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PhD Thesis Presentation

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Nonstationary Models for Spatial-Temporal Processes

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ABSTRACT

We develop a likelihood approximation for locally stationary Gaussian time series that improves on previously suggested approximations in both accuracy and stability with respect to changing parameters. Previously proposed approximations have required smoothness of the evolutionary spectrum in both the frequency and rescaled time domains (e.g. Dahlhaus, 2000), and our approximation relaxes those assumptions in that it does not require any smoothness in the rescaled time domain, although it requires uniform smoothness in the frequency domain. The approximation has the attractive property that it reduces to the well-known Whittle likelihood when a stationary model is assumed. In addition, when a particular form is assumed for the time-varying transfer function, our likelihood approximation provides significant computational advantages through the use of an iterative matrix inverse algorithm and the fast Fourier transform. The form of the transfer function is a natural generalization of the uniformly modulated transfer functions proposed by Priestley (1965). We evaluate the performance of our approximation compared to that proposed by Dahlhaus (2000) in both an artificial numerical experiment and with real data, to which we fit piecewise constant in time transfer functions to high frequency temperature data.

We employ these methods to model and produce conditional simulations of high frequency (in time) spatial-temporal surface temperature data from the Atmospheric Radiation Measurement Program's Southern Great Plains region. The data are collected at regular time intervals at a set of fixed spatial locations, so a natural choice is the modeling framework proposed by Stein (2005, 2009), which we extend to the nonstationary case in order to capture the nonstationary aspects of the temperature time series. We explore the effect of differencing on nonstationary models, and we suggest partial differencing as a safer alternative to taking first differences of nonstationary data. In the course of modeling the temperature data, we propose a spatial-temporal jump process, and we show how the spectral representation allows easy incorporation of meteorological covariates into the covariance function.
