Nonstationary Spatial Modeling Using Penalized Likelihood

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Abstract

We consider nonstationary spatial modeling using empirical orthogonal functions (EOFs) under the consideration that data may be observed only at some sparse, irregularly spaced locations with repeated measurements. Instead of obtaining EOFs by principal component analysis based on a class of pre-specified basis functions or a pre-smoothing step with data imputed on a regular grid, we propose a regularization approach using penalized likelihood, which provides a new EOF-type expansion in terms of a small number of functions with their degrees of smoothness controlled by a tuning parameter. An expectation-conditional-maximization algorithm is applied to obtain the penalized maximum likelihood estimates of the mean and the covariance parameters simultaneously. Some simulation results show that the proposed method performs well in both spatial prediction and covariance function estimation, regardless of whether the underlying spatial process is stationary or nonstationary. In addition, the method is applied to analyze precipitation in Colorado.