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Simulation of two-dimensional turbulent flows in a rotating annulus. (English) Zbl 1085.76546

Summary: Rotating water tank experiments have been used to study fundamental processes of atmospheric and geophysical turbulence in a controlled laboratory setting. When these tanks are undergoing strong rotation the forced turbulent flow becomes highly two dimensional along the axis of rotation. An efficient numerical method has been developed for simulating the forced quasi-geostrophic equations in an annular geometry to model current laboratory experiments. The algorithm employs a spectral method with Fourier series and Chebyshev polynomials as basis functions. The algorithm has been implemented on a parallel architecture to allow modelling of a wide range of spatial scales over long integration times. This paper describes the derivation of the model equations, numerical method, testing and performance of the algorithm. Results provide reasonable agreement with the experimental data, indicating that such computations can be used as a predictive tool to design future experiments.

MSC:
76M22 Spectral methods applied to problems in fluid mechanics
76U05 General theory of rotating fluids
76F99 Turbulence
86A10 Meteorology and atmospheric physics

Keywords:
Atmospheric fluid dynamics; rotating flows; spectral methods

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