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Available Potential Energy budget for an axisymmetric tropical cyclone

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Investigating the evolution of Available Potential Energy (APE) in a tropical cyclone (TC) offers the opportunity to gain greater physical insight into the effects of diabatic processes on TC intensification and maintenance. For example, when TC processes are considered in terms of entropy, irreversible processes are by definition a source of entropy and therefore reduce the efficiency of the TC heat engine; local APE theory shows that in fact irreversible processes may be either a source or sink of APE and so they could in some situations promote intensification.
We present a budget of APE for the idealised axisymmetric TC model of Rotunno and Emanuel [1987], with Craig's modified microphysics scheme. The APE density is defined for each moist air parcel as the work released when the parcel moves from its initial position to its level of neutral buoyancy with respect to a reference state. A discretised APE density and APE production efficiencies are constructed to match the model equations. In the mature stage, the chief source of APE in the TC is the advection of APE along the near-surface radial inflow, with significant additional contributions from local APE production due to surface fluxes and the microphysics scheme. The intensification phase is characterised by increasing APE production efficiencies as well as changes in diabatic forcings.
We outline the link between the APE budget and TC intensification in terms of the kinetic energy budget, and question whether the choice of APE reference state affects the interpretation of diabatic processes as sources or sinks of APE. We also discuss how the components of the APE budget may be useful as process-oriented diagnostics for TC intensification in climate models.