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Reduced-Order Modeling of 3D Rayleigh-Benard Turbulent Convection. PEDRAM HASSANZADEH, Rice University, PIYUSH GROVER, SALEH NABI, Mitsubishi Electric Research Laboratories — Accurate Reduced-Order Models (ROMs) of turbulent geophysical flows have broad applications in science and engineering; for example, to study the climate system or to perform real-time flow control/optimization in energy systems. Here we focus on 3D Rayleigh-Benard turbulent convection at the Rayleigh number of 10^6 as a prototype for turbulent geophysical flows, which are dominantly buoyancy driven. The purpose of the study is to evaluate and improve the performance of different model reduction techniques using this setting. One-dimensional ROMs for horizontally averaged temperature are calculated using several methods. Specifically, the Linear Response Function (LRF) of the system is calculated from a large DNS dataset using Dynamic Mode Decomposition (DMD) and Fluctuation-Dissipation Theorem (FDT). The LRF is also calculated using the Green's function method of Hassanzadeh and Kuang (2016, J. Atmos. Sci.), which is based on using numerous forced DNS runs. The performance of these LRFs in estimating the system's response to weak external forcings or controlling the time-mean flow are compared and contrasted. The spectral properties of the LRFs and the scaling of the accuracy with the length of the dataset (for the data-driven methods) are also discussed.

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