Strategic document for the preparation of an «ALADIN-2» project

2nd draft version / J.-F. Geleyn / 10-12-03

Preamble (that may also be considered as a practical 'executive summary')

A) WHY THIS DOCUMENT?

Let one first go back to the final resolution of the ALADIN-AROME special workshop (Prague, 11-12 April 2003):

Considering *the success of the Aladin cooperation both in terms of research and operational implementation;*

Considering *the worldwide academic research at the meso-gamma scale which has demonstrated the potential for predicting severe weather events;*

Considering *the other potential applications of operational NWP at the meso-gamma scale, often related to an improved description of the water cycle and the boundary layer;*

Considering *the requirement of all partners for a continuous and steady improvement of the forecasts at the meso-beta scale, as well as the preparation for the meso-gamma scale;*

Considering *the importance for NWSs of continuously improving civil security type warning for severe weather dependent events;*

Noting *the feasibility study conducted by Meteo-France under the Arome pre-project;*

Noting *that this feasibility study has shown that the Aladin consortium has developed a non-hydrostatic kernel of world-class level;*

Noting *that the current Aladin MOU remains valid until end of October 2005;*

Article 1 : *The participants of the Aladin-Arome special workshop task the Aladin community to prepare a strategic document aiming at preparing an "Aladin-2" whose ultimate goal is to implement operational NWP systems at the meso-gamma scale while maintaining the meso-beta operational capability at the state of the art level.*

In the core part of the present strategic mission document the following subjects will be treated:

- background
- mission specification
- organisational aspects
- scientific strategy
- feasibility

and the first steps of a practical implementation will be outlined in the form of a tentative work plan for 2004 put in Appendix.

B) (SCIENTIFIC) LONG-TERM OBJECTIVES

1. Ensure the continuity between the international ALADIN project and the French AROME project, this leading to a convergence of tools, that has already begun, since the basic source code (functionalities), the non-hydrostatic dynamics and the variational assimilation algorithms chosen for AROME are taken from ALADIN.

Take maximum benefit from the experience of the French Meso-NH team concerning physical parameterisations at high resolution.

2. Simultaneously, more or less extend the scope of the two projects, with a quicker progress than scheduled (if not a jump) towards very high resolution (2-3 km) for ALADIN partners, and a validation at the present operational resolutions (8-12 km) for AROME.

The additional refinements or developments required for the so-called "grey zone" (4-7 km), especially concerning the description of subgrid-scale processes, will also be considered, though Météo-France teams should not be involved in this domain.

Considering the whole spectrum of scales in concerted research actions should in any case help to get a continuous improvement of the operational skills if those actions are linked with a reasonable and situation-dependent implementation plan at each partner’s service.

3. The basic convergence (of software systems, not to be mixed with the ones of operational implementations that should happen rather later) will mainly be achieved through the design of a "toolbox".

This concept extends in fact beyond the scope of the ALADIN-2 Project. The basic aim is to define projects less and less around an interdependent choice of options in data assimilation, physics and dynamics, but rather to offer high level options and to care that low level implementation details do not contradict any meaningful possible combination of them.

This strategy means paying a lot of attention to interfacing choices (mainly for physics routines) and to their associated code parts and seeking to favour scientific choices which are reducing the overhead for compatibility between differing high level choices. It however requires a stronger involvement in complex maintenance tasks, that cannot be taken on only by Météo-France.

4. This basic convergence is now also likely to involve the HIRLAM system at some stage, in a similar way (just other keys in the toolbox, ideally). The exact conditions of this exercise are however not yet defined at the time of redaction of the present document.

C) GENERAL OPERATIONAL TARGETS

The schedule below was prepared under the following hypotheses:

- the ALADIN-AROME convergence is successfully completed by 2006;
- the AROME developments are on schedule from now up to 2008-2010;
- the computer power increase at equal costs continues for the next 10 years at roughly the same speed as in the past (Moore’s law);
- HIRLAM strategy follows at least until 2006 the "test of the ALADIN-NH dynamics and design of an AROME compatible physics/dynamics interface into their system" approach.

The nominal AROME schedule, as seen from the ALADIN partners, is:

- 2004: beginning of the convergence exercise:
    * the operational models are pure ALADIN versions, more or less as in 2003;
    * all partners are nearly on the same level in operations, concerning model and physics versions.
- 2006: the ALADIN-AROME convergence is achieved:
    * the operational models have started their evolution (may be even earlier for the more ‘daring’ partners):
        - hydrostatic dynamics, still at around 10 km resolution;
        - partly enhanced physics, in particular in the domain of clouds and precipitation;
        - data assimilation becomes more usual than in 2003, and makes use of high resolution observations such as MSG radiances, local ATOVS data, etc..
- 2008: a first version of "real-AROME" is ready; three main categories of operational configurations are available:
    * a 10-km AROME:
        - HPE dynamics;
        - enhanced physics at 10 km based on previous developments at smaller scale, optimised for the long time steps corresponding to that resolution;
        - scalable data assimilation.

      This configuration is used at Météo-France in different versions as basis of the short-range mesoscale ensemble forecasting activities, as support for distant fine-scale forecasts (overseas territories, defence), and possibly as intermediate coupler between ARPEGE and AROME-2.5km (in which case NH dynamics might be considered). Computer resources generally allow all partners to run this type of configuration.
    * a 2.5-km AROME:
        - NH dynamics;
        - full AROME physics;
        - data assimilation.

      This configuration is used at Météo-France on a single domain that is notably smaller than the ALADIN-France but still encompasses the whole metropolitan French area.
    • a "grey zone" AROME (resolution in the range 4-7 km of mesh-size):
        - NH dynamics;
        - a "grey zone" physics;
        - data assimilation (same potential complexity as the 2.5 km version, but using less high-resolution observations).

      At the present stage it's not expected that Météo-France will use such a version; the scientific issues related to the grey zone are much more challenging than those linked to either the 2.5 or the 10 km versions. However if these scientific issues are solved the "grey zone" versions could temporarily be of interest for the partners not having achieved yet the computing resources necessary for the 2.5 km version.
- 2011-2013: most of the partners are able to run a 2.5 km AROME.
- 2015-2018: all the partners are able to run a 2.5 km AROME.

It will be the choice of each of the partners whether to use configurations similar to those run at Météo-France or not. Given the variety of choices for the operational transition towards nominal AROME the advantage in quality with respect to the current situation will exist at a level depending also on the individual involvement of each partner.

D) TERMINOLOGY (FOR THE PRESENT DOCUMENT)

Consortium: ***ALADIN***
NWP System: ***ALADIN and progressively AROME***
Transversal transition mission/project/action: ***ALADIN-2***
Continuation (officially until 11/2005) of the ongoing actions: ***ALADIN(-1)***
Core project for the scales of resolved convection: ***(nominal-)AROME***
Sub-project for the AROME declination at current ALADIN-1 scales: ***AROME-10km***
Sub-project for a cost-effective optimisation of AROME at scales of parameterised convection: ***no name yet => ALADIN-2 by default (probable need for a special terminology)***
First convergence effort: ***ALADIN-2 (as the basic justification of the whole mission)***
Second convergence effort: ***to be named later, if needed***

E) QUICK ESTIMATE OF ADDITIONAL COSTS

The manpower required by the partners is higher by about 15% than currently until convergence is achieved in 2006. Then it goes back to the present situation with more flexibility.

The most powerful computers at the partners in 2003 are approximately equivalent to 4 processors of Fujitsu VPP-5000. The minimal requirement for AROME-2.5 run will be:

- on a small domain (encompassing countries like AU, HU, CZ) about 30-40 VPP-5000 processors;
- for a medium-size domain (just encompassing France including Corsica e.g.) about 300-400 VPP-5000 processors. This corresponds to the resources available at Météo-France in 2008-2010;
- for a domain like ALADIN-France or ALADIN-LACE about 1000-1500 VPP-5000 processors.

<u>Background</u>

In its session of 13/12/02, the CIPN (NWP Informal Committee of Météo-France) dealt with the future of the AROME (Application of Research to Operations at Meso-scalE) project, that was up to then purely internal to Météo-France, with an operational aim for 2008 at the 2 to 3 km mesh-size scale and having a specific data assimilation component included. Three major orientations were given.

- The proposal of the AROME project leader, Francois Bouttier, to rely on the ALADIN-NH dynamics and on the Meso-NH 3D-physics for the modelling part, as well as on the IFS/ARPEGE/ALADIN 3D-Var backbone for data assimilation was validated by the Direction of Météo-France and of CNRM. In fact the final decision was mainly related to the non-hydrostatic dynamical-core part, for which an intercomparison exercise had been previously requested, which involved, beside ALADIN-NH, Meso-NH and HIRLAM-NH. Two things are here noteworthy for what follows: (i) the clear superiority of ALADIN-NH in cost-effectiveness, demonstrated for a NWP-oriented academic-type test, was even more promising since some recently proposed improvements had not been yet included (it happened since) and (ii) this result was an indirect tribute to the ALADIN-NH international team that had invested a lot of efforts with trust in the logic of its choices and in the value of its working methods.

- Contrary to the plans followed and announced up to this CIPN meeting, it was asked to GMAP to study the possibility of a full convergence of the ALADIN and AROME Projects within a few years. It had indeed previously been assumed that, in view of the difficulty that the ALADIN partners of Météo-France would find to operationally use an AROME system strictly oriented to the kilometric scales before the years 2010, it was best to let the two projects evolve in parallel. Only informal means of transfer for common elements of progress, in both directions, would then have been considered. The new orientation came from two paths: (i) the recognition that the ALADIN international community was able to tackle the most advanced NWP scientific challenges (see above) but that the current ALADIN organisation was probably not enough tailored for the AROME additional ambitions (ii) the awareness of a need for Météo-France to rationalise its maintenance of model options while keeping a capacity to forecast at 10 km mesh-sizes in full consistency with the AROME choices. This decision hence brought the seeds of both AROME-10km and ALADIN-2 sub-projects, which should become one and the same thing in term of tools (but probably not of use) if the mission addressed by the present document is successful.

- Since the initial plans for a physics specific to the scales beyond mesh-sizes of 2-3 km were obviously too restrictive for such a generalisation (one hopes there will be no such problem for data assimilation, while the 'transparent' character of the hydrostatic to non-hydrostatic switch in ALADIN, if maintained, ensures continuity and compatibility for the dynamics), some new strategy would have to be established for the parameterisation problems, especially that of deep convection which is not anymore parameterised in Meso-NH for its high resolution applications. Such a targeted strategy should allow finding the optimal compromises between drawing maximum benefits from the most advanced parts of the nominal (i.e. 2.5 km mesh-size) AROME physics implementation that are still relevant at 10 km mesh-size and allowing a smooth transition from the current ALADIN situation in cases where the additional complexity is irrelevant at such a scale. Of course, the experience of the Meso-NH team in embedding its 2.5 km version in a two-way-coupled 10 km 'clone' would be very valuable (and should lead some ALADIN scientist to participate quite early to the work done on Meso-NH itself) but it should also not be forgotten that this experience is limited to very short time steps (with respect to the ~400 s we can expect a 10 km version to use, thanks to the choice of ALADIN for the dynamical core) and to individually tuned case studies.

In the two to three ensuing months some practical consequences of the above orientations were worked out at Météo-France and publicised in the whole ALADIN community. First of all a dedicated workshop was conveyed in Prague on 11-12/04/03 with an important and high-level participation of most ALADIN Partners. Second Météo-France decided to devote one position (since then filled by the arrival -or better say the return back- of Gwenaelle Hello) to the so-called AROME-10km sub-project and offered to its ALADIN partners to put Jean-François Geleyn on secondment in Prague with a task dedicated to all aspects of ALADIN-2, as seen from their own point of view. This of course meant a reorganisation (not yet fully achieved) at the head of GMAP, the consequences of interest for the present document being that the positions of Head of GMAP and AROME Project Leader are occupied by the same person, François Bouttier, that Alain Joly will become his Deputy (and hence somehow come back to ALADIN) in replacement for Jean Pailleux who becomes Deputy to the Head of Research, while Dominique Giard keeps her role as Head of the COOPE team of GMAP.

The Prague Workshop had a very dense programme but it also was the occasion of in-depth discussions that helped shaping new perspectives for the convergence project that got the name of ALADIN-2 (same acronym but radically different meaning, thanks to an idea of Claude Fischer:

AROME Limited Area Decentralised International Network). The main conclusions with relevance to the present document are summarised thereafter (edited extract from the official Minutes).

** For the time being the convergence between the ALADIN and AROME projects keeps the ALADIN name in its second declination, ALADIN-2 in short to avoid confusion. AROME remains the name of the 2.5km target project and any 'ALADIN-2' declination around the two roots will have to choose its own specific name. In any case the 'Consortium' should still be named ALADIN.*
** It was agreed to include the question of the compromise level of optimisation in the ones to be treated in the 'strategic' document. Independently of this more evolutive aspect, the basic cost of the 10-km version, mainly linked to its time-stepping length will be part of its design specification.*
** It was evaluated that the first transition period could be of the order of 3 years if an additional 'hill' could be afforded before a return to the current level of manpower, at 'unchanged use'. The length of the second transition period (before everyone could afford using the nominal AROME version) was not evaluated with precision, but for the fact that it would fluctuate from Partner to Partner, while it was essential that the first length would be homogeneous at +/- 3 months.*
** Given the welcome coincidence between the end of the ALADIN and RC LACE MoUs at a time when the convergence ought to be achieved if ever, it appeared very logical not to touch the current legal structures, but simply to use them as such to mobilise the additional networking forces needed for a success around the turn of 2005-2006.*
** Defence and training aspects were added to the scope of the possible ALADIN-2 ambitions and, for the latter, it was stressed that the publicising effort should start as early as possible. The need for a bit of specialisation of the demo and beta testing was emphasised, since this could help having a shortened and more successful period of additional efforts.*

As already mentioned, the redaction of the present document was also initiated at the Prague Workshop in order to give a more permanent validity to the orientations chosen there and to allow to improve them with the benefit of reflexion.

An unexpected event happened in-between and added a new dimension to the ALADIN-2 anticipated action. At the end of September 2003, the HIRLAM management group asked the HIRLAM Advisory Committee to approve and recommend to its Council a strategy of closer association between HIRLAM-6 and AROME/ALADIN-2. A few comments are necessary here, after the HAC and HIRLAM Council did review, update, but basically confirm the position of their management group.

- This opens the perspective of a collaboration that, if it keeps alive the good balance between innovation and consolidation achieved in the ALADIN-1 and HIRLAM-1 to HIRLAM-6 Projects, will shape the future of LAM modelling for NWP in Europe at a definitively world-top level. On the other hand it obviously puts more responsibility on our shoulders since it is our example that has been contagious. In other words we may have some lowering of our individual burdens for even better results, but the remaining part must be if possible of even higher quality than up to now.

- The attractivity of our 'offer' is not only the result of the ALADIN side of it. The Meso-NH parameterisation and IFS-data-assimilation backbone aspects played an important part in the HIRLAM anticipated decision. This reinforces the view that the AROME basic ambitions to federate the best available contexts in dynamics, physics and data assimilation are credible and offer a good guideline for all associated projects.

- Nevertheless political aspects (namely the care for the interests of 'small' countries that exist rather symmetrically in ALADIN and HIRLAM) also played their part in HIRLAM's choice. In fact their idea for a transition that shall be even harder than the one from ALADIN-1 to ALADIN-2 is to mimic our own one, after catching up at the level of NH dynamics by importing our choices in their spectral version of the HIRLAM model. This shows that the ALADIN-2 concept is judged from outside as having the right level of ambitions and that it can act as an anchor point for the now larger community that we would have to build in the long term (perhaps more than 26 partners in the long term, if one considers the association of HIRLAM with Baltic States).

- All this forces us to split the 'familiarisation' process into two parts: one linked with the transfer of know-how about the NH ALADIN option towards its cousin (the spectral version of HIRLAM) and one concerned with the application to the HIRLAM world of the kind of revised physics/dynamics interface that will be needed for AROME and ALADIN-2. Logically the first item should fall on Météo-France's shoulders and the second one should become an ALADIN-2 side-topic, with some cross implications, mainly at the level of our own internal training.

Whenever appropriate the following paragraphs encompass this additional HIRLAM dimension, either explicitly or even implicitly.

Mission specification

- ***Target scientific objectives***: there is a profound change of emphasis here with respect to the 'downscaling from global' paradigm that has marked operational LAM ventures (and especially ALADIN) for the last ten to twenty years. The idea is that we are going (for the nominal AROME) at the same time for non-hydrostatic dynamics, for detailed microphysics- and turbulent prognostic schemes that should allow an explicit treatment of intense convection and for a data assimilation 3D-Var scheme where moist processes will be at the heart of the 'innovation' with respect to the 4D-Var coupling. And all these changes, only whenever appropriate of course, should be 'upscaled back' to less high resolution applications (typically 4 to 9 km mesh-sizes) where they might not be mandatory but could offer a positive impact even in terms of cost-effectiveness. Paradoxically, while the three targets of the nominal AROME approach are relatively safe ones from the scientific point of view, the 'back-upscaling' will introduce some new challenges. Coming immediately in mind are the quality of a gamma meso-scale physics at long time steps, the treatment of convection for the scales where it is neither fully explicit nor fully parameterised (the so-called 'grey zone' for mesh-sizes from 3 to 7 km typically), the choice of the limit where to activate the NH switch in the ALADIN-based dynamics, the scale-oriented selection of the data sources to be meaningfully assimilated on top of the 'global ones' at intermediate scales. This may appear frightening for the ALADIN-2 community but it also shows that the latter has its own scientific targets, besides its continued involvement at the current ALADIN scale and some studies in the framework of Meso-NH or nominal AROME.

- ***The user-oriented view of these objectives***: users of meteorological products do not like discontinuities in the essence and/or quality of the products they are receiving and they will not accept scientific justifications for such aspects, which they would judge detrimental. In this sense, the ALADIN-2 venture is an excellent opportunity to iron out as much as possible the gap that would necessarily arise from the combination of 10 to 20 km and 2 to 3 km products (even if the latter are likely to be bringing in new types of information). In that sense the challenge linked to the above specific scientific issues for the back-upscaling is very simple: never let you average products be worse than the direct model output from the application providing LBCs and try to have an average quality as close as possible to the one of the quantities produced by an averaging of the nominal AROME results. This may sound only like a truism, but, in particular for the quantitative precipitation forecasts, the goal is quite ambitious both in terms of tools to reach it and of methods for an objective verification of this achievement. There is another aspect of the ALADIN-2 challenge that might progressively get a more user-oriented side than initially anticipated, namely the short-range ensemble prediction problem. Given the high demand in memory and CPU computing resources that the nominal AROME will require to run on big enough domains to have internal predictability, an ensemble based on it is out of reach for many years to come. But, in case the intermediate tool that we aim at developing would reproduce most of the quality and of the sensitivity of the high resolution AROME for their common scales, it might be considered as a candidate for preparing stochastic information as a complement to a high resolution deterministic forecast. This type of information would indeed be valuable for decision-making users that require at the same time warning of extreme events and information about the reliability of such warnings. The list of potential usefulness of such continuity and reliability additional information is probably endless, but the main links between forecasting performance at small scales and users are well known: severe weather warnings of all kinds for civil security, special aspects of the water cycle and explicit turbulence for aeronautics, explicit convection for flash flood hydrological forecasting, storm surges for coastal protection, interaction of cyclones with steep orography for targeted protection-evacuation measures, local enhancement of cyclogenesis for awareness of a possible repeat of the Xmas 99 situation.

- ***Verification strategy (for both above aspects)***: there is in general no steady progress in NWP without an adequate and diversified verification system and the complexity of the latter should in principle be close to the one of the employed data assimilation tools. In fact data monitoring and forecast performance assessment are the two sides of the same coin. It is fair to say that the ALADIN community as a whole has not been as successful in finding a good verification strategy as in other parts of the NWP trade. In some sense this has not been too penalising given the dominating role of dynamical adaptation in the project and the strong links with ARPEGE (and its advanced monitoring-verification package), both aspects sending one back to the first sentence of this paragraph. The situation will be totally different in the AROME/ALADIN-2 case. First, the main advantage of the new projects that will be most easily accessible to all Partners may well be an assimilation procedure treating higher resolution data than its global counterpart; second the transition from a physics close to the ARPEGE one to a cost-effective compromise with respect to the advanced input from Meso-NH will require a careful validation if one wants to avoid having a more expensive model for hardly better results. But the effort needed to master these two challenges is not an easy one: RMS and/or basic field verification will surely be less and less adequate as resolution increases, conventional data are anyhow less and less representative at such scales and the use of imagery-type new data sources will be at least as complicated in verification as in assimilation. Measurement campaigns can sometimes be of some help in this matter, but they are in general targeted to longer term and very specific scientific problems and their NWP value is more that of performance demonstration than that of validating interdependent choices. Hence an urgent and anticipating effort is absolutely necessary here. The nominal AROME Project has taken and will continue to take the lead in such matters, but development and harmonisation of the relevant tools for intermediate scales will still be the task of the ALADIN-2 community. If ever there was the temptation to basically carry on with classical verification procedures while simply doing research on more advanced ideas, the above-mentioned more user-oriented side of the ALADIN-2 venture would immediately ask for a change of priorities. In fact targeting the verification procedures closer to the need of the users, apart from the stochastic aspects for which the basic ‘large scale’ tools are probably appropriate at all scales, mostly raises the same questions of representativity and reliability of the measurements than for the evaluation of absolute model performances at fine scale (most users live and think at ‘points’ in space and time).

- ***Optimal use of observational data***: In the previous paragraph it was implicitly assumed that the data assimilation part of the project would have found the ideal balance between using too few observations and swamping the system with redundant or unrepresentative data. In fact, as already mentioned, this task is one of the three or four main scientific challenges specific to the ALADIN-2 problematic. This will also call for an adaptation process that fortunately may be more progressive than in the case just mentioned. The ALADIN data assimilation community has indeed been excellent in developing advanced algorithms in the 3D-Var framework (a target chosen by Météo-France’s partners, this leading to a strategy made even more judicious by the recent decisions) but was far less at ease with data handling. There are technical reasons to this matter of fact and they will be dealt with later in this document. But the same lack of penalty than in the verification domain was probably also at stake here. And all the reasoning about a needed radical change of situation is therefore equally valid, the advantage being that the algorithmic and data handling issues are here more interdependent, this allowing a progressive character for the transition, the target of which remains however compulsory. Furthermore, it is likely that the nominal AROME Project will be facing tougher challenges on the algorithmic side (balanced conditions in presence of very strong diabatism for instance) and that the current forefront role of the ALADIN community will slowly become less important from a transversal point of view, this allowing a welcome change of emphasis. All this may be a bit idyllic since it assumes that competencies can be rapidly shifted from one aspect of the data assimilation trade to another one when needed and appropriate. It also amounts to assume that the remaining ALADIN-1 data assimilation effort will be more influenced by the AROME perspectives than by its own current ‘sub-synoptic’ momentum. This uncertain and contrasted picture may however have to be revised if the HIRLAM link materialises. The HIRLAM community is indeed clearly more advanced than the ALADIN one on the matter of using new sources of data and it also has a LAM 4D-Var expertise that might be useful to calibrate some aspects of the ALADIN-2 data assimilation choices. Building on these complementarities (knowing that there are compensating aspects, in particular on the NH dynamics) would be a wiser policy than trying to duplicate actions between the two groups. In such a case, the verification (and associated monitoring) efforts could however not be avoided alike, since they are much closer to actual operational implementation conditions that are unlikely to rapidly become similar in HIRLAM and ALADIN countries.

Organisational aspects

- ***Networking concept***: if one wishes to characterise how the ALADIN Project worked up to now, one can say that the communication system was mainly based on a strong central node in Toulouse, and that other transversal contacts (with the notable exception of the so-called Prague-team around the RC LACE common operational solution from 1998 to 2002) were mainly concerned with operational implementation questions, the latter being, on the contrary, very little scrutinised either by Météo-France or by the whole ALADIN community. For reaching the target of a convergence between the AROME and ALADIN Projects without operational gap in any of the Partners' Services, the situation must become very different (may be a return to the current arrangement will be sought afterwards, but this question is out of the scope of this document). First of all, the practical merging between the two projects cannot happen if all ALADIN Partners continue to have very differing levels of phasing with the backbone IFS/ARPEGE/ALADIN tree and its Cycles (an update is in principle necessary every six to nine months but it takes in practice about three years in some extreme cases). The reason for this new constraint can best be understood when remembering the action that led to the ISBA surface scheme's implementation in spring 1998. At that time the change of coupling files' content forced either a convergence toward the software level of ARPEGE or the penalising use of ad-hoc converters while the switch took place in all ALADIN countries on the same day. For the transition from ALADIN-1 to ALADIN-2 the same will happen except, (i) that there will not be the security of converters (the problem is far too complex for that), (ii) that things may not happen on a given day but surely in a defined time window between two Cycles and (iii) that we are starting a very early preparation. Coming back to the change of networking practices, the situation will also be reversed concerning the reliance on Toulouse as the anchor point of any information exchange. The priority put by GMAP on the nominal AROME effort, the fact that Partners not wanting to wait for ever at the scale around 10 km mesh-sizes will have to touch the 'grey zone' problem, the possibility to try some AROME novelties at intermediate scales earlier than in 2008, all this pleads for a less centralised networking practice than up to now. This step can only be successful if it is accompanied by a really flexible offer (see next paragraph) but it will mean far more responsibility for Météo-France's partners in terms of precision and quality for all kinds of transfer of information. This is in fact the second paradox of the envisaged effort: thanks to the transfer to ALADIN of the basic IFS/ARPEGE choices, we have had a lot of potential flexibility (in ALADIN-1) that was only used marginally. But it is at the time when it will be more difficult to maintain this commodity that it will become quasi mandatory to use it! This question might also become one of the most difficult ones to solve with respect to the HIRLAM 'convergence'. Contrary to us, our potential future partners are used to have a monolithic so-called 'reference version' and to maintain locally the (many) divergences that each one of them judge necessary to have with respect to it. Needless to say we shall not compromise on the 'tool-box' concept that should perpetuate our current potential of flexibility, but we could learn a lot from HIRLAM on how to best use this facility through a very high-quality communication policy. To sum up this paragraph, we shall aim at having more flexibility in the availability of tools but also at imposing more stringent technical conditions for their local use, both aspects requesting a clear change of networking practices, in roughly opposite directions.

- ***Toolbox concept***: despite what was written in the previous paragraph (with some specificity in mind), one must first understand that this concept extends beyond the scope of the ALADIN-2 Project. The basic aim is to define projects (or systems) less and less around an interdependent choice of options in data assimilation, physics and dynamics, but to offer on the contrary high level options and to care that low level implementation details do not contradict any meaningful possible combination of them. The main relevant examples for the IFS-ARPEGE-ALADIN-AROME ensemble are the following: global or plane tangent geometry, hydrostatic primitive equations or Euler compressible system, large scale (climate-inspired) or meso-gamma (from Meso-NH) or 'efficiency compromise' physics, 3D-Var, 3D-Var-FGAT or 4D-Var. Of course all combinations will not be encouraged (meso-gamma physics with HPE system and 4D-Var with the compressible equations are two example of such 'strange' choices). Météo-France on the one hand clearly indicates that it will seek for its own use a bigger separation between global and LAM options than up to now (AROME-10km is undoubtedly a sub-project of the nominal AROME one, even if it aims at another scale and roughly at the same cost-effectiveness than requested by Partners for ALADIN-2) but on the other hand it guarantees that the convergence of the AROME and ALADIN software packages will offer other intermediate choices to its partners (in the ALADIN community and perhaps in the HIRLAM one) through a concretisation of the tool-box concept whenever necessary. This commitment shall take the form of a help to the partners, in order to associate them to the concrete problems' handling. On the other hand this does not mean that the entire associated maintenance burden will be taken on solely by Météo-France (on the contrary the spirit of ALADIN-2 should lead to higher commitments of the partners) but that no internal decision in the ARPEGE and nominal AROME frameworks should prevent the application of this approach. As a first concretisation of this strategy, it was decided that the adaptation of the forthcoming new physics/dynamics AROME interface very likely would touch not only ALADIN but also ARPEGE. For smaller practical points, this strategy means paying a lot of attention to interfacing choices (mainly for physics routines and obs-operators) and to their associated code parts and seeking to favour scientific choices which, like the one of Laprise's solution for non-hydrostatism, are reducing or eliminating the overhead for compatibility between differing high level choices.

- ***Flexible transition toward operations leading to short term improvements***: once the points raised in the two previous paragraphs will have been put to the level of precision where a consensus is reached around them, the point treated in this paragraph will become a relatively easy one to handle. Basically, Météo-France's partners will be able to select the parts of the AROME advances that they will judge stable enough as well as cost-effective with respect to their own computing constraints and import them into their operational applications. But while there will be no problem (by construction) for what concerns the dynamics and little scientific difficulties for data assimilation for the few partners soon running a 3D-Var based system, the complex problem of the physics requires not to disperse forces and to avoid duplicating actions. Hence, Meso-NH will be the reference test-bed for quite a long time and it will be recommended to go through an 'interface of interface' in order to build any anticipated compromise solution in an AROME-like framework (with a new set of moist equations, with the predictor-corrector scheme as basis for the time-step organisation and with an externalised surface scheme, among other similar constraints). The reverse operation (i.e. to back-phase AROME adapted novelties to old ALADIN cycles) will be discouraged as much as possible. In this sense, a toolbox approach targeted towards AROME constraints should work as a strong incentive to achieve the software convergence as soon as feasible, in order for everyone to fully benefit from the optimised intermediate solutions that are likely to be found once a larger community will start looking for them. All this assumes that technical ancillary problems will be solved in parallel, which might not be true at early stages for data handling (ODB) and for some more exotic parts of the Meso-NH physics (3D turbulence, non-classical use of ISBA, links with chemical aspects, …). The matters treated in this paragraph are also one of the targets of Météo-France's involvement in ALADIN-2 in order to help its partners accomplishing the needed steps. In both cases (previous and current) the exact form that this help will take is yet to be determined, but some 'seeding money' has already been provisioned.

- ***Maintenance, code management***: the last but two sentence of the previous paragraph also gives a hint to where will be the main hurdles in terms of maintenance. Modularising the functionalities and raising the flexibility aspects higher up in the code are good ideas for a concerted and distributed scientific effort, but they have their price in terms of maintenance, especially at the level of complex interfaces. On the one hand maintenance can be a bit more decentralised alike decisions on which options to use, but on the other hand it becomes even more complex and requires additional training targeted at already well prepared people. This trend has anyhow already been at work in ALADIN for a few years and we can simply anticipate that it will be reinforced. Otherwise, owing to the continuity with ALADIN-1 in terms of data assimilation and dynamics and given the relatively easy maintenance constraints on low level aspects of the physics, there will be no radical change of array of competency in the new situation for the ALADIN Partners before the effective convergence takes place. The situation for the second transition period (until everyone is able to run a nominal AROME) will certainly be more complex. First, the phasing frequency of AROME in its still pre-operational phase (i.e. for 2 to 3 years) will probably be less than the current one for ALADIN, a situation with advantages to enjoy and disadvantages to cope with. Second, the code management practice will automatically be more disconnected from the IFS/ARPEGE one (as the result of a strong internal constraint for Météo-France) and will give even more priority to the 'interfacing business'. Hence Météo-France's partners will have to adapt to this new situation and take in their own hands the maintenance for specificities that they would like to maintain with respect to AROME nominal, in the above-mentioned spirit of a less centralised but more disciplined network concept. All this does not necessarily call for an increased manpower effort but surely for a more rational use of the existing competencies inherited from the ALADIN-1 Project.

- ***Calendar aspects***: strangely enough those are (for the time being) not very crucial. Like already said, if the chosen strategy is going to succeed, the sooner the better, in order for everyone to show early the first benefits of its implication in the new project. But if there has been some misjudgement and that targets are running away as fast as time goes by, the initial option of a parallel and minimally evolving ALADIN solution can be reactivated, starting from any well defined intermediate point. The current estimate is that this would have to be the case, should the full code convergence not have taken place before the second half of 2006. However, in case the HIRLAM link is activated, things might become more complicated. Without speaking of conflict, it is certain that, on this very aspect, some amount of bargaining would have to take place, the outcome of which is yet quite uncertain, especially after the HIRLAM Council decided to put a lot of power in the hands of a task-force it created on purpose for meso-scale modelling. Coming back to the hypothesis that the convergence between the software systems is successful, this will by no means be the end of the ALADIN-2 mission. Until every Partner is able to use at least one meaningful version of the nominal AROME system, there will be a need for more cost-effective solutions, for NWP-result driven improvements and for still back-upscaling at intermediate resolutions the most significant parallel advances of the research and development work at 2.5 km. This phase will have to be driven with similar (but not identical) methods to those described in the present document (except for the maintenance strategy which will have to be updated once the 'old' ALADIN code will be obsolete). In the context of the ALADIN-2 Project one may even dream that the story of the NH version will repeat itself and that the currently more rigidly defined AROME-10km framework of Météo-France will draw some benefits from the above-mentioned work.

<u>Scientific strategy</u>

- ***Key scientific issues***:

  + Dynamics: here the main problem will be that of the representation and/or influence of orography. Indeed the ALADIN-NH dynamics is currently very adequate even for the highest resolution test-beds (André Robert's 'warm and cold bubbles' for instance) but in the absence of orography. It is nevertheless likely that the terrain-following coordinate will lead to big errors in the pressure gradient-type terms when higher and higher horizontal resolution will inject very strong observed slopes in the objective description of the orographic forcing. Furthermore, this description has to be truncated (in finite difference and/or Eulerian models also) in order to avoid misrepresentation of the stationary forcing near the truncation scale. While the latter forced choice mitigates the consequences of the first problem, there might already be unwelcome feedback links between the two underlying problems. In second place the coupling by Lateral Boundary Conditions (LBCs) should be one important concern. It is not easy at all to imagine how to practically accommodate in the spectral framework the concepts of two-way nesting and of transparent LBCs. However, once the differences between spectral and finite difference algorithms have been reduced to the level anticipated in AROME (with a linear grid and a rectangular truncation), this should not be an impossible task. Finally, the concept developed in ALADIN of a semi-Lagrangian flow-dependent horizontal diffusion ought to be further studied in the AROME context. This would probably call for an extension to 3D considerations and may well be merged in a single topic with the problem of convoluting the semi-Lagrangian time stepping and the horizontal contributions of the 3D turbulence parameterisation scheme. Studies on a non-hydrostatic radiative upper boundary condition and on the best way to project diabatism on pressure and temperature perturbations have been initiated in the framework of ALADIN-NH but it is yet too early to say whether this will lead to major challenges, to simple upgrades or to nothing determining.

  + Physics: the adaptation of the current physics/dynamics interfaces to a new set of continuous unparameterised equations will be a difficult exercise but will be made 'once for ever'. The above-mentioned strategy to build for the ALADIN-2 transition an interface of interface rather than relying on back phasing should indeed make it a 'clean' step. Concerning turbulence and micro-physics the challenges to run an adapted declination of the Meso-NH parameterisations at rather long time steps will be of the 'numerical analysis' type and it is expected that our community has now enough relevant expertise in this area, after a lot of investment on the topic in ARPEGE/ALADIN-1. There already exist promising proposals for solutions adapted to the intermediate scales for radiation computations and for the remaining effects of unresolved orographic low-level forcing (drag and lift) at scales between 10 and 5 km of mesh-size. Considering all this as challenging but not deterring, there remains the key question of the grey-zone and/or of the parameterisation of deep convection. Neither the current solution of ALADIN, nor the one of the 10km part of Meso-NH are likely to be up this combined challenge, even if they may offer reasonable back-up positions. The solution for the long term, if there exists one, is likely to require at least two ingredients: a prognostic equation for a quantity linked to convective activity (mass-flux?) and a treatment of microphysics that combines in one go the otherwise arbitrarily separated inputs of the 'resolved' and of the 'parameterised' local forcing. If these two conditions could be fulfilled, there would be a chance to see the proportion of convective forcing progressively decreasing without any additional numerical constraint when mesh sizes would go towards zero. Some tests already made in ALADIN indicate that this goal is not a utopia. Concerning the practical strategy to adopt, it seems preferable to imagine an algorithmic structure that would start backwards from the constraint on the mixed input to the microphysics computations and would dictate the organisation of the deep convective calculations. This might or might not be the occasion to make the latter more modular in order to avoid having sterile battles of opinion around existing too monolithic solutions. The already mentioned work done in ALADIN may alternatively be used as a strong guideline for this step. A third solution would be to convince the CNRM community working on the topic for all types of scales that this rather complex endeavour, if correctly planed, could find simpler declinations at both ends of the scale spectrum, while offering a modern framework for testing new ideas concerning closure assumption, entrainment and detrainment profiles as well as cloud ascent characteristics. It is too early at the present stage to say which way will be followed in priority, especially when the consequences on the links with dry turbulence and shallow convection have not been worked at.

+ Data assimilation: the main questions are linked here with the yes or no to FGAT (first guess at appropriate time, an intermediate between 3D-Var and 4D-Var, or, better said a 4D-Var that technically reduces to a 3D-Var because its tangent linear model is that of persistence), with the search for a variational replacement for the so-called 'blending (with respect to 4D-Var global results)' and with the question of a fine scale oriented dynamical handling of the background and observation error statistics, as well as the possibility to transfer them from one domain to another one. There are many more challenges in the data assimilation issue but they are either covered by the safe reliance on the link with the IFS research effort or by very specific observation operator questions that are strictly speaking no key scientific issues, despite the enormous manpower effort they will require (there is a priori no hurdle that one may not master, simply a lot of work to be done, always keeping in mind 'that the devil is in the detail').

- ***International context on these issues***:

+ Dynamics: on the issue of the orographic forcing, the so-called eta-coordinate (some model cells being considered as entirely under the orography) has failed to deliver the earlier claimed satisfactory answer (the response to the step-wise stationary forcing is even worse at equal scale than in the 'continuous' case). The so-called 'shaved elements' variant (there are mixed-type grid-cells, for a simplified explanation) seems more promising but is computationally penalising and would probably be very difficult to adapt to a spectral framework, even taking into in account the above remark. For the LBC problem, the two-way nesting is mastered by several teams and offers spectacular performances in some cases, as well demonstrated with Meso-NH, but its operational application raises enormous logistic problems, especially in the context of a data assimilation framework. The use of transparent boundary conditions is more at an upstream research stage for the NWP angle. It should be noticed that this is one of the strong points of the HIRLAM community. To our knowledge, the search for links between semi-Lagrangian operators and diffusive effects has no counterpart elsewhere than in ALADIN. Finally, even if we have no more reason to consider that the handling of some last details of the ALADIN-NH formulation will become a key issue, it should be noticed that the international community still appears 'surprised' when discovering our results.

+ Physics: given the enormous variety of solutions 'on the market' and the little amount of meso-scale NWP-oriented answers for the underlying questions to this wealth of proposals, one shall not attempt here to find a relevant picture of the international situation (consensus points are rare, but most controversies are likely to be irrelevant for our main pre-operational and operational challenges, at least in the ALADIN-2 framework). One should simply say that the handling of the convection issue in the grey-zone is deemed as 'lost in advance' by many experts, but that those mostly come from institutions having the computing resources that help by-passing this challenge!

+ Data assimilation: there may be differences of opinion on details but the AROME plan for data assimilation seems to correspond to a compromise between ambition and safety that would be considered as wise by any team dealing with an operational target. The use of such a tool for support in upstream instrumental research is likely to soon become an issue with a few controversies, but this item is surely out of the scope of the present document.

- ***Positioning of the consortium with respect to these issues***:

+ Dynamics: the point about a possible limitation at high slopes of the potential of the ALADIN-NH solution may well be an intrinsic limiting factor. On the other hand, the team developing the NH scheme has now got so much expertise in handling the balance between linear and non-linear terms and in mastering the lower boundary condition that it can feel fit to attack the problem once the currently on-going rationalisation and option-cleaning work will be finished. For a start one could revisit the idea of a semi-implicit scheme applied on deviations from an analytically defined 'basic thermodynamic state'. Other developments might then be necessary, but nothing says that they would be more difficult to master than the ones that lead to the stabilisation of the 3tl and 2tl semi-Lagrangian versions of the NH scheme. For the various aspects of the LBC problem, the basic incentive should come from collaborations and what will be mostly needed on an internal basis is a quite good knowledge of the data flow, alike the one that allowed the design of a semi-implicit compatible coupling scheme in spectral conditions at the beginning of the ALADIN Project. This was a very decisive step at the time for the implementation of a semi-Lagrangian option, something that retrospectively takes even more value nowadays. Concerning the fact that the ALADIN-NH dynamics' performances are still considered as a curiosity by many external experts, the four (or even more) papers about to be published under the coordination of Pierre Bénard are likely to change the situation. Furthermore the team is convinced it has reached both a 'world record' in numerical efficiency for NH adiabatic problems and a very consistent solution (spectral, SI, SL and Laprise-type vertical coordinate all go well together) that makes misgivings against anyone of these basic choices rather meaningless.

+ Physics: the reliance on the ARPEGE link has created the uncomfortable situation that a specific ALADIN physics team may be judged to be only about one-year old. Hence, it would be rather presumptuous to pass collective judgements about the relevance of this or that ambition. Fortunately, the up- or downscaling character of much of the forthcoming work for ALADIN-2 specific issues offers a reassuring framework. For residual problems, let us say that we are nevertheless not starting from scratch thanks to some pioneering work done in the ALADIN framework, and that the situation with respect to the explained ambitions is surely alike that of the ALADIN-NH team back in late 2000.

+ Data assimilation: there seems to be no reason to fear any mistargeting or any internal important disagreement about the key issues. As already mentioned higher up, the main question will be that of the speed of adaptation of an already well-structured ALADIN 3D-Var community to the new situation created by the decision of merging the AROME and ALADIN Projects.

Feasibility

- ***Scientific***: none of the challenges mentioned higher up in the present document seems out of reach for a community that is likely to grow and that should work on well proven solutions with which it should already be very familiar from the beginning. In this sense the ensemble of AROME and ALADIN-2 (with its AROME-10km intersection) represents a very motivating perspective. It will rely on three pillars of top-class performance, namely a very cost-effective dynamical core, a well-tested and fully validated physical basis for high-resolution problems and a link with the best global data assimilation system in the world. The idea to first aggregate these three 'heredities (for lack of a better word)' while building an enlarged community around it (rather than attempting a completely new endeavour, like it had to be the case at the birth of the IFS/ARPEGE, ALADIN and Meso-NH Projects) has just been validated from outside as well, when one considers the step made by the HIRLAM management group. Whatever the outcome of this daring step will be in the end, the fact that our plans were judged both realistic and ambitious enough by independent and competent experts will remain. Of course, when it will come to things not yet encompassed in the existing perimeter, one will have to be, like always in NWP, a bit daring but still consistent with previous choices. Some of the new ambitions will then lead to progress, some alas not, and some good surprises will happen where there was little expectation. All this will be more and more true as the pre-operational character of the projects will gain in importance. The technical and maintenance constraints will then become the definitive boundary marks of our efforts, indicating that things have reached a mature stage!

- ***Technical***: here the situation is unfortunately not as rosy as for the previous item. One hopes that the recent interest of ECMWF for the underlying science to the ALADIN-NH switch means that we can continue to rely on at least a benevolent neutrality for what concerns evolutions of the code architecture, but a bad surprise is always possible. In the physics part, the evolution of an externalised ISBA surface scheme with many users coming from rather different communities will surely raise a few difficult questions for a stabilised and upward compatible operational use. This problematic might extend to any ancillary parts that would, for lack of any other reasonable solution, also have to be externalised and mutualised. Finally, concerning data assimilation, the mitigated experience of ODB in the ALADIN community (and to a lesser extent in Toulouse) clearly points toward what will be our major hurdle. Data handling (and especially that of data sources unused at the global scale) will require efforts that are out of reach of 'small' services (or users of even smaller size), but a common approach is only feasible if the used tool is more stable and less one-platform-type than it is currently the case with the ECMWF-maintained ODB software. Should the HIRLAM community join forces with us on this issue and should they also adopt ODB as a basis for data handling (something they avoided to do up to now despite having data formats quite close to those of ECMWF), the political pressure in Reading would of course become far bigger than it has been the case up to now with the sole ALADIN forces. But there are of course many 'ifs' in the previous sentence.

- ***Computer costs (including scenarios of operational implementation)***: this aspect can be seen from the relative or the absolute side. In the first case a rather extensive study was conducted by Emmanuel Legrand in preparation of the Prague April Workshop. The aim was to see which time lag with respect to Météo-France could be reasonably expected for each partner (given its geographical and economic situation) in its capacity to run operationally a nominal AROME version. Without going into details, the aggregated results ranged from 1.5 to 9 years for the current ALADIN membership, figures that give a good idea of the challenge ahead of us to keep the same level of solidarity in ALADIN-2 as in ALADIN-1. On the 'absolute' side, but still using relative figures to avoid going into local geographical details, one can say the following. At unchanged physics, the switch to non-hydrostatism costs only a factor of about 1.25. When going to higher resolutions than the current ones, the relative loss of efficiency of the semi-Lagrangian algorithm will cost an additional approximate 1.75 factor, and the more sophisticated physics between 1.5 (if we are very clever) and 3 (if we do nothing about it), for the whole model again. All this represents a 4 to 5 years stagnation if compared to the current rate in progress of resolution in the 'hydrostatic' situation. Finally, 'jumping over the grey zone' from the sole point of view of resolution will represent 7 years on the same scale, at unchanged domain size. Of course these numbers sum up to give something roughly equivalent to the above-mentioned study, especially if one considers the anticipated initial reduction of the size of the integration domains at the highest resolution, even for Météo-France. But they also help seeing where will be the main constraints at each level of computing capacity. They also confirm what was already hinted at previously in this document, i.e. that an acceptable solution to the problem of convection in the 'grey zone' would be very welcome for all partners not having Météo-France's anticipated computing capacity for the end of this decade. If this does not happen, other compromises will have to be imagined, that could well include a return to shared access to more performant computing platforms like it was the case at some stage for the ALADIN-PECO and RC LACE actions. But, in any case, AROME and ALADIN-2 will not be cheap in term of computing resources, especially if one also considers the use of an advanced version of the data assimilation tool. This point will however not be evaluated here since practically any level of compromise can be worked out, unlike for the pure modelling part. On the other hand one may imagine what would be the result of the above analysis if the efforts of the ALADIN NH team had not offered the prospect of time steps 4 to 5 times longer than what the gamma meso-scale community has up to now been used to!

- ***Manpower***: most was already said higher up in this document. The ALADIN-2 convergence effort will require a temporary increase in manpower commitment from the ALADIN Partners at a level not exceeding 15% of the current situation, i.e. a maximum of 6 additional equivalent people from the side of Météo-France's partners. In case the HIRLAM interest materialises, the overall ALADIN involvement may decrease a bit in absolute amount after some adaptation time (on both sides), but it will be expected to reach a higher level of quality. Finally, once the first transition phase has been achieved, ALADIN Partners willing to invest more in human resources than previously will surely draw a better benefit from the toolbox approach than those making an opposite choice. As a conclusion for the whole 'feasibility' section (and not simply for this paragraph) one may say that, although there is no direct way to prove that the ALADIN-2 concept will be as fruitful as the ALADIN-1 one, each Partner knows relatively well its own 'boundary conditions', that there are some risks that one should not underestimate (but probably far less than at the launch of ALADIN-1) and that the international community starts considering this as a rather ambitious but safe project. Of course, in the end it will be up to each Partner to take decisions according to the final version of this document (after a careful review by as large as possible a group) but, like said differently one paragraph higher, it is doubtful that any other solution 'on the market' can provide the same level of cost-effectiveness for a NWP oriented use. Being cost-effective was the trademark of ALADIN-1 and will be transferred to ALADIN-2 as much as possible.

Outlook

The first draft of the present document was distributed for a gathering of opinions at the Assembly of Partners in Krakow. This second draft version encompasses, apart from a few corrections, three requests from the Assembly: a 'practically oriented' preamble (written by Dominique Giard and Emmanuel Legrand), some clarification steps (for the link with ARPEGE, for the HIRLAM situation after their HAC and Council meetings and for the exact definitions of the borders of the ALADIN-2 action) and an appended tentative work-plan for 2004.

Compared to the ambitions stated at the Prague workshop in April, we are behind schedule for several points:

- we did not create a task force for preparing the discussion on the MoU renewal (in the framework of the extended 2004 Assembly in Croatia);
- we have neither finalised a basic definition of the ALADIN-2 mission nor allowed to mobilise its already financed coordination actions;
- we did not have an in-depth discussion on the practical consequences of the basic issues addressed in the mission document.

Considering the associated growing time-table problems (and also their likely interference with the HIRLAM discussions), the main question is whether these three issues shouldn't from now on be treated in parallel with the elaboration of the final version of this reference document, provided the second draft appears more acceptable than the first one?

APPENDIX

Tentative ALADIN-2 work plan for 2004 (mainly seen from the point of view of the non-Météo-France ALADIN community, assuming 2004 will be a transition year towards a more integrated situation)

- *Three priorities*:

- establish a close working relationship with the relevant people in Toulouse in order to keep the same medium-term targets for ALADIN-2 et AROME-10km;
- start moving towards code compatibility and early cycle-level updating, in preparation for the 'AROMatisation' of 2006 (this encompasses both the scientific content of operational applications and the familiarisation with an ALADIN version as close as possible to the AROME prototypes);
- contribute to make the toolbox concept effective as early as possible so that both above points can be put forward harmoniously.

- *Eight scientific actions*:

- target some Toulouse stays on nominal-AROME topics that go beyond the convergence's three-years' target but are of sufficient general interest to already justify investment from the partners;
- make local research teams move as soon as possible to mixed-type research topics (i.e. those of interest nowadays and that also have a reasonable chance to be transferable to an AROME prototype for the partner's applications);
- contribute to the maintenance of the ALADIN-NH code so that it remains a totally transparent switch of the 'classical' ALADIN-HPE one;
- verify that ALADIN 3D-Var and blending local research efforts are not getting us away from AROME data assimilation constraints;
- adapt the Meso-NH 1D-turbulence and micro-physics parameterisations both to the long time steps of ALADIN-2 and to the constraints of the toolbox concept;
- contribute to the design and preparation of the new 'transversal' physics/dynamics interface;
- build an 'interface of interface' in order to be able to call slightly modified versions of the current ALADIN parameterisation schemes from this forthcoming new AROME-driven interface; this work may be extended to the organisation of the time step, in 2004 or later;
- start dealing with the 'grey zone' problem, in the spirit of seeking an important improvement without loosing compatibility with either ends of the scale-spectrum where it is relevant.

- *A scientific 'watch' (for 2003) on three future important issues (that will at the beginning mainly be treated in Toulouse and/or in collaboration with HIRLAM teams)*:

- new data sources for higher resolution;
- less 'over-determined' lateral coupling in a spectral model;
- meso-scale verification.

- *A 'scientifico-administrative' effort*:

- starting to identify and flag specific efforts, problems and achievements of ALADIN-2;
- keeping track of all important decisions and early milestones;
- improving the transversal communication process;
- starting the contacts with the academic world;
- participating to the preparation effort for the new MoU.