Rotating turbulent flows to investigate zonal jets on the gas giants

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Abstract

The strong east–west jet flows on the gas giants, Jupiter and Saturn, have persisted for hundreds of years. Yet, experimental studies cannot reach the planetary regime and similarly strong and quasi-steady jets have been reproduced in numerical models only under simplifying assumptions and limitations. Two models have been proposed: a shallow model where jets are confined to the weather layer and a deep model where the jets extend into the planetary molecular envelope. Here we show that turbulent laboratory flows naturally generate multiple, alternating jets in a rapidly rotating cylindrical container. The observed properties of gas giants' jets are only now reproduced in a laboratory experiment emulating the deep model. In parallel, we adopt the approach of complete three-dimensional Global Climate Models (GCMs) solving for hydrodynamical Navier-Stokes equations and setting a Saturn's like "shallow-forcing" climate model. Our findings demonstrate that long-lived jets can exist in our laboratory and numerical experiments with comparible statistical flow properties than the one observed on the gas giants.

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