

Some Principles and Rigorous Results for Parameter Reconstruction in Hydrodynamic Systems

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State and parameter recovery is a fundamental problem in modeling and applications, particularly in the context of hydrodynamic systems used for weather and climate prediction or simulation of turbulent flow, where the underlying models exhibit sensitive dependence with respect to both state and parameter. This talk will summarize some recent progress in our understanding of this problem in the context of such systems. The interplay between nonlinearity, various physical mechanisms intrinsic to these systems, the availability of time-series observations, and their relation to the reconstructability of the unobserved components of the state and latent features of the model will be demonstrated through several example systems, such as the Navier-Stokes equations, Primitive Equations of the ocean and atmosphere, the Rayleigh-Bénard Convection system, and toy models such as the Lorenz 63 and 96 systems. We will state convergence theorems for various algorithms and present numerical experiments that demonstrate the efficacy of these algorithms in achieving reconstruction of the unobserved state and unknown parameters of the system. This talk addresses various joint works with J. Broecker (University of Reading), G. Carigi (Indiana University Bloomington), E. Carlson (Caltech), A. Farhat (University of Virginia), J. Hudson (University of Arkansas–Fayetteville), T. Kuna (University of L’Aquila), A. Larios (University of Nebraska–Lincoln), Q. Lin (Clemson University), J. Murri (University of California–Los Angeles), E. Ng (Stony Brook University), S. Strikwerda (University of Wisconsin–Madison), X. Wan (Loyola University Chicago), and J.P. Whitehead (Brigham Young University).

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