Maintenance and research actions in Toulouse

January – June 2004

1. Introduction

Besides the maintenance and research work described hereafter, a significant effort was devoted to more “administrative” or “diplomatic” issues : closure of the ALATNET project, organization of ALADIN-2 (discussions, clarifications, work plan), enhanced ALADIN-HIRLAM cooperation, training course on ALADIN-NH, and various duties of the same type.

2. Phasing

These six months were “debugging” ones ! After the rather quick creation of cycle 28T0 (with the help of Gergö Bölöni, Adam Dziedzic and Martina Tudor), a long bug(s) hunting exercise started, and the delivery of cycle 28T1 was delayed until the beginning of July.

A debriefing meeting was organized at the very end of June, in order to diagnose the blocking points and try to improve the phasing process. The main decisions concerned the inclusion of new elementary validation tests, a unique and more careful merge of the modifications coming from the (Météo-France) operational versions, the refinement of the leaflet to be filled by contributors, the design of a management tool for namelists, and more feedback from the “automatic” merge operations.

PALADIN was once again updated by Jean-Daniel Gril (v1.12). Besides, while implementing the new cycles at ECMWF (see the dedicated article), Ryad El Khatib undertook to gather the many "porting" bugfixes designed here and there along the years, but never introduced in the official code releases. He also discovered an amazing number of "*ifdef*" options, worth some reorganization. Part of the corresponding modset should enter cycle 29, with the help of ALADIN specialists.

The next phasing exercise (cycles 29 then 29T1) will start soon, in September. The first sets of contributions are expected for the end of August. There will be a two-headed supervision this time, Ryad El Khatib (ARPEGE mainly) and Yann Seity (ALADIN mainly) : some deserved rest for Claude Fischer ! The first ALARO library, i.e. including the prototypes, will be based either on cycle 29T1 or on cycle 30 (decision to be taken in September 2004).

The previous export version for ALADIN partners, delivered in June 2003, was based on cycle 25T1. Let' s recall that cycle 28T1(+ ...) is expected to be used operationally by all partners at the end of 2004. Such a constraint is necessary to ensure a smooth transition towards ALARO and its various applications. At least 3 teams, the Austrian ,Czech and Hungarian ones, have already started to implement it, and found some remaining bugs (documented in the article on cycle 28T1). The corresponding modset and some additional modifications introduced in the present parallel suite at Météo-France (local cycle 28T2) will be merged in a new intermediate cycle, 28T3, and an “incremental” export version to be delivered at the end of August.

3. Dynamics, geometry and coupling

3.1 NH dynamics

The ALADIN-NH code is now roughly stabilized, after the introduction of the P/C scheme and some more debugging / cleaning performed in Toulouse (Martina Tudor, Jan Masek, Gwenaëlle Hello), Bratislava, and Prague. Simultaneously, various configurations of NH dynamics have been introduced in the "mitraillette" set of validation tests.

A 5-days training course was organized in Toulouse in March, for ALADIN and HIRLAM scientists. The corresponding lectures (mainly on NH dynamics, by Pierre Bénard) are available on the ALADIN web site, at http://www.cnrm.meteo.fr/aladin/meetings/NHtraining.html . The documentation was also updated.

Besides, the research work on "diabatic forcing" and "diffusive chimneys" in NH dynamics was pursued (Alena Trojakova, Jan Masek, Pierre Bénard; see the previous Newsletter) and Karim Yessad resumed work on the relaxation of the "thin-layer hypothesis", starting directly this time from the NH equations (according to the proposal of Staniforth and Wood, 2003).

3.2 Design of ALADIN domains

While Jean-Daniel Gril was closing the development of CONEO (a conversion tool required by the previous change of file header and geometry description), Pierre Bénard was looking for the most convenient mapping of large domains such as the outer HIRLAM ones, covering both Northern Atlantic and Europe. The simplest solution is the introduction of a "rotated/tilted Mercator" geometry in ALADIN. A detailed documentation on this projection was written, and work is starting to define how to implement it in the recently cleaned EGGX package.

The impact of the distorsion of the mapping factor (increasing with the domain extension) on the stability of the semi-implicit formulation was examined by Fabrice Voitus and Pierre Bénard. Solutions were proposed that should enable to run ALADIN NH dynamics on very large domains (provided a rotated Mercator projection is used), and even in ARPEGE with a stretched grid. A dedicated paper is available in this Newsletter and a more detailed report (in French) may be sent on demand (*fabrice.voitus@meteo.fr*).

3.3 Coupling

In order to definitely close the study of tendency-coupling for surface pressure, and evaluate the amplitude of the problems this method was expected to solve, Jean-Marc Audoin started experiments using a "typically problematic" domain setting, with boundaries crossing mountains and a high resolution-ratio between the coupling and coupled models. Because of time-sharing between many topics, results are not yet available.

Experiments were launched to evaluate the potential impact of a two-way-nesting configuration based on ARPEGE and ALADIN-France. A simplified scheme was used, applying the "bogussing" method (designed by Ryad El Khatib - initially to enable the modification of some tropical cyclones characteristics in ARPEGE via "manual" corrections in ALADIN) and updating models and coupling files every 3 hours. More details in the next Newsletter (Jean Barckicke, Jean-Louis Ricard, Karim Yessad).

4. Physics

4.1 Introduction

GMAP developments on physical parameterizations focused on ARPEGE physics, now progressively converging towards the "ARPEGE-Climat" ones, and in the meantime diverging from those required for limited-area modelling (imported Méso-NH physics at very high resolution – AROME -, or design of a new strategy at intermediate scales – other ALARO declinations and ALADIN -).

A detailed paper about the corresponding challenges and developments is available in this Newsletter. And many presentations are available on the web site of the 14th ALADIN workshop, with main topic "*Which physics for which scales ?" :* http://www.zamg.ac.at/workshop2004/*)*

4.2 Prototypes

Thanks to the joint efforts of Yann Seity, Sylvie Malardel, Gwenaëlle Hello and Tomislav Kovacic, both AROME and ALARO-10 prototypes are now ready. They mainly differ by horizontal resolution (2.5 km versus 10 km), the systematic choice of NH dynamics for AROME, and the plug-in of an additional parameterization for convection in ALARO-10.

2D test cases, then real 3D experiments (first on the Gard case : floods in southern France, September 2002), were performed. Both prototypes reproduce quite well the behaviour of Méso-NH at the same scales, with far longer time-steps (see the dedicated paper on the ALARO-10 prototype by Gwenaëlle Hello and Tomislav Kovacic.). However the forecast skill is not so high at 10 km as at 2.5 km, at least for the few situations studied so far.

4.3 Radiation and cloudiness

This research topic is the most impressive illustration of the change of strategy :
- the FMR15 package (old ECMWF scheme, Fouquart-Morcrette) is now operational in ARPEGE (and ALADIN-France),
- the RTTM one (new ECMWF scheme, used in Méso-NH) is used by the AROME (and ALARO-10) prototypes,
- several ALADIN scientists, under the supervision of Jean-François Geleyn, are working on the design of a "new-old" scheme, of intermediate complexity, low cost and good accuracy, based on the NER (net exchange rate) concept.

A detailed presentation about this innovative approach, by Jean-François Geleyn, Gwenaëlle Hello and Neva Pristov, is available in the "proceedings" of the last ALADIN workshop.

The Toulouse contribution to this pioneer ALADIN-2 action concerned :
- the computation of new optical depths, based on the RTTM scheme (Gwenaëlle Hello),
- the "approximation of the Malkmus band-model average equivalent width for the case of the Voigt line-profile" (Pierre Bénard),
- 1d then 3d validations and comparisons with other schemes (Yves Bouteloup).

4.4 Orographic forcing

Jure Cedilnik compared once again the computation in IFS, ARPEGE (with and without stretching) and ALADIN, of the various fields describing subgrid-scale orography. The various formulations are consistent, and the differences remain small. He also designed simple tools to "quantitatively" compared the spectrally fitted orography to the reference gridpoint one, and help tuning the optimization.

Besides he carried out numerous experiments in the framework of the coordinated attempt to suppress the envelope orography (another successful ALADIN-2 action). This task was resumed by François Bouyssel afterwards. See the presentation of Bart Catry at the ALADIN workshop for more details about the new description of orographic forcing.

In the meantime, the concept and computation of the semi-envelope orography received more attention. The code of configuration 923 was cleaned and modified in order to have two optimized spectra (with and without envelope) used as targets in the corresponding cost-function, and many comparisons were performed, for the ALADIN-France and ALADIN-SI domains. However the optimization process doesn't work as expected, wearing away some mountain ranges ... Tests based on a simple linear combination of the two reference spectra (with and without envelope) were undertaken, but further work seems now useless (Dominique Giard and Jure Cedilnik).

4.5 Else, in short

Doina Banciu and Eric Bazile studied the impact of changes in the initial humidity profiles on the forecast of precipitations, in stratiform or convective situations. The aim was to define a meaningful shape for the initial corrections derived from the assimilation of radar data. The experiments and results are detailed in the presentation of Doina Banciu during the 14th ALADIN workshop.

Eric Bazile introduced "interactive" mixing-lengths and (positive) modifications of the Louis functions, together with some code reorganization.

He also started to retune the thermal inertia of surface (soil and vegetation), since the initial limitations imposed by weaknesses in the radiation scheme are now relaxed.

Mohamed Jidane further investigated why the new ECOCLIMAP database gives worse forecasts than the present one. The main problems are related to changes in soil characteristics (depth and texture), and in vegetation over Europe.

Near real-time ARPEGE forecasts are now available for the 3 CLOUDNET : Palaiseau (Fr),

Cabauw (Nl), Chilbolton (UK), and the Sodankylä (Fi) site experiments :
http://www.met.rdg.ac.uk/radar/cloudnet/quicklooks/index.html for CLOUDNET,
please contact *eric.bazile@meteo.fr* for Sodankylä tests (site not fully public).

5. Data assimilation

5.1 From Diag-Pack to Var-Pack ?

Ludovic Auger, with the help of Françoise Taillefer and Lora Taseva, started to investigate whether Diag-Pack, based on CANARI (Optimum Interpolation analysis, O.I.), could be replaced by an equivalent Var-Pack tool, based on 3D-Var. Both packages aim at the production of frequent (e.g. hourly) diagnostic analyses, using a dense network of surface observations, as an help for the nowcasting of severe convective events.

Some modifications of 3D-Var were required to improve the fit to observations :

- increase of the standard deviations for background error statistics (lagged-NMC ones) for the lowest models levels, i.e. below 300 m, up to a factor 7 below 100 m : the weight of the first guess is less compared to that of observations in their domain of influence;
- modification of surface temperature (not yet in the control variable) according to the correction at the lowest model level (here about 17 m) when trying to fit 2m observations : the whole vertical temperature profile from the surface to the lowest level is shifted in order to avoid too strong modifications.

Other differences with Diag-Pack are :

- specific humidity is analyzed instead of relative humidity;
- there is no strict control on the height of observations;
- diagnostic CAPE and MOCON fields can be derived either from fields at the lowest model level, or from re-computed 2m (T, q) or 10m ($\vec{V}$) fields, whereas in Diag-Pack they are usually based on analyzed screen-level fields.

The first validation tests, performed on two situations (09.10.2001, 18.08.2001) with comparisons to radar images, show a better fit to observations and smoother MOCON fields with Var-Pack. For more details, the report of Lora Taseva is available at :
http://www.cnrm.meteo.fr/aladin/publications/report.html

5.2 3D-Var assimilation

The design and evaluation of a new cost-function (*Jk*) to restore the LAM analysis towards the one of the coupling model are going on : see the PhD report of Vincent Guidard.

Some 3D-Var assimilation experiments with a very short cycle, 1 hour, were performed by Thibault Montmerle on convective situations, with a positive impact.

The implementation of an operational 3D-Var assimilation suite for ALADIN-France is progressing. The starting configuration is very simple :

- ✔ 6 hours cycling, as in ARPEGE (thus no need to prepare new observation databases);
- ✔ gridpoint surface fields interpolated from the ARPEGE analysis, as in dynamical adaptation mode, before 3D-Var is applied to spectral fields;
- ✔ no blending (of any kind) nor initialization;
- ✔ same observations as in ARPEGE : only the thinning distance for aircraft data is reduced;
- ✔ comparison of three formulations of the background cost-function (*Jb*) : NMC, lagged-NMC, or ensemble.

The first experiments show a significant temperature bias in the upper troposphere, which ALADIN 3D-Var cannot suppress from the first guess (whereas the ARPEGE 4D-Var succeeds).

5.3 Towards 3D-FGAT

Cornel Soci addressed the problem of 3D-FGAT (First Guess at Appropriate Time, introducing the time dimension in the computation of the distance to observations), with investigations in 2 directions. Firstly he performed some basic single- and full-obs. experiments, to compare the behaviour of 3D-Var and 3D-FGAT, with puzzling results. When there is only 1 observation at the centre of the assimilation window, the increments are significantly different (larger) with 3D-FGAT, whereas they should be very close. Using several observations and time-slots further changes the analyzed fields.

Then he examined how to reduce memory cost, prohibitive for an operational use when the trajectory is stored at each time-step, which is the default configuration. A solution, already available, is to store it only every *n*th time-step. With the small domain used (64×64 points), a 6-hour window, a time-step of 400 s and *n*=9 (storing fields every hour), the memory cost of 3D-FGAT is more than halved, and equivalent to that of 3D-Var. However this puts useless constraints on the model time-step. A slight modification of this option is now considered, where the trajectory is stored at every time-slot (i.e. each time the model is compared to observations).

As for Var-Pack, the full report is available on the ALADIN web site.

5.4 Assimilation of soil moisture

Karim Bergaoui and François Bouyssel tried to reduce the cost of the "dynamical optimum interpolation" (often called simplified 2D-Var) assimilation of soil moisture designed by Gianpaolo Balsamo. Using shorter forecasts (from 6 h to 1 h typically), with further rescaling, to compute the O.I. coefficients enables to reduce the cost by a factor 5 with very similar results. Longer validation experiments should start now. See the PhD report of Karim Bergaoui in Newsletter 25 for more details.

Besides, the present operational (standard O.I.) assimilation of soil moisture in ARPEGE was compared to an off-line initialization where the surface scheme is simply forced by observed precipitations once a day. Over the year 2000 (ELDAS reference period) the external forcing leads to a significant drying of soil during summer months, and worse forecasts of screen-level fields (Mohamed Harrouche, François Bouyssel)

5.5 New observations

Work on observations for use in ALADIN focused mainly on radar data, with significant progress achieved by Marian Jurasek, Eric Wattrelot, Rashyd Zaaboul, Dominique Puech, Patrick Moll and Claude Fischer. More details in the dedicated paper by Marian Jurasek.

Besides some more experiments were performed with MVIRI and SEVIRI observations (Thibault Montmerle).

The work on observations for ARPEGE is illustrated by the content of the summer parallel suite : see the report on changes in the operational version of ARPEGE.

6. Information

The new ALADIN web site is now ready, thanks to Patricia Pottier and Jean-Daniel Gril. Some more increase in efficiency is expected for the autumn, once the move to a more powerful Linux station achieved.

The ALADIN-thèque is getting bigger and bigger, due to the tenacity of Jean Maziejewski, and the latest reports from stays are now available on-line. However some visitors still forget to document their work before leaving (and after too).

The main task to be faced now is the management of on-line documentation, splitted or duplicated between the ALADIN, ALATNET, and GMAP web sites.

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