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An isentropic perspective of the atmospheric overturning induced by Hector the Convector

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The overturning inside Hector the Convector, a tropical multicellular convective system of the Northern Australia that regularly overshoots into the stratosphere, is synthesized at the scale of a Large-Eddy Simulation (Dauhut et al., 2015). The isentropic analysis offers the advantage to filter out the reversible motions due to the gravity waves and to take into account the turbulent fluxes that contribute to the vertical transport. Two key circulations are evidenced: the troposphere-deep overturning and the mass exchange due to the overshoots into the stratosphere. The transition from deep to very deep convection is associated with a change in the diabatic tendency inside the tallest updrafts: the latent heat release due to the freezing of a large amount of hydrometeors overrode the loss of energy due to mixing with the drier, colder air of the environment. In agreement with a previous study of Hector examining the properties of its two tallest updrafts (Dauhut et al., 2016), the entrainment rate exhibits a minimum during the very deep convection phase, as low as 0.04 /km. The two-stream approximation corroborates the Eulerian computation of the vertical mass flux in the mid-troposphere and in the lower stratosphere. It however gives a lower estimate of the flux in the upper troposphere, filtering out the reversible motions, and a larger estimate in the lower troposphere and at the tropopause, where slow vertical motions contribute significantly to the transport.