Geophysical Research Abstracts, Vol. 9, 00263, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-00263

Experimental study of planetary-scale turbulence and zonal jet formation

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In this work, we use a rotating annulus with differential radial heating to simulate aspects of quasigeostrophic turbulence and jet formation in the laboratory. Both the flat boundary and sloping boundary (topographic β-effect) cases have been investigated. In the flat case, we find that irregular eddies form in the fluid, interspersed by regions of rapid radial motion. In the sloping case, radial transport of fluid is constrained by conservation of potential vorticity, and the flow evolves into a meandering series of vertically sheared zonal jets. The barotropic zonal mean flow is stable according to the Rayleigh-Kuo criterion $\beta - U'' > 0$, and the characteristic jet width appears to be determined by the internal deformation radius, not the Rhines scale. Most interestingly, the jets become weaker at very high rotation rates, with the flow increasingly dominated by apparent wavelike motion. We discuss the relevance of our results to the atmospheres of the gas giant planets and to the oceans of Earth.