Multivariate spatial modeling is a rapidly growing field with applications in atmospheric and climate science, ecology, econometrics, hydrology and remote sensing, among others. Models typically rely on cross-covariance functions to describe cross-process relationships; an alternative viewpoint is to model the matrix of spectral measures. In this talk we discuss the limitations of constructing models in the covariance domain and illustrate fundamental limitations on some previously proposed constructions. Moreover, almost all extant models are infeasible for use with modern large datasets. We introduce a flexible, interpretable and scalable multiresolution approach to multivariate spatial modeling. Relying on compactly supported basis functions and Gaussian Markov random field specifications for coefficients results in efficient and scalable calculation routines for likelihood evaluations and co-kriging. We analytically show that special parameterizations approximate popular existing models. Moreover, the multiresolution approach allows for arbitrary specification of scale dependence between processes. We illustrate our approach through Monte Carlo studies and examine a complex large bivariate observational minimum and maximum temperature dataset over the Western United States.

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References