On the late-time behaviour of a bounded, inviscid two-dimensional flow

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Abstract

Using complementary numerical approaches at high resolution, we study the late-time behaviour of an inviscid, incompressible two-dimensional flow on the surface of a sphere. Starting from a random initial vorticity field comprised of a small set of intermediate wavenumber spherical harmonics, we find that – contrary to the predictions of equilibrium statistical mechanics – the flow does not evolve into a large-scale steady state. Instead, significant unsteadiness persists, characterised by a population of persistent small-scale vortices interacting with a large-scale oscillating quadrupolar vorticity field. Moreover, the vorticity develops a stepped, staircase distribution, consisting of nearly homogeneous regions separated by sharp gradients. The persistence of unsteadiness is explained by a simple point vortex model characterising the interactions between the four main vortices which emerge.

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