EMS Annual Meeting Abstracts
Vol. 10, EMS2013-732, 2013
13th EMS / 11th ECAM

Diabatic Rossby wave coupling enhancing shear and rainfall on a frontal wave

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Evidence is presented from a model simulation and aircraft data for the importance of a diabatically generated potential vorticity (PV) in driving vertical velocity and precipitation ahead of a frontal wave. Using a PV tracer technique, the PV anomaly is shown to be generated diabatically with almost no PV carried in by advection. In situ aircraft observations and dropsondes (IOP3 of the DIAMET experiment) show the structure of the PV anomaly and strong shears associated with it. Analysis of the model reveals a distinct wave propagating at 4-6km altitude below the heating occurring within the warm conveyor belt of the parent cyclone. Diabatically-generated PV is approximately in quadrature with vertical velocity indicating that it is a diabatic Rossby wave component. Below this near the boundary layer top, another wave was propagating in the same direction along the axis of the cold front through lateral advection of potential temperature - a lower boundary Rossby wave component. The dynamical mechanism for the origins of these two waves and their interaction is investigated. It is argued that this is a unique case where a diabatic Rossby wave, owing its existence to diabatic processes, was observed by a research aircraft. Since they develop rapidly and depend on the representation of cloud processes and latent heat release in models, it is anticipated that such diabatic Rossby waves would introduce considerable uncertainty into short-range (12-24 hour) forecasts.