First experiments with ALARO-10km

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1. Summary

The technical feasibility of ALARO-10 is demonstrated here. The idea is to import the Méso-NH sophisticated physics in an AROME-thinking manner inside the ALADIN dynamical kernel but at 10 kilometers horizontal resolution. This is done first in a one-dimensional context and then on a 3D real case (the Gard heavy flood of September 2002). The aim there is to recover the same type of forecasts from a Méso-NH experiment and from an ALARO-10 experiment. We can conclude here that this part of the sub-project ALARO-10 of ALADIN2 has proved satisfactory. Now next steps will be to demonstrate the "operational" feasibility : to prove that the unavoidable supplementary cost is compensated by a gain in the quality of the forecast.

2. Introduction

ALARO-10(km) is a sub-project of the ALADIN2 project (see ALADIN2 2004 Work Plan) designed in order to verify that the developments introduced at finer scales (AROME-type, see Newsletter 25) can also have an interest at coarser scales. Such scales are the ones currently used in ALADIN : regional ones around 10 km or less, depending on operational use of ALADIN in the different countries. So the first action in ALARO-10km is to build what can be called an AROME-10km as it contains the same dynamical kernel and the same physical parametrisations (coming from the research model Méso-NH) as in nominal AROME. The main difference between ALARO-10km and AROME is that the first one has got one more parametrization, for deep and shallow convection. Indeed, at regional scales, the convection is not resolved.

The aim of this exercise is first to demonstrate the feasibility of the idea. This aspect is assessed by comparing the behaviour of ALARO-10 with the one of Méso-NH. The goal is to reproduce the same behaviour in both models. This is the point we have reached now. Then the question is to evaluate the supplementary cost, the gain in the forecast that can be reached, the part that can/should be optimized in order to assess an affordable cost/efficiency ratio for all ALADIN partners. This will be the next step of this ALARO-10 sub-project.

This article is mainly devoted to the comparisons between Méso-NH and ALARO-10. After a description of the ingredients of ALARO-10 (3.1), we show a 1D experiment in order to verify the transplant of the convection parametrisation in ALARO-10 (3.2), then we show some results on a 3D experiment, the case of the Gard flood (3.3), before drawing some concluding remarks (4).

3. The experiments

3.1 The current ingredients of ALARO-10

The ALARO-10 prototype is based on the AROME one. Thus we retrieve there a lot of elements coming from AROME.

Dynamical kernel:

ALARO-10 keeps the possibility to run either in hydrostatic or in non-hydrostatic mode. This is a difference with AROME as indeed at 2.5 km AROME runs in NH mode.

Physical parametrisations:

Same as in AROME. These parametrisations consist in a detailed micro-physics with five more prognostic variables (*qc* cloud droplets, *qr* rain, *qi* ice crystals, *qs* snow and *qg* graupels), a prognostic TKE (Turbulent Kinetic Energy), the radiation scheme is the one used at ECMWF (RRTM) and finally a surface scheme which includes four different surface types (town, sea, lake and river, soil and vegetation). The main difference with AROME is the addition of a parametrization for the deep and shallow convection. The convection scheme is a Kain Fritsch mass-flux parametrisation adapted for Méso-NH by Peter Bechtold, the so-called KFB scheme (Bechtold *et al.*, 2001).

3.2 A one–dimensional experiment

First, the KFB convection parametrization was imported from the Méso-NH physical package inside the one-dimensional AROME physical-dynamical interface. Then a run was performed on a convective profile in order to compare Méso-NH and ALARO-10 1D outputs after one time-step. Figure 1 shows the comparison between ALARO-10 and Méso-NH runs after one time-step for the temperature tendency. Figure 2 shows the same comparison but for humidity variables tendencies (*qv*, *qc*, and *qi*). From these two figures one could see that the tendencies are equivalent, allowing to validate the good interfacing of the KFB convection parametrization inside the AROME/ALARO physical-dynamical interface.

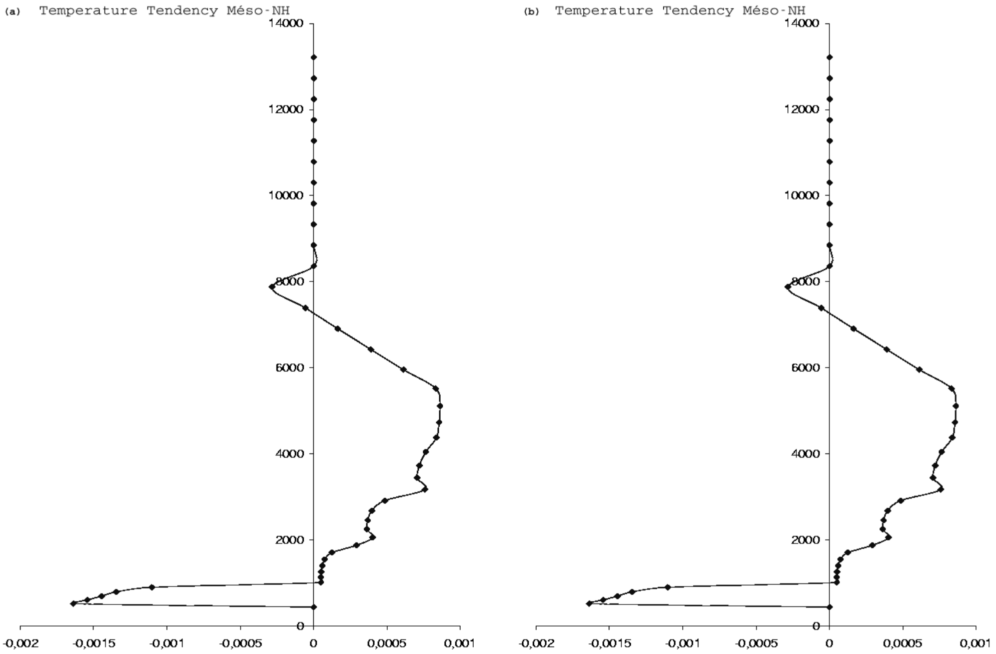

Figure 1: 1D experiments, temperature tendency after one time-step (a) ALARO-10, (b) Méso-NH

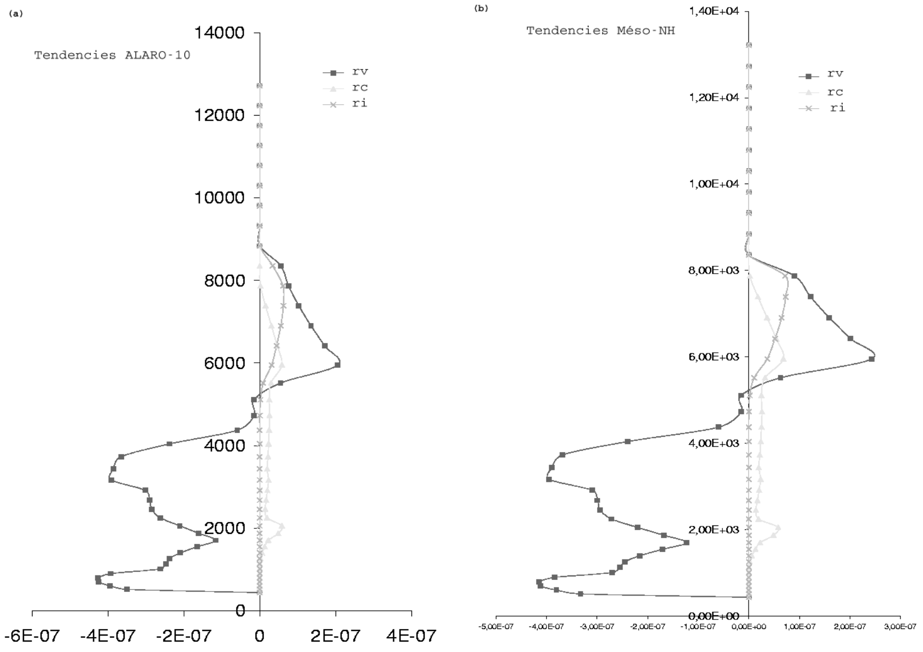

Figure 2: 1D experiments, *qv-qc*, *qi* tendencies after one time-step. (a) ALARO-10, (b) Méso-NH

3.3 The case of the Gard flood

A 3D experiment is then performed. The case chosen is the one of intense flood over the Gard department (southern France). We run a 12 hours forecast starting from the 2002.09.08 at 12 UTC. Again, the aim there is to retrieve the same behaviour as the one of the Méso-NH model. The reference run (Méso-NH) is performed with a 15 s time-step, a call to the radiation scheme every 15 minutes and a call to the convection parametrization every 5 minutes. The Méso-NH model is using an anelastic system and runs with Eulerian dynamics. The ALARO run is done with a call to the radiation scheme every 15 minutes and to the convective parametrization every time-step. The dynamics used is either HPE or NH and it runs with a semi-implicit semi-Lagrangian two-time-level scheme. This last aspect allows to use longer time-steps than in Méso-NH. We performed experiments with 60 s, 120 s and 300 s time-steps. The figures presented here were obtained with the 60 s hydrostatic run. The domain (same for both models) is 192×192 points large with 41 vertical levels. The horizontal resolution is about 10 km in both models.

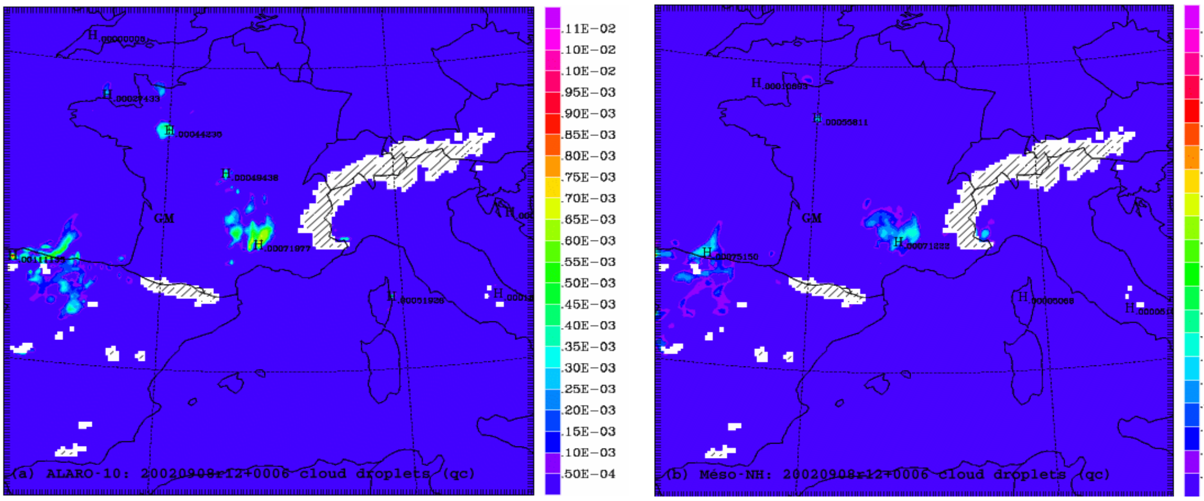

Figure 3: Comparison between ALARO-10 and Méso-NH, the Gard case. Cloud droplets field after 6 hours forecast 2002.09.08r12+0006. (a) ALARO-10, (b) Méso-NH.

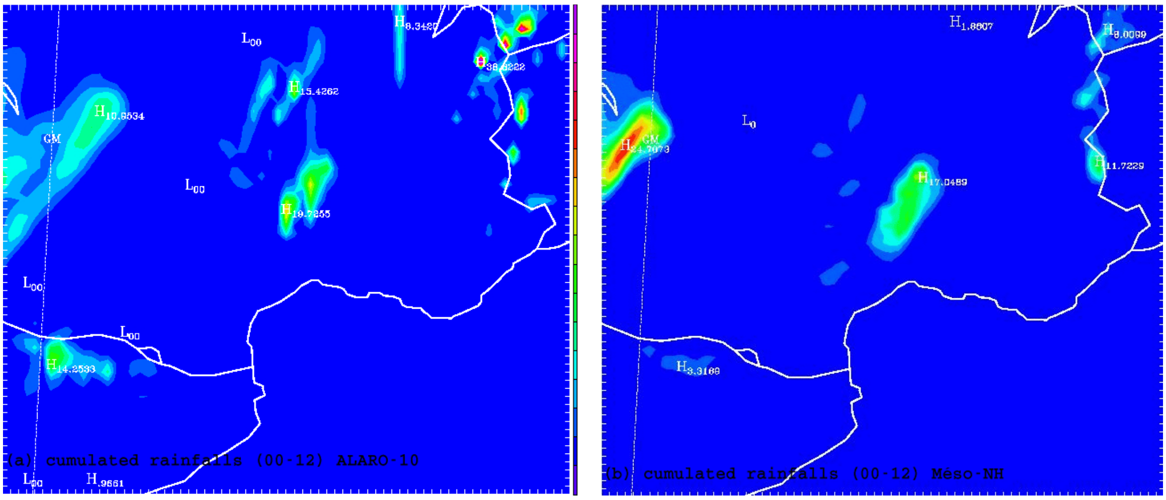

Figure 4: 12 hours forecast, 2002.09.08r12+0012, cumulated rainfalls. The domain is a geographical zoom on the area where the heavy flood occurred. (a) ALARO-10 and (b) Méso-NH

The comparison of the historical fields of the models shows a good accordance between the two. An example is given in Figure 3 where the cloud-droplet field is drawn. For diagnostic fields such as the cumulated rainfalls (see Figure 4 for a zoom on the domain where the heavy flood occurred) some differences can be found. The shape of the pattern is not exactly the same (two cells and more rain northward in the ALARO case) and there is more activity above the Alps in ALARO than in Méso-NH. But the maximum rainfalls (not located exactly at the same place) are of the same magnitude in both cases (20 mm in 12 hours both in ALARO and in Méso-NH). Indeed, both simulations are not realistic enough if one attempts to compare with the real cumulated rainfalls (more than 300 mm), but the simulations are in good accordance showing that it is possible to reproduce the Méso-NH solution in ALARO.

4. Conclusion

The aim of the first ALARO-10 experiments was to demonstrate the technical feasibility to import the Méso-NH physics inside the ALADIN dynamical kernel. This point was in fact reached as the comparison between both models shows good accordance. We were also able to run longer time steps than the ones of Méso-NH thanks to ALADIN dynamics. But indeed the ALARO runs are more expensive than ALADIN runs because of the use of a more sophisticated physics and also of more prognostic variables. So now a new step has to begin in order to evaluate the gain given by this new physics (from a meteorological point of view) and also more precisely the supplementary cost in order to optimize it as much as possible. This will be the future actions of the ALARO-10 sub-project.

5. References

Giard D., G. Hello and J-F. Geleyn, 2004: Work plan for ALADIN2 in 2004, available at http://www.cnrm.meteo.fr/aladin/scientific/2004-program.html

Seity Y. and P. Jabouille, 2004: First tests of the AROME prototype. Newsletter 25, available at http://www.cnrm.meteo.fr/aladin/newletters/newsletters.html

Bechtold, P., E. Bazile, F. Guichard, P. Mascart and E. Richard, 2001: A mass flux convection scheme for regional and global models. *Quart. J. Roy. Meteor. Soc.*, **127**, 869—886.

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