Investigation of Flow Reversals in Vigorous Rayleigh-Bénard Convection

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Abstract

Experimental and numerical studies of thermal convection have shown that sufficiently vigorous convective flows exhibit a large-scale thermal wind component sweeping along small-scale thermal boundary layer instabilities. A characteristic feature of these flows is an intermittent behavior in form of irregular reversals in the orientation of the large-scale circulation. There have been several attempts towards a better understanding and description of the phenomenon of flow reversals, but so far most of these models are based on statistical analysis of few point measurements or on theoretical first order assumptions.
The analysis of long term data sets (> 10^7 time steps) gained by numerical simulations of turbulent 2D Rayleigh-Bénard convection enables us to get a more comprehensive view on the spatiotemporal flow behavior.
By means of a global statistical analysis of the characteristic spatial modes of the flow we are able to extract information about the stability of dominant large-scale modes as well as the reversal path in phase space. We examine PDF's and drift functions of two dimensional phase spaces spanned by different large-scale spartial modes. This also provides information about the coexistence of dominant modes.