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An Equilibrium Between Observational Gain and Chaotic Loss of Information in Data Assimilation Cycles

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Data Assimilation (DA) - Numerical Prediction (NP) systems are designed to monitor the behavior of natural systems. We interpret such systems as shadowing with observations. In this presentation, a general and minimalistic approach is proposed to model the behavior of the coupled Nature - Observing - Data Assimilation - Prediction (NODAP) system. In particular, the difference between the natural and simulated systems (i.e. error variance characterized by a wide spectrum of amplification factors) is assessed and decomposed into just two, a fast amplifying, and a decaying component.

In case of successful shadowing, the distance in the amplifying subspace between the natural and simulated systems is found to reflect an equilibrium between information gained in the DA step from observing the natural system, and information lost due to the chaotic expansion of errors in the NP step of the DA-NP subsystem. The parameter region that supports successful long-term shadowing is quantitatively studied in the space of observational information accessed by DA, chaotic error growth, the analysis ratio between the assumed observational and background forecast error variances, and the amount of noise added in the DA step.