

Spatially varying SAR models and Bayesian inference for high-resolution lattice data

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Abstract We discuss a new class of spatially varying, simultaneous autoregressive (SVSAR) models motivated by interests in flexible, non-stationary spatial modelling scalable to higher dimensions. SVSAR models are hierarchical Markov random fields extending traditional SAR models. We develop Bayesian analysis using Markov chain Monte Carlo methods of SVSAR models, with extensions to spatio-temporal contexts to address problems of data assimilation in computer models. A motivating application in atmospheric science concerns global CO emissions where prediction from computer models is assessed and refined based on high-resolution global satellite imagery data. Application to synthetic and real CO data sets demonstrates the potential of SVSAR models in flexibly representing inhomogeneous spatial processes on lattices, and their ability to improve estimation and prediction of spatial fields. The SVSAR approach is computationally attractive in even very large problems; computational efficiencies are enabled by exploiting sparsity of high-dimensional precision matrices.