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Efficient Estimation of Non-stationary Spatial Covariance Functions with Application to High-resolution Climate Model Emulation

Abstract

Spatial processes exhibit non-stationarity in many climate and environmental applications. Convolution-based approaches are often used to construct non-stationary covariance functions in Gaussian processes. Although convolution- based models are flexible, their computation is extremely expensive when the dataset is large. Most existing methods rely on fitting an anisotropic but stationary model locally and reconstructing the spatially varying parameters. In this study, we propose a new estimation procedure to approximate a class of non-stationary Mat´ern covariance functions by local-polynomial fitting of the covariance parameters. The proposed method allows for efficient estimation of a richer class of non-stationary covariance functions with the local stationary model as a special case. We also develop an approach for fast high-resolution simulation with non-stationary features on the small scale and apply it to precipitation data in the climate model.