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Horizontal dipoles of potential vorticity generated by convective storms

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The structure and dynamics of potential vorticity (PV) anomalies generated by convective storms is investigated both theoretically and in a numerical case study. Linear theory suggests that if the storm-induced heating is on a sufficiently small scale relative to the Rossby radius of deformation and the environment contains moderate vertical wind shear of order 1 m/s/km, then the dominant mode of PV is a horizontally oriented dipole. The horizontal dipoles are typically of larger magnitude e.g., 10 PVU than the vertical dipoles that have been studied extensively throughout the literature. Furthermore, the horizontal PV dipoles are realised almost entirely as relative vorticity anomalies on a time scale of order tens of minutes after the heating. The analysis of horizontal PV dipoles offers a new perspective on vorticity dynamics of individual convective cells, implying that moist processes play a role in the maintenance of small scale vortices in the storm environment.