EMS Annual Meeting Abstracts
Vol. 11, EMS2014-5, 2014
14th EMS / 10th ECAC

Zonal jet formation in numerical simulations of a large rotating annulus experiment

Paul Williams and Christopher Kelsall
University of Reading, Department of Meteorology, Reading, United Kingdom (p.d.williams@reading.ac.uk)

Zonal jet formation in planetary atmospheres and oceans has been the subject of several recent laboratory experiments. The highest Reynolds numbers have been achieved by Read et al. (2004, 2007) using a rotating annulus of diameter 13 m, although the jets that formed were relatively weak and meandering. Here we investigate these experiments by studying numerical simulations using a two-layer quasi-geostrophic model. The small-scale eddies in the initial state evolve through geostrophic turbulence and accelerate zonally as they grow in horizontal scale, first isotropically and then anisotropically. Evidence for a -5 power law is found in the energy spectrum of the zonal flow. In a suite of 15 simulations, the baroclinic Rossby radius and baroclinic Rhines scale are sampled by varying the stratification and root-mean-square eddy velocity, respectively. The conditions most favourable for producing strong persistent jets are large baroclinic Rossby radius (i.e., strong stratification) and small baroclinic Rhines scale (i.e., weak root-mean-square eddy velocity). By applying an objective method for diagnosing the jet width, the spacing between the jets is found to be 2–3 times larger than would be expected according to the usual definition of the Rhines scale, with a best estimate of 2.6 times larger. Our results suggest that future laboratory experiments on this scale would display jets that were stronger and more persistent if the stratification were stronger, the turbulent eddies were weaker, and the experimental duration were longer.