Spatio-Temporal Prediction of Point-Referenced Environmental Data

The climate and the environment have an impact on human living. So, there is an urgency to observe the environment. This thesis is about environmental data sets that have information about the date and point-referenced location of observation. Based on these information, the analysis of this data can be spatial, temporal or even spatio-temporal. Therefore, different methods are investigated. As an example, temperature data and precipitation data in Baden-Württemberg, yearly and monthly aggregated, are chosen. One reason to observe those parameters is the availability of validation raster (Fig. 1).

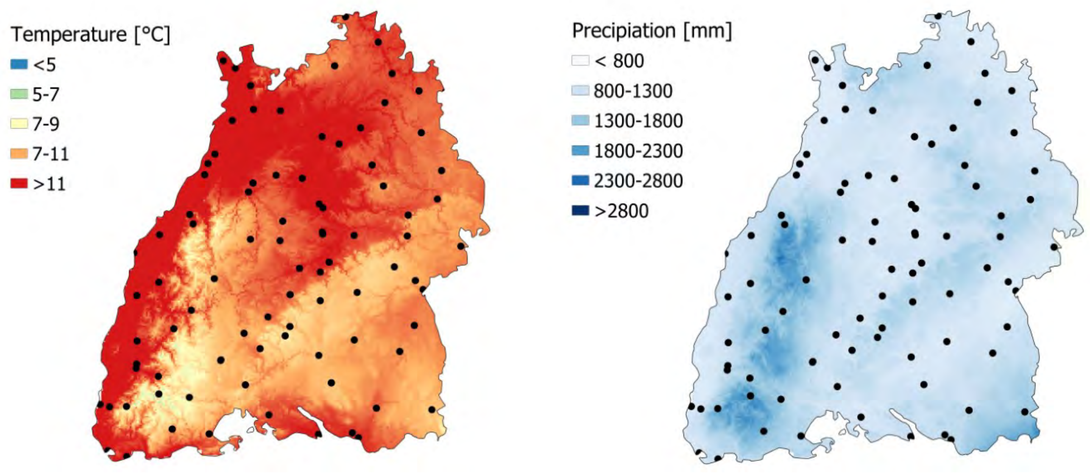

Fig. 1: Validation data by DWD

For the spatial analysis inverse distance weighting, Thiessen polygons, ordinary kriging and universal kriging with the first, second and third polynomial are investigated. For temporal analysis autoregressive model, moving average model, autoregressive moving average model, autoregressive integrated moving average model, seasonal autoregressive integrated moving average model, white noise and random walk are compared. For spatial-temporal analysis, the method space-time inverse distance weighting is compared with a combination of purely temporal and purely spatial methods (Fig. 2 and 3).

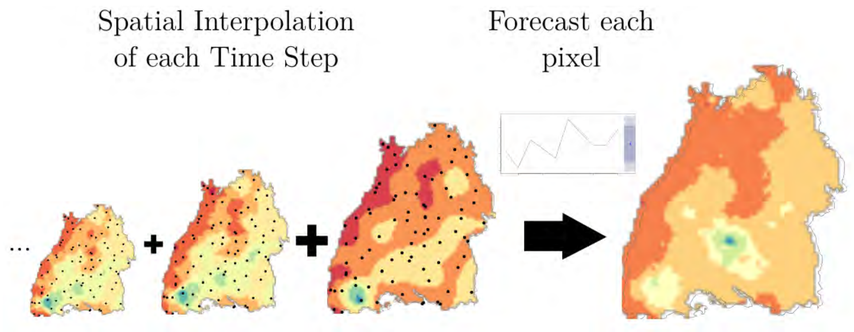

Fig. 2: Spatial-temporal interpolation (spatial then temporal)

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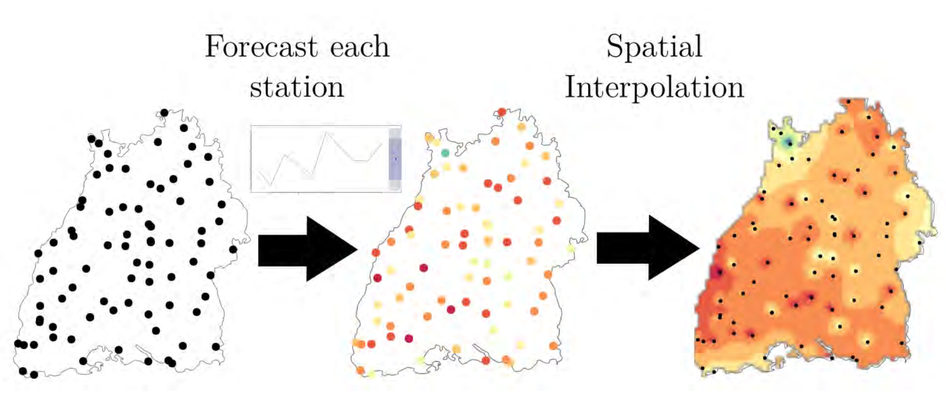

Fig. 3: Spatial-temporal interpolation (temporal then spatial)

Two validations are calculated and compared. The first validation is not using any additional data. The second method compares the result with the validation raster. The programming language R is used for this thesis. With the help of the results, it is reviewed, if and how those methods can be integrated into Cadenza, an analysis software by Disy Informationssysteme using its R-interface.

The objective to implement those methods in Cadenza could be achieved for purely spatial and temporal methods. The analysis of spatio-temporal methods showed, that for interpolation of an observed time the method space-time inverse distance weighting showed no improvement in comparison to spatial interpolation.

For the interpolation of an unobserved time, the method space-time inverse distance weighting is not suitable because seasonality in the data is not modelled. First spatial interpolation then temporal analysis (Fig. 2) might lead to high maximum errors. First temporal analysis than spatial interpolation (Fig. 3) has a high computation time. Therefore, those methods are not implemented in Cadenza.

More parameters should be investigated to define better recommendation for environmental data in future works. Additionally, a multivariate analysis should be tested using multiple parameters or additional data like heights or population density. An improvement of the already considered method can be done. It can be expected, that developments of spatio-temporal interpolation methods for R will continue. Such new developments and improvements should be monitored. New methods could be tested and implemented in Cadenza.