Comparison of interpolation performance for different climate variables in North Germany

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Many fields of hydrology, water resources management and environmental sciences require climate information with various temporal resolutions for the modelling of different processes. These data are usually recorded as site-specific point information by weather stations, however many applications need areal information. Spatial interpolation techniques are a reliable approach in order to estimate climate information for a specific location from adjacent measurements. However, the interpolation performance depends strongly on station network configuration, temporal resolution and the variable itself. This work aims at evaluating the influence of several factors on the interpolation performance using various geostatistical and non-geostatistical techniques and comparing the interpolation performance among different climate variables.

A cross validation analysis of interpolation performance was carried out for meteorological observations of precipitation, temperature, sunshine duration, cloud coverage, relative humidity and wind speed over a period of six years (2008-2013). Temporal resolutions from 1 hour to 1 year as well as network configurations with different station densities were considered. Depending on each variable, various interpolation techniques taken into account and several secondary variables were tested regarding their potential to improve the estimation. The interpolation of rainfall, for instance, was performed using Nearest Neighbour, Inverse-Distance Weighting, Ordinary Kriging, Kriging with External Drift as well as Conditional Merging, while elevation and quantitative rainfall estimates from weather radar were used as additional information. The cross validation experiments and station density scenarios were designed in a way that a comparison of interpolation performance among all climate variables is possible. Moreover, different realisations were used for each station density in order to assess the influence of observation locations.

The results show that geostatistical techniques are able to provide a better interpolation performance compared to simple deterministic methods. However, no interpolation technique that works best for all climate variables was found. Temporal resolution as well as the actual spatial variability of the regarded variable seem to have high impact on the interpolation performance, while the network density appears to be of minor importance. The influence of station locations varies from variable to variable. In particular, a strong impact of the station selection was observed for wind speed. Hourly precipitation shows generally the highest spatial variability and thus the worst interpolation performance is obtained. In general, the spatial variability decreases and interpolation performance improves with decreasing temporal resolution for all variables except wind speed. The best interpolation performance is achieved for relative humidity and temperature.