Non-Stationary Global Geostatistical Modeling Through Space Deformation

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Abstract

Stationary random functions have been successfully used in geostatistical applications for several decades. However, in some situations, the assumption of homogeneous behavior of the spatial dependence structure across the entire interest domain proves untenable. An ingenious approach for non-stationary structure estimation is space deformation due to Sampson and Guttorp (1992). So far, this approach has been functional only in the context of data with several independent realizations of the random field and has a number of shortcomings. In this communication, we tackle non-stationary geostatistical modeling using space deformation in the context of single realization with spatial densification of the data. Our modeling procedure combines aspects of kernel smoothing, multi-dimensional scaling and thin plate splines, to transform the originally non-stationary field to a new deformed space where isotropy is assumed. The data from the geographic space is mapped into the deformed, isotropic space. Standard techniques for prediction and simulation can then be applied in the deformed space. The predicted or simulated results are then mapped back into the original space. A scheme comparison of ordinary kriging under stationary and non-stationary assumptions, shows that the proposed approach has better prediction performance on several data examples. The proposed method implies a higher computational effort than traditional stationary techniques, but if data availability allows for a reliable inference, a higher accuracy of estimates can be achieved.

Keywords: multi-dimensional scaling, thin plate splines, kernel smoothing, global variogram, kriging, space deformation, non-stationarity.

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