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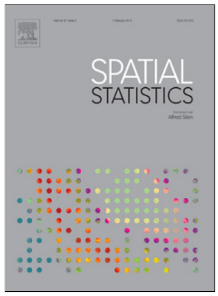

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PII: S2211-6753(16)30176-2
DOI: http://dx.doi.org/10.1016/j.spasta.2017.07.009
Reference: SPASTA 251

To appear in: *Spatial Statistics*

Received date : 10 December 2016
Accepted date : 26 July 2017

Please cite this article as: Alegría, A., Caro, S., Bevilacqua, M., Porcu, E., Clarke, J., Estimating covariance functions of multivariate skew-Gaussian random fields on the sphere. *Spatial Statistics* (2017), http://dx.doi.org/10.1016/j.spasta.2017.07.009

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Estimating covariance functions of multivariate skew-Gaussian random fields on the sphere

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Abstract

This paper considers a multivariate spatial random field, with each component having univariate marginal distributions of the skew-Gaussian type. We assume that the field is defined spatially on the unit sphere embedded in $\mathbb{R}^3$, allowing for modeling data available over large portions of planet Earth. This model admits explicit expressions for the marginal and cross covariances. However, the n-dimensional distributions of the field are difficult to evaluate, because it requires the sum of 2^n terms involving the cumulative and probability density functions of a n-dimensional Gaussian distribution. Since in this case inference based on the full likelihood is computationally unfeasible, we propose a composite likelihood approach based on pairs of spatial observations. This last being possible thanks to the fact that we have a closed form expression for the bivariate distribution. We illustrate the effectiveness of the method through simulation experiments and the analysis of a real data set of minimum and maximum surface air temperatures.

Keywords: Composite likelihood, Geodesic distance, Global data

1. Introduction

The Gaussian assumption is an appealing option to model spatial data. First, the Gaussian distribution is completely characterized by its first two moments. Another interesting property is the tractability of the Gaussian distribution under linear combinations and conditioning. However, in many geostatistical applications, including oceanography, environment and the study of natural resources, the Gaussian framework is unrealistic, because the observed data have different features, such as, positivity, skewness or heavy tails, among others.

Transformations of Gaussian random fields (RFs) is the most common alternative to model non-Gaussian fields. Consider a spatial domain $\mathcal{D}$ and $\{Z(\boldsymbol{s}), \boldsymbol{s} \in \mathcal{D}\}$ defined as $Z(\boldsymbol{s}) = \varphi(Y(\boldsymbol{s}))$, where φ is a real-valued mapping and $\{Y(\boldsymbol{s}), \boldsymbol{s} \in \mathcal{D}\}$ is Gaussian. Apparently the finite-dimensional distributions of Z depend on the choice of φ. In some cases, such mapping is one-to-one and admits an inverse simplifying the analysis. In this class, we can highlight the log-Gaussian RFs,

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