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A case study of an explosively deepening, diabatic Rossby-wave induced cyclone: the influence of environmental conditions

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Diabatic Rossby waves (DRWs) are low-tropospheric positive potential vorticity (PV) anomalies that are continuously regenerated through diabatic processes, leading to a rapid propagation often along an intense baroclinic zone. It has been hypothesized that DRWs can be important precursors for rapid cyclone development. Previously, the mechanism of DRWs has been studied mainly in idealized channel flows.
Here a detailed case study of a DRW that is involved in explosive cyclone development over the North Atlantic is shown. Operational ECWMF analyses and forecasts, and simulations with the regional COSMO model are used to investigate the event.

An overview on the case study is given based upon ECMWF analyses, and a quasigeostrophic omega diagnostic is used that provides a height-attributable solution of the omega equation. The method demonstrates the absence of upper-level forcing during the DRW propagation phase. In the later phase, the overlap of lower- and upper-level induced ascent shows that the explosive intensification is caused by the interaction of the DRW with an approaching PV anomaly at the tropopause level.

In a second part, artificially modified sensitivity experiments with the COSMO model are performed to investigate the conditions that are important for DRW existence, development and eventually intensification.
The results confirm that moist diabatic processes are crucial for the DRW existence. The rapid DRW intensification in the final stage, however, mainly depends on the upper-level structures.