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Helicity generation and maintenance by thermodynamically irreversible atmospheric processes

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In this communication, it is argued that the notions of entropy and helicity usefully complement each other when the vorticity generation/maintenance by thermodynamically irreversible processes in the atmosphere is studied. Two alternative forms of the helicity balance equation, known in the literature and differing in writing down the helicity buoyant production term, are applied to study the helicity budget of an idealized steady axisymmetric vortex, which serves as an exact asymptotic solution of inviscid Boussinesq equations. This helical Rankine-like vortex flow occupies the entire lower half-space, below a critical level, at which the radius of the vortex core becomes infinite. The vortex has a simple kinematic structure, which nevertheless necessitates a complex thermodynamical forcing for its support. Non-vanishing helicity flux (helicity emission) across the critical level is evaluated. This idealized vortex is then truncated at a certain height, well below the critical level, and embedded in a convectively unstable boundary layer, where a thin turbulent viscous surface-adjacent sub-layer provides principal helicity sinks. The resulting vortex model is used to mimic, in a crude sense, the kinematic structure of the central updraft of a convective cell (or a thermal), in which the atmospheric dust devils and/or tornadoes may be embedded.