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Multi-resolution (wavelet) based non-stationary covariance modeling for incomplete data using EM algorithm

T. Matsuo (1), D.W. Nychka (1) and D. Paul (2)

(1) National Center for Atmospheric Research (tmatsuo@ucar.edu; nychka@ucar.edu) (2) Stanford University (debashis@stat.stanford.edu)

Wavelets are versatile multi-resolution bases to characterize the stochastic features of a non-stationary (inhomogeneous) spatial field. A method of multi-resolution based non-stationary covariance, which takes advantage of the computational efficiency of the discrete wavelet transform, is augmented to handle the irregularly distributed incomplete observational data that is often encountered in the Earth sciences applications.

Using the sparse structure of wavelet coefficients' covariance or decay properties of wavelet coefficients' correlation within- and across-scales, the wavelet based covariance can be parameterized with parsimonious number of hyper-parameters. Additionally, Expectation Maximization (EM) algorithm can be used to estimate these hyper-parameters from irregular and incomplete observational data.

The method is being applied to a dataset of NCEP operational forecast innovations to estimate the covariance structure of forecast errors. Additionaly, the nonstationary spatial structure of environmental pollutants is being studied using the method, based on ground-level ozone measurements monitored at 513 stations located in the eastern United States.