Progress with the 3MT scheme in Alaro-0

Luc Gerard (luc.gerard@oma.be), teamwork implying Radmila Brozkova, Jean-François Geleyn, Doina Banciu

RMIB – CHMI – INMH

The Alaro-0 model was developed for operational forecast at high resolution, especially with grid-box lengths between 10 and 2km. It includes more elaborated physical parametrisations than the operational Aladin, e.g. prognostic peusdo-TKE for turbulent diffusion, an enhanced radiation scheme, a microphysics with 4 prognostic condensed phases (2 precipitating species) or the "3MT" scheme allowing a consistent treatment of the subgrid deep convective processes and their combination with the resolved cloud and precipitation schemes. 3MT implements in Alaro-0 the package described by Gerard (2007), including ideas of Piriou *et al.* (2007). Its main components are prognostic mass-flux schemes for deep convection, an interface of the latter through transport and condensation fluxes, a cascading approach to combine the resolved and subgrid moist processes.

For comparison and tests, a simplified version ("LSTRAPRO") of Alaro-0 was used, applying the microphysics to resolved clouds and precipitations but keeping the old diagnostic deep convection scheme instead of using the 3MT package. In this case, the prognostic microphysics is fed by the sole resolved condensation, while the deep convection scheme only produces precipitation reaching the ground within a single timestep, plus a diagnostic contribution to the cloudiness.

This LSTRAPRO scheme was found to give satisfying scores compared to the operational Aladin, when running at 9km (however the inconsitency of maintaining two separate precipitation schemes would compromise the higher resolution results). This was taken as a reference to test the full 3MT package. At the beginning of 2007, the tests of the 3MT at 9km showed it produced insufficient precipitation, while the scores over a 10-days period were quite deceiving. There was an unacceptable positive bias of the mean sea-level pressure, an excess moisture at high levels, a cold bias at the lower level. The geopotential presented a "dipole" bias, positive below 500 hPa and negative higher. The intensive research effort performed from April to September revealed several sources for these problems, including :

- bugs in the coding,
- unexpected behaviour, such as the evaporation by the resolved scheme of the convective cloud generated at the previous time step, because after advection it was assumed to mix with the entrire grid-box,
- problems of numerical consistency,
- approximations in the formulation which together appeared more nocive than expected.

Various tools helped in this work, such as the verification chain (VERAL), the Single Column Unified Model (SCUM) or the DDH (Horizontal Domain Diagnostics) – all of which having been adapted to the new context of Alaro-0. Solutions have been developed to address all the above-metioned weaknesses.

The scores of the present of Alaro-0+3MT at 9km are at least as good as those of the LSTRAPRO version, while the precipitation forecasts appear quite better.

Figure 1 shows that the excessive clouds and preciptiation over Baleares and Western Mediterranean Sea produced by the LSTRAPRO (and the operational Aladin) schemes are no longer there with the 3MT scheme. The structure is more realistic, even though there is still a grid-point storm above Moldavia.

A few problems are still under investigation. On Figure 2, one observes an excessive moistening and heating around 600hPa by the deep convective transport. This is linked to the local reduction of the updraught mass flux around the triple point level, where precipitation melting cools the environment.

Tests at finer resolution have been started (Figure 3). The forecast at 4km, in the so-called grey-zone of the convection, stays consistent with the other scales and no bogus phenomenon appears at this resolution.

References

Gerard L. 2007. An integrated package for subgrid convection, clouds and precipitation compatible with meso-gamma scales. *Q. J. R. Meteorol. Soc.* **133**: 711-730.

J.-M. Piriou, J.-L. Redelsperger, J.-F. Geleyn, J.-P. Lafore and F. Guichard, 2007. An approach for convective parameterization with memory, in separating microphysics and transport in grid-scale equations. *accepted in J. Atmos. Sci.*

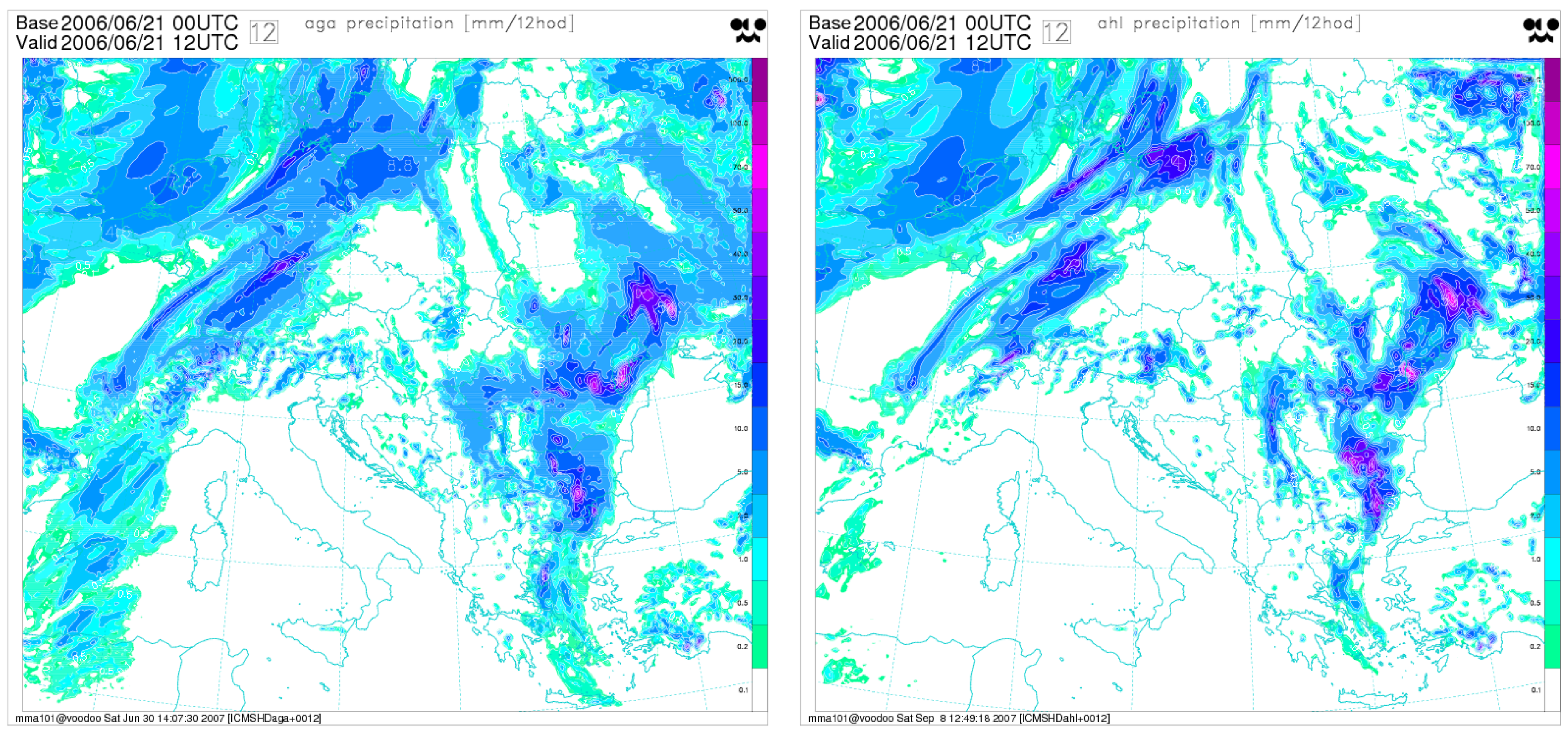

Figure 1: Precipitation maps with LSTRAPRO (left) vs 3MT (right). The structure of precipitation in operational Aladin was was quite similar to the LSTRAPRO simulation.

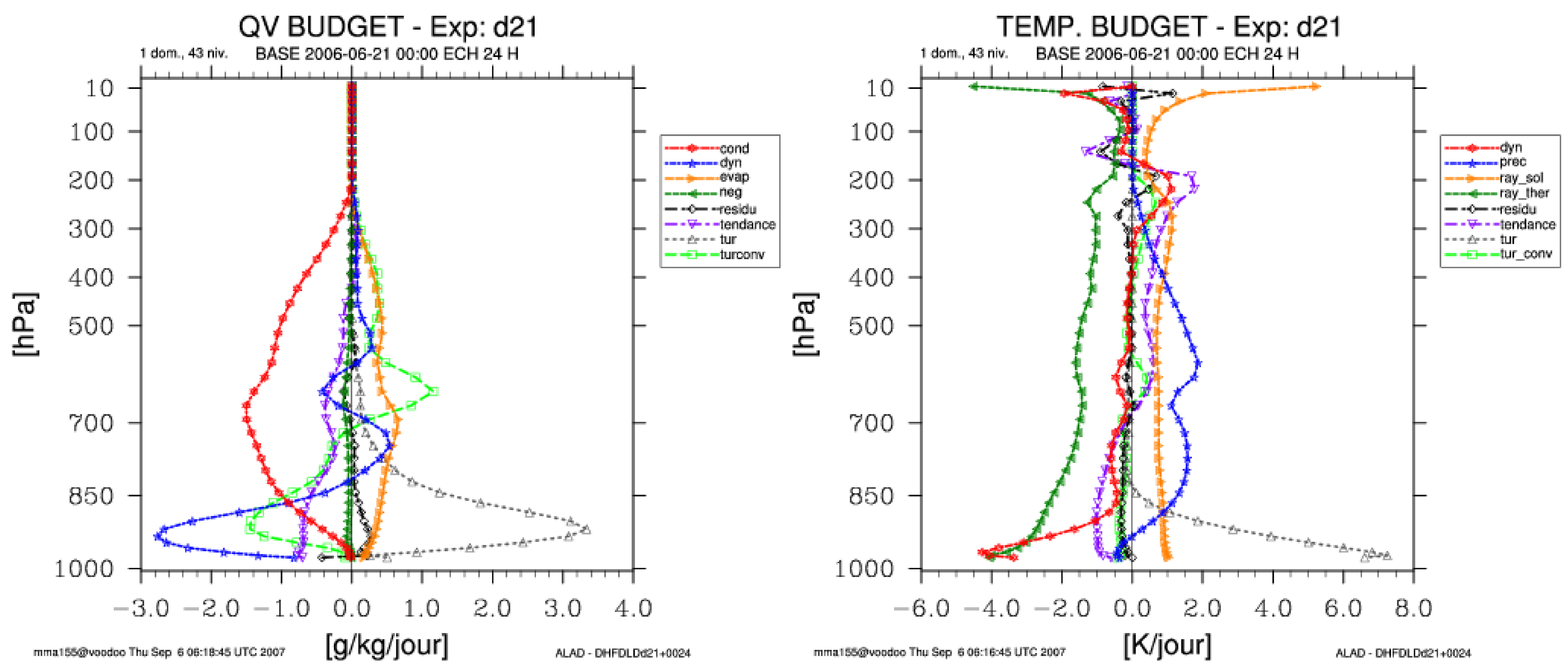

Figure 2: The DDH tool produces mean verticals budget over a chosen area, showing the components of the physical tendency. Left: components of the water vapour tendency (condensation, dynamical, precipitation evaporation, correction against negative water species, turbulent transport, convective transport). Right: components of the temperature tendency (dynamics, condensation/evaporation, radiation, turbulent transport, convective transport).

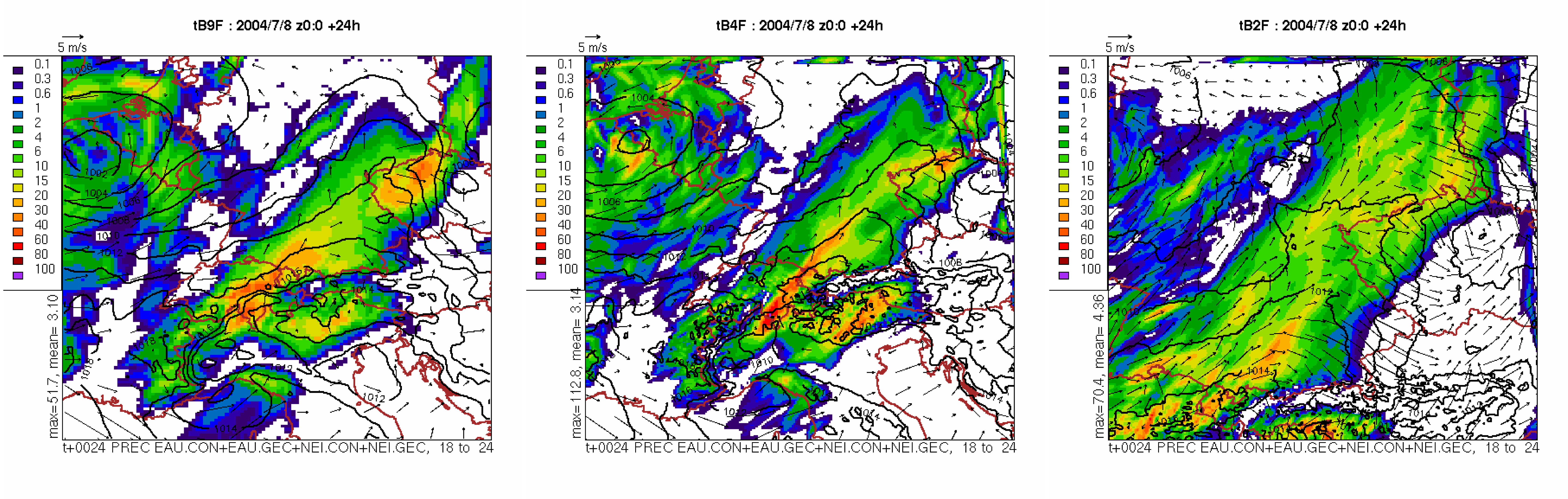

Figure 3: 6-hour precipitation forecast at 9km (left), 4km (center) and 2km (right, smaller area). Cold front over Bohemia/Bavaria.