Accountability and Error in Ensemble Forecasting

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ECMWF Seminar on Predictability. 1, 351-368, 1995

Abstract

Forecast evaluation based on single predictions, each determined from an imperfectly observed initial state, is incomplete; observational uncertainty implies that an ensemble of initial states of the system is consistent with a given observation. In a nonlinear system, this initial distribution will develop a non-Gaussian structure, even if the forecast model is perfect. A perfect prediction (that is, forecasting {\it the} future state of the system) from an uncertain initial observation, is not possible even with a perfect model. Yet this irreducible uncertainty is accountable, in that it is distinct from model error. Ensemble prediction of nonlinear systems reveals shortcomings in the traditional evaluation of forecast-verification pairs with least-squared error cost functions; an alternative evaluation of imperfect models through their ability to shadow uncertain observations is discussed. Difficulties surrounding the construction of an ensemble of initial conditions are considered, the implications of imperfect ensembles are noted, and the use of breeding vectors and singular vectors is contrasted in low-dimensional systems.