Ensemble Kalman Filters: The movie

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Combining a numerical model with observations to improve the estimate of the state of a system is at the heart of numerical weather prediction, air quality forecasts, target tracking and numerous other applications. This talk will explain how to do data assimilation even for complex problems using simple linear regression! This surprisingly simple, sequential algorithm is at the heart of the NCAR Data Assimilation Research Testbed and has been successful on a wide range of geophysical models. Data assimilation has roots as a Bayesian statistics problem where the prior distribution is the current guess of the state of the system, the likelihood is the distribution of the observations given the state of the system and the posterior is the updated estimate of the system given the observations. The Ensemble Kalman filter (EKF) is a Monte Carlo based algorithm for solving this Bayesian problem that has been successful in practice. Usually the EKF is presented using matrix expressions that make it difficult to understand its properties. As an alternative, we present the connection between sequentially updating the state with new observations and regression. This equivalent point of view shows how the EKF works and how to modify the EKF to handle outliers or non-Gaussian distributions. The use of ensembles of states to express uncertainty also has some interesting applications for the analysis of spatial data and is also a promising algorithm for estimating parameters for nonlinear models. Examples of these applications will be given in this talk.