1. Introduction

Diabatic processes are critical for 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 but have to be parameterised in terms of resolved variables at grid scale. Nevertheless, the parameterised version of diabatic processes plays a similar role in shaping the evolution of a model’s atmosphere. Basic research comparing the ways in which diabatic processes interact in numerical models and in the real atmosphere is paramount to improve the quality of weather and climate forecasts.

2. Effects produced by parameterisation differences

Although different short-range simulations of a single system can lead to broadly similar results when certain large-scale variables are assessed, important differences can appear in other dynamically meaningful fields. Figure 1 shows a trajectory analysis of a warm conveyor belt simulated with two models, Met Office Unified Model (MetUM) and the Co-ordinated Regional Scenarios Model (COSMO) model (Martinez-Alvarado et al. 2014). The similarity in pressure and specific humidity is remarkable (Fig. 1a, b). However, there are differences in potential temperature (Fig. 1c). MetUM trajectories reach higher isentropic levels. It can be shown that these differences are mainly due to differences in the convection parameterisation rather than differences in the dynamical core.

3. Same parameterisation, different parameters

The same parameterisation scheme (as used in MetUM and COSMO) was used (Martinez-Alvarado and Plant 2013). The first simulation (STD) uses standard parameter settings while the second (RED) has an increased CAPE closure timescale, effectively reducing the strength of parameterisation. The total rain rates in both simulations are similar, but the latter has a single snapshot (Fig. 2a, b) or an area-average throughout the period of analysis (Fig. 2c).

4. Mass redistribution

Despite similarities in surface fields and in the short-term evolution of the system, there are differences in the way that mass is redistributed vertically. REDCON produces more localised regions of ascent (Fig. 3a, b). A comparison of the position of the dynamical tropopause (2-PVU isosurface) shows that there is a wavelength displacement of one simulation with respect to the other (Fig. 3c). These differences might appear small. However, they provide a mechanism to generate larger forecast differences of the first kind in the medium- and long-range.

Differences in cross-isentropic motions are caused by differences in the representation of diabatic processes. The convective and microphysical parameterisations are both capable of deleting existing CAPE. In STD, microphysics (Fig. 4a) and conversion (Fig. 4d) contribute comparable amounts to total heating. In REDCON total heating is explained almost completely by microphysics (Fig. 4b).

5. Balance between parameterisations

Figure 5 shows a comparison of ascent (Fig. 5a, b) and total heating (Fig. 5c, d) in the two simulations. In both simulations the existing CAPE is depleted through the joint action of the microphysics (Fig. 5c, f) and conversion (Fig. 5g), but in the case of REDCON the heating along each trajectory occurs in a much shorter time span.

6. Conclusions and final remarks

- Different NWP models often produce approximately equivalent short-term forecasts for extratropical cyclones.
- This is despite the fact that different parameterisation schemes and their interactions show different responses to the large-scale conditions.
- The differences are manifest in the diabatic modifications to air masses passing along the warm conveyor belt.
- Modest short-range differences generated there might have important impacts for longer-term integrations.

References

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