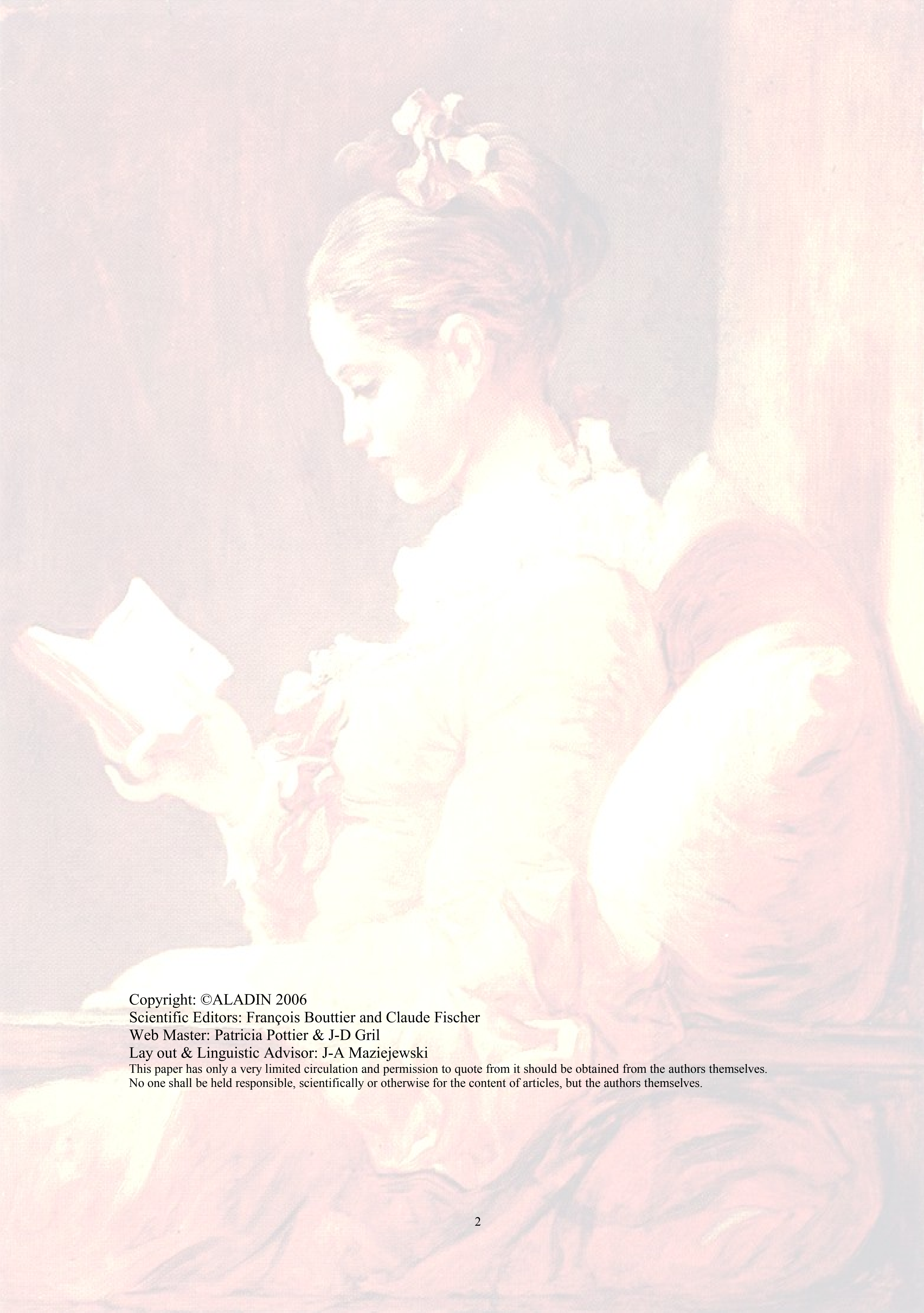
ALADIN

NEWSLETTER n°30

January-July 2006



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Web Master: Patricia Pottier & J-D Gril
Lay out & Linguistic Advisor: J-A Maziejewski

CONTENT

1. EDITORIAL

Foreword: the ALADIN consortium in a changing world

The solid foundations of the ALADIN cooperation are long-established working habits at the scientific, technical and managerial levels. One could even call them traditions. In the previous Newsletter, Claude Fischer excellently reminded us of the important "golden rules" for cooperation that matter at the end of the day. Our somewhat latin penchant for chaotic heated discussions is quite remote from the anglo-saxon and Nordic practices of diplomatic and courteous debates. Whether this is good or bad can only be judged in terms of the implications for our final objective: to deliver valuable weather products to our users.

It is easy to plan the future as a simple extrapolation of what we already do: as they say in football, "do not change a winning team". Yet, as dinosaurs could have taught us, when the environment changes it can be easier to adapt than to resist the change. What does it mean for ALADIN R&D ? Let us just note a few current facts:

- most ALADIN countries are, or will probably soon be, ECMWF member states or associated states. ECMWF's data policy is getting more and more open towards others. This changes quite a lot the options of the ALADIN institutes in terms of available real-time NWP plots and large-scale coupling fields. These issues have technical aspects (e.g. budget for fast telecommunication lines vs local computing resources) which require local managerial decisions.
- HIRLAM is getting more and more involved in adapting the IFS/ARPEGE software for their own needs. This will bring us interesting colleagues to work with, new options in the ALADIN software, but also more difficulty in the choices of options (what if HIRLAM makes better models than ours ?), and more complex software management. Some recent HIRLAM physics are being plugged into the ALADIN software framework this year, which in turn will bring exciting possibilities, but also the danger of scattering our efforts.
- the EU offers great opportunities for expanding our NWP staff, by bringing extra financing. The downside is, a substantial effort is needed to respond to the EU calls, which requires initiative from the ALADIN institutes. Preparing and coordinating a EU contract is a big investment, with usually big rewards. In most cases, EU money will only be provided as a complement to the local effort on the topic of the contracts, i.e. "no pain, no gain".
- there are ongoing talks about a future "Vision for Europe in NWP" among European NWP managers. The discussions are very interesting and may have significant consequences for consortia such as ALADIN. The aim is to increase work efficiency in Europe by a better distribution of tasks, but it is not yet clear who will do what in this future "Europe of NWP".

So let us keep in mind the longer-term perspective in our daily work. ALADIN is still improving and showing good health in the development of the model, in data assimilation, in the work on the technical aspects. The ALARO project is showing steady progress and will certainly be an important part of our modelling future. AROME is nearing completion and it will soon be time to think about our plans for the post-AROME years. It is important to set ourselves goals that are ambitious, but yet realistic, given our limited resources.

Last but not least, let us warmly welcome some newcomers to the ALADIN "galaxy": Turkey and Macedonia, who will progressively get involved into our activities, and the HIRLAMists who have started contributing to the common software.

F. Bouttier, Météo-France

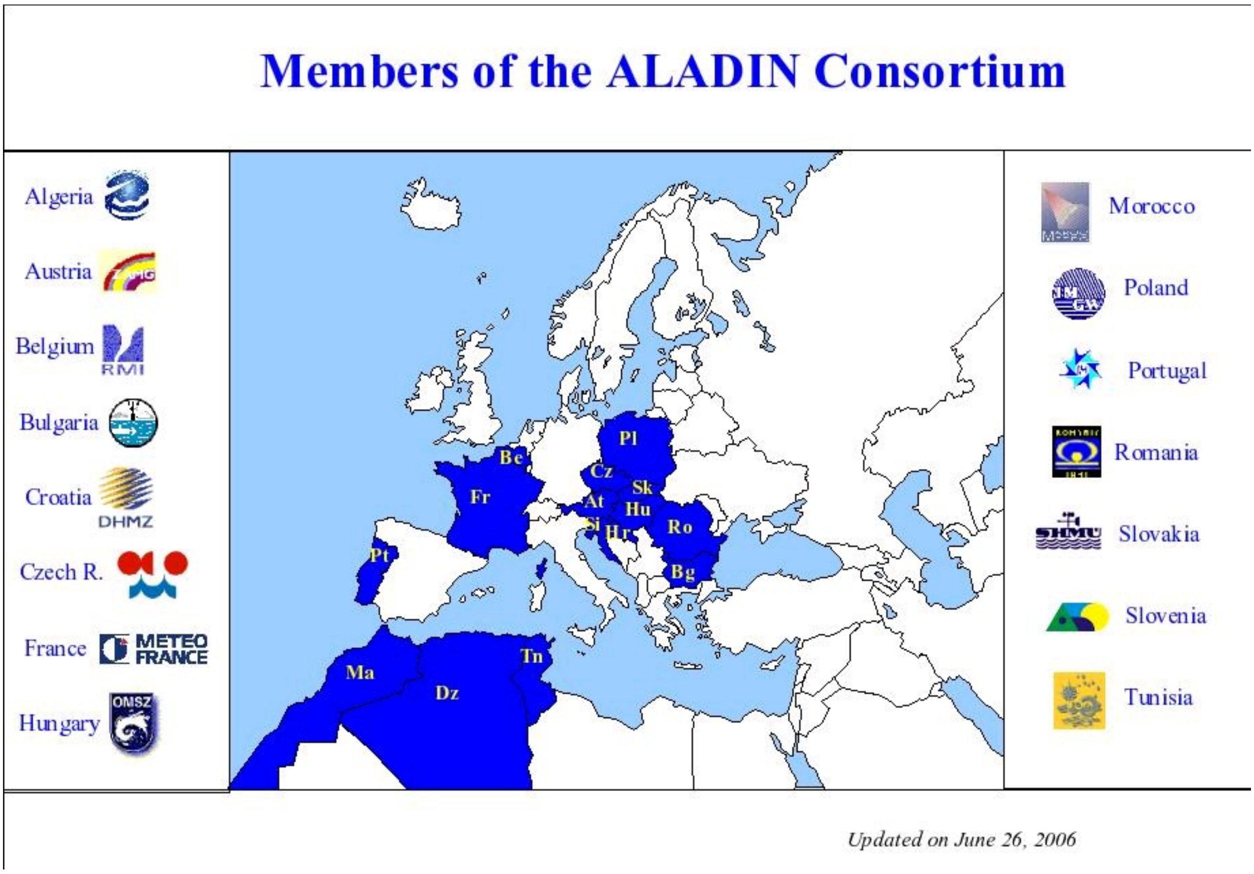
1.1. ALADIN New Governance.

The new organisation is defined by the 3rd MoU and was specified by the General Assemblies:

- the purposes and objectives agreed by the Parties for ALADIN cooperation
- the condition of membership, the rights and obligations of the members
- the governance and the management : General Assembly (with its Chairperson and Vice-Chairperson), Program Manager, Policy Advisory Committee, ALADIN Local Teams Managers, Program Team, Committee for Scientific and System/maintenance Issues, System/maintenance and Scientific Coordinators, Support Team
- the co-operations
- the resources : manpower and ALADIN Annual Budget
- the information exchange within the Members and towards users
- ownership and property rights
- the conditions for access to and implementation to the ALADIN system
- ownership, availability and commercialisation of ALADIN products

Please consult the complete MoU document for details.

For a quick view, please consult the Members map, the matrix schematically describing the bodies/entities established by the new MoU, the Governance Map (AG, PAC, PM, CSSI, etc ... : who does what ?), the PAC's Terms of reference and a summary of the consortium resources



ALADIN Consortium

General Assembly (GA)
supreme governing body of the ALADIN Consortium
Chairperson : Henri Malcorps (Be)
Vice-Chairperson : Jozef Roskar (Si)
Director of each of the Members (Dz, At, Be, Bg, Hr, Cz, Fr, Hu, Ma, Pl, Pt, Ro, Sk, Si, Tn)

Program Manager (PM)
main executive officer of the ALADIN Consortium
Jean-François Geleyn (Fr)

Task force to draft the stategic plan
F. Bouttier (Fr) , R. Brozkova (Cz), E. Legrand (Fr) , A. Mokssit (Mo), C. Soci (Ro), P. Termonia (Be), M. Zagar (Si)

Policy Advisory Committee (PAC)
advisory body
Chairperson : Fritz Neuwirth (At)
Vice-Chairperson : Cornel Soci (R
2 MF Members :
- Eric Brun (Fr)
- Emmanuel Legrand (Fr)
2 RC-LACE Members :
- Gabor Radnoti (Hu)
- Radim Tolasz (Cz)
2 Other Members :
- Abdallah Mokssit (Ma)
- Maria Monteiro (Pt)

Programme Team

Local Team Managers
Dz : Bachir Hamadache
At: Thomas Haiden
Be : Josette Vanderborght
Bg : Valery Spiridonov
Hr : Alica Bajic
Cz : Martin Janousek
Fr : Claude Fischer
Hu : Andras Horanyi
Ma : Hassan Haddouch
Pl : Marek Jerczynski
Pt : Maria Monteiro
Ro : Cornel Soci
Sk : Martin Benko
Si : Neva Pristov
Tn : Abdelwaheb Nmiri

Project Team
all manpower committed by Members and acceding Members

Committee for Scientific and System/maintenance Issues (CSSI)
Chairperson : Andras Horanyi (Hu)

Predictability and Scientific coordination with HIRLAM : Andras Horanyi
Scientific coordination with LACE: Mark Zagar
Scientific coordination with non-LACE/non-MF Partners : Doina Banciu
Data assimilation : Claude Fischer
Numerical efficiency issues : Martina Tudor
Transversal support to distributed operations : Maria Derkova
Maintenance : Ryad El Khatib
Verification and monitoring : ????
Interfacing issues : Bart Catry
Towards AROME : Gwenaelle Hello
SURFEX : Piet Termonia

Support Team
Consortium level coordination :
Jean-François Geleyn
Consortium level cooperation support (LACE) :
Dijana Klaric
Consortium level cooperation support (MF) :
Claude Fischer
Documentation officer :
????
Information officer :
Maria Derkova
Administration and PM assistance :
Patricia Pottier
Secretarial support :
Jean Maziejewski

CNRM/GMAP, Patricia Pottier on 11/04/2006

ALADIN Consortium Resources

Manpower
committed on an annual basis by the Members and the acceding Members
to continue and develop the activities of the ALADIN Consortium
in the field of High Resolution Short Range Weather Forecast

ALADIN Annual Budget
enveloppe of ressources required to support consortium-level overhead activities that cannot be covered by the manpower contributions of the Members and acceding Members

- flat rate financial contribution applicable to all Members to cover absolute minimum necessary administrative or cooperation overheads and mobility expenditure :
  the amount for 2006 : 6KEuro per year and per country
- additional voluntary financial contributions of Members or grouping of Members
- « in-kind » contributions corresponding to consortium-level tasks

CNRM/GMAP, Patricia Pottier, on 11/04/2006

1.2. EVENTS

1.2.1. SOFIA

A big thanks to our Bulgarian colleagues who have successfully organized the first ever ALADIN/HIRLAM meeting. The weather was quite fine, the food and the wine were excellent.

The photo

The main outcome and decisions from the final discussion the 16th ALADIN workshop 15-19/05/2006, Sofia, Bulgaria

Notes by Maria Derkova

During the final discussion the short reports of the working groups were given, the main decisions made during the workshop were summarized, and the date/venue and scope of the next common ALADIN/HIRLAM workshop were discussed.

WG on modelling

A report was given by C. Fischer (available on ALADIN web page). The disagreements between people working on ALARO and AROME were discussed again (lack of mutual discussions, information spread and documentation, possibly leading to duplicated work), therefore probably no convergence can be expected between AROME and ALARO for next few years.

WG on data assimilation and predictability

A report was given by F. Bouttier (available on ALADIN web page). Additional question on the importance of the initialization was asked. In GMAP a newcomer will investigate moist initialization, there is ongoing work in HIRLAM as well.

Main outcomes/decisions of the workshop

- The meeting on simplified physics for "synoptic" scale data assimilation shall be organized along the ECMWF seminar, September 2006, with the participation of ECMWF experts (M. Janiskova), HIRLAM (?) and Meteo-France/GMAP (C. Loo, F. Bouyssel).
- The meeting on the strategic issues for "mesoscale" data assimilation shall be organized after the EWGLAM/SRNWP meeting, 13/10/2006 Zurich, with possible participation of N. Gustafsson, X. Yang, S. Tijm, J. Onvlee, M. Lindskog, J.-F. Geleyn, C. Fischer, F. Bouttier, A. Horanyi.

- 3DVAR/ODB practical training is organized in Budapest, 6-10/06/2006. The lecturers will come from ECMWF (S. Saarinen, D. Vasiljevic), MF (L. Auger) and HMS. Primarily organized for HIRLAM people, but limited number of ALADIN participants are also welcome.

- Technical exercise on the observation operators inter-comparison was delayed. From ALADIN side a basic document listing existing obs-operators and ALADIN contact points exist, now their HIRLAM counterparts are to be identified (till September), the real work shall start before the end of the year.

- It was suggested to build an ALADIN 3DVAR (or varpack) demonstration system to attract more ALADIN Partners to start data assimilation activities (may be to convince relevant bosses easier).

The technical details shall be discussed between MF and HMS

- HIRLAM organizes a mini-workshop to build HIRLAM EPS system/environment (scripts, verification & visualization tools), 12-16/06/2006 Norrköping. ALADIN participants are also welcome.

- GLAMEPS (Grand Limited Area EPS) proposal was presented. Interested participants (apart from the ones already applied: Sweden, the Netherlands, Spain, Norway, Austria and Hungary) shall contact N. Gustafsson ASAP. The full project proposal (which will be also promoted in the EWGLAM/SRNWP meeting) of GLAMEPS will be compiled until autumn based on the inputs of the participating institutes. A coordination meeting will be organized in November (13-14) 2006 in Vienna.

- For surface issues data assimilation, modelling and physics should be treated together with the involvement of all the experts of HIRLAM and ALADIN (currently more parallel than common work is ongoing). The knowledge on the work in each Consortia is missing, therefore a short comparative documents/status reports shall be produced to start with (responsible persons: Eric Martin, Stefan Gollvik, Sander Tijm).

- Workshop on surface issues (and SURFEX) is proposed in Toulouse, 11-13/12/2006 (subject to check the dates of HIRLAM Council). Possible participants: F. Bouyssel, P. Termonia, M. Tudor, E. Martin, G. Hello, L. Kraljevic, N. Gustafsson, S. Gollvik, S. Tijm.

- The call for inquiry about local surface physiographic data was made (during the talk of Eric Martin). The contact point for collecting the information is Stephanie Faroux (Meteo-France).

- For validations, there is ongoing work of the "Oslo group" (S. Tijm, G. Hello, M. Derkova) on 3D cases: final selection of the eight real cases will be pursued together with the collection of the corresponding data; agreement should be reached regarding the minimum set of diagnostics; inter-comparison of model results. Similar effort will start for 1D tests (S. Malardel, P. Siebesma).

- EURRA (EURopean ReAnalysis) project was advertised. F. Bouttier is the contact point for interested ALADIN Partners (2D surface issues) and Jeanette Onvlee for the HIRLAM countries (3D issues). The basic documents shall be widely distributed, and ECMWF shall be contacted for information on current status (J. Onvlee). Until EEA+ECMWF prepares further specifications (within 1 year), our proposals are to be ready by then. A EURRA coordination meeting is scheduled for 27-28/09/2006 in Zagreb, just before the LSC meeting.

- Outcome of the NWP vision meetings states that stronger SRNWP is needed. A common ALADIN-HIRLAM proposal should be prepared for the EWGLAM/SRNWP meetings (Zurich, October, 2006). The harmonization of the three existing documents/reactions (HIRLAM, ALADIN, MF) is to be done. It is recommended that SRNWP follows practices of other EUMETNET programs, i.e. the subprojects in interesting areas (for instance GLAMEPS, verification and validation) shall be identified. Also, SRNWP is not much visible/involved in other EUMETNET programs. Other recommendation is that at EUMETNET sessions directors of both Consortia speak "with single voice". The discussions at EWGLAM/SRNWP should be prepared from our side: M. Alestalo, M. Derkova, C. Fischer, J.-F. Geleyn, D. Klaric, J. Onvlee, P. Unden, A. Horanyi are in charge to prepare the discussion paper for the HIRLAM and ALADIN communities. The share of the redaction work is not yet clear, but the document should be ready and approved by the ALADIN-HIRLAM scientists until the end of summer. Additionally Jean Quiby and the local organizers should be contacted for the organisational (practical) matters.

- For coordination of ALADIN operational switches, more discipline and better communication (including feedbacks) is required. The availability of LBC files from ARPEGE e-suite for all Partners would be beneficial (it is largely sufficient to store them on DELAGE). More communication and documentation concerning the namelists is needed as well. Possible cross representations on ALADIN and HIRLAM system mailing lists.
- Possibility of common standard file formats for post-processed fields will be investigated (R. El Khatib, X. Yang).
- HIRLAM decided to allow an access to restricted part of HIRLAM web to all ALADIN Partners, based on their internet domain recognition.
- The importance of the developments around the Vertical Finite Element scheme was recognised, Jozef Vivoda will have a stay in Denmark to speed-up the developments and cooperation.
- Special project at ECMWF for LBC data: S. Kertesz will provide technical description (user guide); Partners are requested to send proposals for scientific plans to C. Fischer (mid-June).
- LTM meeting is scheduled for October 2006 in Bratislava (currently fixed for 23-24/10).

Next ALADIN workshop & HIRLAM All Staff meeting.

To be organized by HIRLAM country. The existing rotating principle suggests Norway. They have to search for place with affordable price, which means the date during the off-season, possibly mid-April or mid-May, remembering the public holidays constraints. Concerning the format, it was proposed to organize sessions more "joint", i.e. group talks according to topics and not by Consortia.

The big common overview session shall close the meetings. The discussions should be held in smaller groups of people, which would encourage more contributions to discussions.

1.2.2. Extra-Ordinary General Assembly of ALADIN Partners. Brussels, 23-24 February 2006

La picture

See: http://www.cnrm.meteo.fr/aladin/meetings/GA20060223/ga.html/

1.2.3. 3DVAR/ODB practical training 6-10 June 2006 Budapest, Hungary.

1.2.4. 28th EWGLAM + 13th SRNWP Meetings, 9th - 12th of October 2006, Zurich.

1.3. ANNOUNCEMENTS

Dear colleagues!

As announced during the Sofia workshop, ZAMG will organize the ALADIN-HIRLAM Workshop on LAMEPS in Vienna, 13-14 Nov. 2006.

- This ALADIN-HIRLAM Workshop on LAMEPS will be a forum for scientific discussion of topics related to LAMEPS. Presentations from all the scientists of ALADIN/HIRLAM are invited.

Participants could send the title of their presentation to:

wang@zamg.ac.at

until 30 Sept. 2006

Best regards,

Other workshop & meeting:

- PAC meeting, 21-22 September, 2006, Lisbonne, Portugal
- LTM meeting, 23-24 October 2006, Bratislava, Slovak Republic.
- General Assembly, November 9-10, 2006, Budapest
- SNRWP-NT mini-workshop on Numerical Techniques, Zagreb, beginning of December 2006
- Surface/Surfex training course 11-13 December 2006 Toulouse, France

1.4. GUEST COLUMN.

1.4.1. Plans and status of HIRLAM-A. Jeanette Onvlee (KNMI)

In January 2006, the HIRLAM cooperation entered a new phase of its existence, with the official start of HIRLAM-A and the entering in force of the cooperation agreement with ALADIN.

The new HIRLAM management group has spent the first months in formulating the scientific and work plans for HIRLAM-A. Our common plans with ALADIN have been updated just prior to the All Staff Meeting/Workshop. Unfortunately, the management group itself has been incomplete this first half year. After Dale Barker's decision not to join HIRLAM, it was decided to search for a new project leader Dynamics and predictability. This process is still ongoing.

Summarizing, the main targets of the HIRLAM-A programme, as they have been formulated in the scientific plan, are as follows. The most important deliverable of HIRLAM-A is an operational mesoscale analysis and forecast system, at a target horizontal resolution of 2km. A second goal is the continued development and maintenance of the synoptic HIRLAM system, for as long as necessary. The huge past efforts to develop a 4D-VAR system are to bear fruit in HIRLAM-A, through the operational implementation of 4D-VAR as the default analysis scheme on synoptic scales. The third major deliverable is the development of a reliable short-range ensemble forecasting system. A more general goal is to enhance the quality assurance, reliability and user-friendliness of the Reference system. We aim to intensify contacts with (end) users, in order to ensure a proper feedback of user experiences and needs into the programme. And finally, we have been tasked to explore the potential of operational cooperation between HIRLAM institutes. This is new, because until now HIRLAM has always been quite explicitly regarded as a research cooperation only.

A quick review of where we stand after nearly half a year of HIRLAM-A activities:

In the field of **mesoscale modelling**, a growing number of HIRLAM institutes is now gaining experience in running 2-4 km-scale models on a (semi-)operational basis. Denmark is using the HIRALD system, while AROME has been installed at SMHI and FMI, and will presumably be installed later this year at INM and KNMI. Met.no has been running the UM at 4km for years now, and is now also implementing (hydrostatic) HIRLAM at this resolution.

This spring, HIRLAM staff have had their first experience with phasing code into the IFS system. It is expected that at the end of June, a recoded sub-package of the HIRLAM physics will be phased into IFS. This HIRLAM physics will serve as a baseline, against which to test mesoscale physics developments. The ALADIN dynamics and 3D-VAR/FGAT, and the AROME physics and SURFEX surface scheme will form the base for future mesoscale developments. Useful concepts from the present HIRLAM system, from e.g. 4D-VAR, the physics and surface modelling, will be ported to this code. A mesoscale code repository, including a standard system setup, will be installed at ECMWF later this year.

The main initial contribution from HIRLAM to the mesoscale physics package will be the development of a coupled eddy diffusivity – mass flux convection scheme. In addition, several parametrizations have been developed on synoptic scales which presumably will also be useful in the mesoscale model, such as the mean and sub-grid scale orography (MSO/SSO) scheme and the surface slope additions to the radiation scheme. In the field of dynamics, HIRLAM will contribute to the ALADIN dynamics in a number of ways: the implementation of a Mercator map factor, the development of a vertical finite element (VFE) method, and an improved treatment of pmsl near steep orography. Of these, the work on VFE has undergone some delays, but it will be attempted to repair this later this year. In addition, the research on transparent lateral boundary conditions will be continued and intensified.

Surface modelling and data assimilation become of increasing importance at higher resolutions. Mesoscale surface developments will be based on the externalized SURFEX scheme. Until this has been implemented, new developments in both the surface modelling and data assimilation will first take place and be tested on synoptic scales, and then ported to SURFEX. Areas in which HIRLAM is likely to contribute, are the improved snow and forest descriptions by Stefan Gollvik, the assimilation of OSI-SAF sea surface products, and a lake model component, the development of which has recently started. Present surface assimilation schemes are very simple; it is intended to test the impact of more sophisticated schemes, as advocated in e.g. the recommendations from the ELDAS project.

For mesoscale data assimilation, 2006 is a year of learning and preparation. A training week on the ALADIN 3D-VAR system has been held in Budapest last December, and another one will be held in June. Joint work on the assimilation of radar reflectivities has started. The impact of other relevant types of observation, such as satellite radiances and profiles, GPS and radar winds, will first be tested on synoptic scales, and after that on mesoscales. A plan has been proposed to achieve convergence between the ALADIN and HIRLAM formulation of observation operators. Both sides will prepare a description of the treatment of observation operators in their own systems, after which a common formulation will be chosen. This will take place in the second half of 2006. A planning meeting, to determine the strategy on mesoscale data assimilation for the next year or two, will be held in the autumn.

A mesoscale verification working group was set up as an outcome of the Oslo workshop (December 2005). This group is selecting a set of relevant cases of important weather situations, which can be used to validate the performance of (new versions of) mesoscale models against.

For the **synoptic model**, 4D-VAR has been a major area of attention. A breakthrough has been achieved with the introduction of a statistical balance and the detection of a bug; 4D-VAR now appears to perform consistently better than 3D-VAR. Extensive testing and tuning of the 4D-VAR system will be carried out through the summer, in preparation of its implementation in the Reference system. After that, the impact of using more sophisticated (moist) physics in the TL/AD model will be tested. In view of the limited number of people with experience with 4D-VAR, it was decided to train more staff in using this system. A training week for 4D-VAR developers (including participants from ALADIN) was held in April, another training week for scientists working on assimilation in general will be organized at the end of the year.

The number of remote sensing data to be assimilated in the model will increase significantly this year. The assimilation of AMSU-A over sea has been introduced in Reference version 7.0. This will be followed by the inclusion of scatterometer and AMV winds, SYNOP T2m and U10 observations, and OSI SAF sea ice and SST in version 7.1 next autumn. Research on the assimilation of AMSU-B, AMSU-A over land, (slant) GPS, and radar winds is ongoing. Studies on the impact of high-resolution (clear and cloudy radiances, winds (MODIS) and profiles (IASI) have recently started.

As to physics parametrizations on the synoptic scale, the aim is to finish far advanced developments, and then concentrate on solving existing problems, and shift resources to the mesoscale. A moist version of the CBR turbulence has been developed and tuned together with the STRACO convection scheme. It is attempted to adapt the scheme to improve the description of the stable boundary layer. A new spectral turbulence formulation (Sukoriansky et al.) is being tested to see how well it is able to correct for model deficiencies under stable circumstances; possibly this new approach can be used as well to develop a 3D-turbulence scheme for the mesoscale model. A new mean surface and sub-grid surface orography (MSO/SSO) scheme has been prepared for introduction into the Reference system, as well as sloping surface adjustments to the radiation scheme. An improved description of snow and forest has been introduced in ISBA; this will be tested on synoptic scales first. The same will be done for a new lake model component, which is being developed in close cooperation with St. Petersburg University (RSHU).

In the area of **predictability**, several HIRLAM institutes have been active in the past, but these efforts were largely steered at a national level, and not under the control of the programme. Short-range EPS systems are now operational at met.no and INM, and research on LAM EPS systems has also been done at SMHI, DMI and KNMI. The intention is now to integrate these existing and new efforts into a HIRLAM EPS system. In a planning workshop in March, in which scientists from ALADIN and ECMWF participated, it was decided to build a HIRLAM-ALADIN grand ensemble of limited area EPS systems. This grand ensemble (GLAMEPS) is intended to be produced in a distributed manner, on the same area and grid, and using a variety of ensemble generation techniques. Special project resources have been requested from ECMWF to allow the construction of a laboratory environment for GLAMEPS there. In this laboratory, a variety of EPS generation techniques will be tested, and the ensemble performance can be optimized by means of e.g. Bayesian Model averaging techniques. In a strategic context, the GLAMEPS system can be viewed as a European contribution to the THORPEX/TIGGE program.

The HIRLAM Reference System was frozen at version 6.4.3 at the end of HIRLAM-6. The new project leader for System and Applications, Xiaohua Yang, then formed a system expert group. This group has been very active not only in setting up the first Reference System release of HIRLAM-A, version 7.0, but also in upgrading the revision procedures and tools, initiating code and script overhaul activities and creating improved internal communication tools, such as the new mailing lists and the wiki pages on Hexnet. These communication tools may be of interest to ALADIN partners as well. The system group has also provided support to developers and local system managers in the case of (operational) problems.

The validation and quality control of the FMI RCR run was designated to be a core group task. Kalle Eerola has spent much effort in the analysis and identification of problems in the RCR runs. This has led to the detection of problems with the portability and reproducibility of the code on different hardware platforms. A new release of the Reference System, including a resolution increase, 4D-VAR, assimilation of various new types of observation, a moist turbulence scheme, the new snow and forest scheme and an extended postprocessing package, is expected in the autumn.

The meeting in Sofia has been an opportunity for the ALADIN Committee for Scientific and Strategic Issues and the HIRLAM management group to re-align, update and refine their common plans. The challenge for us now will be to manage a transition from parallel to truly joint HIRLAM-ALADIN research and development activities. This will of course take time to grow naturally. But the start has been promising, at least.

1.5. GOSSIP

Nothing really new save for my long lasting divorce which took place after 9158 days of matrimonial hardship, except for a few disenthrallments in threadbare campings.

By Boy Kusek

2. OPERATIONS

2.1. CYCLES

New interim and full cycles have been prepared in Toulouse:

* CY31: Common cycle with ECMWF , includes some further flexibility in the Jb code (to prepare for GEMS assimilation in the IFS), SLHD finalization and code cleaning in the dynamics, pre-Alaro0 settings.

* CY31T0: a quick technical update cycle

* CY31T1: includes preparation and updates for the MF operational plans, a first inclusion of the condensation+convection+radiation schemes from the Hirlam physics, a modified smoothing for some spectral fields in post-processing (see relevant article by Françoise Taillefer in this newsletter)

* CY31T2: a late interim cycle to gather local developments (radar tables and dataflow, porting aspects for NEC) and the first Alaro0 set of switches under APLPAR. Modifications in the Aladin geometry package could unfortunately not enter, because they caused bigger changes (yet irrelevant) in spectral norms. These will probably require a CY32T0 early 2007.

* next to come in autumn 2006: CY32 next common cycle with ECMWF, including from the IFS a revisited surface field dataflow, finalization of Jb code for GEMS, optimized B-level distribution for Gaussian grids.

2.2. Transversal informations

In June 2006, Météo-France changed the production time of its 00UTC ARPEGE/ALADIN-France forecast. This was forced by the French forecaster's department in order to make room on the supercomputer for an extra 'supershort cutoff' 00UTC ARPEGE/ALADIN-France forecast, called PACOURT. This new PACOURT run uses nearly the same observations as the nominal 00UTC (most 00UTC radiosondes are assimilated), but it is available earlier, which is a good thing for some applications, but there are three side effects for the dissemination of the ALADIN coupling files:

- the 00UTC ARPEGE/ALADIN-France starts later than before, which means some delay in the ALADIN coupling files based on this run. The forecast runs faster than before, so the availability of the later forecaster ranges is almost unaffected.
- the PACOURT can be used to make earlier coupling files, but not beyond 54h forecast range, which is the limit of the PACOURT run.
- the Météo-France computing system is stretched to its limits in this new configuration, meaning that any changes to the computer configuration or the cost of the ARPEGE/ALADIN system may result in variations of the availability of the coupling files.

In practice, ALADIN partners have several solutions to cope with this new configuration:

1. either keep their coupling on the 00UTC run, and accept the corresponding change in the timing of coupling files;
2. or switch to the new PACOURT run, which is available much earlier than the 00UTC run with an equivalent meteorological quality; the catch being that a special procedure will be needed on forecast ranges beyond 54h;
3. or switch to the 18UTC run, which is available slightly earlier than PACOURT, with at least 72h forecast range, and stable availability times.

In Spring 2007, a new supercomputer will begin production in Météo-France, with probably new opportunities to fine-tune the coupling file production schedule. Although the computing power will be vastly increased, one shall keep in mind that the forecasts with the tightest production schedule (usually aimed at very short range forecasting) will remain very sensitive to small changes in the production system: speed and stability of the production are, by nature, contradicting requirements. It is interesting to note that ECMWF has similar concerns since it started its Early Delivery Production system: costly improvements to the NWP software cause variations of the availability times over the years.

Due to the complexity of the production system, the June 2006 scheduling change was foreseen very late, and Météo-France apologizes for the late notice to the ALADIN partners.

Changes occurred in the operational French suites, with an impact on coupling data production:

* January : switch to new clim files, ended in April for the last countries
* March : switch all Toulouse e927 namelists to explicit description of vertical levels, in order to be safe with respect to any modification
in the Arpège vertical discretization
* May : new r00 production hours, with a delay of about 20 mns in the provision of LBC data for the production short cut-off

2.3. Changes in the Operational Version of ARPEGE and ALADIN France.

This note reports on the validation of the e-suites for the ARPEGE and ALADIN-France models, including the modifications of the physics with a modified radiation scheme, an explicit microphysical scheme including 4 prognostic variables to represent the hydrometeors et some associated tuning of the parameterizations.

This e-suite also includes modifications of the assimilation scheme with some changes in the simplified physics and a displacement of its calling at the origin point. A specific treatment of DFI is applied to the microphysical variables. The variational quality control is activated. At least, this e-suite assimilates the AMSU-A and AMSU-B of the satellite NOAA18 together with satellite winds provided by METEOSAT 8 and the MODIS instruments of the satellites AQUA and TERRA above the poles.

The scores of this e-suite are in average positive for ARPEGE with improvements for the geopotential and wind fields over the large domains and over Europe. Some problems for the thermodynamical fields near the surface have been reported and this e-suite is neutral in quality for ALADIN-France. From a subjective point of view, we note that precipitation fields are smother in ALADIN-France and therefore more useful over and around the mountains. On the other hand, the « Arpegeades » (spurious numerical cyclogenesis at a too small scale) number with a warm heart increases in comparison with the operational version. This behaviour is partly related to weaknesses in the convection scheme, which occur mainly during the warm season and at the south of 40 ° North. Moreover, Atlantic cyclogeneses are better detected by this e-suite.

This e-suite has becomes the operational version on the 22nd of June 2006.

Next E-suite for summer 2006:

Arpège assimilation:

- GPS zenital delay from ground stations over Europe
- SSM/I over sea in clear sky conditions
- 20 AIRS channels
- extended use of wind profiler data
- randomized Sigma_B's of-the-day in the Arpège screening (introduces some flow-dependent features)
- leveling up of inner loop iterations in the two outer loops of 4D-VAR: 25 each

Arpège forecast model:

- none

Aladin assimilation:

- bator/lamflag/reduce performed in one go in the bator executable
- re-use of the new Sigma_B screening files (from Arpège)

Aladin forecast model:

- none

This E-suite version (CY30T1) has started on June 27th 2006.

It will be upgraded in late August by:

- SLHD in Arpège and Aladin-France
- switch to CY31T1, with a modified handling of blacklists

2.4. ALGERIA

2.5. AUSTRIA

2.6. BELGIUM

2.7. BULGARIA

2.8. CROATIA

Martina Tudor tudor»at»mail.dhz.hr and Stjepan Ivatek-Šahdan ivateks»at»mail.dhz.hr)

2.8.1. Summary

The operational suite on the old machine is only slightly modified and kept for backup. The new SGI machine is used for the operational 72 hour forecast since the first half of May 2006. The backup for the transfer of the LBC files is changed from RETIM to ecgate. The research on EPS, NH dynamics and SLHD in high resolution has continued. A version of Alaro0 is ported to Viking.

2.8.2. Operational suite

Status

ALADIN is operationally run twice a day, on both SGI's for 00 and 12 UTC. Coupling files are retrieved from ARPEGE (Meteo-France global model) via Internet and ecgate. Model resolution is 8 km for Croatian and 2 km for the high-resolution dynamical adaptation domains. The execution of the suite is controlled by the OpenPBS (Portable Batch System) as the queuing system on the old SGI and by PBS Pro on the new SGI.

Initialisation of ALADIN on Croatian domain is provided by Digital Filter Initialisation (DFI). Coupling frequency and frequency of output files is 3 hours. The forecast range is prolonged to 72 hours only on the new SGI, it is kept until 54 hours on the old one. The operational version of Aladin on the new SGI is AL29T1mxl while on the old SGI AL28T3 including some additional modifications linked with SLHD and physics parametrizations remains operational.

Visualisation of numerous meteorological fields from the new SGI is done on the archiving machine while the visualisation of the old suite remains done on a LINUX PC. Comparison of forecasts with data measured on SYNOP and automatic stations is done hourly for the last 5 runs giving an EPS-like picture through 5 days (Figure 2). The products are available on the Intranet & Internet. Internet address with some of the ALADIN products, like total precipitation and 10 m wind: http://prognoza.hr/aladin_prognoza_e.html .

The operational suite on the old SGI will be stopped as soon as all the users switch to the new one.

The new computer

SGI Altix LSB-3700 BX2 Server with 16x Intel Itanium2 1.6GHz/6MB,

32 GB standard system memory, 2x146 GB/10Krpm SCSI disk drive,

OS SUSE Linux Enterprise Server 9 for IPF with SGI Package,

Intel Fortran & C++ compilers, PBS Pro for LINUX,

Aladin code (including a version of Alaro) is ported. Better optimisation of code is still missing. Some problems were solved during compilations as accvimp and accvimpd should not be optimized with Intel compiler version 9.0. PALADIN, emoslib, gribeuse are installed too. Thanks a lot to Jure Jerman for help. Usage of gmkpack is postponed due to linking problems.

Operational model version

The operational version of Aladin is AL29T1 including the "mxl" modifications introduced in Prague. The semi-Lagrangian horizontal diffusion is on.

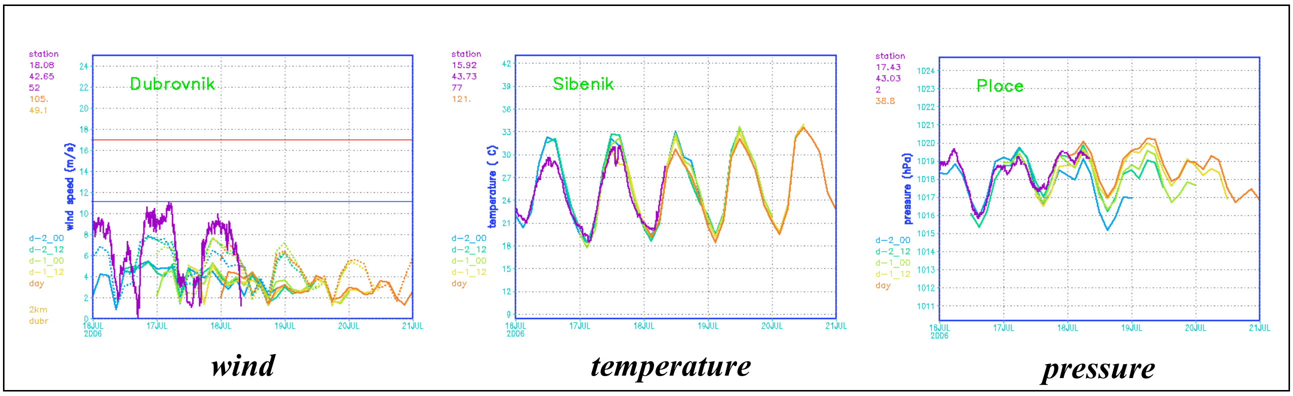


Figure 2. Comparison of forecasts with to the measurements from automatic stations for 10m wind in Dubrovnik (left), temperature in Šibenik (center) and pressure in Ploče (right), 8-km resolution forecasts are in full lines, 2-km resolution wind speed is dashed, measured 10-minute average is purple.

Plans

ALARO0 should be run at least on a daily basis. The size of domain and forecast range will be set depending on the cost of it.

A possibility to use smaller number of larger high resolution dynamical adaptation domains is considered. Also, usage of SLHD and NH dynamics in this part of operational suite would be beneficial.

2.9. CZECH REPUBLIC

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2.9.1. Operational application ALADIN/CE

Change on 10th January 2006: suite AEM

On 10th January 2006 we introduced into operations the e-suite AEM. It had both scientific and technical ingredients. The content of the e-suite is described here below.

Interactive mixing length

One of the main ingredients of the AEM e-suite was new computation of mixing length. It is based on the diagnostics of the PBL height following the approach proposed by Ayotte et al. (1996) but with algorithmic improvements (Piriou and Geleyn, 2002, and Tudor, personal communication). The resulting algorithm is referenced as ATPG (Ayotte-Tudor-Piriou-Geleyn) and is coded in the subroutine ACCLPH. The diagnosed PBL height is further used in two ways:

- as a standalone product (external environment applications);

- inside the model as an input to compute the mixing lengths. This is done by a function fitting quite regularly the mixing length curves for both momentum and heat (Cedilnik, 2005) and coded in the subroutine ACMIXLENZ as a new option.

We have obtained a nice improvement of the scores at the upper limit of the boundary layer (level 850 hPa) for temperature, wind and humidity:

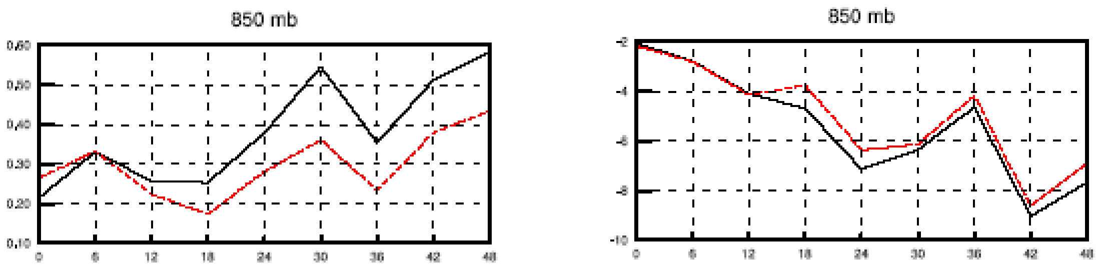

Figure 1. *Bias of temperature [K] and relative humidity [%] at the level of 850hPa against TEMP measurements, 12 cases in December 2005. Solid black line: operational suite; red dashed line: e-suite AEM.*

The impact on the scores had the same signature over all tested periods in order to cover more seasons. While the suite AEM was run for November and December 2005, preliminary tests were made also over a summer period.

The introduction of new computation of mixing lengths was a necessary step preparing for a successful implementation of the pseudo-prognostic TKE scheme in ALADIN later on.

SLHD setup

We introduced a general setup of the Semi-Lagrangian Horizontal Diffusion (SLHD) scheme, which is now resolution and time-step length independent. More details on the scheme and its tunings may be found in Váňa (2005).

Correction in ACPLUIE

Here a bug was found and corrected. It had to do with the mechanism of evaporation of precipitating species as well as the mechanism of their melting and/or freezing. Both these processes depend on the fall speed of precipitations, different for rain and snow. In ACPLUIE the processes are modulated by the square root of the ratio ‘fall speed of rain over fall speed of snow’, which is REVGSL in the code. The bug was that a square root was missing in the expression for the evaporation and melting fluxes. The correction of the bug had a negligible impact on the general scores.

Improvement in the gravity wave drag scheme

A small modification was introduced into the routine ACDRAG: there is a better profile of drag deposition in the model layers supposed to interact with sub-grid scale slopes. This change has also a negligible impact on the scores.

Moist gustiness and sea roughness length tuning

Here we directly profited from the work done in the framework of the MFSTEP (Mediterranean Forecasting System Toward Environmental Prediction) project. We introduced into the model the moist gustiness parameterization after development of M. Belluš. Then we have set the critical value of momentum roughness length to the same value as in ARPEGE (constant VZ0CM= 1.E-04) and we retuned the reference friction velocity for differentiating between z_{0m} and z_{0h} to match the MFSTEP validation data sets. More details could be found in Brožková et al., (2006).

What should be mentioned here is that the moist gustiness parameterisation plays an important role for the cyclogenesis process over sea. We have made a study of a so-called Black Sea case, where ALADIN simulated a cyclogenesis. The cyclone was observed in reality but the one forecasted by the model was too intense. As a first cure we tested SLHD diffusion which indeed lead to substantial improvement of the simulation. As a second step we tested the impact of moist gustiness. It had a nice impact, too, with an amplitude comparable to SLHD. Finally, the combination of both SLHD and moist gustiness kept the quality of the simulation. In other words SLHD added to moist gustiness parameterization have not made a strong impact anymore since the energy cascade in the model was obviously more realistic thanks to the presence of the moist gustiness process.

Although it is a result from only one case study it shows the importance of the moist gustiness parameterization in the model.

Switch to the cycle CY29T2

This cycle was successfully ported on the NEC/SX6 platform and validated against the previous operational cycle (CY28T3). Without using the compiler optimizations, spectral norms were found bit identical for the forecast and full-pos configurations.

Change on 23rd January 2006: new climate files

Shortly after the AEM suite there was a switch to the new set of the so-called climate files. This switch was coordinated for the whole ALADIN consortium and was in preparation for quite a long period. However a series of problems in the configuration e923 caused delays.

Because of the cycling algorithm (blending in our case) it was absolutely necessary to switch the surface boundary condition (climate files) at the same time as it was done in the ARPEGE global model. Within the testing period we were running a couple of e-suites using new climate files together with coupling files provided by the ARPEGE e-suite. The scores were not encouraging but that was later explained by discovered bugs in the climate files preparation. We tested as well a cross combination of the original and new coupling files and we could confirm it was an unusable option due to huge forecast errors. Finally the last version of the climate files was looking correct and the operational switch could be planned.

We have made the cold start (a necessary step) of the blending cycle about one week prior to the announced date of the operational switch. Like that we warmed up the ALADIN/CE guess using new climate files and coupling files from the ARPEGE e-suite. Then we switched really simultaneously with ARPEGE by branching the warm guess into the operational suite.

Change on 3rd August 2006: CANARI surface analysis

During the spring of 2006 we have worked on several future improvements of the ALADIN model. One of them was the replacement of the surface blending by the so-called CANARI surface analysis scheme. This step was planned for a long time and tests have already been made. However the operational use of the surface analysis was blocked by a bug in the routine used for the smoothing of soil wetness. This mistake in arrays addressing was corrected in our version of CY29T2 library and the bugfix was phased into the CY31T1.

Beside the technical difficulties we observed also a worsening of moist bias at the screen level, although temperature was improving. Therefore we went back on two modifications (F. Bouyssel, personal communication) introduced into ARPEGE surface analysis in 2004:

- we changed the so-called ISBA polynomes to compute the temperature and moisture analysis increments from the version 03 to the version 02;
- we have set the parameter SMU0 to 0. (instead of 7.). This parameter is used to reduce the OI coefficients depending on the zenith solar angle. Thus typically in winter and in the night the soil moisture analysis increments are weaker than otherwise. By setting this parameter to zero we removed this increment reduction.

Then we started a new parallel suite, where we have replaced the surface blending by the surface analysis of the soil variables. In addition to the changes described above, there are still some special points to be mentioned:

- We analyse 2m temperature and humidity, from which the increments of soil variables are computed;
- We do not analyse the sea surface temperature: this one is taken from ARPEGE. In fact all sea points are initialised from ARPEGE for all surface variables.
- Any other land soil variables which are not analysed are initialised from the ALADIN guess (like snow, for example) with the relaxation to the climatology as implemented within the CANARI configuration.

Incremental mode

As it regards the cycling algorithm, we have tested as well the so-called incremental mode (switch LAEINC) which is used in the ARPEGE suite. This method consists in the update of the guess upper-air fields by their analysis. In the case of ARPEGE it is then the 4DVAR trajectory which updates the atmospheric fields prior to the surface analysis. In our case we used the result of the spectral blending instead of the 4DVAR. Therefore we have prepared a new routine which makes the upper air blending step (replacement by the long-waves of the ALADIN guess by the ARPEGE analysis) called under the key LAEINC. By activating the key we refreshed the atmospheric guess before performing the surface analysis.

We have made a short parallel test with the incremental option. However the results were worse than in the case when both surface and upper-air analysis were made in parallel. This means that the result of the surface analysis and the one of blending were not influencing each other and were starting from the same guess. The sequential mode, analogical to ARPEGE, lead to worse scores, namely for standard deviation of temperature at 2m.

Therefore we have kept the parallel mode inside the surface analysis parallel suite. This suite started on 10th March 2006 in research mode and in June it was moved under a true e-suite conditions. Thus, charts were available from every run of the 0 UTC and 12 UTC analysis times on Intranet/Internet. Both researchers and bench forecasters could assess the performance of the parallel suite. The main advantage found by forecasters, was the improvement of temperature 2m forecast. The impact on other parameters was neutral. The suite entered the operational application of ALADIN/CE on 3rd August.

2.9.2. Operational application ALADIN/MFSTEP

This is an application which provides atmospheric forcing for sea and shelf models of the Mediterranean basin. Description of the improvements of the model induced by this specific application may be found in Brožková et al., 2006. Except the surface analysis both ALADIN/CE and ALADIN/MFSTEP have the same content.

2.9.3. Future parallel suite of ALADIN/CE

By the end of August we have started to run in a research mode a new parallel suite. It is based on recent developments of many ALADIN colleagues within the so-called ALARO-0 effort. In short, its content is as follows:

- energy-conserving physics-dynamics interfacing framework, ready for future extensions (barycentric rule for the total mass, delta_m=1, ...);
- pseudo-prognostic TKE scheme: there is a prognostic TKE variable but its evolution equation leads back to the diagnostic exchange coefficients for momentum and heat computed by ACCOEK in case there is neither advection nor auto-diffusion of TKE; as a consequence the algorithm of the shallow convection parameterization implicitly remains unchanged;
- new computation of the radiative cloud optical properties, taking into account spectral saturation effects, not only within the considered layer, but also with respect to all interacting clouds above (always) and below (in the thermal case only);
- introduction of improvements in radiation scheme (new statistical model for the rapid computation of the thermal exchange terms between non adjacent layers and Voigt effect in the high atmosphere);
- new microphysics scheme for the stratiform precipitation part, based on the statistical sedimentation method, using prognostic cloud water, cloud ice, rain water and snow ice specific values. This scheme will be used later on within the 3MT scheme with a joint input of stratiform and convective condensation; .

With all these improvements and taking into account the fact to include five new prognostic GFL-type fields, the cost overhead is **less than 30%** of the total model cost.

2.9.4. References

Ayotte, K. W. at al, 1996: An evaluation of neutral and convective planetary boundary-layer parameterizations relative to large eddy simulations.*Bound.-Layer. Meteor.*, **79**, 131-175.

Brožková, R., M. Derková, M. Belluš, and A. Farda, 2006: Atmospheric forcing by ALADIN/MFSTEP and MFSTEP oriented tunings. *Ocean Science*, **2**, 113-121.

Cedilnik, J., 2005: Modification of proposal of reunification of the mixing lengths formulae. *LACE report*, 1 p.

Piriou, J.-M., and J.-F. Geleyn, 2002: Diagnostics de hauter de couche limite atmosphérique. *ARPEGE/ALADIN documentation*, 9pp.

Váňa, F., 2005: Semi-Lagrangian horizontal diffusion in ALADIN/ARPEGE. *ARPEGE/ALADIN documentation*, 13pp.

2.10. FRANCE

2.10.1. Summary of modifications in dynamics and physics in operational ARPEGE and ALADIN-France models (effective since 22th June 2006)

F. Bouyssel, Y. Bouteloup, K. Yessad: Météo France

- Five vertical model levels (from 41 to 46) are added and located in the upper stratosphere and low mesosphere to improve the assimilation of satellite radiances. The uppermost vertical model level changes from 1 hPa (~50km) to 0.05 hPa (~70km).

- Different options are used in the semi-lagrangian advection scheme:
  a) use of a vertical coordinate near to the pressure one (instead of a regularly spaced definition) for the vertical interpolation and the computation of the vertical displacement in the semi-lagrangian trajectory ("LREGETA"),
  b) computation of Coriolis term ($2\vec{\Omega}\wedge\vec{r}$) with an improved search of the origin point in the semi-lagrangian trajectory ("RW2MFF namelist change").

- Tendencies due to simplified physics in tangent-linear and adjoint models used in 4DVAR analysis are computed at the origin point of the semi-lagrangian trajectory (not anymore at the arrival one), as in full physics in non-linear model.

- The simplified large scale precipitation scheme is no longer used in the second minimisation of 4DVAR analysis since there is a degradation of the tangent linear approximation when it is used with the new prognostic large scale precipitation scheme (see below).

- The ECMWF operational radiation scheme is used, as in MESO-NH and AROME models. The RRTM scheme (Rapid Radiative Transfer Model, Mlawer et al. 1997) represents the longwave radiative exchanges. The objective in the development of RRTM has been to obtain an accuracy in the calculation of fluxes and heating rates consistent with the best line-by-line models. It uses the correlated-k method and shows its filiation to the Atmospheric and Environmental Research, Inc. (AER) line-by-line model (LBLRTM) through its use of absorption coefficients for the relevant k-distributions derived from LBLRTM. An improved version of the Fouquart's scheme represents the shortwave radiative exchanges. This shortwave scheme is, for the time being, used with 2 spectral bands instead of 6 spectral bands in IFS, MESO-NH and AROME. The experiments done with 6 spectral bands are currently negative, because of a degradation of a cold temperature bias in upper tropical troposphere. The cloud optical properties are the same as in the operational IFS model.

- The large-scale prognostic cloud and precipitation scheme developed by Philippe Lopez (2002) is implemented. The operational version uses four new prognostic variables for hydrometeors (specific contents of cloud liquid water, cloud solid water, precipitating liquid water (rain), precipitating solid water (snow)). This scheme is based on a statistical cloud scheme (Smith, 1990) which represents cloud condensation and evaporation. A triangular probability density function (PDF) represents the subgrid scale variability of temperature and humidity, from which are computed cloudiness and cloud water content. An instantaneous equilibrium is assumed between solid, liquid and vapour water (named "microphysical adjustment"). The PDF is defined by a "critical relative humidity" above which clouds are present. This "critical relative humidity" depends on the vertical coordinate and the horizontal resolution of the model. Separation of cloud liquid water and cloud solid water is function of the temperature (liquid water above 0°C, solid water below –25°C and continuous transition of mixed phase in between). Large-scale cloudiness and cloud water contents are combined with the convective ones to provide total cloudiness and total cloud water contents to the radiation scheme. Autoconversion of cloud condensate into precipitation (cloud liquid water to rain and cloud solid water to snow) occurs when cloud water contents exceed autoconversion thresholds (Kessler type). These thresholds are constant for liquid water and temperature dependent for solid water. Autoconversion processes are continuous during the time-step for a better 3D representation of rain and snow. Microphysical processes explicitly represented in the scheme are collection of cloud condensate by precipitation, precipitation evaporation and melting. Sedimentation, collection, evaporation and melting are described with a semi-lagrangian scheme which allows long time steps (several hundreds of seconds). The current scheme version assumes constant fall speeds (5m/s for rain and 0.6m/s for snow). The parameterization of the collection is based on the integration of the classical continuous collection equation over the Marshall-Palmer exponential particle spectra, and for specified distributions of particle fall speed and mass. Precipitation evaporation is calculated by integrating the equation that describes the evaporation of a single particle over the assumed spectra of particle number, mass, and fall speed. Falling snow is assumed to melt instantaneously as soon as it enters a model layer with temperature above 0°C, provided the associated cooling does not lead to freezing. This prognostic scheme represents a significant improvement in the representation of microphysical processes compared to the previous scheme.

- The turbulence scheme has been modified according to the new prognostic variables. The conservative variables diffused are not anymore specific water vapour humidity and dry static energy but total water specific humidity (vapour + liquid + solid) and “liquid” static energy, taking into account latent heat exchanges. A microphysical adjustment is realized after the turbulence scheme to compute the tendencies for cloud prognostic variables. The microphysical scheme uses cloud variables modified by turbulence and microphysical adjustment.

- The role of “ensemble entrainment” in the convective scheme has been enhanced to increase the top of convective clouds and to decrease a cold temperature bias in the upper tropical troposphere.

- Intensity of shallow convection is reduced which increases low level cloudiness and improves diagnostics on horizontal domains (DDH), in terms of model humidity tendency in lower troposphere.

- The diagnostic convective cloud scheme (cloudiness and cloud water) is based on the water condensed by the convective scheme in the time-step. These computations now use a characteristic time (instead of the time-step) which reduces the a time-step dependency. The convective condensed water is scaled by a function of saturation specific humidity so as to increase convective cloudiness in the upper troposphere and to decrease it in the lower troposphere. The autoconversion threshold used in the scheme is now similar to the ones defined in the microphysical scheme (temperature dependency).

- The relaxation on wind and temperature in the uppermost model levels (above 2hPa approximately) has been tuned according to the new vertical levels and radiation scheme.

- Digital Filter Initialization (DFI) has been modified to correct an inconsistency when prognostic variables are represented in grid-point space as it is now the case for hydrometeors specific humidity.

Bibliography

Lopez P., 2002: Implementation and validation of a new prognostic large-scale cloud and precipitation scheme for climate and data-assimilation purposes. QJRMS, **128**, pp. 229-257.

Mlawer E.J. et al. 1997: Radiative transfer for inhomogeneous atmospheres: RRTM, a validated correlated-k model for the longwave. J.G.R., **102D**, 16663-16682.

Smith R. N. B., 1990: A scheme for predicting layer clouds and their water content in a general circulation model. QJRMS, **116**, pp. 435-460.

2.10.2. Summer 2006 E-suite scientific description, scheduled for switch on Monday September 18th.

ARPEGE

Reference cycle: CY30T1_op2

Observations:

Assimilation of SSM/I over sea and in clear sky: Global scores are slightly positive, with a moistening of the PBL around 850 hPa in Equatorial regions (too dry in Arpège), a southward displacement of the ETCZ over Africa, and more stable precipitation amounts, with lead time, over the Northern Hemisphere extra-tropical latitudes.

Assimilation of ground GPS: European ground GPS are now assimilated in long and short cut-off runs. A slight positive impact over Europe is expected from experimental runs. MF is the first NMS to assimilate these ground GPS operationally in their global and regional NWP systems.

Assimilation of 20 channels stratospheric AIRS + monitoring of 90 channels: This induces a significant cost increase in CPU, as about 3000 profiles are available at any run time. A positive impact in the stratosphere, especially in the Southern Hemisphere and in the Tropics, has been noticed.

Bigger vertical extension of profiler profiles: Wind profiler data are now assimilated between 850 and 250 hPa , instead of 700-400, which gives about 70 % more data over Europe, with a positive impact over Europe and Northern America.

Algorithmics:

Balancing out the number of inner loops in 4D-VAR: The numbers of iterations in the multi-incremental 4D-VAR is changed from 40/15 to 25/25. This is done at no extra cost, and is slightly beneficial in scores.

Cycling of background error statistics (see also below): Background error variances are computed daily from a Monte-Carlo method and with the B-matrix metric from the minimization as norm (Andersson et al, 2000). This technique produces maps of error variances that are consistent between screening (where they are used instead of simpler maps) and minimization. As a side product, it provides maps of background errors for each satellite channel.

ALADIN e-suite:

Observations:

SSMI : Now assimilated in clear sky over sea, as in Arpège.

Ground GPS: The list of retained stations and the de-biasing values are different from Arpège (file "list_gpssol"). A new task "pre_gpssol" treats GPS data just before BATOR.

Wind profilers: same as Arpège.

No AIRS data in Aladin 3D-VAR yet

Cycling of sigmab:

ARPEGE sigmab maps are used for Aladin screening (thus, large scale flow-dependency according to the Arpège B metric).

Lamflag in bator:

LAMFLAG and REDUCE tasks have been inserted inside BATOR, which considerably simplifies the Aladin observation sequence for 3D-VAR.

2.10.3. Cycling of background standard errors « sigmab » in 4D-Var ARPEGE and 3D-Var ALADIN

12/07/2006

Principle

The goal is to better specify sigmab's used in the screening. Sigmab's are now obtained as statistics through perturbations in observation space. These perturbations are normalized by the B-matrix, and therefore they are consistent with the sigmab's from the minimization. They depend on the flow since B has the Omega and NL-balances (in Arpège) which are flow-dependent. Perturbations for satellite channels also are flow-dependent, as the observation operators include a dependency upon the state of linearisation.

Sigmab's are produced on a T107 grid, and the files can be read both by Arpège and Aladin screening. 6 random realizations are performed to compute the statistics. For radiances, the following channels are computed:

- HIRS (4-7, 11-12, 14-15)
- AMSU-A (5-13),
- AMSU-B (3- 5),
- SSMI (1-7).

The procedure is not applied to AIRS, SEVIRI channels, where static values from the "fgchk" routine are used. Also, ground GPS are not treated.

Due to the small size of the ensemble, the sigmab maps need to be filtered in order to reduce the sampling noise.

Production of random sigmab maps

diag_sigmab is a C131 configuration with the following modifications in namelist:
- T107 first guess input,
- namelist modset:

```
&NAMVAR
  LAVCGL=.TRUE.,
  NBGVECS=6,
  LBGTRUNC=.TRUE.,
  LWRISIGB=.TRUE.,
  LBGOBS=.TRUE.,
  NITER=1,
  NBGTRUNC=42,
/
```

diag_sigmab produces a GRIB file *sigma_b* readable in **screening**.

Modification of screening

In both Arpège and Aladin screenings, the errgrib file is now associated with the new *sigma_b* file, produced at the previous run time (instead of *var.errgrib.20031211.01.scr00).*

2.11. HUNGARY

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2.11.1. There were several small changes in the operational version of the ALADIN/HU model during the first half of 2006:

- Introduction of AMSU-B data into the 3D-Var data assimilation suite (see article in the previous Newsletter about the impact of AMSU-B data).
- Introduction of pre-filter for the thinning of AMDAR data.
- Migration of the operational suite from the IBM Regatta (p690) platform to the IBM cluster platform (p655).
- Application of "PACOURT" data for lateral boundary conditions for the 00 UTC run (hence the results are available for the forecasters much earlier than before).

2.11.2. The main recent characteristics of the operational suite:

- ALADIN cycle: cy28t3
- Horizontal resolution: 8 km
- Vertical levels: 49
- Grid: linear
- Data assimilation: 3d-var with 6h cycling
- Observations: SYNOP (geopotential), TEMP (temperature, wind components, humidity, geopotential), AMDAR (temperature, wind components), ATOVS:AMSU-A and AMSU-B radiances.

2.11.3. Parellel suite during the period:

- ALADIN dynamical adaptation at 8km horizontal and 49 levels vertical resolution for reference

Last, but not least it is mentioned that a new mainframe computer was delivered to our Service during spring, 2006: SGI Altix 3700 BX2 server with 144 Intel Itanium2 processors with altogether 288 Gbyte memory. The half of the system will be used for NWP (ALADIN). At the same time IBM TotalStorage 3584 Tape Library was installed as well, with an overall storage capacity of about 30 Tbyte.

2.12. MOROCCO

2.13. POLAND

2.14. PORTUGAL

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2.14.1. Introduction

During the first half of this year, several important changes have taken place on the Portuguese operational systems. First of all, changes have been focused on the upgrade of ALADIN local version: the CY28T03 is in operational mode locally since the 6th of June. With this upgrade, also the verification system is being reviewed. Besides, a historical database for our GRIB data production is finally being done using a home made relational data base, TIDB2, created for NWP purposes. At the same time, tests on the installation of ALADIN on a PC cluster of 6 AMD64 dual core processors have been successful to run the CY29T02 version of the model in about 10 minutes for 48 hours of integration. Finally, a new product – RISCON – the composite of some instability indexes, was recently created as a risk assessment for heavy precipitation situations that should be validated soon.

2.14.2. Operational version

On 12 UTC run of the 6th of June this year, a new system for ALADIN/Portugal entered into operations. This system was the result of 3 main achievements: the installation and validation of a new ALADIN version for Portugal, the migration to a new computer platform and the switch to the new climatologies both of ARPEGE and ALADIN/Portugal. Main changes are reported here:

- current computer environment: alpha server cluster ES40, 667MHz, 3Gb memory True64 (V5,0); native F90, F77 and C compilers;
- current model characteristics: new geographical area using as central point of domain (long = 350.9ºE; lat = 39.8ºN), most SWestern point (long = 345.2ºE,lat =34.76ºN), most NEast point (long = 356.6ºE,lat = 44.84ºN), resolution = 0.12, number of points along lat = 85, number of points along long = 96.

2.14.3. ALADIN on AMD dual core processors

With the new models generation of the ALADIN community, NWP challenges are growing for countries with few resources. The new computer requirements of the community trigger local strategies based on low price solutions [1]. Recently, the Paipix[2]/IM Linux distribution has been locally implemented as an optimised development environment for NWP activities. This work consisted in creating the appropriate Debian packages and patches for the ECMWF applications using the Debian Sarge distribution and the Linux kernel 2.6. The Paipix work also integrated the database tools being developed at the institute, our TIDB[3]. Although this platform could be directly booted from a DVD (live) it has been locally installed on the hard disk of each AMD64 PC available for each working position.

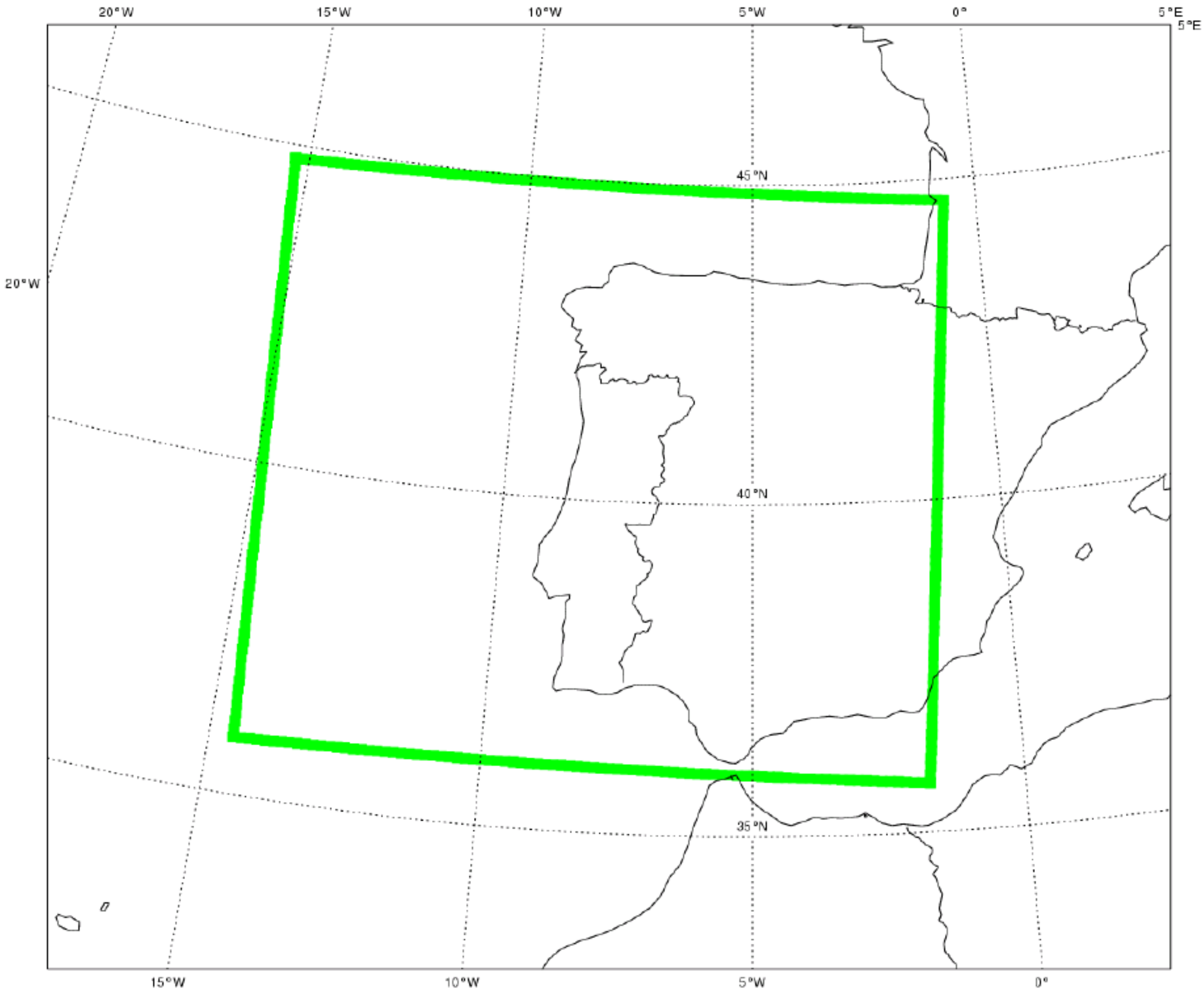
Basic tests with ALADIN source code have now allowed the installation of the local version of ALADIN/Portugal on a (private) 6 AMD64 dual core PC cluster under PaiPix operating system: gmkpack has been used on the installation of CY29T02. Foreseen tests will allow the increase the computer power of this cluster with the compatible AMD64 PC's of each NWP working position.

AMD64 PC characteristics: chipset ASUS A8N-E, 1Gb RAM, 120 Gb disk space; graphical ATI radeon 68 Mb card.

2.14.4. Bibliography

[1]]Amorim, A. and Lígia Amorim, 2006, *Making the ECMWF tools, including METVIEW, available in a restricted version of the PAIPIX scientific live Linux*, Proceedings of the 10th ECMWF workshop on

Meteorological Operational Systems.
[2] http://www.paipix.org
[3] Simões. J. *et all*, 2006, *Implementation and Testing Object Extensions of Open Source RDBMS for Meteorological Data*, Proceedings of the 19th ECMWF workshop of Meteorological Operational Systems



Portugal's new domain

2.15. ROMANIA

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Starting with January 30, 2006 several modifications were done in the operational suite, including a complete reorganization of the scripts:

- The increase of the main Aladin Romania domain from 100 x 100 points to 144 x 144 points, keeping the 10 km horizontal resolution (fig. 1)

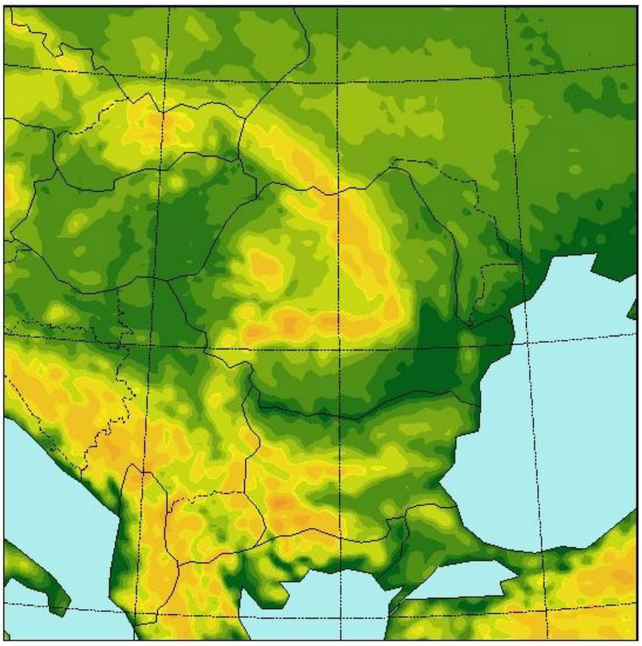

Fig.1. Aladin Romanian operational domain from january 30, 2006: 144 x 144 points, $\Delta x = 10km$

- New climatic files (new frame format): GTOPT030 data base for orography (without envelope), climatological profile for ozone, new fields for the prognostic albedo
- New coupling files (new frame format): up to 78 forecast range
- Physics set up: new version of the gravity wave drag parameterization (LNEWD=T), use of the geostrophic wind in the lift computation, prognostic albedo for snow, climatological profile for ozone in the radiation computations
- New products dedicated to the forecasters, on the Aladin intranet web site (total, low, medium and high cloudiness, 1.5PV geopotential, 12 and 24 h cumulated precipitation, thickness of 1000 -500 hPa layer)

2.16. SLOVAKIA

Operational ALADIN/SHMU system: maria.derkova»at»shmu.sk

The setup of ALADIN/SHMU model domain and version was not changed during the 1st half of 2006. The hardware (computer and archive device) is the same as well.

Two main changes are to be reported here:

- after heavy testing, the **new climate and coupling files** are in use since **23/01/2006,** switched to operations simultaneously with ARPEGE and all LACE applications
- the **forecast** lead time was prolonged **up to +72h** for 00, 06 and 12UTC runs, and up to +60h for the 18UTC run on **23/03/2006**. The forecasts for the additional 3rd day were carefully verified, fortunately no significant degradation of the forecast quality was observed. This is documented on figures 1 and 2. Thanks to the prolonged forecasts new experimental products are prepared based on multirun ensembles: ALADIN epsgram (figure 3) and multirun ensemble maps (fig. 4).

To cope with the announced change of the schedule of the 00UTC ARPEGE run and consequent switch to 30T1, reorganization of the tasks in our operational suite (mainly the fullpos and gribbing in parallel with the integration) took place. The reorganisation compensated the expected delay of the ALADIN/SHMU products, and almost no difference in the availability of the last grib file was observed (figure 5). On the contrary, the historical output files are delayed as forecasted (fig. 6). The faster production of LBC files in Toulouse doesn't compensate it, as our HPC cannot integrate faster.

Some modules of the INCA system, developed by our Austrian colleagues, have been ported to SHMU for nowcasting purposes. A special domain for the INCA fullpos have been prepared together with the conversion of output files to INCA input format. The local observations (for the time being SYNOPs only) are converted to INCA format as well. All applications have been included to run_app schedule and monitoring system and are nearly ready to be used operationally.

The backup applications for ZAMG have been fully integrated into the run_app system as well, allowing their full operational monitoring and control.

The possible solutions for backup of the LBC retrieval after abandoning the RETIM200 systems were investigated. As Slovakia is not the ECMWF member, the standard solution of downloading the data from the ECMWF server could not be applied. Therefore an alternative approach is used – the LBC data will be downloaded from ZAMG server. We would like to thank to ZAMG colleagues for their kind offer and technical help.

The Loadleveler queueing system has been upgraded to the new version.

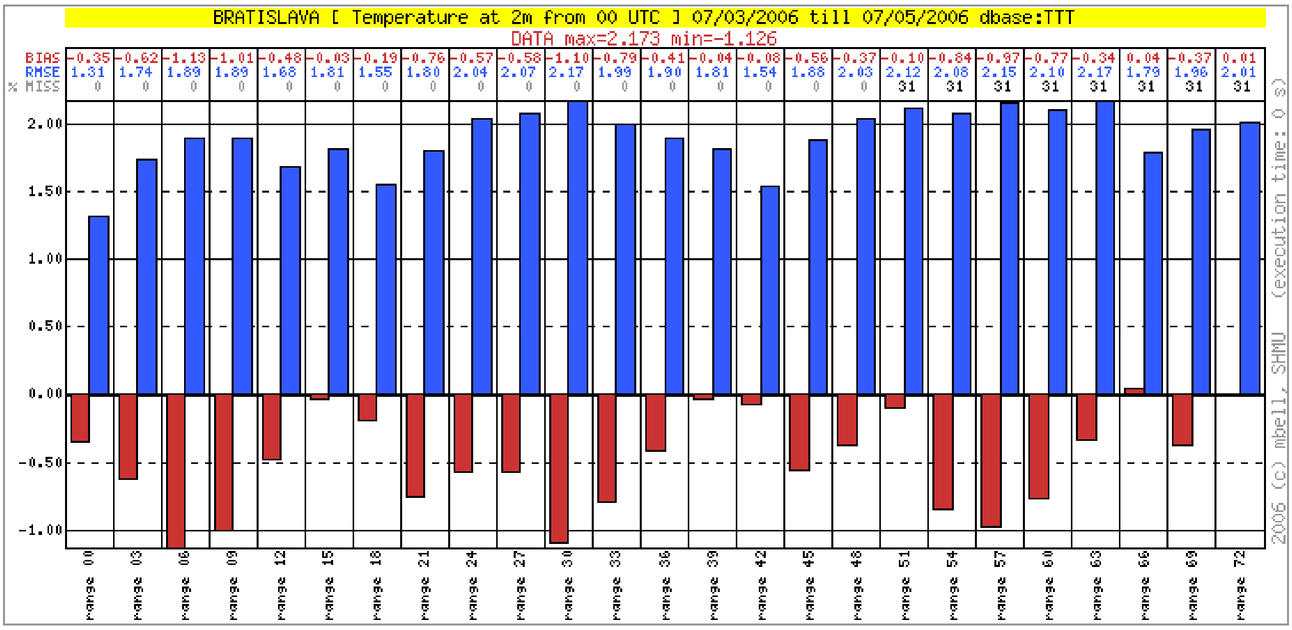

Figure 1: The 2m temperature scores over 2 months for Bratislava station, up to +72h

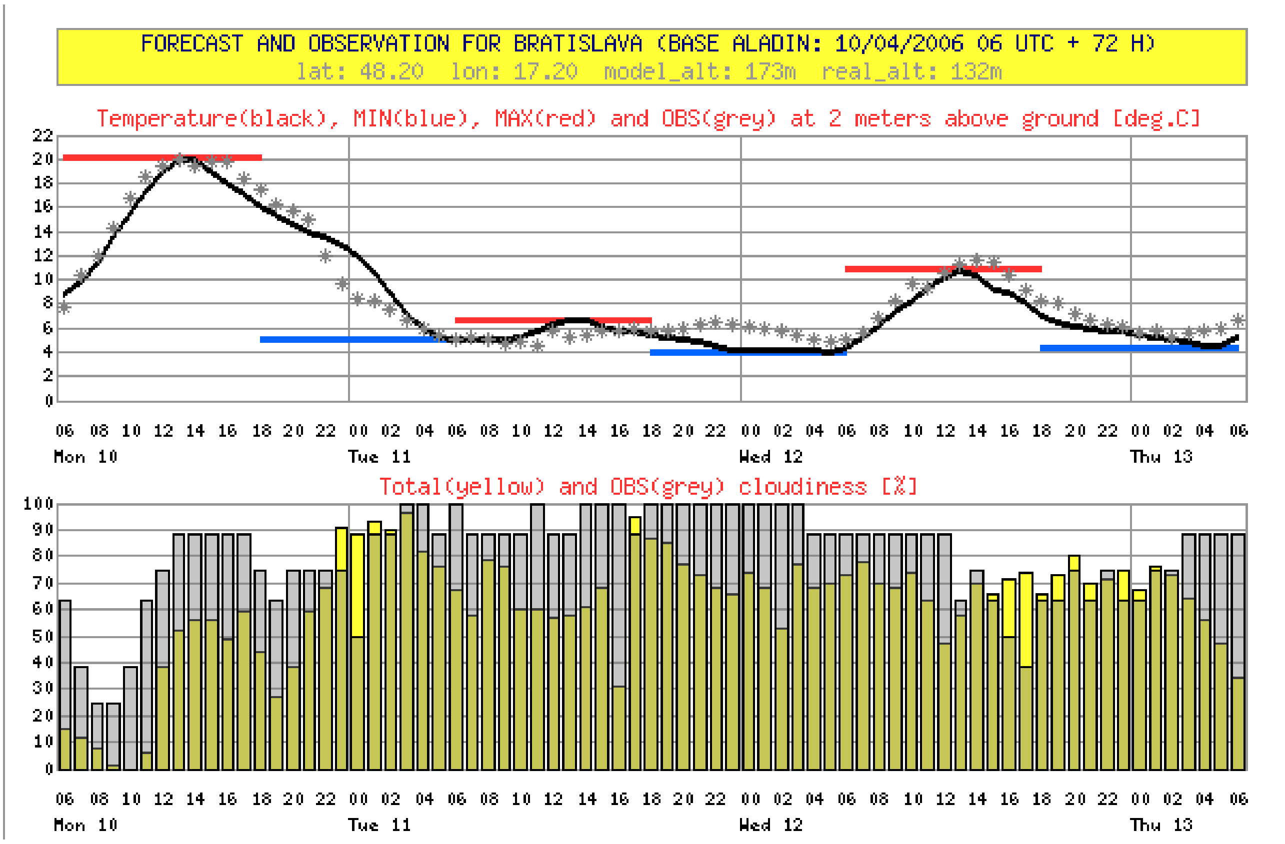

Figure 2: The meteogram and its verification (observations in grey) for Bratislava station

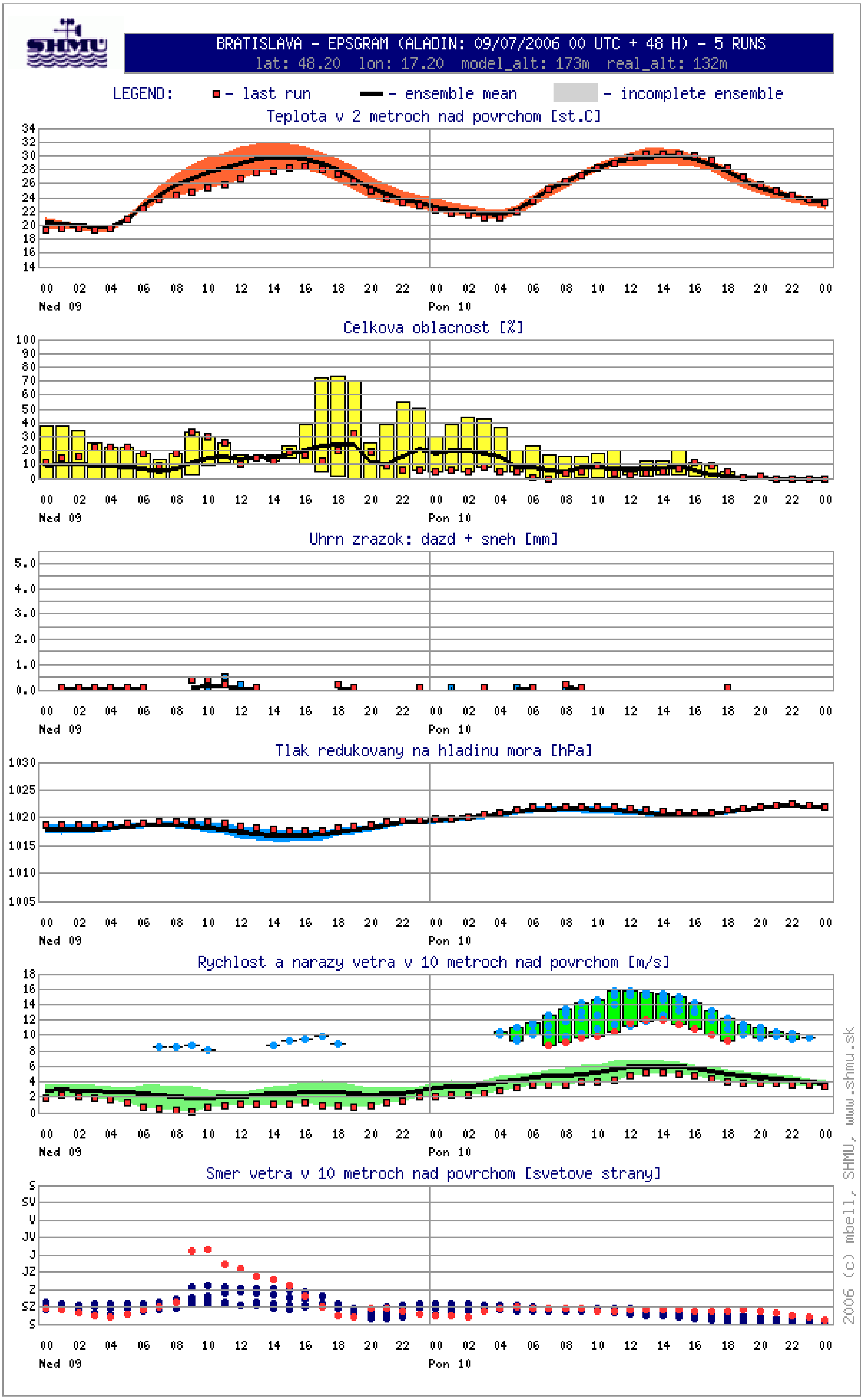

Figure 3: The epsgram based on multirun ensemble

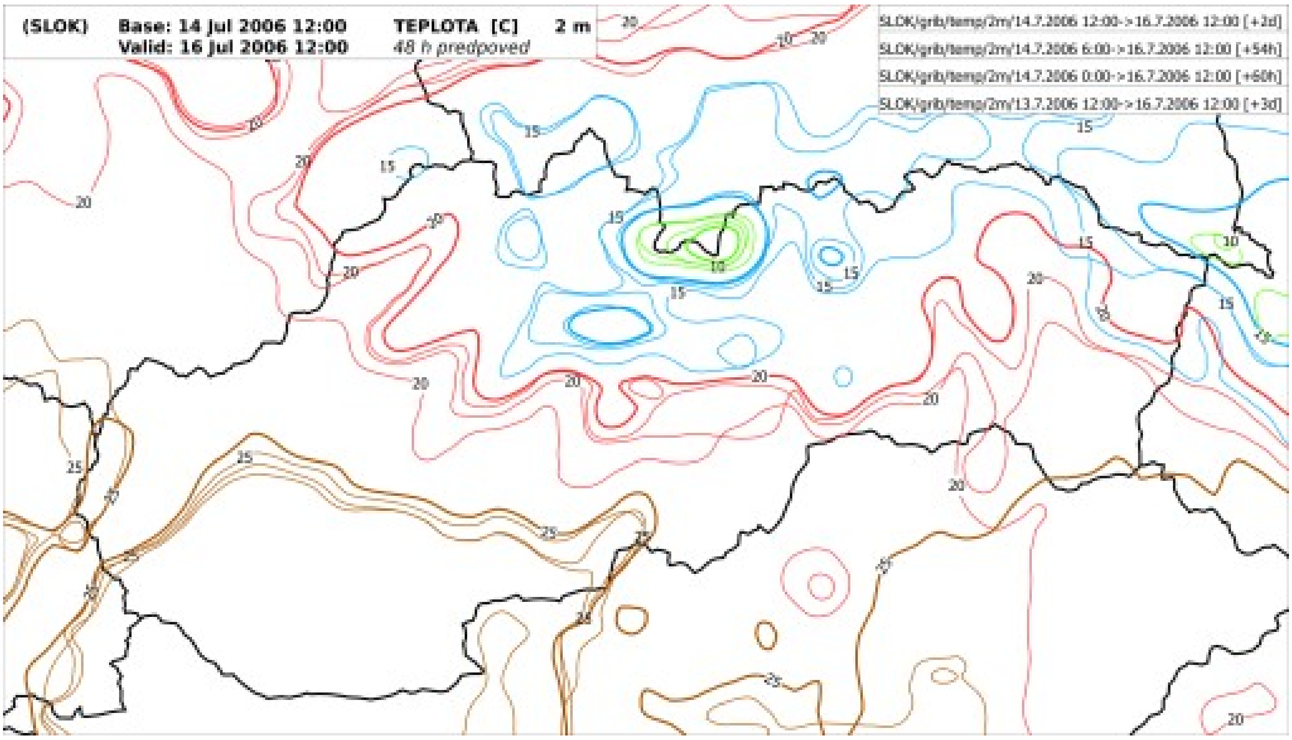

Figure 4: 2m temperature forecast - a multirun ensemble map

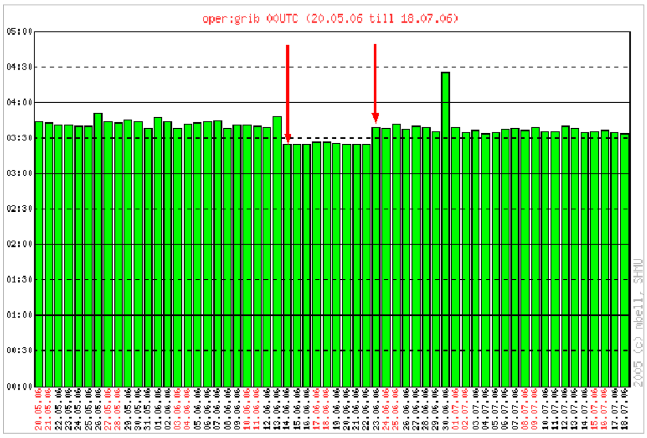

Figure 5: The availability of the last grib files; 2 months statistics. The red arrows denote 2 changes in ARPEGE schedule: delay of 00UTC run (together with the reorganisation of ALADIN/SHMU operational suite) and introduction of new model cycle

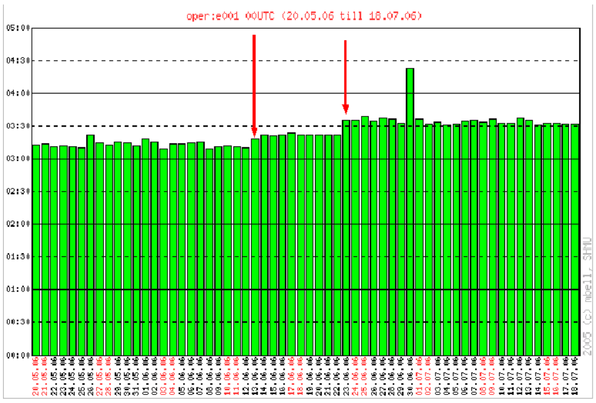

Figure 6: The same as the previous figure, but for availability of the historical files

2.17. SLOVENIA

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In the ALADIN operational suite cy29t2 is used, there were no scientific changes. New climatologial files were introduced 23/01/2006. Simultaneously there were also changes in LBC files which caused problems on our previous cluster system which was still running as backup using cy12 (this cluster was later switched off after 1024 days of up time).

The length of the integration was increased to 72 hours for both 00 and 12 runs on 11/04/2006. After ARPEGE schedule has changed another 48-hours integration starting at 18 UTC with reduced number of post-processed products was added on 09/06/2006.

Because of the new schedule of ARPEGE 00 run and cy30 the end products are available 35 minutes later and additionally 25 minutes later because of extended integration (from +54 to +72 hours).

The computer system and operational suite has been controlled by NAGIOS supervision system which is working nice and is very useful.

The transfer of coupling files from ARPEGE model via Internet from Toulouse was stable. Files were significantly delayed (available after 4:30/16:30 UTC) only 6 times.

RFA package (R library for manipulation of FA files written by Alex Deckmyn, RMI) which is now used for models output comparison has been ported.

Porting al29t2 to altix system (SGI) and comparison of MPI and openMP performance were done. OpenMP is running well on SGI altix system. The best performance is obtained in mixing mode with two openMP threats per one MPI task.

2.18. TUNISIA

2.19. HIRLAM

3. RSEARCH & DEVELOPMENTS

3.1. ALGERIA

3.2. AUSTRIA

3.3. BELGIUM

3.4. BULGARIA

3.5. CROATIA

3.5.1. Alaro0

The research of the impact of different parts of the Alaro0 package is under way.

3.5.2. Air-Sea interaction

In the framework of the DART project the impact of the air-sea interaction on atmospheric conditions is being studied.

3.5.3. Impact of SLHD, NH dynamics and different orography representations on high resolution forecast

The study, performed on 2-km resolution shows removal of some upper-air features when SLHD is used, especially in the case with weak wind.

3.5.4. LAM EPS

The research on downscaling of the ECMWF EPS members has continued (see the paper by A. Kann and Y. Wong).

3.6. CZECH REPUBLIC

See 2.10

3.7. FRANCE

See 2.11

3.8. HUNGARY

The main scientific orientation of the Hungarian Meteorological Service for the ALADIN project is unchanged: data assimilation, short range ensemble prediction and high resolution meso-gamma scale modelling (AROME model). Nevertheless beside these topics we had also the interest to test ECMWF/IFS model outputs as (initial) and lateral boundary conditions of the ALADIN model.

The main scientific developments for the first half of 2006 can be summarised as follows:

- **DATA ASSIMILATION:**

Some of the recent developments went into operations (see above) as far as AMDAR data thinning and the application of AMSU-B data are concerned. Beside that attention was paid to the following areas of interest:

- Computation of ensemble Jb and its intercomparison to NMC and Hollingsworth-Lonnberg methods.
- First preliminary tests with 3d-fgat.
- Completion of EUCOS space-terrestrial study for the winter period (including also case study).

- **LAMEPS:**

The main focus was put into the computation of ALADIN singular vector with the execution of ALADIN 601 configuration. Several technical hurdles were overtaken until the computations seemed to work on cycle 30 of ALADIN.

Beside these developments, intensive coordination was realised between other ALADIN centres working on LAMEPS and also with HIRLAM (participation at the HIRLAM predictability planning meeting in Madrid and at the HIRLAM working week in Norrköping)

- **AROME:**

As it was reported in the previous Newsletter the prototype version of AROME was successfully installed. In this period several cases were investigated and studied, where it is expected that the AROME model can provide improved forecast than the ALADIN one. The preliminary results were presented at the ALADIN workshop in Sofia (see the homepage of the workshop).

- **COUPLING WITH ECMWF/IFS:**

First investigations were done in order to see what is the impact of ECMWF/IFS boundary conditions on the ALADIN forecasts compared to the operational ARPEGE coupling. It was found that there were significant improvements in scores for the upper-air fields, however on the surface some degradation (mainly at the humidity fields) was detected. This latter problem should be understood and cured (it is also one of the subjects of the ECMWF Special Project for the ALADIN partners). More details of the results can be seen in the presentation of Gergo Bölöni at the ALADIN workshop in Sofia.

3.9. MOROCCO

3.10. POLAND

3.11. PORTUGAL

3.12. ROMANIA

See 4.10

3.13. SLOVAKIA

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Case studies and deeper investigations were carried out to explain two model failures (during two independent periods) in the temperature forecasts:

- The first period occurred roughly between 23/01 and 06/02 (by chance coinciding with the change of the climate files), when in the stable anticyclonic situation over Central Europe covered with snow the drop of the night minima below 25deg. was observed. The model errors were more than 10, sometimes even 15 degrees (see figure 7). This was probably a result of the wrong thermal exchange between deep soil and surface, where snow cover is not taken into account (E. Bazile, personal communication).

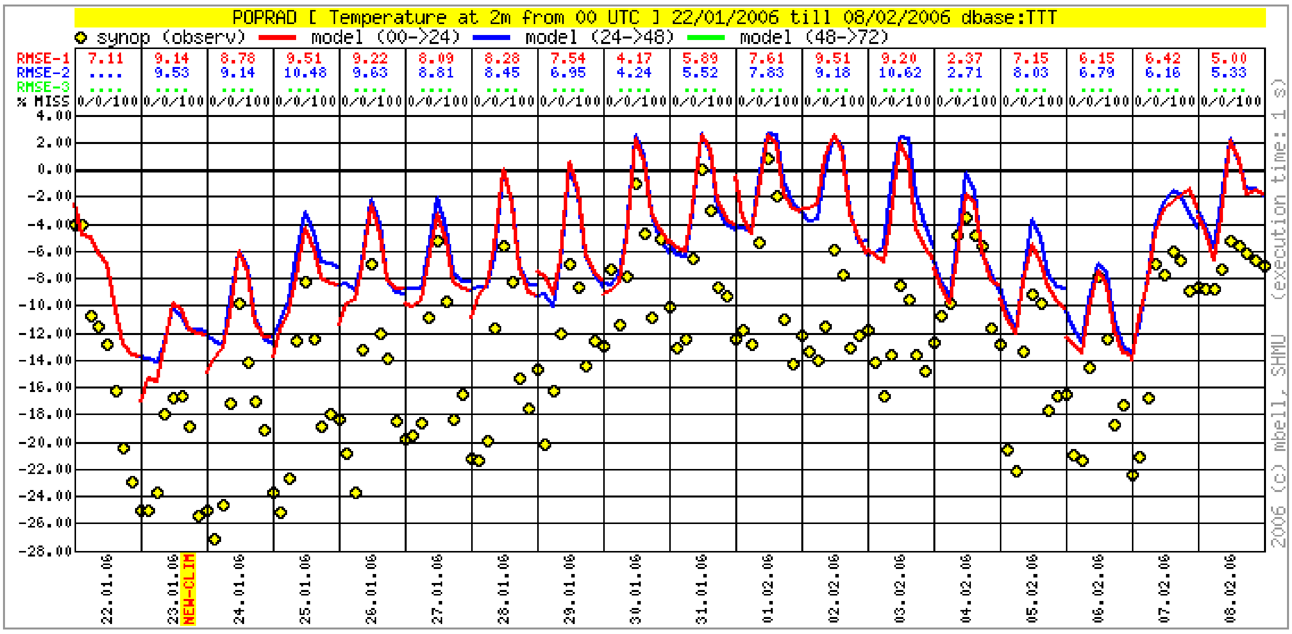

Figure 1: 2m temperature verifications (observations in yellow circles) for station POPRAD

- The second period of wrong temperature forecast was around the end of April, when unrealistic horizontal temperature gradient during the nights was observed in Slovakia, see figures 8 and 9. During the day the unrealistic feature disappeared and forecasted temperatures were OK. The source of the problem was in ARPEGE, where few points with frozen soil water were still present (E. Bazile, personal communication).

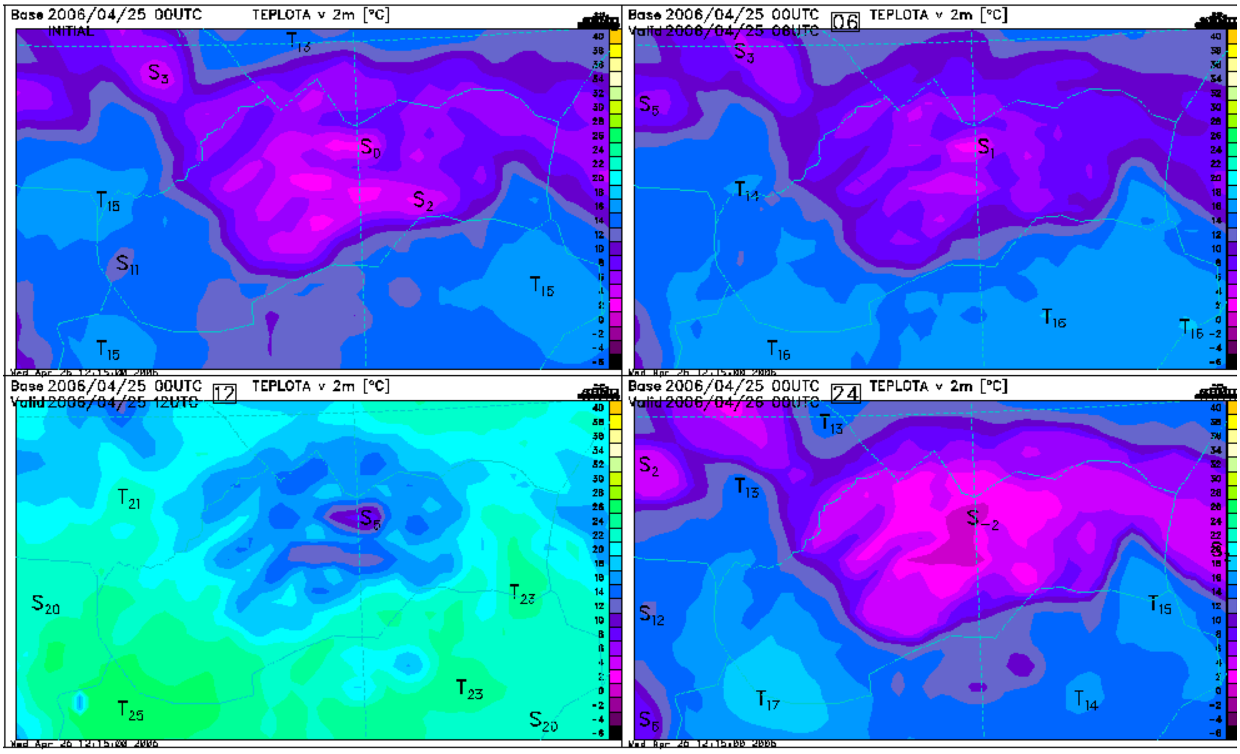

Figure 2: 2m temperature forecast for 00, +06, +12 and +24h ranges.

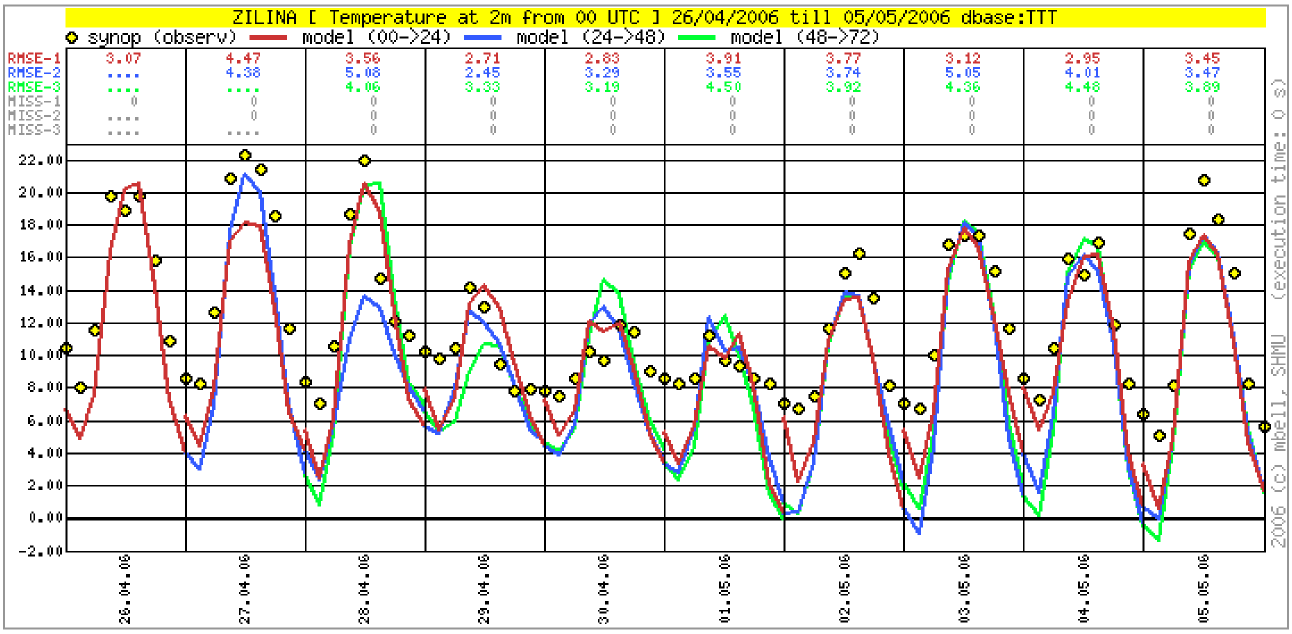

Figure 3: 2m temperature verifications (observations in yellow circles) for station Zilina

The work on the *Vertical finite elements (J. Vivoda)* and on the *New cloud optical properties for ALARO-0 (J. Masek)* will be reported in the next Newsletter.

The CY29T2 with preALARO-0 setup (export version) have been ported and validated at SHMU, and is ready for the parallel suite. The veral tool have been completely ported to SHMU and is now working on CY28T3, with SYNOP observations. The conversion of TEMPs to OBSOUL and ODB formats is underway, to be also included into veral package.

Two LACE scientific stays have been completed in Vienna: J. Vivoda working on Vertical Finite Elements method and M. Bellus on the DFI blending for LAEF; and O. Spaniel have participated on phasing in Toulouse. Six persons from SHMU have participated at the 16th ALADIN workshop in Sofia (two oral presentations, one poster).

3.14. SLOVENIA

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Work on various physics parameterizations has continued. Jure Cedilnik took part in the preparation on ALARO-0 base-line version in Brussels when available physics parameterization and GFL fields for new prognostic/diagnostic variables were included into cy29t2. A more complex statistical method for the weighting function between max and min inter-layer gaseous exchange terms has been prepared during the LACE supported stay in Prague.

For the first experiments with AROME Slovenian domain was defined and script environment has been prepared at Meteo-France. Results have been used for the ongoing project of interpretation of high resolution NWP products. Some additional options for improvement of model-forecaster relationship in case of a very high resolution model have been investigated. In particular, the temporal and spatial distribution of up-scaled precipitation fields were treated as a new forecast parameter. This parameter can also be easily verified using measurements at the spatial resolution lower than the very numerical model, as for example rain-gauges with registrators.

ALADIN verification project

The porting of the application to new dedicated server was successfully finished. Postgresql, Apache and PHP has been upgraded, and Mapserver for visualization of geographical maps has been installed. Some effort has been devoted to the database cleaning and monitoring of database content and charging. The table with basic information about the models has been prepared, it is also possibility to keep track of the changes. First version of automatic creation of a monthly verification report for one station has been produced and tested.

3.15. TUNISIA

3.16. HIRLAM

4. PAPERS and ARTICLES

4.1. Impact of the AMV data in the ALADIN/HU data assimilation system.

Roger Randriamampianina:

Abstract:

The work on Atmospheric Motion Vectors (AMV) at the Hungarian Meteorological Service (HMS) started with the qualitative evaluation of the retrieved wind vectors according to the quality indicator (QI) found in the BUFR file. This consisted of the computation of statistics for the observation departure (obs-guess) and for the analysis increment (obs-analysis) from a few days of objective analysis. The default configuration in the ARPEGE/ALADIN model on the use of AMV data is that these data are not used over land for regions having latitude greater than 30 degrees. We found that the higher the quality indicator, the better the fit to the observation in the "obs-guess" and "obs-analysis" statistics. An other objective of our study was to investigate the use of AMV data over land. Our results showed that data over land seems to have similar quality as those over sea. After a detailed study of the quality of the retrieved wind vectors, a test run was performed with the default configuration. The results showed positive impact of AMV data, mainly, on the analysis. A further evaluation of thresholds used in the quality control for the AMV data showed that the same quality of the observation departure can be kept using data having quality indicator (QI) more than 80% instead of the default value (85%). The three performed additional runs (use of data with QI>80%, QI>85% and data over land also) showed neutral impact over the whole ALADIN/HU domain, but positive impact was observed when zooming into our "target areas" (Carpathian basin and Hungary). Moreover, we observed clear positive impact of the AMV data on the forecasts of precipitation. The obtained results were confirmed by case studies.

4.1.1. Introduction

The local development of the three-dimensional variational (3D-Var) analysis system in Hungary started in 2000, when the system was implemented. It included the radiosonde (TEMP) and the surface (SYNOP) observations only. At that time the French global model (ARPEGE) analyses were used as initial conditions for the operational ALADIN forecasting system. Our goal at the HMS is to improve our analysis and short-range forecasts using all the available local data in the optimal way (using highest resolution possible). The first observations investigated in our analysis system were the ATOVS radiances (Randriamampianina et al., 2006) and the aircraft data (Randriamampianina et al., 2005). The 3D-Var ALADIN/HU analysis system became operational in May 2005. Due to their temporal and spatial resolutions, data from the geostationary satellites – like the AMV data - can be very useful for regional and mesoscale models. The investigation of the AMV data at the HMS started in 2005.

Payan and Rabier (2004), investigated the use of the quality indicators (QI) of the AMV data in the ARPEGE/ALADIN assimilation system. Their studies were done with the global model, so the use of the adopted quality control in a limited area model requires additional investigation. The AMV data used in our study were those transmitted trough the EUMETCast broadcasting system in BUFR format.

4.1.2. The ALADIN/HU model and the assimilation system used in the study

At the HMS, the ALADIN/HU model runs in its hydrostatic version. In this study, the 3D-Var system was applied to assimilate both conventional (surface, radiosonde, aircraft and AMV) and satellite (ATOVS) observations. As a consequence of the direct radiance assimilation, it is necessary to simulate radiances from the model parameters. The RTTOV radiative transfer code, which has 43 vertical levels, was used to perform this transformation in the ARPEGE/ALADIN models. Above the top of the model, an extrapolation of the profile is performed using a regression algorithm

(*Rabier et al.,* 2001). Below the top of the model, profiles are interpolated to RTTOV pressure levels. The background error covariance matrix is computed using the standard NMC method (*Berre* (2000); *Široká et al.,* 2003). No surface analysis was applied. The analysed surface fields from the global ARPEGE model are interpolated into the ALADIN grid. The 3D-Var is running in 6-hour assimilation cycle generating an analysis at 00, 06, 12 and 18 UTC. In this study, a 48-hour forecast was performed twice a day from 00 and 12 UTC. The domain of the ALADIN/HU comprises part of western and eastern Europe as well as part of the Mediterranean sea (Fig. 1).

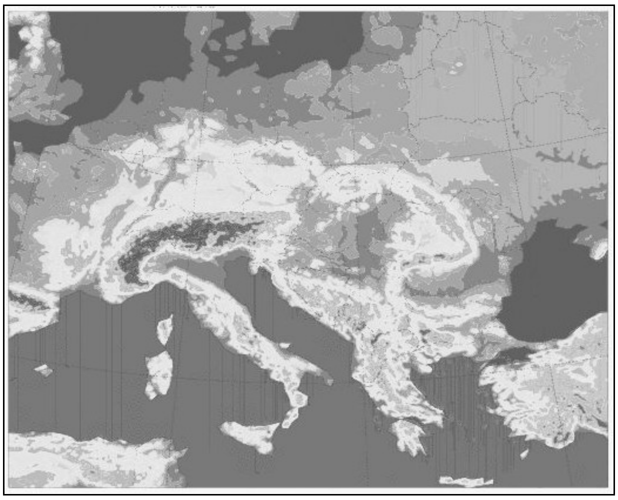


Figure 1: The domain of the ALADIN/HU limited area model.

4.1.3. The quality of the AMV data

First of all, we were interested on the quality of the QI found in the BUFR data. By this, we mean the relation between the QI, the retrieved winds and our assimilation system. For this purpose we performed a few days objective analysis, using observation with different QI in the assimilation process. The following settings were investigated: (1) all data with QI more than 30% assimilated over sea in thinning 50 km resolution, (2) all data with QI more than 70% assimilated over sea in 50 km thinning resolution, (3) all data with QI more than 70% and assimilated over sea in 25 km thinning resolution and (4) all data with QI more than 70% and assimilated also over land in 25 km thinning resolution. Comparing (1) with (2), one can see the "sensitivity" of the analysis system to the quality of the AMV data. Figure 2/a shows the observation departure and the analysis increment values for the settings (1 – SQ050) and (2 – SQ750). The results indicate that the higher the QI the smaller the standard deviation of both the mentioned values. Consequently, higher QI correspond to better quality of the retrieved winds. Comparing (3 – SQ725) and (4 – SL725), we evaluate the quality of the data retrieved over land with those retrieved over sea. The statistics related to the use of data retrieved over sea and the addition of data over land are very similar (Fig. 2/b).

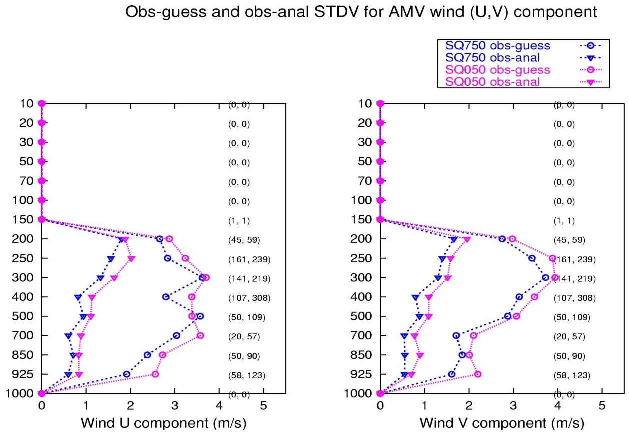


Figure 2/a: The statistics (standard deviation) of the observation departure (obs-guess) (circles) and the analysis increment (obs-analysis) (triangles) when using data with QI more than 30% (pink or light dark – SQ050) and data with QI more than 70% (blue or dark – SQ750).

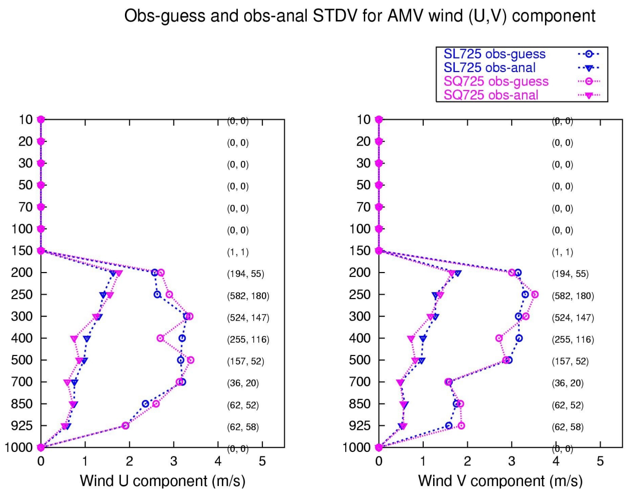
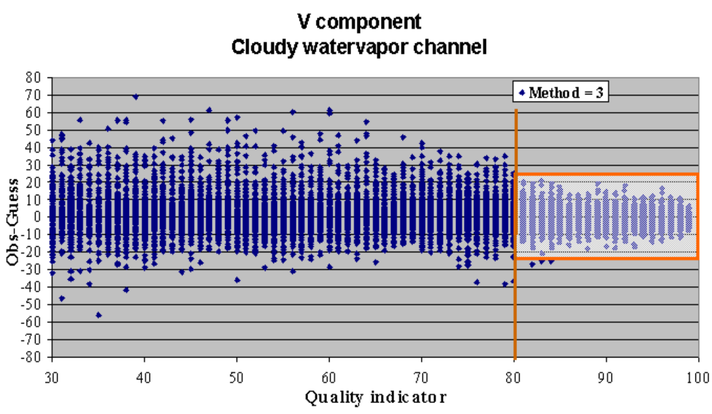
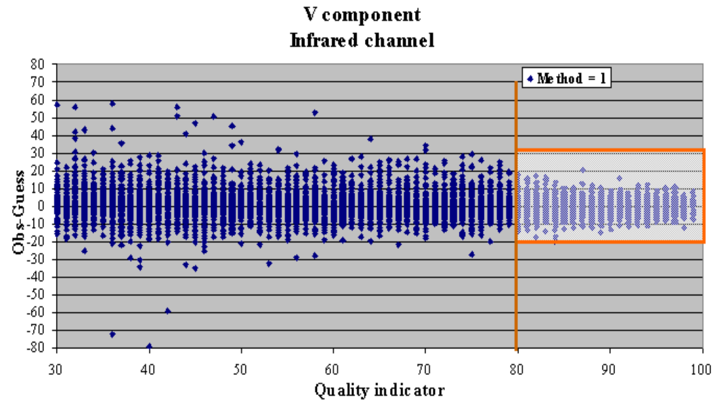


Figure 2/b: The statistics (standard deviation) of the observation departure (obs-guess) (circles) and the analysis increment (obs-analysis) (triangles) when using data over sea only (pink or light dark – SQ725) and the addition of data over land also (blue or dark – SL725).

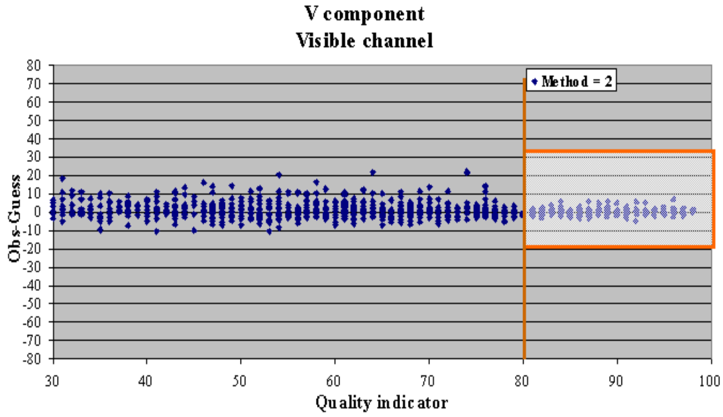
Figure 3 shows the observation departure as a function of the QIs for the wind V component derived from cloudy water vapour channels. One can see that changing the default threshold (85%) to 80%, the same quality of the analysis can be guaranteed. Better statistics were found when analysing the winds derived from infrared and visible channels.



a)



b)



c)

Figure 3: The distribution of obs-guess as a function of the quality indicators (QI) for winds derived from cloudy water-vapour (a), infrared (b) and visible (c) channels.

4.1.4. Impact of the AMV data on the analysis and short-range forecasts

Considering that the ALADIN/HU domain covers more land than sea, and the default threshold value of the QI for the quality control of the AMV data in the ARPEGE/ALADIN analysis system is 85%, we decided to study three configurations for the use of the AMV data. The following settings were investigated, dividing the atmosphere into three layers (Table1.a/b/c).

a)	used over sea only		
WDEF	P>800hPa	800-350hPa	P<350hPa
HRV	QI>85%	not used	not used
IR	QI>85%	not used	QI>85%
CWV	QI>85%	not used	QI>85%

b)	used over sea only		
W80P	P>800hPa	800-350hPa	P<350hPa
HRV	QI>80%	not used	not used
IR	QI>80%	not used	QI>80%
CWV	QI>80%	not used	QI>80%

c)	used over land also		
WLAN	P>800hPa	800-350hPa	P<350hPa
HRV	QI>85%	not used	not used
IR	QI>85%	not used	QI>85%
CWV	QI>85%	not used	QI>85%

Table 1. Description of the configurations on the use of the AMV data in the impact studies.

Beyond the above mentioned configurations, we performed one additional experiment without AMV data. In this study, among the observation, the radiosonde, the surface, the aircraft and the ATOVS (AMSU-A and AMSU-B) data were used (Randriamampianina et al., 2005 and 2006). The impact of the AMV data was studied for the period from 04.12.2004 to 10.01.2005, with a five-day warm up period. Thus, the evaluation period was one month (10.12.2004 – 10.01.2005).

The bias and root-mean-square error (RMSE) were computed from the differences between the analysis/forecasts and observations (surface and radiosondes) as well as analysis/forecasts and long cut-off ARPEGE analyses. Significance tests of the objective verification scores were also performed. The significance was examined based on statistical t-test regarding the difference in the expected values of the RMSE scores of the compared experiments. Plots were provided together with error bars that represent the interval in which the RMSE difference falls with 90% confidence. Consequently we considered a difference to be significant if the corresponding error bar did not include the zero difference line. In the comparison the first model (usually the test model) was better than the second (usually the control model) one if the mean score was negative, indicating an average reduction of the error.

We can see from Fig. 3 that only a small amount of AMV data was selected, thus the relative amount of active data was smaller than those from aircraft or radiosonde observations (Fig. 4). Changing the threshold from 85% to 80% allowed to use a bit more observation, but the addition of observations over land increased the number of active data in the analysis process more than double.

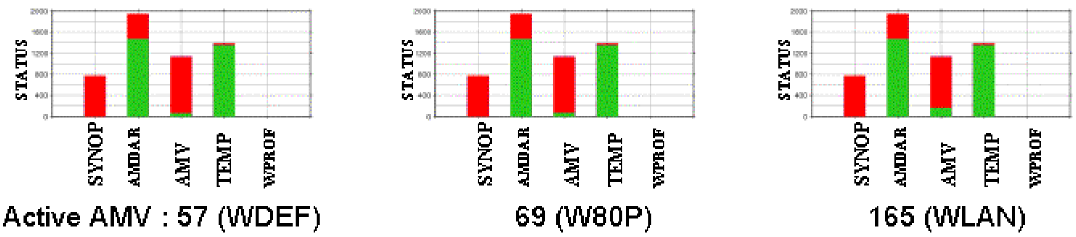


Figure 4: Relative contribution - the relative number of active (green or light dark) and rejected (red or dark) observations - of different wind (V component) observations in the analysis.

4.1.5. Comparison of the analysis and forecasts against the long cut-off ARPEGE analyses

The comparison of the analyses and short-range forecasts against long cut-off ARPEGE analyses showed small differences in root-mean-square errors (RMSE), when estimating the scores over the whole ALADIN/HU domain. The significance test showed small but almost significant positive impact of the AMV data on the forecast of geopotential and wind speed. Clear positive impact on the analysis and remarkable improvement in the forecasts of humidity were also observed (Fig. 5).

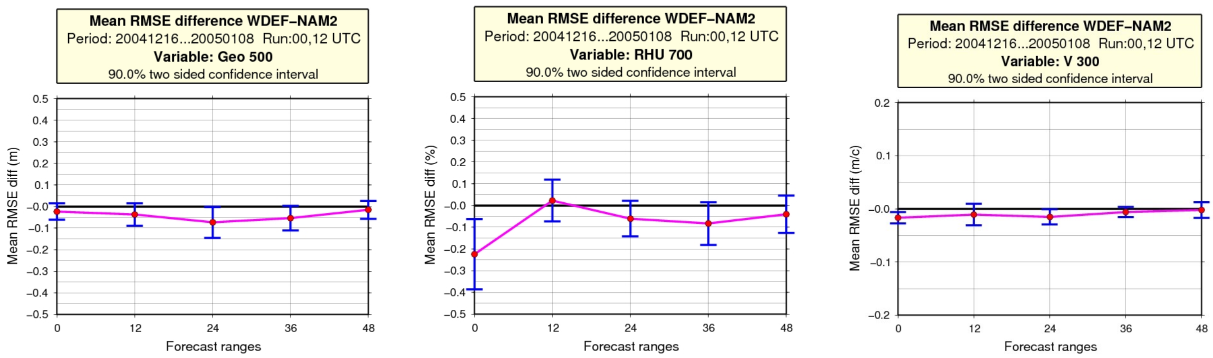


Figure 5: Significance test: Geopotential (left), relative humidity (centre) and wind speed (right) RMSE difference. The RMSE was computed from differences against analyses. WDEF is the run with AMV using the default threshold (85%) and NAM2 is the run without AMV.

Despite the small impact of AMV data, obtained over the whole ALADIN/HU domain, clear positive impact was found when making a zoom to our target areas (Carpathian basin and Hungary) (Fig. 6). No remarkable impact was found when changing the threshold only. But, using the AMV over land showed, however, small reduction of the RMSE of the analysis and short-range forecasts for geopotential within the target area. More sensitivity on the relative humidity was observed in the scores evaluated over the Carpathian basin (Fig. 7). Mainly, the significance test of scores evaluated over target areas showed larger and more significant impact.

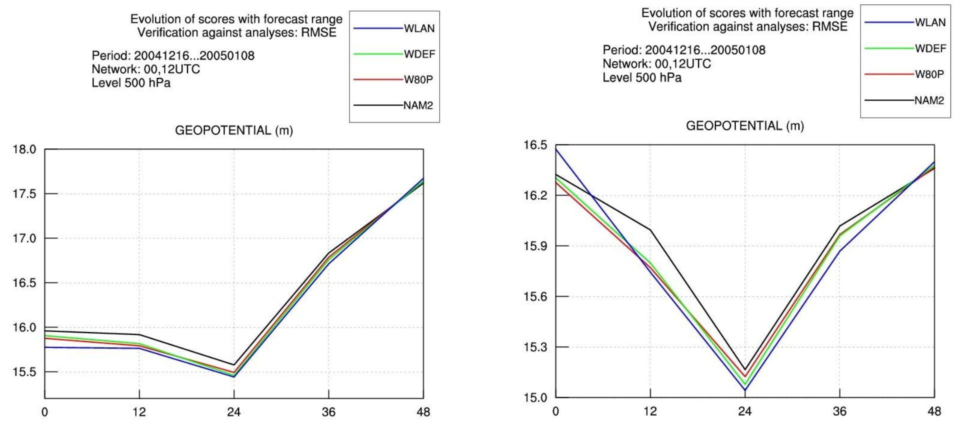


Figure 6: RMSE for different runs evaluated over the Carpathian basin (left) and Hungary (right). The RMSE was computed from differences against analyses.

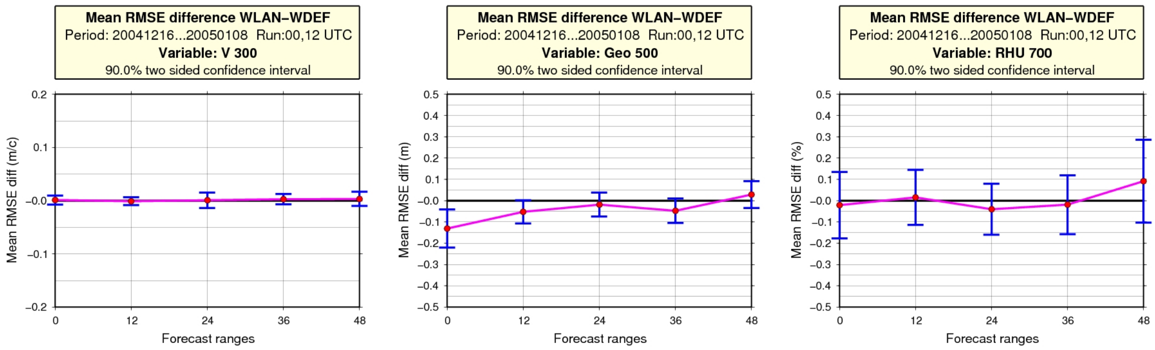


Figure 7: Significance test: Wind speed (left), geopotential (centre) and relative humidity (right) RMSE difference. The RMSE was computed from differences against analyses evaluated over Carpathian basin. WLAN and WDEF are runs with addition of AMV over land and data over sea only, respectively.

4.1.6. Comparison of the analysis and forecasts against observations

Mainly, comparison against observations showed neutral impact of the AMV data on upper-air fields, since the evaluation was done over the whole ALADIN/HU domain. We observed small but significant positive impact of the AMV data on the mean sea level pressure (Fig. 8). Unfortunately, our verification system, is not able to do any zooming computation on the upper-air fields. This part of the software is under development. But, it works well in the evaluation/computation of scores against any surface measurements.

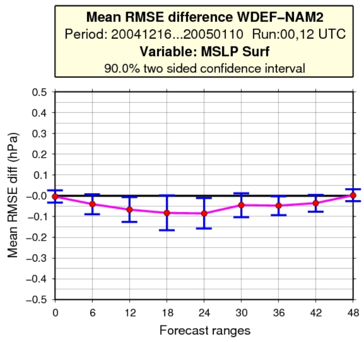


Figure 8: Significance test of the mean sea level pressure RMSE difference. The RMSE was computed from differences against observations evaluated over the whole ALADIN/HU domain.

Clear positive impact of the AMV data on the forecasts of precipitation was observed for all the forecast ranges over both of our target areas. Positive impact was observed, mainly, for day-2 from 00 UTC, and almost for all forecast ranges for forecasts from 12 UTC when evaluating the scores over the whole ALADIN/HU domain. But clear positive impact is observed over our target areas (Fig. 9).

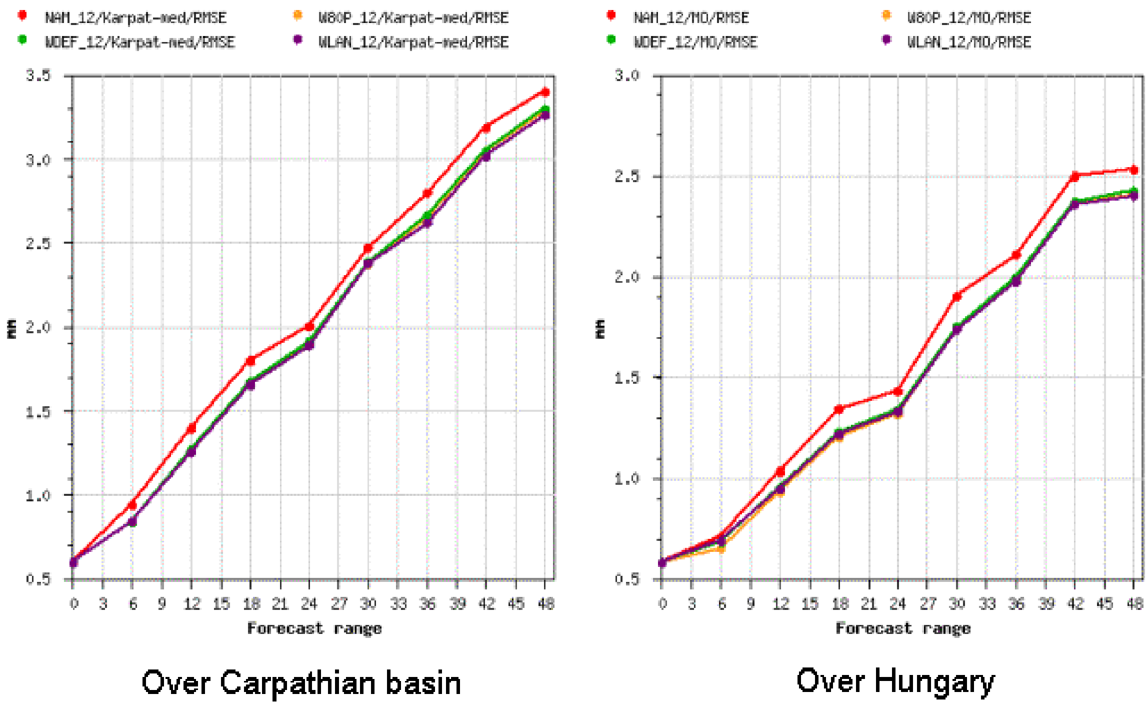


Figure 9: RMSE of the 6-h cumulated precipitation. Comparison against the surface gauges for the 12 UTC network. One can see that all runs with AMV show a remarkable reduction of the error over almost all forecast ranges.

4.1.7. Case studies

Three cases studies were carried out to describe the impact of the AMV data in case of extreme weather conditions. The *first case* was found within the evaluation period, when the eastern part of the ALADIN/HU domain (our target area) was influenced by a Mediterranean cyclone, with centre situated over Corsica. The cyclone, having a complex frontal system passed through Central Europe during the period of 26-29 Dec. 2004 (Fig. 10). Such systems are the typical reasons of large proportions of winter precipitation over Central Europe. The choice was also based on day to day plots of BIAS and RMSE scores of forecast for relative humidity (Fig. 11) and 6-h cumulated precipitation (not shown). Fig. 12 shows a clear positive impact of the AMV data for all the investigated configurations during the above mentioned period. Surface measurements (displayed numbers in Fig 12. – unfortunately, not well visible) prove that 6-hour cumulated precipitation patterns forecasted by runs with WDEF, W80P and WLAN data are more close to the reality than those obtained by the run without AMV data, which are shifted to the south.

The *second case* represented a situation when Hungary was situated between a cyclone (in the east) and a zone of high pressure over western Europe, with large pressure gradient over the country. Figure 13 shows the wind gust forecasted for the last 6-hour of 42-hour forecast. According to the observation, the wind gust over western and eastern Hungary reached 21, 30 m/s and 16, 18 m/s, respectively. Both the forecasts – achieved with and without AMV data - were satisfactorily good. Looking at the lower panels of Fig.13, we observe the low wind speed over the western part of Romania and relatively high wind speed over eastern and western part of Hungary. But the use of the AMV data made a slight positive correction in the forecast of highest wind gust, increasing the western pick and decreasing the eastern one.

The *third case* (summer case) corresponded to a situation, when the central and to a certain extent the eastern parts of Europe were influenced by a large cyclone with a warm front. This cyclone was crossing the southern part of eastern Europe and moved from the south to the north bringing a warm humid air from the Adriatic sea and causing very intensive precipitation over western part of Hungary (in Keszthely the measured cumulated 24 hour precipitation was 109 mm, in Vesprém: 49 mm, in Sármellék: 69 mm and in Pápa: 84.2 mm), Austria (Retz: 44 mm, Vienna: 43 mm, Lassnitzhoehe: 40 mm) and also Slovenia (Ljubian/Bezigrad: 50 mm) etc. Figure 14 shows a remarkable positive impact of the AMV data on both the day-2 24-hour cumulated precipitation (upper panels), as well as on the day-1 (lower panels) forecasts. The positive impact in the forecasts could be observed not only on the position of the precipitation patterns, but also on the precipitation intensity. For example, the day-1 forecast for the maximum precipitation over the western part of Hungary (Vesprém) was very good for both, location and amount: the location was just a few kilometres east from the real position and the measured intensity was 109 mm compared to the forecasted 107,2 mm.

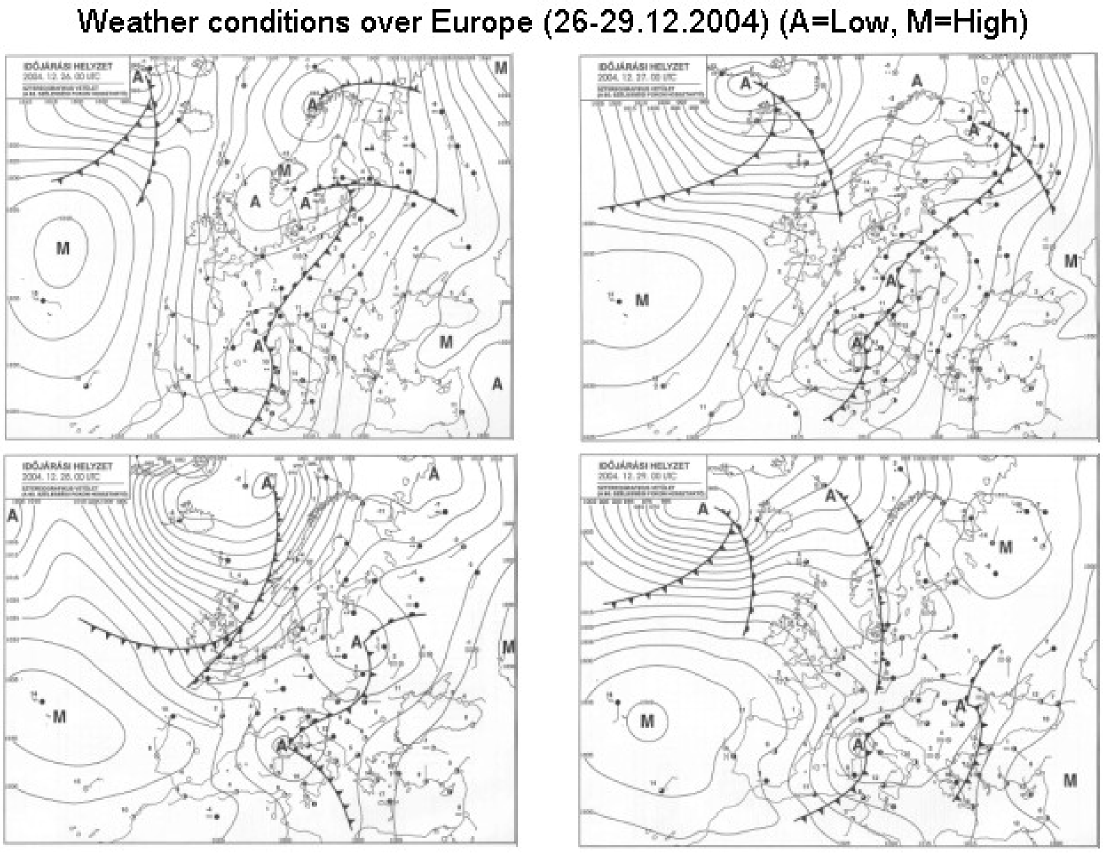


Figure 10: The weather condition over Europe during the period of 26-29 December 2004.

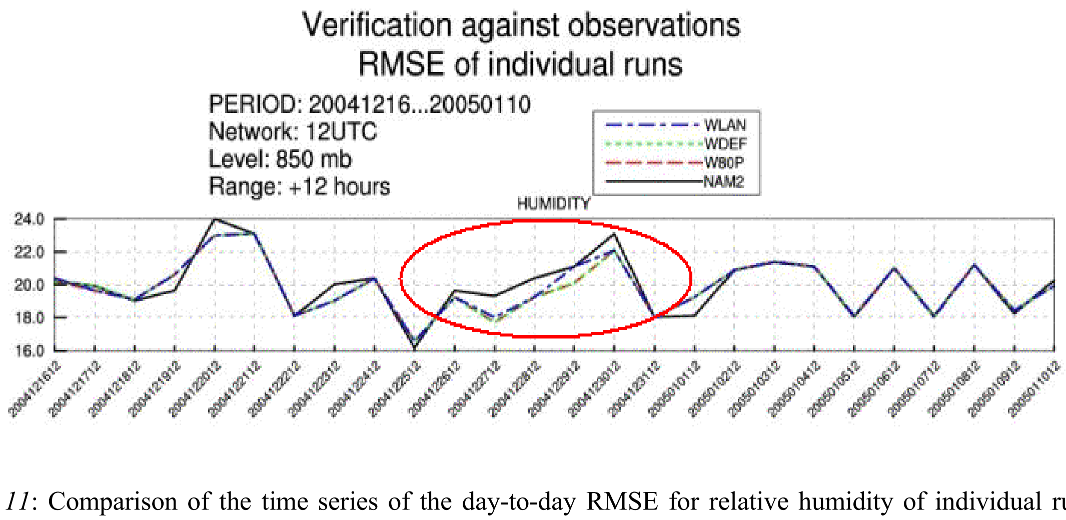


Figure 11: Comparison of the time series of the day-to-day RMSE for relative humidity of individual runs with (WLNA,WDEF and W80P) and without (NAM2) AMV data.

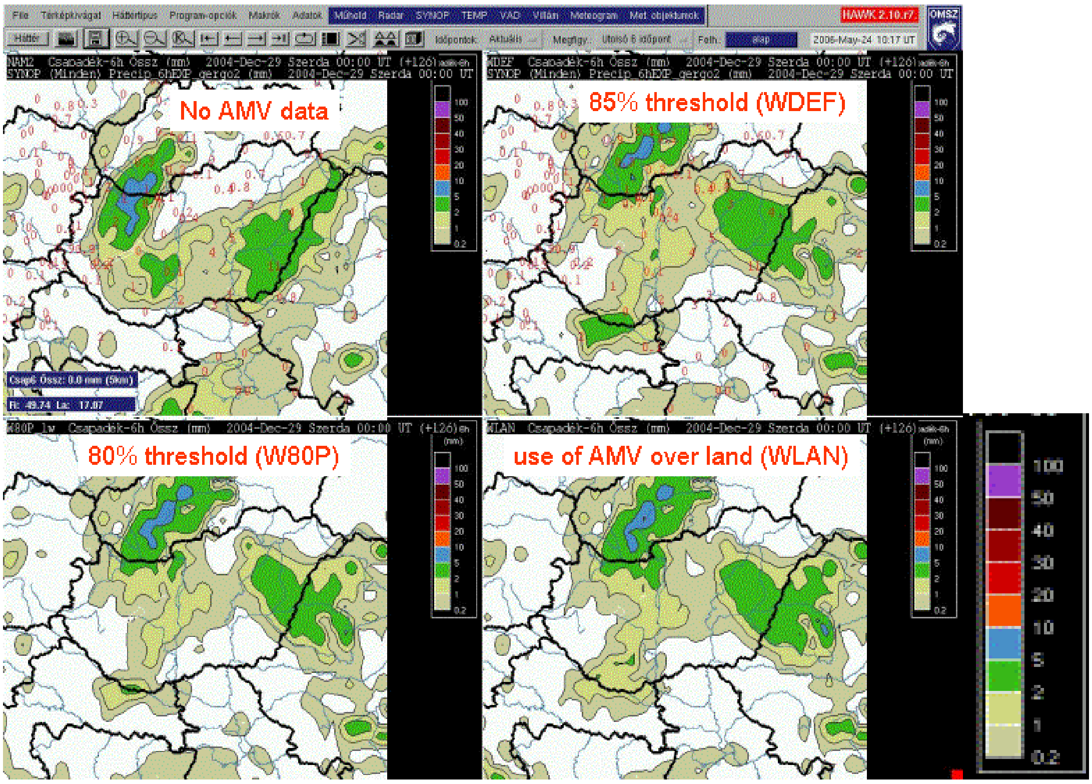


Figure 12: 6-hour cumulated precipitation patterns for 12 hour forecast range (valid for 29 Dec. 2004 00 UTC) from 28 Dec. 2004 12 UTC runs displayed by the HAWK visualization tool.

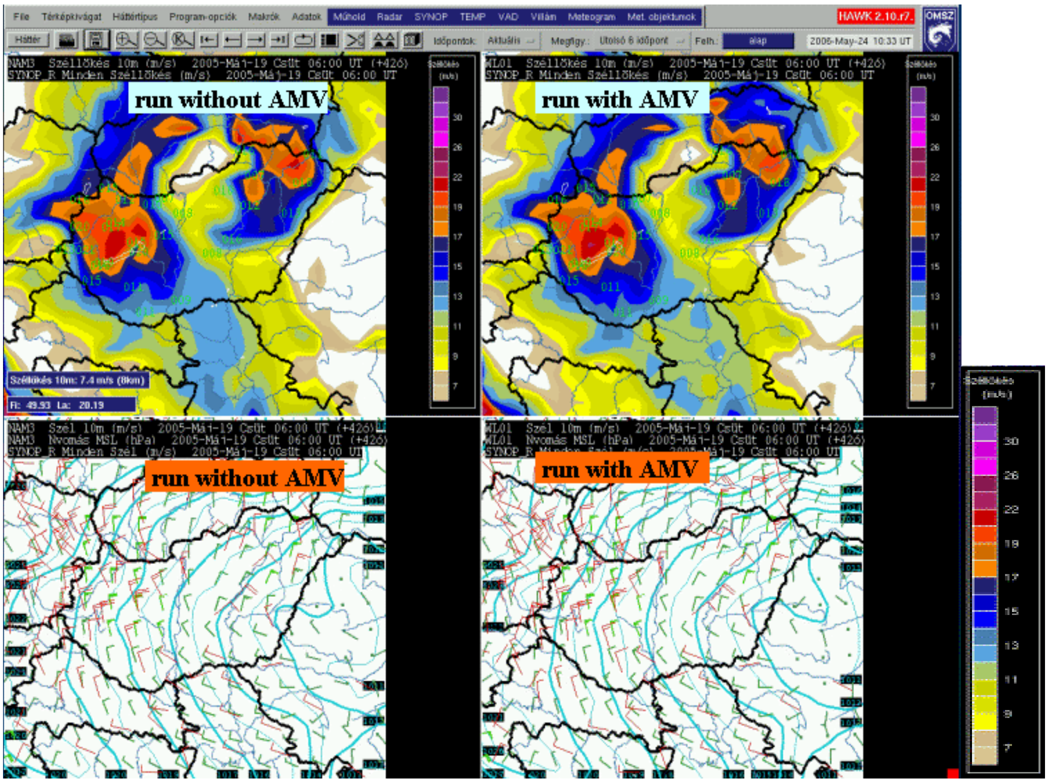


Figure 13: 42-hour forecast of wind gust (upper panels), 10m wind (measured - green arrows and measured red arrows) and mean sea level pressure (lower panels) for Thursday 19 may 2005 at 06 UTC.

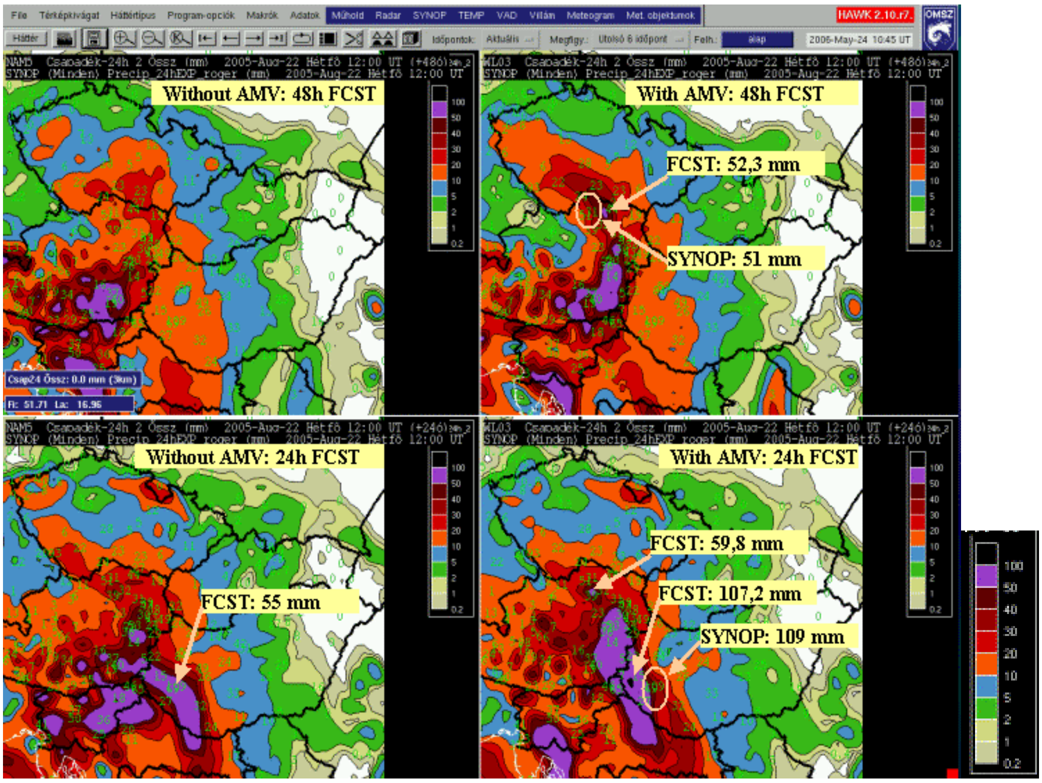


Figure 14: Forecasted 24-hour cumulated precipitation patterns for day-2 (upper panels) and day-1 (lower panels), valid for Monday 22 August 2005, 12 UTC. (FCST stands for forecasted value and SYNOP stands for the measured value).

4.1.8. Conclusions

Our investigation regarding the quality of AMV winds showed that the higher the QI the better the fit to the observation of the "obs-guess" and "obs-analysis". Although a big amount of data is transmitted, only few of them are used in the assimilation process. Comparison against the observations showed neutral impact of the AMV in the troposphere over the whole ALADIN/HU domain. We observed small but significant positive impact of the AMV on the mean sea level pressure. Over the whole ALADIN/HU domain the comparison against long cut-off ARPEGE analyses showed slightly positive impact of the AMV on geopotential, wind speed and humidity. Zooming over our areas of interest, we observed a remarkable positive impact of the AMV data. A significant positive impact of the AMV on the precipitation over our areas of interest was found. Case studies showed clear positive impact of the AMV data in case of extreme weather conditions. The above discussed results looked very encouraging, so we decided to add the AMV data in the operational analysis system.

Despite our satisfaction with the results, in order to use more good quality data in the pre-processing, the revision of the quality control is needed.

Acknowledgements

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4.1.9. References

Berre, L., 2000: Estimation of synoptic and meso scale forecast error covariances in a limited area model. Mon. Wea. Rev., 128, 644-667pp.

Payan, Christophe and Florence Rabier, 2004: The use of Meteosat Winds with Quality Indicators within the Météo-France Global NWP Model, 7th International Winds Workshop, Helsinki, Finland, from 14 17 June 2004.

Rabier, F., É. Gérard, Z. Sahlaoui, M. Dahoui and R. Randriamampianina, 2001: Use of ATOVS and SSMI observations at Météo-France. 11th Conference on Satellite Meteorology and Oceanography. Madison, WI, 15-18 October 2001 (preprints). Boston, MA, American Meteorological Society. 367-370.

Randriamampianina, R., R. Szoták, G. Csima, M. Balogh and G. Bölöni, 2005: Assimilation of high resolution observations in the ALADIN limited area model, 4th WMO International Symposium On Assimilation of Observations in Meteorology and Oceanography, 18-22 April 2005, Prague, Czech Republic.

Randriamampianina, Roger, Gergely Bölöni and Regina Szoták, 2006: Investigation of high resolution satellite observations in the ALADIN/HU model, accepted to the Időjárás.

Široká, M., Fischer, C., Cassé, V., Brožková, R., and Geleyn, J.-F., 2003: The definition of mesoscale selective forecast error covariances for a limited area variational analysis. Meteor. Atmos. Phys. 82, 227-244.

4.2. Rfa: an R package for analysis of Aladin files.

Alex Deckmyn: IRM

4.2.1. Introduction

This article introduces the R packages Rfa (decoding of FA files) and geogrid (visualisation of gridded data). Together they form a powerful tool for the **interactive analysis** of ALADIN output files. A related package, Rgrib (decoding of GRIB files) is also (very briefly) presented.

For those who are unfamiliar with R: R is a powerful open source environment for mathematics and statistics. It is a GPL version of S-plus. The main source for information is the home page http://www.R-project.org. This document does not give an introduction to basic R usage. For the simplest applications (visualisation of one field etc.) it may suffice, but the R web page offers several introductory texts (and a growing list of books) that will help you write more complicated loops and scripts. I especially recommend having a look at the "contributed documentation" list, where you can find several introductory courses.

This article does not offer enough space to fully describe all functions in these packages. More documentation can be had by asking for help from the R command line, e.g.

> ?FAopen

The source code for these packages and some basic documentation (e.g. for compilation of the packages) can be found on delage:~mrpe716/Rfa or from the author (alex.deckmyn@oma.be). The code has been tested mainly in a Linux environment.

WARNING

The code is in constant (but rather slow) development. Although these routines have been tested and used for some time, there will still be bugs and errors. May I invite you to send me some feedback if you use these packages? Any problems you encounter, and any ideas you may have for improvement, I would like to hear them.

4.2.2. Viewing Aladin files

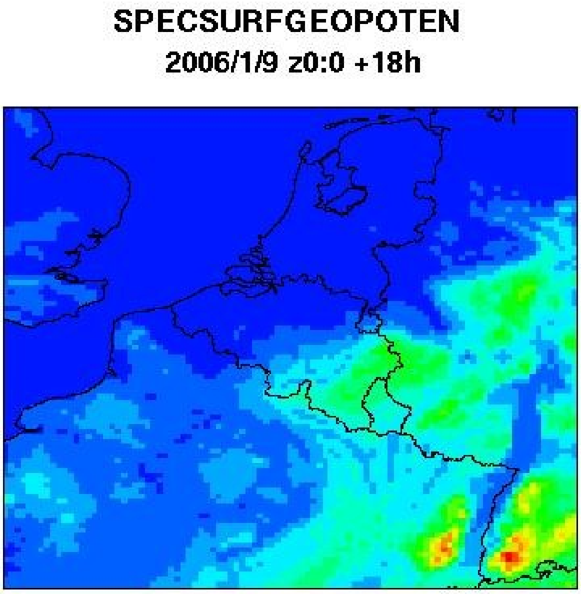
The 2 main functions of the `Rfa` package are `FAopen` and `FAdec`.

A simple example is:

```
> library(Rfa)
> f1=FAopen("ICMSHABOF+0018")
> geop=FAdec(f1,"SPECSURFGEOP")
> iview(geop,mapreso="worldHires",mapcol="black")

 Which will open a graphic window to plot the field:
```

This can in fact be shortened to




```
> iview(FAdec("ICMSHABOF+0018","SPECSURF"),
  mapreso="worldHires",mapcol="black")
```

Which is however less efficient if you plan to decode more than 1 field. The plot may be exported by

```
> dev.copy2eps(file="geopotential.ps")
```

Once a field has been decoded as a data matrix, the power of R can be used to study all possible aspects of FA files. For instance

```
> hist(FAdec(f1,"SURFPREC.EAU.GEC")+FAdec(f1,"SURFPREC.EAU.CON"))
```

will plot a histogram of total rainfall.

Finally, it is also possible to study the data in spectral form. Either by using the internal fft function, or by directly importing in spectral form:

```
> sgeop = Fadec("ICMSHABOF+0018","SPECSURF",outform="S")
> plot(ecto(sgeop),log="y")
```

where `ecto` is in fact a re-implementation of *ectoplasm.* It calculates the spectral energy per wave number for a single field. It was originally introduced to check the decoding routines and is not very fast.

4.2.3. Some additional features

Some additional functions that may be useful (use the help function for more details):

- Vecplot : a very basic routine for plotting vector fields (e.g. wind)
- DomainPoints : returns the co-ordinates of all the points of a grid.
- subgrid, zoomgrid : define a subdomain of a given geofield domain.
- lalopoint : find the value of a field in the grid point closest to a given Lat,Lon.

The `Rgrib` package offers a functionality very similar to `Rfa`. Its main functions are `Gopen` and `Gdec`. One of the differences is that in a GRIB file, the different fields may in fact have different dates and/or grids.

4.2.4. Final remarks

- These R packages are primarily meant for interactive analysis, not for operational use. The plot quality is not as good as that of specialised meteorological graphics routines.
- Also, it should be noted that the political borders in Europe are not up to date.
- The Rgrib package is rather elementary and currently only supports Lambert and LatLon projections, but other projections may be added in the future.
- Data export (i.e. saving data matrices in a FA or GRIB file) is not yet supported.

4.3. The parametrisation of the turbulent diffusion fluxes in the presence of cloud ice and droplets: synthesis and application to Aladin.

Luc Gerard: IRM

4.3.1. Main goals

An air parcel moved by diffusive vertical transport experiences variations of pressure an temperature; these variations affect the saturation pressure, entraining condensation/evaporation processes. When the temperature of the parcel is below the triple point, the condensed phase composition can also change. These processes are diabatic and the local variations of the temperature have a feedback on the local saturation pressure. If the condensate amounts become significant, microphysical processes may start, entraining precipitation. In this context, it becomes a very rough approximation to represent the turbulent diffusion by a mere adiabatic transport.

To handle this problem, some authors like Deardorff (1976) promoted the use of conservative variables, i.e. variables which would be conserved along the transport. This may be done to a certain extent by using a set of hypotheses, which will appear in the further development.

4.3.2. Conservative variables for Aladin

Candidates

First, we restrict to non precipitating cases. In this case, the total water:

1. $$q_t = q_v + q_i + q_l$$
2. is conserved (q_v , q_l , q_i are the specific contents of water vapour, cloud ice particles and cloud droplets). In dry adiabatic motions, the potential temperature θ is conserved:
3. $$\theta = T\left(\frac{p}{p_0}\right)^{\frac{R}{c_p}}$$ $$\text{with } R = R_a + r_v R_v \approx R_a + q_v R_v \text{ and } c_p = c_{pa} + r_v c_{pv} \approx c_{pa} + q_v c_{pv}$$

where r_v and q_v are respectively the mixing ratio and the specific contents of water vapour, T the temperature, p the pressure, $p_0 = 1000\,hPa$, R_a and R_v are the perfect gas constants for dry air and water vapour, c_{pa} and c_{pv} their specific heats.

θ is related to the dry static energy $s = c_p T + \phi$ (with ϕ the geopotential) by

4. $$q_t \frac{\partial s}{\partial p} = c_p \frac{\partial T}{\partial p} - \frac{RT}{p} = \frac{c_p T}{\theta} \frac{\partial \theta}{\partial p}$$

using the perfect gas law and the hydrostatic hypothesis.

When saturation and condensation/evaporation are likely, θ is no longer conserved. Betts (1973) defined the liquid-water potential temperature θ_l as

5. $$\theta_l \equiv \theta - \left(\frac{\theta}{T} \frac{L_v}{c_p}\right) q_l$$

A similar expression may be written for an ice potential temperature θ_i , assuming a single solid condensate and using L_s the sublimation latent heat.

Deardorff (1976) proposes some paths to generalize this to the simultaneous presence of cloud ice and droplets, as an "ice-liquid" potential temperature:

6. $$\theta_{li} \equiv \theta - \frac{\theta}{T}\left(\frac{L_v}{c_p} q_l + \frac{L_s}{c_p} q_i\right) \quad 00$$

We have

7. $$\frac{\partial\theta_{li}}{\partial p} = \frac{\partial\theta}{\partial p} - \frac{1}{c_p}\left(\frac{p_0}{p}\right)^{R/c_p}\left(L_v\frac{\partial q_l}{\partial p} + L_s\frac{\partial q_i}{\partial p}\right) + \frac{R}{c_p^2 p}\left(\frac{p_0}{p}\right)^{R/c_p}(L_v q_l + L_s q_i)$$
$$\Rightarrow \frac{c_p T}{\theta}\frac{\partial\theta_{li}}{\partial p} = \frac{c_p T}{\theta}\frac{\partial\theta}{\partial p} - L_v\frac{\partial q_l}{\partial p} - L_s\frac{\partial q_i}{\partial p} + \frac{R L q_c}{c_p p} \approx \frac{\partial(s - L_v ql - L_s q_i)}{\partial p}.$$

(were we used a bulk $L q_c = L_v q_l + L_s q_i$). Hence

8. $$s_{li} = s - L_v q_l - L_s q_i = c_p T + \phi - L_v q_l - L_s q_i \equiv c_p T_{li} + \phi$$

is an alternative candidate for a conservative variable.

Limitations

Deardorff (1976) says that assuming no precipitation, no freezing/melting , no radiative transfer, θ_l is conservative to the extent that the underlined factor in Eq. (4) is relatively constant in comparison with q_l .

Actually, the latent heats depend mainly on temperature:

9. $$L_v(T) = L_{v0} + (c_{pv} - c_w)(T - T_0), \quad L_s(T) = L_{s0} + (c_{pv} - c_i)(T - T_0),$$

while the specific heat vary with the phase composition:

10. $$c_p(q_v, q_l, q_i) = c_{pa} + (c_{pv} - c_{pa})q_v + (c_w - c_{pa})q_l + (c_i - c_{pa})q_i$$

Differentiating Eq.(4),

11. $$\Delta\theta_l = \Delta\theta - \left(\frac{\theta}{T}\frac{L_v}{c_p}\right)\Delta q_l - q_l\Delta\left(\frac{\theta}{T}\frac{L_v}{c_p}\right)$$

Let's consider an imaginary motion where q_l keeps a constant positive value (for instance the water is put into a watertight bag while the air keeps dry). One could think that in the absence of other exchange of mass or heat (conduction, radiation, molecular diffusion...) with the environment the dry air particle then follows an adiabatic transformation: there is no phase transition to act as a heat source or sink. But if the pressure is changed, the final temperature of the parcel is also changed, and the water in the bag must be brought to this temperature, which will modify θ : for this, the variation of $L_v(T)$ in the last term of the rhs may play its role.

Now let's suppose that the bag were isolated: in this case, the last term still contains the variation of θ/T : one then needs the hypothesis that this variation is negligible, else we loose the conservative character of θ_l . This justifies Deardorff's statement.

The expression for s_{li} in Eq. (7) is simpler than the one for θ_{li} .Considering the same imaginary experiment as above (constant condensates), we only have the variations of the latent heats with the temperature, which correspond to bringing the condensates to the final temperature of the parcel. It appears that unlike θ_{li} , no approximation is required to consider that s_{li} is conservative. The last equality in Eq. (7) means that the parcel behaves like a dry parcel at temperature T_{li} . It looks as if we evaporated all the condensates before the motion, and re-condensed them at the end. This supposes that no other process acts on the way of the parcel, i.e.

- no exchange of substance with environment: no entrainment, no molecular diffusion, no precipitation;
- no exchange of heat: no conduction at the interface, no radiative effect.

These basic assumptions limit the motions where s_{li} is conserved to short and quick motions, like turbulent diffusion or parts of the processes of shallow clouds, excluding deep convection, as well as radiative and microphysical processes.

4.3.3. Application to vertical turbulent diffusion

Calculation

The idea is to compute the turbulent diffusion of the two quasi-conservative variables: q_t and s_{li} , and the to find back corresponding diffusion fluxes for s , q_v , q_l and q_i .

The definition of q_t and s_{li} give two relations: to close the system, we need two additional relations, for instance binding the contents of ice and droplets to the two conservative variables.

The partition between vapour and condensates depends on the local saturation. The model variables represent mean grid-box values: turbulent diffusion acts on the local values, which may vary significantly within the grid box. We use Reynolds' decomposition of the local values between a mean component and a perturbation:

12. $$\psi=\overline{\psi}+\psi', \qquad \overline{\psi'}\equiv 0$$

where the overbar denotes the space averaging.

There can be condensation in parts of a grid box while the mean grid box values are not saturated. Condensation is loosely bound to saturation: it depends on the presence of condensation nuclei, and over saturation may be observed. Practically, in the limits of the diffusion processes, it appears too ambitious to introduce such microphysical details, as long as the development will be based on vague statistical estimations of the subgrid variability. So the simplest is to assume that the condensation occurs as soon as the saturation is reached. The condensation may be expressed on base of the saturation vapour specific content. Deardorff (1976) or Bougeault (1981) show that to a very good approximation, the dependence of q_s to the pressure can be neglected compared to the variation with temperature. So we may linearise the Clausius-Clapeyron equation as

13. $$q_t\frac{\partial q_{sl}}{\partial T}=q_{sl}\frac{L_v}{R_v T^2}, \qquad \frac{\partial q_{si}}{\partial T}=q_{si}\frac{L_s}{R_v T^2}$$

around a temperature T_{li} :

14. $$s_{li}\, q_{sl}(T)=q_{sl}(T_{li})+\left(\frac{\partial q_{sl}}{\partial T}\right)_{T_{li}}(T-T_{li}) \qquad q_{si}(T)=q_{si}(T_{li})+\left(\frac{\partial q_{si}}{\partial T}\right)_{T_{li}}(T-T_{li})$$

This linearisation (computing the derivative at a given temperature) suggests to also suppress the quadratic terms in the expression of the perturbations of s_{li} , i.e. to use the values $L_s(\overline{T})$ and $L_v(\overline{T})$ in Eq.(7), where $\overline{T}$ is the mean grid box temperature.

The saturation also depends on the phase to which condensation occurs.

Below the triple point, there still exists a condensation in the form of droplets when the ice forming nuclei are scarce. One often parametrizes this as a mixed phase present between two temperatures, say 0°C and -40°C, where statistically the ice fraction decreases in function of the temperature. In our scheme (based on Lopez 2001), the ice fraction of the cloud condensates follows

15. $$\frac{q_i}{q_c}=\alpha_i(T)=1-\exp\left(\frac{-\left(T_t-min(T_t,T)\right)^2}{2(T_t-T_x)^2}\right)$$

where $q_c=q_i+q_l$, $T_t=273.15K$ is the triple point temperature and T_x is the temperature of the maximum difference between the saturation vapour pressures with respect to ice and to liquid. Since α_i represents a statistical partition, we should only consider a mean value for a given grid box, $\alpha_i(\overline{T})$.

With the two hypothesis: prescribed $\alpha_i(\overline{T})$ and no over saturation, we can express the local condensate contents as

16. $q_c \equiv ql + q_i = max(0, q_t - q_s), \qquad q_s = \alpha_i(\overline{T}) q_{si}(T) + (1 - \alpha_i(\overline{T})) q_{sl}(T).$

Applying Eq.(13) around T_{li} and $\overline{T_{li}}$,

17.
$$q_{si}(T) = q_{si}(T_{li}) + \left(\frac{\partial q_{si}}{\partial T}\right)_{T_{li}} (T - T_{li}) = q_{si}(\overline{T_{li}}) + \left(\frac{\partial q_{si}}{\partial T}\right)_{\overline{T_{li}}} (T'_{li}) + \left(\frac{\partial q_{si}}{\partial T}\right)_{T_{li}} \frac{s - s_{li}}{c_p}$$
$$q_{sl}(T) = q_{sl}(T_{li}) + \left(\frac{\partial q_{sl}}{\partial T}\right)_{T_{li}} (T - T_{li}) = q_{sl}(\overline{T_{li}}) + \left(\frac{\partial q_{sl}}{\partial T}\right)_{\overline{T_{li}}} (T'_{li}) + \left(\frac{\partial q_{sl}}{\partial T}\right)_{T_{li}} \frac{s - s_{li}}{c_p}$$

Using $q_{ts} - s_{li} = L_v q_l + L_s q_i$, we note

18. $$q_t \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} = (1 - \alpha_i(\overline{T})) \left(\frac{\partial q_{sl}}{\partial T}\right)_{T_{li}} + \alpha_i(\overline{T}) \left(\frac{\partial q_{si}}{\partial T}\right)_{T_{li}} \quad \text{and}$$

19. $$q_s(\overline{T_{li}}) = \alpha_i(\overline{T}) q_{si}(\overline{T_{li}}) + (1 - \alpha_i(\overline{T})) q_{sl}(\overline{T_{li}}).$$

Then, in case of saturation

20. $$q_l \left\{1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_v(\overline{T})}{c_p}\right\} + q_i \left\{1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_s(\overline{T})}{c_p}\right\} = q_t - q_s(\overline{T_{li}}) - \left(\frac{\partial q_s}{\partial T}\right)_{\overline{T_{li}}} \frac{s'_{li}}{c_p}.$$

We assume that the ice fraction is the same for the local condensates (or the perturbations) as for the mean grid box condensates: $\alpha_i(\overline{T})$.

21. $$q_i = \alpha_i(\overline{T}) q_c, \qquad q_l = (1 - \alpha_i(\overline{T})) q_{c.}$$

This hypothesis is justified because α_i represents a statistics and we have no access to the actual local values of the ice fraction. The simple temperature dependence in Eq. (14) is a crude simplification of much more complex processes.

Hence

22.
$$\left\{(1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_v(\overline{T})}{c_p})(1 - \alpha_i(\overline{T})) + (1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_s(\overline{T})}{c_p}) \alpha_i(\overline{T})\right\} q_c$$
$$= q_t - q_s(\overline{T_{li}}) - \frac{1}{c_p} \left(\frac{\partial q_s}{\partial T}\right)_{\overline{T_{li}}} s'_{li}$$

Noting

23.
$$a = \left\{(1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_v(\overline{T})}{c_p})(1 - \alpha_i(\overline{T})) + (1 + \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}} \frac{L_s(\overline{T})}{c_p}) \alpha_i(\overline{T})\right\}^{-1}$$
$$b = \frac{1}{c_p} \left(\frac{\partial q_s}{\partial T}\right)_{T_{li}}$$

we get

24. $$q_c = max\left\{0, a(\overline{q_t} - q_s(\overline{T_{li}})) + a(q'_t - b s'_{li})\right\}$$

Which can be expressed (Smith 1990) as a function of the subgrid variability:

25. $q_c(\zeta) = max\left\{0, Q_c + \zeta\right\}, \qquad \zeta \equiv a(q'_t - b s'_{li}), \qquad Q_c = a(\overline{q_t} - q_s(\overline{T_{li}}))$

Assuming $G(\zeta)$ to be the probability density distribution of ζ in the grid box, the cloud fraction f and the mean condensate are given by

26. $f=\int_{-Q_c}^{\infty} G(\zeta)\,d\zeta\,,$ $\overline{q_c}=\int_{-Q_c}^{\infty}(Q_c+\zeta)\,G(\zeta)\,d\zeta$

The Smith scheme assumes a symmetric triangular distribution $G(\zeta)$ .positive for $-\sigma_\zeta\sqrt{6}<\zeta<\sigma_\zeta\sqrt{6}$, with a maximum $1/(\sigma_\zeta\sqrt{6})$ at $\zeta=0$, where

27. $$\sigma_\zeta=a\sqrt{\overline{q_t'^2}-2\,b\overline{q_t' s_{li}'}+b^2\overline{s_{li}'^2}}$$

is the standard deviation of ζ .

To compute the moments for the vertical diffusion, with $w=\overline{w}+w'$, we need to choose a joint distribution $G'(\zeta,w')$, so that

28. $$\overline{w' q_c'}=\overline{w q_c}-\overline{w}\;\overline{q_c}=\int_{-\infty}^{+\infty}\int_{-Q_c}^{\infty} w'(Q_c+\zeta)\,G(\zeta,w')\,d\zeta\,dw'$$

Mellor (1977) has shown that assuming a Gaussian joint distribution for w' and ζ , the resulting correlation is given by

29. $$\overline{w' q_c'}=Na(\overline{w' q_t'}-b\;\overline{w' s_{li}'}),\quad N=\int_{-Q_c}^{\infty} G(\zeta)\,d\zeta$$

where N is the cloud fraction. Bougeault (1982) questioned the hypothesis of a joint Gaussian distribution, while proposing to keep the relation

30. $\overline{m' q_c'}=\overline{m'\zeta}\,\dfrac{\overline{q_c'\zeta}}{\sigma_\zeta^2}\,,$ $\overline{q_c'\zeta}=\int_{-\infty}^{\infty} q_c'(\zeta)\,G(\zeta)\,d\zeta$

valid for any variable m following Mellor's development, i.e. to extent this result to non Gaussian distributions.

He then uses a set of distributions characterized by a skewness factor A_s and the normalized generalized condensate $Q_1=Q_c/\sigma_\zeta$.

The different integrations yield then different functions, written as

31. $N=F_0(Q_1,A_s)\,,$ $\dfrac{\overline{q_c}}{\sigma_\zeta}=F_1(Q_1,A_s)\,,$ $\dfrac{\overline{\zeta q_c'}}{\sigma_\zeta^2}=F_2(Q_1,A_s)$

This implies to replace the factor N in Eq. (28) by F_2 .

Bechtold et al. (1995) express

32. $$A_s\frac{\overline{\zeta q_c'}}{\sigma_\zeta^2}=N(1+f_{NG})$$

where f_{NG} is the non-Gaussian contribution to the flux.

So we can compute the vertical turbulent diffusion flux of condensate based on the fluxes of the quasi-conservative variables. In the expression of a , we can compute the derivatives at $\overline{T_{li}}$ instead of T_{li} .

Finally, the vertical turbulent diffusion flux for the vapour, the condensed phases and the dry static energy are given by

33. $$\begin{aligned}\overline{w' q_v'}&=\overline{w' q_t'}-\overline{w' q_c'}\\ \overline{w' q_i'}&=\alpha_i(\overline{T})\,\overline{w' q_c'}\\ \overline{w' q_l'}&=(1-\alpha_i(\overline{T}))\,\overline{w' q_c'}\\ \overline{w' s'}&=\overline{w' s_{li}'}+L_s(\overline{T})\,\overline{w' q_i'}+L_v(\overline{T})\,\overline{w' q_l'}\\ &=\overline{w' s_{li}'}+\left[1-\alpha_i(\overline{T})\,L_v(\overline{T})+\alpha_i(\overline{T})\,L_s(\overline{T})\right]\overline{w' q_c'}\end{aligned}$$

This way, the vertical variation of α_i (melting or freezing) contributes to the vertical divergence of $\overline{w's'}$, inducing a local heating or cooling.

Comments

In all these relations, the different local coefficients act on the total flux and *not on the local increments.*

The situation is not the same as for the so-called "physical fluxes" which cumulate the local tendencies and are used as an interfacing tool in the Aladin model. For instance when we accumulate the local increments of condensate into a condensation flux the associated heat exchange is proportional to the local increment while the pre-existing part of the flux is simply transported further.

On the contrary, the diffusion flux is the expression of the local gradients. The equations of the fluxes describe the cause of the motion, not its effect. For instance

- a vertical gradient of the ice fraction between two layers will induce a diffusive motion, affecting the local tendency.
- A vertical gradient of temperature also implies a gradient of $L(T)$ affecting the dry static energy, because moving a parcel would require to heat or cool the condensates in the parcel.

Hence the latent heat in the conservative variables is associated to the flux and applies to the totality of the flux, which may absorb or release some latent heat locally. The variations of the latent heats correspond to bringing the condensates to the local temperature.

The variations of the phase partition are a diagnostic, not the expression of a phase change in a motion: the fluxes being proportional to gradients, those gradients include the one of α_i.

In conclusion, using equations (28) and (32) we have a coherent treatment of the turbulent fluxes, with no need to represent directly the condensation and evaporation processes occurring during the diffusion. The turbulent flux of dry static energy in Eq.(32) is equal to the flux of liquid-ice static energy as soon as the condensate fluxes are zero.

4.3.4. Conclusions

The central hypotheses of the presented formulation are the linearization of the Clausius-Clapeyron equation separately for saturation with respect to ice and to liquid water; and taking all the time the latent heats and the ice fraction at the mean grid box temperature i.e. also in the expression of the perturbations of the condensates and static heat.

The use of conservative variables seems appropriate for the vertical turbulent diffusion process. For horizontal advection, it remains simpler to transport directly the condensate variables and make an *adiabatic* readjustment towards $\alpha_i(T)$, immediately after advection. In this case as well as for deep convection, we cannot ignore the effects of radiation, mixing or microphysical processes so that we no longer may assume the conservation of total water or liquid-ice static energy.

4.3.5. References

P. Bechtold, J. W. M. Cuijpers, P. Mascart, and P. Troulhet. Modeling of trade wind cumuli with a low-order turbulent model: Toward a unified description of cu and sc clouds in meteorological models. J. Atmos. Sci., 52: 455- 463, 1995.

A. K. Betts. Non-precipitating cumulus convection and its parametrization. Q. J. R. Meteorol. Soc., 99: 178-196, 1973.

Ph. Bougeault. Modeling the trad-wind cumulus boundary layer. part i: Testing the ensemble cloud relations against numerical data. J. Atmos. Sci., 38: 2414-2428, 1981.

Ph. Bougeault. Cloud ensemble relations based on the gamma probability distribution for th higher order models of the planetary boundary layer. J. Atmos. Sci., 39: 2691-2700, 1982.

J. W. Deardorff. Usefulness of liquid-water potential temperature in a shallow-cloud model. J. Appl. Meteorol., 15:98-102, 1976.

G. L. Mellor. The Gaussian cloud model relations. J. Atmos. Sci., 34: 356-358, 1977.

R. N. B. Smith. A scheme for predicting layer clouds and their water content in a general circulation model. Q. J. R. Meteorol. Soc., 116: 435-460, 1990.

4.4. Towards the Assimilation of Microwave Satellite Measurements Over Land in the French 4D-Var Assimilation System.

Karbou F., E. Gérard and F. Rabier: Météo France

4.4.1. - Summary

If microwave satellite observations are routinely used over oceans in many operational Numerical Weather Prediction (NWP) models, their use over land is still a challenging issue. At best, only the channels that are not contaminated by surface contributions are assimilated because of uncertainties about the surface emissivity and the skin temperature. Efforts are performed at Météo-France in order to extend the use of microwave measurements to both ocean and land surfaces. This paper reports on three microwave land surface schemes developed at Météo-France in order to assimilate microwave observations over land. These schemes aim to better describe the land emissivity and/or the skin temperature.

4.4.2. - Introduction

The Advanced Microwave Sounding Unit (AMSU) A and B are on board the latest generation of the National Oceanic and Atmospheric Administration (NOAA) polar orbiting satellites and on board the aqua mission. The AMSU-A instrument sound the atmosphere temperature up to 45 km down to the Earth's surface whereas the AMSU-B one is used for atmospheric water vapor probing (Chaboureau et al. 1998, Rosenkranz 2001, Wagner et al. 1990, Shi 2001, Franquet 2003, Moreau et al. 2005, Karbou et al. 2005a). Moreover, both instruments make measurements at window channels which can be used to retrieve surface information such as emissivity, temperature, rain rate, integrated water vapor, etc (Grody et al. 2001, Weng et al. 2003, Zhao et Weng 2002).

Therefore, NWP models can benefit from the information content of AMSU measurements to accurately monitor both air temperature and moisture profiles with good temporal and spatial sampling in most weather conditions. Indeed, unlike infrared measurements, microwave observations are less sensitive to high thin and non precipitating clouds.

Over land, AMSU measurement are still not fully exploited in NWP models. At best, only channels that receive the least contribution from the surface are assimilated (Kelly and Bauer 2000, Gérard et al. 2003, English et al. 2003). The assimilation of surface sensitive channels require both accurate emissivity and skin temperature. These requirements are more difficult to satisfy over land than over ocean. The land microwave emissivity is high (close to 1.0) and varies considerably with surface type, roughness, and moisture to name but a few parameters. Consequently, it is quite difficult to separate the land contribution from the atmospheric contribution to the observed brightness temperature. Despite these limitations, many studies were conducted to estimate the land emissivity directly using ground based measurements (Maztler (1990, 1994), Calvet et al. 1995, Wigneron et al. 1997), airborne measurements (Hewison and English 1999, Hewison 2001) and satellite measurements (Felde and Pickle 1995, Choudhury 1993, Jones and Vander Haar 1997, Morland et al. (2000, 2001), Prigent et al. 1997, Karbou et al. 2005). Unlike land surfaces, oceans are associated with lower emissivities (around 0.5) and also with higher polarisation differences. Moreover, in spite of some remaining surface uncertainties, many oceanic models have been used in atmospheric applications to produce emissivity estimates with good accuracy (Deblonde and English 2000, Guillou et al. 1998, Prigent and Abba 1990, Guissard and Sobieski 1987, Rosenkranz and Staelin 1972, Wentz 1972, among many others).

Useful temperature and moisture information from AMSU measurements or equivalent sensors can not be exploited over land unless the emissivity and the skin temperature estimates are improved. This paper reports on recent studies conducted at Météo-France in order to improve the description of both emissivity and skin temperature within the constraints of the French 4D-Var assimilation system.

4.4.3. - Microwave emissivity and/or skin temperature to help assimilating surface sensitive measurements

AMSU data

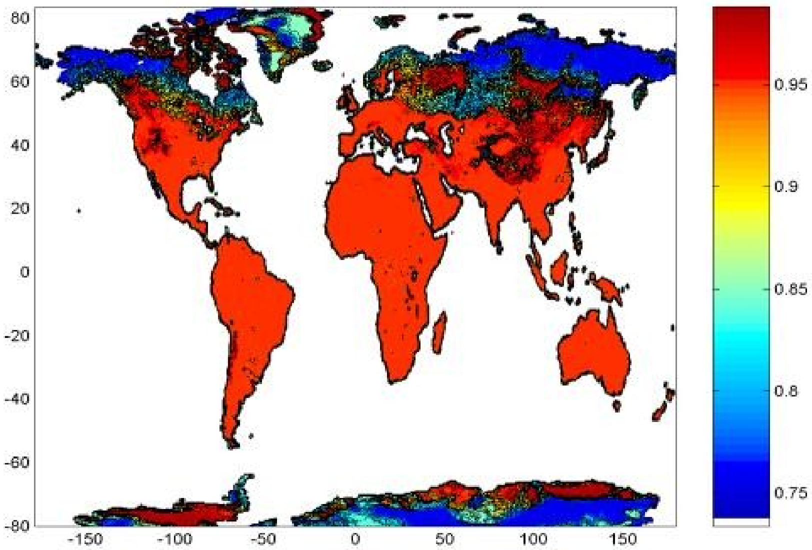
The AMSU sounding units have been operating on board the NOAA satellites since 1998. AMSU-A has 12 channels located close to the 50-60 GHz oxygen absorption lines and 4 window channels at 23.8, 31.4, 50.3, and 89 GHz. AMSU-B has two window channels at 89 and 150 GHz and three humidity ones close to the 183.31 GHz water vapor line. The two instruments have instantaneous fields of view of 3.3° and 1.1° and sample 30 and 90 Earth views respectively. The AMSU observation scan angle varies from -48° to +48° with the corresponding local zenith angle reaching 58°. the following Table gives the channel characteristics for both AMSU-A and -B radiometers and a detailed description of the AMSU sounders is reported in Goodrum et al. 2000.

Channel No	Frequency (GHz)	Noise equivalent (K)	Resolution at nadir (km)
	AMSU-A		
1	23.8	0.20	48
2	31.4	0.27	48
3	50.3	0.22	48
4	52.8	0.15	48
5	53.596+/-0.115	0.15	48
6	54.4	0.13	48
7	54.9	0.14	48
8	55.5	0.14	48
9	57.290=f_0	0.20	48
10	f_0 +/- 0.217	0.22	48
11	f_0 +/- 0.322 +/- 0.048	0.24	48
12	f_0 +/- 0.322 +/- 0.022	0.35	48
13	f_0 +/- 0.322 +/- 0.010	0.47	48
14	f_0 +/- 0.322 +/- 0.0045	0.78	48
15	89	0.11	48
	AMSU-B		
16	89	0.37	16
17	150	0.84	16
18	183.31 +/- 1	1.06	16
19	183.31 +/- 3	0.70	16
20	183.31 +/- 7	0.60	16

Three land surface schemes

This paper relies on the Météo-France assimilation and forecast model system (ARPEGE) that uses a 6-hour time window and a multi-incremental 4D-Var (Courtier et al 1994; Veersé and Thépaut 1998; Rabier et al 2000). the radiative transfer model RTTOV (Eyre 1991, Saunders et al. 1999, Matricardi et al 2004) is used to provide model equivalent to the observations.

Emissivity at 89 GHz from the operational



Emissivity at 89 GHz from scheme1

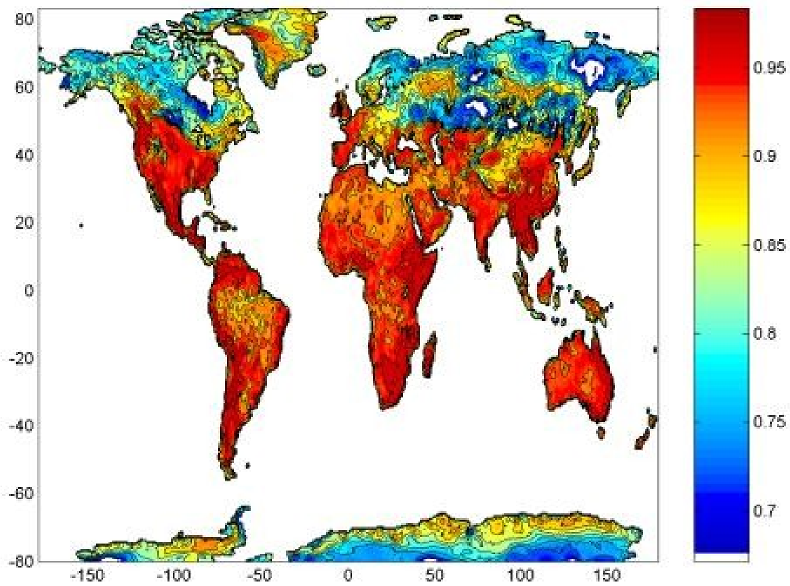


Fig. 1: Mean emissivity maps averaged over two week period (22 March to 2 april 2005) and obtained from the operational model (left panel) and from the land scheme 1 (right panel). (from Karbou et al. 2006)

For microwave observations, a combinaison of two models is used to estimate the land emissivity. Indeed, depending on surface type and observation frequency, the ARPEGE 4D-var system uses Grody 1988 or Weng et al. 2001 models to get emissivity estimates at AMSU frequencies. In this study, three land schemes have been implemented within the RTTOV model in order to allow the estimation of microwave emissivities and/or skin temperatures directly from satellite observations.

The first land configuration uses emissivity atlases obtained using AMSU data from the 2 weeks prior to the assimilation period. The emissivities are computed directly from AMSU surface channels following the method described in Karbou et al. 2005b. The second land scheme is based on dynamical emissivity estimations at AMSU-A channel 1 and AMSU-B channel 1. The obtained emissivities are allocated to the other AMSU-A and AMSU-B channels. The third land scheme is based on the first one with dynamical skin temperature estimation at AMSU-A channel 1 and AMSU-B channel 1. The thus obtained skin temperature is used as a guess for the other channels. For scheme 2 and scheme 3, AMSU-A channel 1 (23.8 GHz) and AMSU-B channel 1 (89 GHz) are discarded from any other calculation or diagnostic to ensure the same information is not used twice. More details about these surface configurations could be found in Karbou et al. 2006. Figure1 compares the emissivity at 89 Ghz obtained with both the operational system (that uses emissivity emiprical models) and the land surface scheme 1 (that allow emissivity estimation directly from satellite observations).

Discussion

The three land schemes described above have been implemented within ARPEGE and tested during different periods in year 2005 (22 March to 15 April, 15 August to 15 september 2005). The results of these schemes have been compared with those obtained while using the operational model. In the following, we will briefly discuss the results in terms of observation departure from first guess and the number of observations that could be used by the 4D-Var system. The results of the comparisons show a significant improvement in the fg-departure statistics when the surface is updated with one of the new land schemes. The fg-departures are the differences between observed and simulated radiances using the background fields without any bias correction. Figure 2 shows the fg-departure histograms at 50 GHz (AMSU-A channel 3) and obtained from 15 to 31 August 2005 while using the operational model and the three surface schemes.

The obtained results differ from one experiment to another. We noted a general increase in the number of observations that could be assimilated with respect to the operational. With land schemes 2 and 3, we note an increase of up to 140 % in the number of observations that pass the quality control check for AMSU-B channel 2 with respect to the operational system.

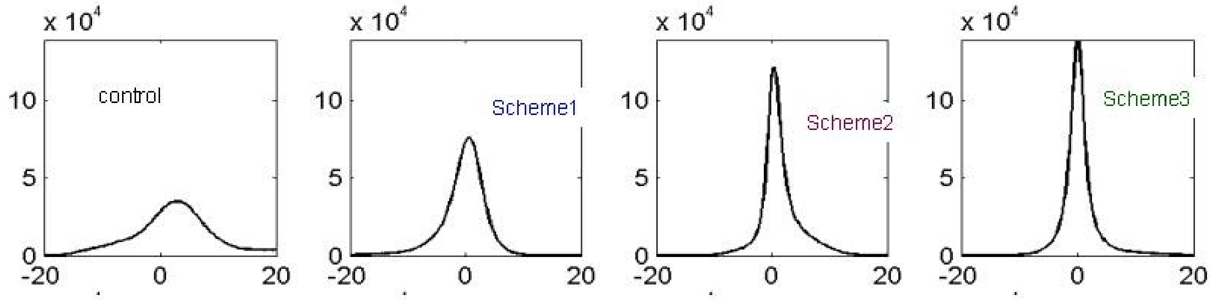


Fig. 2: fg-departures histograms for 50 Ghz channel (AMSU-A channel 3) obtained over the glob and during the period 15-31 August 2005. Results are given for the control experiment and for 3 other experiments using scheme1, 2 and 3 respectively.

These results are encouraging and indicate that many more data coming from microwave surface channels could be assimilated if an adequate land scheme is chosen. However, the sensitivity studies described in this paper are not sufficient to assess the quality of each land scheme and to draw some final conclusions. In particular, additional studies, in terms of impact on analysis fields and forecast skills, are now conducted to choose the best land scheme for our 4D-Var system. Moreover, these land configurations have been adapted for SSM/I observations in order to prepare their assimilation over land.

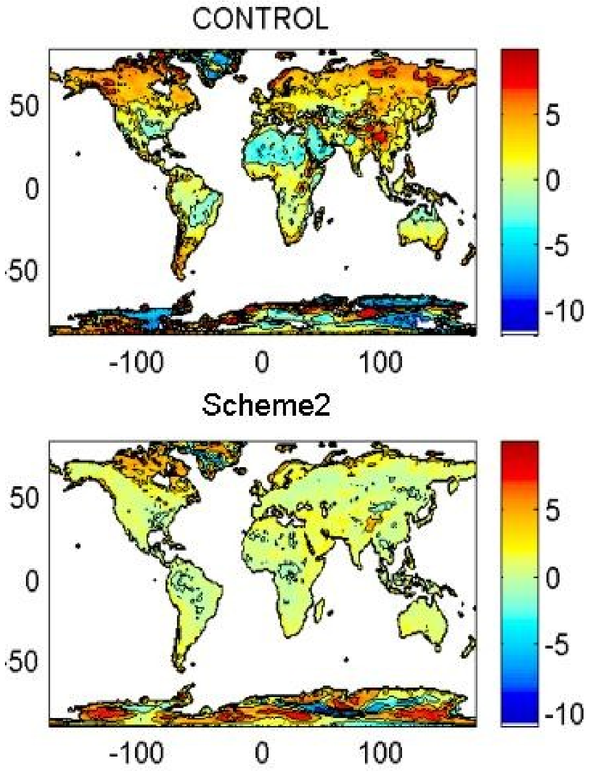


Fig. 3: fg-departures maps for the 50 Ghz channel (AMSU-A channel 3) obtained over the glob and during the period 15-31 August 2005. results are given for the control experiment and for 3 other experiments using scheme1, 2 and 3 respectively.

References

Calvet, J. -C., J.-P. Wigneron, A. Chanzy, S. Raju, and L. Laguerre, 1995, Microwave dielectric properties of a silt-loam at high frequencies, I*EEE Trans. Geosci. Remote sensing*, vol. 33, pp. 634-642.

Chaboureau, J. P., A. Chédin, and N. Scott, 1998, Remote sensing of the vertical distribution of atmospheric water vapor from the TOVS observations: Method and validation, *J. Geophysical Research,* vol. 103, no. D8, pp. 8743-8752.

Choudhury, B. J., Reflectivities of selected land surface types at 19 and 37 GHz from SSM/I observations, 1993, *Remote Sens. Environ.*, vol. 46, Issue 1, pp. 1-17.

Courtier, P., J. N. Thépaut, and A. Hollingsworth,1994, A strategy for operational implementation of 4D-Var using an incremental approach. *Q. J. R. Meteorol. Soc.*, 114, 1321-1387.

Deblonde, G., and S. English, 2000, Evaluation of fastem and fastem2 fast microwave oceanic surface emissivity model. *Proceeding of the 11th International ATOVS study conference*. Budapest, Hungary, 67-78.

English, S., D. Jones, A. Smith, F. Hilton, and K. Whyte, 2003, ATOVS and SSMI assimilation at the Met Office, *Proc. Of the thirteenth International TOVS study conference*, Sainte-Adèle, Canada.

Eyre, J. R., 1991, A fast radiatif transfer model for satellite sounding systems. *ECMWF Tech. Memo*., 176, 28 pp.

Franquet, S., 2003, Contribution à l'étude du cycle hydrologique par radiométrie hyperfréquence: algorithmes de restitution (réseaux de neurones) et validation pour la vapeur d'eau (instruments AMSU, SAPHIR) et les précipitations (AMSU,Radarsau sol Baltrad), Thèse de doctorat de l'Université Paris-Diderot (Paris VII).

Gérard, E., F. Rabier, M. Dahoui, and Z. Sahlaoui, 2003: Use of global ATOVS and SSMI observations at Météo-

France, *Proc. Of the thirteenth International TOVS study conferenc*e, Sainte-Adèle, Canada.
Guillou, C., W. Ellison, L. Eymard, K. Lamkaouci, C. Prigent, G. Delbos, G. Balana, and S. A. Boukabara, 1998, Impact of new permittivity measurements on sea surface emissivity modelling in microwaves. *Radio Science*, 33, 649-667.
Guissard, A., and P. Sobieski, 1987, An approximate model for the microwave brightness temperature of the sea. *Int. J. Remote Sens.*, 8, 1607-1627.
Grody, N. C., 1988, Surface identification using satellite microwave radiometers, *IEEE Trans. On Geoscience and Remote sensing*, 26, 850-859.
Grody, N. C., J. Zhao, R. Ferraro, F. Weng, and R. Boers, 2001, Determination of precipitable water and cloud liquid water over oceans from the NOAA-15 advanced microwave sounding unit, *J.Geophys. Res.*, 106, 2943-2954.
Karbou, F.,F. Aires, C. Prigent and L. Eymard, 2005a, Potential of Advanced Microwave sounding Unit-A (AMSU-A) and AMSU-B measurements for temperature and humidity sounding over land. *J. Geophysical Research*, 110, D07109, doi:10.1029/2004JD005318.
Karbou, F.,C. Prigent, L. Eymard and J. Pardo, 2005b, Microwave land emissivity calculations using AMSU-A and AMSU-B measurements. *IEEE Trans. on Geoscience and Remote Sensing*, 43, 5, 948-959.
Karbou, F., E. Gérard, and F. Rabier, 2006, Microwave land emissivity and skin temperature for AMSU-A and -B assimilation over land, *Q. J. R. Meteorol. Soc.*, ref. 05/216, to appear.
Kelly, G., and P. Bauer, 2000, The use of AMSU-A surface channels to obtain surface emissivity over land, snow and ice for Numerical Weather Prediction. *Proc. Of the Eleventh International TOVS study conference*, Budapest, Hungary, 167-179.
Matricardi, M., F. Chevallier, G. Kelly, and J. N. Thépaut, 2004, An improved general fast radiative transfer model for the assimilation of radiance observations. *Q. J. R. Meteorol. Soc*., 130, 153- 173.
Matzler, C., 1990, Seasonal evolution of microwave radiation from an oat field. *Remote Sens. Environ.*, 31 161-173.
Matzler, C., 1994, Passive microwave signatures of landscapes in winter. *Meteorol. Atmos. Phys.*, 54, 241-260.
Moreau, E., P. Lopez, P. Bauer, A. M. Tompkins, M. Janiskovà, and F. Chevallier, 2005, Variational retrieval of temperature and humidity profiles using rain rates versus microwave brightness temperatures, Q. J. R. Meteorol. Soc. vol. 130, 598, Part A, pp. 827-852(26).
Prigent, C., P. Abba, 1990, Sea surface equivalent brightness temperature at millimeter wavelength. *Annales Geophysicae*, 8, 627-634.
Prigent, C., W. B. Rossow, and E. Matthews, Microwave land surface emissivities estimated from SSM/I observations, *J. Geophys. Res*., 102, 21867-21890, 1997.
Rabier, F., H. Jarvinie, E. Klinker, J. F. Mahfouf and A. Simmons, 2000, The ECMWF operational implementation of four dimentional variational assimilation. I: Experimental results with simplified physics. *Q. J. R. Meteorol. Soc.*, 126, 1143-1170.
Rosenkranz, P. W. and D. H. Staelin, 1972, Microwave emissivity of ocean foam and its effect on nadiral radiometric measurements. *J. Geophys. Res*., 77, 6528-6538.
Rosenkranz, P., 2001, Retrieval of temperature and moisture profiles from AMSU-A and AMSU-B measurements, *IEEE Trans. On Geoscience and Remote sensing*, 39, 2429-2435.
Saunders, R. W., M. Matricardi, and P. Brunel, 1999, An improved fast radiative transfer model for assimilation of satellite radiance observations. *Quart. J. Roy. Meteor. Soc.*, 125, 1407-1425.
Shi, L., Retrieval of atmospheric temperature profiles from AMSU-A measurements using a neural network approach, *J. Atmos. Oceanic Technol*., 18, 340-347, 2001.
Veersé, F., and J. N. Thépaut, 1998, Multiple truncation incremental approach for four dimensional variational data assimilation, *Q. J. R. Meteorol. Soc*., 124, 1889-1908.
Wagner, D., E. Ruprecht, and C. Simmer, A combination of microwave observations from satellites and an EOF analysis to retrieve vertical humidity profiles over the ocean, 1990, *J. Appl. Meteor.,* 29, 1142-1157.
Weng, F., B. Yan and N. Grody, 2001, A microwave land emissivity model, *J. Geophys. Res.,* vol. 106, NO. D17, pp 20,115-20,123.
Weng, F., L. Zhao, R. Ferraro, G. Poe, X. Li, N. Grody, 2003, Advanced Microwave Sounding Unit Cloud and Precipitation Algorithms, *Radio Sci*., 38, 8,086-8,096.
Wentz, F., 1975, A two scale scattering model for foam-free sea microwave brightness temperatures. *J. Geophys. Res*., 80, 3441-3446.
Wigneron, J. -P., D. Guyon, J. C. Calvet, G. Courrier, and N. Bruiguier, 1997, Monitoring coniferous forest characteristics using a multifrequency microwave radiometry. *Remote Sens. Environ*., 60, 299-310.
Zhao, L., and F. Weng, 2002, Retrieval of ice cloud parameters using the Advanced Microwave Sounding Unit (AMSU), *J. Appl. Meteor.,* 41, 384-395.

4.5. ALADIN Limited Area Ensemble Forecasting (LAEF) experiments: Multiphysics downscaling of PEARP.

Alexander Kann and Yong Wang: ZAMG

4.5.1. Introduction

An experimental ALADIN regional EPS system LAEF (Limited Area Ensemble Forecasting, Wang and Kann, 2006) is implemented at ZAMG. Up to now, works have been focused on the initial condition perturbation and on the impact of the uncertainty on the lateral boundary conditions. In the following abstract, ALADIN dynamical downscaling of ARPEGE global EPS system PEARP and ALADIN multi-physics downscaling are investigated to study the performance during the winter season from 26.01.2006 to 26.02.2006.

4.5.2. The ALADIN LAEF configuration

The ALADIN model used for the ensemble forecasting is run in hydrostatic mode, with 18 km horizontal resolution, and 31 levels in the vertical. The model domain covers the area 25°W – 51°E, 26°N – 57°N, which includes Europe and a large part of the North Atlantic.

4.5.3. Experiments

Several experiments with LAEF have been conducted and verified:

· ***Interpolation of PEARP members on Aladin grid (EXP-A)***

· ***Aladin dynamical downscaling (EXP-B):***

ALADIN dynamical downscaling of PEARP members using operational physics.

· ***Aladin dynamical downscaling using different physics parameterizations (EXP-C):***

11 combinations of different physics parameterizations and tunings in ALADIN were chosen for dealing with the uncertainty in the model physics, which are: Bougeault-type scheme of deep convection Bougeault convection scheme, the modified Kain-Fritsch deep convection scheme, moisture convergence and CAPE closure, Kesslertype scheme for large scale precipitation, Lopez microphysics scheme, tuning of the mixing length, entrainment rate, and the computation of the cloud base.

4.5.4. Results

To study the performance of the experiments during the cold season, one winter month (26.01.2006 – 26.02.2006) has been chosen. All the verification is carried out using Arpege analyses as a reference.

Figures 4.1 – 4.3 show Analysis Rank Histograms ('Talagrand Diagrams') of the three experiments (EXP-A, EXP-B, EXP-C, see above) for temperature in 850hPa and forecast range +24 hours. According to the U-shaped distribution all the experiments indicate a significant lack of spread, especially in EXP-A and EXP-B. But using different physics parameterizations (EXP-C), the spread is enlarged by approx. 10%. In addition, the forecasts show a tendency to a high bias.

Figures 4.4 – 4.6 show Analysis Rank Histograms ('Talagrand Diagrams') of the three experiments (EXP-A, EXP-B, EXP-C, see above) for geopotential height in 500hPa and forecast range +48 hours. The spread is too small and the high bias is well pronounced in all experiments. Multi-physics option does not show additional forecast skill as it affects the lower parts of the atmosphere to a higher degree.

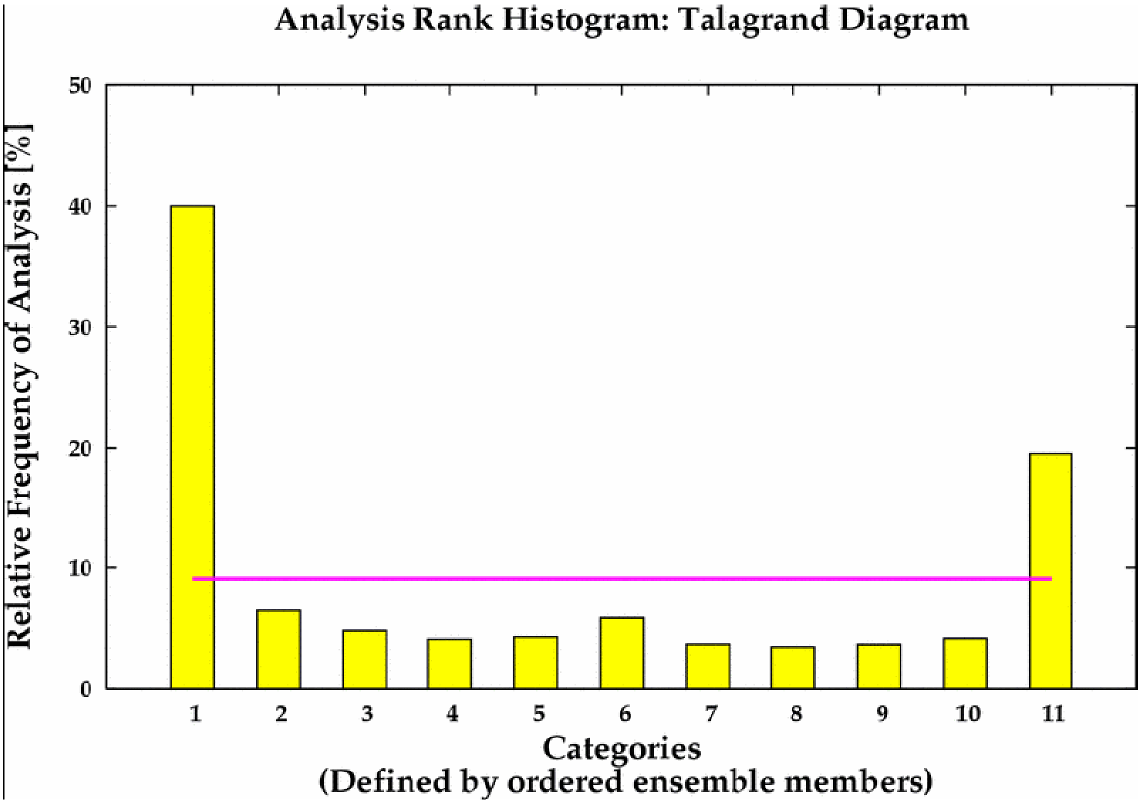


Fig. 4.1: Interpolation of PEARP members (EXP-A): Analysis Rank Histogram (Talagrand Diagram) for temperature in 850hPa, forecast range +24 hours.

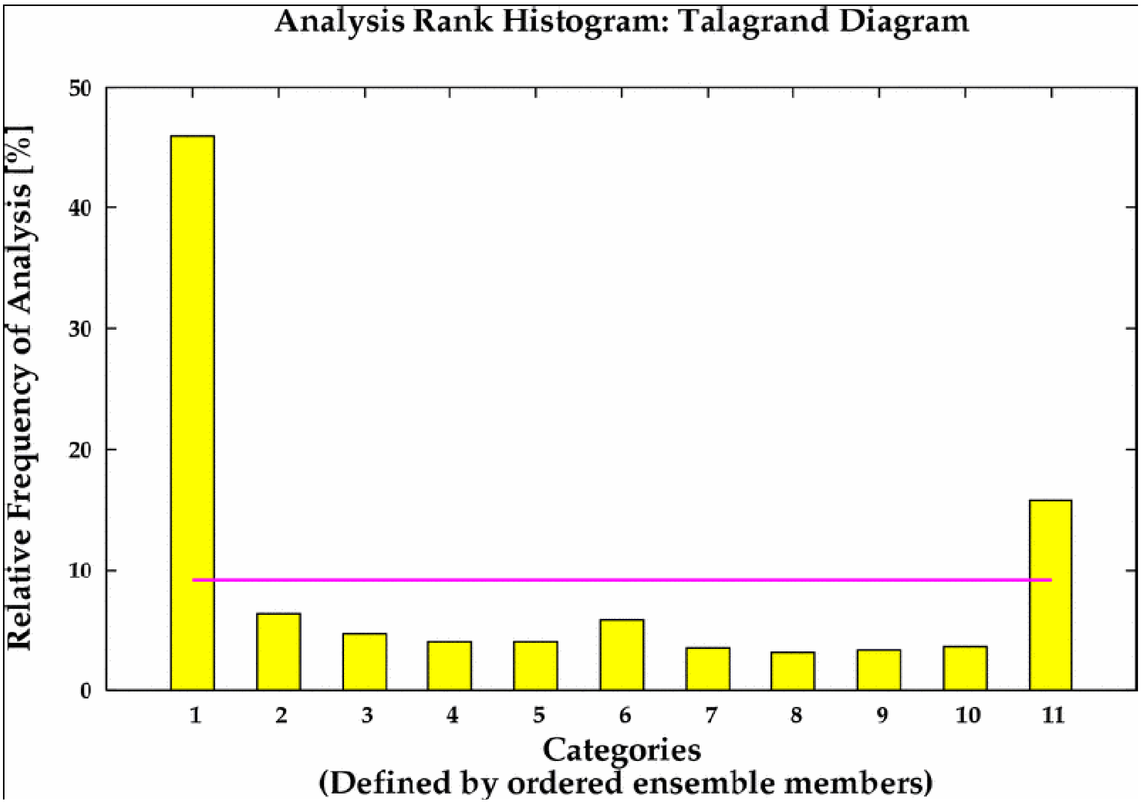


Fig. 4.2: Aladin dynamical downscaling of PEARP members (EXP-B): Analysis Rank Histogram (Talagrand Diagram) for temperature in 850hPa, forecast range +24 hours.

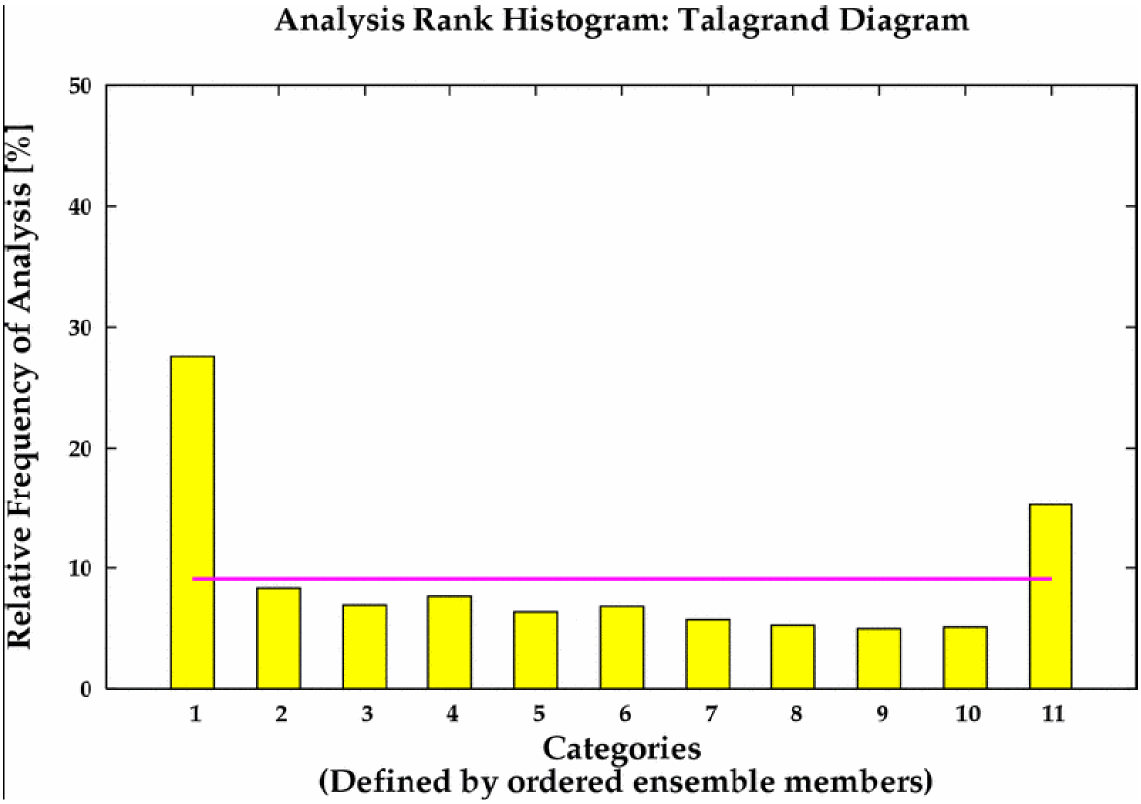


Fig. 4.3: Aladin dynamical downscaling of PEARP members with multi-physics (EXP-C): Analysis Rank Histogram (Talagrand Diagram) for temperature in 850hPa, forecast range +24 hours.

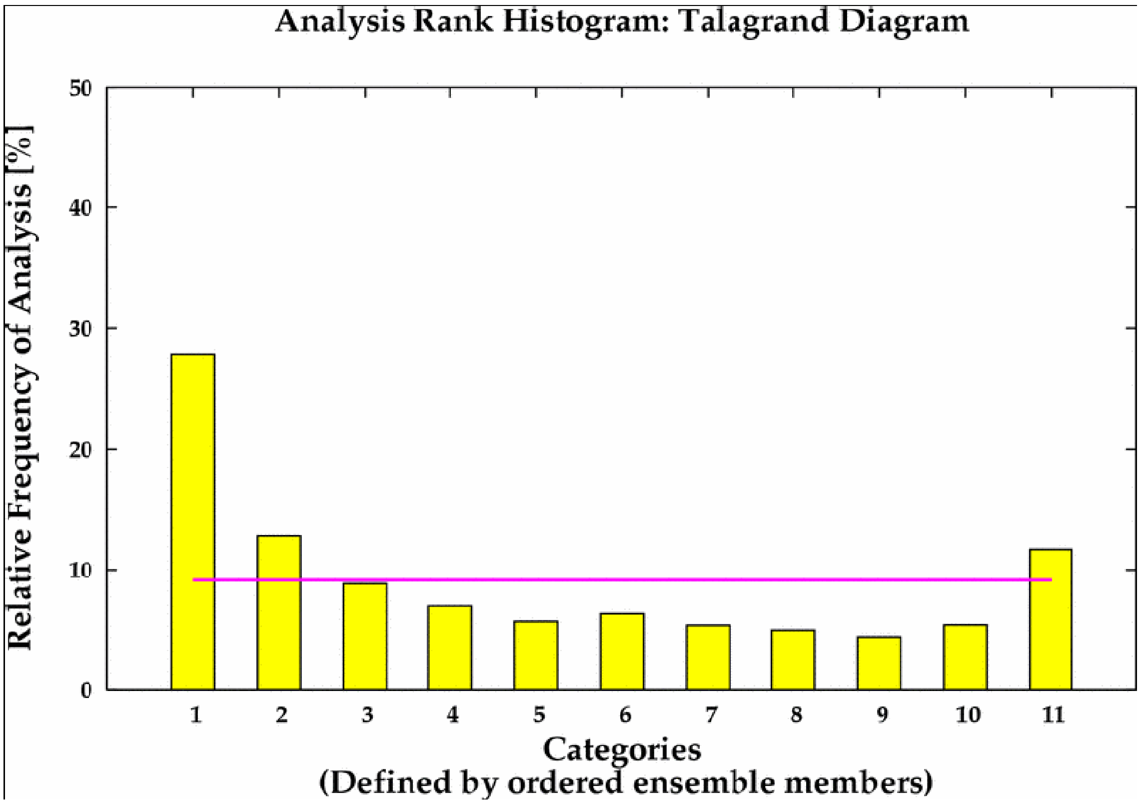


Fig. 4.4: Aladin Interpolation of PEARP members (EXP-A): Analysis Rank Histogram (Talagrand Diagram) for Geopotential Height in 500hPa, forecast range +48 hours.

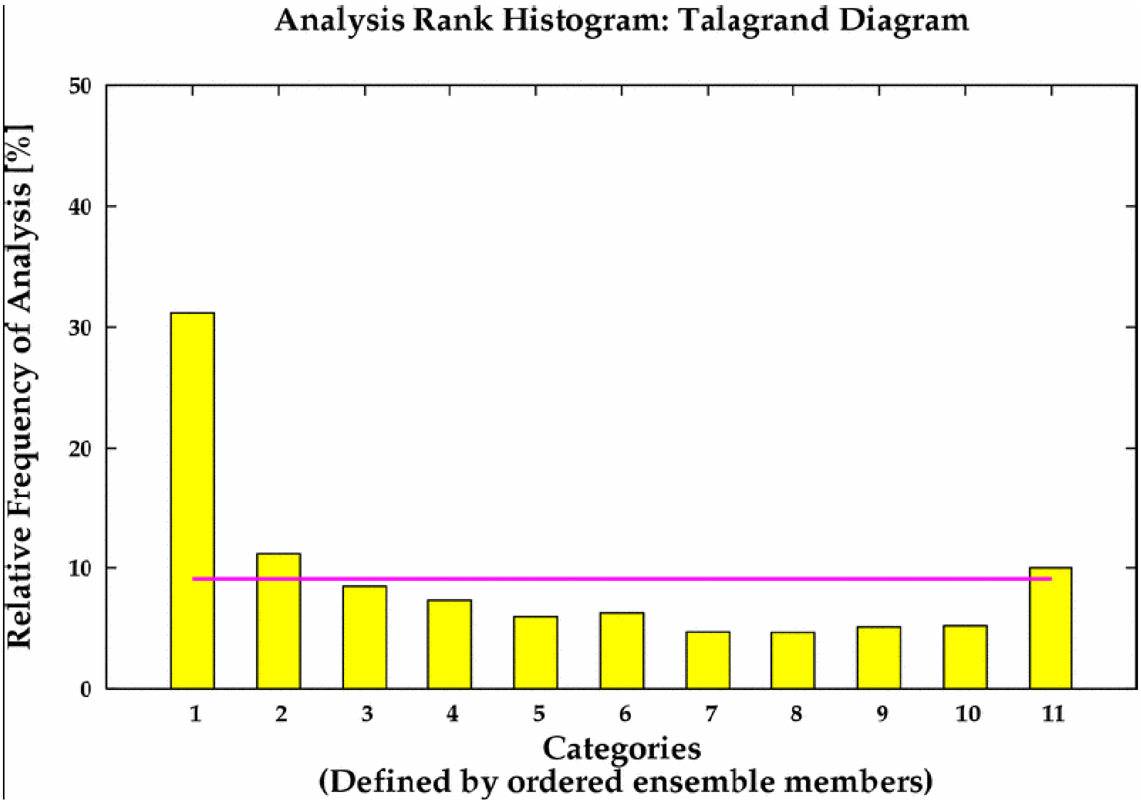


Fig. 4.5: Aladin dynamical downscaling of PEARP members (EXP-B): Analysis Rank Histogram (Talagrand Diagram) for Geopotential Height in 500hPa, forecast range +48 hours.

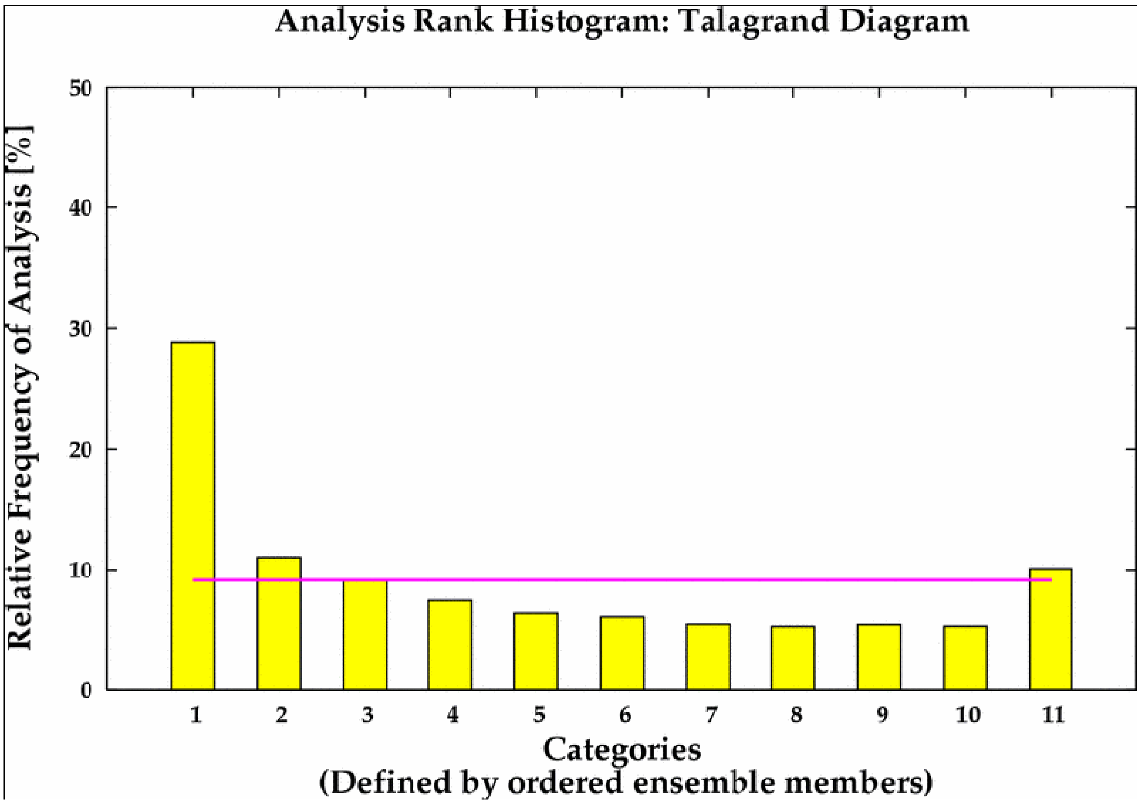


Fig. 4.6: Aladin dynamical downscaling of PEARP members with multi-physics (EXP-C): Analysis Rank Histogram (Talagrand Diagram) for Geopotential Height in 500hPa, forecast range +48 hours.

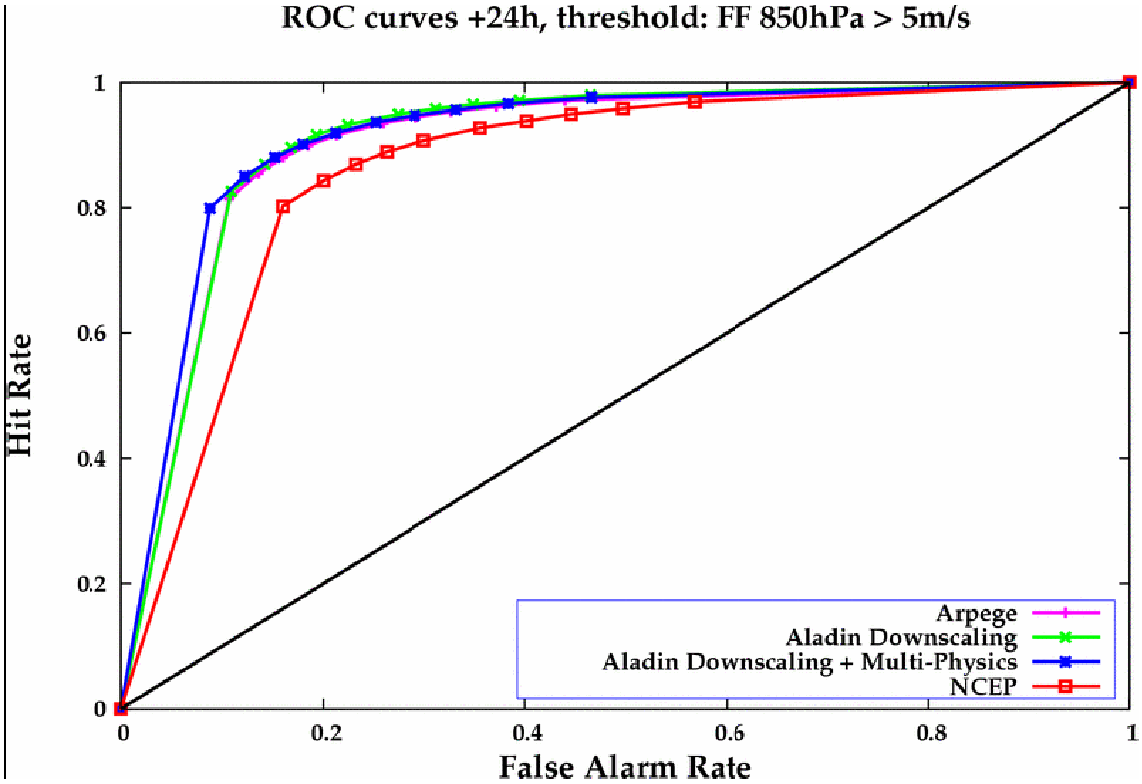


Fig. 4.7: ROC curves for the experiments EXP-A (violet), EXP-B (green), EXP-C (blue). Threshold: windspeed in 850hPa > 5m/s, forecast range +24 hours.

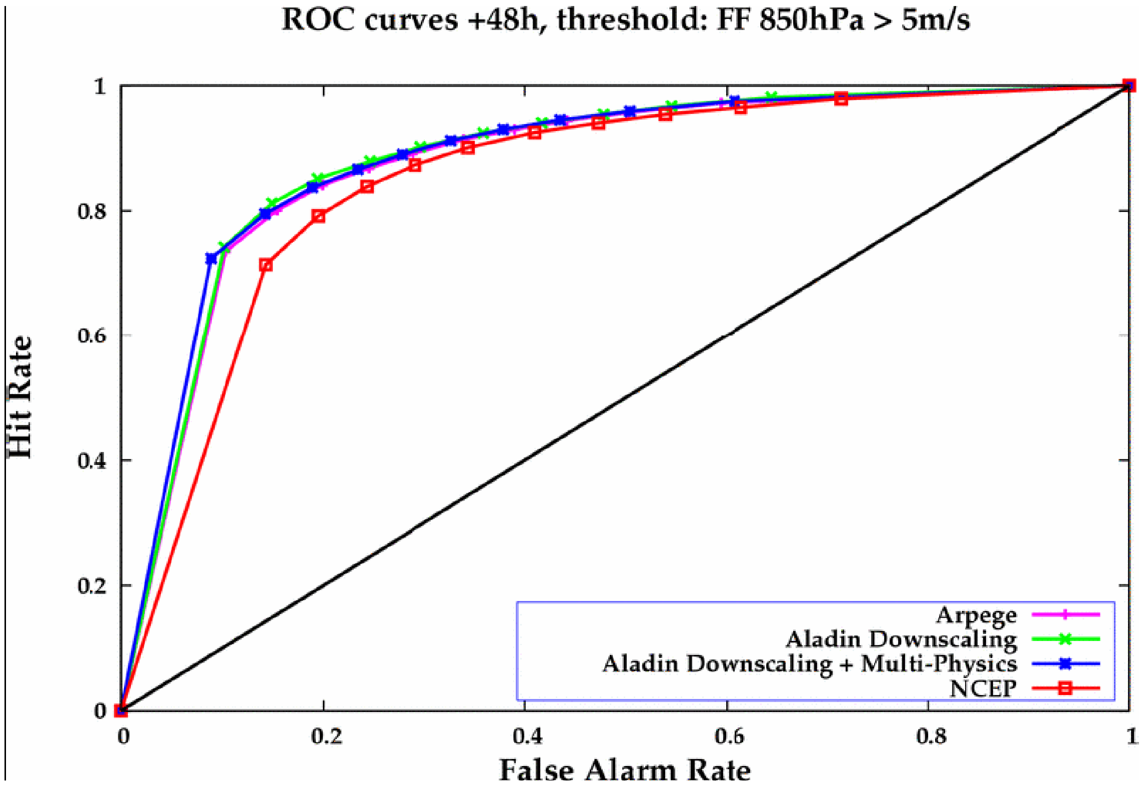


Fig. 4.8: ROC curves for the experiments EXP-A (violet), EXP-B (green), EXP-C (blue). Threshold: windspeed in 850hPa > 5m/s, forecast range +48 hours.

Fig. 4.7 and 4.8 show ROC curves for the experiments, the chosen threshold is FF (850hPa) > 5m/s. All experiments give similar results, the areas under the ROC curves vary from 0.95 to 0.88 (depending on forecast range).

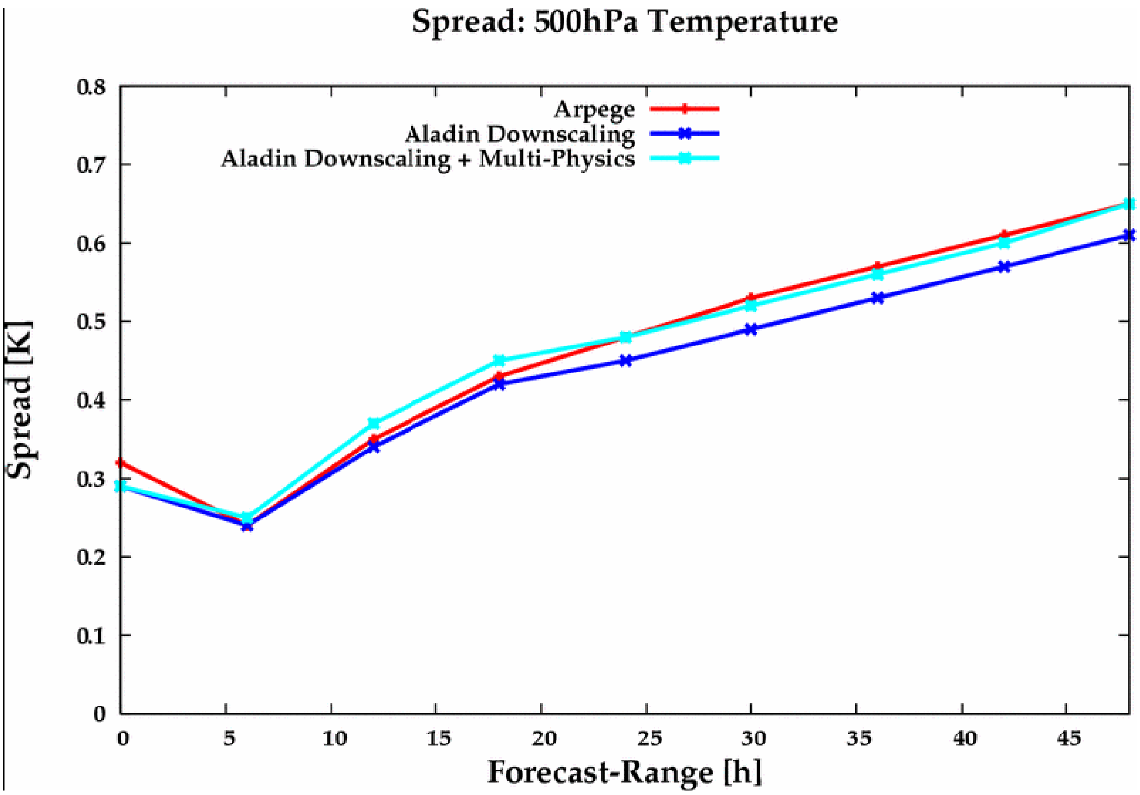


Fig. 4.9: Spread of EXP-A (red), EXP-B (dark blue) and EXP-C (light blue) as a function of forecast range for temperature in 500hPa.

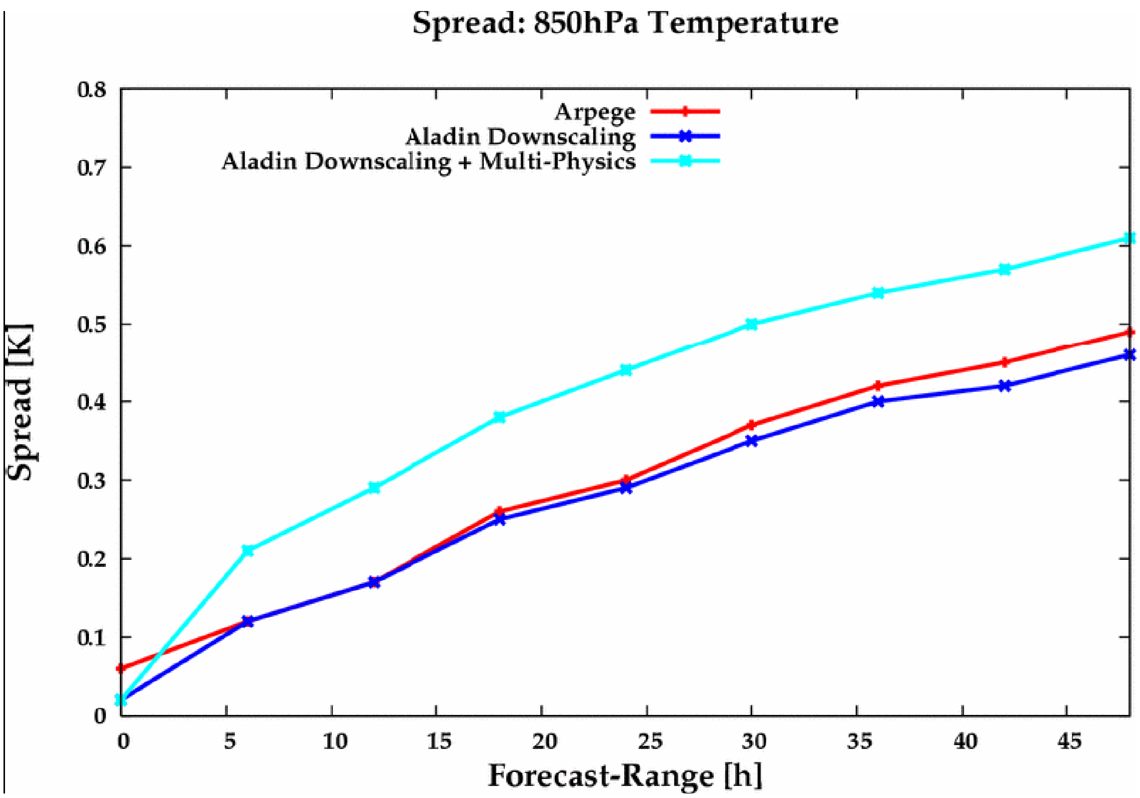


Fig. 4.10: Spread of EXP-A (red), EXP-B (dark blue) and EXP-C (light blue) as a function of forecast range for temperature in 850hPa.

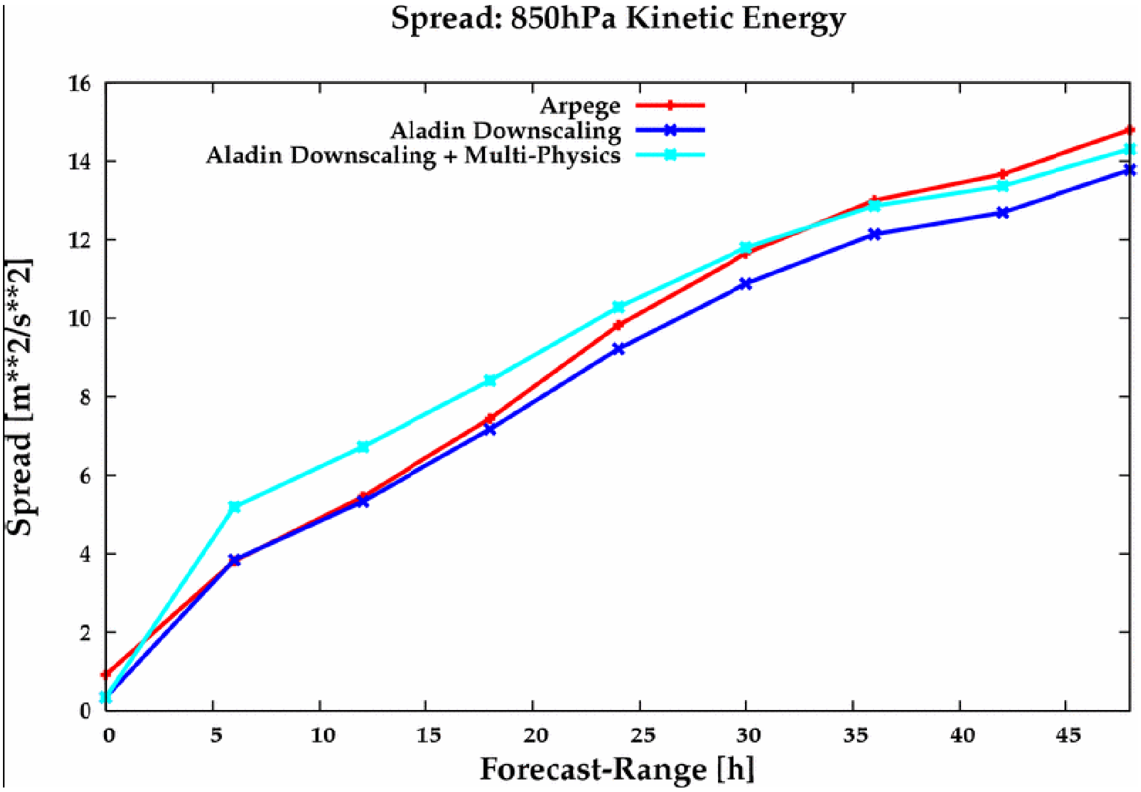


Fig. 4.11: Spread of EXP-A (red), EXP-B (dark blue) and EXP-C (light blue) as a function of forecast range for Kinetic Energy in 850hPa.

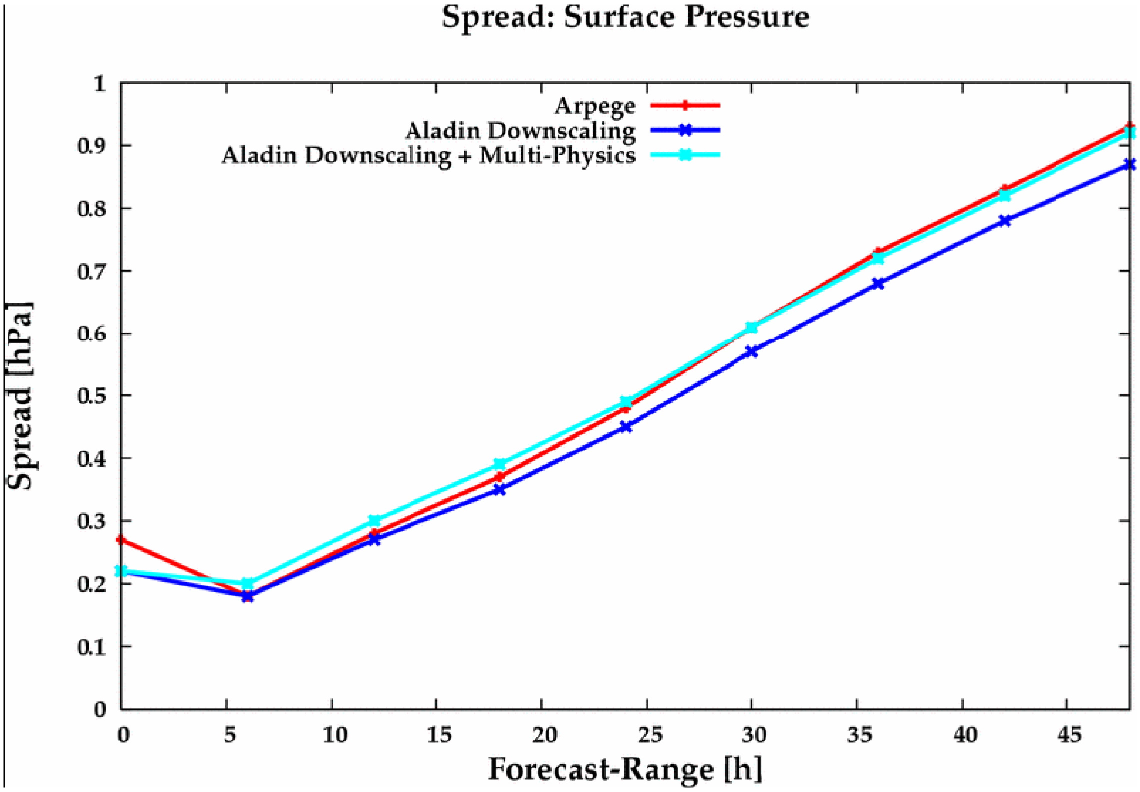


Fig. 4.12: Spread of EXP-A (red), EXP-B (dark blue) and EXP-C (light blue) as a function of forecast range for surface pressure.

Regarding the spread of temperature in 500hPa, the differences between the experiments are marginal (Fig. 4.9). In the lower atmosphere, the impact of different physical parameterizations in EXP-C is evident. The spread is increased in terms of both temperature (Fig. 4.10) and Kinetic Energy (Fig. 4.11) in 850hPa.

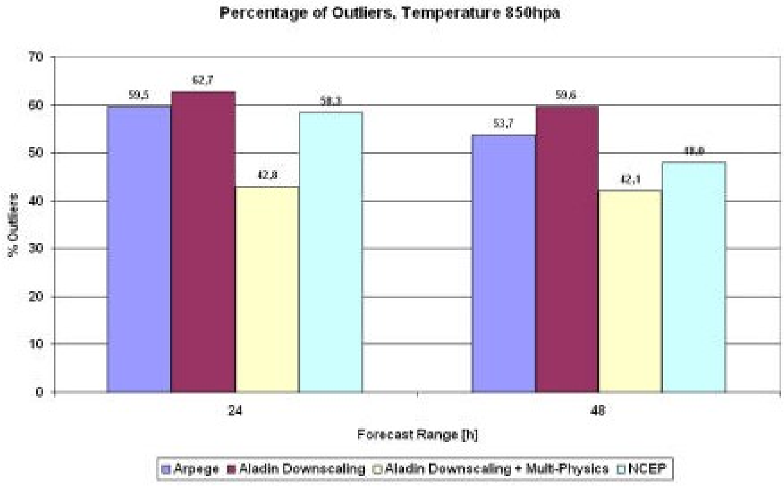


Fig. 4.13: Percentage of outliers for temperature in 850hPa, EXP-A (violet), EXP-B (dark red) and EXP-C (yellow) as a function of forecast range. (NCEP EPS (light blue) is added only for reasons of intercomparison).

Regarding the percentage of outliers for temperature in 850hPa in figure 4.13, both EXP-A (interpolation of PEARP) and EXP-B (Aladin dynamical downscaling) behave similarly, the percentage varies from 59% to 62% (+24hours) and from 53% to 60% (+48hours). Introducing different options in the model physics improves the forecast significantly, the percentage of outliers is reduced to 43% (+24 hours) and 42% (+48 hours).

4.5.5. Conclusion

Carrying out a one month case study gives an overall impression of the performance of the LAEF experiments. It could be shown that the ARPEGE EPS system (PEARP) lacks spread and has a tendency to high bias. These deficiencies are not improved by simple Aladin dynamical downscaling as the verification results of these two experiments do not differ much. Introducing different physical parameterizations in the downscaling process significantly improves the forecasts, especially in the lower atmosphere. Further improvements are expected by the generation of initial perturbation (e.g. by Breeding, ET, ETKF), especially in conjunction with multi-physics approach. Presently, these issues are investigated at ZAMG.

Acknowledgements

We gratefully acknowledge the colleagues from Meteo-France E. Bazile and J. Nicolau for fruitful discussions.

References

Wang Y., Kann A.: ALADIN Limited Area Ensemble Forecasting. Aladin Newsletter **29**, 2006.

4.6. Experimentation on the parametrisation of the shallow convection with AROME.

S. Malardel, V. Masson, J. Pergaud and P. Soares: Météo France

4.6.1. Summary

The daily runs of AROME show a significant weakness in the description of shallow convective situations (small to medium cumulus). Actually, if in AROME the deep convection is reasonably resolved explicitly by the fine resolution, the model equations and the detailed liquid/ice microphysics, the smaller scale updrafts associated with smaller convective clouds are not well parametrized by the current shallow convection scheme.

The research in the domain of the parametrisation of shallow convection is currently very active. Parallel and/or joint actions are followed by various teams in the international physics community. The 1D model version of AROME was proposed as a test bed for an intercomparison of such parametrisations and some of them will also be tested on real cases with the 3D version of the code. We hope that before the end of 2006, AROME will run daily with a better subgrid cloud representation, at least in shallow convective situations.

4.6.2. Turbulence, mass flux and shallow convective cloud parametrisations

It is a bit too early to describe with precise technical details the shallow convection scheme which will be proposed for AROME. Anyway, we give here the main lines of a new mass flux scheme and a modified convective cloud scheme which were developed this summer in GMME. This prototype system is now tested in AROME and Méso-NH.

The mass flux approach

The horizontal and vertical wind defined at the scale of the model grid describe explicitly the motion of the air particules at the mean scale of the model grid. However, subgrid motion also has an effect on the mean variables through non linear terms as for example the mean subgrid advection of any subgrid variable ϕ'.

These non linear terms linked with advection are usually written as a divergence of "turbulent" fluxes. Part of the mixing effect due to these subgrid fluxes of ϕ' is solved by the so-called **turbulence scheme**. But the strong hypotheses applied on the turbulent equations, and in particular the hypothesis of isotropy of the fluxes does not allow the description of the quasi-vertical subgrid motions in dry and cloudy convective thermals in and just above the boundary layer.

It is then proposed to complement the "turbulent" subgrid mixing by a simple description of the vertical mixing associated with vertical shallow convective updrafts. A classical approach estimates the subgrid fluxes with a zero-order expression called the **mass-flux** equation in which eddies are defined as the difference between an environment (usually supposed to be well described by the mean grid scale variables) and an updraft (or thermal core).

Shallow convective updrafts

Three main questions have to be answered for the definition of a convective (shallow) updraft :

- the triggering of the thermals
- the vertical profile of the thermals (in particular entrainment/detrainment formulation)
- the strength of the thermals (or closure)

Some shallow convection parametrisations are mainly devoted to the representation of cumulus clouds. So they are activated only if a level of condensation (LCL) exists (the scheme is not active if no condensation if found). But other parametrisations also describe the dry thermals in the boundary layer .

The shallow convection scheme which is running daily in the AROME prototype is of the first type. And it was found that serious problems in the trigger fonction based on a LCL computation make it quite inefficient in light and medium convective conditions. The effort in GMME to develop a new scheme is now based on the proposition of Soares et al (2004) to build an updraft from the ground (and not from a LCL anymore) with a description of dry thermals and cloudy thermals above. The current option chosen for AROME is to build a single thermals which starts dry in the boundary layer if the surface fluxes (from SURFEX) are positively buoyant enough. This thermals may then remain dry if no LCL is found but it may also be prolongated by a cloudy updraft fed at the LCL by the dry thermals itself.

A scheme based on these general principles is developed at GMME/Turbau team by J. Pergaud, V. Masson and I. This code is tested both in Meso-NH and AROME. It is currently based on a dry formulation of entrainment/detrainment in the dry part based on a mixing length computation as proposed by Lappen and Randall, 2001 and on the cloudy formulation of entrainment/detrainment proposed by Kain and Fritsch, 1990 (the same formulation as the one of the current KFB scheme of Méso-NH and AROME prototype). These choices are now tested and may probably still be improved but the first 1D tests are very encouraging.

The cloud scheme

When a cloudy updraft is built in a grid box, it represents the core of a subgrid cloud. The description of this cloudy structure at the scale of the grid itself is done through a cloud fraction computation (how much of the grid is covered by this convective cloud) and a mean cloud water content (non-precipitating small droplets). But going from the updraft characteristics to the grid scale parameters is not a trivial step. The original formulation of the cloud scheme in Méso-NH and then in AROME relies on a statistical formulation of cloud variance in the grid box. This formulation was used both for ”turbulent” clouds (variance from isotropic turbulence origin) and shallow convective cloud (variance from mass flux origin). The formulation of the updraft computation proposed by Pergaud *et al* allows a direct computation of the cloud fraction of the cloudy updraft. This cloud fraction may then be used in a closure for the cloud content which then conserves the shape of the cloudy updraft.

Note also that by construction, the mass flux equations used in Méso-NH and AROME are written for variables which are conservative in a non-precipitating cloud. The cumulus precipitation would anyway be very difficult to handle properly in such kind of subgrid formulation. For the 1D case proposed in the most recent intercomparison of precipitating shallow cumulus (Rico case), some very encouraging tests were done with a basic subgrid autoconversion in the microphysical scheme (rain is allowed if the autoconversion threshold is reached with the updraft characteristics and not with the mean cloud content as it is done in the current code) and the rain created by autoconvection is then re-scaled by the cloud fraction. Figure 1 shows results obtained with SCUM and a comparison with preliminary results of the LES obtained by F. Couvreux with Méso-NH on this case. These results will be presented at the first Rico workshop (Sept. 18-23 2006, New York).

Convection peu profonde précipitante et quasi-stationnaire (Rico)

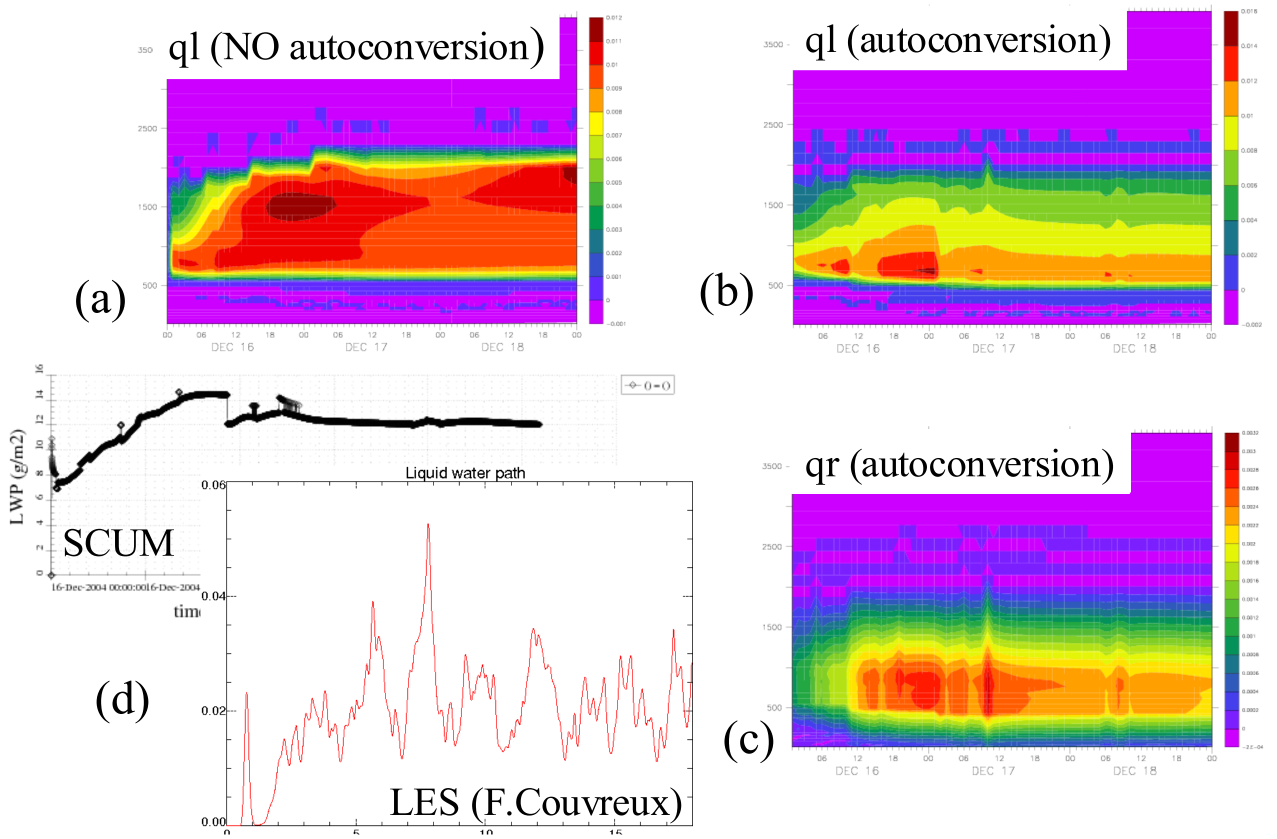


Fig.1 : time evolution of the vertical profile of cloud water content (g/kg) during the 72 hours of simulation of the Rico case (a) without subgrid autoconversion (b) with subgrid autoconversion. (c) Time evolution of the rain water content (g/kg) in the case with subgrid autoconversion. (d) Liquid water path evolution in SCUM (g/m^2) and in the Méso-NH LES (kg/m^2)

4.6.3. Experimentation with a single column model

SCUM (Single Column Unified Model)

From cycle 31T1, the 2D version of ALADIN/AROME may be used as a single column model. In practice, computation are made on 4 identical columns of a (O,y,z) plane. During a pseudo-1D simulation, all standard 3D computations are done, even the spectral ones (but all the horizontal derivatives are zero for example).

Some facilities to use large scale forcing are also introduced in the dynamics.

Initial profils, forcings and output treatment may be handled using basic tools (acadfa and flux) originally developed for the 2D version of the code and adapted for the 1D case.

With this new 1D option of the 3D code, preliminary validation of code developments (even in the dynamics) and intercomparison of physical parametrization package are made easier. Note also that the 1D model will now be available and validated in each new Arpège/Aladin/Arome cycle and that, thanks to Ryad, it is running on PC.

Bomex, Eurocs/ARM/Cu and Rico cases for SCM and LES intercomparisons

Classical 1D cases have been designed from observations gathered during experimental campaigns dedicated to typical cumulus situations. These cases are very useful tools to test and compare different shallow convection parametrisations and help to improve them. Initial files are now available to be used in SCUM with different set of physics (still may need a bit of suffering if the current ISBA scheme is used...)

Figure 2 shows some results with the current state of the new formulation of shallow convection proposed for Arome (Pergaud, Malardel, Masson) in the case of a classical diurnal evolution of shallow convection.

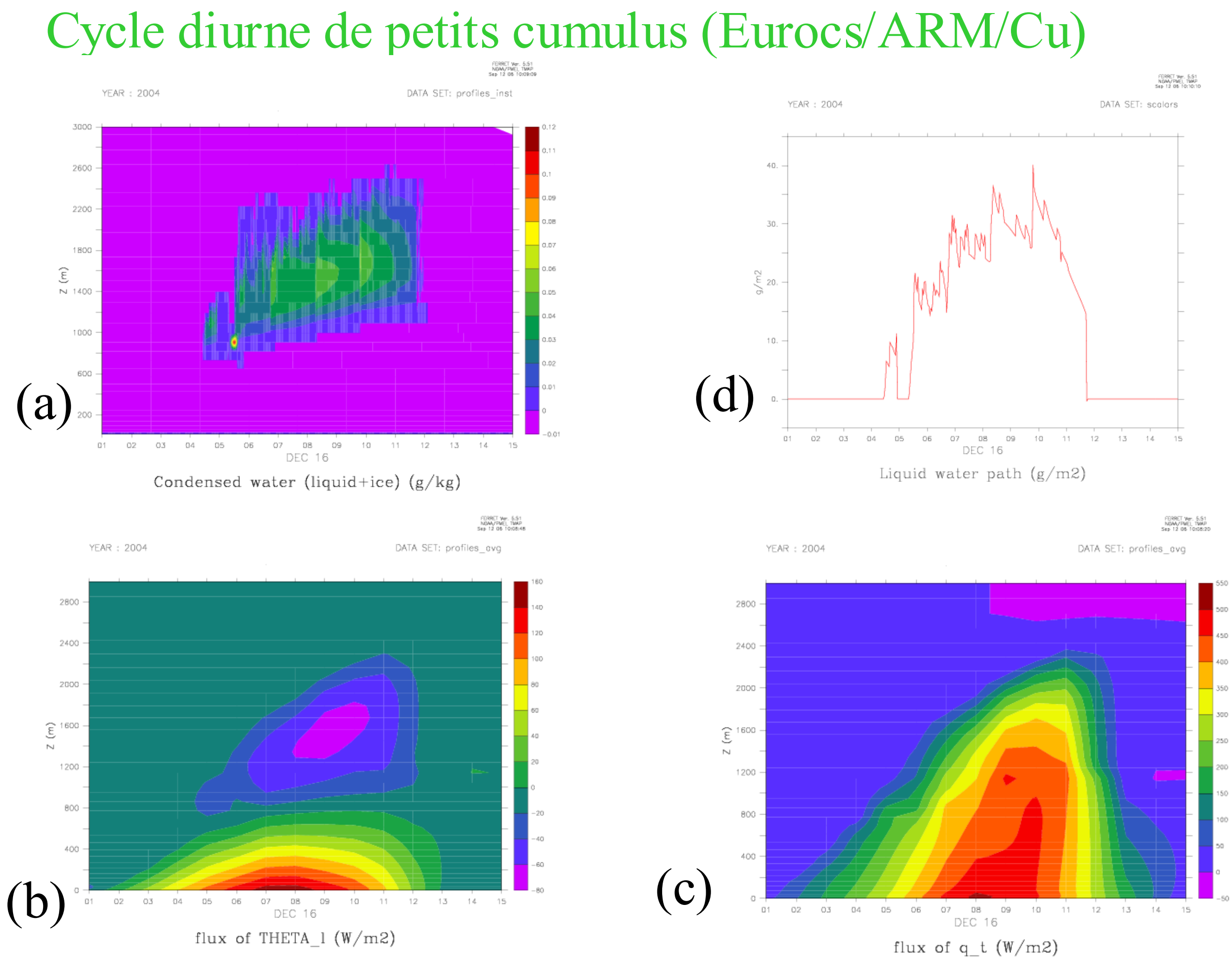


Fig. 2 : Time evolution of the (a) cloud content, (b) subgrid vertical profil of the liquid potential temperature flux (c) subgrid vertical profil of total water flux (d) liquid water path obtained with SCUM for the EUROCS/ARM/Cu case (G. Lenderink *et al*, 2004).

4.6.4. International collaborations and intercomparisons

A short workshop was organised in the CNRM in Toulouse the 3rd and 4th of July 2006 to follow the last matches of the football cup with our colleague of the shallow convection community! We were very happy to have the participation of Pier Siebesma, a colleague from the Hirlam community and of three colleagues from the LMD. But, the participation of Pedro Soares was unfortunately cancelled for medical reason (no Pedro was not kicked by Pier after the terrible match which took place on the Saturday before the meeting!). We could also profit by the short visit of Fleur Couvreux who is currently doing a post-dost on a subject related to shallow convection in the University of Washington. A lot of participants from all the group of the CNRM and from the L.A. where also presenting and discussing results from the scale of climate to the one of « large eddy simulation ». As one of the conclusion of the meeting, it was proposed that SCUM may be a common platform for intercomparison of different updraft formulations. P. Siebesma proposed for example that the current development at ECMWF for separate dry and cloudy updrafts may be plugged in AROME physical interface to be tested and compared with GMME and (we hope) GMGEC (JF. Gueremy) updraft propositions.

In parallel, a 3D case was proposed by Gwen (the 4th of July 2005 on the SW of France) for the real case intercomparison and validation platform which is developed in the framework of the collaboration with HIRLAM. This case is now used for the first 3D cases of the GMME proposal for a new shallow convection scheme in AROME. Further more systematic validations with objective scores are planed in November during the visit of Manuel Joao Lopes from the Aladin team in Portugal.

4.7. Spectral filtering changes in the ALADIN post-processing. 06/2006

F. Taillefer: Météo France

A modification has been introduced in the ARPEGE/ALADIN code, concerning the filtering of some post-processed fields (see details below).

This work was achieved in June 2006, so CY31T1 will include this new code (and not CY31T0).

In fact, the modification impacts only the ALADIN part, because a similar scheme has been already effective in ARPEGE for several years. This action has led to a code unification between the global and the LAM case.

The modification is due to a request coming from our forecasters, who thought the output fields on PV levels were not smooth enough. Until CY31T0, a basic Gaussian filter was applied on all the output fields calculated by FULL-POS, both on P and PV levels. This filter has a very small impact on PV levels. Thus, it has been decided to do the same thing in ALADIN as in ARPEGE, i.e. to filter in a spectral space of homogeneous resolution all the fields which are composed of derivatives (like divergence, vorticity, vertical velocity, but also any field on PV level); so now the output fields are homogeneous, and not polluted anymore by the small scale information.

In practice, with the new code, the divergence, the vorticity, the vertical velocity fields are different on P levels, but any other basic field (temperature, geopotential ...) remains unchanged on P levels; however, on PV levels, all the fields are different.

It is impossible with the new code to have the same results as before; it is possible to deactivate the new filter, but the old filter will not be applied anymore. It is possible to tune by name list the efficiency of the new filter in order to have a small impact on the P level fields, so that the results for these fields will be quite similar to older versions.

To tune the filter, you have to set a value for NFMAX in the name list NAMFPF. This value is related to the wavenumber for which you want to truncate the spectrum over your domain. The default value is calculated in SUFPF according to the domain and is very big, so by default there is no truncation; if you set NFMAX=0 you don't apply any filter at all. As an example, for ALADIN France we have put NFMAX=80 in operations (we have NSMAX=149).

The modifications have been tested over the ALADIN-France domain, for different types of meteorological conditions, both summer and winter situations (23/06/2005, 05 and 06/09/2005, 21/01/2006).

Firstly, I present three figures to illustrate the case of the absolute vorticity field at for example,300 hPa; figure 1 shows a field which has been calculated with the old code (basic Gaussian filter), figure 2 shows a field with the new code but without any filter at all, and figure 3 shows a field with the new code with NFMAX set to 80.

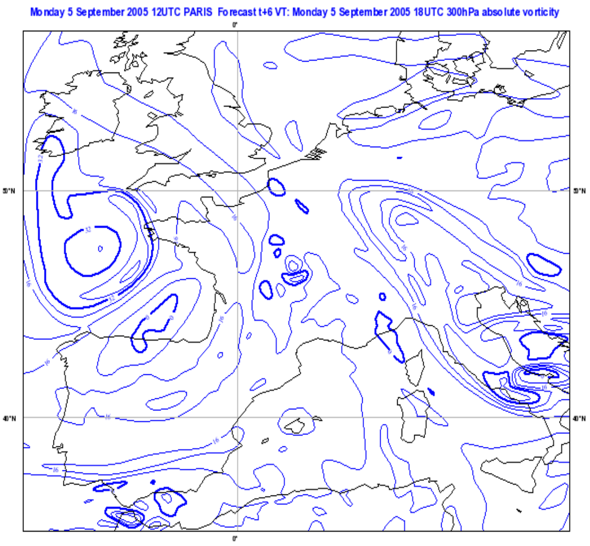


Figure1 (old code)

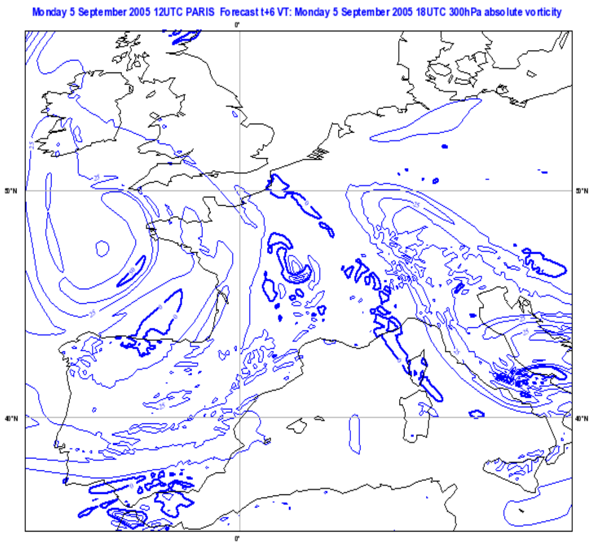


Figure2 (NFMAX=0)

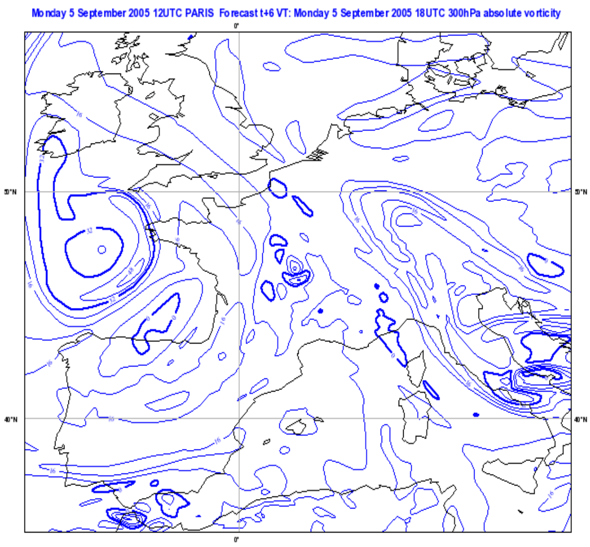


Figure 3 (NFMAX=80)

Now I present the temperature field at 1 PVU level, for the same situation, to illustrate the effect of the new filter. The case is illustrated by five figures: the first one with a field elaborated with the old code and the other four, with the new code, but with a different tuning of the filter, to describe what occur according to the degree of truncation of the spectrum.

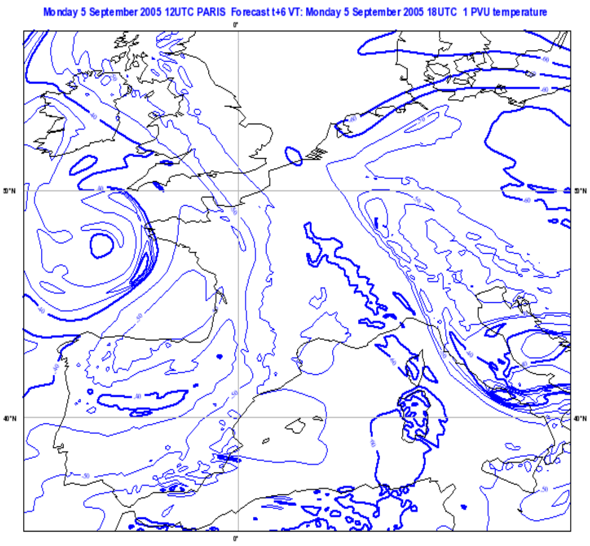


Figure 1 (old code)

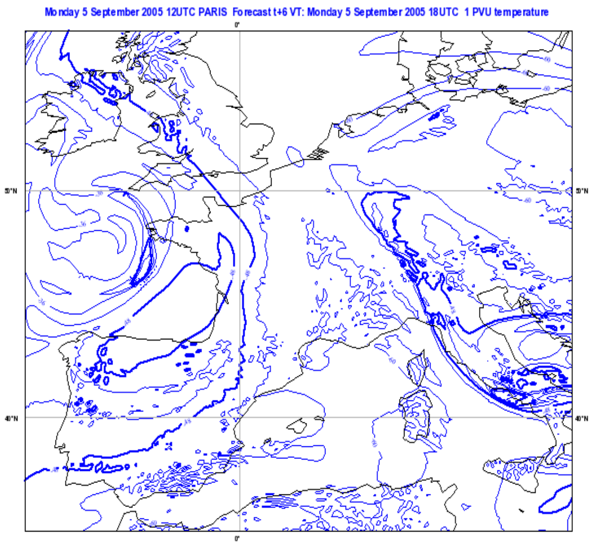


Figure 2 (NFMAX=0)

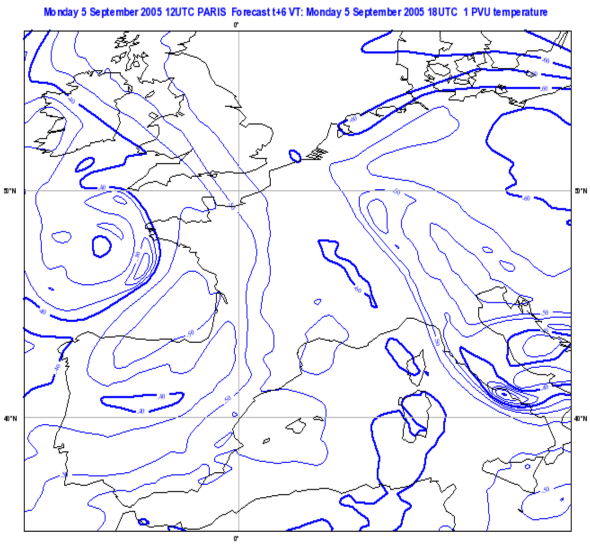


Figure 3 (NFMAX=60)

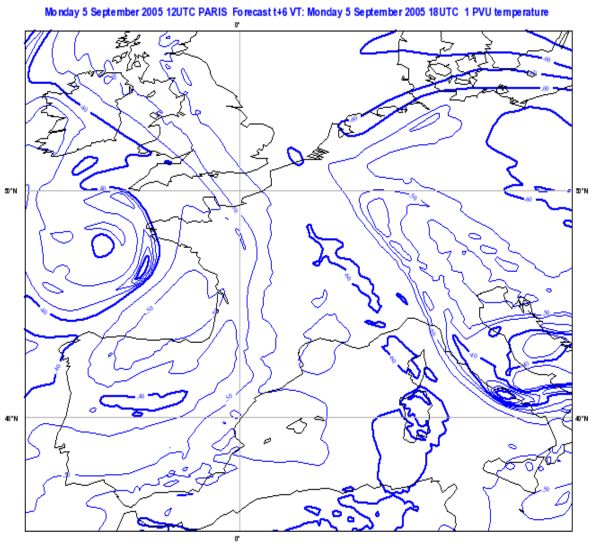


Figure 4 (NFMAX=100)

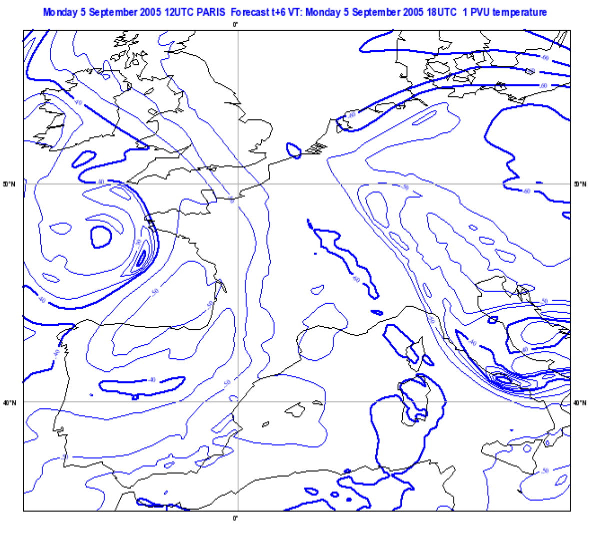


Figure 5 (NFMAX=80)

4.8. A first prototype for the AROME data assimilation system.

P. Brousseau and Y. Seity (MF)

4.8.1. Introduction

A first prototype of a variational data assimilation system in the AROME model has been implemented at Météo-France. This system is based on the ALADIN-FRANCE 3D-Var assimilation scheme used in a Rapid Update Cycle (RUC) in order to assimilate observations more frequently. Available in the OLIVE tool, this prototype has been tested for the first time on a Mediterranean flooding case that occurred in September 2005.

4.8.2. Technical description

A Rapid Update Cycle uses a forward intermittent assimilation cycle (of 1h or 3h frequency for exemple), as described in Fig. 1. Each AROME RUC leg starts off an ALADIN analysis. At each step, recent observations are assimilated, using the previous RUC AROME forecast as a background to produce a new estimate of atmospheric fields. In fact, as we use the 3D-Var ALADIN-FRANCE assimilation scheme, this prototype only analyzes wind, temperature, specific humidity and surface pressure fields at a resolution of 2.5 km. Non-hydrostatic and microphysics fields are cycled from the AROME guess. 00, 06, 12 and 18 UTC analyses use surface fields that have been analysed for the ARPEGE model (CANARI analysis). Others use surface fields cycled from the AROME guess.

The same observations with the same thinning as in the ALADIN-FRANCE operational suite are used : radiosondes, synoper (2 meter temperature and humidity), buoys, ship and airplane measurements, wind profilers, horizontal winds from Atmospheric Motion Vectors and the QUIKSCAT scatterometer, ATOVS and SEVIRI radiances.

The background error covariance matrix used comes from the ALADIN-FRANCE model and is converted to the 2.5 km resolution.

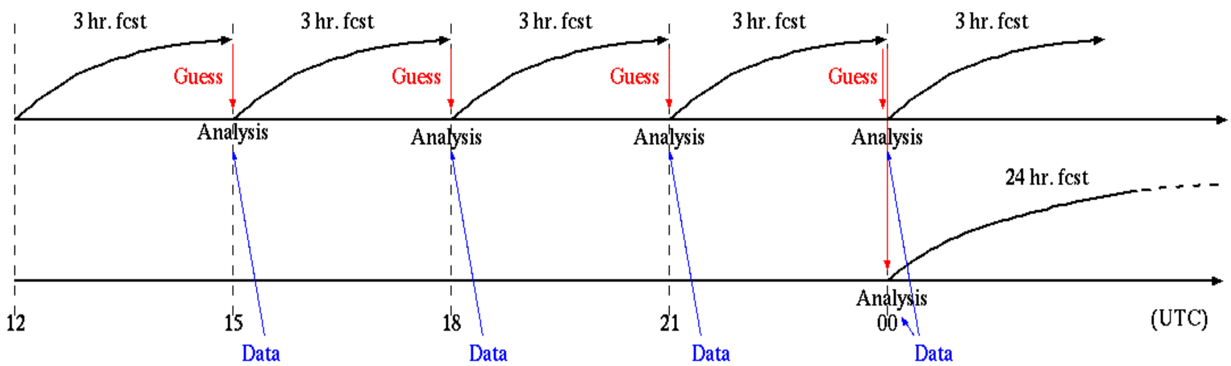


Fig. 1: Rapid Update Cycle 3-h assimilation-forecast cycle

4.8.3. First test

This prototype has been used to simulate a Mediterranean flooding case that occurred in September 2005. Such events are characterized by synoptically-driven convective cells in warm and moist air, that keep regenerating for many hours in a row over coastal orographic features. Three experiments have been made with the AROME model, forced by the ALADIN-FRANCE operational suite and initialized by dynamical adaptation (spin-up model), 3 hourly and 1 hourly Rapid Update Cycle.

The comparison between the different forecasts and the radar data shows that the run without data assimilation gives a good depiction of the event, except in the first six hours during which it localizes the maximum of precipitation too much to the West, as the ALADIN-FRANCE operational model did. This deficiency is corrected by the use of an initial state given by a RUC (Fig. 2).

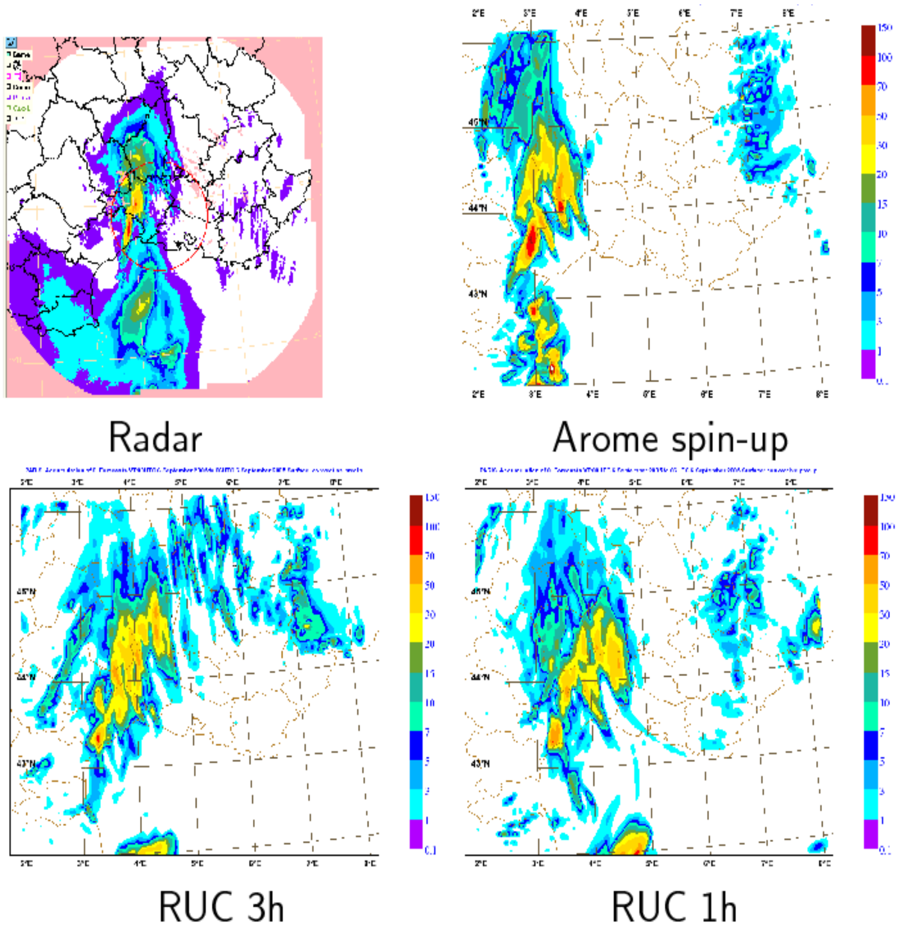


Fig. 2: 3 hours accumulated precipitations radar data and forecasts valid 0600 UTC 6 sep 2005, initialized at 00 UTC spin-up model, 3-h RUC and 1-h RUC

4.8.4. Conclusion

A prototype for the AROME data assimilation system based on the 3D-Var ALADIN-FRANCE and using a Rapid Update Cycle is in test at Météo-France. It gives encouraging results.

Work is in progress on the RUC cycling frequency and on computation of an AROME background error covariance matrix using the ensemble method.

4.9. Flow-dependent background standard deviations for ARPEGE 4D-Var

Simona Stefanescu: INMH

Daily standard deviations for vorticity have been computed using an ensemble of background fields over one month period (18 January 2005 - 18 February 2005). The small size of the ensemble (6 members) requires the filtering of the sampling noise in the estimated covariances.

Two kind of filters has been applied: a low-pass filter of type *cos*^{2} and an objective statistical filter based on spectral regressions between the signal and an ensemble-estimated standard deviation field as a predictor. The regression coefficients correspond to the correlations between the standard deviation fields computed with two independent sub-ensembles which have the same size (3 members). Figure 1 shows the correlation between the two ensemble-estimated standard deviations (red line) and a smoothed version of this correlation (blue line) for which the small oscillations have been filtered out, as a function of total wavenumber. Larger coherence in the large scales than in the small scales has been observed. The reduced coherence in the small scales indicate a large amplitude of the sampling noise, which means that the small scale structures should be filtered out.

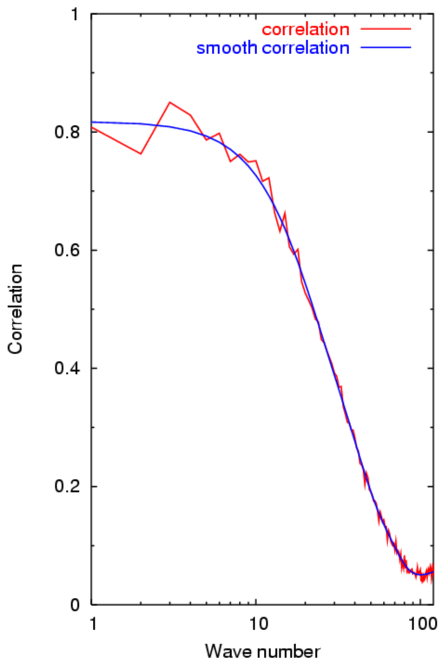


Fig. 1: The correlation between the two ensemble-estimated standard deviations for vorticity at model level 26, as a function of total wavenumber.

The study has been focused on the vorticity standard deviations at model level 26 (around 500 hPa). The comparison with the geopotential height field at 500 hPa has shown that the filtered standard deviation fields exhibit some connections with weather situation: larger values in the vicinity of troughs than near the ridges. The statistical filter applied to the 6-member ensemble estimated standard deviation gives results that are consistent with the *cos*^{2} filter (see figures 2 and 3).

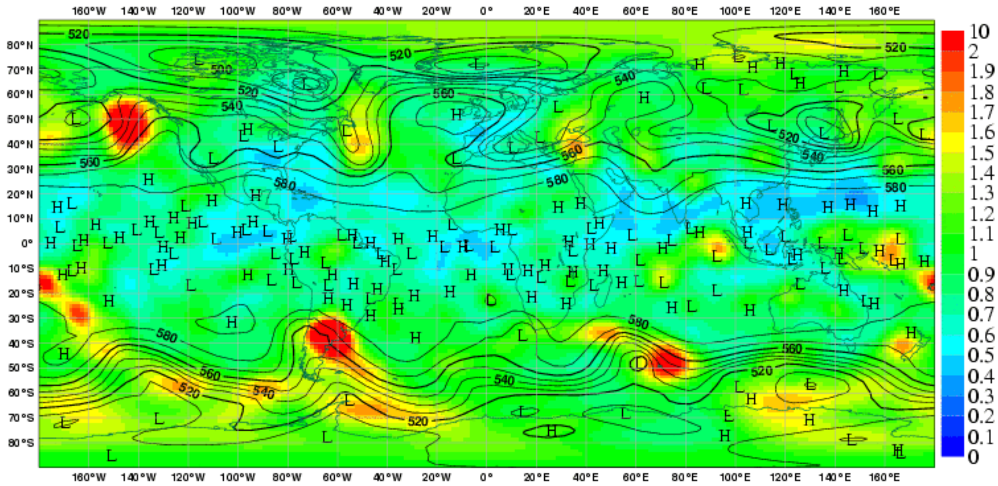


Fig. 2: The filtered standard deviation for vorticity at model level 26 (color scale, unit: 10^{-5} s^{-1}) and the geopotential field at 500 hPa (isolines) for 30 January 2005 00 UTC. The *cos²* filter (with truncation 42) has been applied to standard deviation field.

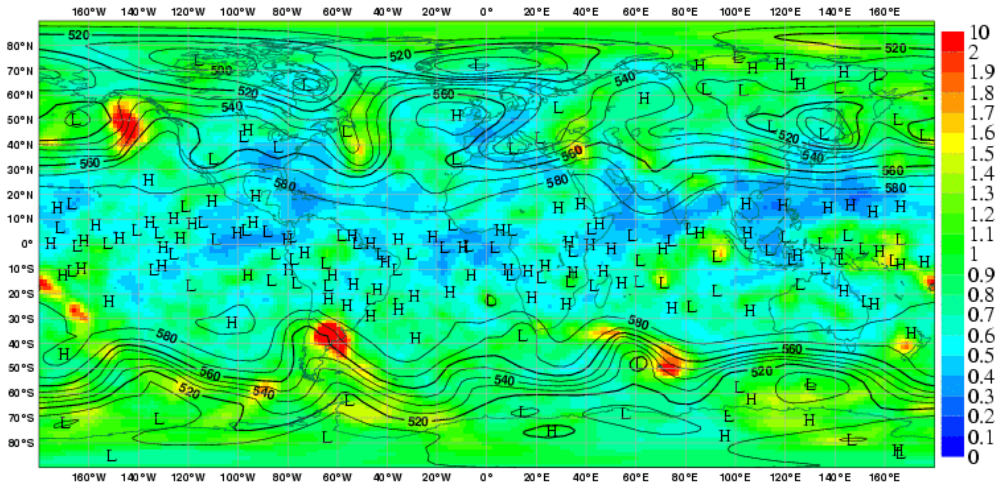


Fig. 3: The filtered standard deviation for vorticity at model level 26 (color scale, unit: 10^{-5} s^{-1}) and the geopotential field at 500 hPa (isolines) for 30 January 2005 00 UTC. The statistical filter has been applied to standard deviation field.

2.2.1. Spectral coupling implementation in the AL28t3 version (Raluca Radu)

The spectral coupling method was phased with the operational version of the ALADIN model. Some differences (operational - spectral coupling) in respect with the previous cycle were noticed; they will be canalized in correlation with the modifications in the new cycle and in the climatic files.

2.2.2. High-resolution simulations with ALADIN-NH at 2.5 km (Raluca Radu)

In order to test the ability of the Aladin model (present operational version) to simulate, at very high resolution, the surface exchange and water cycle in the forest area and its effects on adjacent region, a very small domain covering the Carpathian Mountains and Carpathian hills was set up (fig. 4).

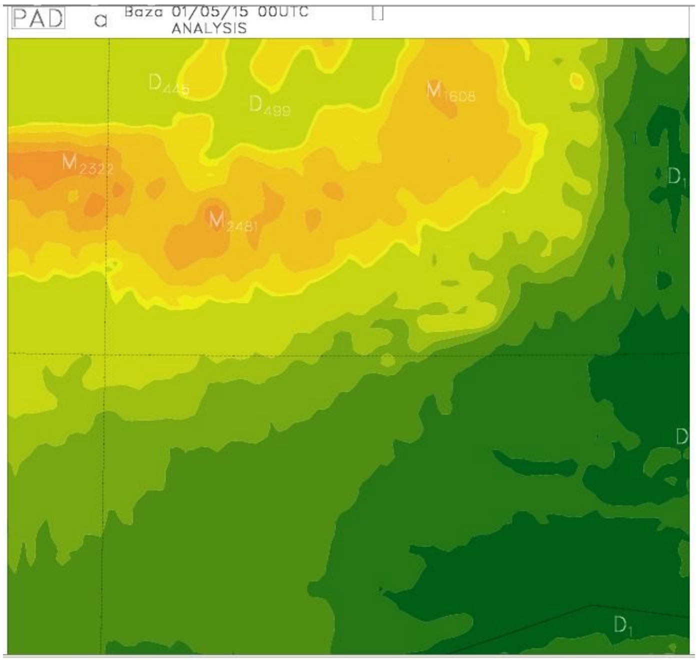


Fig.4. Aladin domain from January 30, 2006: 100 x 100 points, Δx = 2.5 km, used for vegetation experiments

The aim is to calibrate the physics package for high resolutions using all available data (satellite, radar and surface observations). In the beginning numerical simulations have been carried out with the climatic files based on the standard procedure and data bases. The next step will be the use of more idealized physiographic data to emphasize the vegetation effects.

4.10. Verification of ALADIN: CY29 vs CY25

Christoph Wittmann, ZAMG

4.10.1. Introduction

In autumn 2005 ALADIN CY29T2 was successfully installed at ZAMG, first tests with the prognostic cloud scheme on orographic precipitation cases brought promising results. It was set in parallel suite in December 2005. By the reason of unrealistic cloudiness fields it could not become operational. After upgrading some physics- and setup-routines (CY29t2_op2) in March 2006 the cloudiness problem seemed to be solved and CY29 was set in parallel suite again. During May 2006 CY29 was compared with CY25 (which is the operational ALADIN version at ZAMG for the time being) to decide whether using CY29 (with the prognostic cloud scheme is) as operational model is justifiable. In the following some of the verification results are presented.

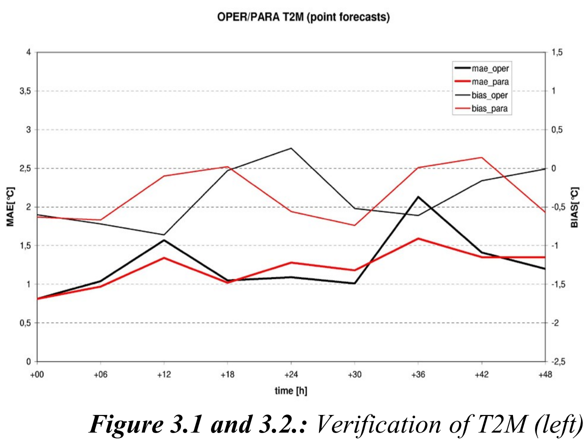
4.10.2. Data

For 2m temperature, mean sea level pressure, wind speed and wind direction ALADIN was verified using observations from 8 stations, representing the provincial capital cities of Austria. In the case of precipitation and cloudiness, data from INCA (Integrated Nowcasting through comprehensive Analysis) was used for verification. INCA represents an analysis and nowcasting tool which is being developed at ZAMG. Precipitation analysis is generated by combining radar-data and rain gauge measurements. In the case of cloudiness satellite data and observation build the input. To compare the coarser ALADIN fields (horizontal resolution 9.6km) with INCA (1km), both fields are interpolated on a regular lat-lon grid.

4.10.3. Results

Point Forecasts

Figure 3.1 shows MAE (thick lines) and BIAS (thin lines) for 2m temperature. A comparison of operational (CY25, labeled as "*oper*" in the following figures) and parallel suite (CY29, "*para*") shows that CY29 performs better, except for the forecast hours +24h, +30h and +48h. The verification was done for 00-UTC-runs only, so these forecast time represent periods during the night. When taking into account BIAS it seems to be obvious that higher MAE during night time is caused by underestimation of temperature.



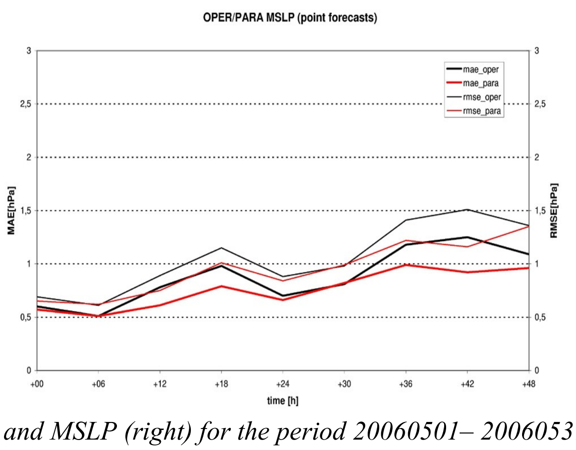
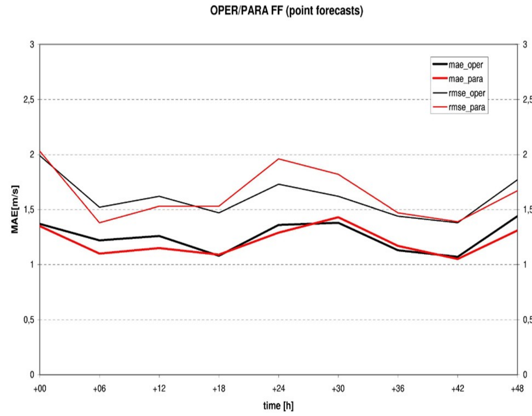


Figure 3.1 and 3.2.: *Verification of T2M (left) and MSLP (right) for the period 20060501– 20060531.*

In the case of MSLP (Figure 3.2) the conclusion is the same: CY29 performs better than CY25. In addition MAE and RMSE were computed for wind direction and wind speed (Figures 3.3 and 3.4), whereas comparison was done just in the case of observed wind speeds higher than 2 m/s. The graphs show that in the case of wind speed parallel suite produces slightly lower MAE for most of the timesteps, but higher RMSE for +18,+24, +30 and +36 indicating few cases with greater deviations to observed wind speed.



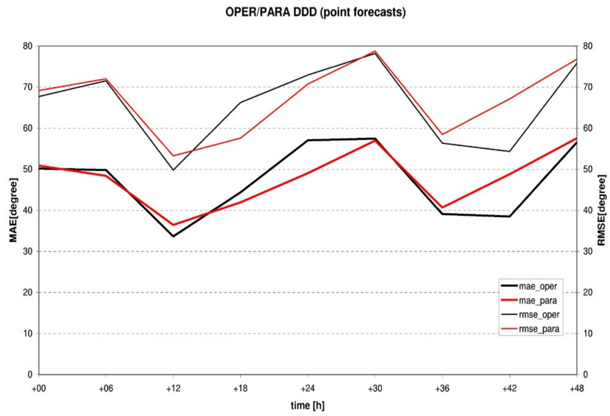


Figure 3.3 and 3.4: *Verification of wind speed (left) and wind direction (right) for the period 20060501 – 20060531.*

Cloud Cover

ALADIN cloud cover was verified using INCA-analysis as observational data. The evaluation was done for all grid points covering Austria on one hand side and in addition for 5 smaller areas representing Alpine regions and areas in the lowland (see Figure 3.5) on the other hand side.

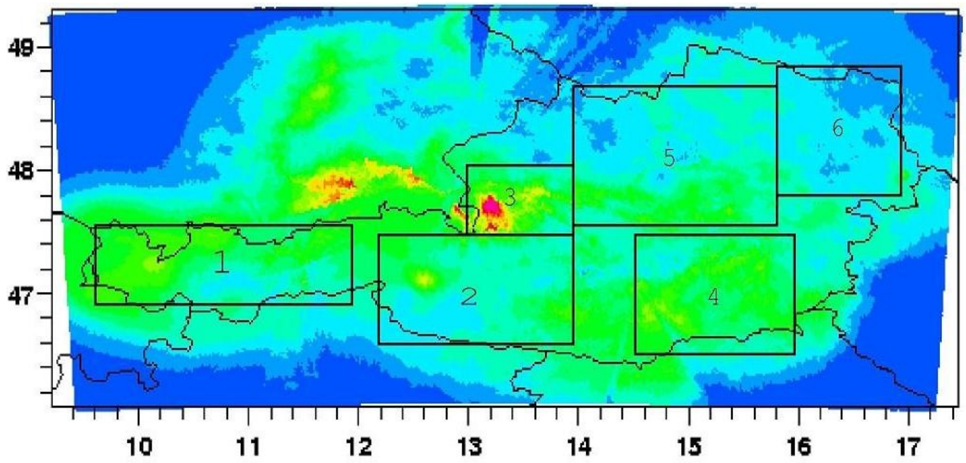


Figure 3.5: *Location of different areas, graphic by Eric Bazile (GMAP, Météo-France).*

In the following selected figures and tables are shown in order to give an idea about the major results. Tables 3.1 – 3.3 show MAE for (total) cloud cover for different areas. When taking into account all gridpoints within area 1, CY29 (with prognostic cloud scheme) gives better results for all timesteps (table 3.1). Area 1 represents a mountainous region in Tyrol and Vorarlberg in the Western part of Austria. The same conclusion can be drawn for area 4 (table 3.2). For area 6 the situation seems to be less obvious, but the scores for parallel suite are better for most of the timesteps.

area 01	oper	para
+06	24,94	23,96
+12	35,25	21,81
+18	24,96	20,87
+24	35,07	32,96
+30	26,02	24,9
+36	34,41	25,25
+42	24,43	21,63
+48	35,68	30,62

area 04	oper	para
+06	19,96	19,03
+12	30,04	17,22
+18	19,68	23,95
+24	35,03	31,39
+30	22,66	19,76
+36	29,1	21,48
+42	22,83	24,28
+48	34,17	29,41

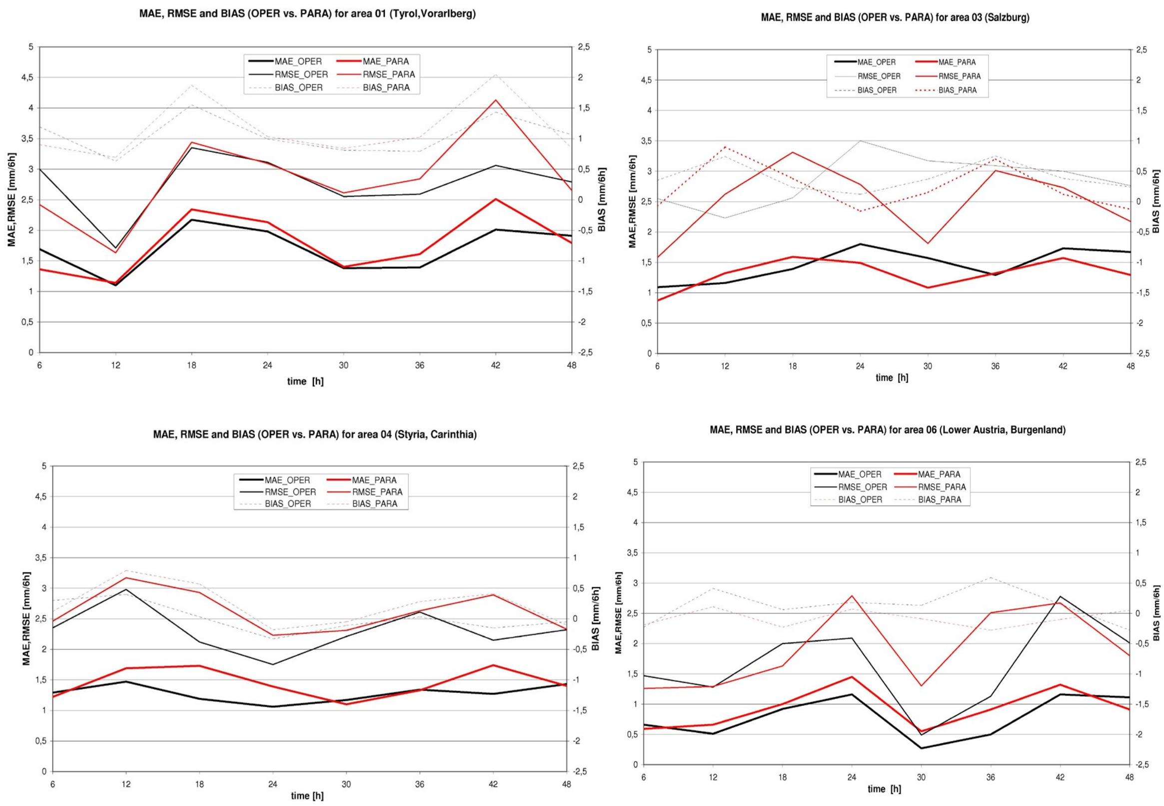
area 06	oper	para
+06	20,84	22,27
+12	20,89	17,47
+18	20,03	25,87
+24	26,52	21,28
+30	19,95	18,69
+36	21,45	19,15
+42	19,73	21,55
+48	26,33	25,65

Tables 3.1 -3.3.: *MAE cloud cover for area 01 (left), area 04 (middle) and area 06 (right) .20060501 – 20060531.*

Beside the shown results several other statistical scores (ETS, FAR, etc.) were computed to evaluate the cloudiness parameter, all bringing similar results as shown in tables 3.1- 3.3.

Precipitation

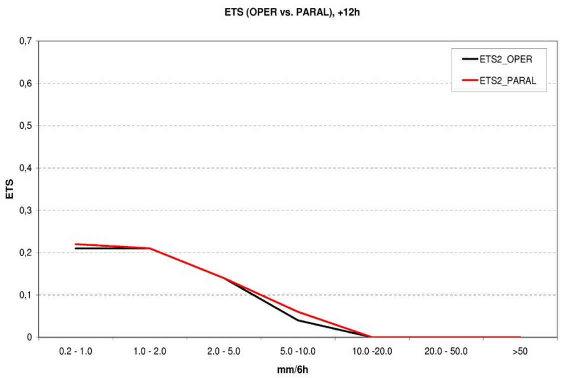
Among all verified parameters precipitation is the most important parameter to decide whether CY29 can be set in operations or not. Up to now the prognostic cloud scheme was predominantly tested in case studies at ZAMG. The tests brought quite promising results, compared to the diagnostic scheme Lopez seems to do a better job in mountainous areas, improving the weakness of the old scheme (unrealistic luv-side precipitation peaks while overestimating the lee-side precipitation). As already mentioned several areas were defined in order to verify areal precipitation means. Figures 3.6-3.9 show MAE, RMSE and BIAS for 6h-periods beginning with +06h, ending with +48h. Areas 1 and 3 represent mountainous regions, whereas area 4 and 6 can be seen as intermediate and lowland areas respectively.

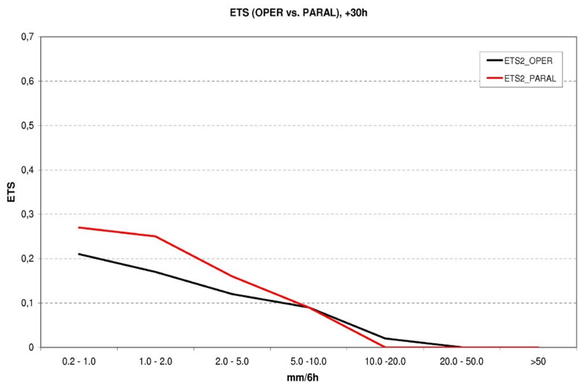


Figures 3.6-3.9: *MAE, RMSE and BIAS for 6h accumulated precipitation; area 01 (upper left), area 03 (upper right), area 04 (bottom left) and area 06 (bottom right). Period 20060501 – 20060531.*

The graphs for area 1 indicate significant better results for operational run. Higher MAE is associated with higher BIAS, indicating a further overestimation of precipitation amounts (with respect to the operational suite). This (somehow surprising) result can also be seen in figure 3.8 for area 4. For rather flat areas the results are different in the way that higher MAE is associated with negative BIAS (further underestimation of areal means with respect to CY25). Among all areas the prognostic scheme performs best for area 3 (figure 3.8).

Several other scores were computed (FAR, HR, grid point MAE, etc) showing similar results: In the case of precipitation CY29 is not yielding crucial improvements, for most of the areas the scores indicate the opposite (better scores for CY25). As already mentioned, different scores give similar results. ETS (equitable thread score) is somehow an exception. When taking into account just ETS, the results are quite neutral, indicating that the quality of precipitation forecasts is quite similar. An example is given in figures 3.10 and 3.11 showing ETS for forecast hour +12 and +30.





Figures 3.10-3.11: *Equitabe Thread Score for area 00 (all gridpoints within Austria) for +12 (left) and +30 (right). Verification period 20060501 – 20060531.*

4.10.4. Conclusions and Outlook

To conclude it can be pointed out that CY29 brings better (or at least equal) scores for 2m temperature, mean sea level pressure, wind speed and wind direction. The same can be concluded for cloud cover. In the case of precipitation (as, scores are not sufficient in order to change operational ALADIN version from CY25 to CY29 (with Lopez) for the time being. The impression of more realistic precipitation patterns gained with Lopez cannot be underlined sufficiently by several scores. The weakness of this present verification is its duration, which is rather short (1 month for precipitation and cloud cover).

Before starting any further experiments or verifications it seems to be favourable to upgrade the Lopez-routines with the changes included in CY30 (splitting of prognostic variable qp into qr and qs, etc).

5. ALADIN PhD Studies

5.1. M. Belo Pereira: Improving the assimilation of water in a NWP model. Thèse de doctorat de l'Université Paul SABATIER Toulouse. Successfully defended on the 29 mai 2006.

5.2. L. Auger: Influence de la dynamique turbulente sur la cinétique chimique dans une couche limite atmosphérique polluée. Thèse de doctorat de l'Université Paul SABATIER Toulouse. Successfully defended on the 26 juin 2006.

5.3. Dahoui M.: Vers une assimilation variationnelle des radiances satellitaires nuageuses. Thèse de doctorat de l'Université Paul SABATIER Toulouse. Successfully defended on the 19 juin 2006.

5.4. Catry B.: "Effects of moisture and mountains in Numerical Weather Prediction". Successfully defended on the 22 May 2006 , University of Ghent, Belgium.

5.5. Vasiliu S.: Scientific strategy for the implementation of a 3d-var assimilation scheme for a double-nested limited area model. University of Bucarest - ROMANIA. Defended on ??

5.6. Radu R.: Extensive study of the coupling problem for a high resolution limited area model. ??

5.7. Simon A.: Study of the relationship between turbulent fluxes in deeply stable PBL situations and cyclogenetic activity. ??

5.8. Szczech-Gajewska M.: Use of IASI/AIRS data over land. ??

5.9. Vivoda J.: Application of the predictor-corrector method to non-hydrostatic dynamics Slovakian thesis: SLovak academy of Sciences. ??

5.10. Guidard V.: Evaluation of assimilation cycles in a mesoscale limited area model.

5.11. Stefanescu S.E.: the modelling of the forecast error covariances for a 3D-Var data assimilation in an atmospheric limited area model.

5.12. Voitus F.: A survey on a well-posed and transpparent lateral boundary conditions (LBCs) in spectral limited area model.

5.13. Bergaoui K.: further improvement of a simplified 2D Var soil water analysis.

6. PUBLICATIONS

In books and referred international journals.

Belo Pereira M. et L. Berre: The use of an Ensemble approach to study the Background Error Covariance in a Global NWP Model. Mon.Wea.Rev. http://www.ametsoc.org

Catry B., J-F. Geleyn, M. Tudor, P. Bénard and A. Trojakova: Flux-conservative thermodynamic equations in a mass-weighted framework. Tellus.

http://www.blackwellpublishing.com/

Cuxart J., A.A.A. Holtslag, R.J. Beare, E. Bazile, A. Beljaars, A. Cheng and ...", Single-column model intercomparison for a stably stratified atmospheric boundary layer: BLM, February 2006, Volume:118,Number:2 Pages: 273-303.

Fischer C., T. Montmerle, L. Auger et B. Lacroix: 2006: L'assimilation de données opérationnelle régionale à Météo-France. La Météorologie.

Fischer C., T. Montmerle, L. Berre, L. Auger and S.E. Stefanescu: An overview of the variational assimilation in the ALADIN/FRANCE NWP system: QJRMS.

http://www.royalmetsoc.org

Fourrie N. , D. Marchal, F. Rabier, B. Chapnik et G. Desroziers: Impact Study of the 2003 North Atlantic THORPEX Regional Campaign, QJRMS http://www.royalmetsoc.org

Guerin R., G. Desroziers and Ph. Arbogast: 4D-Var analysis of potential vorticity pseudo-observation QJRMS April 2006 Part B vol. 132 n° 617 pp1283-1298

Guidard V., C. Fischer, M. Nuret, A. Dziedzic, 2006: Evaluation of the ALADIN 3D-VAR with observations of the MAP campaign, M.A.P., vol. 92, pp. 161-173 http://www.ametsoc.org

Joiner J., G. Brin, A. da Silva, R. Treadon, J. Derber, P. Van Delst, J. Le Marshall, P. Poli, R.M. Atlas, C. Cruz, D. Bungato, 2006: Effects of data selection on the assimilation of AIRS data, soumis au Q JRMS.

Karbou F., E. Gérard, and F. Rabier, 2005, Microwave Land Emissivity and Skin Temperature For AMSU-A & -B Assimilation Over Land. QJRMS http://www.royalmetsoc.org

Mathieu A., J.-M. Piriou, M. Haeffelin, P. Drobinski, F. Vinit, F. Bouyssel, 2006: Identification of error sources in convective planetary boundary layer cloud forecasts using SIRTA observations. Geophysical Research Letters.

Michel Y. et F. Bouttier, 2005: Automated tracking of dry intrusions on satellite and synthetic water vapour imageries. QJRMS. http://www.royalmetsoc.org

Montmerle T., F. Rabier and C. Fischer, 2006: Respective impact of polar-orbiting and geostationary satellites observations in the Aladin/France numerical weather prediction system. QJRMS, http://www.royalmetsoc.org

Pannekoucke O;, L. Berre and G. Desroziers: Filtering properties of wavelets for the local background error correlations. QJRMS. http://www.royalmetsoc.org

Piriou J-M., J.-L. Redelsperger, J.-F. Geleyn, J.-P. Lafore, F. Guichard, 2006: An alternative approach for convective parameterization: separating microphysics and transport in large-scale budget equations. JAS.

Rabier F. 2006: "The importance a data: a meteorological perspective": Chapitre 12 (pp343 a 360) du livre "Chassignet, E.P., and J. Verron (Eds.), /Ocean Weather Forecasting: An Integrated View of Oceanography./ Springer, 577 pp.

Rabier F: Overview of data assimilation developments in NWP centres: QJRMS. http://www.royalmetsoc.org

Soci C., C. Fischer and A. Horanyi, 2006: Sensitivity of high resolution forecasts using the adjoint technique at the 10 km scale, MWR, vol. 134, pp. 772-790. http://www.ametsoc.org

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. Mon. Wea. Rev. . http://www.ametsoc.org

Žagar M., N. Žagar, J. Cedilnik, G. Gregorič and J . Rakovec: Validation of mesoscale low-level winds obtained by dynamical downscaling of ERA40 over complex terrain. *Tellus (2006), 58A, 445-455* .

Stoffelen, A., G.-J. Marseille, F. Bouttier, D. Vasiljevic, S. de Haan and C. Cardinali, 2006: ADM-Aeolus Doppler wind lidar Observing System Simulation Experiment. Quart. J. Roy. Meteorol. Soc., vol 132, 1927-1948. http://www.royalmetsoc.org