Geophysical Research Abstracts
Vol. 18, EGU2016-4763, 2016
EGU General Assembly 2016

Integration of rain gauge measurement errors with the overall rainfall uncertainty estimation using kriging methods

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In many research studies rain gauges are used as a reference point measurement for rainfall, because they can reach very good accuracy, especially compared to radar or microwave links, and their use is very widespread. In some applications rain gauge uncertainty is assumed to be small enough to be neglected. This can be done when rain gauges are accurate and their data is correctly managed. Unfortunately, in many operational networks the importance of accurate rainfall data and of data quality control can be underestimated; budget and best practice knowledge can be limiting factors in a correct rain gauge network management. In these cases, the accuracy of rain gauges can drastically drop and the uncertainty associated with the measurements cannot be neglected. This work proposes an approach based on three different kriging methods to integrate rain gauge measurement errors in the overall rainfall uncertainty estimation. In particular, rainfall products of different complexity are derived through 1) block kriging on a single rain gauge 2) ordinary kriging on a network of different rain gauges 3) kriging with external drift to integrate all the available rain gauges with radar rainfall information. The study area is the Eindhoven catchment, contributing to the river Dommel, in the southern part of the Netherlands. The area, 590 km2, is covered by high quality rain gauge measurements by the Royal Netherlands Meteorological Institute (KNMI), which has one rain gauge inside the study area and six around it, and by lower quality rain gauge measurements by the Dommel Water Board and by the Eindhoven Municipality (six rain gauges in total). The integration of the rain gauge measurement error is accomplished in all the cases increasing the nugget of the semivariogram proportionally to the estimated error. Using different semivariogram models for the different networks allows for the separate characterisation of higher and lower quality rain gauges. For the kriging with external drift, radar composites from the KNMI are used. These are produced by two single-polarization radars, 70 km and 170 km away from the area of study, with a spatial resolution of 1 km by 1 km and a temporal resolution of 5 minutes. The overall uncertainty is then estimated observing the kriging variance. Results for the three approaches with and without the rain gauge measurement errors are then compared.