Testing bulk parameterization of microphysics in ALARO 10

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Summary

The most recent development in Meteo France is a high resolution (<10 km) model, AROME. Its prototype is based on ALADIN non-hydrostatic dynamic core and physics parameterisations from Meso-NH. At the same time a project ALADIN-2 is under way. One of its subprojects is ALARO 10, a hydrostatic counterpart of AROME, to be used on the 10 km scale with longer time step. In short terms it can be described as ALDIN hydrostatic dynamic core and physics parameterisations from Meso-NH plus parameterisation of convection.

For microphysics a bulk parameterisation is used with five water spices, these are: cloud water, cloud ice, rain, snow an graupel. This scheme is used for precipitation on resolved scales. For convective precipitation Kain-Fritch-Bechtold parameterisation is used.

The first results with ALARO 10 prototype revealed a dependency of precipitation amounts coming form microphysical scheme on time step. With longer time steps there is more precipitation than with shorter ones. To cure this problem a time splitting for microphysical scheme was introduced in the model. The microphysical scheme for each vertical column is calculated several times for one time step of the model. This is controlled by number of iterations of microphysics, so the time step for microphysics is given as MPSTEP= TSTEP/NITER, where MPSTEP is a time step for microphysics, TSTEP is a time step of the model and NITER the number of iterations.

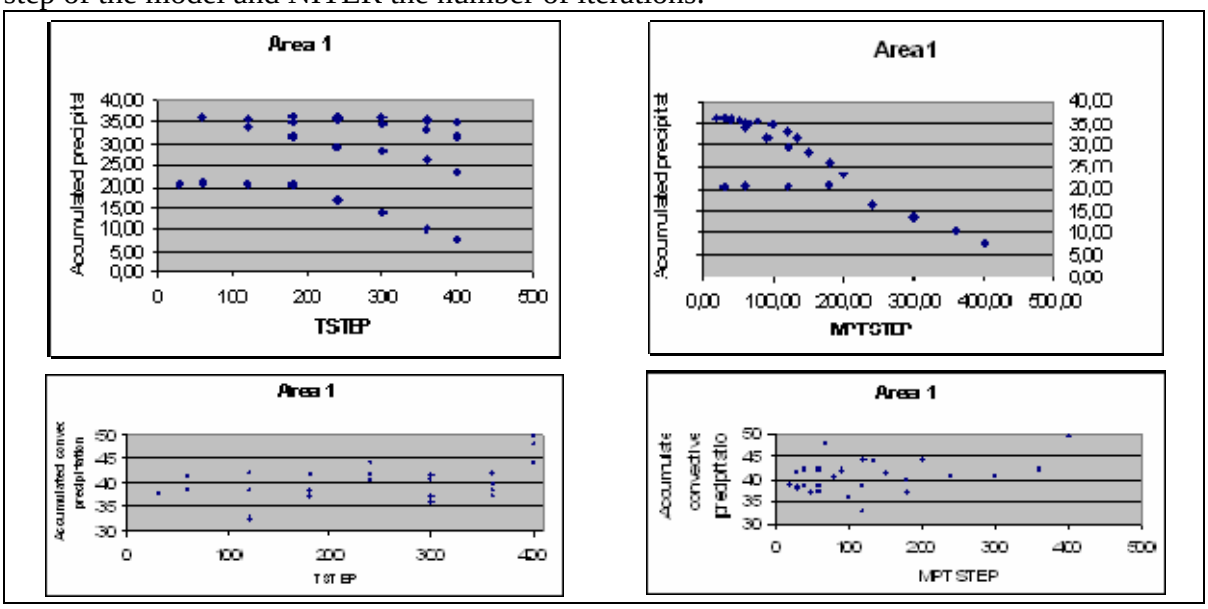

Figure 1: Gard case, area 1.Scatter plot of dependency of maximal amount of accumulated precipitation on time step and number of iterations. Upper row is for precipitation coming from microphysical scheme, lower row is for precipitation from convective scheme.

The effect of iterations of microphysics was studied on flood case in south of France. The flood took place in the Gard department on 2002-09-08. This case was used to test AROME, too. Initial time for ALARO 10 run was 2002-09-09, 12 UTC. A number of 12 hours runs

were done with various combinations of time steps and numbers of iterations. Time steps used were: 30, 60, 120, 180, 240, 300, 360 and 400 s, and numbers of iterations were: 1,2,3,6 and 9, but not all on each time step.

The results for maximal amounts of precipitation in two separate areas of precipitation are shown on figures 1 and 2. In upper rows is precipitation from microphysical scheme and in lower rows from convective scheme. For each time step several runs were done with different numbers of iterations. On the left side, in both figures, over each time step there is several points with higher and higher amount of precipitation, corresponding to increasing number of iterations. The lowest points on scatter plots correspond to one iteration, or no iterations, first one over it is for two iterations and so on. Dependency of maximal amount of precipitation on time step for microphysics is shown on the right sides of figures. Points over one time step for microphysics are from different time steps of the model.

Precipitation are 1 is in Gard department. It is dominated by convective precipitation. Dependency on time step and number of iterations is shown in upper left corner of Fig. 1. Lowest points, no iterations of microphysics, show what was known from the first tests of ALARO 10, that amount of precipitation is growing with shorter time step. About time step 200 s it stops growing and remains mainly constant. We can say that it converges to the finite value as time step is going to lower values. Other points form a separate group with values converging to the same value for each time step. We can say that irrespective of time step the amount of precipitation converges to the same value when number of iterations is growing. The problem is that this with iteration and without them there are different value to which amounts of precipitations are converging. The same can be seen on the upper right side of Fig. 1, where two branches of points can be noticed. In the lower row of the Fig. 1 scatter plots for convective precipitation are shown. No dependency on time step or number of iterations can be seen on them.

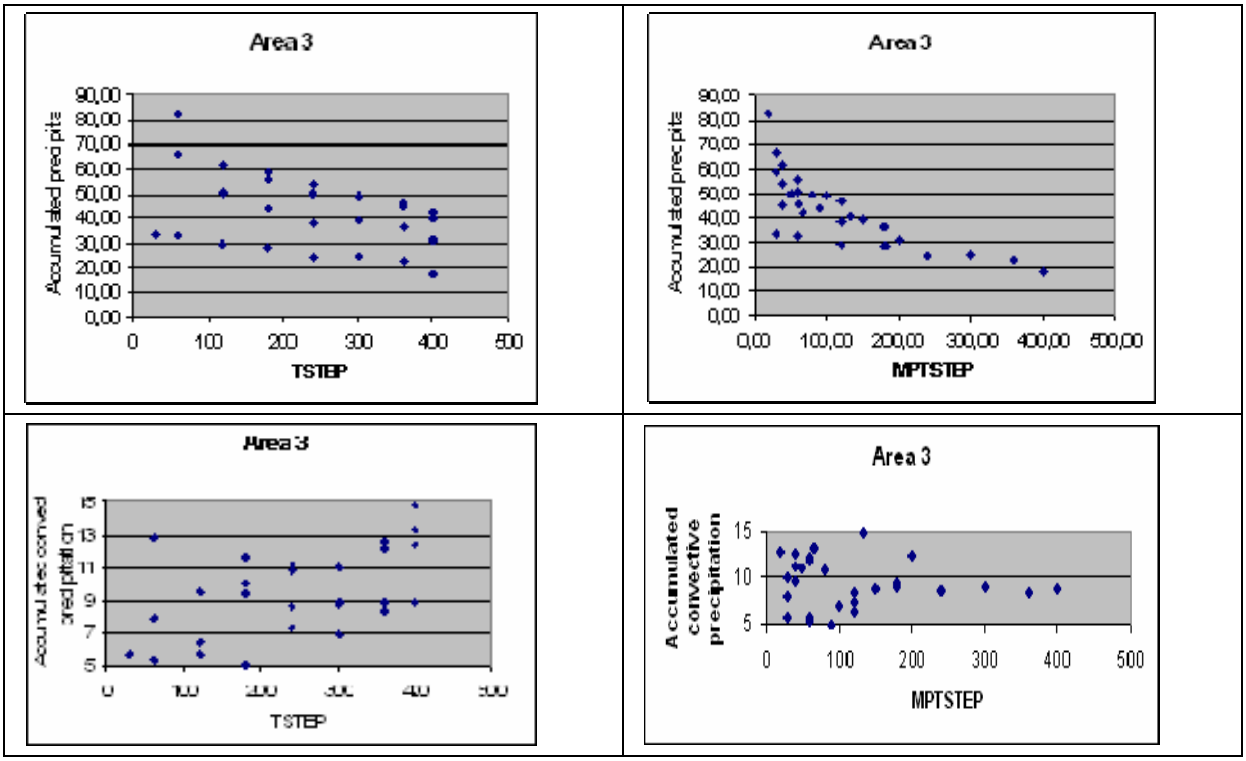

Figure 2: Same as Fig. 1, only for area 3.

Other precipitation area, noted number 3, is connected to the frontal system approaching southern France from the west. In this area more precipitation is coming form resolved precipitation, that is from microphysical scheme than from convection. Results are

shown on Fig. 2. On the upper left scatter plot the dependency on time step is shown. Lowest points, corresponding to no iterations of microphysics, show convergence to a finite value as time step is shorter. Again, for each time step amount of precipitation is converging with growing number of iterations (the spacing between points is diminishing), but limiting value is dependant on time step. These limiting values are not converging to one value, because there is a point, coming form TSTEP= 60 s and NITER= 3, whish gives a southern jump in precipitation amount. Without this point wee could say that limiting values are slowly converging to finite value, but again different from that achieved without iterations. Convective precipitation in this area is slightly dependent on time step. It is increasing with increasing time step.

After testing bulk parameterization of microphysics in ALARO 10 on one case following conclusions can be drown:

- The amount of precipitation increases with decreasing time step, and for converges for both studied areas of precipitation.
- Iterations of microphysics, or time splitting, doesn't converge always, and when it does it is not the same value of amount of precipitation as when time step is decreasing without iterations of microphysics.
- More cases have to be studied to reach final conclusion.