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Estimating the State of Large Spatio-Temporally Chaotic Systems: Application to a Rayleigh-Benard Convection Experiment
MATTHEW CORNICK, BRIAN HUNT, EDWARD OTT, University of Maryland, MICHAEL SCHATZ, HUSEYIN KURTULDU, Georgia Institute of Technology —
Data Assimilation (DA) refers to the estimation of a dynamical system's state from the combined knowledge of past observations (possibly incomplete and noisy) and knowledge of an approximate model for the systems time evolution. Here we consider DA for spatio-temporally chaotic systems, and, in particular, we study the Local Ensemble Kalman Filter DA technique. We have applied this technique to Rayleigh-Benard convection undergoing spiral defect chaos. Using a system model (Boussinesq equations) and time series of noisy shadowgraphs we obtain estimates of the temperature and velocity field everywhere in a convection cell. This technique provides us with an indirect measurement of quantities previously inaccessible such as mean flow. We use the method to form initial conditions which are then used to produce a model forecast and compared to experimental data. In addition, we show how the technique can be extended to estimate fluid parameters such as the Rayleigh number.

Matthew Cornick
University of Maryland

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