until July 2013. The autocorrelations are 0.65, 0.52, and 0.41, at the durations 3.75, 7.5 and 15 minutes. After 1 hour and 42 minutes it is down to 0.2. It should be noted that the auto-correlation of precipitation would be higher if we were able to follow the precipitating clouds. The auto-correlation depends on precipitation intensity, the higher the intensity, the shorter the correlation length. This illustrate the importance for frequent scans of the volume scanning radars. The increase in scanning frequency from 15 to 7.5 minutes will lead to a significant improvement in accumulated precipitation estimates. The degree of intermittency depends on the averaging period, it rains 18% of time when looking at minute data whereas it increases to 38% of the time for hourly data.