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Time-series prediction using Ensemble Kalman Filter without dynamic model

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Ensemble data assimilation techniques have been successfully used to improve predictive skill in cases where a numerical model for forecasting has been developed. It is desirable to extend this utility to systems for which no model exists and observations of the complete state of the system may not be possible. For many natural systems, equations governing the evolution are unknown and only a partial observation of the high dimensional state vector is possible. For dissipative systems in which variables are coupled nonlinearly, the dimensionality of the phase space can be greatly reduced as the dynamics contracts onto a strange attractor. In these cases, it is possible to reconstruct the details of the phase space from a single scalar time series of observations using time-embedding. The Ensemble Transform Kalman (ETKF) can be applied to ensemble forecast and analyze the observations in the time-embedded space constructed from long time series of the data and the future evolution. We apply the method to a long historical time series of measurements of the Earth's magnetic field is recorded by ground based magnetometers The prediction skill improves with respect to persistence by incorporating information from observations and the behavior of nearby trajectories.