Log-lattice simulations of Rayleigh-Benard and rotating convection

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Abstract

Our ability to numerically study turbulent convection is limited by the high cost of direct numerical simulations (DNS) in the regimes relevant to geophysical and astrophysical flows. This motivates the development of alternatives to DNS which enable faster computation by using reduced models of the full dynamics. Here we explore the use of logarithmic Fourier lattices (LFLs) to capture extreme dynamic ranges of spatial scales in Rayleigh-Benard and rotating convection at high Rayleigh and low Ekman numbers. LFL schemes use a Fourier series with logarithmically rather than linearly distributed wavenumbers. By combining LFL horizontal discretizations with a sparse Chebyshev method in the vertical, we can simulate turbulent convection at a substantially reduced cost compared to DNS. Here we will discuss ongoing work to test different forms of LFL discretizations by examining their ability to reproduce spectra and scalings in Rayleigh-Benard and rotating convection. This includes formulations with different lattice spacings, triad weightings, and modifications for the inclusion of coherent structures.

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