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A laboratory model for thermal core–mantle interaction

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Motivated by the influence of the laterally heterogeneous lower mantle on the geodynamo, convection in a rapidly rotating cylindrical annulus with azimuthally varying boundary heat flux is studied experimentally. The absence of axial (z) gradients of the boundary heat flux ensure that the condition of quasi-geostrophy is satisfied even in strongly driven convection. Experiments are performed with water from below the onset of convection to highly supercritical states. The ratio of the azimuthal heat flux variation to the mean heat flux at the boundary is varied in the range 0–2. The coherent vortices that form beneath sectors of enhanced heat flux would likely concentrate the magnetic flux at preferred longitudes. However, shorter time averages of the flow reveal the presence of small scales whose role in the dynamo process is important. The intricate variations in core flow caused by the heat flux heterogeneity at the top of Earth's core are probably better visualized in annulus experiments than in spherical shell simulations. These flow variations can also produce a marked heterogeneity of the inner core.