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Inertial waves in a rotating spherical shell: Comparison between numerical simulations and laboratory experiments

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In geophysical fluids, such as the atmosphere, the oceans or the liquid core of the earth, periodic flows can be found on all scales. Due to multiple reflection, e.g. on the curved boundaries of the spherical shell, wave energy can be focused on certain orbits [1,2], called wave attractors. These detached internal boundary layers have been studied experimentally in a rotating box [1], or a rotating cylindrical gap [3] since about 10 years.

We investigate such waves for the rotating spherical shell geometry, since for this geometry the theoretical understanding is hampered by the occurrence of singularities and a complicated Ekman layer structure. The angular velocity of the inner sphere varies in form of a sinus function, forcing the particles to be deflected from their rest position and thus exciting inertial waves. The waves propagate in the fluid with a fixed angle respect to the rotation axis. The angle depends on the wave frequency.
The experiment is governed by the Rossby and Ekman number, determined by the mean rotation and the viscosity. We vary the amplitude and frequency of the inner sphere′s modulation to control the wave excitation.

Previously we showed the generation of a range of frequencies in the equatorial region of the shell. Also a vertically oriented layer was found, touching the inner sphere’s equator. This layer reminds on a Stewartson layer but shows a different spatial structure.
In the present paper the decomposition for different forcing frequencies and their harmonics are discussed. We also vary the Ekman number to study the impact of viscosity in the flow. For better resolution we compared the measurements of Kalliroscope tracer and aluminium tracer particle. To get quantitative information we apply the Particle Image Velocimetry technique (PIV). Finally, experimental measurements are compared with numerical simulations for a broad range of Rossby and Ekman numbers. The new results together with our previous findings give a rather complete picture of the flow in the rotating spherical shell.

References

[1] L.R.M. Maas, J. Fluid Mech. 437, 13-28, 2001
[2] U. Harlander und L.R.M.Maas, Dynamics of Atmospheres and Oceans 44, 1-28, 2007
[3] Swart, A., L.R.M. Maas, U. Harlander, and A. Manders, Dynamics of Atmospheres and Oceans, doi: 10.1016/j.dynatmoce.2009.08.003 , 2009