La lettre d'informations

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ALADIN Newsletter 22

ALATNET Newsletter 5

January - June 2002

http://www.cnrm.meteo.fr/aladin/ & **http://www.cnrm.meteo.fr/alatnet/**

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This joined Newsletters present you the principal work around ALADIN or ALATNET during the first half of 2002. The news about work or events are related with informations that you sent.

An electronic ALADIN Newsletter 22 is available on the ALADIN web site and an electronic ALATNET Newsletter 5 can be consulted on the ALATNET web site.

Due to the increasing delay in the publication of the Newsletters (resulting from the delays in the reception of contributions, their increasing length and the large variety of formats used, the lack of manpower in the Toulouse Support Team, etc ...), the sections concerning events are omitted. The corresponding information is anyway available and regularly updated on the web sites.

Please do bring to my notice anything that you would like to be mentioned in the next Newsletters (ALADIN 23 & ALATNET 6) before the end of January 2003.

Any contribution concerning announcements, scientific progress, publications, news from the ALADIN versions on workstations or on big computers, verifications results, ... will be welcome.

ALADIN News

A short introduction

These Newsletters correspond to the start of a new medium-term research plan for ALADIN, the third one, and to the mid-term of the ALATNET project. But, most important, this semester was devoted to the setup or the reinforcement of networking, in research and operations. Since work will be more and more decentralized, everyone must feel concerned by activities around ALADIN and ALATNET in other centres.

Several coordination meetings were organized along these six months. The corresponding reports are or will be available on the ALADIN *web* site. However, to improve their diffusion, it was decided to publish them also in the present Newsletters.

To end with, the "News" page of the ALADIN site is NOT updated, since Patricia Pottier left for several months. But informations ARE, and the corresponding changes announced by e-mail, via the *aladin@meteo.fr* list.

2002-2004 : BUILDING A NEW NETWORKING

(Dominique Giard and Andras Horanyi)

July 2002

A. A NEW NETWORKING : WHY and HOW ?

WHY ?

- ALADIN is an old (10 years) and mature project
- It will benefit from less and less external financial support along the next year : research stays for European partners in Toulouse founded by the Ministry of Foreign Affairs (MAE) are likely to be cancelled for 2001, strongly reduced if not cancelled for 2002, and disappear afterwards. The present LACE organisation for operations and research, with a training and research centre in Prague, ends with 2002. The new scientific cooperation model for RC LACE will rely on research group stays at different Member States with strong cooperation, coordination around three main scientific subjects : data assimilation, dynamics and physics. Météo-France fundings are assumed to support only maintenance, and won't increase so much. The ALATNET project will stop at the end of February 2004, and anyway can support only short coordination stays for a few partners.

AS A CONSEQUENCE WE HAVE TO INVENT A NEW RESEARCH NETWORKING !

HOW ?

- increasing responsibilities for each partner
- a higher part of local research (with a concerted distribution of work taking into account the respective topics of interest, scientific experience and computing facilities)
- setup of small (and united) specialized working groups (each with its own coordinator, and meeting regularly in mini-workshops)
- improved communication : intensive e-mail exchanges, writing and reading contributions to Newsletters, reports from working groups, ...
- efficient distance tutorial
- strong coordination (both transversal and thematic)

CONSEQUENCES :

- on training : Basic training (performed locally) and PhD work are not endangered. But alternative solutions are to be designed for advanced training, all the more since the ALATNET seminar organized in May 2002 is the last one. The few research stays in Toulouse should be preserved for advanced training, but this probably won't be enough.
- on maintenance : The corresponding work will increase, and we must think about deported maintenance actions (the first examples - in Budapest and Ljubljana - were successful).

B. COORDINATORS

TRANSVERSAL COORDINATION

- CSSI : Coordinators for Scientific and Strategic Issues
- 6 coordinators designed by the Assembly of Partners :

Luc Gérard	*(Belgium)*
Radmila Brozkova	*(Czech Rep.)*
Dominique Giard	*(France)*
Andras Horanyi	*(Hungary)*
Abdallah Mokssit	*(Morocco)*
Doina Banciu	*(Romania)*

- Duties :
  1. define priorities in the scientific plan
  2. precise cooperation with HIRLAM, UKMO and COSMO
  3. select coordinators, organise more efficient networking
  4. follow the progress of the AROME project
  5. report to the Assembly

THEMATIC COORDINATION

- A list of coordinators proposed by the "CSSI" group :
  - MAINTENANCE : **???** *(to be designed in the French CNRM/GMAP team)*
  - OPERATIONS : **???** *(to be designed in the French DP/Previ/COMPAS team)*
  - APPLICATIONS :
    Ryad El Khatib *(France)* for developments in post processing
    ??? for other topics
  - VERIFICATION : **???**
  - COUPLING : **Gabor Radnoti** *(Hungary)*
  - DYNAMICS : **Pierre Bénard** *(France)* and **Radmila Brozkova** (*Czech Rep.)*
  - PHYSICS
    Precipitations : **Luc Gérard** *(Belgium)* for convective processes,
    Eric Bazile *(France)* for microphysics
    Turbulent processes, PBL : **Martin Gera** *(Belgium/Slovakia)*
    Radiation : **Yves Bouteloup** *(France)*
    Orography : **Jean-François Geleyn** *(France)*
    Surface : **Eric Bazile** *(France)*
    Simplified physics : **Cécile Loo** *(France)*
    Validation / methods : **Jean-Marcel Piriou** *(France)*
    Validation / experiments : **Jean-François Geleyn** *(France)*
  - DATA ASSIMILATION
    Variational methods : **Claude Fischer** *(France)*

Observations : **Elisabeth Gérard** *(France)*
Surface and Diagpack : **François Bouyssel** *(France)*

- ♦ PREDICTABILITY : **Andras Horanyi** *(Hungary)*

- Duties of coordinators :
  - ♦ Keeping in touch with persons working on the topic,
    within the ALADIN group of course
    but also within EWGLAM / SRNWP networking
  - ♦ Keeping informed on progress, especially for ALADIN,
    and trying to avoid duplication of work;
  - ♦ Sending an annual report to the CSSI group before the Assembly of Partners
  - ♦ Organizing or asking for the organization of a mini-workshop whenever required

The coordinators should first check the list of people inside their subject and set up a mailing list for those persons. Each coordinator should write a "kick-off" letter to the members of his team explaining the state of art on the given field and near / longer term objectives and plans. This first e-mail should stimulate the further effective information exchanges.

C. FIRST REALISATION (following the working plan for 2002)

TRAINING

- Basic training at home (pursuing the present effort)
- ALATNET training course "on Numerical Methods and NWP Applications"
  Kranjska-Gora, Slovenia, 27 May - 1 June
- "LACE" training course "on Maintenance / Code Architecture"
  Budapest, Hungary, 25-29 November
- PhD thesis : continuing

MAINTENANCE

- cycles 25T1 in May, 25T2 in September
- mainly distributed between Toulouse, Budapest and Prague
- some well-identified problems may be solved locally anywhere else : just ask !
- New : maintenance of scripts !
- coordination meetings along the phasing exercises, as usually, and during the Budapest seminar

TEAMS AND MEETINGS

- Operations
  - ♦ every ALADIN team is concerned, work is to be done mainly locally
  - ♦ coordination meeting : *Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)*
  - ♦ coordinator still to be designed

- Applications
  - ♦ every ALADIN team is concerned, work is to be done mainly locally
  - ♦ coordination meetings :

    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
    Vienna (Au), December 2002 (during the SRNWP workshop)
  - ♦ coordinator still to be designed

- Verification
  - ♦ every ALADIN team is concerned, work is to be done mainly locally
  - ♦ coordination meetings :

    Budapest (Hu), 11 March 2002 (for objective verification)
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
  - ♦ coordinator still to be designed

- Coupling
  - ♦ persons : JM Audoin (Fr), C Moussy (Be), G Radnoti (Hu), R Radu (Ro), P Termonia (Be) + K Stadlabacher (Au) for validation
  - ♦ coordination meetings :

    Kranjska-Gora (Si), 27-31 May 2002 (during the ALATNET seminar)
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
    Ljubljana (Si), November 2002

- Dynamics
  - ♦ persons : P Bénard (Fr), R Brozkova (Cz), M Janousek (Cz), J Masek (Sk), A Nmiri (Tu), G Skok (Si), C Smith (Uk), P Smolikova (Cz), F Vana (Cz), J Vivoda (Sk), K Yessad (Fr) + I Gospodinov (Bu) for the interface with physics + K Stadlbacher (Au) and A Trojakova (Cz) for validation
  - ♦ coordination meetings :

    Toulouse (Fr), 15 March 2002 (during phasing)
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
    Toulouse (Fr), September 2002 (during phasing)
    Vienna (Au), December 2002 (during the SRNWP workshop) ?

- Predictability
  - ♦ persons : C Fischer (Fr), A Horanyi (Hu), S Kertesz (Hu), J Nicolau (Fr), J Néméghaire (Be)
  - ♦ coordination meeting : *Madrid (Sp), 3-4 October 2002 (during the SRNWP workshop) ?*

Physics : A lot of work and a very strong cooperation are required here ! ➡ divided in subtopics

- Physics / Precipitations (Convection, Microphysics, ...)
  - ♦ persons : D Banciu (Ro), E Bazile (Fr), M Bellus (Sk), K Bergaoui (Tu), JF Geleyn (Fr), L Gérard (Be), S Greilberger (Au), T Haiden (Au), A Kann (Au), L Kullman (Hu), T Kovacic (Cr), JM Piriou (Fr), S Sbii (Mo)
  - ♦ coordination meetings :

    Toulouse (Fr), 17, 23, 24 May 2002

Kranjska-Gora (Si), 27-31 May 2002 (during the ALATNET seminar)
Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)

- Physics / Turbulent processes, Boundary layer
  - persons : M Gera (Sk), H Seidl (Au), A Simon (Sk), Martina Tudor (Cr) + Toulouse team
  - coordination meetings :
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
    Toulouse (Fr), 24-27 June 2002

- Physics / Radiation
  - persons : Y Bouteloup (Fr), JF Geleyn (Fr), H Toth (Hu)
  - coordination meeting : none scheduled

- Physics / Surface
  - persons : E Bazile (Fr), F Bouyssel (Fr), D Giard (Fr), O Latinne (Be) + visits ?
  - coordination meeting : *Toulouse (Fr), September 2002*

- Physics / Orography
  - persons : F Bouyssel (Fr), B Cathry (Be), JF Geleyn (Fr), D Giard (Fr), T Haiden (Au), K Stadlbacher (Au), Y Wang (Au) + D Dvrar (Cr) ?
  - coordination meeting :
    Toulouse (Fr), 18-22 March 2002

- Physics / Simplified Physics
  - persons : F Bouyssel (Fr), C Loo (Fr), C Soci (Ro)
  - coordination meeting : *Toulouse (Fr), beginning of 2003*

- Physics / Validation
  - persons : Romanian and French teams + persons involved in developments
  - coordination meeting : none scheduled but a "Chart for validation" will be written

- Physics / Interface to dynamics
  - persons : I Gospodinov (Bu), M. Jerczynski (Pl) + authors of modifications
  - coordination meeting : none scheduled

- Data Assimilation (upperair) : Methods
  - persons : R Ajjaji (Mo), S Alexandru (Ro), M Belo Pereira (Pt), L Berre (Fr), G Boloni (Hu), P Caille (Fr), A Deckmyn (Be), C Fischer (Fr), V Guidard (Fr), A Horanyi (Hu), S Kertesz (Hu), W Sadiki (Mo), C Soci (Ro), S Stefanescu (Ro)
  - coordination meetings :
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)

- Data Assimilation (upperair) : Observations
  - persons : M Benko (Sk), G Boloni (Hu), P Caille (Fr), C Fischer (Fr), L Gaytandjieva (Bu), V Guidard (Fr), M Jurasek (Sk), S Kertesz (Hu), R Randriamampianina (Hu), Z Sahlaoui (Mo), M Szczech (Pl), R Zaaboul (Mo)
  - coordination meetings :
    Medulin (Cr), 3-6 June 2002 (during the ALADIN workshop)
    next Assembly of Partners (rules for a safe exchange of observations)

- Data Assimilation : Surface (and Diag-Pack)
  - persons : GP Balsamo (It), F Bouyssel (Fr), N Bouzouita (Tu), A Dziedzic (Pl), S Ivatek-Sahdan (Cr), O Latinne (Be), A Mika (Hu), F Taillefer (Fr), JL Ricard (Fr), Y Wang (Au)
  - coordination meeting : *Toulouse (Fr), September 2002*

Skill of operational models
Report from the working group held in Medulin (Cr), 3 June 2002

(Stjepan Ivatek-Sahdan)

Participants :

D. Drvar, L. Gérard, D. Giard, B. Ivancan-Picek, S. Ivatek-Sahdan, A. Jericevic, D. Klaric, I. Kos, J. Merse, M. Mokoric, D. Placko-Vrsnak, N. Pristov, Z. Skaric, K. Stadlbacher, M. Tadin, V. Tusic, Z. Vakula, V. Vucetic, V. Vukicevic

ALADIN versions problem

Status of operational suites in ALADIN community :

- model versions from AL9 to AL15
- majority uses the AL12 different versions
- some problems in old version of the model may be solved in new version
- Météo-France will not spend time to investigate if some of the problems are solved or not

OBLIGATION :

End of the year is the dead line for implementation of at least AL12-op6 (CYCORA-bis).

Problems with portability

- xrd part and Makefiles or compilation scripts
- ECMWF change from time to time xrd part for their OS.

CURE OF THE PROBLEM :

In November 2002 :Workshop about Maintenance in Budapest. ; workshop is recommended especially for people who are involved in phasing and compiling at home.

There is not enough exchange of information about producing of executables and installing between countries with same Computers manufactures (SGI : 5 countries, DEC : 4 countries).

Using of new Physics from AL15 with version of ALADIN older than AL12-op6 is not possible without phasing of some other part of code (xrd, definition of output variables at the beginning), not just physics routines.

ODB problem

Diag-Pack is still part of ALADIN code, tools for converting from ODB to CMAFOC format exist in Toulouse.

Still problems with AL15 with assimilation (ODB) part. Question : is it possible to use AL12 for assimilation or analysis and AL15 for e001, ee927 ?

SUGGESTIONS:

1. to get the help from computer vendors
2. to get help from ECMWF : Almost all ALADIN Countries are ECMWF; during next TAC Meeting representatives of all present ALADIN Countries could ask for help in porting of ODB on platforms that are used in ALADIN Community.

CPU time

Results of integration speed comparison of different model versions are needed. With this information meteorological services could make forecast about needed Computer power.

LBC Data transmission

New way of receiving of the coupling files for LACE Countries by satellite (RETIM 2000), it is not known how often errors will occur during the transmission of the files: backup possibilities ISDN, Internet-not enough reliable for operational purpose.
Definition of rules for changing of the common telecommunication LACE domain is needed, agreement with MF.
Operationally 4 runs per day are run only at Météo-France.
MF will produce time table of available products that other Met. Service and MF could make plan for transmitting / receiving of data.
The problem of a back-up centre for the production of LBCs in case of severe problem in Toulouse comes back with changes in LACE management.

Next steps in :

Tuning of the orography
Tuning of the physics
How to solve problem of differences in skill between 00 and 12 UTC runs ? (esp. with blending)
Coordinator for operational aspects : somebody from Météo-France is needed.
There is in not enough communications between ALADIN Countries !!!!!

Report from the working-group on applications

4 June 2002, Medulin (Cr)

Klaus Stadlabacher, Stjepan Ivatek-Sahdan

Participation : NOT all ALADIN countries

According to the working plan, 2 topics :

A. Better diffusion of information about existing tools

B. Improved portability of tools

A. Better diffusion of information about existing tools

- Existing list on the web has to be checked (+ updated, if necessary) → by everyone !!
  mail to Klaus ? Patricia ? ...?
- Any kind of application should be on this list also "small" ones (e.g. : modified EDF)
- Examples (input, output, graphics ...) should also be available on the web
- Klaus will try to collect expressions of interest

× Time-frame : Today + X weeks [$1 < X < 4$]

- Optimal solution :
  well-documented applications would be available on-line and could be downloaded for the web
  time-frame : Today + X months [$1 < X < \infty$]

B. Improved portability of tools

- Jean-Daniel's package should serve as a reference (= Optimal solution)
- In case of existing tools → direct contact is always possible
- If new tools are developed → one should think about the portability
  (Test on different platforms would be the best - but who can do this ?)
- Repeating for the Xth time : DOCUMENTATION

Report from the working group on Data Assimilation

7 June 2002, Medulin (Cr)

Claude Fischer

The discussions were organised along 3 main items : assimilation systems, observations and surface analysis. The 3rd point on surface analysis was eventually skipped, due to the lack of time.

1. Assimilation systems :

The blending technique was discussed. There exist now 3 different versions of the blending scripts, adapted to the local environment and usage in Prague (under SMS), Toulouse (refreshed research version in preparation) and Bruxelles (A. Deckmyn). This divergence seems presently unavoidable, but a reference version will anyhow be made available in the export version of AL25T1. It was stressed that the diverging local scripts can produce differences in the way each centre does its blending. Furthermore, a potential "bug" was detected : in pure assimilation mode, when the surface blending is switched off, the surface fields would always be those of the 6 hour ALADIN forecast, thus the surface would be kept unchanged throughout the assimilation cycle, which is undesirable for long cycles. A clear "safety" switch to restore dynamical adaptation when no blending is performed must be provided in every local installation (Prague does have such a switch in operations / SMS, but for the full blending algorithm : suppressing only surface blending is not allowed).

So far, blending is operational in Prague, and run in research mode in Toulouse and Bruxelles. The partners in Croatia plan to test and implement it, there are also some considerations in Romania and Portugal.

It was recalled that some forecast errors or shortcomings can be emphasized in the blending suite. A Deckmyn's example of the very bad scores on T2m was recalled : the blending suite simply amplifies the misforecast of T2m, when a strong inversion caps the PBL, because the errors in the forecasted fields are reintroduced during blending into the next "analysis". However, the actual problem is not a problem of blending , but one of the model forecast.

The point was raised whether surface blending was needed in addition to a genuine surface analysis. This point should be open to tests, since it is not clear whether the 2 can be complementary or overlapping. Surface blending is interesting if local adaptation to a better representation of physiographic data (orography, vegetation ...) improves the 6 hour forecast surface fields, compared to the analysis. Surface analysis is however the cleaner way to introduce new data and the relaxation to climatology.

The scientific program was reviewed, to update those items planned for 2002 : the developments around 3D-FGAT were confirmed (to start 2nd semester), continuation of the work on Jb and a posteriori validation. Issues on double-nesting were noticed as well (with blending - Belgium -, without blending - Hungary -). the continuation of some work on simplified physics is postponed to 2003 (via a short stay of C. Soci in Toulouse, to liaise with C. Loo and F. Bouyssel ?).

2. Observations :

The installation of ODB must be continued ; ODB is quite different from the CMAFOC principles, so a significant initial learning is needed in order to install the libraries the first time. An informal group for exchanging informations about SGI implementations is encouraged. Available documentation about ODB should be put on the Web.

The progressive use of observations or assimilation systems should be taken into account when new ALADIN domains are defined. So far, mostly telecom and computational arguments were considered , but "meteorological" connexity and homogeneity of the observation network should now also be addressed.

The validation of raw ATOVS data will be continued, and finished in fall 2002 (CY25T2). Specific LAM aspects for a sounder scientific use will be listed by Elisabeth Gérard. Impact studies are planned by Roger Randriamampianina.

The work on radar data is postponed to 2003. This work should be started by a thorough investigation of present use of radar data in other projects, and the possible use of the data in 3D-VAR or CANARI. The group of persons who can work on this topic should also be redefined.

Other works already done or in progress were listed : drift of RS, pseudo-profiles of relative humidity, RH2m, IASI data, aircraft data.

3. Surface analysis :

skipped from the discussions.

Harmonization and rationalization of iterative time-schemes in IFS/ARPEGE/ALADIN

Pierre Bénard

1 Introduction

In addition to the classical SI time-discretization, several iterative time-discretizations have been developed more or less independently in IFS and in ARPEGE/ALADIN. Although they are not to be used operationally in the immediate future, they represent an investment for future potential use (not sure in next years for IFS, almost sure for ALADIN-NH). This is because better accuracy and/or stability properties are expected from them.

These alternative schemes are as follows:
developed in IFS:
- `LFULLIMP`

developed in ALADIN:
- `LPC_OLD`
- `LPC_FULL`
- `LPC_TRAJ`

The scheme `LPC_OLD` is the so-called partial iterative scheme which has been use for ALADIN-NH since the beginning of ALADIN-NH implementation (Bubnova et al, 1995).
The schemes `LFULLIMP` and `LPC_TRAJ` are based on the same concept of an iterative approximation of the trapezoidal scheme, including the calculation of SL trajectories. However, `LFULLIMP` and `LPC_TRAJ` even if exploiting the same basic idea, are written (and coded) quite differently: `LFULLIMP` is written in a specific "incremental form", while `LPC_TRAJ` is written in the same "non-incremental form" as the traditional SI scheme of IFS/ARPEGE/ALADIN (see Appendix A).
The `LPC_FULL` is also an iterative approximation of a trapezoidal scheme, but the trajectories are computed only from the explicit winds, as for the SI scheme. This scheme is less sophisticated (or consistent) because trajectories are not re-computed at each iteration, but it is less expensive, and could be advantageous in the cases where the trajectory iteration is not the main concern.

The new current implementations of these schemes are actually coded in "research" form not fully rationalized, and not fully integrated in a clean way into the main stream of cycles. This means in particular that:
- ALADIN `LPC_FULL` and `LPC_TRAJ` schemes have been kept outside the official cycles so far, and exist only under the dangerous form of personal branches.
- IFS `LFULLIMP` scheme is inserted in the cycles, but more or less as a "foreign body". In particular it has its own specific subroutine for spectral Helmhotz computations, and similarly, the relevant grid-point part of computations is rather isolated from the normal (SI scheme) grid-point computations.

Since `LPC_FULL` and `LPC_TRAJ` schemes are similar, they should be "harmonized", i.e. merged as deeply as possible. Moreover, there is clearly a need of a better integration of these schemes in the main code. However, this requires an effort of rationalization for smooth acceptance in the official cycles by the other persons in charge of the code. This note lists the points which have been thought as necessary to achieve this objective.

2 Harmonization of iterative schemes

2.1 Merging `LPC_TRAJ` and `LFULLIMP` code

The `LPC_TRAJ` and `LFULLIMP` schemes are based on exactly the same scientific idea, but implemented in the code through a different algorithmic way (i.e. incremental form for `LFULLIMP` and non-incremental form for `LPC_TRAJ`). Rewriting `LFULLIMP` in the normal non-incremental form should normally not change the response of the scheme, and should require very few changes in the code. This statement has been carefully examined between all persons who have been involved in the development of these schemes, and has been agreed as true. This transformation will thus be tested first, since it constitutes the first necessary condition for a deep harmonization of the `LPC_TRAJ` and `LFULLIMP` schemes. If, for a reason not detected yet, a serious difficulty was to appear while verifying the validity of this statement, then the harmonization between `LPC_TRAJ` and `LFULLIMP` schemes could be only much more superficial. However, this situation has rather few risks to really occur.

If this first test is successful, showing that this transformation from incremental to non-incremental form has effectively no impact on the response, then these two schemes will be deeply merged into a single one, written of course in the non-incremental formalism, since it is the form which has been chosen for the general design of IFS/ARPEGE/ALADIN since its origins.

2.2 Retained functionalities for harmonized schemes

It has been agreed that :

- `LPC_OLD` should stay in the cycles for the time being.
- `LPC_FULL` should also go to the cycles.
- `LFULLIMP` and `LPC_TRAJ` should also be merged as stated above.
- the pseudo-second-order decentering (`XIDT`) should be retained in cycles as well as the first-order decentering for all schemes.
- the possibility to use either high-order (HO) and low-order (LO) interpolations or only HO interpolations should be retained for `LFULLIMP` .
- the possibility to have different values of the first-order decentering parameter for some variables should also be kept for `LFULLIMP` .

2.3 Restricting functionalities

Inclusion into official cycles also implies that the less important research switches allowing for slight changes in the scheme should be removed prior to inclusion, in order not to increase too abruptly the size of the code for small details.

After many negociations, it has been agreed to retain almost all functionalities currently implemented in iterative schemes. In particular it has been agreed **not** to eliminate the possibility of using classical time-extrapolation or `LSETTLS` time-extrapolation for the predictor-step, even the value of this is not obvious a priori (a non-extrapolating scheme for the predictor step is claimed to be sufficient in the literature).

At the beginning, it had been thought that this kind of "almost useless" functionalities would make a large increase in code volume too important, and also that this would handicap the readability of the code. However, after a closer examination it has been decided that thanks to the rationalization of the code (mainly of `LATTEX`), these functionalities would enter quite naturally in the code, and would not generate any useless complication in the data flow. On the other hand the code for iterative scheme will reflects more its SI counterpart. A consensus was finally obtained on the fact

that even with these "not very useful" options, the final code will be much more readable and well written than it is now.
It also has been agreed to eliminate the possibility of having several different values of the pseudo-second-order decentering for the differents iterations, hence to retain only one single value `XIDT` for the pseudo-second-order decentering, valid for all iterations, and for all variables.

2.4 Link with physics

It has been agreed that the convergence of scientific choices between IFS, ARPEGE and ALADIN only concerns the time-discretization of the **adiabatic** part of the model so far. These new iterative time-discretizations offer a very wide spectrum of possibilities for the inclusion of the parameterized terms of the evolution inside the time-step, especially when combined to the possibility of fractional vs. sequential approaches.
IFS and ARPEGE/ALADIN have made quite different choices for this inclusion of diabatic terms inside the time-step, and it has been decided that harmonization should not concern this part. As a consequence, the part of the shared (between IFS/ARPEGE/ALADIN) code concerning the inclusion of diabatic terms into the time-step should stay highly protected by the `LEPHYS` and `LMPHYS` switches for time being. For instance, IFS can already use the iterated scheme to perform a more sophisticated inclusion of diabatic terms into the time-step. This generates an extra call of `CALL_SL/LAPINEB` from `GP_MODEL`, and allocation of additional arrays. These features should then be protected by the switch `LEPHYS`. From its side, ARPEGE/ALADIN has not yet addressed too much this problem, and a simple algorithm is still applied (the physics is called only once at the predictor iteration, then applied unchanged to all subsequent iterations).
Hence, to summarize, this harmonization of adiabatic time-discretizations is decided not to be the right time to merge or harmonize the inclusion of diabatic terms inside the time-step or to add new functionalities for them. This should be considered as another subject.

3 Rationalization of the code

3.1 General control of the iterative scheme

The three kinds of iterative schemes will be defined at highest level `YOMCT0`, since they have impact on array dimensioning. Completely new names will be introduced (for rationalization reasons). This names are given here, but not to confuse the reader, they are not used anywhere else in this paper:

- The old partial-iterative scheme will stay defined by `LPC_OLD`.
- The iterative scheme with NO Trajectory Refreshment will become `LPC_NOTR`.
- The iterative scheme with trajectory refreshment will become `LPC_FULL` (i.e. the full potentiality of the iteration is exploited).

It may seem a "silly and trivial job" to almost invert two existing switches, but it appears that the easiness of understanding and mnemotechnics will really be increased. Moreover, this "silly job" is better to be done while these switches has not yet proliferated too much all around the code: the amount of work is still quite limited and the increased comfort will be increased for years.

3.2 Control of the iteration

The total number of iterations is controlled by the module-integer `NSITER` in all schemes, and this will remain.
Beside this, undesirable redundancy of the information on the iteration exists in the current code:

(i) `CDCONF(4)` and `CDCONF(9)` (equal to `'A'`, `'S'`, `'T'` and so on...)

(ii) `NCURRENT_ITER` also gives the information about which substep is currently being performed, when compared to `NSITER` .

It has been agreed that too subtle use of `CDCONF` with various characters leads to confusion. This is because the meaning of a given character is usually documented nowhere, and is not of immediate access when reading the code. The `CDCONF` appears more like an economical but old-fashioned way to transport the relevant information into the data flow. It has been agreed to go towards a generalization of (ii) solution. Hence, it is suggested to use only `NCURRENT_ITER` as primary source of information. For subroutines under `SCAN2MDM` this information will be transmitted through logical switches `LPC_CORR` and `LPC_PRED` read from module, since this information is sufficient and quite mnemonic.

The obsolete switches `LSIMPLE_ITER` and `LSIMPLE_LAST` will be removed. Whenever needed (in `LPC_OLD` scheme), the information will be taken from `LPC_CORR` and `LPC_PRED` .

Some care should be taken in order to keep in the output the information about the successive sub-steps being performed (currently a `CDCONF` is printed each sub-step).

3.3 Control of interpolations

The current implementations of iterative schemes have made an extensive use of the `NxLAG` parameter to manage the way the SL buffers are filled:

- `NxLAG=4` currently means "the `LFULLIMP` scheme is used and all interpolations at the origin point are peformed with HO interpolator"
- `NxLAG=5` currently means "the `LPC_TRAJ` scheme is used and both HO and LO types of interpolations are peformed at the origin point"

This use of `NxLAG` is abusive, misleading, and uselessly restrictive (for example it makes it impossible to use `LPC_TRAJ` with only HO interpolations). This misuse has been recognized, and will be eliminated. In the final code, only `NxLAG=2` and `NxLAG=3` should remain, the specificity of the filling of SL buffer being controlled by the relevant switches (`LFULLIMP` , `LPC_FULL` , `NCURRENT_ITER` ...).

This would allow to maintain a full flexibility about the order of interpolations for all type of iterative scheme.

3.4 Control of time-extrapolation

The time extrapolation is currently controled in SI scheme by one switch `LSETTLS` (`FALSE` means the classical Robert's extrapolation). For iterative schemes, an additional control switch is needed to define the non-extrapolating possibility. It has been decided to define a new switch `LPC_NESC` for Non-Extrapolating SCheme.

3.5 Control of pseudo-second-order decentering

The implementation of a pseudo-second order decentering for iterative schemes requires two additional SL buffers per prognostic variable to be created. These two additional buffers will be allocated (or not, if not needed) in `SUDIM` , hence a high-level switch for controlling this information is needed higher than `SUDYN` , hence in `YOMCT0`. Since this particularity is only for iterative schemes it has been decided to define the switch by `LPC_XIDT`. A careful management of default values and controls in setup must of course be associated to this choice, in order to avoid possible errors when the SI scheme is employed (since this switch is then not relevant and should be ignored).

3.6 Rationalization of `LATTEX`

As soon as the time-treatment is touched (e.g `VESL`, `XIDT`, `LSETTLS`,...), the `LATTEX` subroutines suffers of dramatic growth. On top of this, this subroutine does the same kind of work for all the normal prognostic variables (U, V, T, P,d), and hence consists in the almost exact repetition of the same code duplicated five times. With appearance of iterative schemes, this subroutine has reached a state for which it would be beneficial to modularize it.

The role of the two additional buffers referred to in the previous sub-section will be clearly defined and commented in the code. More generally the computations in this subroutine will be more self-documented (by in-line comments), which will be made possible thanks to its modularization and rationalization.

Further rationalization (i.e. merging the code for second- and first-order decentering in a single formulation) should be discussed in more detail since there is no general consensus about it, and hence this will not be retained for the current action.

3.7 Special points to be checked

The treatment of "non-standard" Coriolis treatment should be examined carefully.

Any subroutine possessing similar characteristic as `CNT4` should be acrefully examined. This is at least true for `EDFI3` (Digital-Filters)

4 Summary of actions for this cycle (in more or less chronological order)

- Modularization of `LATTEX` for normal prognostic variables (JV).
- Checking the neutrality of incremental vs. non-incremental form of `LFULLIMP` (DS)
- Producing an "official" modset for making `LFULLIMP` non-incremental (DS).
- Inserting `LPC_OLD` , `LPC_FULL` , `LPC_TRAJ` in cycle CY25 (JV).
- Harmonization of `LATTEX` for `LFULLIMP` and `LPC_TRAJ` (JV).
- Removal of `CDCONF` for controlling the iterative process, and definition/insertion of new switches (JV).
- Protection of common code to centres specificities for diabatic terms by `LEPHYS` and `LMPHYS` tests (DS).
- Taking care about `LATTES` and `LAVENT` in the same spirit (JV+DS)
- Taking care about special points listed above (JV+DS)
- Keeping information exchange in this area (PB).

Remarks:

- For TL/AD keep only in the new cycle what is likely to survive with these new schemes. The writing of TL/AD of NH will retsart from scratch and will be written only for the new variables and new time-treatment.
- A new intermediate cycle will be required to merge work on new variables, new time-schemes, and new discretization of the cross-terms. This could become the prototype for METEO-FRANCE's AROME project.
- A careful validation is needed, and will require a special action.

5 Further perspectives

The rationalization planned above allows to use for each scheme more variants as possible in the current implementations, through a better integration into the code. However some possibilities have not been coded at all so far, and will be required at least for validation.

The `LPC_FULL` and `LPC_TRAJ` schemes should be made possible to use in 3-TL framework. This not of interest for operational use, but is needed for scientific validation, in the same sense that 3-TL SI is needed for scientific validation of 2-TL SI, in case of problems.

For the same reasons, the `LPC_FULL` scheme should be made possible possible to use in the Eulerian context.

As stated above, the interest of merging first- and second-order decentering code in `LATTEX` could be examined.

A possibility of improved last iteration by recomputing some non-linear residual with the latest iterated variables could be coded if judged interesting.

Finally, a similar harmonization of the physics call could be investigated. This would allow a complete flexibility in the introduction of diabatic terms into the time-step for both "models" (i.e. IFS and ARPEGE/ALADIN) in a similar way. However, as stated above, this is a subject more vast than the scope of this action.

Appendix : Incremental vs. non-incremental (on the ALADIN web site version)

Conclusions of the working group on dynamics
Medulin, 3rd June 2002

Filip Vana

Participants :

C. Fischer (Fr), M. Gera (Sk), C. Moussy (Be), J.-M. Piriou (Fr), R. Radu (Ro), C. Smith (Uk), P. Smolikova (Cz), P. Termonia (Be), M. Tudor (Cr), F. Vana (Cz) (chair), J. Vivoda (Sk)

Previous meetings :

coordination meeting in Budapest, March 2002

P/C coordination meeting in Toulouse, March 2002

People :

same list as defined in coordination meeting in Budapest

+ G. Skok (Si), new person supposed to work with the SL horizontal diffusion

- C. Smith (Uk), who is going to finish his ALATNET work at the end of July

- A. Trojakova (Cz), who has finished her master thesis and is now dealing with a different topic

Actions :

The work on NH dynamics (P/C scheme, new variables) is still going on, although the end of this year seems to be too restrictive limit to be ready with the stable and optimal version. (PS, PB, RB, JV, JM)

Lower (and upper) boundary definition: end of the work of CS and phasing it at the end of July in Toulouse; no successor defined - the work will be probably distributed into the NH group.

Radiative upper boundary condition: the work is actually frozen, anyway there is a interest to go further on (MJ)

Nonlinear horizontal diffusion: final customisation, extension to NH dynamics and solving the remaining problems in semi-Lagrangian gridpoint diffusion and adding some nonlinearity into the spectral horizontal diffusion (FV, GS)

Design of an improved filtering of orography (KS,?)

Relaxation of the thin layer hypothesis ? (KY, AN)

Validation tools for high resolution dynamics:

Scania case

Alpia case

External comparison:

interest to compare NH ALADIN results with the meso-NH model (a call for distribution of the AROME materials into the ALADIN community) (JFG, CF)

UKMO - need of some coordinator for this job (JV volunteered for this)

Report of the working group on coupling

30 May 2002 Kranjska-Gora (Si)

Piet Termonia

People present :

Jean-François Geleyn, Stjepan Ivatek-Sahdan, Martin Janousek, Jure Jerman, Chantal Moussy, Gabor Radnoti, Raluca Radu, Piet Termonia

Practical points that were discussed :

1. The idea is to implement a system that monitors the quality of the linear interpolation of the coupling data, in ARPEGE. This could be checked before sending the coupling files to the different ALADIN countries. If the system indicates that the quality is not sufficient during a certain forecast time interval then for that time interval, extra coupling data will be sent.
2. Practically to implement the above, the following solution was proposed. ALADIN countries should be able to decide for themselves if they want to receive occasionally such extra coupling data. If they do so, then they will be asked to read coupling files at shorter time intervals unconditionally, e.g. read coupling files at an interval of an hour rather than 3 hours. The idea is then to create the coupling files externally by a linear (or an other) interpolation. If the monitoring system decides to send more coupling data to the ALADIN countries then these files will be overwritten by the extra files.

   Such an organization would facilitate quick implementations of research results in the future to the operational ALADIN versions without make severe changes to the code.

Future research :

1. The work to improve the temporal interpolation by means the phase-angle approach will be continued. The last tests in the 3d model were disappointing. In order to continue it was proposed to study the behaviour of physical quantities (e.g. potential vorticity) to get hints of how to proceed.
2. Spectral coupling. Lateral boundary conditions will be needed here also. It was proposed to study the relation between the lateral and the spectral coupling, e.g. one should reconsider the choice of the relaxation coefficients in the intermediate and in the extension zone.
3. Starting the work on two-way nesting. The problem here is that one will be forced to make the fields periodic at each time step, which would be too expensive. The proposal here is to revisit the role of the extension zone. Can one live without it? Can the Gibbs waves be cured?
4. Well-posedness of the boundary conditions: it was proposed to redo the work of the recent paper of McDonald for a spectral model and then see whether the spectral character of the model will yield some advantage.

Extra issues discussed during the "dynamics and coupling" working group in Medulin :

The following issues were raised during the meeting in Medulin. They are considered to be of lower priority than the above issues.

1. Which variables should be coupled in the NH model?
2. Study the sensitivity of the coupling mechanism to the difference in vertical resolution between the coupling and the coupled model.

Report from the working group on Turbulent processes and PBL description

7 June 2002, Medulin (Cr)

Martin Gera

During this working session some topics, especially from the main lectures of the workshop, were analysed in more detail. The discussion focused on these important topics:

Laminar layer

Introduction of a new layer (laminar layer) nearest the surface can improve the vertical structure of turbulent fluxes (idea of Harald Seidl). Implementation raises technical difficulties in the current structure of ALADIN.

Richardson number

Computation of this variable is very sensitive to meteorological situations, especially wind shear. André Simon analysed the contribution of the tuning parameters `USURID`, `USURIDE` to the critical Richardson number, which has direct influence on the turbulent fluxes computation. For cyclogenesis and atmospheric inversion the opposite effect on the Richardson number has been observed.

PBL depth

Vertical oscillations of turbulent fluxes have been observed in the PBL. Spatial and temporal resolution (ALADIN-ARPEGE) dependence is visible. The temperature fields nearest the surface were studied for this reason (by Martina Tudor). Improvement is expected from tuning the anti-fibrillation scheme.

Shallow convection

Discussion about cloudiness problem (Harald Seidl and Jean-Marcel Piriou). Stratocumulus clouds are sometimes represented by one model layer, which triggers model representation difficulties. It is convenient to find more case studies for analyses of model behaviour compared with reality.

Turbulent Kinetic Energy

TKE as prognostic variable can solve some current problems (anti-fibrillation scheme, ...). Discussion was about initialization and implementation of this variable to the ALADIN structure (half or full level ...).

Collaboration

To improve the scientific possibilities, communication is necessary.

Notes from the working group on convection held in Toulouse, on 17-23-24 May 2002

A. Some proposals for a renewal of the parameterization of condensation processes

Basis

- Anticipating the march to smaller scales (typically 5 km) : large-scale precipitations (LSP) and updraughts are to be handled simultaneously, with cloud microphysics variables as input
- Writing a new scheme for shallow convection
- Avoiding a too complex iterative process (expensive and eventually not converging)
- Keeping as much as possible benefit from previous work, e.g. with respect to the Bougeault scheme

Constraints

- Trying to ensure some constraints on "moist enthalpy", h_v :

$$\int \left(\frac{\partial h_v}{\partial t}\right)_{conv.} = 0 \qquad \frac{\partial h_v}{\partial t} = 0 \text{ locally for LSP}$$

- Downdraughts are to be handled separately, with the result of "LSP + updraughts + shallow convection (possibly saved from the previous time-step) + non-organised evaporation" as input (closure); retro-action from downdraughts will be taken into account only at the next time-step
- Rain and snow are to be handled separately from cloud liquid water and ice, i.e. introduced as prognostic variables later

And ...

Work on operational problems must go on ! and is the first priority !

Confrontation with the experience of other teams is very valuable (e.g. in the EUROCS framework, with the ARPEGE-Climat team, with HIRLAM, ...).

B. A possible approach

Jean-François Geleyn proposed the following approach to create, if the general framework is agreed upon, a "baseline version", compatible with these constraints and still close to the present operational version, which should be able to welcome new developments :

First steps

- Merging LSP (large scale precipitations) and updraughts parameterizations, introducing a diagnostic cloudiness variable (consistent with micro-physics) and non-organized evaporation under precipitations (as long as required)

- Isolating the parameterization of downdraughts, introducing improvements to have it at a level of sophistication comparable to that of as the updraughts, at least for the compensation phenomena

Afterwards

- Design of a new scheme for shallow convection, based for example on a mass-flux approach. It should be parallel to the downdraughts computations (with closure problems solved either by saving fluxes to the next time-step or having a short iterative process). Temporary tricks may be used for the first tests of the new architecture, while waiting for a satisfying scheme.
- Design of a simple microphysics, handling prognostically only liquid water and ice, e.g. by adaptation of the scheme of P. Lopez
- Introducing downdraughts in the "Functional Boxes" approach at the same level as microphysics

Longer term actions

- General interface with dynamics, with the use of other new prognostic variables, with the new turbulence scheme, ...
- Further work on the previous scheme of L. Gérard (some more validation, towards a full 3d cloud fraction field, ...)
- Handling precipitating water
- Full forecasting scheme for draughts (new scheme developed by L. Gérard)

Conclusions of the working group on moist physics and convection

Medulin, 4 June 2002

(Luc Gerard)

1 Physical challenges

1. The time response in specific situations calls for the use of prognostic variables for convective mass fluxes and micro-physics.
2. A representation of cloud suspended water, with at least liquid and ice phases is urgently needed.
3. A new specific shallow convection scheme is required, probably using a mass flux approach.
4. The triggering of the convection has to be assessed more closely. We may distinguish two different regimes :
    - passive: large scale convergence induces convection (nearly the present closure);
    - active: deep convection induces large scale convergence.

   For the latter, we can consider
    - the links with other subgrid schemes (turbulent diffusion and the future shallow convection scheme); the coexistence of three or more schemes requires also some work to ensure a smooth transition between them.
    - various predictants may or should intervene: CAPE, CIN, PBL moisture convergence, TKE...
5. Cloud top has been shown to be more correlated to saturation deficit than to the CAPE. The saturation deficit and the DCAPE are then relevant predictants for cloud decay. The idea is to combine Cloud Top Evaporative Instability representation with the downdraught and/or the mass flux shallow convection scheme.

2 Operational efficiency

The correct behaviour of the physical schemes has to be checked and certified in a more systematic way. For this, the following actions are planned :

1. Setting an alarm in the 3D operational model on the total physical tendency, reporting unlikely values and their location in the log file. This requires an adaptation of *cpg* for the next cycle of the model.

   Jean-Marcel Piriou and Eric Bazile will arrange this for the end of July.
2. A validation chart for physics will be issued. The test suite will include at least
    - Single column model validation with respect to experimental profiles extracted from the 3D model;
    - ALADIN 3D model tests;
    - ARPEGE 3D tests using zonal DDH, in order to control zonal biases: these biases directly affect 4DVAR assimilation cycle stability

   J.M. Piriou and E. Bazile will prepare this chart.
3. A documented database of critical/dangerous/typical profiles extracted from the 3D model to force the single column model should be made available.

   Contributions should come from all centers, extracting the information as soon as they observe singular behaviours of the physical schemes.

4. The DDH do not presently work properly in ALADIN.

   Yves Bouteloup will try to fix the problem.

5. Extraction of profiles to force the single column model (tendencies along the run) does not work properly in ALADIN.

   Jean Marcel Piriou will do the debugging work.

Development work plan

Starting with the proposition from the working group in Toulouse, after further discussion, the following plan has been adopted :

1. Separation of
   - updraught, large scale condensation, condensation-evaporation micro-physics;
   - downdraught and final budgets.

   For this, we must
   - harmonize the updraught and large scale precipitation parameterisations, use a diagnostic cloudiness variable consistent with micro-physics, consider non organized evaporation below the precipitating clouds.
   - isolate the downdraught (using the total precipitation as input) and complete it with something like *LCVLIS* for global budgets consistency.

   This part will be developed by Thomas Haiden, in mail contact with Luc Gérard and Eric Bazile. Validation will also be coordinated by mail and performed at different centers.

2. Development of a new mass flux scheme for shallow convection.

   Thomas Haiden proposes to work on this subject, with 1 or 2 colleagues from the LACE group to join the work.
   Jean-Marcel Piriou, who focuses on the issue of transition between shallow and deep convection, may also develop a shallow convection scheme.

3. Adaptation of Lopez's prognostic micro-physics, to separate the ice and liquid phases of the condensate, and return provisionally to a diagnostic precipitation content.

   Luc Gérard works on it, in collaboration with Karim Bergaoui.

4. Further work on the functional boxes scheme, introducing the downdraught at the same level as micro-physics.

   Eric Bazile continues this work.

5. Further work on L. Gérard's prognostic mass flux scheme:
   - Further validation :

     Stefan Greilberger will analyse new cases during this summer, Karim Bergaoui will carry tests over Tunisia.
   - Towards a 3D updraught mesh fraction, and new developments for the updraught with prognostic condensates :

     L. Gérard continues his developments, and will have more contacts with K. Bergaoui
   - Handling precipitating water (as in Lopez's scheme) :

     Luc Gérard will care for this part, in the frame of the development of a full forecasting scheme for the draughts (+ collaborations with K. Bergaoui).

Additional remarks:

- *Jean-François Geleyn, Doina Banciu and Martin Bellus - absent at this meeting - are also expected to participate to the development work around physics and micro-physics.*
- *Last minute news: two more persons are likely to join the team, Alexander Kann from ZAMG and a Hungarian newcomer, with interests in shallow convection and cloud micro-physics respectively.*

The operational ALADIN models

1. Present status of operational ALADIN suites, and plans

Partner / Model	Computer	Library	Operational applications	
AUSTRIA	SGI Origin 3400 20 processors	AL15 → *CYCORA-ter+?*	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h • hourly diagnostic analyses
BELGIUM	SGI Origin 3400 18 processors (/24)	AL15 → *CYCORA-ter+dif*	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h (4 domains)
BULGARIA	SUN Ultra Sparc 60	AL11_export	• 48h forecast twice a day • lagged 6h-coupling	• post-processing every 3h
CROATIA	SGI Origin 3400 16 processors	AL12T1 → CYCORA	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 3h • dynamical adaptation of wind (every 3h , 5 domains)
FRANCE-Métropole	FUJITSU VPP 5000 2 processors (/31)	AL15 → *CYCORA-ter+dif*	• 4 forecasts a day, up to 48h, 42h, 36h, 30h • synchronous 3h-coupling	• post-processing every 3h • coupling files every 3 hours • diagnostic analyses every 3h (every 1h in summer)
FRANCE-Réunion	FUJITSU VPP 5000 1 processor (/31)	AL15 → *CYCORA-ter+dif*	• 72h forecast once a day • synchronous 6h-coupling	• post-processing every 6h
HUNGARY	SGI Origin 2000 16 processors	AL12 → *CYCORA*	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h • hourly diagnostic analyses • dynamical adaptation of wind (every 6h , 1 domain)
LACE	NEC SX4C/3A 3 processors	AL12 → *CYCORA-bis*	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 3h • coupling files every 6 hours • blending cycle (6h)
MOROCCO	IBM	AL13 → *CYCORA-bis*	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 3h • data assimilation based on O.I. (6h cycling)
POLAND	SGI Origin 2000 8 processors (/128)	AL09	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 3h
PORTUGAL	DEC Alpha XP1000	AL12 _bf02 → *CYCORA-bis*	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h
ROMANIA	DEC Alpha 500	AL12 _bf02 → *CYCORA-bis*	• 48h forecast twice a day • lagged 6h-coupling	• post-processsing every 3h
SLOVAKIA	DEC Alpha XP1000	AL12 → *CYCORA-bis*	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h
SLOVENIA	Cluster of 5 stations (DEC Alpha)	AL11	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h • dynamical adaptation of wind (every 3h , 3 domains) • dyn. adaptation of precipitations (every 1h , 1 domain)
TUNISIA	FUJITSU VPP 5000 1 processor (/31)	AL15 → *CYCORA-ter+dif*	• 48h forecast once a day • synchronous 6h-coupling	• post-processing every 3h

Partner / Model	Mesh (km)	Gridpoints (C+I / C+I+E)	Grid type	SW corner (lat , lon)	NE corner (lat , lon)	Vertical levels	Coupling model
AUSTRIA	9.6	133×117 / 144×128	quadratic	41.37*N* 5.89*E*	51.82*N* 21.85*E*	37	ALADIN-LACE
BELGIUM	7.0	97×97 / 108×108	linear	47.47*N* 0.11*E*	53.47*N* 9.60*E*	41	ALADIN-FRANC
BULGARIA	12.0	79×63 / 90×72	quadratic	39.79*N* 20.01*E*	46.41*N* 31.64*E*	31	ARPEGE
CROATIA	8.0	127×109 / 144×120	quadratic	41.79*N* 8.93*E*	49.53*N* 21.98*E*	37	ALADIN-LACE
CROATIA-Dyn Adap	*2.0*	*72×72 / 80×80 (×5)*	*Senj, Karlovac, Maslenica,Split, Dubrovnik*			*15*	
FRANCE-Métropole	9.5	277×277 / 288×288	linear	33.14*N* 11.84*W*	56.96*N* 25.07*E*	41	ARPEGE
FRANCE-Réunion	33.4	117×139 / 128×150	linear	1.12*S* 29.18*E*	36.00*N* 100.41*E*	41	ARPEGE-Tropiques
HUNGARY	8.0	189×133 / 200×144	quadratic	42.08*N* 6.34*E*	51.77*N* 26.06*E*	37	ALADIN-LACE
HUNGARY-Dyn Adap	*2.4*	*239×169 / 250×180*				*15*	
LACE	12.2	229×205 / 240×216	quadratic	34.00*N* 2.18*E*	55.62*N* 39.08*E*	37	ARPEGE
MOROCCO	16.7	169×169 / 180×180	quadratic	18.31*N* 19.98*W*	43.12*N* 9.99*E*	41	ARPEGE
POLAND	13.5	169×169 / 180×180	quadratic	41.42*N* 5.56*E*	61.16*N* 40.19*E*	31	ARPEGE
PORTUGAL	12.7	79×89 / 90×100	quadratic	34.94*N* 12.42*W*	44.97*N* 0.71*W*	31	ARPEGE
ROMANIA	10.0	89×89 / 100×100	quadratic	41.90*N* 20.69*E*	49.80*N* 32.12*E*	31	ARPEGE
SLOVAKIA	7.2	109×79 / 120×90	quadratic	46.05*N* 14.69*E*	51.07*N* 25.26*E*	31	ALADIN-LACE
SLOVENIA	11.2	72×72 / 80×80	quadratic	42.33*N* 8.69*E*	49.44*N* 18.97*E*	37	ALADIN-LACE
SLOVENIA-Dyn Adap	*2.5*	*79×79 / 90×90*	*Gori, Halo, Kamn (wind), Kamn (precip.)*			*15*	
TUNISIA	12.5	117×151 / 120×162	quadratic	27.42*N* 2.09*E*	44.16*N* 18.37*E*	41	ARPEGE

"telecom" domains

Partner / Model	Mesh size (km)	Gridpoints (C+I / C+I+E)	SW corner (lat , lon)	NE corner (lat , lon)
BELGIUM	9.9	79×79 / 90×90	46.97 N 0.30 W	53.68 N 10.96 E
LACE (input)	20.7	139×124 / 150×135	33.67 N 1.83 E	55.78 N 39.79 E
LACE (output)	12.2	133×97 / 144×108	41.15 N 5.66 E	51.90 N 26.56 E
MOROCCO	24.6	117×117 / 128×128	18.06 N 20.19 W	43.30 N 10.34 E
POLAND	21.4	109×109 / 120×120	41.18 N 5.34 E	61.30 N 40.73 E
PORTUGAL	20.6	85×85 / 96×96	31.99 N 18.17 W	47.08 N 2.54 W
SELAM	24.8	79×53 / 90×64	38.62 N 19.90 E	50.06 N 44.55 E

Foreseen changes in operational suites (within end 2002, *for 2003*)

Partner / Model	Computer	Library	Model characteristics	Operational applications
AUSTRIA			*increased domain size*	*coupled to ARPEGE*
BELGIUM				
BULGARIA		AL12		
CROATIA		AL15		*coupled to ARPEGE*
CZECH REP.				*new operational model* *coupled to ARPEGE*
FRANCE-Métropole				blending assimilation
FRANCE-Réunion				
HUNGARY	IBM Regatta 32 processors	AL15	increased domain size increased resolution	*coupled to ARPEGE* *3d-var assimilation*
LACE				ending with 2002
MOROCCO- NA (Northern Africa)	IBM		resolution 28km coupled to ARPEGE	blending + 3d-var assimilation 72h forecast once a day lagged coupling 6h-coupling
MOROCCO- Maroc	IBM		resolution 9km coupled to ALADIN-NA	60h forecast once a day synchronous 6h-coupling
MOROCCO- NordEst	CRAY		resolution ~ 5km coupled to ALADIN-Maroc	
MOROCCO- Nord	CRAY		resolution ~ 5km coupled to ALADIN-Maroc	
MOROCCO- Centre	CRAY		resolution ~ 5km coupled to ALADIN-Maroc	
MOROCCO- Sud	CRAY		resolution ~ 5km coupled to ALADIN-Maroc	
POLAND	SGI 2800 / Cracow + SGI 3800 / Warsaw	AL15	41 vertical levels, linear grid	
PORTUGAL				
ROMANIA	SUN E4500 8 processors	AL15_03	*37 vertical levels* *increased domain size*	48h forecast 4 times a day synchronous coupling *diagnostic analyses* *dynamical adaptation of wind*
SLOVAKIA				*coupled to ARPEGE*
SLOVENIA	AMD Athlon 32 processors	AL15	*increased domain size (~ LACE)* *resolution 12 km*	*coupled to ARPEGE*
SLOVENIA-"small"		AL15	*resolution 8.6 km* *coupled to ALADIN-SLOVENIA*	*coupled to ALADIN-SLOVENIA*
TUNISIA	running in Tunisia		*increased domain size* *increased resolution*	

Foreseen changes in telecom domains :

BELGIUM : the resolution should increase to 9.5km
LACE (output): *it should disappear*
MOROCCO : the domain should increase
SELAM : *the domain should slightly increase*

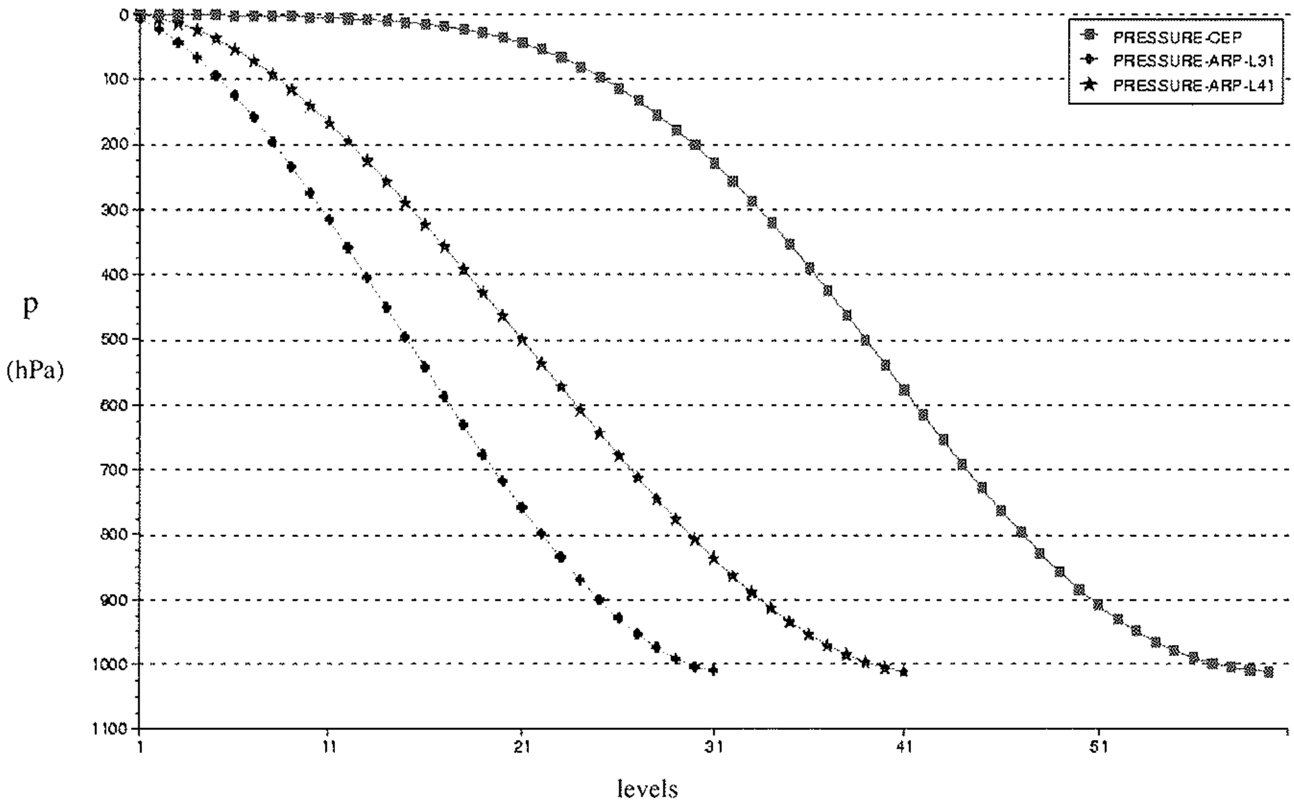
2. Changes in the operational version of ARPEGE along the first half of 2002

(more details samuel.westrelin@meteo.fr)

<u>17 January 2002 : "Increase of resolutions"</u> (new design of the operational suite)

- *Improved stability and reproducibility of the physics*
- *Retunings*
  imposed by the changes of resolution
- 🖱 *: bugs introduction !*
  (in convection)
- *Increase of vertical resolution :*
  from 31 to 41 vertical levels
  highest level : from 5 hPa to 1 hPa
  lowest level : from 20 m to 17 m

Old and new distributions of vertical levels, compared to that of the ECMWF model



- *Increase of spectral resolution*
  the grid does not change
  the orography does not change
  the spectral resolution is increased by 50% for prognostic variables ("linear" truncation, also called "linear" grid)
- *Changes in 4d-var*
  increased vertical and spectral resolution
  less incrementality : innermost loop suppressed, considering the ratio extra-cost / efficiency, semi-Lagrangian advection for the propagation of increments in the TL/AD models

➽ *The new configuration is the following :*

➤ *High resolution :*

spectral truncation $T_L298c3.5$
semi-external incremental initialization (based on finalization)
3 steps :
①. 6h forecast + computation of "obs-guess" + quality control + filtering
②. update after the first minimization step + 6h forecast +computation of "obs-guess"
③. update after the second minimization step + 6h forecast + filtering + surface anal.

➤ *Low resolution :*

spectral truncation T_L161
6h forecast and minimization (second step)
Jc-dfi as a weak constraint
full simplified physics (vertical diffusion, mesospheric drag, gravity-wave drag, large-scale precipitations, radiation, convection)
25 iterations

➤ *Very low resolution :*

spectral truncation T_L107
6h forecast and minimization (first step)
Jc-dfi as a weak constraint
dry vertical diffusion (Buizza)
50 iterations

28 March 2002 : "Bug correction" (correction of the bugs introduced on 12/11/2001)

- *Corrections in the vertical diffusion and anti-fibrillation schemes*
- *Retunings*

14 May 2002 : "Safer physics" (a few improvements in physics)

- *Stronger safety thresholds in the convection scheme*
- *Improved anti-fibrillation scheme*

  The vertical variations of the coefficient controlling the anti-fibrillation scheme are limited, with a maximum equal to the value at the lowest level, in order to avoid the previous (sometimes very strong) oscillations.

Latest parallel suite : "New observations"

- *Use of raw AMSU-A data, use of profilers data, use of temperature observations at all levels for TEMPs (instead of a combination of Z and T), and some technical changes in pre-processing*

  still some technical problems : failures in the analysis step, and improvements mainly after 48h ... The parallel suite stopped at the beginning of July without moving to operations. I was relaunched afterwards.

3. Operational version in Austria

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

Early in 2002, the operational ALADIN-VIENNA suite and all its post-processing applications were ported from the DEC-alpha single-processor machine to an SGI Origin 3400 computer with 20 processors (500 MHz). On the new platform, the operational 48 h integration run (144x128 gridpoints, 37 vertical levels) including DFI takes roughly 10 mn.

Concurrent with the switch of platforms, we moved from *AL11* to *AL12/Cycora_bis* operationally. *AL15* has been installed on SGI and will be run in parallel mode for some time before becoming operational later in 2002.

4. Operational version in Belgium

(more details olivier.latinne@oma.be)

No significant change since the last Newsletter. See part 1 for the present status and plans.

5. Operational version in Bulgaria

(more details andrey.bogatchev@meteo.bg)

The New Operational Suite of ALADIN-BG

The new operational suite of ALADIN-BG was developed during the second quarter of this year. For that purpose the *export_AL12_04* package was used. Also the new climatological files were created for the integration domain.

The distributed memory version of the code was preferred. It is running on a single processor station without initialization of MPI. On Sun Hyper 60 the averaged time for integration job is 90 minutes. The increased integration time is balanced by the introduction of a new system for visualization of forecast fields. The last version (1.8 SL10) of GRADS (Grid Analysis and Display System) was implemented on our station. It has some new features like producing *gif* images in batch mode, which gave us the possibility to decrease almost twice the execution time of the visualization part. The price for this decrease is a larger size of the *gif* files.

There are significant changes in the graphical presentation of forecast fields.

1. All pictures are displayed with colour bars.
2. For 2m temperature, a fixed colour palette is used.
3. The wind is displayed with barbs, coloured with the temperature of the corresponding level.
4. The precipitation fields are displayed in shaded format with the value of the maximum of precipitation printed at the corresponding grid point.
5. The cloudiness is presented in gray scale.

Figures 1-4 show the images for 2m temperature, 6 hours precipitation geopotential height and wind on 950 hPa.

The last part of the new operational suite is related with the production of specific files for end-users like: National Company for Electricity, wind wave model, oil-spill model and MEDIA model.

The new operational suite was run in pseudo-operational mode more than one month and there were no crashes, or some other problems.

We plan to implement it in full operational mode on 16 of July.

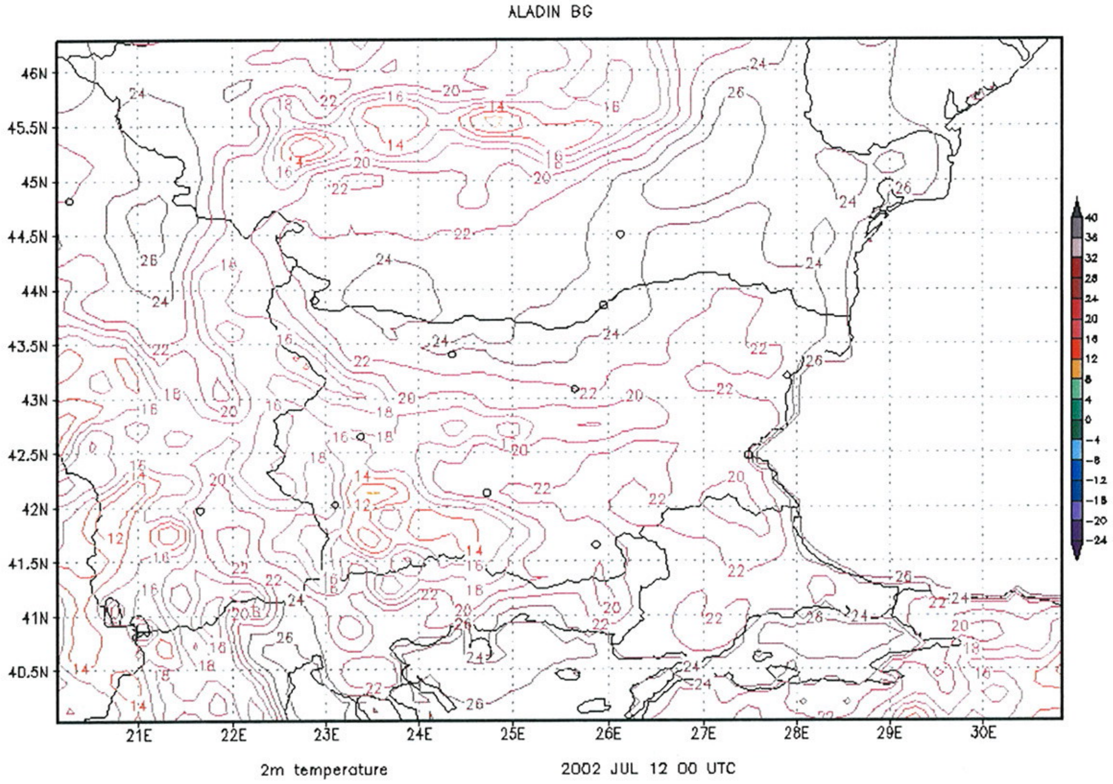


Figure 1

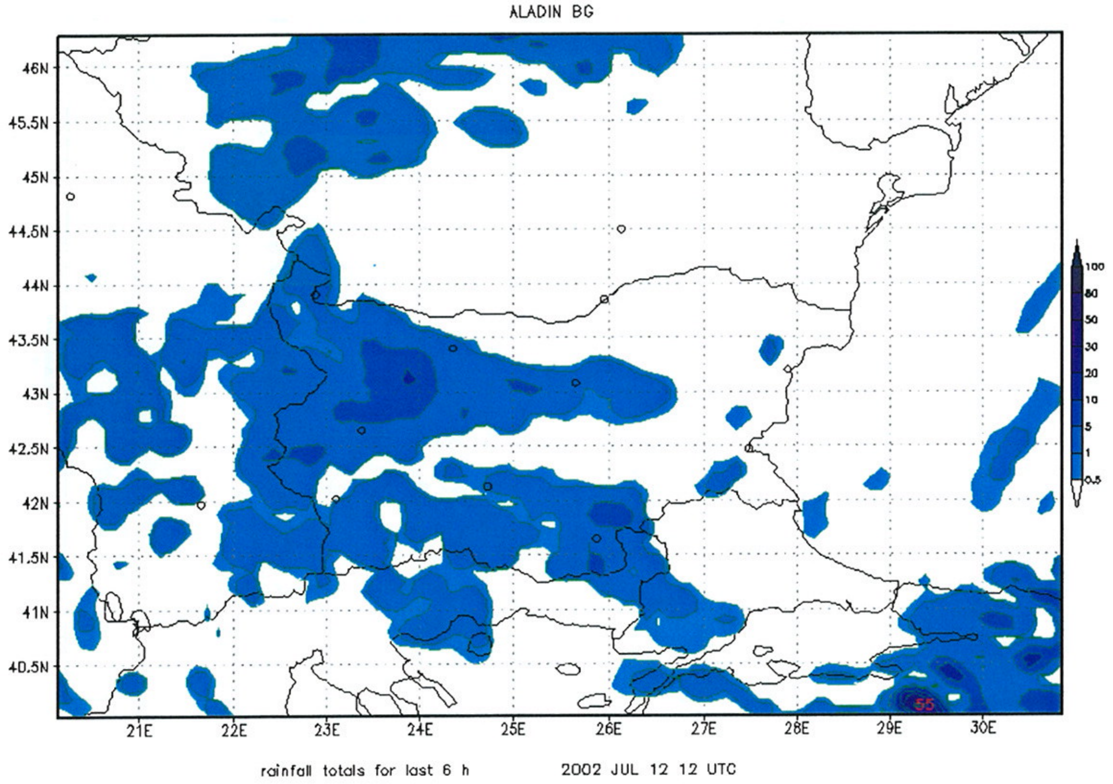


Figure 2.

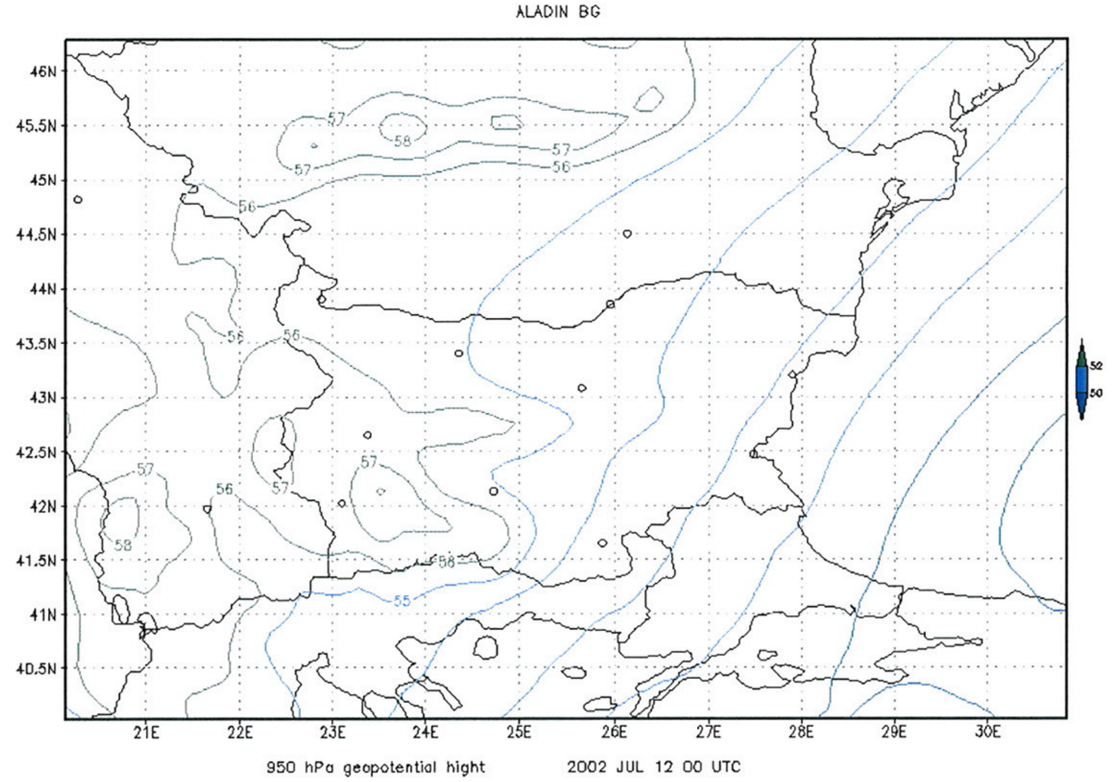


Figure 3.

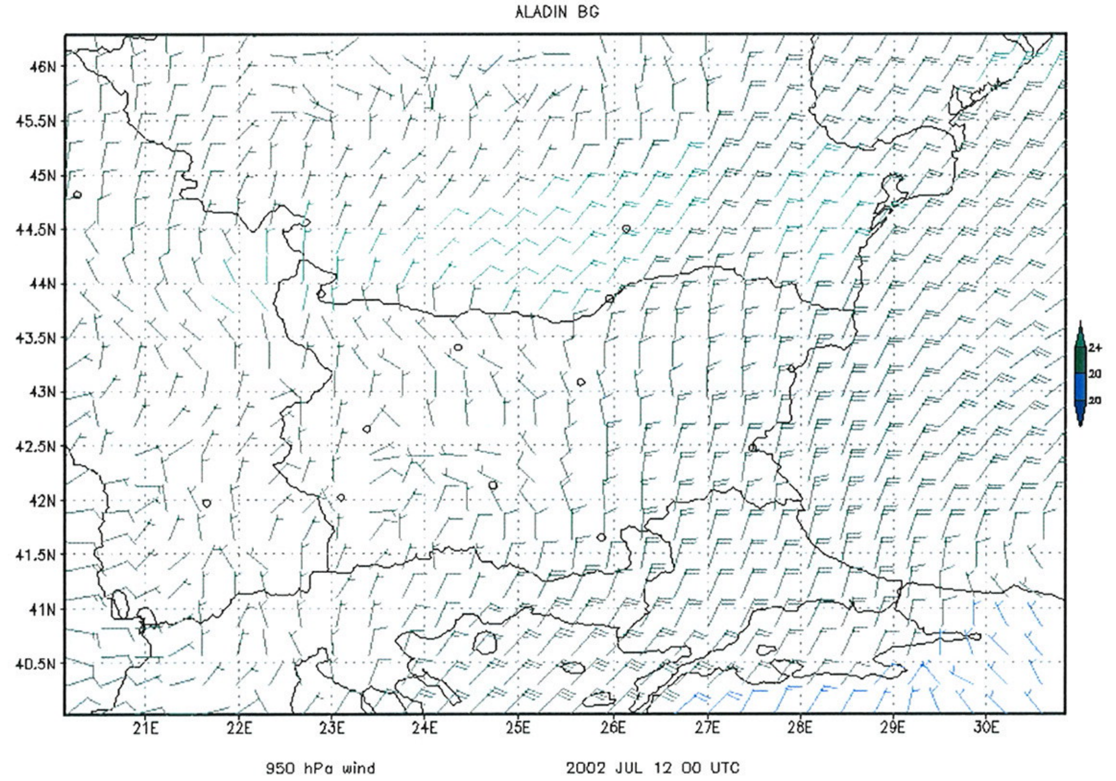


Figure 4.

6. Operational version at Croatian Meteorological Service

(more details bajic@cirus.dhz.hr)

Transfer of operational *AL12* suite on the SGI machine is finished. Modification of scripts and new visualization procedures have been done.

ALADIN is running operationally twice a day on the Croatian HRv8 domain that contains 144x120 gridpoints (127x109 without the extension zone) with an horizontal resolution of 8 km and 37 vertical levels. The surface wind field from the integration on the Croatian domain with a 8 km horizontal resolution is dynamically adapted to orography with a 2 km resolution.

7. Operational version at Météo-France

(more details samuel.westrelin@meteo.fr)

Similar changes as in ARPEGE along these 6 months. The new (linear) spectral resolution is E149×149.

The main worries were related to the so-called "Aladinades", i.e. spurious, and strong, small-scale precipitation patterns, also noticed in other ALADIN models (e.g. the Adriatic storm cases studied by Zoran Vakula et al. in ALADIN-LACE, see the ALADIN report for RC-LACE).

8. Workstation version at Météo-France

(more details jean-marc.audoin@meteo.fr)

Nothing new since the last Newsletter.

9. Operational version in Hungary

(more details horanyi@met.hu)

The most important news for the Hungarian Meteorological Service was the installation of the new IBM Regatta server at the beginning of January. The main characteristics of this computer are as follows (it is noted that ECMWF purchased the same kind of machine with building blocks of such Regatta servers) :

- IBM p690 Regatta server with 32 processors (1,3 GHz POWER4 processors),
- Architecture: Symmetric Multiprocessing (SMP)
- Peak performance: 5,2 Gflops/processor
- Memory: 1 Gbyte/processor
- Disk capacity: 364 Gbyte

To give a rough idea about the performance of our new computer it can be said that a 48 hours forecast for the ALADIN/LACE domain (216 × 240 points with 31 vertical levels) takes less than 8 minutes for the *AL15* version of the ALADIN code.

After installation the first and most important step was the repetition of the benchmark tests provided by the manufacturer. After its completion the official handover ceremony was organised on 18th of February, 2002 in the presence of the Minister of Environment.

The migration work was continued afterwards and until now the most important configurations were put into work: ee927 (lancelot), 001 (morgane), Full-Pos (off-line), 002 (screening), 131 (3d-var). The latter configurations are using the ODB database. Additionally several auxiliary procedures were written for data handling, different interfaces and other important algorithms needed for the operational suite.

As far as the new operational suite was concerned the first objective was to reproduce the same version as it was the case for our Origin 2000 machine. Therefore the differences in the new suite are rather minimal and restricted to the new version of the code (old : *AL12*, new : *AL15*) and to off-line Full-Pos (in the SGI machine on-line Full-Pos was used). A one month intermediate period was considered while the model was running on both platforms and then at the beginning of June the new suite was put into operations on the Regatta server. It is noted here that the nowcasting analysis (CANARI-Diagpack) was and will be kept on the Origin machine (this machine will primarily serve the interest of the nowcasting applications).

After the stabilization of the operational suite, in the near future the following main tasks are planned to be performed :

- Migration of the remaining auxiliary procedures to the Regatta machine.
- Completion of all the steps required for the 3d-var data assimilation scheme.
- Installation and tuning of the loadleveler software for effective resource management.
- Preparations for direct coupling from ARPEGE (with the disappearance of ALADIN/LACE operational model version) together with a new domain definition (higher resolution and extended domain).

As a summary it can be said that significant work was carried out around the new machine of HMS. At the end of June the new operational suite was stabilised on Regatta and the work is going to be continued towards 3d-var and single-nesting strategy (direct coupling from ARPEGE).

10. Operational LACE application

(more details vana@chmi.cz)

1. Evolution of the ALADIN/LACE application.

The ALADIN/LACE suite was switched to 37 vertical levels :

07/02/2002 at 12 UTC network time for the production run and at 06 UTC network time for the assimilation cycle : increase of the vertical resolution from 31 to 37 levels.

This switch was, as usual, preceded by a parallel test. A slight improvement of all parameters near the surface was due to a better resolution in the Planetary Boundary Layer (PBL) in the 37-levels version. Contrary to ARPEGE switching to a 41-levels version, the very high altitude vertical levels were not retained in ALADIN/LACE : the dynamics of these upper-stratospheric levels was likely to cause more problems than bringing in some benefits and in contrast with the global model there is no urgent practical need to keep them. The same applies to the linear grid version, not retained in ALADIN/LACE while applied in ARPEGE and ALADIN/FRANCE : the tests performed in summer 2001 were not convincing enough to motivate the use of the linear grid, which would have brought a non-negligible impact on the telecommunications and archiving costs due to increased size of model files. The switch to 37 levels was coordinated with Members regarding their national applications. A detailed description of the necessary changes made by the Prague Team Leader (PTL) ensured the smooth switch to 37 levels in the nested ALADIN models.

Impact on the forecast : weak improvements in the scores of all parameters within PBL.

Technical impact : prolongation of the computational time due to more levels and also to a shorter timestep which has to be used due to the increased vertical resolution. Now the +48h GRIB bulletins are ready for dissemination around 3 h 30 mn about after the network time (the timeliness constraint is 4 h after the network time). Also the boundary conditions and history files issued from ALADIN/LACE increased their size.

The ALADIN/LACE application switched to a higher temporal frequency of the Lateral Boundary Conditions update on :

05/03/2002 at 12 UTC network time for the production run and at 00 UTC for the assimilation cycle : the update frequency of the Lateral Boundary Conditions (LBC) was increased from 6 hours to 3 hours.

This change was motivated by the increased computational time needed for the 37-levels version, which created a time window to repatriate more boundary-condition files from ARPEGE. At the same time it is a well known fact that a higher update frequency of LBCs allows a better passage of the information from the driving to the coupled model, hence the aim was not only to re-balance the computer and line speeds. At the same time the quadratic time-interpolation of LBC data was kept despite a recent rumour that the quadratic time interpolation in combination with the increased (3h) frequency might cause problems. PTL has made a careful check on that issue and proven it to be only a rumour. In addition, a parallel test was made and the better ability of capturing the signal from ARPEGE was seen again on the recent "Hana" Storm case (storm of 26th February 2002 hitting Danish and German coast).

Impact on the forecast : slight improvement of the mass field scores; known beneficial impact for extreme weather cases such as T1 French Storm (26/12/1999), Hana Storm (26/02/2002).

Technical impact : increase of the downloading time of the LBC files from ARPEGE. In order to keep a balance with the speed of computations, the sending of RETIM charts on the back line to Toulouse was delayed till the end of the downloading task: this eliminates a problem of slowing down the reception of confirmation packets when downloading the LBC files. There is no technical change on the downstream of products to Vienna.

2. Parallel Suites & Code Maintenance

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

- *Suite ABM* : "test of 37 vertical levels". The suite showed slight improvement of all fields near the surface. It became operational on 07/02/2002.

- *Suite ABN* : "repeated CYCORA-ter after bug correction". There was a hope that the bug found in the vertical diffusion parameterization scheme could explain the bad scores of the suite ABL for the winter type of weather. The suite was run for the same period like the suite ABL. Unfortunately the scores were as bad as before.

- *Suite ABO* : "3h quadratic frequency coupling". This suite was meant to check the results obtained back to 1997 when the increased temporal resolution of the lateral boundary conditions (LBC) was tried for the first time and also when the quadratic temporal interpolation was compared to the linear one. Indeed, the signal is almost neutral except for a very slight improvement in the geopotential score. The increased frequency of the update of the LBC confirms to be important when there are fast moving cyclones; otherwise it does not play a too important role. The suite became operational on 05/03/2002.

- *Suite ABP* : "3h linear frequency coupling". As mentioned above, there was a rumour saying that the quadratic temporal interpolation can produce some pathological behaviour with the 3h frequency update of the LBC and that the use of the linear interpolation is better in such case. To be quite sure that it is only a rumour (there was no theoretical evidence), a parallel suite was launched. There was no signal in the scores compared to the quadratic interpolation. The two techniques were compared for the extreme cases. There the quadratic interpolation performed better.

- *Suite ABQ* : "repeat of CYCORA-ter package test but with the mixing length of CYCORA-bis". This suite was run again on the same winter type of weather as the ABN suite. It proved that the tuning of the mixing length was one of the crucial factors influencing the scores. With the old tuning the CYCORA-ter physics performed almost as well as the CYCORA-bis physics for the cold continental weather. It remains to test also the spring and summer situations to assess the qualities of the CYCORA-ter package.

- *Suite ABR* : "slantwise convection & the latest CYCORA-ter". This suite combines several changes in the physics package: it contains all the latest correction and improvements of the CYCORA-ter, it keeps the CYCORA-bis mixing length, it contains a modification of the convection scheme having the same effect as the slantwise convection parameterization. The suite is not yet evaluated.

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

- *Back-phasing of physics and problems with ODB*

As mentioned above, the last version of the physics was back-phased to cycles *AL12/CY22T1* in order to allow its operational application once the tests are completed. This back-phasing is mainly due to the problems related to the port of the ODB software, which is necessary for any configuration using observations with cycles *AL15/CY24T1*. Hence the difficulties with ODB block the introduction of *AL15* into operational exploitation. While ALADIN/ARPEGE/IFS is reasonably hard to port, ODB itself is not finished nor documented. The porting process requires modifying undocumented code that heavily uses techniques in ways long deprecated by computer science community, such as the C pre-processor. The code is big endian dependent and since the data files are not documented either, it is impossible for anyone else that the ODB author to port it to a little endian platform, such as popular PCs. The source tree is not organised and is hard to build. In summary, we had three skilled system administrators working on ODB for 8 weeks in total, and those were not yet able to get it running on any of our platforms.

- *Bug in reading the spectral arrays*

Other maintenance issue concerned the bug in reading spectral arrays and affecting the spectral norms of vorticity. The problem was located with ALADIN cycle *AL15_op1* but also cycle *AL12_op6* on NEC-SX4 super-computer. However, the same problem was reported on other platforms, perhaps except the VPP.

Solution for *AL15_op1* and *AL12_op6* :

Beginning state :

1 processor

```
SPECTRAL NORMS -  SURFACE PRESSURE  0.114791074605369E+02
 LEV     VORTICITY                 DIVERGENCE                TEMPERATURE               HUMIDITY
KINETIC ENERGY
 AVE 0.493188076536417E-04 0.421293426850173E-04 0.256429672957490E+03 0.313741881325838E-02
0.613511922401997E+02
   1 0.123230803794318E-04 0.280337525477330E-05 0.248872736033203E+03 0.204345281969550E-0
0.114191583165689E+03
   2 0.706968502499767E-05 0.445577890475627E-05 0.227309477147068E+03 0.296383928915048E-05
0.433114385866733E+02
   3 0.558903141344059E-05 0.557412052443573E-05 0.221494219308932E+03 0.115399480362638E-0
0.235739446655111E+02
  ......................... ......................... ......................... .........................
.....................
  31 0.240905639045916E-04 0.269483984823826E-04 0.288490086380765E+03 0.875349092093968E-0
0.296433232741700E+01
```

2 processors

```
 SPECTRAL NORMS -  SURFACE PRESSURE  0.114791074605369E+02
 LEV     VORTICITY                DIVERGENCE              TEMPERATURE              HUMIDITY
KINETIC ENERGY
 AVE 0.493166015655407E-04 0.421293426850173E-04 0.256429672957490E+03 0.313741881325838E-02
0.613501380862824E+02
   1 0.122546916483002E-04 0.280337525477330E-05 0.248872736033203E+03 0.204345281969550E-05
0.114158904394253E+03
   2 0.706968502499767E-05 0.445577890475627E-05 0.227309477147068E+03 0.296383928915048E-05
0.433114385866733E+02
   3 0.558903141344059E-05 0.557412052443573E-05 0.221494219308932E+03 0.115399480362638E-04
0.235739446655111E+02
  ...................... ..................... ..................... ......................
......................
  31 0.240905639045916E-04 0.269483984823826E-04 0.288490086380765E+03 0.875349092093968E-02
0.296433232741700E+01
```

The differences are "only" in level 1 for Vorticity and Kinetic energy.

Changes in code :

1. cy24t1op1/setup/suspec.F90

instead of:

```
REAL_B :: PSPVOR(:,:),PSPDIV(:,:)
```

to use:

```
REAL_B :: PSPVOR(NFLSUR,NSPEC2)
REAL_B :: PSPDIV(:,:)
```

2. al15/include/suspec.h -> ../../cy24t1op1/interface/suspec.h

same changes in interface suspec.h

3. recompilation of all routines with changed interface suspec.h

elsirf.F90 su1yom.F90 cun3.F90 cva1.F90 edfi2.F90 rd801.F90 sim4d.F90 suecges.F90 suinif.F90 suvazx.F90 upspec.F90 suspec.F90

After this modification the **norms** are identical and independent on number of processors. Same for values in historical files. However this fix is temporary, before the true mistake is found (like missing interfaces or so).

- *TUC: Transparent Use of ClearCase*

This software was further improved by introducing the *cc_depend* command. The dependencies can be checked also through other projects.

More details on the parallel suites and code maintenance can be asked to : Filip Vana, Tomas Kalibera, Oldrich Spaniel

11. Operational version in Morocco

(more details radi.ajjaji@pioneer.meteo.ma)

ALADIN/Morocco status.

Observations.

Since last January, our BDM (Meteorological Data Base) became operational again after more than two months of hardware problems. Now it processes all observation types on an area between 0° N, 55° N, 40° W and 56° E. This area, which is the target for the expected ALADIN North Africa

(NA) model, is very poor of conventional data especially in the Southern part. We decided to rely on satellite data, especially TOVS 120. Météo-France agreed to send us this observation type.

Concerning ODB, we are still in the process of porting all its components on IBM, but without good results for the while. We expect local assistance from Météo-France (Philippe Caille should come to Casablanca) and remote assistance from Sandor Kertesz.

Assimilation.

ALBACHIR is still running CANARI operationally with the *AL13* code version on IBM. But we expect to go soon to the Blendvar method, when ODB will be OK and when ALBACHIR will be run on the North Africa domain. It has been shown in a local study that Blendvar gives better scores compared to CANARI, Blending alone and 3d-var alone. Surface analysis will still be done by CANARI.

We are waiting for ODB to be ported on IBM in order to begin a pre-operational suite based on Blendvar. This pre-operational version will also use TOVS 120 that will be received routinely from Toulouse.

Forecast.

ALBACHIR is now running until 72 hours twice a day. We expect to extend the domain to the North Africa region by the end of September. This version will cover all Northern Africa and the Mediterranean sea (25 km of horizontal resolution and 41 levels : a grid of 180x300x41 points). We will keep an asynchronous coupling with ARPEGE, with a 12-hour delay. ALBACHIR NA will be used, among others, to couple a fine mesh version of ALADIN centred on Morocco (9km of resolution).

This suite, which will be coupled in asynchronous mode with ARPEGE, is already tested on single situations. It is ready to become operational when Météo-France will send us the corresponding coupling files. It is detailed in a separate paper.

Control and verification.

A verification procedure, described in a separate paper, is running once a day to control ALADIN 24-hour forecasts against TEMP and SYNOP observation types. The first bias and rms graphs for June and July 2002 are available on our web site *http://www.spn.meteo.ma/* . The *verifala* mailing list will receive these results very soon.

12. Operational version in Poland

(more details zijerczy@cyf-kr.pl)

See part 1 for the present status and plans.

13. Operational version in Portugal

(more details margarida.belo@meteo.pt or maria.jose@meteo.pt)

During this first half of 2002 not so many changes have been introduced on the Portuguese operational suite (*AL12_bf_CYCORA_bis*). New meteorological fields are now being post-processed for development and forecasting purposes.

14. Operational version in Romania

(more details banciu@meteo.inmh.ro)

See part 1 and the ALADIN report.

15. Operational version in Slovakia

(more details Olda.Spaniel@mail.shmu.sk)

OPERATIONAL ENVIRONMENT OF ALADIN/SLOVAKIA

COMPUTER CHARACTERISTICS

DEC Alpha Xp1000 (Compaq), EV6 processor DIGITAL UNIX V4.OD
DIGITAL F90 compiler, native C compiler
640 MB memory (will be upgraded on 1GB), 12 GB HDD

MODEL CHARACTERISTICS

size of the domain	862 x 646 km
domain corners	SW : 14.69 E, 46.05 N - NE : 22.26 E, 51.07 N
number of points	120 x 90 (including E-zone)
horizontal resolution	7.18 km
vertical resolution	31 levels
time step	337.5 s
length of the forecast	48 hours
frequency of the outputs	1 hour
runs twice per day	(00 UTC and 12 UTC)
mode dynamical adaptation	
coupling model	ALADIN/LACE (12.2 km resolution)
coupling frequency	6 hours
physics and dynamics the same as ALADIN/LACE	
model version	*AL12_op6* (*CYCORA_bis*) operational; *AL15_op3* ported

MODEL PRODUCTS

- surface parameters in map form (2m temperature, 2m Tmax, 2m Tmin, 2m relative humidity, 10m wind, precipitations, cloudiness)
- meteograms for 22 cities over Slovakia (our SYNOP stations)
- vertical cross-sections
- pseudo-TEMP
- ATPA - automatic text forecast from ALADIN for 22 Slovak towns (user configurable via *web* interface, distributed by e-mail / SMS)
- the area average precipitation for the main river catchments
- wind roses - use of CANARI configuration to determine surface wind characteristic within ALADIN/SLOVAKIA domain
- RODOS - selected meteorological fields for the dispersion model RODOS

16. Operational version in Slovenia

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

There was nothing new in operations but the activities for ITT for a new computer started in March 2002. The replacement of the old cluster is expected till the end of 2002, when *AL15* will be put in operational use on a larger integration domain.

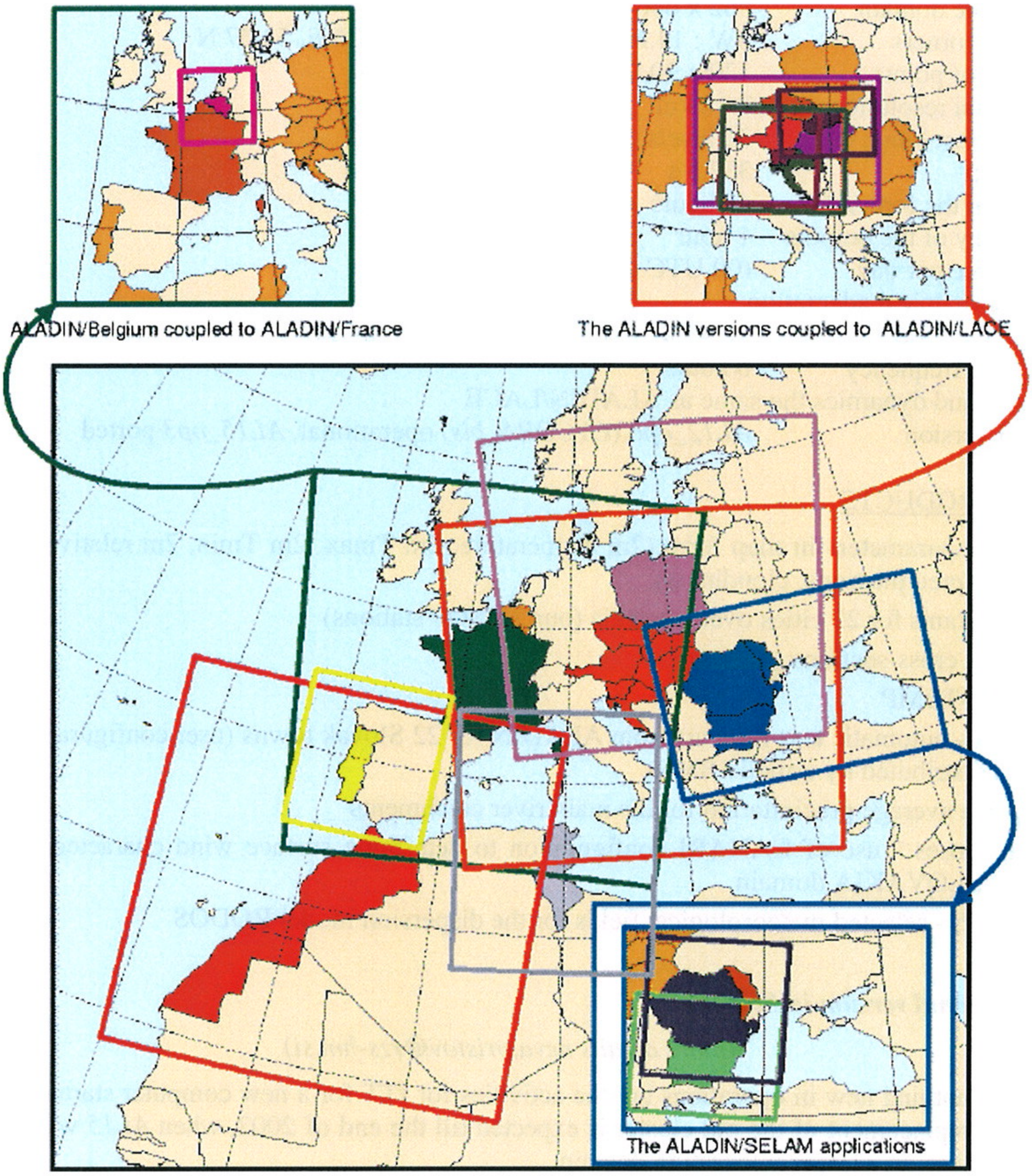
17. Operational version in Tunisia

(more details nmiri@meteo.nat.tn)

Most of the work during this period concentrated on the purchase procedures of computing equipments for the operational forecasting system. The INM invitation to Tender were formal. The technical choice has been done and we should conclude the purchase contract during the few next months. The expected date for a local implementation of ALADIN is December 2002.

Concerning the verification procedures we started last year, there is no commensurate advancement due to lack of required data.

18. The map of operational models



The ALADIN applications directly coupled to the ARPEGE model of Météo-France

ALADIN developments during the first half of 2002

1. In Austria

Stratus prediction

In a cooperation between ZAMG and the University of Vienna (S. Lichtenauer), the forecast errors of the ALADIN model with regard to fog and low cloudiness are investigated. The research is part of COST Action 722 "Short-range forecasting methods of fog, visibility and low clouds". It was found that the frequent under-prediction of low stratus in the Danube area is associated with incorrect prediction of temperature inversion characteristics. In the model, inversions are generally too much smeared out, and too close to the ground. Above the inversion, the model is typically 1-2 degrees too cold compared to sounding observations, whereas it is up to several degrees warmer than observed just below the inversion. The lack of sufficiently cold air just below the inversion leads to an underestimation of cloudiness. With less than 100% cloud cover, the PBL begins to warm during morning hours. This further reduces cloud cover, and a reinforcing feedback loop sets in. The problem of too smooth temperature structures is present from the initial time (+00h) because the data assimilation in ARPEGE rejects cold temperatures just below the inversion if they differ too much from the model state. This was shown for a stratus case in January 2002 (E. Bazile, personal communication). A description of numerical experiments that were made on the stratus / inversion problem, with both the SCM and the full 3d model, can be found in this Newsletter. [Further details: *alexander.kann@zamg.ac.at*]

Prognostic convection

The prognostic convection scheme of Luc Gerard was tested on a case of diurnally forced mountain convection. This is a type of convection that is typically predicted too early in the day. The prognostic scheme, which takes into account the "inertia" of deep convection in the form of prognostic draft strength and active mesh fraction both for convective up- and downward motion, did not show a significant delay in the onset of precipitation. However, the spatial patterns were more selective compared to the standard scheme, and at least for the case investigated, closer to observations (here radar data). Additional tests during the convective season in 2002 need to be carried out, in order to confirm this potentially beneficial behaviour. [Further details : *stefan.greilberger@zamg.ac.at*]

Operational verification

The first in a series of bi-annual verification reports was issued in February 2002. It can be obtained in *pdf* format from the ZAMG homepage *http://www.zamg.ac.at* by clicking on the British flag, following the "Numerical Weather Prediction" link and choosing "Verification" from the pull-down menu. The report contains point verification statistics and shows ALADIN / ECMWF model intercomparisons for near-surface variables over a period of several years. The next issue will appear in September 2002. As a special topic it will contain a preliminary analysis of the performance of ALADIN during the catastrophic rainfall events in August 2002. [Further details: *thomas.haiden@zamg.ac.at*]

More information about research activities of the NWP group at ZAMG can be obtained from the ZAMG homepage *http://www.zamg.ac.at* by clicking on the British flag and following the "Numerical Weather Prediction" link.

2. In Belgium

Most efforts focussed on ALATNET related research, and consequently are described in the ALATNET Newsletter.

3. In Bulgaria

Most of the effort was devoted to the implementation of a new operational suite.

4. In Croatia

Great deal of time in the previous period was devoted to the organization of the 12th ALADIN workshop on "Scientific Development and Operational Exploitation of ALADIN model" and preparing the presentations for the workshop.

Following work has been presented :
Martina Tudor : MAP IOP 15 Case Study
Marija Mokoric : ALADIN products in "Taming the Dragon-Dalmatia 21 to 24 May 2002"
Zoran Vakula : Adriatic Storm Cases
Stjepan Ivatek-Sahdan : Analysis of surface variables

5. In Czech Republic (RC-LACE report)

Note: all ALATNET related R & D, representing the majority of the effort, is reported in ALATNET Newsletter. Here we sum-up topics which are not referred as ALATNET ones for Prague centre.

Developments in physics : *Problems with unrealistic "large-scale" precipitations*

Last spring we noticed a few cases when the model produced unrealistic spots of precipitation reaching sometimes 60 mm/6 h (Figure 1). Although the meteorological situation was favourable for strong rain, such an amount was surely exaggerated. Several tests were made, using both past and newest versions of the physics (pre-CYCORA, CYCORA, CYCORA-bis, CYCORA-ter, very last changes and corrections in CYCORA-ter) but there was almost no sensitivity to this. We tried to diminish the length of the time-step (we used half the nominal one for LACE) in order to exclude any possible numerical instability within the physics. However, the result was even worse since the amount of precipitation was almost doubled. Since the heavy rain was produced by the large-scale or better to say by the explicitly resolved precipitation computation, we could think that the problem was linked to the spatial resolution (in connection to the convection scheme which seemed almost inactive), perhaps to the recent increase in vertical resolution (last summer nobody reported similar cases). After discussing with the physics team in Toulouse (J.-F. Geleyn, F. Bouyssel) we tried to introduce the parameterization of "shear-linked convection" proposed by J.-F. Geleyn.

The impact on forecast was quite significant. For the studied case the amount of precipitation was diminished to more realistic values (Figure 2), more comparable with the rain gauge observations (reaching a maximum of 21 mm/6 h in the concerned area, see Figure 3). The resulting precipitation field moderately changed everywhere. We have tried the physics package including the "shear-linked convection" scheme also for other cases reported this spring. For most of them we obtained more realistic precipitation fields, however we cannot say that the forecast was systematically better.

In addition, we tried to recompute the cases of unrealistic cyclogenesis in the Adriatic (there were three such cases reported last summer). Once more we obtained a nice improvement : the cyclone over the sea was weaker and the pressure field remained almost the same elsewhere.

However, since the impact on forecast is quite important, more extensive testing and perhaps retuning, including parallel suites, must be done before switching to the use of shear-linked convection in the operational application.

More details can be asked to : Jean-François Geleyn, François Bouyssel, Radmila Brozkova, Filip Vana.

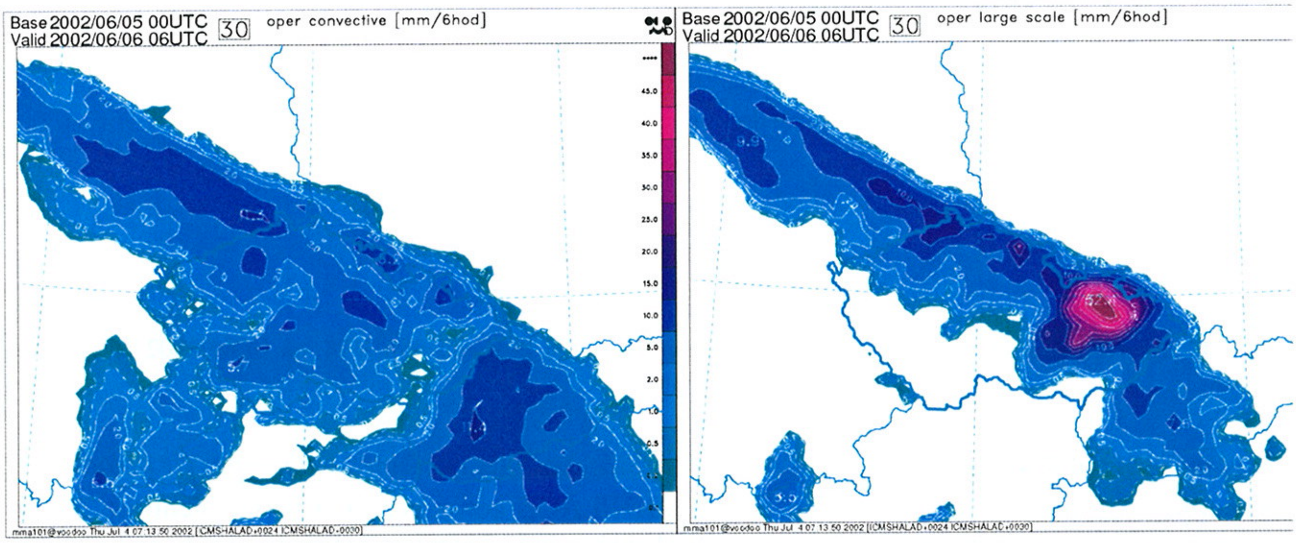


Figure 1 : Operational ALADIN/LACE forecast starting on 05/06/2002 at 00 h UTC : cumulated precipitations between +24 h and +30 h. Convective (unresolved) precipitations are on the left; the ones resulting from the explicit computation are on the right. The maximum coming from the explicit computation reaches more than 52 mm / 6 h in the Jesenik mountains.

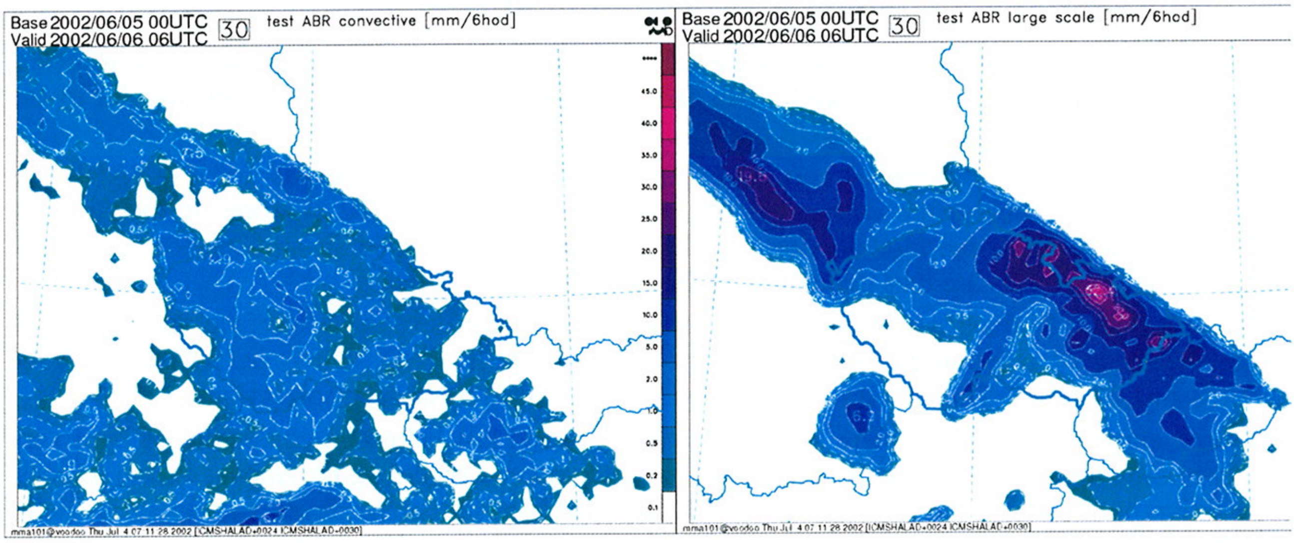


Figure 2 : Same as in Figure 1, but for the parallel test ABR, using the new parameterization with the operational initial and lateral boundary files. The maximum of explicitly resolved precipitation is by 20 mm / 6 h lower in the Jesenik mountains when compared to the operational forecast. On the other hand there is a stronger maximum in Germany. The amount of convective rain is even smaller than in the operational case.

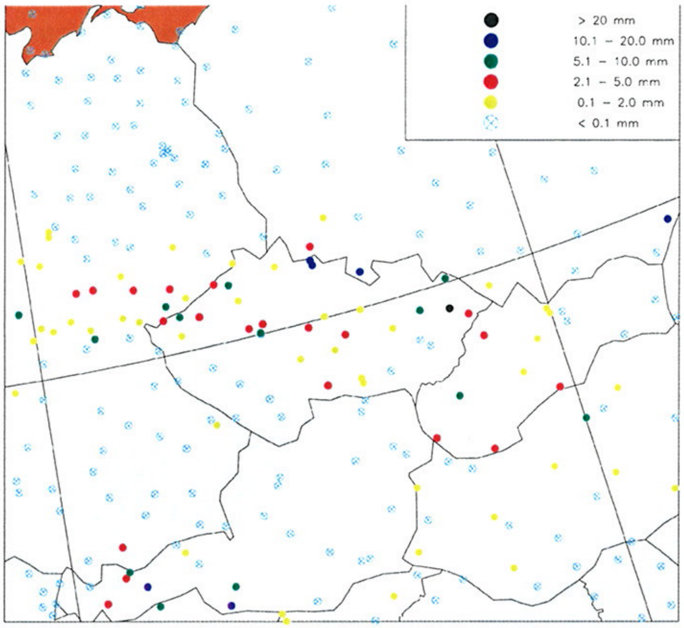


Figure 3: Observed sum of precipitation over 6 h interval between 00 h and 06 h UTC on 06/06/2002 at synoptic stations.

Developments in data assimilation : *CANARI surface analysis combined with upperair blending*

Currently the blending algorithm used in ALADIN/LACE comprises two parts: blending of the spectral dynamical prognostic variables (BLEND) and blending of the surface variables (BLENDSUR). The latter is simply based on a sophisticated interpolation of the ARPEGE analysis increments onto the ALADIN grid and summing them with the ALADIN guess. The aim of this work was to replace this blending of surface variables by a surface analysis / assimilation, using the optimal interpolation scheme CANARI. At the first stage of this work, beside the simple technical change, the aim was to study various possibilities to implement this surface analysis step. Then, another particular problems were looked at. Concerning the above mentioned possibilities of the combination of the surface analysis and upperair blending, three approaches were tried:

Experiment 1: both schemes are independent in the sense that the result of one does not influence the other one, that is both parts work with the original guess. This scheme corresponds to the current arrangement of the BLENDSUR and BLEND.

Experiment 2: The dynamical part BLEND is done first and the guess for CANARI gets refreshed upperair fields (the comparison to observations in CANARI is done at the level of SYNOP stations where the model value is influenced by both the upperair and surface variables). Resulting surface fields are thus dependent on BLEND via the first guess.

Experiment 3: The surface analysis is done first, modifying the state of surface variables. The digital filtering of upperair fields which is the base of the BLEND step is performed with the updated surface fields. Thus the result of BLEND is influenced by surface corrections.

All three experimental setups were tried over a short period last February, characterized by a very windy but relatively warm weather. The results were compared regarding the impact on the forecast (subjective evaluation), on the scores (VERAL) and on the noise level for spectral fields (ECHKEVO). There were not many differences noticeable on the charts except perhaps for precipitation patterns. Concerning the noise, Experiment 3 was the most balanced one, as foreseeable. All three experiments provided slightly better scores against SYNOP observations than pure blending, although Experiment 1 and Experiment 2 were a bit more superior to Experiment 3.

Within the surface analysis, the observations of screen-level temperature and humidity were used to initialize the soil temperature and moisture. A particular point is the sea surface temperature. Within the ALADIN/LACE domain there are small pieces of sea basins where it is not sure to get any ship or buoy observations. It would be rather risky to rely on the sea surface temperature analysis within CANARI-ALADIN. Hence, the sea temperature shall be retained from the ARPEGE analysis.

More details can be asked to : Adam Dziedzic.

Developments in the verification

The long-term verification of ALADIN/LACE was done. Please, refer to the special contribution of Dijana Klaric in this Newsletter.

6. In France

Note : Only non-ALATNET work is reported here. And a large part of the work of the Toulouse team was dedicated to purely ARPEGE problems (new horizontal diffusion, new observations, 4d-var problems, ...) during the present period. See also the PhD report from Jean-Marcel Piriou.

There were only few ALADIN visitors in Toulouse along the last months. Embassy fundings for Central and Eastern Europe are still blocked for 2001 and 2002. Morocco is now in a similar situation for 2002. Only Tunisia escaped from such problems !

The main achievement was the creation of libraries 25T2, with the help of Bodo Ahrens, Andrey Bogatchev, Gergö Bölöni, Marek Jerczynski, Zahra Sahlaoui and Siham Sbii. The corresponding changes are described in a separate paper by Claude Fischer.

Significant effort was also devoted to the strengthening or even to the setup of networking in various domains. Several mini-workshops were organized in Toulouse (non-hydrostatic dynamics and predictor-corrector approach, orographic forcing, convection, turbulence), Kranjska-Gora or Medulin. This was highly necessary for physics, where real networking is just starting, with difficulty and frictions. This also allowed to open new issues. Most reports from the working groups are now available on the ALADIN *web* site, and in the present Newsletter.

Stjepan Ivatek-Sahdan refined his previous work on the statistical model for optimal interpolation analyses of 2m-temperature and relative humidity, using more classes (28 vs 14) and more domains (11 vs 4) in the computation of forecast errors. Its newly proposed formulations for the coefficient of correlation and the dependency on resolution proved again to better fit data. After some retunings, mainly smaller characteristic lengths, analysis experiments were performed for two situations (15/01/2001 and 15/08/2001, 00 h and 12 h UTC). Changes were globally positive, when compared to the operational scheme : smaller corrections in areas with only sparse observations, analysed fields closer to observations. A full data assimilation suite is required to draw more conclusions. A second step was the introduction of an horizontal smoothing of the mean soil moisture just after the correction of soil fields in CANARI. This aims at damping the large heterogeneity present in operational fields, and reducing the associated forecast errors on 2m fields. A "Laplacian" filter, already used to smooth roughness lengths for instance (*(e)lislap.F90* for specialists), is applied on the soil wetness index, taking into account the land / sea mask. The radius of impact and the number of applications of the filter were tuned. Results were promising, but an evaluation within along assimilation cycle is also required here. This will be done next September, with an operational application in ARPEGE beyond and an expected subsequent improvement in the initialization of soil moisture and temperature in ALADIN. A direct application of smoothing to soil / surface analyses in ALADIN is underway (see the ALATNET report from Gianpaolo Balsamo).

A lot a work was dedicated to the cleaning of physics, correcting sleeping or active bugs, ensuring reproducibility and improving safety locks. The situation looks safer now, even if the correspondence between correction actions and model versions (operational and export ones) is not fully clear yet. A simplified version of a document written by Jean-François Geleyn, describing the latest changes in the physics package, is given in Table 1. The full version was sent to *aladin@meteo.fr* and is available on the ALADIN *web* site, as an appendix to the report of Medulin meeting on operations : *http://www.cnrm.meteo.fr/aladin/scientific/2002/WG_oper_0602.html* . In the framework of these studies, Jean-Marcel Piriou designed a useful tool to identify gridpoints where fields or tendencies reach unrealistic values. The corresponding modset should enter the next libraries (CY25T2, autumn 2002).

Table 1 : 18 months of problems/evolutions in the ARPEGE/ALADIN physics (status on 12-08-2002)

n°	Step	Mod code	Action	Mod. namelist	Previous	Comments
0	CYCORA-bis (whole package)				CYCORA	Real clean starting point ; no back phasing beyond it for all wha follows; reference for changes below
1	Code harmonisation	*acdrov* *aplpar*				Only a marginal impact.
2	Modification of the melting process for convective precipitation	*accvimp*	Fraction of snowfall integrating the effects of all temperatures above, instead of depending only on the local temperature	GCVMLT=1.6E-04 (added parameter)	≡ GCVMLT=0.	In case of surface inversion one could previously have snow reaching the soil from convective precipitation fo a slightly cold surface temperatur after crossing very warm layers. The previous situation is still maintaine via a local key but the switch to th new scheme is recommended. The two tunings are equivalent for "standard" vertical temperatur profiles
3	CYCORA-ter	*achmt* *accoefk* *aplpar*	Several consistency corrections			To allow further PBL developments in a better environment. **Bugge twice, see [12]**
4	*Idem*		New mixing length parameter values	ALMAV=300. BEDIFV=0.05 UHDIFV=8.E-04	ALMAV=75. BEDIFV=0.4 UHDIFV=4.E-04	Better results at global scale and over oceans, but not appropriate for all conditions (cold continent) . **Requires local decisions/tuning**
5	*Idem*		New dependency of Kuo-closure on resolution	GCOMOD=1. REFLKUO=10000. + LSRCON=.T.	GCOMOD=0.	To restore the correct dependency of both LS and CV precipitations whe Δx -> 0 while keeping the "local" advantages of LSRCON; it may suppress some instabilities, as i ALADIN-France
6	*Idem*			GCCSV=0.	GCCSV=1.	Better simulation of top of PBL inversions
7	*Idem*			USURID=0.035	USURID=0.016	Tuning for consequences of [3-4-5-6]
8	Reproductibility	*acnebn*	Bug correction		Dependency on NPROC	Allows clean test + bug fixing; the results are changed even if 1-proc mode
9	Blow-up of model fixed + consistency	*aplpar*		LSRCONT=.T. (added switch) (+ LSRCON=.T.)	≡ LSRCONT=.F.	Makes the convective closure mor consistent and symmetric for q & s **Bugged, see [19]**
10	Blow-up of model fixed	*accvimpd*	Modified Kuo-2 test			Prevents the activation of a "sleeping" design bug in downdrafts computations.
11	Preventive action	*accvimp*	Suppression of false virga			Risk spotted while working on [10].
12	Bug corrections	*accoefk*	Two of them fixed; associated retuning	USURID=0.042	USURID=0.035 (if [4])	**Bug correction compulsory with [3];** interaction with the retuning of [7]

13	Anti-fibrillation adaptation to 41/37 levels			XMULAF=-1.85	XMULAF=-1.75,	Change linked to the new Δt and Δz near the surface; this tuning should in principle be redone for each resolution change.
14	Vertical slicing via the anti-fibrillation scheme cured	*acdifus*	β cannot decrease when going downwards	LMULAF=.T. (<u>added switch</u>)	≡ LMULAF=.F.	The antifibrillation scheme ceases to create stationary spurious PBL wind patterns. Necessary if one wants to run with long time steps or XMULAF further away from −2. **XMULAF to be retuned**
15	Avoiding 0 / 0 risk	*accvimp* *accvimpd*	Changing thresholds			Better security; hardly modifies results
16	Model blow-up cured	*accvimpd* *accvimp*	Better consistency			One avoids trying to reach the ground with a downdraft across a well mixed and very dry PBL. For the time being the precipitations spuriously reach the ground in such a case, with this fix. **Further treatment required soon (see 20-21-22).**
17	Clarification of the downdraft's role	*accvimpd*	Protection against a risk of sub-cloud precip.-generating downdraft computations (esp. if 15-16 are active)			This weakness existed from the start of the downdraft parameterisation but its role was probably minor up to now.
18	Safety action	*accvimpd*	Equivalent of [11] for downdrafts			May be superfluous because never used.
19	Bug correction	*aplpar*	Avoid ing a double substraction of LS precipitations in the CV closure			**Bug correction compulsory with [9]**
20	Additional correction for [15] and [16	*accvimpd* *accvimp*	Avoiding a "zero" total effect when the limit is acting			Physically necessary since the strong increase of the protection values via [15]; small impact.
21	*Idem*	*accvimp*	Modulated re-introduction of a non-organised sub-cloud evaporation for convective precipitations	RCVEVAP=0.25 (<u>added parameter</u>)	LCVEVAP replaced by RCVEVA, with the equivalence : .F. <-> 0. .T. <-> 1.	With [16] one may have convective precipitations reaching the surface despite crossing very dry levels. The idea is to have at the start the same value for RCVEVAP than for GDDEVA, in order to get the best possible compensation between the two effects of [16] and [21]
22	*Idem*	*accvimpd*	Updated protection against negative precipitation fluxes			With non-zero values of RCVEVAP a yet unprotected consequence of [17] becomes far more likely to lead to negative fluxes. Hardly modifies the results even if clearly necessary.

Some more modifications will be introduced soon, related to new developments ("shear-linked" convection, temporal smoothing in the shallow convection scheme, "moist" gustiness). Items 1 to 18 are already operational in ARPEGE, and the order is close to the chronological one. The export version *ald_export_AL15_03* corresponds to items 1 to 11. For teams at least at the level of *AL12_op6_CYCORA_bis*, the Toulouse team can prepare source codes for the relevant routines, given a consistent list of items.

The previous work of Martin Bellus on the shallow-convection scheme was pursued, with a careful coding and more tests. This is detailed in a separate paper, and also in the above-mentioned mail, sent to *aladin@meteo.fr*.

Jean-Marcel Piriou coded a new diagnostic of PBL height, based on a proposal of Ayotte (1996) and further improved to get smoother fields, both in space and time. Thanks to Thibault Montmerle, the RTTOV-7 radiation code is now available within the model-to-satellite tool developed by Siham Sbii and Jean-Marcel Piriou.

New physiographic databases are now easily available on VPP and archive machine, under directory *~mrpe603*, as for the operational ones : the GTOPT030 dataset for orography and a new global database for soil and vegetation (the old one without ice on New Caledonia).

Several ODB tools were prepared for Diagpack (the porting of which is now finished), in cooperation between Françoise Taillefer and Dominique Puech (e.g. to visualize the deviation to observations). Some documentation on ODB for ALADIN is now available on the ALADIN *web* site. A more extensive documentation on ODB, but in French, is also available by Dominique Puech or via the GMAP *web* site. Meanwhile Philippe Caille designed a procedure to introduce pseudo-profiles of humidity in CMA files, for the needs of 3d-var experiments.

Jean-Daniel Gril undertook to rewrite the auxiliary (*xrd*) library, to improve the portability of ALADIN and the associated tools. A first package, PALADIN 1.0.1, is ready. It includes the following applications : *ecto*, *edf*, *frodo*, *pseudo*, and basic libraries. It has been tested successfully on 5 mainframes with 4 operating systems and 7 compilers, with the help of Neva Pristov :

O.S. version	Mainframe	Compiler
Linux 2.4.18 #	alpha (DEC)	egcs-2.91.66 (Compacq Fortran compiler)
Linux 2.4.17 #1	i686	Lahey / Fujitsu Fortran 95 Express Release L6.00a S/N: LX072865
Linux 2.4.3-20mdk #1	i686	pgf90 3.2-4 Copyright 1989-2001, The Portland Group, Inc.
Linux 2.4.18-6mdk #1	i686	pgf90 4.0-2 Copyright 1989-2000, The Portland Group, Inc. Copyright 2000-2002, STMicroelectronics, Inc.
HP-UX B.11.00 A	9000 / 782	HP F90 v2.4
HP-UX B.11.00 U	9000 / 800	HP F90 v2.5.3
SunOS 5.6	SUN W, Ultra-4	Fujitsu Fortran Compiler Driver Version 4.0.2.1
SunOS 5.6	SUN W, Ultra-4	Sun WorkShop 6 2000/04/07 FORTRAN 95 6.0
IRIX64 irix 6.5.10	IP30 mips	MIPSpro Compilers : Version 7.30

This work is to be pursued, with support from the Budapest workshop on maintenance. The portability of the ALADIN-ALATNET database was also improved, with a move to Linux. To end with, a documentation on geometry was written and will be very soon available on the ALADIN *web* site.

7. In Hungary

Most of the ALADIN related activities at the Hungarian Meteorological Service were concentrated on ALATNET topics, therefore important additional details can be found in the ALATNET report of HMS.

The main topics of progress can be identified as follows:

– As mentioned at the operational aspects lot of efforts were carried out migrate all the model versions and applications to our new Regatta server. The most important part of this work had been completed until the end of June.

– The ODB software was fully installed in the Regatta machine and certainly all the corresponding softwares as *cma2odb*, *ODB-viewer*, *lamflag-ODB*, etc.

– The verification procedures were upgraded and completed making possible a regular verification of the available models with special emphasis on the ALADIN/HU, ALADIN/LACE and ECMWF models. Plots and quarterly report were already produced and planned to be produced on a regular basis.

– The transform package was phased in Budapest and the new version was given to the Toulouse team.

– During the last RC-LACE Council meeting, Hungarian Meteorological Service was volunteering to organise an ALADIN "maintenance and phasing" workshop. The dates of this training workshop was fixed for the end of November 2002, and the first announcement was circulated. More details under the *http://omsz.met.hu/ismeretterjesztes/rendezvenyek/aladin_ws/paper.html* homepage.

8. In Moldova

Nothing new.

9. In Morocco

A first release of an objective verification package is now ready. A comparison between different data assimilation systems : O.I., 3d-var, blending and blendvar, was also performed using the ALBACHIR application. (see the joint papers)

10. In Poland

Nothing really new since the last Newsletter (routine problems).

11. In Portugal

An objective verification was carried out for the period from March 2001 to February 2002 using the two-meters temperature, two-meters dew-point temperature and ten-meters wind speed as surface predictands and the temperature, dew-point temperature, specific humidity, geopotential and wind speed for upper level checks. Besides, total precipitation was also verified. A warm surface bias in the coastal region of Portugal and the underestimation of dew point at two meters are some of the interesting conclusions that will be published soon.

Concerning the analysis subject, not so much technical advances have taken place, however a pre-operational verification of the CANARI / DIAGPACK package is being prepared.

On the diagnostics topic, some more case studies of extreme precipitation events were performed using the home-developed stability indexes (see the joint paper).

12. In Romania

Post-processing of minimum and maximum temperature for verification (Simona Stefanescu)

The minimum and maximum temperatures for 10 observation stations are extracted from the 3-hour post-processed files. The extreme temperatures are computed for intervals corresponding to the observations and they are corrected taking into account the difference between model and station altitudes. They are used in the verification procedure.

Implementation of Al12_04 version of the ALADIN model (Simona Stefanescu)

The *AL12_04* version has been implemented on the ALPHA DEC platform in order to use the last modifications and corrections. Comparisons with the *AL12_02* version were carried out; no significant differences were found.

Spatial variability of the forecast error covariances (Simona Stefanescu under the supervision of Loïk Berre)

Continuing the experiments made on the spatial variability of temperature forecast error covariances, the 1d spatial variations of 2d spectral covariances were investigated. The latitudinal and longitudinal variability of standard deviation and length-scale of the correlation function were calculated and plotted for different levels. The results for the latitudinal variations were successfully validated by comparison with the results of Mohamed Raouindi based on 1d spectral coefficients. The study will be deepened with diagnostics related to the 2d spatial variations of 2d spectral covariances.

Implementation of the 1D Shallow water spectral model (Raluca Radu)

The last version (3.0) of the one-dimensional "Shallow water" spectral model developed by Ilian Gospodinov was implemented on the DEC platform. This simplified model can be used for testing and improving the coupling method in ALADIN (see details in the ALATNET report).

Implementation of version AL15_03 of the ALADIN model (Doina Banciu)

In order to transfer the operational suite from the 1 processor ALPHA DEC platform to the 8 processors E4500 SUN platform, the version *AL15_03* has been implemented. For the present operational domain the duration of a 48-hour model integration (including digital filter initialization and in-line post-processing) is between 22-27 minutes, depending on the situation. The results of the *AL12_04* (using CYCORA-bis package) and of the *AL15_03* (using CYCORA-ter) versions have shown differences especially for precipitation fields. Further tuning of the free parameters will be considered together with a systematic verification against the real data.

13. In Slovakia

See the joint paper by Rastislav Kvaltyn.

14. In Slovenia

The preparation work for the verification-project prototype application started in early June. The main lines are described on the ALADIN web site :

http://www.cnrm.meteo.fr/aladin/concept/verification.html

Kay Suselj continued his work on high-resolution verification of precipitations.

15. In Tunisia

Still waiting for a dedicated computing system.

ALATNET developments during the first half of 2002 in the ALATNET centres

1. In Toulouse

The work of the five ALATNET PhD students in Toulouse, Gianpaolo Balsamo, Margarida Belo Pereira, André Simon, Cornel Soci and Malgorzata Szczech, is described in separate reports, as well as other PhD reports. The summary hereafter corresponds to the joint efforts of the other visitors and the permanent staff.

1. Theoretical aspects of non-hydrostatism (NH)

a) Stability of the semi-implicit semi-Lagrangian scheme

Petra Smolikova started coding the newly defined prognostic variable called *d4* in the 3d model. This work was pursued in Prague and is documented in the corresponding report.

b) Upper boundary condition

An analysis of a recursive-filter based non-reflecting upper boundary condition (RUBC) for gravity and acoustic waves interaction with the semi-implicit temporal scheme was carried on by Martin Janousek. The main concern was the influence of the modification of phase speed of waves caused by a semi-implicit scheme on the radiative performance of RUBC. It was suggested that RUBC should be kept in an explicit form in order to properly handle wave radiation. More conclusions can be expected from 2d and idealized 3d experiments which will be carried on in the next year.

3. Noise control in high-resolution dynamics

a) Evaluation of dynamics at high resolution

Jean-François Geleyn resumed the experiments of Alena Trojakova with the ALPIA quasi-academic framework, to investigate in details the properties of ALADIN dynamics at very high resolution : hydrostatic versus non-hydrostatic, explicit versus semi-implicit, Eulerian versus semi-Lagrangian, ... This work is described in a separate paper.

Besides, a comparison between ALADIN, HIRLAM and Meso-NH non-hydrostatic dynamics, on a "trapped lee-wave" 2d academic case, has been performed. The solutions were found to be close to each other, at least when the CFL number is not significantly larger than one. Let us recall that the other two models are gridpoint ones.

b) Predictor-corrector approach

A mini-workshop was organized in Toulouse in March to harmonize the different approaches and prepare the next developments. The report is available in this Newsletter and on the ALADIN *web* site. A base version has been coded by Jozef Vivoda and introduced in an official code release.

A theoretical analysis of the behaviour of an iterative time-scheme in the presence of orography was performed by Pierre Bénard and confirmed the previous choices concerning decentering or the use of new variables.

c) Smoothing of orography

A new method was proposed to smooth orography at high resolution, which was proved necessary (to avoid spurious small-scale noise, especially when using "linear" spectral truncations). An additional spectral term is added to the cost function used to compute and optimize the spectral orography, which acts at damping the smallest scales. This should provide smoother spectra than the present method (importing the "quadratic" spectral orography when using a "linear" truncation), which abruptly sets to zero the contribution from the smallest scales (the last third of the spectrum), and will be far more flexible. However the first tests interfered with problems in the minimization library, and the present formulation is to be reconsidered.

6. Specific coupling problems

a) Blending

The positive impact of dfi-blending was confirmed through a detailed case study, on a MAP situation, performed by Vincent Guidard with help from Claude Fischer and described in a separate article. The porting to operations for ALADIN-France is now under progress, with retunings for the new geometry (increased horizontal and vertical resolutions, linear spectral truncation) and refinements in the script.

b) Tendency coupling for surface pressure

The porting of the corresponding modifications to the latest official release of the source code was finalized by Jean-Marc Audoin and 3d tests successfully performed with ALADIN-France. The impact remains to be evaluated, maybe with a more problematic domain (i.e. with more differences between ARPEGE and ALADIN orographies along the lateral boundaries, here mainly on sea).

7. Reformulation of the physics-dynamics interface

a) Study of the interactions between non-hydrostatic features and physical parameterisations

The problem of the introduction of diabatic forcing within the predictor-corrector approach was addressed during the dedicated mini-workshop. Safety locks to preserve the presently used alternatives will be introduced. A more thorough investigation is delayed, waiting for a stable dynamical core and more impact studies.

b) Sensitivity of the physics/dynamics interface to vertical resolution

The large vertical oscillations exhibited by Martina Tudor last autumn while trying to diagnose the PBL height (see the previous Newsletters, Toulouse ALADIN report), and problems noticed when increasing the operational vertical resolution, led to reconsider the anti-fibrillation scheme. First, it is now obvious that a retuning is required for each change in resolution. Second, the vertical variations of the coefficient controlling the anti-fibrillation scheme (β) are limited, with a maximum equal to the value at the lowest level, in order to avoid the vertical slicing.

c) Sensitivity of physics to time-stepping

Eric Bazile used the single-column model to study the impact of the length of the time-step on the behaviour of physical parameterizations. The response of the vertical diffusion scheme was very regular, but for the parameterisation of convection very steep jumps were observed. This is due to the fact that the triggering of convection depends on the tendencies issued from vertical diffusion at two adjacent vertical levels, and the scheme is very noisy on the vertical. A correction was proposed and the first 1d tests performed.

8. Adaptation of physics to higher resolution & 9. Design of new physical parameterisations

a) Parameterisation of convection and implementation of a new microphysics parameterisation

Beside the correction of many problems recently discovered in the convection schemes, described in the ALADIN report, new actions were undertaken. The parameterization of deep convection was improved to take into account the vertical wind-shear, which allowed to solve some operational problems. This work is described in a dedicated paper and in the Prague report, since part of the tests were performed by the LACE team. New strategies were proposed along the several meetings on this topic, aiming at writing a more consistent parameterization set, including an improved microphysics and better handling changes in resolution. They are described in the working-group reports available in these Newsletters. Hence, new convection schemes were tested within ARPEGE/ALADIN and the adaptation of an available microphysics, the Lopez scheme, started in the framework of the PhD thesis of Karim Bergaoui. The "Functional Boxes" approach, a framework for the handling of liquid water and ice as prognostic variables, is nearly ready.

b) Improved representation of boundary layer, new parameterisation of turbulence

The main action was the organization of a mini-workshop in Toulouse to coordinate the work related to the parameterization of turbulent kinetic energy, between Bruxelles (Martin Gera) and Toulouse (Jean-Marcel Piriou and Pascal Marquet). The situation looks safer now.

Besides the behaviours of the vertical diffusion and anti-fibrillation schemes were carefully studied, in connection with operational problems.

c) Improved representation of orographic effects

No developments were performed, but the discussions during the dedicated mini-workshop allowed a better definition of objectives.

d) Improved representation of land surface, including the impact of vegetation and snow

A new database for soil and vegetation characteristics was tested in close cooperation with the Belgian team (Olivier Latinne). It is more recent than the previous ones, and of higher resolution (horizontally as well as considering the number of vegetation classes), but results were quite deceiving.

e) Refinements in the parameterisations of radiation and cloudiness

The work on radiation restarted with the arrival of Yves Bouteloup. The first step was the improvement of ozone profiles, with the introduction of a geographical and seasonal variability.

The investigation of the problem of the underestimation of low cloudiness together with deficiencies in the shallow-convection scheme, was pursued. Jean-Marcel Piriou coded a new parameterization of cloudiness, based on the Xu and Randall proposal, and tested it in 1d and 3d cases, in the framework of the EUROCS intercomparison experiment.

10. Use of new observations

The work related to the use of observations in ALADIN is described in the ALADIN report. No significant step forward was performed, just some more diagnostic or interface tools for limited-area models and the use of pseudo-profiles of humidity (derived from satellite data) in 3d-var assimilation.

11. 3D-Var analysis and variational applications

a) Definition of new background error statistics

Loïk Berre formalized the various "NMC derived" methods to compute background error statistics for limited-area models, taking into account the respective parts of lateral boundary conditions, changes of resolution and initialization. This provides an a posteriori validation of the retained solution. He presented this results, together with an overview of the work around variational assimilation within the ALADIN partnership, at the HIRLAM workshop held in January. The corresponding paper is available in HIRLAM Newsletter 40, and on the ALADIN *web* site.

b) Scientific validation of 3d-var

Vincent Guidard and Claude Fischer tested various combinations of 3d-var, blending and external initialization on a well-documented convective situation. This work is detailed in a separate paper.

Claude Fischer computed background error statistics for the most recent version of the ALADIN-France model, to run and improve 3d-var assimilation starting from more recent situations.

12. 4d-var assimilation

The main progress comes from the PhD work of Cornel Soci, who proposed changes in simplified physics for ALADIN.

2. In Bruxelles

5. Coupling and high resolution modes & 6. Specific coupling problems

a) Blending experiments on ALADIN -Belgium (Alex Deckmyn)

We have run several tests of spectral blending for ALADIN-Belgium. The objective scores (bias, root-mean-square error) are mostly in line with expectancies. For one specific month, December 2001, we found that blending had a strong negative effect on surface temperatures.

In blending, we assume that the high-frequency part of a 6h forecast is an improvement on the analysis. In some cases this hypothesis fails. In December 2001 there were periods with low clouds which were not well predicted by ALADIN and as a result the 18h+6h forecasts in the blending cycle were much too cold. The midday runs were hardly affected.

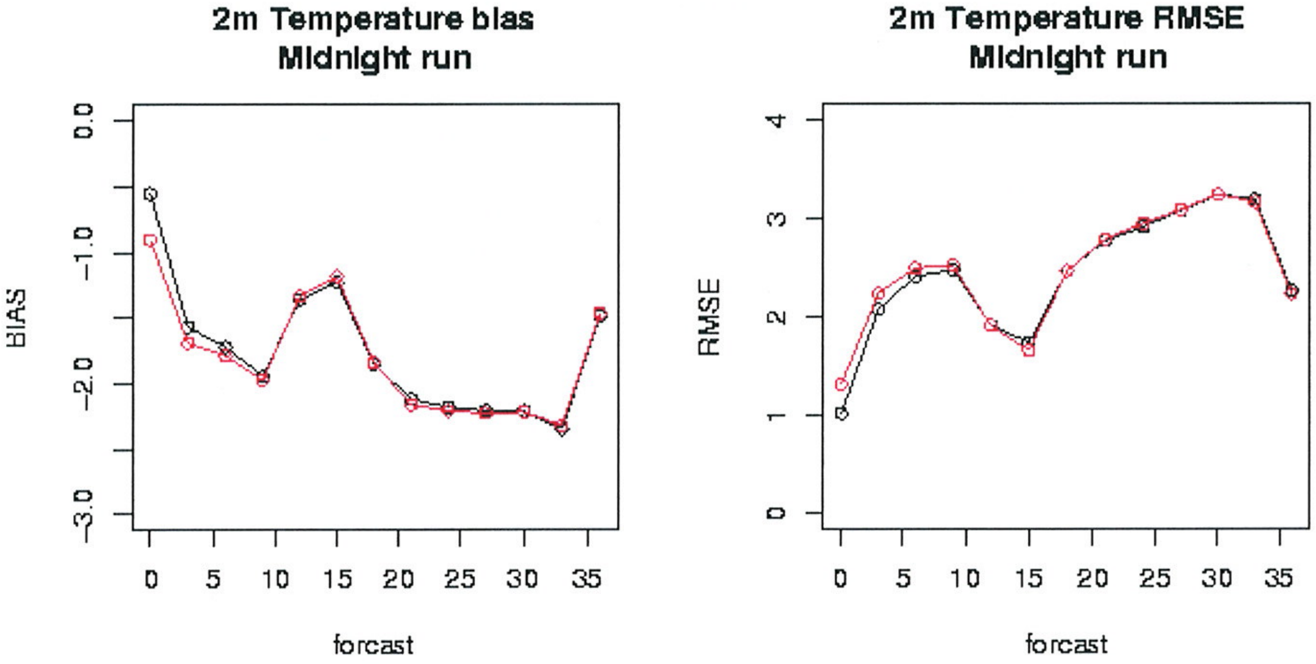


Figure 1: Forecast scores for December 2001, midnight run

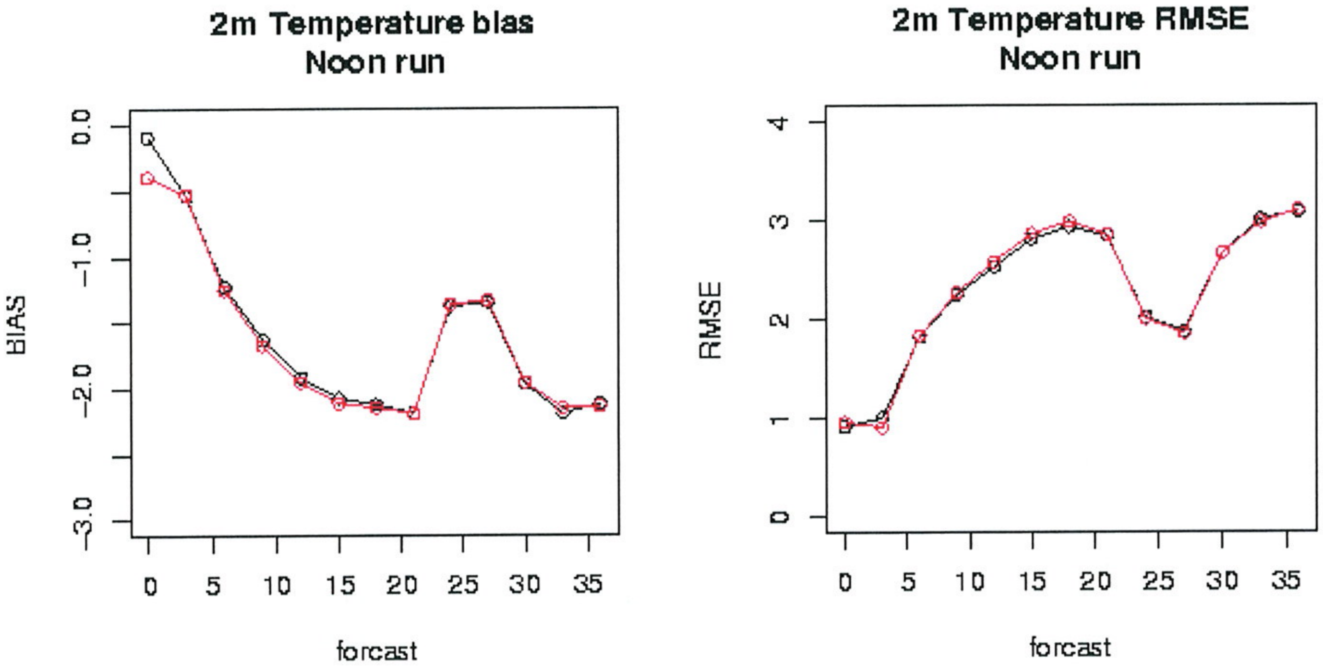


Figure 2: Forecast scores for December 2001, midday run

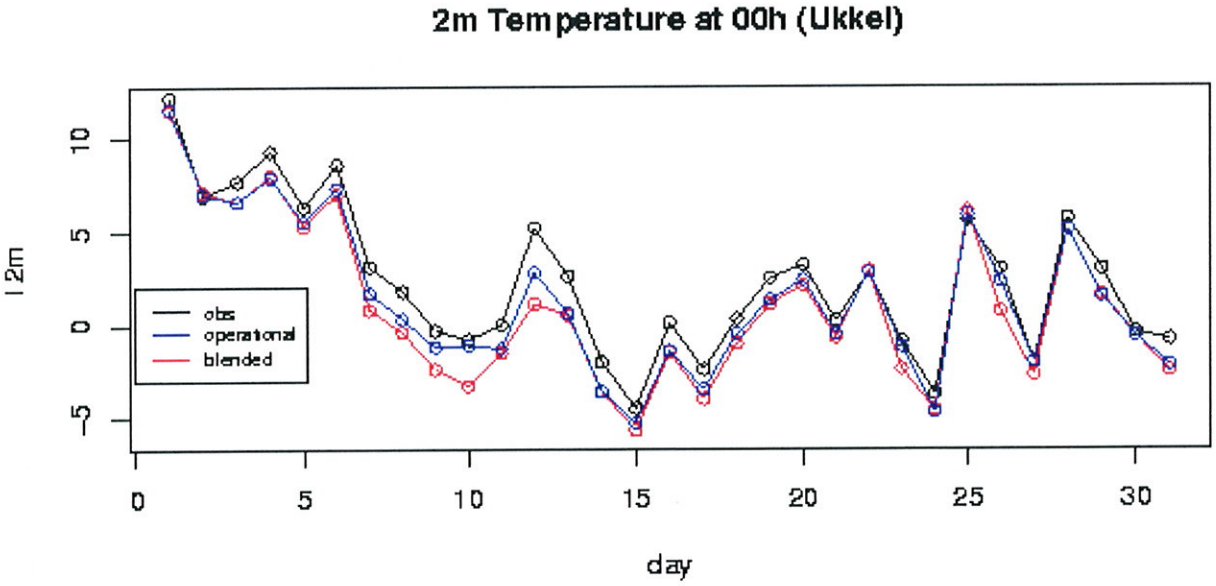


Figure 3: Surface Temperature of initial file

b) Time-interpolation of coupling data (Piet Termonia)

The previous definition of a "linear accelerated" scheme was used to define a "truncation error" indicating when linear interpolation with the present coupling frequency is likely to fail, e.g. because of rapidly propagating storms. A test covering December 1999 demonstrated the efficiency of this warning index : only one sharp increase over the period, corresponding to the Christmas' storm missed by several ALADIN models.

New coupling methods are now under investigation, in close cooperation with the Hungarian team.

7. Reformulation of the physics-dynamics interface

See the report from Ilian Gospodinov (ALATNET Post-Doc student).

8. Adaptation of physics to higher resolution & 9. Design of new physical parameterisations

a) Introduction of prognostic cloud water in a refined convection scheme (Luc Gerard)

The work is described in a joint paper. Cooperation with other ALATNET or ALADIN teams was reinforced through more frequent mail exchanges and a few meetings.

b) Improved representation of boundary layer, based on a parameterization of Turbulent Kinetic energy (Martin Gera)

The work is described in the ALATNET reports from Young Researchers. A few days of discussions in Toulouse allowed to clarify the distribution of work between involved researchers.

c) Improved representation of orographic effects (Bart Catry)

The topic of the PhD thesis was refined along the mini-workshop organized in March in Toulouse. It focuses on a precise diagnosis of the behaviour of the various parameterizations at small scale, including aggregation problems, using real or idealised situations.

d) More precise description of soil and vegetation characteristics (Olivier Latinne)

Experiments to evaluate the impact of newly proposed, more detailed, databases for vegetation and soil (with resolutions 1 km and 5' respectively) were pursued over two summer months and evaluated in cooperation with the Toulouse team. Results are quite deceiving.

11. 3D-Var analysis and variational applications

Alex Deckmyn started to investigate the potential of a new approach, based on wavelet theory, to represent forecast error statistics. The first results are described in a joint paper.

3. In Prague

1 Theoretical aspects of non-hydrostatism

1a) Top and bottom boundary conditions (C. Smith)

The reason why the semi-Lagrangian advection treatment creates a spurious standing wave above the top of the mountain was understood. In the original scheme there are two problems. The first problem was mentioned already in the previous report (from second half of 2001) : the semi-Lagrangian vertical advection on the vertical derivative of a quantity (vertical divergence) instead on the quantity itself (vertical velocity) is unstable. This instability is usually weak and it manifests itself by a noise. However for stronger vertical velocities it may lead to a blow up of the model for a given time-step. The existing instability can be nicely shown on the idealised experiment with the solid body advection in the x-z plane. The second problem was the treatment of the bottom boundary condition. This condition is in practice linked to the surface vertical acceleration diagnosed from the cinematic rule. Thus at each grid point we have a diagnostic relationship where the surface vertical acceleration is given by the surface horizontal wind acceleration and the orographic slope. It was proven that this diagnostic approach should be retained in the semi-Lagrangian advection instead of trying to advect the surface vertical velocity. A kind of an implicit scheme for the surface vertical velocity was formulated: the diagnostic relationship uses the horizontal wind at the future time-level. In order to solve the two above mentioned problems at the same time, a scheme based on the vertical velocity w was developed instead on the pseudo-vertical divergence. However, the pseudo-vertical divergence is retained as a spectral and semi-implicit variable. The switch to w is made before solving the semi-Lagrangian solution of the equation. Like that, the equation of the vertical momentum is much simpler than in the case of the pseudo-divergence form. The cross-term of the scalar product between the horizontal gradient of *w* and the vertical gradient of the horizontal wind V disappears as well as other four small terms from the source term on the right hand side. Once the future time-level field of *w* is computed at the arrival points including the implicit diagnostic treatment of the surface vertical wind, the pseudo-divergence is restored. The big difficulty with the *w* scheme is that we have to advect a half-level quantity due to the vertical staggering of variables. A rather satisfactory solution was found even for this issue. The academic tests made with the new scheme show that the "chimneys" are removed from the solution. In addition, the *w* scheme is more stable and holds for longer time-steps than the pseudo-divergence scheme. Of course, further improvements of the scheme are still necessary. The most difficult point is how to marry the w scheme with the other kind of vertical divergence variables.

1b) Predictor-Corrector scheme *(J. Vivoda)*

The work on the predictor-corrector (PC) scheme was devoted mainly to the code maintenance. The PC ALADIN NH scheme was almost harmonised with the ECMWF PC hydrostatic scheme at the level of the cycle CY25T1. The harmonisation is done at the level of the data flow and of the most important logical switches driving the iterative steps. Beside the maintenance work an analysis of the anelastic approach in ALADIN was done. It was found that the anelastic approximation is not practically applicable using the Laprise coordinate in a spectral semi-implicit model.

1c) Test of new prognostic variables *(J. Masek)*

As shown by the linear analysis results, more stable scheme can be reached by a change of prognostic variables. The change modifies the linear residuals and in some equations these residuals completely vanish. As a crucial change is the one of the pseudo-vertical divergence, influencing the residuals in the compressible continuity equation. In total, five possible variables of the pseudo-vertical divergence were examined, denoted from *d0* to *d5*. The variable *d0* is the one from the original scheme, where the partial derivative of *w* with respect to the vertical coordinate η is scaled by the time and horizontal constants of the basic state. This one leaves the largest residuum in the compressible continuity equation and is the less stable choice. The variable *d3* is a true vertical divergence (the basic state constants are replaced by variables) and leaves in the continuity equation only the cross-term of the scalar product of the horizontal gradient of orography with the vertical derivative of the horizontal wind *V*. The variables *d1* and *d2* are the intermediate steps to go from *d0* to *d3*. Then, there are variables *d4* and *d5* , which try to combine the remaining terms with the variable *d3* or respectively with *d5* so that the residual in the continuity equation completely vanishes for the adiabatic case. For these choices of prognostic variables the stability and precision were tested in the simplified environment of the idealised mountain flow tests. The tests had an increasing difficulty: the first examined regime was the linear hydrostatic one with a very mild mountain. In the following tests the level of nonlinearity was increasing and the last test was the nonlinear non-hydrostatic regime. As the most promising choice of variable is the variable *d3* and possibly *d4* . The variable *d5* produced a strange looking pattern nearby the top of the model.

1d) Clean introduction of the prognostic variable d4 *(P. Smolikova)*

In connection to what was said above, the variable *d4* is one of the most perspective ones. The use of this variable corresponds to the construction of the Canadian MC2 model. However its clean introduction requires a coding of a new pseudo-prognostic spectral variable (the very first tests in the vertical plane model were made with a provisional code changes), which is technically more difficult. The coding started in Toulouse in spring and was completed in Prague at the end of June. The code is now running and a careful validation of the coded pieces has started.

2. Case studies : CFL versus Lipschitz criteria *(A. Trojakova, R. Brozkova)*

The first part of the study based on the ALPIA type of experiment was completed. The pseudo-academic experiment to compare Eulerian and semi-Lagrangian stability criteria was done for four nested domains, each time increasing twice the horizontal resolution and with a square-root-of-two factor the vertical resolution. The starting domain had 10km horizontal resolution and 867m zequidistant vertical resolution through 26km deep atmosphere. The last examined domain had 1250m horizontal resolution and 306m vertical resolution, keeping the same depth. The experiments were done with 3TL Eulerian and 3TL semi-Lagrangian NH schemes. As outcome, there is now a robust result that the 3TL semi-Lagrangian scheme can be used still with at least double of the Eulerian time-step without meeting Lipschitz criterion. At the same time other shortcomings could have been noticed, especially those related to the ALATNET topic on the formulation of bottom and top boundary conditions. Thanks to this work there are now tools to run such an experiment: to create the academic file, to make the nesting of the domains (academic coupling procedure including the horizontal and vertical interpolators) and to make a post-processing. The ALPIA setup is now being used to make the comparison of ALADIN NH with Meso-NH models. It shall be further used for other tests, for example for the horizontal diffusion scheme.

3. Observations : Evaluation of the impact of balloon drift in sounding measurements *(M. Benko, R. Brozkova)*

The monitoring of the sounding reports taking into account the horizontal drift of the balloons continued. The strange results obtained last time were clarified: there were several bugs in the use of these data. Step by step these mistakes were eliminated, starting from the simple vertical split of the TEMP reports and ending by the use of only raw measured data to exclude any mistake caused by approximations. This strategy paid off and at the end a better quality of the data including the correct position of the balloon was proven as expected. To reach this result it was necessary to use the complete report from the sounding. We had at disposal such reports from the sounding stations Praha-Libus and Poprad-Ganovce. When trying to recompute the balloon drift from the data available at the standard TEMP bulletin as internationally exchanged, the approximation is too crude and leads to mistakes (unless a bug is still found there). In any case the use of the correct balloon position would require that this data enter the international code. Hence, it is not in the near future perspective to use the improved TEMP messages within the data assimilation scheme.

4. New parameterisation of exchanges at sea and lake surface : Gustiness *(M. Bellus, J.F. Geleyn)*

Even if the motivation is a bit less relevant for a quasi-continental domain as ours, the idea was to see how to enhance surface fluxes of heat, moisture and momentum over the sea by low mean wind speed but conditions of strong fluctuations of the actual surface wind owing to moist convection. A formulation of that type (via the sea roughness length) already exists for dry convection and the idea was to see (i) whether the two effects can be harmoniously combined and (ii) whether the moist part can be extended to the land areas and to the whole vertical (something that brings it back to our local preoccupations). Both answers were positive. Furthermore a most simpler (and more robust) formulation than the one anticipated by previous studies was found for problem "(i)", a result that made the "(ii)" extension absolutely straightforward. It remains now to go back to TOGA-COARE measurements for verifying that these several changes did not alter the validity of the original idea. Then further tests, probably in combination with the previous idea concerning the time smoothing of the shallow convection, will have to be performed in a complete ARPEGE framework.

4. In Budapest

Most of the research and development topics were concentrated around the ALATNET scientific plan and described briefly hereafter.

Steluta Alexandru continued her first ALATNET stay in Budapest, and after solving several technical problems the first interesting results were obtained and documented (see her short report about the main conclusions of her first stay elsewhere in this Newsletter). She will continue her work in Budapest in autumn.

Concerning the Hungarian lagged Jb for 3d-var background error statistics a few further investigations were made. To explore the impact of coupling ratio (difference in resolution and domain size between the model and its driving model) in the context of lagged-NMC background error statistics the total energy of ARPEGE-ALADIN/LACE and ALADIN/LACE-ALADIN/HU 6 hour forecast differences were computed for a 30 day period. It's turned out that the energy of ALADIN/LACE-ALADIN/HU differences is indeed smaller on all scales which supports again the earlier idea that with a small coupling ratio we loose too much variance using the lagged-NMC constant coupling strategy. The tuning of the REDNMC parameter giving bigger weight to observations (with the increase of standard deviation of background forecast errors leading to smaller weight to the background term) seems to be promising to treat the too small variances following some recently done experiments: even with a strong increase of observation weights the level of noise in the analysed fields is still acceptable.

Important steps were achieved for the local processing of ATOVS data giving a hope that real experiments can be tried in the second part of the year. The following practical problems were solved until now in that topic : An up-to-date observational (CMA) file is required to run the assimilation scheme in operational regime. Up to now, we created the CMA files from an ASCII file using the Mandalay program. This year we adapted the pre-processing packages (*Oulan* and *Bator*) used at Météo-France to create the CMA file from our local observational files (in NetCDF format) for the variational assimilation. In addition to the SYNOP and the radiosonde (TEMP) data, satellite data (ATOVS) received from our HRPT antenna were added to the observational file. We perform a direct read-out of the ATOVS data (level 1-C HIRS and AMSU-A) pre-processed by *AAPP* (ATOVS and AVHRR Pre-processing Package). ODB files are created using a chain of procedures as follows: *Oulan*, *Bator* and *cma2odb*. At the moment we are implementing the *batodb* package (that creates the ODB file from the output of the *Oulan* program) as well as the programs for the computation of the bias coefficient for the satellite data.

We participated in the 3rd ALATNET seminar in Kranjska-Gora : one teacher and one student were representing the Hungarian Meteorological Service at this important event of the ALATNET project.

The paper about the sensitivity of soil texture to the ALADIN forecast was completed and it will appear in the journal *Idojaras* very soon.

Hungarian Meteorological Service has initiated a two month research stay to be realised in Budapest. Piet Termonia was selected as the best candidate and will work together with Gabor Radnoti and with a university student on coupling problems (details are anticipated in the next Newsletter).

5. In Ljubljana

ALATNET student Raluca Radu continued her stay in Ljubljana dealing mainly with the problematic of spectral coupling.

A lot of efforts were put to the organization of 3rd ALATNET Seminar "on Numerical Methods and NWP applications", held in Kranjska Gora, Slovenia, between May 27 and June 1, 2002.

ALADIN PhD studies

1. Radi AJJAJI : "Incrementality deficiency in ARPEGE 4d-var assimilation system"

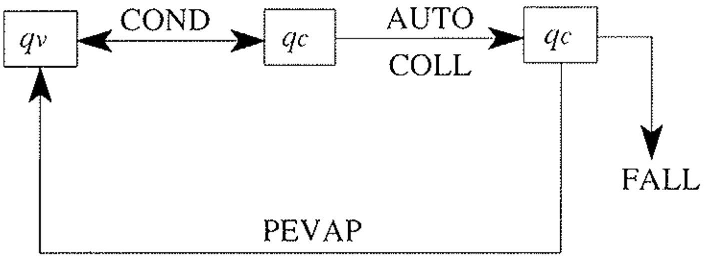
Nothing new (implementation of the new operational suite in Casablanca).

2. Karim BERGAOUI : "Investigation of the potential of a convection scheme using prognostic mass fluxes for NWP in the African-Mediterranean domain"

Introduction of cloud geometry in the Lopez model

We have started to code a subroutine which introduces the cloud geometry in a simple microphysical calculus. The microphysics is limited to the computation of the large scale precipitation tendency in the clouds ($q_{r/s}$, with r for rain and s for snow; we will treat only q_r).

We used the Lopez model for microphysics (see figure hereafter)



$$d/dt\,(q_r) = \mathrm{AUTO} + \mathrm{COLL} - \mathrm{PEVAP} + \mathrm{FALL} \quad (1)$$

q_r = large-scale precipitation content
q_c = large-scale cloud condensate ($q_{l/i}$: l for liquid water and i for ice)
q_v = water vapour

The microphysics processes are parameterized in the right-hand terms of Equation (1) :
AUTO = auto-conversion rate
COND = condensation rate
FALL = precipitation falling rate
PEVAP= precipitation evaporation rate

In our work, we acted by two steps:

1. We tried to stationarize q_r which is a prognostic quantity in the Lopez model, but a diagnostic one in ALADIN. We have then expressed q_r as a function of the precipitation flux R : $q_r = R/xw$ where x is the air density and w the mean fall-velocity of rain drops. We used the Marshall-Palmer formulation to determine a relationship between q_r and R.

2. We have started to introduce a cloud geometry in the expressions of the different microphysical processes of the Lopez model. Each of them (evaporation, auto-conversion) will be treated differently if we are in a cloudy fraction or in a clear-sky one, within a fixed layer. Thus we defined cloud geometry coefficients:

b_1 = fraction of the precipitation flux in a clear-sky area falling in a clear area, $1-b_1$ is then the fraction passing to a cloudy area.
b_3 = fraction of the precipitation flux in a cloudy area falling into a cloudy area, $1-b_3$ is thus the fraction passing to a clear-sky area.

Coefficients b_1 and b_3 depend on the cloud geometry (considering that adjacent clouds have a maximum overlap and unconnected clouds have a random overlap). The improvement of this subroutine and its coding are in process in Tunis.

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

PhD work from January to June 2002 :

- Better understand the role played by the "undilute plume approach" in the operational deep convection scheme, using the EUROCS "idealized humidity" case frame proposed by Steve Derbyshire (Met' Office). Presentation on this subject at the EUROCS Workshop in Utrecht.
- Presentation at the same workshop of a synthesis of the "good points" and "bad points" of the operational deep convection scheme with respect to cloud triggering and large-scale feedbacks, as coming out from 3d operations.
- Bibliography about turbulence, Large Eddy Simulations, and history of deep convection parameterizations.
- Following Ayotte BLM 1996, proposal of a new diagnosis of PBL depth.
- Contacts and coordination work with Pascal Marquet and Martin Gera about the steps to go towards a prognostic TKE scheme for ARPEGE / ALADIN.
- Bibliography about parameterizations of cloudiness. Build up of a new diagnostic cloud condensates scheme for shallow convection, to be used with a "Xu and Randall" cloudiness. Test in 1d and in 3d stable cases.

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

Nothing new (implementation of the new operational suite in Casablanca).

5. *Filip VANA : "The dynamical and physical control of kinetic energy spectra in a NWP spectral semi-lagrangian model"*

Nothing new (LACE duties), apart from good news : the work should restart next autumn.

ALATNET PhD and Post-Doc studies

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

3d-var experiments were performed for a 7-day period (25.02.2002-03.02.2002) using :

- observations : SYNOP and TEMP
- statistics : classical (standard) NMC
- evaluation tools :
  - objective scores (rmse, bias) : vertical profiles for a chosen moment (00h, 06h, 24h), and time-evolution for 24h at standard levels;
  - *"echkevo"* diagnostics
  - *"ectoplasm"* plots

The following combinations were made :

1. Time / Space consistency

Experimental framework :

	cycling	production
first guess	6h ALADIN/HU forecast	-
coupling	ALADIN/LACE (assimilation cycle)	ALADIN/LACE (operational)
initialisation	no	DFI
remark	-	24h forecast

Main conclusions :

- At time 00h, the 3d-var analysis is better than dynamical adaptation, getting closer to observations for all fields. An important improvement is for the relative humidity field. Also for the wind there is an improvement especially for the upper levels. At the surface the scores are close to those of the operational forecast.
- After 6h forecast, the improvement from the initial time is lost. For some levels the forecast with 3d-var is better, but for others, not. So, starting from a better analysis, the results are worse than for dynamical adaptation.
- After 24h forecast, the scores are similar to those for dynamical adaptation.
- The *"echkevo"* plots show that the fields are in balance.
- The time-consistency coupling strategy shows better results than the space-consistency one's.

2. Time / Space consistency with incremental initialization

Experimental framework :

	cycling	production
first guess	6h ALADIN/HU forecast	-
coupling	ALADIN/LACE (assimilation cycle)	ALADIN/LACE (operational)
initialisation	incremental DFI (IDFI)	DFI
remark	-	24h forecast

Main conclusions :

- Comparing the scores of the forecasts when the same coupling technique was applied, with and without IDFI, at the moment 00h, the shapes are very close for temperature and geopotential. Also for the relative humidity and wind the differences are small, maybe with a little improvement when no IDFI is used. But this difference appears because of the IDFI, which is putting the analysis a little far away from the observations.
- After 6h, the scores are similar.
- There is no need to apply IDFI in cycling, because the fields are already in balance.

3. LACE / ARPEGE with space-consistency

Experimental framework :

	cycling	production
first guess	6h ALADIN/HU forecast	-
coupling	LACE/ARPEGE (assimilation cycle) (LBC0 / INIT file= 3d-var analysis) (LBC1 file= LACE/ARPEGE analysis)	LACE/ARPEGE (assimilation cycle)
initialisation	no	DFI
remark	"Moroccan" solution	6h forecast

Main conclusions :

- The forecasts obtained from these experiments are compared to the 3d-var results using the operational coupling files in production (from the experiments 1), with the same coupling strategy (space consistency).
- At the moment 00h, the scores for temperature are similar. For geopotential, the 3d-var with ARPEGE files is a little bit better. The relative humidity is improved with the LACE files, for upper levels, and for the wind the ARPEGE combination shows better scores.
- After 6h integration, the shapes for the temperature are very close. The ARPEGE combination is better for geopotential. In the case of relative humidity the 3d-var with the operational coupling files in production is better for the upper levels. For the wind, one can say that the ARPEGE combination has a small improvement against the others.
- The choice of the second coupling file in cycling (when the space consistency strategy is used) is important.

2. Gianpaolo BALSAMO : "Mesoscale variational assimilation for land surface variables"

Optimization of the soil moisture perturbation for the 2d-var surface analysis

Introduction

The forecast of screen-level variables T2m, RH2m is studied with relation to soil moisture initialization. A set of simple experiments allows to assess the sensitivity of 2m forecast fields to a perturbation of the initial mean soil moisture Wp. The perturbation of the guess is used to evaluate the observation matrix H in the 2d-var assimilation.

The screen-level sensitivity to the soil moisture perturbation is varying with the meteorological situation and the soil state, which is the most desirable feature of the variational soil moisture analysis. This variability has also consequences on the validity of an "horizontal decoupling" hypothesis and on the clear evaluation of the gain matrix K. In fact, where the soil has lower vertical influence, the lateral influence of adjacent gridpoint, as well as the occurrence of noise, may become important. Different perturbations of the control variable Wp have been tried. A satisfactory evaluation is obtained with a double chess-like perturbation to increase the horizontal decoupling between gridpoints. The use of a Laplacian smoothing on the coefficients is sufficient to filter out the noisy patterns without varying the main structures of K.

This study is necessary to design a perturbation strategy for 2d-var assimilation of screen-level parameters for mean soil moisture analysis. The gain matrix K resulting from the linear variational method is examined on the ALADIN-France domain.

The perturbation of the control variable Wp

The importance of the initial perturbation comes from the use of 2d-var in the full 3d Aladin model, and the multiple interactions not simply related to the vertical soil-atmosphere feedback. Anyway, it has to be stressed that even for the Single Column Model (SCM), the perturbation of Wp has to be carefully chosen in order to take into account the sensitivity zone, especially the range between field capacity and wilting point (Mahfouf, 1991 and Bouttier, 1993).

The magnitude of the perturbation is also an important issue : it has to be small in order to satisfy the linear hypothesis but large enough to prevent the occurrence of large noisy patterns.

Particularly to this latter point, the occurrence of noise in screen-level forecast under cyclonic conditions can be shown in the "horizontal decoupling" experiment performed on the ALADIN-France domain (see also the previous Newsletter report for details), in figures 1 and 2.

Figure 1. Horizontal decoupling test in clear sky condition. This test show the sensitivity of 2m temperature (b) and relative humidity (c) to a well known initial perturbation box of mean soil moisture content Wp (a).

(1a)

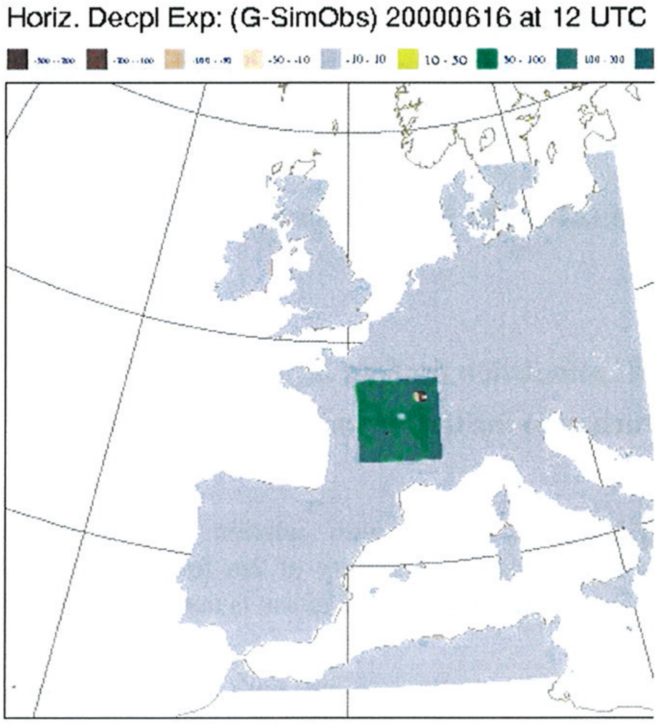
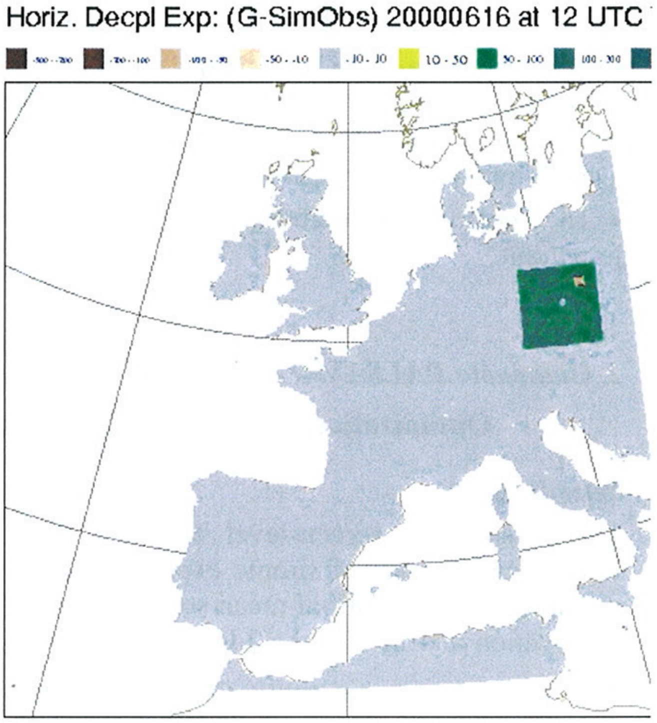
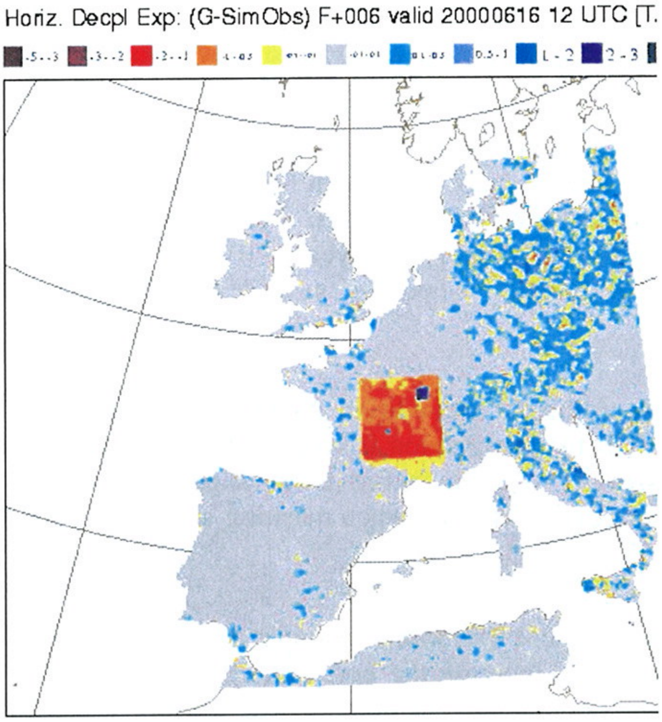


Figure 2. Same as Figure 1 for a box placed near to the north-eastern side of the domain (meteorological perturbed conditions).

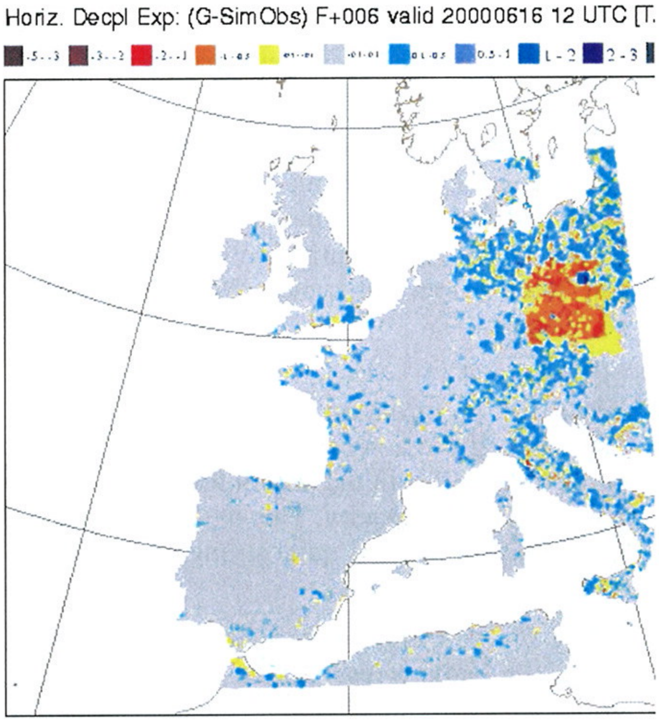
(2a)



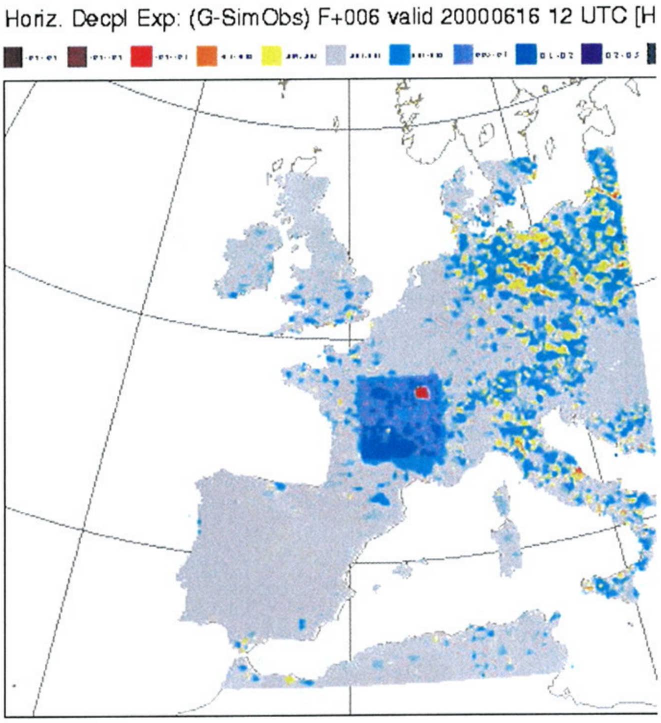
(1b)



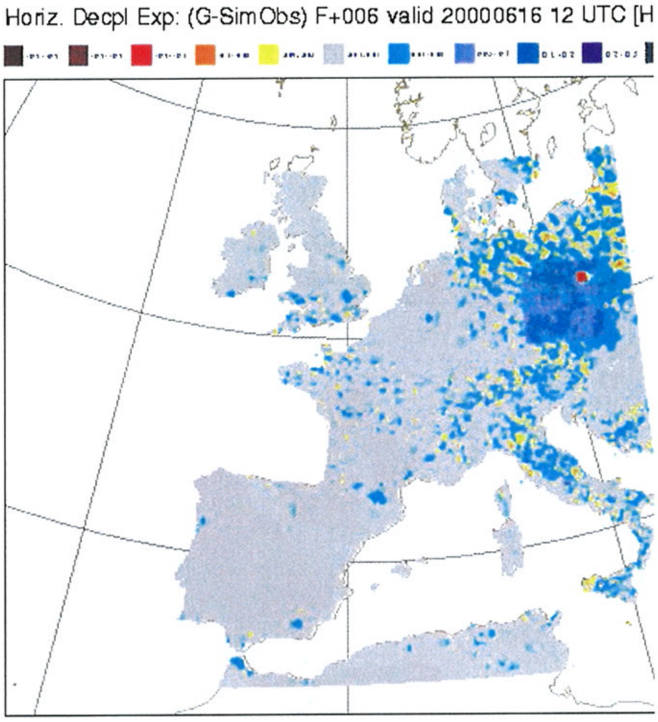
(2b)



(1c)



(2c)



It arises that a secondary effect of the soil moisture initialization causes the noise to appear on locations far from the initial soil moisture perturbation, in both cases. The occurrence of noise in the 2m trajectory was also shown in a previous report and it is mainly addressed to extra sensitivity of 2m parameterization in meteorological perturbed conditions. In the evaluation of the K matrix this feature is undesirable and has to be removed.

The choice of gridpoint perturbation for Wp

The perturbation of Wp can have different forms. The tests are performed on a real first-guess situation (2000/06/16 12 UTC) with a 6-hour assimilation time-window. The initial soil moisture presents several dry and wet peaks and allows to point out the area where a lower sensitivity to perturbation is expected. Three different perturbation methods are presented and are defined as:

- Coherent

When a certain quantity is added homogeneously to the initial soil moisture. In this case, the result of the evaluation of the K matrix is shown in figure 3a. The evaluation of K can be averaged over several perturbed runs or members to add statistical strength to the final K (figure 3b). A drawback of this choice is that the perturbation is rather strong (~30 mm of water added over a ~10^7 km^2 domain) and can reduce the horizontal decoupling between gridpoints, especially in case of weak vertical correlation.

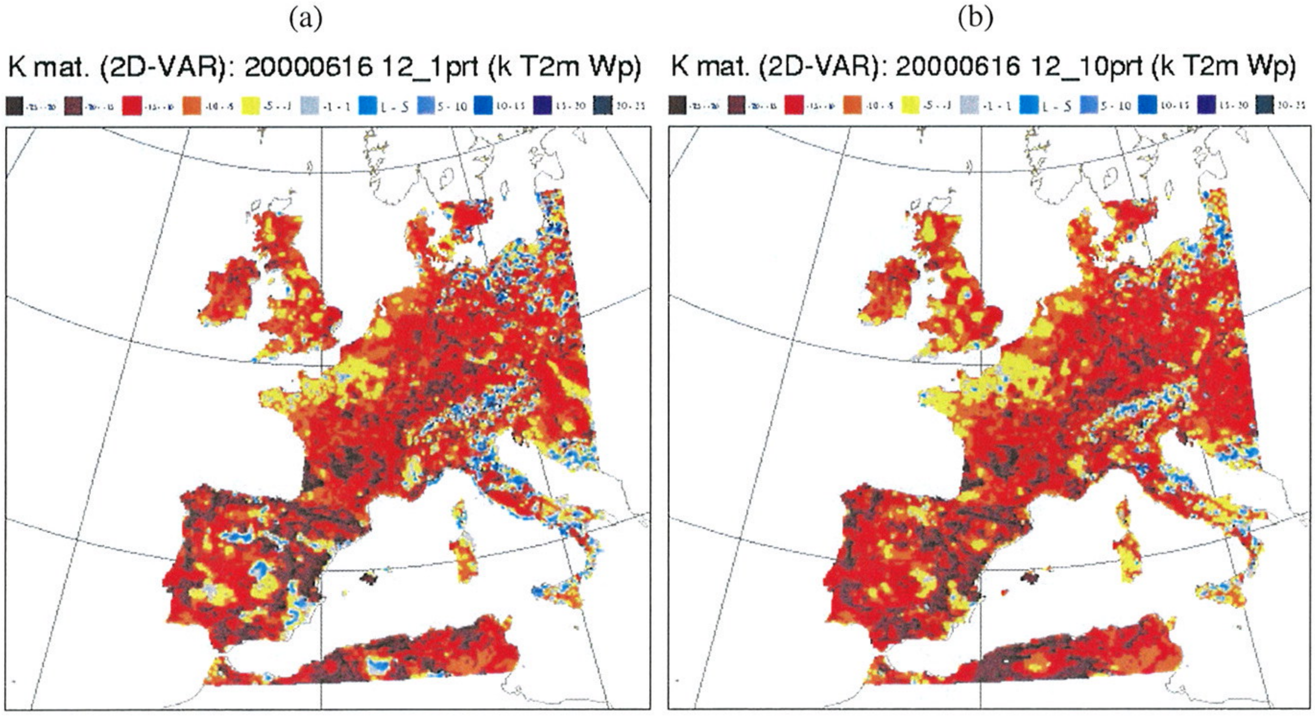
- Conditional

When the perturbation is added or subtracted according to a condition on the initial guess value (typically, if the soil wetness index is lower than 0.5 the perturbation is added). The reason for such perturbations lies in the search for screen-level sensitivity to soil moisture in the range between wilting point and field capacity. This has been widely used in different tests (when masking is applied), but the occurrence of noise is quite strong (figure 3c).

- Chess-type

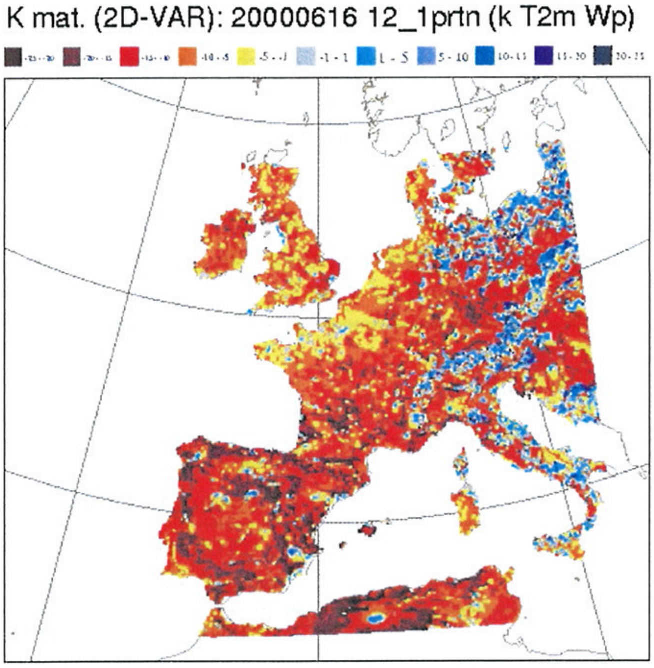
When the perturbation is added and subtracted in adjacent gridpoints in order to have a chess-like perturbed fields (Hess, 2001). This has the advantage to increase the horizontal decoupling between gridpoints without changing the overall soil water content on the domain. On the other hand the occurrence of large noise in the response is found in the 2m fields (figure 3d). A better response is found considering 2 opposite perturbations of this type to evaluate the K matrix. This setup allows to distinguish the noisy patterns from the low sensitive zone (figure 3e) and it is therefore considered for further study.

Figure 3. Evaluation of the mean soil moisture perturbation strategy. K matrix for T2m (Wp correction) for given perturbations : (a) coherent, (b) coherent (average of 10 members), (c) conditional, (d) chess-type (1 member) and (e) chess-type (2 members).

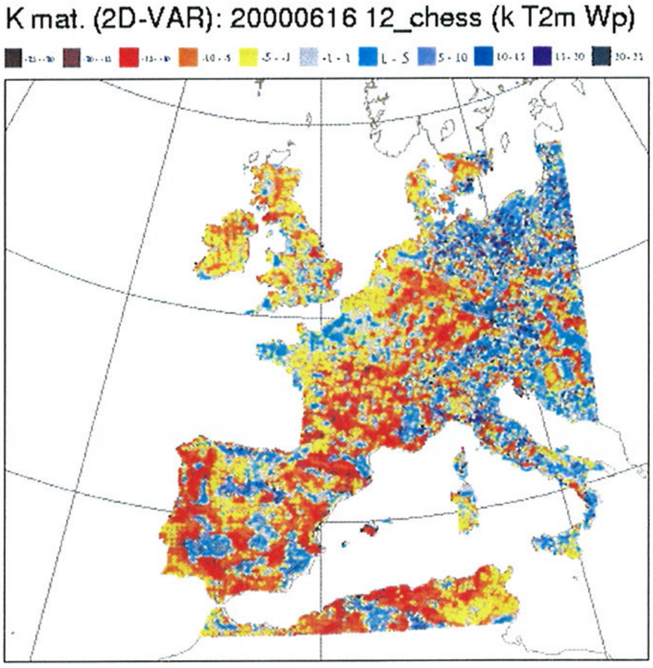

(a)

(b)

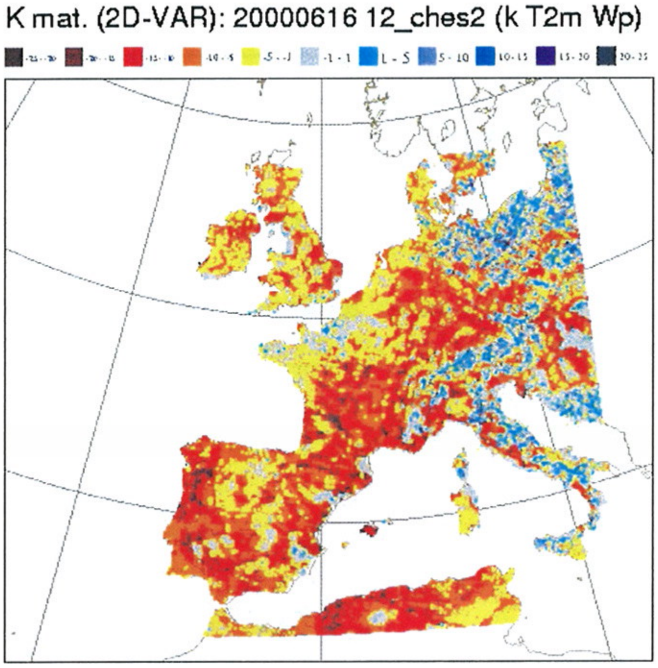
(c)


K mat. (2D-VAR): 20000616 12_1prtn (k T2m Wp)

(d)


K mat. (2D-VAR): 20000616 12_chess (k T2m Wp)

(e)


K mat. (2D-VAR): 20000616 12_ches2 (k T2m Wp)

The masking of sensitive zones

The masking is a technical solution adopted by the operational OI (Optimal Interpolation) analysis (CANARI-ARPEGE/ALADIN) in order to avoid spurious corrections of the mean soil moisture during atmospherical perturbed conditions, such as precipitation events, reduced solar radiation flux or strong lateral advection.

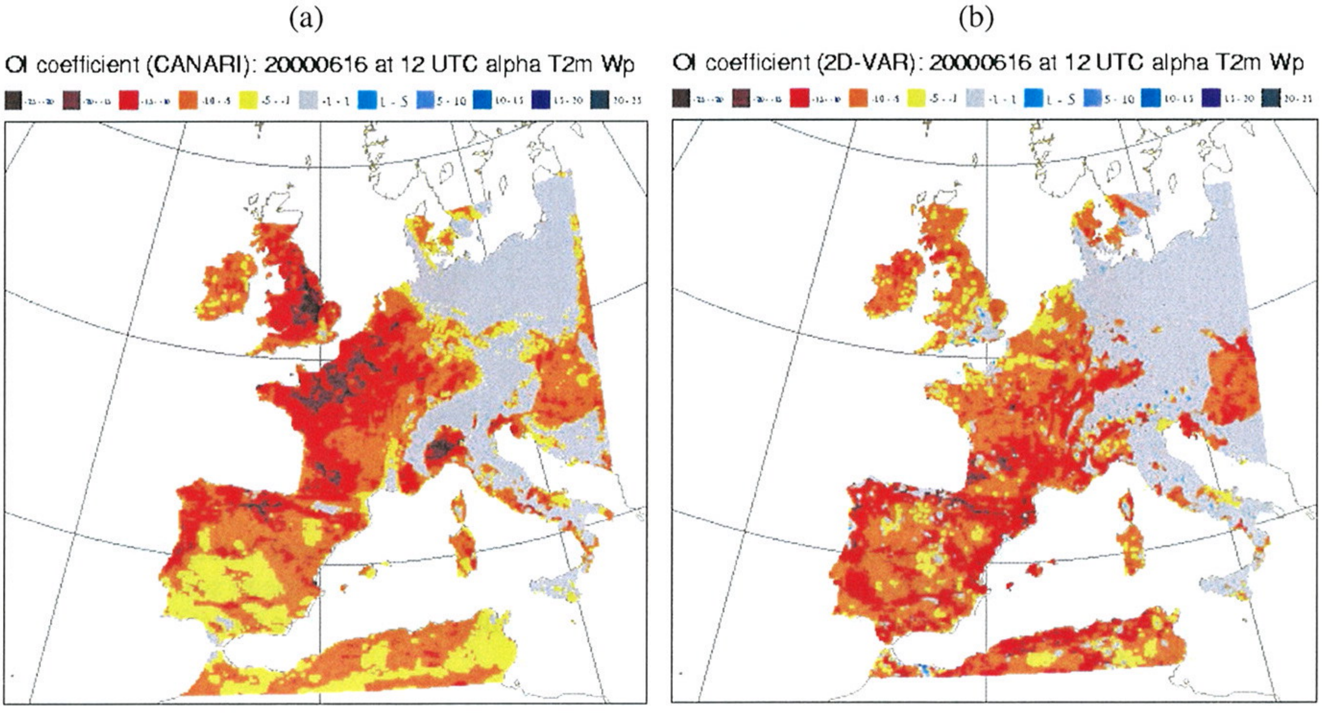
The magnitude of the OI coefficients was evaluated on 1d experiments by a Monte-Carlo method, looking at the correlation between Wp and screen-level parameters, T2m and RH2m. A set of regressions with physiographic parameters (vegetation fraction, Leaf Area Index, soil texture) and model fields provided the value of the OI coefficients (Bouttier et al. 1993, Giard and Bazile, 2000). A masking function is used to cut off the soil moisture correction when some thresholds are over-passed (see Table 1). This has been tuned to stop the analysis when the correlation between soil and screen-level parameters errors is weak. Now, in the ideal case, where all the dependencies are kept into account (too complex to put in operation), the OI coefficient would range continuously between 0 (no information transfer) and the maximum correction (e.g. on a summer day with clear sky condition) without need of masking.

In operational context the OI coefficients transfer the 2m errors of temperature and relative humidity into soil moisture corrections on a limited range of combinations of local physiographic and meteorological situations, explicitly treated in their formulation.

masking in OI test on first-guess fields		***masking on 2d-var*** test on relative or absolute differences between 6-hours forecast from initial and perturbed fields	
		Total cloud cover	r = 0.05
		Convective cloud cover	r = 0.05
Precipitation	s = 0.3 mm	Convective precipitation	a = 0.01 mm
		Stratiform precipitation	a= 0.01 mm
Solar time duration	s = 6 h (min)	Solar radiation flux	r=0.01, a = 1.0 Wm^2
		Snow depth	a = 0.05 m
Frozen soil water content	s = 5.0 mm	Frozen soil water content	a = 0.05 mm
10m wind speed	s = 10 m/s	10m wind speed	r = 0.10, a = 0.05 m/s
Evaporation	s = 0.001 mm (min)		

Table 1: Masking condition in the operational OI surface analysis and analogues in 2d-var.

Figure 4.(a) Evaluation of OI coefficient for T2m (Wp correction) and (b) equivalent 2d-var gain matrix.


(a)

(b)

Nevertheless we can think that in such cases the information content from 2m observations is not negligible although small, and the variational approach should allow to gain a consistent correction of the soil moisture. The statistical properties of OI coefficients, in fact, do not allow a full local description whenever the relation between soil moisture and screen-level parameters is not linearizable on a general case (not case dependent).

Although masking in 2d-var has been developed it was used only for tests (comparisons 2d-var versus OI). A combination of a careful choice of the perturbation and of spatial smoothing to get rid of the remaining noise has been studied.

The Laplacian smoothing

The Laplacian smoothing is used to filter the remaining noisy patterns on the K coefficients. The basic Laplacian smoothing is based on the Laplacian flow :

$$\partial_t I(x,y) = \nabla^2 I(x,y) \qquad (1)$$

The discrete implementation is achieved by multiplying the Laplacian operator mask L(i,j) :

$$I^{n+1}(x,y) = \sum I^n(x+i,y+j)\, L(i,j) \qquad (2)$$

where I(x,y) is the original image and L(i,j) is the Laplacian operator mask. This method gives a smoother image of a given 2d field.

For application on a geographical case the map factor $MAP(x,y)$, the prescribed smoothing length R, the gridpoint dimensioning (X,Y) and the land-sea mask $LSM(x,y)$, have to enter the formulas and be kept into account, therefore the formulation of the Laplacian mask operator is:

$$L(x,y) = 1/4 \times r^2 \times MAP(x,y) \quad ; \quad r^2 = \min(R^2, X^2, Y^2) \qquad (3)$$

The resulting smoothed field I(x,y) is the summation of the gradients in x and y divided by the squared gridpoint dimension, respectively X^2 and Y^2. In the following formulation a generic notation is used :

$$I(+/0/-\,,+/0/-) \equiv I(x+i\,,y+j)*LSM(x+i\,,y+j) \qquad \text{where } i, j=+1/0/-1,$$

so that:

$$I = I + L \times \{ [(I(+,0) - I) + (I(-,0) - I)] / X^2 + [(I(0,+) - I) + (I(0,-) - I) / Y^2] \} \qquad (4)$$

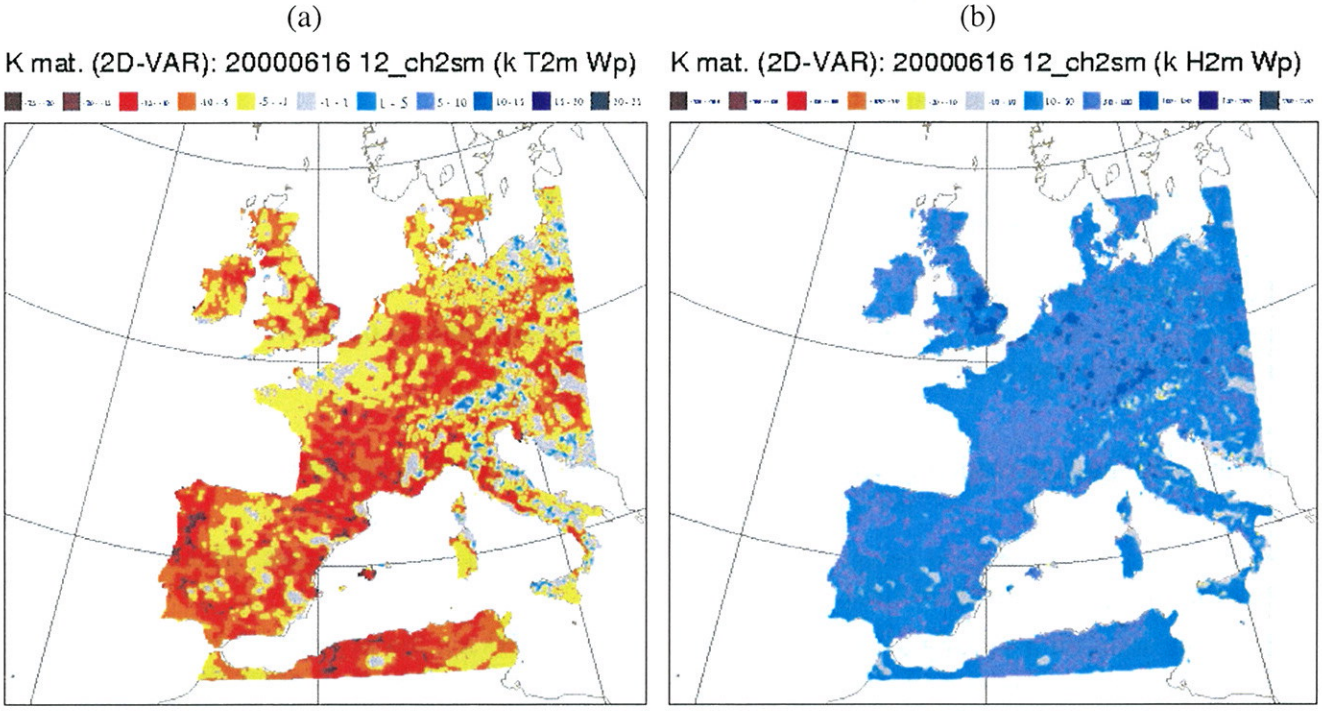
A small value of the smoothing length preserves the main structures of the field filtering only very high resolution features. Tuning for an ALADIN gridpoint dimensioning of $X = Y = 9.92$ km led to the choice : $R = 2.5$ km and 3 cycles of smoothing.

The same smoothing is applied to the analysed field for consistency. This technique is preferable to the thresholds masking for noise removal, as it has smaller impact and easier tuning.

Optimization of the K matrix in 2d-var

As a general warning from the performed test, the degree of horizontal decoupling is dependent from the choice of perturbation of the control variable. Coherent and anti-correlated gridpoint perturbations (chess-type) have different responses in real situation. The evaluation of the K matrix is obtained here with a double chess-like perturbation and Laplacian smoothing. Figure 5 shows the result when applying the method on a real case (16 June 2000).

Figure 5.: K matrix for 2000/06/16 12 UTC as result of chess-type perturbation (2 members) and Laplacian smoothing. (a) K value for T2m (Wp correction), (b) K value for RH2m (Wp correction).

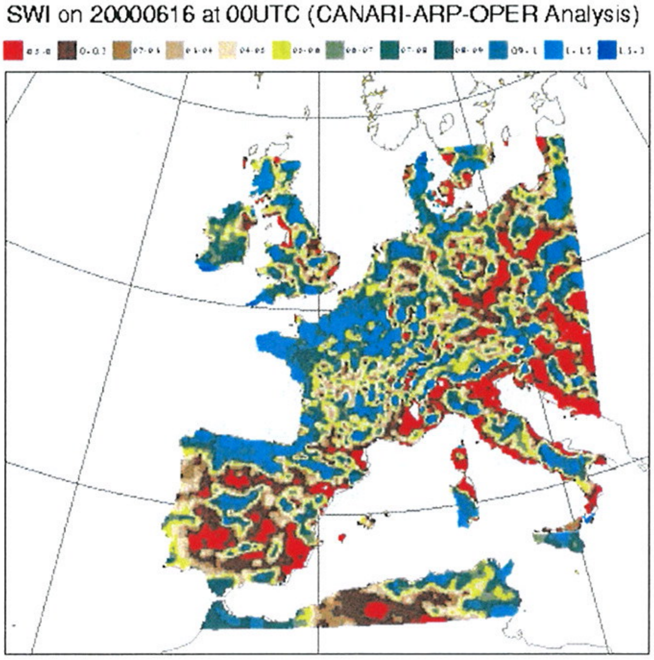


(a) K mat. (2D-VAR): 20000616 12_ch2sm (k T2m Wp)

(b) K mat. (2D-VAR): 20000616 12_ch2sm (k H2m Wp)

The appearance of strong and weak correction peaks is found to well match the previous soil state and can be compared with the operational analyzed soil wetness index (figure 6).

Figure 6.: Soil Wetness Index for 2000/06/16 12 UTC.



SWI on 20000616 at 00UTC (CANARI-ARP-OPER Analysis)

Conclusions and perspectives

The configuration for testing the 2d-var on a real assimilation cycle has been reached. The validation phase will now focus on 4 periods of 2-3 weeks with 2d-var assimilation of Wp using a 24-hours time-window. A 6-hours cycle is maintained for the assimilation of the other soil variables Ts, Ws, Tp. Some more tests for Tp may also be considered.

Over other benefits of the variational approach, it is also likely that moving to a 24h assimilation period would be beneficial to the stability of analysis (more observations coherently assimilated). Problems highlighted in previous tests as coastal moistening during anti-cyclonic periods, will be probably reduced by some technical constraints adopted in the latest version of the 2d-var, like limiting divergent analysis corrections.

The perspective of using the method in the frame of the ELDAS project will guide further tests towards the assimilation of other fields, like analyzed precipitation and satellite data.

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3. Margarida BELO PEREIRA : "Improving the assimilation of water in a NWP model"

Introduction

It is known that the forecasts from NWP models are very sensitive to small errors in the initial state. The aim of the meteorological data assimilation is to determine this initial state, trying to make it as close as possible to the true state of the atmosphere. However, the observations are insufficient to describe the atmospheric state. Therefore, a short range (6 hours) forecast (known as background) is used as a first guess of the initial state. So, the analysis field is a combination of background and observations. The weights given in the analysis to observations and to background are determined by the magnitudes of errors at each location (variances) and the correlations between errors at different locations (covariances). The matrix which contains these statistics for the background is known as the B matrix. In order to determine the B matrix, the NMC method was tried at NCEP (Parrish and Derber, 1992). Afterwards, the Analysis Ensemble method was tried in Canada (Houtekamer et al., 1996) and at ECMWF (Fisher, 1999). Presently, the Ensemble method is under study in ARPEGE (Belo Pereira, 2002).

NMC method versus Ensemble Method

In the present work, the differences between 12 h and 36 h forecasts valid at the same time are used in the NMC method. The description of the experiments made for using the Ensemble method is given in the previous ALATNET Newsletter (Belo Pereira, 2002).

In order to study the differences between the two methods some global statistics of the background errors were analysed. The largest differences between the two methods are found for vorticity and temperature. Figure 1 shows the standard deviation of vorticity background errors, as estimated by the two methods. The largest errors are found near the tropopause, for wavenumbers between 18 and 40, with both methods, but the magnitude of errors is significantly larger for the NMC method. Moreover it is interesting to mention that the NMC method produces a second error maximum near the top of the Planetary Boundary Layer, which doesn't appear when the Ensemble method is used. For temperature, the largest contribution for errors comes from the top levels and from planetary scales, for both methods. Nevertheless, when using the NMC method, the standard deviation of temperature background errors shows a second maximum above the tropopause level, which comes from synoptic scales. The Ensemble method doesn't produce this second maximum.

For surface pressure, the standard deviation of background errors has much larger values when computed using the NMC method than with the Ensemble method. The biggest differences occur for synoptic scales, i.e. for wavenumbers between 3 and 20.

The auto-correlation spectra were also examined for different variables. The results show that the variance of vorticity and divergence errors in the troposphere have a bigger contribution from mesoscale phenomena, when estimated by the Ensemble method than by the NMC method. This difference is stronger for the vorticity field.

The auto-correlation spectra for specific humidity show that the variance maximum is shifted towards the smaller scales in the NMC method.

In the bottom levels, for temperature, the maximum difference between the two methods occurs for synoptic scales, which are the scales that contribute most for the uncertainties in the temperature field. In the middle troposphere, the Ensemble method produces a broader spectra for temperature errors than NMC method. This means that, with the NMC method, the error variance is increased in the synoptic scales, but decreased in meso and in planetary scales. In the tropopause and in stratospheric levels, the maximum variance of temperature error is shifted towards smaller scales when the NMC method is used.

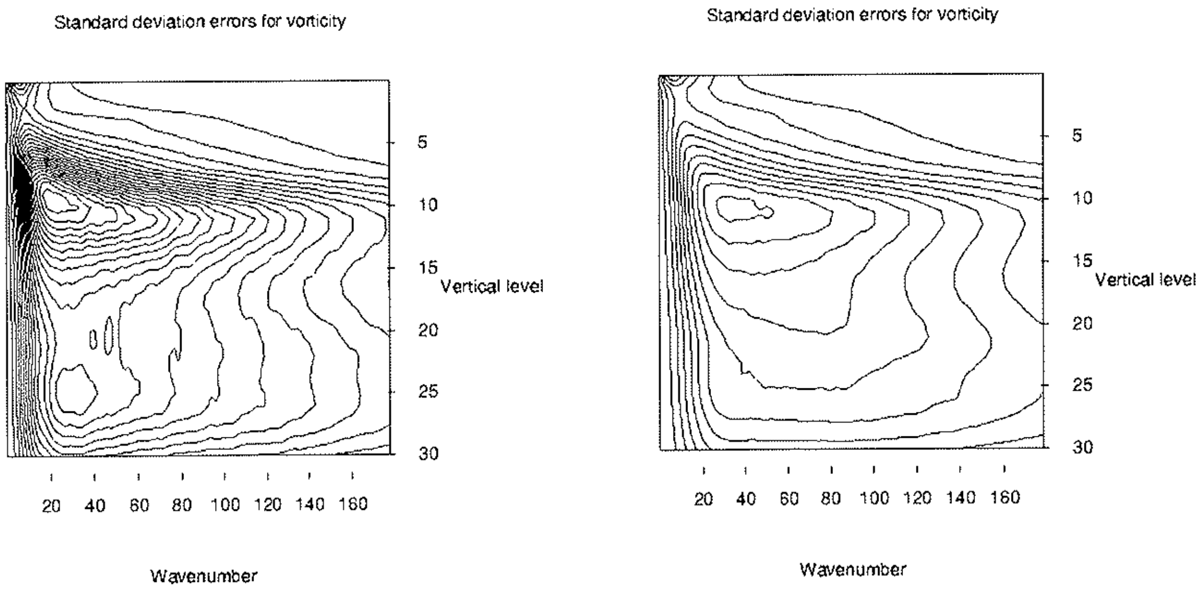

Figure 1. Standard deviation of vorticity background error as a function of model level and horizontal wavenumber, using the NMC method (left side) and the Ensemble method (right side). Isoline spacing is 0.15, starting at 0.15.

The mean vertical correlations, as functions of the horizontal wavenumber, were also analysed. The results show that the Ensemble method produces much sharper vertical correlations for the largest scales (for wavenumbers smaller than 30) than the NMC method. This result is in accordance with those obtained at ECMWF (Fisher, 1999).

Figure 2 shows the mean horizontal correlations for specific humidity at level 20 (700 hPa). When the Ensemble method is used the correlations are sharper than with the NMC method. This result is valid also for surface pressure.

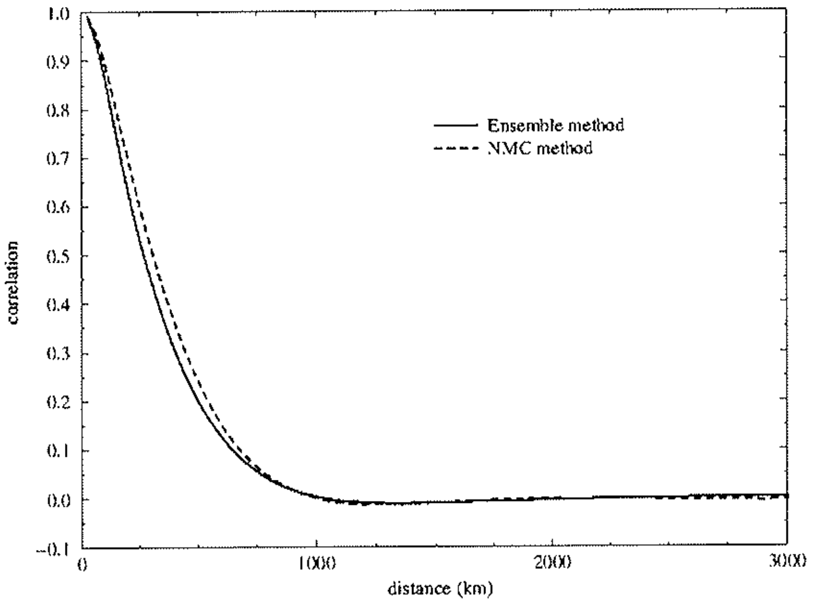

Figure 2. Horizontal correlation for specific humidity at level 20 (700 hPa).

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4. Martin GERA : "Improved representation of boundary layer"

Turbulence scheme

The topic is to find expressions for exchange coefficients which contain directly turbulent kinetic energy (TKE) handled as moderate prognostic variable. This feature allows us to dispose of exchange coefficients with a "history" of turbulence evolution. TKE equation employs virtual potential temperature. If we use potential temperature as thermodynamic variable, it allows us to degrade the number of parameterized equations. However the ALADIN model works with humidity fluxes. These fluxes can be expressed by conversion terms. Here one can discuss, if we do not lose a possibility to manipulate with (co)variances of potential temperature and specific humidity independently.

After introducing the parameterizations one can write a relation for fluxes :

$$\overline{u_i\theta} = \frac{L_k}{c_s\, e^{1/2}}\left[-\frac{2}{3}\, e\, \frac{\partial\overline{\theta}}{\partial x_i} + \frac{2}{3}\delta_{i3}\, g/\overline{\theta_v}\cdot\, \overline{\theta_v\theta}\right] \qquad (1)$$

$$\overline{u_i q} = \frac{L_k}{c_h\, e^{1/2}}\left[-\frac{2}{3}\, e\, \frac{\partial\overline{q}}{\partial x_i} + \frac{2}{3}\delta_{i3}\, g/\overline{\theta_v}\cdot\, \overline{\theta_v q}\right] \qquad (2)$$

$$\overline{\theta q} = \frac{L_\varepsilon}{2c_{\theta q}\, e^{1/2}}\left[-\overline{u_m\theta}\cdot\frac{\partial\overline{q}}{\partial x_m} - \overline{u_m q}\cdot\frac{\partial\overline{\theta}}{\partial x_m}\right] \qquad (3)$$

$$\overline{\theta^2} = \frac{L_\varepsilon}{c_\theta\, e^{1/2}}\left[-2\,\overline{u_m\theta}\cdot\frac{\partial\overline{\theta}}{\partial x_m}\right] \qquad (4)$$

$$\overline{q^2} = \frac{L_\varepsilon}{c_q\, e^{1/2}}\left[-2\,\overline{u_m q}\cdot\frac{\partial\overline{q}}{\partial x_m}\right] \qquad (5)$$

All notations are detailed at the end of the present paper. We can use next expression for the formulation of potential temperature fluxes :

$$\overline{u_i\theta_v} = E_\theta\, \overline{u_i\theta} + E_q\, \overline{u_i q} \qquad \text{with} \qquad E_\theta = \overline{\theta_v}/\overline{\theta} \qquad E_q = 0.61\overline{\theta} \qquad (6)$$

If we ask for the same form of potential temperature fluxes as introduced in formula (1), it seems straightforward to use the expression :

$$\overline{u_i\theta_v} = \frac{L_k}{c\,e^{1/2}}\left[-\frac{2}{3}\,e\,\frac{\partial\overline{\theta_v}}{\partial x_i} + \frac{2}{3}\,\delta_{i3}\,g/\overline{\theta_v}\cdot\overline{\theta_v\theta_v}\right] \qquad (7)$$

After manipulation with equations, we obtain a condition for coefficients c_s, c_h : $c = c_s = c_h$.

For the variance of potential temperature, we create a similar formula :

$$\overline{\theta_v{}^2} = \frac{L_\varepsilon}{c_0\,e^{1/2}}\left[-2\,\overline{u_m\theta_v}\cdot\frac{\partial\overline{\theta_v}}{\partial x_m}\right] \qquad (8)$$

In a similar manner, to retain a consistency between equations, we get a condition for coefficients c_θ, c_q and $c_{\theta q}$: $c_0 = c_\theta = c_q = 2c_{\theta q}$.

After solving the equations for fluxes we get an expression for exchange coefficients :

$$\overline{u_i\theta_v} = -K_h\,\frac{\partial\overline{\theta_v}}{\partial x_i} \qquad (9)$$

where

$$K_H = \frac{2}{3}\,\frac{L_k}{c}\,e^{1/2}\,\Phi_i \qquad [m^2\cdot s^{-1}] \qquad (10)$$

The function of air stratification has form :

$$\Phi_i = 1 - \delta_{i3}\,\frac{2c_1 R'(\theta_v)^2}{R(\theta_v) + 2c_1 R(\theta_v)^2} \quad \Rightarrow \qquad (11)$$

in 1D case : $R'(\theta_v) = R(\theta_v) \;\Rightarrow\; \Phi_3 = \dfrac{1}{1+2c_1 R(\theta_v)}$ (12)

where : $c_1 = \dfrac{2}{3}\,\dfrac{1}{cc_0}$

The Redelsperger numbers R, R' depend on virtual potential temperature instead of potential temperature .

$$R(\theta_v) = g/\overline{\theta_v}\cdot\frac{L_\varepsilon L_k}{e}\cdot\frac{\partial\overline{\theta_v}}{\partial x_3}$$

$$R'(\theta_v) = g/\overline{\theta_v}\cdot\frac{L_\varepsilon L_k}{e}\cdot\left(\frac{\partial\overline{\theta_v}}{\partial x_m}\cdot\frac{\partial\overline{\theta_v}}{\partial x_m}\right)^{1/2}$$

Fluxes for potential temperature and humidity now read :

$$\overline{u_i\theta} = -K_H\,\frac{\partial\overline{\theta}}{\partial x_i} \qquad (13)$$

$$\overline{u_i q} = -K_H\,\frac{\partial\overline{q}}{\partial x_i} \qquad (14)$$

The form of expressions (7) and (8) predefine the setting of the coefficients. Redelsperger numbers contain humidity and potential temperature dependence concurrently. This form yields to the same exchange coefficients for humidity and potential temperature. Their fluxes (variances) only differ through variable gradient. Using equation (9) and :

$$\overline{\theta_v^{\,2}} = c_1\, L_\varepsilon L_k \left(\frac{\partial \overline{\theta_v}}{\partial x_m} \cdot \frac{\partial \overline{\theta_v}}{\partial x_m}\right) \Phi_m \tag{15}$$

together with TKE equation encloses our system of equations.

In a similar manner we express exchange coefficients for momentum fluxes :

$$\overline{u_i u_j} = \frac{2}{3}\,\delta_{ij}\, e \;-\; K_M\left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i} - \frac{2}{3}\,\delta_{ij}\frac{\partial U_m}{\partial x_m}\right) \tag{16}$$

$$K_M = \frac{4}{15}\frac{L_k}{c_M}\, e^{1/2} \qquad [m^2 \cdot s^{-1}] \tag{17}$$

One may express now the local physical tendencies and vertical turbulent fluxes respecting the ALADIN formalism :

$$\left(\frac{\partial \mathrm{U}}{\partial t}\right)_\psi = -g\,\frac{\partial J_\psi}{\partial\, p} \tag{18}$$

$$J_\psi = -K_\psi^{'}\left|\Delta \mathrm{U}\right| \qquad [kg \cdot m^{-2} \cdot s^{-1} \cdot m \cdot s^{-1} \equiv N \cdot m^{-2}] \tag{19}$$

$$K_\psi^{'} = \overline{\rho}\; g\, \frac{K_\psi}{\Delta\Phi} \qquad [kg \cdot m^{-2} \cdot s^{-1}] \tag{20}$$

In 1D situation, where only vertical exchanges are expected, the parameterized equation for TKE, (9) and (16) have the form (for more details see [2]) :

$$\frac{\partial e}{\partial t} = g/\overline{\theta_v}\;\cdot \overline{w\theta_v} \;-\; \overline{uw}\,\frac{\partial U}{\partial z} \;-\; \overline{vw}\,\frac{\partial V}{\partial z} \;-\; 1/\overline{\rho}\,\frac{\partial}{\partial z}\left(\overline{\rho}\; W\, e\right) \;-\; 1/\overline{\rho}\,\frac{\partial}{\partial z}\left(c_{2M}\,\overline{\rho}\, L_k\, e^{1/2}\,\frac{\partial e}{\partial z}\right) \;-\; c_\varepsilon \frac{e^{3/2}}{L_\varepsilon} \tag{21}$$

$$\overline{w\theta_v} = -K_H\,\frac{\partial \overline{\theta_v}}{\partial\, z} \tag{22}$$

$$\overline{uw} = -K_M\,\frac{\partial U}{\partial\, z} \tag{23}$$

$$\overline{vw} = -K_M\,\frac{\partial V}{\partial\, z} \tag{24}$$

Initialization

Doing an analysis of exchange coefficients, one could see a direct dependency on TKE. We said above that TKE will be a prognostic variable. It is apparent that we need for starting computations an initial value of TKE. We have no possibility without additional assumptions to compute subgrid values in the model. One possibility is to use a similar algorithm for the initialization as for the next computation. The initial value is computed from stationary simplification of the TKE equation, neglecting advection terms. One gets the following equation for initial TKE :

$$\frac{\partial e}{\partial t} = 0 = -(\overline{u_i u_j} - \frac{2}{3}\delta_{ij} e)\frac{\partial U_i}{\partial x_j} + g/\overline{\theta_v} \cdot \overline{u_3\theta_v} - \varepsilon \tag{25}$$

Equation has this form after rearrangement :

$$e = \frac{L_\varepsilon}{c_\varepsilon}\left[\frac{4}{15}\frac{L_k}{c_M}\left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i} - \frac{2}{3}\delta_{ij}\frac{\partial U_m}{\partial x_m}\right)\frac{\partial U_i}{\partial x_j} + g/(\overline{\theta_v}\, e^{1/2})\cdot\overline{u_3\theta_v}\right] \tag{26}$$

After solving a system of fluxes equations we get a value of TKE. From turbulent energy expression it is clear that eddy length parameters L_ε, L_k are unknown. We can see a lot of methods for determine these parameters in literature. We use a spectral characteristic for their determination. To study a wavenumber dependence on the spatial structure of TKE and air stratification function one has to use a relationship as :

$$E(k) = \frac{1}{2\pi}\int E^*(\omega)\, F(k-\omega)\, d\omega \tag{27}$$

where F is the Fourier transform of the air stratification function. From this expression one can see the influence of air stratification on the energy spectrum.

Near a wall, energy is blocked. From article [1] we can describe the deficit of turbulent kinetic energy, which is triggered by dissipation, using :

$$D_\varepsilon = \int_{k_M}^{\infty} E_F^*(k)\, dk \Big/ \int_{k_M}^{\infty} E_B^*(k)\, dk \tag{28}$$

D_ε measures the global deficit of TKE . E_F* is the spectral density of TKE in free atmosphere in neutrally stratified air (homogenous turbulence), E_B* is the spectral density of TKE nearest the surface (wall-bounded turbulence). These formulations allow us to compute length parameters and consecutively energy and fluxes. This kind of solution solves the problem while resolving vertical variance automatically.

Implementation to ALADIN

From the previous analysis it is apparent that the computed fluxes will depend on the distance to surface. Near the boundary, we have :

$$J_\psi = -K_\psi^{'}\,\Delta\psi \qquad K_\psi^{'} = \bar{\rho}\, C_\psi \left|U(z)\right|$$

where C_ψ is an exchange coefficient at the surface. Formula (28) is applied on surface layer, which coincide with last interface (half level) and on the last but one half level. It is reason of definition L_ε, L_k nearest the surface. In the free atmosphere we use expression (18).

One can discuss now, that spectral characteristics are used for computation of some coefficients, although vertical grid is irregular. From linear spectral analysis it is apparent that the integral value of total TKE is unaltered with the change of density of the grid. The alteration is visible at intensity of $E(k)$ only. If we do the additional assumption that, in PBL, the density of mesh is quasi-regular, we can use for the derivation a mesh resolution nearest our point of computation. This method serves an estimation of the coefficient's magnitude. Their value must be tuned.

Every next derivation is derived from the fact, that TKE is computed in half levels. The origin of computation is using the dry static energy or Richardson number expression. The moisture is included in the gas constant. It is a similar approach for the introduction of virtual temperature. Correction for shallow convection is well applicable in this moment. For Redelsperger number in 1D case, one has the following expression in ALADIN model :

$$R(\theta_v) = G(z)\,\frac{\Delta\phi\Delta S}{c_p T\, e} = G(z)(\Delta U_i)^2\,\frac{Ri}{e} \tag{29}$$

$$\text{where :}\quad G(z) = \begin{cases} A_k(z)A_e(z)\dfrac{g[z+z_{0M}]\;g[z+z_{0H}]}{(\Delta\phi)^2} & z < 2L \\ 1 & z \geq 2L \end{cases} \tag{30}$$

G is a surface influence function, ΔS is a change of dry static energy and z_{0M}, z_{0H} are roughness length for momentum and thermal processes. For Ri we have expression :

$$Ri = \frac{\Delta\phi\Delta S}{c_p T\,(\Delta U_i)^2}$$

These knowledges are sufficient for the expression of our stability function Φ_i. For initialization of TKE we use analogous proceeding. One has a result :

$$e = \frac{4}{15 c_M \cdot c_\varepsilon}\,G(z)\,(\Delta U_i)^2\,f(Ri) \tag{31}$$

where $f(Ri)$ is stationary equivalent of Φ_i..

After taking into account our expressions for exchange coefficients (10,17), one can easy express these coefficients with present formulas. For computation of exchange coefficient we need to setup parameterization coefficients c, c_0 only. We suppose, that c_M, c_ε are set from spectral knowledge.

The direct dependency of the stratification function or Redelsperger number on Ri can cause some problems with value bounding . In region with strong instability or small wind shear it can produce difficulties. Limitation of Ri value is garbled from current ALADIN scheme for this reason.

PBL parameters at standard meteorological heights (METEO)

Kinematic turbulent fluxes could be expressed nearest the surface by friction, scaling velocity or by adequate thermal quantities. The computation assumes small change (10%) of fluxes in ground layer. Therefore we apply constant statistical moments at this case. The current ALADIN style of computation (application of logarithmic profiles and of stability function) require to know exchange coefficient at neutral stratification. In our case it is problem, because TKE contains directly stability feature and we can not do separation very easy. If we want to solve the problem realistically, we must solve a differential equation for TKE for a neutrally stratified atmosphere. This solution for getting TKE in a neutrally stratified atmosphere is expensive. Another approach, which exploits properties of stationary theory, can solve our problem satisfactory (it is implemented for beginning). For exchange coefficients in a neutrally stratified atmosphere one can now write the expressions :

$$K_H = \frac{2}{3}\,\frac{L_k}{c}\left(\frac{e}{f(Ri)}\right)^{1/2} \tag{32}$$

$$K_M = \frac{2}{3}\,\frac{L_k}{c_M}\left(\frac{e}{f(Ri)}\right)^{1/2} \tag{33}$$

In these formulas we do the same simplification for TKE like for friction fluxes. Energy will has a no vertical dependence at lowest levels nearest surface.

Notations

A bar denotes an averaging

δ_{ij}	... Kronecker symbol
index m	... Einstein's summation ($X_m = X_1 + X_2 + X_3$) (see [1])
e	... turbulent kinetic energy
p	... pressure
q	... specific humidity
T	... temperature
θ	... potential temperature
θ_v	... virtual potential temperature
Φ	... geopotential
u_i	... perturbed wind components
U_i	... components of mean wind : U=(U_1, U_2, U_3)=(U, V, W)
S	... dry static energy
g	... gravitational acceleration
Ri	... Richardson number
c_p	... specific heat at constant pressure
L_ε, , L_k	... dissipitation and eddy viscosity length scales (see [1])
c_s , c_h , *etc..*	... dimensionless parameterization coefficients
K_H , K_M	... exchange coefficients for heat and momentum
z_{0M}, z_{0H}	... roughness lengths for momentum and thermal processes
Φ_i	... air stratification function
$f(Ri)$	... stationary equivalent of Φ_i (for more details see [2])
R	... Redelsperger number (as a function of virtual potential temperature)
R'	... tridimensional Redelsperger number
E	... spectral dependency of TKE
E^*	... Fourier transform of TKE in neutrally stratified air
F	... Fourier transform of TKE in neutrally stratified air
ε	... viscous dissipation of TKE

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5. Ilian GOSPODINOV : "Reformulation of the physics-dynamics interface"

1. Study of different techniques for physics-dynamics interface (hydrostatic dynamics)

Any modern numerical model is composed of two parts : a dynamical part solving mechanical field equations and a physical parameterisation package to account for the ensemble effect of subgrid-scale processes upon the resolved scales of the model. There are several techniques that can be used for combining the dynamics and physics contributions in a semi-implicit model. One such method, called time-splitting, is used in some models because of its simplicity and stability property. In this context time-splitting consists in solving the dynamical part of the model equations with semi-implicit scheme, without the physical contribution to tendencies, and then adding contributions from physics as a second, correction step. The more traditional alternative, used also in ALADIN, is to add physical tendencies together with nonlinear tendencies as part of the explicit component of the semi-implicit scheme. Within this research topic different techniques for the application of the contributions from the physical parameterisations are being tested for the hydrostatic version of ALADIN.

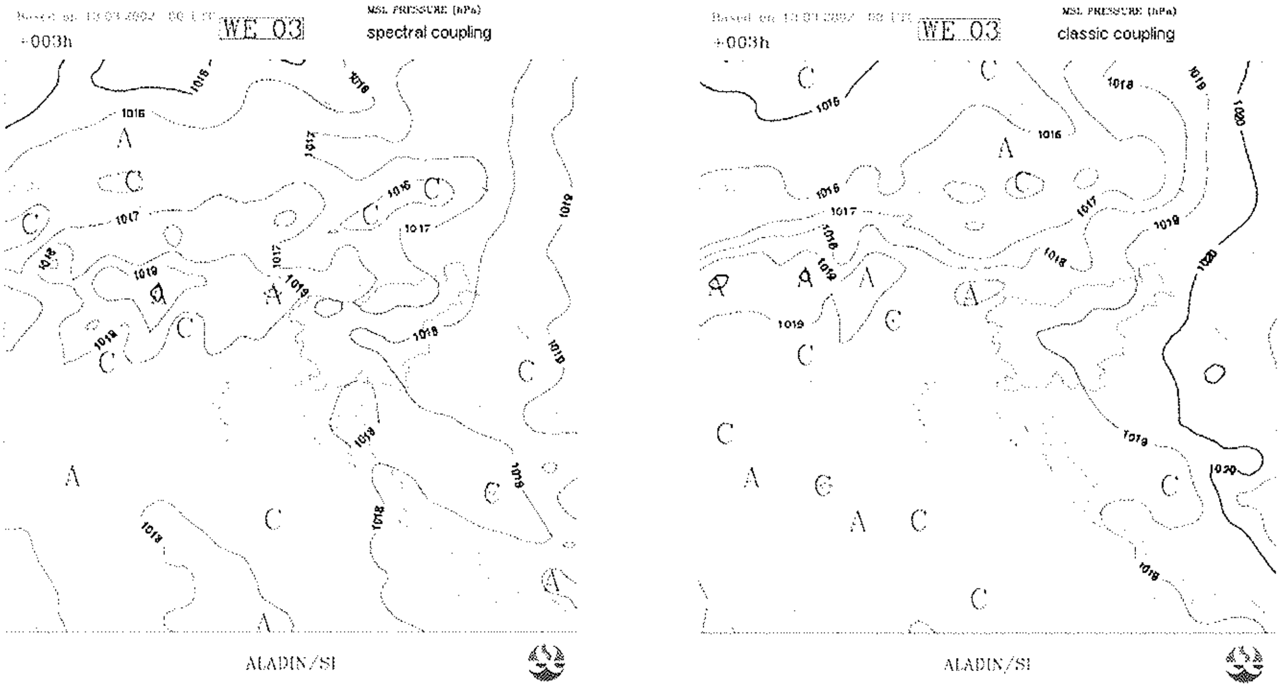
2. Study of the treatment of diabatic terms (non-hydrostatic dynamics)

A number of empirically derived approximations to the treatment of the diabatic heating are being tested. There are labelled quasi-anelastic and quasi-hydrostatic approximations to the diabatic heating because they produce results analogous to those obtained with the correspondingly approximated dynamical models, when using short timesteps.

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

The main part of the code development for spectral coupling has been finished. From technical point of view, at the present, the new spectral coupling scheme is working without major problems. The tests were done assuming mono-processor and multi-processor code version for optimal computation time, running the operational model on the Slovenian domain. A first comparison between the model results using the spectral and gridpoint couplings has been carried out. The mean-sea-level pressure field after three hours of integration keeps almost the same structure. It can be observed that the field with spectral coupling seems to have smaller values and to be less smooth (see Fig. 1 and Fig. 2).

The tuning of the spectral "alpha" function is absolutely important for the next step. The simplified spectral 1d shallow-water model will be used for validation and tuning. In the same time, the "alpha" function retuning for gridpoint coupling has to be considered further in order to avoid the very strong external forcing.



Mean-sea-level pressure field obtained by running the model with :

Fig1 (left) : spectral coupling

Fig2 (right) : classic coupling (Davies' relaxation scheme)

7. André SIMON : "Study of the relationship between turbulent fluxes in deeply stable PBL situations and cyclogenetic activity"

Relationships between turbulent fluxes and cyclogenesis (with aspect to the 20 December 1998' storm)

Description of achieved results during the ALATNET stay between 1.1.2002 and 31.5.2002

The need for this study appeared after several severe meteorological events, where the successful forecast of a cyclone was shown to be considerably dependent on a proper description of turbulent fluxes in the stable PBL layers.

One of the most significant cases was the rapidly developing cyclone in the northern Atlantic that hit France during 20 December 1998. Short and medium range forecast of this cyclone are strongly influenced by the critical Richardson number. The primary role of this variable is to bound the heat flux in situations with very stable PBL layers (when Richardson number is going to infinity).

In the current parameterisation scheme the tuning is provided by parameter USURID (see Geleyn, 2001). Generally speaking, small values of USURID (0.01 to 0.05) allow more heat exchange in the stable PBL and give the desired properties to forecast the cyclone. On the contrary, higher values (around 0.1) keep better inversion capabilities (Fig.1). Rather surprising is the fact that the current parameterisation "works" most sufficiently by Richardson numbers between 1 and 100 and not by extremely high values.

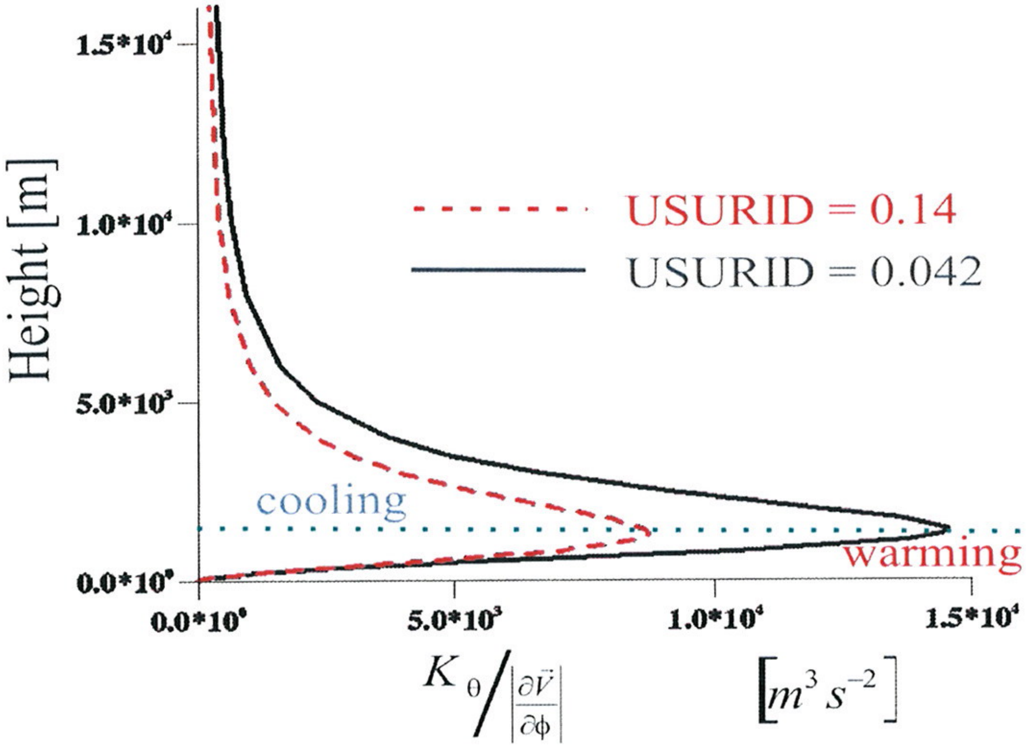


Fig.1 : Vertical profiles of exchange coefficient for heat by constant wind shear and by various values of parameter USURID. Profiles are computed for Richardson number Ri=4.5 . The green dotted line represents the height of "K" coefficient decrease. Below this level turbulent transport provides increase, above this level decrease, of potential temperature with time. The warming / cooling effect is more intense by smaller USURID value.

It was already shown by Bellus (2000), that the success of 84 hour forecasts of the cyclone depends on the Richardson number limitation along the first 21 hours of the run. This sensitivity was confirmed using the CYCORA-ter package in the beginning of 2002.

Because the forecasts of the mentioned cyclone using various setups of parameterisation are very close during this period, the transport of heat has not a direct influence on the process of rapid cyclogenesis (first 18 hours of computation - see Fig.2).

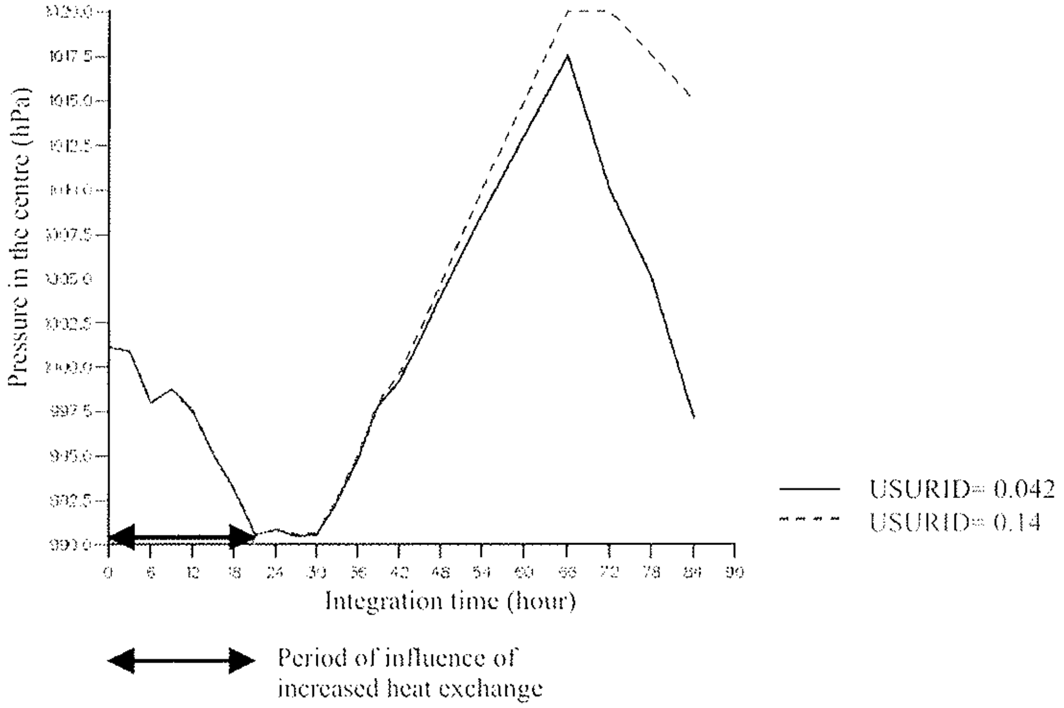


Fig.2 : Time evolution of mean sea level pressure in the centre of the "20.12.1998 storm". The 84 hour forecast of the ARPEGE model was based on 16.12.1998 00 UTC. Note the split of the two runs after 36 hours of integration and remarkable drop of pressure in the run with smaller USURID after 66 hours of integration.

Comparisons with the reference (operational) run show that a decrease of parameter USURID results in a decrease of static stability in the PBL in a few areas, mostly close to Newfoundland (Fig.3).

On the vertical cross-section through this area (Fig.4) one can see the effect of potential temperature increase in the lower PBL levels, with exchanges by cooling aloft and upstream.

The cyclone approaches the mentioned area after 36 hours of integration. In the same cross-section as in Fig.3 we can observe an increase in vertical velocities in the run with decreased static stability using a smaller USURID value, equal to 0.042 (Fig 5.). Consequently the forecasts of mean-sea-level pressure in the centre of the cyclone start to split when using different parameterisations of heat exchange. For smaller USURID (0.042) the decay of the cyclone between 36 and 66 hours of integration is slower and later the cyclone is rapidly reinforced, most probably due to presence of baroclinic instability (Fig.2).

Unfortunately, there is no possibility to forecast this (and any similar) event if the model forecast of surface pressure fails (that's the case for USURID equal to 0.14 or higher). Because the forecast error is mainly situated in low levels of the troposphere and in an area with lack of observational data, any other forecasting technique (e.g. use of potential vorticity inversion) would be most probably unsuccessful as well. Moreover already very high values of USURID (0.14) give significantly less static stability in the PBL when compared to the model analysis.

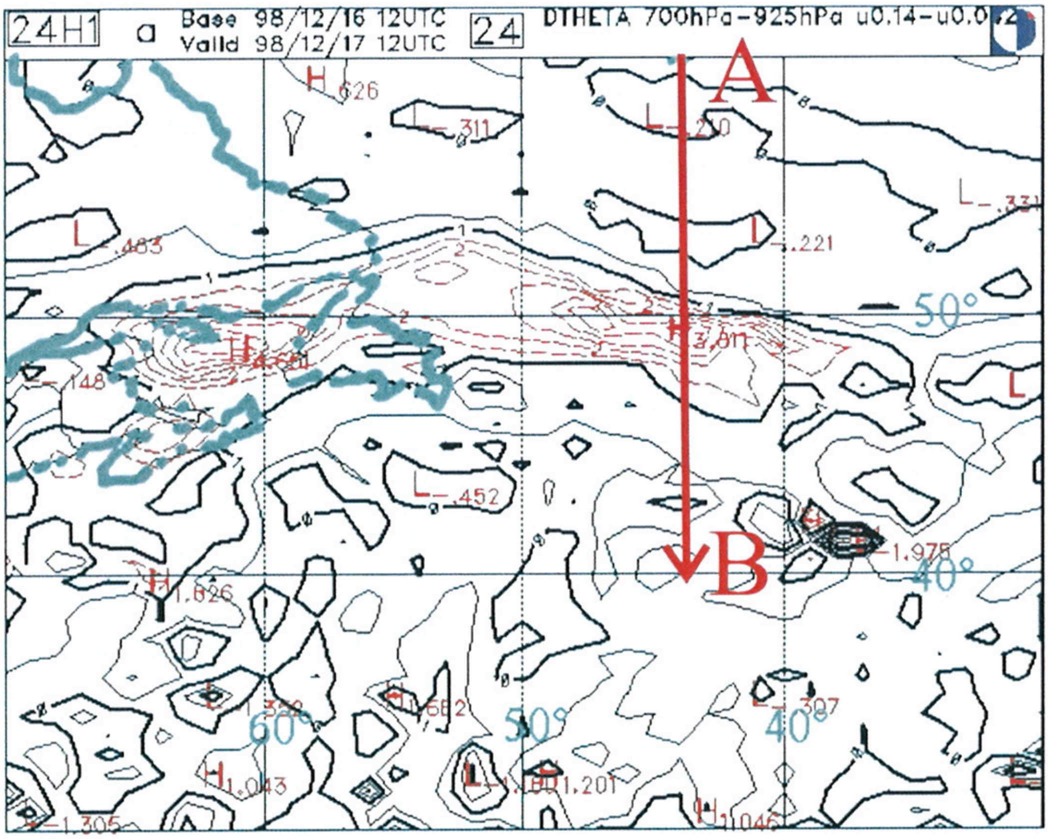


Fig.3 : Static stability changes due to enhanced turbulent transport after 24 hours of integration. The picture was obtained by computing differences of potential temperature between 925 and 700 hPa level and comparing the runs with USURID=0.14 and USURID=0.042. Areas with significant increase (decrease) in stability while going to higher (smaller) USURID are marked by dashed and red lines. The arrow draws the direction of the cross-section in Fig.4

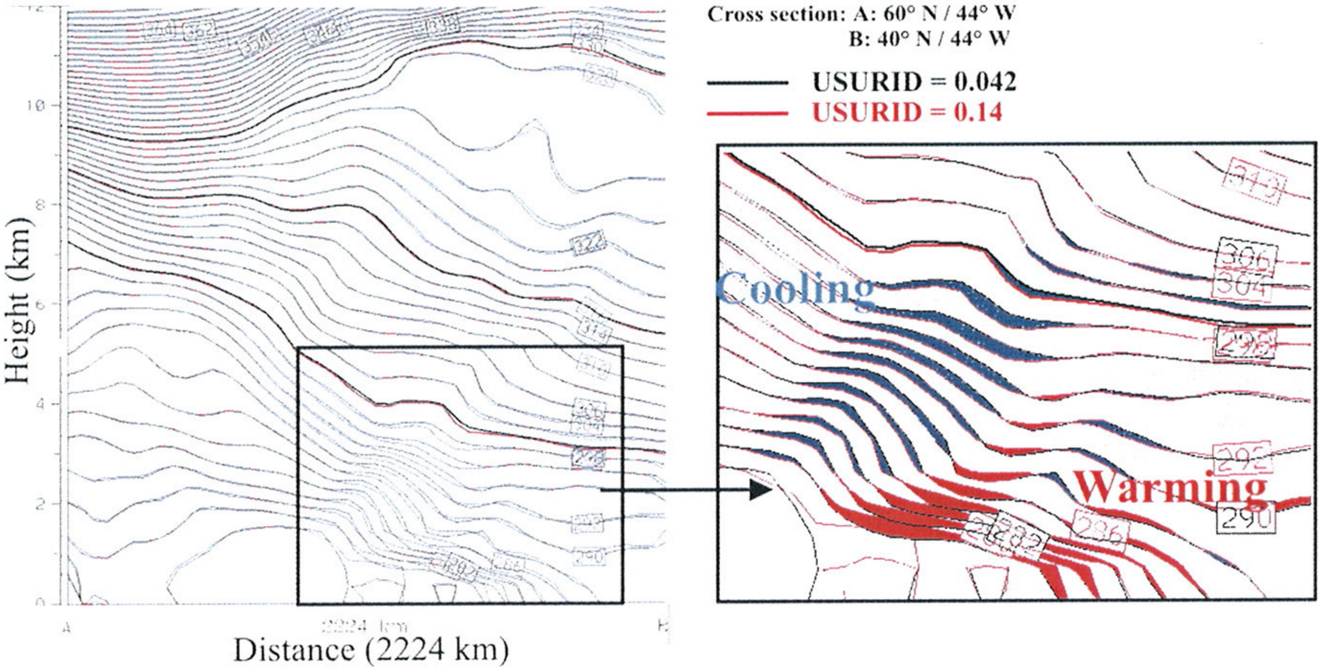
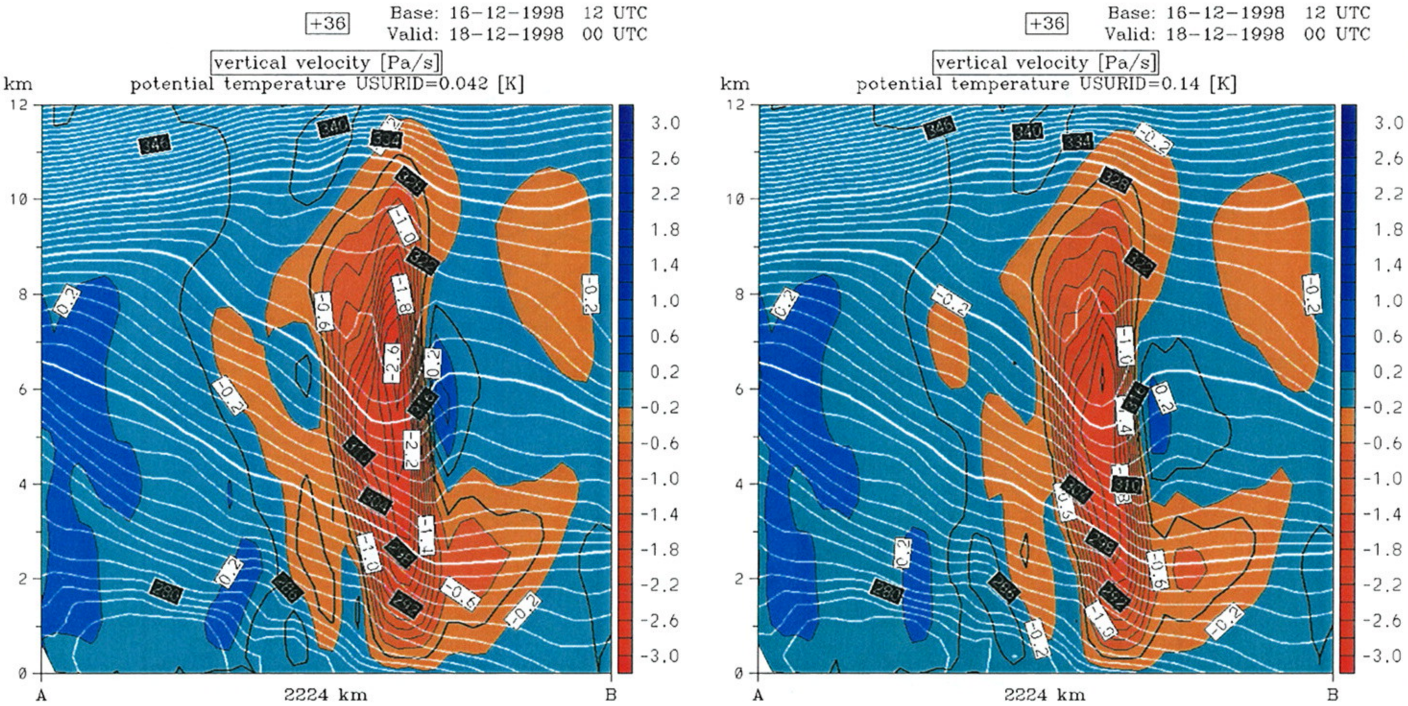


Fig.4 : Vertical cross section through potential temperature field computed from the same forecast as in Fig.3. Warming in low levels and cooling aloft is obtained by decreasing USURID, thus making the slope of potential temperature isolines steeper (decreasing static stability). In contrast to Fig.1, the warming / cooling effects result on a slope.



a

b

Fig.5 : a/ Field of vertical velocity in the same vertical cross-section as in Fig.4 but after 36 hours of integration. Near the area of decreased static stability we can note more intense vertical motions in the mid-troposphere (run with USURID=0.042) comparing to run using USURID=0.14 (Fig.5b). After 36 hours of integration, forecasts of the cyclone using various USURID begin to split (see Fig.1).

b/ 36 hour forecast of vertical velocity in the run with USURID=0.14

Conclusion

One could deduce, that the physics - dynamics interface presented in this case is more or less accidental, nevertheless the parameterisation of turbulent transport played important role in several cases (among other the "famous" Christmas' storms in the year 1999). One reason can be, that the used diagnostic methods don't discover all particularities of the relationship between turbulence and cyclogenesis. Thus more objective techniques will be used for this purpose - i.e. sensitivity tests with adjoint model.

Adjustments of the current parameterisation scheme can lead at least to some kind of compromise in the cyclogenesis - inversion gap. It's possible to enhance the heat exchange over warm instable surface layers while keeping high USURID values over stable stratified lowest model layer. Such investigations already brought in the case of 20.12.1998 first promising results.

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8. Chistopher SMITH :"Stability analysis and precision aspects of the boundary condition formulation in the non-hydrostatic dynamics and exploration of the alternatives for discrete formulation of the vertical acceleration equation both in Eulerian and semi-Lagrangian time marching schemes"

Research Objectives

The purpose of this research project is to investigate deficiencies in the non-hydrostatic (NH) version of ALADIN, specifically with regard to the upper and lower boundary conditions. In numerical weather prediction (NWP) it is standard practice to separate "dynamics" processes from "physics" processes. The same methodology is adopted in NH-ALADIN. For this reason it is necessary that NH-ALADIN should have a "dynamical core" which is capable of solving the inviscid, adiabatic equations of non-hydrostatic fluid flow. For these equations the correct boundary condition at a solid boundary is the so-called free-slip condition. This condition requires that there be no flow in the direction normal to the boundary, and that there be no lateral stresses in the fluid near the boundary. Since an inviscid fluid is incapable of supporting lateral stresses, this boundary condition does not provide additional information to the specification of the problem; rather it is a necessary condition, which must always be satisfied by an inviscid system.

An important tool for the development of NH-ALADIN is the two-dimensional (2D), vertical slice version of the model. This tool allows model results to be compared against well-known analytical results, making it invaluable for assessing whether the model captures true non-hydrostatic behaviour. Experiments with this 2D model indicate that NH-ALADIN sometimes generates spurious behaviour over orography, particularly when a semi-Lagrangian (SL) time-stepping scheme is used. However, this does not indicate any superiority in the Eulerian time scheme. All these tests involve computing steady-state solutions, for which an Eulerian scheme has a clear advantage. This is because an Eulerian scheme uses spatial coordinates which are independent of time, whereas a semi-Lagrangian scheme makes use of Lagrangian, time-varying coordinates. For realistic applications, where the flow is far from steady-state, this advantage is likely to be absent. For reasons of robustness and stability when long time-steps are used, the semi-Lagrangian scheme is much to be preferred over the Eulerian scheme. The problems suffered by the SL scheme in the idealised 2D test cases therefore require a solution.

Research Conclusions

Further numerical investigations, again with the 2D model, showed that the discretisation of the vertical momentum equation was strongly implicated in the spurious model behaviour. There is now strong evidence to suggest that the spurious behaviour is closely related to the fact that vertical divergence is used as the prognostic quantity describing vertical motion. We may list some weaknesses associated with this choice of prognostic variable:

1. The numerical treatment of vertical motion differs markedly from that of horizontal motion. For horizontal motion the prognostic quantities are the components of horizontal wind. Whereas vertical motion is represented by vertical divergence, not vertical wind. This difference is perhaps undesirable for very high resolution modelling.

2. Under certain flow conditions the numerical scheme for solving the vertical motion equation may be unstable. This is due to the fact that a significant amount of downstream data may be used in the computation of an advection increment.

3. Whether or not the numerical scheme for vertical motion suffers the above instability, it has bad error propagation characteristics. An error introduced near the lower boundary is immediately propagated to all the higher grid levels at the next time-step.

4. The prognostic equation for vertical divergence contains more source terms than that for vertical wind. All source terms must be discretised using finite differences in the vertical. Currently, the finite difference representations in NH-ALADIN are first order accurate only. Therefore using vertical divergence, rather than vertical wind, as a prognostic quantity necessarily reduces the overall accuracy of the model.

5. It is a non-trivial matter to introduce the free-slip lower boundary condition as a necessary constraint on the discrete NH-ALADIN model. This is due to the fact that the semi-implicit stage of the scheme does not allow for horizontal variation in the coefficients of the Helmholtz equation. However, the situation is further complicated if vertical divergence is the prognostic variable. This is because the free-slip boundary condition is most naturally expressed in terms of wind components, not their derivatives.

Proposed Solution

The above conclusions indicate that a change should be made in NH-ALADIN: to use vertical wind, rather than vertical divergence, as a prognostic variable. The strongest case for this change is made by the last item in the above list. Failure to respect the free-slip lower boundary condition, as a necessary constraint on the discretised equations, results in the spurious behaviour seen in the 2D tests. When vertical wind is used as a prognostic variable it is possible to apply a pragmatic remedy to the lower boundary condition problem. By simply over-writing the vertical wind data on the lower boundary, using the boundary condition, it is possible to obtain correct solutions over a reasonably wide range of flow situations.

Future Work

The proposed implementation of the free-slip constraint at the lower boundary requires further testing, in a three-dimensional NWP context. There also remain issues to be addressed relating to the stability properties of the semi-implicit scheme for the NH-ALADIN model. Vertical divergence is used to formulate the semi-implicit stage, regardless of whether vertical wind or vertical divergence is the prognostic quantity. The robustness of the model may possibly be enhanced if the semi-implicit stage is always formulated using the chosen prognostic quantity.

Conclusion

It has been demonstrated that NH-ALADIN does not satisfy a necessary constraint, imposed by the free-slip lower boundary condition. As a consequence of this the model often exhibits spurious behaviour when simulating flow over orography. A complete solution to this problem is not currently available, due to restrictions imposed by the spectral formulation on the kind of implicit equations which may be solved in the semi-implicit stage. A pragmatic compromise solution has been proposed. This solution requires that the prognostic quantity representing vertical motion should be vertical wind, rather than vertical divergence. Additional arguments against using vertical divergence as a prognostic quantity have also been put forward.

9. Cornel SOCI : "Sensitivity study at high resolution using a limited-area model and its adjoint for the mesoscale range"

The development of the adjoint model is primarily oriented towards data assimilation and predictability applications. However, since it is able to relate the origin of a numerical forecast failure to the errors in the initial data, it has been used in diagnostic studies such as sensitivity experiments. The latter approach was proven to be successful for studying phenomena linked to baroclinic instability when using a low resolution model. For a high resolution limited-area model, the moist processes which are strongly nonlinear start playing a crucial role. Furthermore, numerical instabilities can occur. Thus, both the physical description of the atmospheric processes and the numerical robustness must be checked and possibly improved in the adjoint model.

In this study, the gradients of the forecast-error cost-function with respect to the initial conditions are investigated. The norms utilized are the so-called dry and moist total energy. The norm is called dry when there is no explicit term in it involving specific humidity. The gradients were computed using a package of simplified and regularized physical parameterizations including vertical diffusion, gravity wave drag, large-scale precipitation, deep convection and radiation. This package was developed for the global model ARPEGE with the aim of being used in four-dimensional variational data assimilation.

Sensitivity experiments for selected cases were performed intending to investigate the failure of precipitation forecasts. As an example of sensitivity analysis, we consider a case of overestimated precipitation forecast covering the period 0-12 UTC, 3 May 2001. However, we have tried to correct the total precipitation generated by the model within 6-12 UTC. One important feature for this experiment is that we have tried to improve the forecast using the 6 hours gradients of the forecast error cost-function with respect to the initial conditions. Usually, the forecast-error norm is computed at the end of the period under consideration, in our case at 12 hours, and not in-between.

Before performing the sensitivity integration we have analysed the gradient field. The adjoint model enfolded the parameterization of vertical diffusion, gravity wave drag, and large-scale precipitation. Results have shown that the large-scale precipitation scheme triggers numerical instability in the adjoint model. Indeed, as one may see in Figure 1 which illustrates the gradients of the forecast error cost-function with respect to the temperature on model level 20, there is a very wavy and noisy pattern. After investigations the problem was cured by modifying the shape and shift of the regularization function. A stable solution of the adjoint model is shown in Figure 2.

By modifying the model initial conditions using the gradients computed as described above, we have tried to ameliorate the precipitation field shown in Figure 3. This was produced by the operational forecast. In this figure a maximum of 27 mm / 6 h over an area situated in the north-western part of France is shown up, while the measured amount was less than 10 mm / 6 h. Although, in reality a convective system developed in the Northern part of France and the numerical forecast missed it. In that area 24 mm / 6 h were measured. The results of sensitivity integration are promising for this case. Analysing the corrected precipitation forecast shown in Figure 4, one may see that the maximum has diminished from 27 to 18 mm / 6 h and, more important that a precipitation core with 24 mm / 6 h has appeared in the proximity of the area were the convective storm did generate in reality.

However, several case studies were performed and not all of them were sensitive to the modification in the initial conditions. Also, there were results with neutral impact. For these, the misforecast may come not only from the errors in the initial conditions but from the errors in the lateral boundary conditions or the model formulation. The results have shown that the precipitation forecast can be improved if the failure is dominated by the fastest growing structures in the initial data.

This study gives a first experimental frame for the evolution and performance of an adjoint model for the mesoscale range. Further studies are needed in order to better understand the behaviour of the mesoscale gradients computed with a package of simplified and linearized physical parameterizations.

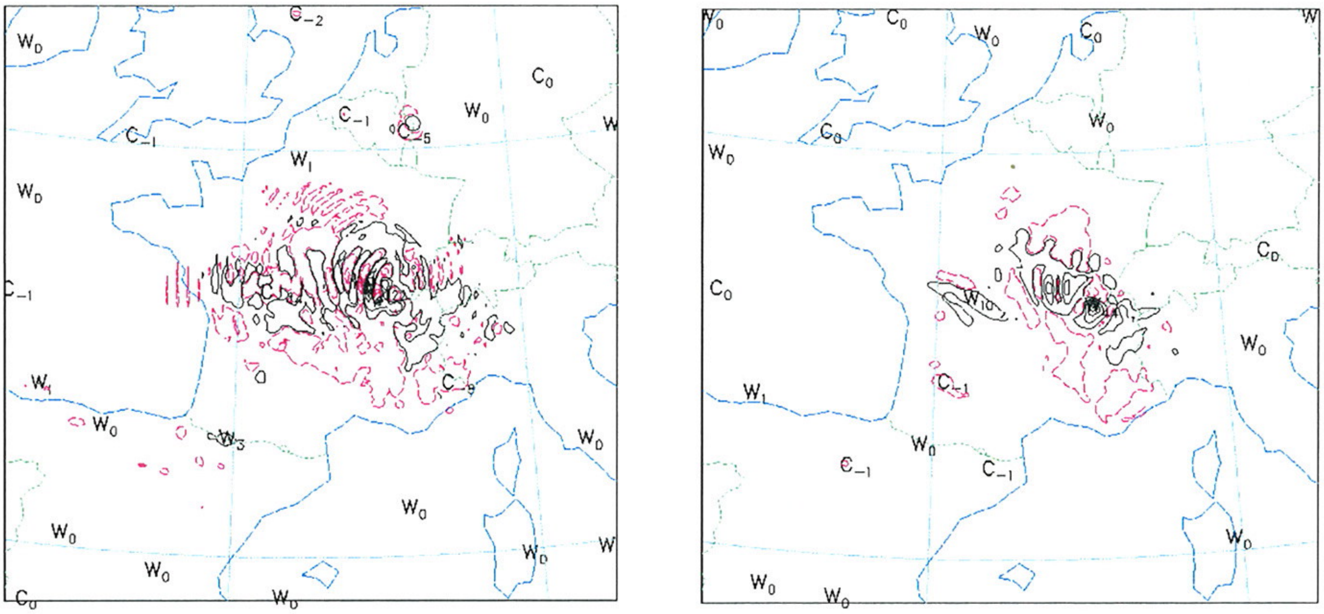


Figure 1. Gradients of the forecast error cost function with respect to the temperature at model level 20, computed with an adjoint model including simplified schemes for vertical diffusion, gravity wave drag and stratiform precipitation processes : before (left-hand side), and after (right-hand side) stabilization of the large-scale precipitation scheme.

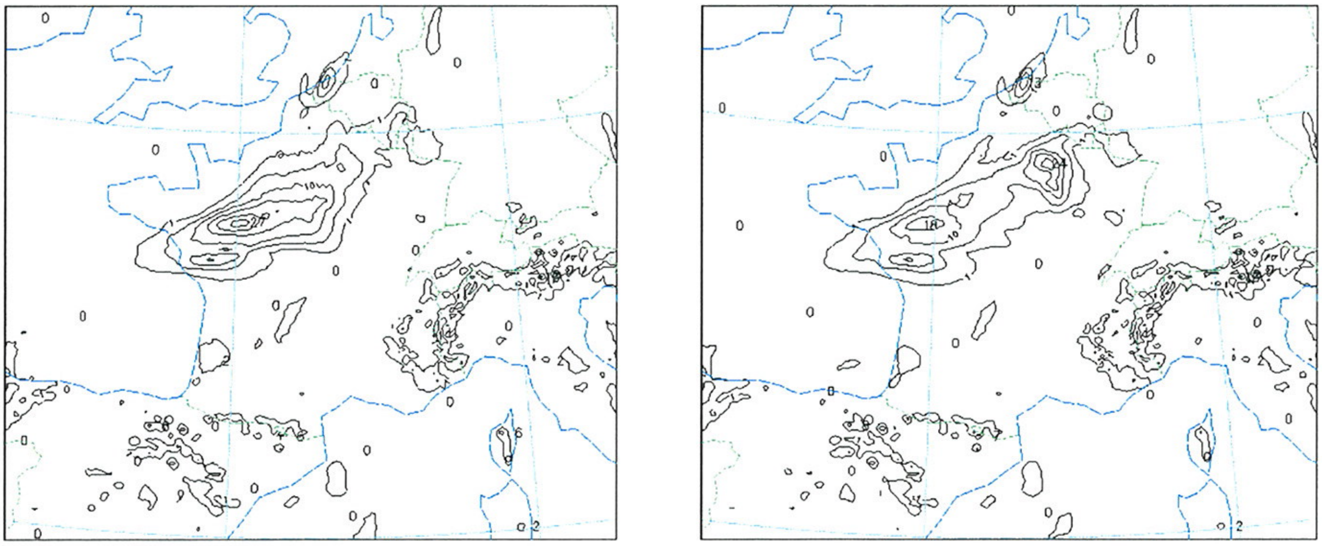


Figure 2. 6 hours precipitation forecast : operational (left-hand side), and after "improving" the initial conditions using the gradient of the 6 hours forecast error cost function (right-hand side).

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

Nothing new since the last Newsletter (work at ZAMG).

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

"Parameterisation of background error statistics for surface parameters (LST, SSE) , to be used for future assimilation of advanced IR sounders over land"

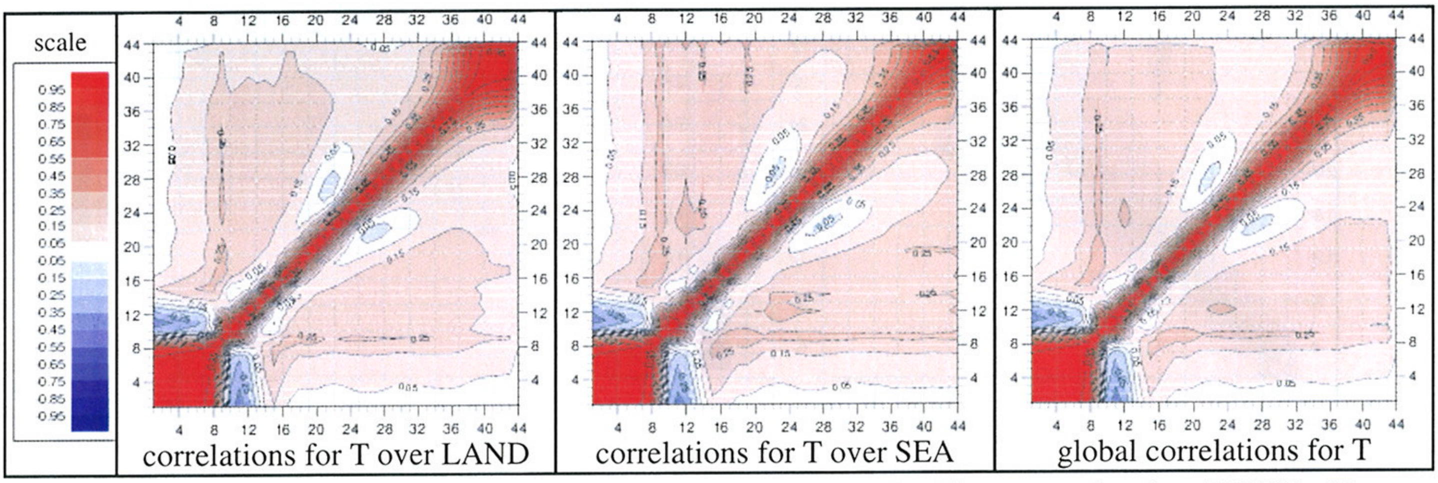
I. Introduction

To retrieve and assimilate the very fine spectral resolution measurements from advanced IR sounders (IASI/AIRS) we need to have the ancillary information (background) which specifies the behaviour of the variables or constitutes some a priori constraints. In order to estimate the quality of the background information one need to compute the background error covariance, called B matrix. This matrix is one of the most important elements of the data assimilation system - it determines the filtering and the propagation of the observed information.

A first estimate of land surface skin temperature (LST) can be taken from model forecast, and surface spectral emissivity (SSE) can be provided by climatological values depending on the land cover type. To calculate the background error covariance for temperature (vertical profile + surface) the Ensemble method was used. This method is based on an ensemble of independent analysis experiments (members), in which all observations are perturbed. The perturbations cause the differences between members analysis, and next they propagate to the 6 h forecast and consequently to the next analysis cycle, in the form of uncertainties in the background. The statistics of the differences between background fields for pairs of ensemble members represent the background errors. Our ensemble is composed of 10 perturbed forecasts for 30 days period (Belo Pereira, 2002), and the calculations of B matrix were done in gridpoint space (separately for land, sea and all points together) for the 43 IASI radiative transfer model (RT-IASI) levels. For the emissivity the B matrix is calculated for 12 wavebands, separately for each of the different land cover types. Chosen wavebands fully cover the IASI and AIRS spectral range. The data for emissivity climatological maps (SSE background) were taken from the MODIS spectral library.

II. Background error statistics for the temperature

As a background (first guess) for temperature we use the 6h forecast from the ARPEGE (cy22t1) model, and to estimate the background errors with Ensemble method we made gridpoint calculations. It means that the ensemble of forecasts was projected onto ARPEGE gridpoint space (truncation T199) and interpolated onto 43 RT-IASI levels. The final ensemble is composed of 10 independent 3d-var analysis experiments for the month of May 2001. For consecutively numbered members were calculated the differences between the background fields for each 6h cycle from 5th to 30th of May 2001, so the statistics were based on 234 background differences. From them we calculated the background error covariances, separately averaged over gridpoints of land, sea and globally. The vertical correlations between all levels derived from the obtained matrices are shown on the Figure 1. The surface is the 44th level.



correlations for T over LAND

correlations for T over SEA

global correlations for T

Fig. 1. Correlations for T for 43 RT-IASI levels + surface skin temperature, for different areas (based on ARPEGE grid).

The correlations for high atmosphere levels do not look realistic, the reason for that is the extrapolation from 31 ARPEGE levels to 43 in the radiative transfer (RT) model. In the stratosphere RT has 14 levels and ARPEGE only 3, next 15 RT levels (stratosphere and upper troposphere) correspond to 12 in the forecast model. Just for the lower troposphere (below 500 hPa) an equivalent spanning of levels between ARPEGE and RT-IASI is satisfactory : 16 model levels refer to 14 of RT.

The global B matrix generally used in RT-IASI was calculated at ECMWF (J.-N. Thépaut), also using the Ensemble method, but the interpolation to 43 RT-IASI levels was from 60 levels in the IFS model, which allow a better description of the high atmosphere. Because none of the B matrices is experimental and we wanted to keep the land surface characteristics and remove "noise" from the top of the atmosphere, we decided to mix both matrices - the present one for land and the ECMWF one. A "transition matrix" combining them was used. For the first 14 RT levels it keeps just the ECMWF covariance, above the 29th level just mine, and in-between a mixture of both matrices, with a linearly growing ratio (with a step of 6.25%). The original matrices, the transition matrix and the final one are shown on Figure 2.

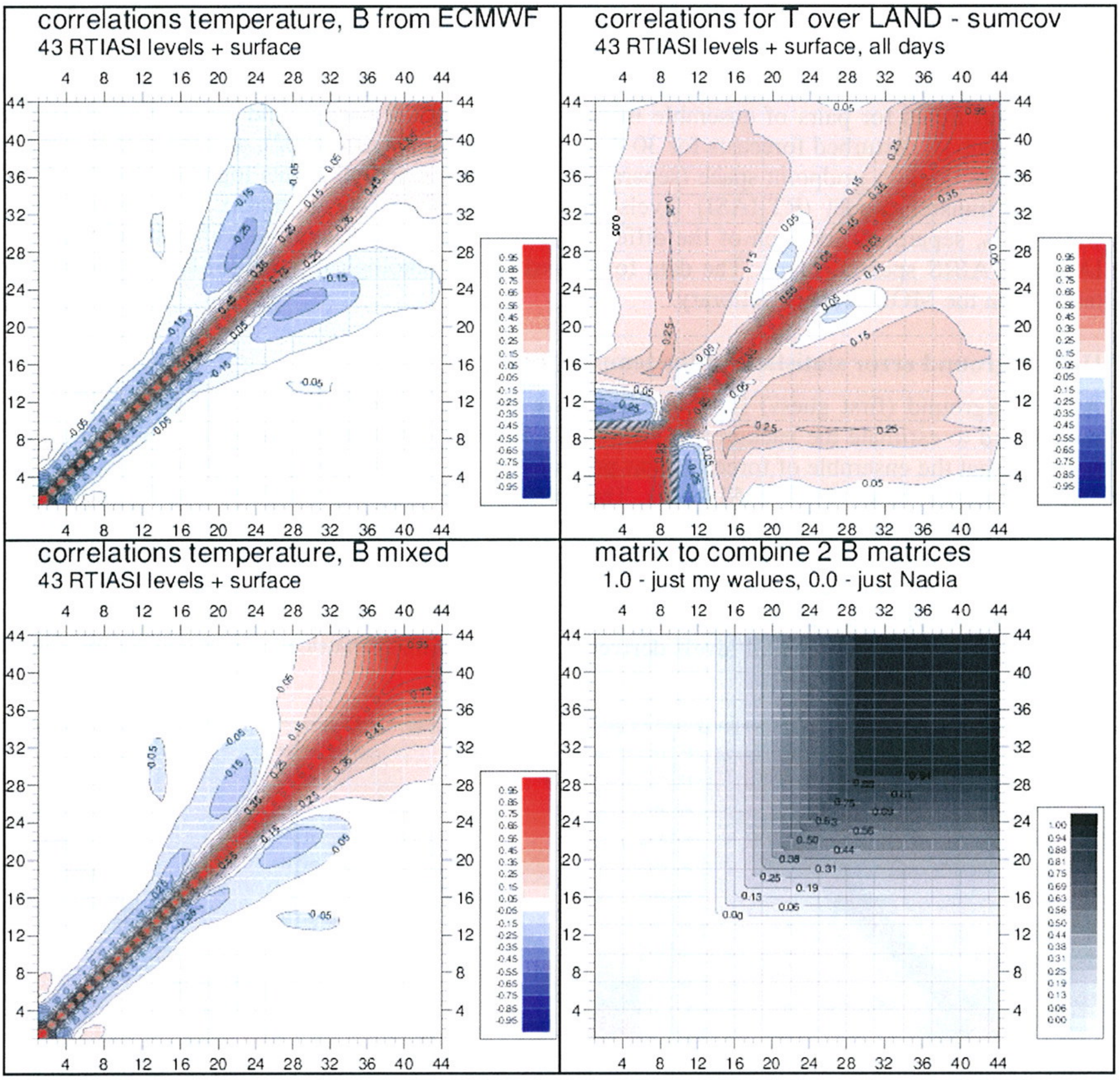


Fig. 2. Creation of the final B matrix for land. The ECMWF B matrix is actually the matrix calculated by J.-N. Thépaut.

Created in such a way, the matrix is non singular, and 1d-var tests with this matrix have given positive results.

Also to give idea about the values of calculated covariance, Figure 3 presents vertical profiles of standard deviations (square-root of B diagonal) for temperature.

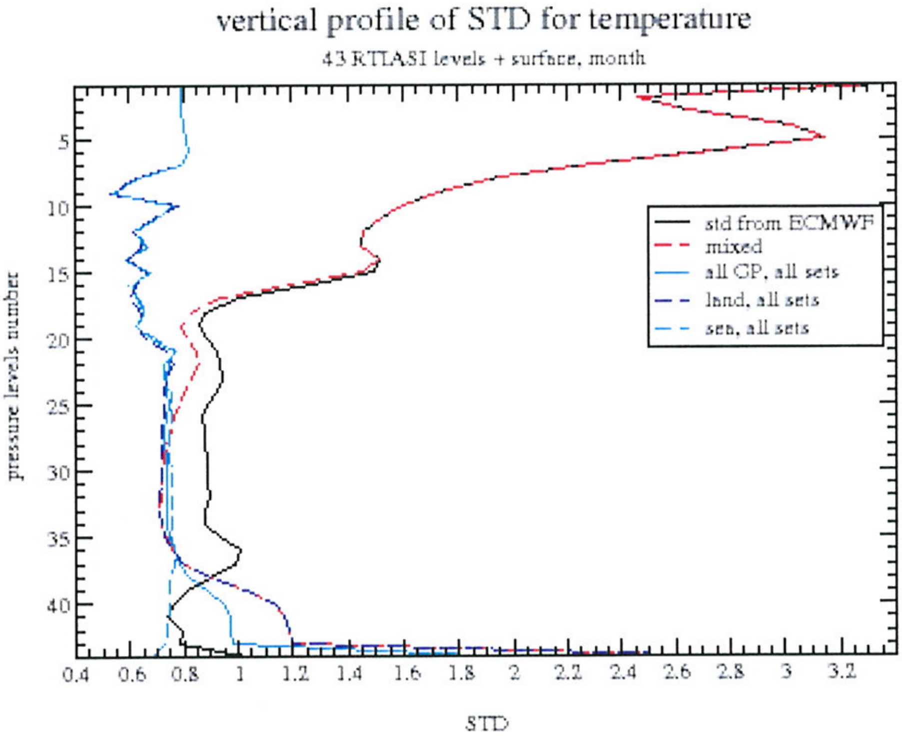


Fig. 3. Vertical profiles of STD for temperature. 43 RT-IASI levels + surface.
In blue are gridpoint calculated values: dark blue corresponds to the values for the land and dashed light blue to the sea ones. Black curve is the ECMWF temperature STD profile and in dashed red is the profile derived from the "combined" matrix.

III. Background error statistics for spectral emissivity

The creation of the background for the emissivity, the climatology, was described in my previous ALATNET report. The method hasn't changed, just we have chosen new wavebands, not equal ones, but corresponding to the IASI transmittance function. Also additional tests had shown that we will use the variable -log(1-SSE) instead of SSE. Emissivity data (laboratory measurements) for many types of soil, vegetation and ice were taken from the MODIS spectral library. We obtained from there : 5 sea-water samples, 9 samples of ice and snow, 128 samples of different kinds of soils, 24 samples of high vegetation (trees) and 5 samples of low vegetation. "Sample" means the infrared emissivity spectrum of some plant or material (range: 600-3000 cm^{-1}). Unfortunately samples do not have the same spectral resolution, so instead of interpolating all spectra to the same resolution and then calculating statistics, we decided to estimate first the mean emissivity value per waveband and per sample, and average them for each land cover type. Next, in each waveband we calculated the differences for each land type, and afterwards emissivity covariances for all 12 bands. Calculation of statistics were done for -log(1-SSE). On the figures below are correlations for separated land cover types (Fig. 4), and global ones (Fig. 5) created with and without respect to the percentage of each land type at the global scale.

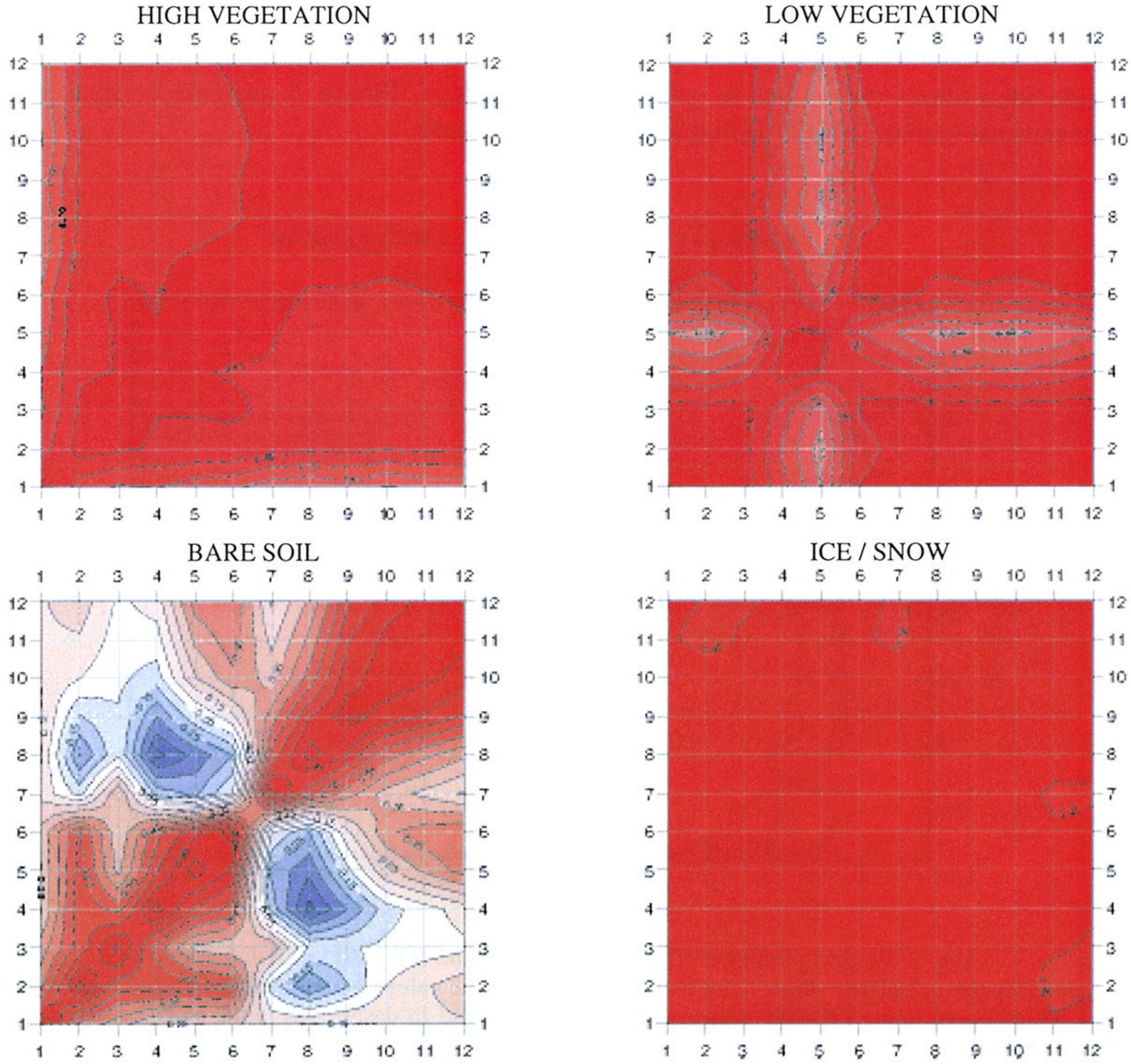


Fig. 4. Correlations of SSE for 12 spectral wavebands, separate for each land-cover type.

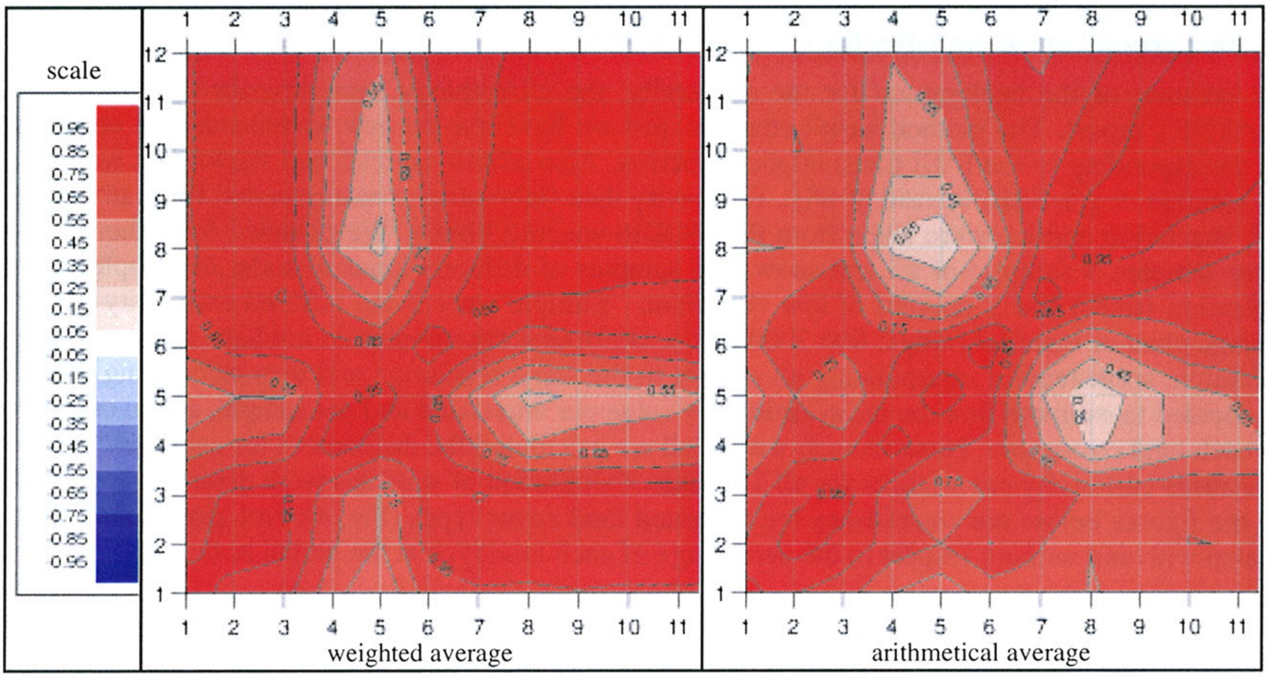


Fig. 5. Global correlations derived from covariances averaged over all land-cover types.

SSE of high vegetation and ice show very strong correlations between all wavebands. It is caused by the low variability of their spectra with wavenumber. The exactly opposite case is for bare soil emissivity and partially for low vegetation. For bare soil, surface spectral emissivity can change from 0.77 to 1.0 in IR IASI range (645-2760 cm^{-1}); for low vegetation it can change from 0.88 to 0.98. The weights (percentage of the globe covered by each surface type) were taken from the ARPEGE grid : sea water - 53.4%, ice/snow - 1.4%, high vegetation - 13.5%, low vegetation - 29.2% and bare soil - 2.5%.

IV. Summary

The already prepared background allows us to start work with 1d-var retrieval and assimilation. The first step will be the insertion of SSE as a control variable. Afterwards the experiments with inversions in 1d-var will address direct sensitivity - influence of SSE change on radiance, calculation of the gradients with respect to SSE and LST. Additionally the work on emissivity needs more investigations. The reason is that in reality the emissivity mixing is not linear, it depends on LST. Nevertheless, for the time being we will test all B matrices for emissivity, to take the decision which one to use. For the temperature, "combined" B matrix already is in use.

References

M. Belo Pereira : "Improving the assimilation of water in a NWP model", ALATNET Newsletter 4, 2002

Laboratory emissivity data were taken (autumn 2001) from :
http://speclib.jpl.nasa.gov/, http://www.icess.ucsb.edu/modis/EMIS/html/em.html

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

Predictor-Corrector scheme for non-hydrostatic ALADIN : implementation and idealized tests

Introduction

The main event during reported period was the implementation of the predictor-corrector (PC) scheme into the main version of the ALADIN model (version AL25T1). The cleaning, optimization and debugging of PC scheme has been done. However only the two-time-level (2-TL) case has been coded up to now. We concentrated on idealized tests in order to validate the PC scheme against results from linear stability analyses. We implemented also an option with a non-isothermal semi-implicit background. The objective is to stabilise the PC scheme after the first corrector step for non-isothermal nonlinear flow regimes.

Implementation of PC scheme in ALADIN

The following formulations of the PC scheme have been implemented (written here without time-decentering although the decentering option has been implemented as well, *L* refering to the linear part and *R* to the nonlinear residual) :

- Predictor step for 2TL non-extrapolating PC scheme :

$$(I-\frac{\Delta t}{2}L)\cdot X^{*} = (I+\frac{\Delta t}{2}L)\cdot X^{t} + \Delta t\, R(X^{t})$$

- Predictor step for 2TL extrapolating PC scheme :

$$(I-\frac{\Delta t}{2}L)\cdot X^{*} = (I+\frac{\Delta t}{2}L)\cdot X^{t} + \Delta t\left[\tfrac{3}{2}R(X^{t})-\tfrac{1}{2}R(X^{t-\Delta t})\right]$$

- Corrector step (independent on the predictor formulation) :

$$(I-\frac{\Delta t}{2}L)\cdot X^{t+\Delta t}=(I+\frac{\Delta t}{2}L)\cdot X^{t}\ +\ \Delta t\left[\frac{1}{2}R(X^{t})+\frac{1}{2}R(X^{*})\right]$$

The non-extrapolating PC scheme was found to be more stable in linear analyses of stability (see Figure 1). It is a true 2-TL scheme without numerical modes (i.e. a non-oscillatory scheme) and is less expensive concerning memory.

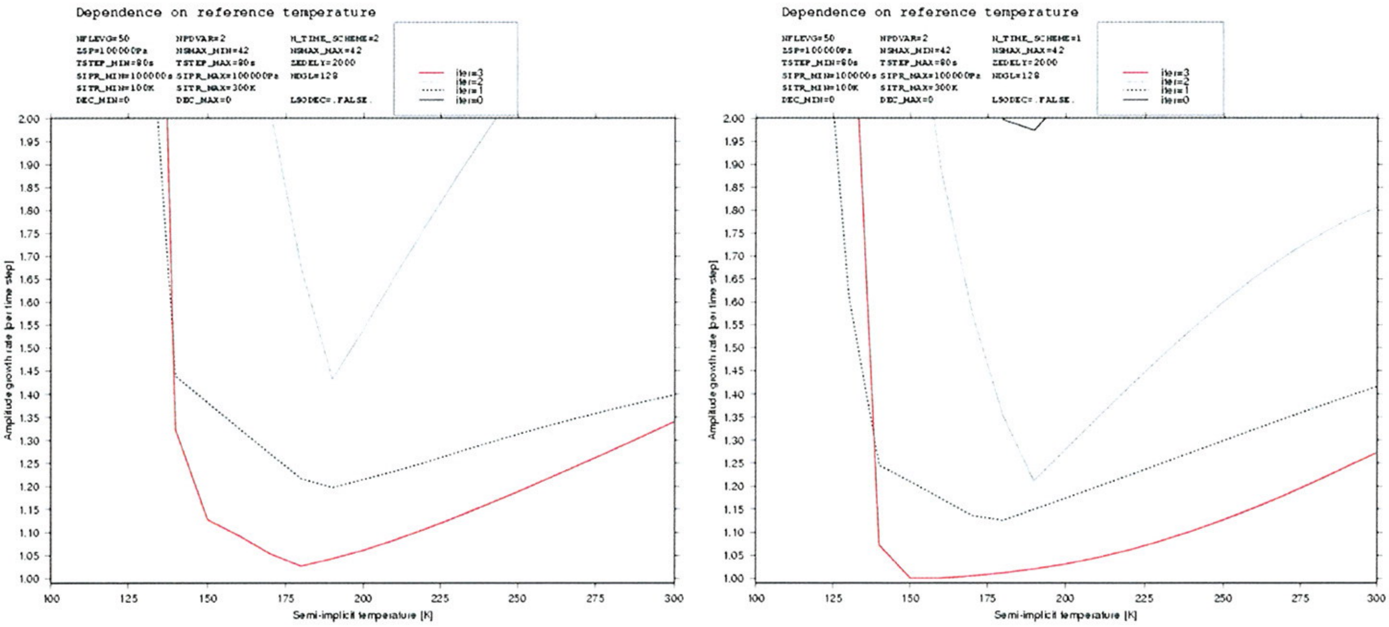


Figure 1. Growth-rate per time-steps of the most unstable mode, for extrapolating (left) and non-extrapolating (right) schemes and the same atmospheric conditions, as a function of the semi-implicit temperature. (black dotted line : after the first corrector step, black solid line : after the second one, red solid line : after the third one).

Choice of Prognostic Variables

It has been found that the stability of the semi-implicit non-hydrostatic model significantly depends on the choice of the additional non-hydrostatic prognostic variables. The following non-hydrostatic prognostic variables have been chosen :

$$d3=-\frac{gp\ \partial w}{mRT\partial\eta}\ ,\quad \mathcal{P}=ln(\frac{p}{\pi})$$

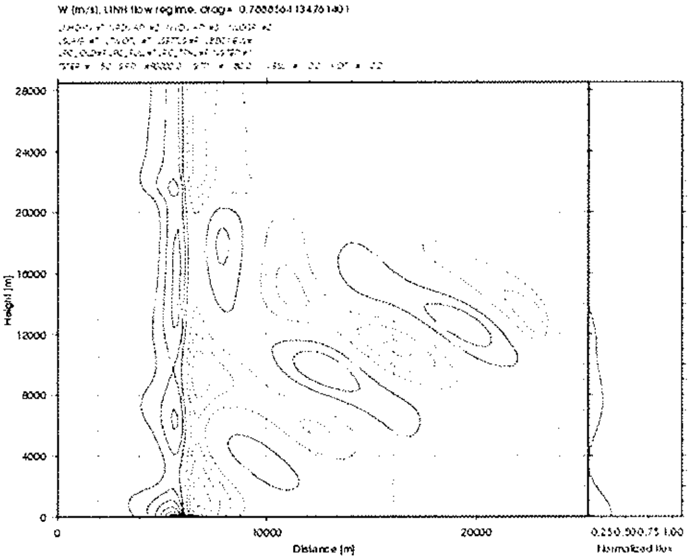
The pseudo vertical divergence $d3$ is equivalent to vertical velocity w, while $\mathcal{P}$ is equivalent to true pressure p. The choice of $d3$ ensures the stability, in σ or η coordinates, for linear flow regimes. The choice of $\mathcal{P}$ is important when η coordinate is used in the vertical. The model is slightly more unstable after a first corrector step according to linear analyses of stability. With this variable, it can be integrated using semi-implicit time-stepping (predictor only) for linear flow regimes. This is not valid for the old prognostic variables.

All the results presented in this document were obtained using this choice for prognostic variables.

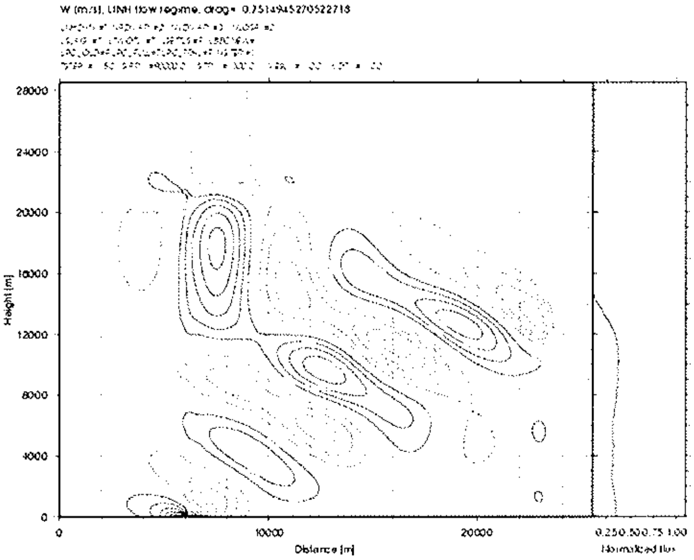
2D vertical plane tests

We found that the solution strongly depends on the choice of temperature for the isothermal semi-implicit background.

The best choices from the points of view of stability and accuracy may not be the same. On the figures below, linear non-hydrostatic flow regime tests (η coordinate, non-isothermal initial state with 220K at the surface and a vertical profile with constant Brunt-Vaisala frequency 0.01 s^{-1}) are presented, where the only difference is the choice of semi-implicit temperature (SITR) : 180 K on the left plot and 300 K on the right plot.



SITR=180 K



SITR=300 K

There is an artificial chimney present right above the mountain when the lower temperature is used. As it increases, the chimney disappears, above approximately 270 K, the normalized momentum flux gets more realistic, but model becomes more unstable. The best choice for stability in this case would be approximately 260 K. That is the value we have chosen for the next tests.

From linear to nonlinear flow regime

We tested the stability properties of the PC scheme when going from linear flow regimes (where linear analyses of stability are valid) to nonlinear ones. Results are summarised in the following tables. *CFL* is the well-known Courant-Friedrich-Levy dimensionless number, calculated as for Eulerian time-stepping. Nonlinearity is characterised by a dimensionless number : NH/V, where N is the Brunt-Vaisala frequency of the background (initial) state, H the height of the Agnesi-shape obstacle and V is the wind speed of the background state. We chose N=0.01 s^{-1} and V=10 ms^{-1}. The linearity was thus controlled by the height of the obstacle.

We integrated the model using the PC scheme with no (NSITER=0), one (NSITER=1), two (NSITER=2) and three (NSITER=3) corrector steps. The length of integration (before model blew up) is multiplied by the wind speed and divided by the width of the obstacle to obtain a dimensionless variable and make comparison of integration lengths easier (as *CFL* is changing). The maximum dimensionless length of integration was 50, and the corresponding solution was considered to be already in a quasi-steady state.

We see that it is not possible to use a simple semi-implicit time-stepping when the initial temperature profile is non-isothermal with N=0.01 s^{-1}. After a first corrector step, linear and quasi-linear flows are stabilised up to *CFL*=1.5. After a second one, all flows are stable for *CFL* around 1, but integrations with lower and higher *CFL* are unstable. We believe this is due to bad interactions between the "sponge" upper-boundary condition and dynamics. After a third corrector steps, all flows are stable up to *CFL*=2.

NSITER=0

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	2	2	2	2	2	2
	2.00	2	2	2	2	2	2
	1.50	2	2	2	2	2	2
	1.00	2	2	2	2	2	2
	0.75	2	2	2	2	2	2
	0.25	1	1	1	1	1	1

NSITER=1

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	5	6	8	9	12	14
	2.00	5	6	8	28	34	35
	1.50	5	6	8	50	50	50
	1.00	5	6	8	50	50	50
	0.75	5	6	50	50	50	50
	0.25	50	50	50	50	50	50

NSITER=2

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	7	8	9	12	14	15
	2.00	15	17	25	31	32	35
	1.50	50	50	50	50	50	50
	1.00	50	50	50	50	50	50
	0.75	50	50	14	17	14	14
	0.25	8	10	10	10	10	10

NSITER=3

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	5	7	9	14	25	31
	2.00	50	50	50	50	50	50
	1.50	50	50	50	50	50	50
	1.00	50	50	50	50	50	50
	0.75	50	50	50	50	50	50
	0.25	50	50	50	50	50	50

Isothermal versus non-isothermal semi-implicit background

To improve the convergence rate of PC scheme, we implemented a "non-isothermal semi-implicit background" option. We kept vertical operators as for the isothermal semi-implicit solver. According to analyses of stability, this choice should stabilise all linear regimes already after a simple semi-implicit time-step (NSITER=0). The results for NSITER=0 are shown in the tables below. Linear regimes are stabilised but there is almost no influence on more nonlinear regimes. The results after a first corrector step are not shown since there was almost no change, when comparing to results obtained with an isothermal semi-implicit solver (see the table for NSITER=1 in the previous paragraph).

This tests proved definitely that the instability in non-hydrostatic ALADIN dynamics is purely nonlinear.

Isothermal semi-implicit
NSITER=0

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	2	2	2	2	2	2
	2.00	2	2	2	2	2	2
	1.50	2	2	2	2	2	2
	1.00	2	2	2	2	2	2
	0.75	2	2	2	2	2	2
	0.25	1	1	1	1	1	1

Non-isothermal semi-implicit
NSITER=0

		Nonlinearity					
		1	0.8	0.6	0.4	0.2	0.1
CFL	3.00	2	2	2	2	8	10
	2.00	2	2	2	2	50	50
	1.50	2	2	2	4	50	50
	1.00	2	2	2	4	50	50
	0.75	2	2	2	4	50	50
	0.25	1	1	1	50	50	50

Content of new libraries CY25T1/AL25T1

Claude Fischer
Météo-France . CNRM /GMAP

In spring 2002, the ALADIN cycles have experienced a tremendous jump in their numbering: cycle 15 was phased directly to 25T1, 10 ALADIN cycles created in only 2 months !

Of course, this gap is simply due to the new rule, which states that the ALADIN cycles will in future have the same number than their ARPEGE counterpart. From a technical point of view, the phasing went on quite smoothly, which was a nice change compared to the hectic phasings of last years (too large delays of ARPEGE / IFS cycles, or ODB ...). Yet, several new features have appeared in the code.

The new geometry package MAKDO has been introduced in the model (Martin Janousek, Bodo Ahrens). This creates some modified numerical values for the geometry parameters, when compared to the old routines. Thus, it would be suitable for every partner to test the use of coupling files produced by AL25T1 in Toulouse, in order to check that the geometry frame-description can be read properly by the local (older) cycles. Thanks to the important work by Martin Janousek, the new geometry can be written in the usual file-frame format, so that old cycles can access and understand the data. The Toulouse system support should come back later to this point, via e-mail coordination.

A scientific change due to MAKDO is that the domains now are defined by their centre point and X and Y half-lengths, instead of corner point positions. For local adaptations, the namelists of ee927 and Fullpos will have to be changed. An automatic tool to highlight these changes has been prepared by Martin Janousek.

Some documentation is available and can be retrieved from Martin Janousek himself, Jean-Daniel Gril or Claude Fischer. It concerns changes in the code and the use of the namelist translator.

The revolutionary non-hydrostatic predictor/corrector scheme has been informatically introduced in the code. It was not yet tested. This development is the direct result of Jozef Vivoda's PhD work and parallel developments by Deborah Salmond in IFS.

Small changes were brought to the variational code (merge of `CAIN` and `ECAIN` routines, Claude Fischer).

A modified version of the test routines "*aatestprog*" for spectral transform was designed, to avoid the reading of a GRIB file, and replace this by the reading of a standard FA file (Siham Sbii).

Other changes were mostly adaptations from cycle CY25 of ARPEGE / IFS (Andrey Bogatchev, Marek Jerczynski, Zahra Sahlaoui, Gergö Boloni, the Toulouse team and Gabor Radnoti in Budapest for the preliminary phasing of the spectral transform package).

Testing of CANARI configuration to determine surface wind characteristics within the ALADIN/SLOVAKIA domain

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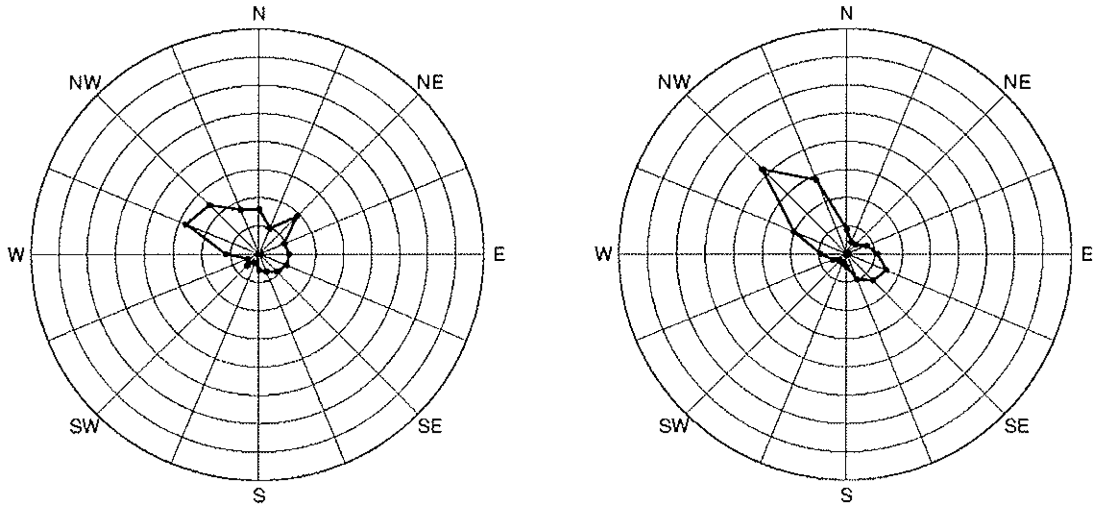
In Slovakia we have to periodically evaluate air pollution from our sources (industry, traffic, ...) for some areas of interest and for given time-periods (usually one year). Distribution of surface wind ("wind rose") is needed as input to air pollution dispersion models.

Use of wind roses determined only from surface wind observations (SYNOP) is not satisfactory, due to insufficient data / stations coverage over the domains of interest. Therefore we decided to test the CANARI configuration of ALADIN to improve the description of surface wind within the ALADIN/SLOVAKIA domain. We used hourly model analyses of ALADIN/SLOVAKIA (AL12 version, 7 km resolution), guess (up to 12 hour model forecast, because lateral boundary conditions are accessible twice a day from ALADIN/LACE) and observations from SYNOP stations. We computed CANARI for Slovak synoptic stations (the nearest gridpoint method) to verify it against SYNOP observations.

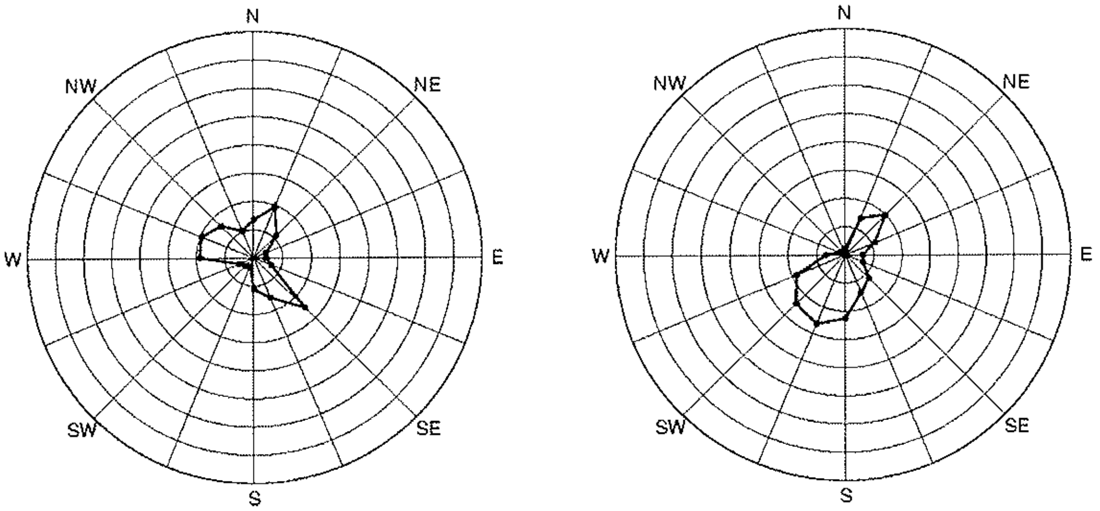
We ran CANARI for the whole year 2001 and then drew wind roses for our synoptic stations from CANARI and SYNOP data. The accuracy of the wind roses provided by CANARI was checked to examine the potential of CANARI to generate the wind roses in the areas where no observation stations are situated.

Results for the following three stations are given:
11816 - Bratislava airport
11952 - Poprad-Ganovce (valley between High and Low Tatras)
11968 - Kosice airport
Distribution of wind direction is shown on the plots with radial step 5 percent. Angular division is into 16 sectors.
On the left side are raw SYNOP data, on the right side are results from CANARI.

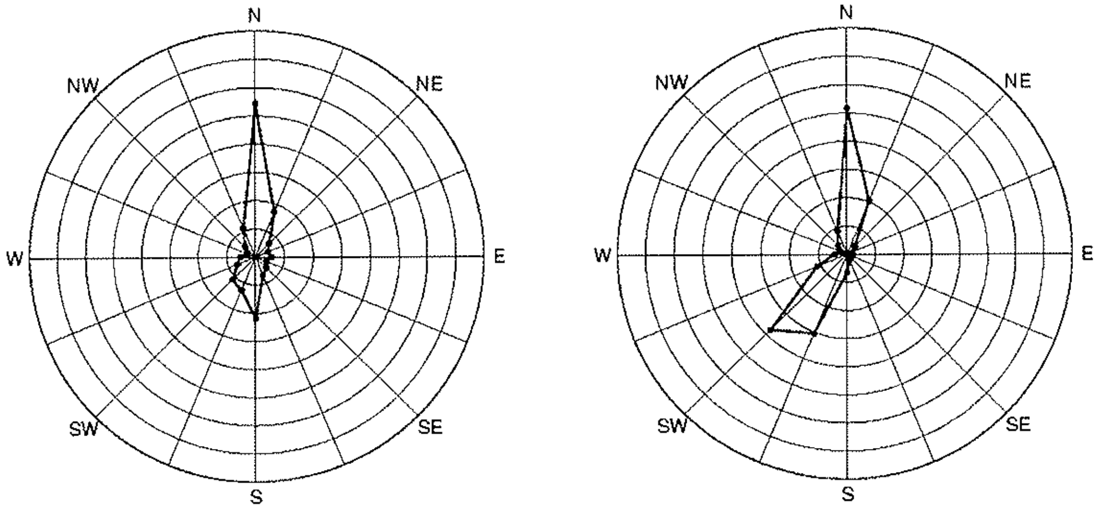
11816 - Bratislava airport



11952 - Poprad-Ganovce (valley between High and Low Tatras)



11968 - Kosice airport



We are still not satisfied with the accuracy of wind description by CANARI. We think this is because of the complex orography in Slovakia. Our plan is to improve this wind analysis by dynamical adaptation (good experiences in some ALADIN countries) with a 2.5 km resolution for orography. We intend to do it within the end of this year.

Combined use of 3d-var and DFI-blending on MAP IOP 14

Vincent Guidard and Claude Fischer
Météo-France . CNRM /GMAP

ALADIN is a limited area model (LAM) coupled to the global model ARPEGE. A key step of a LAM initialization is the introduction of ARPEGE large scales into ALADIN. The DFI-blending technique is a kind of mesoscale assimilation, which does not directly use the observations, based on digital-filter initialization (DFI). It combines large-scale features contained in ARPEGE analysis with small and meso-scale features provided by a short range ALADIN forecast. The latter are expected to be more realistic than those obtained by interpolation from the global model.

The MAP (Mesoscale Alpine Programme) experiment took place in the Alps during the autumn 1999. Its 14th intensive observation period (POI 14) is the meteorological background to this study. It is a well documented case (SYNOP observations, radar, satellite images, etc ...), which allows the evaluation of the assimilation techniques described below.

The experiments performed here aim at testing the sensitivity of the forecast to the initial state for a given network. The blending technique is used with various tunings of the digital filters and various lengths of cycling. An evaluation is applied on the forecasts performed from these initial states and from the nominal run. This evaluation is based on a comparison to the observations and a diagnostic of the initial spin-up of the model. Thanks to the blending, the simulation of the convective activity and of the precipitation field are improved. Some rainfall patterns, not simulated by the control run, are well described in the experiments using the blending technique (Fig. 1).

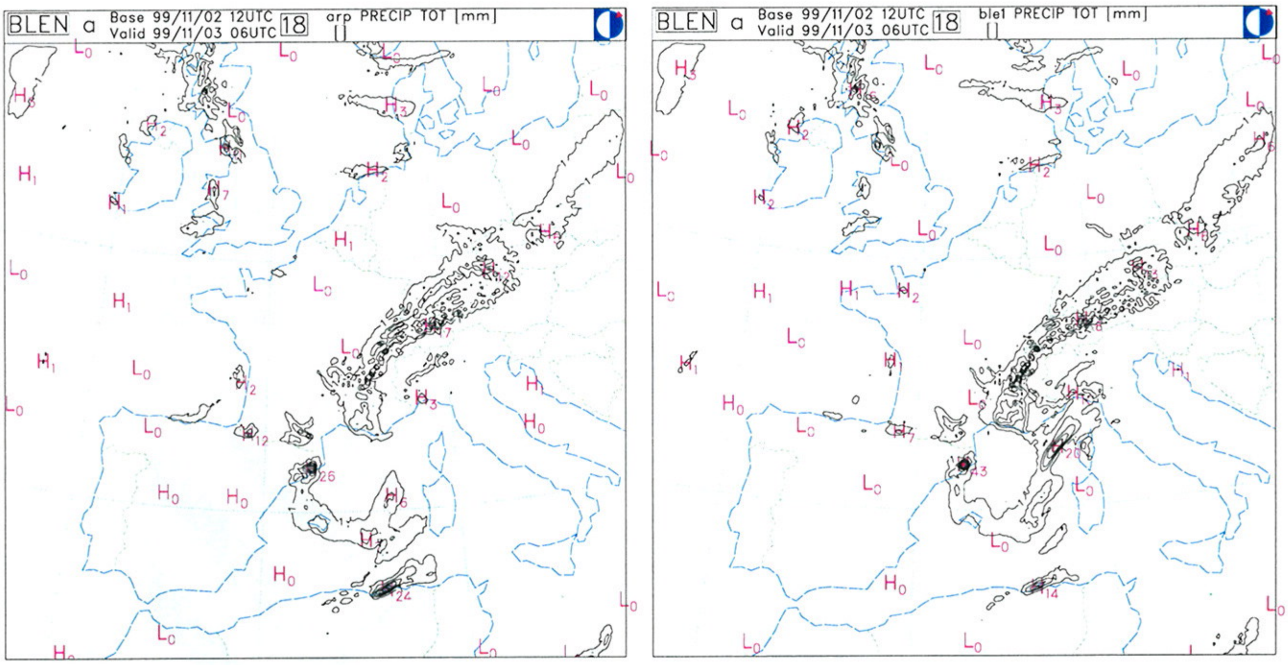
Blendvar, which is a combination of blending and 3d variational analysis, directly introduces the observations in the ALADIN model. The benefits from the observations, shown by the analysis increments (Fig. 2), are complementary to those of the blending. The system activity is better described, and the intensity of some patterns are more relevant. To highlight the importance of the blending step, two experiments only using 3d-var cycling were performed.

"New" data (i.e. data usually unused in variational analysis) are introduced through a 3d-var step. Humidity pseudo-profiles bring information about relative humidity in the troposphere and the initial state is better described. Such data can lead to an improvement of the simulation of precipitations for instance, even for long range forecasts.

The initialization step, performed before a 48 hour ALADIN forecast, is also studied. Its impact is compared with that of DFI-blending and that of 3d-var. Various kinds of initialization are evaluated and the following conclusions can be drawn : incremental DFI is to be used after a 3d-var step; non-incremental DFI is to be applied to initialize an interpolated ARPEGE analysis, and, less obviously, after a blending step.

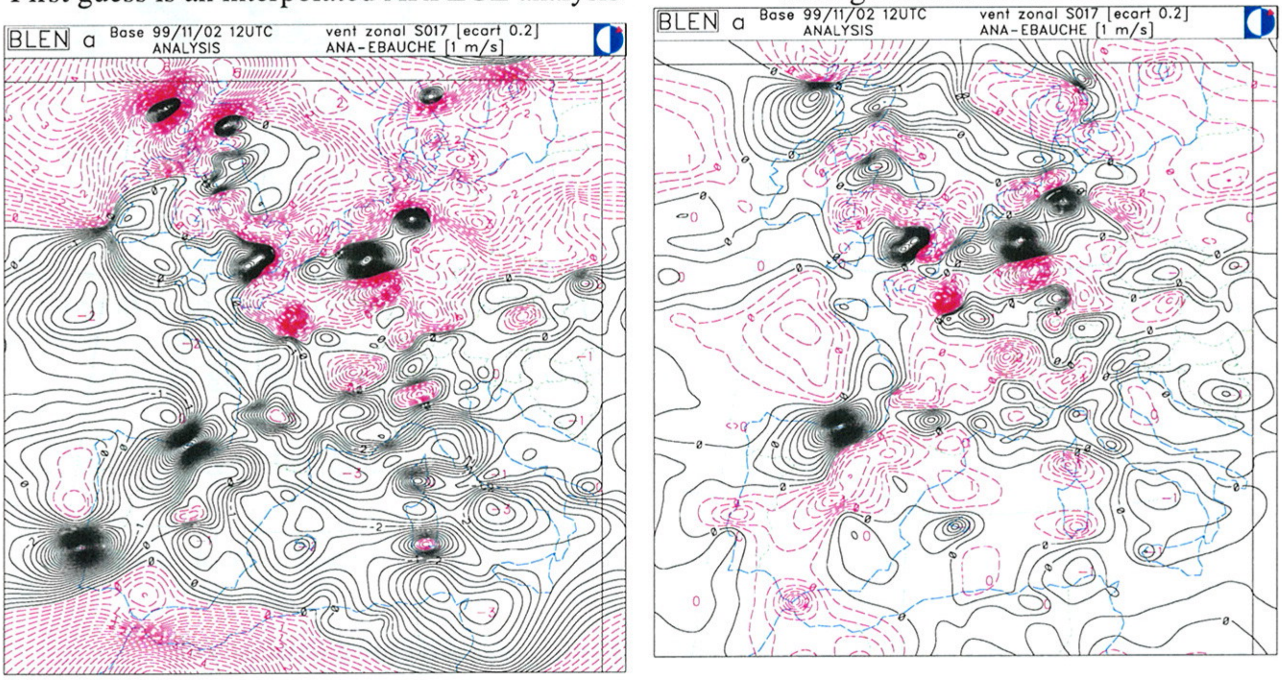
The evaluation performed in this particular POI 14 background leads to very relevant and positive conclusions on blending and Blendvar. Small and mesoscale features are taken into account in a very good way, and the fields generated with blending have a pretty good realism.

Figure 1: Precipitation cumulated between 00 and 06 UTC on November, 3rd


+18 forecast for the control run

+18 forecast using blending cycling

Figure 2: 3d-var analysis increments for zonal wind on model level 17


First guess is an interpolated ARPEGE analysis

First guess is a blended state

New Approaches to Stratus Diagnosis in ALADIN

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Zentralanstalt für Meteorologie und Geodynamik

Observing ALADIN vertical profiles of temperature and moisture for the latest winter periods, some severe model deficiencies were discovered in 3D and 1D forecasts. One type of error is associated with weak gradient cases, where vertical turbulent fluxes of heat and moisture tend to zero (Fig.1). This leads to unrealistically strong inversions too much confined to the ground (Fig.2). Inclusion of an additional model level in the Single Column Model, at 2m, did not really improve fluxes and profiles. Implementing an additional laminar layer on top of the soil, on the other hand, is not straightforward to code in the model. It will need cooperation among the ALADIN community.

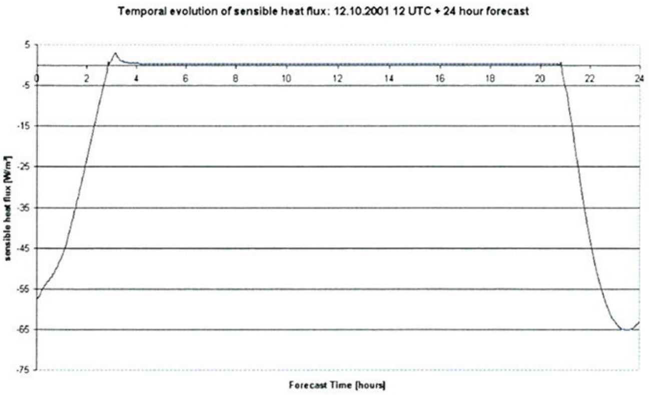


Fig.1: 12.10.2001 24 hour forecast of sensible heat flux in [W/m²] predicted by SCM (CY22T1_OP8) for lon=16.36 and lat=48.22

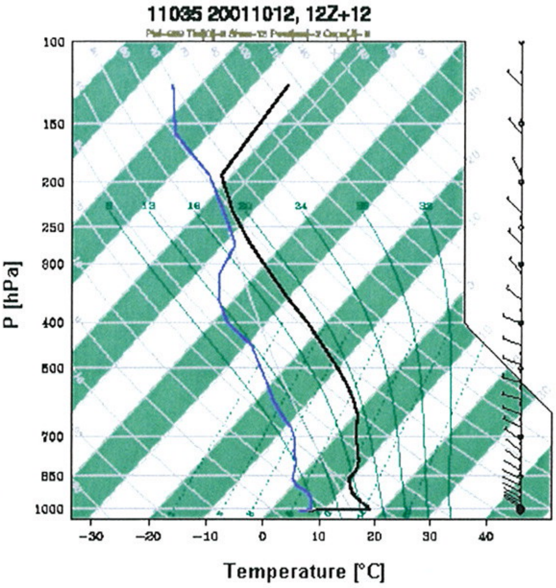


Fig.2: 12.10.2001 12 hour prediction by SCM for lon=16.36 and lat=48.22

The second type of error is related to the diagnosis of low stratus, which leads to an unrealistic evolution of the whole PBL. This may happen right from the initial time of model runs. In order to check for possible ways to improve the boundary-layer cloud representation, some empirical modifications were carried out in the subroutine *acnebn.F90*,. The levels belonging to the Low Cloud Etage were "re-scanned" and 4 new critical parameters introduced :

- Quasi-saturation (currently = 10 %), computed from Q(JLEV) and QSAT(JLEV) which enter the routine, has to be reached.
- Coherent Levels of Quasi-Saturation must define a LAYER thicker than a critical value (currently set to about 200 m).
- Coherent Inversion of critical strength (currently set to only 2K) must exist as well.
- The distance between the lower boundary of this inversion and the upper boundary of quasi-saturation layer must not exceed another critical value (currently set to about 500 m). This seems reasonable because the inversion layer and quasi-saturation layer must not become too much decoupled from each other in order to gain a "stratus signal".

If all 4 criteria are fulfilled, cloudiness for all quasi-saturated levels is set to 1. . Cloud fraction for all other levels within the low cloud etage is set to 0. . As mentioned above, medium and high-level cloudiness are not modified at all. However response from radiation schemes can be expected to be significant and in return may keep temperature and moisture profiles in a realistic "lifted fog shape".

The new scheme was tested both in 3D and 1D with Stratus case 15-16 January 2002. A high pressure system affected Central Europe for a couple of days and led to extensive areas with fog and low stratus conditions (Fig. 3). In contrast to the operational version of *acnebn.F90,* (Fig. 4), the modification improved low cloudiness for large areas but not for the whole domain (Fig. 5). In SCM, the vertical profiles of temperature and humidity better correspond to the radiosounding (Fig.6) than the original stratus diagnosis. So there is a positive impact of our scheme on radiative transfer during the integration time (Fig. 7 & Fig. 8).

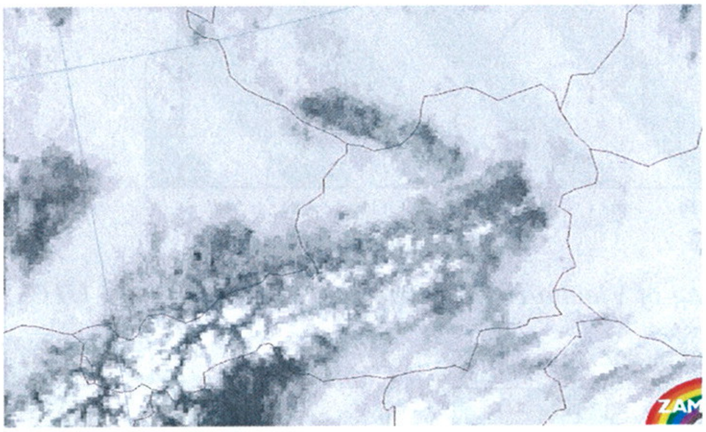
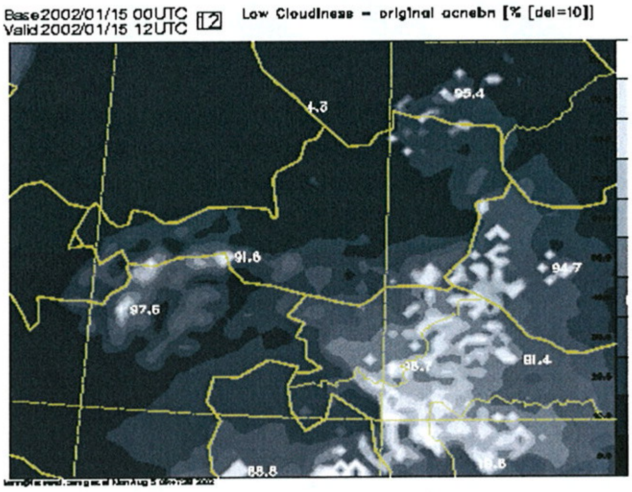


Fig.3: Satellite image (visible) at 15.01.2002 12 UTC



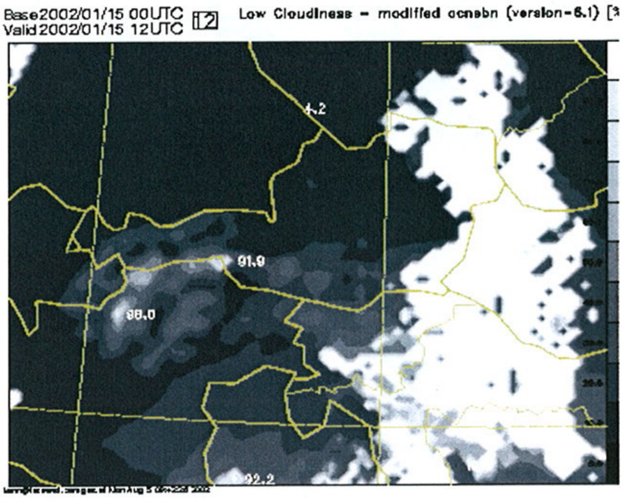


Fig.4: Low Level Cloudiness with original *Fig.5: Low Level Cloudiness with modified*
acnebn.F90, predicted by ALADIN-Vienna (export version al12op03).
Base: 15.01.2002, 12-hour forecast

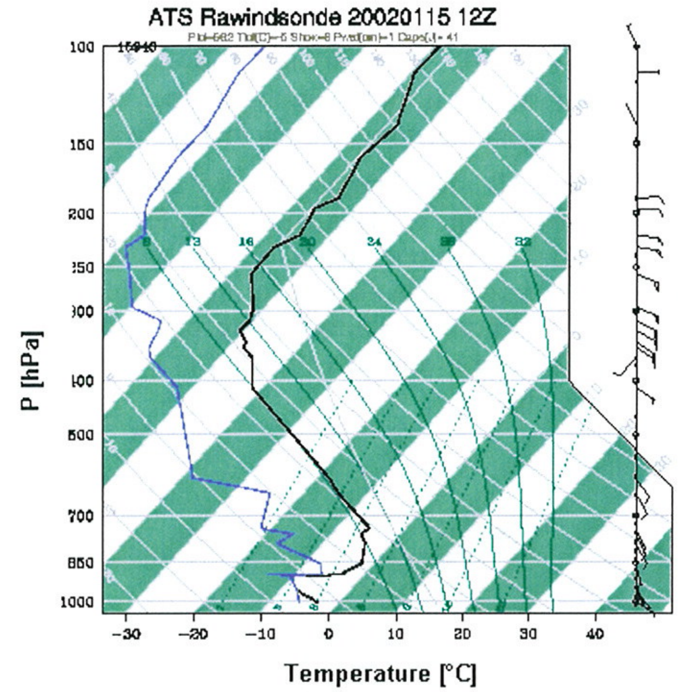
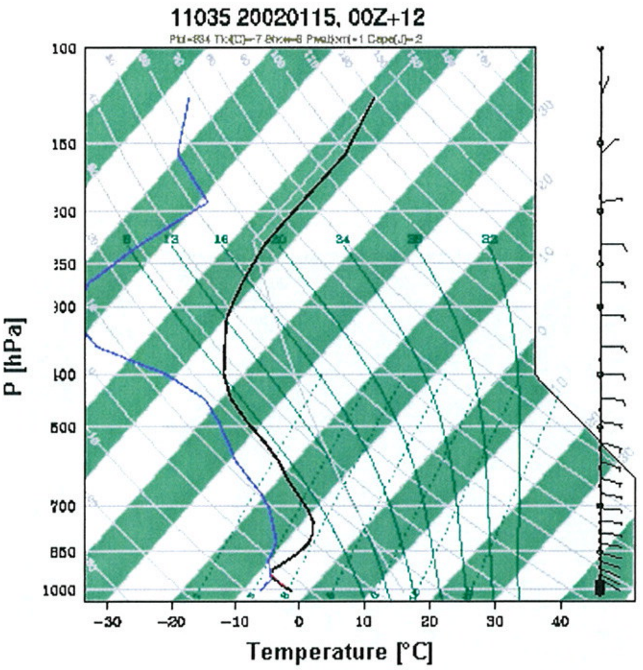


Fig. 6: Sounding of Vienna/Hohe Warte, date: 15.01.2002 12 UTC



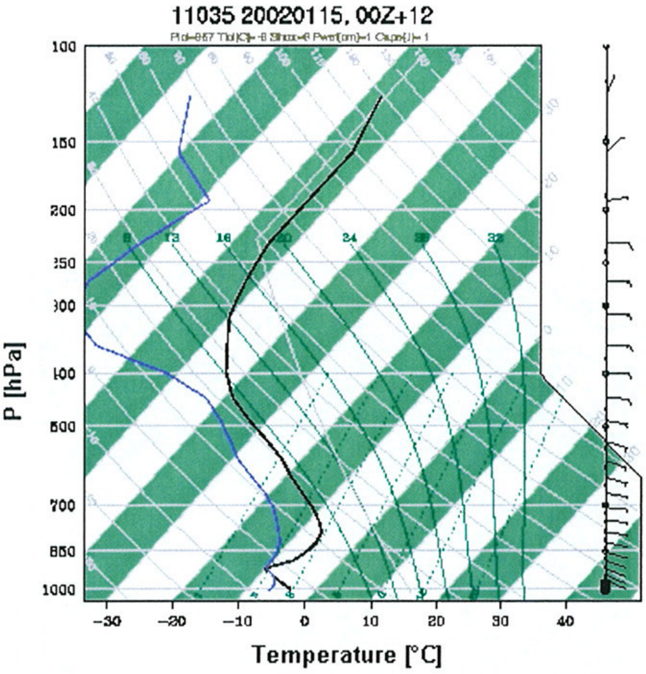


Fig.7: 12-hour prediction by SCM with original Fig.8: 12-hour prediction by SCM with modified acnebn.F90, Base: 15.01.2002 00 UTC, valid for 15.01.2002 12 UTC.

It is of course necessary that the scheme handles not just one but many cases successfully before any actual operational implementation can be recommended. For example, it will be most crucial to make sure that this Stratus Diagnosis scheme also allows for fog clearing whenever frontal or different type of synoptic-scale forcing reach certain degrees of intensity. Such kind of generalization will be part of our future work. Apart from that method, testing of Xu-Randall cloud parameterization scheme in SCM did not improve low cloud fraction in the case of the 15th January 2002 significantly. The problem is very probably due to a wrong forecast of the inversion layer, rather than to the parameterization of cloudiness. Work will go on in close cooperation with other ALADIN teams.

Diagnostic tools applied to ALADIN forecasts in situations of deep convection over Portugal

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1. Introduction

The ALADIN model, with 31 vertical levels and the CYCORA_bis package, is running operationally at the Portuguese Meteorological Institute. The lateral boundary conditions are updated every six hours from ARPEGE forecasts. Recently two cases of deep convection and one false alarm have been studied, in order to find out the capability of the ALADIN model in forecasting the onset and evolution of convective events. Moreover, it would be interesting to know if derived fields from the model could offer a useful additional information for operational forecasters. In order to accomplish this aim, some diagnostic tools were developed and applied to ALADIN forecasts.

2. A case study

In these paper I only present one example of deep convection over Portugal, on day 25/06/2002.

2.1. Diagnostic tools

To identify the areas where favourable conditions exist for the development of deep convection, the following diagnostic parameters are used : (in)stability indices, low-level moisture convergence and temperature advection.

In order to evaluate the stability, the following stability indices were computed : Energy index, Convective instability index, Total-Totals, Modified Total-Totals, Jefferson index, Modified K index and Severe Weather Threat (SWEAT) index. In three cases the SWEAT index was the most useful one, therefore I only present the description of this index:

$$\text{SWEAT index} = 12\, Td_{850} + 20\,(TT - 49) + 2\, f_{850} + f_{500} + 125\,(S + 0.2)$$

where :

- Td_{850} is the dew-point temperature in Celsius at 850 hPa (this term is set to zero if negative);
- TT is the Total-Totals index, which is the sum of 850 hPa temperature and dew-point temperature less twice the 500 hPa temperature ($T_{850} + Td_{850} - 2\, T_{500}$).
- f_{850} and f_{500} are the wind speed, in knots, at 850 hPa and 500 hPa respectively.
- S = sin (500 hPa wind direction - 850 hPa wind direction) ; this term is set to zero if any of the following conditions is **NOT** fulfilled :
  - × 850 hPa wind direction lies in the range 130° through 350°,
  - × 500 hPa wind direction lies in the range 210° through 310°,
  - × 500 hPa wind direction minus 850 hPa wind direction is positive,
  - × and both 850 hPa and 500 hPa wind speeds are at least 15 knots.

In order to evaluate the low-level moisture convergence, the integral of the convergence of specific humidity (F_q) is computed in the layer between 1000 hPa and 850 hPa:

$$F_q = \int_{1000}^{850} \nabla \cdot (qV) \frac{dp}{g}$$

2.2 Deep convection associated with a cut-off low

On 25 June 2002, the weather over Portugal is affected by a cut-off low situated at south-west of the Iberian Peninsula. The onset of deep convection occurs between 15 h UTC and 15:30 h UTC in the centre region of Portugal, near Ansião (see figure 1a and table 1).

At 15 h UTC, the SWEAT index forecasted by ALADIN indicates a local maximum (221) close to Ansião (see figure 2b and table 1), where convection takes place. Its intensity increases during the afternoon, reaching a maximum value of 270 at 18 h UTC. In this area and a little further to East, between 13 h and 18 h UTC, the ALADIN forecast shows an area of low-level moisture convergence, which reaches its maximum intensity (31.10^{-1} $g.m^{-2}.s^{-1}$) at 15 h UTC (see figure 3). The presence of low-level moisture convergence in this area seems to be an important factor for the onset and development of deep convection east of the area where convection started first (see figure 1). Moreover ALADIN forecasts a warm advection at 850 hPa in the area where deep convection takes place (figure not shown).

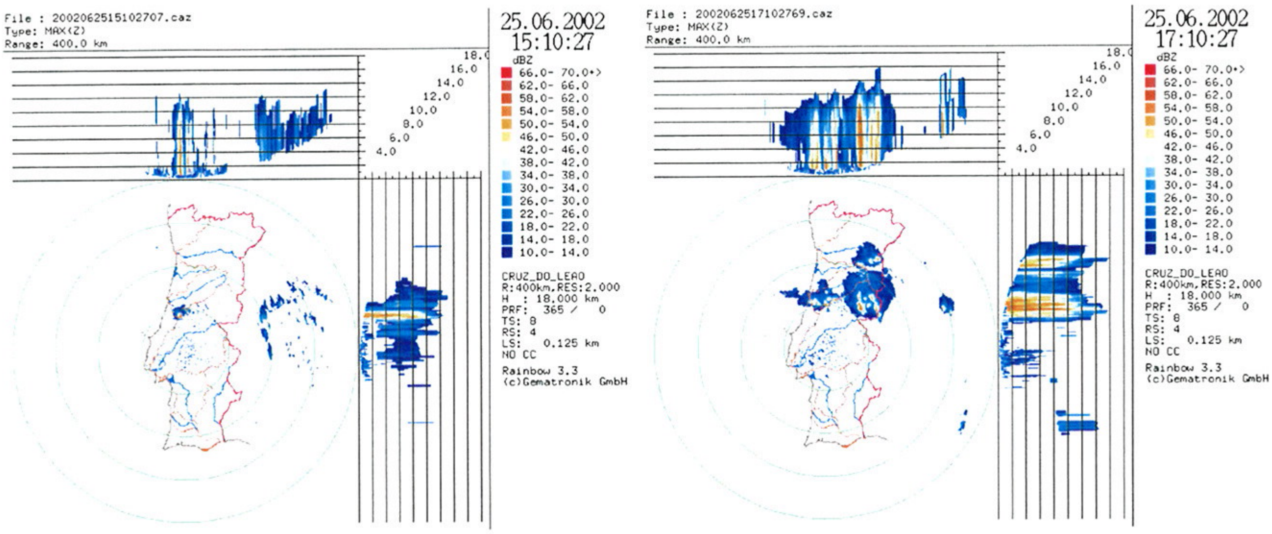
Energy, Jefferson and Modified K indices also give a very good agreement between the area where the onset of convection occurs and the area of maximum instability forecasted by ALADIN. However, in terms of time-evolution, the SWEAT index has a better performance.

In the area around Lisbon, ALADIN forecasts instability (with values of SWEAT changing from 150 to 300, between 12 h and 18 h UTC) and convective precipitation (figure 2). Nevertheless, the ALADIN forecast indicates divergence of moisture (figure 3), which explains why deep convection doesn't take place in this area.

So, using the condition of low-level moisture convergence as a necessary condition for the development of deep convection, a forecaster would be able to detect the false alarm of precipitation forecasted by ALADIN (figure 2a) in the area around Lisbon.

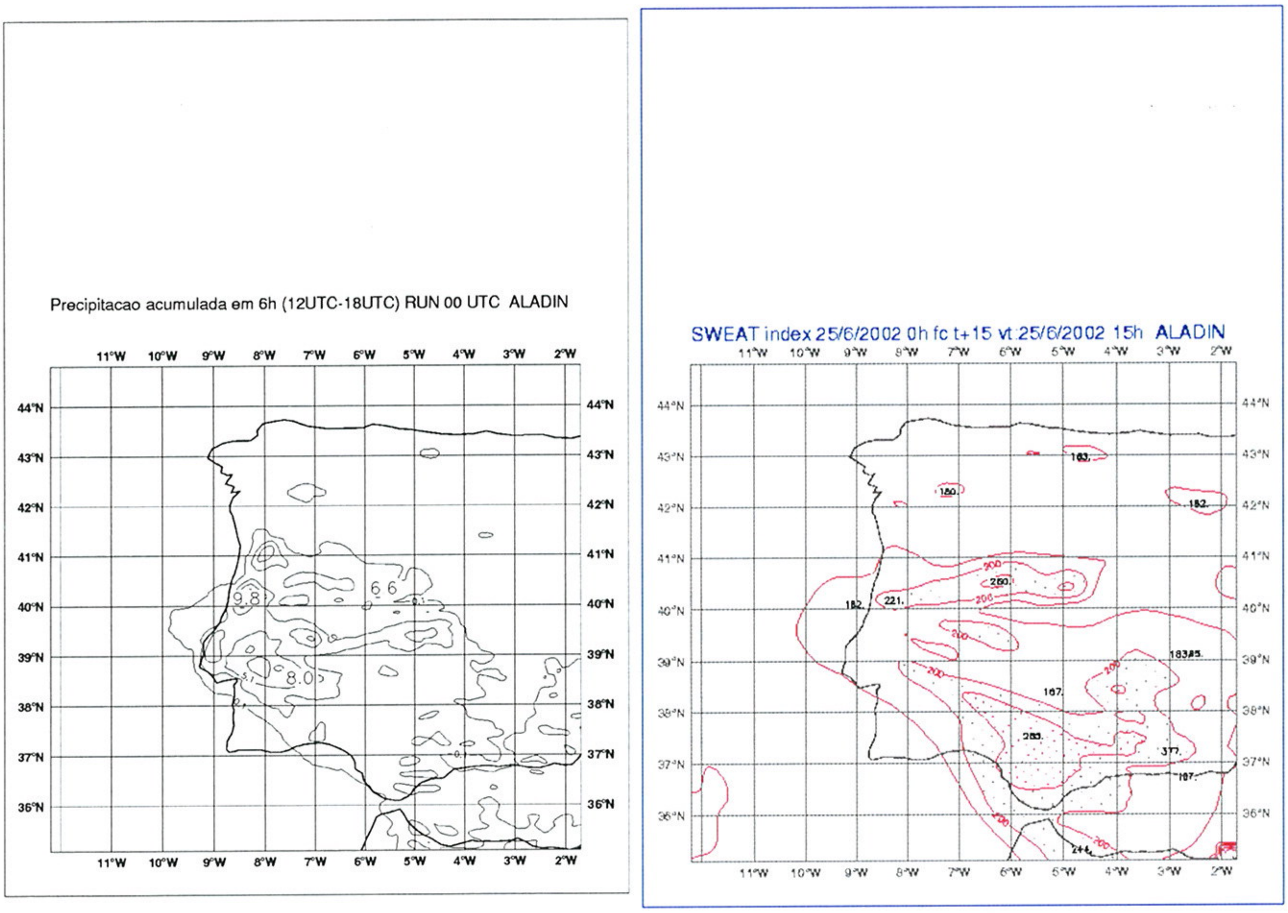
Station	**Lat** (N); **Lon** (W)	**16 h**	**17 h**	**18 h**	**19 h**
Ansião	39.91° ; 8.33°	**1.0**	**7.0**	0.0	0.0
F. C. Rodrigo	40.87° ; 6.90°	0.0	**2.0**	**3.0**	0.0
Zebreira	39.52° ; 7.10°	0.0	**4.0**	**5.0**	0.0
P. Douradas	40.42° ; 7.63°	0.0	0.0	**3.0**	**0.3**
Covilhã	40.17° ; 7.32°	0.0	0.0	**5.0**	0.0
Lousã/Aero	40.13° ; 8.23°	0.0	0.0	**0.9**	**4.0**
Nelas	40.52° ; 7.85°	0.0	0.0	0.0	**0.2**
Anadia	40.43° ; 8.43°	0.0	0.0	0.0	**5.0**

Table 1 Hourly observed precipitation (between 16 h and 19 h UTC).



(a) (b)

Figure 1 : Radar reflectivities at 15:10 h UTC (a) and at 17:10 h UTC (b).



(a) (b)

Figure 2 : Accumulated precipitations in 6 hours (a), and SWEAT index (H+15) (b), from the ALADIN forecast.

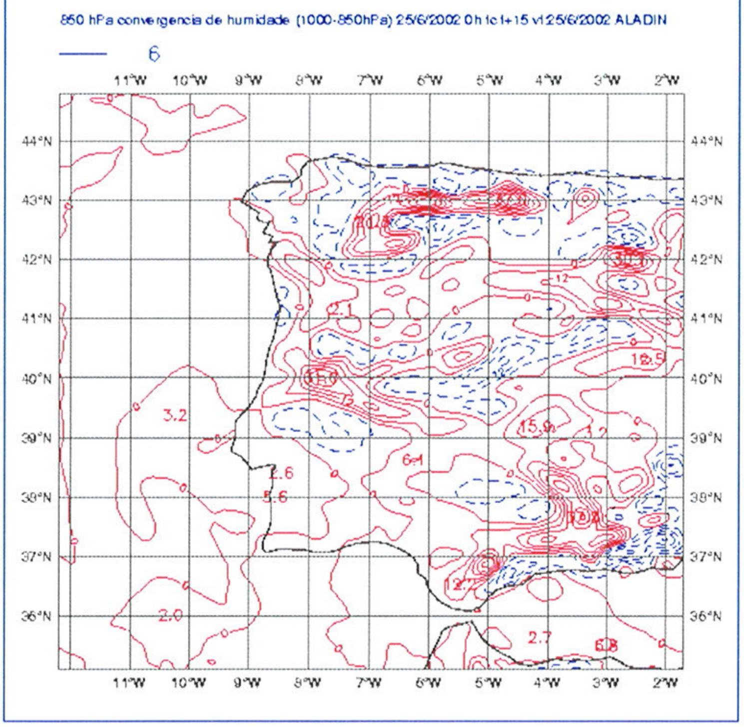


Figure 3 : Divergence (dashed blue lines) and convergence (solid red lines) of water-vapour flux in the layer 1000-850 hPa, forecasted by ALADIN for 15 h UTC on 25 June 2002. The isopleth interval is 6.10^{-1} $g.m^{-2}.s^{-1}$.

3. Conclusion

In two of the recent case studies, the ALADIN forecast was useful for the thunderstorms forecast. Moreover, the results show that deep convection occurs in the areas where ALADIN forecast shows **both** instability and low-level moisture convergence. However, in one of the cases studied, ALADIN forecasts too much instability and produces a false alarm (FA) of convective precipitation. The comparison of diagnostic parameters derived from ALADIN analysis and forecast seems to be an important factor to detect the FA.

Objective control of ALBACHIR application

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The ALADIN-Morocco application, named ALBACHIR, became operational in February 1996. Many developments were accomplished in order to improve the model performances and the forecast quality. These concerned both the software (model cycles) and the hardware (computation machines). The evaluation of this evolution requires an objective and regular control of the model.

This paper aims to explain several phases of the automatic process designed for the objective control of the operational ALBACHIR version, running on the IBM calculator. Two references are used : **Observations** and the **ARPEGE analysis**.

As a first version, it was decided to control only the first 24-hour range of forecast produced by the two daily runs of the model. Furthermore, it is planned to process other forecast ranges : 12, 36 and 48 hour.

Model control versus ARPEGE analysis

The ARPEGE analysis (long cut-off) is considered as a reference. The ARPEGE fields are interpolated onto the ALBACHIR domain, using E(E)927 as for the production of coupling files. A space average (horizontally and vertically) of the difference ALADIN - ARPEGE is evaluated for the following parameters : geopotential, moisture, temperature, zonal and meridional wind.

Model control versus observations

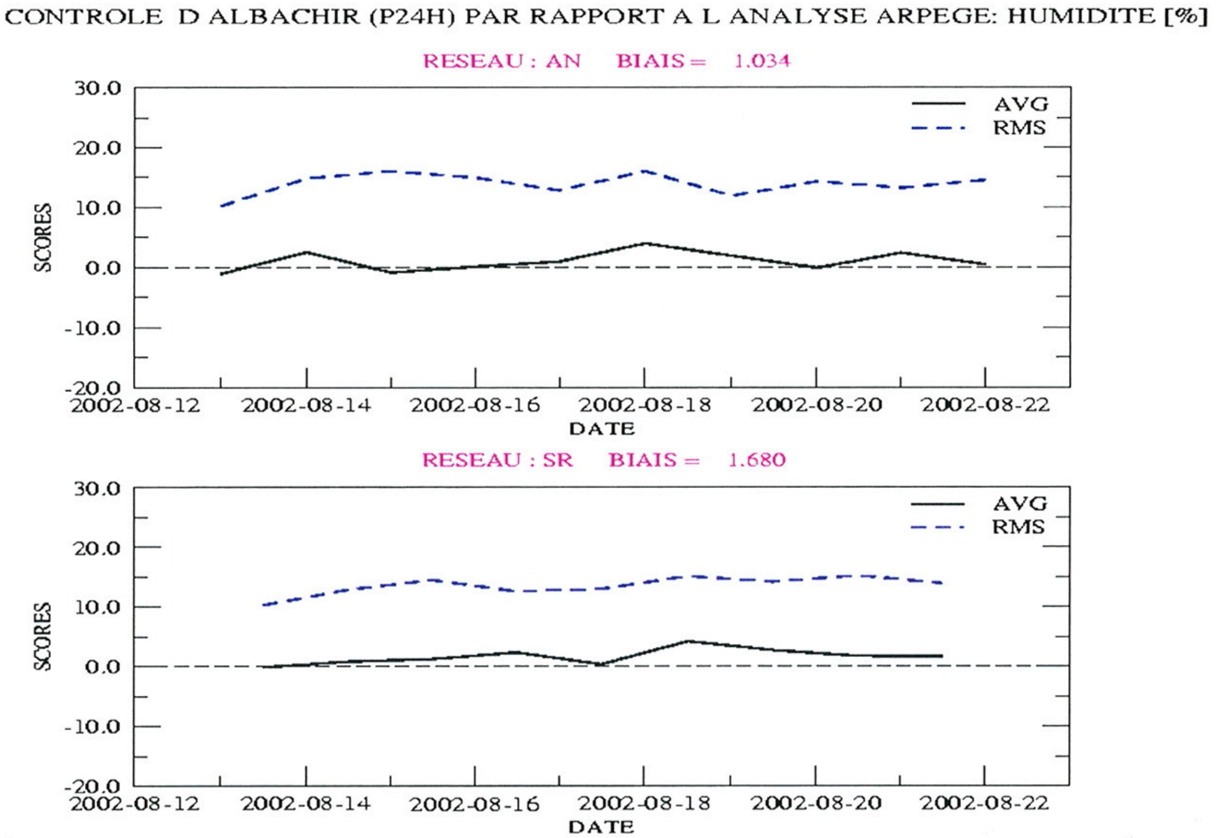
The reference is constituted by all informations coming from the synoptic network (SYNOP) and the radiosondes' one (TEMP). Space interpolation of the model fields onto observation points is carried out before computing the differences between the observations and the values of the model, using E701. The fields controlled by this method are detailed in the following table:

SYNOP	TEMP
Geopotential Moisture at 2 m Zonal wind at 10 m Meridian wind at 10 m Temperature at 2 m Surface temperature	Geopotential (all levels) Moisture (all levels / at 2 m) Zonal wind (all levels / at 10 m) Meridian wind (all levels / at 10 m) Temperature (all levels / at 2 m)

For the two types of control, the procedure is run daily over the previous 10 days. The outputs are the bias and the root-mean-square error for each day, separately for the runs of 00 h GMT (AN) and of 12 h GMT (SR). A similar procedure is run each month to control the performances of the model during the previous month.

The results are processed automatically by the graphic software XMGRACE, recently installed on the IBM, then visualised on the intranet web site of the numerical weather prediction service. The outputs are archived in ASCII tables and also as graphs for possible later studies.

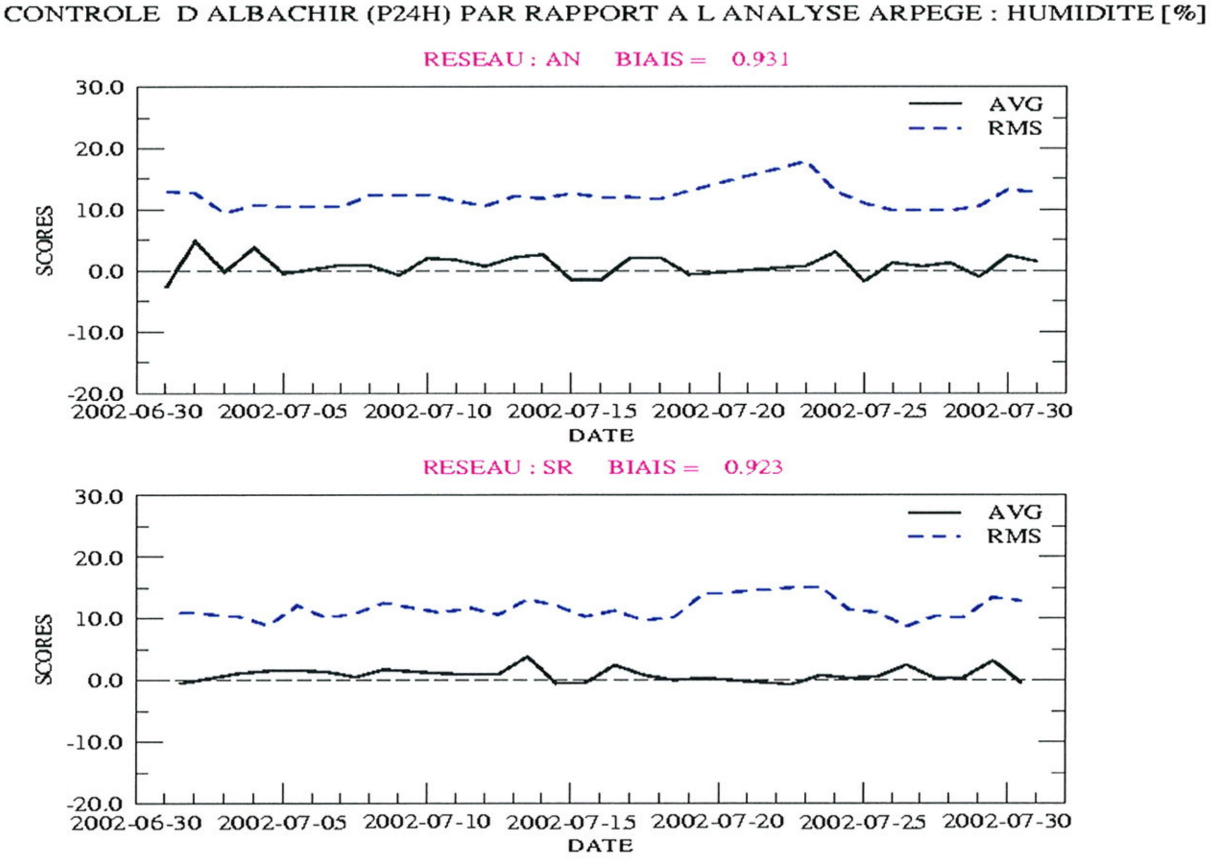
To interpret the graphs, it is necessary to take into account some elements. Indeed, the observation network on the domain of ALBACHIR has a deficiency in radiosoundings compared with the surface synoptic observations. That's why it is recommended to give more importance to the results of surface control. In addition, concerning the control versus ARPEGE analyses, the resolution of ARPEGE on Morocco varies between 25 and 60 km. It remains more sparse than that of ALBACHIR (16.7 km).


CONTROLE D ALBACHIR (P24H) PAR RAPPORT A L ANALYSE ARPEGE: HUMIDITE [%]

RESEAU : AN BIAIS = 1.034

RESEAU : SR BIAIS = 1.680

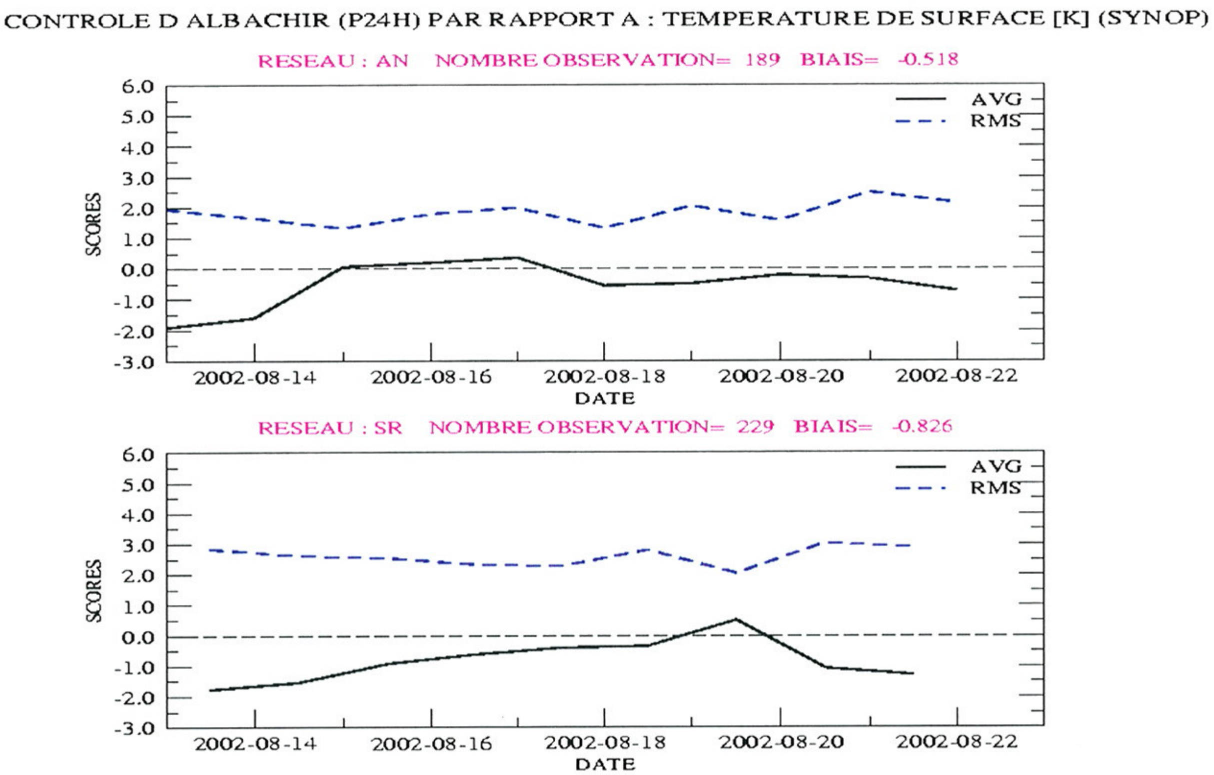
10-day control, 24 h forecast against ARPEGE analysis : moisture (%, vertical average)


CONTROLE D ALBACHIR (P24H) PAR RAPPORT A L ANALYSE ARPEGE : HUMIDITE [%]

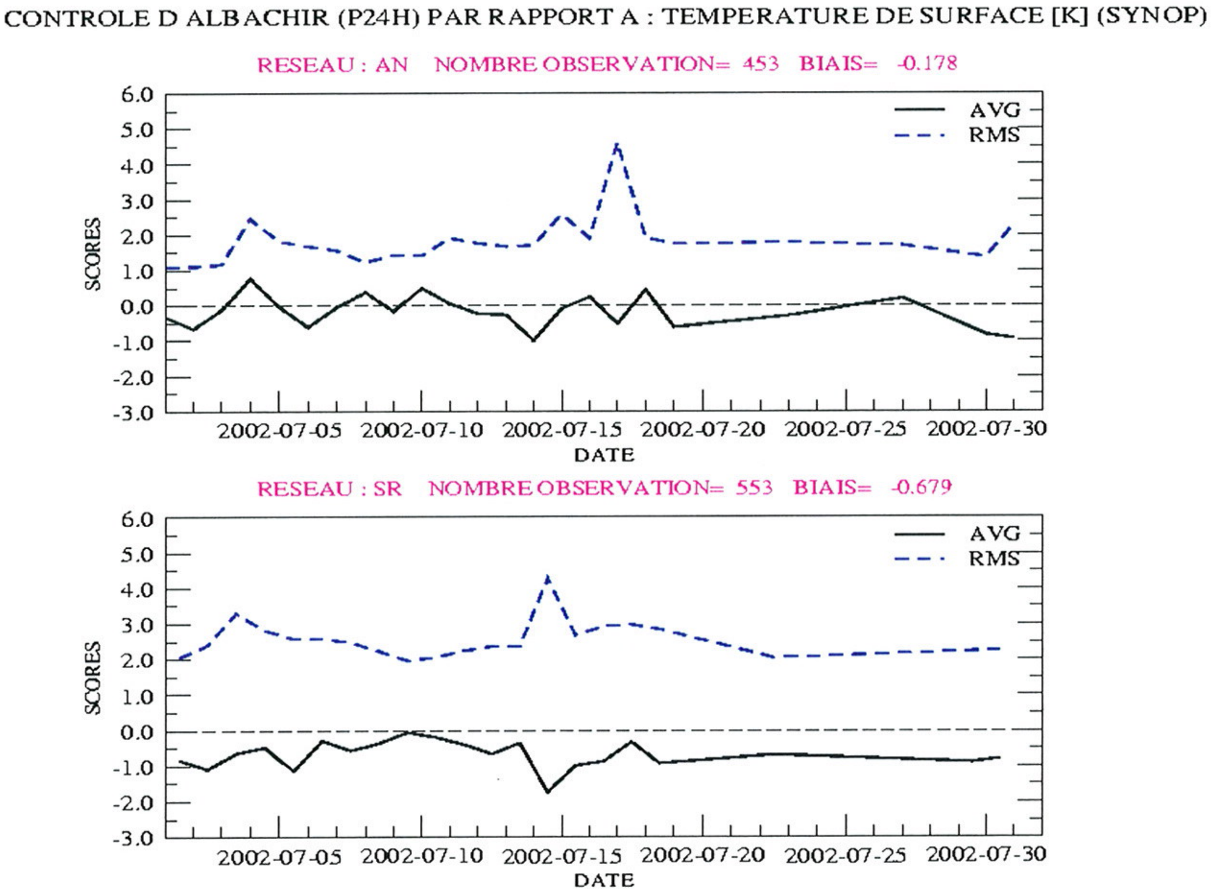
RESEAU : AN BIAIS = 0.931

RESEAU : SR BIAIS = 0.923

Monthly control, 24 h forecast against ARPEGE analysis : moisture (%, vertical average)



10-day control, 24 h forecast against SYNOP observations : surface temperature (K)



Monthly control, 24 h forecast against SYNOP observations : surface temperature (K)

Reformulation of the deep convection scheme for prognostic cloud water in ALADIN

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In the quest for higher resolution and better representation of the physical phenomena, introducing cloud water variables is an important challenge.

Most propositions in the literature are aimed to large scale or Global Circulation Models, and focus on the so-called "stratiform" or resolved clouds.
The coherent treatment of this topic in the frame of a mesoscale model and in particular the links with the subgrid convection parameterisation is not yet very satisfying. In particular, using a "stratiform" cloud water scheme while keeping an independent "deep convection" scheme which ignores the cloud water or directly generates its own precipitation, leads to physical contradictions, prejudicial to a good understanding of the model behaviour and its realism.

Hence, beyond the basic decisions about the choice of the prognostic variables, we decided to take the problem the other way round, focusing first on the deep convection scheme in order to get a coherent cloud water package.

1 The microphysical scheme

It should include

- at least separate cloud ice and cloud liquid water, as their mechanical, hydrological and radiative behaviour are quite different. Precipitation water could also be considered.
- a realistic microphysics treatment: taking into account most important processes (auto-conversion of condensate to precipitation, different kinds of aggregation processes, evaporation, sublimation, melting / freezing of precipitation, Bergeron effect, ...) and the effects of large-scale as well as subgrid sources *and sinks* of condensate.

We based our developments on a completed version of LOPEZ [2001]'s scheme, because it uses simple and acceptable hypotheses, without dangerous assumptions of subgrid homogeneity which would restrict it to large meshes. It implements prognostic cloud condensate and precipitation content, the latter being advected vertically within the parameterisation.
Phase separation was done internally and diagnostically; for ALADIN, we introduced separate prognostic variables for ice and liquid water, and simplified the treatment of the precipitation content (this will be described in a subsequent paper).

2 Features needing revision in the operational convection scheme

- All condensation was immediately converted to precipitation, which could either re-evaporate below the cloud or in the downdraught, or reach the surface in one time-step.
  When introducing cloud water, the deep convection scheme should rather be a source of condensate, while the microphysical scheme is responsible for generating cloudiness and precipitation. This touches the following items :
  - Energy calculations: effective latent heats were used covering the assumptions on immediate precipitation of all condensate and its potential replacement by dry air.

Remark that the heat exchanged in this process was affected to the updraught at the level the precipitation was generated (as if the precipitation fell within the updraught), while at the same time the updraught was not perturbed at all by falling precipitation.

- No condensate was present in the air entrained into the draught, and draught condensate was evaluated from a diagnostic relation.
- Water and heat budgets ignored any suspended condensate.
- Convective cloudiness was derived from the convective precipitation fluxes.

- The closure of the subgrid scheme stated that large-scale moisture convergence was channeled into the updraught. This is physically difficult to imagine: what occurs actually is that grid-box air is pulled into the draught, pushed by (or pulling) large-scale flow convergence.

- The interaction of subgrid and large-scale schemes was a big problem.
  We observe that
  - the large-scale vertical velocity (i.e. mean grid-box vertical velocity) induced "resolved" condensation;
  - the deep convection scheme understood that the mean vertical velocity raised from a nearly zero environment-velocity and a much bigger updraught vertical velocity. This was represented by considering a *pseudo-subsidence* around the updraught, compensating the mean grid-box velocity, so that the net environment velocity stays close to zero outside the updraught.

  If the "resolved scheme" keeps considering the mean grid-box vertical velocity, it contradicts the hypotheses of the subgrid scheme and we make a *double count* of the precipitation.
  The natural way to solve this is, to *take into account the pseudo-subsidence* when computing the resolved condensation, rather than modulating more or less empirically one of the two schemes. The method of subtracting the large-scale precipitation convergence from the moisture convergence flux also implied some superimposition principle, which is abusive for such nonlinear schemes.

- Downdraught hypotheses :
  - The downdraught was following an entraining moist pseudo-adiabat, fed by precipitation evaporation. But it could only be switched on by prior evaporation (resulting from the layers budgets in the updraught calculation), which lacks of realism.
  - Real downdraughts entrain dry air from above, and are not entirely saturated: so the guessed profile is not realistic, nor the downdraught mass flux, mesh fraction and vertical velocity. This limits the possibility of tuning by comparison of these parameters to observations.
  - The closure was rather arbitrary, assuming that a fixed fraction of the precipitation generated by the updraught had to be evaporated. If the updraught does no longer produce precipitation but condensate, such a treatment becomes impossible.
  - The local mass budget was inconsistent (the mass flux being arbitrarily shaped by a given function, while the detrainment and entrainment are taken completely independently of this).
  - The resolved precipitation did no contribute to the downdraught, which might not survive the end of the updraught.

  This lead us to plead more and more insistently for the complete separation of the updraught and the downdraught.

3 Main features of the proposed scheme

In our anterior work [GERARD, 2001], we introduced prognostic variables for the updraught and downdraught vertical velocities and 2d mesh-fractions (representing a vertical mean over the active layers). The present work takes advantage of these developments, but we decided to focus on the updraught and to introduce 3d mesh-fractions, to better fulfill local mass budgets. The downdraught is now completely separated and will be the object of further developments.

- The updraught profile is (as before) a moist entraining pseudo-adiabat, built diagnostically (i.e. we still obtain the properties by building a whole profile from the bottom, while the parcels at upper levels would have actually followed the profile that was at previous time-steps); the production of condensate along this path gives us access to the updraught condensate content, and a simple phase partition is used in function of temperature.
- A prognostic motion equation yields the updraught vertical velocity; the large-scale flow will advect the difference between the updraught velocity and the resolved vertical velocity.
- The updraught mesh fraction *profile* σ^l_u is obtained by writing *local mass-flux continuity*. The detrainment process is parted into two contributions :
  - A constant detrainment rate δ over most of the equivalent draught ascent: the budget equation yields the tendency of σ^l_u .
  - Organized detrainment starts at the level where the fluid begins to decelerate. We diagnose this level by the conjunction of a decrease of the absolute value of ω_u and of the buoyancy force. From there, σ^l_u is kept constant up to the top of the updraught, and the detrainment calculated accordingly.

  Effective detrainment rates can the be estimated, for the final budgets, as well as to feed the microphysical scheme.
- The layer budget can now provide pseudo-subsidence diffusion fluxes for both moisture and enthalpy, as we no longer consider precipitation fluxes at this stage.
- Usually the detrained condensate acts as a direct source in the microphysical scheme.
  But we 'd like personally to release the hypothesis that the detrained condensate from the updraught mixes in one time-step with the full grid-box. Therefore, we considered to pass the detrained condensate separately to the routine computing the auto-conversion of condensate to precipitation, as the properties of this condensate could significantly depart from those of the "stratiform" condensate, supposed more homogeneously distributed.
  For the rest, we assume no precipitation occurs within the updraught mesh-fraction itself, while this fraction is always overcast.

The new scheme also requires a wider re-structuration of the order of the different parameterisations. Layer budgets and downdraught computation occur after the microphysical calculations, and the downdraught now feeds on both condensate and precipitation. This also opens the way to covering additional processes, like Cloud Top Evaporative Instability. For this, we'll consider that the downdraught is not completely saturated, and contains a core of air entrained from above.

References

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Wavelet Representation of Background Error Covariance

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KMI

We have started to study the representation of background error covariances in a wavelet basis. The purpose is to allow for some geographical variation in the covariances while still keeping the covariance matrix B relatively simple.

Currently, B is taken as a diagonal matrix in spectral space, there are non-diagonal elements only for the covariances between different model levels. The result is that the (co-)variance has no geographical variation.

Wavelets are a whole class of function bases that occupy the region between grid space and spectral space. They are partially localized in both grid and spectral space. In the usual theory, the wavelet basis is formed by dilatations and translations of one single "mother wavelet". By dilating this function by (usually) a factor 2 we get a new function that is localized at the same place but analyses our data at a different scale. One can think of such a basis as a set of bases, each living on a subgrid of different scale and describing the data at this scale. So the largest and smallest scale wavelets on a 128×128 domain live on 2×2 and 64×64 grids respectively. It is hoped that an (almost) diagonal B matrix in wavelet space may combine the advantages of spectral space with some geographical variations.

We have chosen to work with the so-called Meyer wavelets. These have compact support in spectral space (i.e. the spectrum of every basis function is strictly limited) but are not as well localized in gridpoint space. For a spectral model like ALADIN this seems the most logical choice.

Most wavelets only scale by 2, restricting the domain sizes to powers of 2. Therefore we started our work using data from ALADIN-Morocco (Raouindi, 2001), which has a domain size of 128×128. We represented temperature errors in wavelet space and found that a simple diagonal approach indeed represents some of the geographical variations in background error covariances.

The restriction to powers of 2 has since then been solved by generalizing the definition of Meyer wavelets to other scales (Deckmyn, 2002). This means that any domain size can now be analysed with such wavelets.

However, there remains a big problem. A restriction to diagonal elements in the wavelet basis gives a strong bias to points that are close to those of the large-scale grid. For example, when we take the B matrix in wavelet space and transform it back to gridpoint space, the variance is concentrated around a few points, especially at high model levels. We have no solution yet for this problem.

References:

Raouindi M., 2001, Etude et représentation spectrales de la variabilité latitudinale des covariances spatiales des erreurs de prévision sur une aire limitée.

Deckmyn A., 2002, Orthogonal Wavelet Transforms with Variable Scale Factor, in preparation.

Test of an assimilation suite for ALBACHIR based on the variational technique

1. Introduction

The operational version of ALADIN-Morocco (ALBACHIR) is running routinely in data assimilation mode using the CANARI analysis, based on the Optimal Interpolation scheme. This technique is more and more obsolescent. It is progressively replaced by a variational algorithm.

Among the particularities of the variational method compared to optimal interpolation :

- It avoids the computation of the gain matrix (so the inversion of a big matrix) by taking the analysis as an approximate solution to an equivalent minimisation problem.
- It allows the use of non-conventional observations by the use of nonlinear observation operators.

The aim of this study is to realize a data assimilation cycle based on 3d-var for ALBACHIR. Two cycling types were tested during this study : one similar to the operational assimilation with only two differences : no coupling and CANARI replaced by 3d-var ; another one, called BlendVar, begins first by creating a suitable first guess with the blending method.

The idea of blending the guess is taken from ALADIN-LACE. The goal of this technique is to create an initial state combining the «large scales» resolved by the ARPEGE analysis to the «mesoscale» features provided by the short-range ALADIN forecast. Blending is considered as a mesoscale data assimilation "without using observations".

2. Experimental design

To evaluate the impact of 3d-var we performed at first a data assimilation cycle using the Optimal Interpolation scheme over a period of 10 days, starting on the 5th November 2001. This experiment (EXP_Ref) is considered as a reference for the following ones. Before setting up the 3d-var cycle, a first validation was made via a single-observation experiment (EXP_single). The other experiments: EXP_3dvar, EXP_blending, EXP_blendvar correspond respectively to the assimilation cycles performed with 3d-var, blending and BlendVar, over the same period. Table 1 describes these experiments.

Experiment	Assimilation scheme
EXP_Ref	Optimal Interpolation
EXP_single	3d-var with a single observation
EXP_3dvar	3d-var with full observation
EXP_blending	Blending of the first guess without analysis
EXP_blendvar	Blending of the first guess with 3d-var analysis

Table 1: Description of the experiment runs

The background error statistics used in Jb (model part of cost function) were computed using the «lagged NMC» method, i.e. obtained by statistics on the differences of forecasts (P36h - P12h) valid at the same time. The forecast P12h uses the same lateral boundary conditions as P36h, in order to decrease the impact of «large-scale» features introduced by a fresher ARPEGE analysis. The statistics were calculated over a period of 30 days.

To perform blending we must first compute characteristic truncations for the ALBACHIR context. The truncation that had been calculated for «low» resolution is E26xE26, and the resolution ratio between «high» and «low» spectral resolution is 2.26. The corresponding ratios are 2.66 for ALADIN-LACE and 3.01 for ALADIN-France.

3. Results

The single observation experiments showed that 3d-var analysis is running correctly in ALBACHIR. Figure 1 shows the averaged forecast scores, over all the period of assimilation and over the domain. We choose to present the relative humidity of SYNOP and TEMP because of the great sensitivity of this parameter to different assimilation methods. Forecast scores correspond to the root-mean-square (rms) error when comparing the forecast fields to the observations.

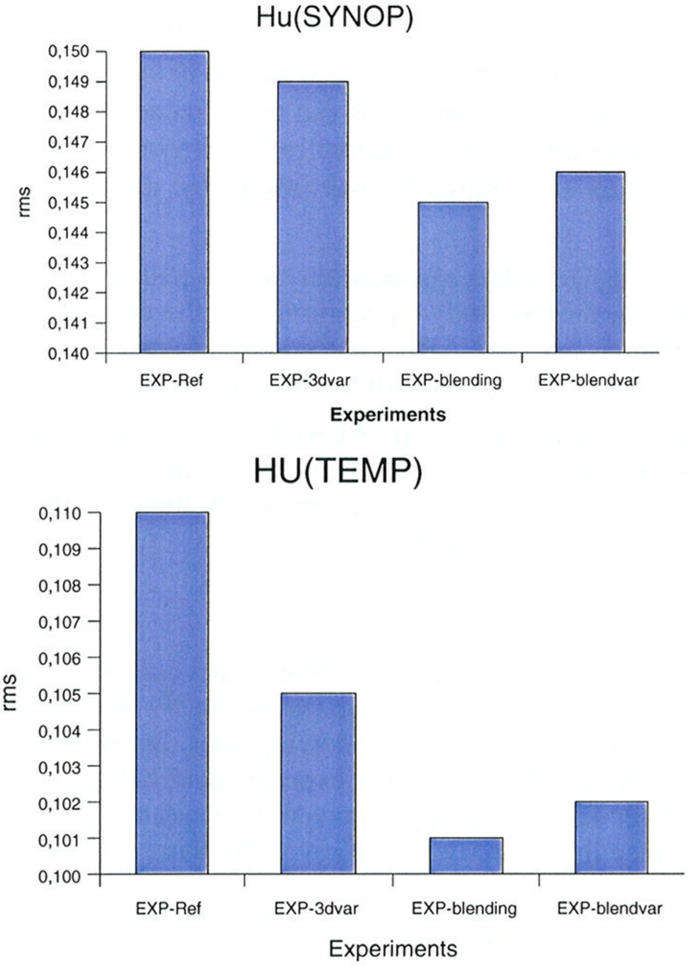


Figure 1 : Forecast scores average for relative humidity compared to SYNOP and TEMP

From this figure it can be seen that the blending and the BlendVar suites have the smallest forecast error against both SYNOP and TEMP. We notice also that the corresponding forecast scores are slightly identical.

In 3d-var cycle we assimilated only the conventional observations (here SYNOP, TEMP, DRIBU and PILOT), so the ability of this technique to use non-conventional observations is not exploited in this study. The use of such observations would certainly improve the forecast. That is why it is foreseen to use satellite observations (TOVS/ATOVS) in ALBACHIR. We intend also to test the use of vertical pseudo-profiles for humidity, produced from a satellite-based cloud classification (in research mode at Météo-France/CNRM/GMME).

It is also foreseen to extend the domain for ALBACHIR in order to cover the north African region. The tuning of BlendVar over this new domain will be done very soon.

The regional model Albachir North-Africa

Hanane Kamil
DMN

1. Introduction

Recently, Maroc-Météo (DMN) was equipped with a new and powerful tool of computing, a super-calculator IBM RS/6000 SP. This acquisition has raised the DMN's computation capacities at the level of its expectations and development prospects. Indeed, a great interest was given to regional forecasting, so a project of changing the present model configuration of Albachir (ALADIN-Maroc) into Albachir North-Africa (Albachir-NA) is in progress.

The new configuration will cover northern Africa to the equatorial belt, with a resolution of 24 km. It will be subsequently used to provide boundary conditions to an embedded model of finer resolution, 9 km, centred on Morocco and covering the current Albachir domain.

2. Albachir-NA running in dynamical adaptation mode

The first stage consists in running the model in dynamical adaptation mode on a wider domain, i.e. : 44° North - 0° South and 36° West - 56° East, with a horizontal resolution of 24 km. The vertical resolution is given by 31 layers. We use a timestep value equal to 900 s. The forecasting range is 72 hours and post-processing is performed every three hours. The coupling files were transformed to 24 km resolution by the ee927 configuration.

We must point out that the upgrade of the computing capacities led to a considerable gain on computing time.

The attached figure is an example of Albachir-NA's product. It shows the 700 hPa relative humidity field for a 24-hour forecast starting on 24/04/2001 at 15 h UTC.

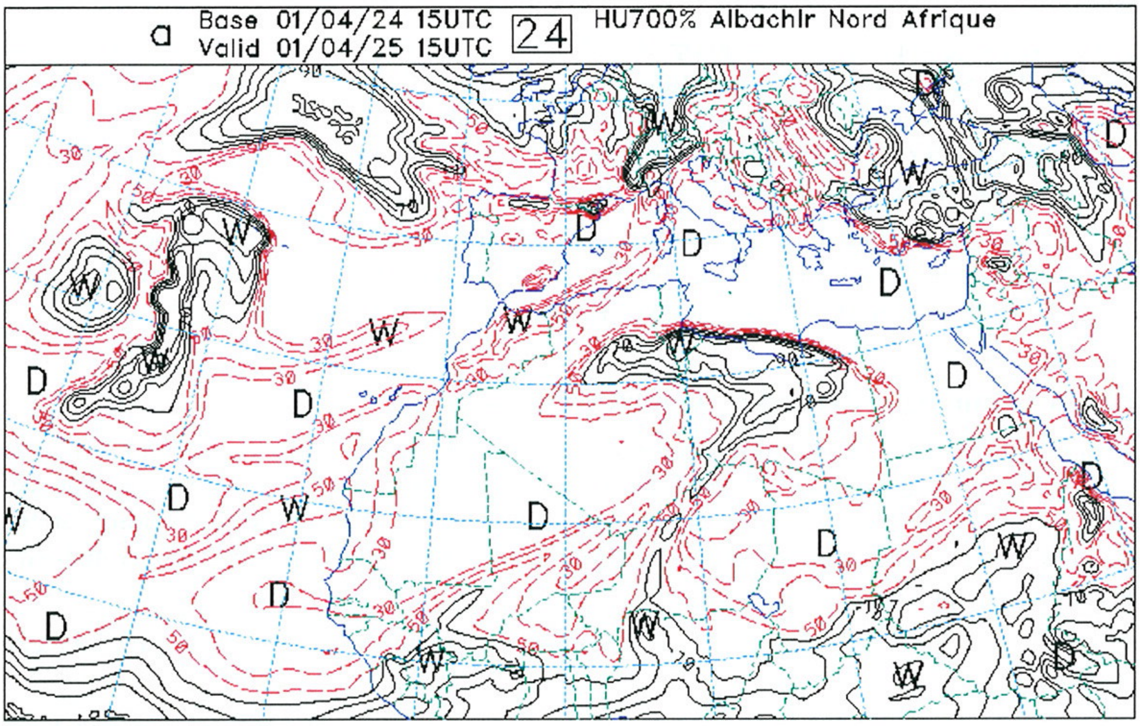
The second stage consists in evaluating the results of this new application, when compared to the existing one. The forecasts produced by this regional model remain very close to those resulting from ARPEGE. Indeed, a comparative study over the Moroccan area showed no significant variations. For the various weather parameters, the graphical charts were mostly close to each other and the differences remain generally weak on the major part of field.

3. Albachir-NA running in data assimilation mode

We were also interested in carrying out the optimal interpolation analysis CANARI on north Africa. The " CANARI's Supplementary Statistics " have presented generally good scores. However, the results concerning the analysis increments have raised a very significant problem: the deficiency in observations on most of the domain, in particular on Sahara Desert.

This encourages us to integrate other types of observations and to reflect more on other techniques of analysis and data assimilation. The integration of TOVS and radar observations and the implementation of a 3d variational analysis in this new application will constitute the best solution. This step will enable us to update the tools for analysis and consequently to improve considerably the quality of the forecasts.

Figure 1 : relative humidity at 700 hPa forecasted for 25/04/2001 at 15 h UTC over Northern Africa



Further tests on the time smoothing of the shallow-convection parameterisation

F. Bouyssel & J.F. Geleyn
Météo-France . CNRM/GMAP

The preliminary work was performed by Martin Bellus on a suggestion of Eric Bazile following some diagnostic results of Martina Tudor (see ALADIN Newsletter 21). The proposed smoothing was afterwards cleanly introduced into the code and revalidated in order to prepare a possible operational implementation. Its main aim is to suppress a coupled time/space oscillation (the second aspect being mainly but not only in the vertical) created by the on/off character of the shallow-convection parameterisation (Geleyn, 1987, *JMS*, Special NWP Symposium Issue, 141-149).

The currently operational parameterisation works in the following way : whenever one may assume from local gradient-type diagnostics the likely presence of shallow convection, a quantity "*Zaux*" is added to "$\partial(Cp.T+F)/\partial z$" inside the computation of the Richardson number used for the stability dependency of the vertical exchange coefficients (not at the surface hence). This modification is not reported in the time-stabilising anti-fibrillation scheme because the spatial discontinuities are contradicting its basic hypotheses (see Bénard et al., 2000, *MWR*, **128**, 1937-1948). This explains the underlying need for the modification described below, even when all known problems of the anti-fibrillation scheme are cured. The formulation of "*Zaux*" is as follows, δci being a Kronecker-type index linked to the pre-existence of moist convective instability as a necessary condition for shallow convection:

$$Zaux = \delta ci\ .L.\ min(0\ ,\ \partial(q\text{-}qsat\,[T,p])/\partial z)$$

When introducing the time smoothing procedure, one has to be careful with the use of the "*min*" function. While the correction to "$\partial(Cp.T+F)/\partial z$" should of course always be negative so that shallow convection systematically enhances vertical mixing via smaller Richardson numbers, the elimination of the intermittent behaviour requires the averaging of positive and negative "basic" quantities. Hence, using the "– & 0" time-step identifiers, the new scheme writes:

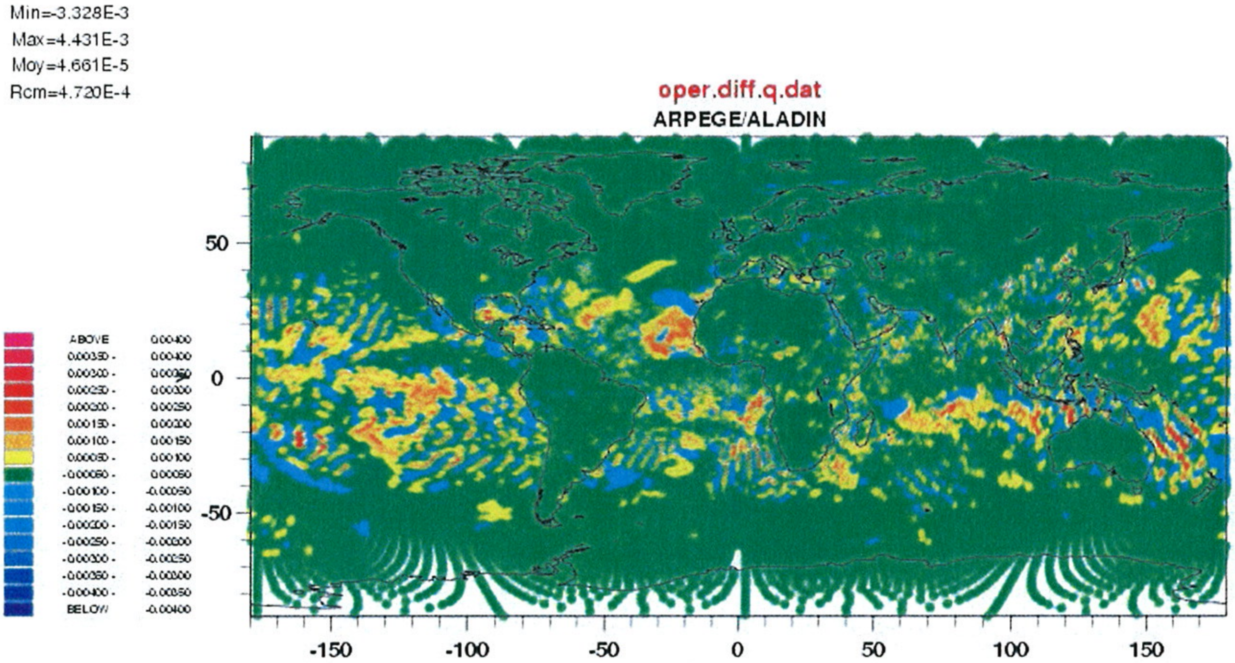
$$Zaux^* = \delta ci\ .L.\ \partial(q\text{-}qsat\,[T,p])/\partial z$$
$$Zaux^{*\,0} = min(0\ ,(Zaux^{*\,-}+Zaux^{*\,0})/2)$$

The new parameterisation (which requires a complex time-step to time-step transfer of the "*Zaux**" information at all level interfaces) is activated under the switch LCVPPLIS and is currently only implemented for the two-time-level scheme (the correct averaging procedure would be different in the case of a leap-frog scheme, with three time-levels to consider and to combine).

Figure 1 shows the vertical and horizontal oscillations of specific humidity near the ground in the operational model (reference) and the corresponding modified run (with the temporal smoothing of shallow-convection parameterisation). The problem, essentially located in tropical and subtropical regions, is strongly reduced with the time smoothing.

Figure 2 presents the model tendencies, between day 4 and day 10 of a 10-day forecast, for temperature, specific humidity and kinetic energy, averaged on horizontal domains for the reference and modified models. The temporal smoothing of the shallow-convection activity enhances the vertical mixing, leading to a positive decrease of the humidification between 1000 and 600 hPa but a detrimental warming between 700 and 200 hPa. This non-negligible impact on global tendencies delayed its inclusion in pre-operational tests until it could be combined with some other fundamental change(s).

The ad-hoc character of the time-smoothing scheme indicates on the one hand that the shallow convection ought to be parameterized in a more modern way. On the other hand the regularising effect of the development described here gives more time to carefully design a replacement parameterisation (a mass-flux type scheme that will also try to build on the respective gradients of q and $qsat$?).



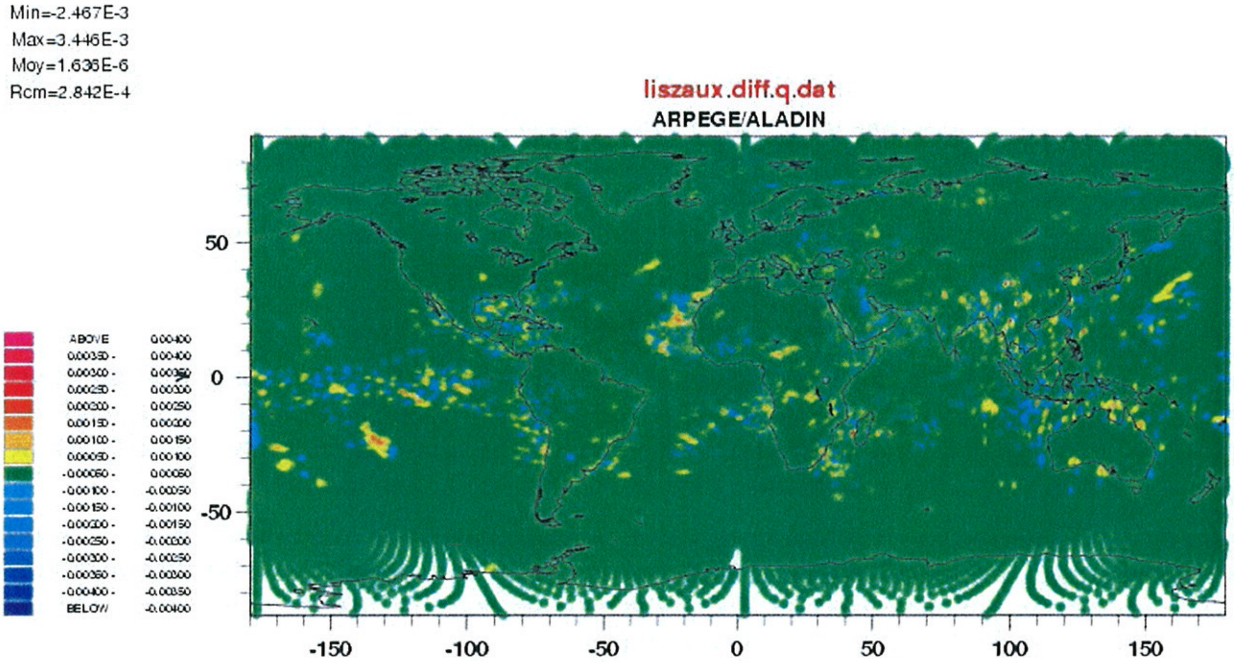


Figure 1: The quantity (q_{41} - 2 q_{40} +q_{39}), q_i being the specific humidity at model level i, is plotted for the reference (top) and the modified (with smoothing) models after 24 h integration.

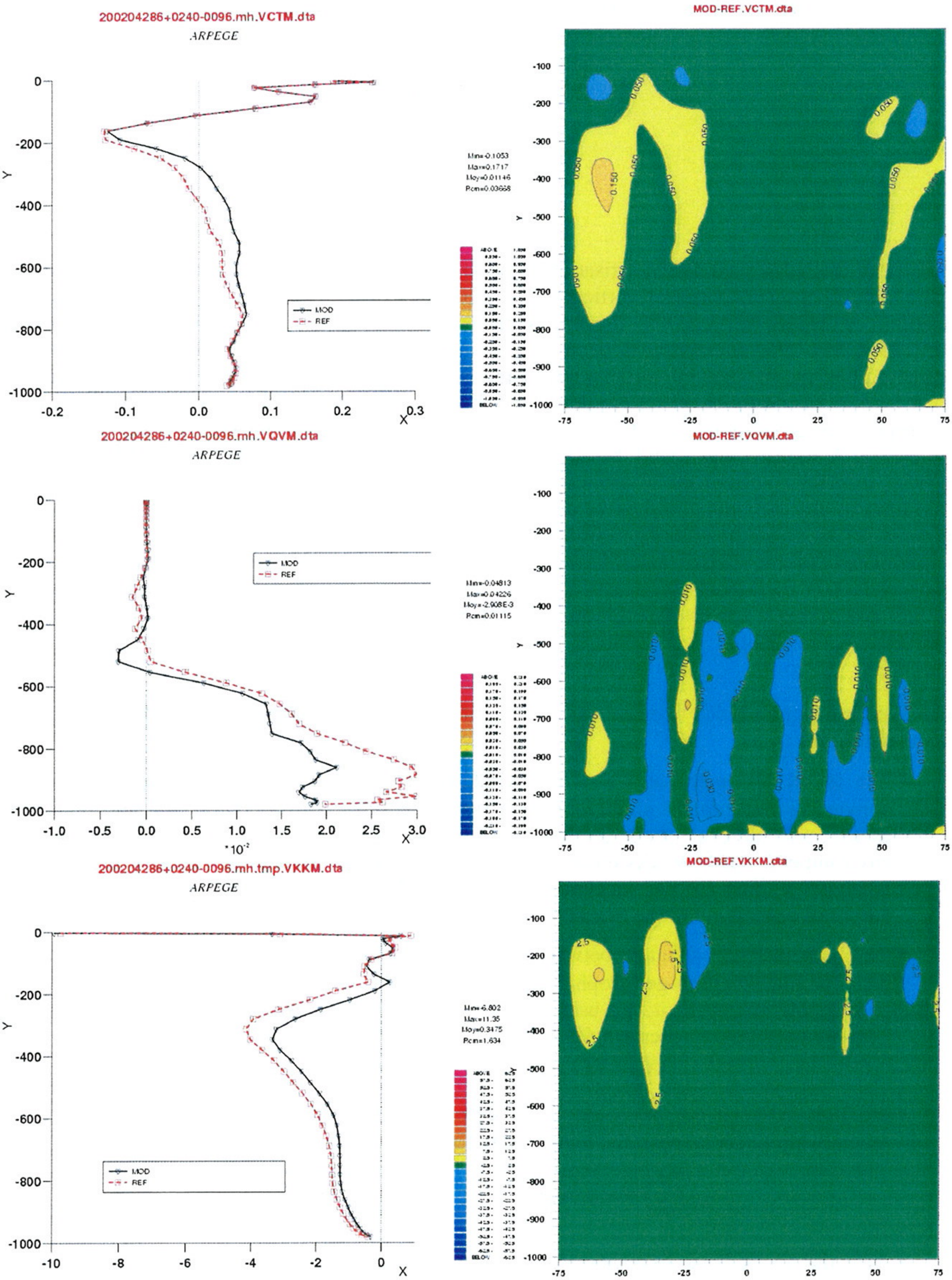


Figure 2: The model tendencies between day 4 and day 10 of a 10-day forecast, for temperature (top), specific humidity (middle) and kinetic energy (bottom), for the reference and modified models. The global tendencies for the two models are presented on the left. The differences of the zonal tendencies (modified model minus reference) are on the right.

Description of the so-called «shear-linked convection» parameterisation

F. Bouyssel & J.F. Geleyn
Météo-France . CNRM /GMAP

The idea of this additional parameterisation arose following some diagnostic studies done by André Simon on pathological potential vorticity (*PV*) structures near the surface in warm cyclogenesis situations of ARPEGE/ALADIN. It reminds the pioneering work of Thor-Erik Nordeng (Tellus, 1987, 39A, 354-375) attempting to parameterise *slantwise convection* in order to keep close to a zero amount of moist potential vorticity (*PVe*) and hence a bounded amount of *PV* in such situations (polar lows in his case). However Nordeng's work was based on Cartesian-LAM and high-latitude geostrophic considerations, all things difficult to sustain in the mixed ARPEGE/ALADIN framework. A solution was found, based on an idea that was unsuccessfully tried in EMERAUDE in 1989, in order to eliminate "*f*" from the same parameterized equations while getting rid at the same time of any horizontal derivative considerations in the calculation. The result will be nearly the same in case of a dominating geostrophic link, but the proposal below is more general and easier to implement. Pierre Bénard made however the remark that it was confusing to still call this a parameterisation of slantwise convection. Hence it was decided to keep the same initials to recall the link and giving a correct description was still possible when calling this a parameterisation of *shear-linked convection.*

Four hypotheses are needed to arrive to the form of one single equation that we shall then develop into an algorithm :

- like in all parameterisations of this kind, the effect will be taken into account in the convective routines by modifying the cloud ascent/descent properties (e.g. the undiluted ascent and descent shall go from neutral to slightly stable) within an unchanged environment; nature works quite differently since the *PV* instability might be removed by adiabatic sloping ascents encountering a modified environment, even if this is not a fully admitted description of the true behaviour;
- the mathematical exchange between horizontal and vertical derivatives is assumed to be done within the semi-geostrophic equations, but the real wind immediately replaces the geostrophic one inside it; this uses the space transformation from the verticals to the slanted "constant absolute momentum *M*" curves :

$$X_{sg}=X+V_g/f \qquad Y_{sg}=Y-U_g/f$$

- the link between the mass and wind derivatives is then taken from the thermal wind relationship under its potential temperature form :

$$f\frac{\partial u}{\partial z}=-g\,\frac{\partial(\ln\theta)}{\partial y} \qquad f\frac{\partial v}{\partial z}=+g\,\frac{\partial(\ln\theta)}{\partial x}$$

- once the above basic hypotheses have been applied to the dry case, one can jump to the moist case by simply replacing the squared dry Brunt-Vaisala frequency N^2 by its moist equivalent Nm^2, a step which should allow the elimination of unstable *PVe* patterns.

The central equation then reads :

$$\delta(Nm^2)=(\partial u/\partial z)^2+(\partial v/\partial z)^2 ,$$

which simply boils down to the fact that, in the balance between absolute vorticity and static stability as horizontal and vertical "resistance" to any motion, the non-vertical shear contributions to vorticity are, with respect to the reference situation of "vertical convection", displacing (hence the "δ" symbol) the neutrality target of the convective computation as expressed by the Brunt-Vaisala frequency, under its moist form.

The expression for the moist Brunt-Vaisalafrequency is taken from Equation (36) of the reference paper of Durran and Klemp (JAS, 1982, 39, 2152-2158) and slightly approximated plus rearranged in :

$$Nm^2 = \frac{g}{CpT}\cdot\frac{1+\frac{Lqs}{RT}}{1+\frac{L}{Cp}\frac{\partial qs}{\partial T}}\cdot\frac{\partial h}{\partial z} = A\cdot\frac{\partial h}{\partial z} \quad \Rightarrow \delta(Nm^2) = A\cdot\delta(\frac{\partial h}{\partial z})$$

h being the moist static energy assumed to be conserved along the vertical saturated adiabatic in the reference neutral case and A being forced to monotonously decrease towards one when going higher up in the atmosphere (to avoid stratospheric oddities).

In order to modify as little as possible the computation of the saturated adiabatic profiles of the updraft and downdraft codes, the same trick is used to introduce the "δ" step as when doing the "ensembling entrainment" calculation: one replaces the geopotential thickness $\Delta\Phi$ of the layer (a quantity that already takes into account several effects) by a modified $\Delta\Phi^*$ one, following:

$$\Delta\Phi^* = \Delta\Phi \ /[1+\frac{g}{A}\left((\frac{\partial u}{\partial z})^2+(\frac{\partial v}{\partial z})^2\right)]$$

This is done three times, twice for the entraining pseudo-adiabats (updraft and downdraft) and once for the undiluted ascent of the updraft part (used as a reference in two other modulations of the entrainment rate).

According to preliminary tests, the impact of activating this parameterisation is important. It indeed removes part of the overestimation of warm cyclogenesis events by ARPEGE and/or ALADIN (Figure 1) and part of unrealistic intense precipitation patterns in ALADIN (see Figure 2 in the centre of France). It modifies the evolution of winter cyclogeneses (this will call for a retuning of the *Rid* part of the CYCORA-bis/ter settings). But it changes also the general circulation as well as the tropical water cycle so that it requires a retuning of some main parameters of the convection and/or PBL physics. One may wonder why ARPEGE and ALADIN now appear to need such a parameterisation while they are approaching horizontal resolutions that could allow an explicit removal of unstable *PVe* patterns by resolved motions. This is probably because the relative ratio of vertical to horizontal resolution decreased at the same time as horizontal resolution was increasing, since the end of the eighties. In any case this parameterisation is promising but will require a lot of studying.

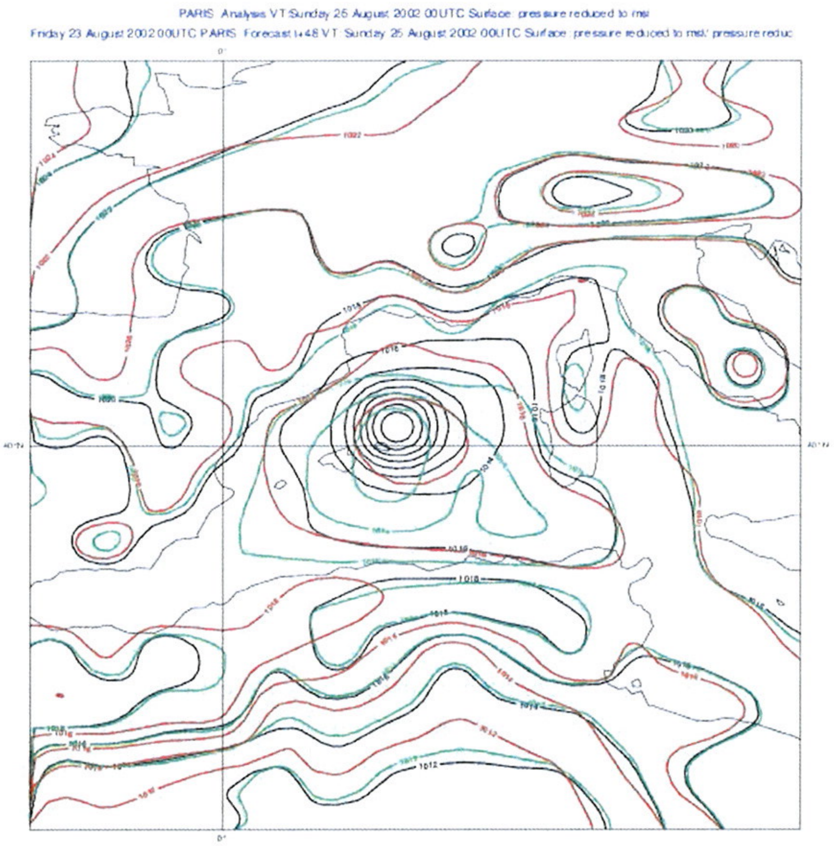


Figure 1: Sea level pressure valid for 2002082500. In red: analysis. In black: 48h ARPEGE forecast with the reference model. In green: 48h ARPEGE forecast when including the shear-linked convection parameterisation.

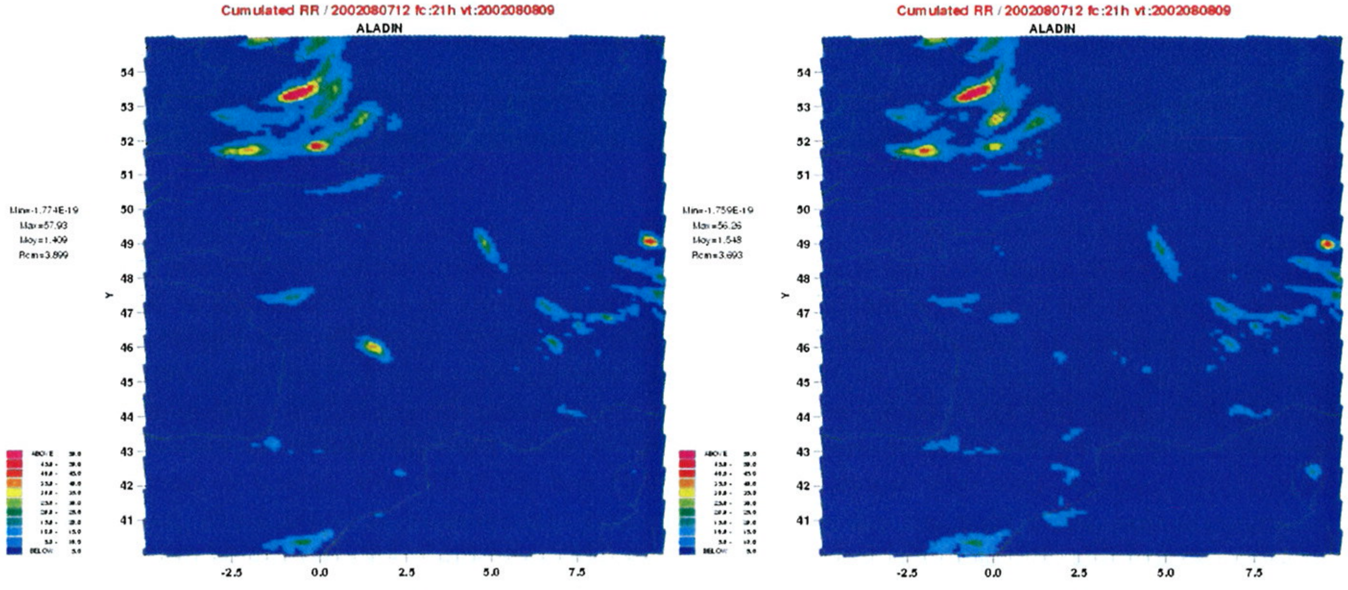


Figure 2: Cumulated total precipitation during 21h forecast with ALADIN-France model. The graphic on the right presnts the impact of the shear-linked convection parameterisation compared to the reference model on the left.

Validation of ALADIN dynamics at high resolution using ALPIA

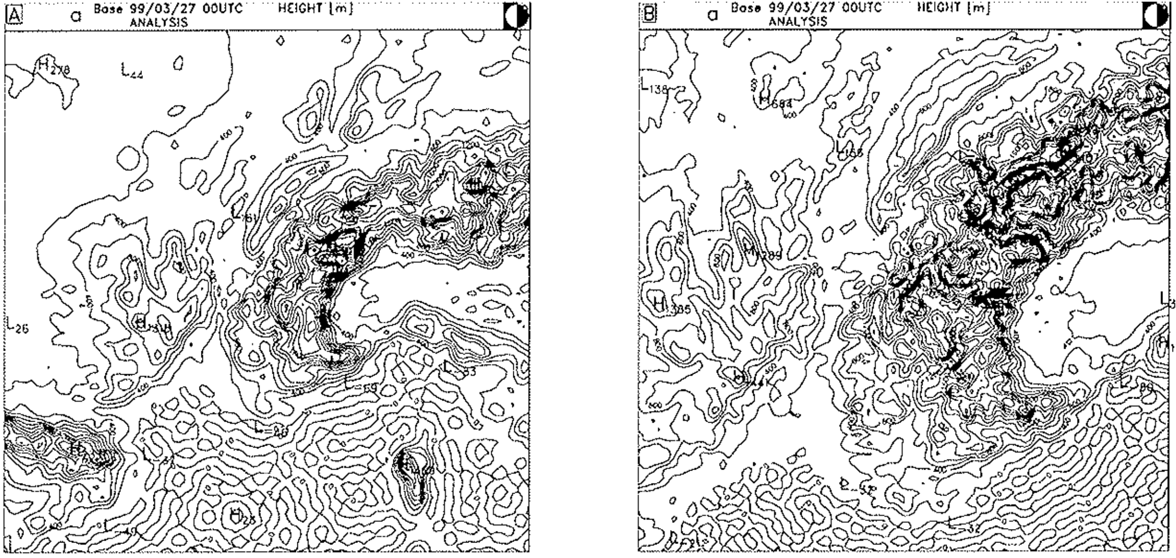
J.F. Geleyn [1], A. Trojakova [2] and D. Giard [1]
(1 : Météo-France. CNRM/GMAP - 2 : CHMI)

Introduction

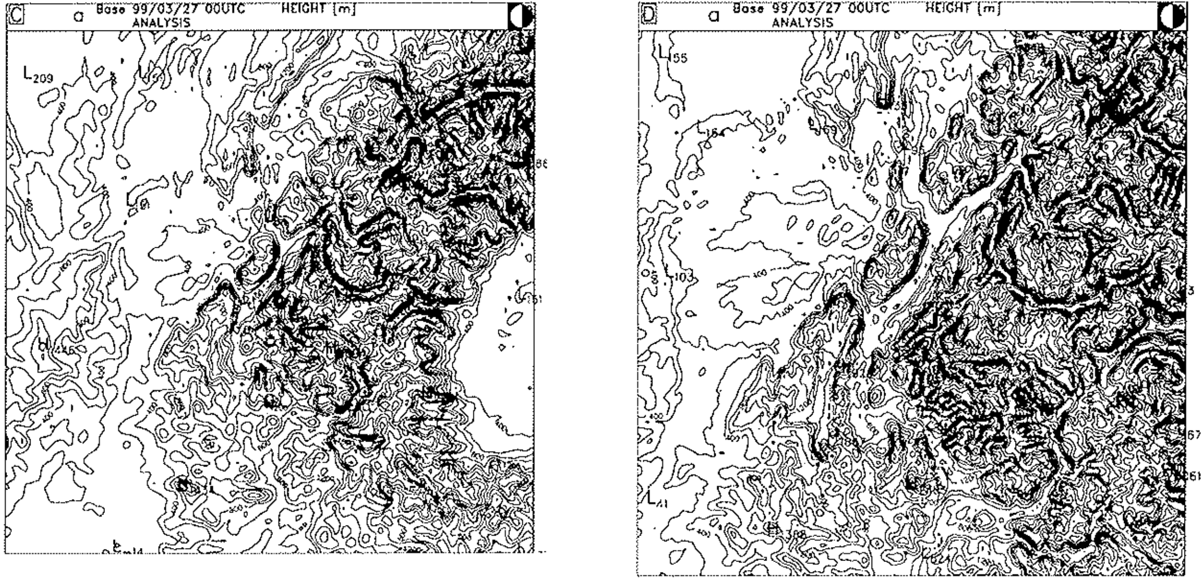
A thorough comparison of a few formulations of non-hydrostatic dynamics (ALADIN, Meso-NH and HIRLAM models) was required in the framework of the AROME project. Consequently the previous work of Alena Trojakova (described in Newsletters 21 & 4) was resumed, to investigate the behaviour of ALADIN dynamics (stability, accuracy, efficiency) at high resolution in a pseudo-academic framework.

The ALPIA framework

ALPIA involves 4 embedded ALADIN models, of increasing resolutions, centred on the French Alps (5.90° E, 45.22° N). The orography is a real one, but the initial flow is an idealized one. The corresponding orographies, extensions and resolutions are described in Figure 1, just hereafter.



A. $\Delta x=10$ km, 30 vertical (η) levels, 108×96 points **B.** $\Delta x=5$ km, 42 vertical (η) levels, 128×108 points



C. $\Delta x=2.5$ km, 60 vertical (η) levels, 144×128 points **D.** $\Delta x=1.25$ km, 85 vertical (η) levels, 180×160 points

Cross-comparisons and results

In the previously reported work, we first tried to find the maximum "safe" time-step for semi-implicit Eulerian non-hydrostatic dynamics, and the allowed range of CFL values for the 4 domains. Both the "initial" and the "preliminary" sets of additional non-hydrostatic prognostic variables were used, and we investigated the dependency on the semi-implicit background (reference temperature -SITR- and pressure -SIPR-). Table 1 summarises the main results.

		A	B	C	D
old NH scheme	Δt "safe"	110 s	40 s	10 s	4 s
	CFL range	1.2434, 1.7961	0.8708, 1.7417	0.4187, 0.9964	0.4187, 1.1638
	SITR	225 K	225 K	220 K	230 K
	SIPR	1000 hPa	1000 hPa	< 700 hPa	< 700 hPa
new NH scheme	Δt "safe"	110 s	45 s	18 s	7.2 s
	CFL range	1.266, 1.5888	0.942, 1.4695	0.7235, 1.5524	0.5788, 1.0731
	SITR	220 K	220 K	220 K	220 K
	SIPR	680 hPa	680 hPa	680 hPa	680 hPa

Table 1 : Investigation of the stability of Eulerian semi-implicit non-hydrostatic dynamics

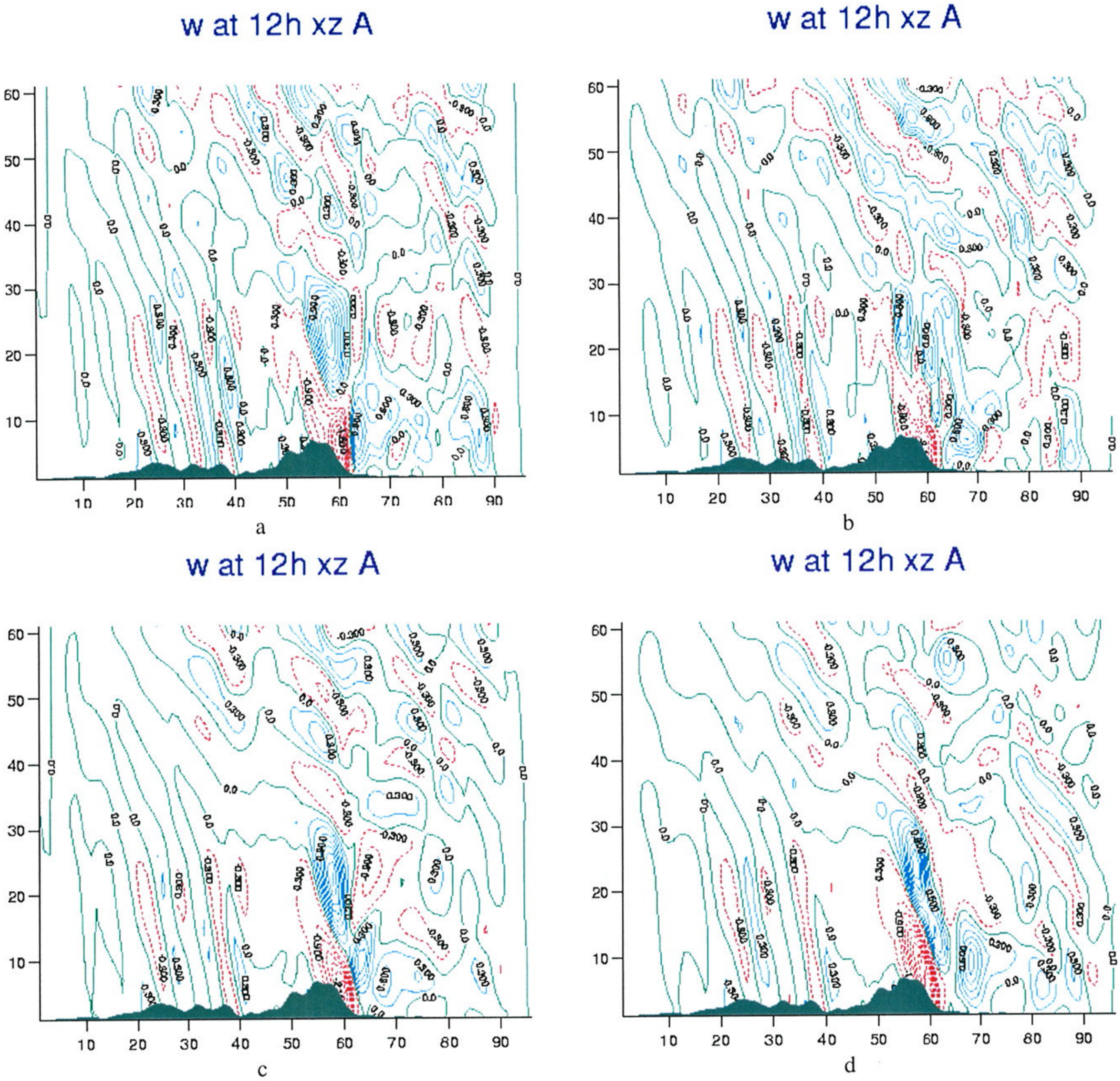
Combinations of the various options of ALADIN dynamics and of domains were tested afterwards (with a tropopause lowered to 12 km), to allow the following comparisons : Eulerian versus 3-time-level semi-Lagrangian advections, quadratic versus linear grid, explicit versus semi-implicit, hydrostatic versus non-hydrostatic, for increasing resolutions. The non-hydrostatic version is the initial one, i.e. with the old set of additional prognostic variables and without refinements in vertical discretisation. The work under progress on new prognostic variables, a new surface semi-Lagrangian boundary condition and the predictor-corrector scheme (for the yet untested 2-time-level discretisation) should hence still significantly enhance stability.

The last set of experiments is summarized in Table 2, just below.

		EXPLICIT				SEMI-IMPLICIT			
		domain / resolution				domain / resolution			
		A	**B**	**C**	**D**	**A**	**B**	**C**	**D**
H	Eulerian quadratic grid	$\Delta t_{eul} = 14s$	▨	▨	▨	$\Delta t_{eul} = 115s$	$\Delta t_{eul} = 40s$	***blew up !*** *(with 17s)*	▨
	semi-Lagrangian quadratic grid	$\Delta t_{eul} = 14s$	▨	▨	▨	$\Delta t_{eul} = 115s$	$\Delta t_{eul} = 40s$	$\Delta t_{eul} = 17s$	▨
	semi-Lagrangian linear grid	***blew up !*** *(with 14s)*	▨	▨	▨	$\Delta t_{eul} = 115s$	***blew up !*** *(with 40s)*	▨	▨
NH	Eulerian quadratic grid	▨	▨	▨	▨	$\Delta t_{eul} = 115s$	$\Delta t_{eul} = 40s$	$\Delta t_{eul} = 17s$	$\Delta t_{eul} = 6.9s$
	semi-Lagrangian quadratic grid	▨	▨	▨	▨	$\Delta t_{eul} = 115s$	$\Delta t_{eul} = 40s$	$\Delta t_{eul} = 17s$	▨
	semi-Lagrangian linear grid	▨	▨	▨	▨	$\Delta t_{eul} = 115s$ $\Delta t_{max} = 318s$ $\Delta t_{safe} = 200s$	$\Delta t_{eul} = 40s$ $\Delta t_{max} = 90s$ $\Delta t_{safe} = 60s$	$\Delta t_{eul} = 17s$ $\Delta t_{max} = 33s$ $\Delta t_{safe} = 25s$	------------- $\Delta t_{max} = 13s$ $\Delta t_{safe} = 10s$

Table 2 : Investigation of the stability of ALADIN dynamics. Dashed areas indicate combinations not tested. The maximum Eulerian time-step, used for Eulerian versus semi-Lagrangian comparisons, and the maximum allowed semi-Lagrangian time-step for a given resolution (resulting from many experiments), as well as an estimated "safe" one for the last case (SI-SL-NH linear grid) are mentioned.

Comparisons between Eulerian and semi-Lagrangian advections on one side, explicit and semi-implicit schemes on the other side, were performed at the lowest resolution (10 km). The Eulerian time-step was used for semi-Lagrangian experiments, and the same (quadratic) grid-type was kept. Even surprisingly for the very short time step used in the explicit case, the main differences are between Eulerian and semi-Lagrangian options (with a clear advantage for the second one), as shown in Figure 2, and very likely related to the first order only accuracy of the vertical interpolations operators in the Eulerian case.



a

b

c

d

Figure 2 . Vertical West-East cross-section of vertical velocity for domain A and hydrostatic dynamics :
a) Eulerian explicit, b) Eulerian semi-implicit, c) semi-Lagrangian explicit d) semi-Lagrangian semi-implicit.

When going to higher resolutions, the non-hydrostatic dynamics proved better than the hydrostatic one, as far as stability (see Table 2) and flow structure (see Figure 3) are concerned, and semi-Lagrangian better than Eulerian advection (see Figure 4), even with the very preliminary code used here.

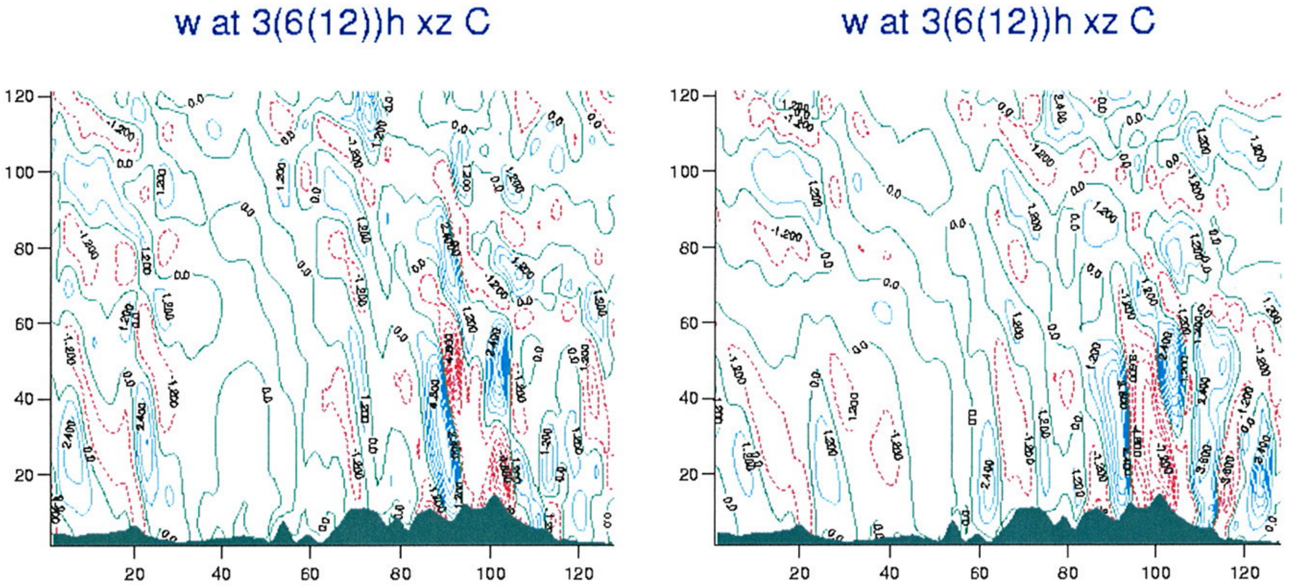


Figure 3. Vertical West-East cross-section of vertical velocity for domain C and a semi-implicit semi-Lagrangian scheme. A quadratic grid and the equivalent Eulerian time-step are used in each case.
Left : hydrostatic dynamics. Right : non-hydrostatic dynamics.

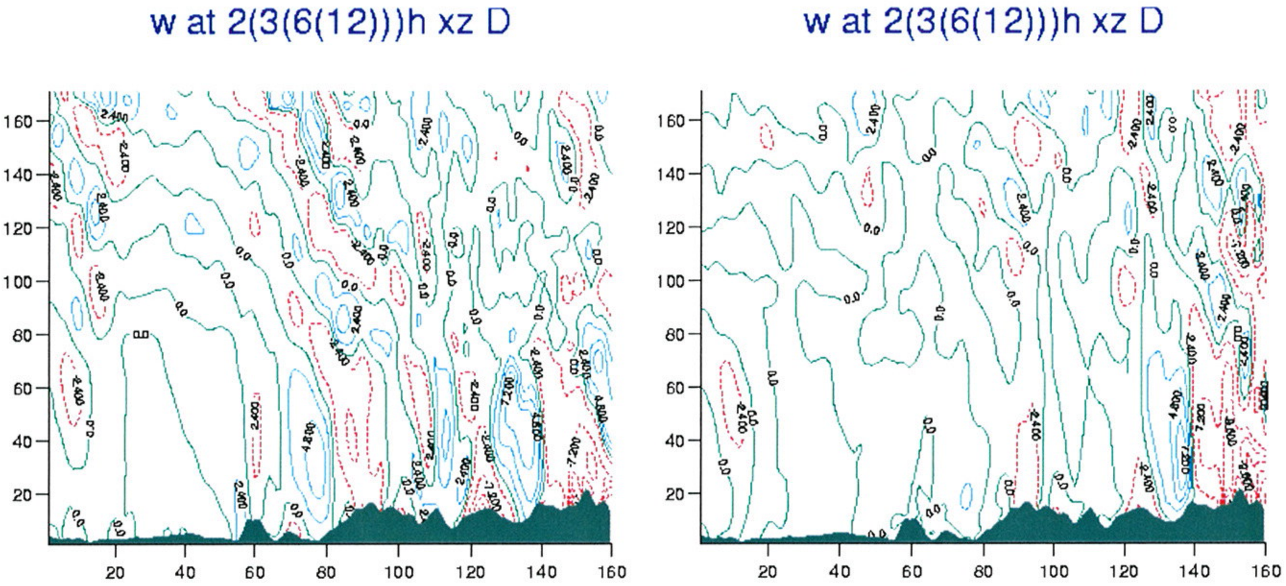


Figure 4. Vertical West-East cross-section of vertical velocity for domain D and non-hydrostatic semi-implicit dynamics. The maximum time-step is used in each case.
Left : Eulerian advection with a quadratic grid. Right : semi-Lagrangian advection with a linear grid.

Even if some of the behaviour of the semi-Lagrangian scheme at higher resolutions is still bringing in some concern (problems with the coupling of the outgoing flow, weakened mountain wave patterns when the time step is pushed beyond the "Eulerian maximum" one, ...), these results are quite promising for the future of ALADIN-NH. But the work is not finished yet, since the new non-hydrostatic dynamics will require further testing, once ready (i.e. within the end of 2002).

A review of the available snow schemes in ARPEGE/ALADIN

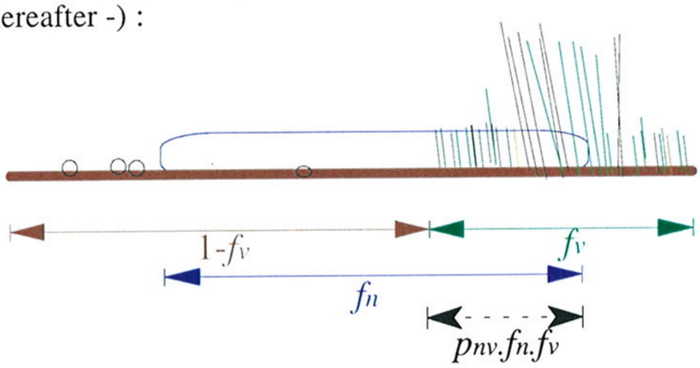
D. Giard, on behalf of the French, Bulgarian, Moroccan and Polish ARPEGE/ALADIN teams
(i.e. E. Bazile, F. Bouyssel; A. Bogatchev, V. Spiridonov; A. Dziedzic; M. El Haiti)

Introduction

Recurrent problems in the initialization and the forecast of the snow cover (hence in the forecast of surface temperature) have been noticed along the last winters, both at large and small scales. This fostered research in two directions :

- improving the formulation of the surface albedo, taking into account the part of vegetation that may partly mask the snow cover. This study was triggered by a simple glance at the Swedish forests in winter and the study of Viterbo and Betts (1999).
- testing once again, in ARPEGE and in a quasi-parallel suite (i.e. including assimilation), the Douville's scheme. The corresponding code is available in ARPEGE/ALADIN for years, and this scheme was tested several times in ALADIN, in pure dynamical adaptation mode. But results were quite deceiving so far.

Both alternatives to the old scheme aim at considering the overlapping between snow and vegetation, as illustrated below (f_n and f_v are the fractions of the grid-box covered with snow and vegetation respectively - more generally indices n, v and s refer to snow, vegetation and bare ground, respectively, hereafter -) :



The old (operational) description of snow cover

The old scheme is very simple :

- 1 prognostic variable :
  W_n : equivalent water content
- albedo of snow :
  α_n, constant (set to : $\alpha_n = .70$)
- fraction of snow cover :
  f_n, independent of surface characteristics and computed as : $f_n = W_n \;/\; (W_n + W_n^c)$
- formulation of the surface albedo :
  $\alpha = max\,(\alpha_n, \alpha_{s\text{-}v}) \cdot f_n + \alpha_{s\text{-}v} \cdot (1 - f_n)$, with : $\alpha_{s\text{-}v} = \alpha_v \cdot f_v + \alpha_s \cdot (1 - f_n)$
- impact on thermal inertia :
  none : $h = h_{s\text{-}v} = max\,[h_v \cdot f_v + h_s \cdot (1 - f_v)\,,\, h_x]$
- impact on roughness length :
  $z0 = z0_{s\text{-}v} \cdot (1 - f_n'[z0_{s\text{-}v}]\,) + z0_n \cdot f_n'[z0_{s\text{-}v}]$, with : $f_n' = W_n \;/\; (W_n + W_n^c + \beta\, z0_{s\text{-}v})$

The Douville's scheme

- 3 prognostic variables :
  - W_n : equivalent water content
  - α_n : albedo
  - ρ_n : density
- albedo of snow :
  evolution depending on surface melting and snow-falls
  - ♦ no melting : slow linear decrease from α_n^{max} (α_n^{max}=.85)
  - ♦ melting : exponential decrease towards α_n^{min} (α_n^{min}=.65)
  - ♦ snow-falls tend to bring it back to α_n^{max}
- fraction of snow cover :
  2 formulations for bare ground and 1 for vegetation

$$f_n^{a/b} = f_{nv} \cdot f_v + f_{ns}^{a/b} \cdot (1 - f_v)$$

$$f_{ns}^a = \frac{W_n}{W_n + W_n^b (1 + \lambda\, z0_{rel})} \quad , \; f_{ns}^b = min(1, \frac{W_n}{W_n^c}) \quad , \; f_{nv} = min(f_{ns}^b , \frac{W_n + W_n^g}{W_n + \lambda\, \rho_n\, z0_v} \cdot f_{ns}^a)$$

- formulation of the surface albedo :

$$\alpha = \alpha_n \cdot f_n^a \; + \; \alpha_v \cdot (1 - f_{nv}) \cdot f_v \; + \; \alpha_s \cdot (1 - f_{ns}^a) \cdot (1 - f_v)$$

- impact on thermal inertia :

$$h = h_n \cdot f_n^b \; + \; h_v \cdot f_v \cdot (1 - f_{nv}) + max\, [h_s, h_x] \cdot (1 - f_v) \cdot (1 - f_{ns}^b)$$

- impact on roughness length :

$$z0 = \sqrt{(1 - f_{nv}) \cdot z0_{s-v}^2 + f_{nv} \cdot (z0_n^2 + z0_{rel}^2)}$$

The newly proposed parameterization

The new scheme, developed under the leadership of Eric Bazile, is of intermediate complexity :

- 2 prognostic variables :
  - W_n : equivalent water content
  - α_n : albedo
- albedo of snow :
  evolution depending on surface melting and snow-falls, following Douville with changes in extrema
- fraction of snow cover :
  depending on the vegetation cover (horizontal and vertical extension, f_v and LAI) and on the "age of snow", estimated from its albedo :

$$f_n = (p_{nv}[LAI, \alpha_n] \cdot f_v \; + \; 1 - f_v) \cdot f_n^0 \, , \qquad f_n^0 = \frac{W_n}{W_n + W_n^c} ,$$

$$p_{nv} = 1 - \frac{LAI}{LAI^1} \cdot \frac{\alpha_n^1 - max(\alpha_n^0, \alpha_n)}{\alpha_n^1 - \alpha_n^0} \quad \text{if } \; LAI > LAI^0, \; 1 \text{ else}$$

- formulation of the surface albedo :
  $$\alpha = \alpha_n \cdot f_n \; + \; \alpha_v \cdot (1 - p_{nv} \, [LAI, \, \alpha_n] \cdot f_n^{\,0}) \cdot f_v \; + \; \alpha_s \cdot (1 - f_n^{\,0}) \cdot (1 - f_v)$$
- impact on thermal inertia and roughness length : as with the old scheme

The intuitive necessity of introducing an increased dependency on vegetation, especially on the Leaf Area Index, was confirmed by diagnostic studies with ARPEGE and ALADIN-Bulgaria, where a significant correlation between forecast errors in presence of snow and areas of high LAI was to underline.

As a further step, the use of snow density as a diagnostic variable is considered (i.e. computation as in the Douville scheme, but with no feedback on other fields) to help evaluating snow depth, for diagnostic purposes and to improve the snow-cover analysis.

Impact studies : Douville's scheme

The Douville's parameterization was first tested in ALADIN, in dynamical adaptation mode, by Adam Dziedzic in 1997. Experiments were performed on the LACE domain with the very first operational version of ISBA. Various initial settings for snow albedo and density were tested, covering the whole range of allowed values [$.50 \le \alpha_n \le .85$, $0.1 \le \rho_n \le 0.3$]. Scores for 2m temperature (T2m) were globally worse than with the old snow scheme.

Some more experiments were performed afterwards by Andrey Bogatchev and Valery Spiridonov, with ALADIN-Bulgaria and the most recent version of ISBA, including the parameterization of soil-freezing processes. The Douville's scheme led to clearly worse scores (against analysis, due to the sparse observations of snow cover) when compared to the operational one, once again. The discrepancy remains when trying to introduce a better description of the impact of vegetation in both schemes.

To take into account the feedbacks that appear within an assimilation cycle, and also try to close this issue, the parameterization was extensively tested in ARPEGE by Adam Dziedzic. He launched a 3d-var assimilation experiment along the 4 months of winter 2000-2001, with one 96 h forecast per day. Due to an external mistake, two experiments were run : one with the standard scheme, and one with the albedo of snow kept constant, equal to .70. Scores were computed against analyses and against SYNOP observations (T2m), over several representative domains. The Douville's scheme leads to worse forecasts, almost everywhere and all along the winter, as illustrated by the table in appendix. The deterioration is enhanced by the mistake, i.e. when snow density is the only effective prognostic variable, which indirectly confirms the choices retained for the new snow scheme.

Impact studies : Bazile's scheme

The new parameterization was tested in several frameworks. The first tests and retunings were based on 30-day forecasts starting from 4 days in March 2000. Second the scheme was proposed to the SNOWMIP experiment (SNOW Model Intercomparison Project), for comparison to 25 other research or operational parameterizations and 4 experimental datasets. The retained tunings were the following :

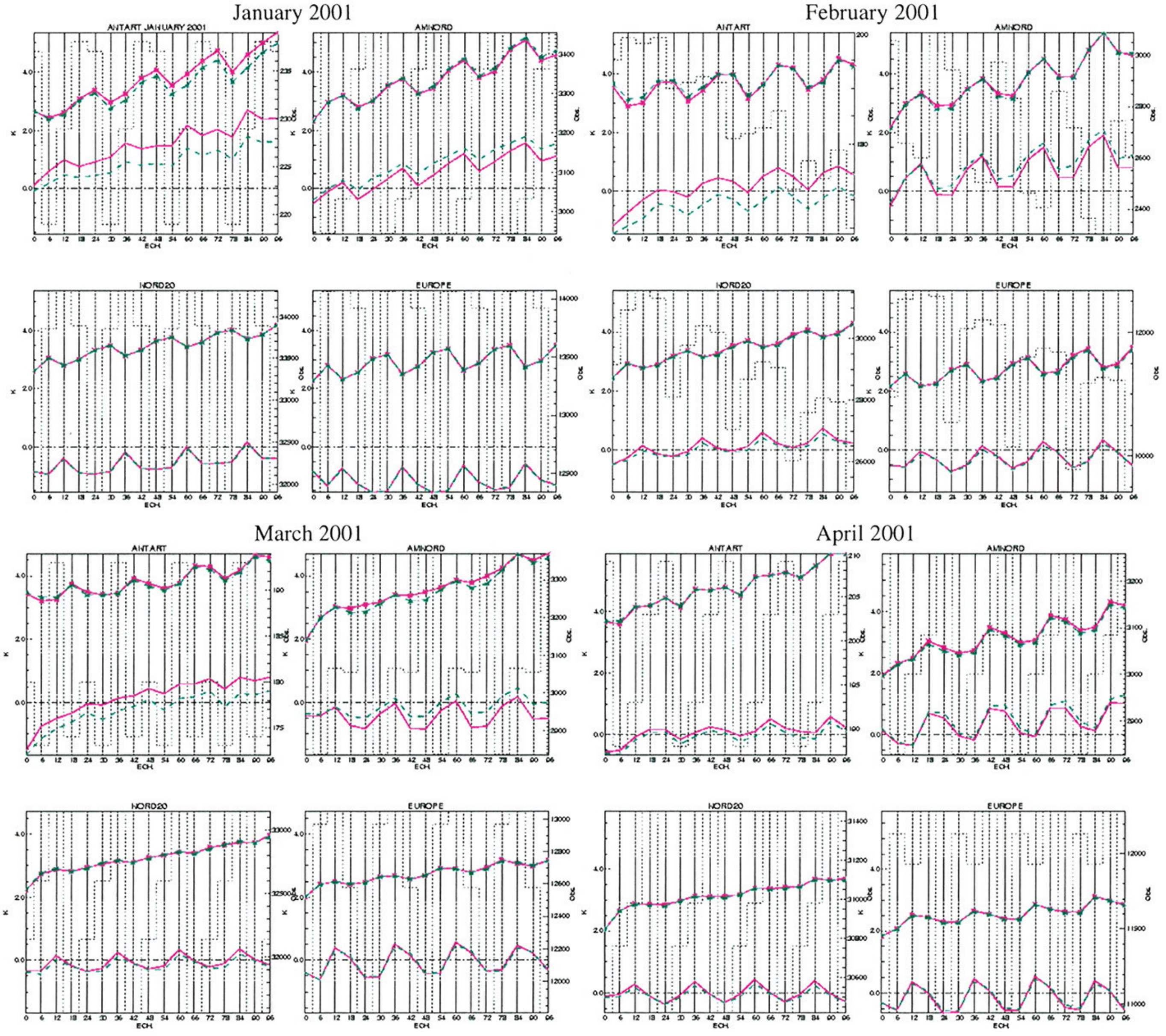
$$\alpha_n^{max} = .85 \, , \; \alpha_n^{min} = .70 \, , \; \alpha_n^{1} = .87 \, , \; \alpha_n^{0} = .84 \, , \; LAI^{\,1} = 7. \, , \; LAI^{\,0} = 3. \, ,$$

The new model behaved quite well, taking into account its simplicity. Its main handicap was the constant snow density, for the forecast of snow depth.

Further validations were based on data assimilation experiments with ARPEGE. A first 15-day test, based on 4d-var assimilation and 96 h forecasts, covered the period 3-18 March 2001. Scores against SYNOP observations showed an improvement of T2m forecasts over large areas, with neutral results else. Changes were as expected. A longer experiment, covering the full winter 2000-

2001, from December to April, and based on 3d-var analysis, was run afterwards. The tunings were the same as for SNOWMIP. Scores were computed against SYNOP and TEMP observations. A significant positive impact on surface fields is observed over Antarctica in December and January (reduction of the warm bias, though no vegetation !), over Northern America in March (reduction of the cold bias). Else scores are slightly positive or neutral. Results are illustrated hereafter.

Skill of 96 h forecasts, with the old and the new snow schemes
comparison to T2m SYNOP observations (bias and rmse), monthly average for 4 domains
red : old scheme, green : new scheme, dotted : number of observations considered (left scale)



Perspectives

The new parameterization has been introduced in the present operational library and in the last cycle. It is expected to be tested in a parallel suite for ARPEGE and ALADIN-France this autumn, together with other modifications in physics and surface analysis.

The next step will be a better description of sea ice, taking into account the evolution of albedo.

Appendix

Monthly scores against analyses for temperature at 1000 hPa, for 4 domains (from A. Dziedzic)

Experiment	Operational scheme	Douville's scheme	Douville's scheme modified
	Dec 00 / Jan 01 / Feb 01 / Mar 01	Dec 00 / Jan 01 / Feb 01 / Mar 01	Dec 00 / Jan 01 / Feb 01 / Mar 01
Domain : "Globe"			
bias at 96 h	0.339 / 0.303 / 0.246 / 0.004	0.359 / 0.320 / 0.293 / 0.073	0.365 / 0.338 / 0.302 / 0.080
rmse at 96 h	*1.748 / 1.609 / 1.652 / 1.906*	*1.765 / 1.627 / 1.680 / 1.923*	*1.770 / 1.635 / 1.682 / 1.926*
bias at 84 h	0.306 / 0.258 / 0.203 / 0.009	0.323 / 0.278 / 0.249 / 0.073	0.331 / 0.293 / 0.256 / 0.079
rmse at 84 h	*1.607 / 1.479 / 1.512 / 1.761*	*1.623 / 1.494 / 1.533 / 1.772*	*1.625 / 1.501 / 1.533 / 1.776*
Domain : "North America" [25 °N, 145 °W - 60 °N, 50 °W]			
bias at 96 h	1.439 / 0.673 / 0.783 / 0.134	1.610 / 0.879 / 1.040 / 0.431	1.625 / 0.897 / 1.058 / 0.444
rmse at 96 h	*4.039 / 2.657 / 3.259 / 2.956*	*4.088 / 2.766 / 3.288 / 2.959*	*4.081 / 2.752 / 3.296 / 2.959*
bias at 84 h	1.500 / 0.759 / 0.879 / 0.320	1.650 / 0.948 / 1.106 / 0.596	1.663 / 0.952 / 1.116 / 0.613
rmse at 84 h	*3.863 / 2.472 / 2.922 / 2.733*	*3.919 / 2.596 / 2.987 / 2.780*	*3.912 / 2.586 / 2.988 / 2.780*
Domain : "Grand Nord" [25 °N, 180 °W - 90 °N, 0 °E]			
bias at 96 h	1.098 / 0.676 / 0.645 / 0.309	1.197 / 0.778 / 0.786 / 0.505	1.196 / 0.800 / 0.801 / 0.522
rmse at 96 h	*3.314 / 2.542 / 2.907 / 2.703*	*3.343 / 2.623 / 2.925 / 2.737*	*3.350 / 2.612 / 2.924 / 2.744*
bias at 84 h	1.070 / 0.662 / 0.710 / 0.421	1.155 / 0.748 / 0.835 / 0.599	1.163 / 0.761 / 0.842 / 0.612
rmse at 84 h	*3.091 / 2.347 / 2.661 / 2.474*	*3.128 / 2.426 / 2.697 / 2.533*	*3.129 / 2.419 / 2.686 / 2.533*
Domain : "Eurasia" [25 °N, 10 °W - 90 °N, 170 °E]			
bias at 96 h	1.566 / 1.450 / 1.176 / 0.470	1.685 / 1.597 / 1.460 / 0.829	1.684 / 1.609 / 1.455 / 0.842
rmse at 96 h	*3.233 / 3.066 / 3.113 / 2.766*	*3.347 / 3.172 / 3.286 / 2.830*	*3.347 / 3.164 / 3.280 / 2.846*
bias at 84 h	1.275 / 1.101 / 0.783 / 0.235	1.404 / 1.257 / 1.083 / 0.573	1.406 / 1.275 / 1.084 / 0.589
rmse at 84 h	*2.820 / 2.688 / 2.678 / 2.416*	*2.919 / 2.764 / 2.785 / 2.428*	*2.908 / 2.764 / 2.777 / 2.440*

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