Mathematical Physics

Typhoon eye trajectory based on a mathematical model: comparing with observational data

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We propose a model based on the primitive system of the Navier-Stokes equations in a bidimensional framework as the l - plane approximation, which allows us to explain the variety of tracks of tropical cyclones (typhoons). Our idea is to construct special analytical solutions with a linear velocity profile for the Navier-Stokes systems. The evidence of the structure of linear velocity near the center of vortex can be proven by the observational data. We study solutions with the linear-velocity property for both barotropic and baroclinic cases and show that they follow the same equations in describing the trajectories of the typhoon eye at the equilibrium state (that relates to the conservative phase of the typhoon dynamics). Moreover, at the equilibrium state, the trajectories can be viewed as a superposition of two circular motions: one has period $2\pi/l,$ the other one has period $2\pi/b_0,$ where l is the Coriolis parameter and b_0 is the height-averaged vorticity at the center of cyclone.
Also, we compare our theoretical trajectories based on initial conditions from the flow with tracks obtained from the observational database. It is worth to mention that under certain conditions our results are still compatible with observational data although we did not truly consider the influence of steering effect. %Note that the %motion of the typhoon eye can not be totally determinated by initial %conditions due to the effect of ambient pressure field ("steering" %effect). Finally, we propose the parameter-adopting method so that one could correct the weather prediction in real time. Examples of our analysis and the use of parameter-adopting method for the historic trajectories are provided.

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