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Multivariate autoregressive models for geophysical fields: application to sea level from Topex/Poseidon satellite altimetry

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Satellite altimetry provides absolute sea level observations on a nearly global scale. Topex/Poseidon mission achieved an unprecedentedly accuracy, yielding a huge, high quality, space-time dataset of precise sea level measurements.

Descriptive space-time statistical methods are important tools to summarise and extract information from time-varying fields. One such a technique is Principal Oscillation Pattern analysis (POP), based on the fit of a first order multivariate autoregressive model to the observations and subsequent eigen-decomposition of the estimated coefficient matrix. Since a temporal autoregressive structure of order one is assumed for the spatial field, POP applicability is restricted to fields for which a first order model provides an adequate fit to the observations. However the methodology can be generalised, allowing to model a larger class of systems, by extending the temporal structure to an autoregressive model of arbitrary error and considering the eigen-decomposition of the augmented coefficient matrix.

Here we discuss estimation of a multivariate autoregressive model to Topex/Poseidon sea level measurements through a computationally efficient stepwise least squares algorithm. An eigen-decomposition of the autoregressive coefficients matrices is carried out to investigate the dynamical characteristics of the system in terms of modes of variability with characteristic frequencies and damping times.