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Characterizing the Chaotic Degrees of Freedom of High-Dimensional Fluid Convection[1] ALIREZA KARIMI, MARK PAUL, Virginia Tech — The variation of the Lyapunov exponent spectra and fractal dimension with system parameters can yield fundamental insights into the nature of spatiotemporal chaos. We explore this numerically for two systems: the Lorenz 96 model and Rayleigh-Benard convection. The Lorenz 96 model is a phenomenological model that captures important features of atmosphere dynamics. We compute the fractal dimension as a function of system size and external forcing for very long times and over many initial conditions. When varying system size we find extensive chaos with significant deviations from extensivity for small changes in system size and also the power-law growth of the dimension with increasing forcing. We use large-scale parallel numerical simulations to study chaotic Rayleigh-Benard convection for experimentally accessible conditions. We compute the variation of the fractal dimension with system size, Prandtl number, and Rayleigh number. Using statistical properties of the Lyapunov exponents and Lyapunov vectors we connect these features with the dynamics of the flow field pattern.

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