Spatial interpolation of daily climate time series for the Elbe River Basin

Objectives

Objective of this work was the generation of a raster climate data set for mesoscale ecological and hydrological modelling in the Elbe River Basin. Daily time series of the climate variables: precipitation (pcp), temperature (tav), hours of bright sunshine (sun) and humidity (hum) are interpolated on a 5 x 5 km raster for the whole German part of the Elbe River Basin for the period from 1981 to 1996.

Methods

Starting point for the interpolation is a comparison of four different methods:

- Nearest Neighbour (NN)
- Inverse Distance (INVD)
- Ordinary Kriging (OK)
- External Drift Kriging (EDK)

(see e.g. Haberlandt and Kite, 1998). From those methods the most advanced approach is EDK which allows the treatment of nonstationary random functions. With EDK it is possible to consider not only the spatial persistence structure of the climate variables for interpolation but also additional time-invariant information (e.g. elevation, exposure) and/or time-variant information (e.g. other climate variables, modelling results). In the present study EDK is applied only with elevation as additional information.

Application

Fig. 1 shows the available precipitation and climate station network[*1] used for interpolation. Before applying the interpolation techniques a correction of the systematic precipitation measurement error has been carried out adopting the method of Richter (1995, p63). Precipitation is corrected for each day and each station separately depending on precipitation type and intensity.

[*1] data provided by the German Weather Service (DWD)

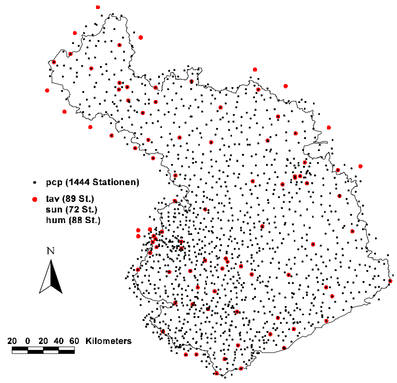

Fig. 1: Climate stations used for interpolation

In **Fig. 2** the four different interpolation methods are compared by cross validation for the daily time series of the year 1990. Considering the Nash/ Sutcliffe criterion as efficiency measure the best results were always obtained by the EDK method except for precipitation, where OK performed better.

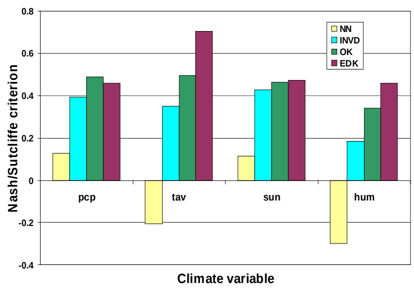

Fig. 2: Crossvalidation results

The most significant improvement using EDK is achieved for temperature interpolation. It is worth to notice that EDK considers time and space variable trends, thus recognising also temporarily occurring vertical inverse temperature gradients.

For precipitation the result is a bit unexpected meaning additional information about elevation does not help to improve the interpolation in this case. Reasons for this may be the high precipitation network density (reflecting already sufficient elevation structure) and the relative low daily correlation between precipitation and elevation (**Fig. 3**). For more than 90% of the days the absolute value of the correlation coefficient is smaller than 0.5.

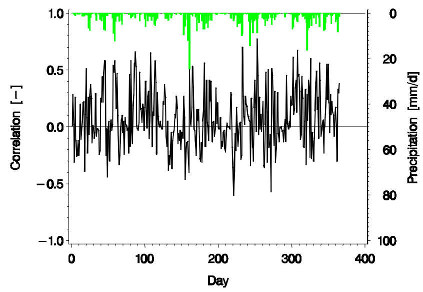

Fig. 3: Correlation between daily precipitation and elevation in the Elbe Basin for the year 1990 (on top daily precipitation for comparison)

For the final interpolation of the 16-year period OK is used for precipitation interpolation and EDK for the other climate variables.(**Fig. 4**)

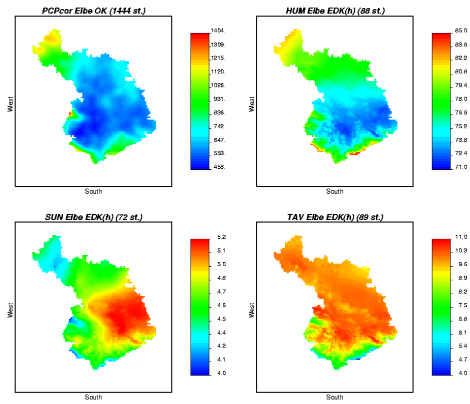

Fig. 4: Spatial distributions of the four climate variables for the Elbe River Basin aggregated from daily interpolated maps for 1990 (pcp in mm/a; tav in °C, sun in h/d; hum in %).

Further work is necessary to investigate more in detail the value of elevation information and other elevation derived variables for interpolation including the application of space-time variable variograms for improved consideration of specific weather conditions.

References

Haberlandt, U. and G.W. Kite (1998): Estimation of daily space-time precipitation series for macroscale hydrological modelling. Hydrol. Proc., 12(9), 1419-1432.

Richter, D. (1995): Ergebnisse methodischer Untersuchungen zur Korrektur des systematischen Meßfehlers des Hellmann-Niederschlagsmessers. Berichte des DWD, 194, 93 S., Offenbach am Main 1995.

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