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An experimental approach on effects of topography in planetary fluid dynamics

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Motivated by geodynamical and seismological evidence for topography at the Core Mantle Boundary (CMB), we address the long standing issue of topographic effects on the dynamics in the fluid outer core. As a preliminary experiment we study the so called spin-up, a classical problem of rotating fluid dynamics, where motion of a contained fluid is created by a sudden increase of the rotation rate. Our experiments are performed in a cylindrical container with a chessboard like arrangement of square blocks on the bottom and we use particle image velocimetry and Kalliroscope visualisation to infer the flow dynamics. Several different horizontal length scales of the bottom topography (λ) are investigated, ranging from cases where λ is much smaller than the lateral extend of the experiment (R), to cases where λ is a fraction of R. Our results suggest that bottom topography enhances the decay of the flow in the container, an effect that is maximised at a particular λ. We demonstrate the presence of inertial waves that are excited at the bottom topography and propagate upwards, a process which may affect the transport of angular momentum in the fluid. Furthermore, we observe a reorganisation of the flow field in the container that is strongly connected to the topography pattern at the bottom of the tank, resulting in vorticity patches emerging predominantly at the length scale of the bottom topography.