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Geographically Weighted Regression – Kriging method for spatial interpolation of air temperature in Poland

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The main aim of this work is to perform the spatial interpolation of the air temperature data aggregated on various time scales: from daily to long-term means. The spatialization is done for 69 sets of data from the decade 1996-2005, covering 250 meteorological stations from Poland and its surroundings. A starting point for the analysis is Matheron's (1969) idea of universal model of spatial variation where a target variable at some location can be modeled as a sum of the deterministic and stochastic components. Up to now in climatology, the deterministic component has been modeled usually by the global regression, and the regression coefficients have been estimated mostly by OLS fitting method. In this paper, due to non-stationary spatial process which is very common in climatology, the method of Geographically Weighted Regression (GWR) is introduced. GWR results are compared with Multiple Linear Regression (MLR) by a set of statistics e.g. determination coefficient, Akaike Information Criterion (AIC) and ANOVA. In both models the same set of explanatory variables, previously selected step-wise from a set of potential predictors, is used. Apart from frequently applied predictors, like coordinates, height, distance from the sea, and terrain derivatives, additional auxiliary variables, including potential irradiation, foehn wind effect, and NDVI are also used for regression models development.
It can be stated that GWR approach is better fitted for air temperature data interpolation than the MLR in each case, which was shown by the improved determination coefficients, AIC and ANOVA statistics. Moran's I statistics of GWR residuals have been then calculated and if positive spatial autocorrelation is detected (variogram does not reflect a pure nugget effect), the model can be extended by stochastic component – ordinary kriging of residuals. The interpolation results are evaluated with the cross-validation (CV) approach. In each case the extended model (GWR with interpolated residuals) has been characterized by significant improvement of interpolation results. The GWR algorithm and its geostatistical extension: Geographically Weighted Regression – Kriging (GWRK) can be considered as one of the most proper interpolation technique for air temperature in regional scale, regardless time-aggregation level.