ALADIN : A year of changes ! Group Report 2002-2003

D. Giard. Météo-France/CNRM/GMAP
42 avenue Coriolis, 31057 Toulouse, France. email: *dominique.giard@meteo.fr*

A. LIFE OF THE PROJECT

Enhanced cooperation with Africa

The ALADIN consortium will help to the development of NWP in Africa via the free dissemination of the **ALADIN-NORAF** products towards African NMSs. The ALADIN-NORAF model is operational in Casablanca since 24 Feb. 2003, and covers the Northern part of Africa with a resolution of 31 km.
Besides, Algeria should enter soon the ALADIN partnership, as Associated Member first.

Training

LACE training course on "Code Maintenance" :	Budapest (Hu), Nov. 2002
LACE training course on "ODB" :	Budapest (Hu), Apr. 2003
last ALATNET seminar :	Kiralyret (Hu), next week

This seminar will be a meeting between students, mentors and coordinators, with final presentations from the "Young Researchers" and discussions about a possible extension of the ALATNET research training network in the framework of FP6.

More decentralized research projects

Decentralization is now effective, thanks to ALATNET, the new organization of LACE, and more experienced (and sometimes larger) teams, of course. However we have again to face a quite difficult step, with a new project organization proposed at the beginning of 2003.

ALADIN and AROME

The last year was severely marked by the interactions between the ALADIN and AROME projects, with the following main steps and questions :

Autumn 2002 :
- AROME is a French project (NWP at scales of 2-3 km, target 2010)
  - -> *which NH dynamics and technical framework for AROME ?*
  - -> *where are the limits between ALADIN and AROME research, if any ?*

December 2002 :
- ALADIN (-NH) is chosen as starting point for AROME
- new "directives" for research in NWP at Météo-France (physics and scales)
  - -> *will this resist experimentation ? what about ALADIN partners ?*

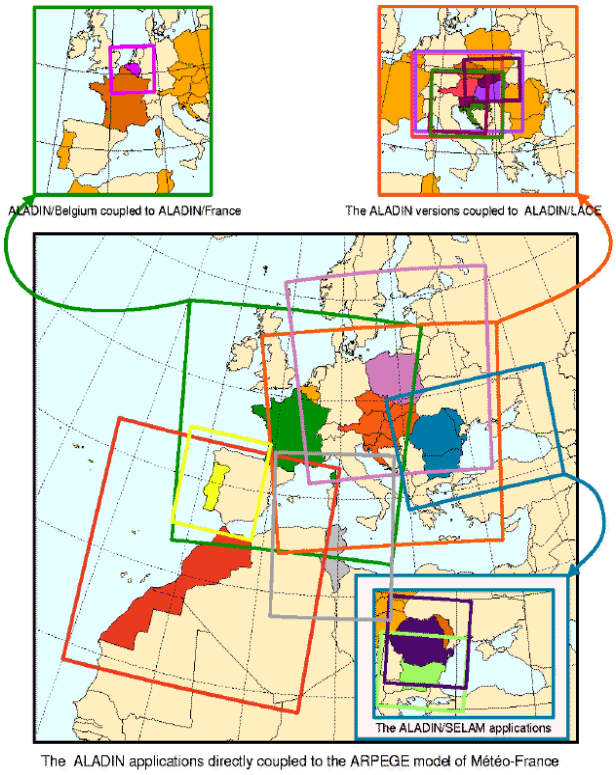
April 2003 : **ALADIN + AROME => ALADIN-2 !**
- a new partition of responsibilities in research inside ALADIN partnership
- a further enhanced decentralization / coordination required
- launching "AROME"-10 km and moving to an upscaling strategy in physics

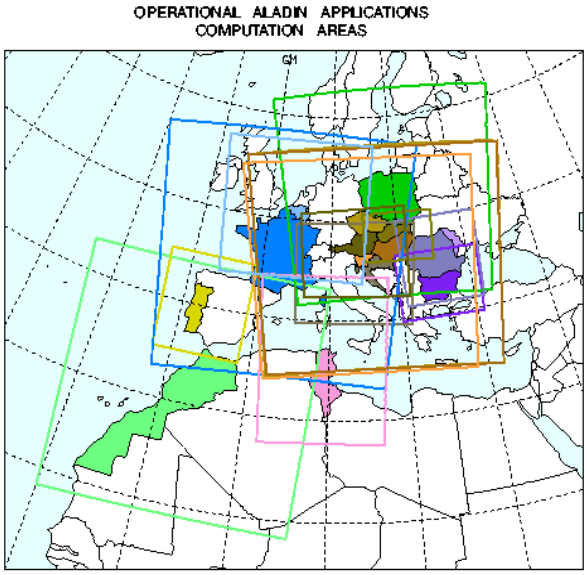
Now : Let's try and see !

Operations

Many changes along the last year (due to the reorganization of LACE and the birth of ALADIN-NORAF mainly) : 2 less, 4 more, 1 enlarged ..., with also upgrades in computers, source code libraries, transmission links ...

June 2002





October 2003

B. HIGH-RESOLUTION DYNAMICS

Stability of non-hydrostatic dynamics

There was a huge step forward. We are now satisfied with the **robustness**, **efficiency** and **accuracy** of ALADIN-NH. It is even difficult to make it blow up ! The main ingredients for this success are :

– the new NH prognostic variables [$d_3=\partial w/\partial z$ or $d_4=D_3-D$, and $q=\ln(p/\pi)$] are now fully coded, leading to a **stable 3TL SI-SL** advection scheme.

- the so-called "SITRA" (***S**emi-**I**mplicit **T**emperature **R**eference **A**coustic*) innovation is based on the remark that the linear SI operator need not be the tangent-linear one. Hence **2** reference temperatures may be used, which allow to have stability problems decoupled for gravity (ref. temp. T^*) and elastic (ref. temp. $T_a{}^*$) waves and have a stability condition: $T_a{}^* < T < T^*$ now satisfied for a wide range of conditions. This allows to have a **stable 2TL SI-SL** advection scheme.

- the ICI (***I**terated **C**entred **I**mplicit*) scheme (ex Predictor-Corrector) is now fully coded and validated. It will allow to solve **residual stability problems, if any**, encountered in the future. There is only one call to physics, to make it cheaper, and one iteration was shown to be enough, up to now. Maybe it will be useful for cases of very steep orography : we are looking for such situations !

Other advances in NH

Lower boundary condition

A simple temporary solution to the "chimney" problem in SL advection was proposed. It is based on a **Lagrangian** treatment of the kinematic lower boundary condition, and is efficient in most cases. The final version should consider the advection of vertical velocity.

Radiative Upper Boundary Condition

The preliminary analysis is now performed.

High-resolution case studies

Experiments were performed using high-resolution domains in the Alps. They aimed at the validation of the spectral smoothing of orography, and at the investigation of alternatives for coupling. They tend to prove that NH dynamics is useful up to 5 km.

Documentation and publications

On a good way : 4 papers submitted, update of the technical documentation started.

Still to be done for NH

code cleaning (to keep only the most useful options), improvement of the interface with physics, more validation on real cases

Flow-dependent horizontal diffusion : ***cf presentation of Filip Vana***

C. COUPLING

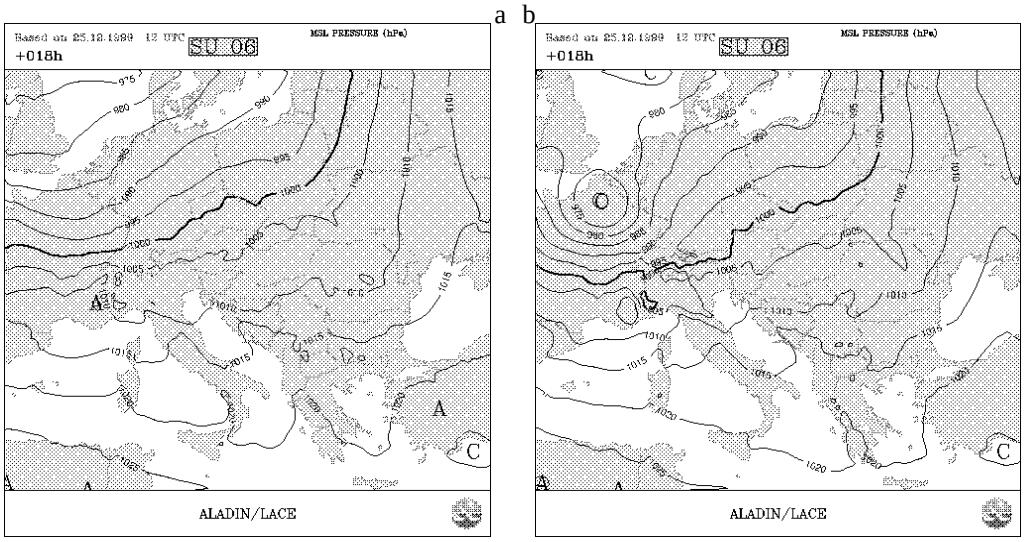
Search for new time-interpolation methods

The previous attempts were not so successful, and nothing really new was done this year.

Spectral coupling

Spectral coupling is intended to be used as a complement to Davies's method. From the coupling model, gridpoint coupling uses information in the narrow coupling zone, while spectral coupling uses information in the largest wavenumbers, which may be useful in case of rapidly moving storms.
A modulation in time of such a combination was investigated : performing spectral coupling either only every n*th* time-step, or introducing an attenuation between 2 coupling times ("relaxation in time").
Validation moved from 1d to 3d tests, with impressive results on the 1999 Christmas' storm case, as shown hereafter :

a b



The storm as forecasted by the ALADIN-LACE model : a/ with gridpoint coupling, b/ with gridpoint coupling AND spectral coupling every third time-step. In each case, coupling files are available every 6 h, and a linear time-interpolation is performed.

Transparent boundary conditions

The work started, using a simplified **spectral** shallow-water model.

Tendency-coupling for surface pressure

Semi-implicit treatment : *done, but no significant impact (in ALADIN-France)*

Explicit treatment : *starting tests in ALADIN-HU*

Complete recoding of the data-flow

This was necessary for phasing with the new data-flow in ARPEGE-IFS. The B-level parallelization was also coded.

Next

Work on two-way nesting for a spectral model should start in 2004.

D. PHYSICAL PARAMETERIZATIONS

There was noticeable progress in many topics, and the problem of spurious cyclogeneses is now partly solved (but only partly, unluckily).

Radiation

The exact computation of exchanges with the surface led to a significant improvement of forecasts, not only close to the surface ! A new climatology for ozone profiles (no longer constant in time and space) was also tested, but not yet moved to operations.

The objective is now the design of an improved radiation scheme, starting with the definition of the desired balance between cost and accuracy. Shall we just try to improve the present simple scheme, use more complex ones but not call them every time-step, or combine both a complex expensive and a simple cheap codes (computing clear-sky values not so often, and modify them according to cloudiness every time-step) ?

Vertical diffusion

The improvements in the radiation scheme led to a significant retuning, mainly a reduction of vertical transport in stable conditions, which helped preserving inversion layers. Besides there were further studies on a flow-dependent vertical diffusion, using the adjoint model to diagnose problems (***cf presentation of André Simon***). Some more work on a TKE based scheme was also performed.

Cloudiness

New, more consistent, formulation**s** were proposed, aiming at an improvement of low-level cloudiness.

Convection

The operational schemes are now far **more stable,** especially the shallow-convection parameterization (thanks to a simple reformulation of the algorithm). And the closure condition for deep convection changed once again, back to an explicit dependency on resolution !

Promising results are obtained in 1d with the new prognostic convection scheme developed by L. Gerard. It shows a nice auto-extinction behaviour, as the resolved contribution to precipitation and cloudiness increase with resolution. However there are still technical problems with the 3d version.

Several tests were performed with the KFB scheme in ARPEGE and ALADIN. They are rather disappointing, with a very low ratio "improvement /(additional cost)".

Besides a thorough analysis of the mis-representation of the diurnal cycle of convection was carried out, and a few solutions tried. The problem of the triggering of convection and its links with orography or soil moisture was also

carefully examined, and some improvements to the present scheme proposed.

Orography

The main problematic is now : **do we need an envelope orography or not ?** A study of the sensitivity of precipitations and wind field to the envelope at small scales in ALADIN-Vienna tends to show that it should be suppressed, since detrimental for precipitations and useless for the wind fields. However the last point is still controversial, and invalidated by other experiments.

Research is performed following two quite different approaches : a thorough investigation of the behaviour of dynamics and parameterizations, and their balance, as resolution increases, in a quasi-academic framework (ALPIA) on the one hand, and a more pragmatic one, launching experiments to evaluate whether the envelope may be (partly or fully) suppressed with a global retuning of the concerned parameterizations, on the other hand.

Besides tests of the spectral smoothing of orography show it leads to more realistic, smoother, precipitation patterns with still high peaks.

Surface

Still trying to implement ECOCLIMAP (a high-resolution global database for soil and vegetation) operationally : tests in a NWP framework, description of the problems, corrections, tests, ...

Validation

Beyond the routine analysis of forecast failures, a significant effort was dedicated to validation tools :

- use of new datasets, such as EUROCS, BOMEX, ERBE, Sodankyla, etc ...
- use of the adjoint model for sensitivity studies
- design of test-beds to evaluate the behaviour of physics as resolution increases
- further improvement of the "model to satellite" tool.

The "model to satellite" application produces satellite images (clear-sky or cloudy, LW or SW), starting :

1. from model forecast : additional computations are performed in the physics, using a RTM code and, whenever required, satellite characteristics for channel selection; this allows to simulate outgoing radiances and compute brightness temperatures from thermodynamical and cloudiness fields.
2. from observations : decoding and post-processing of data

This tool is now fully portable as step 2 is concerned, and as portable as ALADIN for step 1. The Morcrette and RTTOV models may already be used.

Code design

There were noticeable achievements in this domain : careful and complete checking of robustness and stiffness of all parameterizations, cleaning of the interface with dynamics and the data flow, preparing AROME and the plug of a far more complex physics, ... and bug corrections of course !

E. DATA ASSIMILATION

Cycling for variational data assimilation

DFI-Blending

A set of reference experiments was prepared, based on MAP IOPs. Besides, a careful validation was performed with ALADIN-France. Two periods of ~1 month were considered. This showed only very slight improvements, with a neutral impact on skill scores. The general feeling is now that dfi-blending may bring significant improvements but only for some typical situations.

A new cost function, Jk

The introduction of an additional term, to relax the LAM analysis towards the one of the coupling model at large scales, was considered, as an alternative to the Blendvar technique. ***cf presentation of Vincent Guidard***

Intensive validation of 3d-var

Experiments were performed mainly in ALADIN-HU : checking that 3d-var improves / doesn't deteriorate bad / good forecasts, examining the part of coupling files, of each observation type, etc ...

3d-FGAT

4d-screening is working in ALADIN, but 3d-FGAT is too expensive for the while. The code structure has to be deeply modified to reduce memory costs.

A Jc for ALADIN 3d-var ? : answering "No" for the while

Modelisation of background errors for ALADIN 3d-var

A detailed report was published in the last HIRLAM Newsletter. The main problems addressed this year were the management of the extension zone (i.e. periodicity problems) and the representation of geographical variations

Computation of statistics : using the NMC method (with many variants) first, and, **new**, trying the Ensemble method.
The first experiments were performed last Summer with ALADIN-France, using initial and lateral boundary conditions from ARPEGE ensembles ***(described by Margarida Belo Pereira)***. The parts of the various contributions to errors were carefully investigated.

Modelisation of Jb : several approaches

diagonal versus block-diagonal versus full matrix
use of a basis of compactly-supported functions
from spectral (bi-Fourier) space to wavelet space

Variational tools

Sensitivity experiments using the adjoint model were performed, either for case studies or to evaluate simplified physics at small scales.

The problem of a-posteriori optimization of data assimilation systems received further attention.

Use of observations

In short :

- investigation of the relative parts of SYNOP and TEMP observations
- use of AMDAR data
- use of raw ATOVS data

cf presentation of Gergely Bölöni and Roger Randriamampianina

- use of 10m-wind observations over land
- a research plan for the use of radar data

cf presentation of Marian Jurasek

"Surface"

Developments mainly aimed at obtaining a more realistic initial soil moisture. The following directions were investigated :

- further reduction of assimilation increments (i.e. of O.I. coefficients)
- using or not coastal observations in 2m analysis (for *Hu*, for *T*)
- spatial smoothing of the soil wetness index : ***cf LACE presentation***
- further evaluation of a 2d-var assimilation of mean soil moisture

The combination with upperair assimilation was also examined.

F. PREDICTABILITY

Research in this domain will start in 2004. The work plan for Hungary is based on :

- the use of LBCs from ARPEGE-EPS (PEACE project at Météo-France),
- the use of initial states from PEACE or from ALADIN **singular vectors**,

for the first experiments.

In the meantime, an increased activity is expected in France due to the move of the predictability (research) team to the NWP group.

This does not exclude contributions to other European initiatives, of course.

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