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Experiments on baroclinic instability in a differentially heated rotating annulus

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Experiments of baroclinic waves in a rotating, baroclinic annulus of fluid are presented for two gap widths. The apparatus is a differentially heated cylindrical gap, rotated around its vertical axis of symmetry, cooled from within, with a free surface, and filled with de-ionised water as working fluid. The surface flow is observed with visualisation technique while Laser-Lightsheet technique is used for studies of subsurface flows. Velocity time series data of the flow are acquired applying Laser-Doppler-Velocimetry (LDV) technique. Temperature measurements using thermography give a detailed understanding of surface temperature distribution and its time-dependent behaviour.

We focus in particular on transitions between different flow regimes. Using a wide gap, the transition from axisymmetric flow to the regular wave regime is characterised by complex flows. The transition to irregular flows is smooth, where a coexistence of the large-scale jet-stream and small-scale vortices is observed. Furthermore, temperature measurements and Laser-Lightsheet observations show a repetitive separation of cold vortices from the inner wall. Processing of LDV-data enable us to analyse the underlying dynamics of flow states. Using a narrow gap, flow visualisations show no complex flows but strong hysteresis in the steady wave regime, with up to five different azimuthal wave modes as potential steady and stable solutions.