Saddles and centers: effects of nonlinearity on assimilation

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Observations obtained from Lagrangian floats in a fluid flow offers one of the simplest examples of 'indirect' observations (integrals of prognostic variables). The dynamics of such Lagrangian particles has rich nonlinear dynamical features. We will contrast two basic phenomena – the shear around a nonlinear center and the divergence of trajectories near a nonlinear saddle point. We will illustrate the effects of such nonlinearities on data assimilation. In particular, we will discuss how the nonlinearities lead to the appearance of non-Gaussian distribution functions and failure of Kalman filter based methods, and compare these to exact sampling methods.