Application of semiparametric function-on-scalar regression for modeling spatio-temporal earthquake dynamics

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A generalized functional additive regression model is presented for modeling spatio-temporal earthquake dynamics. Function-on-scalar regression is applied, which features a function over some domain as the response while the regressors are scalars. The spatio-temporal data represent surficial ground velocities based on simulated seismic events and come from a large-scale in silico experiment to investigate the effects of physical parameters describing the conditions at the triggering fault on the large-scale dynamics of earthquakes. The flexibility of the semiparametric, spline-based approach is highlighted, both with focus on estimating complex nonlinear and time-varying effect structures and on accounting for spatial and temporal correlation structures in the data. To estimate the model on this huge data set with almost half a million data points and its complex effect structure, a recently developed efficient algorithm for penalized likelihood-based inference is used. Its major advance is a highly efficient and parallelizable block-wise Cholesky decomposition. The estimated effects are geophysically plausible and the methodological approach seems promising for modeling surficial ground velocity. Current limitations of the application are discussed and an outlook on future refinements of the model is given.