ALADIN NEWSLETTER 27

July-December 2004

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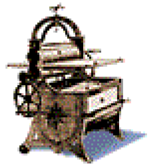


1. EDITORIAL

Experience has shown that the rather strict deadlines fixed last summer (22/07 and 22/01) were too stringent. Many papers, including mandatory ones (reports on operations and research for each centre), cannot be ready in time. And some papers sent, suffer from hasty writing, bringing even more work to the editorial team.

As a consequence, the next deadlines will be fixed for the end July and the end of January respectively, there are nicest ways to celebrate JAM's birthday! And please, do use the (updated) style sheets and proof read your contribution before sending them to the editorial team (JAM and DG).

A new tool, made for openoffice, which you can use to write equations and formulæ can be found on: http://www.dmaths.com/

1.1. EVENTS

1.1.1. 26th EWGLAM and 11th SRNWP meetings

The annual joint EWGLAM and SRNWP meetings were organized by met.no, on 4-7 October 2004, in Oslo (Norway). Most presentations and the minutes are available on the SRNWP web site : *http://srnwp.cscs.ch/*, and the LAM Newsletter should be available soon.

During the SRNWP meeting, the decision to propose "now" a Marie Curie Research Training Network was taken (voted). This led to the STORMNET project. More details in the ALADIN-2 section.

The minutes of the many informal ALADIN meetings and discussions along this week, with several strategic issues debated, are available at :
http://www.cnrm.meteo.fr/aladin/meetings/informal.html#2004

1.1.2. 9th Assembly of ALADIN Partners

This extended Assembly, with several scientists and two HIRLAM representatives present, was held close to Split (Croatia), on 30-31 October 2004. It had to deal with 3 major issues :

- the ALADIN-HIRLAM cooperation, welcomed by all Directors,
- the preparation of the next Memorandum of Understanding, with the nomination of a working group and some preliminary input,
- a partial change of priorities within the ALADIN-2 short-term plan.

The minutes (thanks to Maria Derkova) and the presentations are available on the ALADIN web site, at: *http://www.cnrm.meteo.fr/aladin/meetings/minutesass9.html*. Do have a look at them !

1.1.3. TCWGPDI workshop

The TCWGPDI (Training Course and Working Group on Physical/Dynamical Interfacing) was held in Prague from the 22d till the 26th of November 2004. Around 40 participants from the ALADIN, HIRLAM, ARPEGE-IFS and AROME communities gathered together. The aim of the workshop was twofold : firstly, a training course and secondly, to define the basis of future common physical/dynamical interface for the several physics of the different communities listed above.

The training course was really fruitful with a complete review on the basic equations (considering a multiphase air parcel) and stability aspects, a state of the art of the ideas around the organisation of the time-step and some links with the dynamical part (non-hydrostatic aspects).

The second goal was not reached. However, the talk enabled to get some informations on the constraints imposed by the different physics and also on the way some already implemented solutions were done (AROME prototype, IFS surface scheme).

1.1.4. HIRLAM-ALADIN mini-workshop on convection and cloud processes

This was the first joint workshop, a HIRLAM initiative. It was organized in the framework of the "Nordic Network on Fine-scale Atmosperic Modelling" in Tartu (Estonia), on 24-26 January 2005. Presentations are available at : *http://hirlam.fmi.fi/CCWS/*

This workshop was a real success, with around 30 participants representing the HIRLAM, ALADIN-2 (all declinations), COSMO, Meso-NH, MM5, MC2, ... worlds. Working groups allowed very constructive discussions, especially on the physics-dynamics interface (esp. the definition of implementation rules common to all HIRLAM and ALADIN-2 options) and the grey-zone problem, with the emergence of a new approach, considering the complementarity between the various parameterizations rather than between resolved and unresolved contributions.

1.1.5. Other workshops

Joint HIRLAM-SRNWP workshop on "Surface Processes and Assimilation"

Held on 15-17 September 2004, in Norrköping (Sweden). The report presented by Stefan GOLLVIK at the 11th SRNWP meeting is available on the SRNWP web site.

LAM-EPS days in Vienna

Organized by ZAMG on 25-28 October 2004.

Joint HIRLAM-SRNWP workshop on "High resolution data assimilation: towards 1-4km resolution"

Held on 15-17 November 2004, in Exeter (UK), with very many participants. More details at : *http://www.metoffice.gov.uk/research/nwp/external/srnwp/workshop_nov2004/index.html*

SRNWP workshop on "Numerical Techniques"

Practically included in the ECMWF seminar on "Recent developments in numerical methods for atmosphere and ocean modelling", 6-10 September, Reading (UK).

1.1.6. Other events

Two bad news : Günther Doms, the father of the Local Model and a leader of the COSMO group, and Patrick Jabouille, an expert in Meso-NH physics and one of the first members of the AROME team, died during Summer.

New directors in 2004 or early 2005 : in Tunisia, Croatia, Morocco and Hungary.

1.2. ANNOUNCEMENTS

1.2.1. HIRLAM All Staff Meeting

To be held on March 14-16, 2005, in Dublin (Ireland).

Unfortunately, there will be only French ALADIN representatives. The HIRLAM research plan for the next years, especially mesoscale challenges, will be discussed.

1.2.2. 2nd SRNWP workshop on "Short-Range Ensemble Prediction Systems"

To be organized on April 7-8, 2005, in Bologna (Italy), by the Ufficio Generale per la Meteorologia.

The workshop will be arranged on selected talks covering :

- global prediction systems and evaluation techniques,
- ensemble prediction systems for short range,
- related international projects.

There will be a session dedicated to the discussion on the following selected topics:

- methodologies for initial perturbations in limited-area models and interactions with boundaries
- model perturbations; parameters settings, stochastic physics
- how to combine properly different models (and different analysis) in a different model approach ?
- ensemble data assimilation: feasible for limited-area models ?
- ensemble size
- validation techniques

More details at : *http://www.meteoam.it/*

1.2.3. 4th WMO international symposium on "Assimilation of Observations in Meteorology and Oceanography"

To be held on April 18-22, 2005, in Prague (Czech R.).

This will be a huge meeting, with up to 270 participants registered. And this will be an opportunity for ALADIN and HIRLAM scientists to discuss research plans for the next years.

More details on the program at : http://www.chmi.cz/dasympos/index.html

1.2.4. ICAM-MAP meeting

The 28th International Conference on Alpine Meteorology (ICAM) and the Annual Scientific Meeting of the Mesoscale Alpine Programme (MAP) 2005 will take place in ZADAR (Croatia), from Monday 23 to Friday 27, May 2005.

The conference will be hosted by the Meteorological and Hydrological Service of Croatia, the "Andrija Mohorovi" Geophysical Institute (University of Zagreb) and the Croatian Meteorological Society. ALADIN contributions are welcome !

Local Organizing Committee ICAM/MAP2005: e-mail: icam2005@cirus.dhz.hr

(lien à faire vers ICAM pdf)

1.2.5. LM Users seminar

The Deutscher Wetterdienst (DWD) will be holding a seminar on the design, products and operational use of the NWP model-chain of the DWD in Langen (Germany) from the 30th of May to the 3rd of June 2005.. Non-COSMO participants are also welcome.

Contact: Dr Wilfried Jacobs wilfried.jacobs@dwd.de

1.2.6. 3rd SRNWP workshop on "Statistical and Dynamical Adaptation"

To be held on June 1-3, 2005, in Vienna (Austria), at the Central Institute for Meteorology and Geodynamics (ZAMG).

As in previous years, presentations on all aspects of statistical and physical/dynamical adaptation in numerical weather prediction are welcome. Contributions about adaptation of EPS products, in particular with regard to extreme events, are particularly welcome.

A web page has been set up for the 3rd SRNWP Workshop on Statistical and Dynamical

Adaptation. Please visit http://www.zamg.ac.at/swsa2005/ You can use the on-line form to register, and to make a hotel reservation.

If you intend to give a presentation, send a short abstract to thomas.haiden@zamg.ac.at (until 31 March 2005).

For questions regarding accommodation please contact barbara.steiner@zamg.ac.at

1.2.7. 15th ALADIN workshop "QUO VADIS, ALADIN ?"

To be organized in June 6-10, 2005, in Bratislava (Slovakia), by SHMI (contact points : Maria Derkova and Michal Majek). Web site: www.shmu.sk. The workshop venue is the SUZA Congress Center (www.suza.sk).

The workshop is intended to review the current status and ongoing developments of mesoscale modelling and to enable the exchange of information and ideas inside the meteorological community. Those can cover wide range of research results in the fields of model dynamics, physics and data assimilation, including ensemble predictions. Contributions focussing on 2-3km target scales will be of particular interest. Presentations on local applications, technical and operational environment, verifications are also welcome. The poster session shall be devoted mainly to the status of your operational applications.

And, most important, this workshop should deliver the next medium-term research plan for ALADIN (2005-2008).

1.2.8. And next ...

- HIRLAM workshop on mesoscale modelling (physics mainly ?)
  September 2005 - Norway

- 27th EWGLAM & 12th SRNWP meetings
  3-6 October, 2005 – Ljubljana, Slovenia

- SRNWP workshop on non-hydrostatic modelling
  31 October - 2 November, 2005 - Bad Orb, Germany

- 10th Assembly of ALADIN partners
  October 21, 2005 - Bratislava, Slovakia

- HIRLAM-ALADIN working week on variational data assimilation ?
  An informal proposal from Per Unden ...

- Next ALADIN-HIRLAM training course
  November 2005 ? - Bucarest, Romania
  More details in the ALADIN-2 section

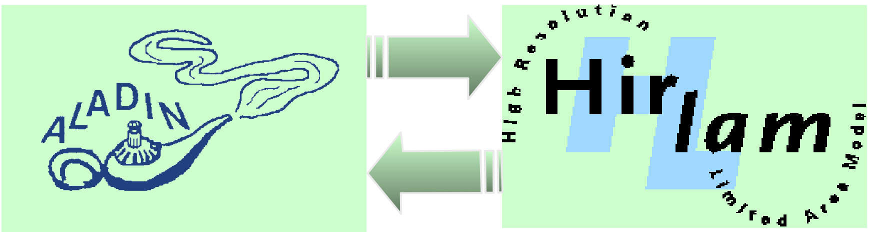
1.3. ALADIN 2

1.3.1. Introduction

This section is dedicated to the project's life. Up to now, contributions were only French ones, but this must change. So don't hesitate to send input next time !

1.3.2. A closer ALADIN-HIRLAM cooperation

The "code collaboration" between the ALADIN and HIRLAM consortia did start, officially and practically.



At the 9th Assembly of Partners (30-31 October), ALADIN directors welcomed the HIRLAM proposal, presented by the chairperson of the HIRLAM Advisory Committee and the Project Leader, of a closer "code" collaboration (i.e. towards the use of a common model allowing historical specificities for all operational applications). The following resolution was adopted, and presented to the HIRLAM Council on December 15th by Dr Ivan CACIC. HIRLAM directors gave a very positive answer.

Resolution on ALADIN-HIRLAM cooperation
Adopted by the ALADIN General Assembly on 30 October 2004

The ALADIN General Assembly, meeting in Split, Croatia, on 29-30 October 2004:

Considering the common goal of HIRLAM and ALADIN to develop, implement and maintain operational NWP systems at the meso-gamma scale, while maintaining state-of-the art meso-beta operational capabilities, based on their respective scientific, technical and managerial heritage;

Considering the proposal of the HIRLAM Council for cooperation with ALADIN, based on code collaboration and scientific exchange;

Noting that cooperation with HIRLAM should be consistent and compatible with the ALADIN high level objectives, strategy and short term plans, in particular the priority assigned to:

- the continuing development of a meso-beta model improving the current operational capabilities available to ALADIN partners, capitalising on the ALADIN scientific and technical heritage and new agreed concepts;
- its necessary and timely convergence with the parallel development of the AROME meso-gamma model, based on the ALADIN data assimilation and core dynamics, and the Meso-NH physics;

Stressing the importance of the guidelines for relations among National Meteorological or Hydrometeorological Services regarding commercial activities attached as Annex 2 to the WMO Resolution 40 (Cg XII), that aim at maintaining and strengthening in the public interest the cooperative and supportive relations among NMSs in the face of differing national approaches to the growth of commercial meteorological activities;

1- Welcomes the decision of the HIRLAM Council to explore full code cooperation with ALADIN and appreciates the relevance of the preparatory work performed by ALADIN and HIRLAM scientists;

2- Agrees that an efficient cooperation based on code collaboration, leading ultimately to a common library available for use by meso-beta and meso-gamma scale NWP models, would be beneficial to both HIRLAM and ALADIN, in particular, but not exclusively, in areas including the following:
   - Extended use of the ALADIN core dynamics;

- Data assimilation techniques and assimilation of high resolution, remotely sensed observations from radars, satellites, etc.;
- Limited area model ensemble prediction systems (LAMEPS);
- Mesoscale-oriented physics;
- Boundary conditions and coupling at high resolution;
- Training.

3- Considers that operational complexity needs to be minimised and efficiency maintained through the adoption of a common code maintenance approach based on best practices across the IFS/ARPEGE/ALADIN/HIRLAM chain, and taking into account the HIRLAM needs related to their near-real time Reference Control Run;

4- Agrees that efficient joint arrangements should be established without delay at science and project levels, aimed at defining consistent scientific strategies and short term work plans, including common elements to be agreed by HIRLAM and ALADIN;

5- Supports, and proposes to HIRLAM, the following approach:
- The ALADIN Committee for Scientific and Strategic Issues (CSSI) and the HIRLAM Management Group (HMG), should establish, on behalf of the ALADIN and HIRLAM scientists and relevant bodies, a joint science plan addressing common issues, that would become part of the respective ALADIN and HIRLAM science plans;
- The ALADIN Workshop and the HIRLAM All Staff Meeting should derive and propose a common annual work plan consistent with this joint science plan and with maintenance constraints, that would become part and parcel of their respective work plans;
- The HIRLAM and ALADIN/AROME project management should approve this common work plan, taking into account committed resources and agreed priorities, and capitalising on the work of the respective advisory bodies.
- This process should be consolidated by July 2005.

6- Agrees to further investigate the details of the cooperation, including political and legal aspects, in the context of the preparation of the next ALADIN and HIRLAM respective Memorandums of Understanding, with the objective of agreeing the articles permitting the HIRLAM-ALADIN cooperation.

7- Agrees in this regard that appropriate reference to the guidelines for relations among National Meteorological or Hydrometeorological and Meteorological Services (NMSs) regarding commercial activities, attached to the WMO Resolution 40 (Cg XII), should be included in the next ALADIN and HIRLAM MoUs.

8- Notwithstanding the above, concurs with the views of HIRLAM that, subject to appropriate cooperation agreements:
- Both consortia would share ownership for commonly developed code;
- Ownership of pre-existing codes would not be transferred;
- All members of each Consortium would have rights to use shared software/common libraries for their operational and research activities;
- All members of each Consortium would have rights to make available research versions of shared software to their national research communities, for exclusive research and education purposes.

9. Proposes that HIRLAM and ALADIN should have observer status at the ALADIN General Assembly and the HIRLAM Council, respectively, in order to facilitate communication and common understanding.

As concerns common actions, the following ones started along the last months, beside the

previous cooperations :
- training of the "mesoscale" group on ALADIN environment,
- implementation of the HIRALD setup at ECMWF and first experiments, with the help of the French team (see the dedicated paper),
- coupling HIRLAM physics with ALADIN dynamics, contribution to the discussions on the rules for physics-dynamics interfacing.

Cooperations on the following issues have also been or should be launched soon : use of frames, penta-diagonal semi-implicit operator, implementation of configurations 923 and 901 at ECMWF. They won't involve only the French team.

1.3.3. STORMNET

✗ Introduction

During the dedicated SRNWP session of the last annual EWGLAM/SRNWP meetings, it was decided to answer the first coming (deadline December 2nd, 2004) call for proposals of Research Training Networks within the Marie Curie actions of the 6th Framework Program of the EC. In case of failure, since this call was restricted to "Interdisciplinary and Intersectorial" projects, a second attempt should be possible, in September 2005.

Thanks to intense networking and the efficient help of the SRNWP coordinator, Jean Quiby, we managed to prepare everything in time. This proposal relies on the fruitful ALATNET experience, but with an enlarged basis : SRNWP cooperation, with 16 participants from all consortia, wider training and research program, and a more decentralized management.

Hereafter is the "identity card" of the project, more informations are available on the STORMNET web site : *http://www.cnrm.meteo.fr/stormnet/* , the first SPIP web site of Patricia Pottier. And thanks to Claude Fischer for the name !

✗ Description

Title : STORMNET (Scientific Training for Operations and Research in a Meteorological NETwork), a European training network for local short-range high-resolution numerical weather prediction and its applications

Short abstract :

European meteorological services now have to face the challenge of a quick march towards very high resolution applications for limited-area modelling and short-range prediction. Beside the research work specific to numerical weather prediction, the increased complexity of equations and the huge amount of data to handle at a reasonable cost will raise new problems in numerics and code organization. The positive feedback on downstream applications like hydrology or air-pollution modelling will have to be checked too. As experts are spread among many small teams, an enhanced transfer of knowledge through training actions is needed.

Full Partners :

Meteo-France / National Meteorological Research Centre,
Central Institut for Meteorology and Geodynamics (Austria),
Royal Meteorological Institute of Belgium,
Meteorological and Hydrological Service of the Republic of Croatia,
Czech Hydro-Meteorological Institute,
Finnish Meteorological Institute,
German Weather Service,
Hungarian Meteorological Service,
Irish Meteorological Service,
Royal Netherlands Meteorological Institute,
Norwegian Meteorological Institute,

National Meteorological Administration (Romania),
Slovak Hydro-Meteorological Institute,
Swedish Meteorological and Hydrological Institute,
Federal Office of Meteorology and Climatology (MeteoSwiss),
Met Office of United Kingdom.

Associated Partners :
University of Zagreb (Andrija Mohorovicic Geophysical Institute, Faculty of Science) (Hr),
National Scientific Research Centre (Laboratoire d' Aérologie, Observatoire Midi-Pyrénées) (Fr),
University College Dublin (Ir),
Comenius University (Faculty of Mathematics, Physics and Informatics, Department of Astronomy, Geophysics and Meteorology) (Sk),
Swiss Federal Institute of Technology Zurich (Institute of Geodesy and Photogrammetry) (Ch).

1.3.4. Coordination

✗ A second life for CSSI

The CSSI (Committee for Scientific and Strategic Issues) structure, a coordination team of 6 persons nominated by the Assembly of Partners (Doina Banciu, Radmila Brozkova, Luc Gérard, Dominique Giard, Andras Horanyi, Abdallah Mokssit), has been more or less shelved when launching the ALADIN-2 project.

Since HIRLAM is a very structured project, the Assembly of Partners decided to both push forward and renew CSSI, in order to make it a mirror of the HIRLAM Management Group. The composition was changed, to better take into account the contributions of the various partners : 2 LACE members, 2 French ones and 2 "non-LACE non-French" ones. Luc Gérard and Abdallah Mokssit resigned, while Margarida Belo Pereira and Gwenaëlle Hello entered the group. Andras Horanyi was proposed as chairperson by Directors, and the other members agreed.

However, one has to underline that this is a temporary organization, waiting for the new MoU. Proposals for a better coordination structure are welcome and should be addressed to Andras Horanyi, who represents scientists within the working group in charge of the new MoU.

✗ Coordination of operational activities

First let's recall that Maria Derkova (Mariska) is responsible for the coordination of the updates of operational suites, with the help of the Toulouse Support Team.

The first step, moving to the most recent export version (cycle 28T3), should be achieved soon (see the section on operations). Some further actions have already been identified :
- coordination around the conception of observation databases, with several partners willing to start data assimilation activities or to update the present tools; CHMI and HMS already provided informations on how to proceed; ANM, NIMH and DMN are likely to organize a working group with joint stays in Toulouse;
- many modifications in coupling files scheduled for summer 2005, with a coordinated operational change expected for September;
- jump to the externalized surface module in 2006.

1.3.5. The misfortunes of the ALARO-10 sub-project, arguments around the physics-dynamics interface, ...

As underlined in Oslo (in October), "this was a difficult year indeed", and the last months of 2004 were even worse, with sharp arguments and again a lack of visibility after re-re-formulations of objectives. The new targets are described in the mail sento all teams by Jean-François Geleyn on the 4th of February, 2005.

1.3.6. Communication problems, obviously

There were complains from ALADIN Partners about the multiple voices of Météo-France, and they were justified indeed, with a poor diffusion of information and significant disagreements within the French team, hence less attention paid to the Partners' opinions.

As an attempt to restart on safer bases, a meeting was organized in Toulouse on January 19th, 2005, with representatives of the various models used at Météo-France. Hereafter are the minutes, written by Jean Pailleux, who is now responsible for coordination at the CNRM level.

Météo-France meeting of 19 January 2005
on LAM NWP (ALADIN, ALARO, AROME, MESO-NH)

The meeting was organised by the Météo-France Research management in Toulouse, involving the Direction Générale in Paris (A. Ratier, C. Blondin) and the Forecasting service (E. LEGRAND). It was triggered by:

- the Prague workshop (22-26 November 2004) which failed to establish a satisfying work-plan, especially for the ALADIN-2 project, and especially in terms of physics-dynamics interface;
- several email exchanges taking place between the Prague workshop and the end of 2004, which were pointing to an insufficient level of coordination between the different LAM projects (ALARO, AROME, etc...) which have been all set up with heavy contraints on their time-tables.

Among the different weaknesses which were identified before and during this meeting, one is the fact that the ALARO prototype has been developed in 2004 in a software environment which is as close as possible to the AROME prototype. As this AROME software environment is a provisional one, which is not expected to converge to its final environment before 2008 (and is quite far from the operational environment which is familiar to the ALADIN world), this is a strong limitation for the scientists working on the ALADIN-2 who have to prepare ALARO runs.

Following a planning effort by Jean-François Geleyn just before the 19 January meeting, a list of critical scientific/technical tasks was identified in terms of work-streams (rather than in terms of ALARO project or AROME project). These tasks were then analysed in order to identify the minimum which needs to be achieved for the ALARO project and its time-table. The following points are coming out from the meeting:

- The intermediate calendar of ALARO is relaxed, i.e. no big phasing effort in 2005, but more preparation for a 2006 upgrade, to happen after the technical change to the externalised surface code and files, planned before mid-2006 (see specific plan by D. Giard, on the ALADIN web). For end 2006, the aim is now a first version of ALARO which would be an improved ALADIN, still preserving further "re-convergence" with AROME.
- A guess of the first version of the ALARO physics can be seen as follows: the use of a sophisticated micro-physics package is postponed and will be revisited in the context of the convection closure; the convection scheme is a modified version of ARPEGE/ALADIN; idem for the gravity wave drag; the radiation code is a simplified and cheap version of RRTM; use of the externalised surface (which is then the first technical jump to the ALARO code, before mid-2006). The new physical routines called in this context should be callable from the Meso-NH side as well as the ALARO side (so-called "symmetric compatibility"). This first version of the ALARO physics is based on pragmatic considerations which have nothing to do with the quality of existing models, or the performance of Meso-NH physics at 10km.
- Most of the coordination problems between ALARO and AROME are now concentrated in the routine APLAROME calling both the AROME and ALARO parameterization routines (APLAROME routine renamed APLXX – see separate short-term plan written by François Bouttier on the ALADIN web).

- Some rules on the evolution of the Meso-NH code have now been suggested (document by François Bouttier– see ALADIN web). They are of the same type as the rules used for years in IFS – ARPEGE – ALADIN. They should be the guarantee that each LAM project can rely on all the other projects in terms of code, in a way which is flexible enough. Each project is expected to benefit from all the others in a symmetric way.
- The "generalised interface of interfaces" is not cancelled, but in its more ambitious form it is postponed , say beyond 2008. It is currently not compatible with the ALARO and AROME calendars, although it is potentially a very powerful tool for research in NWP and climate modelling.

1.3.7. Fourth medium-term research plan

We have now to build the fourth ALADIN medium-term research plan, for years 2005-2008. The third one was valid till end 2004 only, though prolongated for 6 months by a provisional work plan. The target is to build a first draft with contributions from all partners before the next ALADIN workshop (June), then discuss and finalize it there. Common issues with the parallel HIRLAM research plan will be identified during a preliminary CSSI-HMG meeting on Sunday just before the workshop.

A convivial web site for the preparation of the research plan was created by Patricia Pottier :
http://www.cnrm.meteo.fr/aladin/wp2005-2008/

So, please :
- do have a look at the site !
- do contribute to discussions !
- do travel to Bratislava in June (financial support is available) !

1.3.8. Support

✗ Next ALADIN training course

Considering the needs expressed by the ALADIN teams (all answered !) and the candidacies, it was decided to organize an ALADIN-HIRLAM training course :
- in Bucarest (in the brand new school),
- at the end of 2005, November as far as possible, because of the numerous meetings before,
- on the following topics : Meso-NH physics, running the AROME prototype, use of NH dynamics.

✗ Documentation

The most recent version of ARPEGE-ALADIN documentation is now available via the ALADIN web site. The next step is the definition of a web site dedicated to documentation. Patricia Pottier and Jean-Marc Audoin are in charge of it in Toulouse.

✗ MAE supported projects : AMADEUS, ECONET-SELAM

A proposal for bilateral cooperation between Austria and France (AMADEUS) for 2005-2006 was accepted. Coordinators : Eric Bazile and Yong Wang.

A proposal for support to a network involving Bulgaria, Romania, Macedonia, Moldavia, and France, for 2005-2006, was submitted in December. Two main issues are considered : training and design of observation databases. It was not accepted, unluckily (around 200 proposals were submitted).

✗ Météo-France financial support

Support to participation to workshops ("KIT") is available for 2005, as last year. Hoping there will be less problems !

Support to stays in Toulouse, mainly for maintenance and training actions, was accepted for the same amount as last year.

1.4. GOSSIP

Practical English	**Le français Pratique**
To carry a torch for someone	Avoir un faible pour quelqu'un
To get on like a house on fire	S'entendre à merveille
To look daggers at someone	Foudroyer quelqu'un du regard
To let one's hair down	Se détendre
To paint the town red	Faire la fête
To be out on the tiles	Sortir faire la bringue
To be on cloud nine	Être aux anges
To be down in the mouth	Être déprimé
To be in the doldrums	Avoir le moral à zéro
To go off at the deep end	Piquer une crise
To go ballistic	Piquer une crise
To be at the end of one's tether	Être à bout
To be like a bear with a sore head	Être d'humeur massacrante
To haul someone over the coals	Démolir quelqu'un en le critiquant
The pot calling the kettle back	L'hôpital qui se moque de la charité
To pick holes in something	Relever des erreurs dans quelque chose
To get a rollicking	Se faire engueuler
To have someone's guts for garters	Massacrer quelqu'un
To brick it	Avoir les jetons
To get the wind up	Avoir une peur bleue
To be in bed with someone	Être allié avec quelqu'un de façon officieuse
To stick one's oar in	Mettre son grain de sel
To sell someone down the river	Trahir/vendre quelqu'un
To be long in the tooth	Ne plus être tout jeune
To be up the pole	Être timbré
To bend over backward	Se mettre en quatre
To give someone a leg up	Donner un coup de pouce à quelqu'un
To pull somebody's leg	Faire marcher quelqu'un
To look like death warmed up	Avoir une mine de déterré
To laugh all the way to the bank	S'en mettre plain les poches
To cost an arm and a leg	Coûter les yeux de la tête
To push the boat out	Ne pas regarder à la dépense
To go Dutch	Payer chacun sa part
To take someone to the cleaners	Plumer quelqu'un
To wet one's whistle	Se rincer le gosier
On a wing and a prayer	Dieu sait comment
To go out on a limb	Prendre des risques
To be in a rut	Être enlisé dans la routine
It's a different kettle of fish	C'est une autre affaire
To be like chalk and cheese	C'est le jour et la nuit
The penny's dropped	Çà y est! J'ai compris
To put out feelers	Tâter le terrain
To hear something on the grapevine	Apprendre quelque chose par le téléphone arabe
To hear something from the horse's mouth	Apprendre quelque chose de source sûre
To grasp the nettle	Prendre le taureau par les cornes
To shoot the breeze	Bavarder
To bend someone's ear	Pomper l'air à quelqu'un

To talk through one's hat	Parler à tord et à travers
To be all mouth and no trousers	Être une grande gueule
To bust a gut	Se donner un mal de chien
To go through the mill	En baver
A hard nut to crack	Un problème difficile à résoudre
A hot potato	Un sujet délicat
To play the field	Papillonner
To have been left on the shelf	En passe de devenir vieille fille
To go up the wall	Se fâcher tout rouge

Some books I read and what I thought of them.

The diary of Thomas Turner 1754-1765: edited by David Vaisey.

This diary chronicles the daily life of a Sussex shopkeeper in mid-eighteenth century. It begin in 1754 , Thomas Turner then aged 25, and end on the eve of his second marriage. Besides being a multipurpose shopkeeper, Thomas Turner was also a pillar of the community for, for many years, he was either parish officer, churchwarden, overseer of the poor, surveyor of the highway or collector of the window and land taxes.

Well written, it is worth reading as it gives an inside glimpse of the life of ordinary men and women, the hardship for a shopkeeper to get its money, the trading practices of the time, the after Christmas revelling, eating and much drinking, quarrelling with an obstreperous wife and mother in law, and much more besides, in short with life and death.

The Wench is dead :Colin DEXTER

A century old whodunit brilliantly solved by bed ridden Chief Inspector Morse recovering at the JR2 from a perforated ulcer and amid tantalizing nurses and for a one night bed fellow Lowland Sister.

Morse suspects foul play, when, back in the 1850s, three boat men are convicted then hanged for the murder of Joanna Frank, despite their claim to innocence. After much thinking and a nil by mouth diet, Morse proceeds to unravel the swindle enacted by Joanna Frank and her con-man husband.

Julia de Roubigné: Henry McKenzie

Julia and destitute Savillon are brought up together by Julia's parents, and, years later and unknown to each other, they fall in love. Then, Savillon leaves France for Martinique to join a rich childless relative.

In the meantime, Julia's father goes near bankrupt and unexpectedly, Julia's mother dies. Julia's is compelled to marry M. Montauban, a rich neighbour who paid the young woman's haughty father's debts. Lack of communication between husband and wife together with Julia's sentimentality daydreaming about her faraway bosom friend leads to sudden jealousy from Montauban deludes himself of being wronged and then proceeds to poison his young wife and to commit suicide

This epistolary novel, written by the the author of the most famed *Man of feeling* is more concerned with the unruly feelings of the protagonists than with plot. Best left to oblivion, though, one will find a nice passage against slavery, well in advance of its time. In a way, Julia de Roubigné prefigures the novels of, say, Henry James.

The diary of a Cotswold Parson

A biased selection of what must have otherwise been an interesting account of early nineteenth century life. To be read by those interested by landscape, countryside and architecture, otherwise, can be happily discarded.

Lor' luv a duck!

2. OPERATIONS

2.1. An overview of operational ALADIN applications January 2005

2.1.1. Model characteristics

Partner *Model*	Δx (km)	L	Δt (s)	Gridpoints C+I / C+I+E	Grid type	SW corner (lat , lon)	NE corner (lat , lon)	Coupling model
AUSTRIA	9.6	45	415	289 × 259 300 × 270	quadratic	33.99*N*, 2.17*E*	55.62*N*, 39.07*E*	ARPEGE
BELGIUM *BE*	7.0	41	300	229 × 229 240 × 240	linear	43.17*N*, 5.84*W*	57.25*N*, 17.08*E*	ALADIN- FRANCE ARPEGE
BULGARIA *BG*	12.0	41	514	79 × 63 90 × 72	quadratic	39.79*N*, 20.01*E*	46.41*N*, 31.64*E*	ARPEGE
CROATIA *LACE*	12.2	37	514	229 × 205 240 × 216	quadratic	33.99*N*, 2.18*E*	55.62*N*, 39.08*E*	ARPEGE
CROATIA *HRn8*	8.0	37	327	169 × 149 180 × 160	quadratic	39.00*N*, 5.25*E*	49.57*N*, 22.30*E*	ALADIN-LACE
CROATIA *Dyn Adap (6)*	*2.0*	*15*	*60*	*72 × 72* *80 × 80*	*Senj, Karlovac, Maslenica, Split, Dubrovnik, Osijek*			*ALADIN-HRn8*
CZECH R. *CE*	9.0	43	360	309 × 277 320 × 288	linear	33.99*N*, 2.18*E*	55.62*N*, 39.08*E*	ARPEGE
FRANCE	9.5	41	415	289 × 289 300 × 300	linear	33.14*N*, 11.84*W*	56.96*N*, 25.07*E*	ARPEGE
HUNGARY *HU*	6.5	37	270	421 × 373 432 × 384	quadratic	34.15*N*, 2.35*E*	55.3*N*, 38.7*E*	ARPEGE
HUNGARY *Dyn Adap*	*2.4*	*15*		*239 × 169* *250 × 180*				*ALADIN-HU*
MOROCCO *NORAF*	31	37	900	189 × 289 200 × 300	quadratic	1.93S, 35.35*W*	44.86*N*, 57.22*E*	ARPEGE
MOROCCO *ALBACHIR*	16.7	37	675	169 × 169 180 × 180	quadratic	18.13*N*, 19.99*W*	43.11*N*, 9.98*E*	ALADIN-NORAF
POLAND	13.5	31		169 × 169 180 × 180	quadratic	41.42*N*, 5.56*E*	61.16*N*, 40.19*E*	ARPEGE
PORTUGAL	12.7	31	600	79 × 89 90 × 100	quadratic	34.94*N*, 12.42*W*	44.97*N*, 0.71*W*	ARPEGE
ROMANIA	10.0	41		89 × 89 100 × 100	quadratic	41.91*N*, 20.68*E*	49.80*N*, 32.12*E*	ARPEGE
ROMANIA *Dyn Adap (2)*	*2.5*	*26*	*60*	*89 × 109 / 100 × 120* *89 × 89 / 100 × 100*		*43.47N, 27.88E* *44.50N, 23.61E*	*45.90N, 30.67E* *46.48N, 26.43E*	*ALADIN-Romania*
SLOVAKIA *SHMU*	9.0	37	400	309 × 277 320 × 288	quadratic	33.99*N*, 2.19*E*	55.63*N*, 39.06*E*	ARPEGE
SLOVENIA *SI*	9.5	37	400	258 × 244 270 × 256	quadratic	34.00*N*, 2.18*E*	54.82*N*, 33.37*E*	ARPEGE
SLOVENIA *Dyn Adap*	*2.5*	*17*	*60*	*148 × 108* *160 × 120*	*44.57 N, 12.18 E – 46.98N, 16.92E*			*ALADIN-SI*
TUNISIA	12.5	41	568	117 × 151 120 × 162	quadratic	27.42*N*, 2.09*E*	44.16*N*, 18.37*E*	ARPEGE

2.1.2. Practical implementation

Partner / *Model*	Computer / Proc.	Library	Forecast/ Coupling	Other applications
AUSTRIA	SGI Origin 3400 28	AL25T2	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h
BELGIUM *BE*	SGI Origin 3400 16	AL25T2	• 60h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h
BULGARIA *BG*	LINUX PC 2	AL25T1	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 3h
CROATIA *LACE*	SGI Origin 3400 16	AL25T1	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 3h
CROATIA *HRn8*	SGI Origin 3400 16	AL25T1	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 3h • dynamical adaptation of wind
CZECH R. *CE*	NEC SX6B 4	AL25T1	• 54h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h • hourly diagnostic analyses • dfi-blending
FRANCE	VPP 5000 2	AL28T2	• 4 or 5 forecasts a day, up to 54 h max. • synchronous 3h-coupling	• post-processing every 1h • coupling files every 3 hours • hourly diagnostic analyses
HUNGARY *HU*	IBM p655 32	AL15	• 48h forecast once a day • synchronous 3h-coupling	• post-processing every 1h • hourly diagnostic analyses • dynamical adaptation of wind
MOROCCO *NORAF*	IBM RS6000 SP	AL25T1	• 72h forecast twice a day • lagged 6h-coupling	• post-processing every 6h
MOROCCO *ALBACHIR*	IBM RS6000 SP	AL25T1	• 72h forecast twice a day • synchronous 3h-coupling	• post-processing every 3h
POLAND	SGI Origin 2000 8	AL15	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 3h
PORTUGAL	DEC Alpha XP1000	AL12	• 48h forecast twice a day • synchronous 6h-coupling	• post-processing every 1h
ROMANIA	SUN Ent. 4500	AL15	• 48h forecast twice a day • synchronous 6h-coupling	• post-processsing every 3h • dynamical adaptation of wind
SLOVAKIA *SHMU*	IBM p690 32	AL25T2	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h
SLOVENIA *SI*	LINUX Cluster 22	AL25T1	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 1h • dynamical adaptation of wind & precipitations
TUNISIA	IBM p690	AL26T1	• 48h forecast twice a day • synchronous 3h-coupling	• post-processing every 3h

2.1.3. Porting new versions

Most teams have started or are now starting to update their operational libraries, moving to cycles 28T1 or 28T3. Here is the present status.

Let's recall that useful informations are available in the previous Newsletter and in the mail sent par Maria Derkova on December 1st.

<table>
<tr><td>Partner</td><td colspan="2">AL28T1</td><td colspan="2">AL28T3</td></tr>
<tr><td>Austria</td><td colspan="2">ported</td><td colspan="2"></td></tr>
<tr><td>Belgium</td><td colspan="2">ported</td><td colspan="2">pre-operational validation</td></tr>
<tr><td>Bulgaria</td><td colspan="2">ported</td><td colspan="2">ported</td></tr>
<tr><td>Croatia</td><td colspan="4">both ported, but the availability and the cost of Prague's physics may prevent from an upgrade of operations</td></tr>
<tr><td>Czech R.</td><td colspan="2">ported</td><td colspan="2">pre-operational validation</td></tr>
<tr><td>France</td><td>ported</td><td colspan="2">28T2 operational</td><td>ported</td></tr>
<tr><td>Hungary</td><td colspan="2">ported</td><td colspan="2"></td></tr>
<tr><td>Morocco</td><td colspan="2"></td><td colspan="2">pre-operational validation</td></tr>
<tr><td>Poland</td><td colspan="2"></td><td colspan="2">should start in March
(once more CPUs available)</td></tr>
<tr><td>Portugal</td><td colspan="2">no</td><td colspan="2">no</td></tr>
<tr><td>Romania</td><td colspan="2">ported</td><td colspan="2">pre-operational validation</td></tr>
<tr><td>Slovakia</td><td colspan="2">ported</td><td colspan="2">pre-operational validation</td></tr>
<tr><td>Slovenia</td><td colspan="2"></td><td colspan="2">ported (or nearly)</td></tr>
<tr><td>Tunisia</td><td colspan="2"></td><td colspan="2">ported</td></tr>
</table>

2.1.4. Conclusion

These tables are temporary ones, since significant changes in operations are scheduled for the next months by many partners. More details hereafter !

2.2. Changes in the Operational Version of ARPEGE

2.2.1. October, 19th: Observations & Physics & Assimilation changes

The following changes reported in ALADIN Newsletter 26 are recalled below:

- New library CY28 T2
- New satellite observations:
  AMSU-B from Exeter
  Surface winds measured by the Seawind instrument of Quikscat
  ATOVS data from Lannion (Météo-France) (HIRS, AMSU A and B)
- New balance equations for Jb to take into account the ageostrophic motions
- Variational quality control
- New climatology for aerosols and ozone fields used by the radiation scheme
- Tuning of a Rayleigh damping coefficient on temperature in the 2 uppermost levels
- Reduction of 25 % of the thermal inertia for vegetation amplifying the temperature diurnal cycle

These modifications have been tested against the operational ARPEGE version during 73 days and the new version present improved results (see Figure 1) for practically all the meteorological parameters.

The subjective evaluation of both forecasts every day during more than 2 months has revealed that the improvement of this new version is visible for a forecaster after 72 hours with about the double of better forecasts than worse forecast for all the cases where differences existed.

It is hoped that this new version will provide better initial conditions and lateral boundary conditions for all the ALADIN LAM nested in ARPEGE.

2.2.2. Winter new version: modification of the mixing lengths of the turbulence scheme

A new formulation of the mixing length has been proposed by E. Bazile (Météo-France) and has been tested against the GABL data set (the presentation is on the following web site *http://www.cnrm.meteo.fr/ama2004/*) and is being tested during this winter.

2.2.3. Towards a new ARPEGE schedule: objective and intermediate steps

The current ARPEGE schedule, which drives the LBC provision for all partners including France, has been constant since 1994 for the 00 and 12 UTC runs. At that time the ARPEGE assimilation scheme was Optimal Interpolation, with very limited capacities for ingesting satellite data, and therefore very little impact of waiting for this data before starting the analysis.

The current schedule is not well adapted to the internal needs of Météo-France. As often in meteorology, the most crucial issue is the availability in the early morning. The current scheme is not so bad in wintertime, but since it is constant in UTC time while our users, and therefore our whole production, are based on local time, the summertime period is more problematic.

As presented in the 2003 Assembly of ALADIN Partners in Krakow, we have the "final" objective of having an ARPEGE suite that is constant in local time (or that we keep in UTC but change by 1 hour twice a year to mimic a constancy in local time), covering at least:

- night run : Day D0 and D1 at 3h30
- morning run : until D3 at 7h or 7h30
- noon run : until D1 at 13h30
- evening run : until the current D2 (the future D1) at 19h or 19h30.

The runs are intentionally not referred by a classical UTC stamp, the assimilation schemes allowing for possibilities largely exceeding our current classical 6-hour windows.

For a series of reasons, the final objective cannot be met at one go. A first intermediate step was made last summer, with an additional preliminary ARPEGE run on 00 UTC with a 1 h cut-off, providing outputs shortly after 3h30 (by 3h45 actually); this run known as "PACOURT" ended when going back to wintertime end October 2004. For the summer 2005 the first goal is to have an optimised PACOURT. Gérald Desroziers at GMAP tested various configurations, including extended 4D-Var windows like [15 UTC - 01 UTC]. Finally, because the main issue related to PACOURT is the ability to capture or not a minimum of the 00 UTC radiosondes that arrive late in summer, the most promising candidate for 2005 is not such an extended 4D-Var, but a cheaper 3D-Var FGAT, allowing to wait a little longer for observations. The next steps will come later in the summer, when we'll try to slightly delay the other runs in order to get closer to the final objective : the classical 00 UTC run becomes the morning run, the 06 UTC; then we'll have to consider the possible merge of the current 12 and 18 UTC runs into a single one, leading to a scheme with 4 daily runs again after a transitional period with 5 daily runs.

It's difficult to give a precise timetable for all the steps, because the related potential problems have a huge variety and sometimes complexity. In fact part of our suite and of the tools that use it have been built, year after year, under the unconscious assumption that the ARPEGE schedule was frozen forever. So things are not as easy to move as it could look from outside. Anyway, the new PACOURT will be installed in March (the summertime period starting end of March), but the next steps are by any mean not expected before June. It is even likely that we won't be able to finalise the whole process in 2005. Further news later this year.

For the ALADIN partners, in order to smooth the transition to the new ARPEGE schedule, several actions can be taken. First LBCs can be produced if requested on the current 06 and 18 UTC runs. Some partners already use this facility which makes available, at any moment, a reasonably fresh set of LBCs (while using only the 00 and 12 UTC runs obviously leads to larger gaps). Then it can be considered at some stage this summer to also produce LBCs on the PACOURT run. Eventually the local ALADIN data assimilation offers to each partner separately a way to adapt his own NWP schedule to his own needs, the large-scale information provided by ARPEGE at least 4 times a day keeping a good quality and the locally analysed fine scale bringing the last moment details.

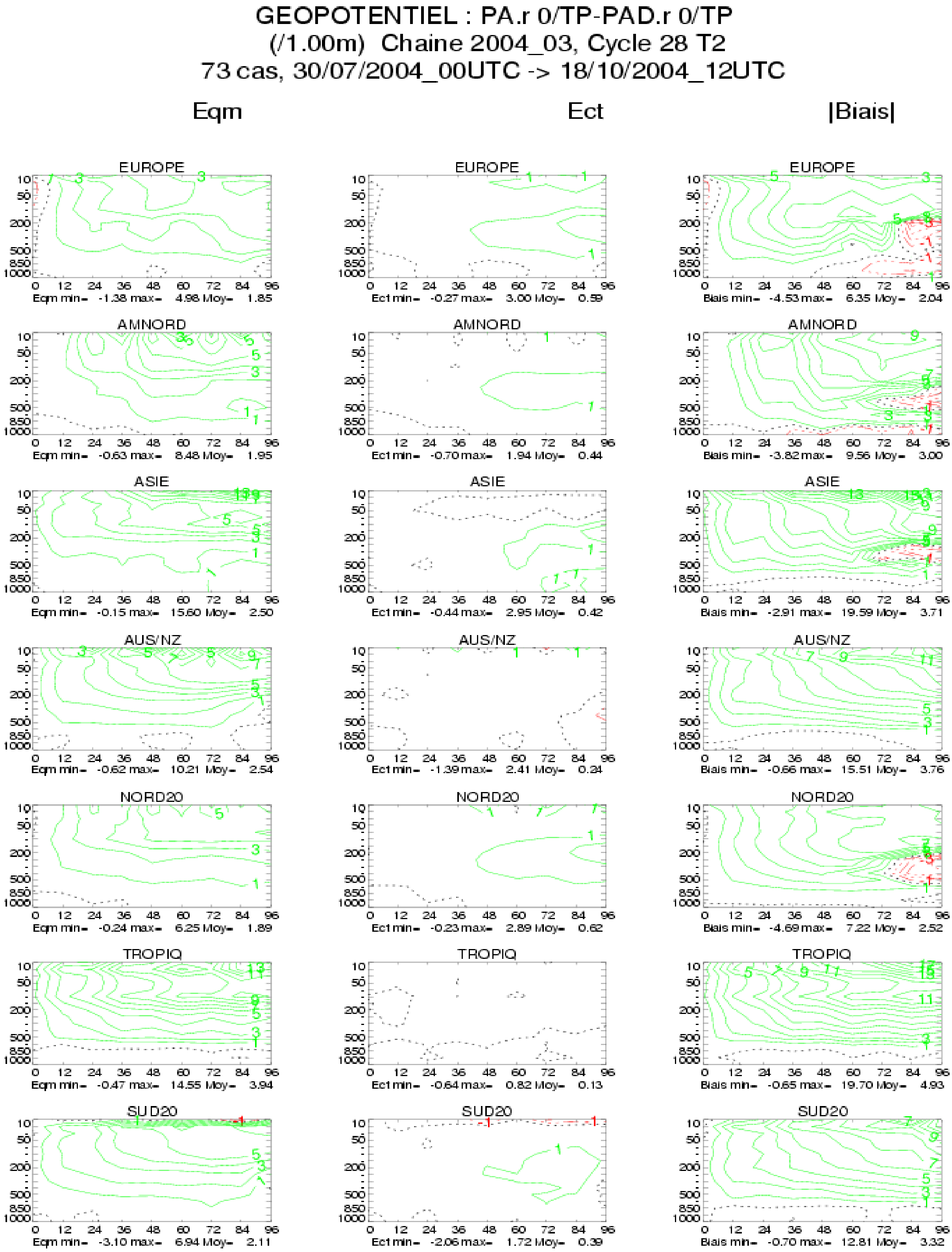


Fig. 1: Comparison of the operational forecast and the new version against the TEMP observations. The isolines of the geopotential are plotted every meter. The green isolines correspond to an improvement and red ones to a deterioration.

2.3. AUSTRIA *(more details thomas.haiden@zamg.ac.at)*

There have been no changes in the operational ALADIN system (CY25) at ZAMG since the last Newsletter.

2.4. BELGIUM *(more details olivier.latinne@oma.be)*

For the operational aspects of ALADIN forecasts, these last months, we have encountered many problems with our SGI ORIGIN 3400 system. Under some specific circumstances, when running ALADIN, a general crash of the machine occurs. This very tricky bug is located in the general SGI-*IRIX* kernel and seems related to the "large page" option which allows to accelerate ALADIN execution by about 15 %. Up to 12 kernel-cores have been made with a close SGI collaboration, without successfully pinpoint the exact problem.

We also plan to switch to cycle 28T3 soon, in March 2005.

2.5. BULGARIA *(more details andrey.bogatchev@meteo.bg)*

No change along the last months, upgrade scheduled for spring 2005.

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

2.6.1. Introduction

There were no important changes in the Croatian operational ALADIN suite. Operational version is still based on AL25T1_op2. More details in Newsletter 26.

Model versions 28T1 and 28T3 were not ported on SGI.

Prague physics package + SLHD was ported in Zagreb. Configuration 001 is ~75 % more expensive in time consumption and ~50 % for memory consumption, what is significantly more than on Prague SX6. At the moment we are not sure what is the reason for such a big difference in time and memory consumption.

Results for one of the performed tests for a "fog and stratus" case is shown below.

2.6.2. Test of new Czech setup

First tests are very promising for the studied "fog and stratus" case.

Example of verification plots for two points (one in inland, Zagreb-Pleso, and one on seaside, Dubrovnik-Aerodrom) for the 14th of December, 2004, start at 00 UTC, are presented hereafter.

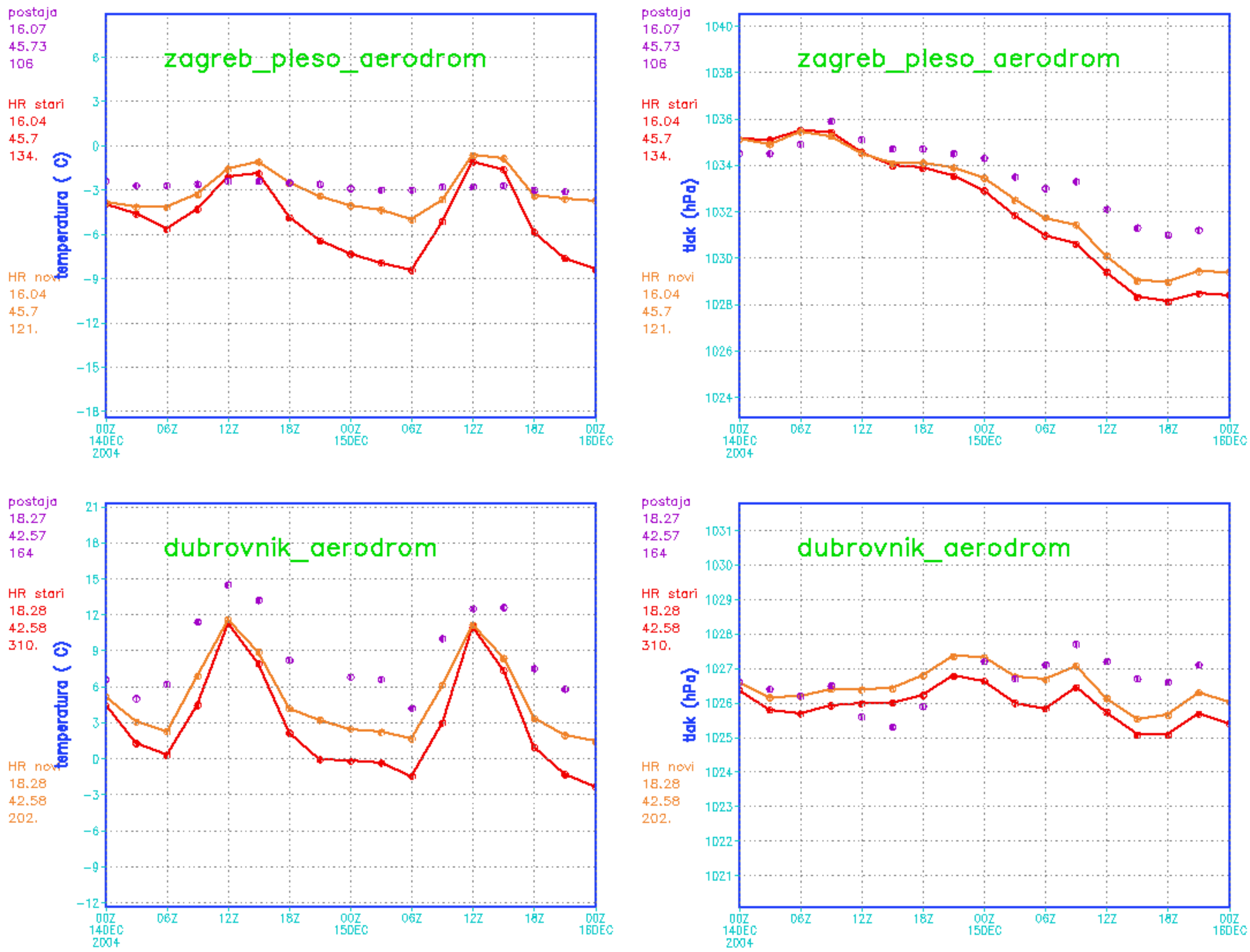


Fig.1 Comparison of old set-up (red), new Czech set-up (orange) and SYNOP data (violet points)

The amplitude of the error on 2-m temperature is significantly reduced for station Zagreb-Pleso and results for sea-side station are better too.

There is a problem in anticyclonic situations, the model has a tendency to reduce the high pressure. Even for this problem the new setup gives better results. Higher SIPR (semi-implicit reference pressure) further improves the result but does not cure it completely.

More case studies are under way. Reduction of time and memory consumption or upgrade of the computer is needed to put the new Czech setup in operational suite.

2.7. CZECH REPUBLIC *(more details filip.vana@chmi.cz)*

2.7.1. Operations

✗ **The ALADIN/CE suite was switched to mean orography and modified physics on:**

07/09/2004 at 12 UTC network time for the production run and at 06 UTC network time for the assimilation cycle.

The corresponding parallel test has the identification name ADN. Here below is the full modset description (roughly in decreasing order of importance):

I) Activation of the SLHD option for the horizontal diffusion processes. Most but not all of the current linear spectral horizontal diffusion process is replaced by a modulation of the strength of the damping properties of the semi-Lagrangian scheme, via the choice of the interpolation operators. The important fact is that this modulation is depending on the deformation field. This helps avoiding false small-scale developments and better structuring rightly forecast ones. There is also a positive impact on the upper-air temperature scores.

II) Use of the new version of ACRANEB (quality equivalent for the atmospheric part to that of FMR15, but without need to have an intermittent calling sequence) with all its novelties (LRMIX=.TRUE., LRPROX=.TRUE., LRSTAB=.TRUE., LRTDL=.TRUE. and LRTPP=.TRUE. with LRAUTOEV=.FALSE. and LREWS=.TRUE.).

III) Use of the random/maximum overlap for clouds instead of the random overlap (LRNUMX=.TRUE.). This change, together with the one above and the one below, brings a small but systematically positive contribution to all kinds of scores.

IV) New "mixed" version of the Xu-Randall cloudiness scheme: one comes back to the published tuning of the X-R function (QXRAL=100.), the critical humidity (HUC) profile is computed in APLPAR with a slightly different formula (3 coefficients rather than 2) and a tuning that matches the ZAMG proposal for quite lower values away from the PBL, QSSUSV is equal to 250 and a continuous function with an intercept at 0.925 replaces the QXRHX=0.99 threshold, this difference compensating the effect of the HUC decrease. All these changes roughly keep the same averaged structure of cloudiness (in mid-latitudes) but with a far less 0/1 behaviour and a slightly better vertical distribution.

V) Suppression of the envelope orography and introduction of the new drag/lift scheme with the recommended values (LNEWD=.TRUE., LGLT=.TRUE., GWDSE=0.02, GWDCD=5.4, GWDLT=1., GWDPROF=1., GWDVALI=0.5, GWDAMP, GWDBC and HOBST remaining unchanged). The pluses (better circulations and reduction of the precipitation dipole of errors, better scores at 850 hPa) and minuses (too weak 10 m winds near mountains and too strong reduction of Foehn effects, hence worse scores at the surface) of this change roughly compensate each other.

VI) Activation of the "moist gustiness" option (LRGUST=.TRUE. with RRSCALE=1.15E-04, RRGAMMA=0.8 and UTILGUST=0.125).

VII) Computation, over sea, of a roughness length for heat and moisture that, while remaining close to the one for momentum at small surface wind values, saturates far earlier for strong winds. The latter two points help getting a better simulation of the famous "Black-Sea" case.

VIII) REVGSL=15 to damp fibrillations around 0°C while keeping a still physically realistic value for this parameter (ratio of the fall speeds of rain and snow).

IX) Quasi-monotonous interpolation for specific humidity only.

X) RCIN=1 in order to prevent one convective cloud low down to un-physically trigger another one higher up across some rather deep stable and/or dry layer (and the same upside down in ACCVIMPD).

XI) A different security tuning from the ARPEGE one for the "King-Kong-butterfly" syndrome: GCSMIN=5.5E-04.

XII) Mesospheric drag like in ARPEGE.

The above mentioned set of modifications is a synthesis of the work of many people inside the ALADIN project. The decision on the operational switch was a trade off between better (PBL top temperatures, precipitations) and worse scores (bias of screen-level temperature and wind). Better results prevailed, however, as well as the conscience that where the worsening of results occurred, we very likely have to do with a case of compensating errors. That is why we shall concentrate within the forthcoming months on the screen level values of wind and temperature.

✗ **The ALADIN/CE suite was switched to the new modification concerning the inversion-layer clouds on:**

20/10/2004 at 12 UTC network time for the production run and at 06 UTC network time for the assimilation cycle.

The corresponding parallel test has the identification name ADP. This modification entered the operational suite just at the beginning of the stratus season, so typical for Central Europe. It is based on the previous work of Harald Seidl and Alexander Kann. It is however a bit algorithmically improved: when a sufficiently thick inversion layer is detected, its temperature is cooled in some proportion of its vertical temperature gradient in order to re-compute the saturation profile used by the cloudiness scheme.

For the time being, there are two tuning parameters. The first one, `RPHIR`, is a minimum thickness of the inversion layer for which the scheme is activated. It was tuned to 1750 J/kg (app. 175 meters). The second one, `RPHI0`, is the length scale for the temperature vertical change to achieve the desired cooling. It was tuned to 1250 J/kg. Tuning was made for the November 2003 period where we had a couple of situations with stratus, where the reference forecast missed low-level clouds (Figure 1) compared to observations (Figure 3). We could observe a weak improvement not only regarding the amount of low-level clouds (Figure 2) but also in temperature scores. Since the scheme has a positive local feedback between cloud and inversion strength we verified that we do not obtain an excessive amount of clouds.

However it should be stressed out that this is not a final solution to the low-level clouds simulation problem. It is simply the first step in a good direction and already helpful in the operational forecast.

At the same time a new diagnostic PBL height (development of Martina Tudor) was put in service, after a set of off-line tests.

✗ **The ALADIN/CE suite forecast length was increased up to 54h on:**

07/12/2004 at 12 UTC network time for the production run.

This was enabled by the availability of the ARPEGE coupling files for +51h and +54h from 06/12/2004.

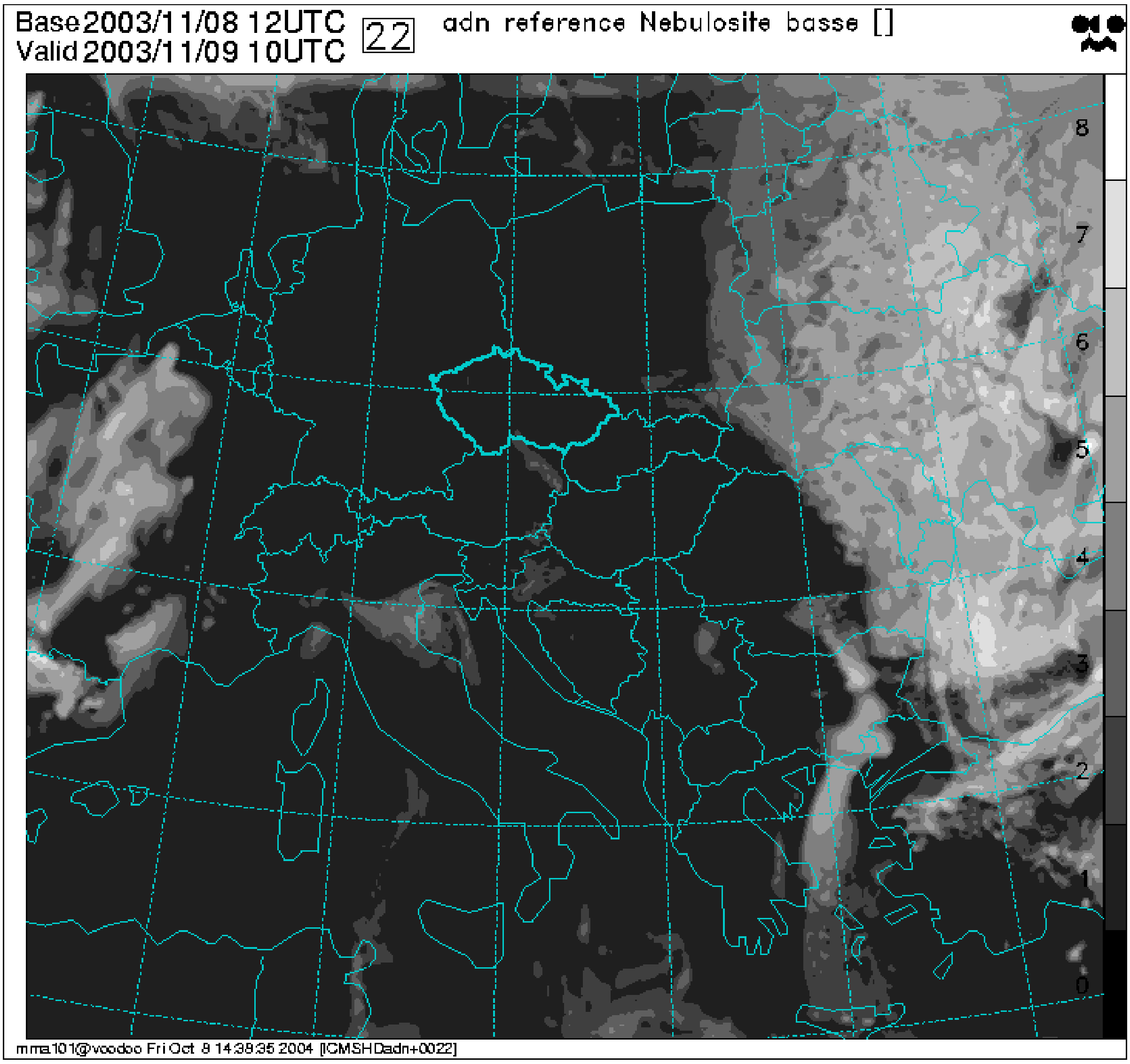


Fig. 1: 22h ALADIN/CE reference forecast of low-level clouds for 9 November 2003 at 10 UT.

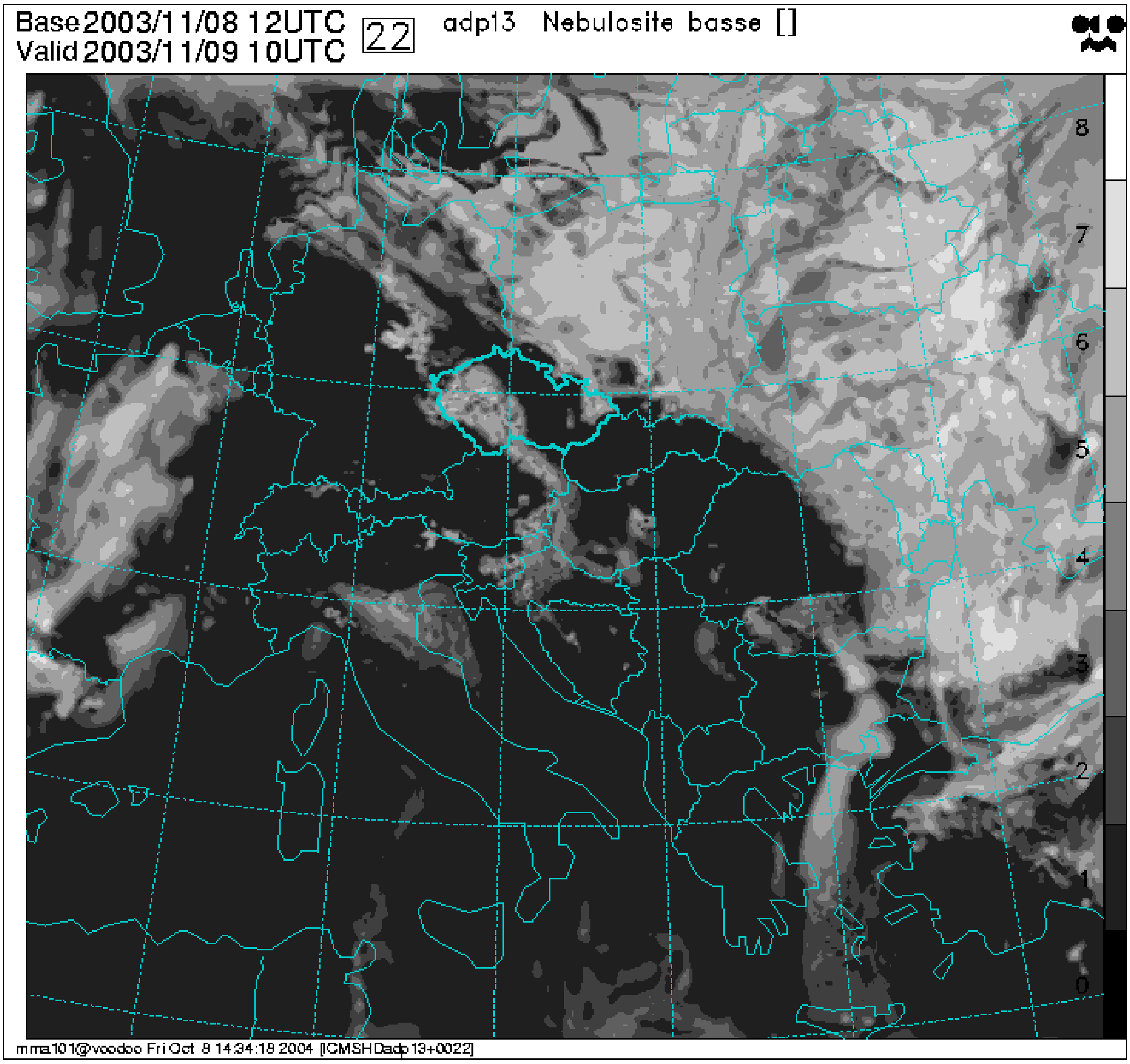


Fig. 2: 22h ALADIN/CE parallel test forecast of low-level clouds for 9 November 2003 at 10 UT, including new modification to simulate inversion clouds.

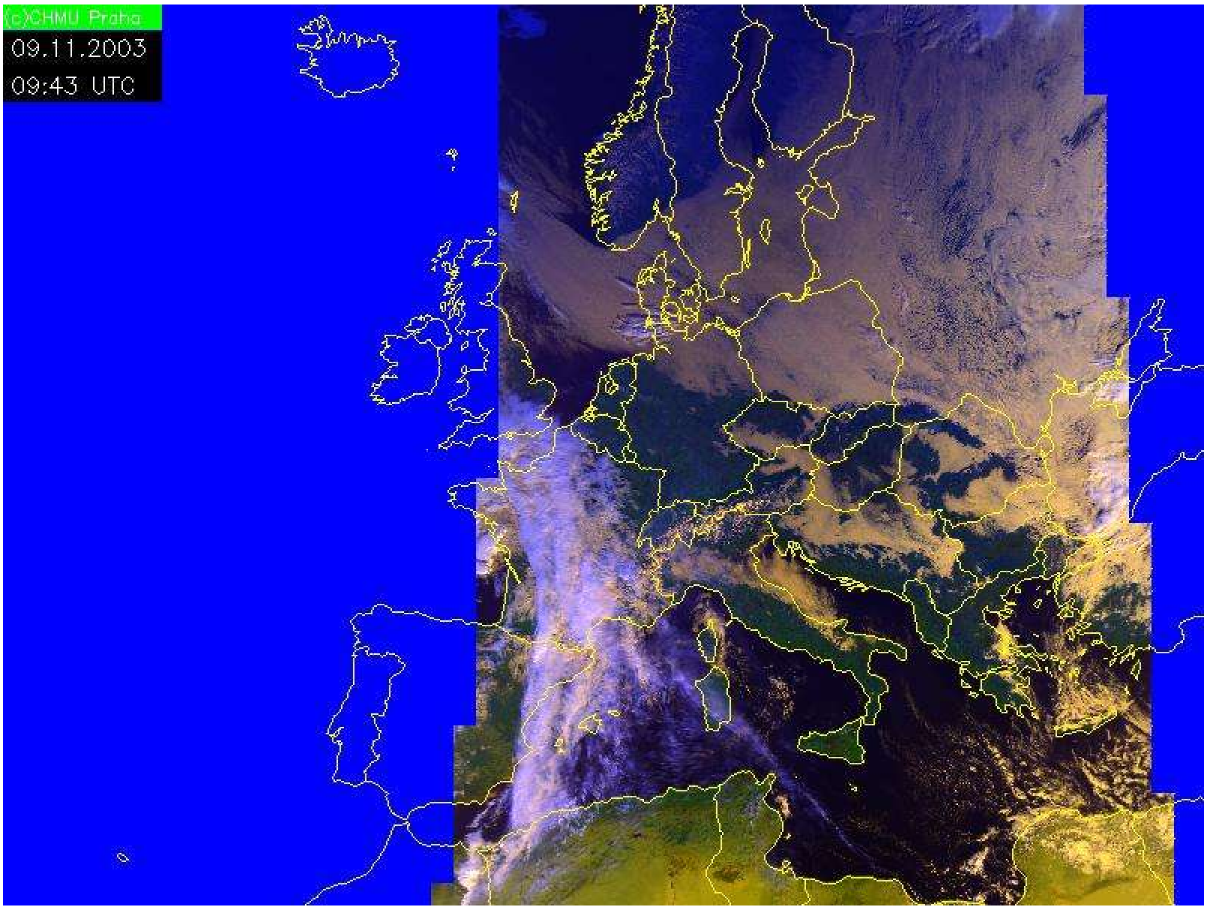


Fig. 3: NOAA picture from 9 November 2003 at 9:43 UT. Yellowish color shows presence of low cloudiness.

2.7.2. Parallel Suites & Maintenance

The two main parallel suites, ADN and ADP, resulted in the successful operational applications. There were other less successful suites, testing an alternative Ekman spiral simulation (ADO, ADQ and ADR). These suites were declared as void since there is no plan to continue with this specific topic.

In the second half of 2004 we spent a lot of time on porting the cycle AL28T3. It was namely due to the new data-flow structure used in the model as well as new style of using the interfaces at every routine. On the other hand we managed to optimize rather well the code for the NEC-SX6 platform. For example, despite more computations, forecast runs at about the same speed as it did with the cycle AL25T1. Concerning *lancelot* (ee927) , it takes more memory (as found on VPP) but it runs almost three times faster compared to AL25T1.

We phased all the locally modified physics (content of ADN and ADP suites) to AL28T3 and we are about ready to verify this cycle in a parallel suite. Here it should be mentioned that the ADN and ADP modifications are already phased into AL29T1.

There will be no further development and/or suite on the currently operational cycle AL25T1. On the other hand we still ought to validate research configurations with AL28T3 including the ODB use.

2.8. FRANCE *(more details joel.stein@meteo.fr)*

Similar changes as in ARPEGE along the last months.

2.9. HUNGARY *(more details kertesz.s@met.hu)*

In the second part of 2004 basically there were no changes in the operational ALADIN suite at the Hungarian Meteorological Service.

The parallel suites were kept active and inter-compared objectively and subjectively :

- ALADIN dynamical adaptation in 12 km resolution,
- ALADIN 3D-VAR in 12 km resolution using surface (SYNOP), radiosonde (TEMP) and satellite (ATOVS) measurements.

Cycle 28 was installed and intensively tested for different model configurations. At the end of the year the new cycle was also considered in the subjective evaluation, therefore beside the objectives scores some subjective impression was also obtained.

Late summer our new IBM server was installed in the new computer room (on the ground floor) of our Service, the main characteristics of the new machine are as follows :

- IBM p655 cluster server with 32 processors (clock rate: 1,7 Ghz),
- Available memory : 4 Gbyte/processor,
- Peak performance : cca. 8 Gflop/s per processor.

At the end of the year it was decided to modify the operational configuration of the model with the following main aspects :

- Horizontal resolution : 8 km,
- Vertical resolution : 49 levels,
- Grid : linear,
- 3D-VAR data assimilation using surface, upper-air and satellite data.

The new model settings were intensively tested in the new machine and the implementation of operational procedures is on progress and should be completed at the first part of 2005.

2.10. MOROCCO *(more details jidane@marocmeteo.ma)*

The present status of operational suites is described in the R&D report.

2.11. POLAND *(more details zijerczy@cyf-kr.edu.pl)*

Upgrades were not possible due to the limited computing ressources.

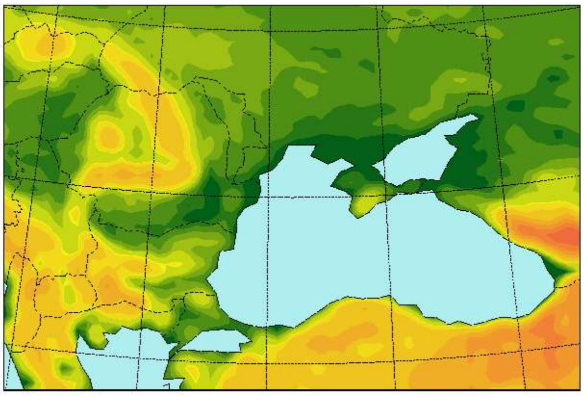
2.12. PORTUGAL (*more details manuel.lopes@meteo.pt)*

During the second half of 2004 few upgrades have taken place on our operational system. New observation stations have been introduced in the objective verification procedures. Besides, a new chart representation has been introduced under the Metview (ECMWF) batch environment for forecasting purposes.

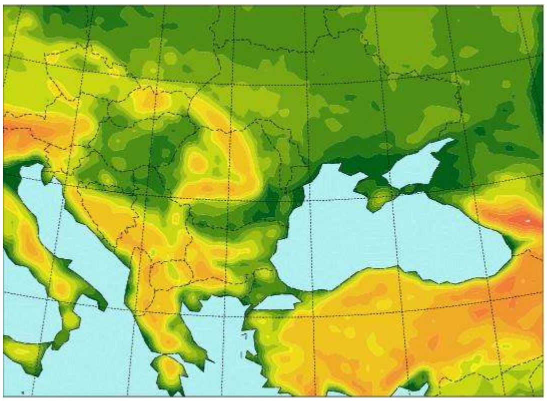
2.13. ROMANIA *(more details doina.banciu@meteo.inmh.ro)*

In agreement with our colleagues from Bulgaria, the SELAM domain for coupling files was increased from 90×64×37 to 120×90×41 points, keeping the same horizontal resolution.

For ALADIN–Romania, the domain size was kept and only the number of vertical levels was increased (from 31 to 41). The operational chain was completed by a new integration of the ALADIN model, over the coupling domain, in order to provide the necessary atmospheric data for Black Sea applications.



Old coupling domain



New coupling domain

2.14. SLOVAKIA *(more details oldrich.spaniel@shmu.sk)*

2.14.1. Summary

In the past, the LAM NWP data used at Slovak Hydro-meteorological Institute were received from the ALADIN/LACE applications running at Météo-France in Toulouse and later at CHMI in Prague. After the end of common LACE operations, the kind offer of our colleagues from ZAMG, Vienna to use their ALADIN outputs covered our needs. Also, the local version of ALADIN/Slovakia was running at SHMI on the workstation over a rather small domain. However, in the course of time the ALADIN model products became the main source of information for our forecasters and also serve as a basic input for numerous other applications. The need for our own operational ALADIN application over a European domain was obvious, both to fulfill increasing requirements for new products and to have own control of the model timing and behaviour.

The purchase of the supercomputer at the beginning of 2004 allowed us to substantially upgrade the ALADIN operational suite at SHMI. The model is now running over the whole LACE domain. All local applications were ported to the new computer under a unified operational framework (*run_app* system). Almost all manpower of our NWP team was devoted to this task during the first half of 2004. Full operational status of ALADIN/SHMU started on July the 1st, 2004.

The new HPC computer, ALADIN model version, domain and operational suite are described below.

2.14.2. The new operational ALADIN setup

✗ **The new computer**

The new computer at SHMI is an IBM @server p690 with code name Regatta. Its hardware and software characteristics are described below and a picture is shown. More details can be found on *www.zamg.ac.at/workshop2004/presentations/olda.ppt*.

HW :
IBM @server pSeries 690
Type 7040 Model 681
32 CPUs POWER 4 Turbo+ 1.7 Ghz
32 GB RAM Memory
IBM FAST T600 Storage Server
EXP700, 1.5 TB

SW :
AIX 5.2
Fortran compiler XLF 8.1.1.0
C,C++ compiler
Engineering and Scientific Library ESSL
Mathematics Library MASS 3.0
Parallel Environment (MPI): PE 3.2.0.16
LoadLeveler 3.2

Brief historical outlook : The Invitation To Tender was declared in June 2003, the evaluations ran during October 2003 and according to final decision of evaluation committee IBM @server Regatta p690 was chosen. The contract was signed in December 2003 and the computer was delivered, tested and accepted in January 2004. The porting, optimization and validation of ALADIN source code together with other applications and tools could start. For this, some help was obtained from The Products & Solutions Support Centre of IBM in Montpellier (porting of ALADIN code, optimisation of the code, optimization of memory manager and I/O, provision of reliability of operational suite: AIX Work Load Manager & LoadLeveler & Vsrac).

✗ **The ALADIN model**

The domain of ALADIN/SHMU covers the whole RC LACE area with an horizontal resolution of 9 km, having 320×288 points in quadratic grid. There are 37 vertical levels. More details are in the table below, the model domain is also displayed.

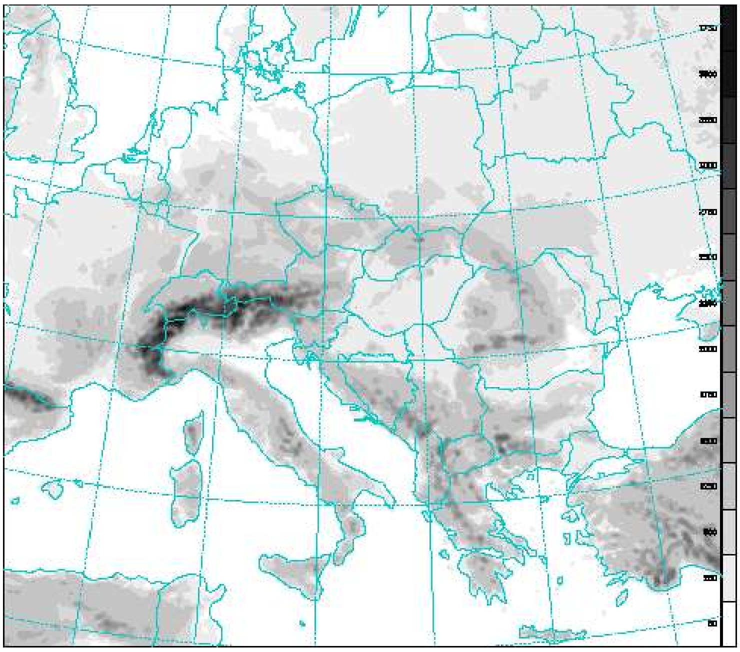


Illustration 1: ALADIN/SHMU model domain and orography

Domain size	2882×2594 km (320×288 points in quadratic grid)
Domain corners	[2.19 ; 33.99 SW] [39.06 ; 55.63 NE]
Horizontal resolution	9.0 km
Vertical resolution	37 levels
Time step	400 s
LBC data	ARPEGE, 3 h frequency
Code version	AL25T2

The model runs twice per day up to 48 hours in dynamical adaptation mode. Lateral boundary data provided by ARPEGE are downloaded using internet, and backup is done by RETIM2000 system (about 40 minutes slower than internet). Whole suite in optimal case needs about 60 minutes to finish. Hourly model outputs are available for further post-processing and visualization. They also serve as the basic input for numerous applications like automatic point forecasts, dispersion models, hydrological models etc. Data for the PEPS project are provided as well.

The verification of ALADIN/SHMU outputs is done in two ways : locally only surface parameters are compared against observations over Slovakia, and data are also sent for processing in the ALADIN verification project.

✗ The operational environment

The operational suite is based on the in-house developed system of Perl scripts and programs, and enables on-line monitoring and documentation (accessible via pocket communicator as well). More details can be found at web page *www.zamg.ac.at/workshop2004/presentations/martinb.sxi*. An example of the diagnostics for last 30 days is plotted on Figures 2-5. Given the importance of the ALADIN/SHMU products, the non-stop human monitoring of the operational suite started recently. One of the handy on-line monitoring diagnostic tool (number of processes of nwp001 user) is shown on Figure 6.

In case of unexpected failure of the operational ALADIN run, a mutual backup was agreed with our colleagues at ZAMG. The remains of the system used in the past to produce data for SHMI at ZAMG are used now to generate the minimum dataset needed for SHMI. These data are daily downloaded.

The privilege of the operational jobs on the machine is guaranteed by submitting all jobs through LoadLeveler batch queueing system, which together with Work Load Manager controls and allocates the system resources (CPU, MEM etc.). The operational suite is launched via a special Perl script scheduled in the crontab. This script reads all operational configuration files and sets the application dependencies, number of used processors, memory requirements etc. All operational applications are then submitted as a single multi-step job into a dedicated LoadLeveler class (except the applications monitoring the products transmission which are submitted into another class with lower priorities but within the same multi-step job). However, there is still some residual problem with the preempting of non-operational jobs.

Active monitoring of the applications is done internally by the *run_app* system itself. It is possible to switch on/off an ALERT for each application separately. In case of application failure the automatic ALERT will be sent immediately to the mobile device and the person on duty will be informed (or even woken up). Using the "pocket" version of the monitoring system he/she can browse the application logs, statuses and documentation then and if possible repair the suite remotely.

2.14.3. Local R&D work and Future plans

Though the implementation of the new ALADIN operational suite was a quite huge task, the new computer was used for other R&D work. In NH dynamics, the technical cleaning of the code was done and the theoretical study of the pathological behaviour related to horizontal diffusion treatment (so-called chimneys) was performed. The dynamical adaptation of the wind field over the territory of Slovakia with a 2.5 km resolution and hourly outputs, for the purpose of atmospheric dispersion modelling, was run. New diagnostics indexes to identify severe weather phenomena (Storm to Relative Environmental Helicity – SREH, Bulk Richardson Number – BRN) were implemented and validated. CY28T1 and T3 export versions were ported. Testing in parallel suite is planned for the nearest future.

For the longer term plans, first of all the prolongation to 54 h (and possibly up to 72 h) is scheduled. Then the investigation of blending assimilation is planned together with porting, implementation and testing of ODB software during the first half of 2005. Also some LAM EPS activities will start in cooperation with other RC LACE partners. Systematic improvement of the operational ALADIN model version via ALADIN-2 and AROME projects is implicit.

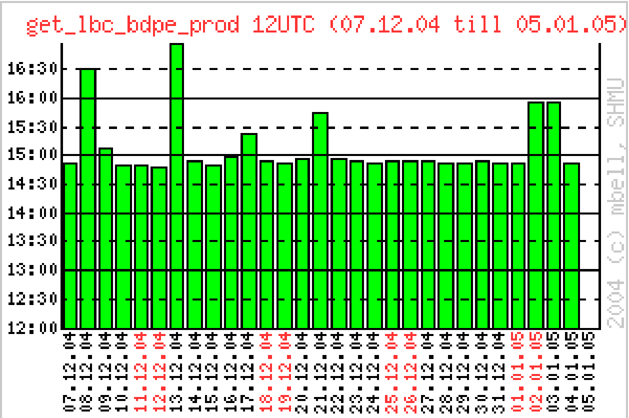


Illustration 2 : LBC download (12 UTC), internet

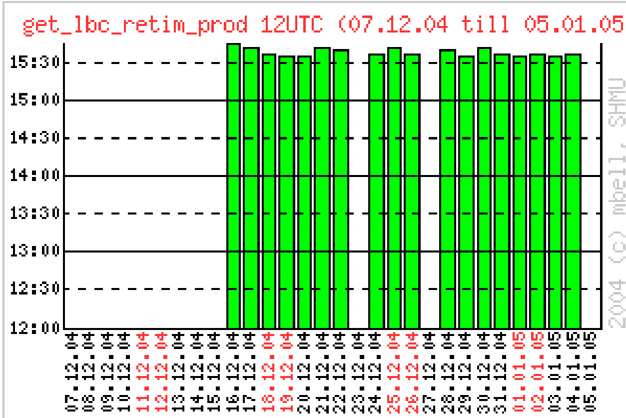


Illustration 3 : LBC download (12 UTC), RETIM2000

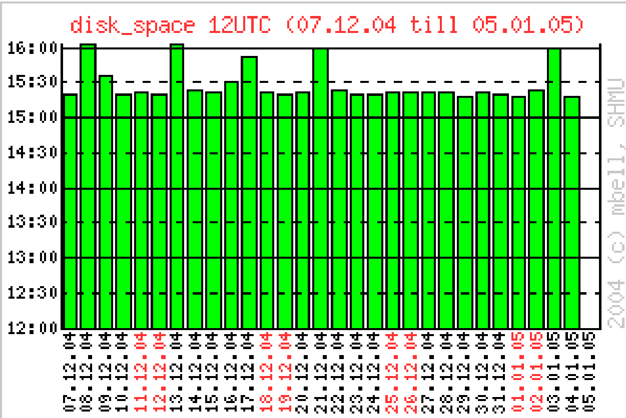


Illustration 4 : end of the suite (12 UTC)

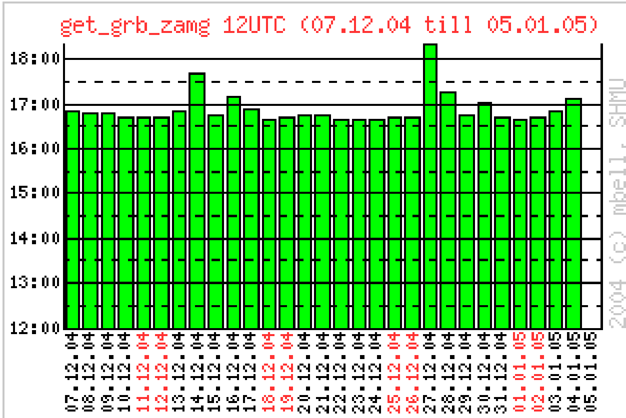


Illustration 5 : backup data(ZAMG) download (12UTC)

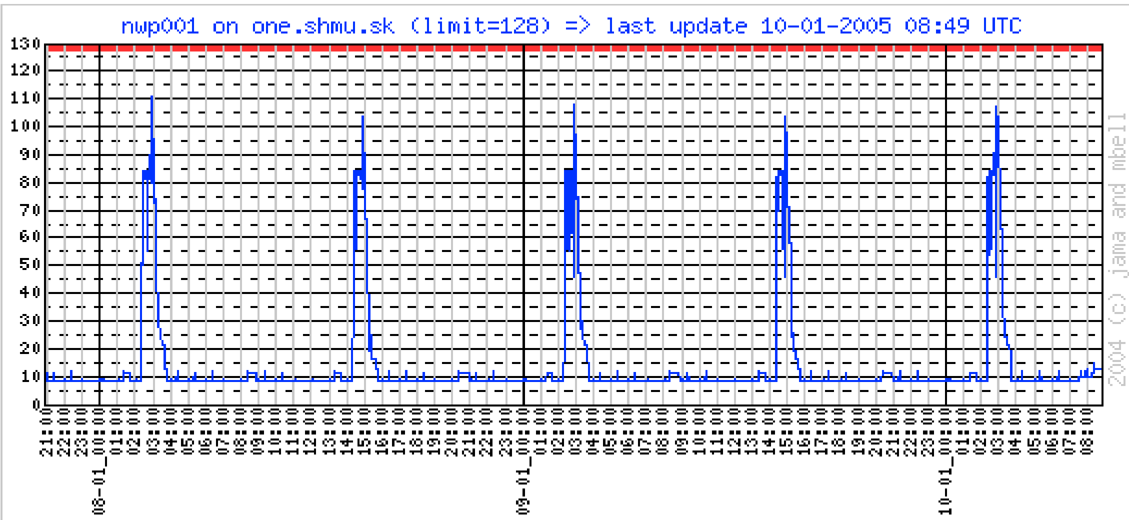


Illustration 6 : Monitoring of operational suite - "EKG"

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

During the second half of 2004 few changes were introduced into the operational suite. Visualization of ARPEGE model on some standard pressure levels based on coupling files data was included. Operational production of products for the PEPS project started in July. Meteorological service from Albania asked for some ALADIN products, so from the end of the year some pictures are made available to them at our *ftp* server.

The coupling files from the ARPEGE model are transfered only via Internet from Toulouse. In the year 2004 the files were significantly delayed 7 times (1.9%) in the morning (after 4:30 UTC) and 17 times (4.6 %) in the afternoon (after 16:30 UTC). Main reason for delays was slow *internet* transfer rate; a few times the connection to *sirius1* or *sirius2* was not possible or files appeared late in the database. The number of cases of missed or delayed products has been decreased in year 2004 (not taking into account the second half of December).

The upgrade of cluster system software was performed in mid-December 2004. The operational system on the computing and master nodes was upgraded from *RedHat* 7.3 to *Fedora core* 1 and *SCore* software (the one which governs the distribution of computing jobs on the cluster) was upgraded from version 5.4 to 5.8. To have the upgrade as smooth as possible the whole procedure was carefully planed, a test cluster with the new version of software was built, but even by executing the procedure unforeseen problems occurred and operational suite was seriously disturbed many times during the 3 week period. However, the problems were solved one by one and the *Tuba* cluster is again in fully operational status. The main message of the upgrading procedure is the importance of proper cluster file system which has been neglected so far. We are looking now for an alternative to NFS. From now on we expect improved stability of the cluster and even some performance gains due to use of *Intel* Fortran compilers.

It is planed to upgrade the ALADIN cycle in operational suite as well (from 25T1 to 28T3). Code itself compiled fine but there are still some unresolved problems with *xrd* library manifesting in configuration ee927. Other configurations run fine. We are still working on the problem and we expect that the new cycle should become operational during mid-February.

We performed different tests on some new architectures (i.e. *Opteron64*) with different versions of compilers (*PG*, *PathScale*, *Intel*, *Lahey*) and we have to report that some of the compilers are having problems with the new EGG routines. We are still investigating the problem.

2.16. TUNISIA *(more details nmiri@meteo.tn)*

Significant changes in coupling: see the R&D report.

2.17. RSEARCH & DEVELOPMENTS AUSTRIA

2.17.1. INCA–A high-resolution analysis and nowcasting system based on ALADIN forecasts

A common characteristic of today's numerical weather prediction (NWP) models is that their forecast errors in the nowcasting range, up to a few hours, are not significantly smaller than those at +12 or +24 hours. This is because NWP models start from analysis fields that may already differ significantly from observed values at the observation locations. No matter which method is used, be it variational analysis, optimum interpolation, or nudging, NWP analyses are strongly constrained by the model's dynamics and physics. The INCA analysis module is specifically designed for forecasting applications, not for model initialization. For temperature, humidity, and wind it is three-dimensional and has a time resolution of 1 hour. For precipitation it is two-dimensional, with a time resolution of 15 minutes. Horizontal resolution is 1 km, vertical resolution 200 m. The vertical coordinate is geometric height z above a "valley floor surface" which is basically the lower envelope of the terrain.

The analysis starts with an ALADIN forecast as first guess. Then an error field is created from the differences between the model forecast and the actual observations at the stations. Since we have a certain number of mountain stations, we can compute the error field in three-dimensions. In the future we may include AMDAR data into the system to obtain improved vertical structures. The spatial interpolation of the point differences is done by distance weighting in the horizontal, and potential-temperature distance weighting in the vertical. The variables used are potential temperature and specific humidity up to now but will be changed to liquid water potential temperature and total water content in the future (e.g. to get a better analysis of low clouds). Figure 1 shows as an example analyses of 2 m temperature and relative humidity. It is a low-stratus situation and in the relative humidity analysis one can see the boundary of the cloudiness at the Alpine foothills. A rather complex temperature structure arises because of the presence of the stratus in low areas, leading to inversions, and the normal decrease of temperature with height in the Alpine areas.

Nowcasting of temperature and humidity is currently based on a simple weighting algorithm that gives a smooth transition from the analysis to the ALADIN forecast after several hours. Figure 2 shows the reduction in temperature forecast error that can be gained. In the future, error motion vectors (EMVs) will be used instead of the prescribed weighting. This will allow better compensation of phase-shift errors in the ALADIN forecast, for example those associated with fronts.

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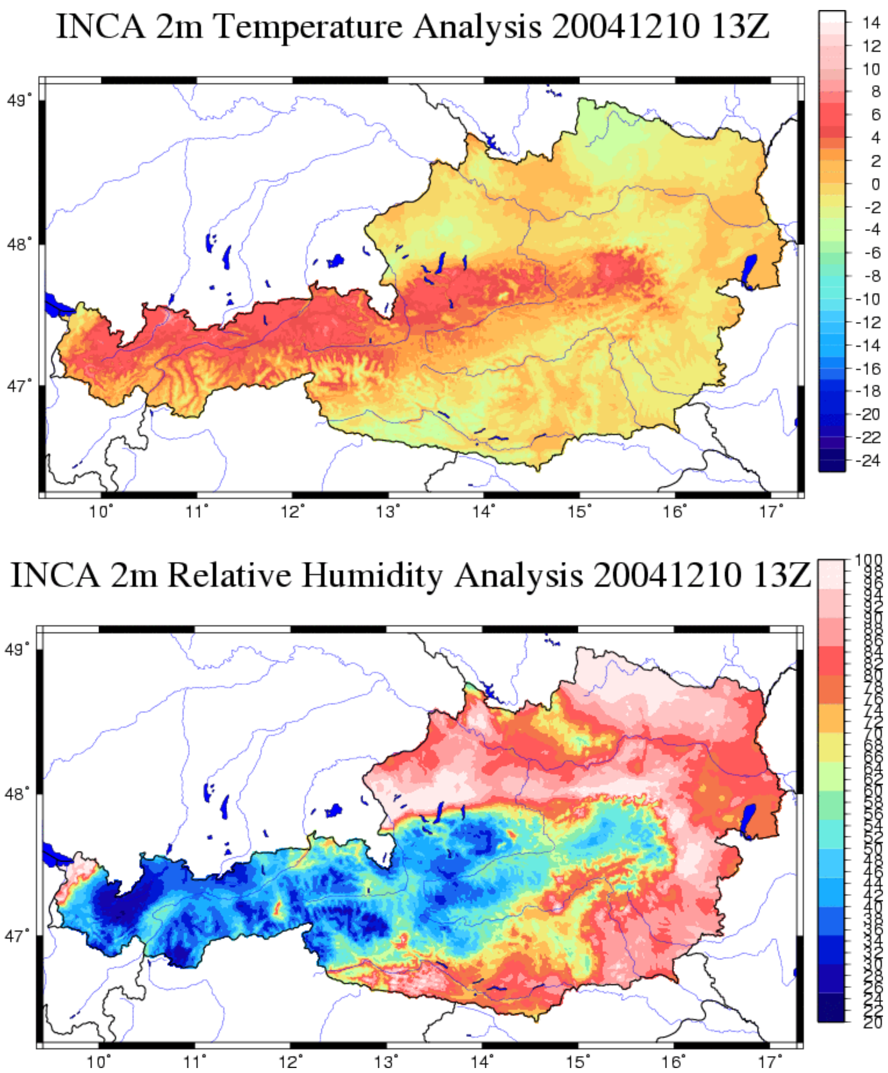

Fig. 1: INCA 1 km Analysis of 2m temperature and 2m relative humidity during a low-stratus episode. It is based on the operational ALADIN forecast, station observations, and high-resolution topographic data.

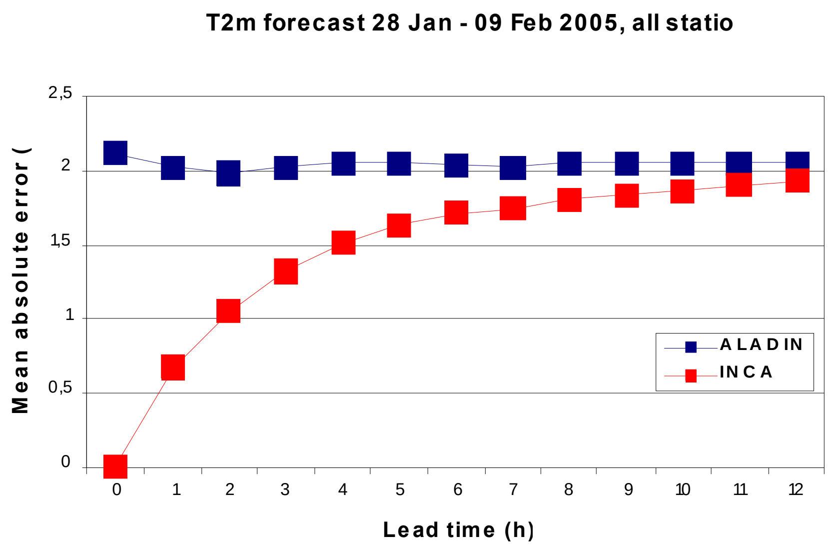

Fig. 2: Comparison of ALADIN and INCA T2m forecast error (mean over ~140 stations) as a function of lead time.

2.17.2. Quantitative evaluation of the orographic precipitation problem in ALADIN

During orographic upslope flow situations, the ALADIN model tends to predict excessive rainfall on peaks and ridges and rather dry conditions with negligible precipitation in valleys and basins. Moreover, the modelled precipitation field is connected to the flow-oriented steepness of the model topography in an extremely close and direct way (Figure 3), most likely much closer than in reality.

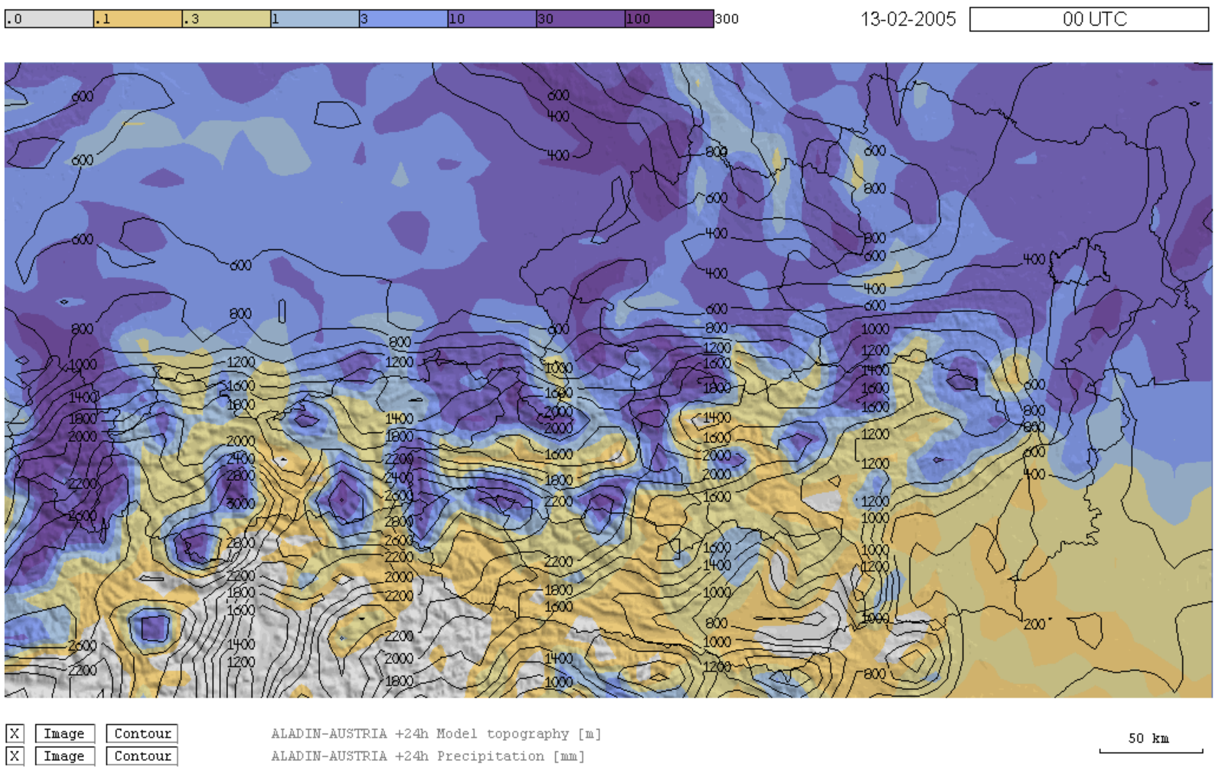

Fig. 3: Typical example of a 24-hourly ALADIN cumulative precipitation forecast (colors). The model topography is shown in isolines, the actual terrain by shading.

We think that the overestimation of upwind/downwind and peak/valley precipitation contrasts is to a large degree caused by the diagnostic treatment of cloud water in ALADIN. It causes precipitation maxima to more or less coincide with vertical velocity maxima in the model, whereas in reality considerable amounts of cloud water (and also precipitation, in the case of snow) may be advected onto the downwind side of a mountain.

In order to obtain a quantitative diagnosis of the problem, ALADIN point forecasts of 24-hourly rainfall (for the lead time period +0 to +24h) are compared to station observations. The comparison is performed on monthly precipitation sums. Figure 4 shows results for the months Dec 2004 and Jan 2005, where a number of orographic upslope events affected the northern Alpine slopes. Figure 4 shows that inner Alpine valleys generally show ratios < 1, and < 0.5 in several areas. Along the northern Alpine rim a systematic overestimation of precipitation by a factor of 1.5-2 is found.

It is instructive to analyse some of the small-scale features, such as the precipitation ratio maximum near the center of the domain, South-East of the city of Salzburg. This is an area that is in reality located on the downwind side of a steep, high mountain (Dachstein) and experiences strong sheltering effects. The model, however, does not resolve the valley. Instead there is an area with a relative topography maximum. Thus (as can be seen in Figure 3) orographic precipitation enhancement is predicted instead of sheltering.

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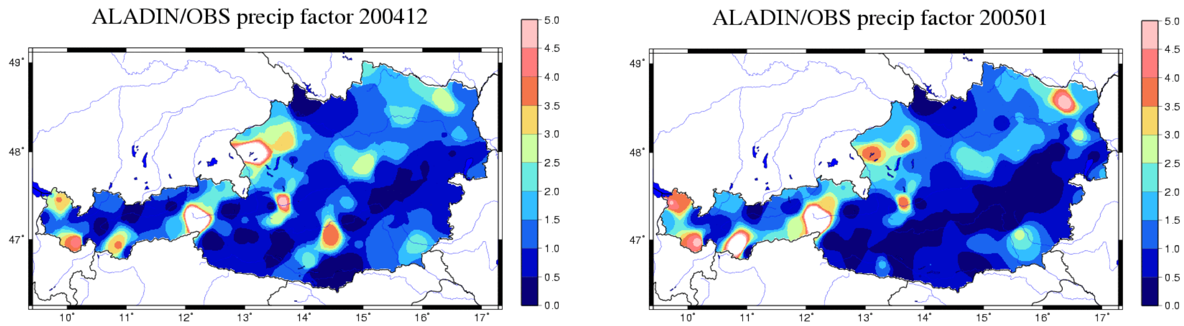

Fig. 4: Interpolated ratio of precipitation predicted by ALADIN (+0 to +24 h) and observed at stations during the months Dec 2004 and Jan 2005. Inner Alpine valleys generally show ratios <1, with values <0.5 in many places. Along the northern Alpine rim a systematic overestimation of precipitation is found.

2.17.3. Stratus prediction

Using the Seidl-Kann (SK) inversion cloudiness scheme, satisfactory low stratus forecasts are obtained for lowland areas in the operational ALADIN run at ZAMG. A good stratus prediction in basins (even if they are very wide, such as the Linz basin in Upper Austria) was however found to require switching off, or setting to a very small value, the "horizontal" diffusion of temperature. This is because the spurious vertical component of this diffusion too strongly smoothes inversions. Thus, in order to get the full benefit of the SK scheme operationally, the T-diffusion would have to be switched off. Since we were not sure whether this has detrimental effects in situations with strong temperature gradients, a few tests were carried out, for example on the storm case of 19 Nov 2004. The results showed no obvious problems, and little difference in forecast fields between the experimental and operational runs. This means we will most likely switch to a rather small T-diffusion operationally.

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2.17.4. Evaluation of mesoscale precipitation forecasts in the Southern Alpine area

A comparison of precipitation forecasts for different regions in Austria shows that the northern upslope precipitation areas (Salzburg, Upper Austria) show a higher predictability than the upslope areas in the South (Carinthia). The orographic situation appears to be the main reason for this. In the south, the primary upslope precipitation belts are the mountain ranges in Italy and Slovenia. Austrian areas are located downwind of these "primary" upslope areas. Several fall and wintertime heavy precipitation events (1999-2003) during southerly flows were analysed and compared with ALADIN forecasts. The existence of systematic forecast errors for parts of Carinthia and East Tyrol was documented and analysed with regard to the dependency on certain weather situations. The results show that regions downwind of strong primary upslope areas show a high percentage of cases in which the precipitation amounts are underestimated by ALADIN. Even in the presence of synoptic-scale lifting (e.g. frontal passage), over-pronounced lee-side downward motion and overestimated loss of water in the upslope areas result in an underestimation of precipitation amounts in the downwind regions. Further it was examined whether comparison of upstream soundings (e.g. Udine) with ALADIN pseudo-TEMPs can give additional prognostic information regarding precipitation patterns and the expected quality of the ALADIN forecast. The results show that only in a few cases differences between TEMP and pseudo-TEMP can be linked with deviations between observed and modelled precipitation patterns in the downwind areas.

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2.17.5. Verification of dynamically downscaled wind

For the 4-month period March-June 2004, 6-hourly forecasts (up to +48h) of
a) the operational (9.6 km) run,
b) the *dynad* (2.3 km) run,
c) the *dynad* (2.3 km) run without envelope,
were compared. The main results are the following. There is little difference between b) and c), as expected. The envelope is not important at this resolution. All stations taken together, there is no clear signal of improvement from a) to b). If stations are grouped according to elevation, a moderate positive signal is found for the highest stations (2000-3400m), especially mountain top stations. Individual stations show up to 15-20% improvement in mean absolute error (MAE) in b) compared to a), but there are also stations which show worsening of the same amount (that's why in the mean over all stations there is no positive signal). In most cases, the changes in MAE reflect to a large degree simply changes in bias.

We had expected that at least for those stations which are inside deep valleys, and thus very poorly represented at the operational resolution, the 2.3 km *dynad* run would bring significant improvements both in wind speed and wind direction. It turns out this is not the case. Apparently the wind regime in those valleys is strongly influenced by thermally induced flows (valley winds) which are not improved by the *dynad* run.

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2.17.6. Development of a LAM ensemble prediction system using ALADIN

Limited-area models provide highly structured forecast fields both in space and time. However, often the small-scale features are extremely sensitive to uncertainties of the model and/or initial conditions. To obtain a guidance for the forecaster with regard to this uncertainty, the project "ALADIN Limited Area Ensemble Forecasting" has been started at ZAMG. It is an ensemble forecast system with 11 members, in which perturbed initial conditions are created using a breeding method. In a second step, the Ensemble Transform Kalman Filter (ETKF) technique will be applied to the breeding vectors. The NWP model used is ALADIN with reduced horizontal and vertical resolutions (16 km, 31 levels). The domain covers the whole of Europe and large parts of the North Altantic ocean.

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2.18. BELGIUM

2.18.1. Stability and accuracy of the physics-dynamics interface

(Piet Termonia)

The aim of this is the generalization of the work in a paper by Staniforth et al. (2002). As shown during my lectures in the TCWGPDI in Prague, extending this to include algorithmic issues imposed by the time-step organization rapidly leads to algebraic complications that are too tedious to be treated analytically. I proposed a way out of this by determining the stability of the scheme by means of a numerical maximization of the amplification factor. In the near future this method will be applied to perform a comparative study between the time-step organization of ARPEGE/ ALADIN (physics before dynamics, parallel physics) vs the ECMWF model (physics after dynamics, sequential physics).

2.18.2. Monitoring the coupling-update frequency

(Piet Termonia)

1. I have implemented the findings of my paper *Mon. Wea. Rev.,* **132**, 2130-2141, in cycle

28T2. This allows to operationally compute a warning index for information loss of the coupling data due to a too long coupling update interval.

2. I have started writing a paper presenting a method to objectively determine the coupling-update interval, with the aim to tune coupling strategies in case of detected information loss.

2.18.3. 2 m temperature forecasts

(Piet Termonia)

I also carried out some research on a proposed model output statistics to improve some bad 2 m temperature forecasts of the Belgian operational ALADIN runs during winter. Since the largest errors occur during stable conditions, I propose a correction of the 2 m temperature based on a time integration of the tendency computed by using the exchange coefficient for the temperature. The result can be physically interpreted as a temperature difference and is thus well suited to be compared with temperature errors. A quasi-linear relation can be identified between them. Tests during last winter showed that, by exhibiting this linearity, the RMSE for the 24 h forecast range 2 m midnight temperatures for ALADIN-Belgium could be reduced by about 1.3 degrees.

2.18.4. "Wavelet Jb"

(Alex Deckmyn)

Research was continued on the use of complex wavelets for the representation of background error covariances. Such wavelets not only represent location and scale of features, but also have a directional component (even though it is limited to a resolution of about 15°). The wavelets no longer form an orthogonal basis like Fourier components, but instead a so-called "tight frame". This non-orthogonal redundant transform increases the number of parameters but improves considerably the representation of anisotropies and reduces the occurrence of artefacts in the local variance.

Work has been initiated on an experimental 3D-Var implementation using wavelets in the control variable.

2.18.5. Adaptations to ALADIN of the Lopez micro-physical package

(Luc Gérard)

See the dedicated paper.

2.18.6. Gravity wave drag

(Bart Catry)

In 2004 I continued the work on the validation/tuning of the new mountain-wave-drag parameterization scheme in ARPEGE/ALADIN. This validation took place on three prediction scales: (1) semi-academical tests performed by ALADIN on an idealised flow over a complex orography (ALPIA) enables one to calculate momentum budgets which prove to be a good diagnostic tool; (2) regional scale tests using the Czech ALADIN-version produce verification scores over Central Europe; (3) global tests using NWP ARPEGE render statistically significant scores over the different continents. Using these three scales one is able to cross-check the validity of the new parameterization scheme or parts of it.

We finally found values for the two new tuning constants ($\alpha=1.0$ and $\beta=0.5$). The already available constants were retuned using the above-mentioned method to find $\kappa=0.020$, $L_t=1.0$ and $C_d=5.4$. The new scheme was found to be resolution independent and usable down to horizontal mesh-sizes of 5 km. Below 5 km the scheme appears to have an incoherent behaviour suggesting that no mountain-wave-drag parameterization should be used at such scales. We were also able to show the clear improvement of the new lift scheme where the additional rotation is now in the correct direction. All these improvements give one the opportunity to remove the envelope orography and use (even operationally) a mean orography, which has been tested for the operational versions of ALADIN-CE and NWP ARPEGE.

At the end of 2004 I also started research on a multi-directional version of the current gravity-wave-drag scheme where the main goal is to have a better representation of the transport of momentum with height. This research should be finished by the end of 2005.

2.18.7. Physics-Dynamics Interface

(Bart Catry)

Due to the decision that one should go from ALADIN to AROME through ALARO, with a possible cooperation of HIRLAM, the need of a new physics-dynamics interface became a necessity. Not only should this new interface be able to be implemented in these different models, it should also be as flexible as possible to allow further developments concerning physical parameterizations in the near future without having to make big changes to the interface.

My work on these issues has been limited for 2004 to the analysis part, i.e. the full declination of the un-parameterized discretized equations with respect to the following problems : (1) account taken of the multi-phasic and baroclinic choices; (2) enthalpy conservation; (3) choice between $\delta m=0$ and $\delta m=1$; (4) optional projection of the heat source on temperature and pressure in the compressible case. These so-called "governing equations" should be obeyed by all low-level routines (i.e. all parameterizations routines).

In order to close the above-mentioned set of equations, some routines will need to add so-called "diagnostic-equivalent" variables to their local input/output stream. We could conclude that this means that one should find an expression for the following pseudo-fluxes : condensation, freezing, evaporation, sublimation and two fluxes related to the auto-conversion for the liquid and solid phases.

2.19. BULGARIA

2.19.1. New Integration Domain for ALADIN-BG

A new integration for domain ALADIN-BG was created and tested. Its characteristics are as follows :

- - coordinates of the centre : 25.5°E, 42.75°N
- - south-west corner : 19.27°E, 38.95°N
- - north-east corner : 32.51°E, 46.22°N
- - number of points : 108×80 (91×69)
- - grid type : linear grid
- - horizontal resolution : 12 km, NSMAX = 39, NMSMAX = 53

The corresponding set of climatological files was created. Increasing the domain size and truncation led to an increase of the integration time by 45 % on average, and the 48 hours forecast is calculated for 28 minutes, using both processors of the PC.

Post-processing for visualisation purposes is done on a latitude-longitude grid of resolution 0.1° × 0.1°, using climatological files.

From the beginning of December 2004, a pre-operational suite based on this domain is running in parallel to the old one. The verification scores over Bulgaria are better than with the operational suite.

It is planned to switch new suite to operations at the end of March.

2.19.2. Porting cycle 28T3

Technical stuff, not described here.

2.19.3. A lot of work in Toulouse !

2.20. CROATIA

See the report on operations.

2.21. CZECH REPUBLIC

2.21.1. ALADIN/MFSTEP configuration

As a result of the recent efforts the differences between ALADIN/CE and ALADIN/MFSTEP were diminished to the necessary minimum. These differences in ALADIN/MFSTEP are: an extra computation of the clear sky solar radiation flux; no use of the LRMIX option in ACRANEB due to cost reasons; absence of the last modification concerning the low-level inversion clouds (ADP).

Besides, there is also a change in the algorithm of the cycling. Due to the fact that the resolution of ARPEGE coupling files is relatively low, i.e. that there is a more important jump in resolution between ARPEGE and ALADIN/MFSTEP than usual, we had to introduce a light incremental digital filter into the blending cycle. Otherwise we got higher root-mean-square error of the mass field despite a better bias – a clear sign of noise.

The ALADIN/MFSTEP application runs in its Target Observation Period (TOP) since September 1st, 2004. This period is 6 months long. It will provide back a lot of interesting material of validation, namely concerning the screen-level fluxes.

2.21.2. Bottom boundary condition

A correct application of the kinematic rule for vertical velocity at the bottom boundary (w_s) was tested for the linear horizontal diffusion equation. The problem is that such a correct treatment requires computing the scalar product of the model lowest level horizontal wind with orography within the part of spectral space computations. The scalar product needs to be computed twice: using the horizontal wind prior and after the horizontal diffusion operator in order to compute a correct tendency of w_s for this equation. This is technically complicated and that is why we attempted to test various simplifying approximations. These tests however confirmed that there is no good approximation of the above-mentioned scalar products; otherwise a so-called "chimney" pattern occurs (but only at very high horizontal resolutions, of hundreds of meters, in presence of quite strong horizontal diffusion).

We started to explore a possibility to compute this product using bi-Fourier coefficients; it would anyway cost some communications. Thus the algorithmic strategy for 3D model has to be thought over. A comprehensive report on this work was written by Jan Mašek.

The problem may be solved to a large extent in case of the semi-Lagrangian advection, where the linear horizontal diffusion is substantially replaced by SLHD.

2.21.3. Tests of SLHD and gravity wave drag in the ALPIA framework

The plan was to explore more in depth the behaviour of SLHD in presence of mountain forcing in combination with the gravity wave drag parameterization. Therefore the ideal tool for such a study is an ALPIA-10km experiment. The topic was taken by a newcomer and for the moment it was rather a learning exercise.

2.21.4. SLHD developments

New SLHD developments (extension to ARPEGE, introduction of spline interpolators) and maintenance were provided by Filip Váňa. Please refer to the relevant article in this Newsletter for more details.

2.22. FRANCE

2.22.1. Introduction

Research around ALADIN restarted in La Réunion (in the Indian Ocean), the corresponding work is described in a separate report.

Not described hereafter are all the tasks related to project management and support to Partners (not at all a minor contribution). They are partly mentioned in the Editorial part.

2.22.2. Source code maintenance

✗ Introduction

As along the first 6 months of 2004 there was no rest for the phasing teams, from the delivery of cycle 28T1 early July to the latest contributions to cycle 29T1 at the end of the year. However the task was somehow alleviated since :

1. Many ALADIN phasers came to help. Thanks to Andrey Bogatchev, Nihed Bouzouita, Alex Deckmyn, Stjepan Ivatek-Sahdan, Cornel Soci, Oldrich Spaniel, Piet Termonia, Alena Trojakova, Filip Váňa, and to the distance support !

2. A rotating supervision of phasing started. Claude Fischer was efficiently replaced by Ryad *El Khatib* for cycle 28T3, and by Ryad *El Khatib* and Yann Seity for cycles 29 and 29T1. The next team will involve Gwenaelle Hello and Patrick Moll (29T2 and 30).

✗ Cycles 28T1 and 28T2

- ***July 2004***

Cycle 28T1 is described in the previous Newsletter.

A new cycle, 28T2, was created just afterwards. No export version was delivered, since it was built as a reference for the summer parallel suite in Météo-France (see the report on operations).

- ***Contributions to 28T2***

- From Christophe PAYAN *(uti)*

  - Management of QuickSCAT observations

- From François Bouyssel, Eric Bazile, Yves Bouteloup, Jean-François Geleyn *(arp, sat)*

  - Changes in the ARPEGE radiation scheme (FMR15) : new 2d monthly fields for ozone and aerosols

  - Vertical diffusion : changes in Louis' functions for the stable case, and in the computation of interactive mixing lengths

  - Writing the short-wave downwards flux at surface in historical files

  - Model-to-satellite tool based on RTTOVS : cautions ! (new namelist NAMMTS not yet working)

  - Changes in the ALADIN radiation scheme (ACRANEB_new)

- From GCO *(uti)*

  - Latest modifications for the extraction of observations

- From Jean-Marc Audoin *(uti)*

  - New fields (chemistry model) and new domains in PROGRID; new name for brightness temperature.

- From Patrick Moll *(arp)*

  - One database per observation type, use of BUFR data for AIRS

- Variational quality control
- Assimilation of AMSU-B, EARS, AIRS, QuikSCAT data

✗ **Cycle 28T3**

- August 2004

This step aimed at providing a cleaner, more portable, code for the update of operational suites, taking into account the problems encountered in the porting of cycle 28T1 and some intermediate developments.

- A new export version was created in September, including the following :

- Use of AIRS and AMSU-B (thinning, blacklisting, std dev.)
  Thomas AULIGNÉ, Patrick MOLL, Florence RABIER, Delphine LACROIX
- Bugfix on restart scheme
  Ryad El Khatib
- Bugfix on interactive mixing lengths (not yet active)
  Eric Bazile
- Bugfix for configurations with NFLEVG=1
  Françoise Taillefer
- Various bugfixes, mostly related to portability
  Ryad El Khatib and ALADIN teams
- Bugfix for the use of the linear grid in ALADIN (initialization of RNLGINC)
  Ryad El Khatib under the control of Jean-François Geleyn
- "model to satellite" code temporarily put off
  Ryad El Khatib
- Developments on the new ALADIN radiation scheme
  Jean-François Geleyn via François BOUYSSEL
- Bugfix on the adding of physical tendencies in the Eulerian scheme
  Jozef Vivoda
- Bugfix for coupling in case of d4 variable (NH)
  Gwenaëlle Hello
- Bugfix to use the "10 meters" wind SHIP data at the proper height in CANARI (when screening is not called before)
  Françoise Taillefer

More explanations are available in the mails sent by D. Giard on September 10th, and M. Derkova on December 1st.

✗ **Cycle 29**

- September-October 2004

This was a common cycle with IFS, with no scheduled export version. Hereafter is a short description of contributions, from the ARPEGE memorandum prepared by GCO and the Minutes of the ARPEGE-IFS coordination meeting help on November 10th. For more detailed descriptions, see the mail sent by D. Giard on February 15th.

Note that there is still a problem in RTTOV8, introduced by ECMWF. However, since they didn't manage to solve it, the position is now : "we'll do with".

- ECMWF contributions to cycle 29 (starting from cycle 28)

- CY28R1

- Humidity control variables generalised to arbitrary numbers of levels

- Start of ODB port to Linux

- METAR data monitored (new subtype under type 1) / ERS2 Scatterometer CMOD5 (update of CMOD4) / Passive monitoring of MSG clear-sky radiances / AMVs - use of GOES

- Diagnostic tool for influence of observations (LANOBS=.TRUE.)

- Modification to trajectory for first time-step, Noise reduction for vertical trajectory in the stratosphere (LSVTSM)

- Higher top for 91 levels

- CY28R2
  - Modifications to get Linux version working (for benchmarks) / More GSTATS
  - Wavelet Jb coding (IFS wavelets) / New tests for 4D-Var components (LTESTVAR: Global switch for tests, LCVTEST: Change of variable test, LADTEST: Adjoint test, LTLTEST: Tangent linear test, LGRTEST: Gradient test, old LTEST)
  - Clean-up of *LARCHE*
- CY28R3
  - 1D-Var rain assimilation / Cloud detection of AIRS / RTTOV-8 introduced / New variables in blacklist (rejection of SYNOP/METAR depending on local conditions)
  - Variational bias correction (tests started – interactions with the triggering of spurious vertical modes in the stratosphere in the trajectory computation have been noticed)
  - Improvements in model error term in 4D-Var / Optional new control variable for O3
  - TL and AD of spectral RT (used in combination with grid-point Q)
  - Singular vectors to be orthogonal to a set of vectors
  - Random number generation with multiple independent seeds for EPS
  - More flexible handling of trajectory (grid-point and spectral fields) / SL buffer optimisation with respect to GFL attributes
  - Bugfix for GRIB header
- CY28R4
  - Changes to scripts
  - Modifications to *OBSTAT* for satellites

- ARPEGE/ALADIN changes from 28T3 to 29

- Merge with the IFS developments
- Cleaning of NH dynamics (removing now useless options)
- Update / cleaning of *CPGTL* and *CPGAD* (split as for *CPG* some time ago)
- Cleaning of physics interface (*APLPAR* etc.)
- Merge of *CNT4* : no more duplicated routines in the model libraries !
- Diagnostics on physical tendencies (from Tomislav Kovacic et al.)
- Warning indices in configuration 001 (from Piet Termonia)
- SLHD developments (from Filip VANA)
- Use of GRIBEX in FA files (from Denis PARADIS, see the dedicated paper)
- Introduction of "radar" tables in *odb*
- Full-Pos optimization (starting)
- etc ...

✗ Cycle 29T1

This is mainly a "cleaning" cycle, with some developments on top. Or rather this will be, since there are still validation problems (mid-February).

The main advances are the following :

- Cleanings and bugfixes
- Merge with the ARPEGE parallel suite : interactive mixing lengths, use of AMSU-A AQUA...
- Xu-Randall cloudiness and other developments in physics (from Radmila Brozkova)
- New setup for horizontal diffusions (from Filip Vana, report available on the ALADIN web site)
- New SL interpolations (from Filip Váňa, see the dedicated paper)
- Some more for radar and SEVRI observations
- Further improvements for portability (especially Linux)
- Update of 923 (yes !), but only for parts 2-10 unfortunately

✗ Towards an improved portability

A huge cleaning of keys in the *xrd* library (and elsewhere) started last autumn (see e.g. the stay report of Nihed Bouzouita), and the test of the new cycles on various platforms (VPP, IBM, PC Linux) in now part of Toulouse validations. But there is still a lot of work.

A further step, as proposed by Jean-Daniel Gril, will be :
- first, to take the FA/LFI package (or more generally I/Os packages) out of the auxiliary library,
- second, to convert the FA/LFI code to F90, since it is now a rather peculiar mixture of F77 and F90, uneatable for some (many ?) compilers. Both "automatic" and "manual" changes will be required. Help will be welcome !

Jean-Daniel Gril also updated PALADIN (mainly phasing up to most recent cycles) and other tools. Please don't forget to send him informations on any problem you met or any improvement you brought, so that everyone may benefit from it.

✗ 2005 program

- Cycle 29T2

Starting in March, with the help of Jozef Vivoda and Adam Dziedzic !

Here is a provisional list of contributions collected by Claude Fischer :

- phasing of the AROME prototype (*Yann Seity*)
- NH developments :
  - "3TL Eulerian PC" (*Jozef Vivoda*)
  - advection of vertical velocity ("LGWADV", for d3 and d4 options) (*Jozef Vivoda*)
  - reorganization (*Karim Yessad*)
  - cleaner call to physics in Predictor-Corrector scheme (*Martina Tudor, Gwenaëlle Hello*)
- some more refinements for semi-Lagrangian horizontal diffusion (SLHD, *Filip Váňa*)
- changes for ARPEGE physics (*François Bouyssel, Yves Bouteloup*) :
  - simple micro-physics (Lopez scheme)
  - changes in radiation (RTTM)
- new rotated tilted Mercator geometry (*Jean-Daniel Gril*)
- "Jk" cost-function in ALADIN 3D-Var (*Bernard Chapnik, Claude Fischer*)
- ($T_S - T_L$) in control variable (*Ludovic Auger*, see the paper on Var-Pack)

- corrections for the monitoring of radar observations (*Eric Wattrelot*)
- + ...

More changes may be included, provided they are carefully validated and sent before mid-March.

- Cycle 30

There should be only one common cycle with IFS in 2005, with phasing starting in May.

The main IFS contributions put forward in November were the following (cf mail DG 15/02) :

- new observations (AQUA, TERRA MODIS winds, NOAA-18, MSG winds, SSMI/S and AMSR, rain-affected microwave radiances, ground-based GPS water vapour, METAR data, ...)
- improved pre-processing of observations (variational radiance bias correction, Huber-norm for VarQC, ...)
- 4D-Var : better interpolation of trajectory and increments, grid-point q and O3 in inner loops, new *M1QN3*, cleaning of SL AD/TL, removing Jb from *STEPO*, pruning LOBSTL=.FALSE. ?
- some more changes in the data flow
- new PBL scheme, ...

The reorganization of NH dynamics shall be continued. To propose other ALADIN contributions, do contact Claude Fischer !

- Cycle 30T1 ?

One more cycle may be expected by the end of 2005, to take into account developments related to :

- the externalization of the surface scheme (the proposed roadmap is now available at : *http://www.cnrm.meteo.fr/aladin/scientific/reunions_surfex_190105d.pdf*),
- the physics-dynamics interface (APLXX calling all physical packages : Meso-NH - APLAROME with a careful handling of missing fluxes –, ARPEGE/ALARO – with a management of missing variables and the reduction of the δm=1 option to a few dynamical and interfacing terms -, HIRLAM ... for more details please contact *jean-francois.Geleyn@chmi.cz*),
- the improvement of portability,
- etc ...

2.22.3. Dynamics, geometry and coupling

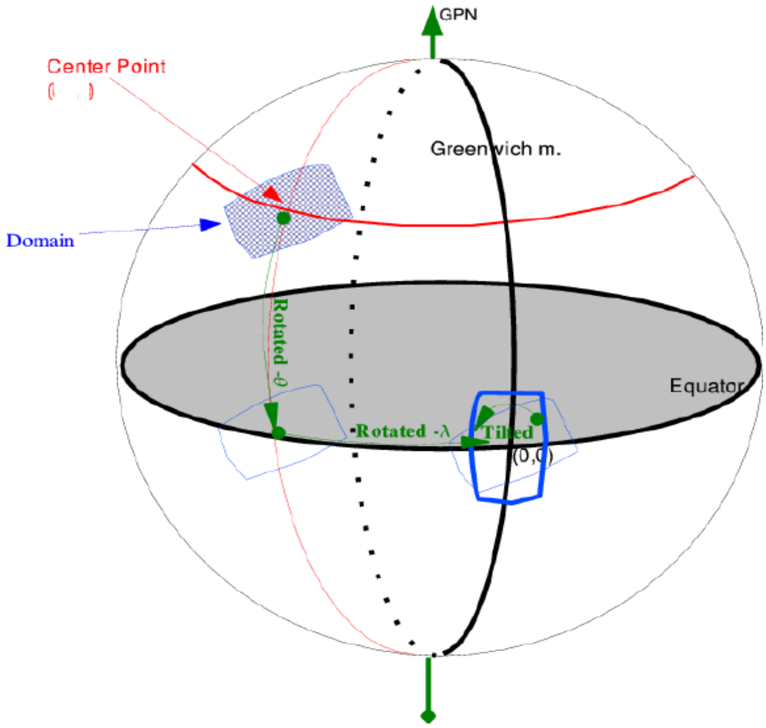
✗ Design of ALADIN domains

- Rotated tilted Mercator geometry

This new projection allows to focus on any part of the world, cumulating the abilities of the 3 previous types.

Besides, but most important, it should allow to better account for distorsions of the mapping factor (here a simple function of Cartesian coordinates $m=\cosh(y/a)$) in the semi-implicit formulation (using penta-diagonal operators as in ARPEGE), hence to run ALADIN-NH dynamics on very large domains.

A detailed documentation was written by Pierre Bénard and should be soon available on the web site. The code should be available soon, too. The new definition has already been coded and validated in PALADIN and in the model by Jean-Daniel Gril. The Full-Pos implementation is on the way and should be ready for cycle 29T2 (i.e. March).



- Clim files

Configuration 923 was partly updated, taking into account the new definition of domains, the new configurations, and some bug corrections introduced by Ryad El Khatib between AL15 and AL29 (Dominique Giard, Stjepan Ivatek-Sahdan). Parts 2-10 can now be run with cycle 29T1. The new options are :

8 : constants for ozone description
9 : aerosols
10 : aqua-planet (all fields in 1 run)

Besides work started around scripts, for Olive (Véronique Mathiot) and for multi-domain updates (Françoise Taillefer).

All the "clim" files used operationally in Toulouse, including those for coupling domains, were updated by Eric Bazile : they now include ozone-related and aerosol fields, and the additional surface albedos required for the new snow scheme.

✗ Vertical discretization

- Definition of the vertical grid

A flexible procedure to define sensible hybrid η levels (i.e. to compute the required A and B arrays) was written and documented by Pierre Bénard, considering the finite-difference approach. Everything is available at : *http://www.cnrm.meteo.fr/gmapdoc/modeles/procedures/AandB.html* . It must be underlined that additional constraints appear when using a vertical discretization based on finite elements.

Besides, an increase of vertical resolution was evaluated in ARPEGE, adding 5 new levels in the stratosphere to improve the assimilation of satellite observations.

- Study of the Vertical Finite Elements (VFE) discretization in view of non-hydrostatic (NH) modelling

The IFS model currently uses a VFE discretization based on cubic spline functions with compact support (Untch et Hortal, QJRMS, 2004). In view of possible future NH modelling, ECMWF has recently asked the ALADIN group whether the current NH dynamical core of ALADIN could be extended for global modelling with their current VFE discretization.

This requires two main tasks : (i) extending the current LAM NH dynamical core to the global context, which appears as a relatively technical task, mainly involving some modifications in the design of the semi-implicit scheme; (ii) extending the current finite-differences NH discretization to the VFE context. This task appears as more scientifically challenging. A preliminary study showed that a direct application of the current VFE discretization to the NH dynamical core was not appropriate (Bénard, 2004, *http://www.cnrm.meteo.fr/gmapdoc/modeles/Dynamique/vfememo1.pdf*).

The reason is that the current VFE discretization does not fulfils some mathematical constraints required for the vertical operators used in the semi-implicit part of the NH system (these constraints were not required for the primitive equation system). As a consequence, the current VFE scheme applied directly in the current NH kernel would result in an unstable model.

Several simple alternative formulations, requiring only slight changes in the design of the VFE scheme, were examined, but even if some of them could be expected to work properly, none appeared to be fully satisfactory. As a consequence, further studies, possibly considering deeper changes in the VFE scheme itself or in the general architecture of the semi-implicit kernel, were recommended.

✗ Coupling

- Monitoring the Coupling-Update Frequency

Termonia{,}The underlying idea is to apply a high-pass recursive filter to model fields (in practice only to $\ln(Ps)$) along the integration of the coupling model, and write the corresponding diagnostic field in coupling files. With a well-chosen cut-off period related to the coupling interval, this should provide information on whether there is a risk to miss a rapidly moving system between two coupling updates. More details in :

P., 2004 : Monitoring the Coupling-Update Frequency of a Limited-Area Model by Means of a Recursive Digital Filter. *Mon. Wea. Rev.*, **132**, 2130-2141.

Piet Termonia introduced a large part of the required code modifications during the summer : setup, additional fields and constants, filtering along configuration 001, writing fields in historical files. The corresponding changes in configuration 927 are now to be addressed.

- Transparent lateral boundary conditions in a spectral model

This is the continuation of the preliminary study of Piet Termonia on how to port Aidan Mc Donald's ideas to a spectral model. Fabrice VOITUS started a dedicated PhD work last summer. More details in the "PhD theses" section.

- Coupling surface-pressure tendency

This issue is definitely closed for the Toulouse team. Jean-Marc Audoin performed some more experiments, using embedded domains with high orography along part of the lateral boundaries. The differences between coupling fields versus tendencies are negligible.

✗ (NH) dynamics

Beside the cleaning effort described in Part 2, the investigation of the impact of diabatic forcing was pursued, addressing real case studies and moist processes. The equations were derived and the corresponding changes coded in the AROME prototype. The first set of experiments, on the "Gard" case (08/09 September 2002) at a resolution of 2.5 km, show an improvement in the precipitation pattern and intensity when using an exact treatment of diabatic forcing instead of hydrostatic adjustment. More details in the stay report of Alena Trojakova.

2.22.4. Physics & Co

✗ **Equations and interface with dynamics**

A lot of exchanges, resulting in a set of equations together with both short- and long-term solutions for the physics-dynamics interfaces. More details in the papers by Bart Catry and Jean Pailleux respectively.

✗ **Meso-NH physics**

Siham Sbii and Martina Tudor spent 1.5 month in the GMME team for training on Meso-Nh physics. Besides, Siham worked on the phasing of the 1d version of AROME, while Martina studied the problems of stiffness, nonlinear instability and oscillations for the various Meso-NH parameterizations, using the 3d prototype. Significant "$2\Delta t$" oscillations (up to 1 K in temperature for a time-step of 60 s) were identified, which are damped by the predictor-corrector scheme (but not completely suppressed). The methods were the same as for ARPEGE physics a few years ago : sensitivity to a "local" change of the time-step (divided by 2 before the chosen parameterization with output fluxes multiplied by 2 afterwards) for stiffness or of the depth of layers for nonlinear instability, evaluation of the impact of time-step, horizontal resolution, H versus Nh dynamics, ...

The stay report of Martina Tudor provides a useful introduction to Meso-NH physics and its AROME interface for ALADINists. It is available on the ALADIN web site :
http://www.cnrm.meteo.fr/aladin/publications/Report/Martina_Tudor.pdf

The complete Meso-NH documentation (version of December 2001, with physics in the last sections) is available at :
http://www.aero.obs-mip.fr/mesonh/dir_doc/book1_14dec2001/book1_14122001.html

✗ **The externalized surface module (SURFEX)**

- Training

Bodo Ahrens, Andrey Bogatchev and Laszlo Kullmann were trained on SURFEX by Patrick Le Moigne, a famous former ALADIN and football expert : intensive reading of the available bibliography on the various parameterization, and off-line experiments to learn how to run it first.

A User's Guide is now available on the ALADIN web site (ALADIN-2 page, temporarily).

- Testing

Several case studies were performed :

- sensitivity to the frequency of upper-air forcing (every 1, 3 or 12 h, for a time-step of 300 s in SURFACE), over a small Hungarian domain (forcing from ALADIN-HU),
- sensitivity to the snow scheme : 1 versus 3 snow layers, for small Hungarian and Bulgarian domains, with significant differences in temperature for the Bulgarian snow storm,
- sensitivity to the number of vertical layers in the soil : 2, 3, 5 or 10 (the so-called ISBA-dif option) for an Hungarian domain,
- climate-type simulations for a domain covering Austria with a resolution of 12.2 km and forcing by ARPEGE analyses, over January 1999 and September 1999 : the simplest scheme was compared to an intermediate one, with 3 layers in the soil and 3 snow layers, but the resulting differences on net radiative fluxes keep small.

At that time, the reference snow scheme in SURFEX was the one of H. Douville, neither the old nor the new ARPEGE ones (cf Newsletter 22).

- Improving

These tests enabled to discover some problems in SURFEX, most concerning setup, and to start correcting them (this e.g. allowed Bodo to use a large domain). The parameterization of soil freezing should be revisited by Laszlo in Budapest. And Andrey dived into the advanced F90 code to introduce the present operational (in ARPEGE) snow scheme.

Besides, work started at GMME to allow the use of SURFEX in ARPEGE/ALADIN and improve the off-line mode. Discussions between GMME, GMAP and the ARPEGE-Climat team (GMGEC), resulted early 2005 in a common proposal of work plan for an operational implementation, available at : *http://www.cnrm.meteo.fr/aladin/scientific/planscientif.html* .

- Coupling

Work on an efficient coupling between ARPEGE physics (and its many declinations) and the externalized surface module (id.) restarted, with Pascal MARQUET (GMGEC) as leader.

✗ ARPEGE physics

New ingredients were evaluated : convection schemes from ARPEGE-Climat, Lopez micro-physics (with adaptations differing from those performed by Luc Gérard and described in a dedicated paper, for the while), RRTM/Fouquart radiation scheme (François BouysseL and Yves Bouteloup).

A new computation of PBL height, following Troen and Mahrt, together with an interactive formulation of mixing lengths, was coded and is under test in a parallel suite : more details in the paper by Eric Bazile. See the PhD and stay reports of Andre Simon too (parameterization of friction with respect to Ekman layer relationships and cyclogenesis).

The problem of spurious triggering of subgrid-scale precipitations, and the impact of horizontal resolution, was addressed using an aqua-planet configuration (Cecile Loo). Not so many answers up to now ...

✗ The ALARO-10 prototype

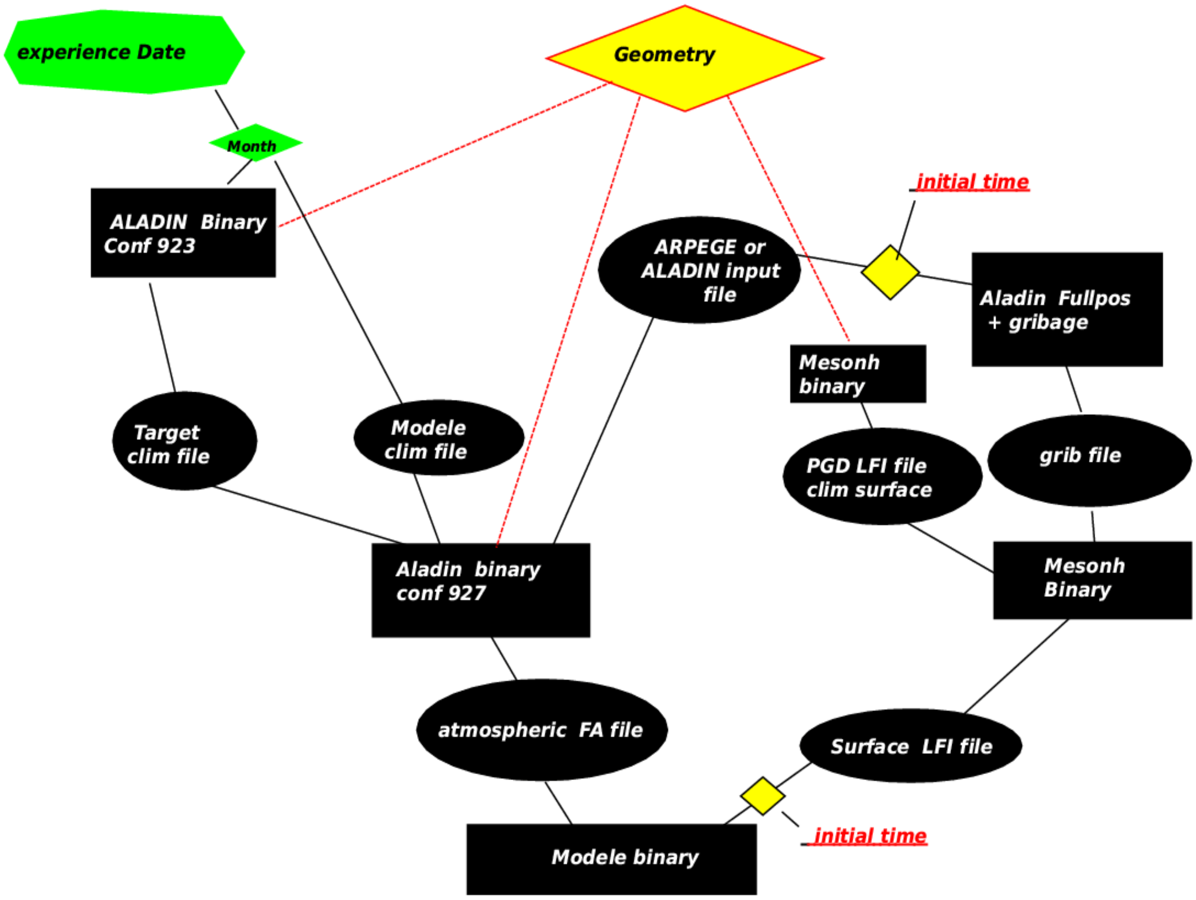
Dramatic months for ALARO-10 !

Early in the summer, the results of the first case studies were published, with a very limited dissemination at that time. They were not as good as expected, and new experiments confirmed the initial feeling. The situation at that time is illustrated in the ALADIN group report, available on the SRNWP web site. Thus an emergency alternative was then designed by Météo-France.

Later in the autumn, Tomislav Kovacic and Jure Cedilnik further investigated the problem with Gwenaëlle Hello. A first major advance was the discovery of a bug in diagnostics, with subgrid-scale (convective) precipitation not taken into account in the previous comparisons. The patterns and intensities predicted by the prototype were far more sensible after the correction, and now comparable to the operational ones on the two situations examined (see the dedicated paper). Besides, the sensitivity of precipitations either to time-step, or to horizontal resolution (5 vs 7 km) and the convection scheme (on vs off) were studied.

✗ The AROME prototype

Improved launching environment, code optimizations, and first real case experiments, for French and Romanian domains ... See the dedicated paper on AROME for more details and the following diagram, illustrating the present data flow.



2.22.5. Data assimilation

✗ **3D-Var assimilation**

There was a very intense activity in this domain, benefiting from the availability of Claude Fischer (no longer supervising directly phasing), and aiming at a parallel 3D-var assimilation suite for spring 2005. The corresponding work is described in 2 dedicated reports.

Various aspects of background error statistics ("Jb") were addressed : comparison of 2 approaches in ALADIN-france 3D-Var, redaction of 2 papers on "Ensemble" statistics by Simona Stefanescu and Loïk Berre, promising evaluation of complex wavelets (versus Meyer ones) and planification of the corresponding code modifications for ALADIN by Alex Deckmyn and Loïk Berre.

Besides the PhD work of Vincent Guidard went on (slower since he had to leave GMAP) with a further evaluation of the "Jk" approach (see his PhD report), while the thesis of Bernard Chapnik (described in a joint paper) found its first applications in the design of tools for retuning observation error statistics ("Jo"), for use in ARPEGE or ALADIN.

✗ **Var-Pack or Diag-Pack ?**

See the dedicated paper on Var-Pack, by Ludovic Auger and Lora Taseva.

The Var-Pack configuration, with $(T_S - T_L)$ instead of T_L in the control variable, modified background error statistics in the lowest levels and use of all screen-level observations (including T2m), was also evaluated within a 3D-Var assimilation cycle (i.e. exactly what was considered as nonsense some years ago) over July 2004 (questions to Ludovic Auger).

Besides, Françoise Taillefer achieved the update of Diag-Pack to cycle 28T3, with problems met in the post-processing of the specific CAPE or MOCON fields.

✗ 3D-FGAT

Beside phasing, Cornel Soci further investigated the problem of significantly different analysis increments between 3D-FGAT and 3D-Var, and costs issues too.

First it was realized that backgrounds were not the same for the two analyses : a 6 h forecast for 3D-Var, an integration based on 3 h, 6 h and 9 h forecasts for 3D-FGAT. Second, the initial experimental framework was not consistent regarding physical packages.

A comparison based on the configuration of ALADIN-France assimilation gave the corresponding figures for cost :
- memory : 3D-FGAT only 1.3 times more expensive than 3D-Var if the trajectory is stored every time-slot (i.e. every hour) instead of every time-step,
- CPU : 3D-FGAT 8 times more expensive than 3D-Var, due to the calls to physics.

✗ Digital filtering

- ***Optimisation of Digital Filtering in the ARPEGE 4D-Var***

Here is a summary of the work performed by Adam Dziedzic, with help from François Bouyssel, Gérald Desroziers and Dominique Giard, to evaluate the impact of the DFI constraints in (ARPEGE of course) 4D-Var on the spin-up of physics.

Digital filters (Lynch and Huang, 1992, Lynch et al 1997) are used twice in the ARPEGE 4D-Var. First, a Jc-DFI term is added, as a weak constraint, to the cost function (Gauthier and Thépaut, 2000). DFI is also applied to filter the last analysed state in the incremental process, that includes two minimizations each followed by a full-resolution update of the model trajectory. Because some important features of 4D-Var have changed since the implementation of DFI under that form, the aim of the present study was to check that the current use of DFI is still valid or at least well optimised.

An ensemble of 4D-Var experiments have been performed in order to evaluate the optimal combination of Jc-DFI and digital filtering of the last trajectory, called respectively inner and outer DFI hereafter.

A first set of experiments showed that incremental outer filtering (that is the present operational formulation) gives better results than non-incremental filtering, that tends to filter the fields too much.

The second set of experiments aimed at evaluating the impact of the use of the inner filtering performed inside the minimization itself. In the operational configuration, the Jc-DFI constraint is applied to all spectral fields (vorticity, divergence, temperature, humidity and surface pressure) and this term is weighted by a factor λ that was tuned by Gauthier and Thépaut (2000). An increase of λ by a factor 5 (as in the operational implementation of Jc-DFI at ECMWF) slightly improves the spin-up at very short range but at the expense of a degradation of the fit of the analysis to observations. Finally the application of the Jc-DFI to the divergence field only, with the amplification of the factor λ (as at ECMWF) did not show any particular improvement.

It has also been noted that the results obtained with and without outer DFI are very close but that the spin-up at very short range is degraded when inner and outer DFI are removed simultaneously. As a consequence, the conclusion of these different tests is that the present ARPEGE 4D-Var configuration in terms of DFI, including both inner and outer filtering, appears satisfactory.

Gauthier P. and J.-N. Thépaut, 2000 : Impact of the digital filter as a weak constraint in the pre-operational 4D-Var assimilation system of Météo-France, *Mon. Wea. Rev.*, **127**, 26-45.
Lynch, P. and X.Y. Huang, 1992 : Initialization of the HIRLAM model using a digital filter. *Mon. Wea. Rev.*, **120**,

1019-1034.
Lynch, P., D. Giard and V. Ivanovici, 1997 : Improving the efficiency of a digital filtering scheme for diabatic initialization. *Mon. Wea. Rev*., **125**, 1976-1982.

- Digital Filter initialization and ALADIN 3D-Var

The impact of initialization on ALADIN 3D-Var assimilation was carefully studied by Claude Fischer, and initial options reconsidered. See the paper on ALADIN-France 3D-Var.

✗ Observations

- In ARPEGE, in short

- From pre-processing to impact studies for satellite data (AMSUB, HIRS, AMSUA AQUA, AIRS, QuickSCAT and MODIS winds, SSM/I, ...)
- Introduction of a bias correction for radiosondes (from the IFS one)
- Starting to work on GPS data

- Status and plans for developments on radar data

The technical work required before addressing the problem of 4D-screening in ARPEGE / ALADIN is now ended. Presently we have radar reflectivity data in ODB file and we have achieved the main work to obtain a technical monitoring system for this observation type.
In particular, a new subroutine (`REFLSIM`) is called within the vertical interpolation of model fields, to compute and simulate the model-equivalent reflectivity at the observation point. This reflectivity observation-operator is an adaptation of the reflectivity simulator developed in the Meso-NH model. In particular the code organization does not allow horizontal integration as is required for radio-occultation data. However the vertical integration takes into account the radar-beam geometry, considering the radar-beam width at each observation point.

But in fact the physical interfacing is not satisfying and the required physical fields to simulate the equivalent reflectivity are not easy to obtain. So, to start with 4D-screening, we have used the diagnostic cloudy parameters (liquid water and ice) computed by ARPEGE/ALADIN physics, and the first trials show that most reflectivity data are rejected, due to too big obs-guess departures. According to this last point, the most important work is now to obtain the best required physical fields in order to have a better first guess. A new observation-operator will be built, with snow, rain and graupel as input : diagnostic fields, derived from precipitation fluxes, in the case of ARPEGE/ALADIN, prognostic ones for AROME.

Moreover we have to optimize the thinning boxes and besides improve the quality control. In particular, the impact of the new quality flags provided by the CMR ("Centre de Météorologie Radar"), stored in new radar BUFR and consequently in ODB, is to be evaluated. Maybe one could also improve screening by using a variational quality-control.

In parallel we intend to elaborate an inversion method, to provide some corrections of (T, q) profiles as retrievals from departures between the simulated and observed radar reflectivities.

✗ Else ?

SEVIRI data in ALADIN : See the dedicated paper by Thibault Montmerle.
Initialization of soil moisture : See the PhD reports of Karim Bergaoui.
LAM EPS : See the paper bu Edit Hágel. Research on EPS is temporary in stand-by at Météo-France since Jean Nicolau is now too busy with other duties on top PEACE, while the RECYF team is waiting for a new member to start such activities.

Hoping none is missing !

2.23. HUNGARY

As before our main areas of interest are data assimilation (3D-Var) and short-range ensemble prediction.

The brief summary of events can be presented as follows :

- The application of new data types of the 3D-Var scheme was continued with the tests carried out with AMDAR, wind profiler, SATOB and AMSU-B data. Most of the progress was concentrating on the development and improvement of data thinning algorithms for AMDAR data (a summary of results will be presented in the next Newsletter). The use of wind profiler data was assessed and the control of their quality was investigated. SATOB winds (cloud-motion winds) were computed from METEOSAT-8 (MSG) data and used in the data ingest procedure of 3D-Var. First trials were also taken by the pre-processing of AMSU-B data. It is hoped that all these developments together with some algorithmic improvements will lead to an overall improvement of the performance of the 3D-Var data assimilation scheme.
- Regarding our LAMEPS research and development we have further studied the sensitivity of global singular-vector computations with respect to the target domain and target-time interval (a report from Edit Hágel can be read in the present Newsletter).
- In October-November, Miklos Voros spent 6 weeks at CHMI (Prague) to get familiar with ALADIN-NH. The original topic proposed by Filip Vana was the correct definition of the bottom boundary condition (BBC) in order to eliminate chimney formation. Miklos had to prepare the ALPIA quasi-academic case to be a test-bed for the investigations. ALPIA, with its detailed orography but simplified atmosphere, represents a step between academic cases (e.g. a single Bell-shape mountain, and uniform flow) and real case studies with realistic terrain and flows. On this testbed he was to study the effects of the semi-Lagrangian horizontal diffusion (SLHD) on the chimney effect. Finally, given the opportunity he had to test the interaction of gravity-wave-drag (GWD) parameterization and SLHD. His work is yet unfinished and he will continue the job from Budapest.
- The dynamical downscaling of ECMWF ERA40 data was pursued on order to compute local wind climatology over Hungary. The length of the applied period was 10 years and a two-step downscaling was carried out : first to an intermediate 45 km resolution grid, then to a 15 km mesh, and finally a short dynamical-adaptation post-processing was run at the final 5 km resolution. Wind climatology was computed for 10 m, 25 m 50 m, 75 m, 100 m, 125 m and 150 m heights.

2.24. MOROCCO: PROGRESS REPORT ON NUMERICAL WEATHER PREDICTION.

2.24.1. A brief summary of research development and main operational changes

The operational system consists of two parts :

ALADIN-NORAF

This configuration covers North Africa to the Equatorial belt with a resolution of 31 km. It is used to provide NWP products to the ACMAD countries. In fact Morocco was engaged to produce forecasts over North Africa with a lower resolution than the other NWP models actually in use in those countries. ALADIN-NORAF is also used to provide the boundary conditions to an overlapping model ALBACHIR.

ALADIN-MAROC (ALBACHIR):

Centred on Morocco with a finer resolution of 17 km, this model is used by local operating services (short and medium range forecast, marine and aeronautic applications) and for other products for specifics users.

The two NWP suites run on a super calculator IBM (RS/6000 SP). This machine is composed of three nodes with 36 processors of 1.5 GFPLOS each (54 GFLOPS on the whole).

In parallel to the work on the operational models ALADIN-NORAF and ALADIN-MAROC, the numerical prediction team carried out several research projects in the aim to validate the new suite and to prepare futures changes. The main research projects in 2004 concern data assimilation methods (3D-Var, BlendVar) and forecast error statistics (called Jb) computation. OSEs[2] were also carried out in order to evaluate the impact of current observation systems and the contribution of introducing new ones (see part II for more details). A preliminary study on Ensemble Prediction System (EPS) has been achieved with the ALADIN-NORAF model.

2.24.2. Research and Development in data assimilation and numerical forecasting

✗ **Data assimilation methods**

A study about data assimilation methods was carried out. The aim was to realize several data assimilation cycles in order to single out the most adapted method to ALADIN-NORAF context. The first step was the running of a cycle based on 3D-Var.

Another data assimilation method called "blending" was tested in this study. 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". The last data assimilation method tested (Blendvar) was a combination of blending and 3D-Var analysis. In this case the first guess for 3D-Var analysis is created by the blending method. As main result, this study shows that Blendvar has the best impact in analysis and forecast performance.

✗ **Calculation of Jb term**

A β-plane horizontal balance has been developed and coded for the Jb term of the ALADIN 3D-Var and for the associated software of error covariance calculations. In this study, instead of taking f (Coriolis parameter) constant over the ALADIN domain, the formulation is based on a truncated spectral expansion of the meridional variations of the Coriolis parameter. It can be seen as a multi-diagonal approach, in contrast with the purely diagonal approach of the f-plane balance. This approach was first validated by examining, over the ALADIN-NORAF domain, the increase of explained variance when using the β-plane balanced geopotential instead of the f-plane balanced geopotential. The formulation was then coded in the ALADIN 3D-Var, and it was validated using in particular single-observation experiments.

✗ **Installation of CY28T3 on IBM/RS6000**

No significant changes were operated on code since the mother calculator is an IBM, only few changes in *odb* because of wrong interpretation of pre-compiler to the use of some characters as variables or as directives.

Hardware configuration :

The system is an RS/6000 SP with 54 GigaFlops composed of 3 nodes High (Night Hawk 2):

- 2 nodes of 16 processors for calcul,
- 1 node of 4 processors for file managing.

The processor is a Power 3-II with 375 Mhz and develop a power of 1.5 GigaFlops. The global machine central memory is 19 Go. The masse memory (RAID 5 discs) is 1019.2 Go

Software configuration :

AIX 5.1 ML3, XLF 8.1.1.1, C compiler 6.0, ESSL, MASS, LoadLeveler 3.1.0.21

[2] OSE : Observing System Experiment

List of compilation projects in al28t3 at that moment: *ald, arp, tal, tfl, ost, coh, sat, xrd, ut*i and *odb*

Compilation : *gmkpack.*5.7 was used

A detailed report will be given later including comparison with CY25T1. In this report comparison of request memory and time clock needed by every configuration will be compared with CY25T1. Namelists and changes will be commented.

✗ **Ensemble prediction system**

Ensemble prediction systems acquire an increasingly important place in the meteorological centres throughout the world. Thus, Maroc-Météo decided to open a shutter of research on this topic.

The method used for perturbing the initial conditions and so getting 36 members is based on the combination of multi-analysis and multi-guess systems. Three different methods of analysis are used : 4D-Var, 3D-Var and Optimal Interpolation. From each method of analysis, we run 12 analyses using each time a different guess, which makes on the whole 3*12=36 members.

This work is not yet complete, a very important stage still to do is the statistical processing of this large quantity of data. Tools of visualisation and verification are in progress of elaboration. The next months will know the first graphical results of the ensemble prediction.

2.24.3. Research and Development results for application of NWP products

✗ **Add and plotting of new parameters**

The ALADIN-NORAF model covers the Equatorial belt, characterised by deep convection and strong storms. Recently, we have added the post-processing of new parameters like CAPE (Convective Available Potential Energy), CIN (Convective INhibition) and TCLW (Total Cloud Liquid Water), useful for characterizing convective systems. Figure 1 is an example of such parameters plot.

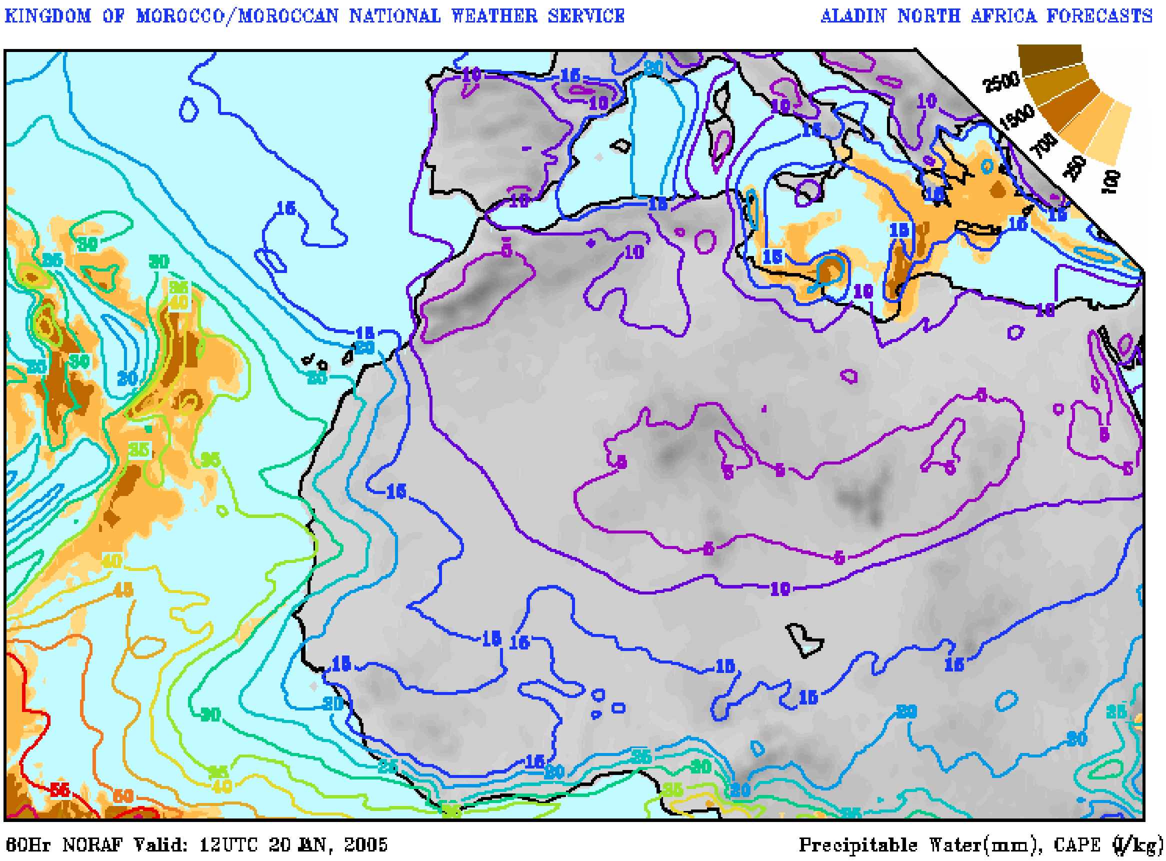


Fig.1: CAPE and Precipitable water for ALADIN -NORAF

✗ **Fight against crick**

Morocco is one of West African countries affected by cricks invasion. The motion of cricks groups is strongly controlled by meteorological conditions like rain, humidity and wind. A special model output is produced to help fighting forces to better localise areas to be disinfected.

2.24.4. Outstanding research and development activities related to improvement of the operational system

As was said above, the NWP system in Morocco is composed of two parts :

✗ **ALADIN-NORAF**

It covers the North Africa area in the aim to respond the ACMAD demand in terms of forecast products with fine resolution. The concerned domain is between 44.8° North, -1.9° South, -35.3° West and 57.2°East with a horizontal resolution of 31 km. The vertical resolution is given by 37 layers. We use a time-step value equal to 900 s. The integration frequency is twice a day (at 00 and 12 UTC). The forecast range is 72 hours and post-processing is performed every six hours. The coupling files coming from the French ARPEGE global model (via a fast connection with Toulouse, at 128 kb) are transformed to 31 km resolution on the above-mentioned area thanks to the "post-processing" configuration called ee927.

In a first stage, ALADIN-NORAF was running in dynamical adaptation mode without data assimilation. Morocco is among the pioneers in the ALADIN consortium to use data assimilation in a limited-area model. It was valid for the ALADIN-MAROC model and we try to keep the same interest for data assimilation methods with the ALADIN-NORAF model. An optimal interpolation analysis was used in the operational suite in the near past but problems with our local BDM (observation database) constrained us to stop CANARI and to run the model by dynamical adaptation. Observations were provided by the local observation database. However, there is a weakness in the conventional observations coverage, which has to direct us to the use of satellite observations. In this context, 3D-Var seems to be a more appropriate data assimilation method than CANARI. Research work was carried out in this direction and put into concrete form in a double suite with 3D-Var data assimilation mode.

Some ALADIN-NORAF outputs (charts of meteorological parameters at several levels) are available via internet (see examples in Figs 2). Moreover, it is expected that, in a near future, GRIB files from the ALADIN-NORAF suite will be sent to ACMAD countries via a satellite RETIM connection.

✗ **ALADIN-MAROC (ALBACHIR)**

It is centred on Morocco with a resolution of 16.7 km. Vertical resolution is 37 layers. Couplings files are provided by ALADIN-NORAF model. The initial state is that of ALADIN-NORAF transformed to the ALBACHIR domain tanks to the same procedure as used for coupling files : the ee927 configuration. GRIB files are produced every 3 hours and are transmitted to the operating centre and to the four regional meteorological centres in Morocco for local use.

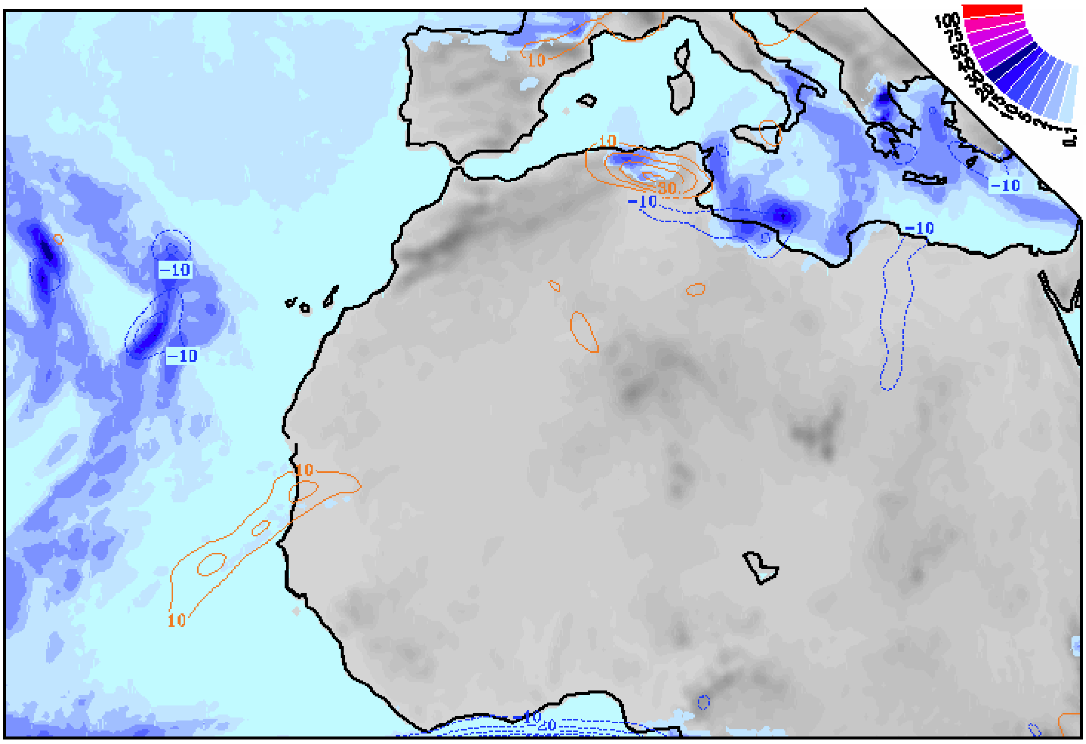
2.24.5. REFERENCE

Elouaraini, R., L. Berre, 2003 : Introduction of the β-plane into the horizontal balance equation of ALADIN Jb

Hdidou, F., C. Fischer, 2002 : Mise en place d’une chaîne d’assimilation pour ALADIN NORAF basée sur la technique Blendvar

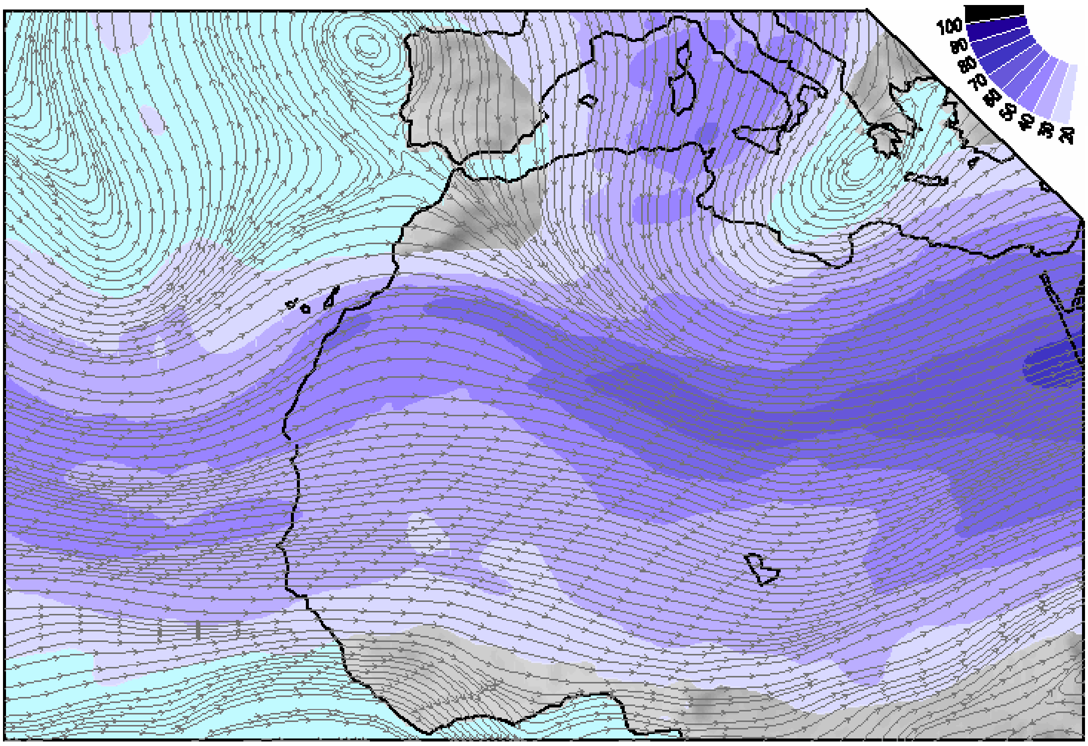
Sahlaoui, Z., E.Gérard, F.Rabier, 2002 : Assimilation of ATOVS raw radiances in ALADIN

KINGDOM OF MOROCCO/MOROCCAN NATIONAL WEATHER SERVICE ALADIN NORTH AFRICA FORECASTS



60Hr NORAF Valid: 12UTC 20 JAN, 2005 700mb Vertical Velocity(mb/hr)/6hr Precipitation(mm)

KINGDOM OF MOROCCO/MOROCCAN NATIONAL WEATHER SERVICE ALADIN NORTH AFRICA FORECASTS



60Hr NORAF Valid: 12UTC 20 JAN, 2005 200mb Streamlines and Isotachs (m/s)

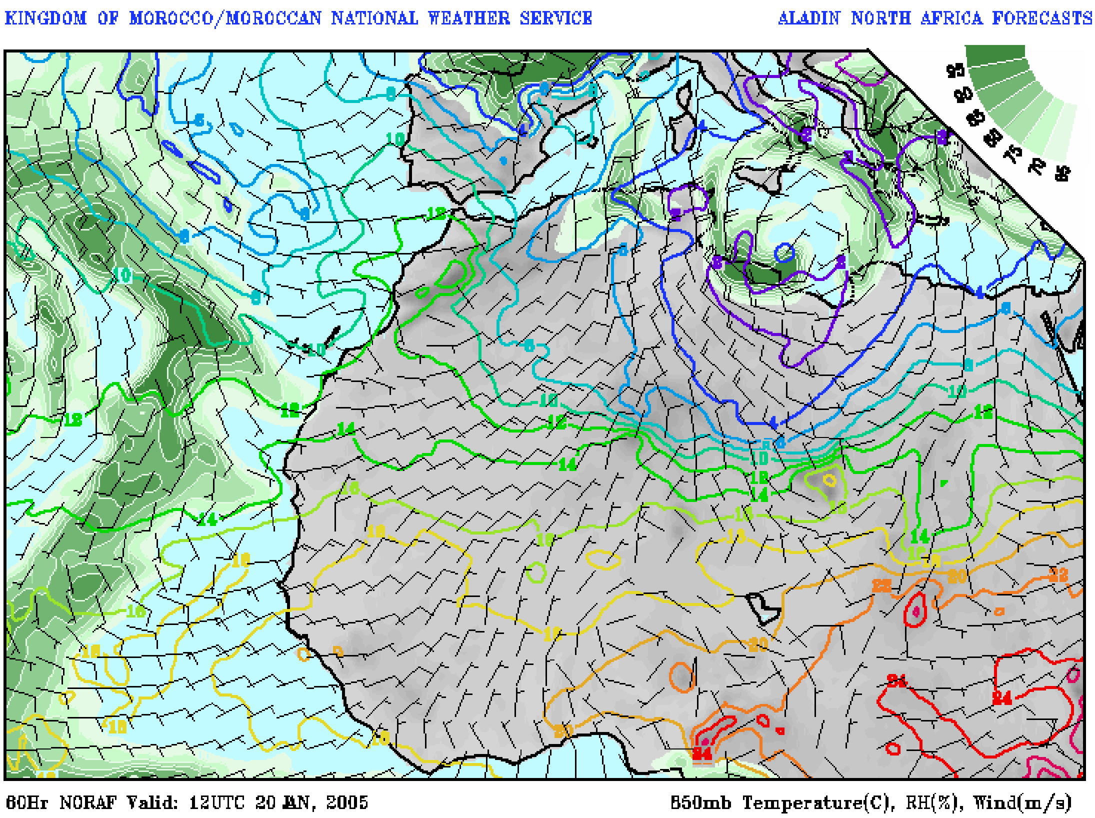


Fig. 2: Some forecast fields of the ALADIN-NORAF model

2.25. POLAND

No news.

2.26. PORTUGAL

On the development side, new diagnostic tools have been under validation in order to become operational. Those are : RISCON, thermal front parameter (TFP), and Q-Vectors. The diagnostic tool RISCON, a composition of several parameters, provides a RISk of deep CONvection (from 0 to 6) for a region by the combination of humidity in low levels, upward motion and instability. These variables are inferred by numerical parameters derived from the model output fields: moisture convergence in low-levels, vertical motion and/or Q-vector convergence and the indices Jefferson and/or Total Totals and/or Convective Instability.

2.27. ROMANIA

2.27.1. The implementation of cycle 28T3 on SUN E4500 and Linux cluster platforms (Cornel Soci)

<u>SUN platform</u>

The implementation has been performed using the explicit interfaces generated on VPP5000. Minor problems, specific to the SUN *Forte 6* compiler, have been encountered.

<u>Linux cluster</u>

The platform was designed and built in our institute. It is based on Intel XEON processor.

There are 6 nodes with 2 processors per node. The cluster is going to be upgraded with 6 more nodes.

ALADIN model was implemented using *gmkpack*, Intel compiler and *mpich* library. We are grateful to Jure Jerman, Andrey Bogatchev, Ryad El Khatib and Stjepan Ivatek-Sahdan for their kind support.

2.27.2. Dynamical adaptation of the wind using the ALADIN NH (Steluta Alexandru)

See the report of Steluta Alexandru "High resolution dynamical adaptation of the wind forecast using the non-hydrostatic version of the ALADIN model", in this Newsletter.

2.27.3. The flash flood event of 28th of August 2004 (Doina Banciu and Cornel Soci)

On August 28 south-eastern Romania (Dobrogea and eastern part of Muntenia) was affected by a Mediterranean origin cyclon evolving over the western basin of the Black Sea. The convective activity intensified over the sea during the night of August 27/28. During the day, the intense convective cells coming from the sea towards the shore and after that onto the land generated tornadic winds (waterspouts), intense electric activity, sporadic hail and an exceptional amount of precipitation: 190 l/m^2 at Constanta (on the shore, cumulated in 12 h), 318 l/m^2 at Pantelimon (in land, cumulated in 24 h).

The operational ALADIN (AL15) forecast indicated large areas of high precipitation in the south and north-eastern part of Romania but completely failed in predicting the severe weather event which occurred in the vicinity of the Black Sea coast.

For the case study two types of experiments have been carried out :

- The operational integration domain (100×100×41, Δx=10 km) was enlarged (160×120×41) for better covering the western basin of the Black Sea.
- The horizontal resolution was increased up to 2.5 km for a domain covering only the south-eastern Romania (216×216 points).

For both series of experiments the non-hydrostatic version of the ALADIN model, cycle 28T3, was used. Another difference with respect to the operational suite was the usage of the linear grid and the absence of orography envelope. For the experiments at 2.5 km the initial and boundary conditions were provided by the simulations at 10km resolution (coupling frequency 3 hours).

The results showed that the precipitation amount was increased and the convective system over the sea was more structured (especially for the simulation at 2.5 km) but there were deficiencies in positioning of the precipitation cores. The case is still under study.

We would like to thanks to Radmila Brozkova for her advices in running the non-hydrostatic version of the ALADIN model. and to Gwenaëlle Hello for providing us an AROME simulation for this case.

2.27.4. The common ALADIN verification project (Simona Stefanescu)

From this summer Romania has joint the common ALADIN verification program.

The data extraction procedure, developed by the Slovenian colleagues has been installed on a SUN workstation without any problem, using the PALADIN package. The surface and upper-air parameters forecasted by the ALADIN-Romania model for the established list of stations are sent by e-mail to Ljubljana to be inserted into the central database.

2.27.5. First test on EPS ALADIN-Romania (Mihaela Caian)

a) The integration area (the coupling domain) was regionalized in sub-domains of similar response to initial conditions perturbations; these sub-domains were identified computing a baroclinic instability diagnostic (the average rate of conversion of available potential energy of the mean flow to eddy potential energy), maximal values indicating areas with increased potential for maximal perturbation growth. An example of the separation in sub-domains of response to initial conditions perturbations is shown in Figs 1 (showing the index at 850, 550, 300 hPa). Preliminary results indicate areas of maximal sensitivity in inner-Carpathian and SV regions in the lower troposphere (as expected emphasizing with a westward tilt on the vertical). A maxima over the Black Sea at higher levels shall be further analysed in connection with local diabatic sources. The higher troposphere is characterized by a mainly dipolar structure for the tested period, with a higher sensitivity in the western region that will be also analysed further.

b) The use of SLAF (Scaled Lagged Average Forecast) method: the method is preliminary used for 6 hours lag, leading to 2 to 4 ensembles with analysis as initial conditions, depending on the comparison time; hourly ranges are compared and the error spread is analysed in connection with regions determined at a).

2.27.6. Verification of spectral coupling method on daily basis (Raluca Radu)

A verification chain of spectral coupling is performed against operational ALADIN (cycle 15). Daily and monthly scores fill daily a database for August 2004. The scale-sensitivity diagnostic tool is under development. In order to determine the impact of the spectral coupling scheme on temperature and mean-sea-level (MSLP) fields, daily and monthly distribution scores (BIAS and RMSE) maps have been realized. The results are indicating generally, an increased forecast performance when using spectral coupling.

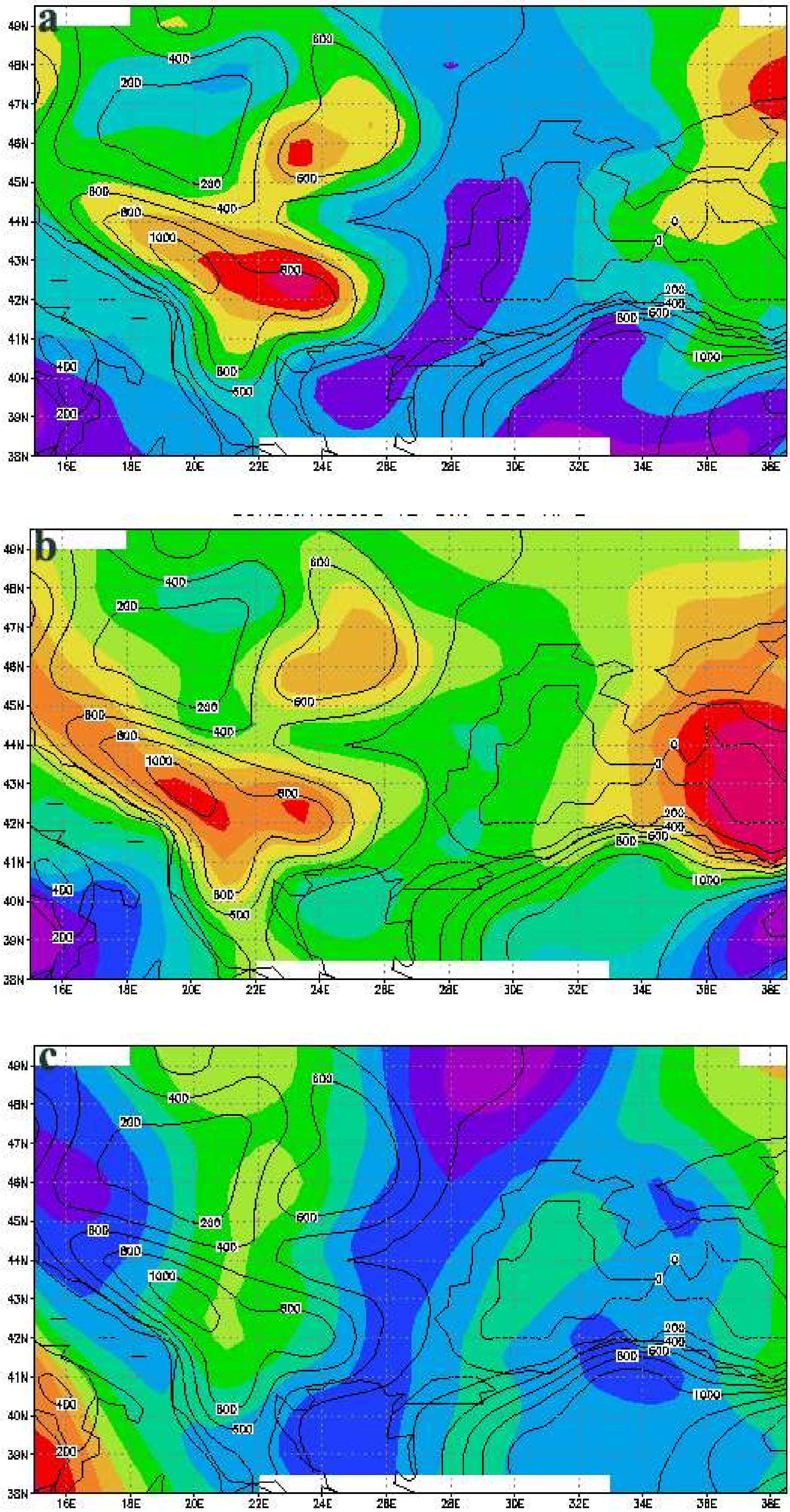


Fig.1: Instability index at 850 (a), 550 (b) and 300 hPa (c)

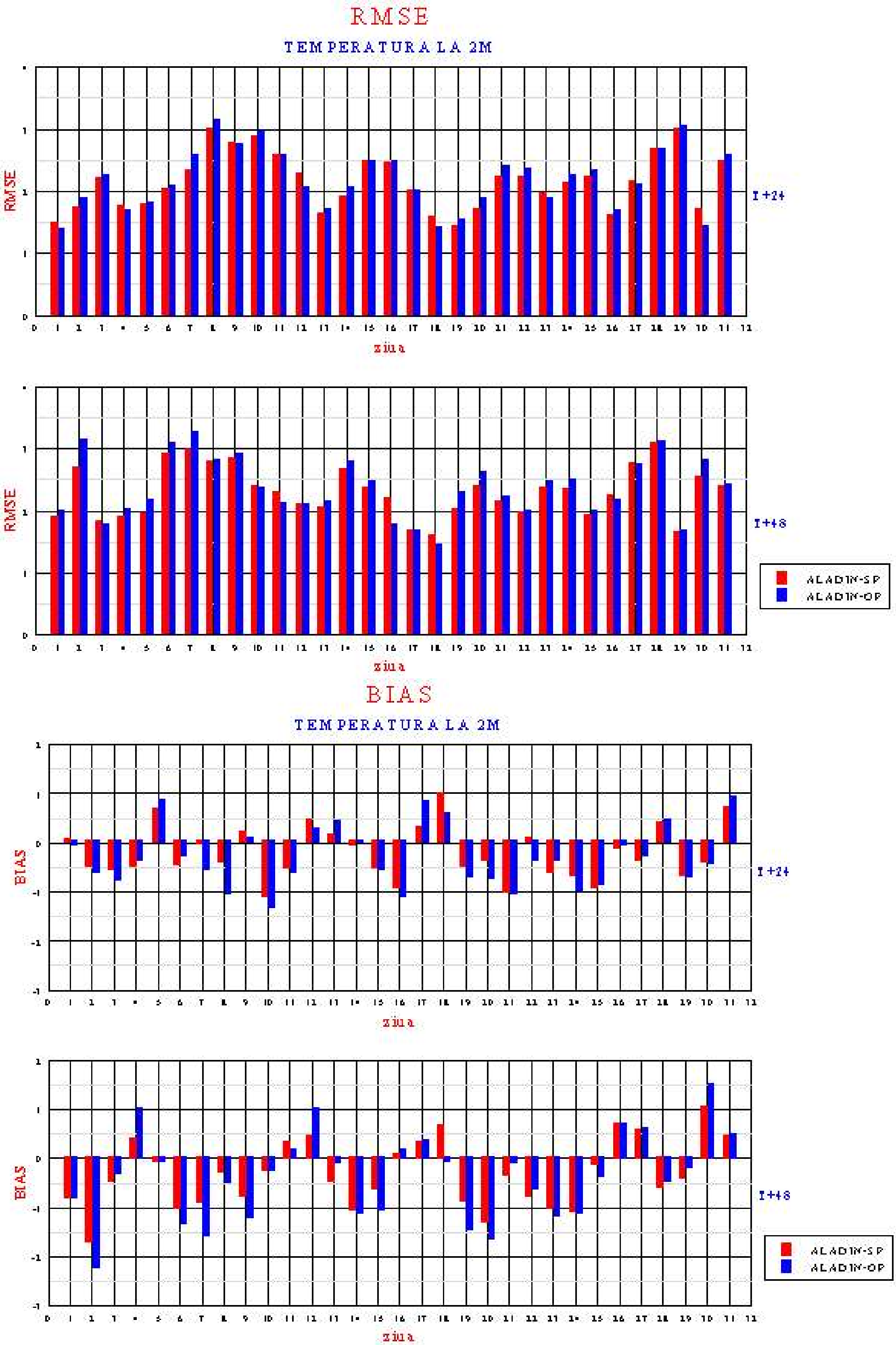


Fig.2: RMSE and BIAS daily scores for temperature using ALADIN operational without/with spectral coupling method

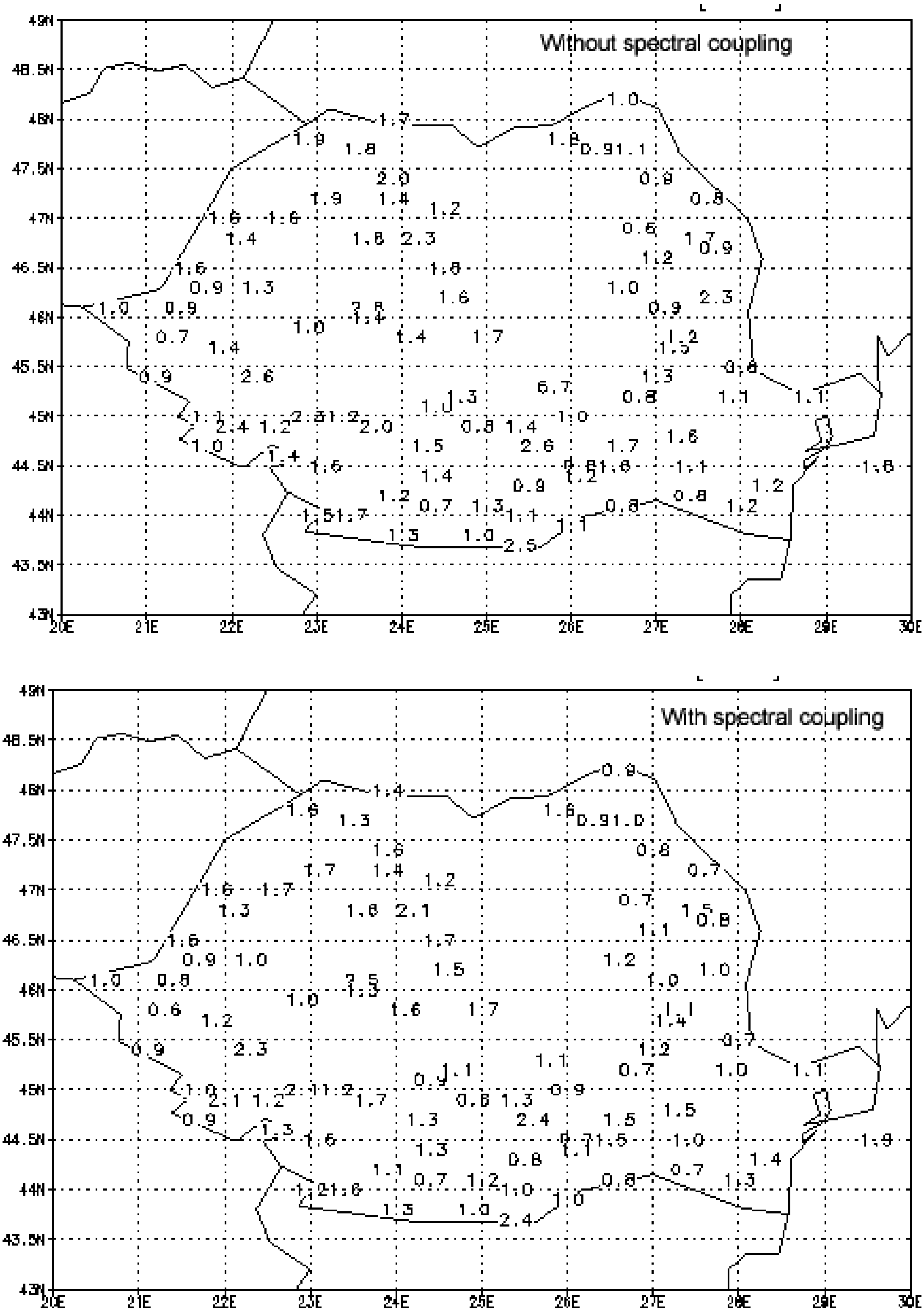


Fig.3: Monthly RMSE distribution for MSLP using ALADIN operational without/with spectral coupling method

2.28. SLOVAKIA

See the report on OPERATIONS.

2.29. SLOVENIA

2.29.1. Verification project

The web interface for visualization of data, calculation and visualization of verification scores, etc. is now accessible through internet. Authentification is not ready yet but anyone interested can ask for the address.

The verification system is still in testing mode (limited number of models, low performance) so currently we are receiving model data from 7 countries (Austria, Croatia, Hungary, Slovakia, Slovenia, Romania, Tunisia).

To solve the performance problems we tested various indexes on tables in *PostgreSQL* database and their combination, but without significant success. We are getting much more promising performances with computing differences for each model point and time slot against the observation and storing them into new separate tables and using them for computations of all verification scores.

2.29.2. Testing of Latent Heat Nudging in ALADIN Model.

Latent heat nudging (LHN) has been implemented in ALADIN model (cycle 25T1). With this method the model is forced with measured precipitation rate. Measurement data are interpolated to model grid and combined with model precipitation values. Latent heat release part of temperature tendency profile in the model is then rescaled with the ratio of observed and analysed precipitation.

LHN runs were performed for the entire year 2002. Measured precipitation data were used from the 3 closest radars. Nudging was performed for the first twelve hours of the run and after that the model was left on its own. Generally there was only marginal positive effect for LHN runs. In some cases a better spatial pattern of precipitation occurred. On the other hand there were some unrealistic cases of outbreaks of convection after the end of nudging period.

2.29.3. Probability forecast of temperature with quantile regression method

A probability forecasting can also be done with a statistical model and not only with the ensembles. An advanced regression method, called quantile regression can be used as such statistical model. This method takes into account the true distribution of residuals, and combines probabilistic forecast and statistical adaptation of NWP direct model output variables to the local conditions. The result is not only the forecasted value but we also get the accuracy estimation of this forecast. This method allows us to produce probabilistic forecast not only for discrete but also for continuous variables. For development of such statistical model the learning data set is needed, big enough to train the model.

The quantile regression method was tested on maximum and minimum daily temperature forecasts and 2 m temperature forecasts for different time ranges and for different locations in Slovenia. As predictors the observations and direct model output parameters from operational ALADIN model were used. With comparison of verification scores for quantile regression and some other regression methods it was shown that the weighted local linear principle is the most privileged method among those tested.

2.29.4. High-resolution wind climatology

Using an advanced numerical model is the best way for producing a physically consistent spatially complete climatological field of surface wind. We produced datasets using several different configurations of ALADIN (single vs. double nesting, continuous in time vs. dynamic adaptation), all initialised and driven by ECMWF ERA-40 at the lateral boundaries. The horizontal resolution we are aiming at is 2.5 km using the ALADIN model and further down to 1 km using a kinematic approach (mass-consistent model) or another dynamic model. In the next newsletter we are going to report on the results, i.e. which configuration appears to be the best for this purpose, and also present an objective verification of the obtained wind climatology.

2.30. TUNISIA

2.30.1. Changes in coupling files resolution as a solution to the transfer problem

Since the first local implementation of ALADIN-Tunisie which is running on IBM Regata platform, we used to receive coupling files from Toulouse at ALADIN-Tunisie resolution (12.5 km) via Internet connection in parallel to a leased line (64 kbits/s), but we registered too many problems to get all the files at the expected hour (06:00 UTC) because of the big volume needed to be transferred in time with regard to the LS speed (about 140 Mo).

A first solution was to practice the so-called "asynchronous forecast", but the quality became debased.

The final solution adopted with the agreement of the DPREVI/COMPAS and GMAP teams is to transfer the coupling files at ARPEGE resolution (24 km). Hence, we have installed the required EE927 configuration after applying some changes on the operational cycle (Tunisia domain, clim files, namelists and scripts). The work was done by ALADIN-Tunisie team.

A successful production test has been achieved by 23 November 2004 on 12:00 UTC run. The change to the new coupling files became operational since 24 November 2004 with 00:00 UTC run. This new configuration is running operationally without registered delay since that date.

2.30.2. Other events

✗ **Gmkpack 5.1**

The *gmkpack* 5.1 version was adopted to manage and compile ALADIN export packages on the IBM Regata platform of INM. This version was tested for the cycle 28T3 which was compiled successfully.

✗ **Configuration tests for cycle 28T3**

The configurations e927 and e001 were tested with success for the cycle 28T3. A validation work will be done in immediate future.

✗ **DiagPack**

A preliminary work was done for the installation of DiagPack on IBM Regata, this led to a successful test of the surface optimal interpolation CANARI. The forthcoming work consists in:

- Hourly integration of SYNOP data,
- MOCON and CAPE computation for Full-Pos.

✗ **VerifAlad**

The compilation and the implementation of the VerifAlad package in the operational regime was done with success. Data to be verified and assessed are sent twice a day for the two networks of the day (00:00 and 12:00). Ten synoptic stations were chosen for a test period control.

3. ALADIN PhD Studies

3.1. Incrementality deficiency in ARPEGE 4d-var assimilation scheme: Radi Ajjaji: .

On temporary (?) leave from Maroc-Météo.

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

Writing a paper in parallel to operational duties at home (see the Romania R&D report and the additional paper in this Newsletter).

3.3. Estimation and study of forecast error covariances using an ensemble method in a global NWP model: Margarida Belo-Pereira.

Trying to write a paper and the PhD report in parallel to operational duties at home.

3.4. Further Improvement of a Simplified 2D Variational Soil Water Analysis: K. Bergaoui.

An extensive validation of the 2D-Var method with observed precipitation increments was performed, examining in particular the response of the analysis increments and the total soil water content to a such correction. The effort is now put on the redaction of a paper summarizing the work performed within the ELDAS project.

3.5. Evaluation of assimilation cycles in a mesoscale limited area model: Vincent Guidard.

3.5.1. Formalism: a very brief reminder

More details in the Newsletter 26 issue.

To input an information about the larger scales of the ARPEGE analysis in the ALADIN 3D-Var, a new term is added in the cost function:

$$J(\delta x) = J_b(\delta x) + J_o(\delta x) + \frac{1}{2}(d^k - \boldsymbol{H}_2\,\delta x)^T V^{-1}(d^k - \boldsymbol{H}_2\,\delta x),$$

where $d^k = H_1(x^{AA}) - H_2(x^b)$ is the innovation vector with respect to the larger scales of the ARPEGE analysis, and V the error covariance matrix related to this source of information.

3.5.2. Evaluation over a 15-day period

✗ **Experimental framework**

The evaluation is performed over a period from the 1st to the 15th of June 2004.

- ***Datasets***

In order not to use the same observations in ALADIN 3D-Var as in ARPEGE 4D-Var, two datasets have been prepared. The first one is composed of all the observations outside the ALADIN-France domain plus a random half of the observations inside the ALADIN-France domain. The other half of the observations inside the ALADIN-France domain is the second dataset. Thus an ARPEGE assimilation cycle and its subsequent coupling files have been recomputed.

- ***Error Covariances Statistics***

The "lagged NMC" statistics are used for B (Široka *et al.*, *Meteor. Atmos. Phys.*, 2003).

The ensemble evaluation described in the previous Newsletter is used for V.

- ***Experiments***

Our reference experiment is a "classical" ALADIN 3D-Var, i.e. a "J_b+J_o" 3D-Var, hereafter called BO. The experiment that we want to evaluate is "J_b+J_o+J_k" 3D-Var, hereafter called BOK.

- ***Score computation***

The scores are computed on the forecasts of our 2 experiments, with respect to the TEMP observations valid for that time. 6-hour forecasts have been computed for each analysis time, 48-hour forecasts have been performed for the 00 UTC and 12 UTC analysis time.

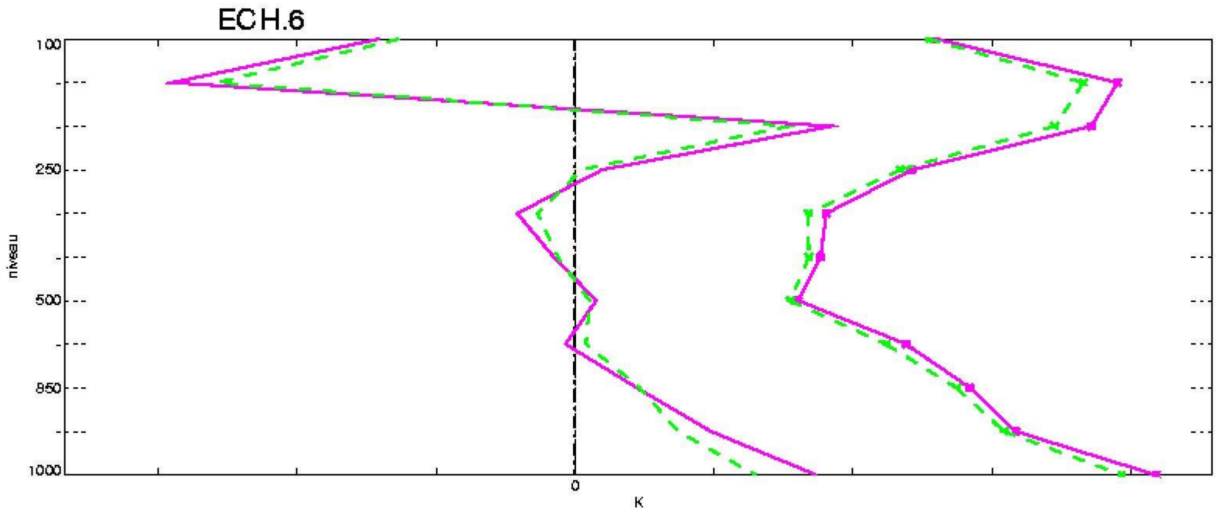
✗ **Results**

- ***6-hour forecasts***

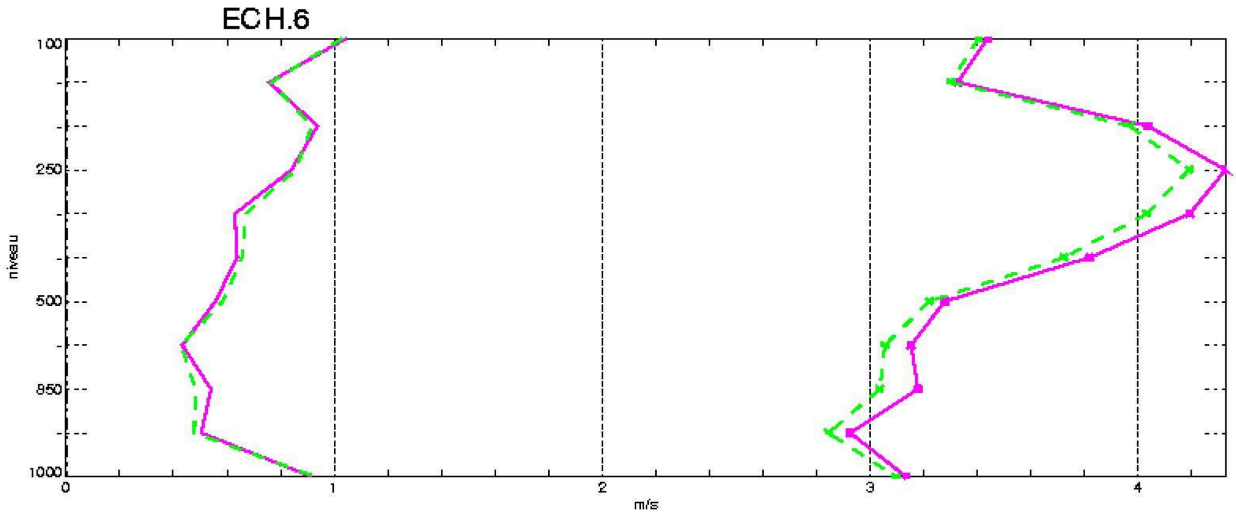
BO is in solid magenta, BOK in dashed green. Biases are plotted without symbols, RMS are with symbols.

The BOK experiment is clearly better than the BO one for temperature RMS. There is also an improvement for temperature bias, but the peaks at the tropopause and in the stratosphere are not significantly reduced. The wind RMS is nicely reduced. No other clear and visible conclusions can be drawn from these scores.

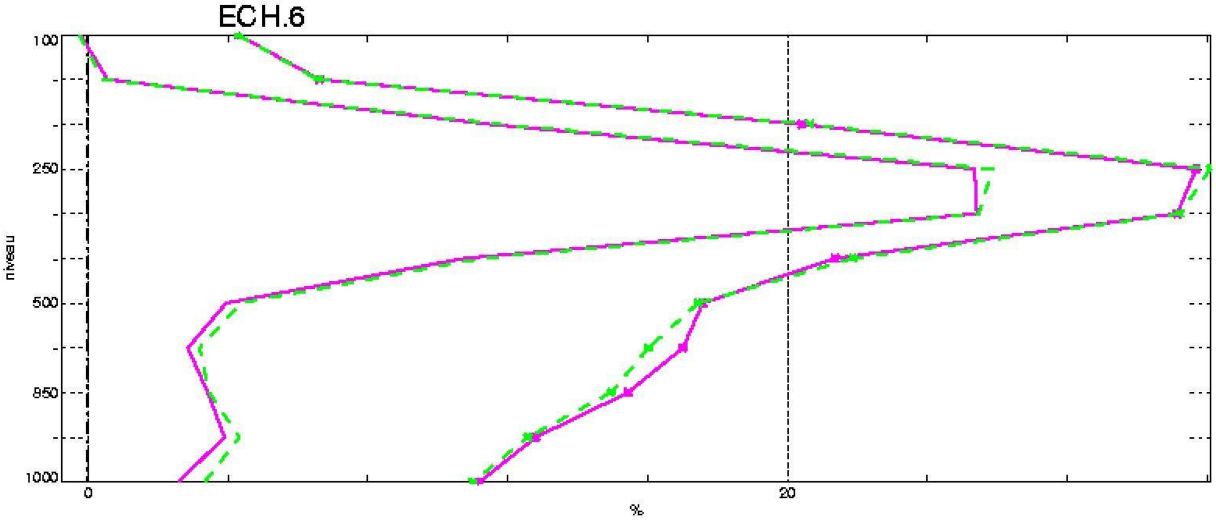
Temperature



Wind



Humidity

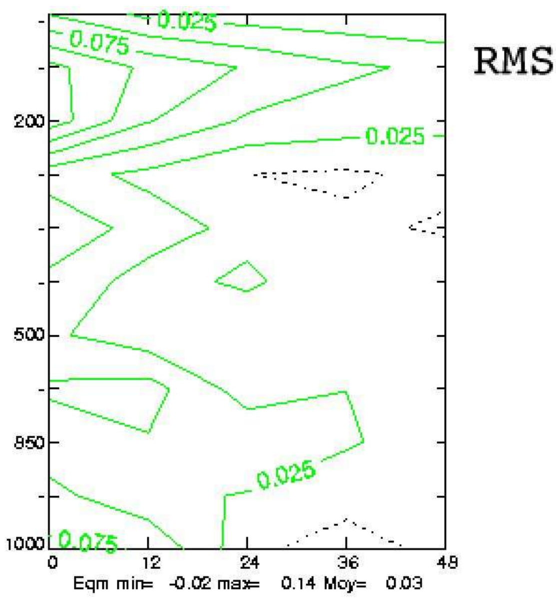


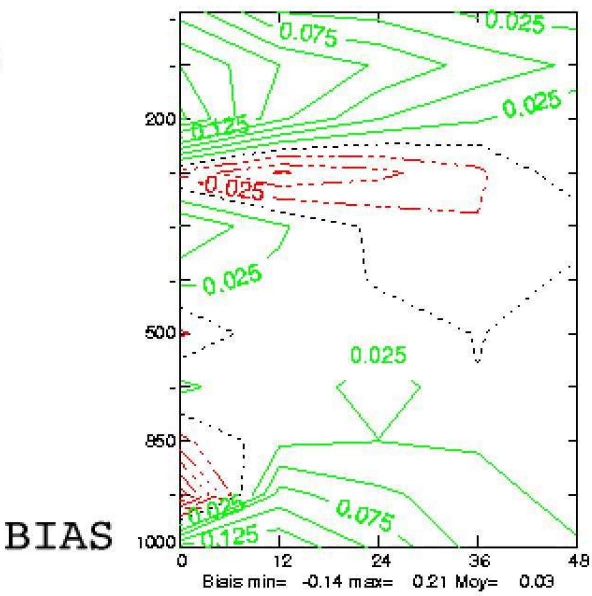
<u>- Time evolution of the scores</u>

Vertical levels in ordinates, forecast range in abscissa.

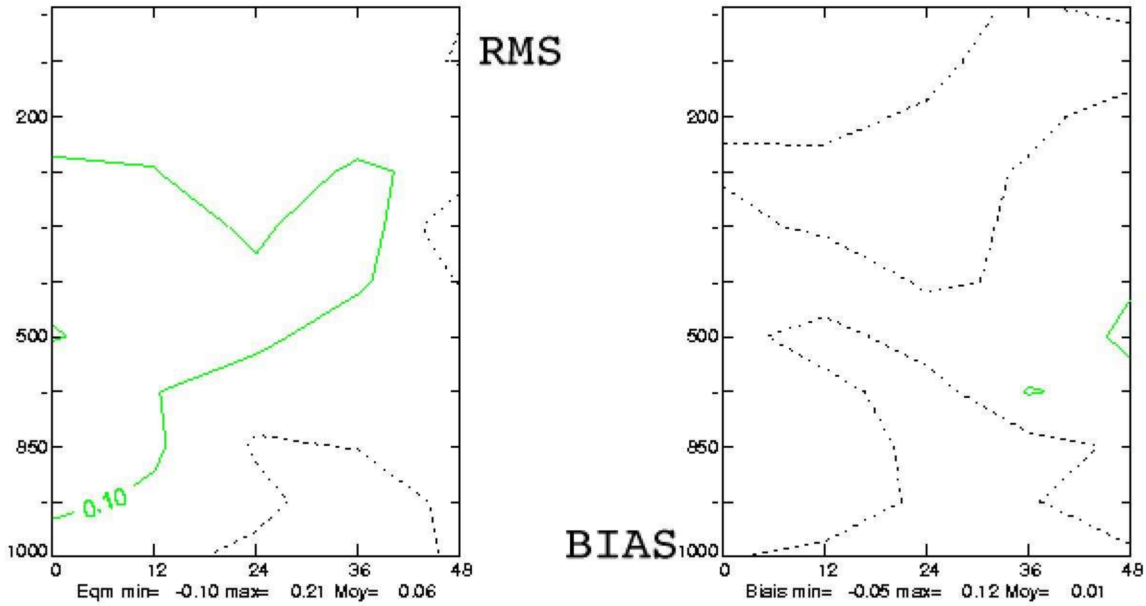
Green: BOK better than BO, Red: BOK worse than BO

Temperature

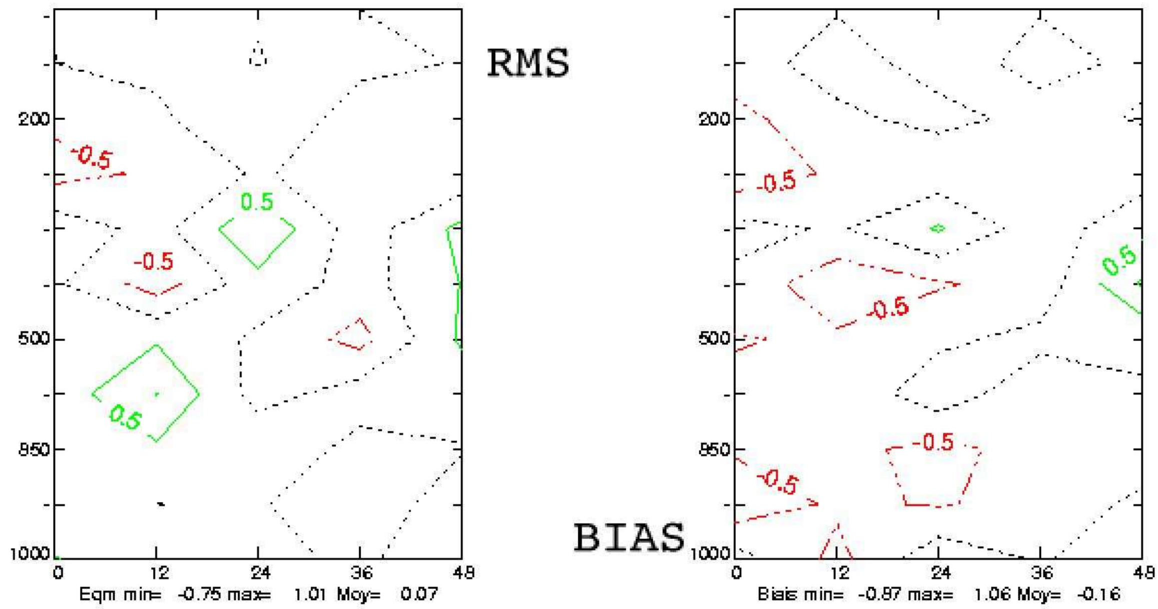




Wind



Humidity



No significant conclusions can be drawn for the wind and humidity scores. Nevertheless, the improvements on the temperature field are pretty encouraging, especially in the stratosphere and in the lower troposphere, both for bias and RMS.

✗ Conclusion

The objective evaluation of the BOK experiment leads to neutral or significantly positive scores, depending on the variable we focus on. No specific improvements were expected for the humidity field, as there is no constraint for this field in the J_k term. The reduction of the RMS for the temperature and wind fields is a clear signal that we modify the description of the atmosphere in the right way. The temperature bias is not sufficiently improved, especially in the upper troposphere.

The truncation at wavenumber 12 applied to the information from the global model may be a bit too drastic. A higher truncation (e.g. 20-25, closer to the one used in DFI-blending) may improve the description of the larger scales of the global analysis, and thus the quality of the BOK ALADIN analysis.

3.6. Interaction between physical processes: cloud life cycle, cloud transient states: Jean-Marcel Piriou.

The PhD work is now achieved and the report ready. Here is the extended summary :

The present PhD work focuses on convection parameterizations for use in GCMs or regional models. Firstly, a diagnostic study of the ARPEGE global NWP model was carried out: (i) comparing single column predictions versus 3D high resolution models (ii) studying the diurnal cycle of the 3D model: local solar time of precipitation maxima or cloud vertical extent.

Secondly, a review of articles about convection phenomenology and parameterization is done. The concept of BCC (Bulk Convective Condensation rate) is introduced to remove the chicken and eggs dilemma, in convective parameterization causality.

It is shown that (i) the humidity convergence cannot be used alone for dimensioning the convective activity within the present parameterization (ii) the hypothesis of an uniform detrainment coefficient has to be relaxed to make the deep parameterization scheme relevant not only for wet cases, but also for drier mid-atmospheric ones or in the vicinity of non-precipitating convective states.

Finally, a new convective scheme is introduced, whose formalism can handle dry, non-precipitating or precipitating convection. (i) The updraft ascent scheme deals explicitly with in-cloud condensates (liquid or ice), adjustment and auto conversion (ii) large-scale equations are expressed directly in micro-physics and transport terms (iii) the closure can shift continuously from a CAPE behaviour to a humidity convergence behaviour (iv) a diagnostic in-cloud vertical velocity is used to determine cloud extent and penetrative updrafts. The results show the relevance of a convective parameterization directly expressed in terms of micro-physics and transport, i.e. Up steam Yanai and al. 1973.

The present work thus deals with three convection-related topics: phenomenology, parameterization, validation of parameterization results.

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

Further validation of the new method : see the Romanian contribution to research and developments.

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

Defence scheduled for April 7th !

3.9. Study of the relationship between turbulent fluxes in deeply stable PBL situations and cyclogenetic activity: André Simon.

Work is still focussing on the study of the relationship between turbulent fluxes and cyclogenesis. The present study (or, better to say, what was studied in Toulouse) is more related to parameterization of the mixing length of momentum with respect to Ekman friction. See the stay report for more details.

3.10. Systematic qualitative evaluation of high-resolution non-hydrostatic model: Klaus Staldbacher.

See the Austrian contribution to research and developments.

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

Continuing the work started in 2003, the experimental comparison of the ensemble approach with the standard and lagged NMC methods, regarding the estimation of the error statistics for the ALADIN 3D-var data assimilation, has been carried out. It was found that the error spectra provided by the ensemble method are intermediate between those of the two other methods.

The differences with respect to the representations of the analysis step and of the involved forecast ranges have been studied. The analysis equation appears to be the equation that transforms the background and observation errors into the analysis errors. In the ensemble technique, the analysis step is also represented by the application of the analysis equation, which transforms the background and observation perturbations into the analysis perturbations.

In the standard NMC method, the representation of the analysis step consists in adding some analysis increments to some evolved earlier increments, instead of applying the analysis equation to some background and observation perturbations. It appears moreover that the analysis increment spectrum is much larger scale than the analysis dispersion spectrum. These increment structures, their accumulation and the forecast evolutions contribute therefore to the enhancement of the large-scale variances in the NMC method, compared with the ensemble approach.

The ensemble technique has also been compared with the so-called lagged NMC method. The links between the implied forecast differences and the ARPEGE/ALADIN model differences have been illustrated. The larger amplitude of the ensemble large-scale variances, compared to the lagged NMC method, may be explained by the representation (in the ensemble approach) of the initial condition uncertainties and of the associated lateral boundary conditions uncertainties.

Two papers realized in collaboration with Loïk Berre and Margarida Belo Pereira have been finalized and submitted to Monthly Weather Review and Tellus:

Stefanescu, S. E., L. Berre and M. Belo Pereira : The evolution of dispersion spectra and the evaluation of model differences in an ensemble estimation of error statistics for a limited area analysis. *Submitted to Mon. Wea. Rev.*

Berre, L., S. E. Stefanescu and M. Belo Pereira : A formal and experimental comparison between an ensemble estimation of limited area model error statistics and two other error simulation methods. *Submitted to Tellus.*

3.12. .Use of IASI/AIRS observations over land: Małgorzata Szczech-Gajewska.

Welcome to Alicja, born on October 30th !

3.13. Application of the Predictor-Corrector Method to non-hydrostatic dynamics: J. Vivoda.

The writing of a common reference article about the NH dynamics of ALADIN has started at the end of reported period. I will contribute to it with the results of idealized and real case studies as a co-author.

3TL predictor/corrector scheme with Eulerian advection treatment has been coded and validated and actually pre-phased into main branch. It will be available for ALADIN community from cycle 29T2. Also the grid-point semi-Lagrangian advection of vertical velocity, implemented with NH prognostic variables *d*3 and *d*4, will enter cycle 29T2.

3.14. A survey on well-posed and transparent lateral boundary conditions (LBCs) in spectral limited-area models: Fabrice Voitus.

The "flow relaxation" scheme of Davies (1976) is presently the technique the most widely used for treating the lateral boundaries. It consist in defining a "relaxation zone" next to the boundary within which all the prognostic fields are relaxed toward the externally supplied "host model" fields (being understood, as in McDonald (2000), as the model supplying the boundaries fields for the limited-area "guest model"). Despite its almost universal use in operational limited-area numerical weather prediction model, the "flow relaxation" scheme has still some unavoidable weaknesses. Over-specification implies that the problem to be solved is ill-posed : we impose fields at the boundary which are not strictly necessary from the point of view of the inwardly characteristics velocities (see Oliger and Sundström, 1979, for details). Moreover, because of the difficulty to determine a suitable width for the boundary relaxation zone (see Kallgerg 1977), the treatment of the boundary is not fully transparent and can generate spurious gravity waves which propagate back into the domain. In order to circumvent these weaknesses, McDonald (2000, 2002, 2003) propose an elegant alternative to the flow relaxation scheme in the (grid-point) HIRLAM model using a C-grid finite-difference scheme. His new LBCs treatment removes the idea of a relaxation zone by imposing the host model fields on the boundary line only (as it's mathematically required) and tries to reduce false wave reflections at boundaries to a minimum while maintaining well-posednesses, as suggested by the theoretical work of Engquist and Majda (1977).

The main object of this study is to try to transpose McDonald's idea to the case of spectral limited-area models (Haugen and Machenhauer 1993). The last months have been essentially devoted to bibliography and to the implementation (as properly as possible) of the well-posed transparent boundary condition derived by McDonald (2000) into a linear spectral 1D shallow-water model. In the spectral model based on Haugen-Machenhauer solution, before the use of fast Fourier transforms (FFT) in the horizontal direction, the fields are extended into a meteorologically meaningless so called "Extension zone" (hereafter E-zone) outside the integration area (hereafter C-zone) in such a way that periodic fields are obtained. Given the field in the C-zone, the values set in the E-zone result from a purely mathematical operation performed by means of a linear spline operator. The coupling is now performed only at the boundary of the C-zone, at the beginning of the time-step.

A first attempt has been made by Termonia (2003) who has found encouraging results for a 2TL-SISL discretization, when small time-steps are used. Termonia has shown that the periodic spline operator should be apply at each time-step to ensure consistency of solution over the C-zone. However, this procedure is too expensive, for the while, to be intensively used. That means that well-posed and transparent LBCs in a spectral model of Haugen-Machenhauer type suppose that we pay a special attention to the "E-zone". In the continuation of Termonia's experiments, we have imposed the characteristic fields at boundaries and observed that this LBCs give satisfactory transparency condition, (there are still spurious reflections, but with acceptable amplitudes). Unfortunately, further experiments with larger time-steps, such as those usually allowed by the semi-implicit semi-Lagrangian time-stepping, lead to computational instabilities. For now, it is difficult to identify the cause of such an instability, but we remain optimistic.

4. PAPERS and ARTICLES

4.1. Some informal news from the AROME project: F. Bouttier, G. Hello, S. Malardel, Y. Seity, with help from many others.

This paper presents an overview of the design choices of AROME and an update on the status of its development.

4.1.1. Objectives

The basic reason for making AROME is to get ready for the next generation of computers, observations and users' requirements, by taking the best of what is already available – ALADIN-NH dynamics and software basis, some physics that are guaranteed to work well at kilometric scales, the IFS/ARPEGE/ALADIN variational analysis – and putting it together as a newer, better operational system. Over ten years of experimentation in the mesoscale research communities have given strong indications that it is a realistic goal, at least, for the most important aspects: much improved precipitation forecasts than in ALADIN. The choice of ALADIN-NH dynamics and ALADIN-3DVar to do AROME is a tribute to the excellent work of many ALADIN scientists who contributed to these projects, as confirmed by the many peer-reviewed publications on their scientific content.

The same software basis in AROME as in ALADIN – the IFS/ARPEGE library – is used, which provides a guarantee that there will only be minimal disturbances to the partners' operational practices. Only a small amount of technical adaptation will be required on the partner NWP services to switch to AROME when they want to start using it. In the meantime, ALADIN will keep running (and improving through the work done on improving its big brother ARPEGE), and ALARO will provide a much improved alternative to ALADIN for those who cannot switch to AROME.

4.1.2. Using the Méso-NH physics

The choice of the complex Méso-NH physics (compared to the ARPEGE/ALADIN physics) was driven by the user requirements to improve products such as quantitative precipitations, small-scale convective rain and gusts, 3D distribution of cloud ice and water, aircraft icing and turbulence risk, urban weather and air quality, accidental pollutant dispersion, road conditions, coastal weather, fluxes for ocean models. Since the Méso-NH physics already are in a usable state, the priority of AROME is the software engineering and qualification for NWP applications, to be done in a fixed time.

As models go to higher resolutions, more subgrid-scale processes are explicitly resolved on the model grid. The AROME physics only borrows from Méso-NH the parametrizations that have been proved to be of significant importance at 2.5km resolution in Méso-NH experiments (the choice is confirmed by other NWP groups):

- a 1-D (i.e. vertical) prognostic turbulent mixing scheme
- a 1-D state-of-the-art radiation scheme
- a cloud micro-physics scheme that separates at least between liquid water and ice, and between small cloudy particles and bigger hydro-meteors
- the best affordable surface scheme, consistent with the available physiographic databases
- a shallow convection scheme

The schemes have been thoroughly validated in a large number of Méso-NH tests: convective storms, hurricanes, synoptic storms, PBL city weather, field experiments such as PYREX and MAP, and many more. There are some changes with respect to the ALADIN philosophy: the surface scheme has explicit time-stepping (not a problem with the AROME time-step, which is much shorter than in ALADIN), the vertical discretization is different, the surface scheme is externalised, and the coding rules, but are a bit different from the ALADIN ones. It was found more efficient to adapt to this new physics software than to rewrite it; an abundance of documentation, peer-reviewed publications and scientific experts is available on the Méso-NH physics.

The vertical turbulent scheme is based on a turbulent kinetic energy closure. It is prognostic, which should help with the depiction of the evolution of boundary layers and clouds. It is scientifically very close to what is being implemented in ARPEGE/ALADIN in 2005 at GMAP (although the code itself is still different). For very high resolutions, theory tells that the turbulent scheme should be a 3D one (i.e. elaborate horizontal mixing), however this effect seems to be significant only at resolutions higher than 1km, 3D turbulence is very complex and expensive, and the parametrization is still far from being in a satisfactory state, so it was decided to stick with a 1D scheme for the next few years.

The radiation scheme is very important for cloud/radiation interaction, and for the production of accurate fluxes at the surface (which is critical for some users). Since it is a lot of work to develop a competitive radiation scheme, it was decided in Méso-NH (and hence in AROME) to use a recent version of ECMWF's radiation scheme, RRTM, which happens to be already conveniently installed in the ARPEGE/ALADIN code.

The cloud micro-physics scheme (called ICE3, because it has three prognostic icy variables, on top of 2 liquid water ones) is scientifically very complex, and deals separately with the conversion («slow») processes, and the ones related to precipitation and saturation («fast» and adjustment). Condensed water species do not have special prognostic temperature or speed, but they interact with the gaseous thermodynamics in complex ways.

The surface scheme is derived from the ISBA we know in ALADIN, but now, with many more processes, since it now includes tiling (i.e. several different surfaces may coexist in each model column, each with their own surface temperature), prognostic models for towns (with a special geometry for walls, roofs and streets, to represent urban heat island effects in particular), lakes, snow, and soon superficial ocean layers (so-called 1D «pseudo-3D» mixed layer). Technically, the really difficult issue is that it means dozens of new surface fields (physiographic and prognostic) in the system. It is no longer necessary to allocate them inside the ALADIN software (because they belong to the surface software, called SURFEX**)** but plugging these new fields inside our NWP technical environments is going to be a significant challenge: one will need, either to manage the model history as two files (one for the ALADIN atmosphere, one for the SURFEX state), or to define, allocate and maintain all these new 2D fields (as well as some non-2D data, there are coefficients and matrices) into the FA files. Fortunately, SURFEX already has a complete environment for computing climate files from high-resolution physiographic databases (the ECOCLIMAP database), doing I/O on SURFEX files and producing diagnostics.

The shallow convection scheme is not yet finalized, and work will be done on this topic in 2005.

This physics package will have its own problems. All convection is not resolved horizontally nor vertically at a resolution of 2.5km and L41 levels. Some of the turbulent eddies are partly resolved, which may cause problems akin to the subgrid convection issue in 10-km resolution models. Some of the cloud physics are missing, which may hurt the description of some cloud types. They may not be serious issues in practice, but they need to be carefully monitored on a good enough sample of real test cases, because they might lead to an evolution of the scientific strategy. The Méso-NH group keeps working in this field, on chosen test cases to target specific processes, it is necessary to complement this effort by looking at NWP-style validation, with lots of unselected cases, and a global view of the performance of the AROME model.

4.1.3. The state of the prototype

Upon examination, it turned out not to be too complicated to plug the Méso-NH physics into

AROME. Yann Seity and Sylvie Malardel produced a first working version of the so-called AROME prototype in just a few months (the word "prototype" means that it is a bread-board testbed that needs to evolve into a clean and efficient configuration). Basically, the relevant Méso-NH and SURFEX source code has been extracted as libraries, and linked with the ALADIN-NH code through a specific physics interface (APLAROME) beside APLPAR. Although the timetable of the AROME project will not allow too ambitious plans for redesigning the physics interfacing from a theoretical and technical point of view, significant improvements can and will be done under the constraint of the available workforce.

The first step for AROME was to prove that it could compete with Méso-NH in terms of quality and cost. This required some Méso-NH-style testing on simplified cases: the dry ALADIN-NH dynamics on low-level orographic waves (already presented a few years ago), 1D simulation of convective and stratiform clouds (using the 1D model with physics), 2D vertical plane simulation of a convective system (an idealized African squall line), 3D simulation of an idealized convective cloud. All these tests revealed differences between AROME and Méso-NH, but no spurious behaviour of AROME.

The first real test cases were run in 2004. Each one required some considerable manual work, due to the technical nature of the prototype. There has been one famous convective flood event in the SE of France (the "Gard case"), and a thunderstorm system on the plains around Paris. On both cases, it was demonstrated that the AROME prototype was

1. performing at least as well as Méso-NH (although there is room for improvement of AROME),
2. sensitive, in a positive sense, to the assimilation, by checking that an AROME run started from a mesoscale analysis does indeed perform much better than one in purely dynamical adaptation mode (which justifies the current effort on developing mesoscale data assimilation).
3. much more efficient than Méso-NH in a CPU sense (by a factor 10 or so), thanks to its longer feasible time-step (which could be stretched to 1 minute, which remains to be confirmed on a wider panel of cases), and not more expensive than what is affordable, computerwise, at Météo-France in 2008 (which looks like a realistic goal so far).

To obtain these results was a huge relief. Although they do not prove that AROME is mature enough to be safely used in operations, they go a long way towards proving that, even though unexpected problems with probably be discovered in AROME in the future, they will be tractable. It also proved that it was feasible to work in a mutually beneficial cooperation between the Méso-NH research groups and the NWP community.

The work on the «old» ALARO model concept (i.e. AROME + convection scheme running at 5, 7 or 10km resolution) has been interesting for the comparison with AROME, too. It was mainly done by G. Hello, T. Kovacic, L. Kullman, who ran the Gard case (and a «Czech front» case) at various resolutions. It showed that the Méso-NH physics can work at larger scales and longer time-steps, although it has not been proven to beat the ALADIN physics at low resolutions.

Further test-cases are being worked on. There has been a case on Romania, on the MAP field experiment (see figure), and more are planned, usually involving ALADIN partners or scientific visitors. The results will be shown to the ALADIN community, of course. But there is a limit to the usefulness of test-cases for NWP, and it will soon be time to start running AROME every day (on a small domain for computational reasons, until the next computer upgrade) in order to test what AROME is worth in terms of robustness (does it ever blow up or produce silly forecasts ?) and average NWP performance (we have worked a lot on convection in AROME, but what about the other kinds of weather ?).

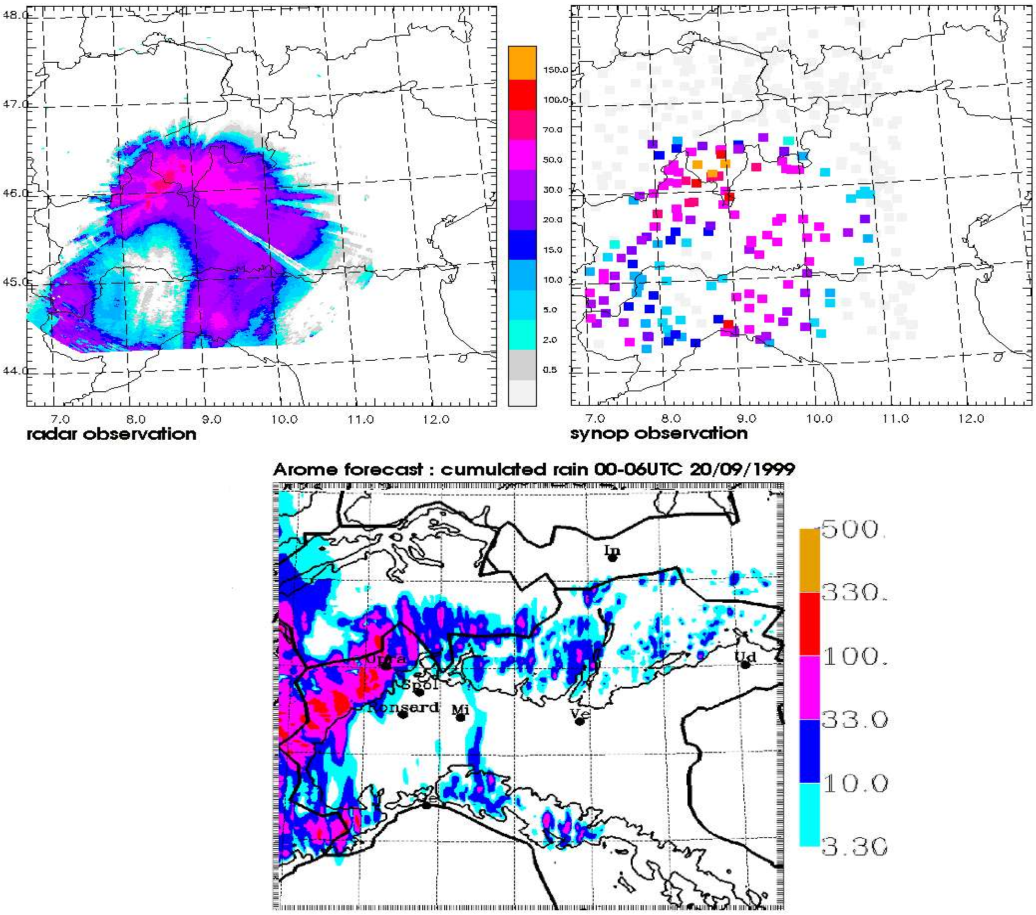


Figure : A rain forecast with the AROME model, started on 19/09/1999, 00UTC from a large-scale analysis(mm cumulated over 6 hours, MAP POI2B case), with radar estimates and SYNOP rain-gauge verification. The model was run by Y. SEITY.

4.1.4. The remaining work

As any good cook (French or not) will say, to make a good meal you not only need the best ingredients, you also need flawless preparation. The AROME model of 2004 is nothing like a ready-to-wear product. To prepare initial conditions is inefficient: one needs to run Méso-NH software every time there is a change to the model geometry. Post-processing is cumbersome, in order to plot most kinds of fields the AROME files have to be converted back into Méso-NH and then fed into a specific plotting package, some fields just cannot be post-processed at all because Full-Pos does not yet understand the AROME surface fields. There is no provision for deported AROME execution yet, for lack of e927 and ee927 coupling file processing jobs that can handle the externalised surface. And AROME has flaws in its parallelization and its computational optimisation. All this means that AROME can currently be used for scientific experimentation, but not for routine production.

It is not as bad as it sounds: only small software development is needed to recover in AROME all the functionalities that ALADIN offers, since the bulk of the software is essentially the same. The main annoyances come from the externalised surface (called SURFEX) and the presence of new 3D fields in the model. They can (and will) be cured with appropriate software developments which are not big, but must be done. The technical issues are as follows:

- the preparation of new domains is done in ALADIN by the 923 configuration, which cannot prepare surface fields for SURFEX. These fields can be prepared by a specific SURFEX tool called *prep_pgd*, on exactly the desired ALADIN domain. This is not a problem per se, but a change of habit: to prepare AROME "climate files", one will need to install and run *prep_pgd* at home beside 923.

- the change of geometry is done by Full-Pos, which needs to read and write the surface fields, currently it can do neither. In order to FullPos atmospheric fields, only a few surface fields need to be read, which can be done either by hacking a copy of the needed SURFEX fields into the FA file given to Full-Pos, or (better) to teach Full-Pos how to reach these fields in a SURFEX file directly. Producing surface fields at a new geometry can be done by *prep_pgd*, except the rapidly evolving ones, which we want to be able to update without rebuilding the complete climate files. They will come with the coupling files, we need to extend the SURFEX software of Full-Pos itself to interpolate these evolving fields efficiently.
- the post-processing has about the same problems to solve as the change of geometry feature above. Plotting of SURFEX fields can be done by tools provided with the SURFEX software itself. But to avoid too much disturbance to the operational systems, we need to keep a consistent interface the new system with the downstream NWP product generation. One solution can be to code into SURFEX the production of the required FA or GRIB fields, or we can send those fields to Full-Pos to post-process them just like in ALADIN. Both are feasible, and we will choose the solution that is easiest to develop, optimize and maintain.

In theory, we could have backward compatibility of the SURFEX I/Os with the old surface scheme, by developing appropriate conversion tools. In practice, it seems that we will try to make everyone (ARPEGE, ALADIN, ALARO, AROME) switch to SURFEX at the same time, which will save the development of conversion tools. This issue is broader than AROME, and relates to the surface work plan proposed by D. Giard.

There are other technical issues with AROME. One, is the coupling of the new 3D fields and their interfacing with the assimilation (discussed below). Obviously, ARPEGE and 3D/4D-Var are not going to have the same prognostic fields as AROME, so some conversion tools are going to be necessary (we already have some model state conversion for the incremental analysis and the launching of ALADIN-NH, and it works fine), as well as an extension of the capabilities of Full-Pos to deal in a basic way with the new fields, at least in order to help with diagnosing the new physics (which applies to DDH diagnostics too).

The computing cost of AROME (per time-step, per gridpoint) is currently in AROME close to 2.7 times the cost of ALADIN. Profiling of AROME reveals that the prototype software can be optimized with some technical work on the dynamics (probably unnecessary biperiodizations are done at every time-step) and the advection (probably not configured for so many prognostic 3D fields). There is work to do to improve the parallelization (some field slicing is missing at the interface with the surface, and it is being worked on). There may be some algorithmic work to do inside the parametrizations, too.

Last but not least, there are scientific issues in the AROME model. The ALADIN-NH dynamics are not completely finalized yet, and the presence of prognostic micro-physical fields imply changes in the philosophy of the dynamics/physics interface. And there are issues with the physics themselves; the Méso-NH community is working on most of them, but some effort in this field will be required. For instance, the behaviour of AROME has not yet been checked in the presence of stratiform clouds, fog or synoptic storms. The existing test cases show some suspicious elongation of the convective cells, and dilution of low-level cold pools below convective clouds. There is no clear methodology for tuning the diffusion of the cloud variables and hydro-meteors, or for optimizing the model vertical resolution. There is evidence that Méso-NH has a strong spin-up of micro-physical processes, and we should check for its existence in AROME as well. Without any doubt, we will discover many more issues with the AROME model as we run more and more test cases, and running the test cases themselves is a significant job.

4.1.5. Computational cost issues

The debate about installing AROME in ALADIN countries is completely dependent on the speed of their future computers. *Assuming constant funding of NWP computers in each country*, it is a safe hypothesis that the power of affordable computing for regional modeling is going to increase at the same speed as in recent years: a doubling every 18 months. This is a result of current technology progress called Moore's law: one person's increase in affordable computing will be 60% in 1 year, a factor 4 in 3 years, 16 in 6 years. That is to be compared with the cost of AROME: dx=dy=2.5km, dt=7min, the cost per gridpoint per time-step is 3 times that of ALADIN (which is as much due to the extra 3D fields required by the micro-physics, TKE and the NH dynamics, as to the cost of the physics themselves, by the way). Bringing together Moore's law and the cost of AROME, there can be two extreme point of views (and of course an infinity of intermediate views):

- *The pessimistic view*: I have an ALADIN at 10-km resolution and 7-min time-step. And I will not use AROME until Moore's law gives me a computer to replace ALADIN with the same domain, forecast ranges, number of forecasts per days. That means AROME needs an (approximately) 4x4x7x3=300 computer increase, which Moore's law will give me in 12 years, that is, in 2012.
- *The optimistic view:* I have an ALADIN at 7-km resolution and 5-min time-step, runs to 48-h range, and I believe current optimization work on AROME will bring the per-gridpoint overhead from 3 to 2.5. My ALADIN domain and forecast ranges are ludicrously oversized for AROME which is going to be primarily useful in the 0-24h forecast range; for longer ranges I can keep running my good old ALADIN model or the brand-news ALARO model. So I can shrink the AROME area to 20% of my current ALADIN domain, which covers the important areas of my country, and to half of my previous range. That means a computer increase of 3x3x2.5x0.2x0.5=2.25; adding 1 to the cost to keep running ALADIN, the total power needed is 3.25. Applying Moore's law since the last time my boss bought me a new computer, say 2 years ago, means that AROME is affordable for me by the end of 2005.

As one can see, the key aspects fo the AROME expense are not the AROME physics cost, but the required domain size, useful forecast ranges, and current ALADIN resolution. Each partner should consider its own options carefully. To try to replace ALADIN completely with AROME to do the same thing will not be an optimal approach for short-range, regional modelling. ALARO will probably be more suited for NWP over wide areas.

4.1.6. Assimilation, predictability and coupling

The bulk of so-called AROME activities in Météo-France are on developing the model. However, data assimilation is very important, because it is known (from the mesoscale scientific literature of e.g. NCAR and from Méso-NH initialization impact studies since 1997) that data assimilation gets more and more important as the resolution increases. This is mainly because deep convective systems have interesting memory properties: the regional assimilation of low-level fields, cloud fields and humidity has a substantial beneficial impact on mesoscale forecasts for at least the first 12 hours, at constant large-scale forcing. Of course, it is important to improve the large-scale forcing too, but the novelty is that there is an enormous amount of unused mesoscale data in many regions, whereas all the easy large-scale data is already being used in the global data assimilation system. The other good news is that the most important part of the regional data assimilation system can be setup regardless of the model: the ALADIN 3D-Var can be applied with very few changes to ALADIN itself, to ALARO, AROME, or even Méso-NH. The important differences are in the computation of the background term Jb (it requires different ensembles and some fiddling of the variances), the data thinning (adapted to each model's resolution) and in the interface between 3DVar and the forecast model (using the incremental approach: 3DVar analyses wind, T and q, it is useful to correct them in all models). Thanks to the excellent work of the ALADIN scientists, Météo-France has been able to set up a pre-operational 3DVar for ALADIN and Méso-NH relatively quickly, and AROME and ALARO will follow soon.

To go to higher resolution, a few extras will need to be put into 3DVar, starting with those with the best cost/benefit ratio. Suggested ones are FGAT (First Guess at the Appropriate Time, which increases the use of frequently reporting data by several orders of magnitude), analysis of cloud humidity (mainly based on Meteosat data), use of radar Doppler winds and reflectivities (more difficult, so it was important to start early), and (later) initialization of micro-physical fields, on top of the already existing work plan activities: blending, Jk coupling, work on Jb, etc... More ambitious stuff like 4D-Var and adjoint physics will become important, but only later, since they will only be affordable several years after we have moved to AROME.

Predictability is another fairly transversal activity, the basic techniques can be applied to all mesoscale models, so what is being done on ALADIN will be useful for the other models too. AROME is of course handicapped because of its high model cost that will limit the development of ensemble prediction for the next few years. But there is a significant demand for fine-scale probabilistic forecast, and what is done on ALADIN or ALARO is important. The current emphasis is on ensembles perturbed by changing the large-scale coupling (which suggests we will need a specific strategy for coupling file compression). Now that more attention is paid to the quality of short-term forecasts, it may be the time to think more seriously on strategies to perturb these short-range forecasts, which is likely to involve work on how regional data assimilation works, and how we can perturb precipitation forecasts.

Coupling is still a poorly understood issue, in the sense that we do not much know how much priority it should have. It is easy to anticipate that AROME will require bigger (and more frequent) coupling files to be transmitted, which shall be compared with the planned increases in telecommunication lines. It is less clear how much sense it makes to transmit full-domain files when the information inside the coupling frame is not really used at the end, or how serious it is to couple non-hydrostatic, micro-physical and TKE prognostic fields. Some experimentation is needed there, but it will require complete AROME (and ALARO) deported systems to be installed before it can start.

On the scientific side, there is work in Toulouse on improving the mathematical formulation of the coupling in the dynamical part of the model, so progress is expected soon. But if it does not seem possible to have a physically really accurate coupling strategy in spectral space, one must weigh the pros and cons of both aspects of the models.

4.1.7. Conclusion

Now the community is working is parallel on ALADIN, ALARO and AROME, it is important to ensure a correct allocation of workforce between these three models, if we want to keep all of them alive. This will be an important issue to discuss at the next ALADIN workshop, when preparing the next ALADIN work plan.

References on the ALADIN web:

- the ALADIN work plan (D. Giard et al)
- documents from the Split ALADIN Assembly, 2004
- the proposal for a CNRM work plan on the AROME and ALARO models in early 2005 (F. Bouttier)
- the proposal for a work plan on the externalised surface (D. Giard)
- other articles about AROME and ALARO in recent Newsletters including this one.

4.1.8. Basic references on the Méso-NH physics and fine-scale assimilation:

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Pinty, J.-P. and P. Jabouille, 1998: A mixed-phase cloud parameterization for use in mesoscale non-hydrostatic model: simulations of a squall line and of orographic precipitations. Proc. Conf. of Cloud Physics, Everett, WA, USA, *Amer. Meteor. soc.,* Aug. 1999, 217 - 220.

4.2. Use of geostationnary SEVIRI radiances in ALADIN 3D-Var: Montmerle Thibaut.

ABSTRACT

The pre-operational French ALADIN 3D-Var configuration, that includes an Ensemble Jb formulation, has been used to assimilate geostationary SEVIRI radiances during a 15 days test period. A cloud type product developed by CMS (Centre de Météorologie Spatiale, Lannion, France) is used to keep channels non contaminated by clouds in the assimilation process, including those whose weighting function peaks over the cloud top. The near IR 3.9 µ and ozone 9.7 µ channels are blacklisted. One pixel out of 5 has been used with thinning boxes of 66 km^2, constant biases are applied and empirical observation error variances are used. The monitoring shows stable features in RMS error and bias for each channel. The (obs–analysis) RMS error is much smaller than the (obs-guess) one, meaning that a lot of information coming from the assimilated channels is taken into account in the variational process. The resulting mid-to-high tropospheric humidity increments present realistic mesoscale patterns. Scores against radiosoundings show positive impact up to 12 h of forecast, compared to the dynamical adaptation version of ALADIN. Biases are however observed for humidity and high level temperature. The information brought out by SEVIRI allows to predict realistic amount of total rain between 12 and 6 h of forecast for all the precipitating events of the test period.

4.2.1. Introduction

An operational version of the ALADIN 3D-Var will hopefully start at the beginning of 2005 at Météo-France. Details about its first configuration and results can be found in Fischer et al. (2004). It shows in particular that, compared to NMC-type formulations, the **B** matrix computed from an ensemble of ARPEGE/ALADIN analyses/forecasts (Stefanescu and Berre, 2004) has shown the best behaviours : mesoscale correlation lengths and appropriate vertical covariances that allow to correct model errors, notably the temperature bias below the tropopause. This first configuration has been adapted to study the impact of geostationary radiances observed by SEVIRI on board Meteosat-8 (ex-MSG). After a presentation of the product that is sent and stored operationally in Météo-France at Toulouse in section 2, the pre-processing of the data will be described in section 3. Monitoring and impact on analyses will be addressed in section 4. Forecast scores and impact on the prediction of precipitations will finally be presented in section 5.

4.2.2. Presentation of the product

Since May 2004, the CMS (Météo-France/ Centre de Météorologie Spatiale, Lannion, France) is sending to Toulouse a SEVIRI/MSG product of particular interest for ALADIN. This product is received and stored in GRIB format every hour. It is composed of different fields at full-resolution covering all European ALADIN domains (18°S to 65°N, 25°W to 40°E) :

- The 8 IR SEVIRI channels, from 3.9 μ to 13.4 μ,
- The associated date, latitude-longitude position, angles of sight,
- A cloud type (CT hereafter) and the cloud top pressure with the associated quality flags.

As described in the next section, the latter fields permit to keep in the assimilation process channels whose weighting function peaks above the cloud top. These cloud products have been developed by CMS in the SAF/NWC MSG framework. Complete documentations can be found at *http://www.meteorologie.eu.org/safnwc/* . The CT product contains information on the major cloud classes : fractional and semitransparent clouds, high, medium and low opaque clouds (including fog) for all the pixels identified as cloudy in a scene. The set of thresholds to be applied depends mainly on the illumination conditions, whereas the values of the thresholds themselves may depend on the illumination, the viewing geometry, the geographical location, and NWP data describing the water vapour content and a coarse vertical structure of the atmosphere.

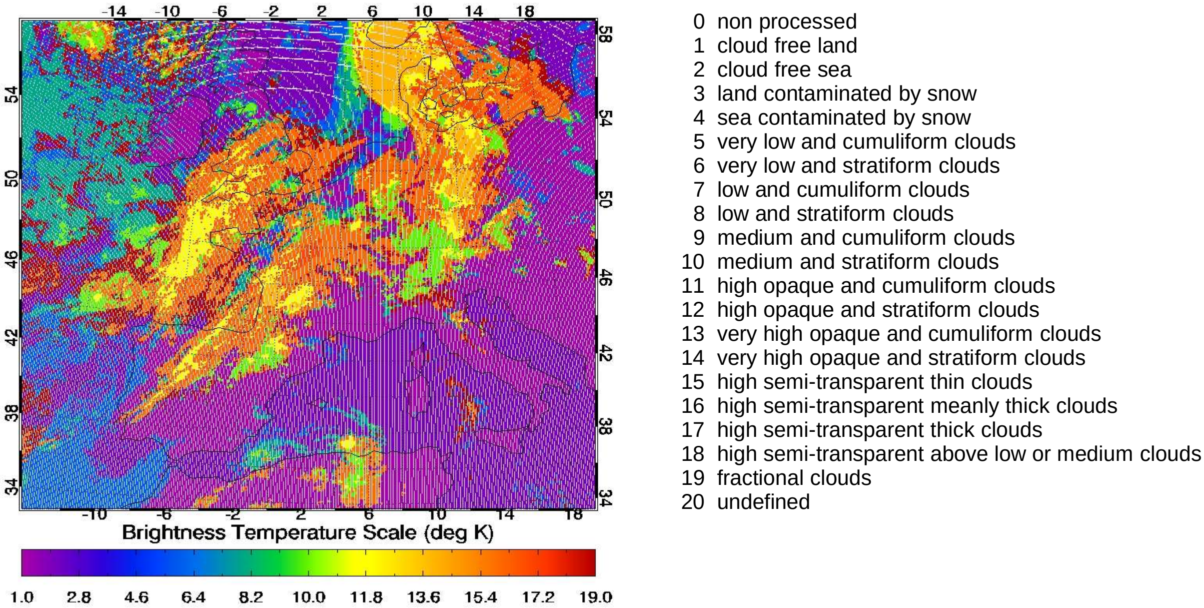
Fig. 1 gives an example of this product and its associated cloud top pressure for the 18^{th} of July 2004. It has to be noticed there is no separation between cumuliform and stratiform clouds currently done in the CT product.

4.2.3. Pre-processing of the data

The SEVIRI radiances assimilated in the configuration of ALADIN 3D-Var presented in this report are pre-processed in the following way :

To keep the observations relatively uncorrelated, one pixel out of 5 is extracted from the database, which gives approximately a 25 km horizontal resolution over France, and thinning boxes of 66 km^2 are applied during the screening.

a)



b)

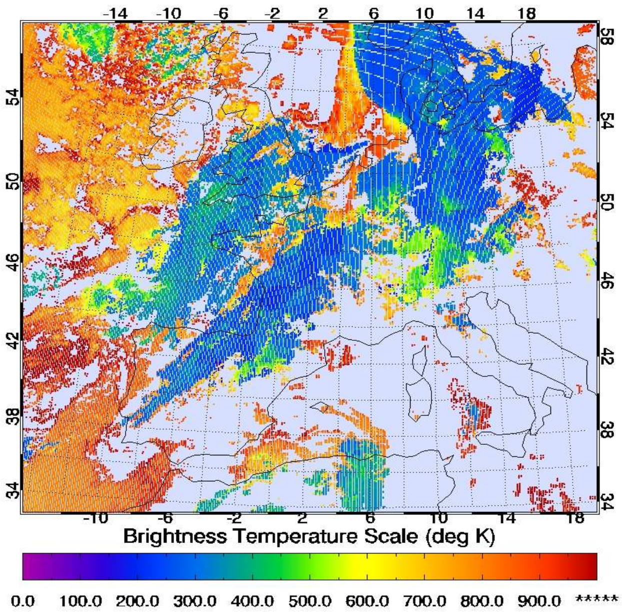


Fig.1: a) Cloud types and b) cloud-top pressure for the 18th of July, 2004.

- The near IR 3.9 μ and the ozone 9.7 μ channels are blacklisted. The broad 3.9 μ channel is not used because RTTOV has troubles to simulate it (Roger Saunders, personal communication).
- Since the domain of interest is relatively small, a constant bias is assumed as a first hypothesis for the remaining channels.
- The observed brightness temperature error for each channel has an empirical value, based on measurements errors and errors due to RTTOV. 1.05 and 1.7 K have been chosen respectively for the IR and the WV channels. As a matter of fact, the uncertainty of the humidity estimation in the troposphere leads to take a larger σ_O for the two WV channels.
- A quality control is applied to reject data whose (obs-guess) value exceeds the sum of the background and the observation error variances times an empirical constant.
- The CT product presented in the previous section is used to select channels : the low peaking IR channels 8.7 μ , 10.8 μ and 12 μ are kept only in clear-sky conditions, the 13.4 μ is also

kept above very low clouds and the two WV channels are considered even above mid-level clouds.

4.2.4. Impact on analyses

A test period of 15 days with 4 daily assimilations has been performed from the 6th to the 22nd of July, 2004. In order to study the relative impact of SEVIRI data within ALADIN 3D-Var, a control experiment (CNTRL hereafter) has been run. This experiment follows the configuration presented by Fischer et al. (2004) : an Ensemble **B** matrix (Stefanescu and Berre, 2004) has been used with an a-posteriori tuning of the REDNMC factor, to 1.8. It assimilates the same complete set of observations as ARPEGE at that time (AMSU-B microwave radiances and the sea-wind scatterometer on board QuikSCAT are in particular not taken into account in these experiments), within an assimilation window of +/- 3 hours. 36 h forecast have been run from each analysis time with digital filter initialization applied.

An experiment that presents the same characteristics than CNTRL but with the addition of SEVIRI radiances (SEV hereafter) has then been run during the same period. Assimilation statistics plotted in Fig. 2 show that a lot of information coming from the 6 assimilated channels is taken into account in the analyses. The (obs-analysis) root-mean-square (RMS) errors over the whole test period are indeed much lower than the (obs-guess) ones. The relative error decrease is however less pronounced for the 13.4 µ channel as noted in Montmerle (2004) which is probably due to the broader shape of its weighting function and/or the choice of a non-optimal observation error variance. The mean biases have values less than 0.2 K which seems to justify the values of the constant bias correction.

Monitoring has been performed and results are plotted on Fig. 3 for the six assimilated channels. It shows firstly a strong negative bias of about –2.6 K for the WV 6.2 µ channel, which is well corrected by the flat bias correction. As for the 3.9 µ channel which is blacklisted, this bias is due to its broad spectral resolution that is badly taken into account by the radiative transfert model RTTOV. The bias-corrected channels present very stable features during the period. A diurnal cycle is visible for the biases and the number of active data for the low peaking channels. For each analysis time, about 1500 observations from the WV channels, 1000 for the 13.4 µ one and between 500 and 1000 for the three other channels are considered in the variational process. The (obs-guess) RMS error presents also a weak oscillation for the WV 6.2 µ that coincides with two peaks of convective activity at the beginning and at the end of the test period.

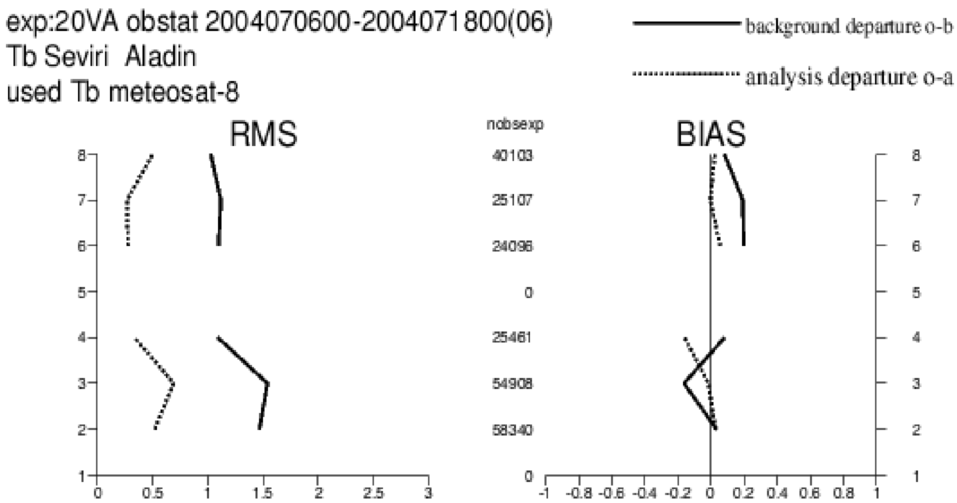


Fig.2: Assimilation statistics of the SEV experiment computed considering every analysis times over the July 2004 test period. The vertical axis denotes the channel number, the left panel the RMS error and the right panel the bias between (obs – guess) (plain line) and (obs-analysis) (dashed line) for brightness temperature. The number of assimilated data is plotted between two panels.

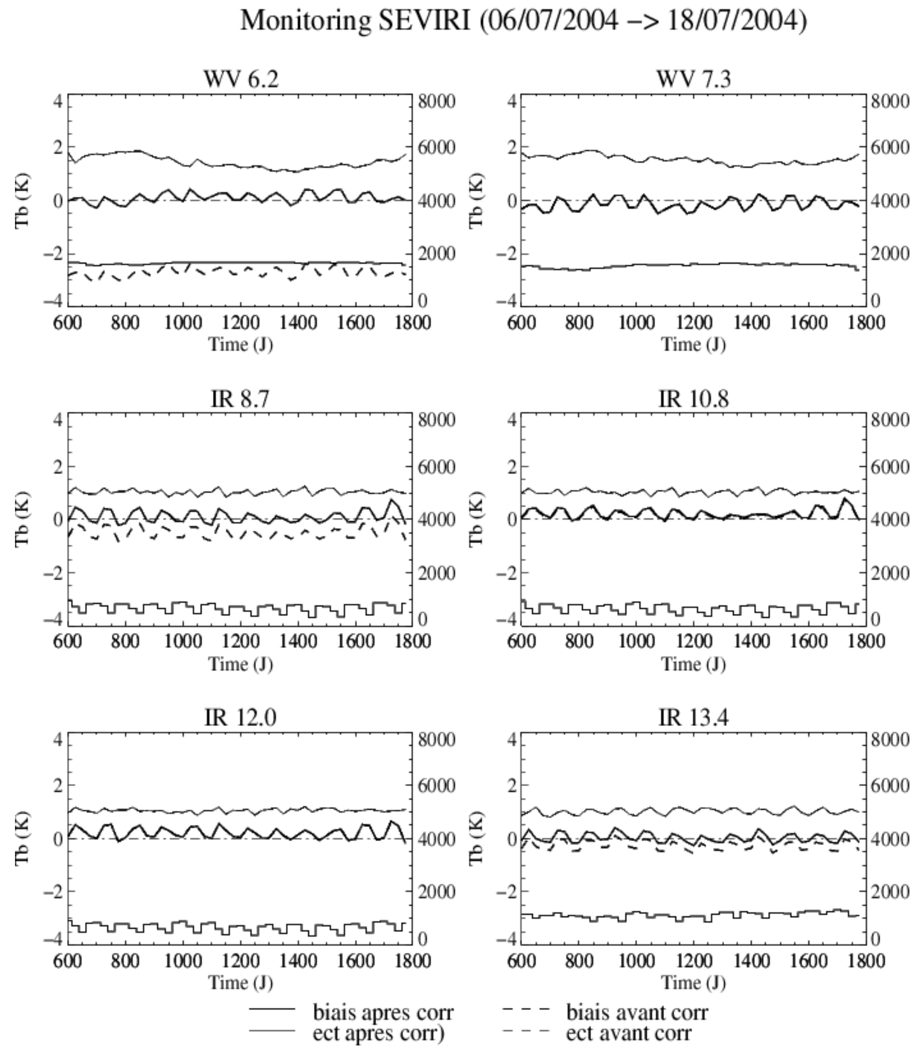


Fig.3: Monitoring for the 6 assimilated SEVIRI channels for the SEV experiment from the 6th to the 18th of July, 2004. Histograms on bottom of figures (associated with the right vertical axis) represent the number of active data that enter the minimization.

4.2.5. Impact on forecast

✗ **Forecast scores**

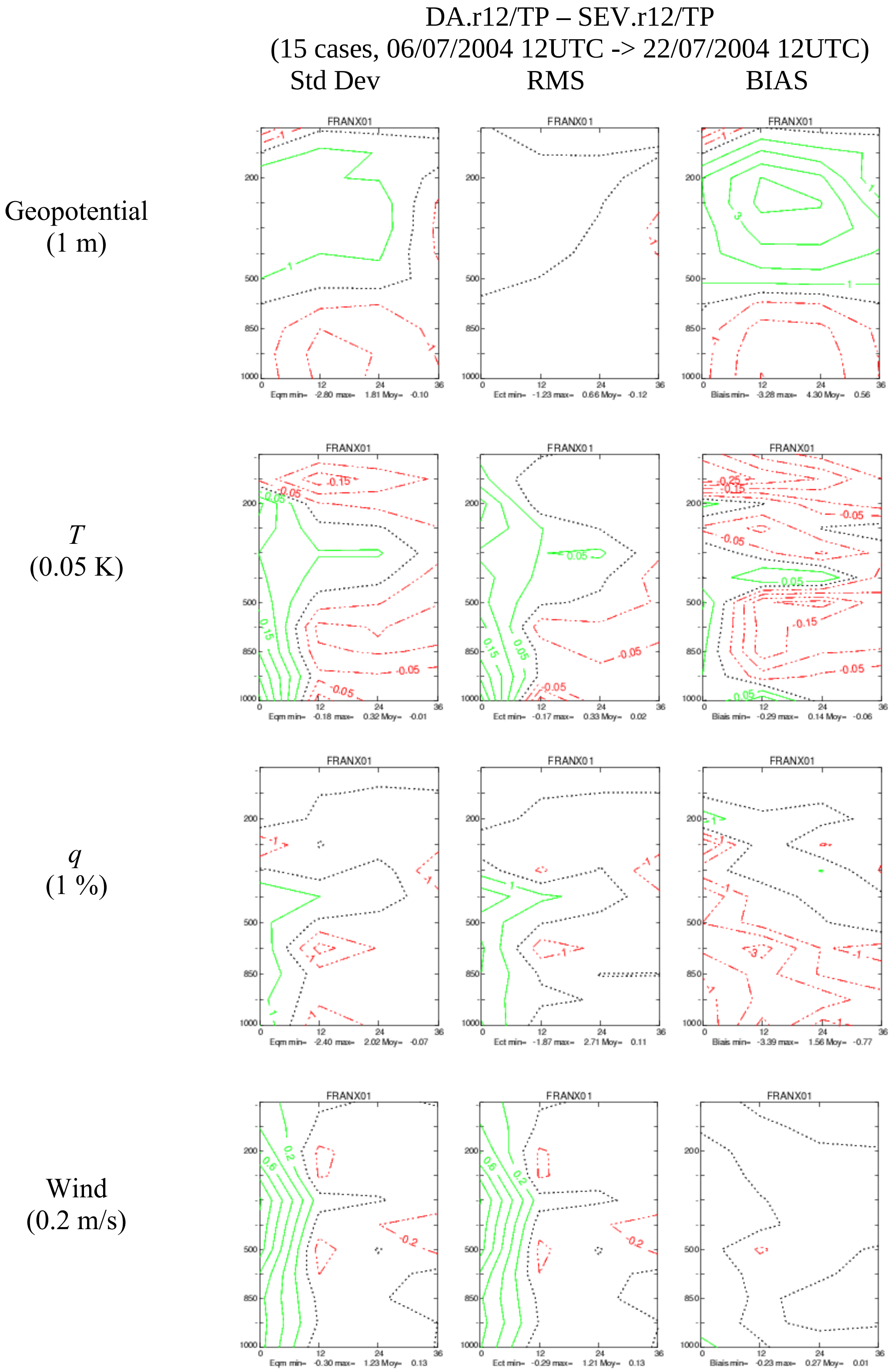


Fig.4: Differences in forecast scores against TEMP observations : DA vs SEV, over the ALADIN-France domain for the July 2004 test period. Left column is the standard deviation, middle the RMS error and right the bias. Green isolines denote positive impact of SEV.

Forecast scores have been computed relatively to the dynamical adaptation version of ALADIN (DA) and are plotted in Fig. 4. For the geopotential height, the assimilation of SEVIRI data reduces the bias against radiosoundings of about 4 m between 12 and 24 h of forecast above 600 hPa, and increases it slightly below. This impact induces logically negative bias on sea-level pressure during the forecast, which is difficult to explain since no negative bias is present in the analyses. For the temperature, SEV brings a diminution of RMS error on all vertical levels before 12 h and up to 24 h near 300 hPa. Negative bias are however present from the start above 300 hPa and in the middle troposphere after 6 h. The RMS error for humidity is slightly improved before 6 h of forecast and up to 12 h near 400 hPa. The analyses for this quantity show however small biases at all vertical levels that propagate downward with time. Finally, SEV show better scores than CNTRL on RMS error of the wind intensity in mid- to-high troposphere (CNTRL scores are not shown).

Globally, the scores of CNTRL against radiosoundings have been slightly degraded. This can be explained by the fact that the large amount of SEVIRI data added in the assimilation process has slightly taken away the analysis from radiosoundings observations which are the main source of observation in CNTRL. To give better weight to the different observation types, the tuning of the observation error variances will be undertaken in the near future, following Chapnik (2004).

✗ Total rainfall forecast

<u>Case of the 18th July 2004</u>

The total rain forecasted between 6 and 12 hours by DA, CNTRL and the SEV experiments from the 00 UTC analysis time are plotted on Fig. 5 and compared to rain-gauge values over France. DA missed the NE/SW orientation of the main rain band. CNTRL produces the good orientation and the SW part of the line seems realistic, although a little bit too South. The use of SEVIRI data allows to forecast the observed second cell of intense precipitations located in the NE part of the line, with a slightly overestimated amount (> 20 mm). The maximum over the Bordeaux region is however located too South but with an amount of 40 mm comparable to rain-gauge observations. The secondary line of precipitation is also quite well captured over the NE of France with realistic shape and amount.

To understand why SEV produces the observed second cell of intense precipitations in the north-eastern part of the line contrary to CNTRL, increments of humidity and temperature at 700 hPa for the 00 UTC analysis have been plotted for the two experiments (Fig. 6). The most striking difference between the two is that increments produced by SEV present more realistic and mesoscale patterns than for CNTRL, where the main source of information seems to come mainly from radiosoundings. In particular, SEVIRI data are cooling and humidifying the mid-to-low troposphere pre-convective area located upstream of the frontal rain band over western France, which produces intense rain 6 hours later.

At each analysis time, a large amount of IR radiances coming from SEVIRI is taken into account in the assimilation process compare to ATOVS data for example. The ratio of the number of data that enters the screening for these two observation types is varying indeed between 10 and 25. It has however to be noted that for both CNTRL and SEV, ATOVS data have been assimilated using the screening features of ARPEGE. For HIRS for instance, 1 pixel out of 5 have been extracted and thinning boxes of 250 km^2 have been applied which is not comparable to SEVIRI. In the near future, the impact of a higher density of ATOVS data will be tested in 3D-Var using two complementary approaches :

- Extraction and thinning at higher horizontal resolutions,
- Use of the "EARS-Lannion" data that are already used in the operational ARPEGE suite. Their shorter reception time delay allows indeed to get more data within the +/- 3 hours assimilation window considered in ALADIN 3D-Var.

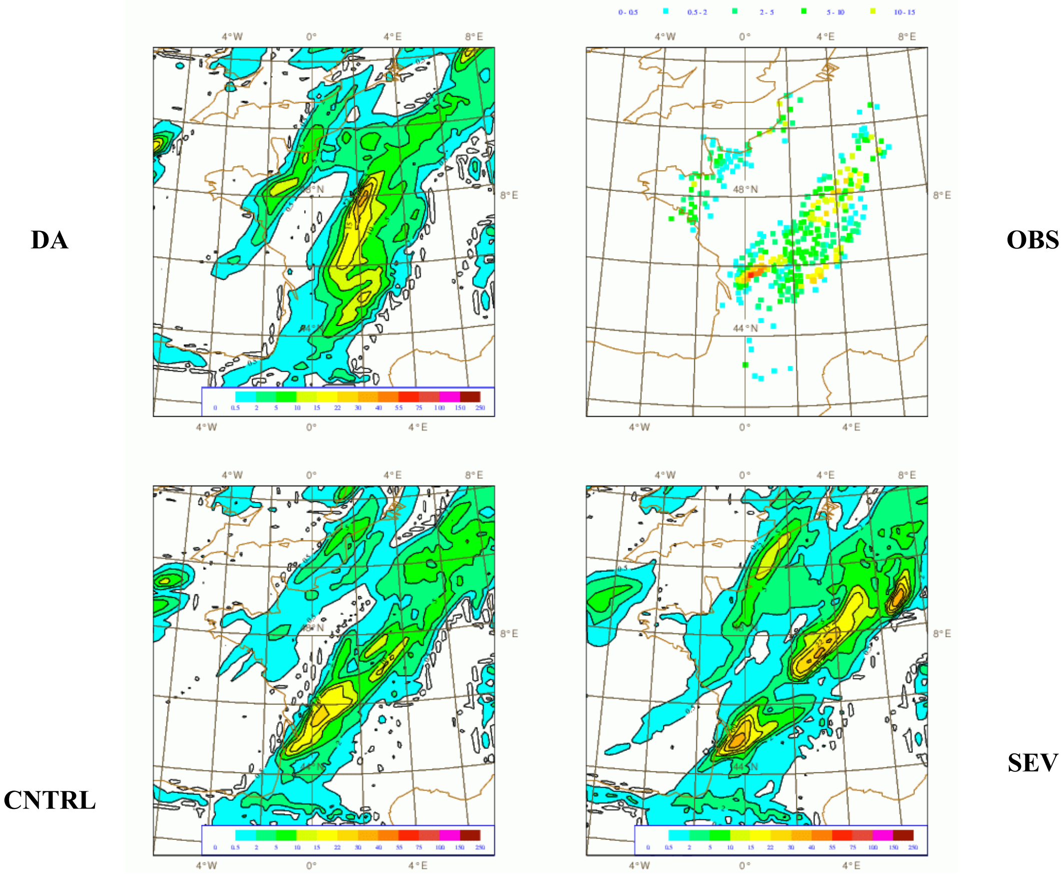


Fig.5: Rain-gauge observation (top right) and simulated total rainfall between 6-12 h of forecast for July 18th, 2004.

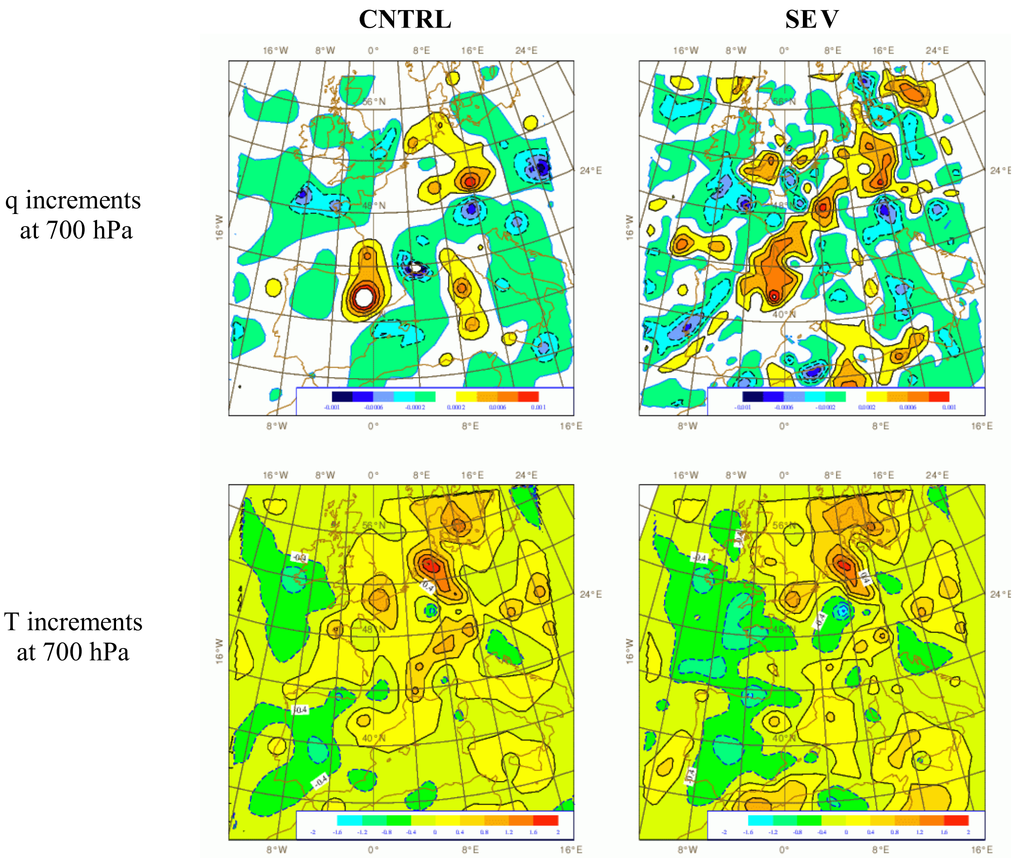


Fig.6: Specific humidity (top panels) and temperature increments (bottom panels) for CNTRL (left) and SEV (right), for July 18th, 2004, at 00 UTC.

Case of the 8th of July 2004

The total rain forecasted between 6 and 12 hours of simulation by CNTRL and SEV, compared to rain-gauges and DA are displayed on Fig. 7. DA produces unrealistic large amounts (over 40 mm) of rain over NE of France contrary to the two 3D-Var experiments that are more comparable to observations. CNTRL reproduces well the shape and intensity of the northern part of the N-S oriented line of heavy precipitations located in eastern France, whereas DA totally missed it. The addition of SEVIRI data allows to enhance realistically precipitations in its southern part with amounts up to 20 mm and to produce light rain over the centre of France that are observed by rain gauges.

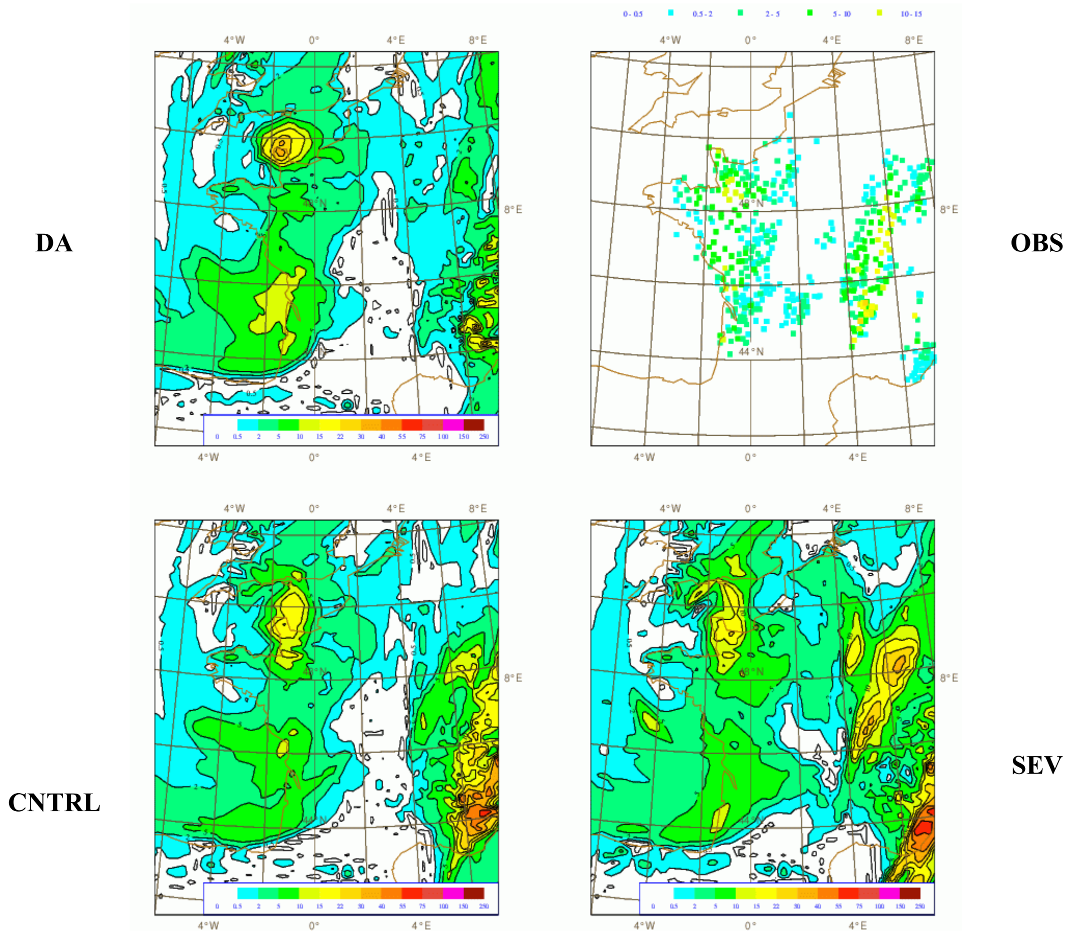


Fig.7: same as Fig. 5 but for the 8th of July 2004.

Case of the 22nd of July, 2004 : for that case, DA underestimates strongly the precipitations that occur over the western part of France (Fig. 8). The use of a cycled 3DVar allows to correct this failing. Shapes and intensities of the precipitating cells as forecasted by SEV seem moreover in better agreement with rain gauges observations and rain rates derived by radars over the sea (not shown) where amount greater than 30 mm were measured.

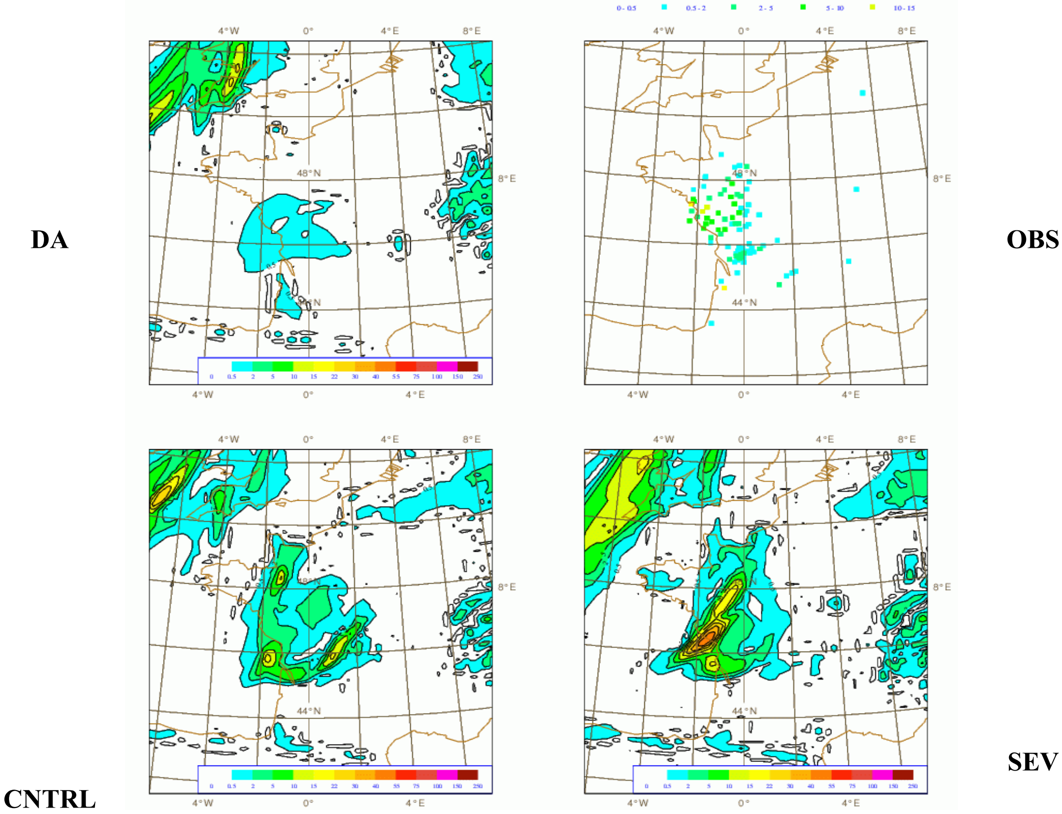


Fig.8: same as Fig. 5 but for the 22nd of July 2004

✗ QPF scores

Quantitative Precipitation Forecast (QPF) scores were computed for the July test period for different thresholds. The observations used to compute those scores are the 6 hours total rain measured by rain gauges.

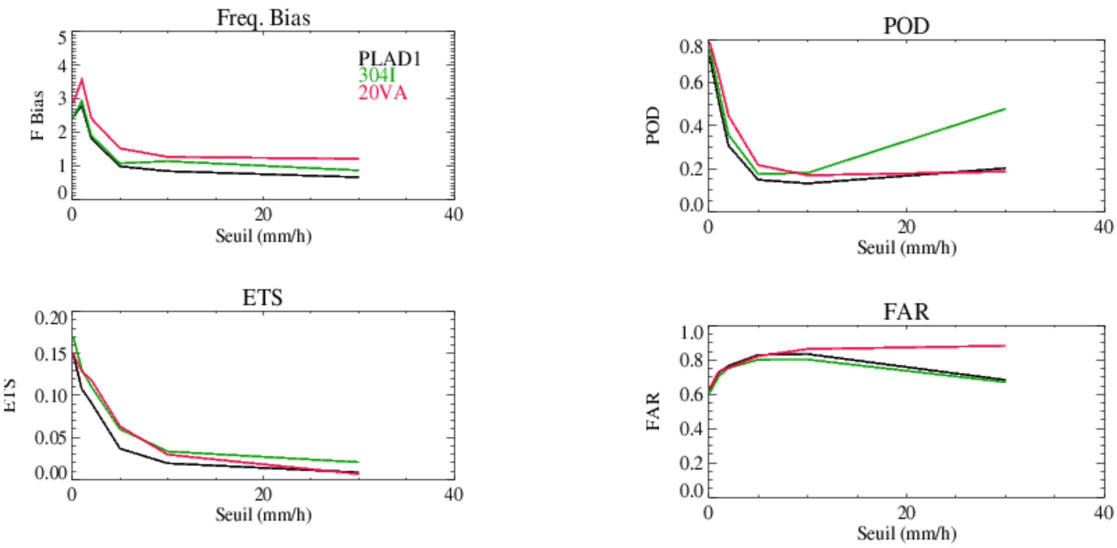


Fig.9: QPF scores for **DA**, **CNTRL** and **SEV** computed for the whole July period for the total rain forecasted between 12 and 6 h, from the 00 and the 12 UTC analyses. Precipitation thresholds are 0.1, 1, 2, 5, 10 and 30 mm.
FBIAS : Frequency Bias, POD : Probability Of Detection, ETS : Equitable Threat Score, FAR : False Alarme Rate

The two detection scores (ETS and POD) displayed in Fig. 9 are higher for the experiments that are using an assimilation scheme. The ETS is comparable for CNTRL and SEV and shows values almost twice greater than DA for the 5 mm threshold. The addition of SEVIRI data permits to perform a better detection of precipitating events mostly for the 2 and the 5 mm thresholds, with respective POD of 0.46 and 0.23 compared to 0.34 and 0.16 with CNTRL. However, this better detection is made to the detriment of the FBIAS : SEV produces to much precipitations for all thresholds. For small thresholds, the overestimation of the number of simulated precipitating pixels shown by DA and CNTRL is accentuated for SEV. For thresholds greater than 5 mm, the FBIAS are comparable for the 3 experiments although slightly greater than 1 for SEV. Finally, the FAR is greater for SEV for the 30 mm threshold. Since a very small number of observed/simulated pixels are characterized by values greater than this threshold, QPF scores are weakly representative at this level.

Assimilating SEVIRI data using the first configuration defined in this report seems thus to produce too much precipitation, particularly light rain. The weight of the information given by these radiances during the assimilation step has to be weaken to limit this drawback through the tuning of the observation error variances and/or the use of larger thinning boxes.

4.2.6. Conclusions and future work

SEVIRI data have then been assimilated in ALADIN 3D-Var following the configuration defined by Fischer et al. (2004) to study their relative impact. Channels 3.9 μ and 9.7 μ have been blacklisted, 1 pixel out of 5 has been used, a constant bias has been applied for each channel and empirical error variances have been chosen in the first configuration. The cloud-type classification computed by CMS in the SAF/NWC framework has been used to keep data non contaminated by clouds in the variational process, which includes channels that peak over the cloud top. The monitoring shows stable features for all channels during the whole test period. A lot of information coming from SEVIRI radiances is taken into account in the analyses through the 3D-Var, producing realistic increments. Results deduced from the 15 days test period are encouraging notably for the short term (i.e < 12 h) precipitation forecasts, where the addition of these kind of data allows to simulate realistic precipitation patterns, in shape and intensity. Forecast scores are slightly degraded compared to the control experiment, probably because of the large amount of additional data that move slightly away the analyses from radiosoundings. Moreover, QPF scores have shown that the experiment that includes SEVIRI radiances has better rain detection scores but produces spatially too much light precipitations.

One priority in the near future will thus be to tune error statistics and/or thinning to lower the relative impact of SEVIRI in the analyses. Methods based on the use of the DFS (Degrees of Freedom for Signal) related quantities will be applied to improve covariances matrices (Desroziers and Ivanov, 2001; Chapnik, 2004). In parallel, studies will be addressed to the use of additional ATOVS data by considering radiances coming from EARS extracted with a better sampling. In particular, the impact of AMSU-B data is one major concern. Finally, the cloud-top pressure product sent by CMS and a convection-detection algorithm will be used to compute proxy humidity profiles for convective clouds for assimilation purposes.

The first configuration of ALADIN 3D-Var (including SEVIRI radiances) is scheduled to become operational hopefully around March 2005. Further tests are envisaged on this operational suite, including the use of a 3D-Var FGAT (First Guess at Appropriate Time) and shorter assimilation cycles (typically 3 hours).

4.2.7. References:

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4.3. Case of extreme wind occurrence at high Tatras on 19th November 2004: Vivoda J. & Simon A.

4.3.1. Summary

High Tatras are the highest mountains of Slovakia. They are located at the border between Slovakia and Poland. They are one of the most attractive touristic destinations in the Slovak republic. The area was hit by strong northern wind on 19th of November 2004. The wind has been orographically strengthened and the wind gusts at the lee side have been measured greater than 50m/s. The period of strongest wind started at 14 UTC and it lasted approximately 10 hours.

Fig.1 Photo of damages caused by the severe wind gusts in High Tatras area on 19.11.2004

Wind of such speed occurred in the region several times in the past, but it has rarely reached the altitudes around 700-800 m above sea level where the spruce monocultures grows. 100 km^2 of forest was destroyed at the lee side of the mountains (figure 1). There was one casualty.

This extreme weather event was excellently predicted by the operational model ALADIN at SHMI [1]. The position of the driving small-scale cyclone has been already well predicted by ARPEGE and operational ALADIN model (resolution 9 km) described well the impact of the orography on the flow. It provided very good guidance for our forecasters. The first warning has been issued one day ahead and it was based on the 18.11.2004 00 UTC run, although the location of maximum wind has been predicted more to the west. Later, on 19.11.2004 00 UTC, the position of the cyclone has been improved and the model prediction of this extreme event was very realistic.

4.3.2. Operational prediction of ALADIN/SHMI

The wind has been associated with a rapid developing cyclone moving over South Poland towards Ukraine. The mean-sea-level pressure from SYNOP measurements is shown on figure 2. The equivalent prediction of model ALADIN available to forecasters, based on 19.11.2004 00 UTC operational run, is on figure 3. The situation is valid at 15 UTC, on the initial stage of the event. The position and intensity of the cyclone are very well predicted.

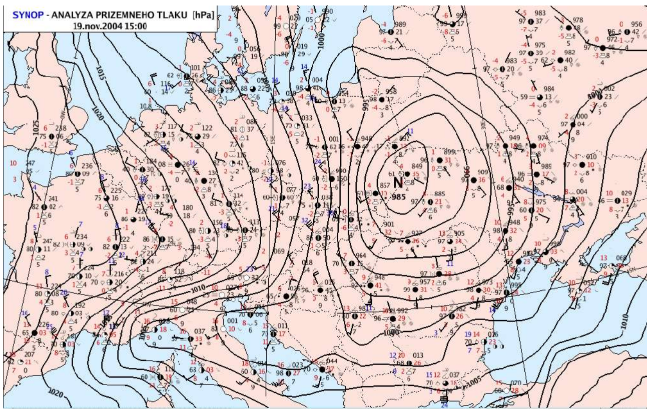


Fig.2 : Mean-sea-level pressure, analysed from SYNOP 19.11.2004 at 15 UTC.

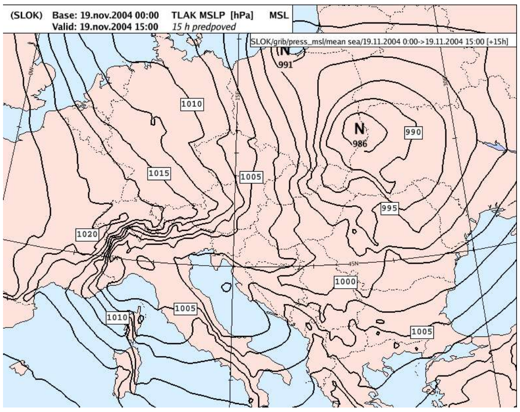


Fig.3 : Mean-sea-level pressure, 15h ALADIN forecast, from 19.11.2004 00 UTC

As the cyclone was moving, the wind direction changed from western to northern wind. During the period of the strongest wind, the flow was almost perpendicular to the mountain ridge. The model has simulated an effect similar to hydraulic jump (more in the next section) and the downslope windstorm has been formed at the lee side with strong turbulence. The maximum wind gusts in the operational prediction exceeded 40 m/s while average wind was around 20 m/s.

The prediction of wind gusts is shown in figures 4 and 5. It is the +16h and +17h operational model forecasts from 19.11.2004 00 UTC. The green color represents the wind gusts above 25 m/s, the yellow color above 30 m/s and the red color above 40 m/s.

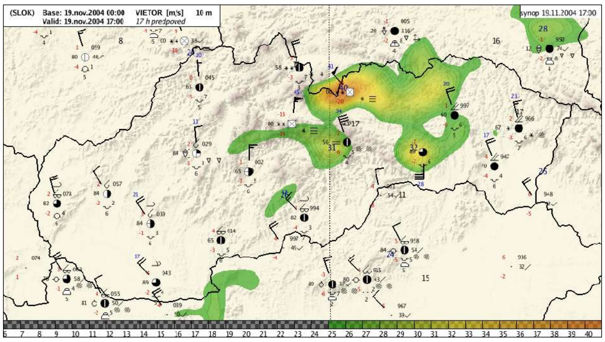


Fig.4: Instantaneous wind gust +17h prediction from ALADIN/SHMI operational run from 19.11.2004 00UTC

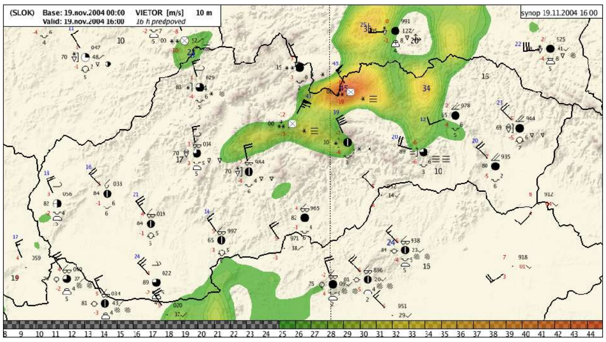


Fig.5:Instantaneous wind gust +16h prediction from ALADIN/SHMI operational run from 19.11.2004 00UTC

4.3.3. High resolution prediction of ALADIN

The operational prediction was not detailed enough to capture exactly the areas where the forest has been destroyed. To further improve model prediction of wind we ran the ALADIN model with a 2.5 km resolution in order to describe orography more realistically. The model was integrated hydrostatically with the same model settings as the operational model except that convection was turned off, horizontal diffusion was adjusted to the new resolution and the model time-step was 100 s.

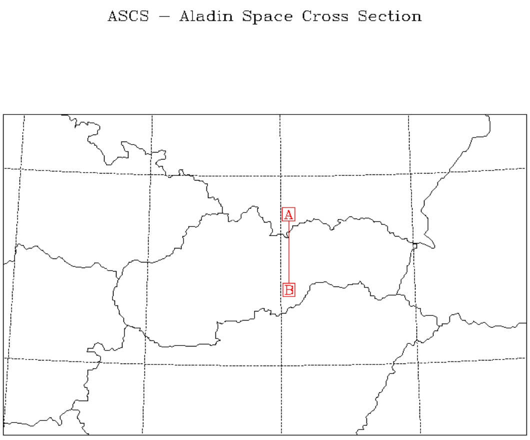


Fig.6: The direction of vertical cross section on figure 7.

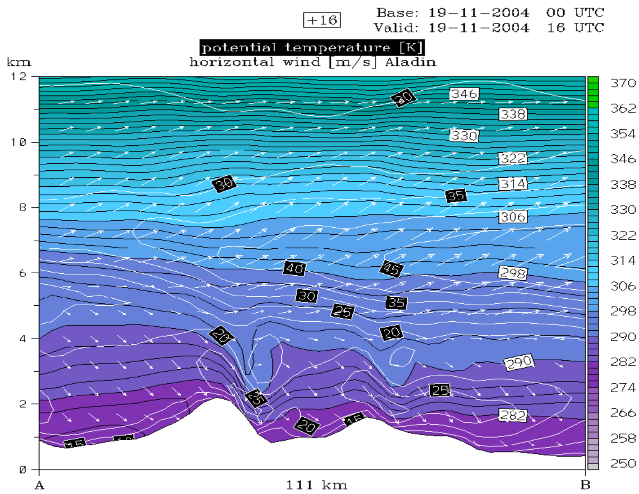


Fig.7: Vertical cross-section perpendicular to High Tatras and Low Tatras ridges. Hydraulic jump is visible in the field of potential temperature (coloured isolines). The wind speed (white contours) is locally strengthened in the area of jump. From high resolution experimental run, 19.11.2004 00 UTC +16h.

The effect of hydraulic jump was very apparent in the high-resolution run. It is clearly visible in the potential-temperature field on figure 7. If we consider almost adiabatic processes, then the air particles follow the potential-temperature isolines, descending very deep along the lee side of the mountains and successively after on ascending very quickly to its original altitude. This forms the shallow high velocity, very turbulent flow at the lee side near the surface, because streamlines density is very high in this region. Another but less intensive jump has been predicted behind Low Tatras ridge. The direction of the vertical cross section is shown on figure 6.

The area with the strongest wind gusts coincides with the area of observed wind breakages at the lee side of High Tatras. The wind gusts from the high-resolution run are shown on figure 8 for the 16 h forecast range, when the strongest wind gusts were predicted. The maximum values of gusts are greater than 50 m/s. The area of observed forest damages, provided by Slovak environmental agency, is depicted by red color on figure 9. Although the density of the observing stations is not sufficient to verify all the features predicted by ALADIN, we assume that the prediction was very precise, because the area of maximum wind gusts is almost identical to the area with observed breakage.

The second maximum of wind gusts was predicted to the South of High Tatras (figure 8). It is the area of Low Tatras mountain, where wind gusts above 50 m/s were really observed. However, we do not have available the map with damages in this area.

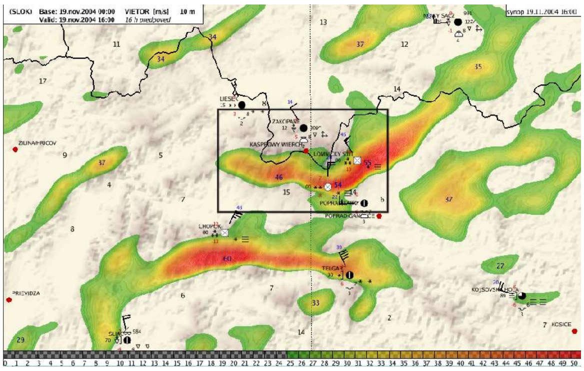


Fig. 8: Instantaneous wind gust +16h prediction from ALADIN high resolution (2.5km) run from 19.11.2004 00UTC. Zoom over High Tatras.The frame selects the area showed on figure 9.

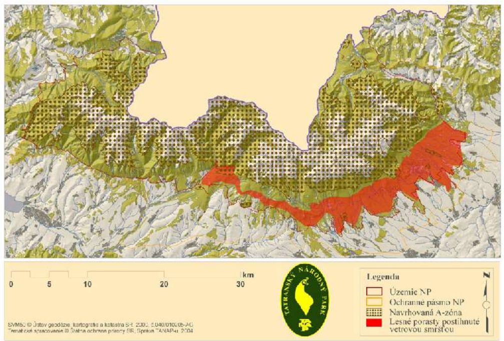


Fig.9: The High Tatras with the area of destroyed forest (red color). Courtesy of Slovak Environmental Protection Agency (http://www.sopsr.sk)

4.3.4. References

Derková, Belluš, Mašek, Španiel and Vivoda : New Operational ALADIN setup at SHMI, ALADIN Newsletter 27, 2005

4.4. High-resolution dynamical adaptation of the wind forecast using the non-hydrostatic version of the ALADIN model: Alexandru S.

ABSTRACT

The high-resolution dynamical adaptation procedure of the wind field from the low-troposphere consists in the interpolation of the wind forecast of the ALADIN model to a higher resolution, taking into account the new description of the surface parameters (as a result of increasing the resolution). It is well known that the surface wind is highly influenced by the orography described into a NWP model. By increasing the resolution, the orography has been improved, and consequently the surface wind field is expected to be a better forecast. Two case studies have been investigated for some meteorological situations. The novelty of these experiments is that the non-hydrostatic version of the ALADIN model has been used. PHYSICAL PROCESSES

4.4.1. Introduction

The wind field from the planetary boundary layer is influenced by the orography described in the model. There are many situations when the surface wind is mis-forecasted, mainly in the mountainous regions or on the seaside, because the orography in the model is smoother than in reality. So it happens that some points over the mountains are at a lower altitude or, on the seaside, some grid-points, which are located on land, are considered as being on water.

The dynamical adaptation procedure of the surface wind at high resolution has been developed by Zagar and Rakovec (1999) and is performed in two steps. First the wind forecast of the ALADIN/Romania hydrostatic model at 10 km horizontal resolution is interpolated to a finer grid of about 2.5 km. As a result of increasing the resolution, the representation of the surface parameters (including the orography) has been improved (comparing with those of the coupling model). Thus the wind field is influenced by the new model orography. After the interpolation to the high resolution, the next step of the dynamical adaptation of the wind field to these new characteristics of the orography is the integration of the non-hydrostatic model, for a corresponding period of time (for 30 minutes with a time-step of 60 seconds). Because the time-scale for some physical processes is longer than the necessary time for the dynamic adjustment of the fields, parts of the physical parameterizations are further omitted. As mentioned by Zagar and Rakovec, if the coupling model fails to have a reasonable prediction in some special meteorological situations, the dynamical adaptation of the wind field at higher resolution cannot improve the forecast.

Because the wind forecast is mainly influenced by the orography, the number of vertical levels describing the higher troposphere and stratosphere has been reduced. Thus from the 41 levels in the operational version of the ALADIN/Romania model, only 26 levels have been kept. These are mainly located in the lower part of the troposphere (Figure 1).

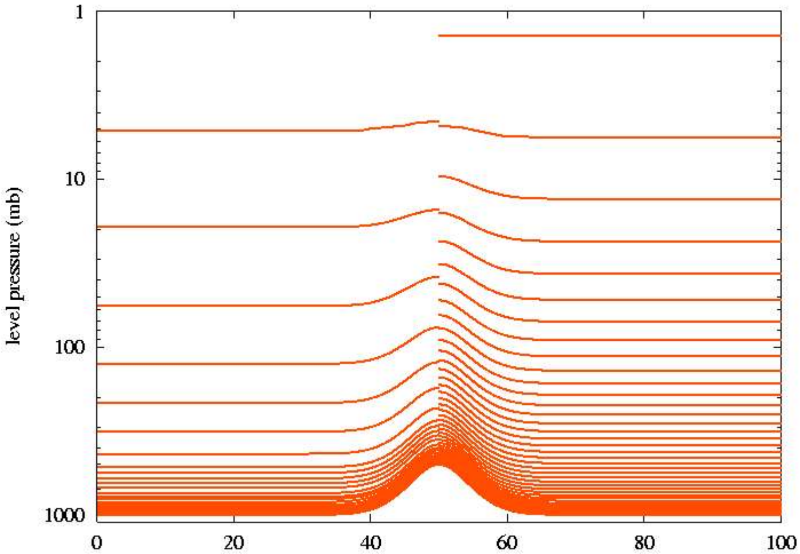


Fig.1: Distribution of the vertical levels for the ALADIN/Romania model in dynamical adaptation at high resolution (left side) and for the operational one (right side)

4.4.2. The experimental results

The experiments have been performed for two cases : for the 12th - 13th of October 2004 and for the 17th - 18th of October 2004. They were selected because the 10 m wind intensity reached values of about 25 m/s in the mountainous region. The hydrostatic model has been integrated at 10 km horizontal resolution, in order to have a reference for the experiments at high resolution. The dynamical adaptation of the surface wind was carried out on a domain covering Romania at 2.5 km resolution.

The results of the reference experiment can be seen in Figure 2, where the forecast of the surface wind field of ALADIN/Romania at 10 km resolution is represented for the case from the 17th

of October 2004. In order to point out the region of interest, the pictures represent a zoom confined within 45°- 47.5°N in latitude and 23°- 27°E in longitude.

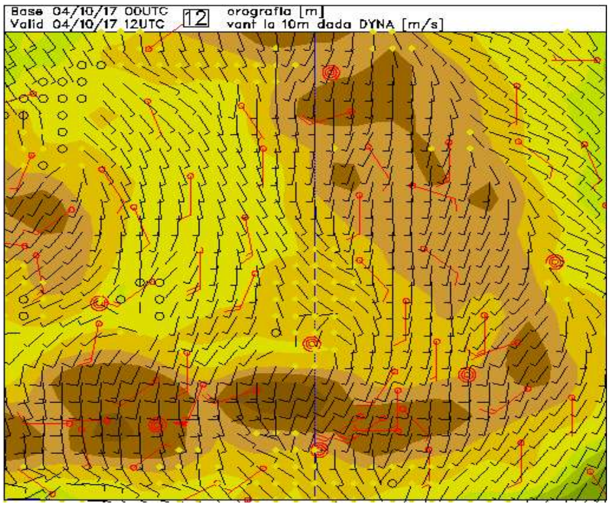


Fig. 2: The 12h forecast of 10 m wind field, performed by the ALADIN/Romania hydrostatic model at 10 km, from 17.10.2004 00 UTC run, together with the real measurements of the wind (represented by red barbs)

In Figure 3 the forecasts of the wind field from the low troposphere with the ALADIN/Romania model in its non-hydrostatic (left side) and hydrostatic (right side) versions at 2.5 km horizontal resolution are compared. As one can see the differences between the results of the model appeared mainly in the regions of high orography. Having a better representation of the orography, new valleys and higher peaks appeared. These new features influence mainly the wind direction. Regarding the forecast of the wind intensity, both versions of the model at 2.5 km resolution succeeded to give a rather good prediction, although the biggest values of the 10 m wind, as measured in the Meridional Carpathian Mountains (in the southern part of Figure 3), were not forecasted.

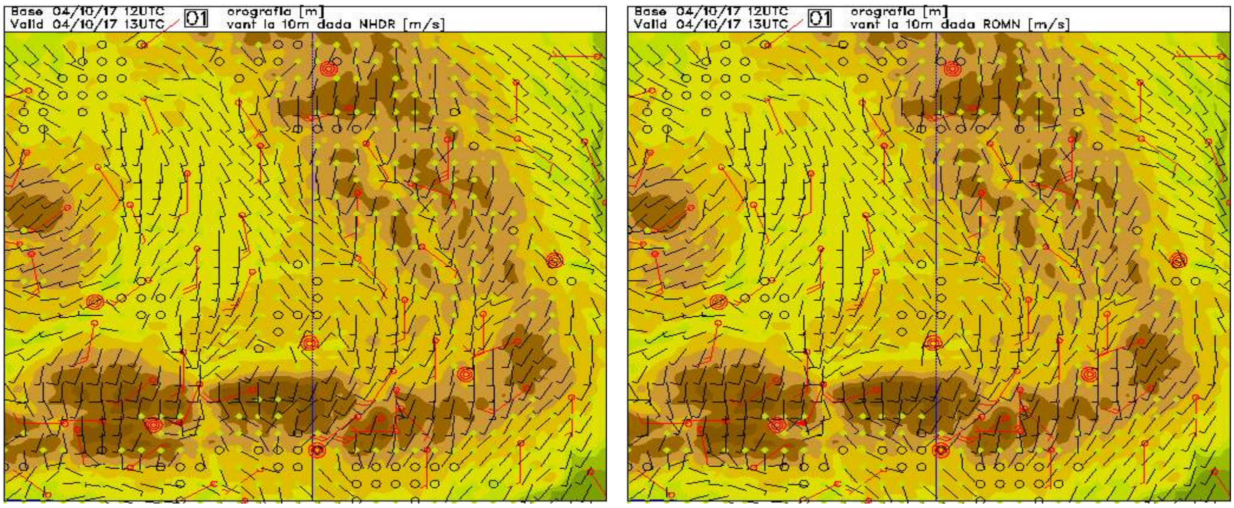
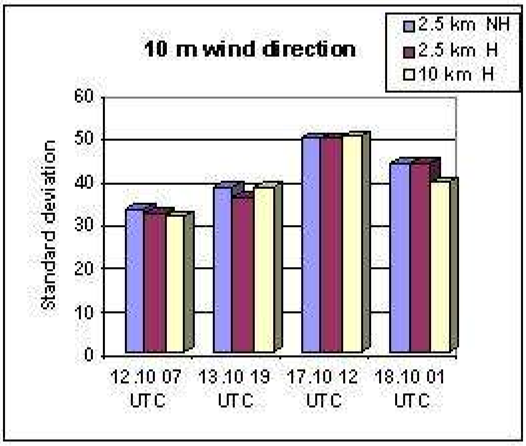


Fig.3: The 10 m wind forecast in dynamic adaptation at 2.5 km resolution, performed by the non-hydrostatic (left side), and the hydrostatic (right side) ALADIN/Romania model from 17.10.2004 00 UTC run, valid at 13 UTC, together with the real measurements of the wind (represented by red barbs)

Another method to evaluate the results of the dynamical adaptation procedure of surface wind at high resolution consists in computing some statistical measures (such as standard deviation or mean absolute error). Figure 4 presents the standard deviation scores of all three experiments. One can see that the differences between the model results at 2.5 km resolution are quite small. As one might expect, the operational model (i.e. at 10 km resolution) gives bad scores for the surface wind intensity.



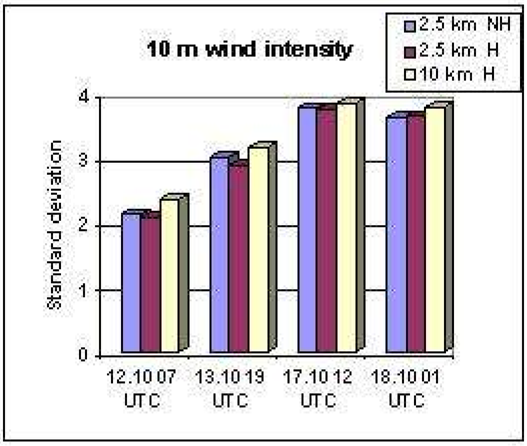


Fig.4: The verification scores (the standard deviation) of the 10 m wind forecasts performed by both non-hydrostatic and hydrostatic ALADIN model, in dynamical adaptation made at 2.5 km (blue/red colors) and at 10 km in the hydrostatic version (yellow color) for four different forecast ranges

From the operational point of view, it was important to assess the time needed to run the dynamical adaptation procedure on SUN E4500 workstation, which is the platform for the operational suite at NMA (National Meteorological Administration) (Figure 5). For the first step, i.e. the interpolation of the forecasts of the coupling model from 10 km to 2.5 km resolution (EE927), around 1.7 minutes is necessary (for each forecast range) for the non-hydrostatic (NH) version, compared with 1.23 minutes for the hydrostatic (H) model. During the integration of the NH model in dynamical adaptation (C001), new computations are performed, although some physical parameterizations are not used. The integration time is very long (almost 22 minutes) for only one forecast range. At the post-processing step, there is no difference between the NH and H versions at high resolution.

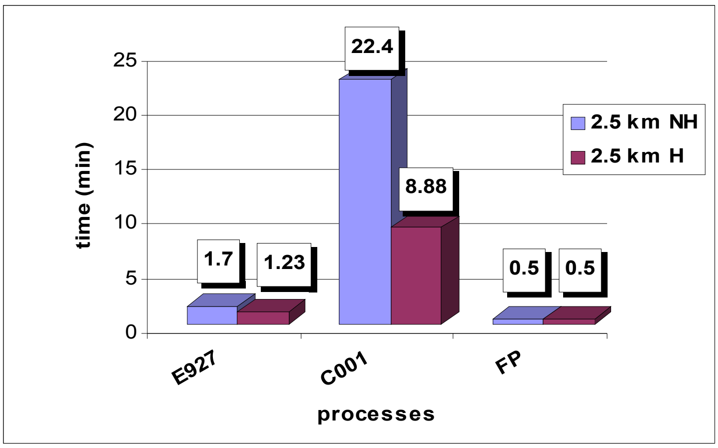


Fig.5: The processing time (expressed in minutes) necessary for only one forecast range performed by the ALADIN/Romania model in the non-hydrostatic (NH) and hydrostatic (H) versions, in dynamic adaptation at 2.5 km (blue/red colors)

4.4.3. Conclusions

In this paper, the preliminary results of the procedure for the dynamical adaptation of the surface wind forecast of the ALADIN/Romania using the non-hydrostatic version are presented briefly. For the two selected cases, the results of the NH and H models are relatively similar. In addition, taking into account the processing time (almost three times longer for the ALADIN/NH than for the ALADIN/H model), we consider that the experiments performed were not convincing enough to state the necessity of using the non-hydrostatic model for the dynamical adaptation procedure of the wind field. In this respect more investigations are needed.

4.4.4. References

Zagar, M., and Rakovec, J., 1999: Small-scale surface wind prediction using dynamic adaptation. *Tellus*, **51**, 489 – 504.

4.5. Pre-operational testing of a 3D-VAR assimilation in ALADIN-FRANCE: Fischer C., Th. Montmerle & L. Berre.

ABSTRACT

We explain the aim, strategy and first results for the implementation of an operational variational data assimilation system in the ALADIN-France model. Starting from the experiences gathered over the last five years with 3D-VAR in ALADIN as a research configuration, the goal is to settle a continuous, permanent assimilation cycle with an initial update frequency of 6 hours. ARPEGE data plus extra data (Meteosat-8 radiances to start with) are considered. The goal is to obtain at least as good conventional scores over Western Europe as with ARPEGE, plus a beneficial effect on short-range wind, temperature and precipitation forecasts. The retained solution offers such an improvement, with better precipitation "scores" at least up to 12 hours. In 2005, this assimilation cycle will be improved by more frequent updates and additional algorithmic facilities.

4.5.1. Initial choices

The core choices are the following, starting from earlier experiences gathered in the four leading ALADIN centres (Budapest, Casablanca, Prague, Toulouse) :

- analysis every 6 hours, in a continuous cycle, to mimic the ARPEGE system,
- lagged Jb formulation with a specific error variance inflation (after the works by M. Široka, W. Sadiki),
- ARPEGE observations to ensure a maximum of variety and coverage of observations acting as the main constraint in the problem, at our present knowledge (and technical ability),
- accompanying developments : Olive configuration, interaction with the AROME project and the GMME group,
- evaluation using a mixture of conventional COMPAS-type scores (for synoptic and meso-alpha scales) and subjective evaluation on chosen situations for meso-beta and large convective scales

4.5.2. Impact of B matrix and statistical behaviour of the assimilation

The first striking results from a one-month cycle were very bad scores on temperature, bias errors in the stratosphere and at tropopause level. Investigations have shown that this bias is due to a model error, present both in ARPEGE and ALADIN, though we have not been able to pinpoint the actual cause (dynamics or physics for instance). This negative behaviour, in the analysis itself (the analysis being even worse than the initial state of dynamical adaptation), had a detrimental impact on 6 hour forecasts and background scores, throughout most of the troposphere and for all fields. The cure was to change both the B matrix (sampling) and the global tuning of error variances (REDNMC). Thanks to S. Stefanescu's investigations on an ensemble-derived B sampling, we have switched to the ensemble Jb which does have statistical characteristics intermediate between the lagged and standard NMC ones. For instance, correlation length-scales are shorter than in the classical NMC case, which is suitable for keeping mesoscale analysis increments, but larger than in the lagged case, which allows to spread the observation information content into data-poor areas where the background may be of low quality. Additionally, the error variances are significantly inflated (by a factor of 1.8^2). Figure 1 shows the scores for background and analysis, for experiments using the lagged (red) and ensemble (black) Jb formulations, in the space of radiosonde temperature observations. The improvement of the analysis is striking, for the ensemble case..

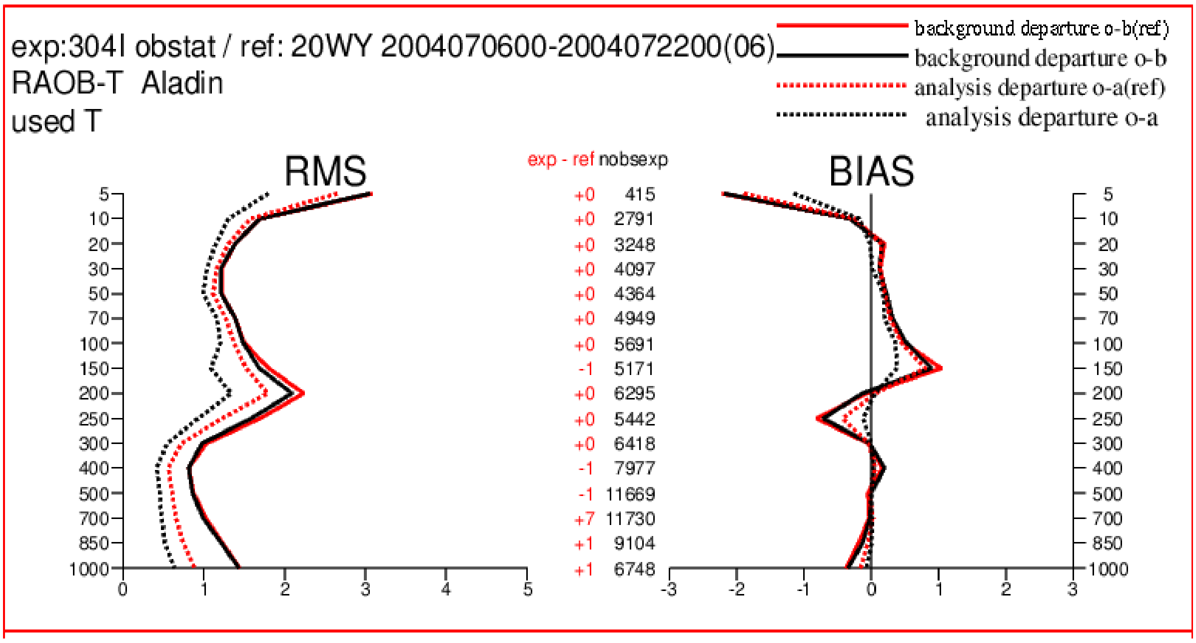


Fig.1: RMS and bias computed for radiosonde temperatures. Lagged Jb (red), ensemble Jb (black)

4.5.3. Case studies

✗ **20/07/04**

This is a case with a synoptic-scale front passing over France and Germany at the time of interest. The front exhibits interesting mesoscale features, such as a maximum over the Mosel valley in Germany (unfortunately no rain-gauge coverage is available for this area, Figure 2), small-scale maxima over the Western edges of the Massif Central and the Dordogne area. The operational ALADIN-France dynamical adaptation over-exaggerated the Mosel valley event, and produced a wide shed of rain over South-Western France (Figure 3), where mostly dry conditions were observed. The data assimilation cycles produce more realistic amounts of precipitations over Germany and the Massif Central. With a lagged Jb, the front has a very narrow and strong structure, which is not the case with the ensemble Jb. This latter, wider structure, probably is closer to the truth. The data assimilation cycles generally produce no or little precipitation over South-Western France.

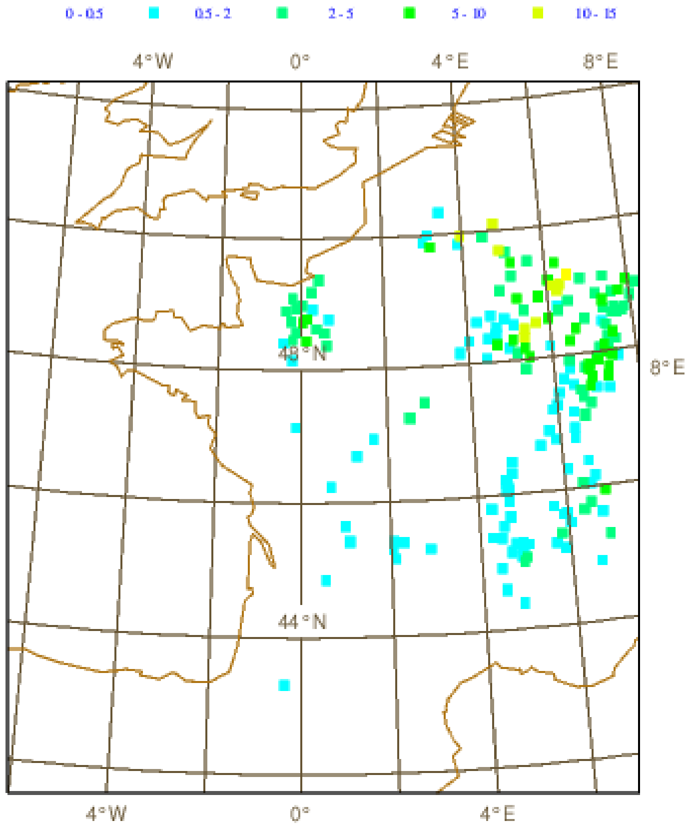


Fig.2: raingauge measurements

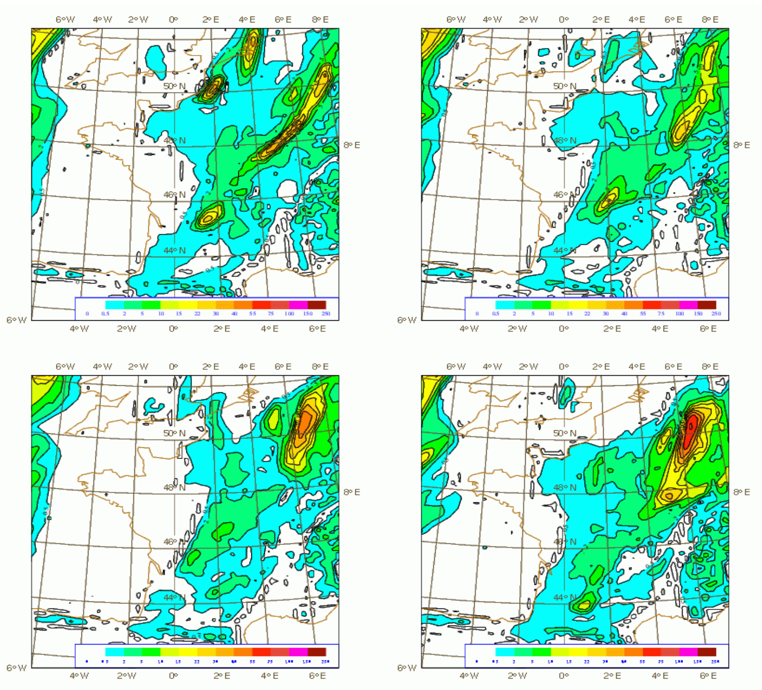


Fig.3: 12h-6h cumulated precipitations. Lagged Jb (top left), ensemble Jb + DFI (top right), ensemble Jb – no DFI (bottom left), dynamical adaptation (bottom right)

✗ **22/07/04**

In this case, an upper-air trough is moving northward along the Western French coast. Doing so, it triggers a mixed stratiform and convective activity over Central Western France, with a maximum of precipitations over Vendée and lower Loire valley. In dynamical adaptation, the precipitations are quite small, far below observed values. Taking into account the rather large mesoscale size of the phenomenon and the (hopefully) ended time of dynamics/physics spin-up in the operational version, the result is disappointing for a short-range forecast. In data assimilation mode, the core of the system and its overall geographical spread are visible. At fine scale (~100 km) however, each solution exhibits its particular structure, with sometimes an exaggerated activity in the Southern part of the system (Charente and Vienne valleys). The amounts of precipitations are fairly well predicted

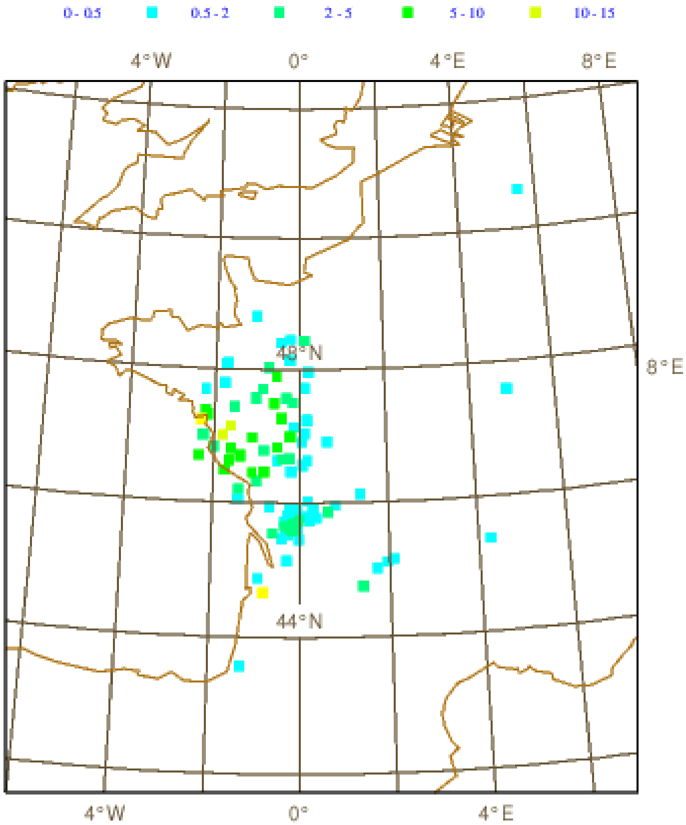


Fig.4: raingauge measurements

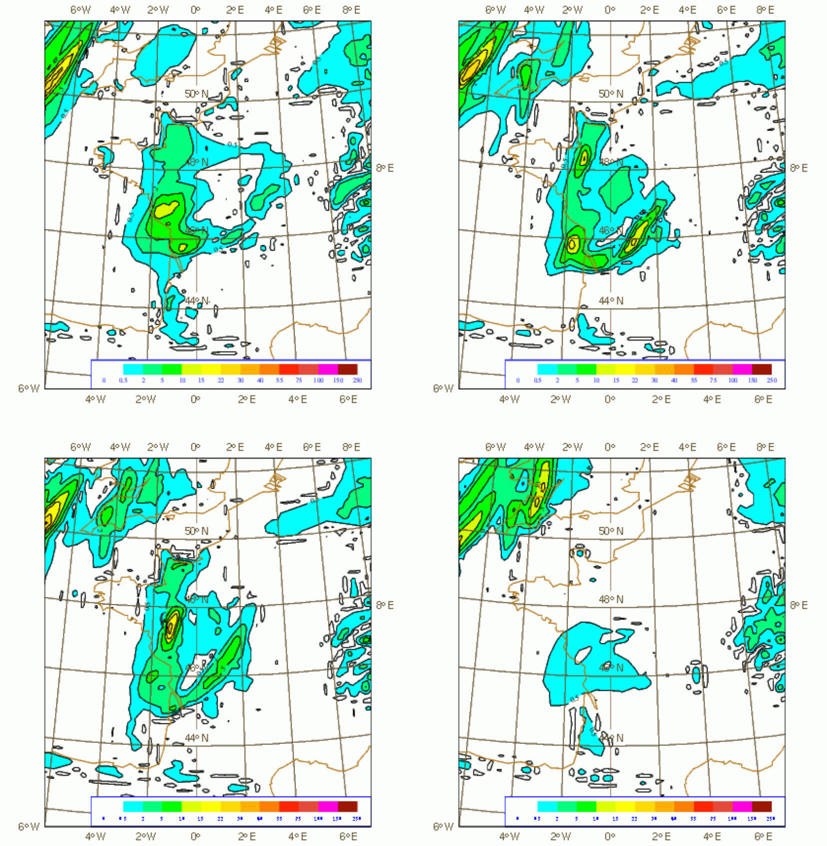


Fig.5: 12h-6h cumulated precipitations. Lagged Jb (top left), ensemble Jb + DFI (top right), ensemble Jb – no DFI (bottom left), dynamical adaptation (bottom right)

4.5.4. Conclusions and outlook.

The following general conclusions arose from the test experiments, performed over two periods of respectively one month (03/06/03 through 02/07/03) and two weeks (06/07/04 through 22/07/04) :

- Conventional scores match those of ARPEGE 4D-VAR over Western Europe. There is an impact on large scale scores ("output statistics") when the B matrix is changed ("input statistics").
- The 3D-VAR data assimilation cycle has a beneficial impact on almost all fields in the analysis. After between 6 and 12 hours, statistical scores go back to those of dynamical adaptation. After 12 hours of integration, the improvement of the initial state is lost in a statistical sense, using conventional observational networks as a reference.
- Precipitations are improved qualitatively and quantitatively for forecast lead-times between +3 and +12 hours. Before (0-3 h), spin-up/spin-down processes are probably active and more investigation would be necessary. For the time being, we have decided to maintain non-incremental digital filter initialization in both the assimilation cycle and in "production" forecasts. We have however decreased the strength of the filter, in a manner similar to DF blending, following the Prague experience.
- Not shown specifically here, the inclusion of the Meteosat-8 radiances generally further improves the precipitation features, especially when activity was under-estimated. A slight positive bias (over-estimation) of wide, weak precipitations remains as the major shortcoming of these data. We refer to Thibaut Montmerle's contribution in the same Newsletter and associated technical reports for more details.

- An E-suite is planned for about February 2005, based on CY29T1. Meteosat-8 radiances will be included.

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Berre, L., Stefanescu, S.E. and Belo Pereira, M.: An ensemble estimation of error statistics for a limited area model analysis. Part II: A formal and experimental comparison with two other error simulation methods, 2005, in preparation

4.6. Latest results of the LAMEPS experiments: Hágel E.

ABSTRACT

In this paper we are presenting the main results of a two months stay in Toulouse (October-November, 2004). The research carried out during this two months was a continuation of the work started at HMS in the topic of short range ensemble forecasts. (The full length report of this stay is available on the ALADIN webpage: http://www.cnrm.meteo.fr/aladin/publications/report.html.)

4.6.1. Motivation

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

4.6.2. Experiments

For making an ensemble forecast lots of methods can be used (e.g. multi-model, multi-analysis, perturbation of observations, singular vector method, breeding etc.). It is not known yet (especially at mesoscale) which method would provide the best forecasts. It was decided to start our experiments with the downscaling of the global (ARPEGE based) ensemble. This work can be divided into two parts:

- Direct downscaling of the ARPEGE/PEACE[3] members

[3] Prévision d'Ensemble A Courte Echéance; a short-range ensemble system operational at Météo-France, with 10+1 members, based on the model ARPEGE

- Investigation of the impact of target domain and target time window in the computation of singular vectors and downscaling the ARPEGE ensemble members

From previous studies (see Hágel and Szépszó, 2004) performed at the Hungarian Meteorological Service (HMS), we found that by simply downscaling the PEACE members the spread obtained is not big enough in the area of our interest (Central Europe). This fact can be explained easily if we consider that the PEACE system was calibrated in order to get enough spread over Western Europe between 24 and 72 h steps, for wind speed, 500 hPa geopotential and mean sea level pressure. The aim of the PEACE system is to detect strong storms. This raises some questions:

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

During this two month stay - as a continuation of the work started at HMS - we tried to investigate and better understand the impact of different target domains and target times in the singular vector computation. In our experiments an ARPEGE ensemble system was used, based on an earlier version of the PEACE system:

- For the generation of perturbations the singular vector method was used
- The singular vector computations were performed on T63 resolution
- 10 ensemble members were computed + the control run
- The integrations were performed on T199 resolution
- The forecast length was 54h (we use 54h because of the verification of precipitation, since the daily precipitation amount is observed at 06 UTC, so a 48h forecast started from the 00 UTC analysis would only cover one 24h period like this, while a 54h forecast covers both)

The main difference between the PEACE system and the system used by us is that the target domain and the target time was not fixed. For the target time 12h and 24h were used, and different target domains were defined.

In previous studies performed at the Hungarian Meteorological Service, we tried to investigate the effect of different target domains. Four domains were defined (fig. 1):

- Domain 1: Atlantic Ocean and Western Europe (70N/260W/30S/20E; the same as used earlier in PEACE)
- Domain 2: Europe and some of the Atlantic (70N/330W/30S/35E)
- Domain 3: covering nearly whole Europe (60N/1W/30S/35E)
- Domain 4: slightly bigger than Hungary (49N/15W/45S/24E)

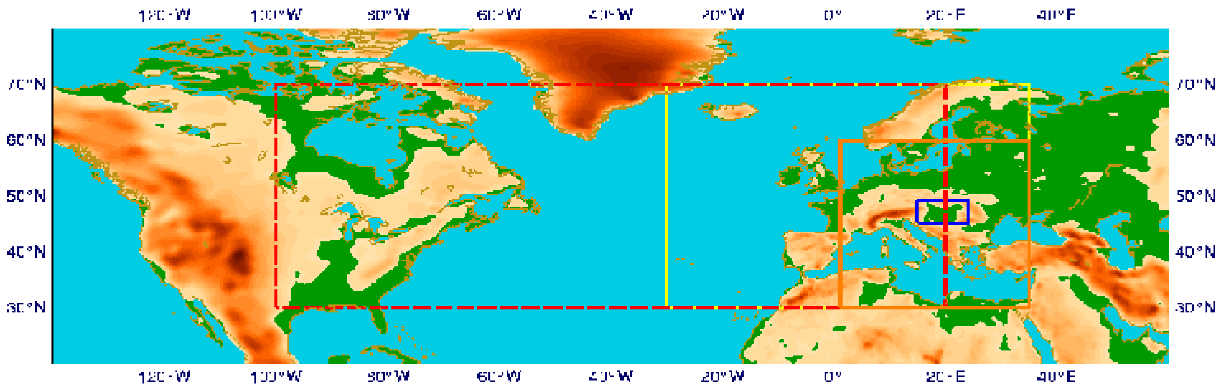


Fig.1: The defined target domains (red: domain 1, yellow: domain 2, orange: domain 3, blue: domain 4)

With the use of these domains case studies were performed. We concluded, that the use of domain 2 provides better results compared with domain 1, and also seems to be more rational than the use of domain 4. Domain 2 and domain 3 provided quite similar results in most of the cases, so next to domain 1 we chose domain 2 for a 10 day experiment (the target time in these experiments was 12h).

The chosen period for the ten day experiment was 10-19 July 2004. It was chosen randomly, the meteorological situation was not particularly interesting. At the beginning there was some frontal activity at the area of interest, but in the second half of the period the weather situation was determined by an anticyclone over Central Europe.

The results of the 10 day experiment showed that by using domain 2 for singular vector computation we can obtain a bigger spread, and better scores, also.

4.6.3. Experiments with different target times

During this stay in Toulouse our first aim was to repeat the above mentioned case studies and the 10 day experiment, but only with the use of domain 2, and with 24h as target time instead of using 12h.

✗ **Case studies**

It is expected that in different meteorological situations the use of different target domains would provide better results and a compromise should be found to choose the best domain. So far three different meteorological situations were examined (and a fourth one, with a cyclone coming from the South-East, has already started). One of them was a convective event in 2002 (18 July 2002). In this situation large quantity of precipitation (40-70 mm during 24h) was measured at some places along the river Danube and all the models (ALADIN, ARPEGE, ECMWF) failed to forecast the event. The second case (22 June 2001) was a situation with a fast moving cold front coming from the west. This time the models overestimated the precipitation. The third situation (22 February 2004) was one with a significant temperature overestimation. This error in the forecast of temperature caused a big problem: the models predicted rain, but in reality it was sleet.

Every time the ARPEGE ensemble runs were performed with singular vector target domain 2, and target time 24h. The average standard deviation over Hungary was computed (for 850 hPa temperature, 10 meter wind speed, mean sea level pressure and 500 hPa geopotential) and we also looked at different meteorological parameters. The results were compared with those obtained from the previous experiments (performed at HMS).

✗ **Results of case studies - Standard deviation**

In nearly every situation it was found that with the use of singular vector target domain 1 and target time 12h the average standard deviation was small in the beginning of the forecast and it increased quite slowly with the integration time. Around the end of the forecast range it usually reached the values obtained by the use of domain 2, but we do not want to concentrate only on the last few hours of the forecast. Instead we would like to find an optimal target domain for the singular vector computation which guarantees sufficient spread in the 12-48h time range.

When target domain 2 was used the (average) standard deviation was bigger. The second case (fast moving cold front) was the only one when standard deviations were nearly the same with the use of domain 1 and 2. The reason of this might be that in this case the examined phenomenon was a large scale one.

The use of 24h as target time also (on average) increased the standard deviation.

✗ **Results of case studies - Meteorological parameters**

Not only the standard deviation was examined but we also looked at different meteorological parameters each time. In the first case (convective case, 8 July 2002) we got nearly no precipitation at all when we used target domain 1 and target time 12h in the global singular vector computation. Using target domain 2 and target time 12h gave slightly better results. Some members of the ensemble forecast started from 12 UTC, 17 July 2002 indicated bigger amount of precipitation, but the location and the quantity was not perfect. By changing target time from 12h to 24h (and using target domain 2), the best results were obtained from the integration started from 00 UTC, 17 July 2002. Some members again predicted significant precipitation near the area where it occured in reality.

The second case was the only one when standard deviations were nearly the same with the use of domain 1 and 2, and also the predicted amount of precipitation was quite similar. The results of the forecasts showed that some members predicted too big amount of precipitation in the eastern part of Hungary along the river Tisza (which was also the problem with the operational forecast for that day, since the front in the model was not moving so fast than in reality), but there were also a significant number of members predicting much less amount of precipitation.

The result obtained in the third case (temperature overestimation) was not so good. In reality the temperature was around or below zero celsius all day, but the models predicted much higher values. A sufficient spread was obtained when domain 2 was used, but still the values for the temperature were very high. At least some of the members were colder than the control one, but they were not cold enough.

✗ **Ten day experiment**

We repeated the 10 day experiment with the use of target domain 2 and with target time 24h instead of 12h.

✗ **Ten day experiment results - Standard deviation**

The results of the 10 day experiment show that on average, the use of configuration target domain 1 and target time 12h would provide the smallest standard deviation values for all examined parameters (500 hPa geopotential, 850 hPa temperature, mean sea level pressure, 10 meter wind speed). This can be explained by the fact, that this domain is covering not only Western Europe but also the North Atlantic region and some part of the North American continent. The perturbations created usually have their maximum amplitude in the North Atlantic region and during a 54 hour forecast they do not always have a significant effect on the forecast over the Central European area.

With the use of target domain 2 the standard deviation (on average) can be increased and further improvement can be obtained with the use of 24h as target time. On average this configuration (target domain 2 and target time 24h) provides the biggest values in terms of standard deviation computed over Hungary (fig. 2).

Looking at the forecasts one by one, instead of the ten day average, we can find that the spread was bigger in the first few days of the period in case of every target domain and target time. This is reasonable if we consider the fact that there was some frontal activity at that time in the area, and in the second half of the period an anticyclone was determining the weather situation.

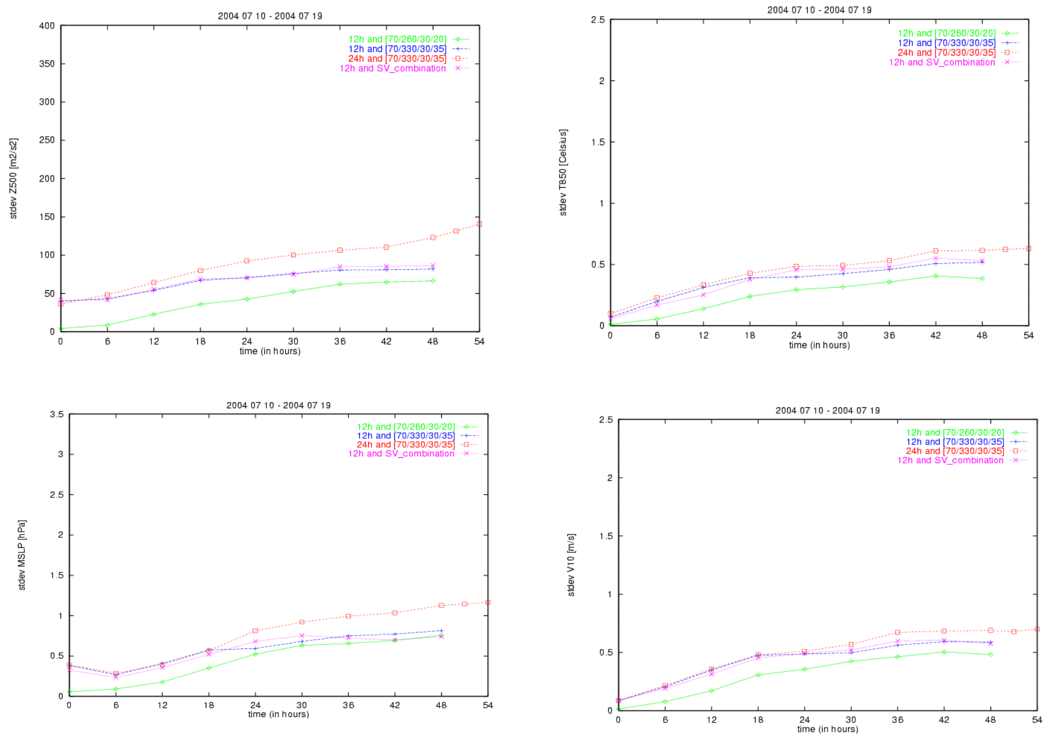


Fig.2: Average standard deviation over Hungary for the period 10 July 2004 - 19 July 2004, for Z500, T850 (top row), MSLP and V10 (bottom row). Computed from ARPEGE ensemble forecasts. The green curve is for target domain 1 and target time 12h, the blue one is for target domain 2 and target time 12h, red is for target domain 2 and target time 24h, and magenta is for the experiment with two sets of singular vectors and target time 12h.

✗ Ten day experiment results - Scores

Root mean-square error (RMSE) and the systematic error (BIAS) were computed both for ensemble mean and for the control forecast. Both RMSE and BIAS was computed for 500 hPa geopotential, 850 hPa temperature and mean sea level pressure for the ten day period over Hungary. Instead of observation, the analysis was used to compute these scores.

The BIAS of the ensemble mean and the control run on average seems to be quite similar, especially until +18h. Between +18h and +48h the difference becomes bigger. In some time steps the control forecast performed better, in other cases the ensemble mean. If we look at the BIAS of the individual forecasts and not the ten day average, we can find cases when the BIAS of the ensemble mean and the control run is nearly identical (mainly in the second half of the period when an anticyclone was determining the weather situation) and also cases when one of them performed much better than the other (fig. 3).

For the 850 hPa temperature the control run and the ensemble mean performed nearly identically in terms of RMSE values. In the case of mean sea level pressure between +18h and +48h the control run was slightly better. For 500 hPa geopotential ensemble mean was better between +18h and +30h and the control run was better from +30h. Looking at the forecasts one by one cases can be found when the ensemble mean outperformed the control run and vice versa. However, there are also cases (mainly in the second half of the period) when the RMSE of the control run and the ensemble mean was nearly equal (fig. 4).

The evaluation of the 10 day experiment will be continued (at HMS), by computing various kinds of probability scores such as ROC diagrams, Talagrand diagrams, Brier score and Brier skill score for several meteorological parameters and several thresholds.

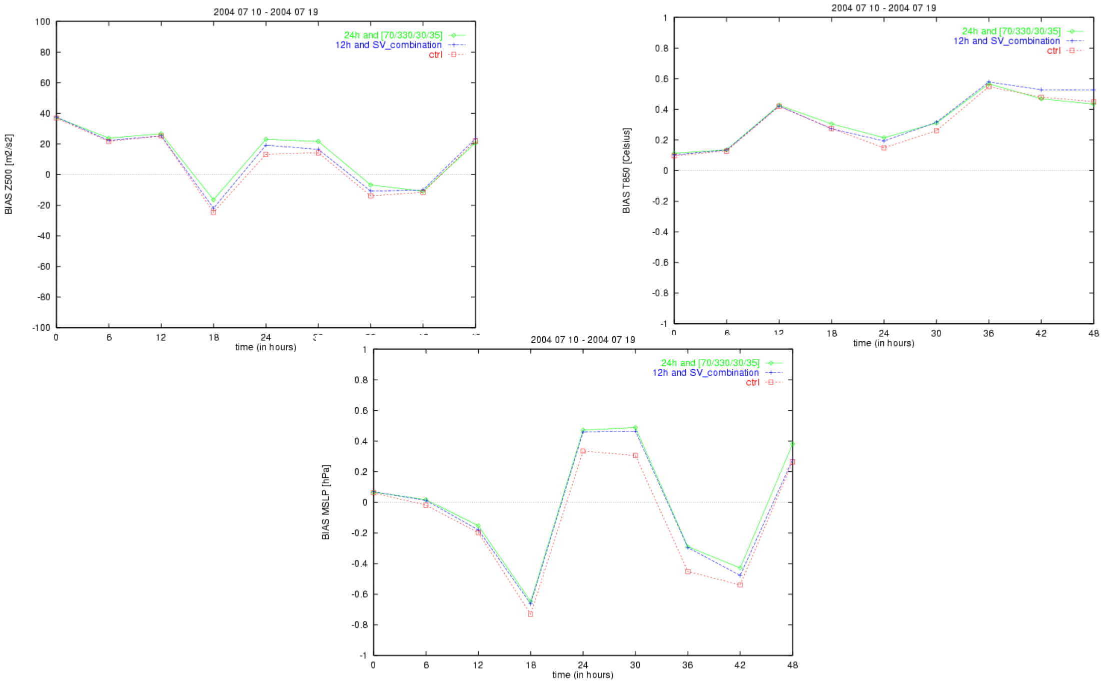


Fig.3: BIAS of the ensemble mean and the control forecast over Hungary for the period 10 July 2004 - 19 July 2004, for Z500, T850 (top row) and MSLP (bottom row). Computed from ARPEGE ensemble forecasts. The green curve is for target domain 2 and target time 24h, the blue one is for the experiment with two sets of singular vectors and target time 12h, and the red curve is for the control forecast.

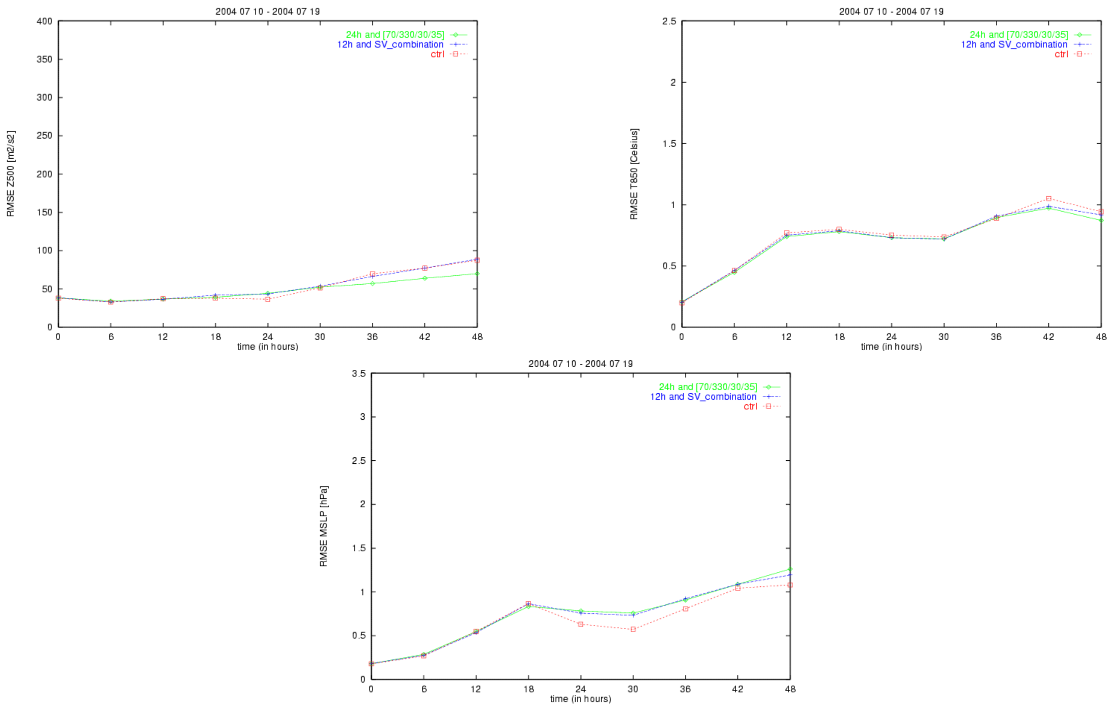


Fig.4: RMSE of the ensemble mean and the control forecast over Hungary for the period 10 July 2004 - 19 July 2004, for Z500, T850 (top row) and MSLP (bottom row). Computed from ARPEGE ensemble forecasts. The green curve is for target domain 2 and target time 24h, the blue one is for the experiment with two sets of singular vectors and target time 12h, and the red curve is for the control forecast.

4.6.4. Experiments with combining different sets of singular vectors

The results show that the spread in the ensemble system over Central Europe is - usually - not big enough with the use of the configuration target domain 1 and target time 12h. Changing the target domain and also the target time seems to be a good way of increasing the spread over the area of our interest, but this method requires the rerun of the global ensemble system.

As our final goal is to develop an operational short range ensemble system, an alternative solution has to be found which does not require the local integration of a global ensemble system.

The most obvious solution would be to compute singular vectors in the framework of ALADIN. Preliminary works have already started at HMS, but up to now we have not been able to run this configuration. Until this problem is solved another possible alternative solution can be the combination of different sets of global singular vectors. The idea is the following:

Next to the singular vectors computed operationally every day at the PEACE system, a second set of singular vectors, using different target area and probably different target time, could be computed locally (at HMS). From this second set of singular vectors, perturbations can be built. The global ensemble run (PEACE) could provide the lateral boundary conditions for the limited area model (ALADIN) and the initial conditions could be produced by combining the initial conditions coming from PEACE and the perturbations generated from the second set of singular vectors.

Since this is a very complex system, first we concentrated only on a small part of it. We wanted to examine, whether the combination of two different sets of singular vectors can inprove the quality of the ensemble system in terms of spread. For the sake of simplicity as a start we did the combination in the framework of ARPEGE in the following way:

- Singular vectors with the use of target domain 1 and target time 12h were computed
- Singular vectors with the use of a different target domain (one which is inside the LACE domain, 55N/2W/30S/40E) and target time 12h were computed
- Independency check was performed to select singular vectors from the second set which are independent from the vectors in the first set (this was necessary, because we wanted to be sure, that the spread will not be reduced, the perturbations from the two sets of singular vectors will not weaken each other)
- After checking the independency, perturbed initial conditions were built from the vectors of the first set and the selected vectors of the second set
- Integration of the global ensemble system was performed for the ten day period (10-19 July, 2004)

✗ Independency check

We performed the independency check in the following way: scalar products were computed between the vectors of the two sets (16 vectors in each set). If the vectors are independent, their scalar product is zero. Of course we can not expect to have values exactly equal to zero, therefore we had to set a threshold; if the scalar product is below this value we consider the vectors to be independent. First we chose this threshold to be 0.1, but we found that there were cases when only one or two singular vector was selected from the second set with the use of this threshold. With a threshold of 0.2 the situation was better (fig. 5).

So finally from the second set we used only the vectors which had scalar product less than 0.2 with all the vectors of the first set; from the first set all of the vectors were used.

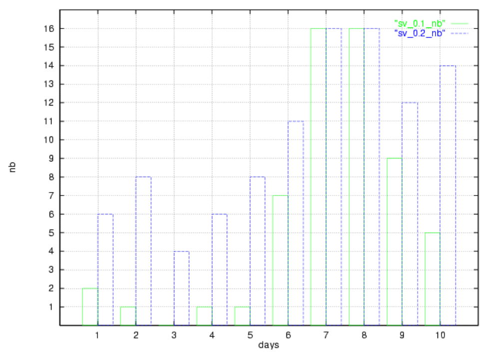


Fig.5: Number of singular vectors selected from the second set for each day of the ten day period. The green curve is representing the case, when vectors with scalar product less then 0.1 were selected, the blue curve is for the case when vectors with scalar product less then 0.2 were selected.

✗ Ten day experiment results - Standard deviation

The results of this experiment show that by combining the two sets of singular vectors, the average standard deviation over Hungary is similar to the results of the experiment using target domain 2 and target time 12h. A clear improvement can be found compared with the spread obtained by the use of target domain 1 and target time 12h, but still, the highest standard deviation values (over Hungary) are provided by the use of target domain 2 and target time 24h (fig. 2). An experiment has started to repeat this one, but using 24h as target time during the computation of the second set of vectors.

✗ Ten day experiment results - Scores

In this case the same conclusions can be drawn as for the experiment with 24h as optimization time, since the scores of the two experiments were very similar on average. Also it is true, that if we look the forecasts one by one and not the ten day average, bigger differences can be found between the performance of the ensemble mean in the two experiments, and also between the performance of the ensemble mean and the control run (fig. 3, fig. 4).

In this case also, the evaluation of the 10 day experiment will also be continued (at HMS), by computing various kinds of probability scores such as ROC diagrams, Talagrand diagrams, Brier score and Brier skill score for several meteorological parameters and several thresholds.

4.6.5. Preliminary conclusions

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

Changing the target domain and possibly also the target time seems to be a good way of increasing the spread over the area of our interest, but this method requires the rerun of the global ensemble system.

An alternative method can be the combination of two different sets of singular vectors. Preliminary results seem to be promising, but still lots of work has to be done in this field.

4.6.6. Future plans

We would like to continue to further investigate the topic of combining two sets of singular vectors. The experiment should be continued with combining the two sets not in the framework of ARPEGE, but in the framework of ALADIN, in the way which is described in section 3.2., and check whether the the same improvement can be obtained that we achieved in the case of ARPEGE.

Besides it is important to test the ensemble system on (much) more cases distributed in all four seasons (so far we ran experiments for four consecutive days from autumn 2003, ten consecutive days from summer 2004, and three case studies, two from the summer period and one from the winter, but the sample is not big enough so far), and to test it on independent cases instead of consecutive days.

Also it is planned to start the experiments with other methods especially with ALADIN native SV perturbations, but there is still a lot of work to be done to be able to run this configuration.

The errors in the forecasts are not only caused by the errors in the analysis, but also by the errors in the model itself (e.g. from the parameterisation of physical processes). A possible approach of this problem could be to run the model with different parameterisation schemes and/or by changing the parameters that represent important assumptions in the parameterisation. Work in this field has already started at Météo-France, and it would be useful to investigate the efficiency of such an ensemble system.

As our final goal is to develop an operational short range ensemble system we also have to consider the problem of transfering the lateral boundary conditions. Since the ensemble system consists of 10+1 members, there is a significant amount of data which has to be transfered. To solve this problem different proposals can be made:

- To discriminate the information coming from the lateral boundary conditions provided by the different ensemble members and the perturbed initial conditions. If it is found that the information coming from the perturbed initial conditions is more important than the information coming from the lateral boundary conditions, a possible solution could be that e.g. in the first 24h of the forecast the lateral boundary conditions for every member would be provided by the control run of the global ensemble system, and only after 24h would we use the lateral boundary conditions supplied by the ensemble members. This would reduce the amount of data which has to be transfered by nearly 50%.
- The PEACE system runs every day starting from the 18 UTC analysis. By running the LAMEPS starting at 00 UTC and using initial and lateral boundary conditions from the (previous) 18 UTC PEACE run, we could gain some time which could be used to download the lateral boundary conditions for the 10+1 members. This possibility could also be investigated in detail.

4.6.7. References

Hágel, E. and Szépszó, G., 2004: Preliminary results of LAMEPS experiments at the Hungarian Meteorological Service. *ALADIN/ALATNET Newsletter,* 26.

4.7. The HIRALD setup: B. H. Sass, K. Lindberg & B. S. Andersen.

4.7.1. Introduction

A new model setup based on non-hydrostatic ALADIN, the so-called HIRALD setup at ECMWF has been established. The idea is that this setup can be accessed in the future by both HIRLAM staff and people from Météo-France and the ALADIN community for various experimentation. The setup represents a concrete sign of a new collaboration between the HIRLAM community, Météo-France and the ALADIN community. More details about the planning of future collaborations are expected to become available during 2005.

The background for establishing the HIRALD setup is connected to the strong expectation that modelling at a very high resolution will be important for the HIRLAM community in the future.

Non-hydrostatic model effects will then start to become significant. Since non-hydrostatic dynamics has not been developed so far by the HIRLAM members it has been considered necessary to look for an adequate limited-area model system for very high resolution non-hydrostatic experiments. It has been found most suitable to propose a collaboration with Météo-France and ALADIN countries around the ALADIN model.

The very first HIRALD setup at ECMWF was established by Ryad El Khatib and a small group of HIRLAM people during a working week at DMI in July 2004. The HIRLAM people who have started to work with ALADIN have been in a learning process since March 2004 where a one-week training course on IFS/ALADIN was arranged for HIRLAM people by Météo-France

The purpose of the present short report is to briefly review the status by early January 2005 of the HIRALD setup at ECMWF and to summarise some preliminary experiences.

4.7.2. Evolution of the HIRALD setup

It was realised that the first model area of the HIRALD setup was insufficient (10 km grid size) for meso-γ scale studies. As a consequence the setup was developed further to become a double nested system. Hence a "Scandinavian setup" was defined (shown in figure 1). An outer model (grid size 11 km) is covering the whole of Scandinavia, the North Sea and the British Isles. Two internal models (grid size 2.5 km) were defined with target areas of southern Scandinavia and Finland, respectively.

In order to run experiments a period of interest was defined. The first week of July 2003 has been chosen, with significant precipitation events over Scandinavia. With the help of Météo-France staff the associated climate generations were generated. Small modifications to the areas shown in figure 1 were needed to do this. Also the appropriate ARPEGE boundary files for the outer area were transferred to ECMWF to be used for the outer Scandinavian model area. The boundary conditions for the inner model areas were then generated from ALADIN runs with the outer Scandinavian model area. After these modifications experiments could start on the inner model areas using the available model code of cycle 29 (ARPEGE physics). A re-assimilation of observational data has not been done so far, which is likely to put a limit to the potential of the model experiments with this setup to reproduce observed critical parameters such as accumulated precipitation with high accuracy.

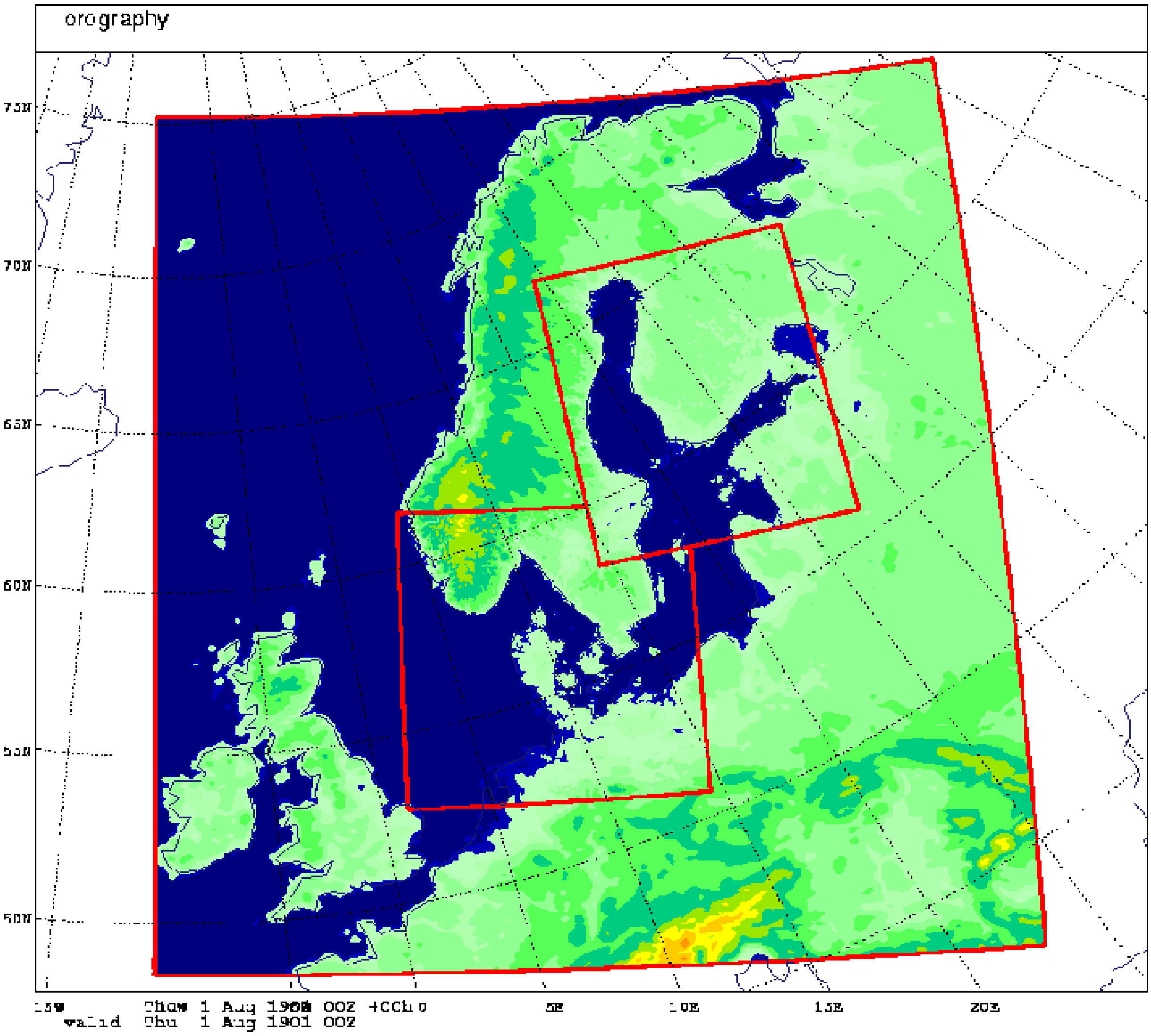


Fig.1: ALADIN domains

4.7.3. First experiments

It is often difficult to start experiments with a new model system. Getting started with ALADIN has been no exception. Even though there is some good documentation of some parts it seems not always up to date, and more guidance for newcomers on how to make simple experiments would be advantageous. A specific challenge is to understand to use the many namelist options. This problem will be met as soon as "non-standard" experiments are to be carried out, e.g. in the context of testing new code. An example of this has been met when trying to test HIRLAM physics code with cloud condensate as a prognostic variable and a new "pseudo" (one time level) humidity variable. A HIRLAM cloud and condensation scheme has been coded and linked successfully without too many problems, but runs could not start immediately because of some basic problems linked to the fact that the new fields were introduced. This means that problems occurred even with the new physics schemes not activated, e.g. complaints from the system related to non-availability of new fields at the boundaries. Subsequently the model crashed immediately after DFI. The initial problems were not solved by the end of 2004, but will hopefully be clarified and solved during the first quarter of 2005.

Instead it has been possible to start running with the existing ARPEGE physics and investigate features connected to the setup. Preliminary experiments show that the permissible time-step for the NH forecast on the 2.5 km Danish domain is 60 s or smaller. For this reason, a good parallel performance on a multiprocessor system is essential in order to obtain a reasonable execution time for a complete forecast. To test the performance, forecasts are run with and without the NH option on an increasing number of processors from 4 to 128. The average elapsed computing time for a time-step is plotted against the number of processors in Fig. 2. In an ideally scalable situation the two graphs should be straight lines with slope -1. However the slopes of the graphs decrease when more processors are added indicating the significance of the communication overhead and the inherent sequential part of the code.

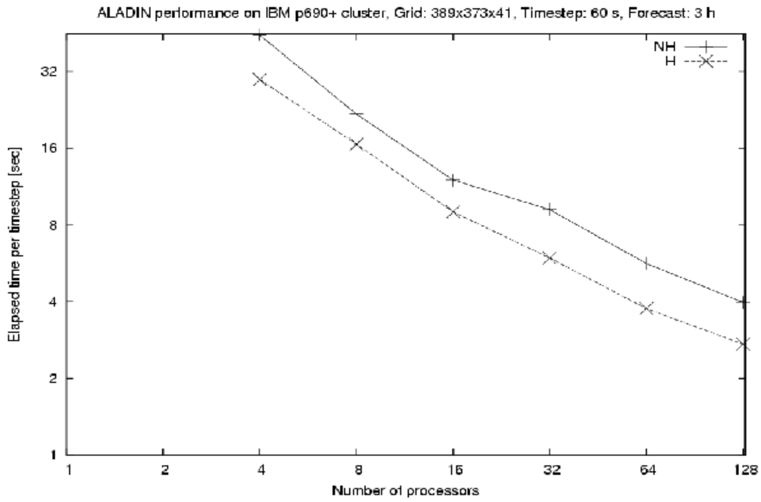


Fig.2 : Elapsed time per timestep versus Number of processors. Logarithmic axes

Also preliminary runs with the ALADIN-NH model have been made using ARPEGE physics (model domains of Fig.1). The test period is the one mentioned above, that is, the first week of July 2003 where some convective storms are observed over Denmark. One example of a test case is the 2nd of July 2003 18 UTC where we have an unstable atmosphere with weak winds. Convection is activated over parts of Denmark. The 12 hour forecasted accumulated precipitation using ALADIN NH-dynamics is shown in Fig. 3. and the corresponding 12 hour accumulated precipitation from observations are shown in Fig. 4. We see that the model captures the locations of the local precipitation maxima very well, but the quantitative values are not very good; in this case they are too low. In general it is found for this test period that convective type precipitation is underestimated in the model whereas large-scale (stratiform) precipitation is overestimated. Concerning other forecast parameters such as mean-sea-level pressure, 10 meter wind and 2 meter temperature, the model simulates the observations fairly well although we haven't looked into the details yet.

4.7.4. Future work

The model setup at ECMWF will be further developed and some documentation material on the system will become available. It is intended to implement various upgrades during 2005. These should make it possible to test different physical parameterizations, e.g. HIRLAM parameterizations. Also the climate generation system for ALADIN will be installed, and it is hoped to make it possible to run ALADIN with lateral boundary forcing from HIRLAM fields. After these developments it will be possible to set up runs on a daily basis which will allow for much more experience on the behaviour of high resolution runs using ALADIN NH-dynamics.

Acknowledgments: We would like to thank Météo-France staff and ALADIN people for their helpful support during 2004.

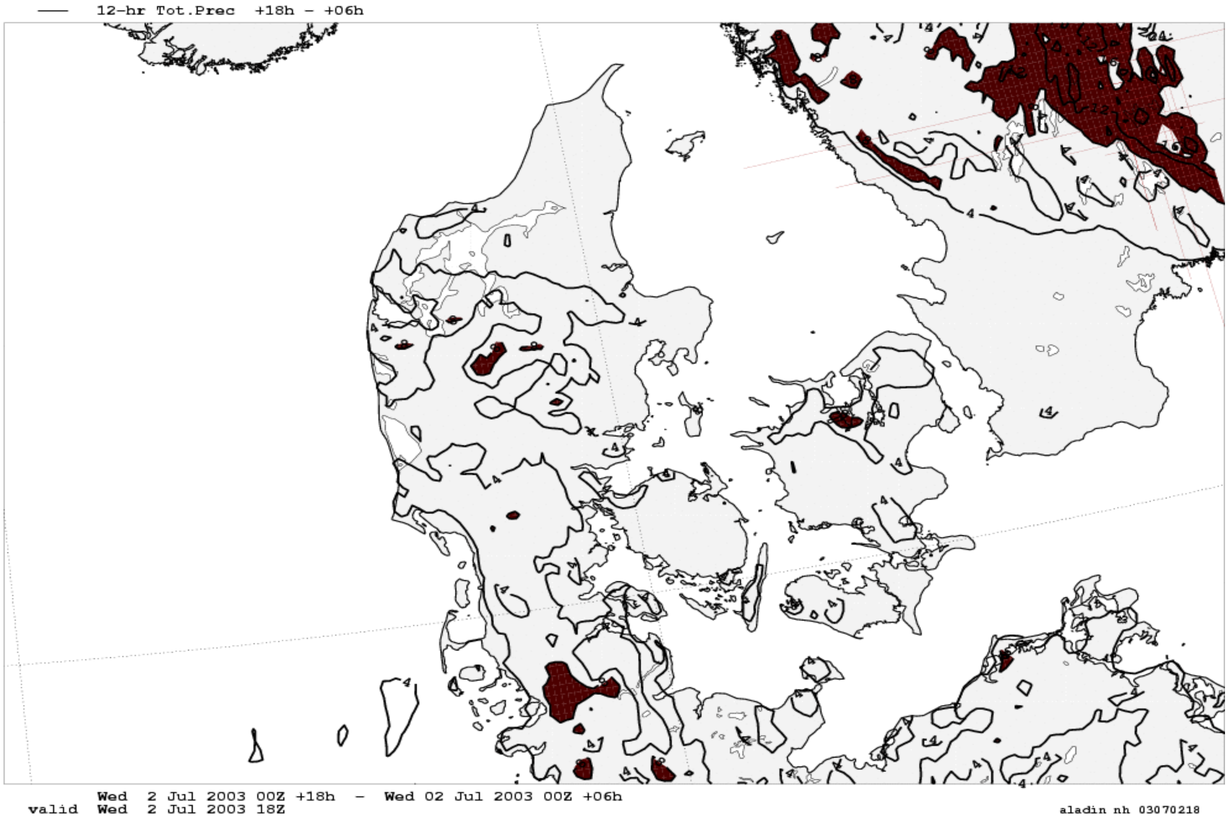


Fig.3: 12 hours accumulated precipitation forecasted with ALADIN-NH the 2nd of July 18 UTC. Black shaded areas has precipitation above 8mm.

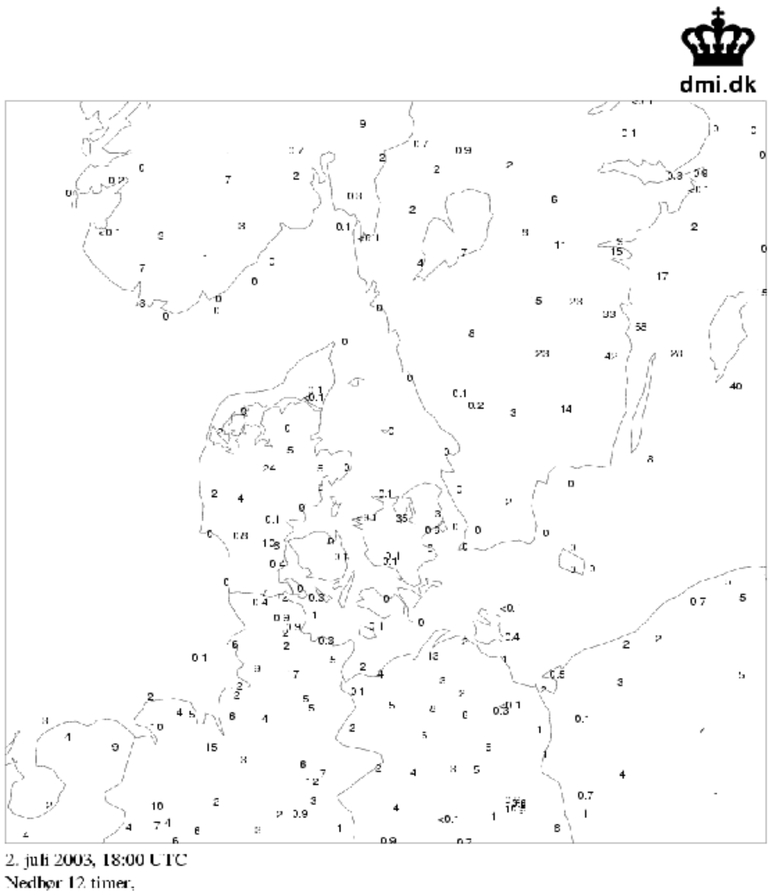


Fig.4: Observations 2nd of July 18 UTC. 12 hour accumulated precipitation

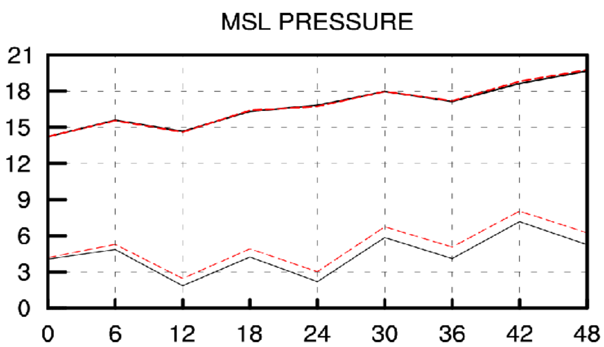
4.8. Spline interpolation in semi-Lagrangian advection scheme of ALADIN/ARPEGE/IFS: Váňa Filip.

4.8.1. Introduction

Most operational NWP models are currently using for their advection computation the semi-Lagrangian scheme. This scheme, among some other advantages, allows fairly longer time-steps with respect to the Eulerian advection, while preserving the computational model grid contrary to the pure Lagrangian solution. The price to achieve these nice features is typically to perform an interpolation of advected fields at every integration time-step. The accuracy of such interpolation is then a compromise given by need to keep it sufficiently precise and not too expensive with respect to the model performance. Typically, for most of the prognostic fields, this compromise is reached by interpolation based on cubic polynomials (Staniforth and Côté, 1991).

The ALADIN/ARPEGE/IFS code uses for the purpose of the semi-Lagrangian "accurate" interpolation sort of 2D and 3D interpolators based on Lagrange cubic polynomial in destinations close to the target point and linear interpolation for the outer sphere (Yessad, 2004). This interpolation works with sufficient efficiency and computational cost (Ritchie et al.,1995). However its performance is limited by the performance of the Lagrange cubic interpolators, which tends to be sometimes too stiff when applied to a rapidly changing quantity (field with dominating small-scale features). This known limitation is already, on current operational scales for some fields, too restrictive. Hence, for example, vertical interpolation for prognostic ozone can be optionally performed by spline (IFS) or by Hermite interpolators (ARPEGE/Climat). However the use of those higher order interpolations is restricted just to the vertical direction and prognostic ozone.

Since the semi-Lagrangian horizontal diffusion (SLHD) becomes a model feature, it has implicitly raised a need for more precise semi-Lagrangian interpolations. When SLHD is activated the original semi-Lagrangian interpolator is selectively corrupted by additional diffusive interpolation. Consequently the conservative ability of the advection scheme is deteriorated. It is a known feature that, because of the inability to conserve total mass, the semi-Lagrangian models produce generally a slight positive bias of surface pressure (Gravel and Staniforth, 1994). This tendency is typically small enough that, especially for the purpose of NWP, it can be ignored. The presence of SLHD further enhances the positive mean-sea-level pressure (MSLP) bias tendency caused by the semi-Lagrangian scheme.



This feature is illustrated by the figure displaying MSLP bias (lower lines) and rmse (upper lines) signals computed from a 19-days parallel test of ALADIN/LACE with SLHD (red colour) and without (black colour). The signal is not really dramatic and as proven it is even not further cumulated within a continuous assimilation cycle using the results of previous runs as the background fields for the new analyses. Once again the conclusion can be that we can live with a slightly worse model performance in term of mass conservation having the benefit of relatively cheap non-linear horizontal damping.

The aim of NWP research should be always the interest to improve a model performance keeping all good features of a code rather than to replace one advantage by another (even when it seems to be a good deal). This would imply a need to search for a possibility to reduce the above-mentioned side weakness of SLHD. Studying the structure of the semi-Lagrangian interpolators with activated SLHD it has been concluded that just something like between 0 and 15% of the whole interpolated amount is obtained by the diffusive interpolators. This is not a big contribution which means that there is not really much freedom to further reduce the portion of the diffusive interpolators while keeping the same diffusive properties of the SLHD. Logically the most promising way seems to improve the performance of the accurate interpolators. When the more precise interpolators will be contaminated by the diffusive interpolation, the total performance ideally should be around the performance of the current Lagrange cubic interpolators which is generally considered as sufficient for the NWP purpose.

Of course a new high-order interpolation should not be much more expensive with respect to the current one. Otherwise the scheme will not be competitive with the original one. Other constraint for the new potential interpolators, specific to the ALADIN/ARPEGE/IFS model, is the ability of the interpolators to be evaluated locally allowing computers to use the profit of a parallel computation.

4.8.2. Spline interpolation in ALADIN/ARPEGE/IFS

Keeping previous restrictions new interpolators were designed for semi-Lagrangian interpolation in the ALADIN/ ARPEGE/IFS model. It has been designed in the exactly same way as the current high-order interpolators (the order of computation, the interpolation grid) with the only difference that the Lagrange cubic interpolations are replaced by cubic interpolators with smooth first derivative and continuous second derivative. This definition fits the definition of splines. The new interpolators then can be considered as splines on four points.

✗ **A bit of theory**

The general spline interpolation formula can be written as (Press et al.,1986) :

$$y = A y_i + B y_{i+1} + C y_i'' + D y_{i+1}'' \ , \tag{1}$$

where *A* and *B* are the weights for linear interpolation ($B=1-A$) and :

$$C \equiv \frac{1}{6}(A^3 - A)(x_{i+1} - x_i)^2 \ ,$$
$$D \equiv \frac{1}{6}(B^3 - B)(x_{i+1} - x_i)^2 \ .$$

Here x_i are gridpoint coordinates with corresponding known values of an interpolated amount y_i .

The unknown values for second derivatives y_i'' are obtained by using the condition for continuity of first derivatives. For *N* given points it gives set of *N* - 2 equations:

$$\frac{x_i - x_{i-1}}{6} y_{i-1}'' + \frac{x_{i+1} - x_{i-1}}{3} y_i'' + \frac{x_{i+1} - x_i}{6} y_{i+1}'' = \frac{y_{i+1} - y_i}{x_{i+1} - x_i} - \frac{y_i - y_{i-1}}{x_i - x_{i-1}} \ . \tag{2}$$

To complete this system for *N* variables the values for y_1'' and y_N'' has to be defined. The simplest solution used also for our purpose is to define so-called natural spline by setting :

$$y_1'' = y_N'' = 0 \ .$$

✗ **ALADIN/ARPEGE/IFS implementation**

As already mentioned for the semi-Lagrangian interpolation in ALADIN/ARPEGE/IFS the "local" approach of spline is used so N will be always equal to 4. In such case with the natural spline boundary condition the equation (2) can be reduced to system of two equation for the two unknowns y_2'' and y_3'':

$$\frac{x_3 - x_1}{3} y_2'' + \frac{x_3 - x_2}{6} y_3'' = \frac{y_3 - y_2}{x_3 - x_2} - \frac{y_2 - y_1}{x_2 - x_1}$$
$$\frac{x_3 - x_2}{6} y_2'' + \frac{x_4 - x_2}{3} y_3'' = \frac{y_4 - y_3}{x_4 - x_3} - \frac{y_3 - y_2}{x_3 - x_2} \quad (3)$$

This set is always diagonally dominant when $x_2 - x_1 \neq 0$ and $x_4 - x_3 \neq 0$, which is always the case with the model grid. This means that a solution always exists as :

$$y_2'' = \frac{C_1 B_2 - C_2 B_1}{A_1 B_2 - A_2 B_1} ,$$
$$y_3'' = \frac{A_1 C_2 - C_1 A_2}{A_1 B_2 - A_2 B_1} ,$$

where :

$$A_1 = \frac{x_3 - x_1}{3} \quad B_1 = \frac{x_3 - x_2}{6} \quad C_1 = \frac{y_3 - y_2}{x_3 - x_2} - \frac{y_2 - y_1}{x_2 - x_1} ,$$
$$A_2 = \frac{x_3 - x_2}{6} \quad B_2 = \frac{x_4 - x_2}{3} \quad C_2 = \frac{y_4 - y_3}{x_4 - x_3} - \frac{y_3 - y_2}{x_3 - x_2} .$$

The horizontal interpolation can be fairly simplified by interpolating virtual function $F'[x_i', y_i]$ instead of $F[x_i, y_i]$. Here the x_i stands for general model computational grid while x_i' represents virtual regular grid $(x_i' - x_i \equiv 1)$. In case of ALADIN grid $x_i' \equiv x_i$, hence $F \equiv F'$. The two functions F and F' are illustrated by Figure 1. This trick is applied just to horizontal mesh since here the computational grid distribution is controlled by some rules (gauss grid, stretching) ensuring that the derivatives of an interpolated amount on the virtual grid would still somehow correspond with the computational grid. Vertical grid is determined by namelist without any a priori restriction, so the interpolation is performed on the real grid along this direction. Fortunately the vertical interpolation is performed just once at the end of the 3D interpolation, so it is not causing a dramatic increase of the model computational cost.

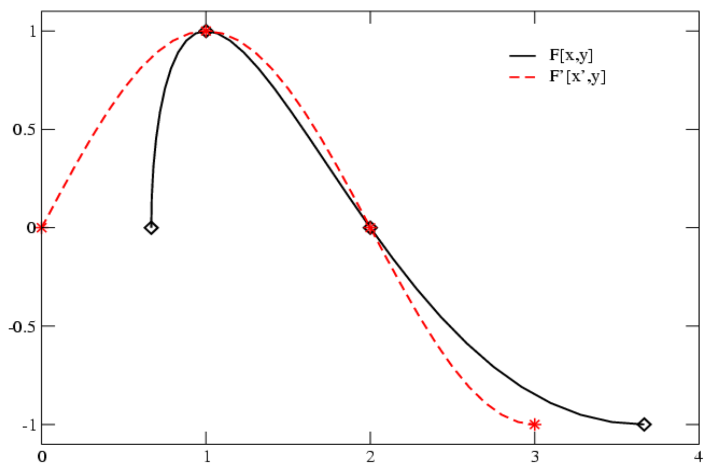


Fig.1: The true function F to be interpolated on stretched model grid fitting the model gridpoints (black full line with the points marked as diamonds) and the equivalent function F' transformed to regular grid which is interpolated instead along vertical during spline interpolation (red dashed curve with the points marked as stars). The target area to be interpolated is located between points 1 and 2 on x-axis.

The equations (3) will have then for horizontal interpolation solution :

$$y_2'' = \frac{2}{5}(4 \; y_1 - 9 \; y_2 + 6 \; y_3 - y_4)$$
$$y_3'' = \frac{2}{5}(-y_1 + 6 \; y_2 - 9 \; y_3 + 4 \; y_4)$$

In this case also the computation of the coefficients C and D in (1) can be simplified to just :

$$C = \frac{1}{6}(A^3 - A)$$
$$D = \frac{1}{6}(B^3 - B)$$

Thanks to this simplification the computation of these interpolators is just around 2.8% more expensive than the less exact Lagrange cubic interpolation[4]. There is still some space to further optimise this performance, but it is questionable how much it would improve the final performance (i.e. it can happen that a lot of code-work will improve this performance by just negligible factor).

✗ User's guide

To switch the current Lagrange high-order interpolation to the one with splines in the ALADIN/ARPEGE/IFS model is quite simple. A set of **`NAMDYN`** namelist switches called `LRSPLINE_[X]` for separate variables (kind of variables) is defined to activate (when set to `.T.`) the spline interpolation :

`LRSPLINE_W`	for horizontal flow components
`LRSPLINE_T`	for temperature
`LRSPLINE_SPD`	for (NH) pressure departure
`LRSPLINE_SVD`	for (NH) vertical divergence
`LRSPLINE_P`	for continuity equation
`LRSPLINE_Q`	for moisture
`LRSPLINE_O3`	for ozone
`LRSPLINE_V`	for other GFL fields

((Note that for ozone this spline interpolation has higher priority than quasi-monotone vertical spline interpolation (IFS), and both have higher priorities than vertical Hermite interpolators(ARPEGE/Climat).)

All the other features of the semi-Lagrangian interpolators like quasi-monotonicity (keys `LQM [X]`), horizontal quasi-monotonicity (keys `LQMH[X]`) or SLHD (key `LSLHD`) are preserved independently to the actual value of `LRSPLINE_[X]`. The defaults values for cycle 29T1 are `.F.`, only in case of SLHD are `LRSPLINE_W`, `LRSPLINE_T`, `LRSPLINE_Q` and in case of NH dynamics `LRSPLINE_SPD` with `LRSPLINE_SVD` automatically set to `.TRUE.`

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4.8.3. Performance of the splines

So what should one expect from the splines used instead of the Lagrange cubic interpolators despite some increase of CPU time consumption ? Surely it is an improvement of the advection scheme interpolation precision reducing a model random damping. This effect is reflected by the figure 2, showing the response of interpolators to the kinetic energy spectra during an academic frontogenetic idealised adiabatic 3D experiment with the model ALADIN (Vana, 2003). It is evident, that when spline is used instead of Lagrange interpolators, the inherent diffusion of the semi-Lagrangian scheme is reduced especially for the small scale information.

[4] This result was obtained with operational ARPEGE TL359L41c2.4 on Fujitsu VPP5000 and spline interpolation used for u, v, T, q but not π_s .

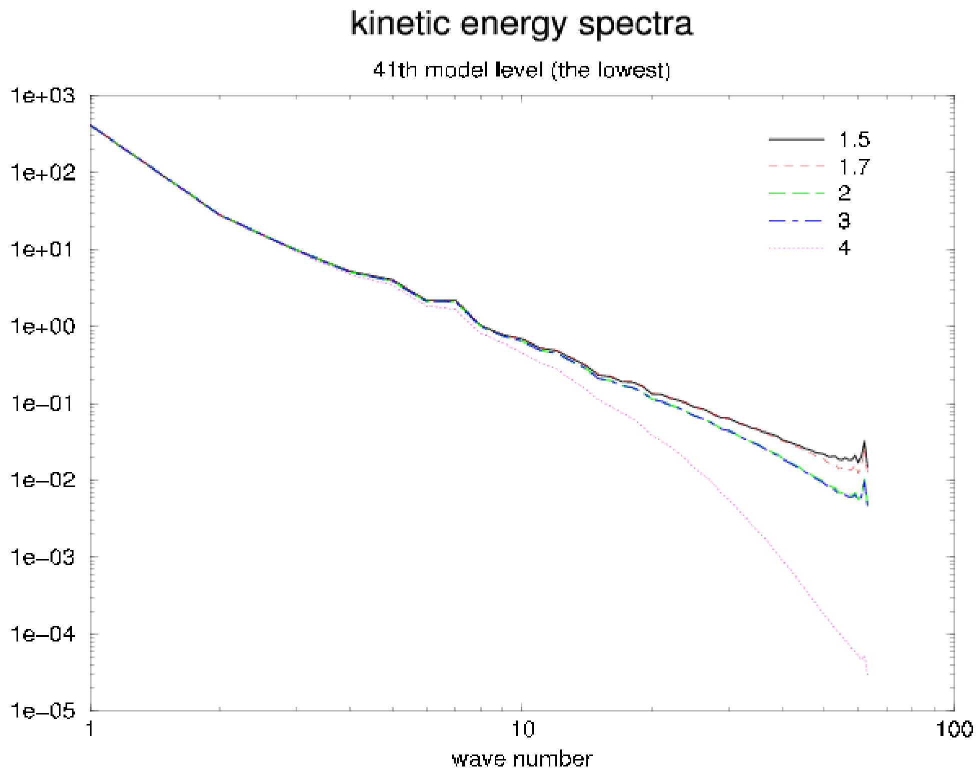

Fig.2: The kinetic energy spectra from the idealised adiabatic frontal development simulated with the model ALADIN as a result of used interpolators for semi-Lagrangian scheme. Black full line (1.5) represents the spline interpolation used for all interpolations (N[X]LAG=2), dashed red line(1.7) represents the same with the small difference that the tendency part of the interpolated amount is interpolated by linear interpolation (N[X]LAG=3). Long dashed green line (2) is representing the spectra obtained when Lagrange cubic interpolators is used exclusively for the whole semi-Lagrangian amount (N[X]LAG=2), dot-dashed blue line (3)represents the Lagrange interpolators used for fields while the tendency are interpolated by linear interpolation(N[X]LAG=3). Finally dotted violet line (4) represents the result after just linear interpolation.

Figure 3 shows the mean quadratic error of several interpolators with respect to the waves of model spectrum (with quadratic truncation). As it can be seen the Lagrange interpolation is outperforming the others for the long waves. Once the interpolated quantity becomes more rapidly changing, the spline interpolators, fulfilling the additional conditions for derivatives, start to interpolate with smaller error. This makes the spline interpolators especially profitable when some rapidly changing fields (of small scale character) will be advected.

Anyway some extensive validation to prove the response of the spline interpolation in term of increase of the computational precision of the model still has to be done. Up to now no parallel test focused on this new model feature has been launched. Hence currently we can just speculate about a possible improvement of the model scores.

Other reason to use the splines in the ALADIN/ARPEGE/IFS model was linked to the SLHD diffusion. To prove clear profit from the existence of spline interpolators for this case is relatively easy. As shown on the figure 4 the SLHD creates a systematic positive bias of the surface pressure. When the accurate interpolators of SLHD are spline ones, the positive bias tendency is significantly reduced (the portion of areas with warm - yellow and red - colours is reduced). This reflects the ability of the more precise spline interpolators to reduce the bias caused by semi-Lagrangian interpolation.

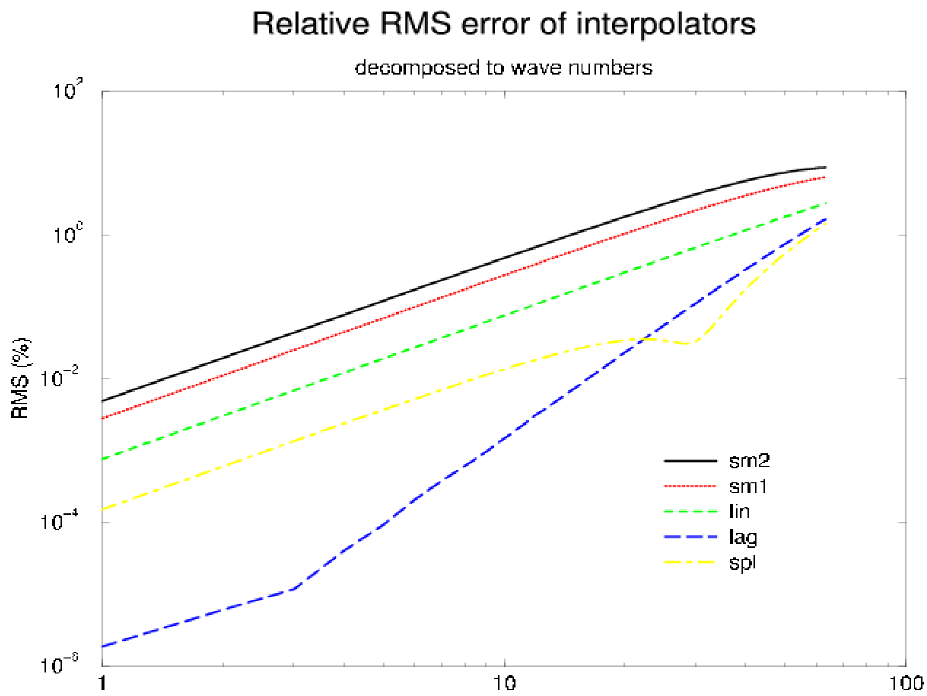

Fig.3: Mean quadratic error (as the percentage of the wave amplitude) of different interpolators obtained as the result of 10^6 1D interpolation of separate waves from a model spectrum with quadratic truncation. The curves represents following interpolators : `sm2` - average of 4 adjacent points, `sm1` - average of 2 adjacent points, `lin` - linear interpolation, `lag` – cubic Lagrange interpolation and `spl` - natural cubic spline on 4 points.

4.8.4. Conclusion

Since CY29T1 the spline interpolation is available as an alternative to the other interpolations for semi-Lagrangian scheme advection. This interpolation tends to be more precise than the default Lagrange interpolators especially for the fields with a dominating small-scale character. To achieve such increase of accuracy, one has to expect increase of the model CPU consumption by around of 3% of the total performance. Contrary to the other alternatives to the default interpolators this new one can be used with all model fields being advected by semi-Lagrangian scheme.

Another advantage of the more precise spline interpolators is the ability to reduce systematic MSL pressure bias. Since the SLHD produces the opposite effect it is especially useful to combine SLHD with this new kind of interpolators.

Moreover even when it is preferably constructed for a regular mesh, the spline interpolation is introduced in a very general way. It means that its usage is not restricted by SLHD or by other interpolation switches. It can be combined with any other constraint for semi-Lagrangian scheme (quasi-monotonicity, `N[X]LAG`, ...)

4.8.5. References

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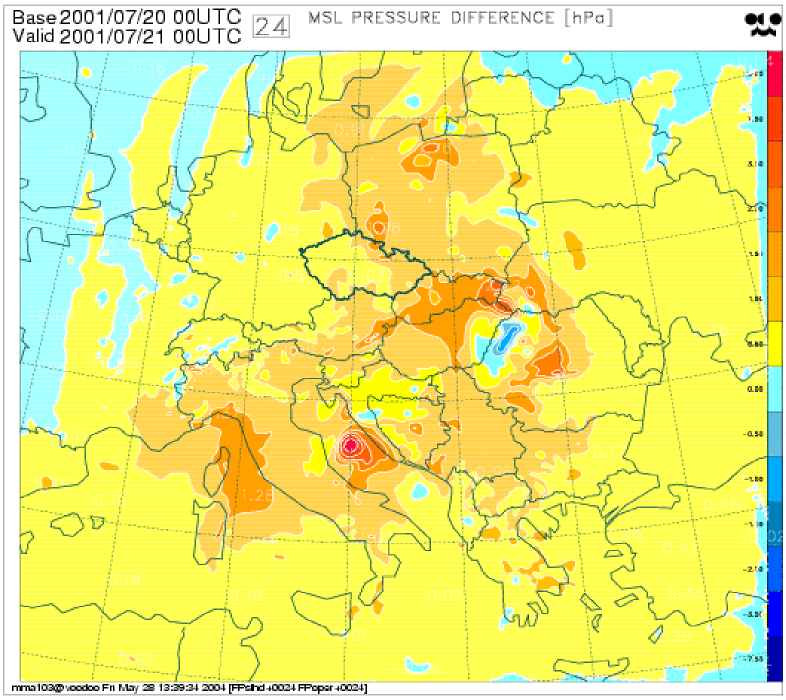

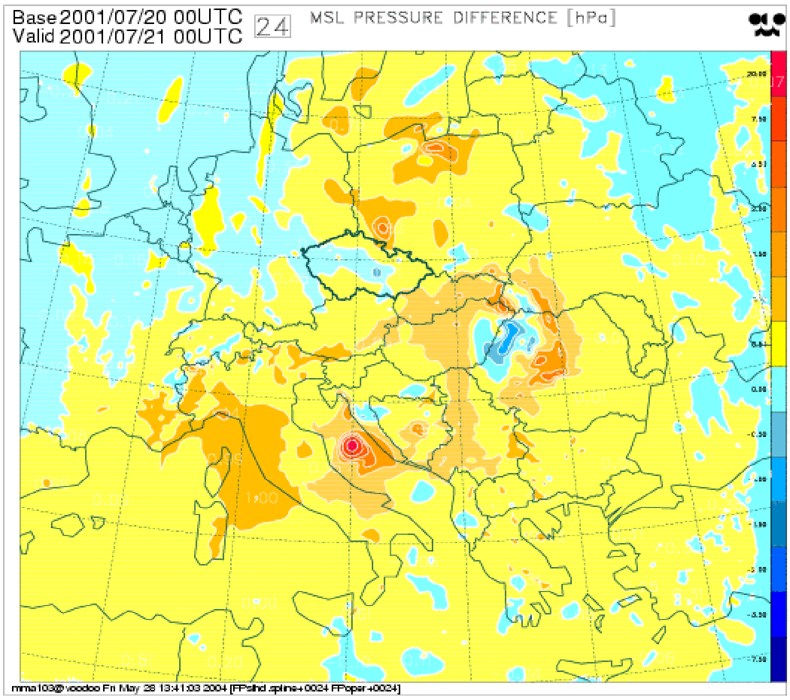

Fig.4: The MSL pressure difference of 24 hours forecast of ALADIN/LACE with SLHD compared to the spectral diffusion as reference (upper figure) and with SLHD + spline interpolation compared to the same reference (spectral diffusion with default Lagrange interpolators) (bottom figure).

4.9. Impact of observations and tuning of observational error statistics: Chapnik Bernard.

4.9.1. Introduction

This short paper aims to sum up results obtained during a PhD supervised by Olivier Talagrand (CNRS/LMD) and closely advised by Gérald Desroziers and Florence Rabier (CNRM/GMAP) in Toulouse. Most of of the results were obtained in the French global ARPEGE 4D-Var system.

The ever growing amount of available observations (among others, satellite data) reinforces the necessity of efficient tools able to evaluate the impact of each of them on the analysis ; moreover, proper statistics must be specified in order to retrieve as much information as possible from those observations.

Most data assimilation scheme rely on linear estimation theory : the analysis (further denoted x_a) is fundamentally a linear combination of the background (x_b) and of observations (*y*). From this basis, it will be tried to answer to the following questions :

- How to evaluate the impact of observations, or of a certain subset of the observations?
- How to use this impact in order to tune a data assimilation system?

4.9.2. Theory

A short theoretical part will be useful to introduce the notations and concepts required in order to answer those questions.

Let us first define an information vector *z*, $z^{\mathrm{T}} = \begin{pmatrix} x_b^{\mathrm{T}} & y^{\mathrm{T}} \end{pmatrix}$, the vertical concatenation of the background and the observation vectors. This vector is linked to the truth (*x*) by means of a linear operator Γ, $\Gamma^{\mathrm{T}} = \begin{pmatrix} I_n^{\mathrm{T}} & H^{\mathrm{T}} \end{pmatrix}$: $z = \Gamma x + \varepsilon$, where H is the observation operator and ε is the information error, concatenating background and observation errors $\varepsilon^{\mathrm{T}} = \begin{pmatrix} \varepsilon_b^{\mathrm{T}} & \varepsilon_o^{\mathrm{T}} \end{pmatrix}$ with covariance matrix $S = E(\varepsilon \varepsilon^{\mathrm{T}})$, where E is the expectation operator. In case observation and background errors are not correlated, *S* is equal to $\begin{pmatrix} B & 0 \\ 0 & R \end{pmatrix}$, where *B* and *R* are the background and observations error covariance matrices.

The analysis x_a is equal to : $x_a = x_b + K\,(y - H\,x_b)$, where *K*, the "gain matrix" can be written $K = P_a H^{\mathrm{T}} R^{-1}$, with $P_a = (B^{-1} + H^{\mathrm{T}} R^{-1} H)^{-1}$ which, in case the *B* and *R* matrices used in the system are the optimal matrices, is also the analysis error covariance matrix.

In variational data assimilation this analysis is obtained as the state vector minimizing an objective function *J* (often called "cost function") :

$$J(x) = (y - H\,x)^{\mathrm{T}} R^{-1} (y - H\,x) + (x - x_b)^{\mathrm{T}} B^{-1} (x - x_b),$$

which, using the information vector can be rewritten : $J(x) = (z - \Gamma x)^{\mathrm{T}} S^{-1} (z - \Gamma x)$.

If one supposes that this cost function can be split into several parts : $J = \sum J_i$, with each J_i written as : $J_i(x) = (z_i - \Gamma_i x)^{\mathrm{T}} S_i^{-1} (z_i - \Gamma_i x)$, z_i is the i^{th} subpart with dimension n_i extracted from the information vector *z*, associated with the Γ_i observation operator and the S_i covariance matrix of its associated errors.

Then, if the specified covariances of the assimilation system really are the optimal matrices, an important result provided by Talagrand (1999) applies. The expectation of the i^{th} subpart of the objective function at the minimum is :

$$E(J_i(x_a)) = n_i - Trace(\Gamma_i P_a \Gamma_i^T S_i^{-1})$$

Moreover, $Trace(\Gamma_i P_a \Gamma_i^T S_i^{-1})$ is a measurement of the contribution of $\mathbf{z_i}$ to the overall precision of the assimilation system.

A more explicit signification of these values can be obtained when focusing on the background/observations splitting of the objective function :
- when $z_i = x_b$, $Trace(\Gamma_i P_a \Gamma_i^T S_i^{-1}) = n - Trace(KH)$, then $E(J_b(xa)) = Trace(KH)$
- when $z_i = y$, , $Trace(\Gamma_i P_a \Gamma_i^T S_i^{-1}) = Trace(HK)$, , then $E(J_o(xa)) = Trace(I_p - HK)$. (I_p is the identity with order p)

It must be remarked that the use of the Trace of HK as quantification of the impact of observations had already be introduced by Wahba (1995) in a meteorological context. This quantity is called DFS, for Degrees of Freedom for Signal, see also Cardinali et al. (2004) for another example of implementation of this diagnostic in a global data assimilation system.

Several points must be stated at this stage about DFS. DFS quantifies how the system uses the observations to pull the signal from the background; in the optimal case (i.e K operationally specified = true K), this is also the relative reduction of variance. Used on its own, DFS says what the system does, without any other criterion it cannot say what it should do in order to improve the analysis.

A first clear problem appears : How do we compute DFS when K generally does not even explicitly exist in a variational scheme ?

4.9.3. Practical Computation of *Trace (HK)*

Two methods have been implemented in order to compute estimates of this Trace.

✗ **Girard's method**

The first method was proposed Girard (1987), it was introduced in the field of meteorological data assimilation by Wahba (1995), and by Desroziers and Ivanov (2001).

The method is based on the following mathematical identity : considering a random vector ε with 0 mean and the identity covariance matrix, and an operator *A*, the expectation of the quadratic form $\epsilon^T A \epsilon$ is :

$$E(\epsilon^T A \epsilon) = Trace(A)$$

This mathematical property is used as following :
- make a first "normal" analysis x_a using the usual background and observations,
- make a perturbed analysis x_a^* using the same background and perturbed observations, $y^* = y + R^{0.5}\zeta$

It can easily be verified that the following scalar product approximates the wished quantity :

$$(y^* - y) R^{-1} (H x_a^* - H x_a) \tilde{} \, Trace(HK)$$

✗ **The Simulated Optimal Innovations (SOI) method**

This method is introduced in Chapnik et al. (2005). It is based on the properties of subparts of the optimal objective function at the minimum described in section 2.

The algorithm consists in generating a situation, the errors of which are consistent with the specified covariance matrices.

A state vector x (for example a background vector) is considered as the "truth". Adding some noise, consistent with the specified statistics, a simulated background $x_b^* = x + B^{0.5}\zeta_b$ and observations $y^* = y + R^{0.5}\zeta_o$ are generated. The variational analysis of this simulated situation naturally leads to the computation of $J_b(x_a^{(*)})$ and of $J_o(x_a^*)$ and of possible subparts of them. One then has :

$$J_b(x_a^*) \simeq Trace(KH);$$

$$J_o(x_a^*) \simeq Trace(I_p - HK) \;;.$$

The following equality : $(H(x_b^* - x_a^*))^T R^{-1}(y_o^* - H x_a^*) \simeq Trace(HK)$ can also be applied in order to compute subparts of $Trace(HK)$ (this can only be applied if this subpart corresponds to a diagonal block of R).

✗ **Comparison of the two methods**

Figure 1 compares the DFS computed for several upper atmosphere observation types on 4/02/2004 at 00 UTC within ARPEGE 4D-Var system. One may see that the results of the two methods compare quite well. The small discrepancies observed, at least those larger than what can be expected from randomized estimation methods (see the AMSU observations DFS, for example) may be explained by the non-linearities of the multi-incremental 4D-Var scheme used here. It can be shown that even in this case, Girard's method still evaluates a good estimate of the sensitivity of the analysis to the observations while the SOI method may be less accurate.

4.9.4. The tuning of variances

A way to use DFS (or a very similar quantity) to tune the specified statistics was provided by Desroziers and Ivanov (2001).

An hypothesis is made that the true optimal matrices can be obtained from the specified matrices, just by multiplying them by multiplicative coefficients, the tuning coefficients; for example, it may be supposed that $\mathbf{B}_t$ and $\mathbf{R}_t$ (the optimal background and observation error covariances) may be deduced from the specified **B** and **R** as:

$$B_t = s_b B$$

$$R_t = s_o R$$

Supposing the system is variational, if J_o and J_b are the subparts of the objective function related to $\mathbf{x}_b$ and **y** respectively then $J_{opt} = J_o / s_o + J_b / s_b$ is the optimal objective function. The criterion of the expectation of subparts of the objective function at the minimum must then apply. Let $\mathbf{x}_a$ be the minimizer of J_{opt} ; replacing the expectation operator by one realization (which in case there are enough observations is justified) yields the following criterion to determine s_o and s_b:

$$J_b(x_a(s_o, s_b)) / s_b = Trace(K(s_o, s_b) H);$$

$$J_o(x_a(s_o, s_b)) ¿ / s_o = Trace(I_p - HK(s_o, s_b))..$$

The notations used here are to emphasize the fact that x_a and K are functions of s_o and s_b. Those equalities are easily transformed into:

$$s_o = 2 J_o(x_a(s_o, s_b)) / Tr(I_p - HK(s_o, s_b))$$

$$s_b = 2 J_b(x_a(s_o, s_b)) / Tr(K(s_o, s_b) H)$$

This set of equation is a fixed-point relation $((s_o, s_b) = f(s_o, s_b))$. A fixed-point algorithm is then applied to compute (s_o, s_b) . The Trace term can be computed with Girard's method, but with the SOI method the previous relations become

$$s_o = J_o(x_a(s_o, s_b)) / J_o(x_a^*(s_o, s_b));$$

$$s_b = J_b(x_a(s_o, s_b)) / J_b(x_a^*(s_o, s_b)).$$

xa^* is the analysis made from the simulated situation defined in the presentation of the SOI method. These expressions outline that the method compares "true" and "simulated" statistics. An advantage of the SOI method is that the numerator and the denominator of these expressions can be obtained in the same way.

A nice property of the algorithm is that the first iteration of the fixed point used here converges very quickly. The first iteration generally provides a good estimate of the result and convergence is generally reached after two or three iterations, except for cases that are going to be defined in the next section.

4.9.5. Properties of the method

✗ Equivalence to Maximum Likelihood Tuning

It may be shown (Chapnik et al 2004) that the tuning performs a Maximum Likelihood tuning of variances (see Dee and da Silva 1998 for meteorological use of Maximum Likelihood in data assimilation), meaning that the tuning coefficients are the most probable coefficients, considering an a priori model of covariance (the specified B and R matrix) and the data (in our case the innovation, obs-guess difference). This has important consequences for the tuning :

Since the method performs a statistic over he innovation, a large innovation vector, therefore a large observation vector, is needed.

An a priori hypothesis about the structure of correlations, allowing to split the innovation into observation and background errors is necessary (like in Hollingsworth and Lönnberg, 1986). This hypothesis is in HBH^T and R (the *a priori* specified matrices) which must be different (e.g. no spatial correlation in R, spatial correlation in B) to allow a useful tuning.

If this hypothesis is not (even roughly) respected by the true ϵ_o and ϵ_b, a poor tuning may be expected. In particular, performing the method on an observation type with spatially correlated errors represented with a diagonal R yields a very weak, possibly null s_o, which is the opposite of what should be done in this case (inflate the optimal σ_o). Note that a non optimal correlation length in B does not have such bad consequences.

✗ A first try with real data

A first try is made to check in a first time if the tuning coefficients have *a priori* desirable properties they should have. Desroziers and Ivanov (2001) had already shown the ability of the method to retrieve the tuning coefficients for a simulated case in a comprehensive data assimilation system. The consistency between the tuning coefficients and the known quality of the observations is tested here.

Figure 2 shows the tuning coefficients computed for satellite borne instruments channels, in 1997 and in 2001. One may clearly see that small coefficients remain small and that large coefficients remain large over four years. Moreover, the variability between the two dates is of the same order as the one encountered when comparing the tuning coefficients computed at different dates of the same month (not shown). Such a behaviour is a positive point if we suppose that there were no major evolution of the quality of the observation between the two dates; yet, evidence that the result is not an artifact is still needed, evidence that the same result will not be obtained independently of the σ_o of the observation errors. A known dysfunction of NOAA 15 instruments was the occasion to document this point. Figure 3 shows the tuning coefficients obtained for three channels on dates when there were no problems (dashed black and white bars), on the day before the problem begins (green bars), and during the incident (the other bars). It is clearly seen for two of the channels that the tuning coefficients are multiplied by two (and even more on the last date) during the incident. The tuning coefficients are clearly related to the quality of the observations.

4.9.6. Impact of the tuning of the variance

The final point of this study is the assessment of the tuning of the specified observational error variances on the analysis and on the forecasts.

In a first time the tuning was performed for the assimilated observation types. For observations known to have very correlated observation errors (like SATOB observations), the tuned values were taken similar to the specified values (the true tuned values dropping to 0 along the tuning as noticed in section 5). A single coefficient was applied to tune B , and was found equal to 1, meaning that, as a whole, B was approximately correct.

An experiment was carried out, performing an analysis cycle for 20 days with the "tuned" analysis system. Figures 4a-c compare the rms differences between geopotential observations and forecast, for "tuned" forecasts and operational forecasts. The green lines denote improvements of the rms, the red ones show a deterioration. It can be seen that for this parameter, the impact is positive for all forecast ranges. For other parameters, the impact, though positive, may be less spectacular.

4.9.7. Conclusion

Techniques to evaluate the quantification of the impact of the observations, known as DFS, have been implemented for the French ARPEGE data assimilation system. These techniques can also be used for Desroziers and Ivanov's tuning of the variances. This tuning has been shown to have some positive impact on the analysis and on the forecasts.

The first future direction which might be taken is the tuning of the B matrix. As stated before, only one global coefficient was applied to this matrix, which is certainly not enough. Several strategies for a finer tuning may be considered.

Another difficulty to be considered in the future is the tuning of observations with correlated errors (like SATOB). This case is more difficult since no known objective criterion allowing to tune it can apply.

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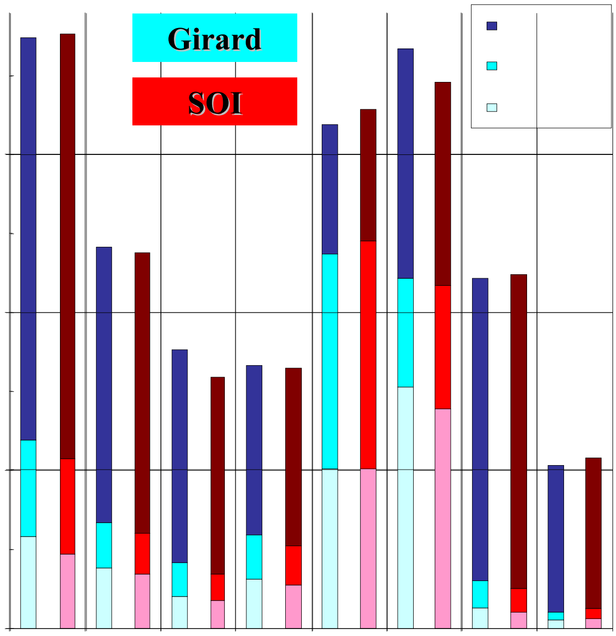

Figure 1 : DFS computed for different observation types. The bars in blue were computed with Girard's method, bars in red with the SOI method. Each bar is divided into three parts: the upper part is the contribution of observations from the northern hemisphere; the middle part is the contribution from subtropical observations ; the lower part, the contribution from the southern hemisphere.

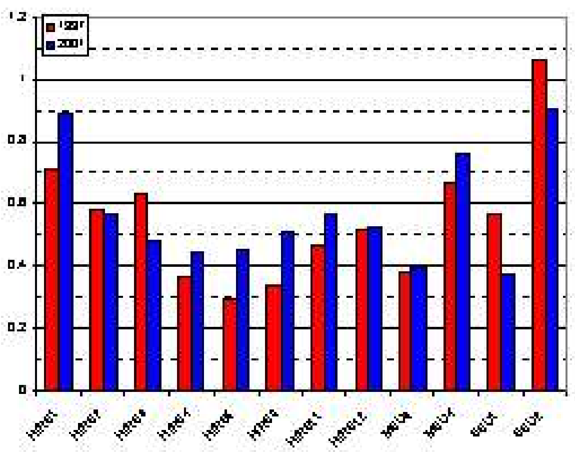

Figure 2 : Comparison between tuning coefficients computed on a 1997 date (in red) and a date in 2001 (in blue), for different satellite channels (along the x axis).

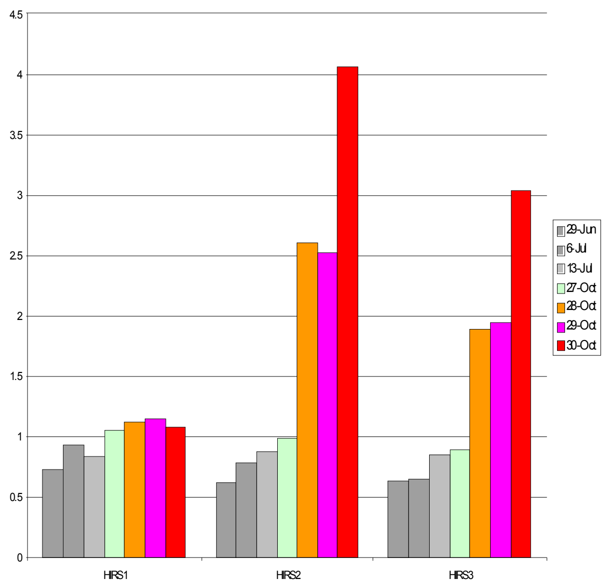

Figure 3 : Detection of an incident. Tuning coefficients computed for dates before the incident (dashed grey bars),the day before the incident (green bars), and during the incident (orange, purple and red bars).

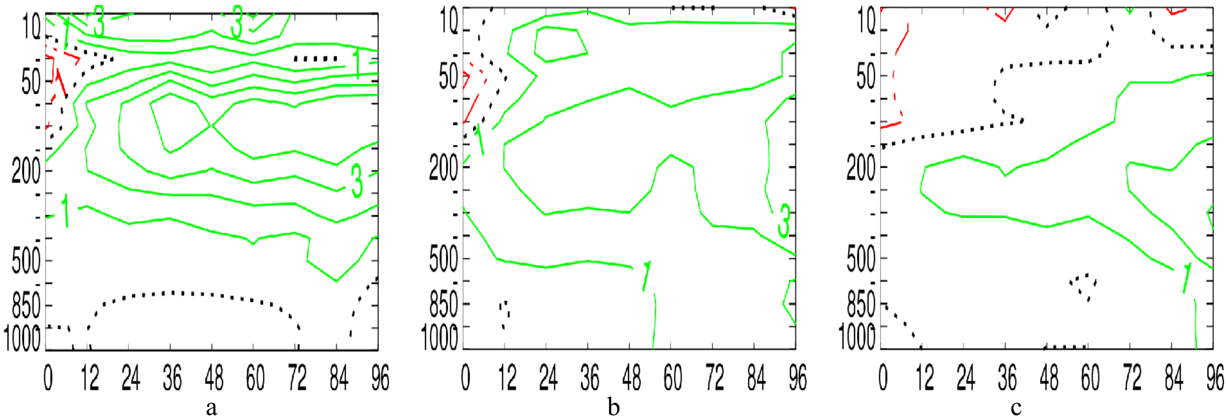

Figure 4 : Difference between the rms (geopotential TEMP observations minus forecast) for operational forecasts and "tuned" forecasts. The unit is the meter. Green lines show an improvement, red lines a deterioration. The x axis is the range of the forecast, the y axis is the pressure level. Panel 4a is for inter tropical areas, panel 4b for the southern hemisphere and panel 4c for the northern hemisphere.

4.10. Adaptations to ALADIN of the Lopez micro-physical package: Gérard Luc.

4.10.1. Introduction

Our ongoing development of a parametrization set combining the convection with other moist physical schemes required to get a suitable micro-physical package.

We started from the one developed by Ph. Lopez (2002) in the frame of ARPEGE-Climat, and dedicated to "resolved" or "stratiform" clouds and precipitation.

4.10.2. Original scheme

The original Lopez scheme uses two prognostic variables : a total specific cloud condensate q_c and a total specific precipitation content q_P . However, in each of the micro-physical routines, a diagnostic phase partition is estimated. For the condensate, it assumes a progressive transition of the ice fraction between two temperatures (e.g. -10 and -40 °C). For the precipitation, a nearly step transition at 0 °C is considered (actually it may extend over several levels to avoid that the associated cooling brings the local temperature below 0°C).

The package works as follows :

1) A resolved condensation scheme, base on Smith (1990), yields a condensate tendency and a resolved cloudiness.
2) This tendency is added to the original condensate content (advected from the previous time-step), to yield a transitional value before precipitation.
3) A parametrization estimates the rate of auto-conversion of this condensate to precipitation.
4) The auto-converted part is subtracted from the condensates and added to the prognostic precipitation content, which is then advected vertically in a semi-Lagrangian way. The instantaneous q_P as well as the total precipitation crossing a layer in one time-step are used to compute the precipitation evaporation and the collection of the cloud condensate by the precipitation. For the latter, one distinguishes the aggregation of cloud ice by snow, the accretion of droplets by rain, and the riming of droplets by snow.
5) Some corrections may be brought to the tendencies of the water specific contents to prevent the occurrence of negative values.

The package implied to adapt the expression of the tendencies, to include additional fluxes : condensation fluxes, precipitation evaporation fluxes, both with their associated heat fluxes; a precipitation melting heat flux, and fluxes associated to the precipitation content evaluation : a flux of precipitation generation, and a flux of precipitation evolution, including the different processes they experience during their fall.

The progress of our scheme led us to make several adaptations to the original routines.

First, it appeared advisable to use separate model variables for cloud ice and liquid water. This distinction is essential for radiative properties, and for further refinements of the micro-physical description. At the same time, the use of a full prognostic variable (advected by the mean model wind) for precipitation content seemed less important. In a first step, we replaced it by a pseudo-historic variable, i.e. a passive memory of the values from the previous time-step, with no resolved advection. Later, we found it better to suppress completely the precipitation content (see below). Using separate model variables for cloud ice and liquid water implied to reassess the treatment of the mixed phase : each of the different micro-physical processes tends to modify the phase partition, so that we must care for restoring it at the end, to prevent an unrealistic situation.

We were also confronted to some flaws or hidden approximations in the original scheme. Seen the difference in phase partition for cloud particles and precipitation, cloud droplets may be converted (either by auto-conversion or riming) into falling snow : the released latent heat was not taken into account.

The semi-Lagrangian vertical advection of the precipitation content posed several problems. The auto-conversion is applied at once at the beginning of the time-step, instead of considering a continuous feeding. It is possible that some layers directly below the cloud receive zero advected content, because the origin of the trajectory is above the cloud. On the other hand, the evaporation calculation is based on the total precipitation crossing the layer, and applied to the final advected content. When the latter is zero, it results into a negative final content. The problem is that the evaporation should be based on the conditions along the trajectory, not at the arrival point. Finally, the resulting precipitation contents could not be directly related to the precipitation fluxes, which posed serious conceptual problems for introducing a downdraught calculation.

4.10.3. Scheme adaptations

✗ The condensation scheme

A peak of condensation was observed near the 0° C isotherm, associated to the cooling by the melting of the precipitation. To limit this, a smoothing of the temperature profile around the level of the triple point may be applied; the number of levels above and below may be chosen in the namelist.

Unwanted condensation could also occur near the lowest model level, consecutive to the cooling by the downdraught. We introduce the possibility to use there the arithmetic mean with the surface temperature, which in this case is higher than the air temperature.

✗ The auto-conversion routine

The rather intricate calculation coded by Lopez has been replaced by a more transparent formulation.

An integrated Kessler formula yields the decrement of cloud water content due to auto-conversion. For liquid condensate q_l, it writes:

$$\Delta q_l = q_l^x \, (1 - e^{\,E_l \, \Delta t}) \qquad \qquad if \quad q_l > q_l^x$$

where E_l is the auto-conversion efficiency for droplets. In presence of ice, the threshold for liquid auto-conversion q_l^x is lowered to zero.

Subsequently, an auto-conversion gain GWBFAUT, associated to the Bergeron-Findeisen mechanism is applied :

$$\Delta q_l = \Delta q_l^x \, (1 \; + GWBFAUT \cdot E_l \cdot \alpha_i)$$

where α_i is the ice fraction in the cloud.

In the mixed phase, the ratio of water to ice must be maintained, so that the final ice content may be derived from the final liquid content. In the pure ice phase, a Kessler integrated formula also holds, but the auto-conversion efficiency is made dependent on the temperature. We introduced additional parameters to tune this dependence.

4.10.4. The precipitation routine

Given the above-mentioned problems with the precipitation advection routine, we proposed a simpler and more clearly justified approach.

The auto-conversion alone yields a gross precipitation flux P_{au} (which may also include a pseudo-historical flux memorized from the previous time-step), from which we derive :

- the total precipitation crossing the layer in one time-step :

$$q_{Ptot} = P_{au} \frac{g \Delta t}{\Delta p}$$

(this makes the hypothesis that the precipitation generation varies slowly enough in time so that even the lowest layers are crossed by a flux corresponding to the present auto-conversion in the layers above)

- the instantaneous densities of snow and rain in the layer :

$$\rho_{Ps} = \frac{P_{au} \alpha_{snow}}{w_{Ps}} \quad \text{and} \quad \rho_{Pr} = \frac{P_{au}(1-\alpha_{snow})}{w_{Pr}} ,$$

where w_{Ps} and w_{Pr} are the fall speeds of snow and rain, which are assumed constant and may be chosen in the namelist, α_{snow} is the solid fraction of the precipitation.

These quantities allow to compute first the evaporation/sublimation processes, and afterward, the different collection processes.

We now consider that the evaporation/sublimation, occurs in the clear part of the grid box, but only the part of it under a "precipitating" area, which can be estimated from the cloud fractions at different levels. In the original scheme, the same collection efficiency was assumed for aggregation of ice and riming of droplets by falling snow : we introduced separate tunings.

✗ **The final corrections.**

An adaptation of the mixed phase composition is performed after the precipitation. It implies a melting/freezing flux and an associated heat flux, between solid and liquid condensate.

The adaptation of the tendencies to prevent negative specific contents has been adapted to :

- extend the treatment to the cloud water variables,
- forbid cloud ice above the triple-point temperature.

4.10.5. Conclusions

Most adaptations described above appeared useful or necessary during our work on the integrated scheme for clouds, precipitation and convection, after controlling the profiles and behaviour of the cloud water phases or other associated variables.

We think to have got a more realistic behaviour, together with a reduction of the cost, mainly by suppressing the heavy advection calculation. Now more systematic tests and comparisons should be performed to validate the adapted package.

4.10.6. References

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4.11. VARPACK– A diagnostic Tool, based on the 3DVar/ALADIN surface scheme: Auger L & Taseva L.

4.11.1. Introduction

The purpose of this work on Varpack was to study the possibility of implementation of the ALADIN/3DVar scheme for diagnostic and nowcasting purposes. Such a software would have been an analogue of Diagpack, based on the CANARI OI scheme. The first tests with the Varpack software have been performed early 2004 and a comparison with Diagpack has been done. The results have shown that Diagpack and Varpack give similar meteorological fields and there is a possibility to improve the application of the ALADIN 3D-Var scheme as a diagnostic tool (Auger, 2004; Taseva and Auger 2004). During the Summer of 2004, the ALADIN/3Dvar scheme has been modified by introducing the difference ($Ts - T_N$) where N is the lowest model-level, as a new control variable (Auger 2004b). The tests with Varpack performed late 2004 have shown that there is a significant advantage of the new Varpack with respect to the old one (Taseva and.Auger 2004b).

In Section I the results of the comparison between Diagpack and Varpack are presented, while the results of the experiments with Varpack are presented in Section II.

4.11.2. Section I – Basic features of Diagpack and Varpack

✗ **Diagpack**

With Diagpack an operational hourly CANARI OI analysis is performed with:

- a first guess field from ALADIN forecasts (from 3 to 8 h ones)
- surface data, obtained from manual and automatic land and ship SYNOP stations.

When running Diagpack, some constrains are applied:

- only the stations below the altitude of 1500 m are used in the analysis;
- the stations, for which the difference between the model orography and the altitude at the observation point is bigger than 800 m, are not assimilated.

The observation operators allow performing an upper-air analysis of geopotential, temperature and humidity at the model levels up to approx. 1500m only with SYNOP observations and a direct analysis of T2m, RH2m, V10m. Those fields together with the diagnostic parameters CAPE and MOCON, computed by specific post-processing options, are used afterwards for nowcasting purposes (CAPE computed from analysed 2m fields, mainly NFCAPE=4, MOCON calculated as div($q_{2m}V_{10m}$).

✗ **Varpack (2004)**

We used all the SYNOP data that passed through ALADIN screening to perform temperature, wind and specific humidity analysis on model levels only.

Three different modifications of the basic 3DVarc onfiguration scheme were tested :

- The value of the model standard deviation error (i.e. The scaling factor REDNMC) has been increased to better fit observations, this version is referred as Varpack/bas3D.

- Another modification on top of bas3D has been included, with the artificial update of the surface temperature Ts according to the temperature at the lowest model level 41 approx. 17 m) at each step of the minimization. This modification has been done to enable more meaningful physical to fit to the 2m temperature through the observation operator (version referred as Varpack/mod3D);
- In addition mod3D has been modified, giving bigger values of the model error variances in the PBL (planetary boundary layer) and keeping the initial ones on the upper levels (REDNMC = 7, 7, 5, 3, 1, …1) (version referred as Varpack/sod3D).

✗ Validation tests

The comparison between the Diagpack and the Varpack focussed on:

- the meteorological fields (T, RH, wind on the last model levels)
- the distribution of the derived parameters CAPE and MOCON, used for nowcasting purposes, after post processing on the FRAN X 01 domain.

The validation tests described in Taseva and Auger (2004) have been done for two cases: on the 09/10/2001 at 10h UTC; 09/10/2001 at 15h UTC and on the 18/08/2001 at 00h UTC; 18/08/2001 at15h UTC, with a run every hour over the ALADIN/FRANCE domain.

Radar echoes for that situation and results of the experiment at 14H00 are presented in Fig.1, Fig.2 and Fig.3.

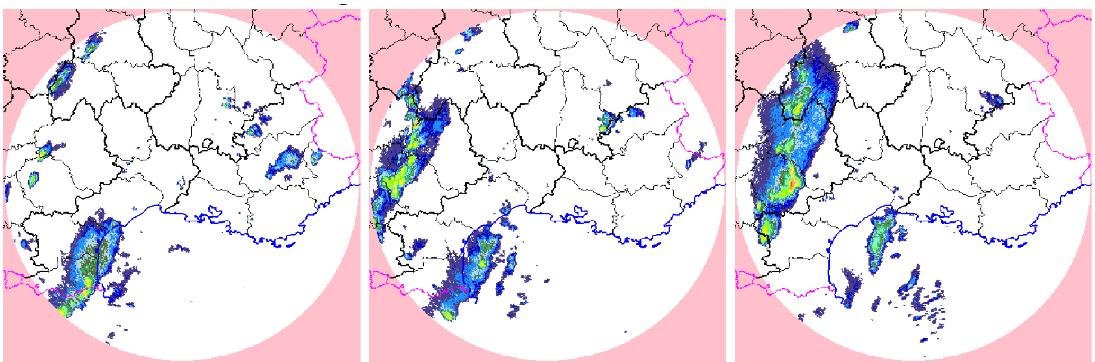

Fig.1: Radar images for the 18/08/2001, 16H00,17H00,18H00

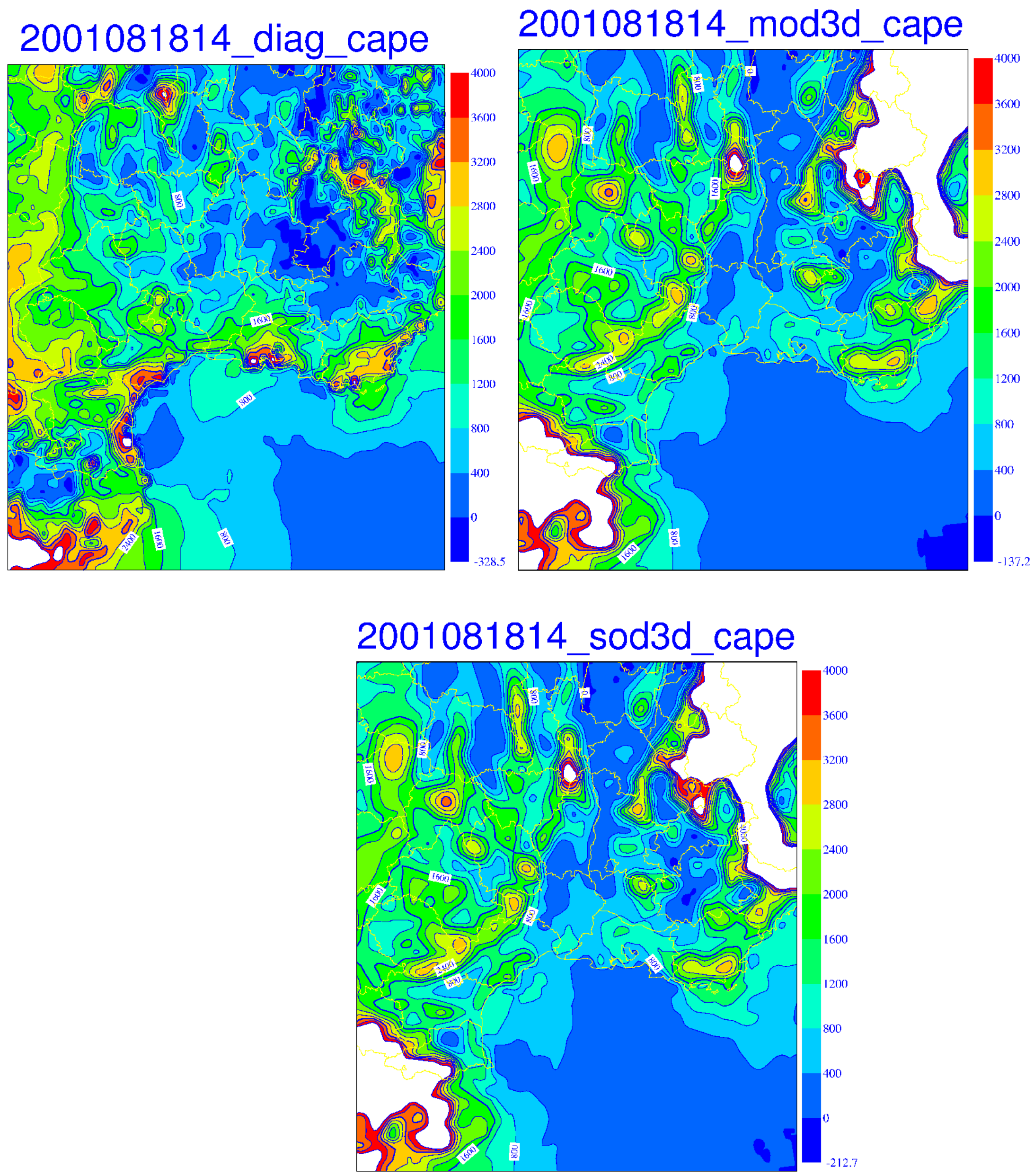

Fig.2: Cape for Diagpack (top left), Varpack experiment mod3d (top right) and Varpack experiment sod3d (bottom) for the 18/08/2001 at 14H00.

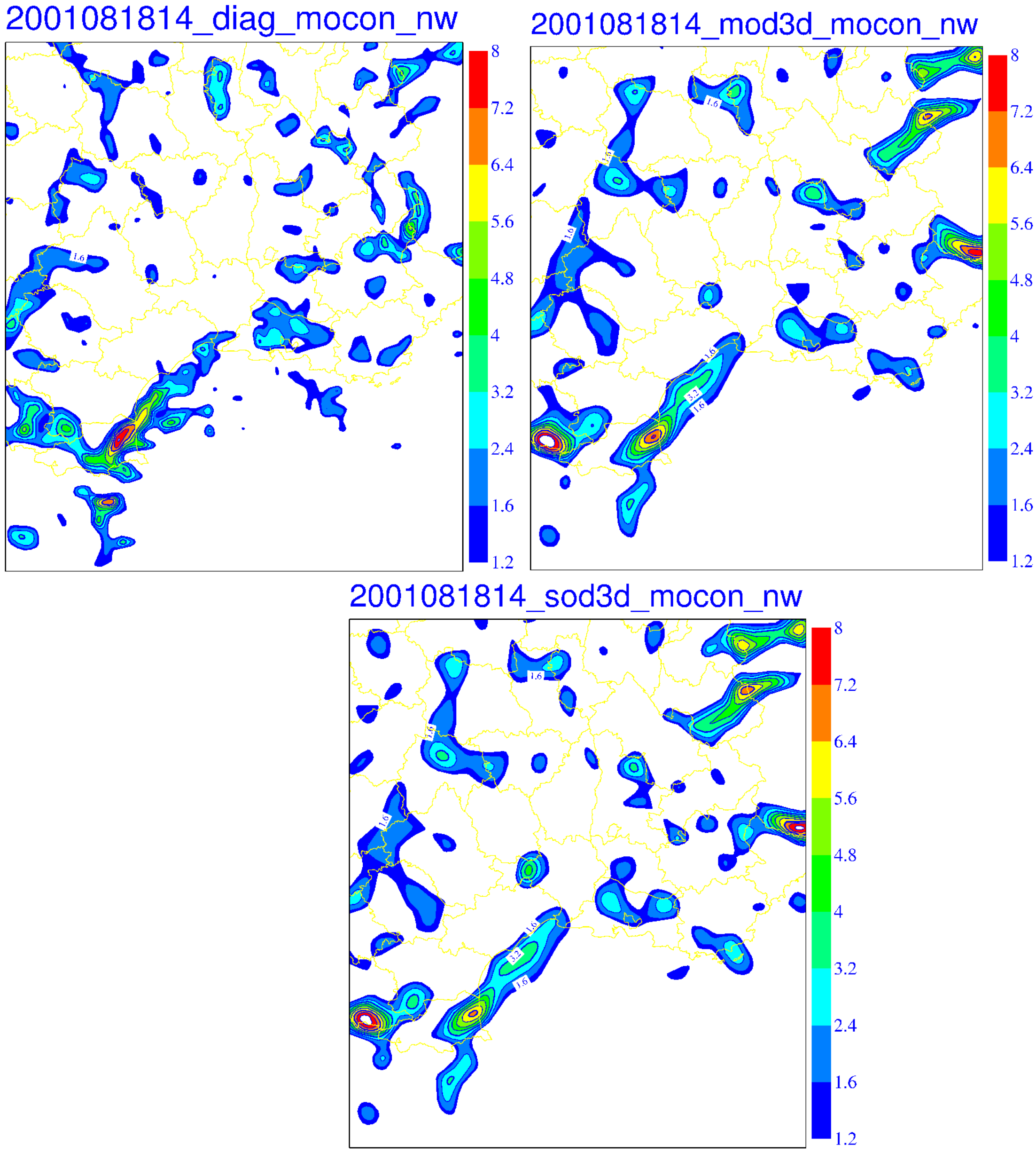

Fig.3: MOCON for Diagpack (top left), Varpack experiment mod3d (top right) and Varpack experiment sod3d (bottom) for the 18/08/2001at 14H00.

It can be seen that:

- MOCON fields derived from Varpack, are very similar to those derived from Diagpack, but smoother;
- CAPE fields derived from Diagpack and Varpack are quite different, both giving on that case, a quite poor diagnostic for future convective events.

4.11.3. Section II – Experiments with Varpack

During the summer of 2004, the ALADIN 3D-Var surface scheme has been modified by introducing the vertical temperature difference between surface and the lowest model-level (Ts – T_N) at the observation point as a new control variable in the vector. This modification, made by L. Auger has been validated by comparison with Diagpack and the previous version of Varpack .

- ✗ **Basic ideas of the new 3D-VAR/ALADIN surface scheme - surface temperature in the control variable.**

In the 3D-VAR formalism, the goal is to minimize a coast function:

$$J = J_b + J_o = \frac{1}{2}\delta x^t B^{-1} \delta x + \frac{1}{2}(H\delta x - d)^t R^{-1}(H\delta x - d)$$

Where: $d = y - H(x^b)$ is the departure between the observation vector y and the model equivalent computed from the background x^b and δx is the control variable.

The goal of the algorithm is to minimize the J cost function with respect to δx .

So far in ALADIN 3D-VAR only upper-air fields were used inside the control variable.

But, when analysing 2 meters observations, one needs to be able to modify during the minimization cycle also the surface variables, because the observation operator H is using surface parameters to compute the model equivalent at 2 meters or 10 meters.

Let's call T_S the surface temperature departure (actual temperature minus background temperature) and T_N the lowest level temperature departure.

The difference $T_S - T_N$ was introduced as a new control variable. To this new control variable was associated a forecast error standard deviation $\sigma_{T_S - T_N}$ representing the error made by model on this parameter. So the new model error cost function reads:

$$J_b = \frac{1}{2}\delta x^t B^{-1} \delta x + (T_S - T_N)^t \sigma_{T_S - T_N}^{-2} (T_S - T_N)$$

Introducing $T_S - T_N$ as a control variable, provides a correlation between the surface and the lowest level temperature without having to modify the B matrix structure (model forecast covariances error). The main problem when using a B matrix which would include surface parameters is that in ALADIN, upper-air fields are specified in spectral space whereas surface fields are specified as gridpoint ones. It also seems difficult to compute a reliable B matrix near the ground because the model forecast error inside the boundary layer might be quite important.

More details are given in Auger (2004b).

Only this new version will be considered hereafter.

- ✗ **Results of the experiments for the case study 2004/10/09**

That case has been chosen because the CAPE obtained by Diagpack at 12H00 indicated a potential for a storm, that developed in the following hours.

To create a reference run, the new ALADIN/3D-VAR surface scheme has been modified to be consistent with the settings of Diagpack :

- the data base included only the observations within the 10 minutes interval around the observation time,

- the old blacklist was modified by excluding the French RADOME observations from it,
- smaller values of the observation errors were set,
- the operational 6-hour ALADIN forecast was taken as first guess,
- the ALADIN/3D-VAR surface scheme was modified with a complete de-correlation of the temperature and humidity, and a new executable had been created,
- in screening and minimization the default values of RGBQC were taken,
- in minimization with LTSCV=. T. (LTSCV is the new logical flag for activating the Ts control variable) the value TSCVER=0.5 was used,
- in minimization model error covariances were inversed in PBL;
- in forecast no DFI were applied,
- in FullPos CAPE was computed from the lowest model-level (NFPCAPE=1) or from meteorological standard height after the computation (NFPCAPE=3).

The analysis of the diagnostic JOT tables before screening, before and after minimization have shown that :

- screening had rejected mainly U10 observations for all subtypes of SYNOP data (11-land manual report, 14-land automatic report, 15-French automatic land report, 16-French RADOME);
- the result of the minimization is a state, close to the observations – the values of the normalized JO/n have decreased an order of magnitude for all SYNOP subtypes and all variables.

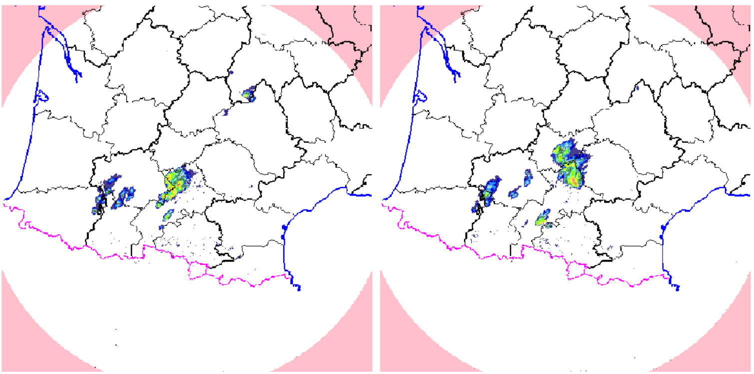

Fig.4 : Radar data for 20041009, 16H00 and 17H00.

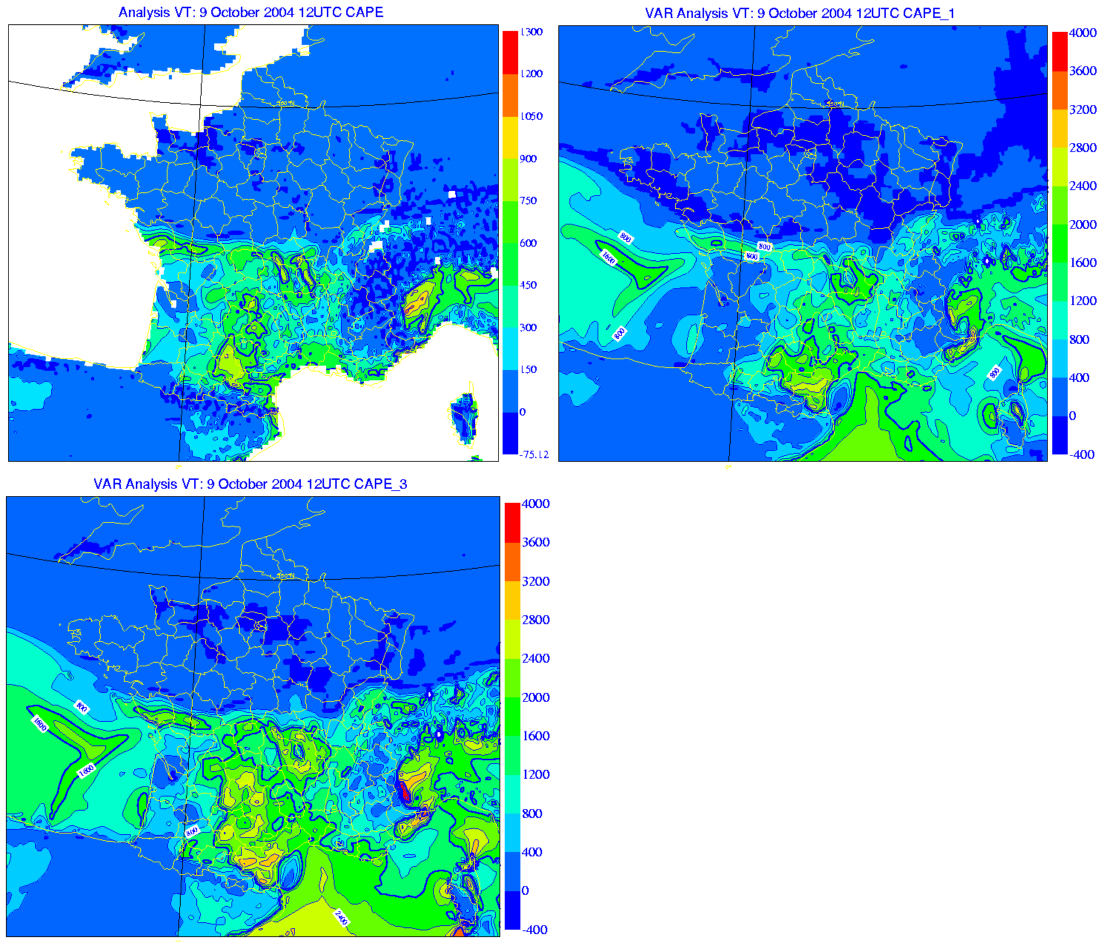

Fig.5: Time evolution of CAPE, derived by Diagpack (top left), new Varpack with NFPCAPE=1 (top right) and with NFPCAPE=3 (bottom)

On radar images (Fig. 4) we can see that a strong convective event starts at 16H00 UTC on the South-West part of the domain. On the CAPE diagnostic from Diagpack (Figure 5), we have a strong signal at 12H00 at the same location, proving the convective capacity of the atmosphere at that place, leading to the development of the storm a few hours later.

On Figure 5 (top right and bottom panel), the Varpack diagnostic is not so good, it shows more maxima at some places where no rain event was observed later.

We can also observe that the CAPE computation with NFPCAPE=1 and NFPCAPE=3 gives somehow different CAPE fields, although there is a lot of common pattern between the two pictures.

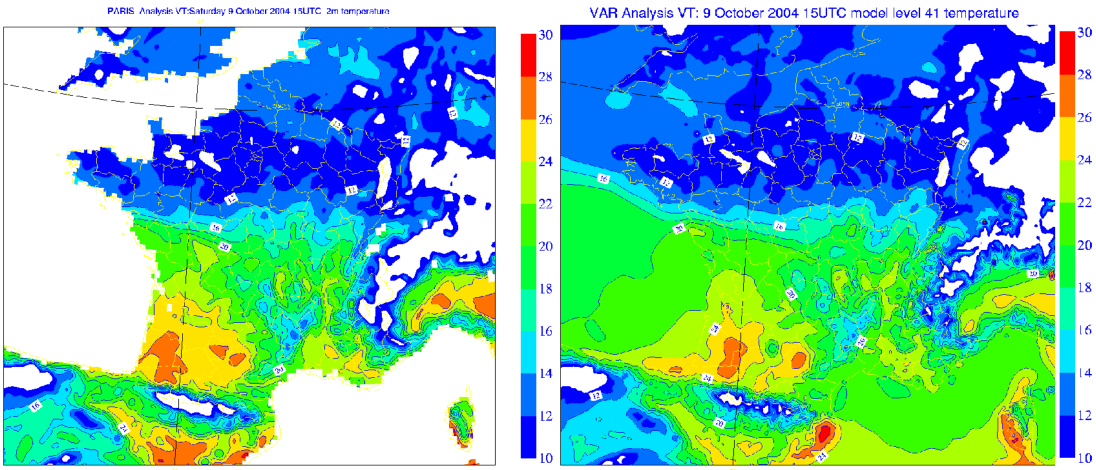

Fig.6: 2m temperature analysis by Diagpack (left) and temperature at the last model level for Varpack.

Figure 6 presents the 2m temperature field, obtained by Diagpack, and the one (at the lowest model level (41), obtained by Varpack at 12H00. It can be seen that there is a good agreement between the two temperature fields even if level 41 corresponds approx. to 17 m height. For that day the boundary layer is quite well mixed so temperature at 17m is not much different from temperature at the ground.

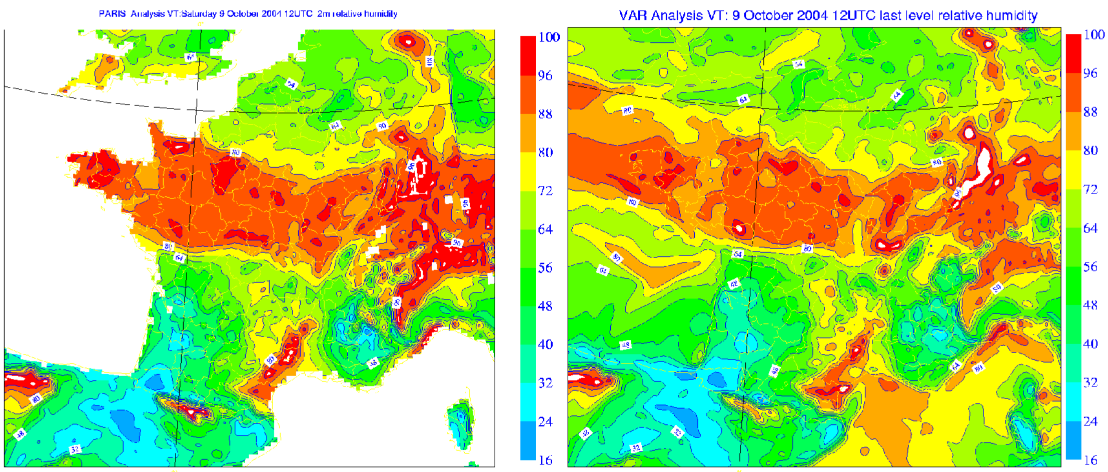

Fig.7: Relative humidity at 2m for Diagpack (left panel), relative humidity at the lowest model level, recomputed from temperature and specific humidity, with correction from MSL pressure, obtained by Varpack (2004b) (right panel).

The humidity fields from Diagpack and Varpack (Figure 7) are also very similar, except for mountainous areas.

It is seen that:

- there are small differences for temperature and relative humidity for most part of the domain.
- these minute differences explain the differences between the CAPE fields obtained by Diagpack and Varpack, mainly because CAPE is very sensitive to the temperature and humidity at the starting point in the integral computation.

The comparison with the observed values of 2m relative humidity (Hu 2m)have shown that when there are no observations in an area with a characteristic size of 50 km, Diagpack is giving much importance to the guess and produces a poor diagnostic of Hu 2m, whereas for such cases, the Varpack analysis gives a relative humidity field that seems to be in better agreement with reality.

4.11.4. Impact of the observations for altitude stations.

On the specific case shown before, the CAPE diagnostic from Diagpack enabled a good forecast of the storm that develops at 16H00 UTC.

Looking more carefully at the temperature and humidity analysis provided by Varpack, we saw that one station at 600 m gave a quite different increment analysis for T2m and Hu2m on the South-East part of the domain.

This is because there is no horizontal correlation between our control variables (T_S-T_N) at different observation points. As a matter of fact, unplugging the modification of the control variable in that specific case gave a CAPE diagnostic that is much closer than the Diagpack CAPE (Fig.8).

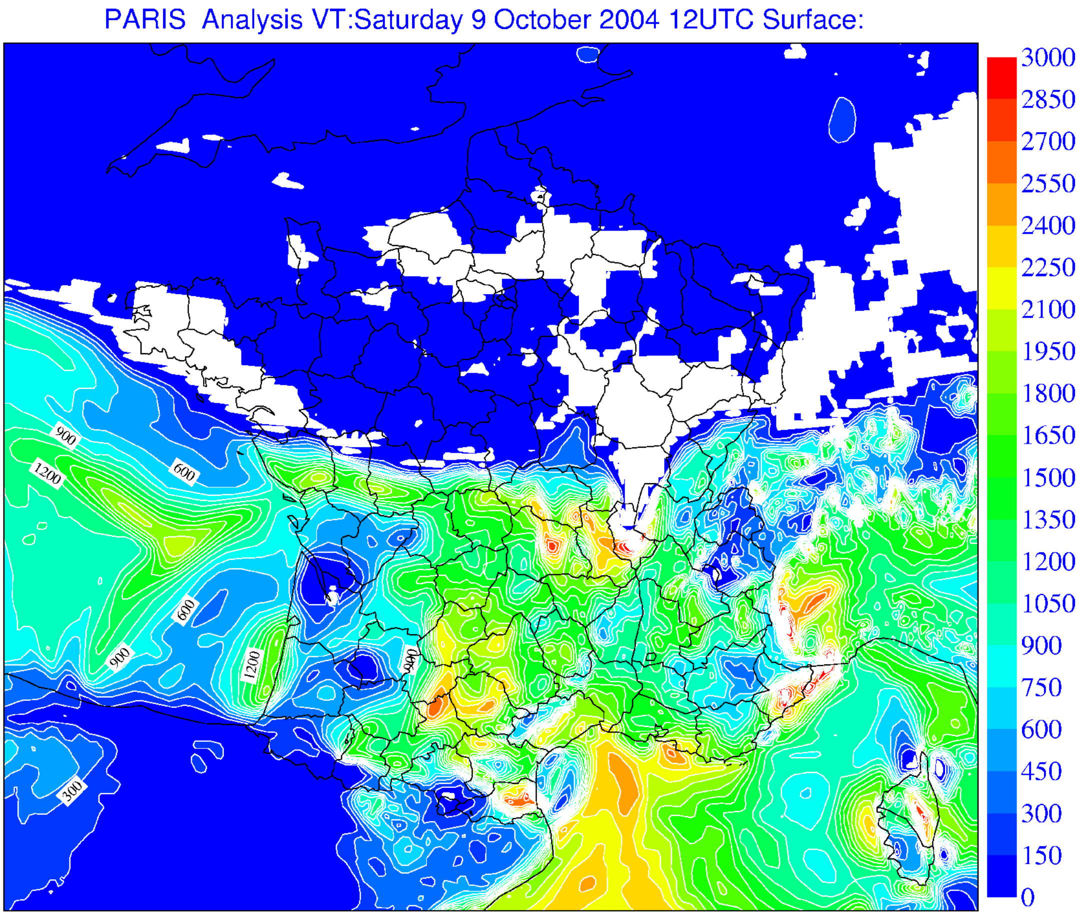

Fig.8: CAPE diagnostic from Varpack, for the 09/10/2004 at 12H00, without the modification concerning the control variable.

4.11.5. Section III. Conclusions and intents for the future work

The main conclusions, reached on the basis of the performed experiments in Section I and Section II are as follow:

- there is a significant advantage of the new Varpack version with respect to the previous one (Auger 2004). Besides, the results are scientifically more satisfying due to the new control variable (T_S – T_N),
- The temperature fields obtained by Diagpack and Varpack are similar,
- the humidity fields obtained by Diagpack and Varpack are a little different. For most of the

cases we looked at, the ALADIN/3D-VAR humidity analysis seemed at least as good as Diagpack one, in comparison with the 2 m observations,

- the CAPE fields derived from Diagpack and Varpack are still different, mostly because some altitude observations have a different impact But as the CAPE field is used for convective activity diagnostic and is not 100% reliable, it is difficult to evaluate its quality on a few cases,
- MOCON fields derived from Diagpack and Varpack are close.

The further study of Varpack analysis requires

- to study more the Varpack humidity analysis,
- to study the possibility of using new observation types,
- to correct the problem linked with altitude station impacts.

4.11.6. Acknowledgements

The authors are mostly grateful to F. Taillefer and F. Bouyssel for their help in performing the experiments and in the discussion of the obtained results.

4.11.7. References

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4.12. An update on the 2002 Gard flood simulation with the ALARO-10 prototype in 2004: A comparison between ALADIN, Méso-NH, ALARO-10 and AROME: Hello Gwen.

4.12.1. Summary

In summer 2004, some preliminary testing was run using a model consisting of the AROME prototype software at 10-km resolution plus a subgrid convection scheme. This model is called "ALARO-10" in this paper although the contents of the ALARO-10 subproject changed in 2005. Preliminary results from the tests were shown on four cases. Runs on the Gard case were published in ALADIN Newsletter 26. Later, in December 2004, it turned out that the precipitation diagnostics from these runs were incorrectly interpreted : the displayed cumulated rainfalls did not include the cumulated rain coming from the parametrized convection. That is the reason why there was too little rainfall in the output of ALARO-10. This article shows the new results with the corrected ALARO-10 runs on the GARD case.

The Gard case is a very extreme meteorological flood event over the South-East of France, it is also a major case for the qualification of the AROME prototype.

4.12.2. Characteristics of the different runs used

The GARD case is a 12 hours forecast run, starting on 08/09/2002 at 12 UTC and ending on 09/09/2002 at 00 UTC.

✗ **ALADIN-oper**

The characteristics of the ALADIN-oper runs are the same as ALADIN-France operational in September 2002 (i.e. not the present operational physics) :

- Semi-Lagrangian dynamics with 2 time-levels, hydrostatic formulation
- Time-step = 415,318s (7 minutes), Δx = 9.5 km, 41 vertical η-levels and coupling every 3h to ARPEGE.

✗ **Méso-NH**

- Eulerian dynamics with anelastic formulation
- Time-step = 15s, Δx = 10 km, 41 vertical z-levels and coupling every 3 hours to ARPEGE.
- Radiation scheme: RRTM, convection scheme: KFB (called every 5 minutes), externalised surface, complete micro-physics with prognostic water variables, and prognostic turbulent kinetic energy.

✗ **ALARO-10**

- Semi-Lagrangian dynamics with 2 time-levels, hydrostatic formulation.
- Time-step = 60s, Δx = 10 km, 41 vertical η-levels and coupling every 3 hours to ARPEGE
- Same physics as Méso-NH except that the convection scheme is called every time-step.

✗ **AROME**

- Semi-Lagrangian dynamics with 2 time-levels, non-hydrostatic formulation with a PC (ICI) scheme.
- Time-step = 60s, Δx = 2.5 km, 41 vertical η-levels and coupling every 3 hours to ALADIN-France or Méso-NH.
- Same physics as Méso-NH or ALARO-10, but no convection scheme (the convection is assumed to be resolved).
-

4.12.3. Results

✗ **Boundary layer fields**

We look there at temperature at 2 m and wind at the lowest level for the different models. Observed 2 m temperature and 10 m winds are also shown.

- ***2m temperature field***

The 2m temperature field on the 09/09/2002 at 00 UTC shows a cooling under the thunderstorm. This is an important feature of this case. The cooling area is outlined on the following figure (Fig. 1) with T2m observations.

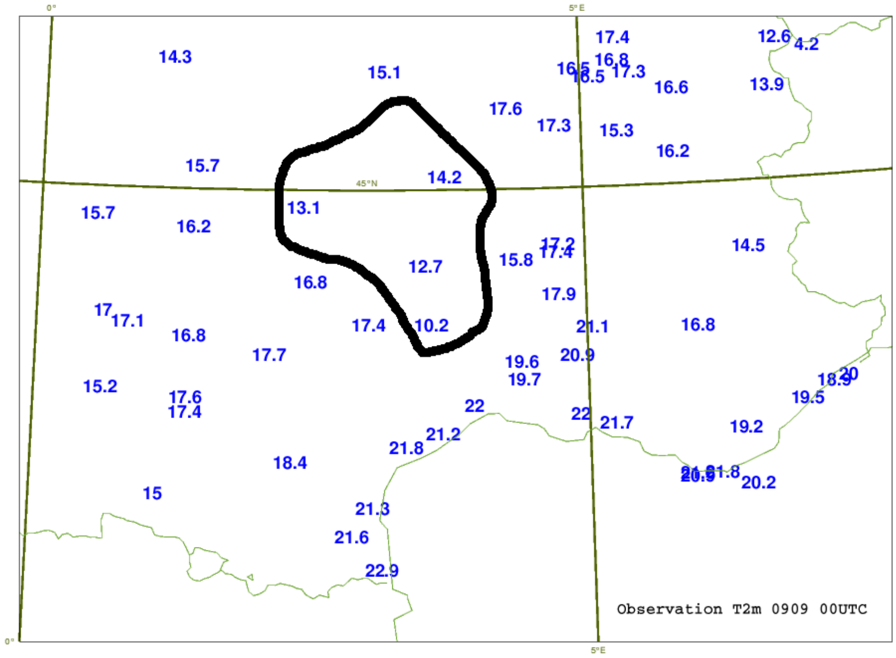


Fig.1: Observations of 2m temperature on 09/09/2002, 00 UTC, on Southern France.

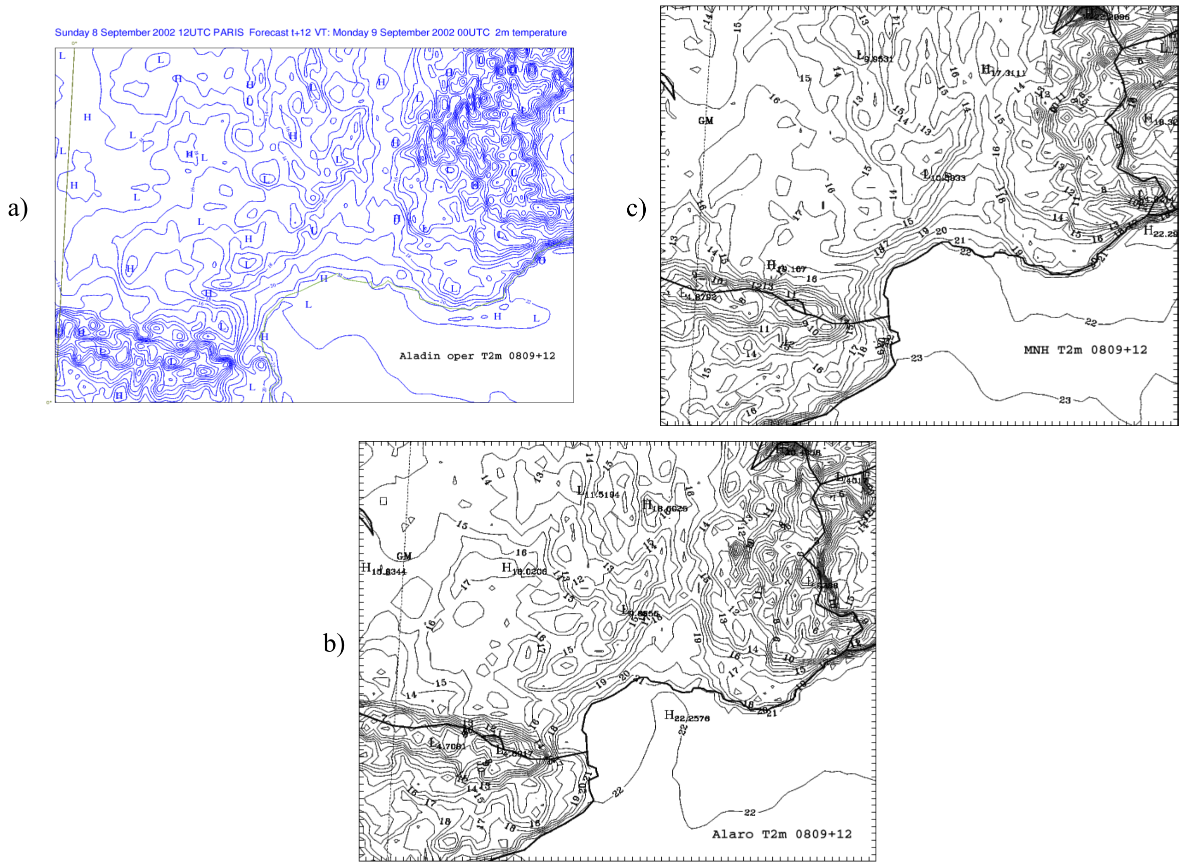


Fig.2: 12 h forecasts of 2 m temperature, valid at 09/09/2002 00 UTC.
a) ALADIN-oper (Δx = 9.5 km), b) ALARO-10 (Δx = 10 km), c) Meso-NH (Δx = 10 km)

The cooling is seen by the several models : Méso-NH at 10 km, ALARO-10 and ALADIN-oper, the corresponding 12 hours forecasts are show on Figure 2. The minimum temperature in the cooling area is 10°C for Méso-NH and ALARO-10, and 13°C for ALADIN-oper. The other remarkable features, such as the heating inside the Rhone Valley, are similar between the three models.

- Low-level wind

The low-level wind shows a South/Southeast flux that brings hot and moist air from the Mediterranean sea to the convective system. This is well seen on the 12 hours forecasts of all models. The inland penetration of the southeasterly flux is deeper in ALADIN-oper than in ALARO-10 and Méso-NH, and its leading edge is better defined in ALARO-10 and Méso-NH than in ALADIN-oper outputs, in terms of consistency with the observed wind values (Fig. 3)ure, the centre panel is the Méso-NH low-level wind).

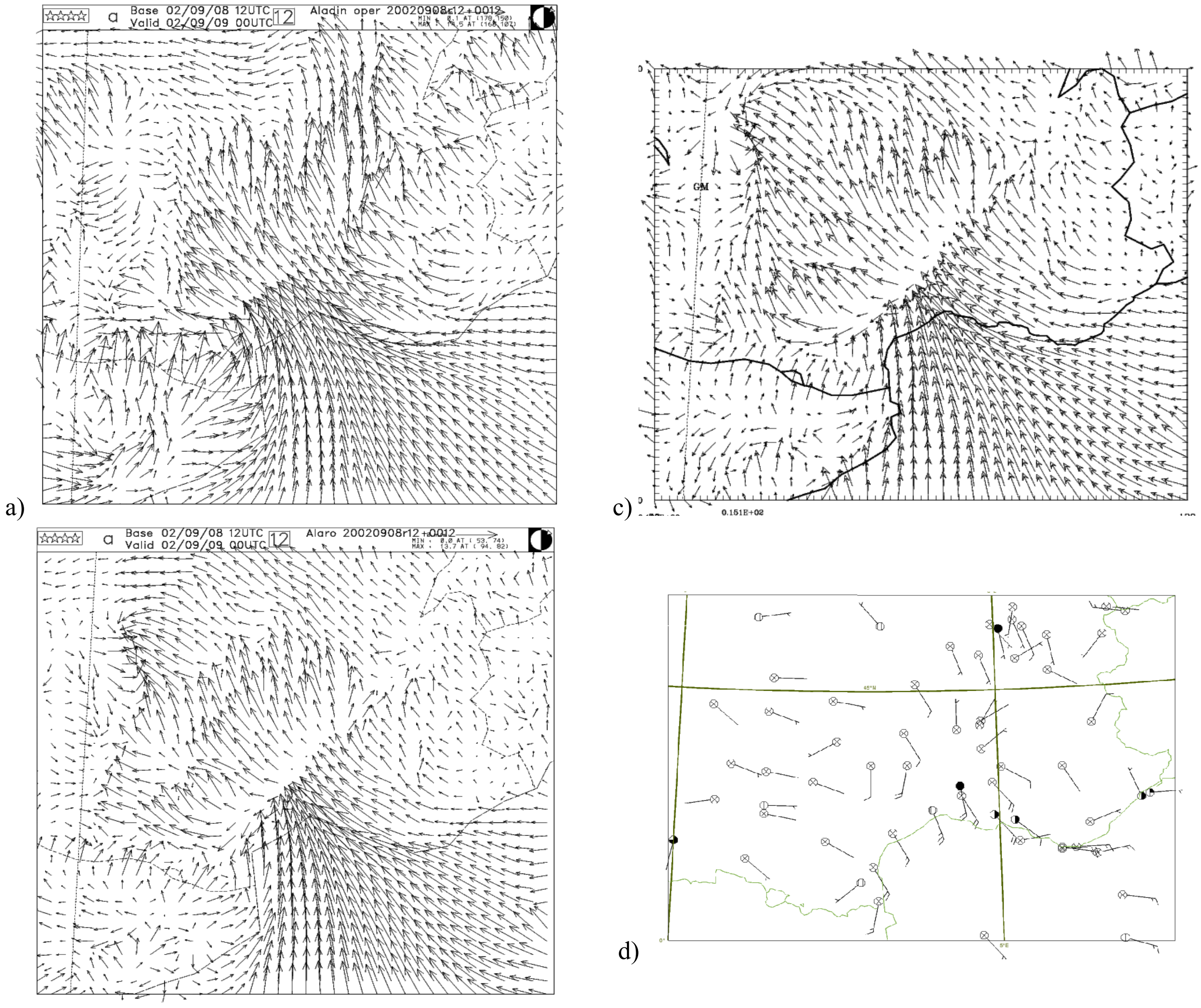


Fig.3: 12 h forecasts of lowest-level wind, valid at 09/09/2002 00 UTC, and observed values of 10 m wind. a) ALADIN-oper (Δx = 9.5 km), b) ALARO-10 (Δx = 10 km), c) Meso-NH (Δx = 10 km), d) SYNOP data.

✗ Cloudiness

The cloudiness field is shown by distinguishing between low, medium and high cloud cover as is done in operations. Note that the cloudiness is a 3D field for AROME, ALARO-10 and Méso-NH, so the cloudiness field interpretation is intentionally biased towards the ALADIN-oper post-processing. The low, medium and high cloud cover are built from the 3D cloud field in the layers 15-2200 m, 2200-7300 m, 7300 m-model top, respectively. An infrared satellite image is used as observed truth. The imagery shows a large cloud system made of a cluster over western France and another one associated to the convective system over Southeast France. Southwest France has mostly clear skies. These features are shown by all forecasts with some differences from the IR image.

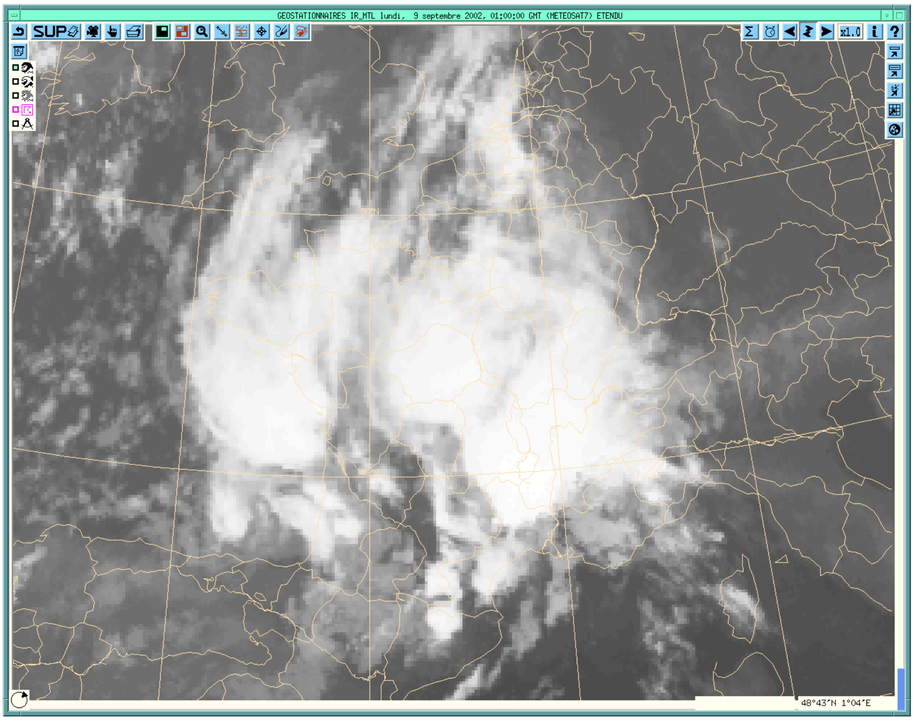


Fig.4: Infra-red satellite image (Meteosat 7) valid on 09/09/2002, 01 UTC.

The model clouds are shown in the next figures (5-7). I is a feature of the Meso-NH plotting that high clouds are shown as a colour plot. The Meso-NH and ALARO-10 clouds are similar to the imagery. In both models, the clear part over southwestern France is well represented as well as the convective system over the Southeast. The high clouds are similar to the imagery except for a positional weakness on the northwestern cluster, which is too far South in both models. The ALADIN-oper cloud products have their own problems such as too many high clouds over the Mediterranean Sea and too many low clouds in the northwestern part of the domain. The convective system is well seen by all models from the point of view of cloudiness.

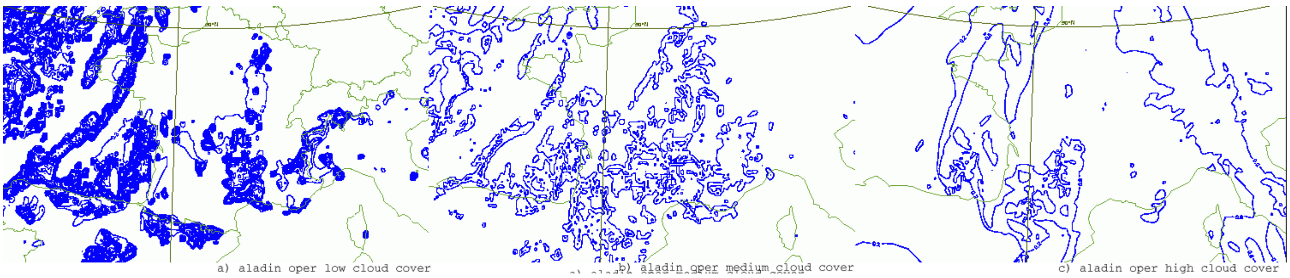


Figure 5 : ALADIN cloud-covers (12 h forecast valid at 09/09/2002, 00 UTC. low, medium, high, from left to right.

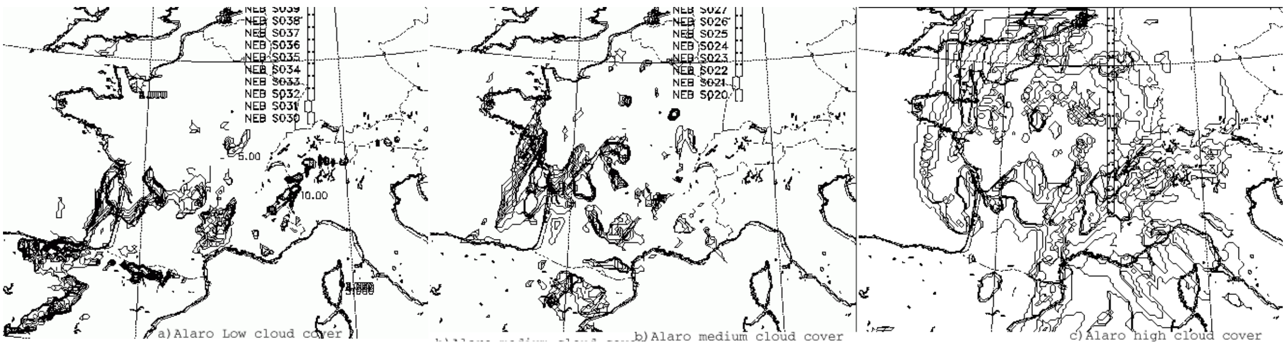


Figure 6 : As Fig. 5 but for ALARO-10.

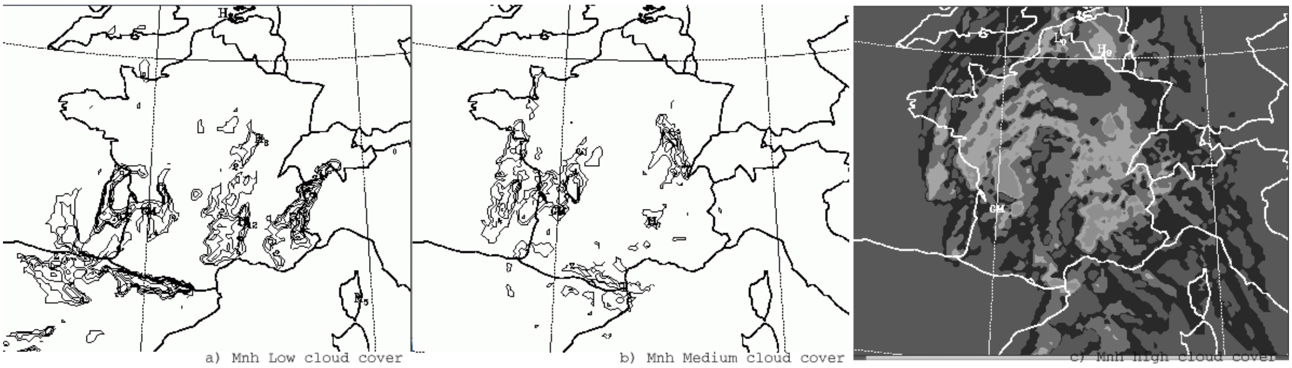


Fig.7: As Fig. 5 but for Meso-NH (at 10 km)

✗ **Rain**

Cumulated rain amounts are shown for the three models, on the integration domain (Fig. 10) and with a zoom on a smaller domain, at the same model resolution (Fig. 11). We also show results from Meso-NH and AROME with a 2.5 km horizontal mesh-size in order to show the improvement brought by a finer horizontal resolution (Fig. 12). The corresponding observations from radar data are shown in Figs. 8-9.

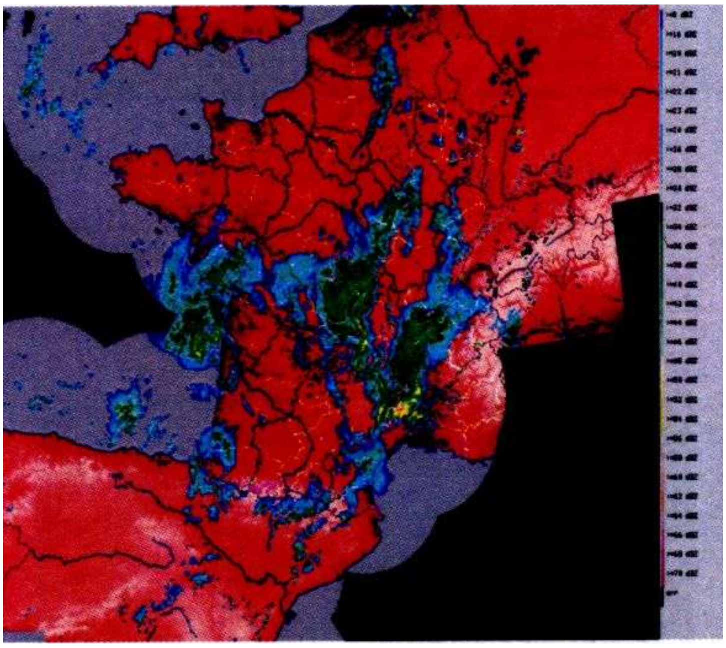


Fig.8: Radar reflectivities , 09/09/2002 00 UTC.

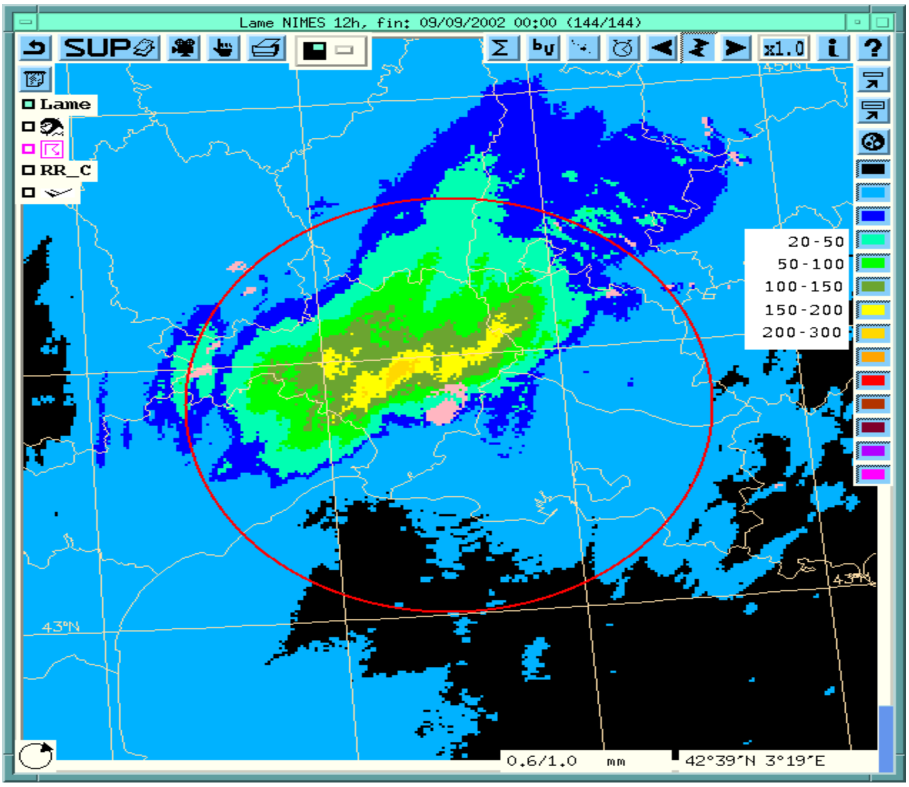


Fig. : Cumulated rainfall derived from radar data, zoom over South France (Nîmes radar only). Cumul over 12 h, valid on 09/09/2002 00 UTC.

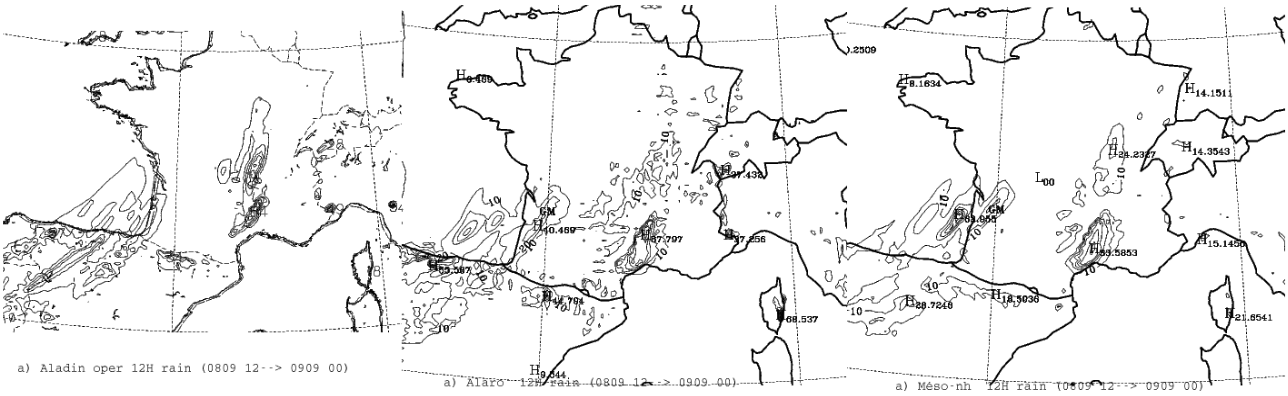


Fig.10: 12 h-cumulated rainfall

From left to right : a) ALADIN-oper ($\Delta x = 9.5$ km), b) ALARO-10 ($\Delta x = 10$ km), c) Meso-NH ($\Delta x = 10$ km)

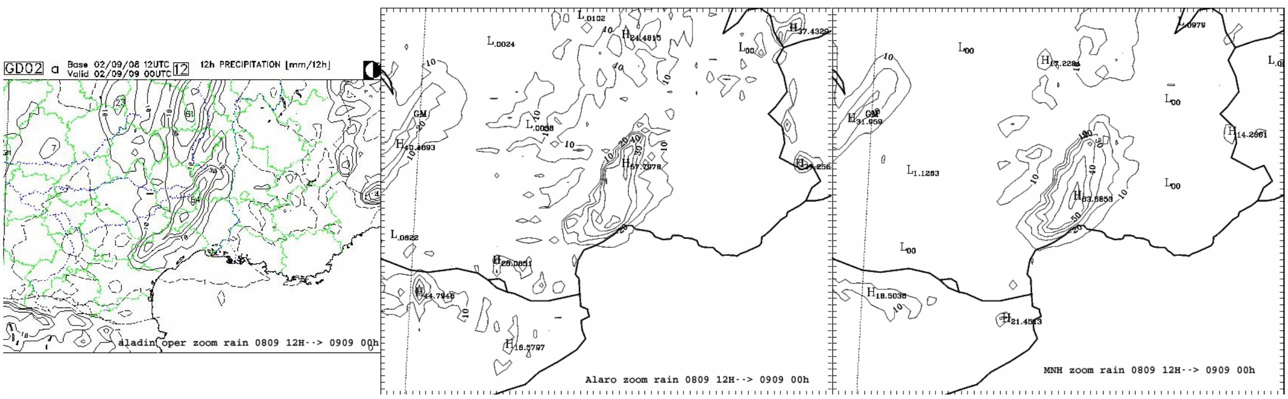


Fig.11: Zoom of Fig. 10 over southern France.

The ALARO-10 and Meso-NH results are similar except that the output from ALARO-10 is noisier. The reason for that is not yet understood. Looking at the convective event, the amount of precipitation is about the same between all models at 10 km resolution (~ 60 mm in 12 h), which is far from what is given by the observations and by the finer-scale models (~ 300 mm in 12 h). Regarding the location of the convective system, no 10-km resolution model is satisfactory, they have the common problem that the simulated system has a too North-South orientation. The high resolution runs exhibit a better West-East orientation. It is important to note that the location and orientation of the system is very sensitive to the initial and coupling conditions which are different in the high resolution runs (thanks to with fine-scale data assimilation with bogussing of humidity data).

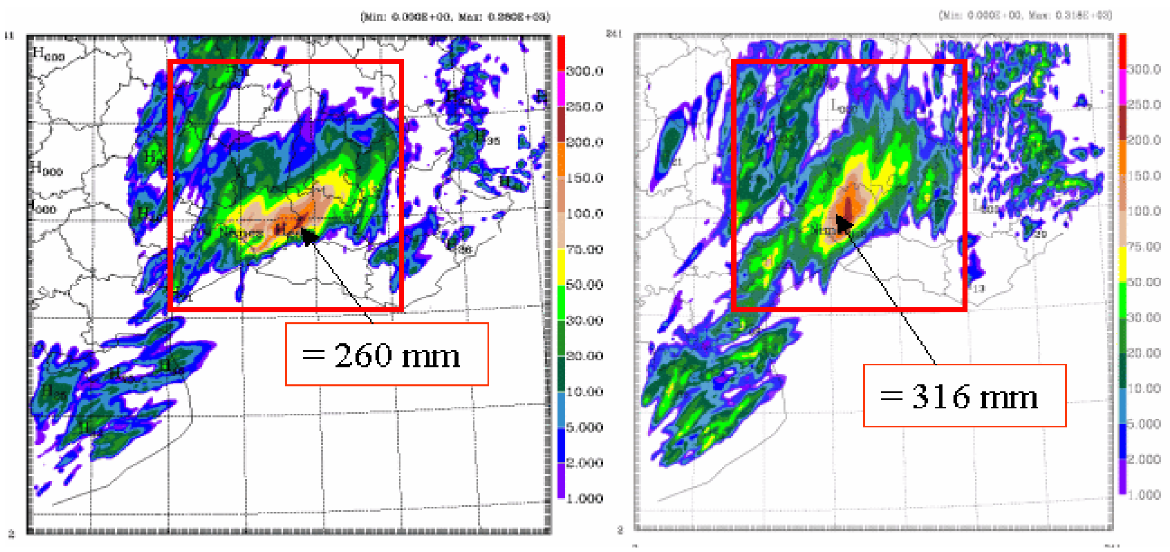


Fig.12: Méso-NH (left) vs AROME (right) simulations at a resolution of 2.5 km.
Méso-NH is used in grid-nesting mode, with an intermediate run at 10 km, and coupling every 3 h at each level.

4.12.4. Conclusion

One cannot draw a final conclusion about the relative merits of ALADIN and ALARO-10 on the sole basis of these experiments. It can only be said that each model behaves in a physically reasonable way, and has its own weaknesses. ALARO-10 was never optimized physically or algorithmically, so it could probably be improved. At the time of writing it is unlikely that CNRM will be able to perform any more work to understand or improve this ALARO-10 model, since all the available ALADIN-2 workforce in the GMAP group has been shifted to new priorities.

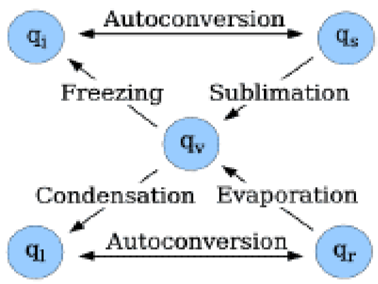
4.13. The "how?" and "why?" of the discretized governing equations in the proposed new physics-dynamics interface: Catry B.

One might ask : "Why do we need such a set of discretized governing equations?". The answer to this question is the easy part of this note and is twofold : (1) to ensure consistency between the different models which the new interface should host and (2) to be able to have a meaningful cross-model comparison and useful DDH-type diagnostic tools. The last point is of course logic, the first point might be a bit less clear. But for instance, in the case of the AROME/ALARO-10 prototypes, there appears to be a lack of enthalpy transport by precipitation and of local enthalpy formal conservation, for which tests in ALADIN have shown a potentially significant impact on the precipitation forecasts. I hope this explains the "why?".

To answer the "how ?" part I won't give you an equation-related derivation. Instead, I will explain the reasoning behind these equations. For those really interested in the equations themselves and not having read them, please contact *bart.catry@ugent.be* or *jean-francois.Geleyn@chmi.cz*.

The starting point is a small manuscript, ARPEGE/ALADIN oriented and dating back to 1983, that derives conservative forms of the thermodynamic equation in case of three water phases (water vapour, liquid water and ice) in the cases δm=0 and δm=1. In the latter case however there wasn't a true conservative form (the tendency of enthalpy could not be written fully as the divergence of a flux). As the so-called AROME equations were derived in a barycentric framework and use more water-phases (rain water, snow, graupel, hail), it seemed useful to redo the exercise of many years ago.

This exercise was indeed redone with two partial limitations: for a mass-type vertical coordinate (like for AROME and unlike for Méso-NH) and without yet considering the dissipation terms linking dynamics and thermodynamics, especially in the compressible case.



As hail and graupel have the same thermodynamical properties as snow they can be incorporated into snow for our purposes. Another assumption is that all processes should go through the vapour phase which is of course physically not the case but thermodynamically it is fully correct. The allowed phase-changes are shown in the figure. Furthermore we used the proposal of Martina Tudor that in the barycentric case and in case of δm=0 only dry air moves to compensate for the mass fall associated with precipitation. Using these assumptions we were able to derive a set of conservation laws for the different mass species and also to find back a conservative form of the thermodynamic equation similar to the one with only three water phases but with additional fluxes (phase-changes) of course.

In the case of δm=1 we don't have any compensation by dry air anymore but due to the barycentric behaviour, new compensating fluxes appear in the conservation laws of the mass species. Fortunately, these additional fluxes are the reason why we also find in this case a conservative form of the thermodynamic equation. This thermodynamic equation was furthermore independently derived starting from the basic entropy equation related to phase-changes and precipitation.

Moreover, from dynamical point of view, because in the barycentric case there are no fluxes which can be considered as source terms, the continuity equation can be simplified which has consequences for the vertical velocities, which now depend only on the surface fluxes of evaporation and precipitation.

Finally, the addition/removal of heat due to phase-changes should in the non-hydrostatic compressible case not only lead to a temperature change but also to an associated pressure change. Using basic principles (the state law and the relation Cp = Cv + R) we were able to derive the associated pressure change, which not only depends on the diabatic heat source but also on the change in air composition.

So we have a barycentric set of equations (the only one deemed by the AROME team fit to accommodate compatibility with both AROME and ARPEGE/ALADIN dynamical cores) where the following issues are treated :

- (1) multi-phase choice;
- (2) enthalpy conservation;
- (3) choice between δm=0 and δm=1;
- (4) optional projection of the heat source on temperature and pressure in the compressible case.

Furthermore, no additional simplifying hypotheses were needed on top of those already used in the derivation of the AROME equations. The latter condition plus obeying the four above-mentioned constraints were indeed the "boundary conditions" of our work, set on the basis of known open questions, for lack of a purely AROME-based definition.

Work has now started on how to implement the mathematical and/or physical consequences of the obtained set of equations with respect both to ALADIN (extension and simplification of the concept) and to AROME (projection onto a new dynamical core of what was originally thought only for the Méso-NH one with its short time-steps). This should lead to something fully prepared for ALARO and for the HIRLAM likely demand, but this goes beyond the scope of the present note.

4.14. Interactive mixing length and modifications of the exchange coefficient for the stable case: E. Bazile, G. Beffrey, M. Joly and H. Marzouki.

4.14.1. Introduction

The GABLS experiment (GEWEX Atmospheric Boundary Layer Study) provides a clear framework for 1d and large-eddy simulations (LES) inter-comparisons on a stable boundary layer (SBL) situation (Holtslag, 2003). It is based on an Artic case studied by Kosovic and Curry (2000), the single-column model is driven by an imposed geostrophic wind, with a given surface cooling rate. The roughness length is specified, the radiation scheme is switched off, therefore only vertical diffusion is active. The ARPEGE/ALADIN model is not able to reproduce correctly the Ekman spiral and the low-level jet does not exist due to the excess mixing in the SBL on wind (Fig. 1) and temperature. The PBL parametrization, based on Louis et al (1981), computes the exchange coefficients for momentum and heat ($K_{m/h}$) as functions of the corresponding mixing lengths ($l_{m/h}$), the vertical wind-shear and the Richardson number (Ri) :

$$K_m = l_m l_m \left|\frac{\partial V}{\partial z}\right| F_m(Ri')$$
$$K_h = l_m l_h \left|\frac{\partial V}{\partial z}\right| F_h(Ri')$$

The mixing-length profiles (l_m, l_h) are constant in time and in space. Ri' is a Richardson number function of l_h, z. and a critical Richardson number, Ri_c.

4.14.2. The modifications

Firstly, a new coefficient k (EDK in NAMPHY0) has been introduced in the formulation of $F_{m/h}$ to reduce mixing in stable conditions (Fig. 1) :

	Oper, $b = d = 5\ (k \equiv 1)$	Dbl, $b = d = k = 5$
$1\ /F_m$	$1 + 2bRi/\sqrt{1+dRi}$	$1 + 2bRi/\sqrt{1+\frac{d}{k}Ri}$
$1\ /F_h$	$1 + 3bRi\ \sqrt{1+dRi}$	$1 + 3bRi\ \sqrt{1+dk\ Ri}$

Secondly, the PBL height ($PBLH$) is now computed following the Troen and Mahrt (1986) proposal and used to compute the mixing lengths. For temperature and humidity, the mixing length is a cubic function verifying :

$$\frac{d\,l_h}{dz} = k \quad \text{as} \quad z \to 0 \;, \qquad l_h(z) = \lambda_h\,\beta_h \quad \text{for} \quad z \geq PBLH$$

For the momentum part the operational function is used but, now, the parameter H_m (previously 1/UHDIFV) depends on the PBL height :

$$l_m = \left(\frac{kz}{1+kz/\lambda_m}\right)\left(\beta_m + \frac{1-\beta_m}{1+(z/H_m)^2}\right)$$

with : $\lambda_h = \frac{3}{2}\,d\,\lambda_m$, $\beta_h = \beta_m/\sqrt{3}$, $H_m = PBLH \cdot \mathrm{XKLM}$, hence $l_m(z) \approx \lambda_m\,\beta_m$ as $z \to \infty$. The new mixing lengths are shown in Figure 2 for two PBL heights, 1000 m and 4000 m (dotted and dashed lines respectively, the full line is the operational version).

The modified version, on the GABLS case, improves the vertical profile of wind speed with a maximum near the SBL top as seen in LES (Fig. 1). The friction velocity (u^*), the Monin-Obukhov length (L_{MO}) and the surface angle for the wind direction are improved. However, it is not yet perfect for the Ekman spiral and the PBL height. The Prandl number is also overestimated by a factor 2 or 3 compared to the value provided by LES.

	PBLH	$\overline{w'\theta'}$	u^*	L_{MO}	surface angle
oper.	383 m	-0.013	0.34	204	23
modified	333 m	-0.014	0.31	142	29
LES	[160, 195]	[-0.01, -0.013]	[0.26, 0.30]	[120, 170]	[32, 38]

1D simulation with the prescribed vertical resolution δz = 6.25 m and δt = 30 s

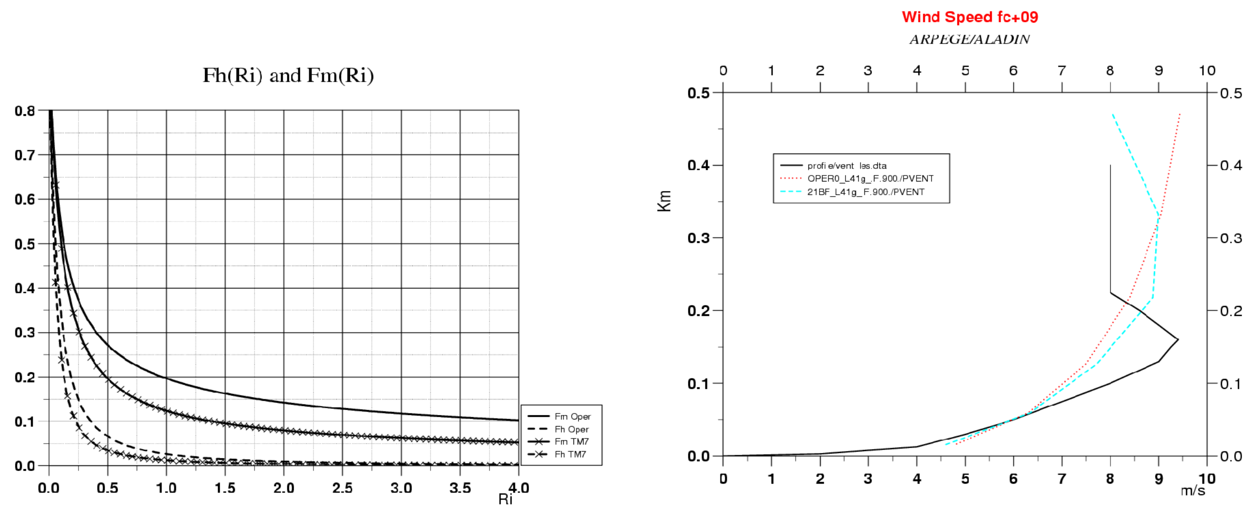


Fig.1: Left : Functions $F_{m/h}$. Full line : F_m, dashed lines : F_h and lines with stars are for k=5. Right : Wind speed after a 9 h forecast with the 1D model on the GABLS case with the operational vertical level. Full line : LES mean profile. Dotted line : operational version. Dashed line : modified scheme

The main results of GABLS (Cuxart et al., 2004) are :

- 1. Operational schemes have a general tendency to mix more than the research models, with two important consequences :
- the upper air inversion is not seen;

- the surface friction velocity is overestimated.
- 2. Those using a Turbulence Kinetic Energy (TKE) scheme overestimate the mixing to a smaller extent, compared to the first order schemes.

4.14.3. The 3d impacts

Following the GABLS results, the impacts should be limited to the cold regions in stable conditions, but the interactive mixing-length should also modified the treatment of the dry PBL, in particular over Sahara, where the PBL height can reach 4000 m. The reduced mixing should improve the humidity profile with a moister PBL and consequently provide more lower clouds, as shown in Figure 3.

Since the 16th of December 2004, the modifications are tested in a parallel suite and should become operational in March. The scores are improved in the PBL over North America but also to a lower extent over the "North20" domain (Fig. 4). The wind direction is also improved, especially over the EWGLAM domain (Fig. 5).

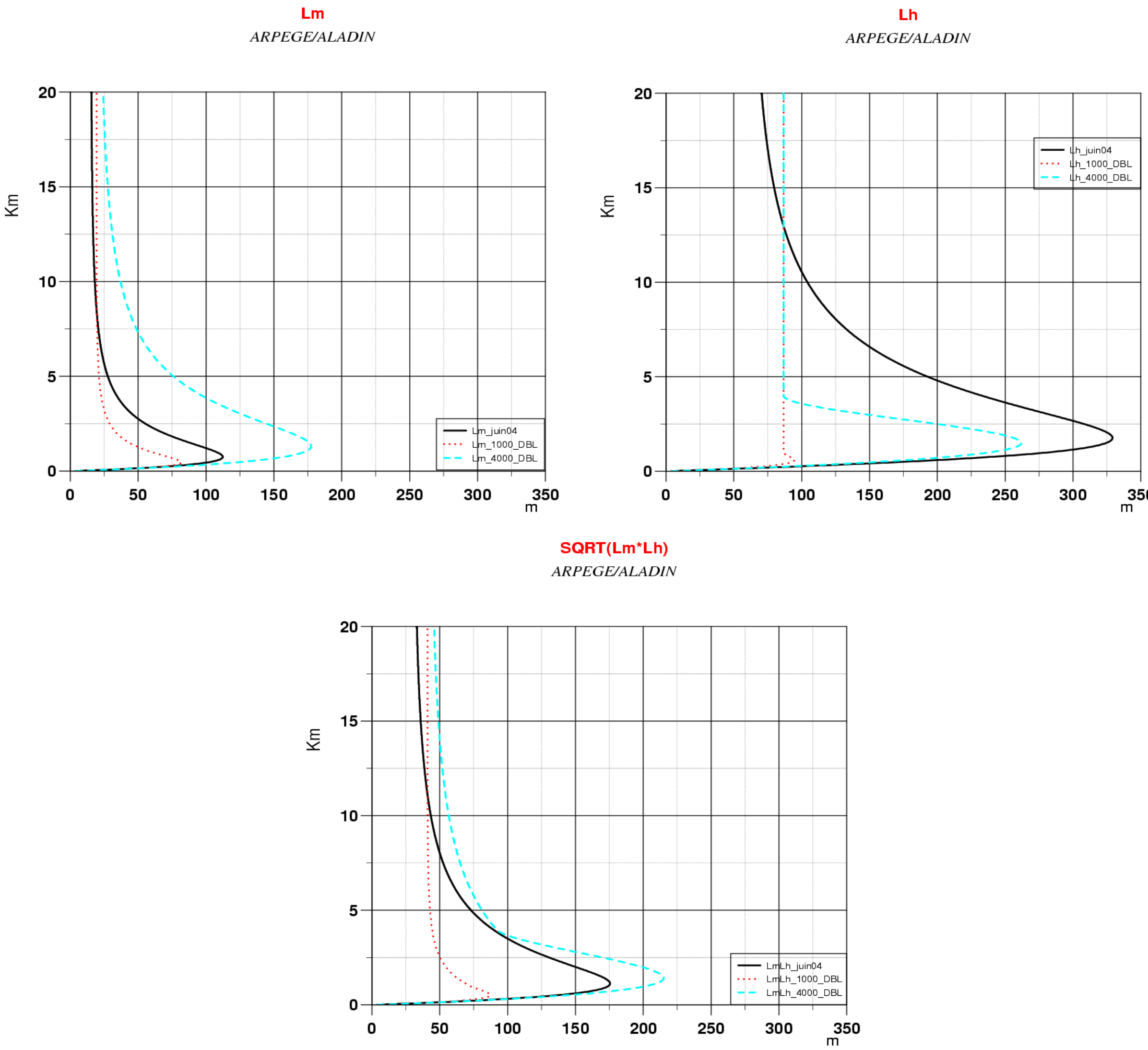


Fig.2: l_m, l_h, $\sqrt{l_m l_h}$ for two PBL heights : 1000 m (dotted line) and 4000 m (dashed line); operational mixing length : full line.

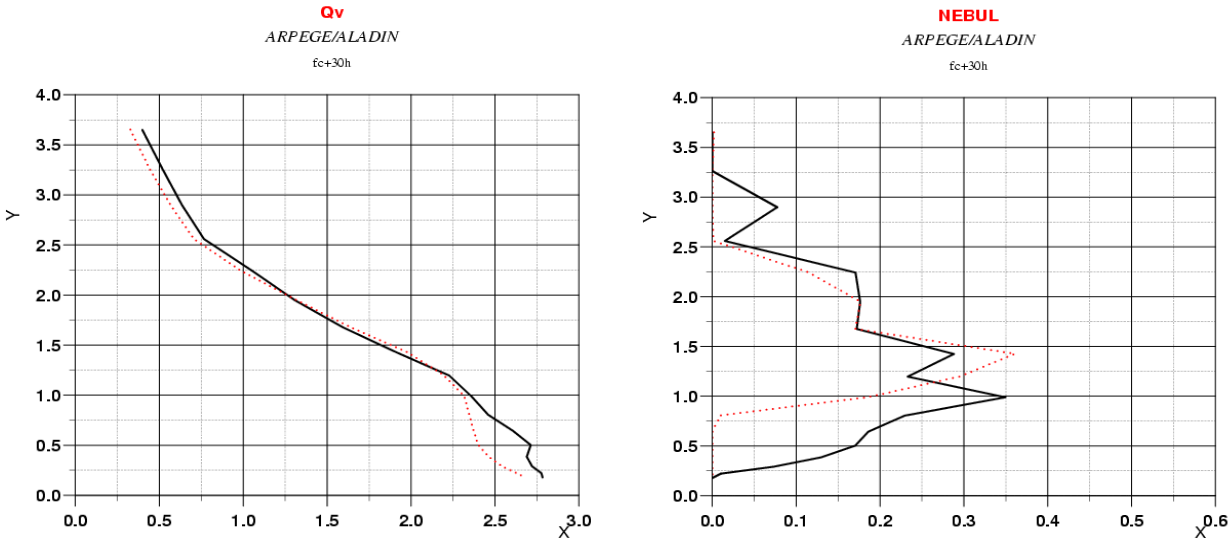


Fig.3: Mean of five 30 h forecasts at Roissy Airport (24/02/2004-28/02/2004). Left : vertical profile for the specific humidity. Right : vertical profile for the cloud cover. Dotted line : operational version. Full line : modified one.

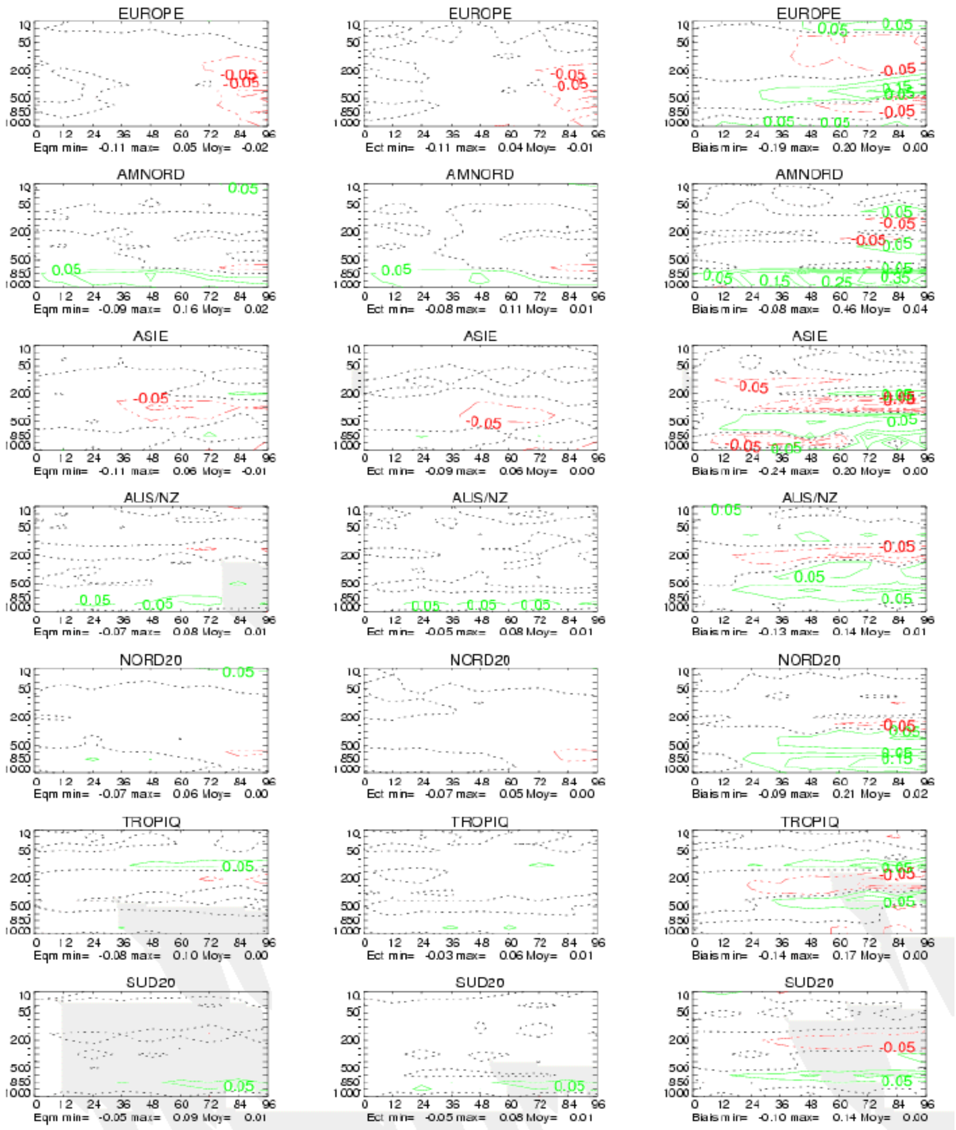


Fig.4: Scores against radiosonde data for temperature (rmse, std, bias, period 15/12/2004-24/02/2005).
Full (green) lines : the test model is better. Dashed (red) lines : the opposite !

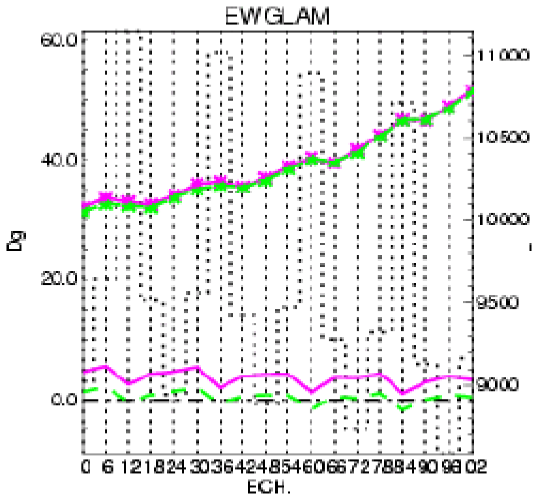


Fig.5: Score against SYNOP data (EWGLAM stations) for wind direction (rmse and bias, 15/12/2004-24/02/2005). Full (magenta) line : operational suite. Dashed(green) line: test suite

4.14.4. How to use it ?

The modifications are on the cycle *28t3_op1* and when compared to the ALADIN export version only a small modification in APLPAR is needed.

In NAMPHY :

- add CGMIXLEN='TM' (the default is CGMIXLEN='Z')

In NAMPHY0 :

- ALMAV=400. (operational scheme : ALMAV= 300.)
- XMINLM=500. : minimum PBL height for the computation of $l_{m/h}$
- XMAXLM=4000. : maximum PBL height for the computation of $l_{m/h}$
- RICRLM=0.5 : critical Richardson number Ri_c used to determine the PBL height (default)
- XBLM=8.5 : parameter to correct θ_s : $\theta_s = \theta_{vs} + \text{XBLM}\,\overline{(w'\theta'_v)_s}/w_m$, w_m is a function of the friction velocity and the scale of the convective speed (the default is 6.5)
- EDK=5. : new parameter used in the computation of $F_{m/h}$ (operational scheme : EDK=1)
- XKLM=0.6 : parameter to use the interactive PBL height for momentum

4.14.5. References

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4.15. Capability of the ALADIN 3D variational mesoscale assimilation scheme to simulate a cyclone in the South-West Indian Ocean: Jean-Marie Willemet &, Samuel Westrelin.

4.15.1. Introduction

Over the last years, the global models have realized great progress concerning the trajectory forecasts but their representation of the cyclone itself remains very poor due to rough horizontal resolutions, including the initial state. Improvements in cyclone track and intensity predictions are expected with a better simulation of the cyclone structure. This can probably be achieved with a mesoscale model. In a global model, the background errors statistics are not well suited for the cyclone prediction. The correlation functions are not sharp enough. We expect them to be sharper in a limited-area model in a tropical zone.

These arguments encourage to test the impact of a mesoscale assimilation/prediction suite on the cyclone predictions. ALADIN 3D-Var has naturally made up our test software.

4.15.2. ALADIN-Réunion characteristics

✗ **The coupling model**

The coupling model is ARPEGE-Tropiques, a global model with a uniform resolution, about 55 km. The analysis uses a 4D-Var algorithm acting at 187 km resolution. The calculation grid is linear. The vertical is described by 41 levels from 17 meters to 1 hPa. The binary file name is *cy28t2_tropique-op1.09.*

✗ The domain

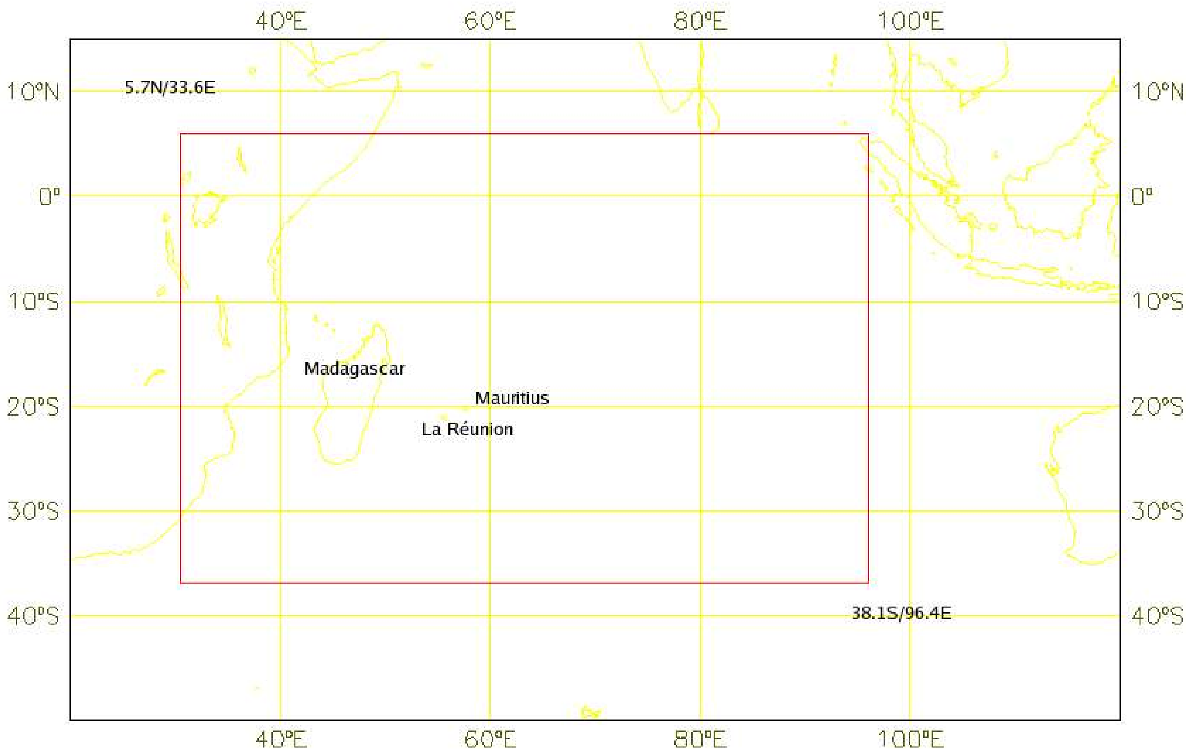


Fig.1: The ALADIN-Réunion domain (coupling and inner zones) is represented by the red rectangle.

The horizontal resolution is 21.6 km in both latitude and longitude. The domain covers the entire RSMC (Regional Specialized Meteorological Center) area for cyclones analysis and prediction, over which Météo-France/La Réunion has international duties for cyclone monitoring.

The entire calculation grid corresponds to 270 points in latitude and 360 in longitude. 36

points in longitude and 27 in latitude are used for the extension zone necessary to get a biperiodic domain; 8 points define the coupling zone both in latitude and longitude; the remaining points constitute the inner area. The projection is the Mercator one. The vertical resolution is the same as in ARPEGE-Tropiques. The calculations grid is quadratic but it is planned to use a linear one in a near future.

✗ **Background errors correlations**

They have been computed with the lagged-NMC method over the first quarter of 2004, corresponding to warm season meteorological conditions. They should then better fit our cyclonic prediction aim. A rapid scan of these matrices showed that they contain some specific structures probably linked to the characteristics of the domain.

✗ **The assimilation algorithm**

The ALADIN 3D-Var available on OLIVE has been used with a 6 hours window.

The assimilation is made at the same resolution as the forecast model. The observations file is a simple extraction from the ARPEGE-Tropiques' one over our area.

4.15.3. Experiment description

✗ **The case study : the cyclone BENTO**

The forecasters have issued regular warnings on Bento between 20th and 30th of November 2004. Bento intensified very suddenly on the 22th. On the 23rd, it was an intense tropical cyclone which is rare at this period (Fig. 3). It moved slowly to the South at 10 km/h mean speed (Fig. 2).

ARPEGE-Tropiques forecasts were disappointing, particularly at the beginning of the cyclone life (Fig. 4).

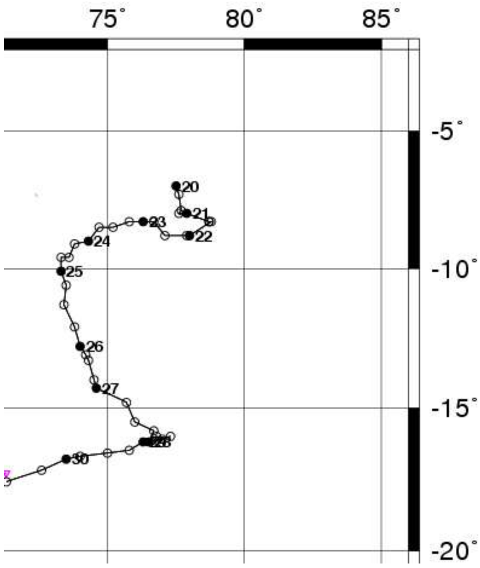


Fig.2: Observed BENTO track.

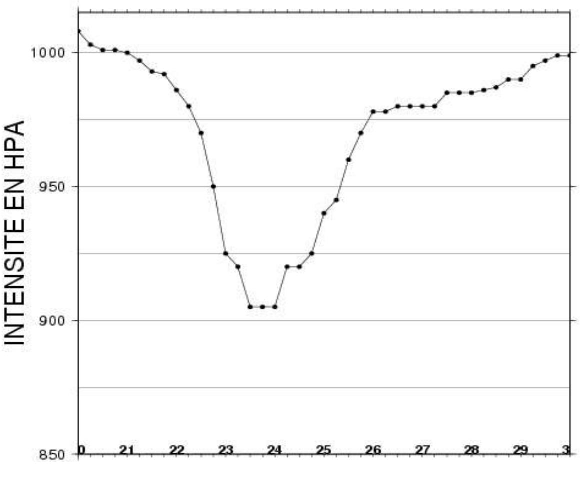


Fig.3: Observed BENTO intensity.

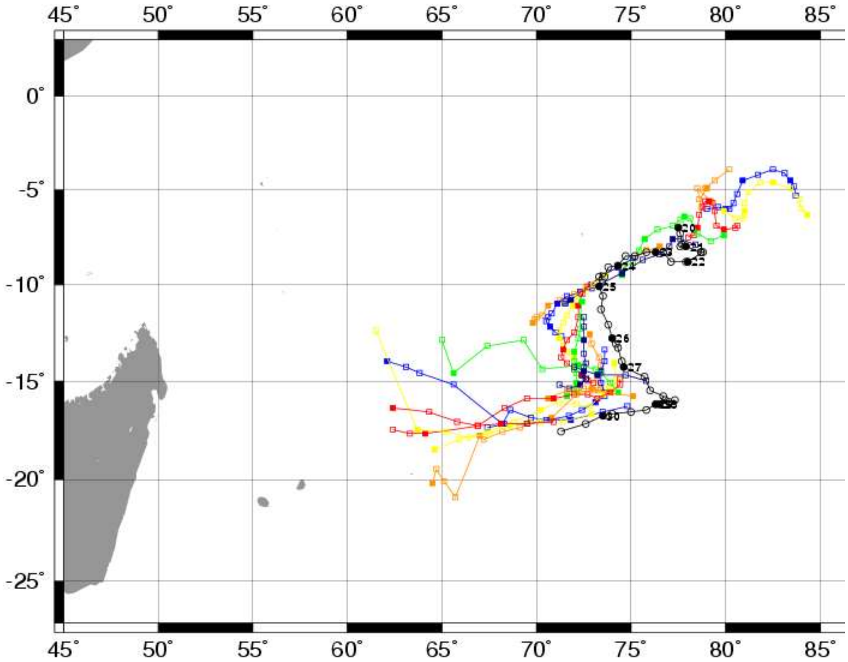


Fig.4: ARPEGE-Tropiques 3-days forecasts every 12 hours on 00 and 12 UTC basis. The observed track is black.

✗ **ALADIN configuration**

The run cycle is *al28t3_main.03*. The assimilation of observations types 8 (cyclone bogus) and 9 (QuickScat scatterometer winds) has been activated as in ARPEGE-Tropiques. To take into account QuickScat winds, a new binary has been built which is used only for the observations screening. The forecast model has run on the 00h UTC basis up to 2 days.

The assimilation period extends from November the 19th at 06h UTC till the 30th at 00h UTC. It began one day before the first warning related to the system.

4.15.4. Results

✗ **Assimilation**

- ***Assimilated observations***

More conventional observations and SATOB winds are assimilated by the ARPEGE-Tropiques 4D-Var. The reason is intrinsic to the assimilation algorithm that takes into account the temporal dimension. Several measures at the same place but at different times are used by 4D-Var when just one, associated to the time at the centre of the assimilation window, is used in 3D-Var. More aircrafts data are assimilated by ALADIN-Réunion; it has been noticed afterwards that their thinning was looser than the ARPEGE-Tropiques' one. No difference appears for other observation types.

- ***Bento track and intensity analysis***

On average, the cyclone position (Fig. 6) is better forecasted by ALADIN-Réunion than by ARPEGE-Tropiques, but the sample is very weak (10 forecasts). In both models the cyclone position is analysed at the same position. The interesting feature is the decrease of the position-error slope with range obtained in ALADIN-Réunion.

In the following paragraphs, the focus will be made on the cyclone structure.

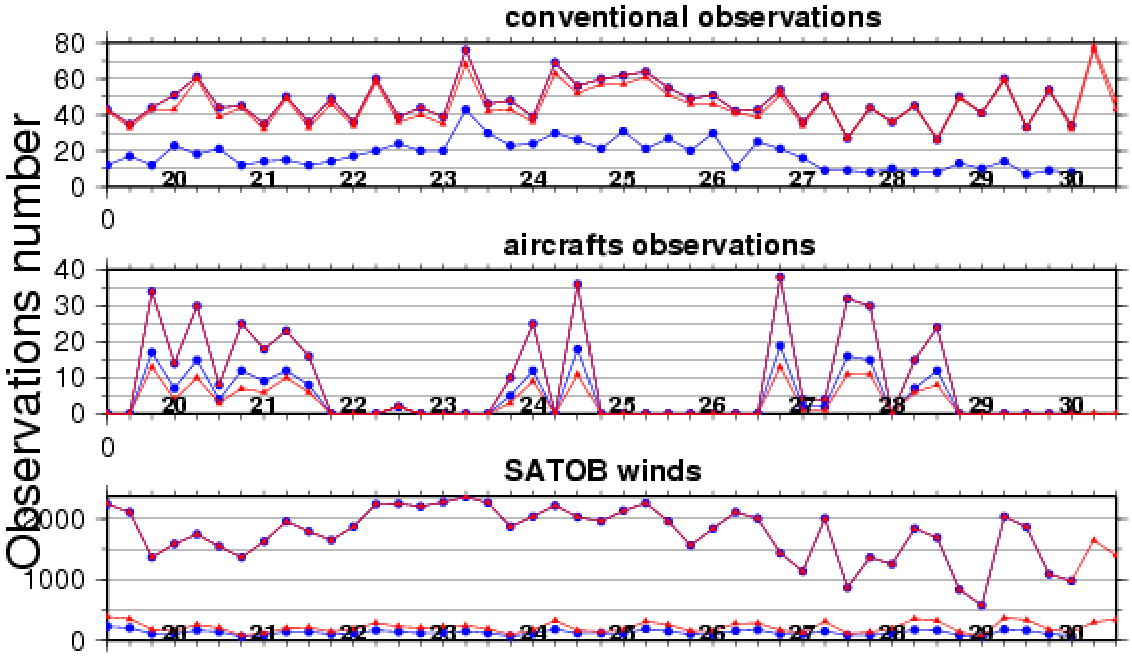


Fig.5: Available and assimilated observations in a 8 degrees side square centered on Bento. Red triangles stand for ARPEGE-Tropiques and blue circles for ALADIN-Réunion. Conventional observations gather observations types 1 (SYNOP, SHIP,...) and 4 (BUOY).

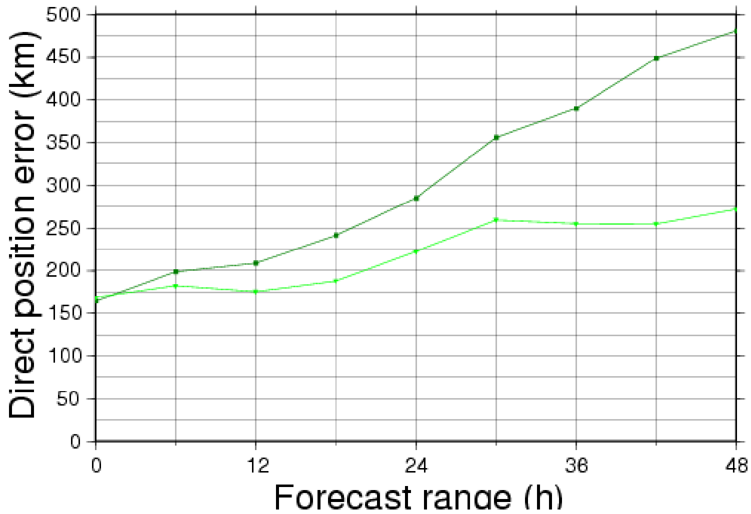


Fig.6: Evolution of direct cyclone position error with range for ARPEGE-Tropiques (dark green) and ALADIN-Réunion (light green) over the entire experiment period.

On Figure 7, the maximum wind radius analysed by ALADIN-Réunion is far closer from the reality than ARPEGE-Tropiques' one. The analysed maximum wind is 10 m/s stronger and better with ALADIN-Réunion.

In both models, the analysis weakens the intensity of the cyclone present in the guess. This can be explained by two reasons :

- The cyclone position error in the guess is on average 200 km; there is a contradiction between the guess and the observations in the cyclone area.
- Almost no observations are assimilated in the cyclone core, except the mean-sea-level pressure bogus because most of satellite observations are contaminated by the rain or are not reliable in strong winds conditions.

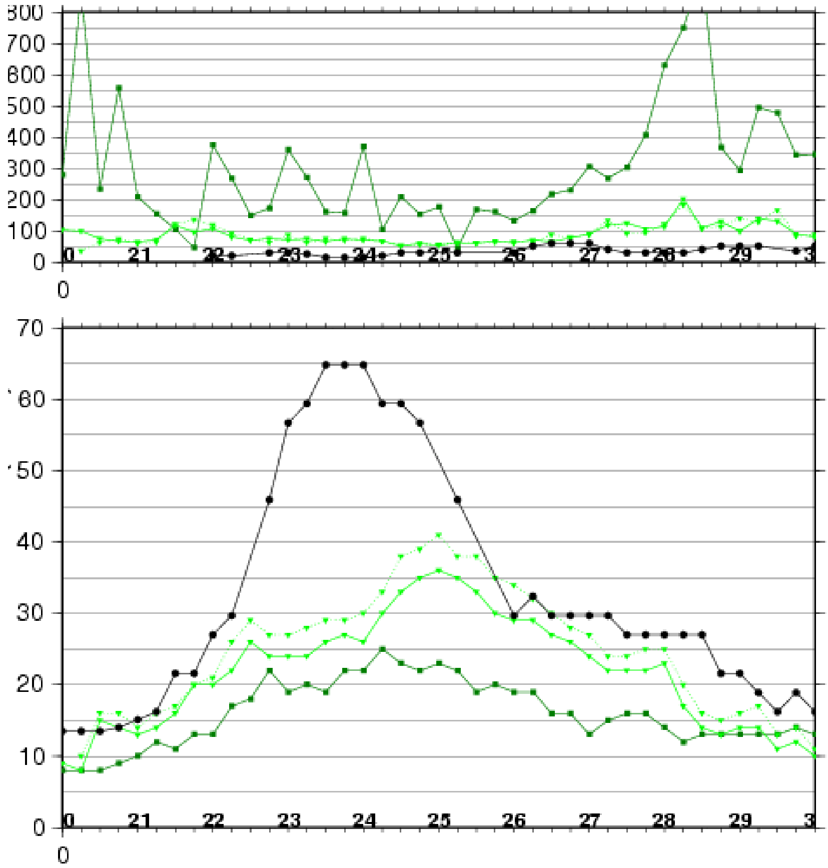


Fig.7: Maximum wind speed (bottom, m/s) and radius (top, km) analysed by the forecasters with the help of satellite pictures (black) and analysed by ARPEGE-Tropiques (dark green) and ALADIN-Réunion (light green) over the entire experiment period. Dashed lines represent the maximum wind in the guess used for the corresponding analysis.

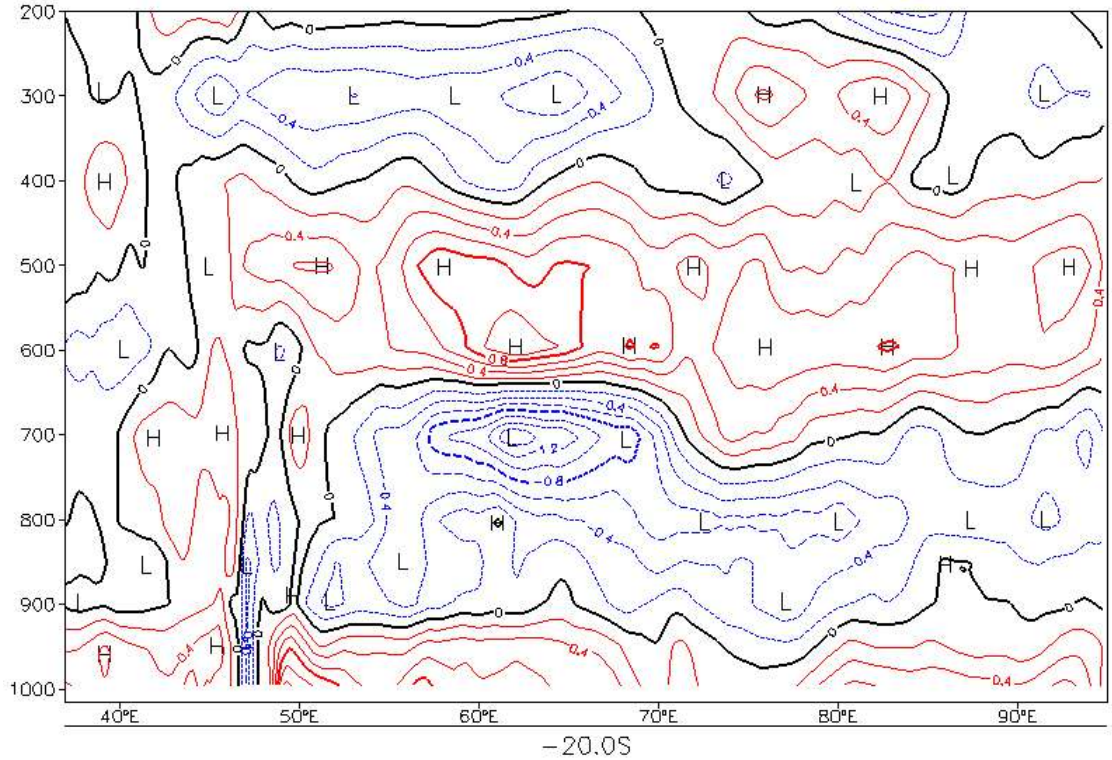


Fig.8: Vertical cross-section at 20°S of ALADIN-Réunion and ARPEGE-Tropiques 24 hours temperature forecasts mean differences (K) from 20th to 30th of November runs.

✗ A problem detected with scores

Mean forecast differences between ALADIN-Réunion and ARPEGE-Tropiques show a stratified structure (Fig. 8). Associated to scores in which the ECMWF analysis is taken as a reference (not shown here), it can be said that the heating in the lower layers by ALADIN-Réunion is not correct ; neither is the cooling around 850 hPa; the heating at 500 hPa is exaggerated even if ARPEGE-Tropiques seems too cool and the cooling at 300 hPa emphasizes a cold bias existing in ARPEGE-Tropiques.

The heating in lower layers is propagated in the assimilation cycle by the guess and the analysis can not correct it. This points out a problem in the temperature forecast. A default in the convection or turbulence scheme is suspected. This problem does not hinder though from studying the cyclonic structures both models produce.

The run model cycle is experimental and afterwards two 6 hours forecasts have been run with *al28t2_op1.05* and *al28t3_op1.02* cycles : they both fix the problem.

✗ Forecasted cyclone structure based on the 24th at 00h UTC

In the following we focus on the cyclone structure simulated by both models because it tells a lot about the capability of the model.

We have chosen the forecast based on the 24th of November at 00h UTC analysis. At this date in reality the cyclone is weakening but both models analyse quite an intense cyclone (984 hPa for ALADIN-Réunion and 991 for ARPEGE-Tropiques) and deepen it during the forecast.

- *A few fields after a 36h forecast*

The ALADIN precipitations field is more realistic (Fig. 9) :
- precipitations are more intense and more concentrated around the eye;
- the ring of heavy precipitations linked to the eyewall is more apparent with ALADIN.

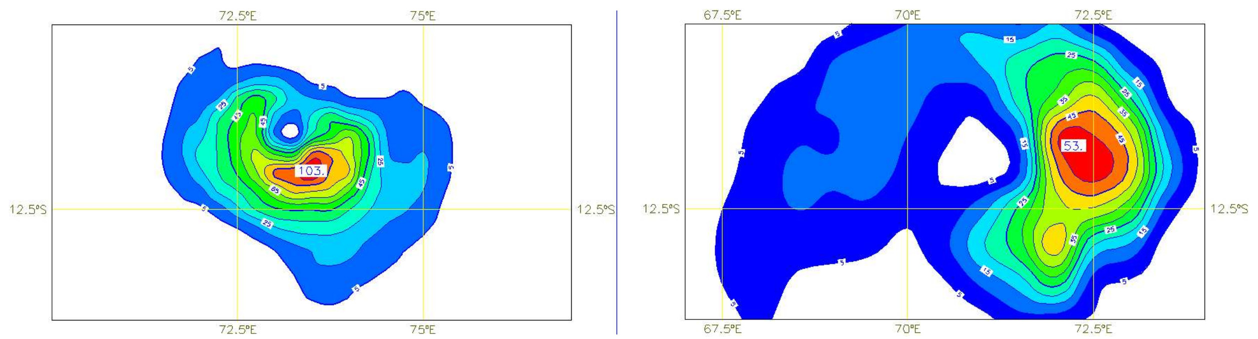


Fig.9: Cumul of precipitations between 33h and 36h forecast ranges in mm, for ALADIN-Réunion on the left and ARPEGE-Tropiques on the right. Base date : 24th of November, 00hUTC.

A characteristic of tropical cyclones is the presence of a warm core, the maximum of which is located in the 250-300 hPa layer. In this layer the horizontal extension of the warm anomaly (compared to the cyclone environment) is the biggest. Figure 10 shows a nice anomaly for ALADIN. In ARPEGE-Tropiques, the warm anomaly appears too large and strangely sheared. The wind force cross-section (Fig. 11) of ALADIN is also in good agreement with literature : on either side of the calm zone corresponding to the eye, the wind is very strong in the lower layers and decays above 700 hPa and away from the eye. The tilted structure simulated by ARPEGE-Tropiques is suspicious.

The maximum wind (50 m/s) in ALADIN is quite reasonable. The maximum wind radius simulated by ALADIN (50 km) is a bit high but not very far from the estimated reality (30 km).

Another characteristic of tropical cyclones is the weak subsidence in the eye. This cannot be seen in a cross-section of simulated vertical velocity (Fig. 12), even in ALADIN that simulated however quite a nice structure in temperature and wind. This is perhaps due to the diagnostic nature of the vertical velocity parameter. The large-scale compensating subsidence is much weaker in ALADIN than in ARPEGE-Tropiques.

Not shown here, the troposphere is not moist enough in the analysed cyclone core. However, during the forecast, the model is able to humidify the cyclone core. This point needs further investigation.

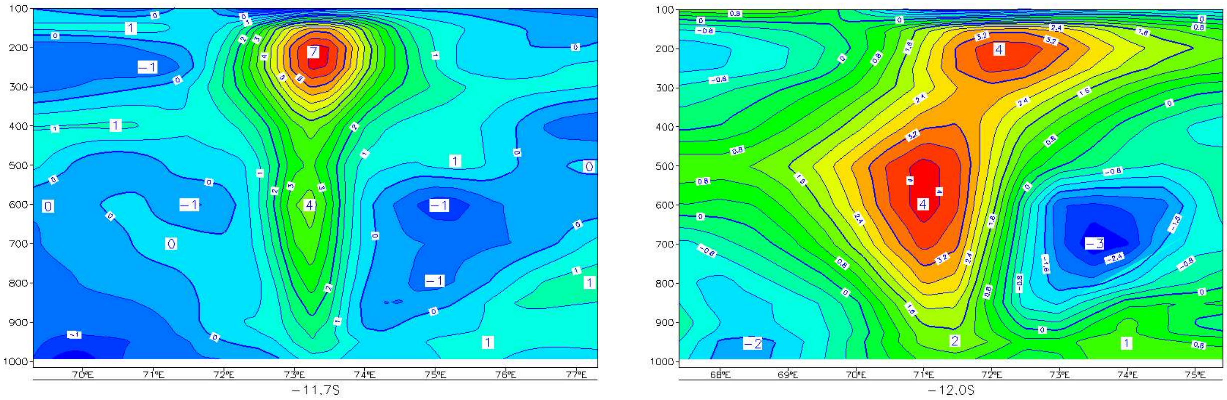


Fig.10: West-East vertical cross-section of the temperature anomaly (local temperature-environment temperature in K) West-East at the simulated cyclone center (ALADIN in the left panel, ARPEGE-Tropiques in the right one). Base date : 24th of November, 00hUTC.

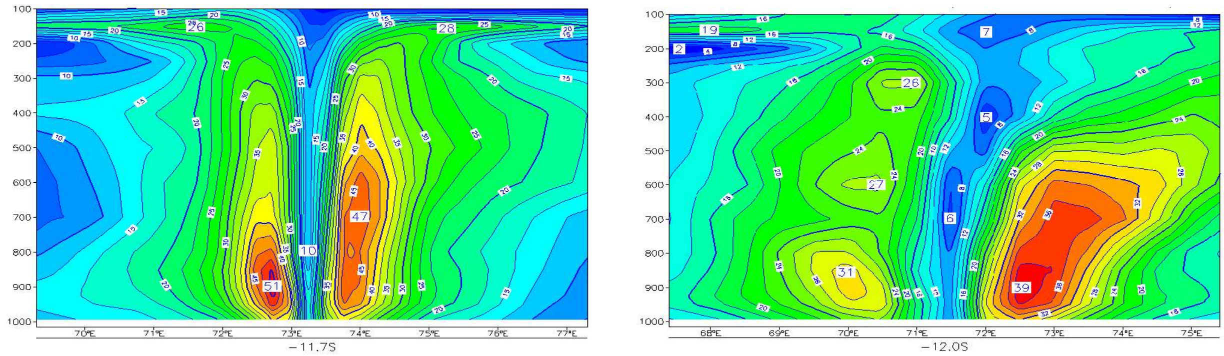


Fig.11: West-East vertical cross-section of the wind force (in m/s) at the simulated cyclone center (ALADIN in the left panel, ARPEGE-Tropiques in the right one). Base date : 24th of November, 00hUTC.

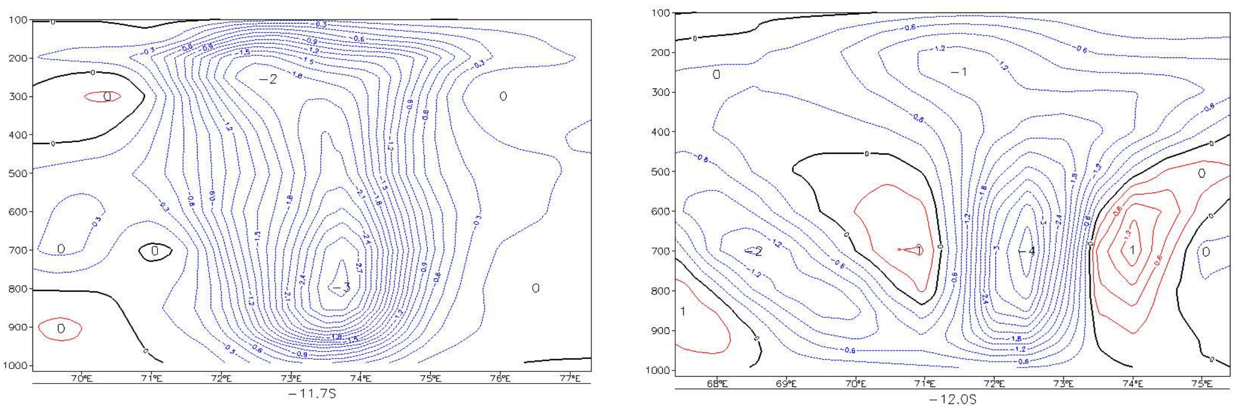


Fig.12: West-East vertical cross-section of the vertical velocity (in Pa/s) at the simulated cyclone center (ALADIN in the left panel, ARPEGE-Tropiques in the right one). Base date : 24th of November, 00hUTC.

- Rainy bands in a 12h forecast

The precipitations location around the cyclone center is more realistic in ALADIN (Fig. 13). A nice rainy band associated to lower-levels convergence can be seen in ALADIN. ALADIN simulates a cyclone structure in better agreement with theory than ARPEGE-Tropiques. The chosen date (24th of November) is favourable in the sense that both models deepen the cyclone during the forecast.

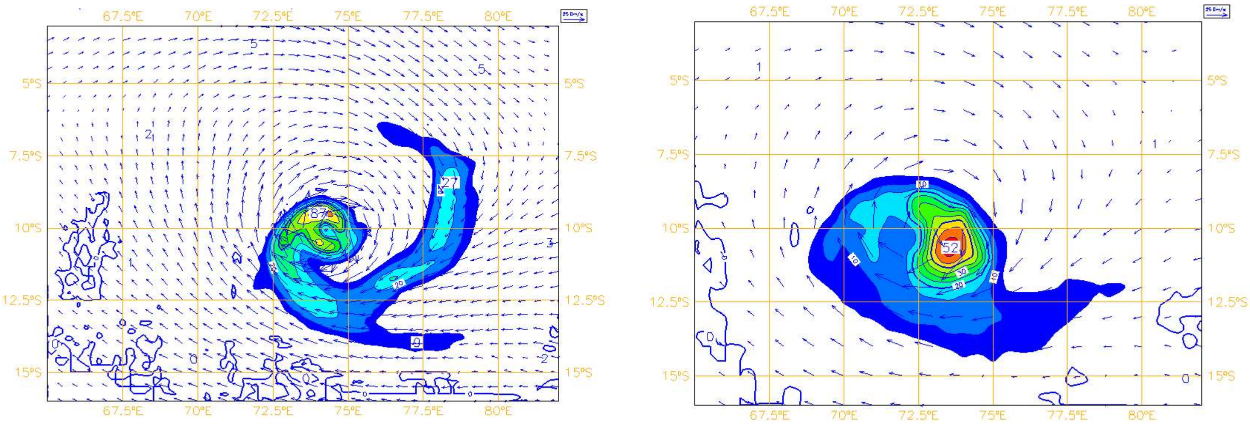


Fig.13: Cumul of precipitations between 9h and 12h forecast ranges (in mm) superimposed to 850 hPa wind for ALADIN-Réunion, in the left panel, and ARPEGE-Tropiques, in the right one. Base date : 24 November, 00h UTC.

4.15.5. Conclusions and prospects

These experiment results are encouraging in regard to the pertinence of ALADIN 3D-Var over the South-West Indian Ocean for cyclonic prediction. The much better resolution both in analysis and forecast has been translated into a better simulated cyclonic structure.

Several ways are now worth being investigated :

- In the experiment the observations set is the same for the limited-area model as for the global model. Satellite data are used in Numerical Weather Prediction models at a spatial resolution allowing a description of large scale patterns and of the cyclone environment, which is crucial to forecast quality. But the cyclone description remains schematic and needs substantial improvement. In a near future the issue under investigation will be the assimilation of satellite data at optimal spatial resolution. More sophisticated refinements will probably be necessary in the assimilation since high density observations are correlated.
- We plan to use an ensemble technique to estimate the background error covariances. This produces sharper correlation functions which should be beneficial in tropical cyclones cases.
- The ALADIN model is able to simulate more intense cyclones with a correct structure. The initial position is still approximative (around 150 km error) but the error increase with forecast range appears weaker than ARPEGE's one. A more sophisticated bogussing (wind vertical profiles in the cyclone core) than the only bogussing of the mean-sea-level pressure at the centre could probably give better results.
- Too few observations are assimilated in the cyclone core : because the conventional observations network is sparse over oceans and because the majority of satellite measurements are contaminated by rain or cannot estimate strong winds. The challenge for next years is to assimilate satellite observations contaminated by rain which will give a lot of information on the cyclone core.

4.16. GRIBEX introduction in FA files: D. Paradis and J. Clochard.

4.16.1. Context

Moore's law, namely the doubling of the number of transistors on a chip every 18 months (or the doubling of the computing power at fixed cost every 18 months), has been maintained for 40 years, and still holds true today. However, in the face of this around 60 % annual increase of the CPU power, the memory access speed only grows by 7 % per year. Moreover, data storage and data international exchanges continuously raise, due to the resolution enhancement or the new productions.

This trend motivated us to implement the use of the second order packing in the **FA** (Fichier ARPEGE) software: this feature is already available in GRIB edition 1 (GRIBEX) and allows to store data on less bits than initially planned, without loss of accuracy.

4.16.2. Second order packing

Practically speaking, it may well be explained at encoding time. GRIB encoding of N grid point values on B bits leads to transform (in a linear fashion) original field values (generally floating-point) into the interval [0,2B-1], rounding them at the nearest integer values.

Ordinary ("simple") packing ends up processing at this stage, and packs the values obtained into a binary string of N*B bits.

The **basic idea of second-order packing** is to make extra processing, **splitting the full sequence of values into groups**. For each group, an **integer reference** value is taken (such as the minimum value of the group), stored as descriptor (**"first-order value"**), and the **positive deviations** from this reference value, called **"second-order values"**, are then **packed** together, **using just the bit number ("group width") sufficient** for that.

The **goal** is clearly to **reduce the overall size of data directly associated to field values**, with a drawback of **descriptors overhead**. All the associated processing, performed on integer-type data, is data conservative (lossless).

The "first-order" descriptors are stored on a bit number that uses the same place within GRIB as bit number for ordinary packing. There is also the **need to document the group widths, and how field is split into groups**. To do so, there are **three different methods** available in WMO standard: so-called row by row packing, constant width packing and a general method. All these methods (and sub-methods) do not change the data contents themselves at user level.

✗ **Row by row packing.**

The idea is to **use coordinate lines as groups**: for instance, latitude lines. The group splitting is "induced", and there is **no need to document group boundaries** (e.g. section 2 is sufficient). Computing of group widths is straightforward. Source coding may even be done without any work array (but then leads to non optimal width of first-order values).

This method is in use at UKMO.

✗ **Constant width packing.**

The idea is to save descriptors, but here on group widthes: there is a **single group width**, instead of one per group. Arbitrary group splitting is enabled; **group boundaries are documented by a secondary bit-map** (one bit per effective grid point value, taking into account potential primary bit-map), with one bit set at each group starting point.

✗ **General WMO second-order packing.**

In this case, all simplifications described in previous methods are relaxed. **Secondary bit-map describes group boundaries** as described above, and there is **one group width per group**.

Moreover, three extensions for the WMO standard have been coded to increase the compression rate: general extended second-order packing, boustrophedonic ordering, and spatial differencing.

✗ **General extended second-order packing.**

The first extension starts from a remark. The general WMO second-order packing exhibits limitations for compression efficiency at 2 levels:

-group widths are stored on 8 bits each (though 3 or 4 bits are generally sufficient);

-secondary bit-map is a fixed but important overhead, and leads to "non-linear" source code for decoding: **group splitting** may be **described** more economically (and decoded more simply) **with group lengths**, provided these lengths are **encoded with an adapted width**.

An extension may be coded, using an additional extended flag and three extra scalar descriptors (**bit number of widths and lengths**, pointer to group lengths), and re-allocating the secondary bit-map area to store group lengths. This extension is a variant of general WMO second-order packing, and may use the same algorithm for group splitting.

✗ **Boustrophedonic ordering.**

The second extension aims at giving a more continuous series of values for splitting. There may be large differences of values between 2 consecutive lines of coordinates, especially for non-global fields. To improve numerical continuity, **lines of even rank** (starting from the 2nd line, as specified by scanning mode flags) may **have their values reversed**.

This may be described just by an appropriate extended flag, and coding is easy. It is a **sub-method** that **may be applied to all second-order packing methods**, but is disabled (at encoding level) for row by row packing, where it would have no interest (coordinate lines acting as groups). Such ordering is (in this context) fully handled internally within data section, and not reflected to user at data level.

✗ **Spatial differencing.**

The basic idea of second-order packing methods is removal of local minima. But still, there is often remaining point to point redundancy. This **redundancy may be removed by preprocessing field (integer) values** just before second-order packing, using a **spatial differencing scheme**, (with order N=1 to 3) that may be compared to approximation of a Nth-order derivative. That's signal processing, finding some echo with (analogic) derivative circuits in electronics.

This spatial differencing being not efficient for all fields, implementation has to determine *a priori* whether the feature is worthwhile to be used. This is achieved in relationship with splitting algorithm, and so may only be selected sub-method with general extended second-order packing.

4.16.3. How to use it

Up to now, there were three possibilities to encode data with FA:

Type 0 encoding: no packing is done, to preserve all the precision of the data (surface geopotential for example);

Type 1 encoding: GRIB version 0 is used only to code data in a packed form (data are presented to GRIB in the integer form);

Type 2 encoding: as type 1 encoding but with the storage (8 bytes) of the min and the max of the data and with the use of all available bits.

From now on (XR28T2), two other types are introduced:

Type –1 encoding: no packing is done (the only difference with type 0 encoding is the ordering of the spectral coefficients);

Type 3 encoding: GRIB version 1 is used, with the possibility to make compression (second order packing).

First thing to do when using the type 3 or –1 encoding, is to keep the model ordering of **spectral fields**: coefficients are ordered along |JM|=cte columns or, differently said, the zonal wave number, JM, is used as an outer loop index. The call to SPREORD routine before writing an horizontal spectral field on a FA file or after reading one, is not yet useful (and must not be done!).

This is due to the fact that with the type 3 encoding, the FA software directly uses the GRIBEX capability to pack Arpege spectral coefficients, which are supposed to be ordered as in model. This ordering type has been kept to pack Aladin's spectral coefficients with type 3 and the type –1 encoding has been introduced to give the possibility to have only one spectral ordering type in a FA file.

Secondly, the encoding type has to be specified to the FA software. There are two possibilities to do that:

. before opening the FA file(s), with a call to the FAGIOT routine,

. after you had opened the FA file, just call the FAGOTE routine.

For these two calls, the KNGRIB argument has to be set to 3 (or –1 if no packing is required). The number of bits used to pack the grid point values (KNBPDG) or the spectral coefficients (KNBCSP) and the non-packed sub-truncation (KSTRON) keep their meaning. You can reuse the predefined values for these 3 variables by previously calling the FAVORI or FAVEUR routines. However, the two other arguments (KPUILA and KDMOPL) lose their sense in the type 3 encoding.

Finally, you have to choose the second order packing options. The default in FA software, is to ask the selection of the best method between no-compression, row by row packing and the general extended 2nd-order packing, to make a boustrophedonic ordering and a spatial differencing with a dynamically estimated order. If these options have to be changed, the FAREGI or the FAREGU routines are available to modify the implicit tuning and the file specific tuning respectively. You will then be able to activate/deactivate the boustrophedonic ordering, to modify or activate/deactivate the spatial differencing, to activate/deactivate the general extended 2nd-order packing, to select constant width packing or general WMO second order packing, to ask GRIBEX to retain the most efficient packing method etc…

You can now write the horizontal fields with a FAIENC call!

To summarize, here is the calling sequence you can use to encode 'SURFTEMPERATURE' with the type 3, in an already opened FA file:

(...)

integer irep, inumer; ingrib, inbcsp, inbpdg, istron, ipuila, idmopl

*real*8 ztsurf(ngptot)*

logical llcosp

(...)

call faveur (irep, inumer, ingrib, inbcsp, inbpdg, istron, ipuila, idmopl)

ingrib = 3

call fagote (irep, inumer, ingrib, inbcsp, inbpdg, istron, ipuila, idmopl)

llcosp = .false.

call faienc (irep, inumer, 'SURF', 1, 'TEMPERATURE', ztsurf, llcosp)

(...)

To read an horizontal field, the use of the FACILE routine is identical whatever the encoding type. Just remember that the ordering for the spectral fields is different between the types 0, 1 and 2 and the types –1 and 3 (see above).

4.16.4. Some relevant features

✗ ALADIN spectral fields

The only spectral coefficients that are accepted by the GRIB norm, are the spherical harmonic ones (ARPEGE spectral fields, for example). To bypass this restriction, the FA software give to the ALADIN spectral fields the appearance of a field on a quasi-regular latitude/longitude grid before calling GRIB code. Moreover, to better pack the spectral coefficients, the packing method for the spherical harmonic coefficients is adapted and applied: first, all coefficients on the axes and in the square whose vertex have the coordinates (0,istron), (istron,0),(0,-istron) and (-istron,0), are extracted from the field and stored separately in the FA article with all the original precision (8 bytes); then an optimal Laplacian exposant ("p") is calculated to smooth the remaining spectrum with the factor (jn**2 + jm**2)**p ("p" is stored in the FA article, as well as the non-packed sub-truncation "istron"); then the smoothed spectral field is given to GRIBEX to be packed as a grid points field, and being so able to take advantage of the second order packing.

✗ **ARPEGE spectral fields**

As for the types 1 and 2 encoding, the type 3 encoding for an Arpege spectral field stores the spectral coefficients contained in the triangle defined by (jn<istron, where jn is the total wave number and istron the non-packed sub-truncation) separately in the FA article with all the original accuracy (8 bytes), the only difference being the presence of (istron+1)*(istron+2) non-packed coefficients instead of (istron+1)**2, due to the difference in ordering.

Unlike the types 1 and 2 encoding, the type 3 encoding gives directly the whole original ARPEGE spectral field to GRIBEX and leaves it to transform the spectrum (smoothing by a factor (jn*(jn+1))**p, where jn is the total wave number and p the optimal laplacian exposant) before packing. The dynamical computation of the laplacian exponent (for ARPEGE and for ALADIN) makes all the pre-computed laplacian factors useless if only the type 3 encoding is used. For the type 1 and 2 encodings, these pre-computed factors were actually stored in several arrays in FA software and took up a lot space in memory when the maximal permitted truncation was high: the goal was then to replace the CPU consumption by a memory consumption. Now, the aim has changed and, with the constraint to only use the type 3 encoding, the memory need is greatly weaker and this advantage will become even more important when higher resolution will be used. A unique version of the FA software will also allow very high resolution without needing too much memory if the used resolution is actually crude.

✗ **GRIB auto documentation**

The FA software uses the FA documentation articles to provide most of the information necessary to initialize the documentary sections of each GRIB message. However, the routine FAREGU can be used to specify another identification centre (KSEC1(2)=85 by default) or another generating process identification number (KSEC1(3)=177 for ALADIN, 211 for ARPEGE forecast and 201 for ARPEGE analysis, by default). The routine FARPAR allows also to modify or to create a connection between an horizontal field name (prefix and suffix in FA) and its GRIB descriptors: 6 integers which represent the version number of the parameters table (KSEC1(1)), the parameter indicator KSEC1(6), the type level indicator KSEC1(7), the level value KSEC1(8), the bottom of the layer in case of a layer or 0 otherwise (KSEC1(9)) and lastly a time range indicator KSEC1(18) (=0 except if the field is a min/max during a period (=2) or except if the field is an accumulation in a period (=4)). The basic connections are quite numerous (215 cases are taken into account in the set up of FA, see routine FAICOR) but the user can modify the connection of a field (prefix+suffix) or create new ones.

This auto documentation of the GRIB message and the respect for the GRIB norm allow to decode a FA file containing only type 3 encoded fields with other softwares such as the PBIO interface of ECMWF : all GRIB messages (containing an horizontal field) can be completely identified except for GRIB messages containing an ALADIN spectral field (these fields are disguised as grid points fields and the spectral coefficients have been transformed to be better packed).

✗ **Decimal factor**

For each grid points field and each ALADIN spectral field, the FA software computes the decimal factor which will optimize the bits use in the packing (for the type 3 encoding only). This feature is automatic in FA and is then handled by GRIB software. It allows to approach the best bits use done in type 2 encoding when the minimum and the maximum of the field were respectively represented by 0 and 2B-1, where B is the bits number used for packing.

✗ **Specific treatment**

The latitude/longitude grid points fields built by Full-Pos have their values ordered from SouthWest to NorthEast (for ARPEGE and ALADIN). But for the data base at Toulouse, it is better to order them from NorthWest to SouthEast. So these fields are reordered before being written on the FA file (and the scanning mode flag in the GRIB message is set to NW -> SE to be coherent with the data). However, when these fields will be read on the file, the FA software will reorder them again from SouthWest to NorthEast before giving them to the user.

A special processing is also done for some fields whose values in ARPEGE and ALADIN are comprised between 0 and 1 instead of 0 and 100% (norm in the GRIB): albedo, nebulosity, vegetation proportion and relative humidity. The GRIB message is then slightly modified (just the decimal factor) to multiply all the field by the factor 100. When data are read again by the FA software, the opposite action is done by FA and the user will find the original values (included in [0,1]).

Normally these two specific features have no consequence on the user, GRIB messages being coherent, but in the case of the use of another interface than the FA software, the user must be aware of this GRIB logic.

4.16.5. Some results

To test the GRIBEX implementation in the FA software on a VPP5000 Fujitsu processor, an ALADIN FA file has been written during a forecast of the ALADIN-France model (elliptic truncation of 149) without packing the fields (type 0 encoding). This file contains 166 spectral fields and 65 grid points fields and has a size of 133.8 MB.

Similarly, an ARPEGE FA file has been written during a forecast of the global ARPEGE model (TL358C2.4) without packing the fields. This file contains 166 spectral fields and 92 grid points fields and has a size of 290.9 MB.

Then, for these two files, the experience has consisted in reading one file, in writing all the articles on another new file with the type 2 encoding, and then in reading again the packed fields and in checking the decoded data with the original ones. The experience has been run again but with type 3 encoding.

The packing options (identical to those used in operation at Toulouse) are the following:

	Bits number for grid points values packing	Bits number for spectral coefficients packing	Non-packed sub-truncation
Aladin T149	16	18	20
Arpege TL358	16	16	35

For the type 3 encoding, two methods have been tested: firstly, the default second order packing options (APAC1, GEXTE, BOUST and DIFFE(-1), see paragraph C) and secondly, APAC1 (best method between row by row and no compression).

On the following tables, one can evaluate the second order packing impact:

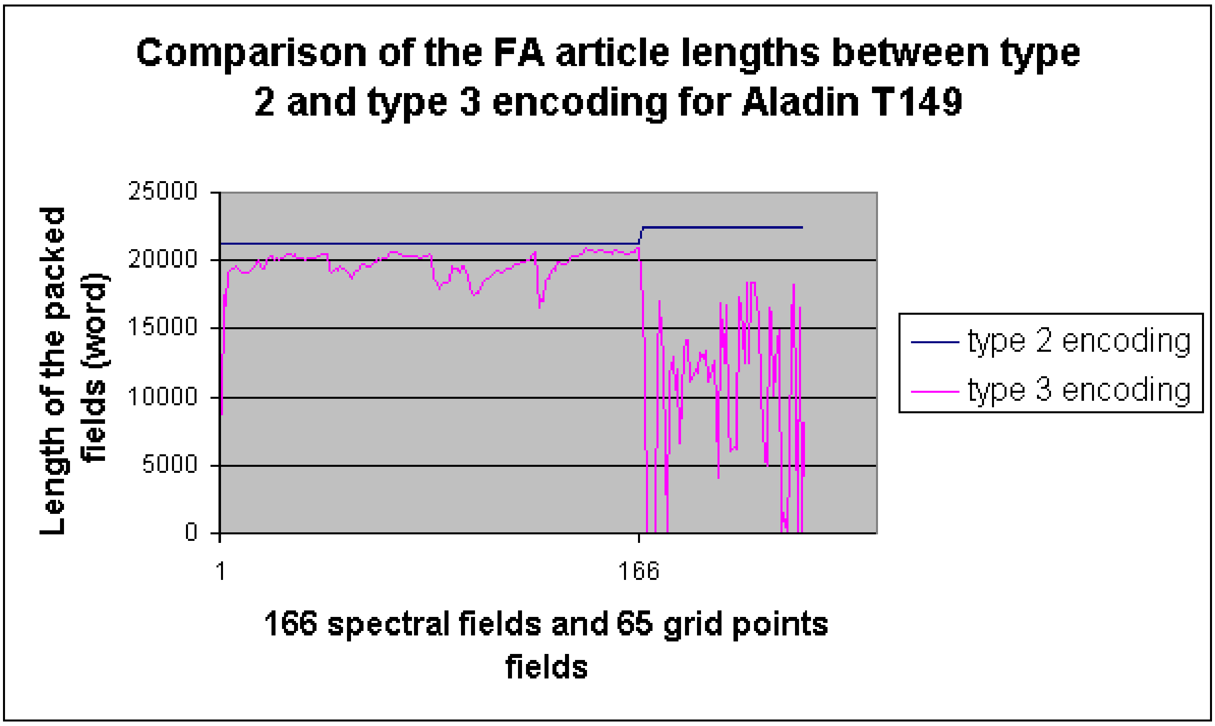
for ALADIN, the default second order packing increases the CPU time by a factor of 4.3 (7 to 30 s), decreases the memory need by 42% and generates a file whose size is 21% smaller. With a more basic method (APAC1), the CPU cost is weak (8s instead of 7s for the type 2 encoding) and the file size decreases even so by 10 %.

ALADIN T149			
type of encoding	**2**	**3** **default options**	**3** **APAC1**
Total user CPU time (s)	7	30	8
User vector CPU time (s)	2	14	1
System CPU time (s)	7	8	7
Memory (MB)	384	224	224
File size (MB)	38.1	30.2	34.5

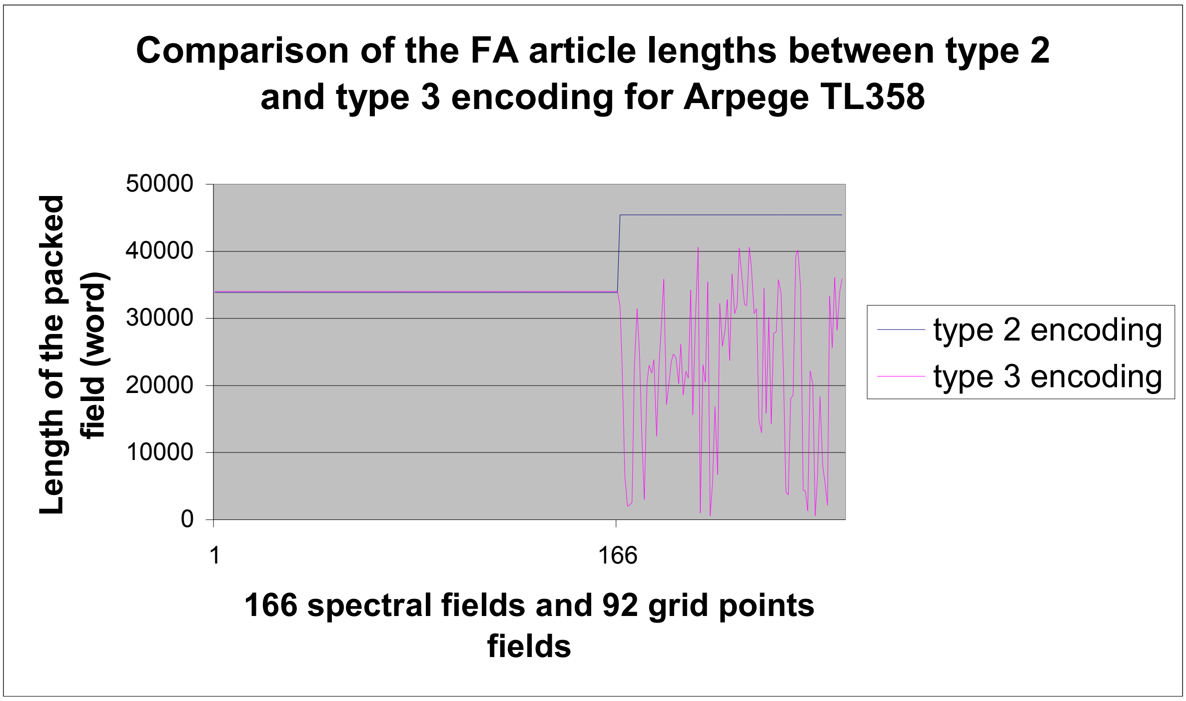
for ARPEGE, the default second order packing increases the CPU time by a factor of 2.8 (12 to 33 s), decreases the memory need by 42% and generates a file whose size is 22% smaller. With the APAC1 method, the CPU cost is, once again, negligible but the file size does not go down greatly: only 5%.

ARPEGE T358			
type of encoding	**2**	**3** **default options**	**3** **APAC1**
Total user CPU time (s)	12	33	13
User vector CPU time (s)	1	12	1
System CPU time (s)	15	14	15
Memory (MB)	384	224	224
File size (MB)	74.9	58.7	71.2

To detail the behaviour of the second order packing (with the defaults options), one can see its work on each field of the two files. The first figure shows the length of each field (spectral ones and then grid points ones) for the ALADIN FA file. In this case, the second order packing is also applied to the spectral coefficients but the gain is weaker than with grid points values (the point to point redundancy is actually less important).



A similar figure is proposed for the ARPEGE fields. No second order packing is then applied to the spectral coefficients and the corresponding articles are a little bit larger than with the type 2 encoding, due to the more documented GRIB sections (which allow the GRIB to be decoded independently from the FA software).



Finally, the precision of the encoding has been compared for the type 2 and 3 encodings. Except for the ALADIN spectral coefficients which lose less precision, all other fields seem to be a little less accurate with the type 3 encoding. It is well explained by the better use of the bits done with the type 2 encoding, despite the decimal factor optimization in the type 3 encoding. Anyway, the overall impact on the quality of the fields have to be evaluated with an e-suite and a comparison based on meteorological criteria instead of statistical ones.

5. PUBLICATIONS

5.1. Bénard P., R. Laprise, J. Vivoda & P. Smolíková: Stability of Leapfrog Constant-Coefficients Semi-Implicit Schemes for the Fully Elastic System of Euler Equations: Flat-Terrain Case. *Monthly Weather Review:* Vol. 132, No. 5, pp. 1306–1318. http://www.ametsoc.org

ABSTRACT

The stability of semi-implicit schemes for the hydrostatic primitive equations system has been studied extensively over the past 20 yr, since this temporal scheme and this system represented a standard for NWP. However, with the increase of computational power, the relaxation of the hydrostatic approximation through the use of nonhydrostatic fully elastic systems is now emerging for future NWP as an attractive solution valid at any scale. In this context, several models employing the so-called Euler equations together with a constant- coefficients semi-implicit time discretization have already been developed, but no solid justification for the suitability of this algorithmic combination has been presented so far, especially from the point of view of robustness.

The aim of this paper is to investigate the response of this system/scheme in terms of stability in presence of explicitly treated residual terms, as it inevitably occurs in the reality of NWP. This study is restricted to the impact of thermal and baric residual terms (metric residual terms linked to the orography are not considered here). It is shown that, conversely to what occurs with hydrostatic primitive equations, the choice of the prognostic variables used to solve the system in time is of primary importance for the robustness with Euler equations. For an optimal choice of prognostic variables, unconditionally stable schemes can be obtained (with respect to the length of the time step), but only for a smaller range of reference states than in the case of hydrostatic primitive equations. This study also indicates that (i) vertical coordinates based on geometrical height and on mass behave similarly in terms of stability for the problems examined here, and (ii) hybrid coordinates induce an intrinsic instability, the practical importance of which is, however, not completely elucidated in the theoretical context of this paper.

5.2. Termonia Piet: Monitoring the Coupling-Update Frequency of a Limited-Area Model by Means of a Recursive Digital Filter. *Monthly Weather Review:* Vol. 132, No. 8, pp. 2130–2141. http://www.ametsoc.org

ABSTRACT

In operational applications lateral-boundary coupling data are provided to one-way nested limited-area models with time intervals of more than an order of magnitude larger than the time step of the coupled model. In practice, these fixed coupling-update frequencies are established by common-sense guesswork and by technical restrictions rather than by rigorous methods. As a result, situation-dependent failures are never completely excluded when coupling data enter the domain more rapidly than can be sampled by the a priori fixed frequency. To avoid misinterpreting such failures, the data transfer between the coupling and the coupled model should be monitored.

The present paper approaches this as a problem of undersampling. It investigates how the coupling-update frequency can be monitored by using a digital recursive filter in the coupling model. A response function for such a filter is derived. Its implementation in a NWP model is discussed and some extensive tests are presented. A possible application is discussed in which this monitoring is used for assessing the data transfer to the coupled model and additionally for adapting the coupling updates to the actual meteorological content of the coupling-model output.

5.3. Bénard P.: On the Use of a Wider Class of Linear Systems for the Design of Constant-Coefficients Semi-Implicit Time Schemes in NWP. *Monthly Weather Review:* Vol. 132, No. 5, pp. 1319–1324. http://www.ametsoc.org

ABSTRACT

The linearisation of the meteorological equations around a specified reference state, usually applied in NWP to define the linear system of constant-coefficients semi-implicit schemes, is outlined as an unnecessarily restrictive approach that may be detrimental in terms of stability. It is shown theoretically that an increased robustness can sometimes be obtained by choosing the reference linear system in a wider set of possibilities. The potential benefits of this new approach are illustrated in two simple examples. The advantage in robustness is not obtained at the price of an increased error or complexity.

5.4. Sadiki W. and C. Fischer: A posteriori validation applied to the 3D-VAR ARPEGE and ALADIN data assimilations system. Tellus 57A pp.21-34.

http://www.blackwellpublishing.com/

ABSTRACT

In this paper we present results from the application of a posteriori diagnostics on existing data assimilation systems. The systems of interest are the global data assimilation Arpège 3D-VAR of Météo-France, and the limited-area 3D-VAR analysis of

ALADIN. First, we discuss how the diagnostics can be ported from theory to practical applications, using aggregates of analysis information over time. We then compare the behaviour of the diagnostics in the two different data assimilation systems, with a focus on the properties of the background and observational error variances. Secondly, the a posteriori validation is used for the off-line tuning of two scalar error parameters in the ALADIN 3D-VAR. The tuning provides error variances that better fit the statistics of the innovation vector, without loss of quality in the analyses. Finally, the link of this approach with ensemble-based techniques is made. Especially, we propose to couple the a posteriori diagnostics directly with the usual output of ensemble samples, which could be done at no extra cost. If the results are then used to tune error parameters, then an on-line adaptive assimilation system, based on a posteriori considerations, is obtained.

5.5. Stefanescu S. and L. Berre: Ensemble dispersion spectra and the estimation of error statistics for a limited area model analysis. WGNE.

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