COOPERATION BETWEEN THE ALADIN AND HIRLAMCONSORTIA: MAIN OBJECTIVES and FIRST TOPICS OF COMMON INTEREST

15th of October, 2005

Introduction

According to the resolution accepted at the last ALADIN Assembly in Split the ALADIN Coordinators for Strategic and Scientific Issues (CSSI) and the HIRLAM Management Group (HMG) met in June, 2005 in order to plan a procedure for the creation of a joint scientific plan for the ALADIN and HIRLAM projects.

In the CSSI-HMG discussion it was agreed that until the last Assembly/Council meetings of 2005, the first common scientific plans will be derived with the help of scientific contact points from each project. The objective of this early planning is to further demonstrate to the managers of both projects the feasibility of code collaboration and the will of the ALADIN and HIRLAM scientists for a future common successful work.

Hereafter, the common long-term scientific and technical goals are identified for the main numerical weather prediction issues (with details in the appendices). It is emphasised that the list of common topics and the fine details are certainly not yet complete, they are under further refinement in a quasi-continuous process for producing an updated version (as basis for the actual work) until the end of year.

The strategic objectives below are aiming to guide the work for several years ahead, while the list of concrete actions in the appendix contains work that will take place in 2006. Some of the tasks are quite comprehensive and contain scientific challenges so that the work in those areas will extend also over the following years.

Long-term objectives

The long-term objectives of the HIRLAM-ALADIN cooperation are first briefly summarised (details of the common topics of interest can be found in the appendix). It is underlined that at the beginning of the cooperation significant training activity must take place in order to on one hand understand the working habits (culture) of each other and on the other hand to perform specific training actions (related to specific parts of the ARPEGE/ALADIN code system as non-hydrostatic dynamics, data assimilation in both HIRLAM and ALADIN etc.). Such actions have already been scheduled for 2005.

Dynamics and coupling

The first interest of the HIRLAM team in the cooperation with ALADIN is the future development and use of the AROME mesoscale model. One of the basic ingredients of this system is the ALADIN non-hydrostatic kernel with its efficiency and proven reliability, which was a primary factor in the HIRLAM decision. The non-hydrostatic version of ALADIN now is considered as a safe basis for further use. But on the other hand there is much work to do together as far as lateral boundary coupling is concerned. Therefore the main strategic issues for the common work are as follows:

- The most important challenges concern coupling. Strategies should be revisited, especially taking into account the small horizontal extension of domains on which AROME will be

run by most partners (due to its high computational cost): development of "well posed and transparent" lateral boundary conditions, careful investigation of the nesting strategy (what is the best way to proceed from global to meso-gamma scale applications, considering increases in vertical resolution and in the sophistication of physics, data assimilation strategies etc.) and other smaller issues (such as the possible application of "frames" for coupling). Especially the work related to transparent boundary conditions is challenging from the scientific point of view with difficult estimation of its practical realisation.

- The development of the tangent linear (TL) and adjoint (AD) of the semi-Larangian advection scheme is a crucial and at the same time urgent task, badly needed for code convergence in variational data assimilation and very useful for ensemble prediction as well (since improving numerical efficiency).
- The non-hydrostatic version of ALADIN is rather consolidated and well tested in academic cases, and intensive experimentation in real cases is ongoing. Nevertheless several smaller issues (e.g. variations in map factor, horizontal pressure gradient in presence of sharp orography) are scheduled for the common work.
- The development of a Vertical Finite Element (VFE) discretisation is motivated by the "large" vertical domains required for a better assimilation of satellite data (and corresponding need for more precision) and the need to maintain a close code compatibility with IFS.

(Atmospheric) Physics

One of the most difficult problems lies with the physical parameterisation schemes. The complexity of this issue is coming from the fact that we would like all to increase the realism of the parameterised phenomena, at the same time keeping high level numerical efficiency (stability and accuracy) and moreover considering all the constraints and taking benefit from all the advantages of code collaboration (with the increase of the possible choices in the physics). The related diagnostic and inter-comparison tools are of crucial ingredients for the success of the common endeavour. The main strategic issues are as follows:

- Basic equations and interfacing problems: with dynamics, with surface, between different physics schemes, with data assimilation.
- Design of common validation and diagnostic tools; inter-comparisons of different options.
- Improvements of "existing" and design of "new" physical parameterisations with consideration for both scientific and algorithmic aspects. This includes scientific challenges in very high resolution (3D turbulence, sloping surfaces etc.) and resolution dependency (with the aim of achieving more "integrated" parameterisations).

Surface (physics, data assimilation, physiographic data)

The first common activities (which are mainly technical ones) around surface issues are urgent, but heavy tasks imposed by code convergence:

- Externalisation of the surface schemes: the work is already ongoing in ALADIN and about to start in HIRLAM (certainly with help from ALADIN).
- Interfacing with upper air physics, data assimilation etc.
- Externalisation of surface data assimilation.

- New climate generation tools to be developed based on high resolution (ECOCLIMAP) data bases.

Refinements in parameterisations (e.g. lakes, sea-ice, irrigated crops etc.) and in data assimilation, with an increased use of satellite data (especially EUMETSAT SAF products), more consideration to the time-dimension and the high level of anisotropy, and the necessary adaptation to a more sophisticated physics, will be addressed afterwards.

Data assimilation

One of the biggest potential benefits from the ALADIN-HIRLAM cooperation is in the domain of data assimilation. All this is coming from the fact that as far as data assimilation theory and practise are concerned, the HIRLAM group has always been in the forefront of the developments (see the successful 4d-var implementation of the HIRLAM model). Tools developed already at HIRLAM will be ported to the ARPEGE/ALADIN coding framework. The eventual goal will be to provide a tractable basis for the meso-gamma scale data assimilation research and developments. The innovative ALADIN developments in the field of three-dimensional variational data assimilation (3d-var) should not be forgotten (structure functions, background errors, observations and their handling). It is important to underline that even if all the forthcoming developments are scientifically and technically challenging, their common realisation is promising. The main strategic issues can be formalised as follows:

- Code convergence regarding variational data assimilation (3d-var, 4d-var).
- Approaching towards higher resolutions (meso-gamma scale): structure functions (variable, heterogeneous and anisotropic background errors), observations (high resolution surface data, radar reflectivities, Doppler wind data, clear-sky radiances, cloud-affected radiances, atmospheric motion winds, GPS data etc.), regularised physics and their tangent linear and adjoint version etc.
- Increase use of satellite data (EUMETSAT SAF products) for surface data assimilation and initialisation (see also surface issues).

Predictability

Both consortia recognise the high importance of the work on predictability, i.e. short range ensemble prediction. In spite of the fact that distinct efforts are already performed on short range limited area ensemble prediction systems in Europe no real coordination has yet been ensured until now (in spite of the common challenges at synoptic scales and higher resolutions). Another uncertainty is the fact that it is not clear at all, what is the best strategy to adopt (basic research and developments are badly needed), while designing an ensemble system (how to account for initial and lateral boundary errors or model deficiencies etc.). It is foreseen that the developments on data assimilation and predictability will be closely linked together in such systems, where on the one hand the uncertainties in the initial conditions will be addressed from the data assimilation system (analysis errors) and on the other hand the model uncertainties (background errors) will be fed back to the data assimilation module. An ALADIN-HIRLAM kick-off meeting will be organised at the beginning of 2006.

Verification and diagnostic

The aspects about the diagnostics (i.e. tools to study model behaviour and thus discover model deficiencies) are already treated in the physics planning, therefore hereafter only verification (quantification of model quality in order to provide objective methods to assess the effects of new developments) will be considered. The verification methods used for synoptic scale numerical weather prediction cannot all be used for mesoscale (meso-gamma). Therefore new methods, procedures, tools should be designed and invented for high resolution deterministic and probabilistic forecasts.

System (embedding)

This item covers all the technical (computer) environments needed to run the main components of a numerical weather prediction system. The main objective is to harmonise and utilise the best combination of existing tools and expertise from both consortia together with the development of common, user-friendly (preferably open source) tools.

Some final remarks

It is hoped that this document (together with the appendices) will give an insight into the planned common activities between the ALADIN and HIRLAM projects. According to the persons mentioned in the planning the involvement of both parties (more than 40 persons from ALADIN and more than 35 from HIRLAM) is strong. For this (first) common research plan the parties have agreed not to try to incorporate all areas of activities but rather to identify the areas of common interest where both are active in order to achieve synergy effects and to be successful in these areas of collaboration. It is underlined that the further refinements of the common planning and its execution is considered as a continuous process in the forthcoming months.

APPENDIX 1: LIST OF TOPICS OF COMMON INTEREST

SUBJECT	ALADIN contact	HIRLAM contact	REMARKS
Dynamics and lateral boundary coupling	**Radmila Brozkova**	**Per Unden**	
Development of the TL/AD version of the ALADIN semi-Lagrangian scheme	Filip Vana, Karim Yessad	Nils Gustafsson	To be done by ALADIN with contacts in HIRLAM
Improvement of the treatment of the map factor in the semi-implicit scheme of ALADIN	Pierre Bénard	Tomas Wilhelmsson	Needed for large domains
Investigation on a possible Vertical Finite Elements discretisation for the NH version of ALADIN	Pierre Bénard, Jozef Vivoda	Karina Lindberg, Bjarne Andersen	Needed for large vertical domains.
"Well-posed and transparent" boundary conditions coupling strategy for ALADIN	Fabrice Voitus	Aidan McDonald, Isabel Martinez	Needed for small domains.
Other coupling issues	Mohamed Jidane, Martin Gera, Raluca Radu	Ana Morata, Isabel Martinez	Nesting strategy, possible application of frames for LBC …
Investigation of the horizontal pressure gradient term in presence of sharp orographic slopes	Radmila Brozkova	Ulf Andrae	
(Atmospheric) physics	**Jean-Francois Geleyn, Gwenaelle Hello (both of them involved in all issues below)**	**Bent Hansen Sass, Laura Rontu (both of them involved in all issues below)**	**Coordination started in January at the Tartu workshop**
Convection issues	Sylvie Malardel, Luc Gerard, Jean-Marcel Piriou	Pier Siebesma, Javier Calvo, Wim de Rooij, Sami Niemelä	Towards more integrated schemes (together with turbulence and microphysics)
Turbulence	Pascal Marquet, Jure Cedilnik, Eric Bazile, Filip Vana, Valery Masson, Martina Tudor	Pier Siebesma, Veniamin Perov, Sander Tijm	3D turbulence, link with dynamics (SLHD), moist effects
Microphysics	Yves Bouteloup, Tomislav Kovacic, Christine Lac	Karl-Ivar Ivarsson,	Algorithmic aspects.
Radiation	Neva Pristov	Anastasya Senkova	Interaction with clouds and 3D issues.
Orographic effects	Francois Bouyssel	Laura Rontu	
Interfacing, consistency, harmonisation of the various physical packages	Sylvie Malardel, Piet Termonia, Bart Catry, Jean-Marcel Piriou, Christine Lac	Carl Fortelius, Wim de Rooy, Sander Tijm, Gerard Cats	Crucial for the code convergence.
Development of common diagnostic and validation tools (1D version, idealised flows, real cases)	Sylvie Malardel, Jean-Marcel Piriou, Alena Trojakova, Yann Seity, Doina Banciu, Martin	Javier Calvo, Pier Siebesma, Aarne Mannik, Carl Fortelius, Christoph	

	Bellus, Siham Sbii	Zingerle	
Surface (physics, data assimilation, physiographic data)	**Eric Martin, Francois Bouyssel, Dominique Giard (all of them involved in all issues below)**	**Beatriz Navascues, Stefan Gollvik, Ernesto Rodriguez (all of them involved in all issues below)**	**Cooperation already exists for 10 years.**
Externalisation (separation of surface and atmospheric processes) and coupling (between surface and upper air) issues	French team, Luksa Kraljevic, Piet Termonia, Mohamed Jidane	Stefan Gollvik, Han The	Next meeting planned for summer 2006.
Cross-testing of existing schemes, use of advanced options			Common work on implicit coupling, starting later.
Improvements in physics (sea-ice, lake, irrigation etc.)			Starting later, common needs.
Improvements in data assimilation (new fields: SST, sea-ice border, snow; new methods: variational; new observations: SAF products, satellite data)	Francois Bouyssel, Mohamed Jidane, Karim Bergaoui, Francoise Taillefer, Stjepan Ivatek-Sahdan, Luksa Kraljevic	Beatriz Navascues, Alberto Cansado, Mariken Homleid	
(Variational) data assimilation	**Claude Fischer**	**Nils Gustafsson, Harald Schyberg**	**First coordination meeting was already held in Prague at the WMO data assimilation symposium**
Regularised physics and its TL and AD	Cecile Loo, Francois Bouyssel	Xiaohua Yang, Nils Gustafsson	
Wavelets for background errors (Jb)	Alex Deckmyn, Loik Berre	Tomas Landelius, Martin Ridal	
Radar reflectivity assimilation	Eric Wattrelot, Claude Fischer, Marian Jurasek	Guenther Haase	
Non-linear balance equation and omega-equation for the ALADIN Jb	Loik Berre	Ole Vignes	
Evaluation of new emissivity maps for IR radiance assimilation over land	Florence Rabier, Fatima Karbou	Per Dahlgren, Magnus Lindskog, Bjarne Amstrup	
Assimilation of cloudy IR radiances/cloud retrievals	Nadia Fourrie, Florence Rabier (Mohamed Dahoui)	Per Dahlgren, Magnus Lindskog, Frank Tveter	
ODB: installation and teaching	Sándor Kertész	Tomas Wilhelmsson	
Predictability	**András Horányi**	**Ben Wichers Schreur**	**Important, but at that stage it is not clear at all what is the best strategy to adopt in that area. Therefore a workshop with brainstorming is essential to have a kick-off (proposed by**

			LACE) for the common short range EPS work.
Verification and diagnostics	**Joel Stein, Jean-Marcel Piriou**	**Gerard Cats, Ben Wichers Schreur, Carl Fortelius**	**This is an area, where the strong cooperation is a must, however the technical details are hard to be agreed at this early stage.**
System	**Jure Jerman, Eric Sevault**	**Gerard Cats**	**The system issues are of critical importance for the code convergence. The harmonisation of model environment should ease the code convergence. The first training steps are as follows:** • **Significant, desired contribution of HIRLAM scientists to the common phasing actions** • **Training about the IFS/ARPEGE/ALADIN code system (workshop in Budapest mid-November)**
Source code management	Eric Sevault	Ole Vignes, Tomas Wilhelmsson	Urgent need for harmonisation!
Portability issues	Oldrich Spaniel	Gerard Cats	
File format (including coupling files)	Ryad El Khatib, Jean-Daniel Gril	Maryanne Kmit	
Interfaces to GTS		Daniel Höglund	Longer term issue
Parallellisation issues including IO	Ryad El Khatib, Jure Jerman	Kalle Eerola, Tomas Wilhelmsson, Ole Vignes	
User interfaces			User-friendly tools.

APPENDIX 2: RECENT AND CURRENT CONCRETE ACTIONS

EVENT	PLACE and DATE
Non-hydrostatic training course	Toulouse (France), 12-16 March, 2004
Training on model use	Copenhagen (Denmark), July, 2004
ALADIN Assembly: HIRLAM representation in observer status	Split (Croatia), 29-30 October, 2004
Training Course on Physics Dynamics Interface	Prague (Czech Republic), November, 2004
HIRLAM Council: first participation of ALADIN in observer status	Reading (United Kingdom), December, 2005
Common workshop about physics	Tartu (Estonia), January, 2005
First publication on the experiments performed by the HIRLAM mesoscale team with ALADIN in the ALADIN Newsleter	January, 2005
Participation to the HIRLAM All Staff Meeting (and debates on code collaboration)	Dublin (Ireland), 14-16 March, 2005
Data assimilation coordination meeting	Prague (Czech Republic), April, 2005
HMG-CSSI meeting	Bratislava (Slovakia), 5 June, 2005
Participation to the ALADIN workshop and discussions on research plans	Bratislava (Slovakia), 6-10 June, 2005
First daily runs of ALADIN coupled to HIRLAM at ECMWF	July, 2005
First HIRLAM stay at Meteo France/GMAP (collaboration on the use of radar data)	Toulouse, September, 2005
Participation to the HIRLAM working week on "physics cleaning" (for consistency with ALADIN)	De Bilt (the Netherlands), 26-30 September, 2005
Informal HIRLAM-ALADIN planning meeting	Ljubljana (Slovenia), 6 October, 2005
Workshop on maintenance and data assimilation	Budapest (Hungary), 14-18 November, 2005
AROME training course	Brasov (Romania), 21-25 November, 2005
Workshop on physics planning	Oslo (Norway), 12-13 December, 2005