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Statistical vs. stochastic orthogonality and the Ensemble Kalman filter

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Ensemble Kalman Filter became one of the most attractive Data Assimilation engineering procedures for its simplicity and nice properties inherited from the Monte Carlo approach. The filter uses a bridge from pure stochastics equations to their statistical counterparts - the law of big numbers. Derivation of the classical Kalman filter equations has a stochastic basis and utilizes a key notion of stochastic orthogonality - mutual independency of random variables. Additionally, realizations of the unofirm random noise generated each model time step are assumed to be independent. In most cases this again imply stochastic orthogonality.

The author suggests a notion of the Statistical orthogonality. Each time step the white noise serving the basis for the system noise and the measurement noise is generated and then modified to be statistically self-orthogonal and orthogonal to a fixed number of previously generated white noises. Measurement noise purification was presented by Wei et al. 2004 under the name "Breeding with orthogonalization", so the paper can be seen as a generalization of this approach.

The performance test results of the Ensemble KF with Statistical Orthogonality vs the classical Ensemble KF are presented for the simple Advection-Dispersion equation.