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Evaluating the effect of precipitation correction method and rain gauge network density by integrated hydrological modelling

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Precipitation data of good quality and with sufficient temporal and spatial resolution is paramount for integrated hydrological modelling. In Denmark precipitation has traditionally been collected in a network consisting of automated rain gauge stations supplemented by a large number of manual stations providing daily accumulated measures. Prior to its use for hydrological modelling, precipitation data have been corrected for under catch using historic mean monthly correction factors that were uniform for the entire country. Problems on closing the water balance in hydrological modelling have questioned this correction approach, leading to a detailed national water balance study. The backbone of the analysis was the national water resources model (DK-model), which is a physically based, coupled and fully distributed model for the entire Denmark, constructed using the MIKE SHE/MIKE 11 code. The results suggested that a time-space variable approach for rain gauge catch correction based on gridded daily wind speed and temperature data is superior to the correction approach historically used. The new correction approach enabled a far better model performance on simulated discharge throughout the country and is now used in all hydrological modelling in Denmark. The results illustrates the importance of choosing an appropriate rain gauge catch correction method, especially in mid-high latitudes where solid precipitation is common.
The study was carried out utilizing data from the period 1990 – 2003. Following this period the network of automated rain gauge stations have been expanded, but all manual stations have been shut down, resulting in a significant reduction in the total number of stations, with only around one fifth remaining in 2010. In 2014 the national water resources model was updated, which included a new model calibration. The model was setup for 1990 – 2010 and due to the transfer from manual to automated rain gauge station, the number of stations varies for the period, with the reduction mainly occurring between 2007 and 2009. The model was calibrated from 2000 – 2006 followed by a validation from 2007 – 2010. This showed a significant poorer performance for the validation period compared to the calibration period, especially considering the dynamics of the stream discharge. Validating the model on the period 1995 – 1999 the model performance is as good or better compared to the calibration. Since the deterioration in model performance is coincident with the reduction in rain gauge stations, it is speculated that the poorer model performance is due to the change in the spatial resolution provided by the new station network, a hypothesis currently being investigated.