Negative PV in warm conveyor belt airstreams: Observations, theory and models

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Ridges in meandering mid-latitude jet streams are associated with negative potential vorticity anomalies (in the Northern Hemisphere). These arise partly from the adiabatic advection of low PV air from further south along isentropic surfaces, and partly from “dilution of PV” by diabatic mass transport upwards across isentropic surfaces from the boundary layer into upper tropospheric ridges, associated with the outflow of warm conveyor belts within cyclones. Additionally, diabatic heating in the presence of vertical wind shear can produce negative PV anomalies of sufficient magnitude that the Ertel PV turns negative on the mesoscale, leading to locally enhanced jet stream wind maxima.

This study presents observational evidence for negative PV structures within warm conveyor belt air streams in the NAWDEX field campaign. Theory is used to explain the conditions under which negative PV can arise, the structure of the resulting negative PV structures expected and the ramifications for diabatic modification of the jet stream. Finally, the representation of negative PV structures in an operational NWP model is investigated, and the physical processes responsible for the diabatic heating and PV modification are identified, using online PV tracer diagnostics.