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PhD Thesis Presentation

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Wavelet Analysis in Spatial Interpolation of High Frequency Monitoring Data

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ABSTRACT

For interpolating high-frequency monitoring data, wavelet analysis is more advantageous than Fourier-based methods because of their location-scale and whitening properties. In the past, wavelets have been used to simplify the dependence structure in multiple time or spatial series, but little has been done to apply wavelets as a modeling tool in a space-time setting, or, in particular, to take advantage of the localization of wavelets to capture the local dynamic characteristics of high-frequency meteorological data. This thesis analyzes minute-by-minute air pressure data for the Southern Great Plains obtained from the Atmospheric Radiation Measurement program using different wavelet coefficient structures at different scales and incorporating spatial structure into the model. This method of modeling space-time processes using wavelets produces accurate point predictions with low uncertainty estimates, and also enables interpolation of available data from sparse monitoring stations to a high density grid and production of meteorological maps on large spatial and temporal scales.

The decorrelation property of wavelet transforms is crucial to our proposed methodology. In the literature, theoretical aspects of this property have been studied exclusively from the increasing-domain perspective. However, if the goals are to understand the underlying data-generating process and to obtain good interpolations, then fixed-domain asymptotics, in which the number of observations increases in a fixed region, is more appropriate than increasing domain asymptotics. Under fixed-domain asymptotics, we prove that, for a general class of covariance functions, with suitable choice of wavelet filters, the wavelet transforms of a nonstationary process are asymptotically uncorrelated. These results provide theoretical justifications for analyzing space-time data through the aforementioned wavelet method.

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