Mechanical Engineering Master's Defense

Numerical Solution of a 2-D model for formation of Zonal Jets

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abstract

The formation and stability of a slowly evolving zonal jet in 2-D flow with beta effect is analyzed using the model developed by Manfroi and Young in which the final governing equation was derived by means of a perturbation analysis of a barotropic vorticity equation with sinusoidal meridional mean flow. However in the original study the term β0, that represents the effect of large-scale Rossby waves, was dropped and was proceeded on a path of finding solutions for a simplified 1-D flow. The idea of this study is to understand the effects of the dropped term on the overall dynamics of the zonal jet evolution. For this purpose the system that is entirely deterministic with no additional forcing is solved by means of a standard finite difference scheme. The Numerical solutions are found for varying β0 and μ values where μ represents the bottom drag. In addition to this the criteria for the formation of zonal jets developed originally for the 1-D system is verified for the 2-D system as well. The study reveals the similarity in some of the results of the 1-D and the 2-D system like the merging of jets in the absence of bottom drag, formation of steady jets in presence of a non-zero bottom drag and the adherence to the boundary criteria for the formation of zonal jets. But when it comes to the formation of steady jets, a finite β0 value is required above which the solution is similar to the 1-D system. Also the jets formed under the presence of non-zero bottom drag seem wavy in nature which is different from the steady horizontal jets produced in the 1-D system.

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