Assimilate Red-noise or Incomplete Observations via PDA

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Data assimilation and state estimation for nonlinear models is a challenging task mathematically. Traditional approaches were mostly developed based on the assumption of independent and identically (Normally) distributed observational noise. In practice, such kind of assumption is rarely met, furthermore the system of interest is often partially observed (either spatially/geographically or temporally), which makes the assimilation task even more challenging. Pseudo-orbit based data assimilation (PDA) provides an attractive, alternative approach in data assimilation in nonlinear systems such as weather forecasting models. PDA improves state estimation by allowing an enhanced balance between the information derived from the dynamic equations and the information derived from the observations. And PDA is not hampered by any assumptions of the observational noise. Empirical results based on Lorenz96 flow with red noise are presented for demonstration. In the case of partial observations, a two pass approach to PDA is taken; the first using background information of the unobserved state variables with the observations frozen, the second a standard application of the PDA approach. This is demonstrated in Lorenz96 system where the state vector is not completely observed.