EGU2020-3610
https://doi.org/10.5194/egusphere-egu2020-3610
EGU General Assembly 2020

Centrifugal Instability of a Geostrophic Jet

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Oceanic and Atmospheric jets with sufficiently strong anticyclonic vorticity are subject to centrifugal instabilities. This mechanism is relatively fast in comparison to barotropic and baroclinic instabilities and require non-conservative forces that mix the fluid properties. In this work, we present a novel approach to compute the linear stability characteristics of both barotropic and baroclinic jets. This enables us to compute the growth rates and spatial structures very accurately and efficiently. Subsequently, by integrating the fully nonlinear, non-hydrostatic dynamics using the spectrally accurate numerical model SPINS, we validate the predictions of the linear theory and then investigate the nonlinear equilibration that results. Depending on the Reynolds number of the flows, there are instances where a secondary instability occurs that eventually produces vortical structures, some of which are themselves subject to centrifugal instabilities. This idealized investigation quantifies the effects of centrifugal instabilities as an initial step to determine how to parameterize them.