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Modelling spatial heteroskedasticity by volatility modulated moving averages

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Spatial heteroskedasticity, which refers to changing variances and covariances in space, is a feature that has been observed in environmental data. We propose a model to capture this behaviour: the volatility modulated moving average (VMMA).
Let $\mathbf{t} \in \mathbb{R}^d$ for some $d \in \mathbb{N}$. A VMMA is defined by:

$$Y(\mathbf{t}) = \int_{\mathbb{R}^d} g(\mathbf{t} - \mathbf{s})\sigma(\mathbf{s})W(\mathrm{d}\mathbf{s}),$$

where g is a deterministic (kernel) function, W is white noise and σ is a stationary stochastic volatility field, independent of W. Without σ, this model reverts to the Gaussian moving average which is frequently used in Geostatistics to design covariance structures.
In this project, we develop a discrete convolution simulation algorithm for the VMMA. With particular focus on the so-called two-tiered model where the stochastic volatility field is a Lévy moving average, we derive results for the mean-square error involved. Next, we tackle the problem of inference and develop a two-step moments-matching estimation method involving a moving window. Simulation experiments are conducted and the consistency of the estimators is proved under suitable double asymptotics. As an illustration, we apply our method to sea surface temperature anomaly data.