Internal CNRM workplan with identified resources on the ALARO and AROME models for the 1st half of 2005

F. Bouttier, 10 February 2005

This document is based on large contributions by G. Hello, J.-F. Geleyn, D. Giard, C. Lac, and takes into account the reorientation of the ALARO-10km project in Setp/Oct 2004 and extensive discussions following the « TCWGPDI » Prague workshop on Nov. 2004. It clarifies the short-term R&D activites of Météo-France staff at CNRM, Toulouse, **specifically** devoted to the model components of the ALARO-10km and AROME projects. The relevant sections of the Aladin-2 workplan are 1a and b, 2b and c, 4a, b and c. For questions please contact the main project managers directly : J.-F. Geleyn for ALARO-10km (jean-francois.geleyn@chmi.cz) and F. Bouttier for AROME (bouttier@meteo.fr). The differences between this paper and the Aladin-2 workplan are (1) only work done inside CNRM is mentioned, (2) only work with actually identified resources is mentioned, (3) the level of workplan detail is finer, (4) only model-specific topics are covered i.e. assimilation etc are outside the scope of this document.

> **Here, AROME and ALARO activities are not distinguished according to long-term objectives: virtually all activities cited here will be beneficial for both projects in the long run. The distinction is that of immediate expense: since both projects have tight deadlines, they are actually competing for manpower, so that each item below is explicitly attributed to the project to which it is most critical.**

Most actions deal with short-term priorities, which does not imply that longer-term issues are being neglected, they will be solved in due time, which may take many years. *It is hoped that this plan as seen from Météo-France in Toulouse matches the needs of everyone else in the ALADIN community. Comments and questions are always welcome at bouttier@meteo.fr and we will do our best to include suggestions for alternative strategies in our future internal workplans.*

Note 1: a longer-term roadmap has also been proposed by for the externalisation of the surface in ARPEGE/ALADIN/ALARO. This plan partly overlaps with that one (in part G)
Note 2: the work done for ARPEGE is not mentioned, even if it is going to be useful for ALARO or AROME, so as not to confuse the issues.
Note 3: in a future step, this document should be extended to include a list of (much needed) commitments of workforce from Aladin partners in order to speed up the work.

I. Short-term CNRM workplan on the AROME model

1. Cleanup of the AROME experimental environment

aim: more efficient experimental tools in order to carry out the required preoperational testing of AROME, development towards an AROME software that can run operationally and be exported.

1a. Preparation of initial conditions and lateral boundary coupling files

aim: a simpler forecast launching system (script, namelist, Olive configuration)

actions:

- port the surface physiography preparation software prep_pgd from PC Linux to VPP (P. Le Moigne, 0.5 month)
- remove the need to run the extract_arpege utility by directly loading the required surface fields in Arpege/Aladin memory from the externalized surface. Implies altering I/O routines of the externalised surface software (S. Malardel and V. Masson, total 1 month)
- gather the operations into a single script that can do either the complete domain configuration and model initialisation, or the date-dependent model initialization only (i.e. the equivalent of 927 to avoid remaking the physiographies on each run, but the daily updating of time-dependent surface evolving fields will not yet be implemented in 2005) (J.-M. Audoin and collaborators, total 2 months).
- (further simplifications will be developed in the 2nd half of 2005)

1b. Post-processing

aim: make the Arome model output suitable for generation of the most important products of full-POS. Currently, full-POS requires access to some surface fields which are no longer accessible in the FA file output because the surface has been externalized.

actions:

- compute from the surface files the required fields (such as Tsurf), insert them into the AROME FA files, check that the essential fullPOS functionality is recovered for plotting (F. Bouttier, total 0.5 month)
- extend the feature to the T2m etc. which can be computed directly by the surface software, so that fullPOS only does the horizontal part of the interpolations on these fields (R. El Khatib, total 0.5 month)
- make fullPOS work as expected on new upper-level fields: TKE, NH fields, microphysics fields, in particular with respect to postprocessing noise and clipping of non-physical values (G. Hello and R. El Khatib, total 1 month)

2. AROME technical development

aim : solve short-term problems

2a. Phasing of cycle 30

aim: put the complete Fortran code of the AROME prototype into an official ARPEGE/ALADIN cycle, with the physics phased on the latest Méso-NH release. Partly done in cy29t1, some cleaning and the ensuing validation remain to be done. (Y. Seity and K. Yessad, total 2 months)

2b. AROME/MésoNH mutual phasing

aim: maintain full AROME/MésoNH software consistency. The procedure has been clarified on paper, the appropriate MésoNH release Masdev4.6 + $n 'bug' release will be available in March and shall be copied under ClearCase, then AROME has to be revalidated with respect to MésoNH changes. (C. Lac, S. Malardel, Y. Seity, F. Bouttier, COMPAS/GCO, total 1.5 month)

2c. Externalized surface (core issues)

aim: cleanup the quick-and-dirty physics calling interface, by moving the call to the surface inside the processing by NPROMA packets. The feasibility of using the MésoNH $n (i.e. subfield instancing for gridnesting) feature has been demonstrated for the initialization and the call to the parametrisation. It must be reimplemented using the new MésoNH instancing technique ($n's have been phased out), and extended to writing the fields. (visiting 6-month scientist to be identified, until then it will require about 1 month/semester of work from G. Hello, S. Malardel and V. Masson)

2d. NH dynamics

aim: fix known weaknesses with the d4 + Predictor/Corrector NH configuration. Most of the work will probably be done by the Aladin-NH experts.

- the biperiodization of the d3 term at each timestep is prohibitive. It shall be done in a simpler way, or removed by making d3 a coupled variable. (problem submitted to F. Vana and R. Brozkova, we are awaiting instructions)
- results are sensitive to the choice of the ND4SYS switch, which should change the algorithm but not the result. To be clarified (task overseen by P. Bénard and G. Hello)
- check whether the Digital Filter Initialisation is compatible with the P/C scheme (issue submitted to J. Vivoda)
- investigate stability problems apparently linked to the LRDBBC Bottom Boundary Condition option (issue raised by Y. Seity)

3. AROME validation

aim: to gather more experience with the physical strength and weaknesses of the model.

3a. MAP

aim: run POI2B, for which initial conditions are already available, there is some prior experience in the community (N. Asencio in GMME, Y. Wang in Austria). Results to be presented at the next MAP meeting (Croatia, summer 2005) (Y. Seity, 3 months)

3b. Routine forecasts

aim: run lots of short-range forecasts on small domains in order to highlight unforeseen problems, and to give bench forecasters a flavour of what is to come. Need to define domains, outputs, scores, evaluation procedure.

3c. Horizontal diffusion

aim: to investigate suspiciously noisy convective structures. The new SLHD diffusion of F. Vana shall be finalized and tested. (G. Hello and K. Yessad, total 1.5 month)

4. Training and management

Aim: expand the use of Arome.

4a. Stage de modélisation of the ENM School of Meteorology

Supervision of ENM students for testing several Arome options on existing 2D and 3D test cases. (Y. Seity)

4b. Aladin visit

Supervision of L. Kullman to configure and test Arome on Hungary (5 weeks around March, by Y. Seity and G. Hello)

4c. Stage de fin d'études ITM of the ENM School of Meteorology

Supervision of D. Raspaud to diagnose diabatic contributions to the T1 Christmas 1999 storm, and response of Arome to TSR large-scale forcing perturbations on the Gard flooding case. (January to June 2005, by P. Arbogast and G. Hello)

4d. Coastal ocean coupling

Supervision of G. Casagrande to compare Arome and Aladin surface flux quality in terms of forcing of a coastal ocean model. (3 months starting in February, by S. Malardel and G. Hello)

4e. Deported Aladin work

Help T. Kovacic to rerun Arome-10km test cases (G. Hello).
Help J. Cedilnik to run grey-zone tests intercompared with Aladin (G. Hello).
Help D. Banciu in case there are further requests for intercomparisons on Romania (G. Hello).

4f. Deported Hirlam work
Minor help on e.g. NH or GFL (on top of R. El Khatib and J.-D. Gril's work)

4g. Aladin training course on Arome in Romania
Will require heavy preparation work.

5. 1D model

aim: to have a well-working 1D model in order to undertake thorough work on physics.
Requires phasing the existing 1D model with Arome (3 months of S. Malardel to finish the work started with S. Sbii)

6. Diagnostics

aim: to define and implement diagnostics specific to Arome, allowing basic comparisons of physics behaviour between Méso-NH, Arome and Aladin.
Requires a prior specification work before a substantial coding, in relation with the work on equations and APLXX (A and B below) (J.-M. Piriou, 2 months)

II. Short-term CNRM workplan on the ALARO model

The following tasks are sorted following J.-F.'s Geleyn classification in processes (*filières* in French). Most processes will extend over several years, here we only mention the actual short-term work. It usually corresponds to the first column of J.-F. Geleyn's table of priorities (dated 9 Jan 05), but not always, some longer-term actions are starting early.

A. « Equations » process

aim: to clarify the relationship between the « governing equations » used in each mesoscale model. It would be nice to have a clean documentation of that.
action: The plan is to have a set of documentation papers to depict the following:

- reference set of continuous multiphasic equations (partly written by S. Malardel)
- how AROME approximates the reference set (partly written by J. Stein)
- how ALADIN approximate the reference set (partly written by M. Tudor)
- how Méso-NH approximates the reference set (partly written by S. Malardel)
- the discretisation of the application of the diabatic tendencies to the NH dynamical core (some has been written by B. Catry)

This action has no tight deadline. Some substantial work has already be done by M. Tudor (work coordinated by S. Malardel who will contribute 1 month this semester)

B.« Tendencies » process

aim: to gather all physics routines under a single calling interface that will facilitate intercomparison of individual parametrisations, and to improve the I/Os of the physical parametrisations in order to be able to call them in any order. It could be useful for Hirlam.

action: rewrite routine APLAROME into a new, general physics calling subroutine (suggested name: APLXX), that encompasses the old APLPAR, using the following steps: (the actual order of operations might be a bit different)

1. Upgrade APLPAR to make it able to call the new operational ARPEGE/ALADIN physics. (PROC team)
2. Copy APLAROME under the name APLXX and import the pieces of APLPAR necessary to call the ARPEGE/ALADIN physics from it.
3. Convert the existing output of Méso-NH physics routines (tendencies) into fluxes, introducing dummy fluxes where necessary (all the fluxes are not computed in Méso-NH), in such a way that the integration of fluxes done on CPTEND leads back to the exact, original Méso-NH tendencies. It will involve computing dummy fluxes (to set to zero and to document **carefully !**) for the conversion terms that are not available from the parametrisations. (This step should not involve any change to the code that is shared with MésoNH) (G. Hello)
4. check that APLXX reproduces the results of both APLPAR and APLAROME.
5. (the computation of the missing fluxes from the MésoNH physics will be introduced later according to future progress of item E(i))

who: G.Hello, J.-M. Piriou and E. Bazile with supervision of F. Bouyssel and Y. Bouteloup, total 3 months.

C. « Diagnostics » process

aim: to extend the DDH (*Diagnostics par Domaines Horizontaux*) diagnostic package to the AROME model as much as possible. It would provide a nice, familiar working environment to physics people who are used to DDH in ARPEGE and ALADIN.

action:

1. Implement the required modifications to the delta-m=1 option (pertaining to the status of precipitating mass in the governing equations) when the model particle is assumed to move with the barycentric velocity (essentially, it is a simplification of the Cp computation), following the paper by B. Catry.
2. Add the new Lopez and AROME microphysics phase changes to the DDH set of diagnostics

who: J.-M. Piriou, 1 month (+ 1 month in 2nd half of 2005) (how far this goes towards fulfilling the ALARO project requirements shall be checked before summer 2005)

D. « Quasi-dynamical » process

aim: to clean the use of the delta-m option in the whole code, as a first step towards a thermodynamically consistent dynamics/physics coupling: application of the diabatic tendencies to the NH dynamical core, and TKE diffusion (A. Trojakova).
action: remove the delta-m=1 code from relevant places in the old ACCVIMP convection scheme and in 'experts only' places of the dynamics, it only shall only remain in the Cp computation.
who: Y. Seity with the help of K. Yessad, 1 month (+1 month in 2nd half of 2005)

E. « Méso-NH physics adaptation» process

aim: to facilitate the planned interfacing and diagnostic work on the ALARO side, some modification of the AROME/Méso-NH common library would be nice. Three actions have been requested and will be dealt with by the MésoNH community as stated below:

(i) *Output new diagnostic terms from the microphysics in order to have a complete set of diagnostic fluxes between all condensates.* This development must follow the existing MésoNH diagnostic code structure. As much as possible will be done given the resources, starting with the easier bits. (C. Lac and S. Malardel, total 1 month, will required continuing work later)

(ii)*Implement the transport of heat by precipitation.* This is acknowledged as a current weakness of Méso-NH physics, although there is no clear scientific consensus on what happens in nature and how it should be parametrized. A tentative heat exchange term will be developed within the next year or so (action managed by J.-P. Lafore). The nature of this term shall be advertised as soon as possible in order to check that it is compatible with the thermodynamical equilibrium hypotheses implied by the chosen equations in process « A » above. (costing is evaluated at 2 months of code analysis by J.-P. Pinty and S. Malardel, then 1 month of actual coding by S. Malardel, probably during 2nd half of 2005)

(iii) *Clean the hard-coded references to the leap-frog timestepping* inside the parametrisations. This a matter of code cleaning, which will be undertaken during 2005. (C. Lac, 0.5 month)

F. « ARPEGE physics adaptation» process

aim: to alter the new ARPEGE/ALADIN physics in order to make it follow the old physics principles of interfacing and diagnosis.
work:

- Change the ARPEGE prognostic TKE diffusion code so as to have the TKE on full model levels
- Split the TKE parametrisation so that the actual diffusion is done by the old ACDIFUS routine

- Check whether there are issues of stabilities at varying resolutions

who: feasibility study by Y. Bouteloup, coding work with E. Bazile, total 1 month.

G. « Surface » process

aim: to speed up the ARPEGE/ALADIN plugging in of the externalised surface so that ALARO can use it. This is tricky because specific technical development is needed, and some inter-team coordination needs to be organised in CNRM, this process must be split into smaller subtasks.

work packages:

- develop the surface/diffusion implicit coupling in the ARPEGE/ALADIN Fortran code (P. Marquet et al, 5 months for the ARPEGE-Climate model, this is the most urgent)
- implement new features into the external surface code and files, mainly the ALADIN and ARPEGE geometries (P. Le Moigne et al, 3 months, coordination with GMAP, GMME, DSI)
- enforce compatibility with the non-model operational ARPEGE/ALADIN configurations, including FullPos, surface and upperair assimilation. Need to start with an inventory of requirements (R. El Khatib, F. Taillefer, F. Bouyssel, J.-M. Audoin, etc., coordination with GMAP, GMME, DSI, total 6 months)

There are two additional processes, **« Symmetric compatibility »** and **« Grey zone physics »**, which are not done in Toulouse except perhaps for some help in running 1D intercomparisons between Alaro and MésoNH (help from S. Malardel and G. Hello)

On top of these ALARO actions, limited supporting work by GMAP/PROC and G. Hello will be given (typically, to run tests: e.g. on radiation). G. Hello shall also publish the corrected results from the AROME-10km test cases.

III. Implied workload on CNRM staff

The unit is the person.month; multiple-person actions are either shared or allocated to the first cited person, depending on what is most likely to happen. The action numbers are given between square brackets. The names are sorted in alphabetic order. For G. Hello, S. Malardel and Y. Seity we also mention the particularly large number of 'minor' tasks (management and training) which will add up to a few extra person.months . For most people there will be some added workload for the ALADIN meeting in Slovakia (June 05), too.

L. Auger 0.5 [G]
J.-M. Audoin 2 [1a] + 2 [G]
E. Bazile 2 [B] + 0.5 [F]
Y. Bouteloup 0.5 [F]
F. Bouttier 0.5 [1b]
F. Bouyssel 0.5 [G]
G. Casagrande 3 [4d]
R. El Khatib 0.5 [1b] + 2 [G]
J.-D. Gril 1 [G]
G. Hello 0.5 [1b] + 0.5 [2c] + 1 [3c] + 1 [B] + 12 'minor' tasks
C. Lac 0.5 [2b] + 2 [Ei] + 0.5 [Eiii]
P. Marquet 5 [G]
V. Masson 0.5 [1a] + 0.5 [G]
P. Le Moigne 0.5 [1a] + 3 [G]
S. Malardel 0.5 [1a] + 0.5 [2b] + 0.5 [2c] + 3 [5] + 1 [A] + 5 'minor' tasks
J.-M. Piriou 2 [6] + 1 [C]
Y. Seity 1 [2a] + 0.5 [2b] + 3 [3a] + 1 [D] + 7 'minor' tasks
F. Taillefer 1 [G]
K. Yessad 1 [2a] + 0.5 [3c]
(visitor on surface interface 6 [2] if recruited)
(GMME work [E] on Méso-NH physics and operations-oriented extra work on the externalised surface [G] not yet quantified)

Conclusion: this adds up to about 39 person.months, when one includes holidays and the overhead of 'small' tasks, this amounts to about 7 full-time staff, including more than 2 on ALARO-specific work.