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Resolved versus parameterised convection in numerical simulations of extratropical cyclones

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Diabatic processes determine the evolution of the atmosphere through the modification of mesoscale circulations and vice versa. Diabatic processes cannot be directly resolved in numerical weather forecast and climate models. Instead, they have to be parameterised in terms of resolved variables at grid scale. Basic research into the ways these processes and the atmosphere interact in numerical models and reality is paramount to improve the quality of weather and climate forecasts.
In this contribution newly developed theta-tracers are used to investigate diabatic processes as simulated via parameterisations in the Met Office Unified Model. The theta-tracer method decomposes diabatic changes in potential temperature in terms of parameterised processes. In addition, a by-construction conserved component of potential temperature serves to identify distinct air masses and track their displacement in an approximate Lagrangian specification of the flow field. Trajectory analysis was also used in order to determine the timing and location where diabatic processes became important. The analysis is short-term and has been restricted to the vicinity of an extratropical cyclone. The cyclone has been simulated using two different settings of the convection parameterisation scheme. The first setting corresponds to a standard configuration of the parameterisation scheme; the second setting corresponds to a reduction in the response of the scheme to large-scale convective forcing.
It is shown that the convection parameterisation regulates the action of large-scale latent heat exchange by the release of convective available potential energy. Moreover, it is shown that with reduced parameterised convection, large-scale latent heat exchange tends to eliminate convectively unstable regions in an abrupt manner. However, the regulatory action acts in both directions so that parameterised and resolved convection moderate each other. The potential implications of these results for longer-term simulations are also discussed.