THE UNIVERSITY OF CHICAGO

Department of Statistics

DISSERTATION PRESENTATION AND DEFENSE

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TWO PROJECTS IN GAUSSIAN RANDOM FIELD SPACE-TIME STATISTICS

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ABSTRACT

Two projects are included in this work. In the first project, we consider the problem of estimating an unknown covariance function of a Gaussian random field for data collected by a polar-orbiting satellite. The complex and asynoptic nature of such data requires a parameter estimation method that scales well with the number of observations, can accommodate many covariance functions, and uses information throughout the full range of spatio-temporal lags present in the data. Our solution to this problem is to develop new estimating equations using composite likelihood methods as a base. We modify composite likelihood methods through the inclusion of an approximate likelihood of interpolated points in the estimating equation. The new estimating equation is denoted the I-likelihood. We apply the I-likelihood method to 30 days of ozone data occurring in a single degree latitude band collected by a polar orbiting satellite, and we compare I-likelihood methods to competing composite likelihood methods. The Ilikelihood is shown capable of producing covariance parameter estimates that are equally or more statistically efficient than competing composite likelihood methods and to be more computationally scalable.

In the second project, we develop two new classes of space-time Gaussian process models by specifying covariance functions using what we call a half-spectral representation. The halfspectral representation of a covariance function, K, is a special case of standard spectral representations and has been studied previously by Cressie and Huang [1999], Gneiting [2002] and Stein [2005a]. This work develops desirable theoretical properties of certain half-spectral forms. In particular, for a model, K, we determine spatial and temporal meansquare differentiability properties of a Gaussian process governed by K, and we determine whether or not the spectral density of K meets a natural condition posed by Stein [2011]. ixThe condition in Stein [2011] will in some cases imply a screening effect for K in which distant observations will be nearly independent of some observation given the values of its neighboring observations. We fit models we develop in this paper to the Irish wind dataset first analyzed in Haslett and Raftery [1989], and we show our models fit these data better than other separable and non-separable space-time models developed in Cressie and Huang [1999] and Gneiting [2002].
