ALADIN NEWSLETTER 26

January–July 2004

ALADIN Newsletter 26

1. EDITORIAL

1.1. EVENTS

1.1.1 A & AAA meetings in Prague

On the 13th of February, just after the last ALATNET meeting, the so-called « AAA » meeting (AROME-ALARO-ALADIN) was held in Prague. Discussions allowed to give some clarifications on the inter connexion of the three « A » and also some guidelines to start working on ALADIN2.
See http://www.cnrm.meteo.fr/aladin/meetings/AAA.html for more details.

1.1.2 ALATNET : the end

Exactly 2 months after the end of the ALATNET project and as requested by the E.C., the ALATNET final report (see photo) was flying to Brussels. The ALATNET website is fully up-to-date now (including this last report on-line) ! Each ALATNET centre will receive a paper copy of the final report with a CD containing the full web site in its very last version. Many thanks and congratulations to all participants to the ALATNET adventure !!!
More informations on http://www.cnrm.meteo.fr/alatnet/.

1.1.3 Training course on ALADIN and NH dynamics

A training course on NH dynamics and the main ALADIN features was organized in Toulouse on March 15-19, 2004. Students were HIRLAM scientists and ALADIN newcomers. More informations, including lectures and a few conclusions, are available on-line :

http://www.cnrm.meteo.fr/aladin/meetings/NHtraining.html

1.1.4 14th ALADIN-Workshop

The 14th ALADIN-Workshop, organised by ZAMG, was held from 1-4 June 2004 in Innsbruck, Austria. More than 50 colleagues from ALADIN countries and two HIRLAM scientists attended the workshop.

Most topics of interest for the ALADIN scientists and users were considered within the 43 presentations and 5 working groups. However more focus was given to critical ALADIN-2 topics, especially the main one *"Which physics at which scales for limited-area models ?"*. Discussions on predictability issues, with most researchers meeting for the first time, were also quite successful.

More detailed information about the workshop, on-line presentations and reports from discussions, can be found under : http://www.zamg.ac.at/workshop2004/ .

No rest for ALADINists

Congratulations to the organizer (Klaus, on the right)

ALADIN-HIRLAM cooperation

1.1.5 Enhanced cooperation with the HIRLAM group

The HIRLAM group has to face very similar challenges as the ALADIN one for the coming years : developing applications at very high resolution while simultaneously improving the forecast skill at the present operational scales and limiting maintenance burden, with contributions from several but rather small NWP teams.

So they now considerer a move towards AROME for their kilometric-scale target application, this also meaning a far closer cooperation with ALADIN, with going towards the same model, i.e. the ALARO package including the main HIRLAM specificities, for use at ***all*** scales. The diplomatic aspects of the cooperation require however a clearer definition, and will be jointly examined at the next HIRLAM Advisory Committee and Council, and at the Assembly of ALADIN Partners.

But collaboration in research mode has been already effective for years, and intensive training of HIRLAM scientists on ALADIN has now started. We had a few ALADIN scientists knowing how to run HIRLAM, the reverse is now true ! And some specific actions, such as the design of a suitable ALADIN geometry for the very large HIRLAM domains, or the plug-in of HIRLAM physics in ALADIN (for preliminary comparisons) are on the way.

The HIRLAM deputy leader for high-resolution modelling, Bent Hansen Sass (DMI, *bhs@dmi.dk*) and the project leader, Per Unden (SMHI, *per.unden@smhi.se*), are the main contact points.

1.2. ANNOUCEMENTS

1.2.1 Good bye ...

An important change happened in the leadership of the NWP team at the Hungarian Meteorological Service. Gabor Radnoti (now *gabor.radnoti@ecmwf.int*) joined the ECMWF team for a 2-years job. He is the fourth ALADIN scientist leaving for Reading, after Martin, Marta and Vanda. His successor at HMS is Sandor Kertesz.

Philippe Caille (alias Touffe), the famous specialist of observations and coffee breaks, left the GMAP team for a more "communication" oriented position.

Alfred Quinet, the head of the Belgian team, retired. He significantly contributed to the project's life, having Belgium enter the ALADIN partnership and the ALATNET project, and contributing to the refinement of the Memorandum of Understanding and to the definition of the role and scope of ALADIN-NORAF.

1.2.2 A new ALADIN website

After long months of cleaning and porting under open softwares, a newly updated ALADIN web site is available, wit the following innovations :

- ✔ ALADIN Newsletters

The last joined ALADIN/ALATNET Newsletter (ALADIN 25, ALATNET 8) is available through 2 *pdf* files (the smaller one for on-line consulting and the bigger one for better quality printing). An improved presentation and paper copies should be available soon.

Please consult the new guidelines for contributions to the next Newsletters.

- ✔ ALADIN ... (ALARO - ALADIN-2) ... AROME ! : first ALADIN-2 web pages

A website will be dedicated to the new ALADIN-2 actions once the new host Linux PC will be available. Meanwhile, the relevant informations on will be available through :

http://www.cnrm.meteo.fr/aladin/aladin2.html.

A specialized AROME site will be designed too.

- ✔ More documentation is now available

e.g. the two last reports from stays, a documentation on the porting on AL26T1 on IBM, information on the prototypes, and the developers' bedside reading : "New coding rules for ARPEGE/IFS/ALADIN".

- ✔ News mailing lists and presentation of addresses in the web site,

as a protection against "*spam*" ... See the "News" page on the ALADIN site !

1.2.3 Workshops, meetings and training courses in 2004

- ✔ ECMWF Seminar on Recent developments in numerical methods for atmosphere and ocean modelling (6-10 September, Reading, UK)
  The SRNWP workshop on Numerical Techniques will be consequently delayed by one year.
- ✔ Fourth Joint SRNWP/HIRLAM Workshop on Surface Processes and Assimilation of Surface Variables (15-17 September, Norrköping, Sweden).
- ✔ COSMO General Meeting (22-24 September , Milano, Italy).
  Dijana Klaric will attend it as ALADIN representative.
- ✔ 26th EWGLAM and 11th SRNWP meetings (4-7 October, Oslo, Norway).
  The special topic is "High Resolution Modelling in Mountainous Regions" and a half-day session will be devoted to MAP.
  Informations at http://www.met.no/EWGLAM_2004.
- ✔ WGSIP/WGNE/WGCM Workshop on Ensemble Methods (18-21 October, Exeter, UK).
- ✔ 9th Assembly of ALADIN Partners (29-30 October, Split, Croatia).
  ALADIN-2, the HIRLAM-ALADIN cooperation, and the renewal of the MoU will be the "hot" topics of this extended Assembly (with the participation of scientists).
- ✔ Joint SRNWP/Met' Office/HIRLAM workshop on Variational Assimilation (15-17 November, Exeter, UK).
- ✔ Mixed Training course / Working group on physics-dynamics interface (22-26 November, Prague, Cz).
  For informations, contact *jean-francois.geleyn@chmi.cz.*

1.2.4 Next ...

- ✔ Fourth WMO International Symposium on Assimilation of Observations in Meteorology and Oceanography (18-22 April 2005, Prague, Czech Republic).
  More informations on : http://www.chmi.cz/dasympos/index.html
- ✔ 15th ALADIN Workshop, Spring 2005, in Bratislava, Slovakia.
- ✔ 16th ALADIN Workshop, Spring 2006, in Sofia, Bulgaria
- ✔ 27th EWGLAM &12th SRNWP meetings, Autumn 2005, in Slovenia.
- ✔ Assembly and (hopefully) signing of a brand new MoU, November 2005, Bratislava, Slovakia.

Do not hesitate to have a look at the "Meetings" pages of the ALADIN web site or at the SRNWP web site : http://srnwp.cscs.ch/

1.2.5 Support to travels : "KIT" money

This Météo-France funding supports coordination visits, e.g. to enable "all" ALADIN countries to be represented at the annual ALADIN or EWGLAM workshops.

Concertation meetings are of growing importance in the framework of an enhanced decentralization of research, but have to face a severe lack of fundings in some institutes.

On August 16th, these funding had been used or were scheduled for :

- 7 participations to the ALADIN workshop,
- 8 participations to the EWGLAM workshop,
- 3 or 4 participations to the SRNWP-Var workshop
- 2 to 4 participations to the Assembly of Partners,
- 3 participations to the Prague workshop.

On average, this corresponds to 2 or 3 travels per partner in 2004.

1.2.6 Aladin correspondents

Participation registration: in order to make easier the http interface tool, some no longer "active" people and fundings have been removed from the proposed list. Of course, all the data concerning these people and fundings are kept in the data base. The criteria to define a not "active" person are a mixture of conditions on the date of the last registered action, the number of actions and other information received in Toulouse about changes in the teams. Please, let me know if you want some one to be added to the list or to be be removed from it.

The statistics have been updated with all contributions at the end of March 2004 and new graphics are available. As soon as all contributions for the second quarter are registered, statistics will be updated again.

The coordala email was first created for ALADIN correspondents (i.e. Persons responsible of the participations) at the rate of 1 correspondent per country. It is now used for exchanges between scientists in charge, representatives and correspondents in all countries. Therefore the list of addresses in coordala has been extended accordingly. Just a reminder, in order to avoid spam when one sends a message to coordala, this message is only received by Eric and Patricia who then re send it to a similar list (obviously if it is a spam, then it is not sent).

1.3. ALADIN 2

The last months were fruitful for the ALADIN2 project. On the 13th of February, the so-called « AAA » meeting (Arome-Alaro-Aladin) was held in Prague. This meeting was the opportunity to give some clarifications on the inter connexion of the three « A » and also some guidelines to start working on ALADIN2. See, http://www.cnrm.meteo.fr/aladin/meetings/AAA.html for more details.

Following this meeting, a work plan for the year 2004 and early 2005 has been written that plans the work and developments inside ALADIN2. The organization is built around five sub-projects. Some of them are devoted to specific horizontal scales: AROME-2 (Arome nominal resolution, i.e. 2,5 km where the convection is resolved explicitly), ALARO-5 (also called the grey-zone where the convection is not fully resolved) and ALARO-10 (for regional scales around 10 km where a parametrization of the convection is needed).

The others sub-projects are transversal ones: INTERFACES (flexibility, exchanges between models and physical packages), ALAROPAC (for assimilation, predictability and coupling) and ALAD1 (operations). One can see http://www.cnrm.meteo.fr/aladin/scientific/2004-program.html to get the work plan on line.

The implications of this important preliminary definition and organizational work could have been felt during the Innsbrück meeting all along the working groups, presentations and discussions. One practical aspect of the WP04 is also the possibility to have a glance at the (very) first AA prototypes on-line: http://www.cnrm.meteo.fr/aladin/aladin2/prototype.html.

The bend towards AROME is now taken, hopping that the road will bring us many scientific challenges and forecast improvements.

Besides the usual coordination team, 2 persons were appointed for specific support actions to ALADIN-2. Maria Derkova (Sk) is responsible for the coordination of the upgrade of operational suites. Bart Catry (Be) is in charge of the design of an improved physics-dynamics interface, a key task with the diversification of physical packages (from 1 to 3, not counting the native Méso-NH one, or more).

1.4. GOSSIP

Thanks to the new rules, the use of Open Office, the careful design of style-sheets and links by Jean Maziejewski, and more consideration from contributors, the present Newsletter will be ready within a reasonable delay !
(roughly 1 month work for 2 Newsletters instead of 2 months for 1 this summer)

2. OPERATIONS

2.1. Introduction

Please do not forget to send informations on the main operational changes to Patricia Pottier *(patricia.pottier@meteo.fr)* so that she may update the corresponding pages on the ALADIN web site !

2.2. Changes in the operational version of ARPEGE

(more details joel.stein@meteo.fr)

2.2.1 2004, January 29th : Improvement of 4d-var (et al.)

- new background error statistics *(from an "ensemble" method, work of M. Belo Pereira)*
- improved simplified physics : *improved vertical diffusion in the two inner loops, suppression of the (expensive) radiation and convection schemes*
- new minimizer , using a preconditioned conjugate-gradient algorithm (*CONGRAD*) : *more efficient for quadratic problems, preconditioning allowed*
- lower cost : *from (45+20) to (40+15) iterations*
- improved SST analysis *(finer description of sea-ice extension)*
- use of monotonic semi-Lagrangian interpolators in dynamics
- a "few" changes in physics :

  reduction of snow-melting / rain-evaporation speeds *(to limit fibrillations around 0 °C, according to the results of M. Tudor)*,

  tuning of the convective cloudiness diagnostic,

  cleaning and speed-up of the radiation code,

  new computation of mixing lengths (a step towards interactive ones),

  improved robustness to changes in vertical resolution,

  new tuning parameters for cloud condensates et cloudiness
- longer forecast ranges (24 h longer at 06 and 18 UTC)

⇨ ***clear improvements of wind field and SST, less spurious cyclogeneses***

2.2.2 2004, February 10th : New "production" run

- 30 h forecast from 00 UTC
- very short cut-off : 1h instead of 1h50 *(and 8h10 in the assimilation cycle)*

⇨ ***to have forecasts available early in the morning***

2.2.3 2004, May 24th : New physics

- new, intermittent *(called every 3h)*, radiation scheme : FMR15 *("old Morcrette scheme")*
- improved cloudiness (less 0/1, more ice ⇨ *more cirrus)*
- preconditioning of the second minimization in 4d-var *(using output from the first one, allowed by CONGRAD)*
- new statistical model (forecast errors) for the analysis of surface fields (T2m, H2m) *(more details in Newsletter 21)*
- improved soil moisture initialization :

  from better analysis increments of T2m and Hu2m first ! *(impact on surface temperature too)*

  reduced increments (halved), direct use of the sun direction

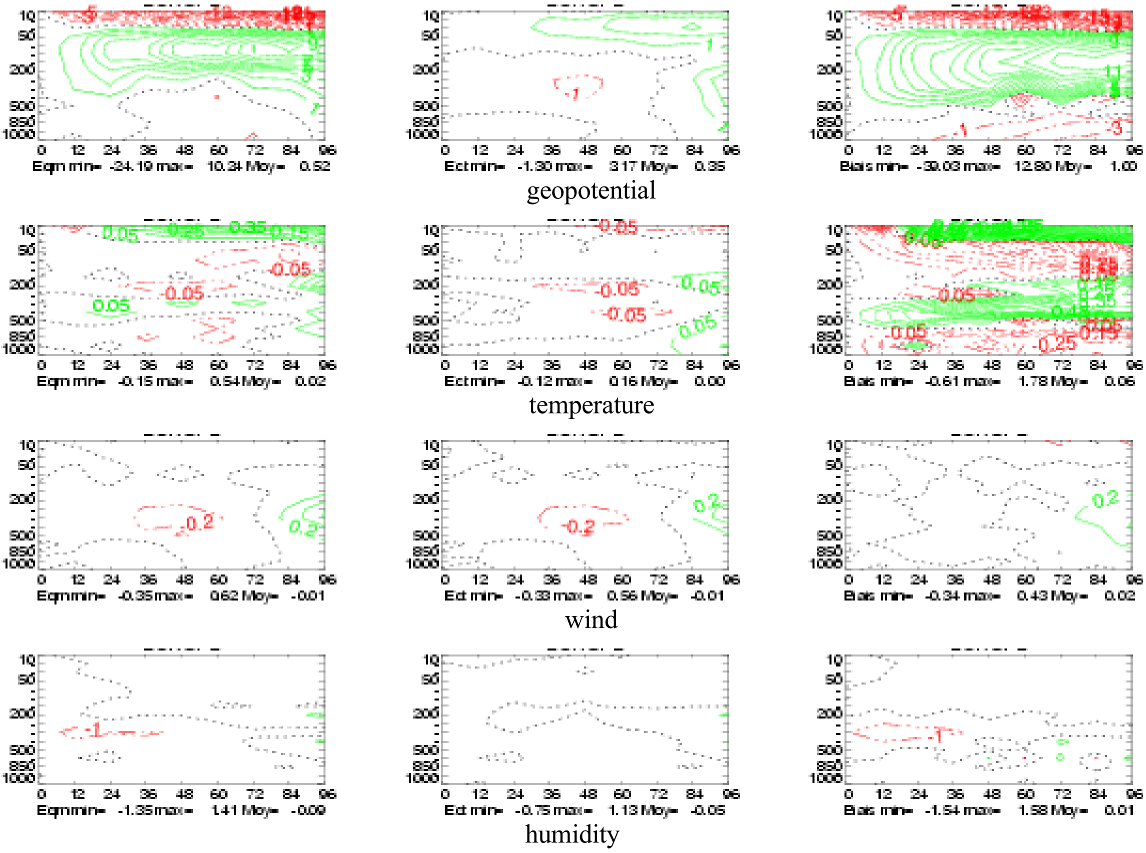
  spatial smoothing of initial soil moisture after corrections

  bias correction for T2m and temporal smoothing of soil moisture increments suppressed

  (more details in Newsletters 24 and 22)
- some slight code changes

⇨ ***a positive impact***

Comparison against TEMP observations over Europe : new against old model,
average over 2 months : 15/03 – 23/05; green corresponds to an improvement, red to a deterioration;
isolines every 1m for geopotential, 0.05 K for temperature, 0.20 m/s for wind, 1% for relative humidity



2.2.4 Summer parallel suite : Observations & Physics & ...

- New library : CY28T2 (CY28T1 + the following changes)
- New satellite observations :
  - QuikSCAT winds
  - AMSU-B observations (*thanks to the contribution of Z. Sahlaoui)*
  - AIRS observations
  - EARS ATOVS data (from EUMETSAT and Lannion)
- Variational quality control *(thanks to the work of M. Jurasek)*
- New balance equations in Jb, to better take into account ageostrophic contributions
- 2d climatological fields for ozone, instead of constants, to be used by the radiation scheme & 2d climatological fields for aerosols (id.)
- Reduced thermal inertia for vegetation (by about 25 %), following the improvement of the radiative budget, and improving surface temperature at night.
- Retuned mesospheric drag to reduce temperature bias at the top of the model (around 1 hPa)

2.2.5 About cut-off changes :

The sensitivity experiments performed to evaluate the impact of shifted and longer assimilation windows were not so conclusive. Consequently the operational schedule at Météo-France, with now 2 production runs at 00 UTC, is remain unchanged.

2.3. Austria

(more details thomas.haiden@zamg.ac.at)

Since May 2004 ALADIN-AUSTRIA has been put into operational use at ZAMG. Its main features are : LACE domain, 9.6 km resolution in horizontal, 45 levels in vertical. Both the ALADIN-

LACE and the ALADIN-VIENNA models do not run operationally any more. More details about ALADIN-AUSTRIA are in the dedicated paper.

2.4. Belgium

(more details alex.deckmyn@oma.be)

The current operational version is ALADIN-25, running on 16 processors of a SGI Origin 3400 computer.

The ALADIN-Belgium domain has been extended to 240×240 grid points, at the same resolution of 7 km. The model is coupled to ALADIN-France (and ARPEGE for forecasts up to 60h).

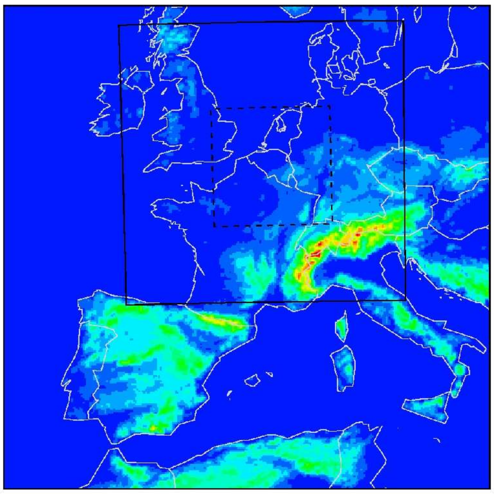
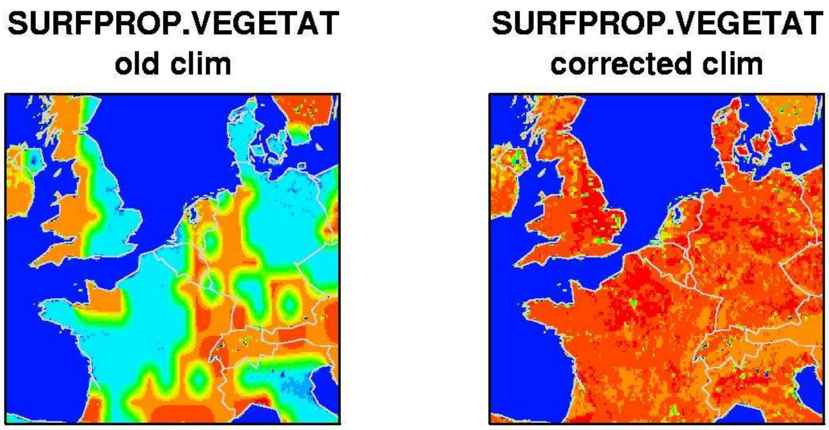
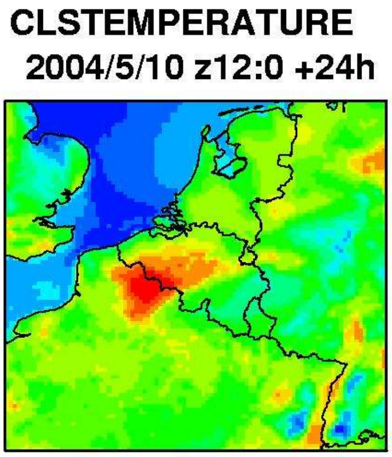


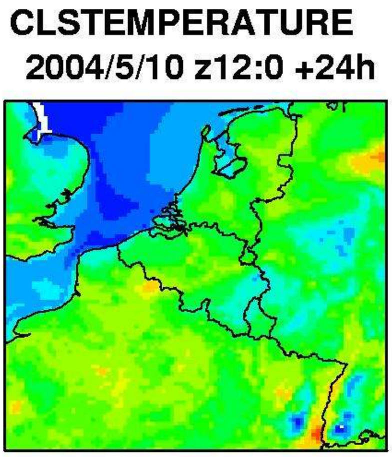
Figure 1: The old and new ALADIN-Belgium domains embedded in the ALADIN/France domain.

In June 2004 we found a severe problem with forecasts of 2m temperatures, which were up to 5 degrees too high at noon. The error was caused by the "clim" files. In the e923 script used to produce the "clim" files, part 5, which improves the vegetation index for Europe, had been suppressed.

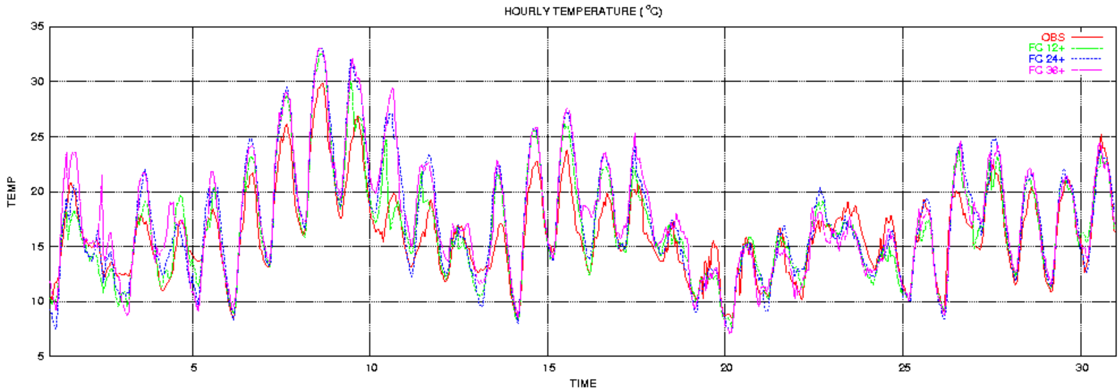


The effect of this error is very clear when comparing the original and corrected forecasts of e.g. May 10, 2004 :





In a plot of hourly temperature forecasts and observations in Uccle for the whole of June 2004, the impact of the new "clim" files (introduced on 16/06/2004) is very clear :



2.5. Bulgaria

(more details andrey.bogatchev@meteo.bg)

2.5.1 Changes in operations

The operational suite was switched to new SELAM coupling domain and new coupling files (41 levels) on 06.07.2004.

2.5.2 Running the pre-operational suite

EE927 procedure was tuned for the new SELAM coupling domain and 41 vertical levels and is running on own processor.

Integration job is running using two processors on the ALADIN-BG integration domain with 90×72 points (79×63) on 41 levels. The command for running model looks as follows :

- *Path_to_MPICH2/bin/mpd&* : activation of message-passing interface daemons
- *Path_to_MPICH2/bin/mpdrun -np 2 Name_Of_Your_Binary [model options]*
- *Path_to_MPICH2/bin/mpdallexit* : desactivation of message-passing daemons.

The averaged CPU time par time-step is between 2.8 and 2.9 seconds. Total time for EE927, model integration, post-processing and visualization is 18 minutes. The visualization tool is GRADS v1.9xp5 for LINUX.

The pre-operational suite is running since 16th of July and is planned to replace the old operational suite on 16th of August.

2.6. Croatia

(more details ivateks@cirus.dhz.hr, tudor@cirus.dhz.hr)

No changes along the last months. See the report on research and developments (§3.4) for details on verification and case studies.

2.7. Czech Republic

(more details filip.vana@chmi.cz)

2.7.1 Evolution of the ALADIN/CE application.

The ALADIN/CE suite was switched to 9 km mesh-size and 43 vertical levels on 13/01/2004 at 12 UT network time for the production run and at 06 UT network time for the blending cycle.

The corresponding parallel test has the identification name ADA. Beside the increased grid-point space resolution, a linear grid is used as well. The increased spectral resolution required a specific tuning of the horizontal diffusion coefficients, where we found the same set-up as used in ALADIN/France, where the linear grid is used, too. The effect of higher resolution was tested in the suite ACN showing weak improvements of the most of the scores. Then a modified Xu-Randall cloudiness scheme was added, and tested by the suite ADA. General results of the ACN and ADA suites were already reported in the previous Newsletter.

Since the problem of the low-level cloudiness was specifically addressed by the modified Xu-Randall scheme, a few words should be mentioned here. Till this operational switch the old cloudiness scheme and old tuning of the radiation scheme were kept in use, since the results of the COCONUT physics version seemed even worse in winter. With the additional modification of the Xu-Randall scheme there was a hope to increase the amount of low-level clouds and thus to correct a too cold bias of the screen-level temperature. The modification allowed a cloud presence at a bit lower relative humidity threshold accompanied by a security avoiding the super-saturation. Indeed, the tests made in winter periods showed the required tendency but mainly due to the effect of increasing amount of points with 100% cloudiness cover. This feature is already present in the COCONUT physics version itself and the modification did not change it really. Intermediate clouds were mostly replaced by either clear sky or a full cloud cover. Although the screen-temperature scores got better in winter, it was then due to a bad reason of the binary-like clouds distribution. Further work on the cloudiness scheme was therefore strongly motivated and some results are described below.

2.7.2 Parallel Suites

The following parallel tests were launched to assess the impact of different modifications:

- ✔ **Suite ADD** : this was a short suite to validate a new compiler release. The results were slightly different, very likely due to some optimization features in the code of the physics. In debug mode both compiler versions give identical results. In addition, we found that a choice of the semi-Lagrangian or Eulerian set-up within the e927 jobs has some impact on the results. It is due to the different truncation of the map factor. The impact on results is of course weak but some attention has to be paid to keep consistent choices in the testing procedures.
- ✔ **Suite ADE** : test of the future ALADIN/MFSTEP configuration. A special setup of ALADIN for the MFSTEP project was described in the previous Newsletter. As a next step, the configuration should comprise the SLHD diffusion, the abandon of the envelope orography compensated by the introduction of a new version of the gravity wave drag and orographic lift parametrizations. There are improvements of the radiation scheme as well. This future configuration was thus pre-tested on the ALADIN/CE domain. It showed better scores in the upper-air temperature and wind. On the other hand there is a colder bias of the screen level temperature and too weak screen level wind. The geopotential score has a characteristic change of the bias and pending the situation, it is translated either to an improvement or a worsening of the score. To analyse this scores' response other suites were launched, testing individual ingredients of the ADE suite.
- ✔ **Suite ADF** : the SLHD was switched off in the test. The purpose was to see whether there was

not an accumulation effect of SLHD compared to the ADE test. This hypothesis was found negative.

- **Suite ADG**: it was a repeat of the ADE suite with still retuned gravity wave drag and orographic lift parametrizations. The screen level scores of temperature and wind remained almost the same, although the tuning corresponded rather well to the values derived from the theory.
- **Suites ADH, ADI, ADJ** : these tests are the complementary ones to the ADE and ADG ones. The goal was to perform cross-tests of the impact made by SLHD scheme and new gravity wave drag scheme. We found that SLHD has similar effects as the drag; we concluded that a specific study of the SLHD scheme in presence of mountains should be undertaken. Very likely the ALPIA experimental framework shall be chosen for this benchmarking.
- **Suite ADK** : this test is based on the ADG one, where the cloudiness scheme was slightly revisited and retuned, regarding the curve of the critical relative humidity to diagnose clouds. The Xu-Randall limitation formula is rewritten, using a tangent hyperbolic function, allowing an easier tuning. Quite important change is in putting the switch LRNUMX=.TRUE., activating the computation of the random maximum of clouds. This change helped to get-rid of the binary-like clouds distribution and to reintroduce a reasonable amount of intermediate clouds. Suite ADK provided improved results with respect to ADG suite, surely in terms of the geopotential score and bit in terms of the screen-level temperature score.
- **Suite ADL** : here a small retouch of the critical humidity function was made, still having a small positive impact compared to ADK.
- **Suite ADM** : based on ADL, more consistent but also more expensive computations are activated in the radiation scheme. Another small improvement of the scores follows.
- **Suite ADN** : there is a last retouch of the cloudiness scheme, providing probably the best trade-off with the current formulation; therefore this configuration will be likely introduced into the operational use.

The results of parallel tests may be consulted on the following pages :
www.chmi.cz/meteo/ov/lace/aladin_lace/partests/

2.7.3 ALADIN/MFSTEP configuration

Since February 2004, a MFSTEP suite is computed regularly for the pre-TOP (Target Observation Period in the Mediterranean Sea) results validation; since April it is fully under the operational constraints and supervision. The suite runs in a blending assimilation mode with one production forecast up to 120 h every Wednesday.

2.8. France

(more details joel.stein@meteo.fr)

Same model changes for ALADIN-France as for ARPEGE (§2.2).

2.9. Hungary

(more details kertesz.s@met.hu)

In the operational suite of the ALADIN model, there were no changes in the first part of 2004.

Beside the operational model version, in parallel suite the following versions were integrated and compared (see the article of Helga Toth on the subjective evaluation of the ALADIN model):

a) ALADIN dynamical adaptation at 12 km resolution
b) ALADIN 3D-Var at 12 km resolution

It is noted here that an invitation to tender (ITT) was initiated to upgrade our computer system. Three companies were applying to the tender : HP, SGI and IBM. The final decision was in favour of IBM with the following system :
IBM p655 cluster server 4 * 8 processors (1,7 Ghz) with 2 Gbyte/processor memory.

The initial capacity of the new (highly expandable) system will be approximately 1,5 times bigger than the already existing Regatta system.

2.10. Morocco

(more details ajjaji@marocmeteo.ma)

2.11. Poland

(more details zijerczy@cyf-kr.pl)

Nothing new.

2.12. Portugal

(more details margarida.belo@meteo.pt)

During the first half of 2004 some effort was put on the installation of ALADIN on a new machine, making possible the increase of the coupling frequency and the number of vertical levels, besides the increase of the local domain. In addition, significant attention was given to the objective verification of ALADIN products and to its comparison with ECMWF forecasts. Moreover, after a validation period, some instability indexes (Jefferson, Total-Totals and Convective Instability) computed from ALADIN forecasts became pre-operational. Other diagnostic tools, such as low-level moisture convergence, vorticity advection and temperature advection, became also pre-operational. Finally, the validation of CANARI is going on.

2.13. Romania

(more details doina.banciu@meteo.inmh.ro)

The switch to new coupling files (larger domain and 41 vertical levels instead of 31) for the SELAM domain (covering the Bulgarian and Romanian ones) was prepared by Cornel Soci. This is part of a general upgrade of the operational suite, which will be described in the next Newsletter.

2.14. Slovakia

(more details oldrich.spaniel@shmu.sk)

The main event during the first half of 2004 was related to delivering, installation and operational tuning of the new high performance computing system IBM @server pSeries 690, Typ 7040 Model 681, 32 processors POWER 4+ 1,7 GHz , 32 GB RAM of memory, IBM FASt T600 Storage Server + EXP700 – 1,5TB.

The operational suite is expected from the beginning of July with the following parameters:

- code version AL25T2
- domain 320×288 points
- horizontal resolution 9.0 km
- 37 vertical levels
- time step 400 s
- 48 hours forecast, twice per day
- dynamical adaptation.

The operational suite has been completely overwritten with respect to the on-line monitoring and documentation tool that has been developed in house. This tool is based on Perl script and the internal web interface. The pre-operational suite has been launched for 1 month with emphasis on testing the queuing and batch system. A complete output result from post-processing is expected 1 hour after receiving LBC files from Toulouse.

2.15. Slovenia

(more details neva.pristov@rzs-hm.si)

During the first half of 2004 nothing changed in the operational suite except including some additional products in the output for our users. Computation of products for PEPS project and for RODOS *match* and l*smc* modules was prepared but not yet put into operation.

2.16. Tunisia

(more details nmiri@meteo.nat.tn)

Moving to cycle 26T1_op4 : see the R&D report (§3.14).

3. RESEARCH AND DEVELOPMENTS

3.1. Austria

Local work was dedicated to the organization of the 14th ALADIN workshop :
http://www.zamg.ac.at/workshop2004/
and the implementation of a new operational suite.

3.2. Belgium

3.2.1 Retirement of Prof. Quinet

"L' important n' est pas ce qu' on fait de nous, mais ce que nous faisons nous-mêmes de ce qu' on a fait de nous."
Jean-Paul Sartre

Speakers Corner .... or Variations in Time on a Theme :

On May 1st, 2004, Professor Dr Alfred Quinet retired as Head of the Meteorological Research and Development Department of the Royal Meteorological Institute of Belgium. “Alfred”, as he is known by his friends, has been the initiator and inspiring leader of the Belgian ALADIN team ever since Météo-France and RMIB signed a MoU in October 1996.

Without his knowing, a scientific workshop was organized on May 7th, 2004, by Mrs. Béatrice Libioulle, secretary of the Research Department, to honour Prof. Dr Alfred Quinet for his long standing scientific work and outstanding achievements. Many of his Belgian and French colleagues happily volunteered to bring an appropriate contribution to the selected themes that were divided as follows :

- From the physics of the atmosphere to applied meteorology or the time of the meteorologist;
- Between Parmenides and Heraclites or the time of the climatologist.

To name only those contributions dealing with ALADIN, it was Jean-François Geleyn, who opened the session with the sparkling subject *“ALADIN, or how to try bringing together scientific policy and international politics”*. Piet Termonia followed by expressing his vision of the present and future of the Belgian ALADIN project. Josette Vanderborght and Jean Neméghaire provided an overview of the weather forecast and modelling with respect to ALADIN. Serge De Ryck, former legal advisor at RMIB, concluded with the fireworks titled *“The retirement of Alfred Quinet or the indisputable change of climate”*.

The Director of RMIB, Dr. Henri Malcorps, has asked Prof. Quinet to further contribute to the tasks of the ALADIN-Belgium research team for both the scientific aspects and its international representation.

For further information: *Gaston.Demaree@oma.be*

3.2.2 ALADIN-2

See the presentations of Bart Catry, Alex Deckmyn, Luc Gerard and Piet Termonia at the 14th ALADIN workshop and the list of publications :
http://www.zamg.ac.at/workshop2004/ibk_2004.html

3.3. Bulgaria

- **Porting of ALADIN 25T1 (second export) on LINUX PC**

3.3.1 Introduction

The experience from experiments for running ALADIN on a two-processors LINUX PC was used for porting ALADIN 25T1.

3.3.2 System description

- two Intel Xeon processors of 2.8 Ghz clock-rate each
- 2 GB shared memory
- Two 150 GB disks, with RAID-5 system for mirroring the main file systems
- Operating system: Linux 2.4.20-30.9smp
- FORTRAN compiler – Intel 32 bit FORTRAN compiler v 8.0 for LINUX
- C compiler (if any) – GCC
- Message passing interface - MPICH2 Release 0.97
- compilation tool e-make.0.4 (Eric Sevault) – *Thank you Eric!*
- LAPACK library source code version 3.0 and corresponding BLAS library, compiled with the Intel compiler

3.3.3 Software tuning

- MPICH2 configuration options:

  --with-device=ch3:sshm --enable-f77 --enable-f90 –enable-fast

  ch3:sshm is the MPI2 device with scalable shared-memory communication for shared-memory machine.

  -enable-f77 -enable-f90 are options for supporting FORTRAN 77 and 90

  -enable-fast is option for highest performance of MPICH2.
- necessary environment variables to be exported before configuring and making MPICH2

  export FC=ifort

  export F90=ifort

  (*ifort* is the name of Intel FORTRAN compiler)
- compiling the code : the compilation should be done, using the drivers of MPICH, *mpif77* and *mpif90* for FORTRAN and *mpcc* for C.

- FORTRAN 90 flags:
  -O3 -xN -free -noauto -std90 -DLX86P -DMPI2 -convert big_endian -pc 64 -traceback -assume byterecl.

  F77 flags are the same with exception of -nofree and -DBLAS.

  -DLX86P is preprocessor definition for LINUX

  -DMPI2 is necessary for compiling the MPL routines

  -convert big_endian keeps the big endian presentation of unformatted files

  -xN is specific optimisation flag.

3.3.4 Code modifications

- **XRD**

- introducing proper timing routines in timef.F, cptime.F
- introducing in facomp.h and lficom0.h LX86P at the proper place
- in directory grib_mf – only FORTRAN routines are used and their modifications for LINUX (*thanks to Jean-Daniel Grill and his PALADIN*)

- **ARPEGE and ALADIN**

- namnasa.h – taken form Clear Case
- removing of double entities in USE statement in number of routines – *see Olda's report:*
- correcting misplaced declarations in some routines – usually the shape of array is declared after array declaration (see for example canari.F90, extrapad.F90, extrap.F90 and so on.
- correcting some formats, on which compiler complains – canali.F90, evcost.F90 et caetera
- eggpack.F90 – some vector functions are not working properly (may be due to compiler) and were replaced by their scalar versions:

```
! Compute XY grid points under CENTER origin
DO i=_IONE_,NB_PTS%ONX
  DO j=_IONE_,NB_PTS%ONY
    GRID_XY_C(i,j)%X = (FLOAT(i)-(FLOAT(NB_PTS%ONX+_IONE_)/_TWO_))* PDEL%ONX
    GRID_XY_C(i,j)%Y = (FLOAT(j)-(FLOAT(NB_PTS%ONY+_IONE_)/_TWO_))* PDEL%ONY
!ab>>
  GRID_XY_P(i,j)=XY_NEW_TO_STD_ORIGIN(GRID_INFO%CT_COORD,GRID_XY_C(i,j),P_P,TPI)
!ab<<
  END DO
END DO

! Change XY coordinates in CENTER Origin in STD Origin
!ab GRID_XY_P=UNPACK&
&(XY_NEW_TO_STD_ORIGIN(GRID_INFO%CT_COORD,PACK(GRID_XY_C,M),P_P,TPI),M,DUMMY_XY)
and after the tests
! Compute ouputs datas depending projection type
!ab>>
DO i=_IONE_,NB_PTS%ONX
  DO j=_IONE_,NB_PTS%ONY

!ab GRID_COORD=UNPACK(XY_TO_LATLON(PACK(GRID_XY_P,M),P_P,TPI),M, DUMMY_COORD)
    GRID_COORD(i,j)=XY_TO_LATLON(GRID_XY_P(i,j),P_P,TPI)

!ab GRID_MF=UNPACK(MAP_FACTOR(PACK(GRID_COORD,M), P_P,TPI,RT), M,_ZERO_)
    GRID_MF(i,j)=MAP_FACTOR(GRID_COORD(i,j),P_P,TPI,RT)

!ab GRID_PGN=UNPACK(GN(PACK(GRID_COORD,M),P_P),M,DUMMY_PGN)
    GRID_PGN(i,j)=GN(GRID_COORD(i,j),P_P)
```

```
!ab GRID_COORD=UNPACK(ANGLE_DOMAIN(PACK(GRID_COORD,M),TPI,'0+','R'),M,DUMMY_COORD)
    GRID_COORD(i,j)=ANGLE_DOMAIN(GRID_COORD(i,j),TPI,'0+','R')

  ENDDO
ENDDO
!ab<<
```

– corresponding modification was introduced in PALADIN package also.

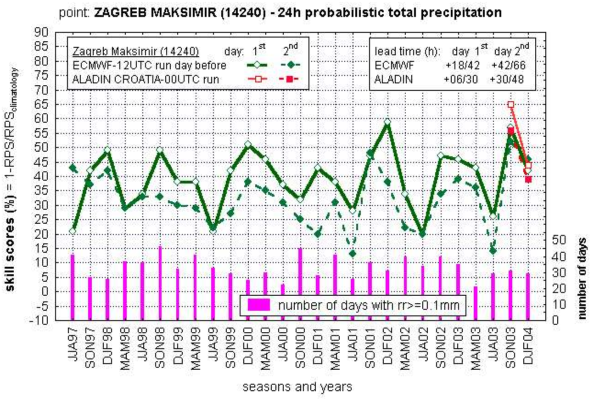
3.4. Croatia

3.4.1 Summary

In the Croatian meteorological service ALADIN is operationally run twice a day, for 00 and 12 UTC. Coupling files are retrieved from ARPEGE (Météo-France global model) via Internet and RETIM2000. Model resolutions are 12.2 km for the LACE domain, 8 km for the Croatian one and 2 km for the high-resolution dynamical adaptation domains. The execution of the suite is controlled by Open PBS (Portable Batch System) as queuing system. During the last period more attention was paid to verification of the operational forecast and a few case studies of cyclones in the Adriatic. Results are shown below.

3.4.2 Verification

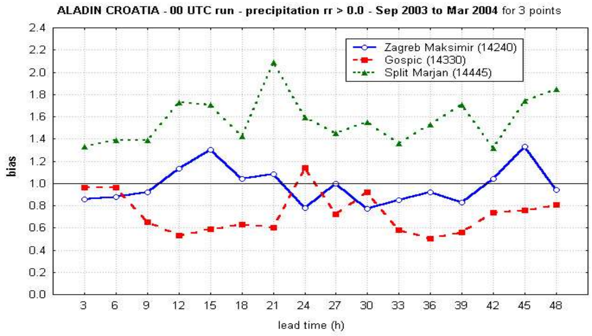
- **Precipitation (1)**



Skill scores for probability of precipitation made from ranked probability scores of quantitative ECMWF and ALADIN/CROATIA precipitation forecasts for "1st" and "2nd" day for Zagreb Maksimir (14240), from summer 1997 to winter 2003/04.

Probability precipitation forecasts are made from quantitative precipitation forecasts. The sum of 6-hourly (ECMWF) and 3-hourly (ALADIN) accumulations during the 24-hour period from 06 till 06 UTC (for 12 UTC model run: from t+18 to t+42; for 00 UTC model run: from t+06 to t+30) and "2nd day" (t+42 to t+66 and t+30 to t+48) is compared with the corresponding 24-hour accumulated precipitation for Zagreb Maksimir (14240) for the period summer 1997 to winter 2003/04. The contingency tables are made by 4 classes (no precipitation, trace to 1.0 mm, 1.1 to 5.0 mm and more than 5.0 mm).

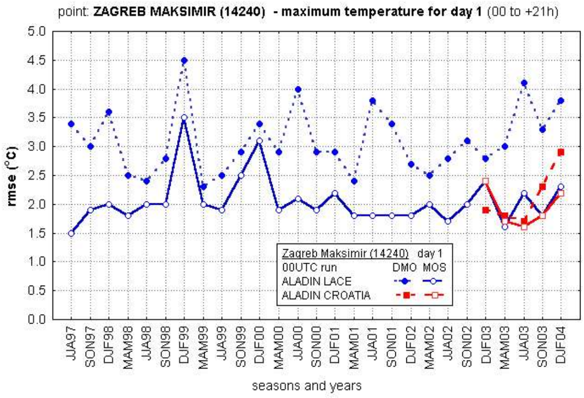
- **Precipitation (2)**



Bias for precipitation forecast (rain versus no rain) of ALADIN/CROATIA for Zagreb Maksimir (14240), Gospic (14330) and Split Marjan (14445), and year 2003.

Hilly point has underestimation. Sea point has overestimation. Heidke and Kuipers skill scores (not shown) are also relatively good (between 0.45 and 0.65 in the majority of cases).

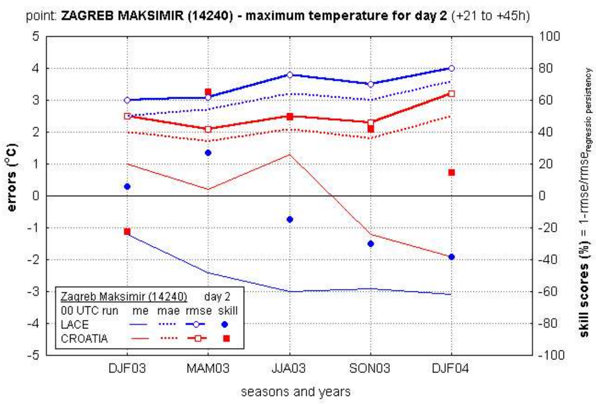
- **Maximum temperature (1)**



Root-mean-square errors of maximum temperature for day-1 forecast of ALADIN/LACE and /CROATIA for direct model output (DMO) and model output statistics (MOS), for Zagreb Maksimir (14240), from summer 1997 to winter 2003/04.

MOS are made by regression equations ($y=ax+b$) which were calculated from historic data for warm (April to September) and cold (October to March) parts of the year.

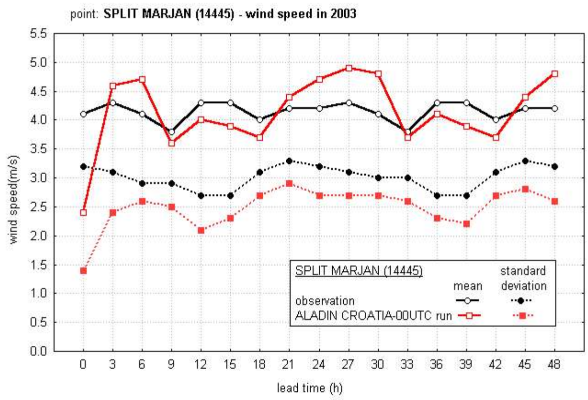
- **Maximum temperature (2)**



Mean errors (me), mean absolute errors (mae), root-mean-square errors (rmse) and skill scores (skill) for maximum temperature for day-2 forecast of ALADIN/LACE and /CROATIA for direct model output, for Zagreb Maksimir (14240), from winter 2002/03 to winter 2003/04.

Reference forecasts used in calculating skill scores were regression persistency for minimum and maximum temperature, respectively; ($Txt=a*Txy+b$, Txt is today's maximum referent temperature, Txy is yesterday's maximum temperature, a,b are coefficients).

- **Wind**



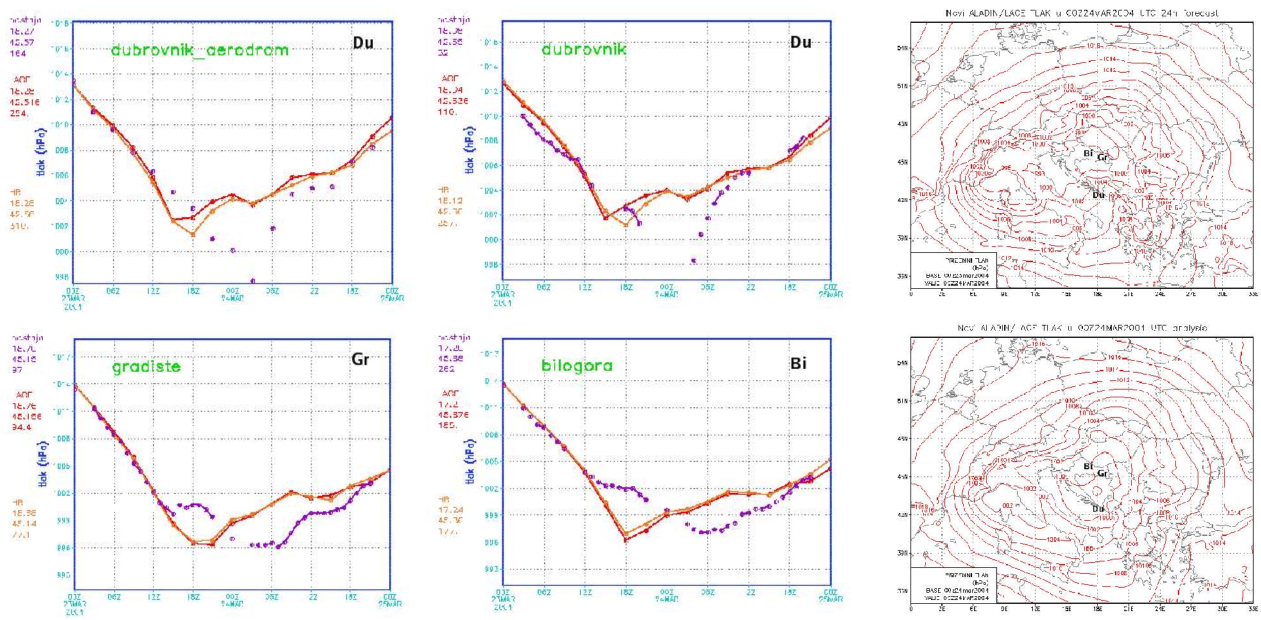
Mean error and standard deviation of ALADIN/CROATIA wind-speed for Split Marjan, and year 2003.

Forecasts are relatively good according to the observations. Problem with reference forecast occurs in calculation of skill scores (not shown) for both scalar and vector values. Wind at 00UTC is not a good control forecast and mean resultant wind vectors for every day and hour during year are not available for all station.

3.4.3 Case studies

- **Adriatic cyclone (1)**

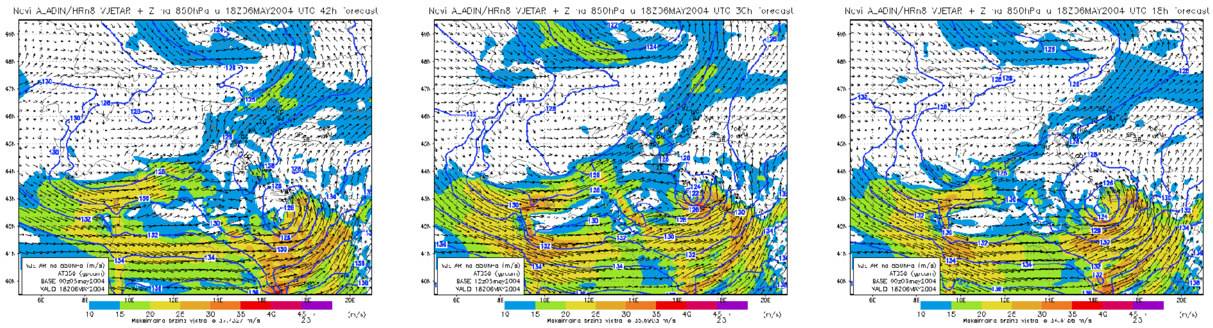
On 24th March 2004 03 UTC a cyclone stroke the southern part of Croatian coast in the Dubrovnik area. Unfortunately, the movement was forecasted too fast and the depth of this cyclone was severely underestimated.



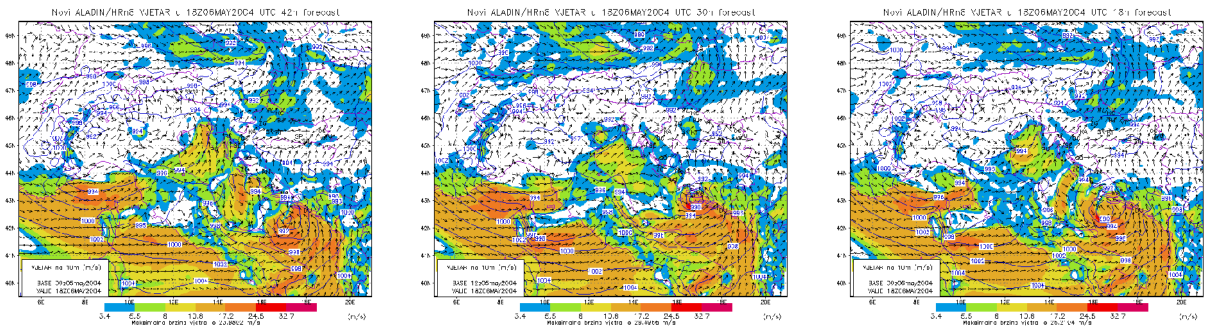
Comparison of the forecasted mean-sea-level pressure at 12 km (red) and 8 km (orange) resolutions to measurements from the SYNOP (violet) stations is presented :
mean-sea-level pressure forecast (top right) and analysis (bottom right) for 00 UTC 24th March 2004.

- **Adriatic cyclone (2)**

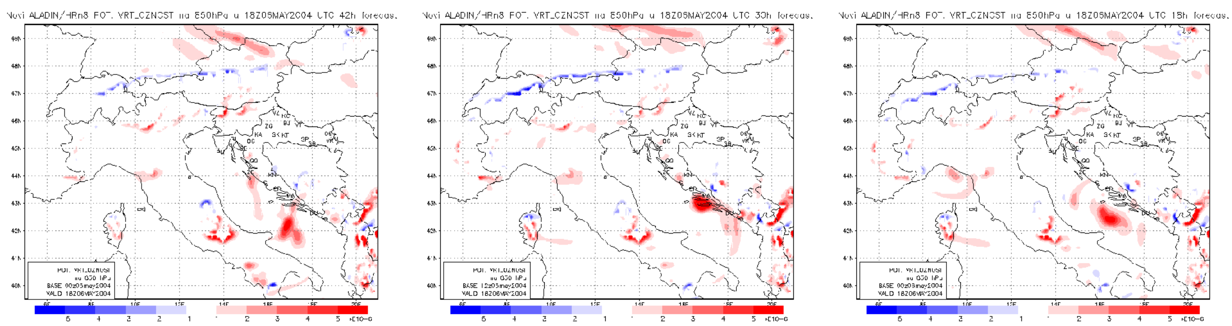
On 6th May 2004 18 UTC a small cyclone crossed the Adriatic to the Balkan peninsula. The depth, path and speed were reasonably well forecasted by the 00 UTC run from the day before. The next runs only confirmed this cyclone. The depth of the cyclone was a bit overestimated.



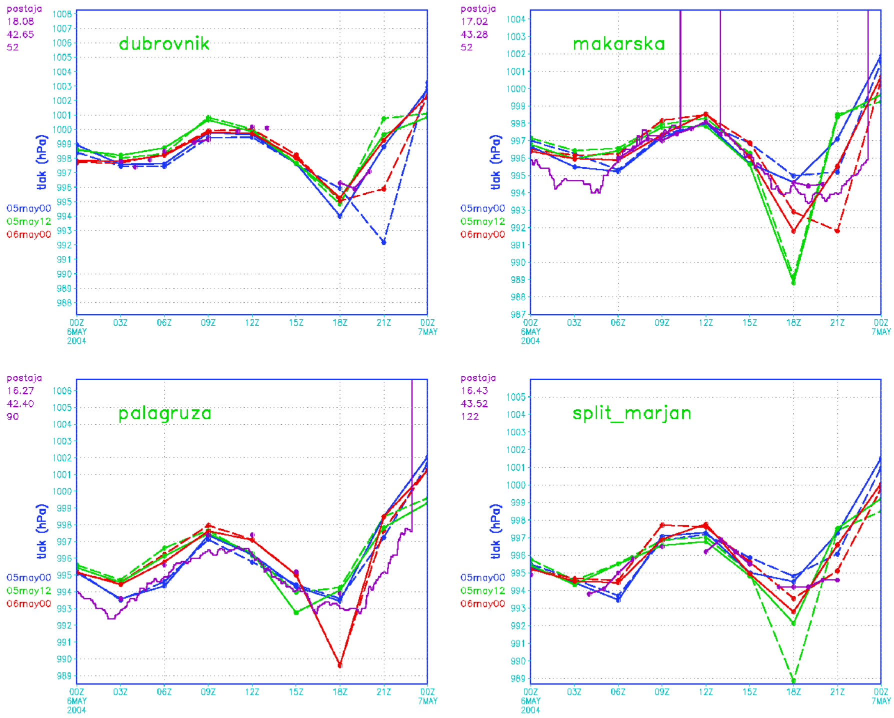
850 hPa wind and geopotential for : 42 hour forecast (left), 30 hour forecast (centre) and 18 hour forecast (right) from 3 consecutive forecast runs for 18 UTC 6th May 2004.
Although the position and depth vary, the cyclone persists through runs.



10 m wind and mean-sea-level pressure for : 42 hour forecast (left), 30 hour forecast (centre) and 18 hour forecast (right) from 3 consecutive forecast runs for 18 UTC 6th May 2004.



850 hPa potential vorticity for : 42 hour forecast (left), 30 hour forecast (centre) and 18 hour forecast (right) from 3 consecutive forecast runs for 18 UTC 6th May 2004.



Comparison of the forecasted mean-sea-level pressure from the 3 consecutive forecast runs (00 UTC run 5th May 2004 is blue, 12 UTC is green and 00 UTC run 6th May is red) with measurements from the SYNOP (violet, with dots) and automatic (violet line) stations.

3.5. Czech Republic

3.5.1 ALADIN/MFSTEP configuration (M. Derkova, J.-F. Geleyn, R. Brozkova)

As described in the previous Newsletter, a special configuration of ALADIN was prepared to provide the forecasts of surface fluxes for the near real time atmospheric forcing of ocean and shelf models. The computational domain covers near Atlantic Ocean, the whole Mediterranean Sea and Black Sea. This activity belongs to the European project MFSTEP, financially supported by the European Commission.

Since February 2004, a MFSTEP suite is computed regularly for the pre-TOP (Target Observation Period in the Mediterranean Sea) results validation, since April it is fully under the operational constraints and supervision. The suite runs in a blending assimilation mode with one production forecast up to 120 h every Wednesday.

Since the products from ALADIN/MFSTEP should satisfy a bit different needs than it is the case of classical meteorological forecasts, an important part of the work on this configuration was devoted to the improvements of the fluxes above the sea surface.

One important modification is the introduction of the selective semi-Lagrangian horizontal diffusion (SLHD), which proved to cure too intensive cyclogenesis, in all such cases tested up to now. The SLHD scheme was still slightly improved and retuned to allow its first operational use (F. Vana).

The second important modification is the abandon of the envelope orography, compensated by the new version of the gravity wave drag and orographic lift schemes (J.-F. Geleyn, B. Catry, R. Mladek). Normally, this modification should improve the fluxes in the coastal areas with high mountains.

The third package of modifications concerns the cloudiness and radiation scheme. From the scientific validation period of MFSTEP computed for January 2003 we learned that in the COCONUT (or modified COCONUT) cloudiness version there is a too high albedo of the clouds; together with the binary-like clouds distribution this leads to almost zero solar flux in presence of clouds. Normally, the solar flux should not be lower than about 100 W/m^2 in daylight. It was then quite necessary to look for a better formulation of the cloudiness scheme and checking its feedbacks with the radiation scheme. A new formula of the Xu–Randall scheme was proposed, allowing easier tuning. As proposed by T. Haiden, the shape of the critical relative humidity curve was modified to provide a better fit to the observations. The new critical humidity formula has now two "HUCOE" tuning coefficients to obtain the desired profile. It was also discovered, a bit by chance, that taking into account the random clouds maximum (key LRNUMX for the "acraneb" radiation scheme) is very important when using the Xu-Randall cloudiness diagnostics. Finally a tuning was made by looking to the solar flux values, clouds distribution, and scores.

All these three major changes need still to pass a last set of validation tests. They should however enter the reference MFSTEP suite before 1st September 2004, when the TOP period starts.

As it can be easily concluded, these modifications are beneficial for the nominal ALADIN applications as well, not only for oceanographers. They were tested in the ALADIN/CE configuration at first, also due to the reduced cost compared to the MFSTEP set up. The final tuning is included in the parallel suite ADN, as shortly mentioned above, topped by the latest improvements of the "acraneb" radiation scheme. However, there are still two problems on which future work should focus. The first problem is still the insufficient amount of low-level winter stratus. From the tests recently made we concluded that another piece of the cloudiness scheme would have to be added to answer this problem. The second issue is a weak bias of the screen-level wind, where we think that the turbulent momentum flux needs a retuning with respect to the one used up to now in presence of the envelope orography.

3.5.2 MAP reanalysis : downscaling with ALADIN (Stjep. Ivatek-Sahdan)

The MAP IOP cases provide an excellent benchmark for the mesoscale modelling. Therefore it was decided to provide to the ALADIN community a set of files downscaled from the re-analysis of the MAP IOP period made by ECMWF. As the first set, there will be results obtained from the blending assimilation cycle to reduce the model spin-up, which could be used further on for either simple higher resolution forecasts or mesoscale reanalysis with ALADIN.

A special MAP domain was created for this purpose; in fact it is a bit shorten MFSTEP domain in longitude. A set of procedures was put in place and first validation started by including also the SLHD scheme and switching from the envelope to the mean orography, having new gravity wave drag and orographic lift schemes (it did not contain yet the last cloudiness and radiation scheme versions and tunings).

For the preliminary validation two moist IOP cases were chosen and scores of the blending assimilation cycle were computed for 20 days against observations and compared to the scores of the coupling data (coarser resolution). We found an important diurnal cycle present in the scores of the screen-level parameters for all compared datasets. ALADIN assimilation scores are systematically better than those of the coupling data except for the guess computed from the evening (18h UT) analysis. By consequence, midnight analysis is affected by a bit stronger bias in temperature and wind, coming from the mesoscale guess. It is very likely that when the vertical stratification becomes stable, the ALADIN physics is not yet optimally tuned for the use of the mean orography, new drag and lift scheme and feedback with the SLHD scheme in mountains. Despite this weakness, the current MAP downscaling configuration provides a solid start for future experiments.

3.5.3 SLHD Diffusion Scheme (F. Vana)

As it becomes obvious from the previous text, there will soon be the first operational application of the SLHD scheme. For this purpose, the necessary modifications were cleanly phased into the 25T1 local library and to the cycle 28T1 library reference. Some small improvements were made for the choice of the interpolators, including splines. A small bug was corrected to enable the SLHD scheme work stably within the backward integrations in the digital filter sessions. Future validation will be made for optimizing the scheme in presence of mountains and for the non-hydrostatic variables. To find robust tuning rules when changing the horizontal resolution is also a part of the "to do" list.

3.5.4 Bottom Boundary Condition – Problem of the semi-Lagrangian Chimneys (R. Brozkova)

While the cure of the so-called chimney problem present in the semi-Lagrangian advection (ALADIN NH) was found and successfully implemented, a linear analysis of the problem was made in order to explain the chimney creation. The analysis shows that the current default discretization scheme used to evaluate the surface vertical acceleration is not consistent with the kinematic rule for the surface vertical wind. This is, however, not very surprising result since both methods removing the chimney problem were based on the restoration of the kinematic rule validity within the computations of the surface vertical wind tendency. In addition, the analysis shows that for short trajectories, the chimney error is proportional to the third derivative of the orography. A complete documentation of the problem, including practical demonstration, is on the way.

3.5.5 Verif-Pack tools with ODB (A. Trojakova, F. Meszaros)

Quite an important piece of work is devoted to the adaptation of the verification tools to the latest library cycle and usage of the ODB system. It concerns also the format of the observations archive, ensuring the compatibility of the used information, including the observation quality flags.

3.6. France

3.6.1 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.

3.6.2 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.

3.6.3 Dynamics, geometry and coupling

- **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).

- **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 distortion 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*).

- **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).

3.6.4 Physics

- **Introduction**

GMAP developments on physical parametrizations 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/)

- **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 parametrization 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.

- **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).

- **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).

- **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).

3.6.5 Data assimilation

- **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 analysed 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 analysed 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

- **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).

- **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 analysed 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.

- **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)

- **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.

3.6.6 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, split or duplicated between the ALADIN, ALATNET, and GMAP web sites.

3.7. Hungary

The main areas of interest for the first half of 2004 were on the one hand the 3d-var data assimilation scheme for ALADIN and on the other hand the development of the LAMEPS system based on the ALADIN model.

Some brief summaries of the activities are as follows:

a) Regarding 3d-var the data assimilation scheme was running in parallel suite and continuously compared to dynamical adaptation versions. At the beginning of the year the evaluation was also carried out subjectively (see the reports of Helga Toth in the same volume). The ATOVS satellite data was incorporated into the data assimilation system (see the report of Roger Randriamampianina and Regina Szotak in this Newsletter) around April and further impact studies were delivered on aircraft data. Preliminary work had been started on the application of wind-profiler data as well.

b) The first LAMEPS experiments were performed during this period and the sensitivity of the global singular vectors with respect to the target domain was investigated. The system was tested on some special cases as well (see more details in the report of Edit Hagel and Gabriella Szepszo in the same issue).

c) Beside these projects some work was done in the dynamical downscaling of ERA40 re-analysis data to high resolution. At the moment the basic configurations, plans were discussed and accepted and now the technical realisation is under elaboration.

3.8. Morocco

3.9. Poland

During the spring of 2004 the work of the ALADIN group in Poland was focused mainly on further enhancement of model software environment and preparation of new NWP products. Two points must be stressed.

On the one hand, our operational software was overflowed with multiple versions and branches which forced us to rethink our software management system. We made a choice between various open softwares and compared in detail three packages: *cvs*, *subversion* and *arch*. *Subversion* has appeared to us the most flexible and promising one. Then the preparatory steps to apply *subversion* were carried out.

On the other hand, our work involved the study of application of combined soft computing methods in NWP. First analysis shows that post-processing and maybe parametrization are fields where the mentioned methods can be fruitful. Further studies in fuzzy-neural methods and fuzzy dynamical systems should bring more concrete answers.

3.10. Portugal

See the report on operations (improvement of the verification and diagnostics packages).

3.11. Romania

3.11.1 The implementation of the high-resolution dynamical adaptation for the forecast of the surface wind (Steluta Alexandru)

In order to apply the dynamical adaptation of the forecast for wind field at kilometric scale (Mark Zagar' s method) two different domains of touristic interest have been selected : one covers a mountain region, and the other one the Romanian Black Sea coast. The climatic files were created for these domains. The chosen resolution is 2.5 km, while the resolution of the operational ALADIN/Romania model is 10 km.

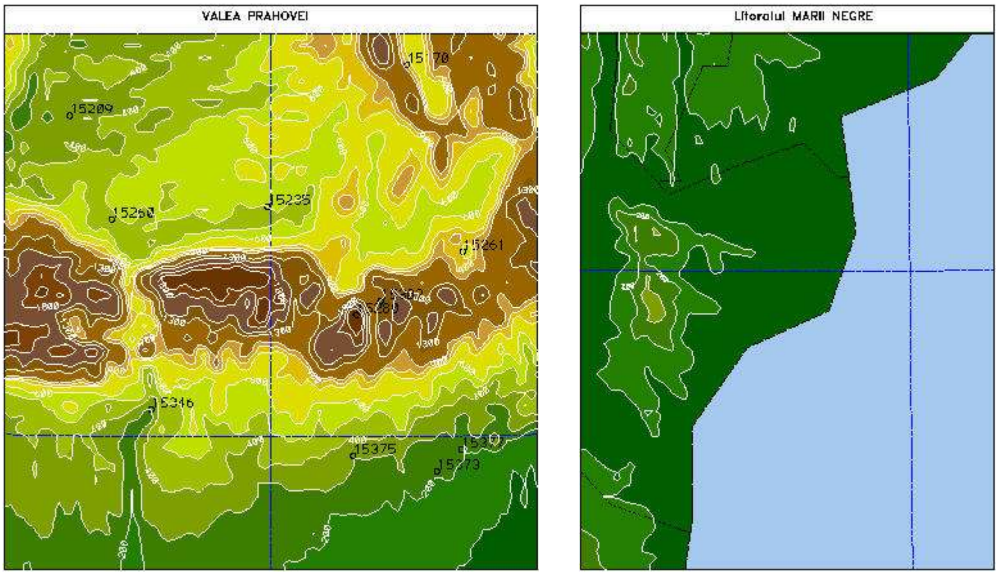


Figure 1 : Orography of the domains chosen for the dynamical adaptation

In order to study the impact of the increasing resolution for the wind field, the snow storm of 22nd - 23rd of January 2003 has been selected; it affected mainly the sea coast and the eastern part of Romania. The dynamical adaptation forecast showed an improvement both in direction and intensity of the wind :

- for the coastal zone (Fig. 2), over the land the speed was increased up to 7.5 m/s (usually in such situation the wind speed is underestimated by the operational model)
- in the mountain area (Fig. 3) the improvements concerned mainly the wind direction.

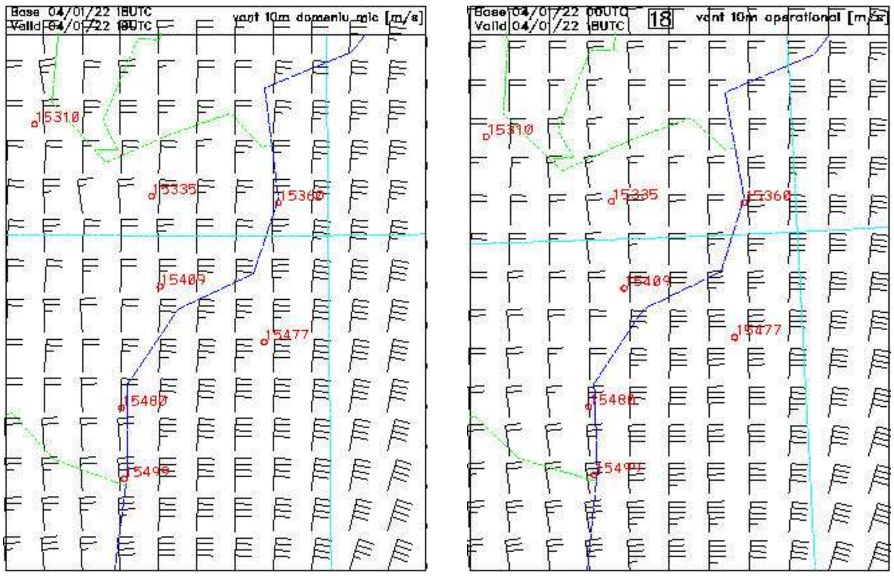


Figure 2 :10 m wind field obtained by operational integration of the model ALADIN (right) and by dynamical adaptation (left) over the Black Sea coastal area.

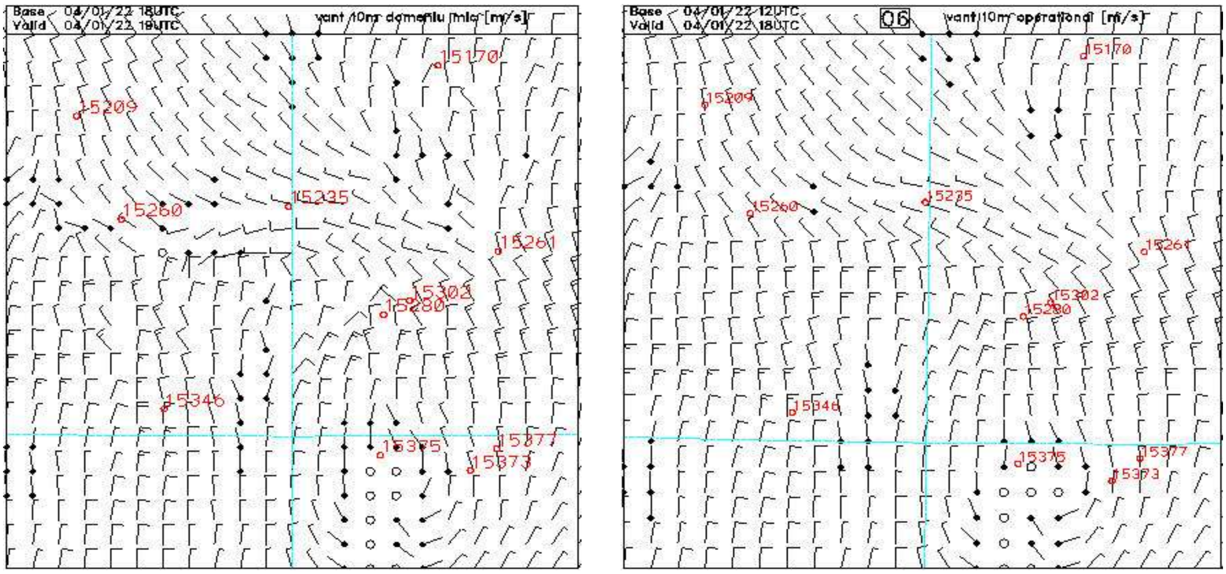


Figure 3 : 10 m wind field obtained by operational integration of the model ALADIN (right) and by dynamical adaptation (left) over the mountainous area.

3.11.2 New fields from the outputs of the ALADIN model transmitted in GRIB format (Steluta Alexandru, Simona Stefanescu)

Besides the already existing fields in the post-processing procedure like Convective Available Potential Energy (CAPE), Moisture Convergence (MOCON), Convective Inhibition Energy (CIN), Wind Gusts (U, V), new fields for the estimation of the atmospheric instability are computing using the ALADIN model outputs : Total Totals Index (TTI), K-Index (KI), Vertical Totals Index (VTI), Cross Totals Index (CTI). These parameters are available in GRIB format

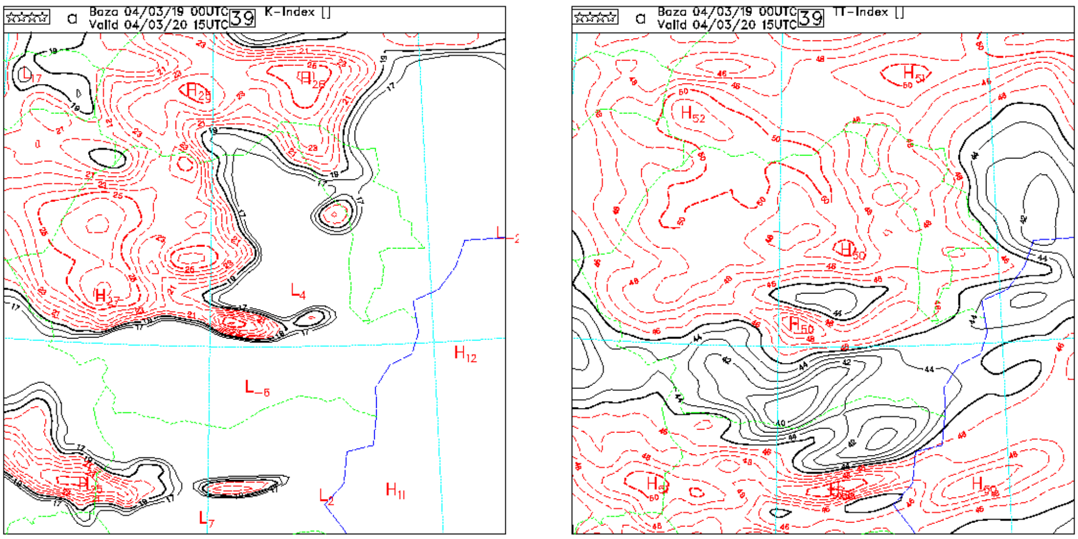


Figure 4 : K-index (left) and Total Totals index (right), valid on March 20, 15 UTC, based on March 19, 00 UTC

3.11.3 Verification of spectral coupling results (Raluca Radu, Rodica Dumitrache)

Going further on the spectral coupling validation topic, an objective verification was carried out for the period June-July 2004 using AL15_04 operational version. The daily statistical measures (BIAS, RMSE) with anticipation for 24h and 48h are calculated for forecast of the operational model and for forecast of model using spectral coupling scheme, with the following settings for the namelist parameters: NEK0=2, NEK1=10, TSTARTSC=0.5, BETAEXP=4 (see previous ALATNET reports). The compared fields are mean-sea-level pressure and temperature. Note that we had to cancel from our verification the stations with errors in measured data.

In the pictures is represented the evolution of the RMSE and BIAS data with time. It is observed that in general the models are behaving quite similar, but it is noticed a better BIAS when using spectral coupling scheme and a quite smaller RMSE as well. This indicates that the model which uses the spectral coupling scheme seems to perform slightly better in some cases.

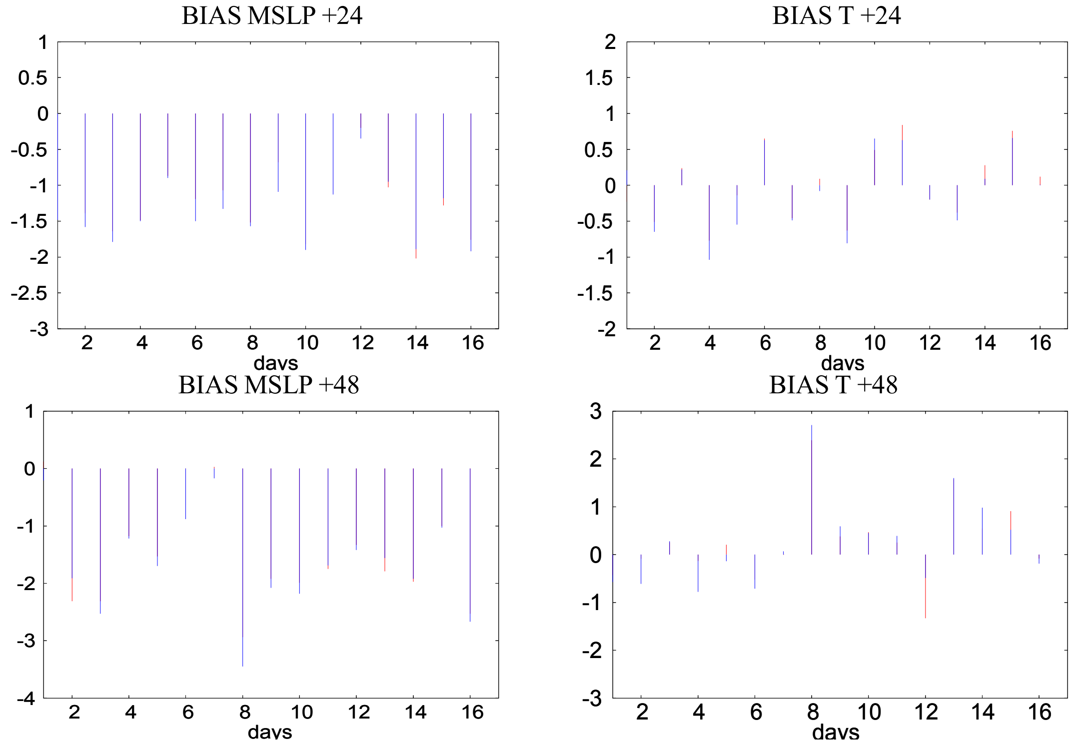


Figure 5 : Evolution of mean-sea-level pressure (MSLP) and temperature (T) BIAS scores with time (red line : ALADIN using spectral coupling scheme, blue line : operational ALADIN)

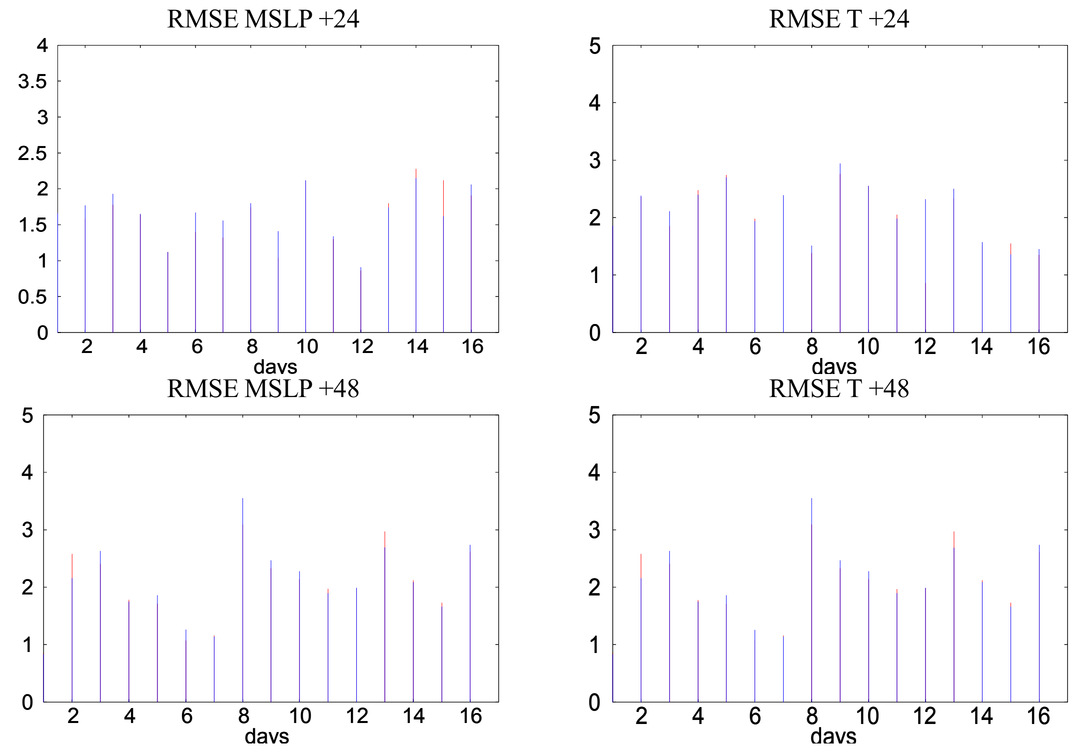


Figure 6 : Evolution of mean-sea-level pressure (MSLP) and temperature (T) RMSE scores with time (red line : ALADIN using spectral coupling scheme, blue line : operational ALADIN)

3.12. Slovakia

Local work focussed on the implementation of the operational suite on the new computer. See the report on operations

3.13. Slovenia

- **Verification project**

A prototype of the web interface is running in Ljubljana where a centralized database is built.

A first version of the program (*extract4verif.F90*) which extracts the data from the model files was ready in May. This program needs routines from PALADIN package and must be installed locally at each of the participating centres. The output files of the program *extract4verif* are sent by e-mail and are inserted into our central database. The application is now able to correctly insert the minimum and maximum temperatures and the wind gusts into the database.

The list of SYNOP and TEMP stations was prepared in May. At that time the ALADIN countries were invited to participate to the testing period via the *verifala* mailing list. At the time being 5 countries (Croatia, Hungary, Slovakia, Slovenia, Tunisia) have implemented the program and are sending the requested data daily. The upper-level variables from the ARPEGE coupling files for LACE domain are also put into the database.

All the participating users will be able to use and test the new web interface for visualization of data, calculation and visualization of verification scores, etc. Presently we are investigating Verification project

A prototype of the web interface is running in Ljubljana where centralized data base is built.

A first version of the program (extract4verif.F90) which extracts the data from the model files was ready in Mahayanist program needs the routines from PALADIN packet and must be installed locally at each of the participating centres. The output files of the program extract4verif are sent by e-mail and are inserted into our central database. The application is now able to correctly insert the minimum and maximum temperatures and the wind gusts into the database.

The list of SYNOP and TEMP stations was prepared in May. At that time the ALADIN countries were invited to participate in the testing period via the verifala mailing list. At the time being 5 countries (Croatia, Hungary, Slovakia, Slovenia, Tunisia) have implemented the program and are sending the requested data daily. The upper level variables from the ARPEGE coupling files for LACE domain are also put into the data base.

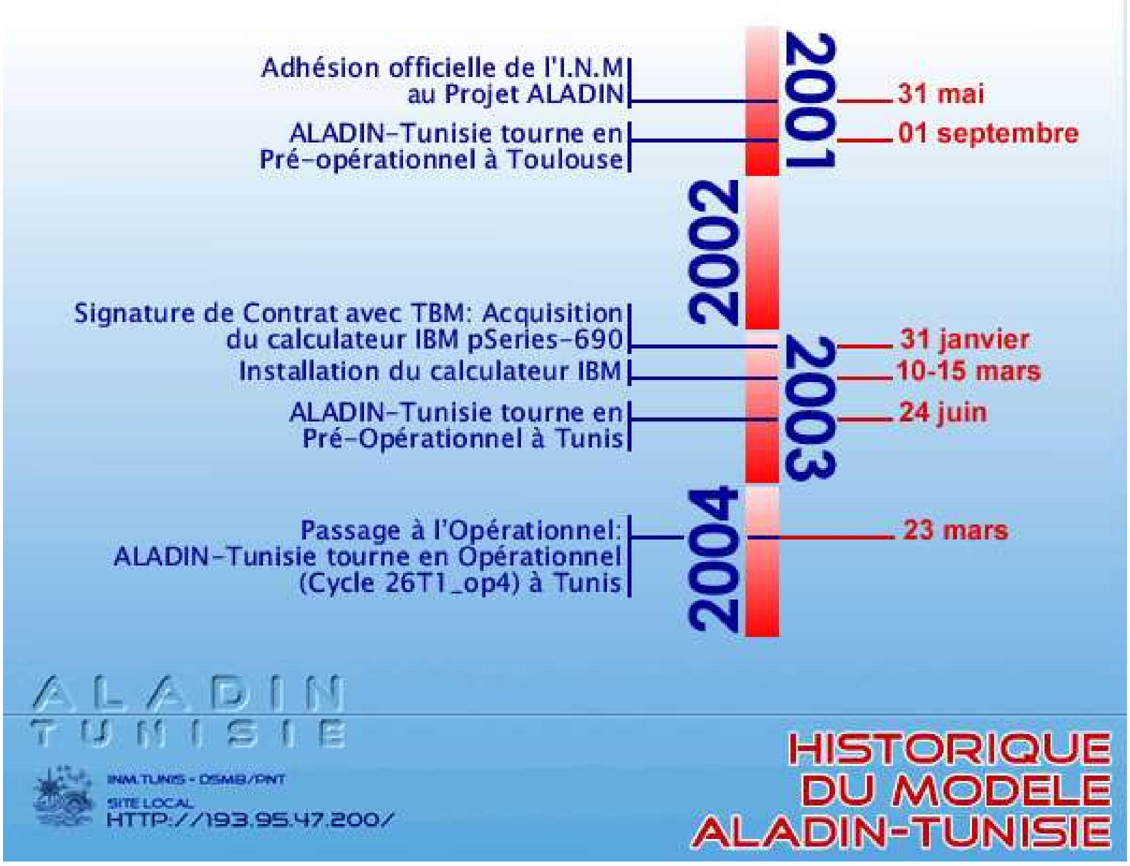
All the participating users will be able to use and test the new web interface for visualization of data, calculation and visualization of verification scores, etc. Presently we are investigating the best way to access the web interface through our firewall and we hope to find the solution soon.

3.14. Tunisia

ALADIN-Tunisie project : How does it progress

3.14.1 Introduction

ALADIN activities were concentrated on putting into operations cycle AL26T1_op4. We outline below the history of the ALADIN-Tunisie project and the main work performed at the National Institute of Meteorology (INM) during the first half of 2004.



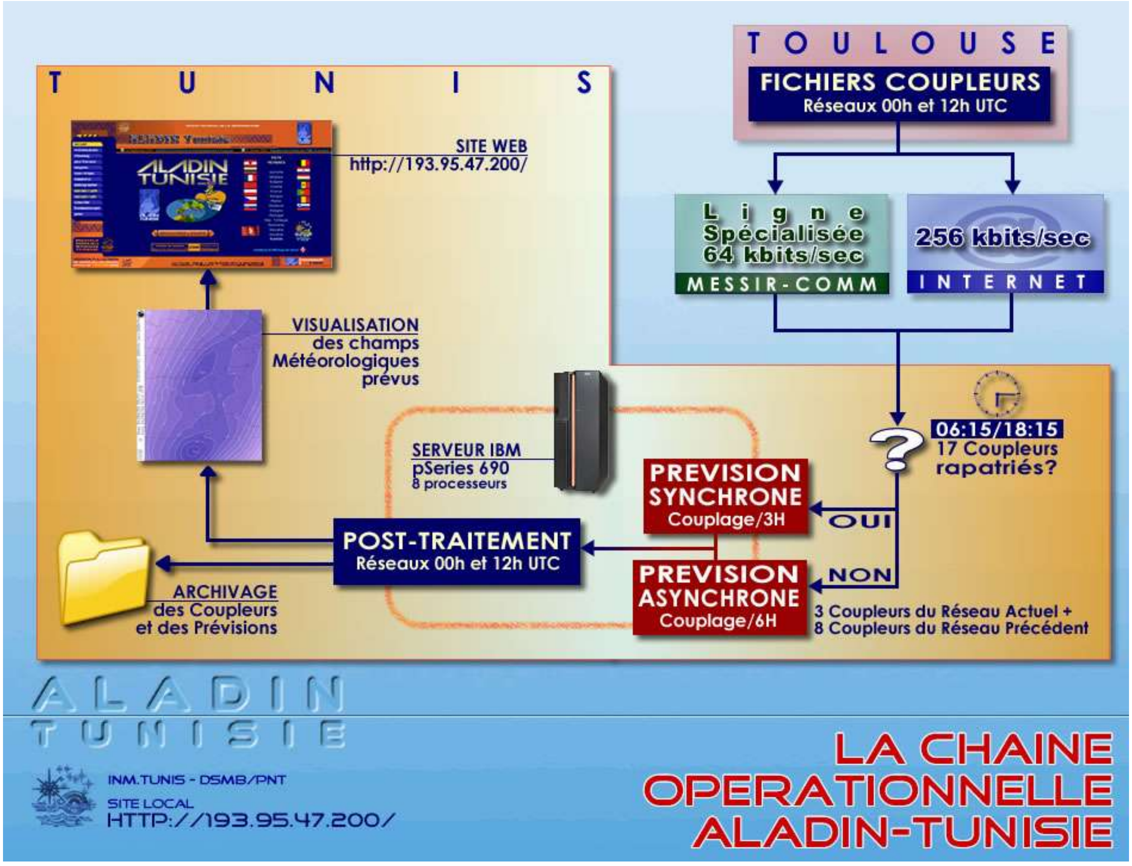
3.14.2 Porting AL26T1_op4on IBM computer

Francois Thomas (IBM), Abdelwahed Nmiri, Karim Bergaoui & Nihed Bouzouita (INM)

Hopping it will be of benefit for ALADIN partners and particularly those using IBM machines, the different installation steps of the new library are detailed in a technical document that that is now available on the ALADIN web site :

http://www.cnrm.meteo.fr/aladin/publications/report.html .

The synoptic scheme of the actual operational configuration is shown below.



3.14.3 Validation of the installation

Karim Bergaoui, Nihed Bouzouita & Abdelwahed Nmiri,

- Numerical validation : spectral norms verification
- Scientific validation : statistical verification

3.14.4 Asynchronous coupling

Nihed Bouzouita & Karim Bergaoui

Even if the use of the 64 Kb/s link (LS) between Tunis and Toulouse is not the solution to easily transfer the coupling files (more than 8 Mo per file) , we are still using it simultaneously with internet as a way out, waiting for the upgrade to 128 Kb/s.

3.14.5 VERIFALAD program

Nihed Bouzouita

Starting contribution to the operational verification program of ALADIN (VERIFALAD program) against observations by sending daily the ground parameters (SYNOP) and altitude parameters (TEMP) together with cumulated precipitation every 3 hours for 10 selected synoptic stations (for the two runs : r00 and r12)

4. PHD THESES

4.1. Introduction

A ALADIN new doctor since April 20th : ***Cornel Soci*** (second ALATNET doctor)
Research topic : **Sensitivity study at high resolution using a limited-area model and its adjoint for the mesoscale range**

4.2. Radi AJJAJI : Incrementality deficiency in ARPEGE 4d-var assimilation scheme

4.3. Steluta ALEXANDRU : Scientific strategy for the implementation of a 3D-Var data assimilation scheme for a double-nested limited-area model

Operational duties at home (see part 3.11), and starting writing an article.

4.4. Margarida BELO-PEREIRA : Estimation and study of forecast error covariances using an ensemble method in a global NWP model

A method based on an ensemble of analysis has been tested and evaluated in ARPEGE 4D-Var. The global and local covariances have been diagnosed, and compared with those of the NMC method. Moreover, some impact studies have been performed in the ARPEGE 4D-Var, with respect to the global background error covariances, and also concerning the local background error variances. It was verified that the use of the "ensemble" statistics has a positive impact on the forecasts of non-stretched ARPEGE. A publication about these results is under preparation.

Then operational duties at home (see e.g. the proceedings of the 14th ALADIN workshop).

4.5. Karim BERGAOUI : Further improvement of a simplified 2d variational soil water analysis

Work on the ELDAS project.

4.6. Vincent GUIDARD : Evaluation of assimilation cycles in a mesoscale limited-area model

4.6.1 Formalism : a brief reminder *(cf. ALADIN Newsletter 25)*

The larger scales of the ARPEGE analysis (x^{AA}) are introduced in the ALADIN 3D-VAR as a new source of information. The subsequent information vector is :

$$Z=\begin{pmatrix} x^b \\ y \\ H_1(x^{AA}) \end{pmatrix},$$

where x^b is the background state, *y* is the observation vector, and the projections H_1, H_2 are defined as : H_1 : ARPEGE → ALADIN *low res.*; H_2 : ALADIN *full res.* → ALADIN *low res.*

The cross-covariances between the 3 error vectors : ε^b, ε^o, and $\varepsilon^k=H_1(x^{AA})-H_2(x^t)$ are summed up in the following matrix :

$$W=\begin{pmatrix} B & 0 & E(\varepsilon^b\varepsilon^{k\,\mathrm{T}}) \\ 0 & R & 0 \\ E(\varepsilon^k\varepsilon^{b\,\mathrm{T}}) & 0 & V \end{pmatrix},$$

assuming that the observation errors are correlated neither with the background errors nor with the "large scale" errors.

If the non-diagonal terms of the *W* matrix are negligible, the cost function is simply modified with an extra-term :

$$J(x)=(x^b-x)^{\mathrm{T}}B^{-1}(x^b-x)+(y-H(x))^{\mathrm{T}}R^{-1}(y-H(x))+(H_1(x^{AA})-H_2(x))^{\mathrm{T}}V^{-1}(H_1(x^{AA})-H_2(x)),$$

or in its incremental formulation:

$$J(\delta x)=\delta x^{\mathrm{T}}B^{-1}\delta x+(d^o-\boldsymbol{H}\delta x)^{\mathrm{T}}R^{-1}(d^o-\boldsymbol{H}\delta x)+(d^k-\boldsymbol{H_2}\delta x)^{\mathrm{T}}V^{-1}(d^k-\boldsymbol{H_2}\delta x),$$

where $\delta x=x-x^b$, $d^o=y-H(x^b)$ and $d^k=H_1(x^{AA})-H_2(x^b)$.

First, the *B* and *V* covariances, and the cross-covariances $E(\varepsilon^k\varepsilon^{b\mathrm{T}})$ (hereafter named E_{kb}) are evaluated in a low-resolution spectral space, and some horizontal diagnoses are plotted. Then the first results are shown.

4.6.2 Evaluation of the statistics in ARPEGE-ALADIN

The statistics are evaluated thanks to an ensemble method. We rely on the ensembles generated in ARPEGE by Margarida Belo-Pereira (Gaussian perturbation of the observations using their own σ^o) and the subsequent ensembles generated in ALADIN by Simona Stefanescu.

- **Spectral**

The nominal ALADIN-France truncation is 149 both for zonal and meridional wavenumbers. 12 is chosen to be the truncation of the low-resolution spectral space. Caution : all formulas hereafter correspond to a "square" domain (NSMAX=NMSMAX).

Vertical profiles of standard deviation

For vertical level *l*, the standard deviation σ_l is a definite positive quantity which gathers the contributions from the horizontal wavenumbers :

$$\sigma_l=\sqrt{\sum_{m,n}Q_{l,l}(m,n)}$$

where $Q_{l,l}(m,n)$ is the auto-covariance for vertical level l and wavenumber pair *(m, n)*..

The vertical profiles for the "full-resolution" ARPEGE analysis standard-deviations (dotted lines on Fig. 1) are greater than the "low-resolution" ARPEGE analysis standard-deviations (σ_l^k, solid lines), which is a direct consequence of the definite-positiveness of the standard deviation. The contributions of the smaller scales seem to be more important in the troposphere than in the stratosphere.

The ("full-resolution") ALADIN background standard-deviations (σ_l^b, dashed lines) are larger than the σ_l^k for vorticity and divergence, but the σ_l^b and σ_l^k profiles have the same shape for temperature and specific humidity.

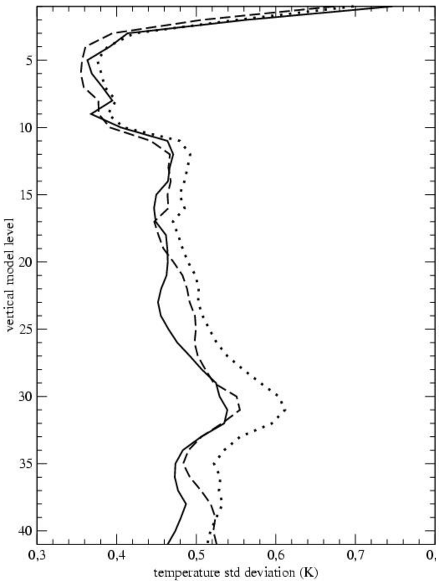


Figure 1 : Vertical profiles of standard deviation for temperature (K).:

dashed : ALADIN background error
dotted : ARPEGE analysis error nominal ALADIN
solid : ARPEGE analysis error low resolution ALADIN

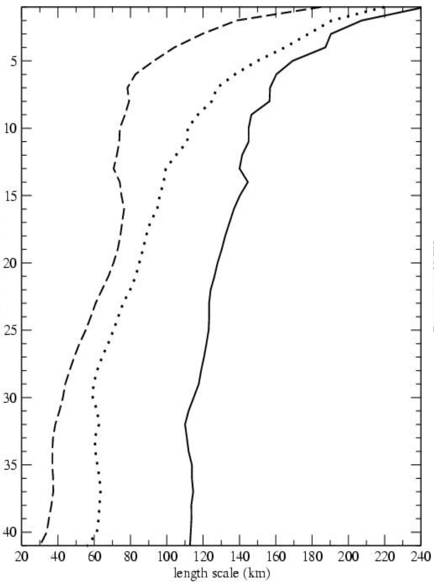


Figure 2 : Vertical profiles of length-scale for temperature (K).:

dashed : ALADIN background error
dotted : ARPEGE analysis error nominal ALADIN
solid : ARPEGE analysis error low resolution ALADIN

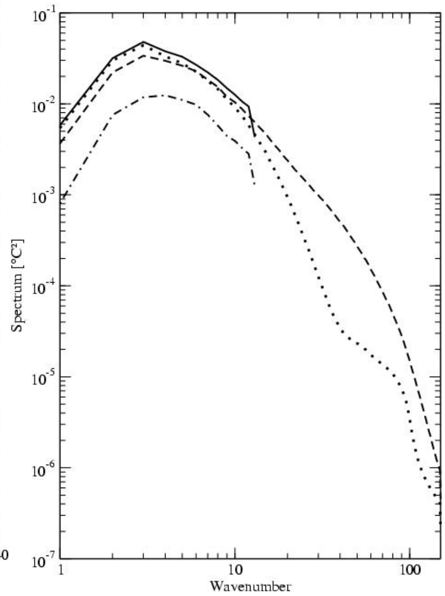


Figure 3 : Horizontal variance spectra for temperature (K) on model level 22:

dashed : ALADIN background error
dotted : ARPEGE analysis error nominal ALADIN
solid : ARPEGE analysis error low resolution ALADIN
dot-dashed : *Ekb*

Vertical profiles of length-scale

For a vertical level l, the length-scale can be defined as :

$$L_l = F\sqrt{\frac{\sum_{m,n} Q_{l,l}(m,n)}{\sum_{m,n}(m^2+n^2)\,Q_{l,l}(m,n)}},$$

where F is a scaling factor. The larger the truncation, the smaller L_l .

The change of truncation (nominal to low resolutions) clearly implies an increase of the length-scale (dotted to solid lines, on Fig. 2). The length-scales of ALADIN background errors are a bit smaller than those of the "full-resolution" ARPEGE analysis errors in the troposphere for all variables, and also in the stratosphere for temperature.

Horizontal variance spectra

Assuming horizontal homogeneity and isotropy, the B and V matrices are diagonal for each variable and vertical level. With the same hypotheses, we have :

$$E_{kb} = \begin{pmatrix} \square & & 0 & 0 & \cdots & 0 \\ & \ddots & & \vdots & & \vdots \\ 0 & & \square & 0 & \cdots & 0 \end{pmatrix}.$$

The first block is a $q \times q$ diagonal block and the second block is a $q \times (n-q)$ null block, where n is the nominal truncation and q the low-resolution truncation..

The spectra for the full and low resolution ARPEGE analysis errors overlap quite well for the first wavenumbers (dotted and solid lines respectively, on Fig. 3). A strong decrease can be observed for wavenumber 12 in the low-resolution case, which is similar to an "end of spectrum" in full resolution.

E_{kb} is roughly 5 times smaller than B or V. At first order, we will assume E_{kb} is negligible. But, later, the (σ^k) $\left(\text{i.e. } \sigma_l^k \text{ for all } l\right)$ should be retuned to take these cross-covariances into account.

- **Gridpoint**

The variances $\sigma_l^{k\,2}$ and $\sigma_l^{b\,2}$ have been plotted for various variables and model levels l. They have the same horizontal inhomogeneities, which are also of the same order over the ALADIN France domain as the ARPEGE analysis error variances (in ARPEGE geometry). [not shown]

An average over a 45-days period (02-03 2002) of the innovation $d^k = H_1(x^{AA}) - H_2(x^b)$ is plotted on Fig. 4a for temperature on model level 29. The innovation is stronger over the Atlantic Ocean, over the North-Western corner of the domain and over the Alps. One can split the innovation into to contributions : $d^k = \left(H_1(x^{AA}) - H_1(x^{BB})\right) + \left(H_1(x^{BB}) - H_2(x^b)\right)$. Here x^{BB} is the ARPEGE background, that is to say the innovation is the sum of the ARPEGE analysis increment and of the difference between the ARPEGE and ALADIN forecasts, both put on the ALADIN low-resolution geometry. When having a look at the average of $H_1(x^{AA}) - H_1(x^{BB})$ over the period (Fig. 4b), it arises that the ARPEGE analysis increment is the main contribution to the innovation.

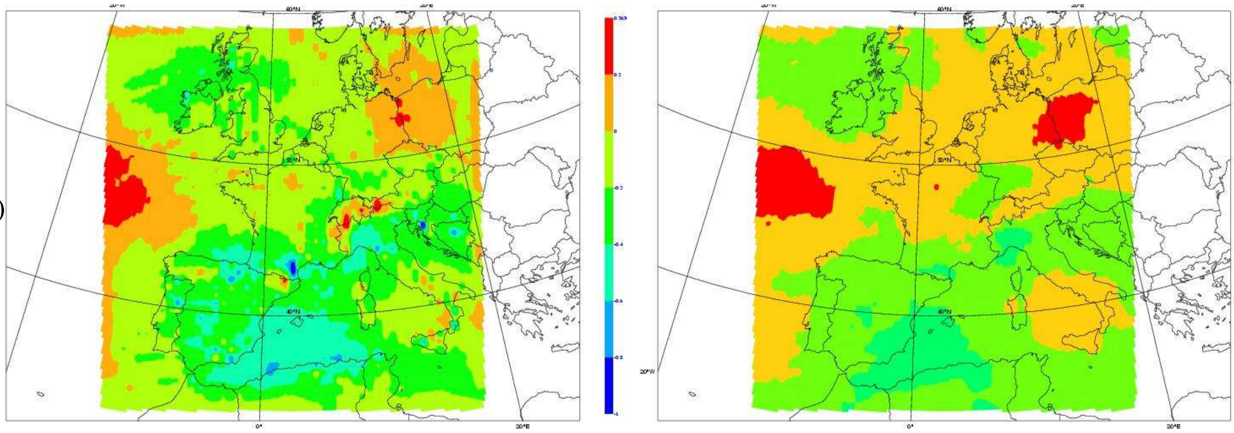
a)  b)

Figure 4: Temperature on model level 29
a) average of the d^k innovation, b) average of the ARPEGE analysis increment

4.6.3 First Results

- **Technical Implementation**

The new cost-function J_k, defined as $J_k(x) = (H_1(x^{AA}) - H_2(x))^T V^{-1} (H_1(x^{AA}) - H_2(x))$, has been first implemented in the ARPEGE-ALADIN cycle 28 environment. The cost-function is activated through a new namelist (NEMJK) and key LEJK. The truncation of the low-resolution spectral space is 12. No particular tuning of the statistics is performed upstream. The weight of the cost function can be tuned thanks to the real parameter ALPHAK.

The first results, shown hereafter, have been produced with the operational cycle 26T1. In this particular test, ARPEGE and ALADIN were fed with the *same* observations, which is not really suitable with the formulation.

- **Verification**

This early test has been performed on the situation of the day (April, the 19th). The results for the temperature on model level 22 are shown on Fig. 5. Two areas are highlighted :

✔ Blue rectangle over the Atlantic Ocean :

The ARPEGE analysis isolines are shifted northwards compared to the ALADIN background (5a). The ALADIN analysis without J_k (5b) remains closer to the background than the analysis with J_k (5c). The analysis is modified as was expected, i.e. towards the ARPEGE analysis, as it is as large-scale shift.

✔ Blue circle between Sardinia and Sicily :
There is a small-scale oscillation in the ALADIN background but not in the ARPEGE analysis (5a). This pattern remains in the analysis without J_k (i.e. it is not modified by the observations) and in the analysis with J_k (i.e. it is not modified by the new source of information).

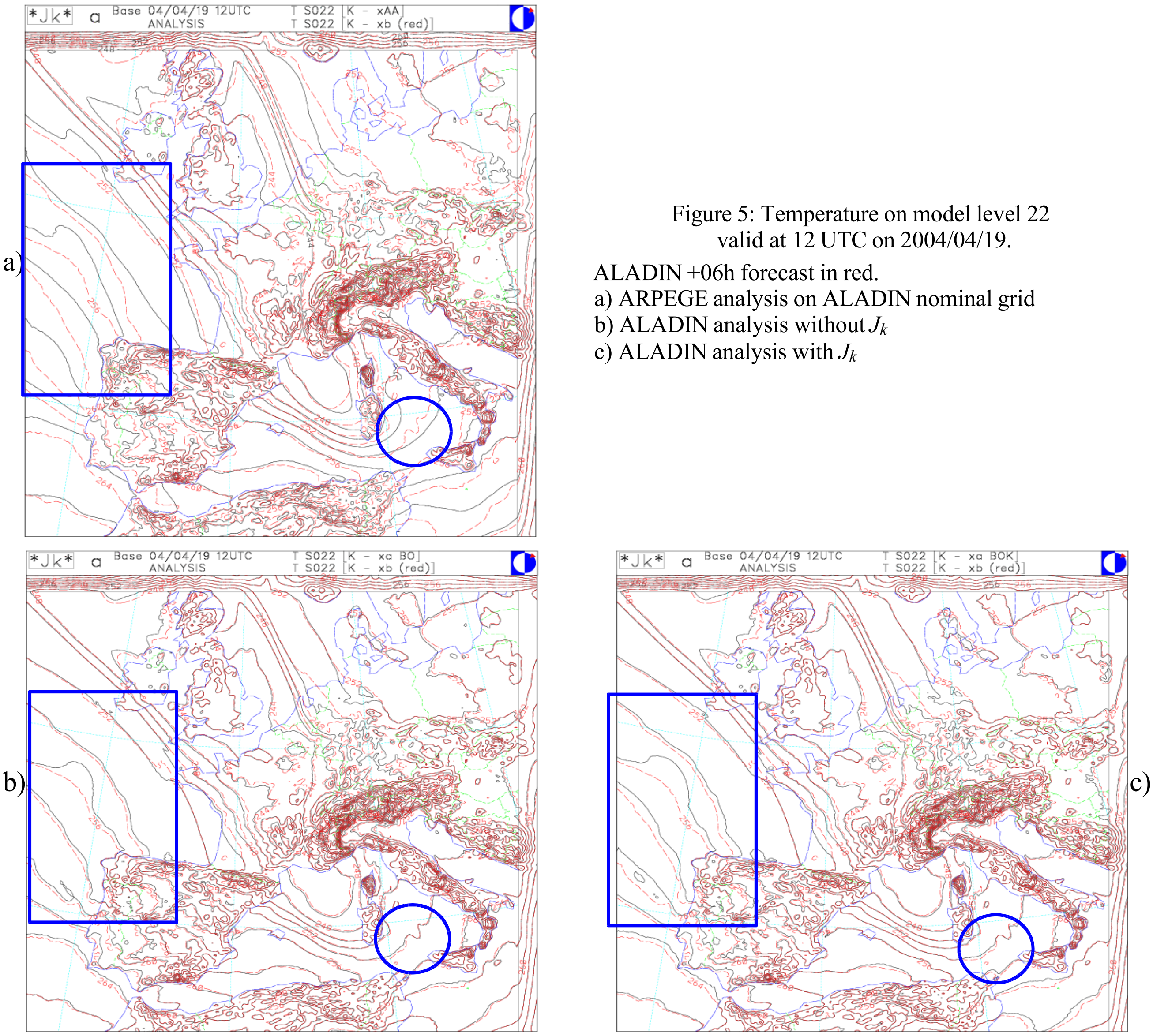


Figure 5: Temperature on model level 22
valid at 12 UTC on 2004/04/19.

ALADIN +06h forecast in red.
a) ARPEGE analysis on ALADIN nominal grid
b) ALADIN analysis without J_k
c) ALADIN analysis with J_k

- **Conclusion**

This new cost-function introduces some information about the large scales, but it does not modify the meso- and small-scale patterns either present in the background or built by the "classical" analysis.

A "full" evaluation of this new analysis will be performed over 2 periods of 15 days, with score computation and case studies.

4.7. Jean-Marcel PIRIOU : Correction of compensating errors in physical packages; validation with special emphasis on cloudiness representation

Bibliography of convection: Emanuel, Mapes, Yano, Arakawa, ...

Work on the manuscript.

Work on lateral entrainment of deep convective clouds, and its link with environmental moisture. Deal with CRM data to get this sensitivity of entrainment to environmental moisture.

4.8. Raluca RADU : Extensive study of the coupling problem for a high-resolution limited-area model

Extensive validation of the new method : see the Romanian contribution to research and developments (§3.11) .

4.9. Wafaa SADIKI : A posteriori verification of analysis and assimilation algorithms and study of the statistical properties of the adjoint solutions

The PhD manuscript is almost ready.

4.10. Andre SIMON : Study of the relationship between turbulent fluxes in deeply stable PBL situations and cyclogenetic activitySee the ALATNET final report for the most recent results.

Nothing new (operational duties at home).

4.11. Klaus STADLBACHER : Systematic qualitative evaluation of high-resolution non-hydrostatic model

Nothing new (operational and administrative duties at home, including the organization of the 14th ALADIN workshop : http://www.zamg.ac.at/workshop2004/).

4.12. Simona STEFANESCU : The modelling of the forecast error covariances for a 3D-Var data assimilation in an atmospheric limited-area model

4.13. Malgorzata SZCZECH-GAJEWSKA : Use of IASI/AIRS observations over land.

During this period, the validation of the emissivity database for infra-red sounders was evaluated with AIRS data. Results confirm prior results with HIRS : for surface-peaking channels, the use of the new emissivity values slightly improves the agreement between observations and model values with respect to the standard 0.98 value. A very preliminary draft of a paper has been written.

4.14. Jozef VIVODA : Application of the predictor-corrector method to non-hydrostatic dynamics

5. PAPERS and ARTICLES

5.1. Summary of answers to the LAMEPS questionnaire (HMS)

Andras Horanyi *(HMS, ALADIN coordinator for predictability studies)*

5.1.1 Summary

1.The questionnaire was sent to all ALADIN coordinators (15 countries).
The letter is enclosed.

2. Formal answers to the raised questions:
1 (Slovakia)

3. Number of answers, reactions:
4 (Slovakia, France, Belgium, Romania)

4. Information through other centers:
1 (Austria from France)

5. No answer, no reaction, no news:
10 (Algeria, Bulgaria, Croatia, Czech Republic, Moldova, Morocco, Poland, Portugal, Slovenia, Tunisia)

6. The answers are detailed hereafter

7. Conclusion, outlook

Albeit there is interest to work on LAMEPS and predictability related topics in ALADIN framework at the moment the dedicated manpower is rather low. This state should be revisited in the Innsbruck workshop.

5.1.2 Details of the answers

- **Slovakia**

There is an interest to obtain dynamical estimate of ALADIN forecasts reliability, however they don't have free capacity in 2004. They hope to join the project later.

- **France**

a) A student is working on LAMEPS (Jean-Marie Lepioufle)

b) Loïk and Simona are working on ensemble Jb

c) PEACE (ARPEGE EPS): Jean Nicolau

- **Belgium**

They fully agree with the relevance of the LAMEPS experiments and they are interested in both theoretical and operational aspects. They would like to test if the regional ensemble gives a realistic dispersion of weather parameters (if it is helpful to catch extreme events). The LAMEPS project should be introduced at RMI and exchange of basic ideas is needed.

Possible participant: Stephane Vannitsem.

- **Romania**

a) Direct application of PEACE outputs as initial and lateral boundary conditions

b) Generation of initial perturbations: breeding/system simulation approach.

c) Research on short-range EPS construction for severe weather situations.

Manpower: 2 man×months, Raluca Radu

- **Austria**

Implementation of an Ensemble Transform Kalman Filter.

5.1.3 Letter

Dear ALADIN coordinators,

We have recently compiled a working plan for LAMEPS related research and development at the Hungarian Meteorological Service (we have two newcomers for this project and Sandor Kertesz is the leader of the work at us). The plan was heavily discussed and afterwards agreed with Meteo France.

The plan is focusing on some specific problems, what we feel that we can tackle, but certainly doesn't address all the general questions, problems at the moment (e.g. the use of other techniques for providing perturbations than singular vectors, etc.)

Due to the fact that we are responsible for the coordination of predictability-related work on ALADIN now we would like to address you some questions:

a) Would you be interested in to be involved in LAMEPS and predictability work on ALADIN?

b) If yes, what fields, aspects you are mostly interested in (certainly not exclusively the ones, which are in the attached plan).

c) What manpower you can dedicate to this work (with also names possibly)?

Based on your answers we will extend (modify) the programme and try to make an ALADIN-level plan.

We expect your contribution by the end of the year.

In advance thank you very much for your answer!

Best regards

Andras

5.2. Preliminary results of LAMEPS experiments at the Hungarian Meteorological Service

Edit Hágel and Gabriella Szépszó *(HMS)*

5.2.1 Introduction

The ensemble technique is based on the fact that small errors in the initial condition of any numerical weather prediction model (or errors in the model itself) can cause big errors in the forecast. When making an ensemble forecast the model is integrated not only once (starting from the original initial condition), but forecasts are also made using little bit different (perturbed) initial conditions. This ensemble of initial conditions consists of equally likely analyses of the atmospheric initial state and, in an ideal case, encompasses the unknown "true" state of the atmosphere. This technique is capable to predict rare or extreme events and has the advantage of predicting also the probability of future weather events or conditions. Despite its success, at the moment the ensemble method is mainly used for medium range forecasting and on global scales, though nowadays the emphasis is more and more moving towards the short ranges and smaller scales. However methods used in the medium range cannot be directly applied to short-range forecasting. Research has already been done in this field and there are some operational short-range ensemble systems (e.g. at NCEP, or the COSMO-LEPS). We also wish to develop a short-range ensemble system with as main goal the better understanding and prediction of local extreme events like heavy precipitation, wind storms, big temperature-anomalies and also to have a high resolution probabilistic forecast for 2 meter temperature, 10 meter wind and precipitation in the 12-48 h time-range.

For making an ensemble forecast lots of methods can be used (e.g. multi-model, multi-analysis, perturbation of observations, singular-vector method, breeding etc.). It is not known yet (especially at mesoscale) which method would provide the best forecasts. Therefore the following methods will be tried:

- ALADIN EPS coupled with global (ARPEGE based) ensemble members. This would include the investigation of the impact of the target domain and target time-window of the global singular-vector computation.
- ALADIN EPS coupled with representative members of clusters formed from ARPEGE based ensemble forecasts (the so called "super ensemble")
- ALADIN EPS based on ALADIN native singular-vector perturbations

Hereafter the first activities and results of this LAMEPS project will be briefly described.

5.2.2 Verification and visualization

The first task was to implement and develop the special verification and visualization tools needed for an ensemble system. The tools are mainly based on the softwares MAGICS and METVIEW (both are ECMWF visualization softwares).

Our verification package includes the most important scores and methods:

- ROC diagram
- Talagrand diagram
- Brier score, Brier skill score and reliability diagram

In the case of wind speed, temperature and geopotential the models are verified against SYNOP data in grid points. In the case of precipitation it was decided to do it in a different way because of the following reason. The forecast model predicts precipitation fluxes over areas of the order of about 10 km×10 km while SYNOP stations report values representing less than a m^2. Because of this inconsistency it was decided to use a special verification method in the case of precipitation. Forecasts are verified not in grid points but instead the average values computed over bigger areas (such as watersheds) are verified.

Our visualization package includes the usual plots, such as:

- Spaghetti diagrams
- Plume diagrams
- Ensemble mean
- Members (together or one by one)
- Probabilities

5.2.3 LAMEPS runs – Experiments

It was decided to start our experiments with the downscaling of the global (ARPEGE based) ensemble. This work can be divided into two parts:

- Downscaling the ARPEGE/PEACE[1] members
- Investigation of the impact of the target domain and target time-window and downscaling the ARPEGE ensemble members (the integration of the global ensemble is performed locally)

- **Downscaling of the PEACE ensemble members**

We started with running ALADIN EPS coupled with PEACE ensemble members. The PEACE system is now run at Météo-France operationally once a day (at 18 UTC). It has 11 members (10 perturbed and a control one). It is based on the global spectral model ARPEGE. The initial perturbations of this global ensemble system are based on targeted singular vectors, the target domain covering Western Europe and the North Atlantic region. The target time-window is 12 h. We performed the ALADIN EPS integrations coupled with PEACE members for a 4 day period in October 2003 (the time interval was short because of the heavy computational cost). Both the ALADIN EPS and the PEACE members have been verified over the LACE domain (resolution 12 km, domain covering Central Europe) and the following results were obtained.

<u>Talagrand diagram</u>

The Talagrand diagram is a very useful measure of the spread. If the spread in the ensemble is big enough the histograms should be flat. A U shape indicates lack of spread (the verifying analysis lies outside the ensemble lots of times), a L shape indicates overestimation, a J shape means underestimation. For 10 meter wind speed it can be seen that the histograms have a U shape both in the case of PEACE (fig. 1) and ALADIN EPS (fig. 2). For geopotential (fig. 3) the situation is better especially if we go ahead in time. At +36 h the histogram is nearly flat.

It can be seen that the diagrams for the two models are very similar, which means that in this situation no extra information came from the integration of the limited area model ALADIN.

<u>ROC diagram</u>

In this method the bigger the area under the curve, the better the forecast is. The diagonal line represents the climate. If our curve lies below this line (so the area under the curve is less than 0.5) then our forecast gives less information than the use of the climate. ROC diagrams were made for many different parameters. For example the following events were examined: 10 m wind speed exceeds 5 m/s, and 2 m/s. In the first case it was found that the area under the curve at analysis time is smaller than at later stages of the forecast (fig. 4). The reason of this might be that the forecast starts at 00 UTC, when the wind is usually not so strong, therefore the number of cases is quite small. As we go ahead in time we get better results because of the growing perturbations. If we look to the event that 10 m wind speed exceeds 2 m/s (fig. 5), this problem can not bee seen, which can

---

1 Prévision d'Ensemble A Courte Echéance

be explained by the fact that there are more cases for this lower wind speed.

Reliability diagram

In this case the forecast probability (x axis) and the observed probability (y axis) is plotted. In an ideal situation the points lie on the diagonal which means that the event is forecasted as many times as it was observed. If the points lie above the diagonal it means underestimation, if they are under the diagonal, then it is overestimation. Because of the short time-interval (only 4 days) the number of cases is quite small, that is why the curve has a zigzag shape in the early stages of the forecast (fig. 6). The curves get smoother as we go ahead in time.

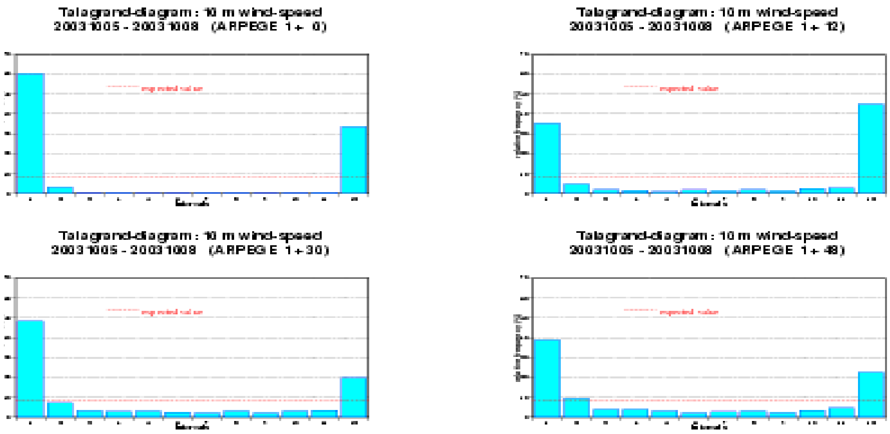


Figure 1. Talagrand diagram for the model ARPEGE, for 10 m wind speed (time steps: 00, 12, 30, 48)

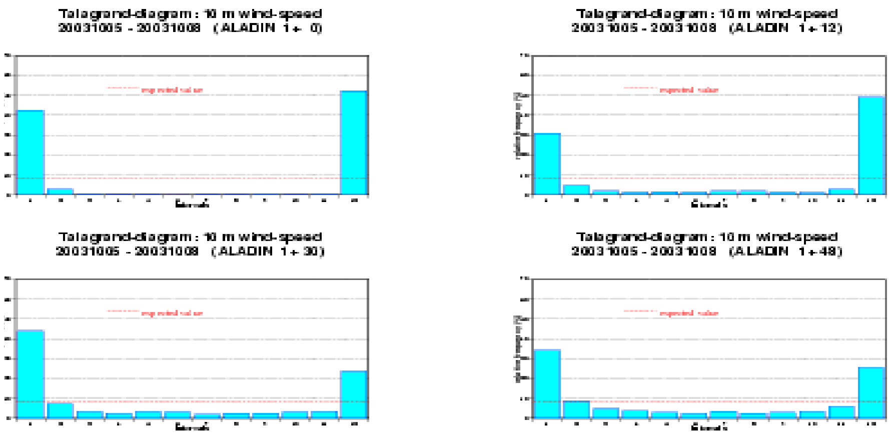


Figure 2. Talagrand diagram for the model ALADIN, for 10 m wind speed (time steps: 00, 12, 30, 48)

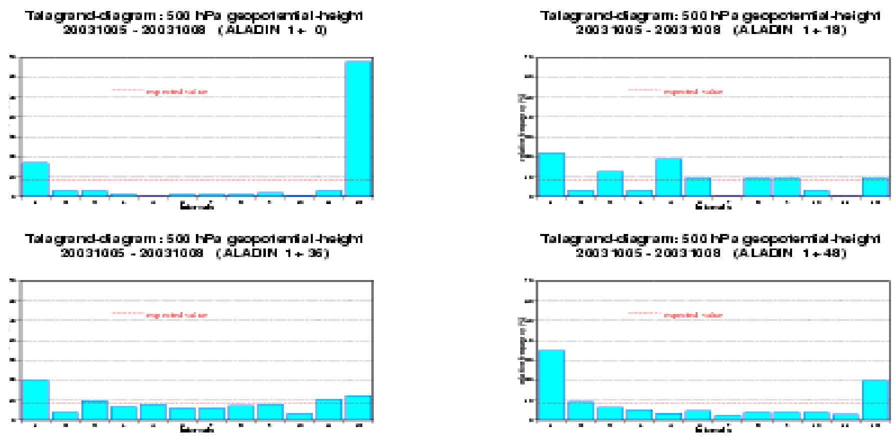


Figure 3. Talagrand diagram for the model ALADIN, for 500 hPa geopotential height (time steps: 00, 18, 36, 48)

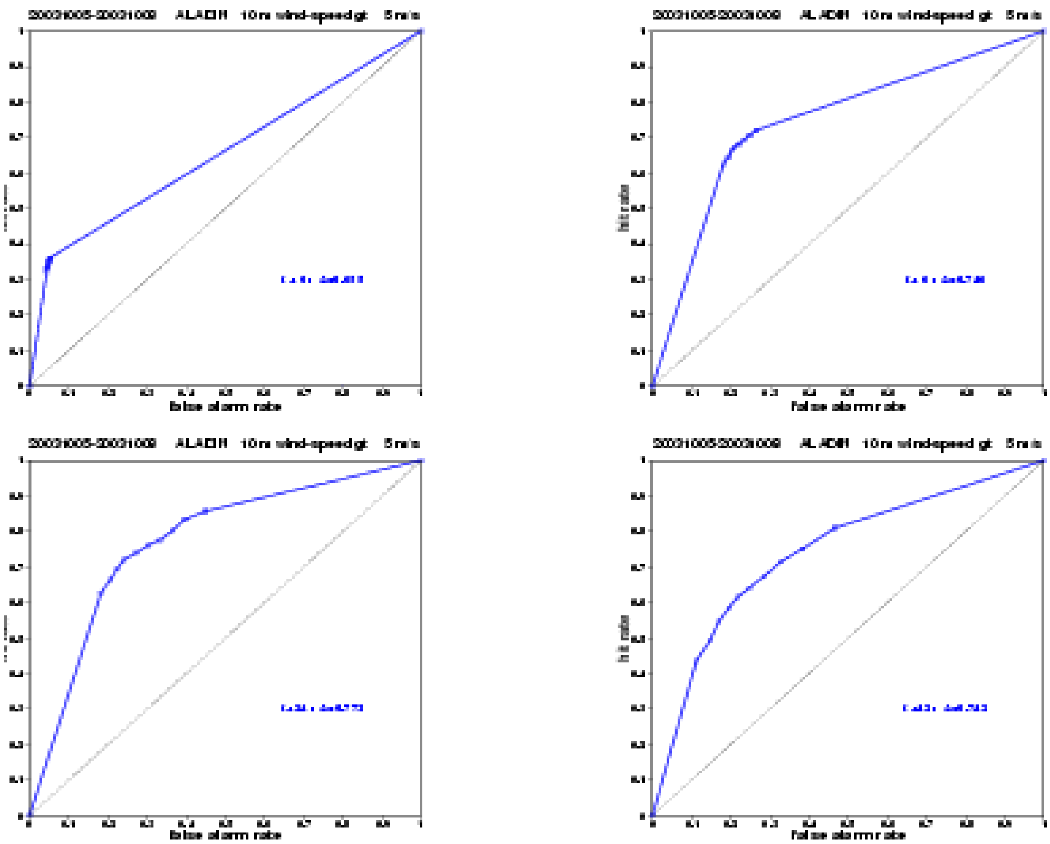


Figure 4. ROC diagram for the model ALADIN, event: 10 m wind speed exceeds 5 m/s (time steps: 00, 06, 24, 42)

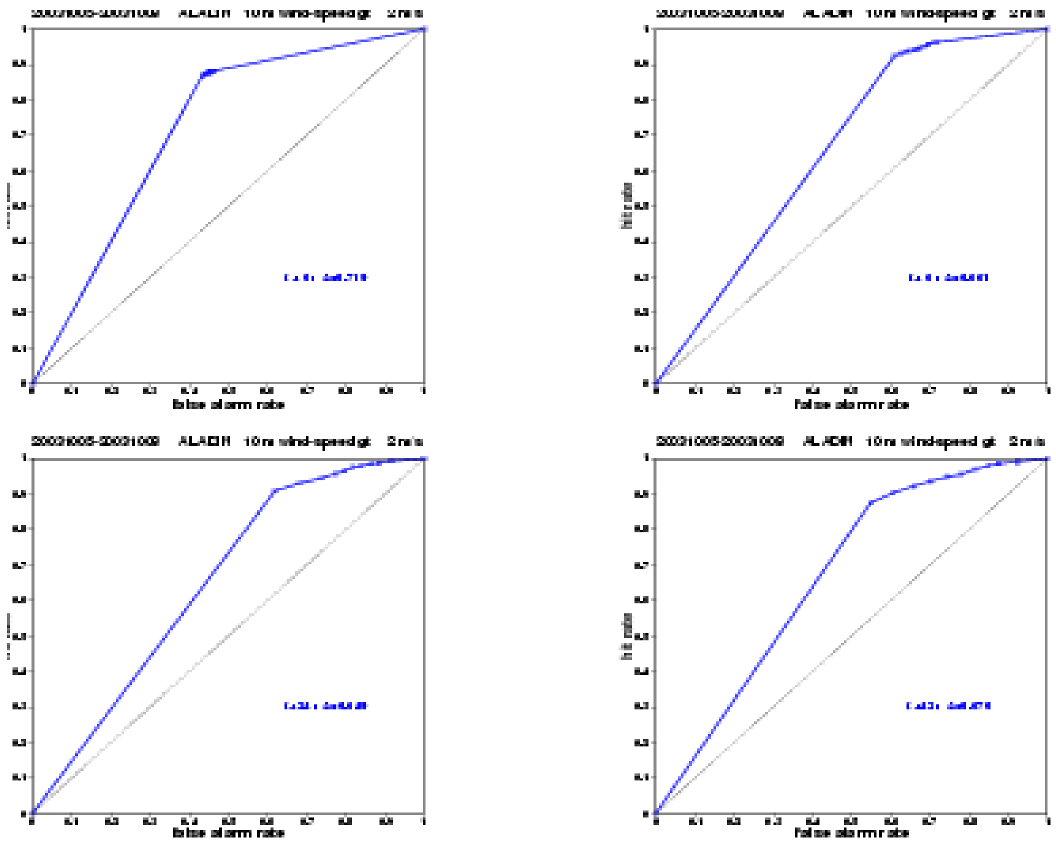


Figure 5. ROC diagram for the model ALADIN, event: 10 m wind speed exceeds 2 m/s (time steps: 00, 06, 24, 42)

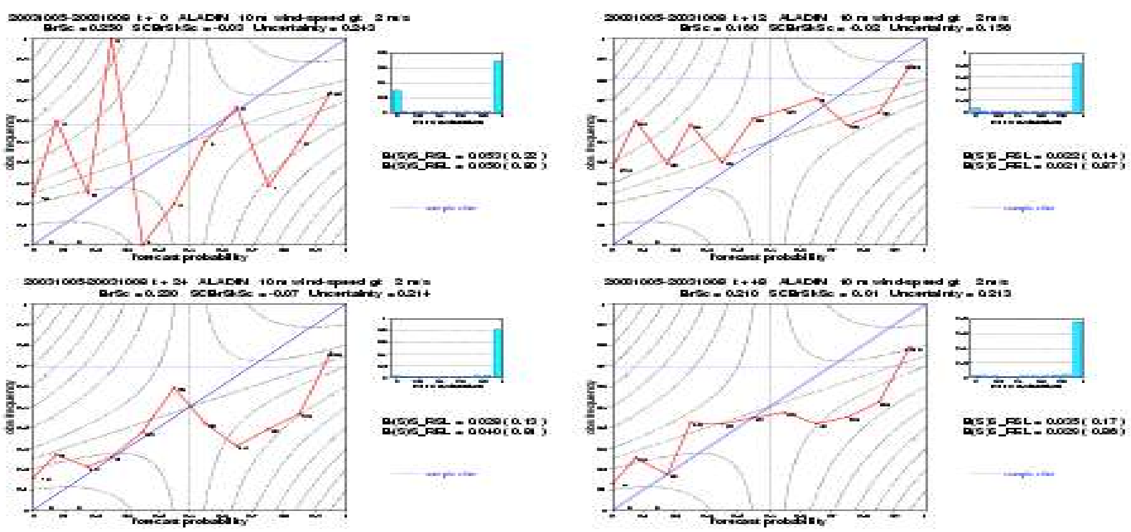


Figure 6**.** Reliability diagram for the model ALADIN, event: 10 m wind speed exceeds 2 m/s
(time steps: 00, 12, 24, 48)

Results of the downscaling

From these first experiments with downscaling the PEACE members it seems that the spread is not big enough in our area of interest (Central Europe, especially Hungary). It seems reasonable if we consider that the PEACE system was calibrated in order to get enough spread over Western Europe between 24 and 72 h steps, for wind speed, 500 hPa geopotential and mean-sea-level pressure. The aim of the PEACE system is to detect strong storms. This raises some questions :

- Are the PEACE provided initial and boundary conditions convenient for the local EPS run, for a Central European application?
- What is the impact of different target domains and target times?

To answer these questions it was decided to make some case studies.

- **Experiments with different target domains**

In our experiments an ARPEGE ensemble system was used, based on PEACE. The main difference is that the target domain was not fixed (for the target time 12 h was used). Four different target domains were defined (fig. 7):

- Domain 1: Atlantic Ocean and Western Europe (the same as in PEACE)
- Domain 2: Europe and some of the Atlantic
- Domain 3: covering nearly whole Europe
- Domain 4: slightly bigger than Hungary

We expect that in different meteorological situations the use of different target domains would provide the better results and a compromise should be found to choose the best domain. So far three different meteorological situations were examined. One of them was a convective event in 2002. In this situation large quantity of precipitation (40-70 mm during 24 h) was measured at some places along the river Danube and all the models (ALADIN, ARPEGE, ECMWF) failed to forecast the event. The second case (from 2001) was a situation with a fast moving cold front coming from the west. This time the models overestimated the precipitation. The third situation (from 2004) was one with a quite big temperature overestimation. This error in the forecast of temperature caused a big problem : the models predicted rain, but in reality it was sleet.

Every time the ARPEGE ensemble runs were performed locally with the use of the above mentioned singular-vector target domains, and the ALADIN model was coupled with these ensemble members. In all three cases domains 1, 2 and 3 were used. In the convective situation target domain 4 was also tried. Every time the average standard deviation over Hungary was computed (for 850 hPa temperature, 10 meter wind speed, mean-sea-level pressure and 500 hPa geopotential) and we also looked at different meteorological parameters.

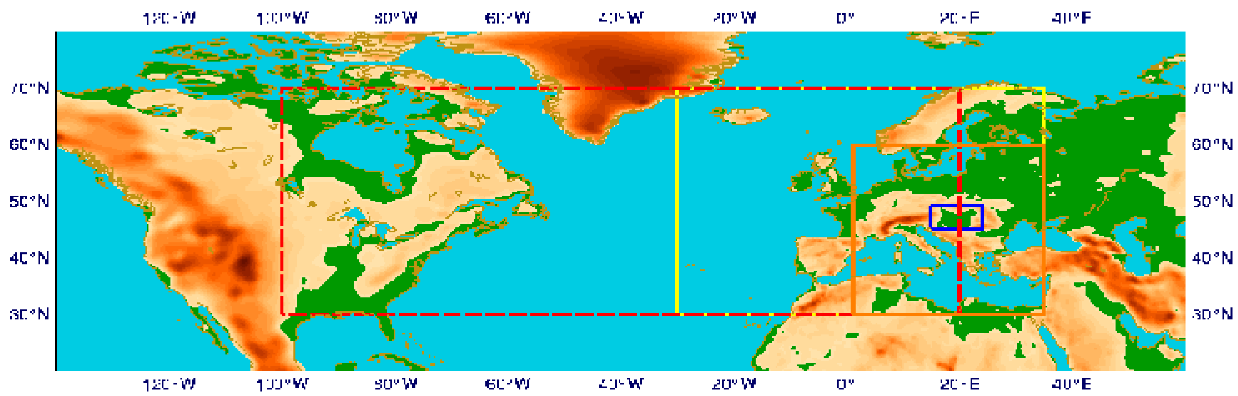


Figure 7. The defined target domains (red: domain 1, yellow: domain 2, orange: domain 3, blue: domain 4)

<u>Results – Spread</u>

In every situation it was found that with the use of the first singular-vector target domain (this is the one used in the PEACE system) the average standard deviation was quite small in the beginning of the forecast and it increased quite slowly. Around the end of the forecast range it usually reached the values obtained by the use of the other domains, but we do not want to concentrate only on the last few hours of the forecast. Instead we would like to find an optimal target domain for the singular-vector computation which guarantees sufficient spread in the 12-48h time-range.

When target domains 2 and 3 were used the (average) standard deviation was bigger and quite similar both times. In the convective situation the fourth domain (its size being a bit larger than Hungary) was also tried. Doing so the spread over Hungary was quite big in the beginning of the forecast but started to decrease as we went ahead in time. The second case (fast moving cold front) was the only one when standard deviations were nearly the same with the use of domain 1, 2 and 3. The reason of this might be that in this case the examined phenomenon was a large scale one.

It seems that for our purposes the first domain in not convenient in every meteorological situation because the area of biggest spread is usually far from our area of interest (which is Hungary and Central Europe).

Results - Meteorological parameters

Not only the standard deviation was examined but also we looked at different meteorological parameters each time. In the first case (convective case) we got nearly no precipitation at all when we used target domain 1 in the global singular-vector computation. The best results were obtained with the use of domain 4 : some of the members predicted big amount of precipitation at right position (fig. 8). The second case (fast moving cold front) was the only one where standard deviations were nearly the same with the use of domain 1, 2 and 3, and also the predicted amount of precipitation was quite similar. In the third case (sleet) the result was not so good. In reality the temperature was around or below 0 °C all day, but the models predicted much more. A sufficient spread was obtained when domain 2 and 3 was used, but still the values for the temperature were very high. At least some of the members were colder than the control one, but they were not cold enough (fig. 9).

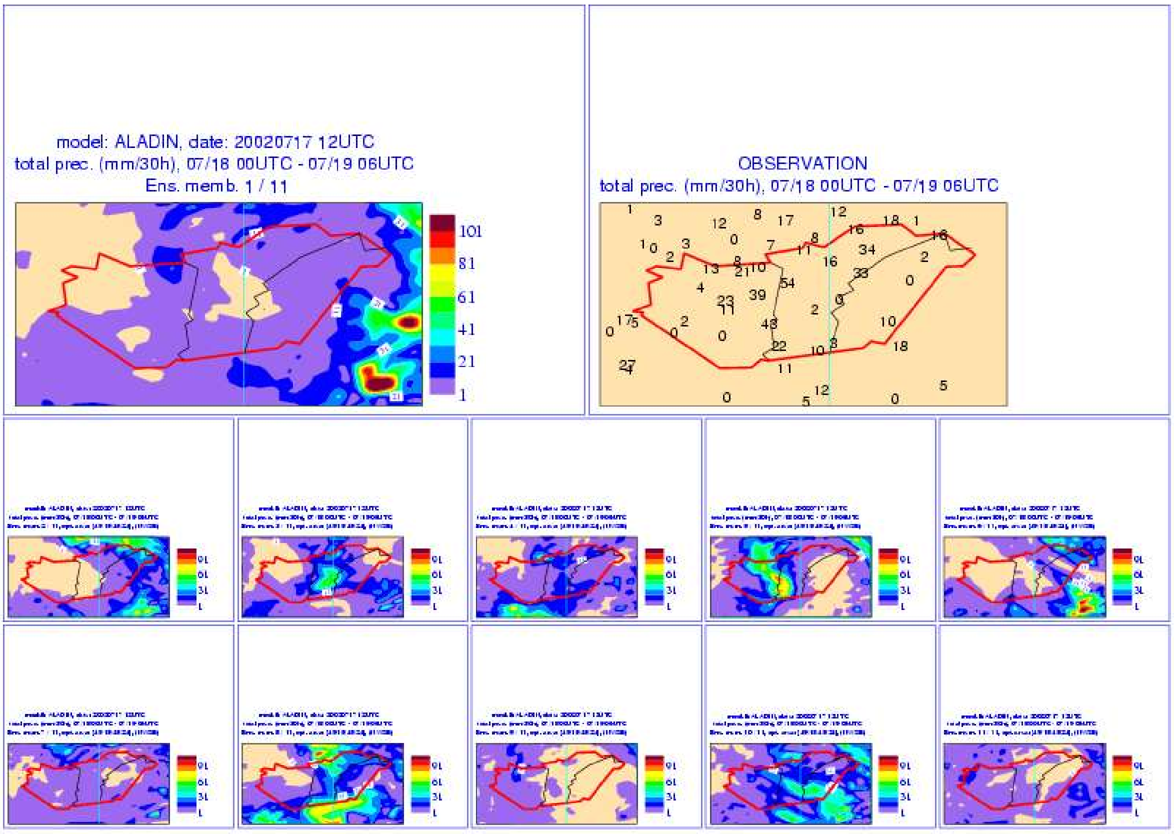


Figure 8. Ensemble members for the 2002 July case. The plotted parameter is total precipitation (mm/30 h) from 18 July 00 UTC until 19 July 06 UTC. The control forecast is at the top left corner, observations at the top right corner. The 10 ensemble members are also plotted. Some of the ensemble members forecasted big amount of precipitation at right position.

Figure 9**.** Plume diagram for the 2004 February case. The plotted parameter is 2m temperature. Forecast started at 21 February 2004 00 UTC; target domain 2 was used in the global singular-vector computation. On 22 July the highest observed temperature in the country was around three celsius. At +36 h (which is 22 July, 12 UTC) the spread is quite big, but all members are above zero, which means overestimation.

5.2.4 Preliminary conclusions

From the case studies and the experiment with downscaling the PEACE members it seems that the PEACE provided initial and boundary conditions are not really optimal for the local ensemble run, for a Central European application. It can be understood if we consider that it was calibrated to Western Europe. Our aim is to find an optimal target domain which fits our purposes, but some case studies still have to be done to find out which domain is the better to use.

5.2.5 Future plans

We would like to continue with further case studies to investigate the sensitivity with respect to target domain and also start experiments with different target times. Scores obtained by using the first singular-vector target domain and a different one (domain 2 or 3) will be compared for a longer period (one week - 10 days). It would be interesting to try what would happen when using more perturbations (e.g. to integrate 20 members instead of 10). Also it is planned to start the experiments with other methods especially with ALADIN native singular-vector perturbations.

5.3. Choice for radiance-bias correction for a limited-area model

Regina Szoták and Roger Randriamampianina *(Hungarian Meteorological Service)*

5.3.1 Abstract

In order to assimilate satellite measurements directly we must correct biases between the observed radiances and those simulated from the model first guess, caused by systematic error of radiances and by the radiative-transfer model. The method used for bias correction was developed for global models, its adaptation to limited-area models raises further questions.

The quality of the bias correction coefficients - scan-angle biases and coefficients for air-mass predictors - depends on the sample of the observation-minus-model-first-guess data obtained at each satellite (AMSU-A) scan position. In the case of a limited domain (limited-area model, LAM), we do not have the same amount of satellite measurements along the scan line, due to the fact that satellite paths might be cut at different scan positions during pre-processing in the analysis system. This might be a source of problems when evaluating of scan-angle biases for a LAM.

This paper investigates the use of different bias correction coefficients for the ALADIN limited-area model. In our study, the bias correction coefficients computed for the global ARPEGE model, those computed for the ALADIN limited-area model, and many of their combinations have been tested out in order to find the best one to process satellite data in a LAM.

The results of our experiments show that the impact of the bias correction coefficients computed for the ALADIN model is more "stable" in the analysis as well as in short-range forecasts, while the impact of the bias correction coefficients computed for the global model depends on the synoptic situation of the investigated period. This is especially true for the layers between 850 and 500 hPa, which is very important for synoptic meteorology.

5.3.2 Introduction

In most numerical weather prediction (NWP) centres satellite data are assimilated in the form of raw radiances. In order to efficiently use raw radiances (from ATOVS), biases between the observed radiances and those simulated from the model first-guess must be removed. A lot of articles deal with the removal of these biases (Eyre, 1992; Harris and Kelly, 2001). In general, these studies are based on global models and assume that radiance biases come from two different sources : from differences in measurement quality depending on the scan angle and from radiance and air-mass dependencies. In ARPEGE/ALADIN, we use the method described by Harris and Kelly (2001) to correct radiance biases. The main assumption of the above-mentioned study is that scan-angle biases vary with latitude, and air-mass predictors are composed of the following geophysical quantities from the model first-guess : two thicknesses (1000-300 hPa and 200-50 hPa), surface skin temperature and total column of water vapour.

Minor modifications had to be done in order to compute the radiance biases on a limited area. The most important modification concerns the consideration of the case of no satellite observation inside the "domain of interest" (central (C) + inner (I) zones).

In Fig. 1, one can see two satellite paths : a whole path can be seen on the right side of the domain and a portion of a second path is on the left side. Scan-angle biases depend on the number of samples obtained at each scan position. Due to the "problem" illustrated in Fig. 1, it is easy to understand that it is not possible to have the same number of samples for all scan positions in a given channel when computing scan-angle biases for a LAM. It leads to fluctuating curves instead of well-smoothed ones along scan lines (see Fig. 2a). In Fig. 2a we have the statistics computed for the old domain (Fig. 3a) of ALADIN-Hungary (ALADIN/HU), which is relatively small compared to the new one (Fig. 3b). When enlarging the domain, we get smoother curves, but we can still observe the above-mentioned problem for several channels. See, for example, the curve representing the scan-angle bias for channel 9 of AMSU-A (red triangle in Fig. 2b).

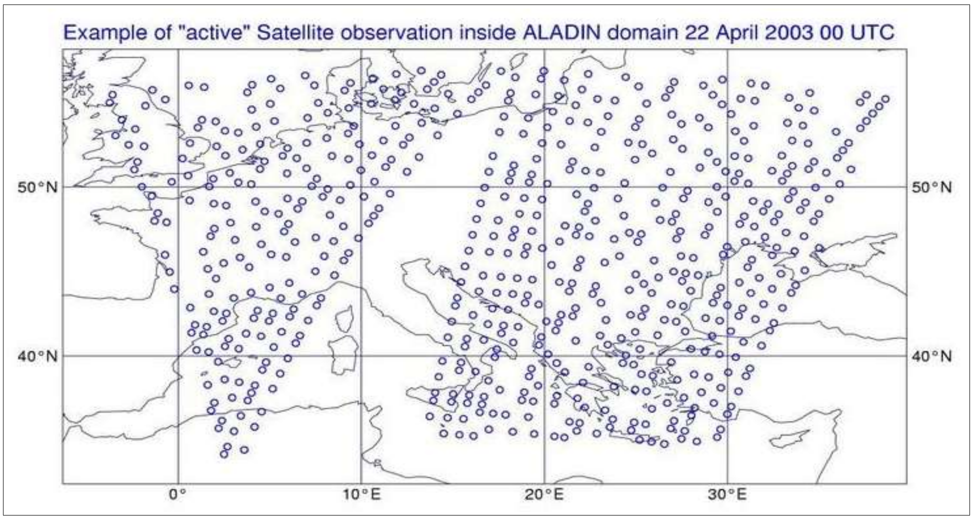


Figure 1 : Example of satellite paths inside the ALADIN/HU domain (C+I zone), observed on 22 April 2003 at 00 UTC.

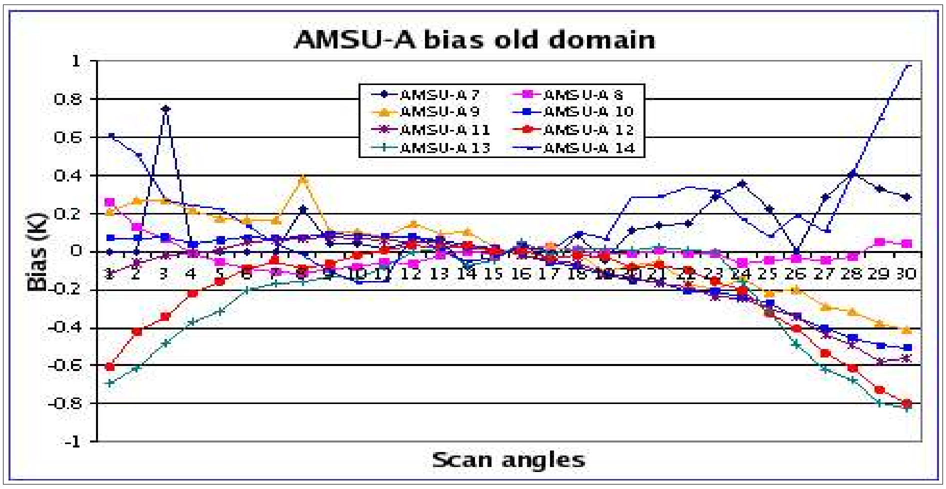


Figure 2a : Scan-angle biases computed for the old ALADIN/HU domain. Note that the domain is presented in Fig. 3a.

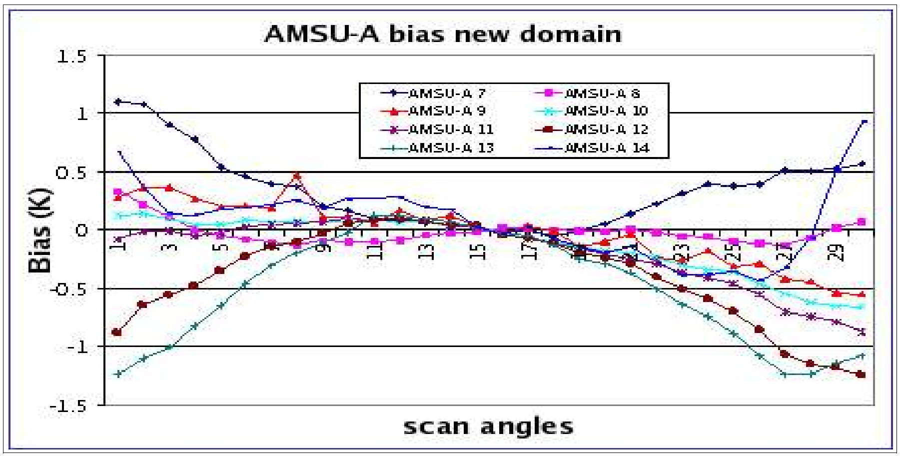
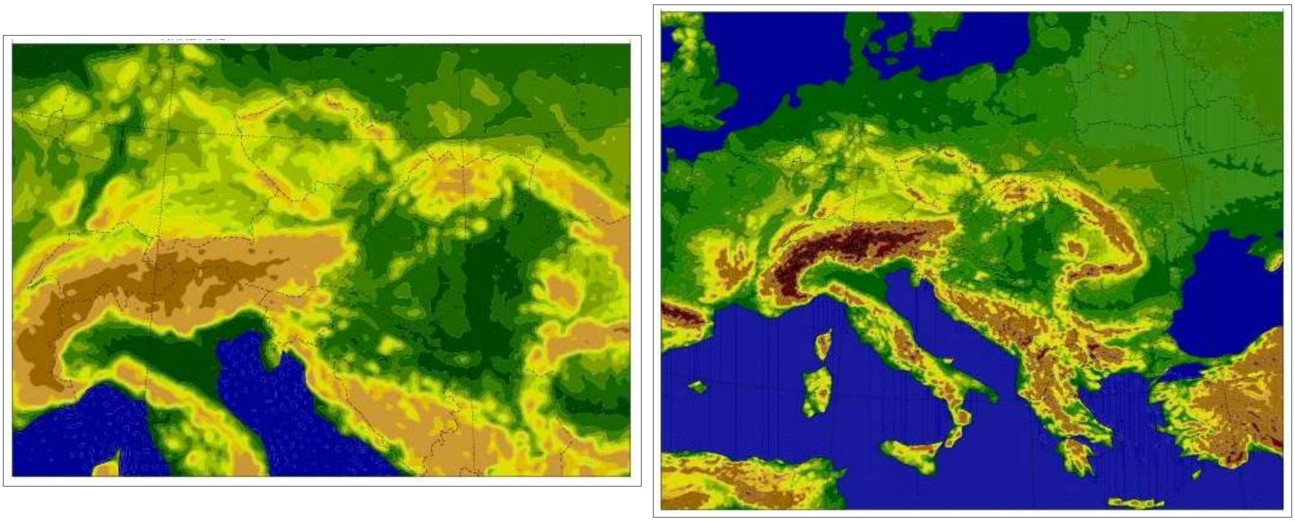


Figure 2b: Scan-angle bias computed for the new ALADIN/HU domain. Note that the domain of the latest ALADIN/HU version is presented on Fig. 3b.



(a) (b)

Figure 3 : Topography of the ALADIN/HU domains a) old, b) new.

We do not have the above-mentioned problems when doing the computation of scan-angle biases for global models, because there is a sufficient number of samples. A question arises concerning the bias correction coefficients to be used for the assimilation of ATOVS data in LAMs. Do we need to compute bias correction coefficients for the restricted domain of the LAM or can we use the ones computed for the coupling[2] global model? We have to pose another question regarding biases related to air-mass : is it at all necessary to remove biases related to air-mass to assimilate the ATOVS observations in a LAM?

The purpose of this paper is to answer these questions, investigating the impact of bias correction coefficients computed in two different ways : first using the coefficients of the ARPEGE global model, and second using those of the ALADIN/HU limited-area model. Bias correction coefficients computed for a global model cannot characterize radiances measured in a limited area as well as coefficients specifically computed for this domain. Despite smaller samples of observation-minus-first-guess, bias correction coefficients computed for the limited area is more suitable and reliable when assimilating radiances in a LAM.

Section 3 describes the main characteristics of ALADIN/HU model and its assimilation system. Section 4 illustrates the local pre-processing of satellite data, and provides a short description of the bias correction method used in ALADIN/HU. Section 5 gives a detailed description of the experiments performed with various bias-correction files. Section 6 reviews the results of the experiments, and in section 7 we draw some conclusions from the results presented in this paper.

5.3.3 Main characteristics of the ALADIN/HU model and its assimilation system

At the Hungarian Meteorological Service (HMS) the ALADIN/HU model runs in its hydrostatic version. In this study we used the model with 12-km horizontal resolution (Fig.3b), and with 37 vertical levels from the surface up to 5 hPa. The three-dimensional variational data assimilation (3D-Var) was applied to assimilate both conventional (SYNOP and TEMP) and satellite (ATOVS) observations. As the variational technique computes the observational part of the cost function in the observation space, it is necessary to simulate radiances from the model fields. In ARPEGE/ALADIN we use the RTTOV radiative-transfer code, which has 43 vertical levels, to perform this transformation (Saunders et al. 1998). Above the top of the model, an extrapolation of

2 The integration of a limited-area model needs information about its lateral boundary conditions - the coupling files. In the case of ALADIN model, we use file from the global ARPEGE model, referred here as coupling model.

the profile is performed using a regression algorithm (Rabier et al., 2001). Below the top of the model, profiles are interpolated to RTTOV pressure levels. A good estimation of the background error covariance matrix is also essential for the variational technique to be successful. The background error covariance - the so-called "B" matrix - is computed using the standard NMC method (Parrish and Derber, 1992). Due to the problem related to the assimilation of specific humidity, it is assimilated in univariate form (see Randriamampianina and Szoták, 2003, for more details). The AMSU-A data are assimilated at 80 km resolution. The 3D-Var is running in 6-hour assimilation cycles generating an analysis at 00, 06, 12 and 18 UTC. We performed a 48-hour forecast once a day, from 00 UTC.

5.3.4 Pre-processing of satellite data

- **Selection**

The ATOVS data are received through our HRPT antenna and pre-processed with the AAPP (ATOVS and AVHRR Pre-processing Package) software package. We used AMSU-A, level 1-C radiances in our experiments.

For technical reasons our antenna is able to receive data only from two different satellites. To acquire the maximum amount of satellite observations we have chosen the NOAA-15 and the NOAA-16 ones, which have orbits perpendicular to each other and pass over the ALADIN/HU domain at about 06 and 18 UTC, and 00 and 12 UTC respectively.

For each assimilation time we used the satellite observations that were measured within ±3 hours. The number of paths over the ALADIN/HU domain within this 6-hour interval varies up to three.

- **Bias correction**

The direct assimilation of satellite measurements requires the correction of biases between the observed radiances and those simulated from the model first guess. These biases are calculated to estimate the systematic error of satellite data. It may be significant and arise mainly from instrument characteristics or inaccuracies in the radiative transfer model. In order to remove this systematic error we used the method developed by Harris and Kelly (2001).

5.3.5 Description of the experiments

The purpose of our experiments was to study the impact of different bias correction coefficients, including coefficients computed for the global ARPEGE model and for the ALADIN/HU limited-area model.

As ARPEGE uses every second pixel of ATOVS measurements, it has zero scan-angle coefficients at non-used pixels, which may cause a large remaining bias. To overcome this problem, we interpolated the values of two adjacent pixels to pixels with zero coefficients.

In order to estimate the impact of different bias correction coefficients we compared the scores of all experiments with the run performed with our bias correction file (specific for ALADIN/HU).

We investigated the impact of each experiment over a twenty-day period (18.04.2003-07.05.2003 - to be denoted as first period later on). In order to confirm our main results we reran some experiments for another fifteen-day period (20.02.2003-06.03.2003 - to be denoted as second period later on).

The following experiments were carried out, all using radiosonde (TEMP), surface (SYNOP) and ATOVS observations :

NT80U: The bias correction file was computed for the ALADIN/HU domain (this was the control run in this study).

T8B1I: The bias correction coefficients were computed for the ARPEGE model (interpolated scan-angle coefficients, see explanation above).

T8B2I: The scan-angle coefficients were the interpolated ARPEGE ones, but no air-mass correction was applied.

T8B3I: We used the interpolated ARPEGE scan-angle coefficients and the air-mass bias correction coefficients were computed for ALADIN/HU.

T8B4I: We used the scan-angle biases as well as the air-mass correction coefficients computed for ALADIN/HU, but for channels with tropospheric peak (channel 5, 6 and 7) air-mass correction coefficients were the ARPEGE ones.

NOT8U: The same as NT80U for the second period.

O8B1I: The same as T8B1I for the second period.

O8B3I: The same as T8B3I for the second period.

5.3.6 Results and discussion

In this study we have compared the impact of our bias correction coefficients with the impact of bias correction coefficients computed for the global ARPEGE model in order to find the best solution to the processing of the AMSU-A in the ALADIN/HU model. In the previous section we have presented the main characteristics of the performed experiments. The results could be classified as follows :

- **Comparison of biases using different bias-correction files**

Concerning the impact on biases in a temperature profile, we can emphasise that the use of bias coefficients for the global ARPEGE model (mentioned as global bias-correction file later on) have a cooling effect under 500 hPa and heating effect above this level (Fig. 4) compared to the control run. Unfortunately, our verification concerns only the levels below 100 hPa.

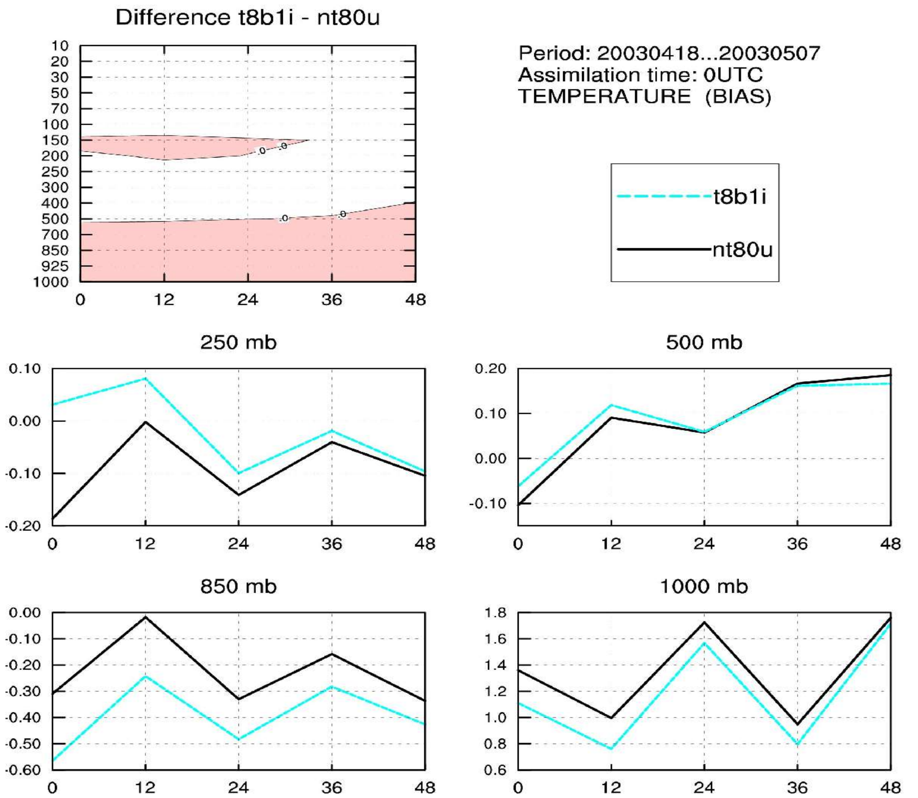


Figure 4.: Temperature biases for run with global (ARPEGE) bias correction coefficients (T8B1I) against run with LAM coefficients (NT80U) for the first period. In upper left picture we can see the difference between biases, where coloured area represents negative values.

- **Impact of the global bias correction file**

The ALADIN/HU model has different biases (positive or negative) in different layers of the model. The systematic cooling or heating does not necessarily yield an overall positive impact on temperature forecasts. For example, one can see a definite positive impact on temperature forecasts at 500 hPa during the second period, though there was a definite negative impact at 850 hPa during the first period (see Fig. 5). So, the behaviour of the limited-area model is not really "controllable" when we apply the global bias-correction file in the assimilation system to process satellite observations.

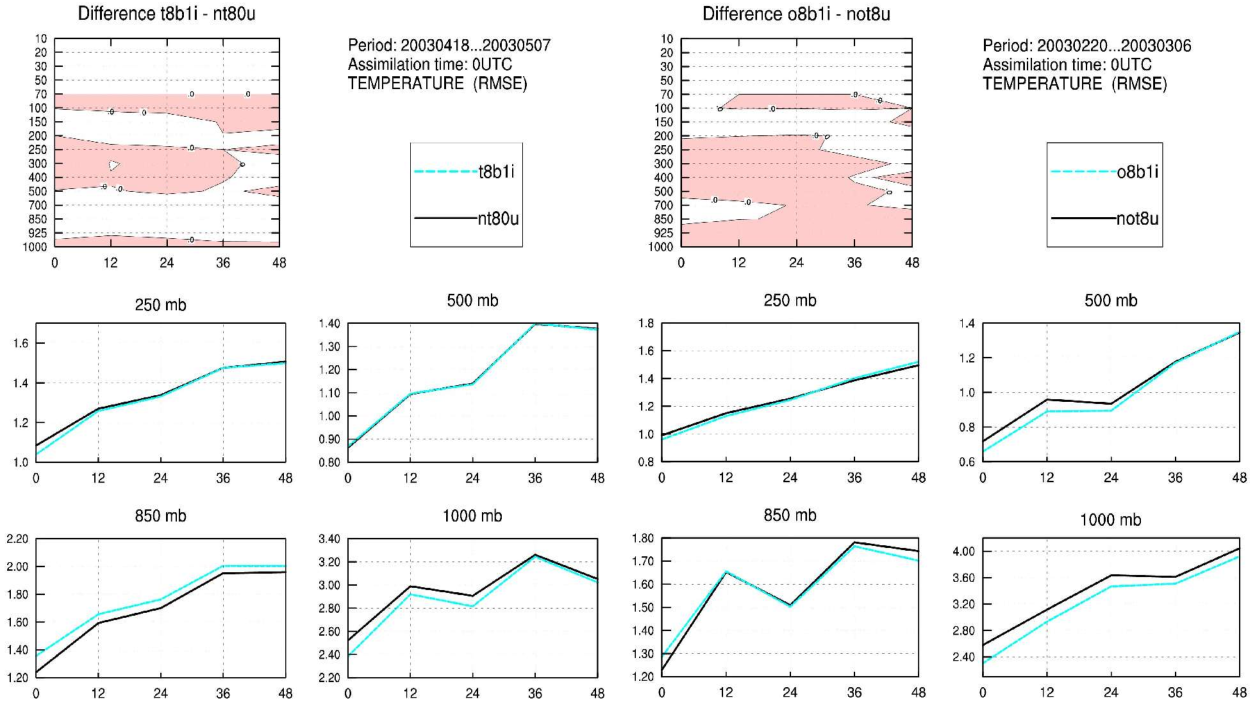


Figure 5.: Temperature root-mean-squares errors (RMSE) for run with global bias correction coefficients (ARPEGE) (T8B1I and O8B1I, for the first and the second period, respectively) against run with LAM coefficients (NT80U and NOT8U, for the first and the second period, respectively). In upper left picture we can see the difference between biases, where coloured area represents negative values.

- **Impact of no air-mass bias correction in the processing of AMSU-A**

It was an interesting question about bias correction whether the use of air-mass bias correction could be avoided in limited-area models or not. In order to assess the importance of air-mass bias correction, we did not apply air-mass correction in the experiment T8B2I, we used only the interpolated ARPEGE scan-angle bias correction. Without air-mass bias correction, satellite measurements warmed the model fields to a larger extent, which indicates that there was a residual bias in the temperature field shifted by satellite data (not shown). Accordingly, the verification scores showed a slightly negative or negligible impact on all variables, including temperature for which the positive impact completely disappeared (Fig. 6). It seems likely that we need air-mass bias correction to assimilate radiances, since the ARPEGE scan-angle bias correction itself was not satisfactory.

- **Combining the scan-angle bias correction of the global model with the air-mass bias coefficients of the LAM**

Based on the assumption that air-mass bias correction needs to be used, we combined the interpolated ARPEGE scan-angle bias correction with the ALADIN/HU air-mass bias correction in the experiment T8B3I. The combination of the global and the local bias correction coefficients showed structurally similar results to those of the experiment with only ARPEGE bias-correction file (see Fig. 5), but both negative and positive impacts were negligible (Fig. 7). This reveals that we cannot use the global scan-angle bias correction with LAM air-mass bias correction coefficients.

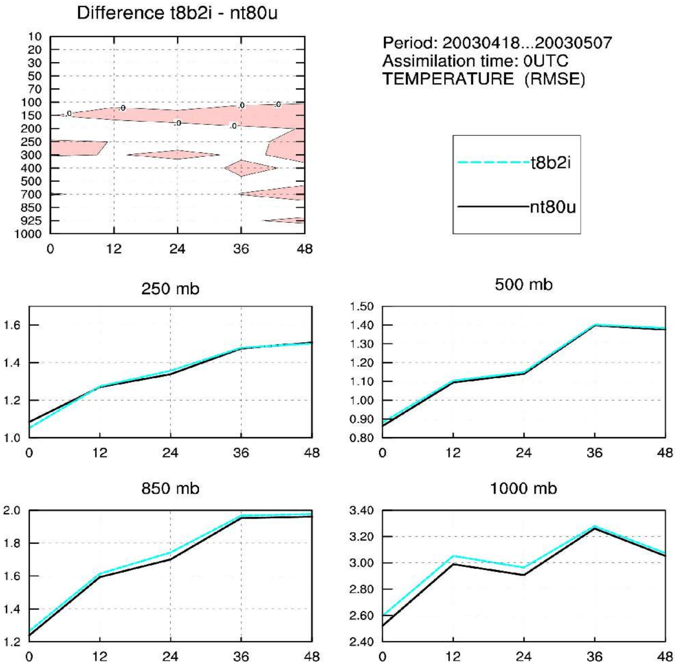


Figure 6.: Temperature root-mean-square errors (RMSE) for run with global bias correction coefficients (ARPEGE) (T802I - no air-mass bias correction) against run with LAM coefficients (NT80U), differences between them are illustrated in upper left picture, where coloured area presents negative values.

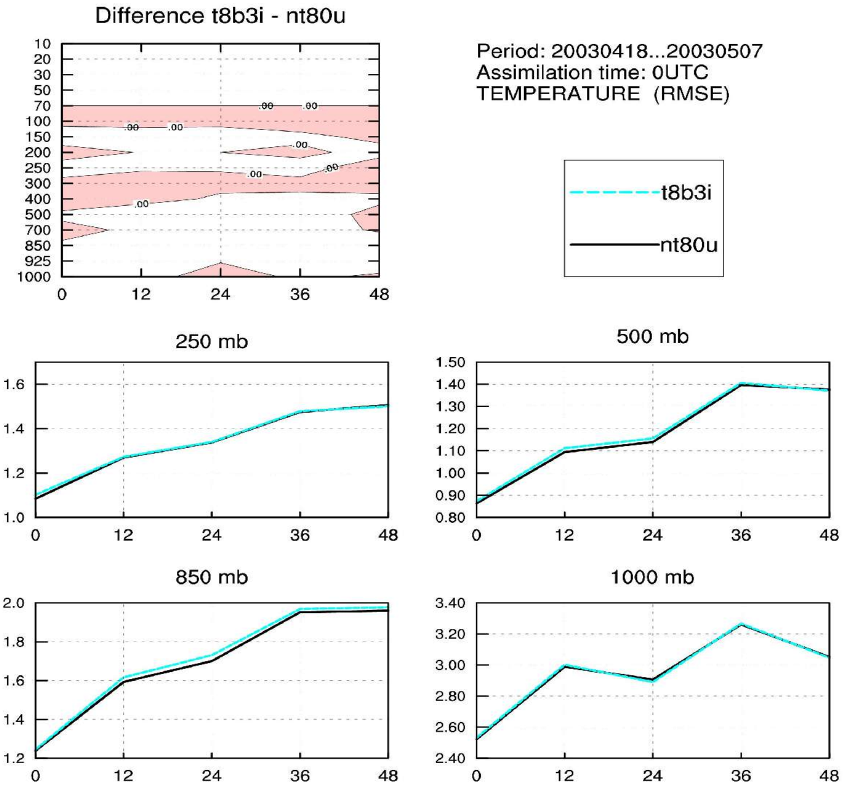


Figure 7.: Temperature root-mean-square errors (RMSE) for run with global (ARPEGE) scan-angle bias correction coefficients and with LAM air-mass bias correction coefficients (T803I) against run with LAM bias correction coefficients (NT80U). Upper left picture shows the difference between them, where coloured area presents negative values.

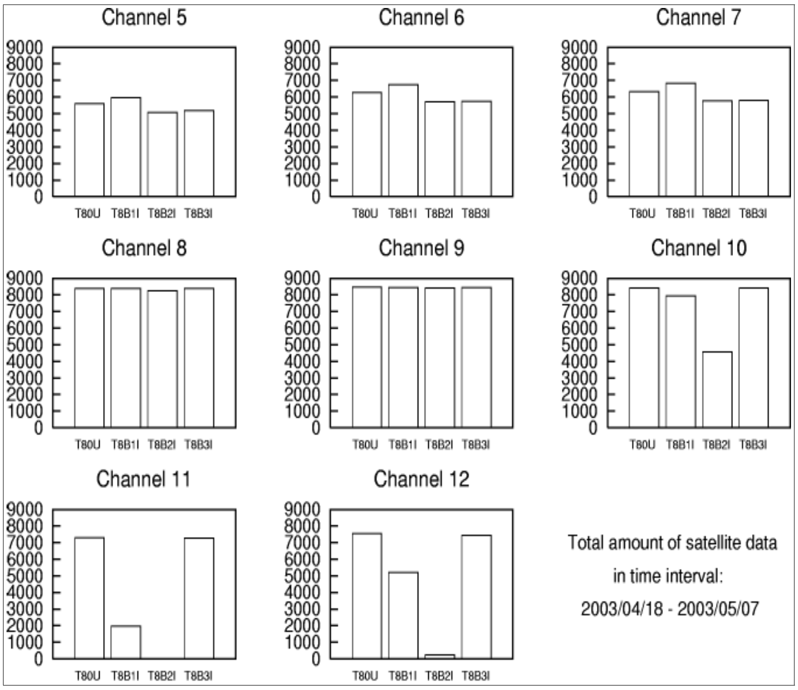


Figure 8: Total number of assimilated satellite observations (active data) for the period 18.04.2003 - 07.05.2003.

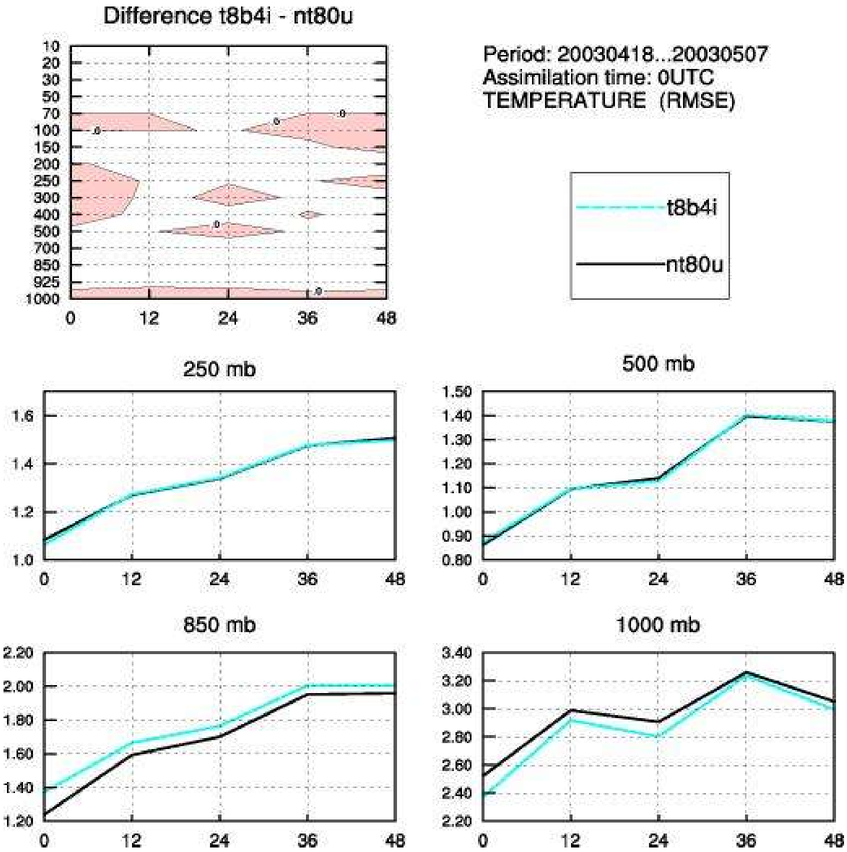


Figure 9.: Temperature root-mean-square errors (RMSE) run with LAM bias correction coefficients (NT80U) against run with LAM bias correction coefficients except the air-mass bias coefficients for AMSU-A channel 5, 6 and 7, which were the global (ARPEGE) ones (T804I). In upper left graph we can see the difference between theirRMSE, coloured area presents negative values.

Analysing the number of assimilated satellite data (Fig. 8), we can see the sensitivity of channels 5, 6, 7, 10, 11 and 12 to the bias-correction files. We were able to use more observations in the troposphere (channels 5, 6 and 7), while less data were used for channels 10, 11 and 12 when applying the global air-mass bias coefficients in data processing. Taking into account that using the global air-mass bias correction we had significant positive impact at 1000 hPa for both periods, we decided to make an additional experiment (T8B4I), where we replaced some of the coefficients for air-mass bias of the LAM bias file (for channels 5, 6 and 7) with those computed for the global model (Fig. 9.). We got a positive impact at 1000 hPa, but unfortunately, we could not remove the negative impact at 850 hPa.

5.3.7 Conclusions

This set of experiments shows the importance of bias correction coefficients in the processing of AMSU-A data in the ALADIN/HU limited-area model. We have to underline the fact that the ARPEGE and ALADIN models use basically the same parametrization of physical processes. Nevertheless, we have to compute the bias-correction file for ALADIN to have better processing of the AMSU-A data in the analysis system.

The air-mass bias correction must be included in the processing of AMSU-A data for the LAM.

The use of the global bias-correction file showed different impacts on short-range forecasts, especially in the lower troposphere which is very important for synoptic meteorology. LAM bias correction coefficients provide a "stable" impact on the analysis as well as on the short-range forecasts. Consequently, we decided to keep the LAM bias-correction file in the processing of AMSU-A data.

5.3.8 Acknowledgements

This paper was supported by János Bólyai Research Scholarship of the Hungarian Academy of Sciences.

5.3.9 References

Eyre, J. R., 1992 : A bias correction scheme for simulated TOVS brightness temperatures, *ECMWF Technical Memorandum*, **176**.

Harris, B. A., Kelly, G., 2001 : A satellite radiance-bias correction scheme for data assimilation, *Quarterly Journal of the Royal Meteorological Society*, **127**, 1453-1468

Parrish, D. F., Derber, J. C., 1992 : The National Meteorological Centre's spectral statistical interpolation analysis system, *Monthly Weather Review*, **120**, 1747-1763

Rabier, F., Randriamampianina, R., 2001 : Use of locally received ATOVS radiances in regional NWP, *NWP SAF report*, available at HMS

Randriamampianina, R., Szoták, R., 2003 : Impact of the ATOVS data on the Mesoscale ALADIN/HU Model, *ALADIN Newsletter 24*, available on-line at :
http://www.cnrm.meteo.fr/aladin/newsletters/newsletters.html

Saunders, R., Matricardi, M., Brunel, P., 1998 : An improved fast radiative transfer model for assimilation of satellite radiance observations, *Quarterly Journal of the Royal Meteorological Society*, **125**, 1407-1425

5.4. Radar Reflectivity Data Assimilation

Marián Jurašek *(SHMI)*, and Eric Wattrelot, Claude Fischer, Patrick Moll (*Météo-France)*

5.4.1 Summary

Development in NWP leads to high resolution models, which need more accurate initial conditions. In other words, high-resolution modelling needs high-resolution data assimilation. Classical observations such as SYNOP or TEMP have not enough density to catch e.g. local convection etc. Radar measurements provide a sufficient density of data, but this observation type is not implemented in the ARPEGE/ALADIN/AROME forecasting system yet. In this report, I will show our first steps in the implementation of radar reflectivity. I will introduce the prepared data-flow, followed by the first work done in implementation.

5.4.2 Data-flow for radar reflectivity

To have well-working radar-reflectivity assimilation, we have to pass the following three steps :

- pre-processing,
- screening,
- variational assimilation.

- **Pre-processing**

Radar reflectivity should be available from different radar sites in common BUFR format. For some radars we will have volume data divided to single elevations, for others only 2D data (one elevation or one product). BUFR file contains reflectivity values for each radar elevation defined on a 512x512 Cartesian/cone-shaped 1 km grid. BUFR file with the associated flag pixel values should be provided for each elevation as well. We have to be aware that the Nth pixel for each elevation of a radar have not the same (lat., lon.) location. The projection on the Cartesian cone-shaped grid is only *x=r*sin(azimuth)* and *y=r*cos(azimuth)* (*r* is distance on beam) at each elevation. That means, we can have significant differences in latitude and longitude between the lowest and the highest elevations for the Nth pixels. These BUFR files should be archived for future re-pre-processing in case of changes in model geometry or resolution.

In pre-processing, first quality check should be performed. What does it mean ? We should check wrong data, wrong beams, too noisy data and also occurrence of anomalous propagation or bright band or strong attenuation. Perhaps we will need some model fields for this preliminary check, e.g. temperature for bright-band check.

Next step in pre-processing should be "translation" to common, and "understandable" by the model, format for all radars. It means we should prepare ODB files. Here we will need other additional information about radar site, such as beam width in degrees, etc. Next, at least the following information should be stored in ODB :

- radar reflectivity (dBZ)
- horizontal position (degree)
- vertical position (m)
- vertical width of beam at observation point (m)
- elevation (degree)
- starting time of elevation (time)

Reflectivity data will be stored in ODB as pixel vertical reflectivity (PVR) messages - in vertical profiles (columns) of reflectivity for each point in radar horizon. Each radar should be processed separately. It can be very interesting to put some additional variable for each column, containing the cloud-top value from different sources than model, e.g. satellite observations. This can help in 1D-Var to set the maximal height where model column will be modified because of observed reflectivity.

Thinning of much more dense radar data (horizontal resolution 0.5 – 1 (2) km) should be performed here, because thinning in screening is very expensive (call for whole observation operator is performed). Radar data can be thinned only to the gridpoint. The nearest gridpoint is suggested, because it has no sense to mix different cloud types in averaging.

- **Data flow in screening**

In this part, it is supposed that we have radar-reflectivity data in ODB file and we are working with 4D screening to have access to required physical fields. The main aim of this section is to design a data-flow for reflectivity to obtain functional monitoring system for this observation type. That means, we need to have direct, one-way observation operator - just reflectivity simulator from model data. Reflectivity will be treated as other observations.

The specification of a new type of observation must be prepared and then a new table for this observation should be created in OBSTABS. We need to set all parameters for reflectivity processing. The new subroutine for setting can be called SURADAR and should be called from SUOBS as well. In the future, further settings necessary for radar Doppler wind measurement can be added to this subroutine.

For reflectivity simulation, we need to have some physical fields such as mixing ratio from hydrometeors (for rainwater and ice for ALADIN), information about hydrometeors' size distribution and dry air reference density and temperature. We need to define new GOMSNOW, GOMRAIN, etc. arrays in YOMMVO for these purposes. These arrays will be filled in MPOBSEQ subroutine from buffer. Buffer is filled in COBS and COBS is called from SCAN2MDM. Model data will be then horizontally interpolated to the observation point (SCAN2MDM -> COBSLAG -> OBSHOR -> SLINT).

In next step, under OBSV, vertical "interpolation" of model fields will be performed. We have to be more careful about this interpolation, because for some reflectivity observations we will need interpolation, but for the rest the average is necessary, depending on radar beam width at observation point.

For monitoring of reflectivity, a new subroutine REFLSIM for simulating reflectivity should be called from HOP. Then all the necessary values for *Jo* can be calculated and stored. In HOP, we must be as generic as possible, following the usual way as other observations are processed. All differences should be put into the subroutine REFLSIM to avoid problems of maintenance of HOP at ECMWF. This should be still consulted with ECMWF. It is important to have the reflectivity-simulating subroutine REFLSIM, because REFLSIM will be called from two different places : from HOP for monitoring and from HREFL for 1D-Var (see 2.3.1), otherwise the code will be duplicated.

Last step is to compute all statistics in subroutine SCREEN.

- **Variational assimilation**

Real assimilation of radar reflectivity will be done indirectly, in two steps. First, we need to retrieve T and q profiles from reflectivity profile. Second, these T and q profiles should be assimilated as a specific set of pseudo-TEMP or pseudo-SATEM observations.

Computation of (T, q) vertical profiles

Computation of T and q profiles will be performed in another step of screening and can be done in parallel with the monitoring described in section 2.2. For this purpose the 1D-Var method will be used.

Again, assuming 4D-screening (model is running with its physics), we have two possible solutions :

a) Save model physics and call 1D-Var retrieval from inside of observation operator for reflectivity HREFL, before HOP. This solution can be used for 3D screening as well, because physical fields can be read from external file.
b) Call 1D-Var retrieval from inside the model physics, through a specific interface. Below this interface, 1D-Var must also be able to call the reflectivity simulator and read adequate

information from ODB tables.

At the end of screening, the model reflectivity equivalent from monitoring as well as *T* and *q* profiles from 1D-Var retrieval are stored in the ODB tables.

Some observation error standard deviation σ_o must also be set for the 1D-Var retrieval. This could be derived from comparison of the retrieved profiles with usual data such as radiosondes.

Variational analysis

Configuration 131 will process 1D-retrieval (*T* and *q* profiles) from ODB most easily as a specific set of pseudo-TEMP or SATEM observations. During 1D-Var retrieval we can produce the whole profile of *T* and *q* (at all model level). Variational quality control (VarQC) can help to protect the whole NWP system to be not compromised by bad observations. The problem is that VarQC is implemented only for pseudo-TEMP observations.

Specific observation error standard deviation σ_o values are "assumed" in section 2.3.1

5.4.3 Status of implementation

Implementation of the new observation type for radar measurement started in CY28T0_T1. It is continuing with CY28T1.

- **Radar observation type**

After consultation with ECMWF, the radar observation as new observation type has got 13th position (NRADAR = 13). The 11th and 12th positions are already set for observation types used in Reading and should be available in next cycles (from CY28_R2). One subtype was defined for the radar : "BUFR RADAR REFLECTIVITY 1". The number of CMA variables was increased to 71 (NOVARIB = 71) and CMA number for radar reflectivity was set to 192 (NVNUMB(71) = 192). This value comes from the official BUFR code table.

- **Cost-function (*Jo*) modifications**

Due to the new observed quantity – radar reflectivity -, the number of variables in cost- function (JPXVAR) was increased and new NVAR_RFL = 26 was added to NVAR array as well as 'RFL' to CVAR_NAME. Whole data-flow for *Jo* was checked. Computation of *Jo* itself has been left general as for other observations. Missing part of Jo computation for radar reflectivity is now only error statistics. *Jo* values and other statistics will be stored in ODB as usual.

- **ODB**

For radar reflectivity, two new tables are designed in ODB : *radar_hdr* and *radar_body*. *Radar_hdr* contains basic information about observation, e.g. date, time, latitude, longitude, number of elevation, etc. *Radar_body* contains data from vertical column and is composed the following fields:

- **refl** : radar reflectivity (dBZ)
- **height** : vertical position (m)
- **width** : width of radar beam at observation point (m)
- **brange** : range of observation on beam (m)
- **elev** **:** elevation which the observation comes from (degree)
- **etime** **:** starting time of elevation

as well as standard fields for departures and statistics.

- **Observation operator**

The most important part for radar-reflectivity assimilation is the observation operator. The main part of the observation operator is a reflectivity simulator, which transforms model fields to reflectivity. This part is provided by people from Méso-NH team. Version from May 2004 is a quite complicated radar simulator, which simulates from the 3D model fields a whole volume radar measurement. There are two problems : first, we don't have the whole 3D model fields in that part where the observation operators are called from; second, the source code is in a different style than that we are using in ALADIN. It is necessary to rewrite this observation operator and extract the point reflectivity simulator only.

As it was mentioned before, reflectivity simulator should be called from two places, from HOP and from 1D-Var retrieval. Another problem is that all the necessary model fields are not available – mainly physical fields for the snow and the graupel. For this purpose we need to implement new GOM arrays. Because it is very complicated, this part is not done yet. We should decide whether to change idea of the GOM arrays - as it was done for GFL, or continue in the old way and spend lot of time first for implementation of new "GOMs" and then again in the future for new necessary arrays.

5.4.4 Conclusion

Development of radar reflectivity assimilation has already started. Lot of effort is already spent and much more work is still waiting for us. The progress in implementation brings new and new problems and we are forced to revise our first ideas. First neutral tests were performed to check if the whole system hasn't been badly affected by our modifications. Some problems were discovered, but they will be solved soon and at the end radar reflectivity assimilation will work properly and will help to improve model weather forecast.

5.5. Some facts about CY28T1

C. Fischer, P. Bénard, K. Yessad, E. Bazile and R. El Khatib *(Météo-France/CNRM/GMAP)*

5.5.1 Introduction

This is an updated version of the mail sent by Claude Fischer to several ALADIN correspondents on July 9th, 2004. But it is worth making some more advertising.

5.5.2 Duplicated routines (prepared by C. Fischer)

The following duplicated routines are now merged inside the ARPEGE code:
CNT3, SU0YOMA, SU0YOMB, CNT4TL, CNT4AD

Only CNT4 is still duplicated in cycle 28T1 (so AL28T1 version differs from CY28T1 one).

5.5.3 New data-flow (prepared by C. Fischer)

GFL and GMV/GMVS data structures now carry all prognostic or pseudo-historical variables through scan2mdm, and from one time-step to the next. Unlike the old gridpoint buffers (GPPBUF, GPP, GPUABUF), these gridpoint data are basically kept at the end of GP computations, and remain existent during spectral computations. However, time-steps are clearly separated, as are semi-implicit variables from the pseudo-advective ones.

Thus, we have for short:

- U/V/T/Ps/PD/VD in GMV/GMVS structure. "VDAUX" also is there, in a bit hybrid form. GMV contains t0 and t9 data, plus horizontal derivatives. In addition, there is a GMVT1 for updated data at the end of scan2mdm and a GMVT5 for trajectory data. GMVS contains the surface 2D variables (mostly: Ps and derivatives and time levels).
- Q, O3, Ice, Cloud fraction of EC scheme, new variables for ALARO/AROME (cloud liquid water, TKE, graupels, cloud ice, etc...) as well as pseudo-historical variables from the physics are stored inside another structure: "GFL". GFL also contains t0/t9, plus derivatives. In addition, there is a GFLT1 (updates) and a GFLT5 (trajectory). Furthermore, GFL does have a flexible (yet not always totally debugged ....) data layout, using a list of attributes that are defined at setup stage and tell the IFS how the GFL variable is treated. For instance, you can create a GFL variable that would not have horizontal derivatives, no trajectory and no coupling in the LAM.

I refer to Mats' documentation for the details. There is no "GFLS" (surface fields in GP space are kept in GPPBUF).Another good documentation is Martina's technical report about the inclusion of pseudo-historical variables in GFL.

Reported/encountered bugs in CY28 and due to the "youth" of the GMV/GFL:

- new GFL variables are better defined by asking a "trajectory" component. Our TL/AD models crash due to bad addressing if a new variable is created in the T0 structure, but no T5 counterpart is defined (both timestamps use the same pointers, as Mats has supposed the T5 would be basically a copy of the T0). This problem is of course not seen if only conf 001 is run.
- the SL interpolations were bugged for specific keys (LVECADIN) when a new GFL non-advective variable was created. This bug should be fixed in CY28T1, thanks to the efficient advices of Clive T.

5.5.4 Code cleaning and explicit interfaces (prepared by C. Fischer)

From CY28 onwards, the code of the IFS, including "arp" and "ald" projects, but not "tfl" and "tal" for instance, should follow the new coding standards that have been agreed and enforced commonly by ECMWF and Meteo-France.

There are some automatic tools to verify the compliance of any piece of code with respect to the new standards, but the best is to be aware of it, to read a bit Ryad's documentation, and to follow the coding style as you see it in CY28.

Explicit interfaces have been enforced in the IFS for CY28. They are mandatory in Reading and Toulouse. The principle is that any called routine has its interface declared in the calling one (#include toto.intfb.h) and this interface is automatically generated and introduced in-line at compilation (thus gmkpack for Toulouse). This is one reason why "gmkpack.5.3" should be used to create packs. An earlier version would fail.

Interfaces are only mandatory for "arp" and "ald" routines. ARPEGE and the IFS run with dummy interfaces for ALADIN routines called from there. Of course, an ALADIN pack/binary should have all its interfaces provided.

For CY28T1, we have organised the work such that the explicit interfaces are not yet mandatory for remote installations. Thus, partner Centres can install CY28T1 without taking care of them, and it is possible to generate dummy interface blocks in order to compile properly the code. From CY29 onwards, we will not guarantee any more this possibility, and thus by end of 2004, everybody should be ready at home to install a source code which will be more demanding from F90 compilation point of view (more strict about interface consistency including type declarations, array shapes, intents, number of arguments ...).

5.5.5 New set up for horizontal diffusion - 1 (prepared by P. Bénard)

Here is a small explanation about the piece of code concerning the new set-up of the Horizontal Diffusion (HD).

- **Spirit**

The spirit of the new set-up is that the coefficients HDIR* do not belong any longer to namelists (NAMDYN) but are computed through a minimal set of information, via 2 new variables set by NAMDYN :

- RRDXTAU: the absolute strength of the diffusion
- RDAMPDIV: the ratio for HD of divergence compared to other variables

The HDIR* variables still exist, but as internal variables which are computed internally, using other informations about the configuration being run currently (truncation,...).

- **Defaults**

The new set-up of default value for ECMWF is as follows:

- If LNEWHD =.F., then the default HDIR∗ (i.e. as activated for a void namelist) are determined according to the old step-function hard-coded in the old set-up.

- If LNEWHD =.T., then the default HDIR* (i.e. as activated for a void namelist) are determined by a formula which gives a strength equal to the last current one at T799 (HDIR* =1200. for a T799) and which diffusion coefficient is proportional to $\Delta x^{(r-1)}$ where *r* is the order of the diffusion and Δx is the grid-length, as desirable according to the documentation of new HD.

- **Non-default**

In case you want to modify the HD in a way not provided by the two above defaults, the method is to specify RRDXTAU and RDAMPDIV.

The formula is:

ARPEGE:

$$\text{HDIRVOR} = \frac{\pi}{\text{RRDXTAU}} \frac{a}{N} \quad ; \quad \text{HDIRDIV} = \frac{\text{HDIRVOR}}{\text{RDAMPDIV}}$$

where

a is the earth radius (in meters) and *N* the spectral truncation.

ALADIN:

$$\text{HDIRVOR} = \frac{\sqrt{1/2\ (\Delta x^2+\Delta y^2)}}{\text{RRDXTAU}} \quad ; \quad \text{HDIRDIV} = \frac{\text{HDIRVOR}}{\text{RDAMPDIV}}$$

where

Δx = grid-mesh in X direction (EDELX)

Δy = grid-mesh in Y direction (EDELY)

The obtained HDIR* are then printed in the listing. If the printed HDIR* do not correspond to your expectations then you can modify RRDXTAU accordingly, in order to obtain the wished values for HDIR*. Note that HDIR* is proportional to (1/RRDXTAU).

N.B.: The new HD is less flexible than the old one in the sense that only two strengths can be specified (i.e. the so-called DIV and the VOR strengths). However, the possibility of more various strengths had not been used for many years, and could be re-established in subsequent cycles in case of strong (although unlikely I presume) demand.

5.5.6 New set up for horizontal diffusion - 2 (prepared by K.Yessad)

Practical impact on namelists, valid for both cycles CY28T0 (for validation purposes if any) and CY28T1 (for the export/operational versions).

- **ARPEGE CY28T0:**

- HDIR∗, HDUR∗, REXPDH, REXPDHU removed from namelists (NAMDYN)
- parameter RRDXTAU should not appear in namelists
- in NAMCT0: NOPGMR=0 if no stretching, NOPGMR=2 if stretching
- in NAMDYNA: LNEWHDU=T only for stretched geometry

- **ALADIN AL28T0:**

- HDIR*, HDUR*, REXPDH, REXPDHU removed from namelists (NAMDYN)
- RRDXTAU should be set in namelist NAMDYN (e.g. set to 123. for ALADIN/France) for comparisons with AL28T1 (different default computation in both cycles)
- NOPGMR, LNEWHDU not needed in namelists (default values ok)

- **ARPEGE CY28T1 and ALADIN AL28T1:**

- parameters HDIR*, HDUR*, REXPDH, REXPDHU, RRDXTAU, NOPGMR, LNEWHDU, and RDAMPDIV, should not appear any more in namelists : either their default values are ok, or they have disappeared.

- **Caution:**

One always should have :

REXPDH=4,
HDIRVOR=HDIRT=HDIRQ=5*HDIRDIV

- 5. is the default value of RDAMPDIV
- HDIRDIV being always truncated to the nearest integer)

5.5.7 New set up for semi-implicit (prepared by K.Yessad)

As far as the semi-implicit scheme is concerned:

- **ARPEGE CY28T0:**

- set LSIDG=F in NAMCT0 in non stretched geometry
- set LSIDG=T in NAMCT0 in stretched geometry

- **ALADIN AL28T0:**

- set LSIDG=F in NAMCT0.

- **ARPEGE CY28T1 and ALADIN AL28T1:**

- parameter LSIDG is removed from namelist; it is replaced by another variable which is not in namelist but automatically computed in SUDYN.

5.5.8 Changes in the physics (prepared by E. Bazile)

On the side of physics, there were a number of changes that could be "traced-back" by a thorough survey of the Toulouse "oper" and "dbl" suites. The basic physics for AL28T1 follow those of our present operational version CY26T1_op6.

Below, Eric has listed the main differences, including those that cause an irreversible change in the code, which means that Aladinists who are doing development on the physics on the last export versions (AL25T1 or possibly "wild" versions of AL26T1) have to be careful and possibly phase their modset:

- **New routine:**

ACMIXLENZ.F90 : externalization of the computation of the mixing length for momentum and heat (before performed inside ACCOEFK.F90), no scientific change.

- **Modified routines:**

ACHMT.F90 :

- minimum value of the wind shear depends of the depth of the layer (ZEPS1=1.E-4 replaced by GCISMIN*PDPHIV/RG with GCSMIN=6.7E-05) no reproducibility (J.M. Piriou)
- New parameter EDK in the function F_m and F_h for the stable case (default=1 reproduces exactly the previous version) (E. Bazile)
- **Warning**: The correction for the anti-fibrillation scheme for EDK and for USURID=0 will be available in CY28T2.

ACCLPH.F90 :

- Wind gusts in case of LRAFTUR=.F. (M. Bellus) only output (no impact)

ACCOEFK.F90 :

- New input PLMU, PLMT : mixing length (computed in *acmixlenz.F90*)
- minimum value of the wind shear depends of the depth of the layer (ZEPS1=1.E-4 replaced by GCISMIN*PDPHIV/RG with GCSMIN=6.7E-05), no reproducibility (J.M. Piriou)
- New parameter EDK in the function F_m and F_h for the stable case(default=1 reproduces exactly the previous version) (E. Bazile)
- Correction of a "required bug" (for reason of computer time saving see the History of the operational PBL ECMWF seminar by JFG) in the function F_h in unstable case (λ_m^2 replaced by $\lambda_m \times \lambda_u$) very small impact. (E. Bazile and thanks to A. Simon)
- **Warning**: The correction for the anti-fibrillation scheme for EDK and for USURID=0 will be available in CY28T2.

ACRANEB.F90 :

(for more information please contact J.F. Geleyn)

- LREWS = exact computation of exchange with the surface
- LRPROX = F new development done by JFG
- with LREWS=F no exact reproducibility

ACNEBN.F90 :

- change definition for PQLI and PQICE: they become grid size values
- **Warning**: modification in APLPAR (Y. Bouteloup and J.M. Piriou)
- substitution of QSUSX by QSUSXC (convective part) and QSUSXS (stratiform part). (F.

Bouyssel)

- No impact with QSUSXC=QSUSXS with the value of QSUSX

ACDIFUS.F90 :

- New input LDZ0H and PGZ0HF: only for output to be fully consistent with PGZ0F. (F. Bouyssel)
- NCHSP : modification of the deep soil heat transfer in presence of snow (default=0 no impact). (E. Bazile)

ACCVIMP.F90 and ACCVIMPD.F90 :

Security for crazy case with Tw > T (very small impact)

5.5.9 Later corrections (prepared by R. El Khatib)

- ✔ ald/setup/SUEGEO1.F90 :
  important bugfix on non-initialized RNLGINC in ALADIN (ref : JF Geleyn)
- ✔ arp/utility/MAXGPFV.F90 :
  bugfix for portability on Full-Pos 1 processor on IBM (ref : JF Estrade)
- ✔ ald/dia/EWRIMOVA.F90 :
  bugfix for portability (ref : F. Vana)
- ✔ ald/setup/SUEGEO2.F90 :
  bugfix for OPEN-MP (ref : D. Paradis)
- ✔ ald/transform/EUVGEOVD.F90 :
  bugfix for OPEN-MP (ref : D. Paradis)
- ✔ arp/setup/SUAFN1.F90 :
  bugfix for portability (ref : Y. Wang)
- ✔ arp/control/GP_MODEL.F90 :
  bugfix for portability concerning DFI (ref : L. Kullmann)
- ✔ ald/c9xx/EBICLI.F90 :
  bugfix for ALADIN e923, from cycle 28T0 only (ref: R. El Khatib)
- ✔ arp/control/RERESF.F90 :
  major bugfix for ARPEGE restart mechanism (ref: R. El Khatib)
- ✔ arp/utility/WRRESF.F90 :
  minor bugfix for ARPEGE restart mechanism (ref: R. El Khatib)

All these modifications should enter the next export version.

5.6. Some details about ALADIN physics in cycle 28T1

Jean-François Geleyn et al.

5.6.1 Introduction

This document is a kind of users guide for the CY28T1 physics, in the spirit of the forthcoming ALADIN-2 evolutions that will lead to a more and more pronounced separation from the ARPEGE physics.

5.6.2 Convection

Together with a protection for the case $T_w > T$ in *ACCVIMP* and *ACCVIMPD*, a new tuning parameter was introduced in order to prevent any convective cloud lower down to trigger another one higher up in a non physical manner across some rather deep stable and/or dry layer (and the same upside down in *ACCVIMPD*). It is called RCIN. The (non-active) default is RCIN=0 and it indeed corresponds only to the small modifications of the results for the above-mentioned “protection” against a stupid situation. With RCIN=1, some slight improvement was found at CHMI on the “Black-Sea case” with the MFSTEP early set-up. Higher values of RCIN would probably be non physical. Anything between 0 and 1 may be tried but the sensitivity is of course small. All this was first detected by Jean-Marcel Piriou.

5.6.3 Stability

In the work of Martina Tudor on stiffness and/or non-linear instability, it was found that the default value of REVGSL (ratio of the fall speeds of rain and snow) at 80 was indeed favouring fibrillations around 0 °C (something detected years ago by George Ganev and never explained since). The new recommended compromise value is REVGSL=15. It does not completely suppresses the syndrome but values reaching that other goal (around 4) are indeed physically too small.

5.6.4 Orographic forcing

The 28T1 export version contains a new version of the *ACDRAG* code (with revised dependencies of the drag on the Froude number -to be activated by LNEWD in *NAMPHY*- and a lift orthogonal to the geostrophic wind and not any more to the real wind -to be activated by LGLT in *NAMPHY*-, see the presentation of Bart Catry in the proceedings of the 14th ALADIN workshop, http://www.zamg.ac.at/workshop2004/). The default namelist values indeed give back the present operational situation but the team working on the topic (François Bouyssel, Radmila Brozkova, Bart Catry, Maria Derkova, Dunja Drvar, Richard Mladek and Jean-François Geleyn) believes that there is now an occasion of getting rid of the envelope orography. When doing so, the following namelist values in *NAMPHY* and *NAMPHY0* are the highly recommended ones :

LNEWD=.TRUE., LGLT=.TRUE.,
GWDSE=0.02, GWDCD=5.4, GWDLT=1., GWDPROF=1., GWDVALI=0.5
(GWDAMP, GWDBC and HOBST remain unchanged).

Several advantages of this envelope disappearance and drag/lift improvement have been diagnosed (more realistic flow around the mountain ranges, better wind scores at 850 hPa and around, less upwind exaggerated precipitations on mountain flanks unfortunately without any shift in position, increased compatibility with the theory of sub-grid mountainous forcing, ...) but there are also some disadvantages (too weak 10 m winds near mountains, decreased foehn effect that was apparently well tuned before, slightly negative upper-air geopotential scores, ...). Everybody ought to make up its mind on the balance of its own experiments, but, in the preparation of the ALARO future work, it is clear that envelope orography has to disappear someday from our recommended version. AROME will indeed have neither envelope nor any need of a drag/lift parametrisation because of its sufficient horizontal resolution; so compatibility requires that the parametrisation at scales where we still need it -down to about 5km according to tests of Bart Catry- be a version tuned without envelope.

5.6.5 Radiation

Radiation is surely the most complex issue with respect to the 28T1 export version.

Using LREWS=.TRUE. is absolutely necessary for any version of *ACRANEB*.

The operational code in ARPEGE and ALADIN-France is not any more *ACRANEB* but FMR15 (a former version used at ECMWF and maintained since in Toulouse by the ARPEGE-Climat team of GMGEC). Since the FMR15 code is far more expensive than *ACRANEB_oper* (but more exact of course) it has to be called with a reduced frequency and some time extrapolation is then used in between for "classical" time-steps. Scores indicate a strong improvement with respect to the previous operational situation in the upper part of the atmosphere (from 400 hPa onwards) and some small induced benefits below. Partners wanting to use this option should contact Yves Bouteloup. Planned enhancements are now the use of ozone and aerosols 2d fields with monthly climatologies (already in parallel suite).

There exist now a version of *ACRANEB* (more expensive than the old one but still in reasonable proportions) that completely modifies the thermal computations and that improves the scores roughly like FMR15with respect to the *old ACRANEB*. This version can in principle be used in two modes :
(i) the so-called “statistical” one for which one continues to have a “basic” call at each time-step;
(ii) the “self-learning” one (LRAUTOEV=.TRUE.) where some chosen time-steps are far more expensive but help to better tune the “classical” ones used in-between (which also become a bit cheaper).

This development was undertaken with AROME and ALARO in mind and the current guess is that solution (i) will be appropriate for ALARO-10, solution (ii) for AROME, and that we do not yet know the transition scale. Note however that the mechanism for storage/re-use of information between expensive and half-cheap time-steps in option (ii) has not yet been coded so that this choice is far from pre-operational status (it can be used at all time-steps but is then very expensive). All related developments were discussed, prepared and tested by Pierre Bénard, Yves Bouteloup, Radmila Brozkova, Maria Derkova, Richard Fournier, Gwenaëlle Hello, Neva Pristov, Mikhail Tolstykh and Jean-François Geleyn.

Concerning the availability of this *ACRANEB_new* code, an intermediate version is already present in the export version 28T1. It is sufficient to set LRMIX=.TRUE., LRPROX=.TRUE. and LRSTAB=.TRUE. in *NAMPHY* for activating it (the first of the three switches carries nearly all the CPU overhead with itself, but it is also the one that makes the results most alike those of FMR15). This set-up has most but not all advantages of the new solution. People wanting to have the full version can contact Jean-François Geleyn and they will get a “transparent to use” ASCII file for that purpose. Note that the additional switches LRTDL=.TRUE. and LRTPP=.TRUE. are also to be activated, with a little further extra expense for the first of these two new switches, that are still hard-coded in CY28T2, the intermediate cycle corresponding to the present parallel suite in Toulouse. The above-mentioned enhancements in FMR15 will be phased with this “new-new” version but not any more with the old ones of *ACRANEB*, which results can anyhow be retrieved when all above-mentioned switches are let to .FALSE., except LREWS of course.

A few experiments made by Maria Derkova and Radmila Brozkova seem to indicate that the compatibility in the radiative forcing between ARPEGE and ALADIN has some positive impact on scores (LRMIX=.TRUE. only improves the ALADIN scores after the end of May when the operational switch to FMR15 for ARPEGE happened in Toulouse). It is therefore strongly recommended to switch as soon as possible either to the FMR15 or to the *ACRANEB_new* options. For those wanting to do the latter even before going to 28T1, there exists a tested version of the *ACRANEB_new_new* code phased with CY25T1 (and compatible with CY26) that Jean-François Geleyn can distribute to people ready to do a bit of interfacing.

For the comparison between FMR15 and the full new version of *ACRANEB* (in its "statistical" full version) the results were first rather neutral (and contradictory between geopotential and temperature). It then turned out that FMR15 was implicitly using an option of random-maximum-overlap of clouds rather than the random-overlap version presently used in all *ACRANEB* applications. A test in ARPEGE then showed that (probably especially with the recent cloudiness tuning of *ACNEBN* and *ACNEBXRS*) using the same option in *ACRANEB* (i.e. activating the ever-sleeping switch LRNUMX=.TRUE.; beware, the “MX” indeed means “random-maximum” and not ”maximum-only") was improving all aspects of the radiative forcing (surface and upper-air). With this, the results of *ACRANEB* in its full new version are now slightly but consistently better than those of FMR15. Therefore, even for people wanting to stick to the current *ACRANEB* options (for reasons of CPU cost) the use of LRNUMX=.TRUE. is rather mandatory if one wishes to benefit from the cloudiness structure improvement coming from COCONUT and from the recent retuning made in Toulouse (so-called Xu-Randall cloud schemes). This activation of the random-maximum option (also automatically present in the cloudiness diagnostic and obligatory with FMR15 for the sole diagnostic part) is more expensive for the cost of *ACRANEB* but the benefits are here unambiguous.

Neither of the two solutions (FMR15 and *ACRANEB_new_new*) is definitive. The former is frozen by construction so that a replacement by RRTM (the current ECMWF operational solution) is envisaged, if one sticks to the strategy of two completely different types of time-steps. *ACRANEB_new_new* should for itself be improved in two directions: first the incorporation of a Voigt parametrisation for upper stratospheric and mesospheric levels (little interest for ALADIN though); second a better tuning of the gaseous transmission functions to get them closer to the RRTM ones. The latter step is supposed to even further increase the benefits of the 'statistical' mode at equal costs. After that, two ALARO-bound developments should take place: (A) separating the code into three parts ((a) gaseous transmission functions, with a hierarchy of expense-versus-accuracy solutions; (b) model for "grey" properties, i.e. clouds, aerosols, etc.; (c) the "solver" like in *ACRANEB_new_new* but with both its "modes" then at an equal level of maintenance) and (B) refining the strategy of use of the "self-learning" mode.

5.6.6 Cloudiness

The cloudiness issue has already been mentioned in the part about radiation. Seen from the climatological point of view, the zonal mean distributions of cloudiness and cloud content are far better than the ones previous to the change linked with COCONUT. But the problem is the too much zero-one character of the cloudiness "seen from above". The recent changes (available in the 28T1 export version) do improve the situation as well as the use of LRNUMX=.TRUE. .

Recently Thomas Haiden proposed to strongly modify the vertical profile of critical relative humidity in order to get medium and high clouds starting to appear at lower relative humidity values. This change taken alone would create far too much cloudiness. The proposal of Thomas in order to counteract this effect is to strongly reduce both the relative humidity ceiling QXRHX in input to the Xu-Randall computations and the QXRAL constant linking cloud content and cloud cover. While the former seems acceptable, the latter of these tunings surely goes against observations and may lead to problems in radiative computations (too optically thick clouds while we already have too much solar optical depth, an independent problem). François Bouyssel, Radmila Brozkova, Ales Farda and Jean-François Geleyn are currently investigating whether one can take the "published" Xu-Randall values and a critical humidity curve close to Thomas' results as a basic "truth" and tune a smooth formulation replacing the relative humidity ceiling QXRHX as well as the constant QSSUSV (that already replaced the QSSHUS of COCONUT). Current problems are too thick mid-level clouds in the tropics and rather too little amounts of low level high latitude clouds (again, alas).

The following changes were also introduced in *ACNEBN*. First the definition of the PQLI and PQICE variables changed. They now correspond to values averaged over the whole grid-size, no longer to the cloud fraction. Warning : *APLPAR* was modified accordingly (Yves Bouteloup and Jean-Marcel Piriou). Second there is a distinction between convective and stratiform maximum condensed (liquid + ice) water contents at the grid-point scale : QSUSX is replaced by QSUSXC (convective part) and QSUSXS (stratiform part), with no impact when "QSUSXC=QSUSXS with the value of QSUSX"(François Bouyssel).

5.6.7 Changes in vertical diffusion

The computation of the mixing lengths for momentum and heat (previously performed inside *ACCOEFK*) is now done in a dedicated routine (*ACMIXLENZ*), to allow an easy implementation of new formulations, like interactive mixing-lengths based on Tron and Mahrt or "Ayotte" PBL heights. No scientific change by default. (Eric Bazile)

The minimum value of the wind-shear (*ACHMT* and *ACCOEFK*) now depends on the depth of the layer (not any more a constant), in order to remove a dependency on vertical resolution. (ZEPS1=1.E-4 replaced by GCISMIN*PDPHIV/RG with GCSMIN=6.7E-05). There is no reproducibility, but since the tuning of GCISMIN has been done according to the previous situation, the impact is very small. (Jean-Marcel Piriou)

A new namelist parameter (EDK) has been introduced in the Louis functions F_m and F_h in stable conditions in order to reduce turbulent mixing (*ACHMT* and *ACCOEFK*). The default value (EDK=1) reproduces exactly the previous version. Be careful, some corrections of the anti-fibrillation scheme for EDK≠1 and/or for USURID=0 are necessary that are available only in CY28T2. (Eric Bazile)

The correction of a "required bug" (for reason of computer time-saving see the "History of the operational PBL", ECMWF seminar by Jean-François Geleyn) was done in the Louis' function F_h in unstable case (*ACCOEFK*). The impact is very small. (Eric Bazile and Andre Simon)

The thermal and dynamical roughness lengths are computed at each time-step over sea, but what was saved in historical files was th historical value for the dynamical roughness-length and the climatological value for the thermal roughness-length. The same treatment is now performed for both, the historical values are saved (*ACDIFUS*). (François Bouyssel)

A modification of the deep soil heat transfer in presence of snow was introduced. The default value (NCHSP=0) reproduces the previous situation (*ACDIFUS*). (Eric Bazile)

5.6.8 MFSTEP set-up

It is mentioned here because it has been the basis of many of the above-mentioned trials. Furthermore it contains some other choices that will be listed below, for completeness:

* activation of the 'moist gustiness option' developed by Martin Bellus (LRGUST=.TRUE. with RRSCALE=1.15E-04, RRGAMMA=0.8 and UTILGUST=0.125);

* computation, over sea, of a roughness length for heat and moisture that, while remaining close to the one for momentum at small surface wind values, saturates far earlier for strong winds (like suggested by observations); this did not enter CY28T1 for reasons of interaction with the data assimilation (10 m winds); for pure forecasting purposes a version of the code exists on CY25T1_op4 but probably needs a lot of attention to be merged with any other cycle; a "diff" in the same spirit will soon be prepared with respect to the export 28T1 version and interested people can contact me, but handling this piece of code will still require a lot of care, given the planned evolutions of *ACHMT* and *ACDIFUS* (mixing lengths, anti-fibrillation, EDK, etc., see Eric's documentation);

* some specific tunings: RCIN=1., GCSMIN=5.5E-04, REVGSL=15.;

* activation of the SLHD option for the horizontal diffusion processes. This is at the limit between physics and dynamics and interested people should contact Filip Vana for details.

The "frozen" MFSTEP set-up to be delivered for 1/9/04 (start of the so-called TOP period) will contain the four above elements, the removal of the envelope and its replacement by the new drag/lift tuning, the *new_new ACRABEB* (except LRMIX, since it has little impact on surface fluxes and in the lower troposphere) with LRNUMX=.T. and a preliminary version of the cloudiness computations inspired by the HUC proposal of Thomas (no tuning of QSSUSV yet, since it is mostly a tropical problem). This version will very probably be alike the operational one of ALADIN-CE in Prague (apart from mesh-size and LRMIX) at the said date, but the latter will not be frozen, of course, especially concerning low-level cloudiness.

5.7. ALADIN and GMKPACK at ECMWF

Ryad El Khatib *(Météo-France/CNRM/GMAP)*

5.7.1 Introduction

This is a short report of my work to port the ALADIN libraries of cycle 28T1 on IBM at ECMWF (*hpca*) with the help of ***gmkpack*.5.5** : more complete than the mail sent on July 21st, but without the joint pieces.

5.7.2 Explicit interface blocks:

Note that cycle 28T1 use auto-generated explicit interface blocks for the F90 procedures in the project *arp* and *ald*. They appear as included files suffixed "`.intfb.h`" in the source code. You can possibly ignore they in cycle 28T1, having dummy empty files instead. But this will not be possible in the next cycles because of the further code cleanings programmed for cycle 29 and the enhancements allowed by the use of these explicit interface blocks.

Some scripts were sent by e-mail, written by Mats Hamrud (Perl scripts) and slightly adapted by myself, and actually used in ***gmkpack*.5.5** to generate these explicit interface blocks :

- *Fortran90_stuff.pm* : Perl module used in the Perl scripts
- *make_intfbl.pl* : interface generator
- *my_check_inc_intfb.pl* : included-interfaces checker
- *my_check_norm.pl* : norms checker

All interfaces are supposed to be generated before starting the compilation in order to enable the use of the included-interfaces checker.

In addition you will find the "korn shell" scripts used in ***gmkpack*** to plug the above scripts :

- *mkintfb.sh* : wrapper of *make_intfbl.pl*
- *intfbF90.sh* : wrapper of checkers and F90 compiler

I have not tested them on other platforms than Fujitsu and IBM.

5.7.3 Compilation:

First of all if you are not on a VPP machine you must exclude from the compilation the following subroutines :

- ✔ `xrd/not_used/minv.vpp.F`
- ✔ `xrd/not_used/sgemmx.vpp.F`

I hope that in the next release they will really be removed !!

In this cycle a huge number of useless subroutines have been removed. But the *xrd* library in this package is not yet ready for use on other platforms than IBM or VPP : we still have to compound this *xrd* with the one in PALADIN.

All the source code compiles alright on Fujitsu and IBM.

However if you exclude *odb*, *coh*, *ost* and *sat* projects you should have the following headers available as dummy files (in ***gmkpack*** directory *unsxref/quiet*) to achieve the compilation :

- ✔ `abortdb.h`
- ✔ `bool_setparam_obsort.h`
- ✔ `closedb.h`
- ✔ `getdb.h`
- ✔ `int_setparam_obsort.h`
- ✔ `opendb.h`
- ✔ `putdb.h`
- ✔ `shuffle_odb.h`
- ✔ `storedb.h`

- ✔ `swapoutdb.h`

5.7.4 Links:

To solve all the links you should have the following routines defined as dummies, in **g*mkpack*** directory *unsxref/verbose* :

- **Dummies which are machine-dependent:**

- ✔ `util_cputime`
- ✔ `getstackusage` (may also be set in *unsxref/quiet*)

- **Dummies which are probably old-fashioned CRAY routines:**

- ✔ `ystbl`
- ✔ `ranset`
- ✔ `ranf`

- **Dummies which come from projects not used at Météo-France:**

- ✔ `blackbox_init`
- ✔ `blackbox`
- ✔ `dvssmi`
- ✔ `advar`
- ✔ `incdate`
- ✔ `wvalloc`
- ✔ `wavemdl`
- ✔ `wvdealloc`

- **Dummies which are used for operations at Météo-France only:**

- ✔ `wdhlis`

- **Dummies which are used for operations at ECMWF only:**

- ✔ `iinitfdb_vpp`
- ✔ `iinitfdb`
- ✔ `iopenfdb`
- ✔ `isetvalfdb`
- ✔ `isetfieldcountfdb`
- ✔ `iwritefdb`
- ✔ `iclosefdb`
- ✔ `iflushfdb`

- **Furthermore :**

If you exclude *odb*, *coh*, *ost* and *sat* you should have the following supplementary dummy routines :

- ✔ `abortdb`
- ✔ `amsu_sfc`
- ✔ `closedb`
- ✔ `co2cld`
- ✔ `getbias`

- ✔ `getdb`
- ✔ `helber`
- ✔ `opendb`
- ✔ `putdb`
- ✔ `rttov`
- ✔ `rttovad`
- ✔ `rttovcld`
- ✔ `rttovtl`
- ✔ `rttvi`
- ✔ `shuffle_odb`
- ✔ `srgevent`
- ✔ `storedb`
- ✔ `util_cgetenv`
- ✔ `suadvar`
- ✔ `swapoutdb`
- ✔ `bool_setparam_obsort`
- ✔ `int_setparam_obsort`
- ✔ `setup_obsort`
- ✔ `wtfunc_obsort`

- **Last but not least :**

I had to compile `getcurheap.c` with *-D_64BIT_* in order to link `profile_heap_get` . So alternatively, you could add `profile_heap_get` as a dummy.

5.7.5 Execution:

- **Caution**

The OPEN-MP directives in `suegeo2.F90` are bugged, I really had to remove them to run ALADIN.

- **Namelists**

Starting from the VPP namelists I had to, or I was recommended to, or I recommend to do the following modifications :

<u>In NAMPAR0 :</u>

- MP_TYPE=2 (the technique used for message passing) is necessary (the default, which is 1, fits for the VPP)
- Better have LIMP=.TRUE. and LIMP_NOOLAP=.TRUE. (immediate message passing and no overlap of communications/calculations)
- If you want to switch off the message passing while running on a single processor, you have to set both LMPOFF=.TRUE. and LIMP_NOOLAP=.FALSE. .
- Better not use NPROCA or NPROCB to set up the numbers of processors in the distribution because they are obsolescent. One should set up :

- NPRTRW (distribution of spectral waves),
- NPRTRV (distribution of vertical levels in spectral space),
- NPRGPNS (distribution of latitudes in gridpoint space),
- NPRGPEW (distribution of longitudes in gridpoint space),

with the rule : NPROC=NPRTRW*NPRTRV=NPRGPNS*NPRGPEW .

- Mailbox size : while we are used to setting it as an environment variable on Fujitsu, it is better in all cases to have it set via the namelist parameter MBX_SIZE ; for instance : MBX_SIZE=64000000 .

In NAMPAR1 :

- NCOMBFLEN=64000000 (size of communication buffer)
- LSLONDEM=.TRUE. (semi-Lagrangian on demand; more efficient with a large number of processors)

In NAMDIM :

- NPROMA=-17 : It MUST be a small value on scalar machines. The minus sign forces the software not to change the absolute value in an "optimization" attempt.

In NAMCT0 :

- N_VMASS=0 is necessary in ALADIN (the use of IBM mass libraries is not yet coded). In ARPEGE you can set N_VMASS=8 to improve the efficiency of the run. Note that in cycle 28T1, the IBM mass libraries are used only in the semi-Lagrangian scheme and in ECMWF physics.

Miscellaneous :

➔ Blank characters inside brackets causes an abort while reading the namelists file. Hence one should replace in the namelists lines like :
ARRAY(1)= ...
by
ARRAY(1)= ... .

- **Runs**

I tested my current scripts on ALADIN configurations 001 and Full-Pos (post-processing, coupling, nesting). Everything works fine in A-level and B-level distribution. Tests on ARPEGE are under progress.

I didn't tested OPEN-MP yet because my executables were not built for it. However, from the benchmark report we suspect ALADIN configuration 001 not to work yet properly with OPEN-MP on cycle 28T1.

5.7.6 About *gmkpack*

The amazing ☺ last version ***gmkpack*.5.5** can be used to install the code.

It is able to compile the whole code at once including *odb* and its pre-compiler, providing that the source code is exactly what is in the *clearcase* database, i.e. no "filter" has been applied to the source files and the symbolic links between files are preserved in *odb*.

The export package has been re-made on July 20th, 2004 to restore these links (*andante:~marp001/public/export/export_CY28T1_01.tar.gz*).

If you decide to use ***gmkpack*.5.5** to install the code, be aware that :

✔ The procedure is (still) very slow to install such a huge piece of code. Actually it should be re-written in Perl (or Pithon ?) to be fast. I hope that Eric Sevault will help soon me in this job !!

✔ You will have to invest a bit yourself to learn about an advanced usage of ***gmkpack*** !

✔ If you work on an IBM machine things will be easier since a configuration file for such machines is available. Note that due to a bug in the compiler you need to use a wrapper to compile with

OPEN-MP.

- ✔ If you work on a LINUX or NEC platform, note that the porting of ***gmkpack*** is under (good) progress.

The package ***gmkpack*.5.5** was sent by e-mail as well (including the wrapper for IBM). It is better to forget the beta-version 5.4 where I found lately some bugs. In the package you will find there a "*read-me*" file, and two html files below *doc/* to start with. After installation you will get more detailed "*man*" pages.

5.7.7 A dedicated ALADIN-HIRLAM account at ECMWF

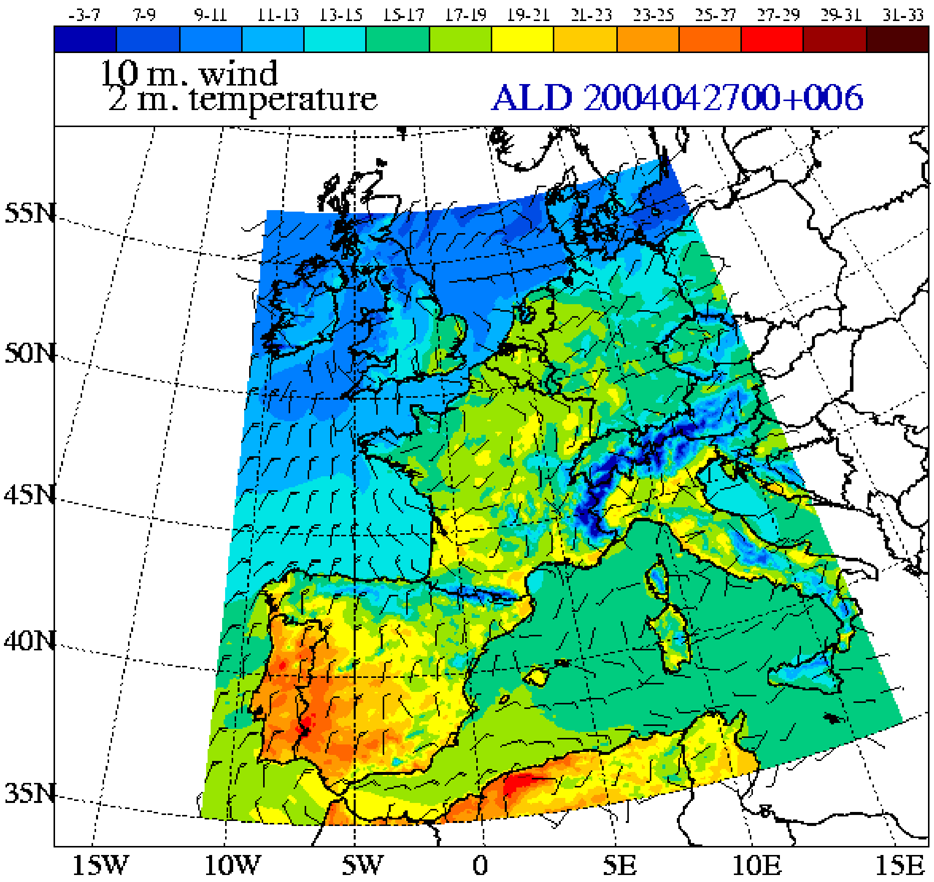
A new "super group" for ALADIN and HIRLAM users was created at ECMWF : ***hirald*** . The following tools and libraries are already available :

. gmkpack 5.5 ;

. ALADIN cycle 26T1, together with PROGRID, scripts and namelists for configurations 001 and 927.

Cycle 28T1 (or 28T3 ?) should be implemented soon.

Here is the first ALADIN forecast run on ***hirald***, by a few HIRLAM pioneers under the guru's supervision.



5.8. Detailed case study of a dramatic winter temperature overestimation in the ALADIN/HU model

Helga Tóth *(Hungarian Meteorological Service)*

5.8.1 Introduction

The ALADIN/HU model usually produces wrong forecasts near the surface in strong inversion cases. In these situations the 2 meter temperature and the daily temperature fluctuation are overestimated systematically. The experiences show that in case of large snow surface these overestimations become larger. Our aim was to examine and declare the reasons of the errors through a representative example. In January and February 2003 there were some cold air pad situations with strong inversions and principally the 2 m temperature forecasts suffered from the largest systematic and RMSE errors.

At the beginning of February (13th and 14th) the operational ALADIN/HU model had a large minimum temperature overestimation in the Carpathian Basin. The measured 2 m minimum temperature was around -10 - -15 °C and in some places even lower (-20 °C over the central part of Hungary). A large anticyclone extended over central and northern Europe without considerable cloudiness and precipitation. At the same time there was a big amount of snow cover over almost the whole country, which originated from the previous snow-fall at the beginning of February (Fig. 1). The snow field and the clear sky together produced extreme cold nights due to the long-wave radiation.

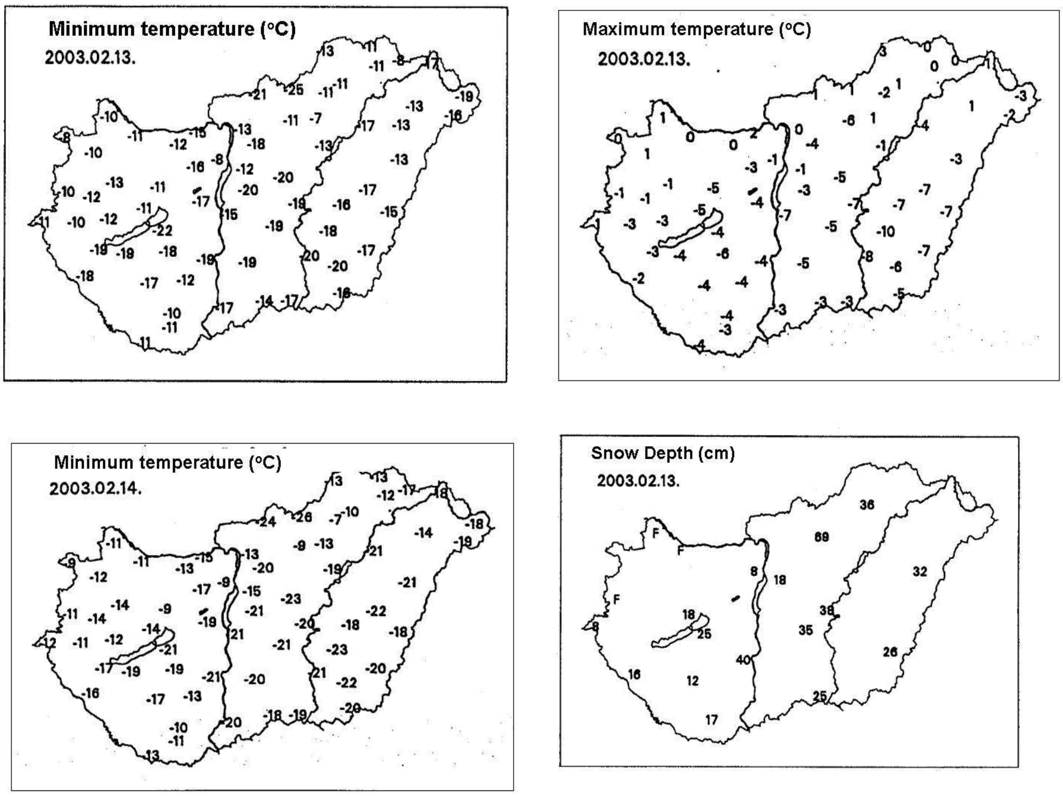


Figure 1. Temperature and snow depth measurements over Hungary on 13th – 14th February

5.8.2 Models

The operational ALADIN/HU model was not able to forecast this extreme cooling event, the average overestimation of the 2 m minimum temperature was about 8 - 10 °C for both nights, but the forecaster and even the ECMWF model predicted smaller minimum temperatures and their errors were about 2 - 4 °C. The largest temperature overestimations occurred in the coldest southern and central part of Hungary, where the snow field was the deepest (the observations were more than 25 cm). The north-western part of the country was the "warmest" region with –11 °C and with spotted snow cover, and the ALADIN/HU model produced the smallest error over this region. The large snow field in

Hungary appeared as a large radiative surface, and the main problem was that the operational model did not contain sufficient amount of snow (Fig. 2a) compared to the measurements, especially over the southern part of the country. This erroneous configuration of the snow surface had two reasons, on the one hand there is no operational snow analysis in ARPEGE (only the ARPEGE forecast keeps the snow from the previous precipitation events), and on the other hand the February "climate" file contains almost no snow field all over the Carpathian Basin. Both problems led to this failure in the description of snow cover and depth in the initial conditions of the model.

Beside this the operational 2 m temperature analysis was also not too successful at the border of southern and eastern part of Hungary (Fig. 2b), e.g. the analysed value was -7.6 ºC whereas the observed one was -16.3 ºC in Szeged (N: 46.25º, E: 20.10º), so the initial error was about 9 °C. This difference was kept during the model integration, and moreover at +30 hour forecast time the error came up to 11 °C (-7.4 °C forecasted, -18.6 °C observed).

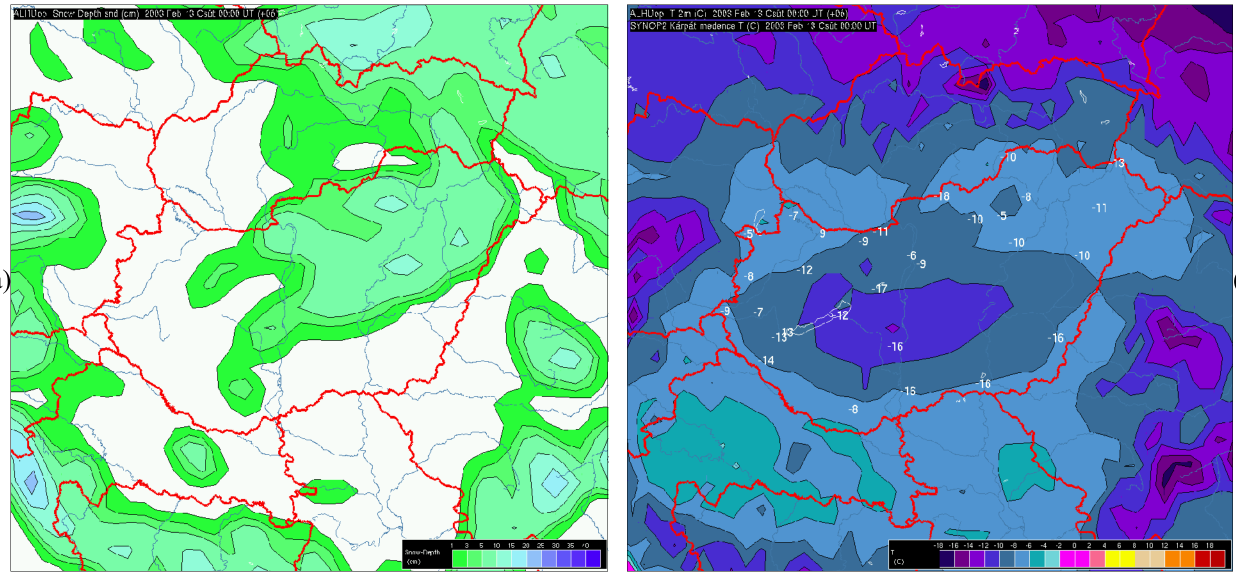
(a)  (b)

Figure 2. ALADIN/HU dynamical adaptation : a) snow and b) 2m temperature analysis at 00 UTC, 13 February 2003. Figures are plotted with the HAWK visualization system of HMS. The white numbers represent the measured values.

The 2 meter temperature is a diagnostic variable calculated as an interpolation between the surface and the lowest model level, taking into account the stability near the surface. The surface temperature is determined by the radiation budget, the latent and sensible heat transport between the atmosphere and the ground and the heat transport between the different ground layers (Gerard, 2001) :

$$\frac{\partial T_s}{\partial t} = \delta_{land} C_T \left(Q_R + Q_{sens} + Q_{lat} - F_{sp} - L_{w-i} \left(F_n - F_{si} \right) \right) \qquad (1),$$

where :

- δ_{land} is the land-sea mask,
- C_T is the ground thermal coefficient which depends on the ground type,
- Q_R is the surface net radiative energy flux,
- Q_{sens} is the surface sensible heat flux,
- Q_{lat} is the surface latent heat flux associated to liquid and solid water,
- F_{sp} is the heat flux between the surface and deep ground,
- F_n is the snow melting flux,
- L_{w-i} is the melting heat,
- F_{si} is the surface freezing flux.

Equation (1) considers some important processes connected to the snow properties, for instance the depth and the equivalent water content. Beside this, the long-wave emission near the surface also depends on the ground type (vegetation, snow) via the albedo. Above the snow surface the saturated water vapour can be easier condensed from the air to the ground than above bare ground and in dry air the outgoing radiation is increased. The gain from the raised latent heat flux derived from the condensation is too small compared to the deficit coming from the cooling by long-wave radiation, the average ratio is about 1/20 to the benefit of radiation in a chosen snow covered point in central Hungary (Fig. 3). In this picture only the period of surface temperature decrease was examined. In this case the radiation has the biggest influence to the evolution of the surface temperature and the second most important process is the heat flux between the surface and the deep ground, which is negative that means the deep ground warms the surface above.

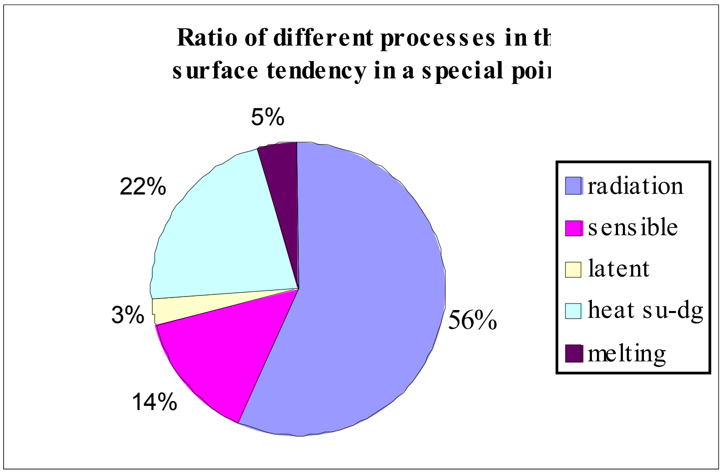


Figure 3. Ratio of different processes in the surface temperature tendency (radiation, sensible heat, latent heat, heat flux between the surface and the deep ground, snow melting/freezing flux)

5.8.3 3D-VAR experiments

First of all we tried to perform an experiment using a 3D-VAR data assimilation cycle with CANARI surface analysis to get more realistic 2 m temperature analysis and forecast. So a "3D-VAR+CANARI" cycle was run from 00 UTC, 12th of February, with 6 hours assimilation range. In CANARI the 2 m temperature and relative humidity and the 10 m wind analyses were activated, however the snow analysis was not switched on at that stage. We got a very promising 2 m temperature analysis (Fig. 4), the south-east and central part of the country was the coldest area and the northern part the warmest one.

Unfortunately, after some hours of integration the corresponding forecast became worse than the dynamical adaptation one, especially at the southern part of the country. It seems that the forecast with "3D-VAR+CANARI" produced smaller 2 m relative humidity forecasts in the studied area at 12 UTC 13th of February (12 hours forecast), which allowed more incoming short-wave and more outgoing long-wave radiation, with raising 2 m temperature :

dyn. ad. : relative humidity 67%, short-wave radiation 307 W/m^2 and –1.2 ^{o}C,
assim. : relative humidity 44%, short-wave radiation 361 W/m^2 and +0.1 ^{o}C,

at Szeged, while the observed temperature was –5.1 °C at that time.

This difference between the operational dynamical adaptation and the forecast with 3D-VAR was kept for the entire integration time, which means that the 3D-VAR based forecast was even worse than the operational one (Fig. 5). After 30 hours integration 2 - 4 °C differences could be noticed.

The main problem can be identified in the unbalanced fields at the initial time, for example a too strong and considerable correction was brought to the surface and 2 m temperatures by the analysis process, which deteriorated the humidity field near the surface.

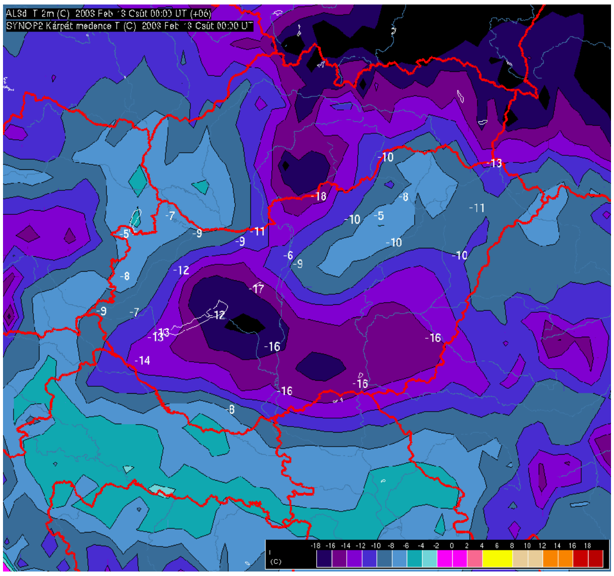


Figure 4. 2m temperature analysis at 00 UTC 13th of February, 2003. obtained with 3D-VAR+CANARI

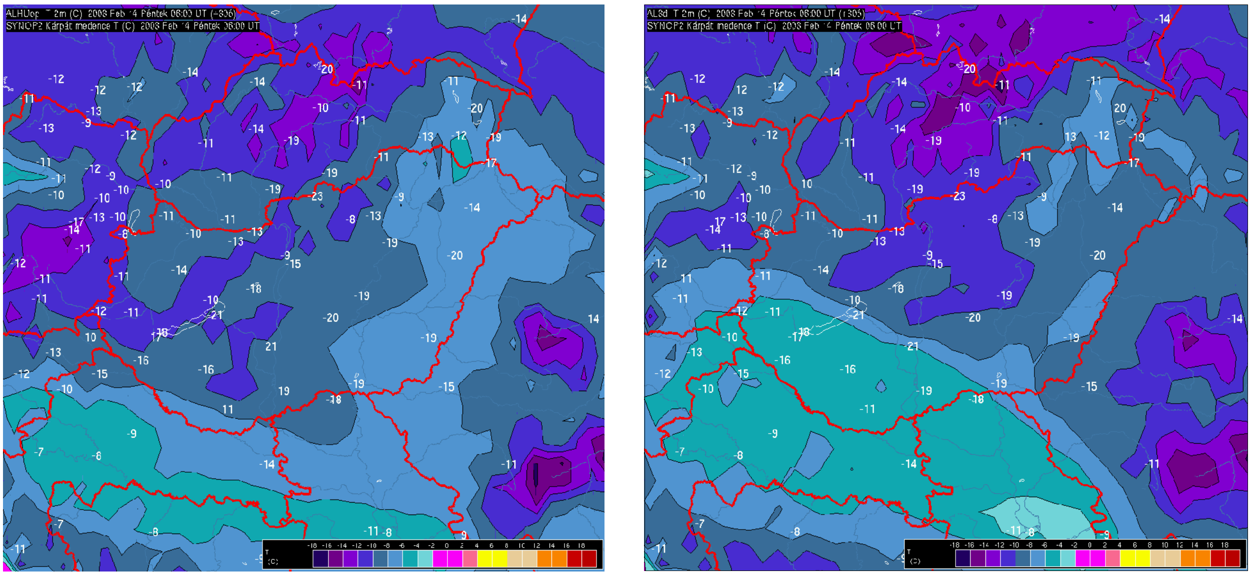


Figure 5. 2m temperature 30 hours forecasts with dynamical adaptation (left) and 3D-VAR+CANARI (right).

Beside this, as was mentioned, snow analysis was not carried out in the previous experiments, which could cause some negative effects on the surface temperature forecast. Therefore a "3D-VAR+CANARI+SN" analysis cycle and 48 hour forecast were performed including snow analysis in the cycle. The initial snow depth was more correct than in the operational dynamical adaptation, especially on the south-western part of the country, but the south-eastern part was not well represented (Fig. 6), and the snow was melting continuously. The 2 m temperature analysis was almost the same as without snow analysis. The forecast was a little bit worse at the beginning, which means that the atmosphere warmed at night apart from the reality, but after 12 hours the forecast turned into a bit better. The temperature difference between the two kinds of runs came about 3 °C after 30 hours integration at station Szeged : "3D-VAR+CANARI "produced -6.9 °C, "3D-VAR+CANARI+SN" –9.8 °C. But the measurement was –18.6 °C at 06 UTC 14th, so the overestimation remained still unacceptably huge.

It seems that the model broke the very stable air mass near the surface by the intensive wind in the planetary boundary layer. This can be confirmed by visualization of the 10 m wind and gust forecasts (Fig. 7). The weakest wind and gust were generated by the dynamical adaptation especially in the central part of Hungary (wind speed is 1 m/s, gust 1.2 m/s at Szeged), and "3D-VAR+CANARI" predicted the strongest ones, 2 m/s wind speed and 2.8 m/s gust. These results were in agreement with the 2 m temperature forecast : if the "3D-VAR+CANARI+SN" had produced smaller wind forecast the temperature would have been smaller too.

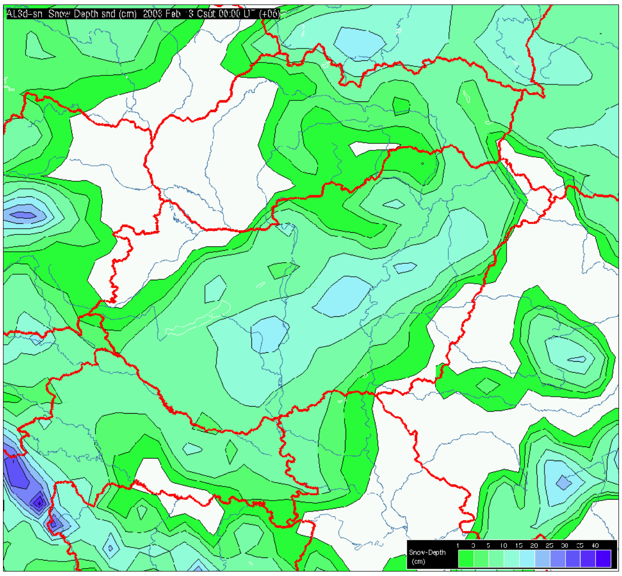


Figure 6. Snow analysis at 00 UTC 13th of February, using3D-VAR+CANARI+SN cycle

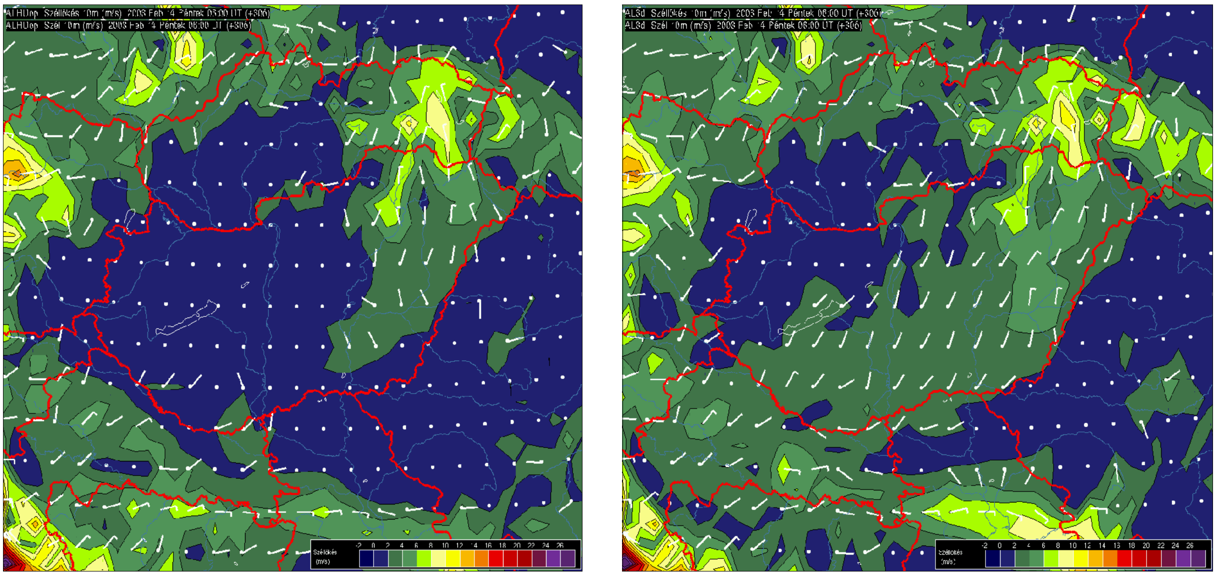


Figure 7. Wind forecasts obtained with dynamical adaptation (left) and 3D-VAR+CANARI (right)

If this speculation is correct, it is worth to do some experiments with improved physical parametrization processes in the planetary boundary layer. So first of all we tried to make a forecast using the operational package but with some modified parameters with respect to stable conditions, namely to reduce the vertical turbulent transport, e.g. with a change of the inverse critical Richardson number, from 0.25 into 0.175.

A "3D-VAR+CANARI+SN+NPAR" cycle and then a 48 hours forecast were performed using "3D-VAR+CANARI" with snow analysis and new sets of turbulence parameters in the calculation of the guess. Then another experiment, "3D-VAR+CANARI+SN+NPHYS", was carried out using a new physical-parametrization package advised by experts from Toulouse (Geleyn, 2003). In this package the *cloudiness* (Xu-Randall), *radiation* (EWS), *deep convection*, *vertical turbulent transport* computations are improved, and the *stability parameters* are also changed, and used in addition to the "3D-VAR+CANARI+SN" experiment. The best results were obtained with this last settings, especially at the beginning of the integration. After 3 hours the most realistic temperature distribution was found compared to other experiments, which means that the new process description produced more realistic states near the surface. This latter fact was also proven by the evaluation of the 10 m wind fields. However at the end of the integration we had still 4 - 5 °C errors in 2 m temperature.

Since the snow analysis was not as successful as desired, some other treatments were carried out related to the extension of the snow surface. Some parameters had to be modified in the optimal interpolation namelist, either increasing the guess error (the operational value for the snow equivalent water content is 5 kg/m^2 which approximately corresponds to a snow depth of 5 cm) resulting in the use of more observations, or increasing the radius of influence of observations (the operational value is 50 km). The first modification means that our confidence in the guess is diminished and the second one results in the increased reliability on the observations. These two properties need to be enlarged, therefore the guess error was set to 20 kg/m^2 because the differences between the observations and the guess was quite big in a lot of points.

A new "3D-VAR+CANARI+SN+NPHYS" cycle was carried out with modification of the two parameters, but the analysis was still unrealistic because of the deficiency of observation operator for the snow quantity in ARPEGE/ALADIN. The calculation of the corrected model equivalent of snow quantity is called twice, first time for calculating the observation departure (obs-guess) and second time for the determination of the analysis differences (obs-analysis) (Gaytandjieva, 2000). If the weather situation is extreme, and the observations are far from the "climate" fields, the correction doesn't work properly, as can be seen from its formulation :

$$Sn=\frac{1}{2}(276-T_{clim})+\frac{1}{3}(276-T_{mod})(Sn_{mod}-Sn_{clim}) \quad (2),$$

where :

- Sn is the corrected model equivalent at the observation point, Sn_{clim} and Sn_{mod} the "climate" and model fields just interpolated at the observation point, for snow;
- T_{clim} is the "climate" and T_{mod} the model 2 m temperatures interpolated at the observation point;
- threshold 276 K refers to the consideration of avoiding snow surface where the surface temperature is higher than 3 °C.

In our case the temperature and the snow depth were both too far from the climatology, so we got extreme values for Sn in the calculation of obs-guess and this values are overwritten into 0 at the obs-analysis calculation. To avoid this problem we suppressed the corrections in Eq. (2), using the simpler observation operator : $Sn = Sn_{mod}$.

With this new formulation in a "3D-VAR+MOD_CANARI+SN+NPHYS" cycle and 48 hours forecast we got very good snow depth analysis, and the best 2 m temperature forecast (Fig. 8).

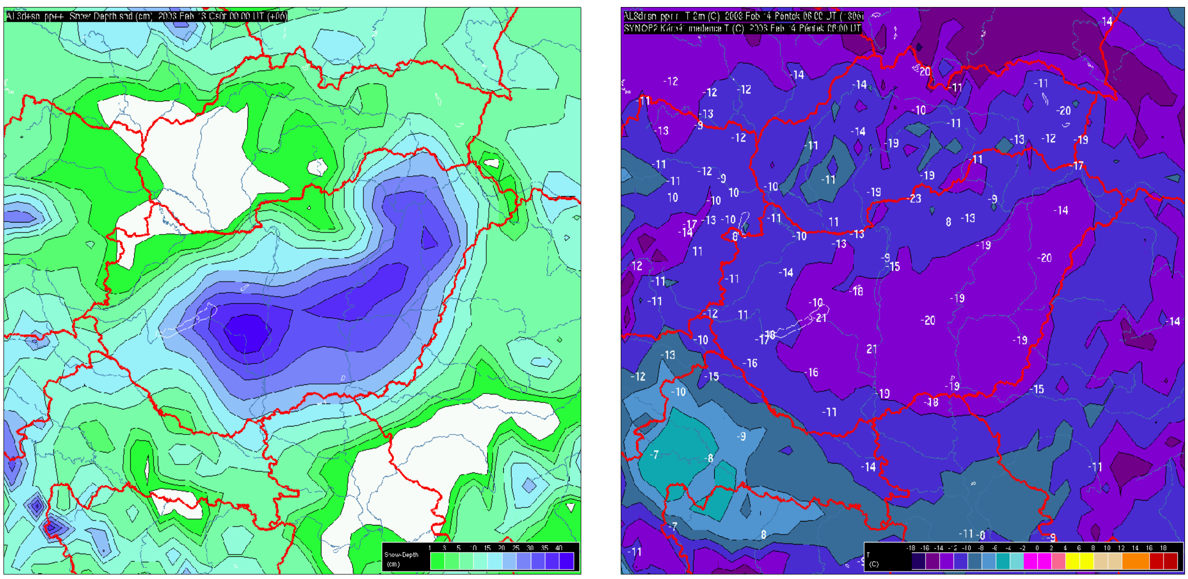


Figure 8. Snow depth analysis at 00 UTC 13th February, 2003 (left), 30 hour 2 m temperature forecast (right) made by 3D-

5.8.4 Summary and conclusions

At the beginning of February 2003 ALADIN/HU model strongly overestimated the 2 m temperature, our aim was to investigate the reason of this deficiency and correct this error by some improvement of the model.

Our results are illustrated by Fig. 9, which shows the evaluation of 2 m temperature forecast s from our different integrations at a critical station, Szeged (which is by the way also my birth place). The dark blue curve is the SYNOP observations, which should be reached. Let's see the model forecast in the order of the experiments :

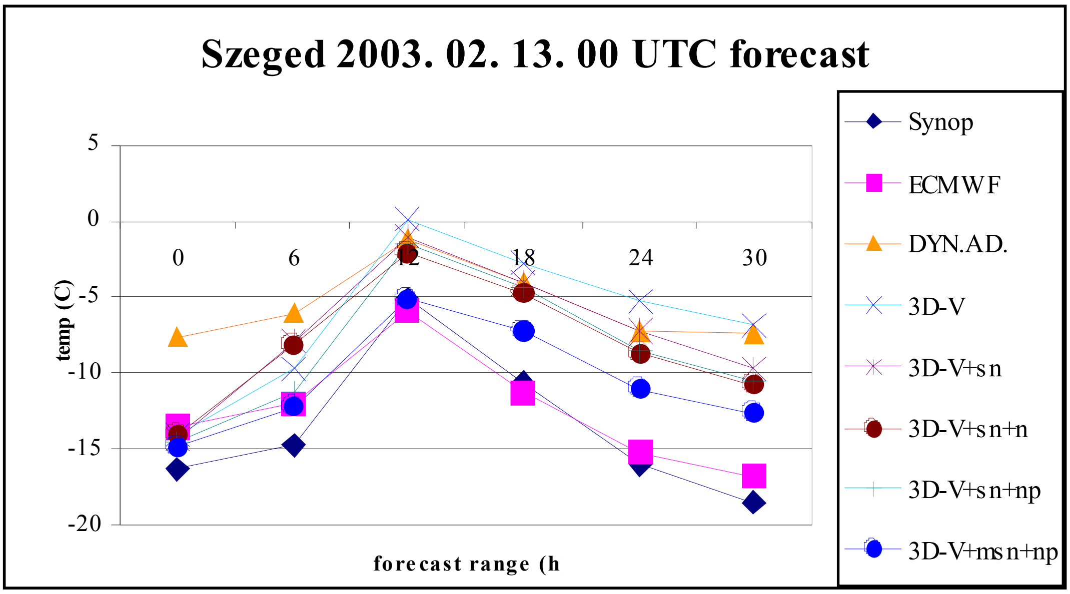


Figure 9. 2 m temperature forecast (2003. 02. 13. 00 UTC + 30 h) made by different model runs.

- It can be seen that the operational dynamical adaptation (orange) had a very big, 10 °C, overestimation.
- The simple "3D-VAR+CANARI" (bright blue) experiment without snow analysis got correct initial fields, but after 12 hours integration the result became worse than the operational one, because of the unbalances in the initial fields and the lack of snow.
- A little bit better forecast was produced by "3D-VAR+CANARI+SN" which contains snow analysis (purple), but the difference remains still too huge. Similar quality of prediction was performed using different sets of physical parametrizations, "3D-VAR+CANARI+SN+NPAR" (brown) where some vertical stability parameters were changed, and "3D - VAR+CANARI+SN+NP" (green), where some processes (radiation, cloudiness, vertical turbulent transport, deep convection) were modified. This last one was a little bit more correct at the beginning of the integration than the others.
- The best forecast was carried out with the modified snow analysis applied on the previous, improved physical parametrization run, "3D-VAR+MOD_CANARI+SN+NP" (blue), but still there were about 4 – 5 °C of error.

It was shown that basically all added ingredients to the operational model slightly corrected the unsuccessful forecast but the predictions were still not sufficiently successful. We got the nicest result with using all the possibilities we can apply, however the results of the ECMWF model was still much nearer to the reality than the ALADIN one. The problem was connected to the absence of snow analysis and the deficiencies in physical parametrization in ALADIN. From the treatments it was turned out that with better analysis we didn't certainly got more realistic result. The interaction between the ground and the atmosphere is also need to be largely improved.

5.8.5 References

Gaytandjieva, L. 2000 : Update and validation of snow analysis in CANARI/ALADIN.*ALADIN internal report.*

Geleyn, J-F. 2003 : Information about the ARPEGE physics and its relevance for ALADIN.*Internal report*

Gerard, L. 2001 : Physical parametrization in ALADIN. Part V. Soil Processes.*ALADIN report*

5.9. Subjective evaluation of different versions of ALADIN/HU model

Helga Tóth *(Hungarian Meteorological Service)*

5.9.1 Introduction

At the beginning of 2004 a new project started at the Hungarian Meteorological Service with the aim to subjectively evaluate our operational and quasi-operational model versions in an operational manner. This project was motivated by different reasons. On the one hand the experience gained by the subjective evaluation can be a valuable complement to the widely used objective verification scores. On the other hand we can judge and control the opinions of the forecasters about the models in a very simple way. On top of that we can have an opportunity to compare the subjective marks with the objective scores. From the common evaluation of all verification information we are able to make conclusions and decisions about development directions and the choice of operational model versions.

5.9.2 Method

During the subjective evaluation we compared different models over the Hungarian territory: the ALADIN/HU dynamical adaptation at horizontal resolutions of 12 km (former LACE resolution) and 6.5 km, the ALADIN/HU forecast based on the 3D-VAR+CANARI assimilation cycle at 12 km resolution, and the ECMWF model. The models are compared to each other and to the surface and radiosonde observations, radar and satellite measurements. At the end of the process we classify subjectively the forecast quality of the different predicted meteorological parameters. The verified variables are as follow s: precipitation, 2m temperature, total cloudiness and 10m wind. A 5-grade classification was created : from "5" mark for excellent forecasts to "1" for completely wrong predictions. The categorization is rather subjective, however some common criteria were considered, e.g. for temperature the mark is 5 if the spatial and temporal mean difference between the forecasts and measurements is within a 2 K interval, or it is 1 if the defined difference is larger than 6 K.

We were evaluating the forecasts based on the previous day integration (0-30 hours integration in case of ALADIN models and 12-42 hours for the ECMWF model), but from 1st of July 2004 the runs from two days before are considered (0-48 hours integration) and the time period is divided into two parts (0-24 hours and 24-48 hours for ALADIN models and 12-36 hours and 36-60 for ECMWF model). 5 persons in the NWP group are in charge of the subjective evaluation in weekly periods. During the first weeks we got some help from a forecaster expert regarding the evaluation and the interpretation of the model results.

5.9.3 First results

Up to now we have roughly half a year of experience about the subjective evaluation and hereafter 2 plots are showing the basic results for the period February-May 2004. The figure about the total average of marks (left) shows that the most reliable model is the ECMWF one and the two kinds of dynamical adaptation produce almost the same but a little bit less quality of forecasts. The 3D-VAR predictions are a bit worse than the others but the difference is not so significant.

We can check the variables individually as well from the other figure (right panel). It can be seen that the best predicted element is the wind, and the precipitation is also rather well represented. The cloudiness and the 2m temperature values are not forecasted too successfully especially in the case of 3D-VAR based forecasts. The largest difference (more than 0.2 mark in average) can be found between the forecasts of ECMWF and ALADIN/HU models for cloudiness. This discrepancy is coming from the problem of the ALADIN/HU cloudiness parametrization. A lot of times partly covered sky was predicted by the model, however there were no cloudiness at all in the reality (and in these cases the ECMWF model provided very good forecasts). On the top of that this kind of forecast is not sufficiently informative when the cloud cover is going to change.

Surprisingly the 2m temperature forecasts based on ALADIN/HU 3D-VAR system showed very weak quality. This was interesting because the 2m temperature is an analysed variable of the data assimilation scheme, so the guess is corrected by the observations, therefore the 3D-VAR analysis provides usually the best initial state for the model. Nevertheless starting from a good initial state the forecast becomes worse than the other models (probably some balance properties in the initial conditions are not kept). In the future we have to find the reason of this deterioration and correct it as far as possible.

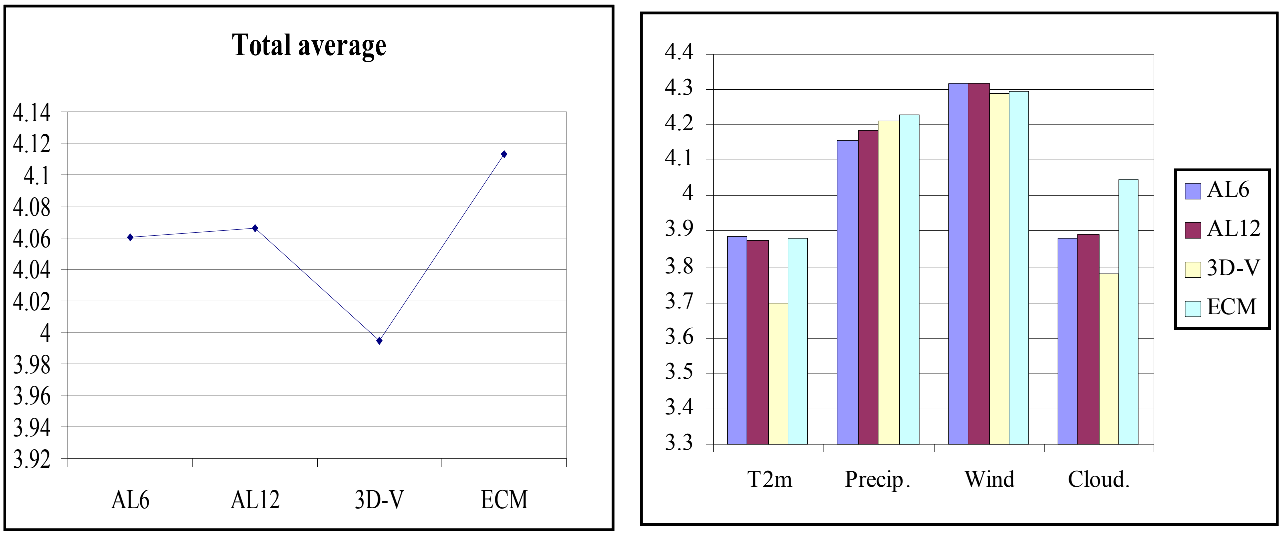


Figure 1. Total average marks (left) and averages for different parameters (right)

5.10. ALADIN-AUSTRIA : increasing the vertical resolution in ALADIN

Y. Wang, A. Kann, T. Haiden, K. Stadlbacher, H. Seidl and F. Wimmer (*ZAMG)*

5.10.1 Summary

The growth in computing power has made it possible to use higher model resolution. Indeed, the example of Méso-NH has shown that very high horizontal resolution with better model physics can improve the quality of numerical weather prediction. However, one should question the adequacy of vertical resolution in the NWP models, and at ZAMG we have experienced with ALADIN-LACE and ALADIN-VIENNA that increasing the horizontal resolution alone cannot guarantee a better forecast.

Linzen and Fox-Rabinovitz (1989) derived a consistency criterion between horizontal resolution Δx and vertical resolution Δz, for example for quasi-geostrophic flows,

$$\Delta z = \frac{f}{N} \Delta x \qquad (1)$$

where f is the Coriolis parameter and N is the buoyancy frequency. It is apparent from Eq. (1) that vertical and horizontal resolution should be proportional to each other. Pecnick and Keyser (1989) studied the relationship between Δz and Δx for a frontal structure, Persson and Warner (1991) for the conditional symmetric instability associated with frontal systems; similar investigations have also conducted to examine the importance of model resolution consistency in heat transport (Weaver and Sarachik, 1990) and cloud and radiation parameterisations (Lane et al., 2000). All the mentioned studies suggested that one should not simply increase the horizontal resolution without considering appropriate vertical resolution. In addition, these studies indicated that a consistent model resolution would lead to more realistic simulations and eliminate some artificial features and noises, such as spurious gravity waves. Thus, to examine the impact of increasing the vertical resolution is the aim of our work. In the following, we will give a brief report of the impact studies performed with ALADIN-AUSTRIA, the new LAM system at ZAMG.

5.10.2 ALADIN-AUSTRIA

To use the computer power efficiently and to simplify the operational production procedure of ALADIN forecasts at ZAMG, we have changed the operational suite of ALADIN at ZAMG, from two Central European domains (LACE and VIENNA) to one domain (AUSTRIA). The main characteristics of ALADIN-AUSTRIA are as follows:

- The model domain is almost the same as LACE.
- The horizontal resolution is 9.6 km, similar to VIENNA.
- The vertical resolution is increased from 37 (for both LACE and VIENNA) to 45.

Figure 1. shows the LACE and AUSTRIA domains and the model topography with the horizontal resolutions 12.2 km and 9.6 km respectively. The vertical levels in ALADIN-LACE and ALADIN-AUSTRIA are shown in Fig. 2. Most additional levels are set in the lower atmosphere.

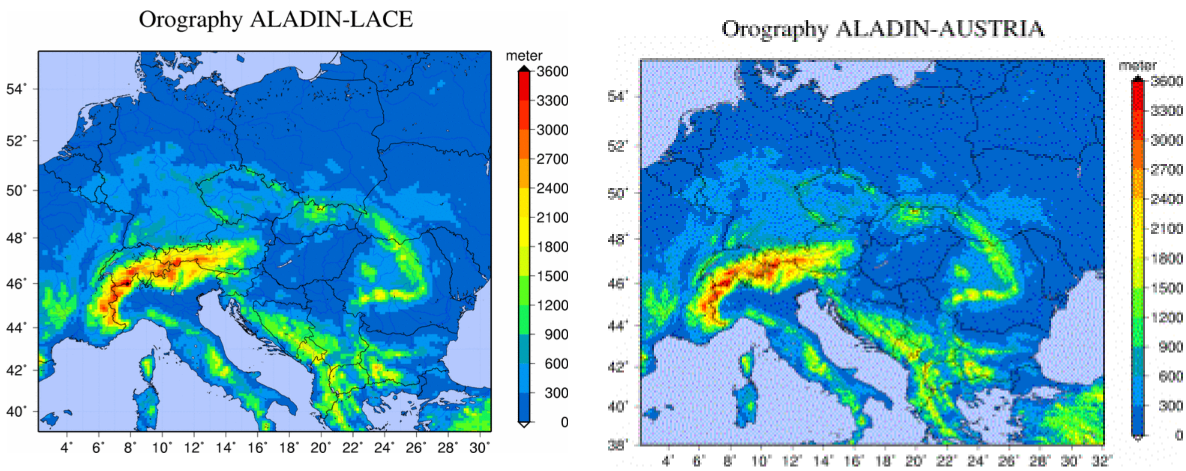


Figure 1 : Domain and model topography of ALADIN-LACE and ALADIN-AUSTRIA.

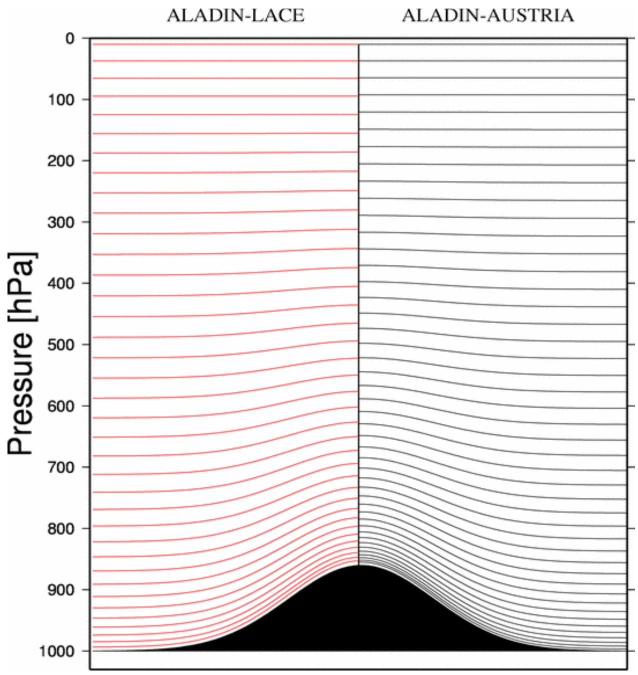


Figure 2 : Comparison of the vertical levels in ALADIN-LACE and ALADIN-AUSTRIA.

5.10.3 Results

For the present study, we carried on a two-months parallel suite of ALADIN-AUSTRIA from 20 Feb. 2004 to 20 Apr. 2004. To verify the results of ALADIN-AUSTRIA the model analysis (12h interval), for the upperair parameters, and the observations, for the near-surface parameters, have been used. The forecasts of LACE, AUSTRIA and VIENNA have been compared against each other for investigating the impact of the model resolution.

- **Verification of upper air fields**

In Figs. 3 and 4, we compare time series of the mean (BIAS) and root-mean-square (RMSE) errors (averaged over the whole domain) of ALADIN-LACE and ALADIN-AUSTRIA 24h and 48 h forecasts for the 500 hPa geopotential. Both ALADIN configurations (AUSTRIA & LACE) behave similarly, but a slight improvement with ALADIN-AUSTRIA has been observed for longer forecast ranges (48h), at least regarding the BIAS (not shown).

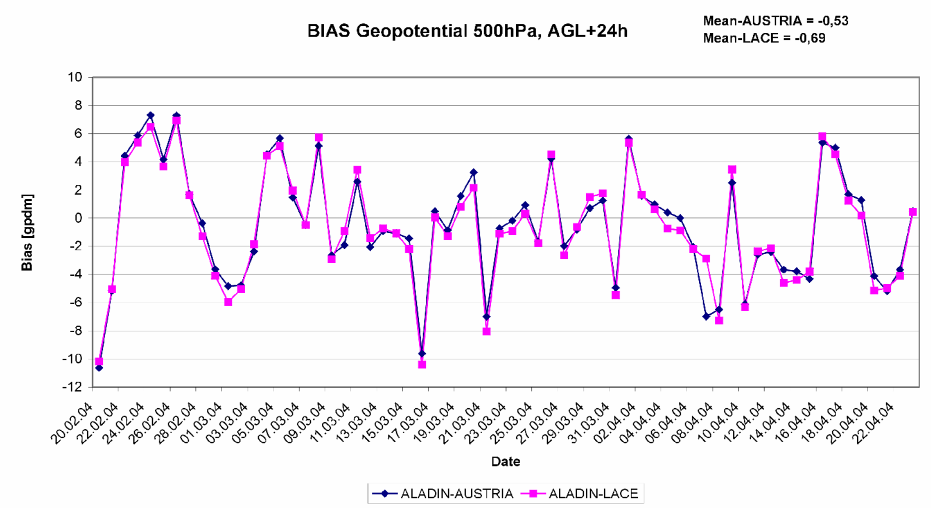


Figure 3 : BIAS for 500 hPa geopotential, 24 h forecast, the value indicates the model means.
Blue line : ALADIN-AUSTRIA, red line : ALADIN-LACE.

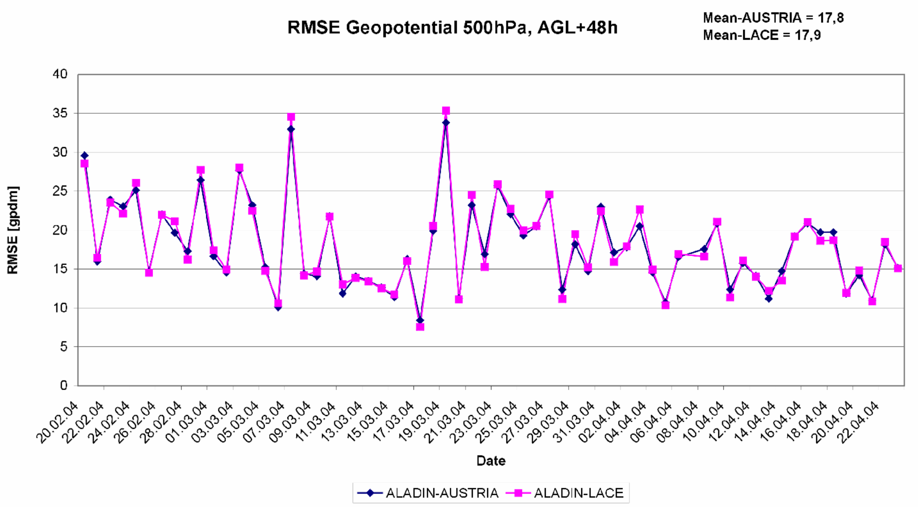


Figure 4 : Same as Fig. 3, but for RMSE and 48 h forecast.

- **Verification of surface fields**

The verification of the surface fields is done for 2m temperature, mean-sea-level (MSL) pressure and 10m wind speed for the 9 major Austrian cities. Figure 5 is the comparison between ALADIN-AUSTRIA and ALADIN-VIENNA for the averaged BIAS over the 9 cities. For 2m temperature, BIAS and RMSE are reduced by up to 10% by ALADIN-AUSTRIA, errors of wind speed do not differ much between ALADIN-AUSTRIA and ALADIN-LACE

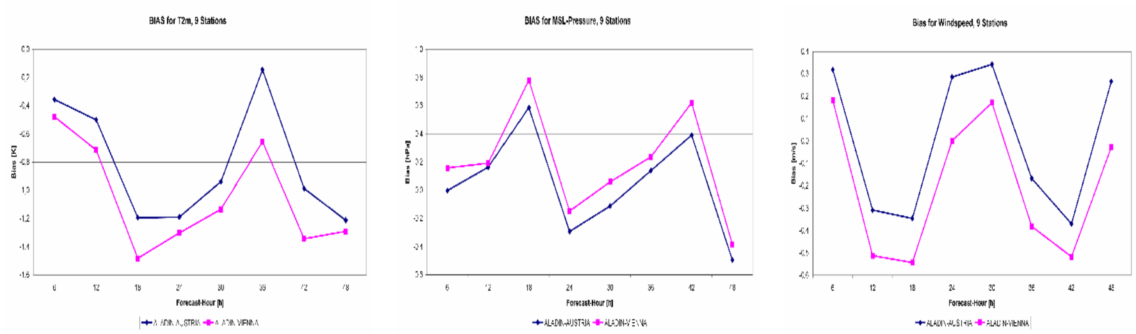


Figure 5 : BIAS for T2m, MSL pressure, 10m wind speed (averaged over 9 major Austrian cities).
Line in blue : ALADIN-AUSTRIA; in red : ALADIN-VIENNA.

Focusing the verification on station Vienna, as shown in Figs. 6 and 7, the slight improvement of the 2m temperature and MSL pressure forecasts is confirmed, whereas the quality of the wind speed forecast remains rather unchanged.

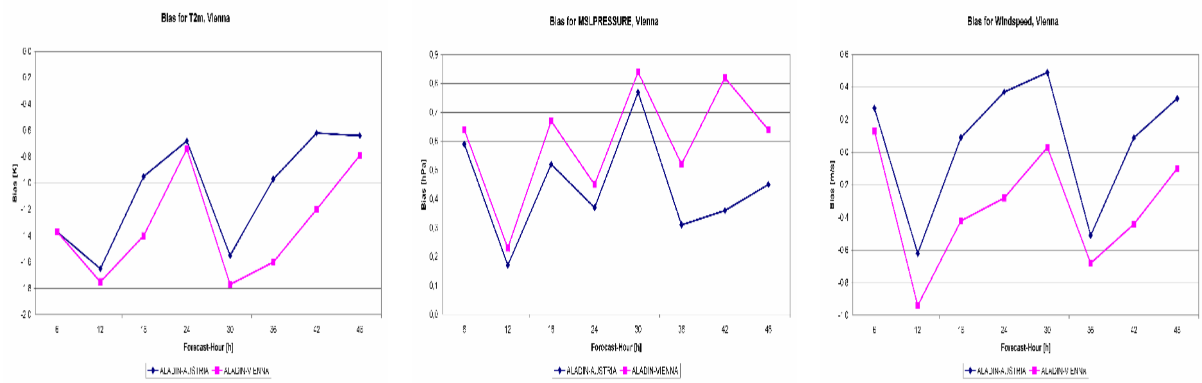


Figure 6 : Same as Fig. 5, but for station Vienna.

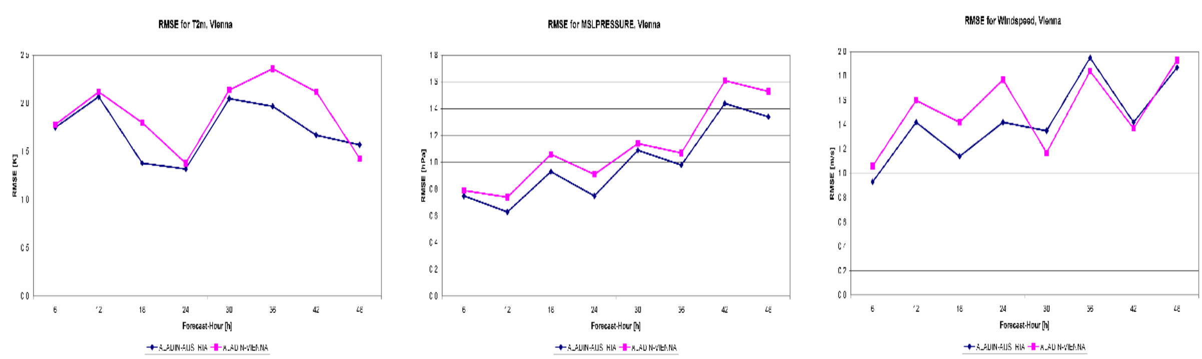


Figure 7 : Same as Fig. 6, but for RMSE.

5.10.4 Conclusion

In this work we investigated the performance of ALADIN-AUSTRIA, in which we have not only increased the horizontal model resolution but also the vertical one, from 37 to 45 levels. The results of a 2-months parallel run of ALADIN-AUSTRIA have been compared with ALADIN-LACE and ALADIN-VIENNA. Observations and model analysis have been used for the verification. The verification statistics show a slight improvement, especially for surface parameters, like 2m temperature, and at longer range forecasts. The quality of the wind speed forecast remains rather the same as in ALADIN-VIENNA.

5.10.5 Acknowledgement

We gratefully acknowledge Karim Yessad of Météo-France, for providing the program for computing the vertical coordinate.

5.10.6 References

Lane, D.E., R.C.J. Somerville, and S.F. Iacobellis, 2000 : Sensitivity of cloud and radiation parametrisations to changes in vertical resolution. *J. Climate*, **13**, 915-922.

Lindzen, R.S., and M.S. Fox-Rabinovitz, 1989 : Consistent vertical and horizontal resolution. *Mon. Wea. Rev.,* **117**, 2575-2583.

Pecnick, M.J., and D. Keyser, 1989 : The effect of spatial resolution on the simulation of upper-tropospheric frontogenesis using a sigma-coordinate primitive equation model. *Meteor. Atmos. Phys.*, **40**, 137-149.

Persson, P.O.G., and T.T. Warner, 1991 : Model generation of spurious gravity waves due to inconsistency of the vertical and horizontal resolution. *Mon. Wea. Rev*., **119**, 917-935.

Weaver, A.J., and E.S. Sarachik, 1990 : On the importance of vertical resolution in certain ocean general circulation models. *J. Phys. Oceanogr.*, **20**, 600-609.

5.11. First experiments with ALARO-10km

Gwenaëlle Hello *(Météo-France, CNRM/GMAP)* and Tomislav Kovacic *(DHMZ)*

5.11.1 Summary

The technical feasibility of ALARO-10 is demonstrated here. The idea is to import the Méso-NH sophisticated physics in an AROME-thinking manner inside the ALADIN dynamical kernel but at 10 kilometres horizontal resolution. This is done first in a one-dimensional context and then on a 3D real case (the Gard heavy flood of September 2002). The aim there is to recover the same type of forecasts from a Méso-NH experiment and from an ALARO-10 experiment. We can conclude here that this part of the sub-project ALARO-10 of ALADIN2 has proved satisfactory. Now next steps will be to demonstrate the "operational" feasibility : to prove that the unavoidable supplementary cost is compensated by a gain in the quality of the forecast.

5.11.2 Introduction

ALARO-10(km) is a sub-project of the ALADIN2 project (see ALADIN2 2004 Work Plan) designed in order to verify that the developments introduced at finer scales (AROME-type, see Newsletter 25) can also have an interest at coarser scales. Such scales are the ones currently used in ALADIN : regional ones around 10 km or less, depending on operational use of ALADIN in the different countries. So the first action in ALARO-10km is to build what can be called an AROME-10km as it contains the same dynamical kernel and the same physical parametrisations (coming from the research model Méso-NH) as in nominal AROME. The main difference between ALARO-10km and AROME is that the first one has got one more parametrization, for deep and shallow convection. Indeed, at regional scales, the convection is not resolved.

The aim of this exercise is first to demonstrate the feasibility of the idea. This aspect is assessed by comparing the behaviour of ALARO-10 with the one of Méso-NH. The goal is to reproduce the same behaviour in both models. This is the point we have reached now. Then the question is to evaluate the supplementary cost, the gain in the forecast that can be reached, the part that can/should be optimized in order to assess an affordable cost/efficiency ratio for all ALADIN partners. This will be the next step of this ALARO-10 sub-project.

This article is mainly devoted to the comparisons between Méso-NH and ALARO-10. After a description of the ingredients of ALARO-10 (3.1), we show a 1D experiment in order to verify the transplant of the convection parametrisation in ALARO-10 (3.2), then we show some results on a 3D experiment, the case of the Gard flood (3.3), before drawing some concluding remarks (4).

5.11.3 The experiments

- **The current ingredients of ALARO-10**

The ALARO-10 prototype is based on the AROME one. Thus we retrieve there a lot of elements coming from AROME.

Dynamical kernel:
ALARO-10 keeps the possibility to run either in hydrostatic or in non-hydrostatic mode. This is a difference with AROME as indeed at 2.5 km AROME runs in NH mode.

Physical parametrisations:
Same as in AROME. These parametrisations consist in a detailed micro-physics with five more prognostic variables (*qc* cloud droplets, *qr* rain, *qi* ice crystals, *qs* snow and *qg* graupels), a prognostic TKE (Turbulent Kinetic Energy), the radiation scheme is the one used at ECMWF (RRTM) and finally a surface scheme which includes four different surface types (town, sea, lake and river, soil and vegetation). The main difference with AROME is the addition of a parametrization for the deep and shallow convection. The convection scheme is a Kain Fritsch mass-flux parametrisation adapted for Méso-NH by Peter Bechtold, the so-called KFB scheme (Bechtold *et al.*, 2001).

- **A one–dimensional experiment**

First, the KFB convection parametrization was imported from the Méso-NH physical package inside the one-dimensional AROME physical-dynamical interface. Then a run was performed on a convective profile in order to compare Méso-NH and ALARO-10 1D outputs after one time-step. Figure 1 shows the comparison between ALARO-10 and Méso-NH runs after one time-step for the temperature tendency. Figure 2 shows the same comparison but for humidity variables tendencies (*qv*, *qc*, and *qi*). From these two figures one could see that the tendencies are equivalent, allowing to validate the good interfacing of the KFB convection parametrization inside the AROME/ALARO physical-dynamical interface.

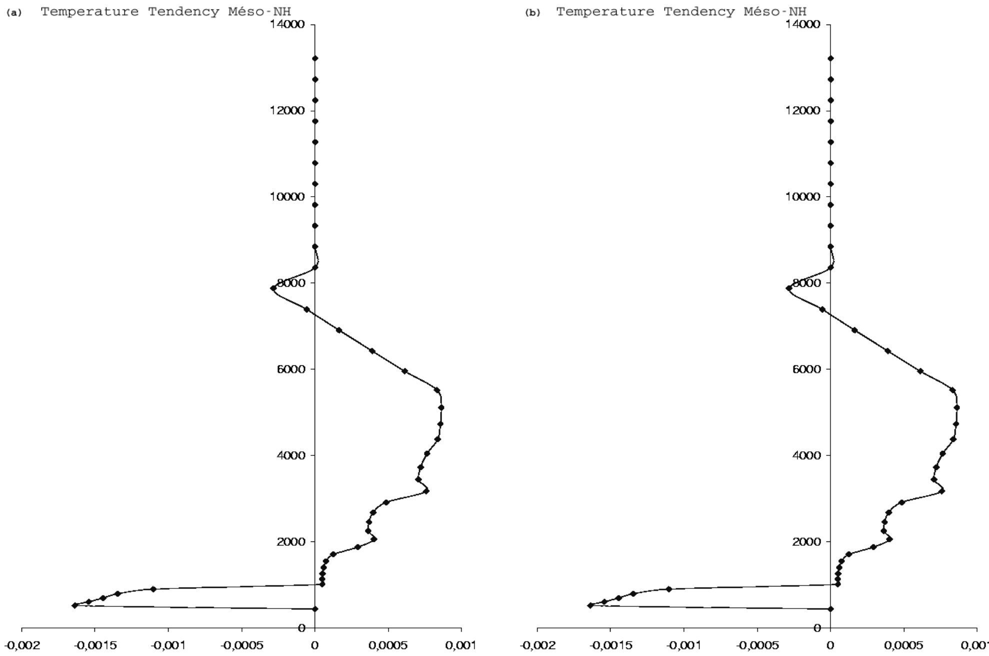


Figure 1: 1D experiments, temperature tendency after one time-step (a) ALARO-10, (b) Méso-NH

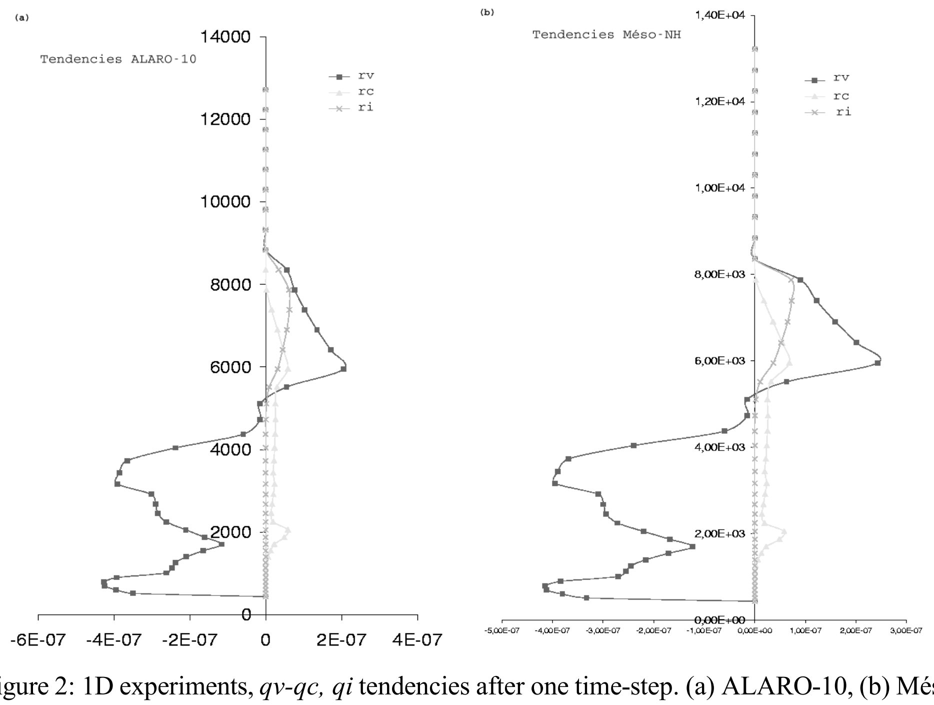


Figure 2: 1D experiments, *qv-qc, qi* tendencies after one time-step. (a) ALARO-10, (b) Méso-NH

- **The case of the Gard flood**

A 3D experiment is then performed. The case chosen is the one of intense flood over the Gard department (southern France). We run a 12 hours forecast starting from the 2002.09.08 at 12 UTC. Again, the aim there is to retrieve the same behaviour as the one of the Méso-NH model. The reference run (Méso-NH) is performed with a 15 s time-step, a call to the radiation scheme every 15 minutes and a call to the convection parametrization every 5 minutes. The Méso-NH model is using an anelastic system and runs with Eulerian dynamics. The ALARO run is done with a call to the radiation scheme every 15 minutes and to the convective parametrization every time-step. The dynamics used is either HPE or NH and it runs with a semi-implicit semi-Lagrangian two-time-level scheme. This last aspect allows to use longer time-steps than in Méso-NH. We performed experiments with 60 s, 120 s and 300 s time-steps. The figures presented here were obtained with the 60 s hydrostatic run. The domain (same for both models) is 192×192 points large with 41 vertical levels. The horizontal resolution is about 10 km in both models.

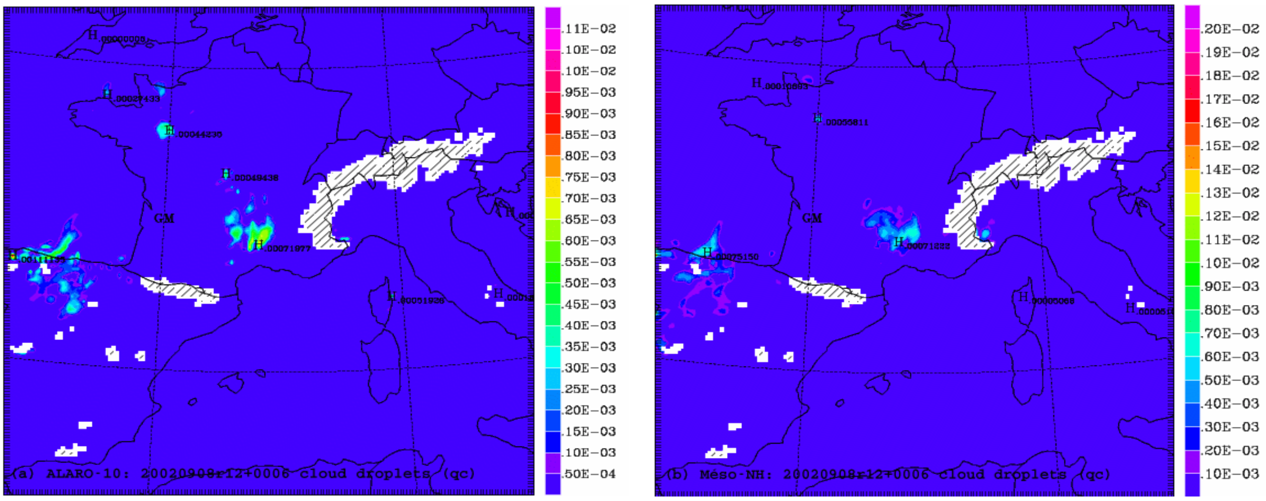


Figure 3: Comparison between ALARO-10 and Méso-NH, the Gard case. Cloud droplets field after 6 hours forecast 2002.09.08r12+0006. (a) ALARO-10, (b) Méso-NH.

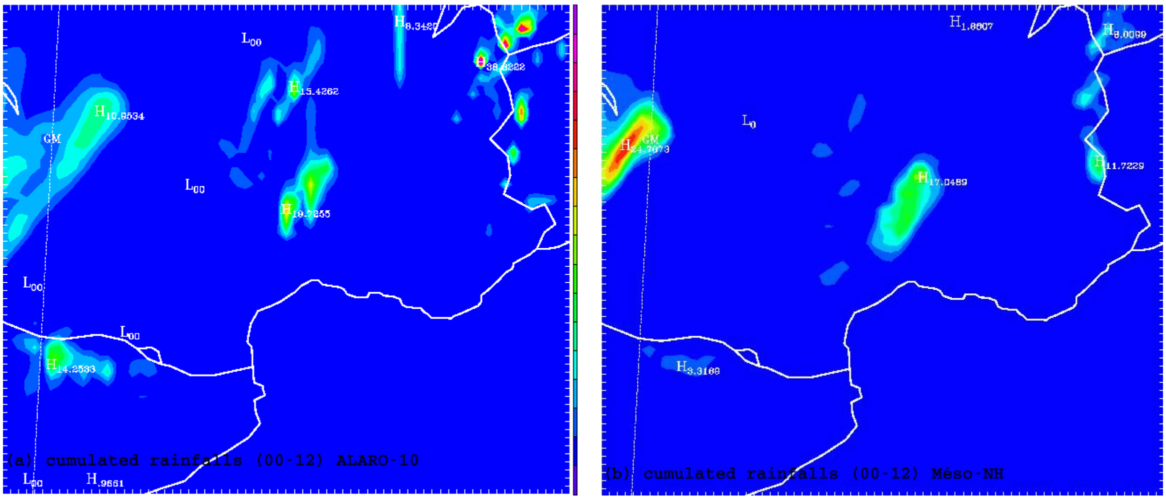


Figure 4: 12 hours forecast, 2002.09.08r12+0012, cumulated rainfalls. The domain is a geographical zoom on the area where the heavy flood occurred. (a) ALARO-10 and (b) Méso-NH

The comparison of the historical fields of the models shows a good accordance between the two. An example is given in Figure 3 where the cloud-droplet field is drawn. For diagnostic fields such as the cumulated rainfalls (see Figure 4 for a zoom on the domain where the heavy flood occurred) some differences can be found. The shape of the pattern is not exactly the same (two cells and more rain northward in the ALARO case) and there is more activity above the Alps in ALARO than in Méso-NH. But the maximum rainfalls (not located exactly at the same place) are of the same magnitude in both cases (20 mm in 12 hours both in ALARO and in Méso-NH). Indeed, both simulations are not realistic enough if one attempts to compare with the real cumulated rainfalls (more than 300 mm), but the simulations are in good accordance showing that it is possible to reproduce the Méso-NH solution in ALARO.

5.11.4 Conclusion

The aim of the first ALARO-10 experiments was to demonstrate the technical feasibility to import the Méso-NH physics inside the ALADIN dynamical kernel. This point was in fact reached as the comparison between both models shows good accordance. We were also able to run longer time steps than the ones of Méso-NH thanks to ALADIN dynamics. But indeed the ALARO runs are more expensive than ALADIN runs because of the use of a more sophisticated physics and also of more prognostic variables. So now a new step has to begin in order to evaluate the gain given by this new physics (from a meteorological point of view) and also more precisely the supplementary cost in order to optimize it as much as possible. This will be the future actions of the ALARO-10 sub-project.

5.11.5 References

Giard D., G. Hello and J-F. Geleyn, 2004: Work plan for ALADIN2 in 2004, available at http://www.cnrm.meteo.fr/aladin/scientific/2004-program.html

Seity Y. and P. Jabouille, 2004: First tests of the AROME prototype. Newsletter 25, available at http://www.cnrm.meteo.fr/aladin/newletters/newsletters.html

Bechtold, P., E. Bazile, F. Guichard, P. Mascart and E. Richard, 2001: A mass flux convection scheme for regional and global models. *Quart. J. Roy. Meteor. Soc.*, **127**, 869—886.

5.12. Limitations of projected limited-area spectral models for large-domains

Fabrice Voitus *(Météo-France)*

5.12.1 Abstract

A particular attention is given to operational limited-area models (LAM) in order to make detailed weather forecast (high resolution) over areas of interest. High resolution is required to adequately simulate mesoscale processes which affect the atmosphere's evolution. To this purpose, Météo-France has developed, in cooperation with other European partners, a LAM named ALADIN using classical conformal projections (Lambert, Mercator) which enable to represent any part of the sphere on a plane. Furthermore, the space-discretization of ALADIN is performed by a spectral bi-Fourier decomposition over the horizontal, and finite differences over the vertical. The time discretization is semi-implicit (SI), which implies the resolution of an Helmholtz equation at each time-step.

Nevertheless one of the main issue concerning LAM forecast reliability is the negative impact of the boundary-induced error. Previous researches have shown that the computational error generated by the over-specification of the lateral boundary conditions (LBC) can propagate inward into the domain and contaminate at the centre the forecast over the area of interest. In order to reduce the shortcomings of forcing by LBC, a pragmatical way would be to extend the geographical domain of the LAM, with an increase of computational power. But even if this latter approach seems to be intuitively easy to understand, in practice there is no guarantee that it could be done for projected spectral regional model like ALADIN. The feasibility (or not) of the extension of ALADIN domains has to be demonstrated.

5.12.2 Problematics

It is obvious that the limitations of ALADIN strategy for large domains involve a link between the spectral method, the semi-implicit time-stepping and the horizontal projection used in the model. As mentioned above, ALADIN runs with projection on a map. Any of the projections used is characterized by its map factor, denoted m and defined as the ratio between the distance on the map and the associated distance on the sphere at a considered location. The map factor varies over the horizontal.

As the spectral part of the model computations handles map variables and horizontal derivatives, the map factor has to be taken into account in the SI scheme. In order to keep a diagonal Helmholtz operator in the spectral space, and ease the resolution of the implicit problem, the map-factor m is replaced in the SI formulation by its maximum value over the domain (denoted m^*).

This restrictive simplification appears to be legitimate for usual projected LAMs, for which m remains close to one. But the larger the domain is, the larger the map factor values becomes. Therefore, it is highly likely that this helpful simplification shall not any longer be reliable for very large domains. For the global stretched ARPEGE configuration where the map factor reaches large values, Yessad and Bénard (1996) have shown that this simplification cannot be applied since it leads to dramatic computational instabilities, especially for long time-steps within the semi-Lagrangian (SL) advection scheme. Therefore, the question to be answered is if such instabilities can occur when the ALADIN domain is extended. What we formally know is that the incorrect treatment of the map factor in the SI scheme introduces additional non linear (NL) residual terms explicitly treated which could jeopardize the stability of the scheme when the LAM domain is extended.

The aim of this study is to examine more in detail the limitations of projected limited area spectral models for large domains. Thanks to the ARPEGE/ALADIN system (hydrostatic primitive equation (HPE) and Euler equations (EE) non-hydrostatic versions), we have investigated the response of the three-time-levels (3TL) SISL scheme with respect to the domain extension; more precisely we focus on the impact of an increase of m^* in the SI scheme.

5.12.3 Hydrostatic Primitive Equation (HPE) case : ALADIN-H

In the case of the HPE system, a preliminary experimental study has shown that an unstable behaviour of the SI scheme occurs with respect to the increase of m^*, exclusively when the orographic forcing interacts with the non linear residual terms associated with the map factor. At first sight, the physical processes don't seem to be of primary importance in such an observed behaviour. A more detailed stability analysis, in presence of a simple orography consisting in a "uniform slope mountain", has shown that the increase of the map factor reinforces the destabilizing effects of the leading non linear orographic source on the stability of the SI scheme. Even if for $m < 2$ the resulting instabilities appear to be too weak to endanger the current NWP application, our results indicate that some care has to be taken for very large domains, especially over mountainous regions.

5.12.4 Euler Equation (EE) case: ALADIN-NH

Conversely to what occurs with the HPE system, the EE system shows a larger sensitivity of the 3TL SISL scheme stability to an increase of the map factor (to m^*), and in consequence, to the domain extension. In ALADIN-NH, orographic forcing is no more strictly required to trigger the instability. The nature of this instability is only intuitively understood, but thanks to a numerical stability analysis together with the use of an alternative prognostic variable for vertical divergence, can give a better understanding of this phenomenon. This new variable is denoted d' and is defined as the ratio between the actual vertical divergence d and the square of the map-factor : $d' = d / m^2$.

The use of d' instead of d in the spectral part of the computations leads to a substantial stabilisation of the SI scheme. This stabilisation seems to be good enough to be able to run ALADIN-NH over larger domains than at present.

5.12.5 A new strategy for projected limited area spectral model

As regards the previous results, the approach which consists in replacing the local map factor m by its maximum value m^* in the SI scheme is irrelevant for large-domains in HPE and especially EE models. As a consequence some improvements have to be made to better take into account the map factor in the SI. To that effect, we have shown that the rotated Mercator projection offers some possibilities to improve the treatment of the map factor in the SI, and that the rotated Mercator projection allows the feasibility of the extension of ALADIN domains (with a very good degree of confidence), even for the Euler equations system.

6. PUBLICATIONS

6.1. Balsamo G., F. Bouyssel and J. Noilhan:

2004: A simplified bi-dimensional variational analysis of soil moisture from screen-level observations in a mesoscale numerical weather-prediction model.Q.J.R.M.S. Vol.130 Part A n° 598, pp 895-915. http://www.royalmetsoc.org/

Abstract: The analysis of soil moisture for the initialization of a mesoscale numerical weather-prediction (NWP) model is considered subject to operational constraints, both in terms of computational cost and data availability. A variational technique is used to analyse the soil moisture by assimilating screen-level observations of temperature and relative humidity. We consider a simplified bi-dimensional (z and t) variational approach (simplified 2D-VAR), where the estimate of the observation operator is obtained from extra integration(s) of the numerical model. The fundamental assumptions of the method are first evaluated: linearity of the observation operator, horizontal decoupling between grid points, and truncation of the control variable space (variable decoupling), that allow the simplified 2D formalism. Thus, the variational method is applied at each grid point separately and the gain matrix is computed from finite differences given the small dimension involved. The 2D-VAR technique keeps count of the full physics of the model, so the corrections applied to the control variable are adapted to the current meteorological conditions and the grid-point characteristics (texture and vegetation), as well as to the previous soil state. The linear estimate of the observation operator is studied in detail to optimize its evaluation. The validation of the method is shown with simulated observations, and the assimilation of real observations is performed with different time-windows. A sequential assimilation cycle on a 6-hour time-window allows the comparison with the optimum interpolation technique, while a 24-hour window is considered to extend the temporal consistency of the assimilated observations in the analysis. Results from the performed analyses with the simplified 2D-VAR method show a good retrieval of soil moisture, and a comparison with other initialization methods is also provided.

6.2. Geleyn J-F and P. Bénard:

2004: An efficient approximation of the Malkmus band-model average equivalent width for the case of the Voigt line-profile. Q.J.R.M.S., vol.130 Part X no. 598, pp xxx-xxx. http://www.royalmetsoc.org/

CONTENTS