Verification of EDMFm and EDKF in Harmonie

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EDMFm is an eddy diffusivity mass flux (EDMF) scheme developed at KNMI and applied in the Harmonie and RACMO model. Recently it is tested against EDKF for one summer and one winter month in an extensive verification experiment set up by Xiaohua Yang.

1. Introduction

In the so-called EDMF approach [1] small-scale turbulent and larger-scale convective transport are parameterized in one consistent framework. EDMFm is an EDMF scheme developed at KNMI. We start with a short description of EDMFm and subsequently discuss a verification of this scheme against the already longer available EDKF scheme.

2. The EDMFm scheme

The most important differences between EDKF and EDMFm concern the convection scheme. The basic framework of the EDMFm convection scheme is the dual updraft transport model of [2]. However, in comparison with [2] EDMFm contains several modifications. Most important difference is the parameterization of the lateral mixing ([3], [4]). In contrast to EDKF and most other mass flux schemes, the mass flux profile and the fractional entrainment coefficient are treated independently (for a theoretical foundation see [4]). The cloud layer height dependence (not captured by most other mass flux schemes including EDKF) and the dependence on environmental as well as updraft properties are taken care of by a flexible detrainment coefficient. These dependencies are based on LES results.

3. Verification

After several 1D and 3D testcases, EDMFm is recently validated in an extensive verification experiment. The verification concerns a winter (January 2010) and summer month (August 2010). One of the best parameters to study the impact of the convective transport are specific humidity profiles during unstable conditions. Fig.1 shows some improvement with EDMFm in that part of the atmosphere where impact of the convection scheme can be expected. However, most verification results do not show a significant difference between EDMFm and EDKF. Although the overall meteorological impact of EDMFm compared to EDKF is quite small there are two reasons

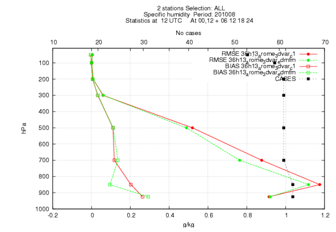

Figure 1: Verification of the specific humidity profiles of EDMFm (green) and EDKF (red) against radiosonds for 12UTC at 2 stations (approx. 60 cases) for August 2010. Shown are the bias (squares) and the RMSE (circles).

why this outcome can be considered positive. Firstly, we are just getting experience with the performance of EDMFm in 3D runs and consequently almost no optimizations are done. For example, updraft precipitation, wind mixing, mass flux closure etc. are not yet adjusted to the Harmonie model. EDKF on the other hand has regularly been updated during its use for several years in the operational AROME. So EDMFm updates improving the performance can be expected in the near future. Secondly, EDMFm runs indicate approx. 15 % CPU time reduction compared to EDKF. Fig. 2 shows the CPU time usage for the here described summer and winter month. Probably the reduction in CPU time is less in winter due to decreased convective activity. Finally,

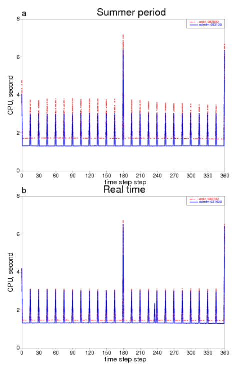

Figure 2: Cpu costs per time step for a summer (upper panel) and winter period (lower panel)using EDMFm (blue) and EDKF (red).

to illustrate the capabilities of Harmonie, here including EDMFm and the cloud scheme update, we show a case with cloud streets formed above the Netherlands well captured by the model (Figs.3, 4).

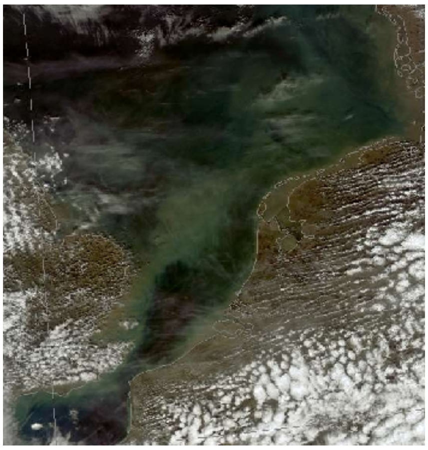

Figure 3: Satellite image of cloud streets 11th of March 2011 13 UTC

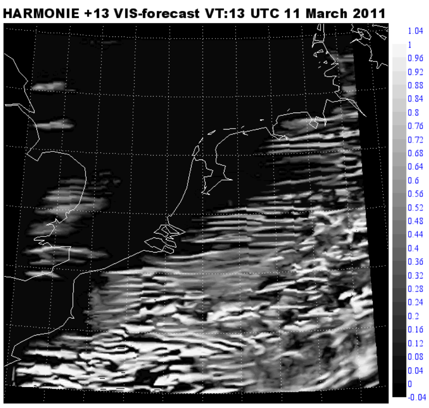

Figure 4: Harmonie (EDMFm with cloud scheme update) cloud fraction 11th of March 2011 13 UTC

4. Conclusions

Recent verification of Harmonie shows promising results for the EDMFm scheme. Moreover, runs with EDMFm i.o. EDKF indicate an overall reduction in CPU usage of approx. 15%. Further improvement in the performance can be expected as the scheme is hardly optimized fur usage within the Harmonie model.

5. References

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