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Bayesian Area-to-Point Kriging using Expert Knowledge as Informative Priors

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Spatial disagregation is needed when environmental models of climate, air quality, hydrology, etc. require input data at a finer scale than available or when models produce outputs at a coarser scale than required by users. Area-to-Point Kriging is a common geostatistical framework to address the problem of spatial disaggregation from block to point support. Spatial disaggregation using Area-to-Point Kriging requires that the point support variogram is known. However, retrieving the point support variogram from block observations can only be done approximately and as a result, the parameters of the point support variogram that are estimated using block support observations are uncertain. Bayesian Area-to-Point Kriging is recommended because it takes the uncertainty in the parameters of the point support variogram into account.
In this research, we first clarify that the nugget parameter of the point support variogram cannot be estimated from block support observations. Hence, Bayesian Area-to-Point Kriging with non-informative priors of the point support variogram parameters cannot improve the estimation of the nugget parameter. Therefore, we propose to use informative priors for the point support variogram parameters. These informative prior probability distributions of the parameters were elicited from expert knowledge using a formal statistical elicitation procedure. Next, Bayesian Area-to-Point Kriging was implemented using Markov chain Monte Carlo simulation.
The case study addressed the disaggregation of MODIS (Moderate Resolution Imaging Spectroradiometer) Atmospheric data, i.e. the air temperature extracted from the retrieved temperature profile at 1000 hPa, 5x5km resolution, for the Gelderland province, The Netherlands. Experts with expertise in meteorology and geostatistics were invited to give probability judgments on the priors of the point support variogram parameters. As the nugget parameter of the point support variogram cannot be estimated from block support observations, the posterior distribution of this parameter is the same as the prior. Spatial disaggregation of the MODIS image to point support on a 1x1km grid was done and the associated uncertainty was quantified with spatial stochastic simulation. The uncertainty propagation of the point support variogram to the predictions was quantified as well and had a substantial contribution to the overall uncertainty. By incorporating several point support observations of the temperature from meteorological stations inside and outside the Gelderland province, uncertainty of the variogram parameters decreased and so did the disaggregation prediction uncertainty.