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A Bayesian approach to particle filtering

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Data assimilation using particle filters potentially offers unique advantages in highly non-linear situations where forecast/analysis uncertainty is clearly non-Gaussian. The cost of particle filters, however, can be computationally prohibitive in complex systems. In this presentation, a more efficient, local approach to ensemble-based particle filtering is introduced. The proposed approach consists of two steps, a Bayesian update and a smoothing procedure. In the first step, a Bayesian processor applied in a point-wise manner updates an a priori distribution generated by the ensemble forecasts (the background PDF) using observations that influence the analyzed grid-point. Anticipated noise across grid-points is mitigated by the second step of the approach, where the posterior field (ie, the analysis) is smoothed by an operator that penalizes departures between the spatial structure of the background PDF and the analysis increment, and effectively spreads out the information content associated with each observation to neighboring gridpoints. The concept will be illustrated, and compared with other, more traditional ensemble-based data assimilation method using the Lorenz-96 model.