AROME-ALADIN special workshop

April 11-12, 2003, Prague

5 - Specific problems linked to the AROME / ALADIN physics and its interfacing

Given the choices now made for the physics of its nominal 2.5km version (Meso-NH's one) and for its dynamical core and variational backbone (both from ALADIN), work on AROME will differentiate itself from what would have been the run-of-the-mill continuation of ALADIN business mainly in three scientific aspects: the physics and its interfacing (i), the coupling (ii) and the use of imagery-type observed data (iii). The former aspect gets even more emphasis when one considers the added objective of a so-called 10km version of the AROME software. While there is no apparent gap between the assimilation of data within the envisaged scales and knowing that the ALADIN-NH dynamics is a 100% compatible extension of IFS-ARPEGE-ALADIN hydrostatic primitive equations, the complete change of scope for the design of parameterisation schemes between the two extreme scales indeed points to problems of high priority.

First of all, the target solution for the most sophisticated AROME high-resolution physics will contain elements unknown (because basically unnecessary) at the scales reached by ALADIN up to now. The 'turbulence' scheme will have a 3-dimensional behaviour (even if its 1D vertical restriction will resemble the most advanced schemes known at the 10-km scale) and the simulation of microphysics will require perfectly balanced states with respect to water phase changes. The envisaged strategy is here to isolate the two additions (nothing will be said here of their handling in AROME) and to seek convergence with the ALADIN interfacing only for the remaining so-called 'evolutive' part.

Second, getting to the details of the parameterisation schemes for the current Meso-NH and ALADIN implementations, one rapidly discovers some structural differences in their respective interfacing, even with the above restriction on the Meso-NH side. Some of these discrepancies reflect the differing characteristics of both host models and they thus require a careful analysis of basic unparameterised equations on each side (now an on-going work). One hopes to soon find an acceptable set of compatibility rules. Some other differences are more annoying because they indicate a lack of portability of the Meso-NH physics with respect to the time-stepping. It appears likely that modest changes in the interface will fortunately allow running such a complex physics at the time steps allowed by the ALADIN-NH dynamics at 2.5km (~50s) but that this will prove impossible with what would be expected at 10km (~400s). Hence the cost-effectiveness dilemma of the AROME 10km version will reopen the issue of also having some in-depth discretisation specificities for that scale, more inspired by NWP considerations than by cloud-resolving ones.

One cannot either exclude that this would also be true for the ingredient that has to be reinstalled at the 10-km scale, namely the parameterisation of unresolved moist convection. Here also, the 'truth' at time steps of the order of 10s might become an unaccessible dream when considering computing requirements for users only interested by the 10km scales.

Furthermore, handling correctly this moist convection at the intermediate scales (say 3-7km) where it is neither fully parameterised nor fully resolved, is such a daunting task that the 'rich man solution' of jumping over such scales when one can already afford a 2.5km version will be the nominal AROME one. The ALADIN on-going work on this issue however bets on two ideas: that merging the resolved and sub-grid scale cloud forcing around a unique treatment of microphysics will help creating some truly self-extinguishing parameterisation of convection when mesh-sizes get smaller and smaller (a) and that having a physically-based prognostic treatment of the convective closure assumption will help alleviating the numerical oddities responsible for the so-called 'physics grey zone' (b). Even if the proof of the pudding will only come when both scale-extreme versions of AROME will be well underway, a (yet quite uncertain) success on this crucial issue would pave the way to a much welcome continuous transition from the ALADIN-type current operational applications to the high resolution AROME world for all ALADIN Partners. Such a solution would indeed valorise even more their investments into cost-effective schemes for the NH-dynamics and the 3D-Var.

Finally, two interfacing issues specific to a very high resolution use of the physics will have to be reopened. First the impact of modifying the surface pressure by taking into account the difference between precipitation and evaporation fluxes will have to be reassessed when reaching horizontal scales way below the radius of deformation. Second, the validity of assuming no impact of the diabatic heat sources and sinks on the pressure departure from its hydrostatic equivalent will need experimental confirmation at the highest AROME resolution. Both these issues cannot be treated in the anelastic framework of Meso-NH.

One might have thought that the choice of the Meso-NH physics for the nominal AROME version would lead to a drought of topics for the parameterisation work at the articulation between the two projects. Independently of the (also crucial) implication of some scientists of the ALADIN Partner Services into the Meso-NH design of physical improvements, all the above is there to prove that it will rather be the opposite. A progressive reordering of priorities would however be urgently needed if a true convergence (and not a sudden jump) would become the main objective in this trade. This would fortunately be fully compatible with the objectives to diminish maintenance costs between the 2.5 and 10km version of AROME, once it is admitted that the dream of a unique scientific solution for both extreme goals is surely out of reach, even with our joint forces.