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Robust geostatistical analysis of spatial data

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Most of the geostatistical software tools rely on non-robust algorithms. This is unfortunate, because outlying observations are rather the rule than the exception, in particular in environmental data sets. Outliers affect the modelling of the large-scale spatial trend, the estimation of the spatial dependence of the residual variation and the predictions by kriging. Identifying outliers manually is cumbersome and requires expertise because one needs parameter estimates to decide which observation is a potential outlier. Moreover, inference after the rejection of some observations is problematic. A better approach is to use robust algorithms that prevent automatically that outlying observations have undue influence.
Former studies on robust geostatistics focused on robust estimation of the sample variogram and ordinary kriging without external drift. Furthermore, Richardson and Welsh (1995) proposed a robustified version of (restricted) maximum likelihood ([RE]ML) estimation for the variance components of a linear mixed model, which was later used by Marchant and Lark (2007) for robust REML estimation of the variogram.
We propose here a novel method for robust REML estimation of the variogram of a Gaussian random field that is possibly contaminated by independent errors from a long-tailed distribution. It is based on robustification of estimating equations for the Gaussian REML estimation (Welsh and Richardson, 1997). Besides robust estimates of the parameters of the external drift and of the variogram, the method also provides standard errors for the estimated parameters, robustified kriging predictions at both sampled and non-sampled locations and kriging variances.
Apart from presenting our modelling framework, we shall present selected simulation results by which we explored the properties of the new method. This will be complemented by an analysis a data set on heavy metal contamination of the soil in the vicinity of a metal smelter.

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