Numerical simulations of banded jets in the laboratory

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It is natural to want to study banded jets in the laboratory, so that controlled and repeatable experiments can be performed in a wide range of dynamical regimes. The potential vorticity gradient required for zonation, which is supplied on a rotating sphere by the planetary vorticity gradient, is typically supplied in laboratory experiments by using either sloping topography or the parabolic shape of the free surface associated with solid-body rotation. Several such laboratory experiments have been performed to study zonation. Due to their small geometric dimensions, however, laboratory experiments have typically been unable to access dynamical regimes at the high Reynolds numbers relevant to zonation in planetary atmospheres and oceans.

In an attempt to access dynamical regimes at higher Reynolds numbers, Read et al. (2004, 2007) performed laboratory experiments on the French Coriolis platform, which has a diameter of 14 m. The experiments were performed in a rotating annulus, with an inner radius of 2 m and an outer radius of 6.5 m. The bottom of the tank sloped downwards with increasing radius, providing a topographic beta-effect. The local Reynolds numbers (based on the jet scales) were estimated to exceed 2000, which is at least an order of magnitude greater than in previous experiments. There was clear evidence of zonal jet formation on the Rhines scale, although there was substantial meandering of the jets and occasional splitting and mergers.

This talk will present results from the first study to attempt to simulate the laboratory experiments of Read et al. (2004, 2007). Fifteen high-resolution, long-duration numerical simulations have been performed using a two-layer quasi-geostrophic model, at various combinations of the baroclinic deformation radius and the Rhines scale. The numerical results will be compared with the laboratory experiments, in an attempt to gain an improved dynamical understanding of the jet features observed, and to investigate the impacts of finite baroclinic deformation radii on the jet spacing.

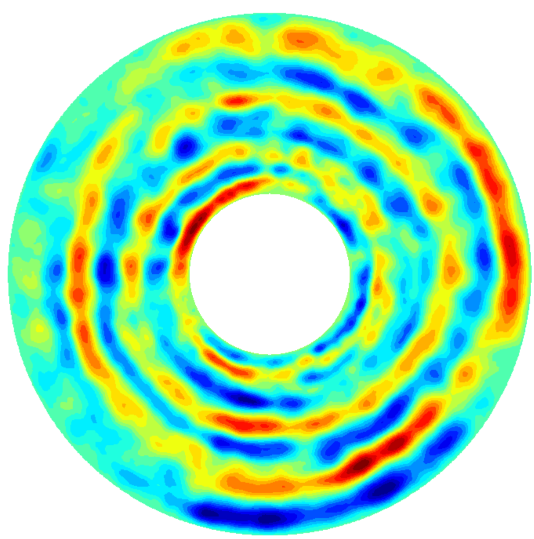

Figure 1 Baroclinic interface height perturbation in a quasi-geostrophic numerical simulation of a rotating annulus experiment performed in the laboratory.