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Large-scale potential vorticity anomalies and deep convection

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The effect on deep convection of large-scale potential vorticity (PV) anomalies and their associated tropospheric stable layers is complex and not well understood. This article examines the meteorological events of 9 July 2007 (IOP7b of the Convective and Orographically-induced Precipitation Study (COPS)), which was dominated by an upper-level PV anomaly that stretched from the UK to southern France and as far northeast as Denmark. Three precipitation regions were identified from the case: lines of intense storms beneath the PV anomaly; less intense, more widespread convective precipitation to the east of the PV anomaly; and, in between, a region of no precipitation. The latter of these coincided with the high-resolution measurements and model analyses from COPS. The extensive and varied data analyzed in this investigation show that convective available potential energy (CAPE) was present in this region (the distribution of CAPE and convective inhibition (CIN) is presented via an innovative, pseudo-3D visualization that allows horizontal and vertical interactions to be considered). However, convection was capped by a complex arrangement of dry layers; the base of the key layer was at 750 hPa. These dry layers descended separately from the upper troposphere, moving around the PV anomaly as it developed from a breaking Rossby wave to the west during the seven days before the IOP. This case adds to other studies that show that descent of complex dry layers is an important mechanism for forming convection-inhibiting atmospheric lids in Western Europe. A simple conceptual model is developed that synthesizes the effect of large-scale PV anomalies on deep convection from a series of consistent case studies. This model has significant implications for storm forecasting and projections of storminess in future climates, as it highlights the importance of thin structures that can advect hundreds of km before having an impact.