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Tracking diabatic effects in simulations of extratropical cyclones through the use of potential vorticity tracers

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A key challenge in the design and improvement of numerical weather prediction systems is the accurate representation of parameterized processes and their impact on the grid-resolved flow. In an extratropical cyclone, broad regions of cloud and precipitation contribute large diabatic heating and cooling which in turn modify the structure of the cyclone. The processes that contribute heating are parameterized, and hence the capacity of a diabatic process (e.g., convection, large-scale precipitation, radiation) to modify the dynamical structure of a cyclone is addled by the involvement of a parameterization scheme. The DIAMET project (DIAbatic influences on Mesoscale structures in ExraTropical storms) was conducted to elucidate the role of diabatic processes in the dynamics and prediction of extratropical cyclones. DIAMET combined a programme of numerical experimentation with an airborne observational campaign. In this presentation, a method for tracking diabatic effects in high resolution simulations of DIAMET cases will be described, and the primary lessons learned from these simulations will be discussed. The method involves the use of a set of tracers which receive and accumulate tendencies of potential vorticity (PV). The analysis of PV tracers reveals a) how different parameterized processes modify the total PV and b) where in the storm are those changes realized. Examples of diabatic modification of cold fronts and warm conveyor belts will be presented, and the dependence of the simulated diabatic effects on model resolution will described.