A sensitivity analysis for the interaction of a tropical cyclone and a tropopause front in a barotropic model

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We investigate the interaction of a tropical cyclone with a jet stream in a non-divergent barotropic model. The circulation of the cyclone excites Rossby waves on the strong potential vorticity gradient in the upper troposphere that is associated with the jetstream and which can be interpreted as a front. This has consequences for the motion and intensity of the cyclone as well as for the downstream development. Model runs for different vortex types and jet speeds indicate that resonant frontal waves -- those whose phase speed matches the zonal translation speed of the cyclone -- are decisive for the interaction. A pre-existing resonant wave on the jet modifies the interaction significantly. In this case the model evolution depends sensitively on the initial position of the cyclone relative to the troughs and ridges. We identify a bifurcation point located on the trough axis. Arbitrarily small displacements from this position determine whether a cyclone is advected towards the front and accelerated in the zonal direction, or is repelled from the front and decelerated. We compute singular vectors to determine the perturbations that have the largest impact on the cyclone motion. Furthermore, we investigate for which time spans the evolution of a perturbation is well-represented by a tangent linear model.