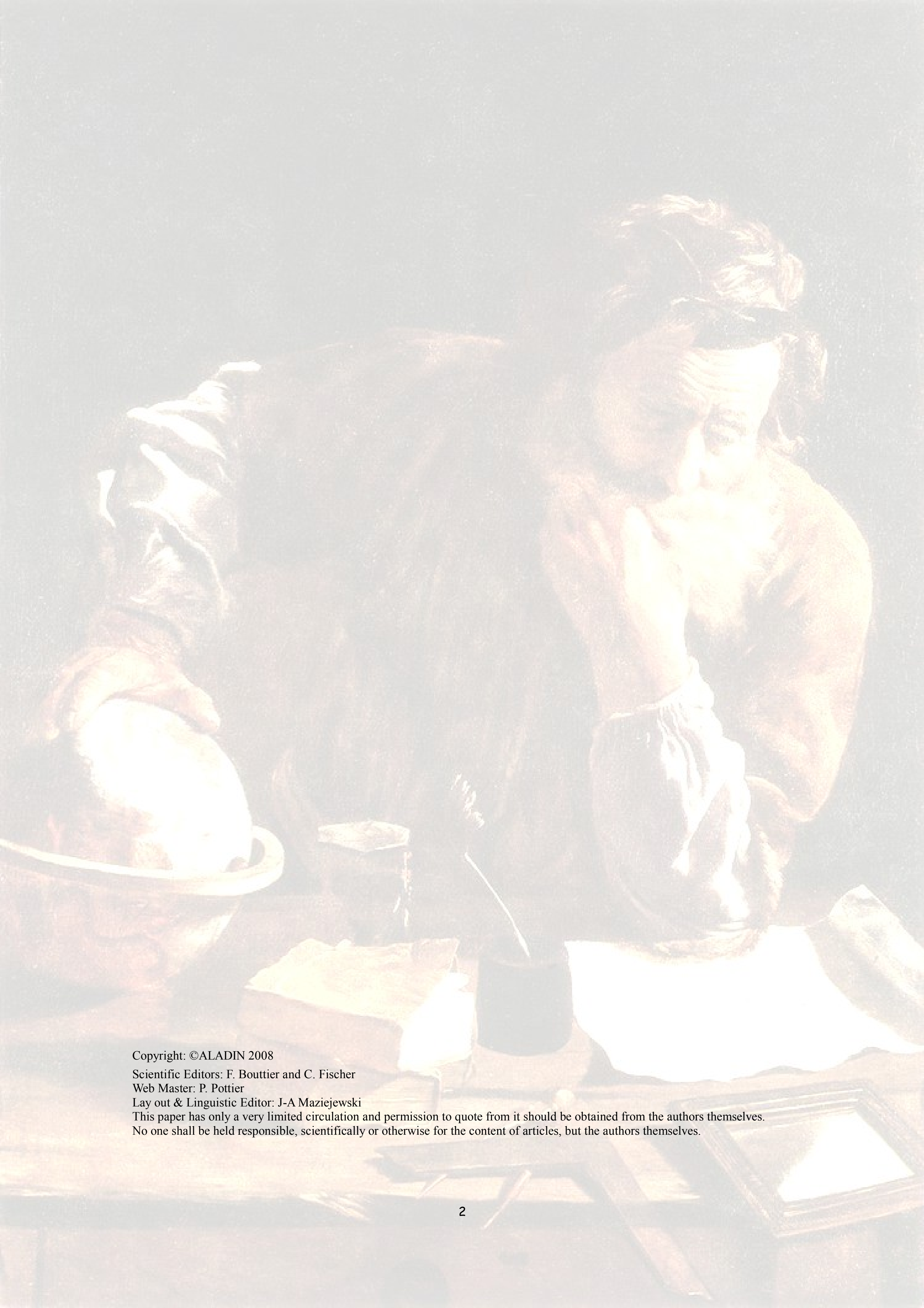
ALADIN

NEWSLETTER 35

July-December 2008



CONTENT

1. EDITORIAL

1.1. Foreword

J.-F. Geleyn (ALADIN Programme Manager)

ALADIN? What do you mean?

We are at a strange time in the history of our Programme. Many successes (past or yet partly to be confirmed) can be registered or anticipated (non-exhaustive list, sorry for the 'misses'):

- AROME became operational on 18/12/08 in Toulouse (2.5 km mesh and with a data assimilation mode using specific observations); progress on all related fronts should now become more steady;
- After several implementations at the '9km scale', ALARO-0 in a 'grey zone configuration' (4.5 km mesh) followed soon afterwards (15/01/09) in Brussels;
- The 'Convergence days' organised last September by Météo-France have redefined in a positive way the manner one should consider scales of application, interfacing procedures and longer-term evolutions of operational physics;
- Prepared in Vienna with the help of LACE colleagues, the EPS application LAEF appears as a good compromise between innovative features (e.g. blending-breeding) and more classical ways to ensure dispersion; tests made at the occasion of a Beijing'08 demo project allow to be optimistic for this approach;
- Thanks to recent efforts made in Brussels and by the LACE management, our future contribution to GLAMEPS gets a more and more consistent shape;
- Driven from Budapest, the OPLACE project of common data pre-processing for distributed data assimilation applications is well advanced and shall open the door for a better share of manpower resources in this delicate area;
- Plans are drawn to benefit from the integrated scripting approach of HARMONIE through a (yet to be fully defined) joint effort;
- In Prague, plans are well advanced for a substantial upgrade of ALARO incorporating advances prepared in several places;
- Small but real progress is registered on the item of some re-appropriation of the dynamics issues (avoiding at least that it would be considered only as a global IFS/ARPEGE topic);
- In many domains the cooperation with HIRLAM is now relying on concrete actions rather than on some a-priori planning for longer term common goals.

Still not forgetting a few weak points, we may on the one hand be quite satisfied with registering all this (as did the General Assembly last November) but, on the other hand, there is one very worrying signal in the above: without much effort I could describe the present situation with many acronyms or specific locutions, while never using the word 'ALADIN'! The tendency is obviously not new. It probably started in 2003 with the hyper-identification of AROME, but the existence of many offsprings indicates that it rather corresponds to some strong drive for 'particularising' sub-actions.

Of course, I believe that the issue is not only semantic. It reflects a worrying trend in which centralised maintenance and networked scientific watch would soon remain the only truly transversal backbones of the ALADIN trade. All other aspects are indeed more and more characterised either by dispersion of efforts under specific 'banners' or by reduction of ambitions in order to maintain some illusion of solidarity between Members.

So, with this 'Editorial', I'm launching a very specific call: you may be proud of your 'local' or ‘specialised’ efforts, but please recognise that they could not flourish as much without the existence of the ALADIN structure, within its wider IFS/ARPEGE ‘host’. Please acknowledge this true duality and hopefully the current snowballing trend can be reversed, for the good not only of ALADIN, but also in the end of its AROME, ALARO, LAEF, GLAMEPS, OPLACE, HARMONIE, … declinations.

1.2. EVENTS

- Stjep is on maternity leave and Martina is back at work.

- ALADIN on the web (Pottier Patricia)

... or a short history of ALADIN website

- before the website : end of 1995 : informations for ALADIN partners are available (in *postscript format*) on a **public ftp** : newsletters, information for visitors, quasi-operational bulletins, ...
- beginning of 1999: the ALADIN project has its web site : **http://www.cnrm.meteo.fr/aladin/** : presentation of the consortium, how to contact people, newsletters, information for visitors, meetings announcements and minutes, documentations and stays reports. The website is managed "by hand" and contains short *html pages* with many links within themselves.
- end of 2000: the website has some new functionalities such as a "trombinoscope", a site map, a search tool, an interface for registration of ALADIN participation (*cgi code*); a dedicated website is built for **alatnet** (using *frames* tool).
- end of 2003: a new graphic design for the aladin website (using *CSS* and *tables* rather than frames that are now completely out of fashion !), more information (stays reports, documentations, ...).
- end of 2005: the aladin documentation is moved on a new dedicated website : http://www.cnrm.meteo.fr/gmapdoc/ that contains also gmap and arpege documentation.
- end of 2006: a restricted part of the aladin web is added ("Partners pages") where authorized partners can get some technical documentation on cycles or E-suites and some daily outputs
- end of 2007: each LTM/correspondent can maintain information about his/her models, domains, platforms, ... up-to-date thanks to new interfaces in the LTM pages (*php, MySQL*)
- mid-2008: **the aladin website gathers 12000 files (.html or .ps or .pdf or .jpg or .php or .cgi files, directories, ...) and the average files transmitted daily is about 2500 !**.. : let's homogenize and reorganize everything with modern tools !
- end of 2008: **just before its 10-year anniversary, the whole aladin public web has been moved on a SPIP[1] website.** The pages have been reorganized in order to diminish the number of SPIP articles (gathering former .html files in one article with many join documents in .pdf or .jpeg for pictures). Hopefully, one can now find information more easily. The interface pages (registration of aladin participation, update of information about models, domains ..) are unchanged. Passwords for these interface pages or for "Partner" pages remain the same.

- Instructions for an easy use of the new ALADIN website

The home page of this site presents the main sections with a short description and the recently published articles.

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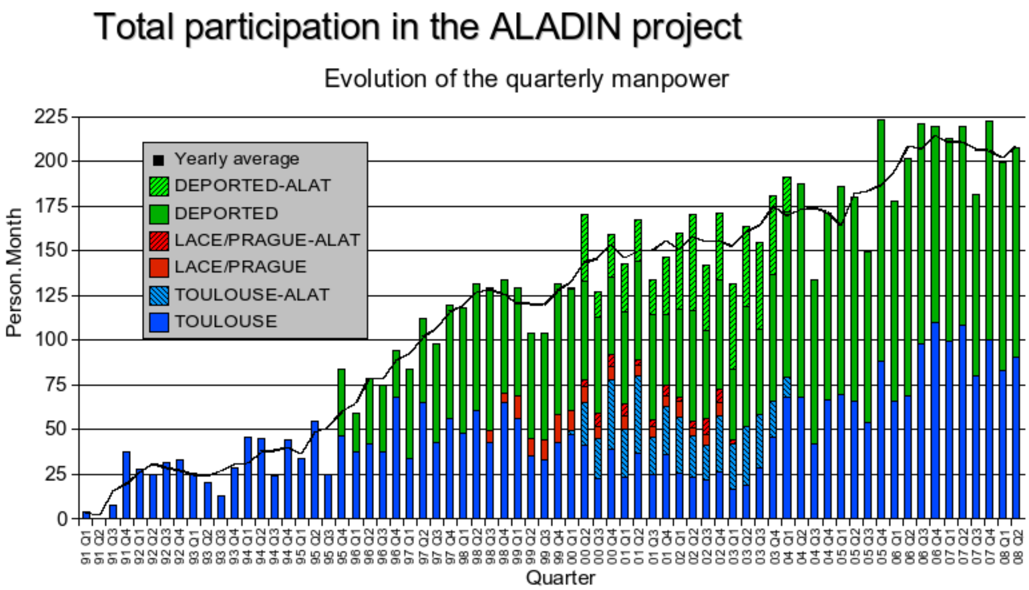
1 SPIP consists of a bundle of files allowing to take advantage of a number of automated tasks: multi-user management, laying out articles without the need to use HTML, easily modifying the structure of the site. SPIP is a free software distributed under the General Public License (GPL). SPIP completely separates and distributes three kinds of tasks over various players: the graphic design, the site editorial input through the submission of articles and news items and the site editorial management (which includes organizing sections and validating articles submission). The templates follow the W3C standards and accessibility guidelines closely. They have inclusions: three for the navigation menu by section, the header and the footer (which are repeated on each page) and two others for forums and petitions signatures. For better accessibility, the SPIP forms render easily using CSS. The syndication feed templates (backend) are in RSS 2.0 format.

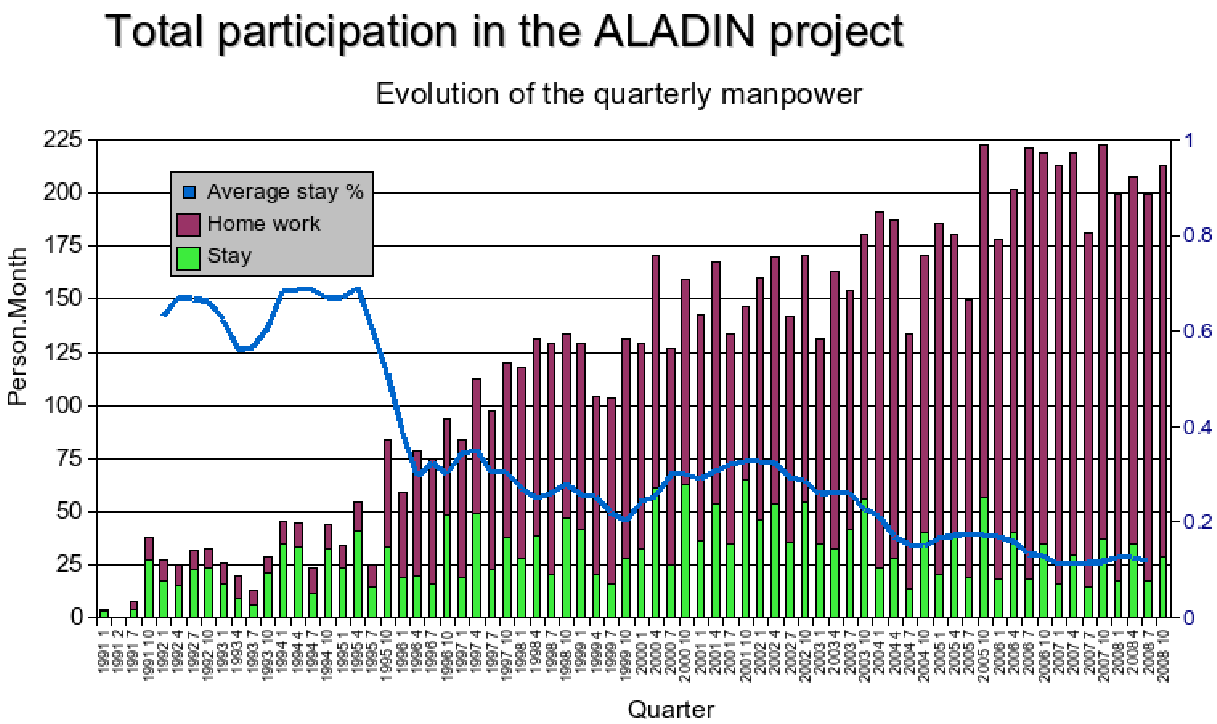
On the home page as well as in all others, one may find :

- menus to navigate through the sections/sub-sections
- link to the **site map** : all (sub-)sections by alphabetical order, the articles being ordered also by alphabetical order within a same (sub-)section.
- link to the **search engine** based on a word indexing system : it is available in the header of all pages ("search"). The results of the search engine is :
  - sections or sub-sections that contain the searched word
  - articles that contain the searched word
  - joined documents (.pdf, .ps, ...) that contain the searched word
  - a possibility to search also the requested word in html pages outside SPIP
- possibility of **syndication** for each section, sub-section, article, ...
- link to the **administration area** for
  - administrators who manage, among other things, the site structure and the validation of articles
  - editors who submit articles.
- access to a **forum** using "React" : SPIP includes a forums system, forums can be associated with articles (one forum per article), sections or news items : to avoid spam, these forum are moderated beforehand thus your contribution will only appear after being validated by a site administrator.
- link to **News** page : last published articles, articles modified recently, last referred web sites
- link to **Agenda** : announced evens by month
- **contact** to webmaster
- **Kiosk web** : the articles diffused in the web sites partner
- **My profile/leave** : registration for access to "partners pages" or "administration area"

This is how it looks now

❑ The yearly mean amount of work on ALADIN has been the same for many years now and remains constant. Work « at home » and work « during stays » is stable at around 12%. Same-wise, work in Toulouse (regular staff and « visitors ») and « DEPORTED » work remain unchanged.
Therefore, why are you so reluctant to send contributions about your work at « home » to the ALADIN Newsletter ?





1.3. ANNOUNCEMENTS

- **HIRLAM All-staff Meeting 2009 and ALADIN 19th Workshop**, 12-15 May 2009, at Centraal Museum Utrecht, Utrecht, The Netherlands. www.knmi.nl/samenw/harmonie

Dear HIRLAM and ALADIN researchers,

During the EWGLAM meeting in Madrid we had a small discussion between us about sports activities that were arranged in earlier days and that they were very nice occasions to meet with the colleages working in the field of NWP in an informal manner.

Based on this discussion we have decided to establish the Tennis Expert Team Organising Committee (TETOC), which would complement the already existing Expert Teams inside SRNWP.

We felt that the forthcoming HIRLAM-ALADIN annual meeting would be an excellent occasion to have a kick-off to this new Expert Team and to revive the tradition of organizing a sports event beside the serious (?) business meetings.

To put all these words into action we will organize a small tennis tournament in a tennis hall close to Utrecht on Wednesday evening (13th of May) during the HIRLAM - ALADIN meeting. The exact details will follow later, but the tournament will probably last from 19.00 to around 22.00. The hall has 5 indoor tennis courts, so there is plenty of room for anyone interested in participating! The costs for this event will be between 10 and 15 euros per person for the tennis.

We would be happy to get "expression of interests" until the end of March in order to better estimate and organise the requirements for this endeavour. Note that we will play indoors (on felt-carpet like surface) so we are not dependent on the famously changeable weather in the Netherlands.

We are looking forward to your early answers, opinion!

Best regards

Tennis Expert Team Organisation Committee (TETOC)

Neva on behalf of ALADIN (neva.pristov@rzs-hm.si)

Sander on behalf of HIRLAM (tijm@knmi.nl)

Andras on behalf of C-SRNWP (horanyi.a@met.hu)

Dear HIRLAM and ALADIN researchers,

Jose Antonio Garcia Moya, from AEMET (previously INM) has volunteered to organize a small squash tournament on the same evening and in the same sports centre as the tennis tournament, that is scheduled during the HIRLAM-ALADIN meeting, on 13 May 2009.

If you are interested to participate in this sports event then please contact Jose Antonio (png@inm.es) or me (tijm@knmi.nl).

More information on both the tennis and the squash tournaments can be found on:
http://www.knmi.nl/~tijm/Tennistournament.html

We hope to meet you all in good shape,

Jose Antonio and Sander.

- The Nordic Network on Fine-scale Atmospheric Modelling (NetFAM), the EUMETNET Short Range Numerical Weather Prediction Programme (SRNWP) and the Swedish Meteorological and Hydrological institute (SMHI) organize a **Workshop on Moist Processes in Future High Resolution NWP/Climate Models** on June 15-17, 2009 in Norrköping, Sweden.

  Details and registration at: http://netfam.fmi.fi/CLOUD09/

2. OPERATIONS

2.1. INTRODUCTION

2.2. CYCLES

2.2.1. *CY35T1:

- Assimilation:

Plug-in LAM wavelet code (A. Deckmyn)

Make baseline Aladin 4D-VAR minimization work (B. Chapnik), including Jc-DFI and multi-incremental treatment of analysis increment (UPDSPEC, …)

- Arpège and Aladin-FR Physics:
  - completed code for TKE-CBR
  - modifications in KFB shallow convection and in the Bougeault mass-flux deep convection scheme
- Dynamics:
  - Rationalisation of the SL Interpolators (plus pruning some options) – J. Masek & F. Vana
  - cleanings in semi-Lagrangian code (including too long lists of dummy arguments) – K. Yessad replace LPC_XIDT by a simple XIDT management in PC schemes
  - prune obsolete options (conf 951, option LSL_UNLPHY=T, etc…); recode option NxLAG=2 in an alternative way and prune old code
  - unify some DM-communication routines
  - rename some variables (root L,I,LSM for liquid water, ice, land-sea mask everywhere)
  - adapt "DYNCORE" set-up to MF applications
  - split 'eta' into 'eta_vfe' (for VFE operators) and 'eta_sl' (for SL trajectory research and vertical interpolations), allow LREGETA_VFE=T and LREGETA_SL=F in a same run
- Extensions and bug corrections inside EGGPACK (= limited area, plane projection geometry package)
- Surface/PBL observation operator compatibility (L. Kullman, R. Hamdi, J.-F. Mahfouf) => code contribution only inside SURFEX libraries (via P. Le Moigne); more generally, 35T1 contains updated SURFEX code (version 4 bugfix 3)
- Full-Pos:
  - Try to compact sections 2.1 and 3 in POS
- Complete prototype of new DDH data flow structure
- AROME:
  - Introduction of Surfex V4 :
    - ✕ rotated lat/lon (Hirlam projection)
    - ✕ I/O (for off line version only ?) :
      - # reading of forcing in ascii, binary or NETCDF formats
      - # read/write of surface fields in LFI format
      - # read/write of surface fields in FA format (for the time being, only on regular lat/lon grids)
    - ✕ CMO1D model (1D ocean superficial mixing layer)
    - ✕ Interface with ECOCLIMAP2
    - ✕ optimisation of ECUME (sea surface flux model)
    - ✕ further modifications:
      - # for operations (« rimax », flag for field writes)

for simulations at the Dome C location

- Introduction of Masdev4.8:
  - ✕ New version of EDKF (modified tunings)
  - ✕ microphysics: Homogenisation of Méso-NH and Arome codes for statistical sedimentation and introduction of a switch (for activating statistical or eulerian sedimentation)
  - ✕ Modifications for chemistry and desert sand particle transport (in link with the surface)
- Clim files (e923):
  - ✕ Introduction of a relaxation of the orography towards the orography of the coupling model (key LOROCPL)
- Reflectivity:
  - ✕ Cleaning and harmonization (reflsim_dop, reflsim, gpprs0d,
  - ✕ New modifications for the 1D+3DVAR code according to tests to be performed in summer 2008
- Assimilation:
  - ✕ Modifications for activating the “Jk term” in Arome
- E927 and fullpos:
  - ✕ Some corrections for Arome, if ready
- Dynamics:
  - ✕ Code adaptations in order to be able to switch on the rectangular truncation

2.2.2. CY35T2: deadline for contributions December 15th, for a quick and tight phasing between mid-January and beginning of February !

❑ Assimilation:

- write out of background fields in GRIB format, instead of FA format (for use in the ensemble D.A. and B-computations) – G. Desroziers
- Computation of dynamical emissivity over sea-ice for AMSU instruments (F. Karbou)
- Coding of the neutral wind observation operator for scatterometer data (C. Payan)
- Some cleanings in codes concerning scatterometer data (scatt parts in Bator and Arpège) (C. Payan)
- Decoding of Aeolus L1B data in Bator (beginning of the work by Charles Desportes – post-doc -) (C. Payan)

Choice by name list of the AMV channels inserted in Météo-France's ODB and Bator, with some additional cleanings (Bator, Arpège) (C. Payan)

- ❑ Full OpenMP parallelizsation for AD of SL code on vector computers; TL and AD code for SLHD (F. Vana)
- ❑ Further cleanings in the SL code and merger of some routines below CALL_SL and LACDYN(+TL/AD) (K. Yessad)
- ❑ Scale selective DFI (P. Termonia)
- ❑ optimization features and model I/O improvements (R. El Khatib)
- ❑ improvements in the new DDH data flow: inclusion of 2D fields, call from Arpège global model (O. Rivière)
- ❑ Arome changes (Y. Seity):
- ❑ some cleanings in APL_AROME and for chemistry model
- ❑ updated version of SURFEX4 (bugfix version 8)
- ❑ Hirlam: miscellaneous bug and portability fixes
- ❑ Arpège/Aladin physics:
  - ✕ Correction of bugs related with the use of SURFEX in ALADIN:
  - ✕ initialization of Wpi in PREP_SURFEX,
  - ✕ inquiry mode of roughness lengths (Z0, Z0h),
  - ✕ creation of PGD executable with gmkpack
  - ✕ Correction of a bug in the setup of the entrainment name list parameter used in the "CAPE fullpos" computation
  - ✕ Correction of a bug in the algorithm for the adjustment of negative humidity
- ❑ ALARO0:
- Rationalization of the turbulence scheme, new options for p-TKE (F. Vana)

2.2.3. CY36: Start of phasing on May 5th 2009 (common with ECMWF/IFS)

- ❑ MF and partners contributions on top of CY35T2: AROME: MASDEV4.8 (mostly new EDKF scheme for shallow convection) – S. Malardel and Y. Seity -
- ❑ Hirlam: shallow convection code from KNMI (W. De Rooy) via Sylvie + Yann's contribution
- ❑ cleaning in the SL code, especially some reorganization of the SL/AD code (K. Yessad)
- ❑ preparation for the pre-treatment of ADM/Aeolus data at MF (C.
Payan, C. Desportes) – to be confirmed
- ❑ some small rearrangement of the code for spectral orography filtering under key LSPSMORO in e923 (M. Dahlbom, F. Taillefer)

2.3. PROGRESS & PLANS AT METEO FRANCE

claude.fischer@meteo.fr

2.3.1. Progress in 2008

1. **End the ARPEGE-Tropiques assimilation cycle**, run ARPEGE-Tropiques forecasts at TL538C1.0L60 resolution from the ARPEGE assimilation cycle. This switching eventually took place on June 11th 2008

2. **Start on a routine basis an ensemble of 6 assimilation cycles** of 6h-window 3D-VAR FGAT in TL358C1.0L60 under OLIVE (started in early February 2008).

3. **ARPEGE and ALADIN-France E-suite number 1 for 2008**:

- CY33T0
- assimilation of new AQUA/AIRS channels (~54 channels in total),
- assimilation of MetOp/IASI channels (~50 channels), MetOp/HIRS,
- assimilation of MSG/SEVIRI Clear Sky Radiances (the 2 so-called “water vapour channels”),
- assimilation of clear-sky microwave radiances over sea (DMSP F14 SSM/I),
- Increase in the number of assimilated microwave radiances (AMSU-A/B, MHS from NOAA and MetOp) over land, in clear-sky, using improved surface emissivity computation (no additional channels used),
- assimilation of AMSU-A channel 13 (with a frozen bias correction)
- Increase the number of assimilated GPS-RO data (improved vertical thinning), with an assimilation from 1km to 6km at the lowest (from poles to equator) until 25km (top)
- Increase the horizontal density of aircraft observations
- Switch-on the assimilation of 4 ambiguous winds from QuikSCAT to prepare for a new set of data
- couple the ARPEGE assimilation with variances "of the day" derived from the real time ensemble assimilation, in order to allow a consistent use of σb's of the day within the ensemble itself (in place of a climatological σb map)
- ALADIN-France: new observations as in ARPEGE, remove RH2/T2 observations in night time analyses (spurious surface/PBL forcing via **B** matrix, flag will be on real solar time), VarBC for SEVIRI.
- ARPEGE physics: new GWD, revised surface turbulent exchange coefficients, corrected snow melting reaching the ground
- modified timestep of ALADIN-FR (450 s) to have an even number of iterations per hour, modified post-processing for isolated lakes

This E-suite has been under test from February up to June 2008. The E-suite has been first monitored under OLIVE, then delivered to Operations (end of May). **The switch to operations has occurred on July 1st 2008**. Note that the presence of VarBC in ARPEGE induces a change in the strategy for starting an E-suite containing new observation types. Since VarBC is a bias correction scheme where all observations are inter-dependent (plus the analysis) inside VarBC, one needs to proceed to a warm-up of the E-suite prior to the actual start. This warm-up consists in introducing progressively the new observations, over about 2-4 weeks. For ALADIN-France, the ARPEGE VarBC file is read in and the coefficients are merged with those computed adaptively for SEVIRI by the ALADIN/VarBC.

4. Development of on-demand LBC file production for any ALADIN partner domain, from an ARPEGE E-suite (implementation postponed)
5. ARPEGE and ALADIN-France E-suite number 2 for 2008 (autumn/winter 2008):

- CY33T1
- assimilation of METOP/GRAS radio-occultation (as soon as regular data dissemination from provider has started),
- more microwave radiances over land,
- ARPEGE physical parameterization:
  - horizontal diffusion coefficients now similar for vorticity, divergence and temperature,
  - vertical turbulent diffusion scheme with prognostic turbulent kinetic energy following Cuxart, Bougeault and Redelsperger (2000),
  - shallow convection scheme from Bechtold et al. (2001), modified to provide a new source term of turbulent kinetic energy
  - These changes lead to adjust parameters from other schemes, in particular within the extended Bougeault deep convection scheme. Furthermore, vertical diffusion, shallow convection and deep convection are somehow coupled.
  - extend from 2 to 6 solar radiation bands in the Fouquart and Morcrette scheme,
  - use of a version of the sea surface turbulent fluxes scheme ECUME from the GMGEC/MEMO group (see Weil et al., 2003),
  - a scheme for improving entrainment at the top of the boundary layer (“GBM”),
  - new Ozone monthly climatology (same as IFS),

- introduction of in line Fullpos post-processing
- ALADIN-France: same changes as ARPEGE plus introduction of the surface assimilation (CANARI) adapted from ARPEGE.

This e-suite has been switched to operations on February 4th 2009.

6. Developments preparing for the NEC 2009 upgrade, focused on a new resolution of the ARPEGE system (TL800C2.4L70) have begun end of 2008.

In the fall and winter 2008/9, a major upgrade of the production and data bases environment has entered a pre-operational and porting phase. This project has reduced the ability of the Production Department to install e-suites. As a result, it was not possible to further develop our ensemble prediction PEARP over that period. On a non-operational basis, the PEARP developers have run separately from the operational application a further 10 member group under the OLIVE framework.

7. AROME operational suite number 1 (from spring to the end of 2008):

- Forecast model configuration:
  - 600*512 gridpoint domain, 2.5 km resolution, 41 levels,
  - Méso-NH physics: turbulent kinetic energy version CBR – Cuxart, Bougeault, Redelsperger -, ICE3 microphysics that include graupel, Surfex coupled in explicit mode with atmospheric vertical diffusion including an additional CANOPY scheme for boundary layer profiles, IFS-based radiation scheme called every 15 mns, no deep convection nor gravity wave drag,
  - timestep = 60 s *not using* the Predictor/Corrector scheme.

- Assimilation will be with a 3 h frequency 3D-VAR cycle, including:
  - ensemble B statistics recomputed on newly tuned horizontal diffusion version of AROME

- Arp/Ald bias correction files so far, with later on switch to VarBC
- GPS ZTD with specific (station, center) quality control and blacklist
- specific channel selection for AMSU data (because of different vertical discretization than ARPEGE/ALADIN-FR)
- 10 m wind
- 2m T and RH on daytime
- 2m T and RH first guess values extracted from Surfex model (rather than ACHMT)

radar radial winds assimilated (15 km thinning)

- 6 hourly reset to the ALADIN and ARPEGE CANARI surface.

AROME runs four times a day up to 30 h range with a 3h 3D-Var assimilation cycle. One 30h forecast currently requires about 40 minutes elapse on 56 processors on the NEC-SX8R, without post-processing.

This AROME-FR suite has been declared fit for operational use by Météo-France Forecasters on December 18th, 2008.

2.3.2. Plans for 2009

1. Introduce the ARPEGE ensemble-based flow-dependent sb information in regional assimilations such as ALADIN-France, ALADIN-Réunion and possibly AROME, and prepare the installation of the ensemble assimilation for the ALADIN-Réunion system (*to be confirmed*)
2. Complete Acceptance Test ("VSR" in French acronym) of NEC Phase 2 upgrade: currently scheduled for March/April 2009
3. The operational suite will be moved to the new system within 2 months after the satisfactory conclusion of the "VSR".
4. ARPEGE and ALADIN-France E-suite number 1 for 2009 (summer/autumn):

- CY35T2
- new change of resolution of ARPEGE: T800C2.4L70
- new resolution for the 4D-VAR analysis increment: between T340L70 and T400L70
- move to 3 outer loops and minimizations
- changes in the assimilation ensemble: L70
- Double the density of about all radiance types (change the scale of data use from one spot every 250 km to one every 125 km),
- extend the number of assimilated advanced IR sensor channels (IASI, AIRS), in particular above clouds,
- introduce a bias correction for MSLP and T observations (based on ECMWF practice),
- ALADIN-France: L70, slight increase of resolution to about 7.5/8 km

5. AROME-France E-suite number 1 for 2009:

- AROME will inherit some of the ARPEGE/ALADIN changes: doubled radiance density, extra IASI channels, switch to VarBC
- Assimilation of radar reflectivities
- Increased vertical resolution (about 60 to 70 levels)
- upgrade of ICE4 microphysics , EDKF convection, canopy diagnostics

6. PEARP Version 2: target is an increase of the number of PEARP members to about [20] +

coupling with the ensemble assimilation + some physics perturbations + L65. Forecast set-up upgraded to the latest standard of the deterministic ARPEGE physical parameterization except those schemes contributing to the "modelling error" representation approach.

After moving the operational suite to the new super-computer framework, and once the 2009 configurations will be well under way, significant efforts will be dedicated to the following subjects. Those may influence the ALADIN activities:

- works to upgrade the organization and maintenance of the operational suite, with a view to improve productivity to switch a suite from OLIVE to operations
- revise, possibly in-depth, the schedule of the operational suite, with the primary objective of simplifying the 00 UTC production
- decide of a future for ALADIN-France: it may well be that ALADIN-Réunion becomes the reference ALADIN, supplemented by 2 or 3 overseas ALADIN
- in close cooperation with ECMWF: upgrade of top level parts of the IFS-ARPEGE code, as well as works to improve the overall scalability of the code

2.4. Transversal informations

2.4.1. Operational implementation of AROME at Météo-France

(F. Bouttier, P. Brousseau, G. Hello, Y. Seity, E. Wattrelot)

After many years of daily experimentation, and several months of quasi-operational real time testing, the AROME system was declared fit for operational use at Météo-France on 18th Dec 2009. This is thanks to the contribution and help from many institutes and scientists, going back to the early developments of the ALADIN-NH dynamical core about 18 years ago. The AROME concept really began in 2002: an hybridation between the IFS/ARPEGE/ALADIN system (the software basis, data assimilation and dynamical core) and the Méso-NH system (most of the physical parameterisations). This began as a kind of Frankenstein monster, with bits and pieces stitched together. Despite encouraging early results, much tuning, debugging and scientific work has been necessary to turn it into an effective, proven NWP tool. One big factor has been the feedback from forecasters who evaluated the early AROME forecasts and pointed out weaknesses, which have guided many important actions, for instance:

- development of a shallow convection scheme (EDKF) to fix artefacts related to the partial resolution of convective/turbulent circulations in the planetary boundary layer;
- correction to the horizontal numerical diffusion, in order to reduce excessively intense deep convective cells
- development of a specific postprocessing in order to facilitate the interpretation of model behaviour by forecasters
- considerable technical developments related to the surface scheme (SURFEX) interaction with the atmospheric software
- work on the lateral boundary condition, to alleviate the consequences of orographic mismatch on the edges
- work on the cycling of the data assimilation, particularly with respect to the use of surface observations
- several problems have been addressed by putting special priority on related ARPEGE/ALADIN developments, such as the new PBL physics (see article by Bouteloup et al in this issue) that make the AROME lateral boundary conditions more realistic, and more compatible with the AROME physics. The introduction of the CANARI assimilation into ALADIN helps AROME thanks to a better surface analysis.

- enormous effort has been devoted to the radar assimilation, which allows doppler wind observations to be assimilated in AROME at a suitable resolution for mesoscale forecasting purposes.

Most of the above developments will continue in some form or the other. In addition, new operational evolutions are planned for the near future, among which:

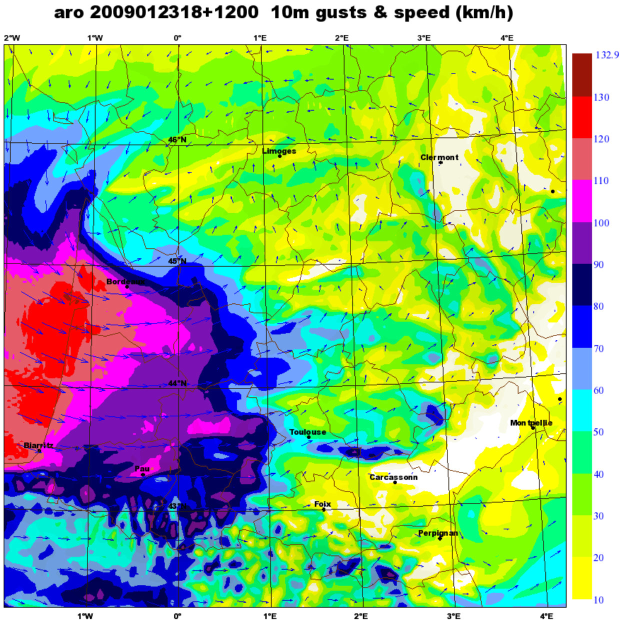
- introduction of a surface analysis consistent with the SURFEX physics,
- test of microphysics changes (e.g. hail option)
- correction of precipitation biases,
- correction of windspeed biases over valleys and mountain crests,
- increase in model vertical resolution for the benefit of low cloud and fog forecasts
- assimilation of radar reflectivities, and new observations assimilated by ARPEGE/ALADIN (e.g. AIRS and IASI)
- higher-frequency data assimilation, and variational coupling with ALADIN
- study of direct coupling with ARPEGE when its resolution has reached 10km
- use of ensemble information (from ARPEGE/ALADIN) in the AROME system

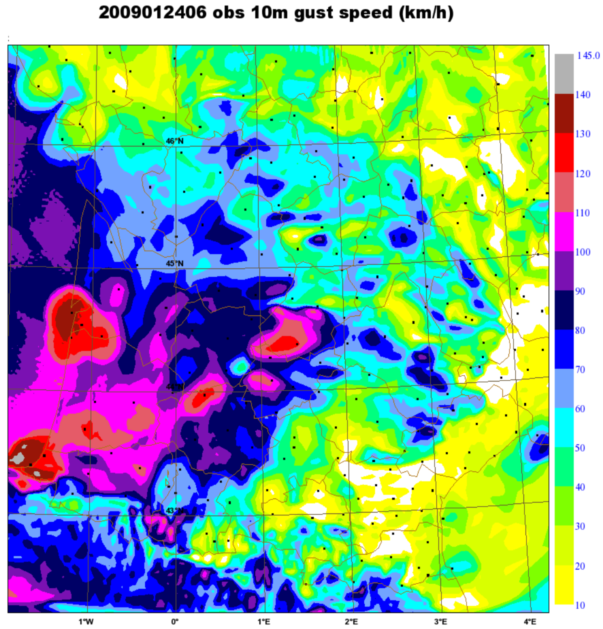
In parallel, new applications of AROME are being studied, such as its applicability at higher resolution (1-km daily forecasts have been produced in winter 2008/2009, and 500m resolutions appear quite feasible), and its adaptation to nowcasting needs (with very frequent forecast updates, to be demonstrated over airports). A major effort on model computer efficiency in foreseen in relation to the availability of new massively parallel supercomputers. Some work is also devoted to making to AROME system more user-friendly for the research community.

In its current form, the AROME-France system can be summarized as follows:

- model with NH dynamics, 512x600x41 grid with 2.5km horizontal resolution and 1min timestep, semi-lagrangian advection on linear collocation grid, semi-implicit spectral solver (elliptic truncation), numerical diffusion is a mix of spectral and gridpoint (SLHD) schemes
- atmospheric physics with radiation adapted from ECMWF (RRTM-IR), 1D CBR turbulence with prognostic TKE, EDKF (a mix of EDMF and Kain-Fritsch-Bechtold) shallow convection, prognostic cloud microphysics with 5 condensed species (cloud ice & water, graupel, rain and snow) and pdf-based sedimentation
- surface physics (SURFEX software) with tiles for towns (TEB scheme), nature (ISBA scheme with soil and vegetation subtypes), simple snow scheme, ocean/ice, lakes (FLAKE scheme). The physiographies are derived from the ECOCLIMAP database
- surface analysed fields are interpolated from the 6-hourly ALADIN CANARI analysis: soil moisture and temperature, sea ice, SST (with climatological relaxation to NESDIS SST product).
- the data assimilation is a 3-hour incremental 3DVar cycle at full resolution and no relinearization. There is no specific initialization procedure. The cycle is uninterrupted and there is one single cutoff analysis at each cycle.
- low-level observations are assimilated using SURFEX-derived background values. Radar observations are assimilated as doppler radial wind components in 3D scans from the French radar network. Satellite observations are used as in ARPEGE/ALADIN, with the RTTOV package as observation operator. Like ALADIN, AROME directly assimilates Meteosat/SEVIRI radiances.
- model lateral boundary conditions at 1-hour frequency are refreshed every 6 hours using the latest ALADIN-France forecast (itself coupled to the latest ARPEGE forecast).

As an example, an AROME gust forecasts for a recent storm (with massive tree destruction in South West France) is displayed below. Although winter storms can also be forecast by lower resolution models, AROME offers an interesting delineation of the damage areas, despite the extreme natural variability of the gust windspeed field. (left panel: AROME 12-h gust forecast; right: spatialization of gust observations)





2.5. AUSTRIA

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Operational Setup:

Concerning the operational ALADIN model used at ZAMG, no major change can be reported for the second half of 2008. The operational settings for ALADIN-AUSTRIA can be summarized as:

Model Version:

CY32T1

Model Version:	**9,6 km**
Number of levels	**60**
Number of grid point	**300 x 270**
Time-step	**415 sec**
Coupling model	**ARPEGE**
Coupling	**3 hours**
Forecast runs per day	**4**
Forecast range	**72h / 60h**
Output every	**1 hour**
Physics	**ALARO-0 (without 3MT), Seidl-Kann sub inversion scheme**
Orography	**envelope**
Grid	**quadratic**
Hardware	**NEC SX-8R, 16 CPU with 0.51 Tflop (32 Gflops/CPU), 128 GB RAM, 4.4TB storage**

ALADIN-AUSTRIA is operationally run four times per day. The forecast range is 72 hours for the main runs (00 and 12 UTC) and 60 hours for the intermediate runs (06 and 18 UTC). LBC are downloaded via Internet from MF; first backup: Retrieval of LBC files via RMDCN; second backup: LBC production using ECMWF T799 as input.

Parallel/test runs:

At the moment there are 3 parallel/test suites running:

- CY32T1 full ALARO-0 physics on 4.9km horizontal resolution using 59 level; 540x501 grid points; 1 run per day (00 UTC, +48h); hydrostatic mode; linear grid; mean orography;
- CY33T1- AROME on 2.5km horizontal resolution using 60 level; 432x320 grid points; 1 run per day (00 UTC,+30h); non hydrostatic; linear grid; mean orography;
- CY32T1- ALARO (minus 3MT) on 9.6km resolution using CANARI surface assimilation; 60 level; 300x270 grid points; hydrostatic; envelope orography; quadratic grid;

Verification for high resolution (4.9km and 2.5km) runs is still ongoing. Therefore, the verification method named SAL (*Structure Amplitude Location*) has been implemented in order to allow a fair comparison of precipitation forecasts on different horizontal resolutions (9.6km, 4.9km, 2.5km,…), whereas INCA precipitation analysis is used as observation.

ALADIN-LAEF:

The work on the ALADIN-LAEF (ALADIN Limited Area Ensemble Forecasting) system continued during the last months. For details see the Newsletter 35 contribution “Second Generation ALADIN-LAEF” .

2.6. FRANCE: «Arpège, Aladin-France and AROME models »

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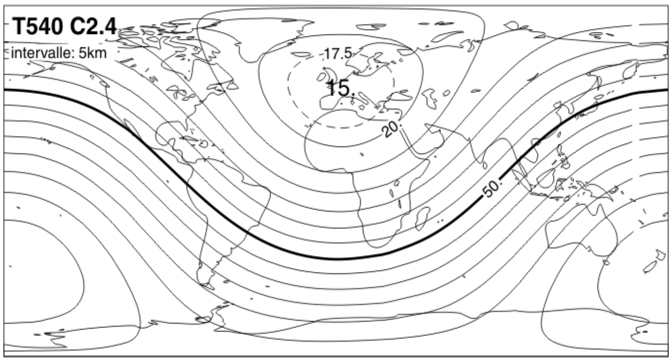
2.6.1. Chaîne 2007_04

- Description of the e-suite

The main changes of the ARPEGE e-suite are listed below:

- The horizontal resolution is increased and varies from 15 km over France to 89 km over New-Zeeland, this corresponds to a spectral troncature of T538C2.4. The time step is equal to 900 s. The number of vertical increases from 46 to 60 levels. Most of the supplementary levels are added around the tropopause. The vertical discretization uses a finite elements technique



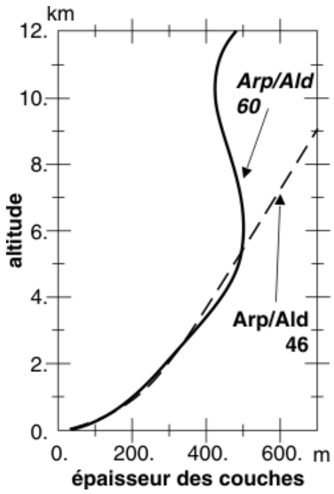


Figure: Resolution isolines of horizontal resolution in km (left panel) and vertical depth in metres of the vertical layers along the vertical.

- The assimilation scheme is composed by 2 steps: a first minimisation at T107L60C1 and a second at T224L60C1. This leads to an equivalent uniform resolution of 90 km. The statistics of the error for the guess are computed from an assimilation ensemble that is run in parallel with the same vertical grid (L60) but for a reduced troncature.
- Before their assimilation, the bias of the satellite radiances was previously removed according to the ARPEGE model using a fixed regression taking into account ARPEGE fields. The parameters of the regression were computed for a 3 weeks learning period and then used day after day. This methodology is replaced by the computation of these parameters during the minimisation i.e. the parameters are considered as new ARPEGE variables.
- The surface winds over sea deduced from the diffusiometer ASCAT of the METOP satellite are assimilated. A new bias correction for the winds deduced from the diffusiometer AMI of the satellite ERS is introduced.
- The intensity of the numerical diffusion is increased for the wind in particular at the tropopause level.
- The explicit microphysical scheme includes a statistical sedimentation scheme.

2.6.2. The related changes for the ALADIN-France e-suite are listed below:

- The LAM uses the same vertical grid as ARPEGE (L60) and the same vertical discretization scheme based on a finite elements technique
- The ARPEGE changes for the sedimentation, numerical diffusion are also present in ALADIN-France
- The bias correction for the satellite data assimilated by ALADIN-France is deduced from the ARPEGE variational correction of the model bias. The statistics for the guess error are also deduced from an assimilation ensemble with 60 levels.

- The new ASCAT data are also assimilated and the correction for the AMI winds is also used.
- The 3DVAR analysis provides the initial coupling file
- A new dynamical initialization is performed by using digital filters only for the increments of the analysis.
- A non-linear balance similar to the ARPEGE balance is used in the variational analysis and the relative confidence guess against observation is increased.

The e-suite and the operational suites have been compared from 06 October 2007 to 05 February 2008, i.e. during 4 months. The objective and subjective validations concludes to the superiority of the e-suite for every reference, every physical field and every verification domain. Geopotentiel heights scores are presented in Fig. 1 and they are improved at all levels.

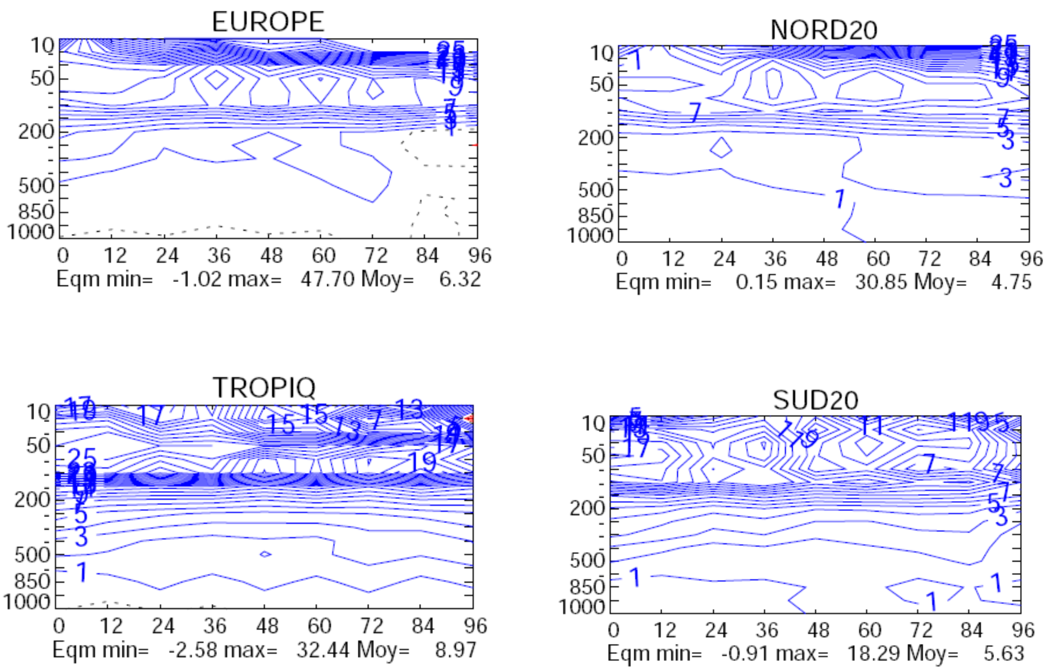


Fig. 1: Differences (in meters) of the root mean squared errors (RMS) for the géopotentiel height in function of the duration of the forecast performed by the ARPEGE e-suite and the operational suite. If the e-suite improves the operational ARPEGE model, the isolignes are coloured in blue and red in the opposite case. The error is computed against the reference provided by the radio soundings belonging to 4 different spatial domains: Europe (top left), the domain extending from 20° North to North pole (top right), the tropical domain between 20° North and 20 ° South (bottom left) and the domain extending from 20° South to South pole (bottom right). The RMS is computed every day from 06 October 2007 to 05 February 2008 and averaged over this temporal period.

The variational correction of the model bias leads to a reduction of the differences between observations and guesses for the brightness temperatures but also for the radio soundings.

The DFS of the e-suite increases and is 46 % stronger than its operational counterpart. This increase is related to the adding of the Ascat data, the more important number of GPS satellite data, and the new design of the assimilation scheme (horizontal and vertical finer resolution for the increments, change of the vertical resolution of the guess statistics, better convergence of the minimisation,).

The subjective verification concludes on a better forecast of the large scale features but it should be noted an increase of the number of spurious numerical cyclogenesis of small scale. The quantitative precipitation forecast was improved with a reduction of the bias of ARPEGE but this reduction was too important in some cases of heavy rainfalls.

The same improvements were recovered for the ALADIN-France forecasts coupled with the ARPEGE e-suite and Figure 2 shows similar information as Figure 1 but for a verification domain reduced to the ALADIN-France domain.

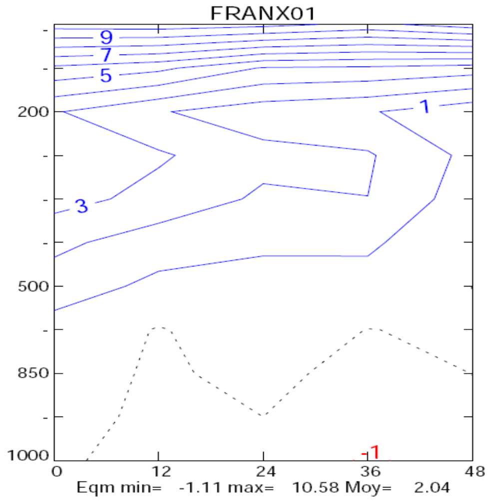
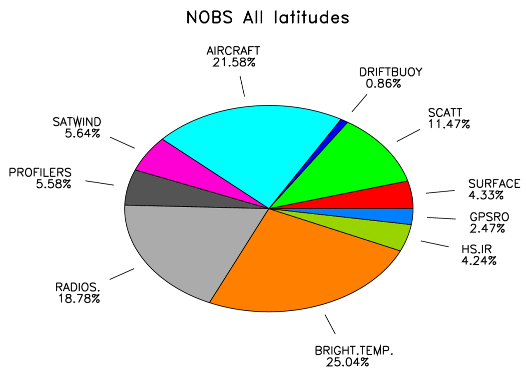


Figure 2: same legend as Figure 1 but the forecast is performed by the ALADIN-France model. The verification domain corresponds to the ALADIN-France domain (FRANX01) and the temporal period extends from 19 December 2007 to 05 February 2008.

2.6.3. Chaîne 2008_01

(see 2.3.1.)

The number of observations has strongly increased (44 %) and the number of degree of freedom (DFS) controlled by the observations has also increased but in a smaller fraction (12%). This is illustrated by Figure 1 and 2.



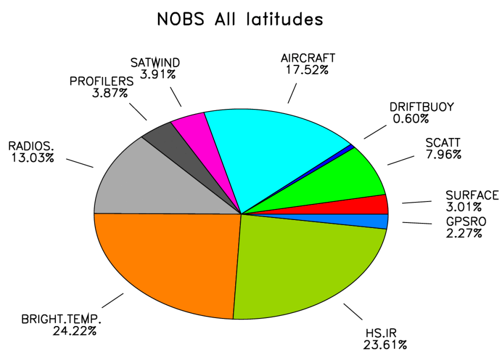


Figure 1: distribution by observation types of the relative number of observations for the operational version of ARPEGE (left) and the e-suite (right) . These statistics are based on the assimilation at 0 UTC of the 30 June 2008.

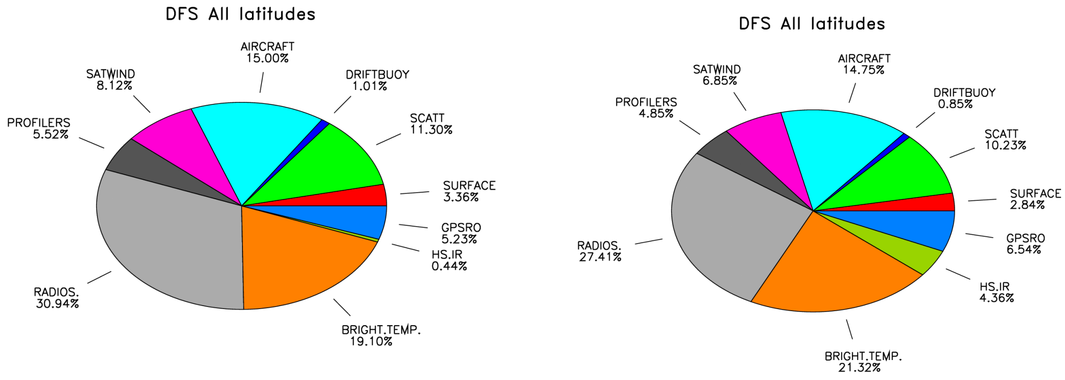


Figure 2: same legend as Figure 1 but for the DFS of the 2 versions of the ARPEGE model.

The improvement of the e-suite versus the operational suite is shown by computing the scores against the ECMWF analysis. They are represented in Figure 3 for the geopotental height. The RMS error is reduced over Europe by one metre after 48 hours of simulations. The extra tropical large domains are also improved in the troposphere in the same way. A small improvement is also found for the wind at the jet level (0.2 m/s) and for the relative humidity (<1%). The surface parameters are improved for the temperature and humidity at 2m in relation with the turbulence modification.

The ALADIN e-suite scores are also better than the scores of the operational version for the temperature and the humidity in the troposphere. They are neutral for wind and geopotential height. The removal of the T2m and Hu2m from the set of assimilated data for the assimilation occurring during the night leads to an increase of the rms error during the first hours of simulation for the relative humidity. Later, the scores become oscillatory. The temperature score are nevertheless improved due to the turbulence modification (like in ARPEGE) which warms the lowest layer.

This e-suite was declared operational the 01 July 2008.

2.7. HUNGARY

(kullmann.l@met.hu)

There were two important changes in the operational version of the ALADIN/HU model during the second half of 2008:

- We use CANARI to calculate surface analysis
- We use lagged ECMWF LBC files (from the 6h earlier ECMWF forecast).

2.7.1. The main characteristics of the recent deterministic operational suite:

- ALADIN cycle: cy30t1
- Horizontal resolution: 8 km
- Vertical levels: 49
- Grid: linear
- Lateral boundary conditions: ECMWF
- Data assimilation: 3 3D-VAR with 6h cycling, CANARI (OI) at the surface
- Observations: SYNOP (geopotential), TEMP (temperature, wind components, humidity, geopotential), AMDAR (temperature, wind components), ATOVS:AMSU-A and AMSU-B radiances, MSG/GEOWIND (AMV), SYNOP SHIP, WINDPROFILER.
- Observations for OI: SYNOP (T2m, RH2m)
- Production is performed 4 times per day: 0 UTC (+54h), 6 UTC (+48h), 12 UTC (+48h), 18 UTC (+36h).

2.7.2. The operational ALADIN EPS (dynamical downscaling of Meteo France's PEARP system by the ALADIN model) started in February.

- The main characteristics of this ALADIN model version are as follows:

- Horizontal resolution: 12 km
- Domain covering continental Europe (LACE domain)
- Vertical resolution: 46 levels
- Integration once per day to 60h starting from the 18 UTC data
- Boundary conditions updated every six hours by the ARPEGE EPS (PEARP) system.
- At present work is going on in the field of visualization and verification of this ALADIN LAMEPS system.

2.7.3. Parallel suites during the period:

- An atmospheric 3D-VAR data assimilation suite using ECMWF LBC (both in assimilation cycle and production) was run and compared to the operational 3D-VAR suite.
- An atmospheric 3D-VAR + surface OI (CANARI) data assimilation suite using ECMWF LBC (both in assimilation cycle and production) was run and compared to the operational 3D-VAR suite.
- Dynamical adaptation as a reference to 3D-VAR system at same vertical and horizontal resolution (using also ECMWF LBC data).

2.8. POLAND

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The basic operational suite has remained practically unchanged during second half of 2008. Only many minor improvements to ALADIN software environment were added to increase forecast production reliability. In mentioned period most efforts was focused on development of new visualization system and on testing of new operational suite with resolution of 10km.

New visualization system is based on NCL / NCAR Graphics and it will replace the old one based on Vis5d. The visualization uses new auxiliary operational data bases.

Several months ago new operational suite with enhanced resolution was prepared but pre-operational tests revealed plenty of problems and bottlenecks due to insufficient computational and transfer resources. So, the suite is still being tested and rearranged to achieve proper level of efficiency, reliability and robustness.

2.9. PORTUGAL

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At the end of the second semester of 2008, a new model version of ALADIN, cy32t3, entered into operations in Portugal. With the new cycle we also changed to a new domain, which extends deeper into the Atlantic and encompasses the Azores and Madeira islands. The main characteristics for the actual operational model are:

- domain (C+I) of 439 x 277 points
- 9 km resolution
- 360s time step
- 46 levels
- 2 runs (00 and 12 UTC) with 48 hours integration range
- 3 hour coupling frequency

We are running the model on a IBM p5-575 machine, using for configuration 001 the total of 4 nodes, 32 dual-core processors, 64 tasks with OpenMP and SMT activated. SMS is the tool for scheduling and launching the tasks from a Dell PowerEdge 2950. As queue software IBM's LoadLeveler is used. Some examples of the hourly post-processed fields are shown below.

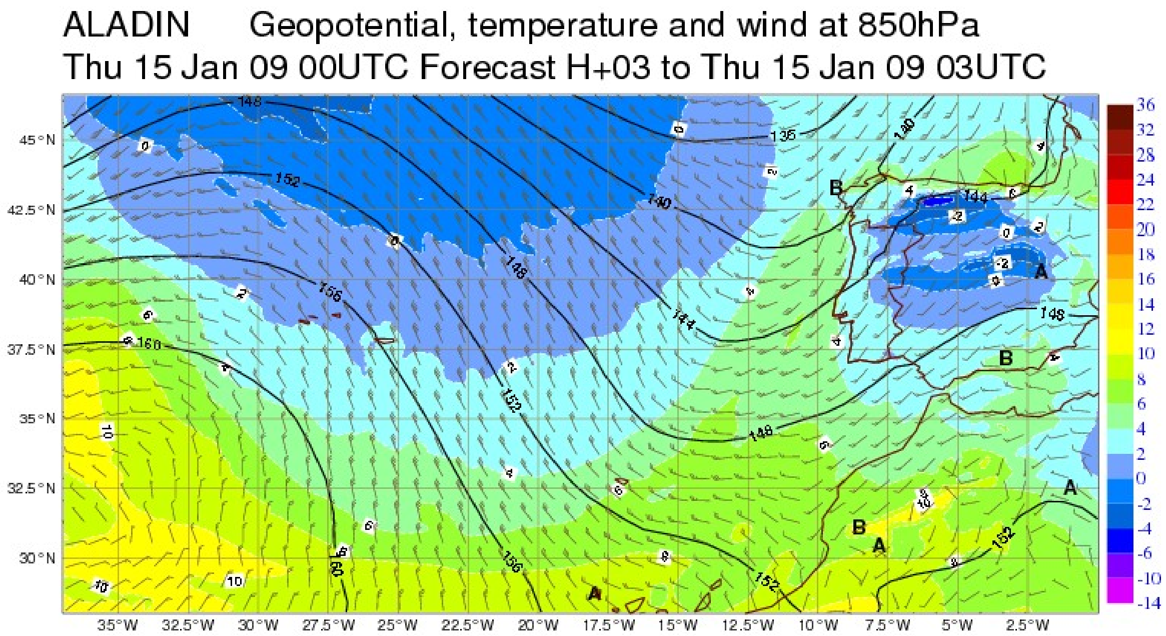


Figure 1 – ALADIN Portugal composite of geopotential, temperature and wind fields at 850 hPa.

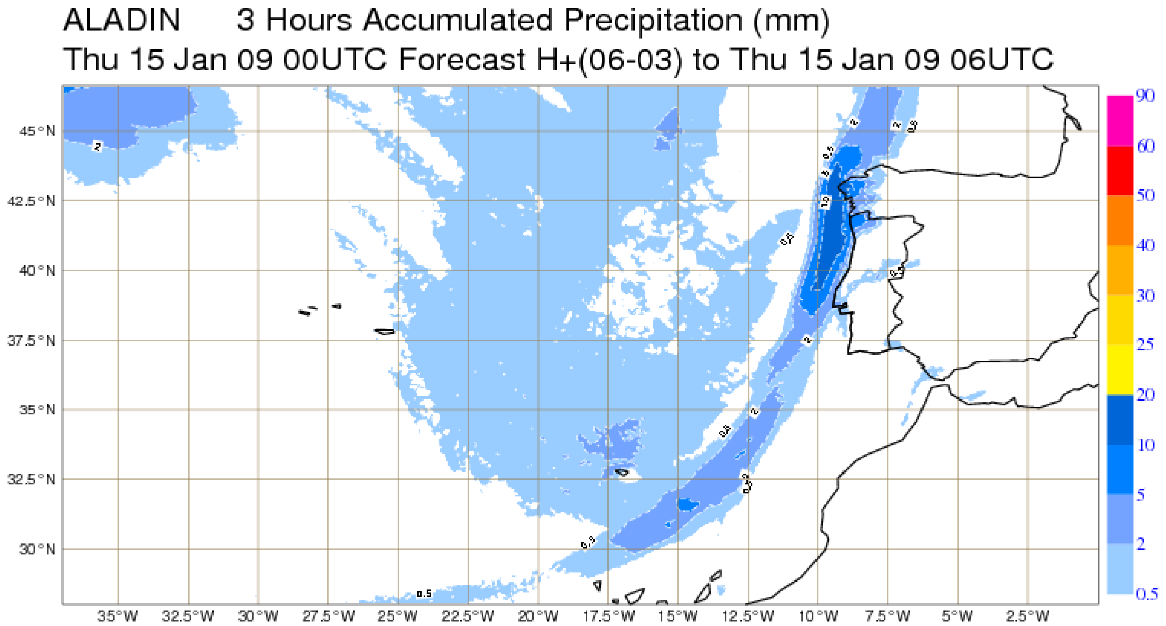


Figure 2 – ALADIN Portugal 3 hours accumulated total precipitation.

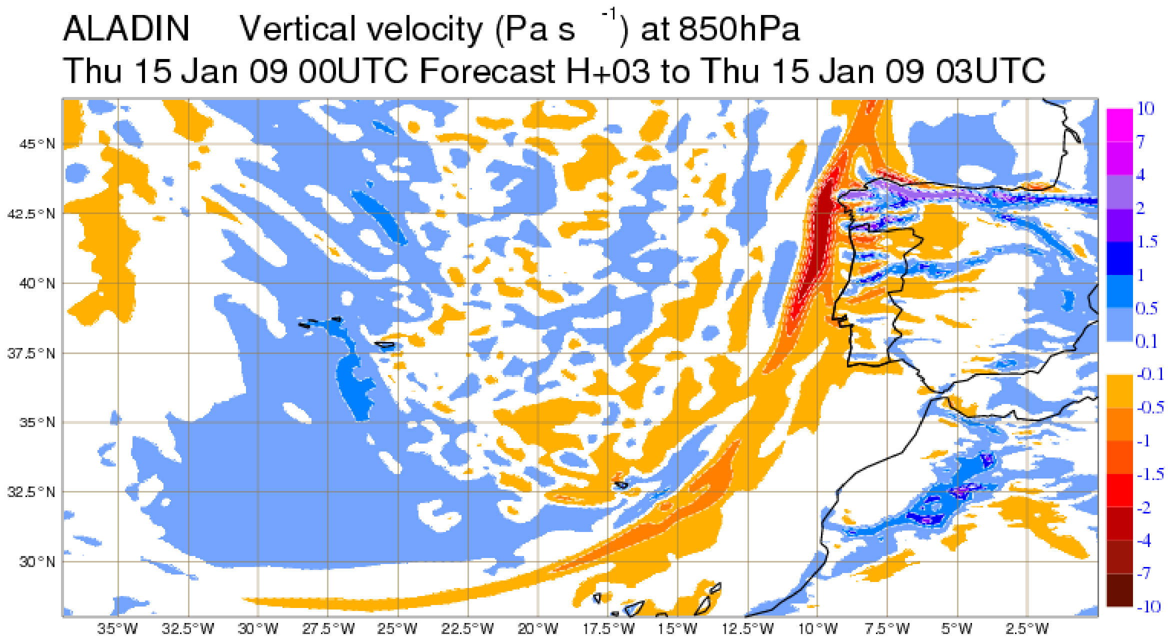


Figure 3 – ALADIN Portugal vertical velocity field at 850 hPa.

For the validation of this cycle several statistics and scores were calculated for Winter 2008 (January 1st till February 29th), Spring 2008 (March 1st till May 31st) and Summer 2008 (July 1st till August 26th). Here we show only Bias and RMSE for temperature at 2 meters and Heidke Skill Score (HSS) for 3 hour accumulated precipitation. In the case of precipitation, contingency tables were built with the following classes in millimetres: [0-0.5[, [0.5-10[, [10-25[and [25- ∞[. For observations 10 synoptic stations were used, chosen as to represent the majority of inland Portuguese territory.

The results were compared against ALADIN cy28t3 (the previous local operational cycle) and ECMWF global model statistics. Due to operational and practical matters, both ALADIN cycles were integrated with 6 hour coupling files and post-processed to a 12.7 km mesh grid, but cy28t3 with 31 vertical levels and cy32t3 with 37 vertical levels. ECMWF model results were in the post-processing mesh size of 0.5 degrees.

In the following graphics, the red line ALP_999 is ALADIN cy28t3, the green line ALM_003 is ALADIN cy32t3 and the blue line ATL_05_999 is ECMWF global circulation model.

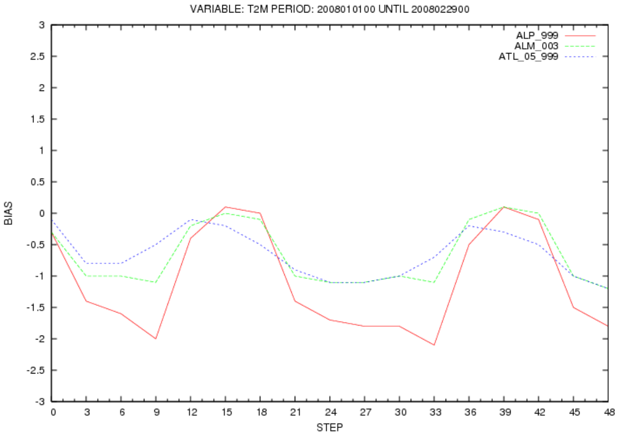


Figure 4: T2m (℃) Bias, Winter 2008.

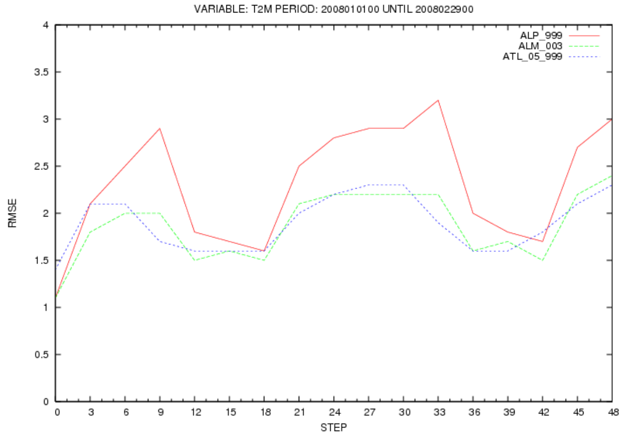


Figure 5: T2M (℃) RMSE, Winter 2008.

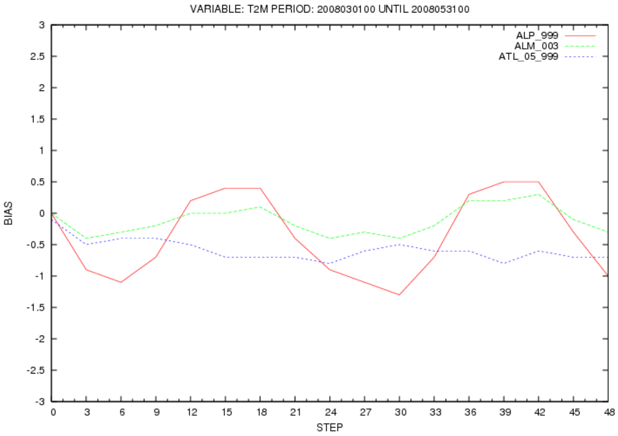


Figure 6: T2m (℃) Bias, Spring 2008.

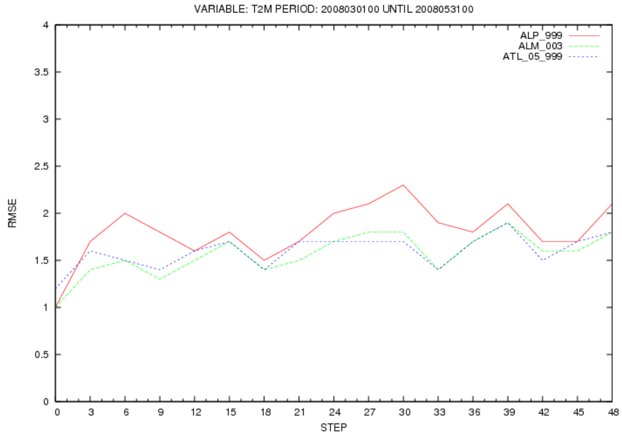


Figure 7: T2m (℃) RMSE, Spring 2008.

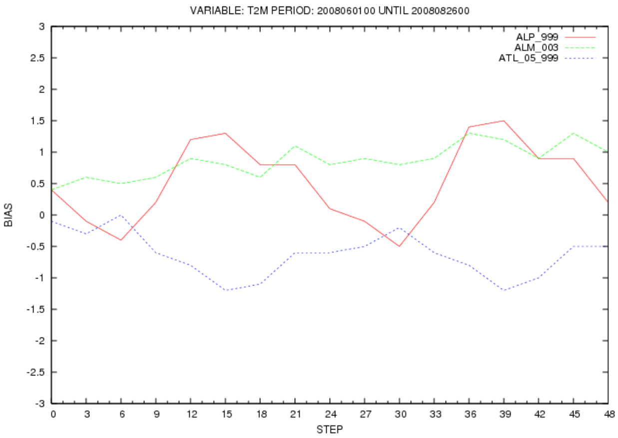


Figure 8: T2m (℃) Bias, Summer 2008.

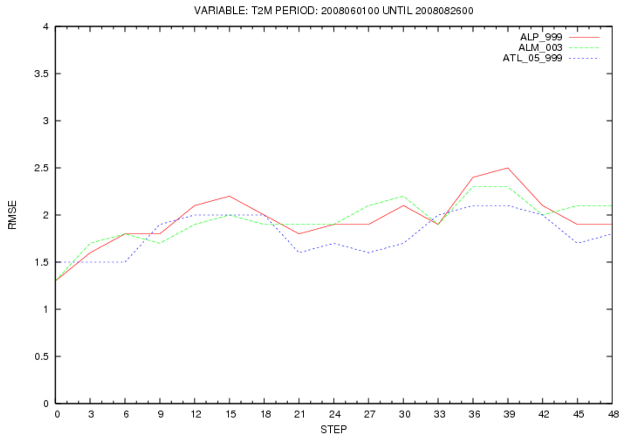


Figure 9: T2m (℃) RMSE, Summer 2008.

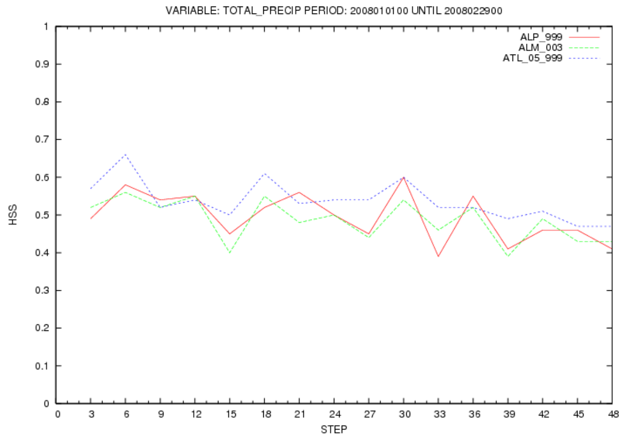


Figure 10: Precipitation HSS, Winter 2008.

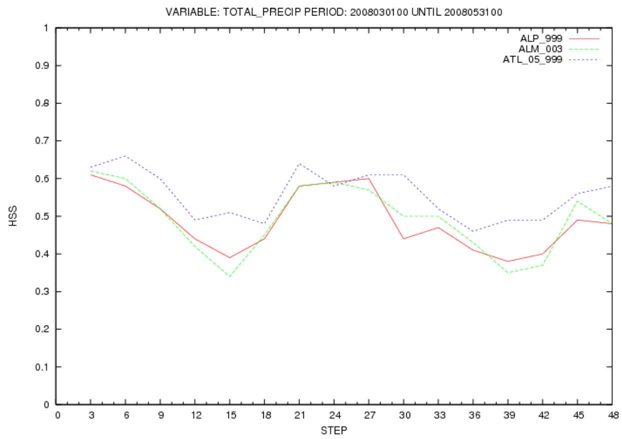


Figure 11: Precipitation HSS, Spring 2008.

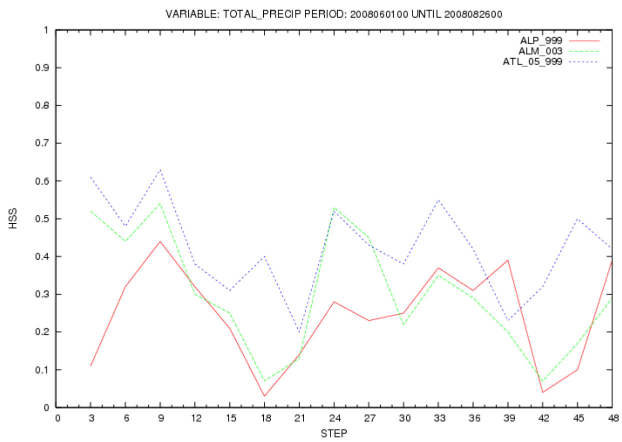


Figure 12: Precipitation HSS, Summer 2008.

The new cycle 32t3 shows an expected improvement over the previous operational one, as well as similar forecast scores when compared to ECMWF. A verification report for the islands of Azores and Madeira will be made and presented later in ALADIN's Newsletter.

2.10. SLOVAKIA

Changes between 09/2008 and 02/2009 (oldrich.spaniel@shmu.sk)

2.10.1. HARDWARE

- Computer [no change]:
  - IBM Regatta
  - 32 CPUs of 1.7 GHz
  - 32 GB RAM
  - 1.5 TB disk array

- Archiving facility [no change]:
  - IBM Total Storage 3584 Tape Library with IBM Tivoli Storage Manager
  - current capacity of tapes around 30 TB
  - used for automatic backup of ICMSH files, GRIBs and selected products

2.10.2. OPERATIONAL SUITE

- Domain and geometry [no change]:
  - 309 x 277 points (C + I zone)
  - dx = 9.0 km
  - quadratic truncation
  - 37 vertical levels

- Operational model version [no change]:
  - cy32t1 - ALARO with 3MT
- Integrations [no change]:
  - 4 runs per day (00, 06, 12 UTC up to 72 hours, 18 UTC up to 60 hours)

- Pseudo assimilation cycle (Upper air spectral blending)
  - 4 runs per day (00, 06, 12, 18 UTC up to 6 hours with long cut-off ARPEGE LBCs)

(Assimilation guess is used to copy new hydrometeor fields, TKE and new 3MT prognostics fields)

2.10.3. ARPEGE LBC DOWNLOAD

Both assimilation and production LBC are downloaded 4 times per day. Primary channel is internet/BDPE. Backup of production LBC is done via ECMWF and ZAMG.

2.11. SLOVENIA

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

The ALADIN operational suite is running on the SGI Altix ICE 8200 system without major problems since it was declared operational in June 2008.

Some basic facts about operational system and configuration are recalled:

Domain and geometry:

- 258*244 points, (with extension zone 270*256), E134x127
- 9.5 km horizontal grid spacing
- 43 vertical model levels
- linear spectral elliptic truncation
- Lambert projection
- Integration:
- four runs per day: 00 UTC (72 h), 06 UTC (60 h), 12 UTC (72 h),18 UTC (48 h)
- initial and lateral boundary conditions from ARPEGE
- digital filter initialization
- 3 hours coupling
- 400 s time-step
- Operational model version:
- AL32T3 using ALARO with 3MT physics

The only significant change in the second half of the 2008 has been the creation of files for the peps project. They are additionally produced for 06 and 18 runs.

The parallel suite has been running using the model resolution 4.4km since mid-July. The domain is somewhat reduced (439*421 points, with extension zone 450*432, E224x215), time step is 200 s. There are two runs per day (00, 12 UTC) till +54 h. The model integration is using 128 processors on 16 nodes, 54 hour forecast is computed in 55 minutes.

Cy35t1 (available in December 2008) was compiled with Intel 10.1 Fortran compiler, em64t architecture using gmkpack 6.3.2. Routine acacon has to be compiled with no optimization.

Several MPI implementations were tested to solve problems with jobs pre-emption inside PBS Pro queuing system (Scali MPI jobs were not easily suspended in a PBS Pro environment) .

For the integration part (c001), SGI MPI performed worse than ScaliMPI while OpenMPI was the fastest, approximately 7% faster than ScaliMPI.

First steps for the implementation of the DDH tool has been done. There are some problems in cy33t2 and test has to be repeated with cy35t1.

3. RESEARCH & DEVELOPMENTS

3.1. AUSTRIA

3.1.1. Implementation of 2nd generation ALADIN-LAEF

Florian Weidle, Yong Wang, F.Weidle@zamg.ac.at

- Introduction

Since 11th February 2009 the new version of the Limited Area Ensemble Forecasting system is in operational use at ZAMG. For this purpose a SMS-suite has been installed at ECMWF running under time-critical option 1. The new system contains 16 perturbed members, one control run and one deterministic forecast. Below the structure of the SMS-suite is presented and some results of the verification of the new LAEF-system are shown.

- SMS-suite *LAEF* running at ECMWF

The suite LAEF consist of two large families that control the control run and the forecast run of the perturbed members. The latter family is again subdivided into families that control the time-critical part of the suite and the non time-critical part where data are prepared for the succeeding forecast run, respectively.

In the time-critical part of the suite (family tc_jobs in Fig. 1) the initial conditions, which are taken from ECWF-EPS system and converted to an appropriate format using 901 and 927 (families mars_ana, 901_ana and 927_ana). To create upper air perturbations the breeding-blending cycling method has been implemented which combines the large scale perturbations gained from the ECMWF-EPS system and small scale perturbations from short range forecast of ALADIN.

In addition surface perturbations are created by a non-cycling breeding-blending technique where the blending of the surface perturbations with the upper air perturbations is implemented in the time-critical part of the suite (family surf_pert).

Family run_e001 performs the 60 hour forecast of the 16 perturbed members and the transfer of the results to ZAMG.

In the non time-critical part of the suite lateral boundary data are prepared for the next forecast run and the surface perturbations are created that will be combined with the upper air perturbations using blending technique in the succeeding forecast run. A snapshot of the *LAEF*-suite is shown in Fig. 1 to demonstrate the structure of the suite.

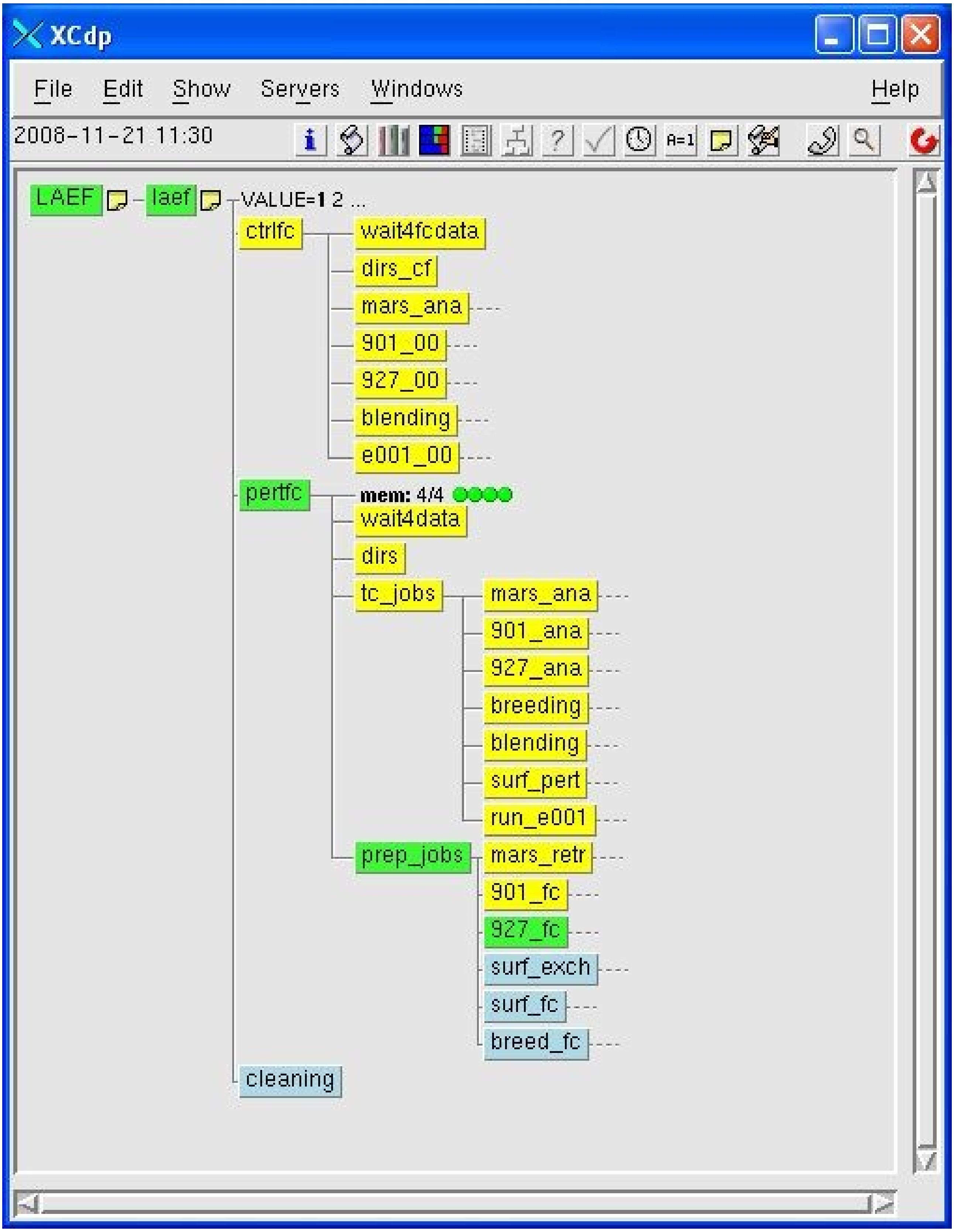


Figure 1: The suite LAEF implemented at ECMWF

- Verification of the new ALADIN-LAEF system

Before the new system has been used as the operational system a verification of has been performed to compare results of the 2nd generation LAEF with results of the first version. The time under investigation is from 24/12/2008 until 07/01/2009.

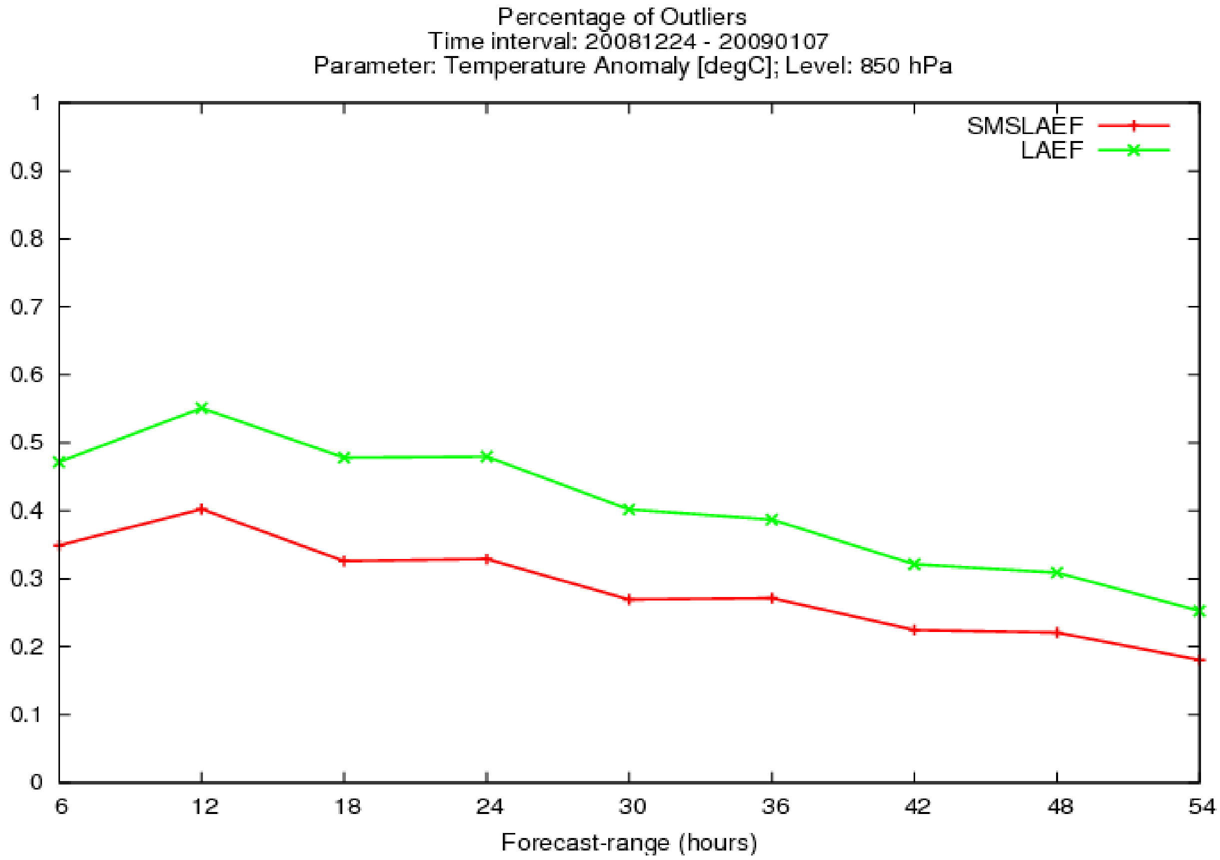


Figure 2: Percentage of outliers of temperature anomaly at 850 hPa

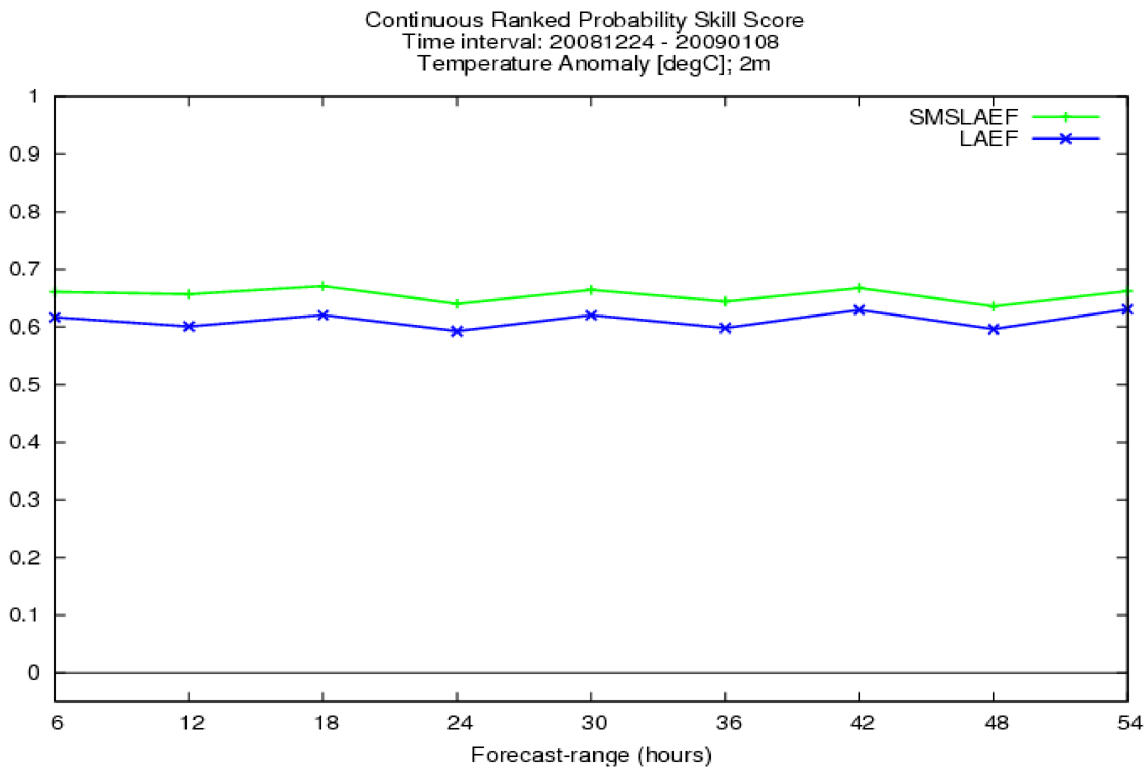


Figure 3: Continuous Ranked Probability Skill Score of Temperature anomaly at 2m

Figure 2 and 3 show two examples of the results of the verification of the both LAEF systems. SMSLAEF names the new system. The percentage of outliers in temperature anomaly at 850 hPa decreases remarkably due to larger spread in the new system. Especially at 850 hPa the 2nd generation LAEF leads to better Scores compared to the old version where at 500 hPa the differences are quite small. The improvements for low level parameter are less significant since the changes in the system have only minor impact. Nevertheless some scores, like the Continuous Ranked Probability Skill Score for temperature anomaly at 2m (denoted by Fig. 3) indicate a slightly better performance of the new system.

3.2. CROATIA

3.2.1. CANARI INSTALLATION IN CROATIA

Antonio Stanešić, Stjepan Ivatek-Šahdan

- Summary

CANARI surface optimal interpolation is installed in Croatia. Data assimilated are synop and automatic station data. Technical verification and single observation experiments are done. Assimilation cycle is set up based on long cut off ARPEGE files. Production from cycle is plotted against observations and operational forecast.

- Technical verification of CANARI

In order to test technical correctness of CANARI installation in Croatia, we used data package received from Alena Trojakova (CHMI) containing first guess file, OBSOUL, ECMA data base, climatological files, ISBA polynomial file, analysis file, output listings and plots of analysis increments (T2m and RH2m). From output listings we extracted CANARI namelist and modified it only in part concerning local computer settings. In order to avoid crash of CANARI run one more change was necessary, we changed interpolation from bi-cubic (203) to bi-linear (201). We used given input files and ECMA database. Results showed that in comparison with CHMI output listing there was small differences in rejection of observations data (probably due to different interpolation). Visualization of 2m analysis increments showed very similar forms and comparable magnitudes when compared with CHMI visualization (same for surface fields).

We also used given package to test correctness of creation of ECMA data base with BATOR, so one more test was done; ECMA database was created locally from given OBSOUL file, and analysis was preformed. Results were identical to results from previous test, so we concluded that BATOR also works well (at least for this data). We extracted data from both bases (CRO and CHMI) with MANDALAY and made comparison. Differences were negligible (in 13th digit).

So we can conclude that installed CANARI software in Croatia is technically working well with one restriction – usage of bi-linear (201) interpolation.

- CANARI single observation experiments

Single obs experiments were done on guess coming from operational forecast (6h forecast). Two single obs experiments were done:

3.2.2. 2m temperature

2m temperature coming from synop data, at location of Zagreb, with innovation $y-H(x_b)=2\text{K}$. Only T2m CANARI analysis.

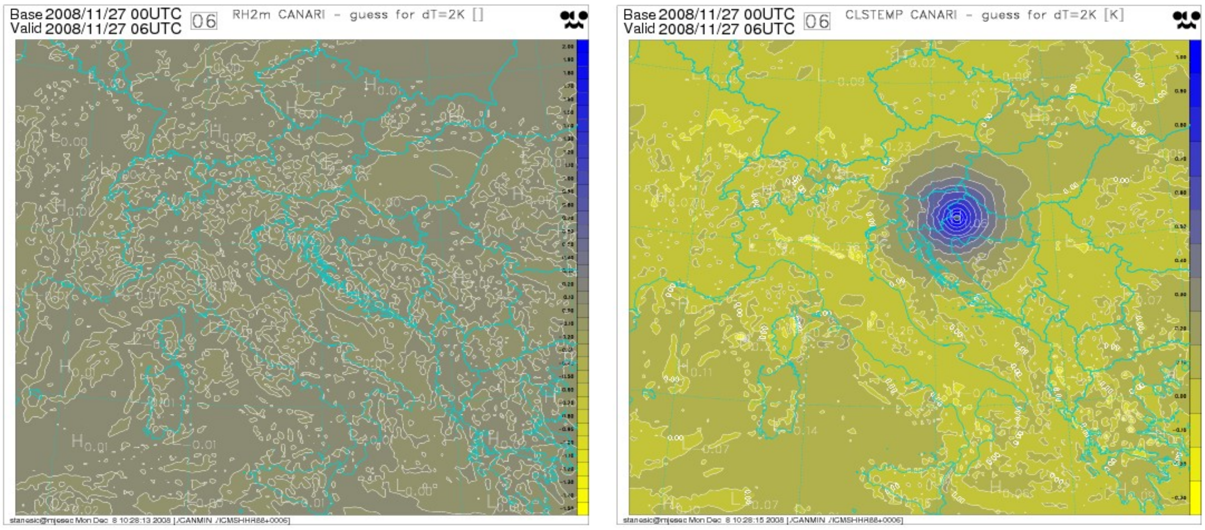


Figure 1. RH2m i T2m difference between CANARI analysis and guess (6h operational forecast)

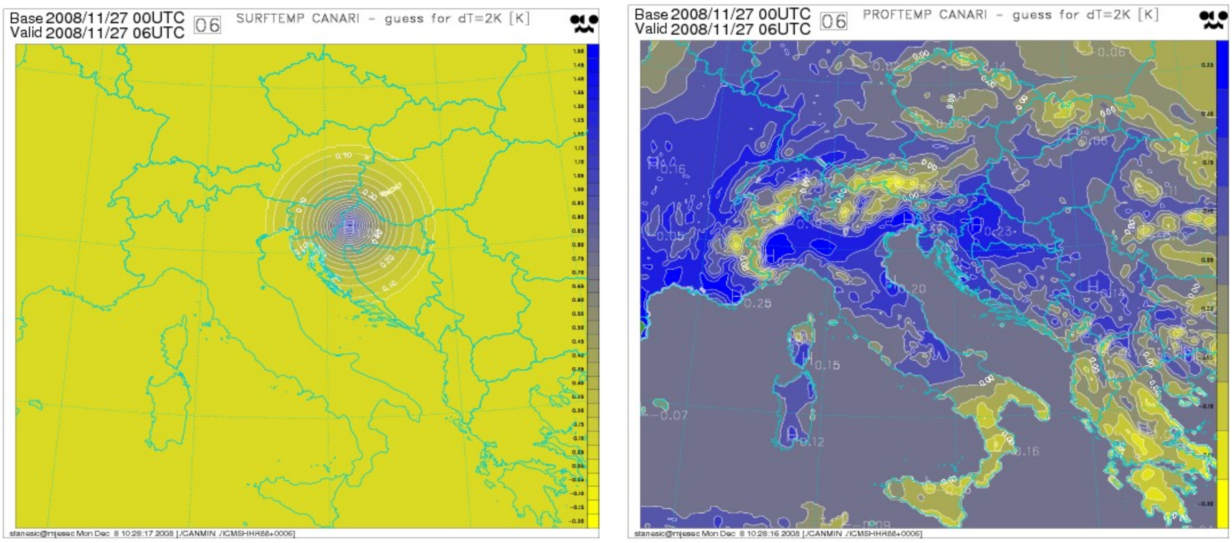


Figure 2. SurfTemperature and ProfTemperature difference between CANARI analysis and guess (6h operational forecast)

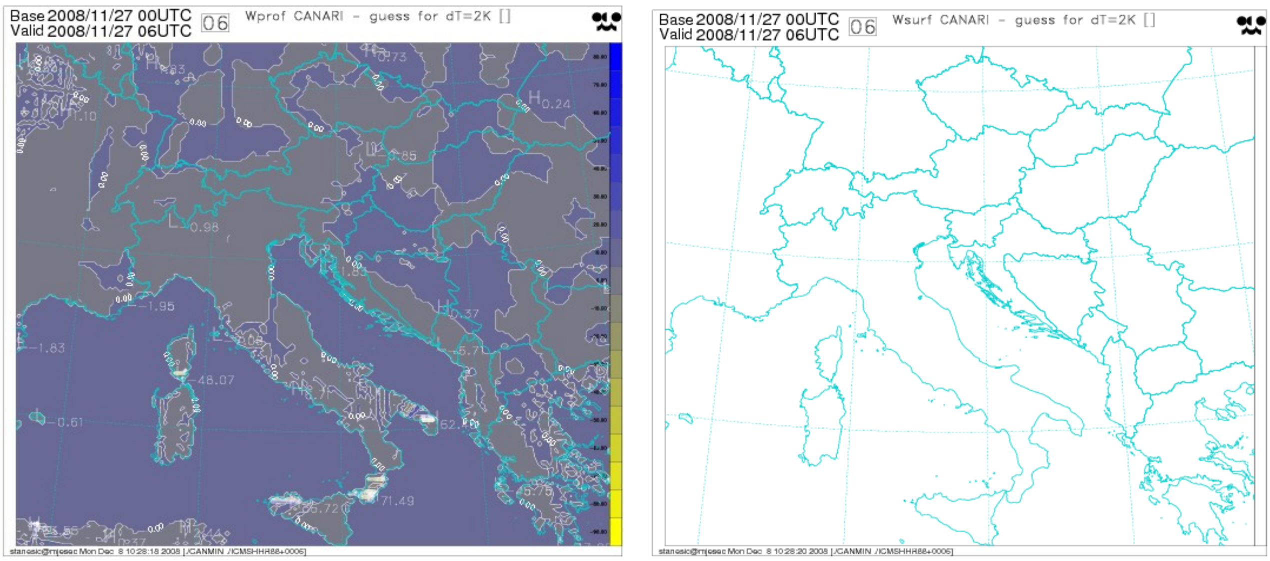


Figure 3. ProfReserv.Eau and SurfReserv.Eau difference between CANARI analysis and guess (6h operational forecast)

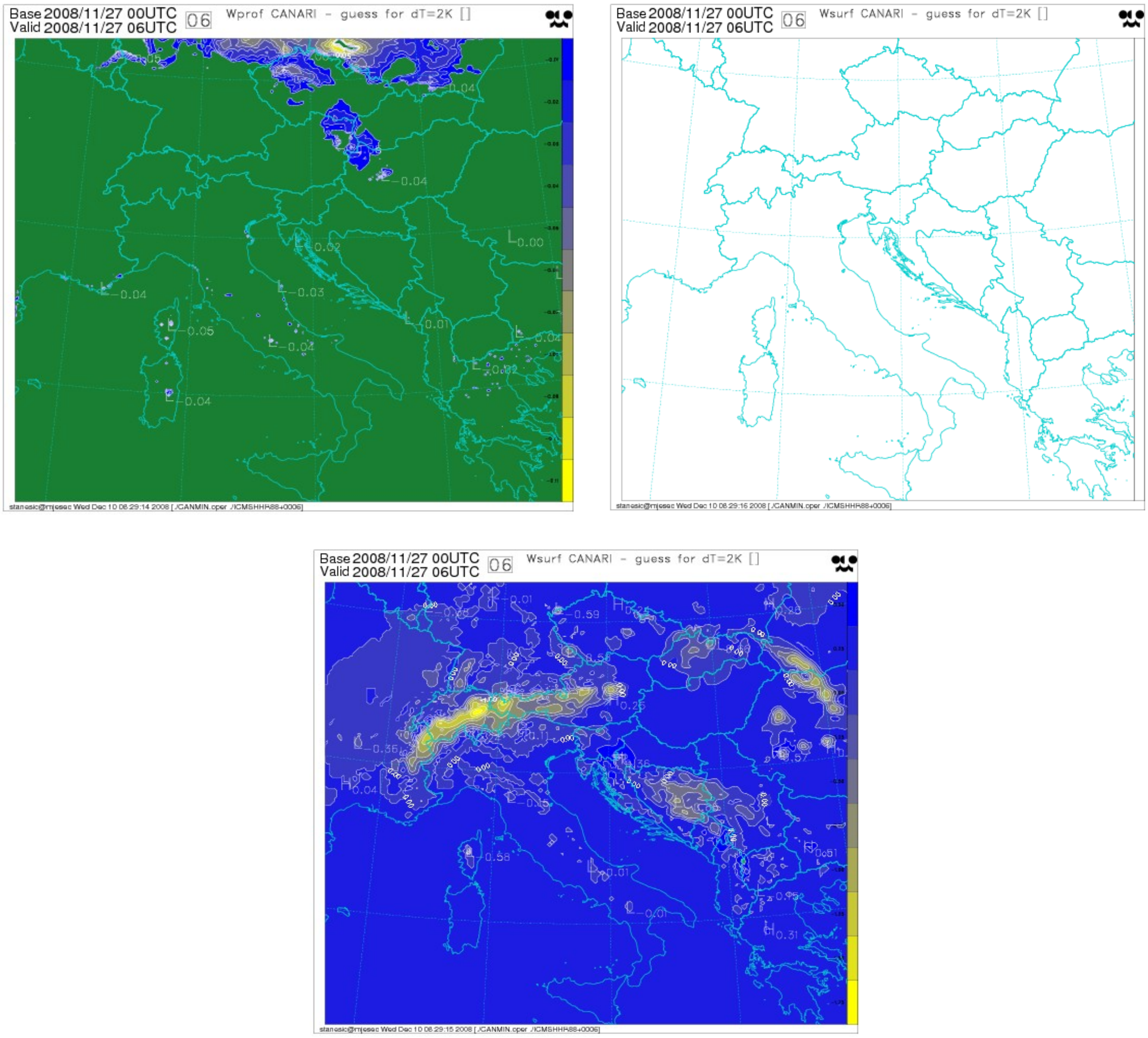


Fig.4: PROFRESERV.GLACE (upper left), SURFRESERV.GLACE(upper left), SURFRESERV.NEIGE (down) difference between CANARI analysis and guess (6h operational forecast)

Results (Fig. 1 – Fig. 4) show no increment of RH2m (OK - only T2m CANARI analysis) but there is some noise signal. T2m increment is approximately in agreement with sigma's (σ0=1.4, σb=1.6). Increment of Tsurf is also good (it should be same increment as for T2m) and increment of Tprof is masked because there is relaxation to climatology. When this relaxation is switched off increment is clearly visible and it's value is $\Delta T_{2m}^{analysis}/2\pi$. It is much harder to comment increments of water content because of its relationship with T2m analysis increment is not so straightforward. There are some bigger increments at south of domain for PROFRESERV.EAU, but when compared with values of PROFRESERV.EAU [500-8000 in that case], they are not too big. We think that they come from ARPEGE-ALADIN change of geometry, because they are near coast, and they do not exist if guess is coming from assimilation cycle (because they are smoothed in cycling).

✕ 2m relative humidity

Increment of RH2m in Zagreb, coming from synop data, with innovation $y-H(x_b)=-0.1$. Only RH2m CANARI analysis.

Due to similarity of plots with the one shown before only increment of RH2m is plotted.

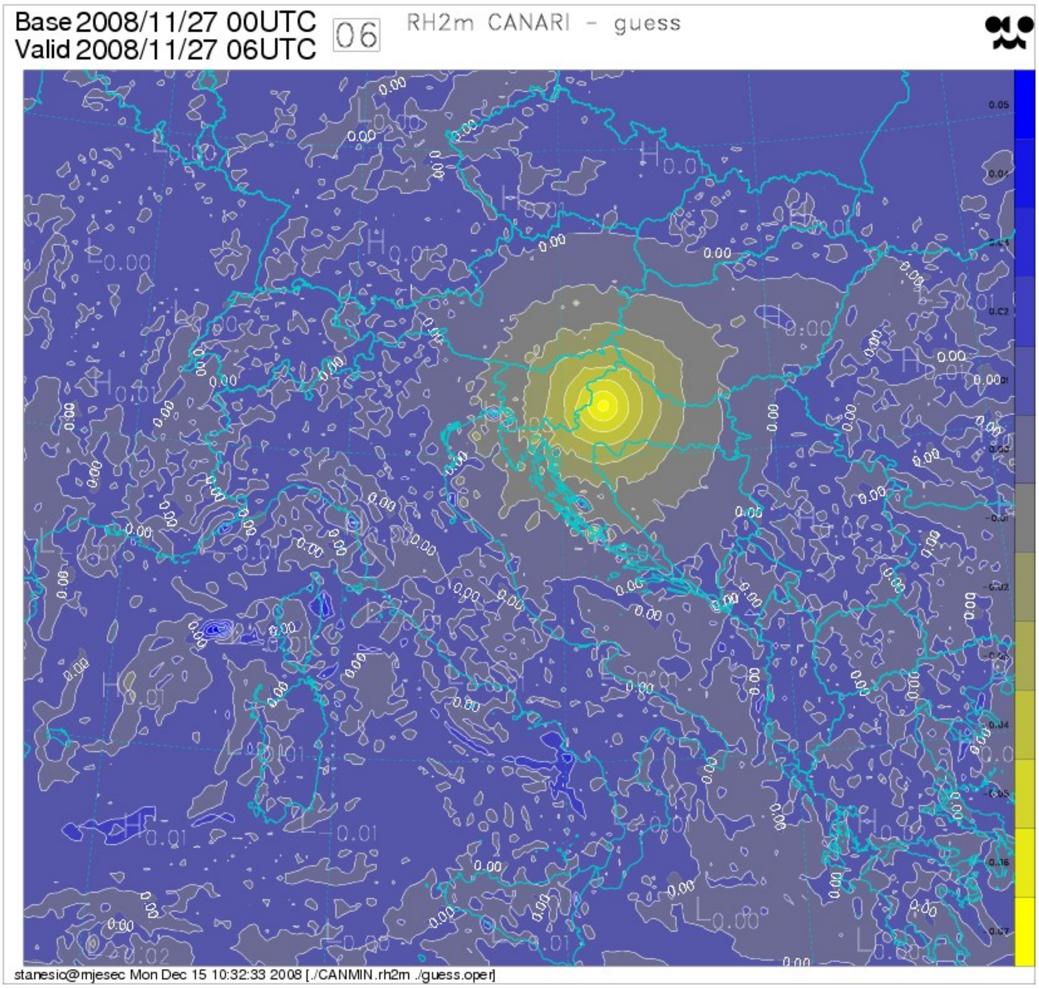


Fig. 5: RH2m difference between CANARI analysis and guess (6h operational forecast)

There is clear increment of RH2m (Fig. 5), with maximum of around -0.07 (sigmas σ0=0.1, σb=0.18). Only difference for other variables (in comparison with Figs. 1 - 4) is that there is no increments for SURFTEMPERATURE, T2m and for PROFTEMPERATURE.

❑ CANARI Cycle

At beginning of October we started assimilation cycle with CANARI analysis. Data that is assimilated includes synop and Croatian automatic stations 2 meter temperature and 2m relative humidity. We have used CHMI approach, where T2m and RH2m are assimilated. We have similar namelist as CHMI, only changes concern specific computer parameters, change of interpolation (201 instead of 203) and smaller horizontal length scale for 2 meters temperature (50km) and 2 meters relative humidity (55km). Our assimilation cycle is based on ARPEGE long cut off files, from where we take analysis over sea (BLENDSURF) and we just copy upper air fields from ARPEGE analysis (BLEND). During blending fields are added and divided and their values could became incorrect (example, negative amount of water in soil). Then we run program check_limits in order to be sure that all surface fields are correct. After that we preform CANARI analysis over land and we use output as initial file for 6h forecast (Fig. 6).

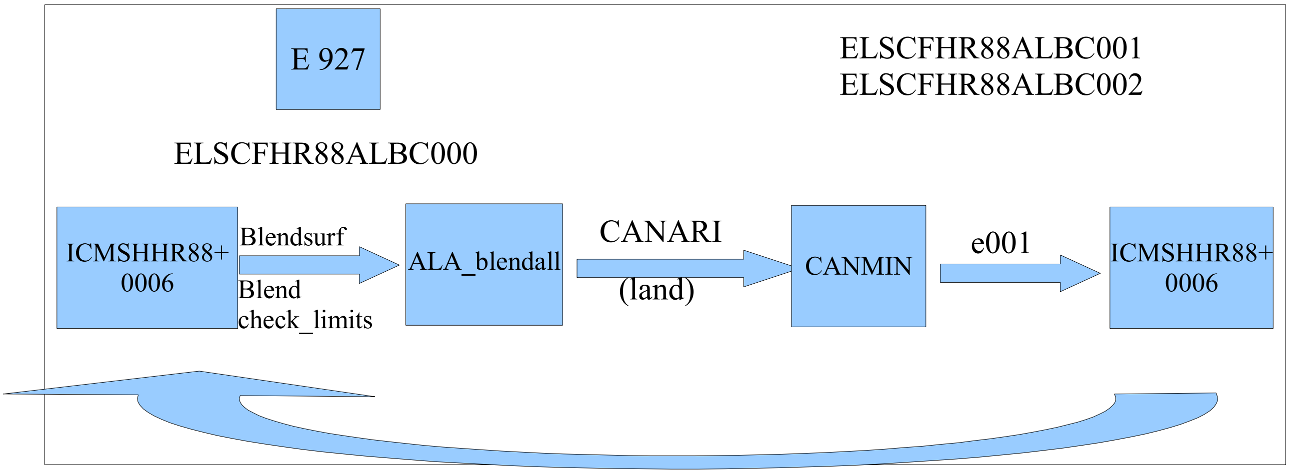


Fig. 6: Schematic of CANARI assimilation cycle

For production we use 6h forecast from assimilation cycle and do 72h integration for 00UTC . Before integration firstly we copy upper air fields from short cut off ELSCFHR88ALBC000 and then CANARI analysis over land is performed. Forecast from assimilation cycle is ready 5-6 hours after operational forecast. So far we don't have objective verification (there are plans for installing VERAL verification package) but we have graphs showing operation forecast, forecast from assimilation cycle and observations. This 'verifications' shows that CANARI in general gives smaller RH2m and higher maximum T2m (Fig. 7).

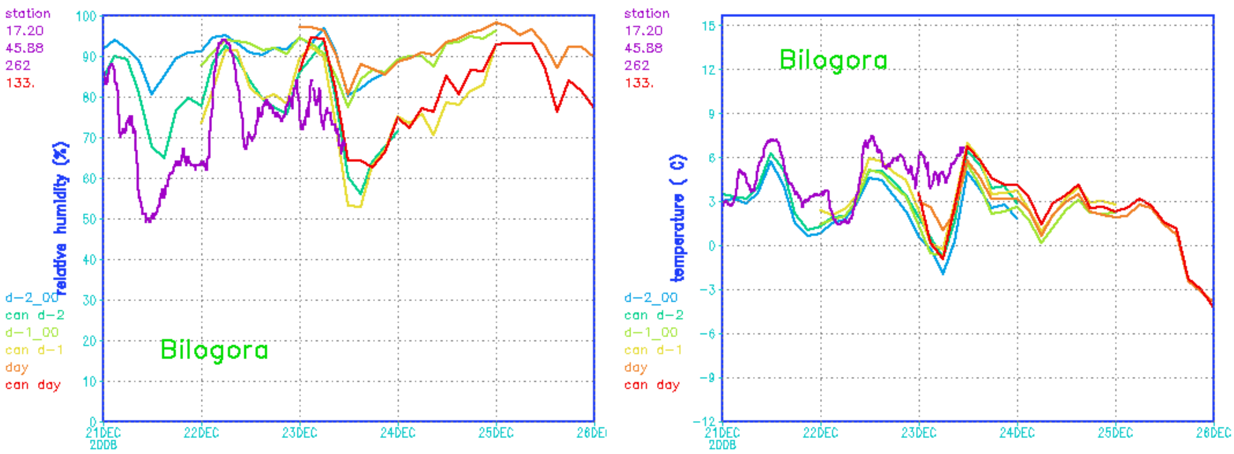


Fig. 7: Visual verification of operational and forecast from CANARI assimilation cycle

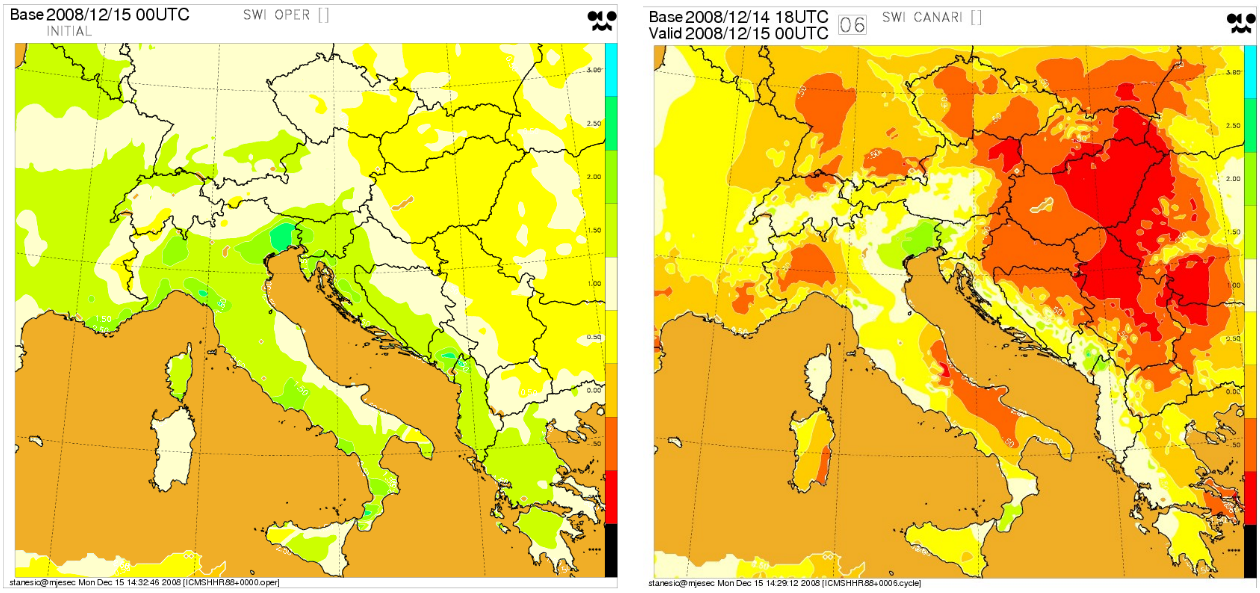


Fig. 8: SWI for operational (left) and forecast from CANARI assimilation cycle (right)

In Fig. 8, SWI is plotted for operational and forecast from CANARI assimilation cycle valid at 20081215 at 00 UTC. It is visible that land is dryer in CANARI than in operational forecast.

One problem should be mentioned here. When we first started cycling we used operational 00 initial file for start. After some cycling we tried to plot SWI but it was not possible. After conversation with Alena Trojakova it came out that one should always use forecast for CANARI analysis. It seams that there is division by forecast length in routine CACSTS so it can not be zero.

It is hard to tell without objective verification whether CANARI cycling gives positive impact. Subjectively it looks so, but objective verification is needed. Also just copying of upper air fields is probably not good solution, but when we install 3DVAR this problem will be solved.

3.3. HUNGARY

Major ALADIN developments

(kullmann.l@met.hu)

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).

The main scientific developments for the second half of 2008 can be summarized as follows:

3.3.1. Data assimilation:

As the CANARI surface assimilation, improved the 2m forecasts in earlier tests, it has been implemented operationally in the 1st of October 2008

The work on the Ensemble Transform Kalman Filter has been continued with a testing of the Transform matrix. We found that the Ensemble Transformation provides a similar spatial structure of the analysis perturbations as a set of real 3dvar assimilations but with smaller amplitudes. This suggested the use of an inflation factor in order to amplify the perturbations. Presently, experiments are ongoing in order to test different inflation techniques. An other important step is that the ETKF elements are now organized in a cycle (except the update of the P_f matrix).

A centralized preprocessing system has been built up for LACE (PPLACE) at HMS with a very important help from the LACE Data Manager (Alena Trojáková). The preprocessing system provides an hourly update of GTS and EUMETCAST observations in OBSOUL and GRIB format for the following observation types: SYNOP, SHIP, TEMP, AMDAR, AMV, AMSU-A/B, HIRS and MHS from the NOAA satellites, SEVIRI from MSG2, WINDPROFILER. The data are down loadable for LACE members via ftp from HMS. The regular run of PPLACE started on the 17th December 2008.

We kept doing tests with SEVIRI from MSG2 and SYNOP T and RH data with the help of a guest from Turkey (Ersin Kucukkaraca). The point was to use only the water vapour channels from of SEVIRI. The previously found degradation of the PBL temperature scores were eliminated by the blacklisting of the infra red channels, however also the overall good impact has been reduced in terms of rmse and bias scores compared to SYNOP/TEMP observations and ECMWF analysis. A good impact of the SYNOP T and RH observations was found.

Experiments have been run in order to use HIRS data from the NOAA satellites at high resolution (80 km thinning) together with SYNOP T and RH data. This work was done with the help of Ahmed Bouzid from Algeria. Over the chosen period the HIRS data had neutral impact on the forecast skill, while the SYNOP observations improved it significantly for the PBL levels.

3.3.2. LAMEPS:

Quasi-operational dynamical downscaling of Meteo France's PEARP system by the ALADIN model. The main characteristics of this ALADIN model version are as follows: Horizontal resolution: 12 km Domain covering basically the continental Europe (LACE domain) Vertical resolution: 46 levels Integration once per day to 60h starting from the 18 UTC data Boundary conditions updated every six hours by the ARPEGE EPS (PEARP) system.

After performing post processing to a latitude-longitude grid, the outputs of the LAMEPS system are mainly visualized using HAWK (Hungarian Advanced WorKstation).The available products from our LAMEPS system are the ensemble mean, the ensemble spread (computed around the mean), individual ensemble members and probability fields for several parameters . The individual members can be visualized in the form of “spaghetti diagrams”. In addition, “plum diagrams” are also plotted for several parameters and selected Hungarian locations.

Verification of the quasi-operational LAMEPS system is performed using the common LACE verification package.

3.3.3. SURFEX:

Evaluation of PBL diagnostic schemes in SURFEX

The previous experiments showed that the new diagnostic formula (with the stability function proposed by Gratchev et al.) is able to produce similar results as the Canopy scheme in the direct model.

The second task was to test whether the new formula can be applied in upper air data assimilation, i.e. if the TL of the new formula is a good approximation for the TL of the Canopy scheme. We have run experiments with the off line SURFEX model. During the integration the surface fields were taken constant and we used a step like function for the upper air forcing with small but finite changes at the steps. (The step function enables the SBL fields to have relaxation.) We have also computed the TL of the new formula and compared with the finite difference of the Canopy scheme. The results have shown that the TL of new formula is a good approximation for the Canopy scheme except for humidity.

3.4. SLOVENIA

Slovenian team (Neva Pristov, Mark Žagar, Jure Cedilnik, Benedikt Strajnar, visitor Nuno Lopes)
(more details neva.pristov@rzs-hm.si)

3.4.1. Data assimilation

Our group started with the implementation of assimilation cycle with CANARI surface analysis. Assimilation configuration 701 was tested and validated first in cy32t3 and now in cy35t1. Scripts were prepared under SMS environment. The observational input data format (obsoul) is generated by conversion of XML stream from Visual Weather system. The first experimental assimilation cycle contains (steps in the same order as listed here):

- 6 h ALADIN forecasts as first guess (ARPEGE short cut-off LBC's),
- ARPEGE sea-surface analysis included (using BLENDSUR),
- surface analysis (CANARI) using synop observations (2 m temperature and relative humidity),
- cycling of microphysics (ADDGFL).

Model configuration is the same as in the parallel suite (421 x 439 points, 4.4 km resolution). Microphysical quantities (cloud water and ice, rain, snow) and TKE are initialized with 6 h guess values. The 48 hour forecast production based on this cycle is performed every 12 hours (also using ARPEGE short-cutoff LBC's).

This experimental cycle has been run for the period of 6 December 2008 - 4 January 2009. Objective verification scores were clearly worse compared to parallel suite during first 24 hours of forecast. It means that our assumption that we needed no upper-air blending, assimilating only surface data, was wrong. The next cycling experiment will contain 100% ARPEGE upper-air blending and also some additional synop observations.

The help from LACE, especially CHMI, is acknowledged on this topic.

3.4.2. LBC coupling

There was a short stay in Brussels on lateral boundary coupling. The idea was to do some preparatory work to implement Boyd's style of lateral boundary coupling which would replace Davies scheme, used in ALADIN for years. The majority of efforts was spent to enable various model geometries (e.g. to run it with different positions of I+E zone or with no E zone) which would be needed while implementing Boyd's coupling.

3.4.3. Use of LandSAF albedo product for surface analysis in ALADIN

A simple Kalman filter based system was used to assimilate operational LandSAF albedo product values in ALADIN.

The assimilation sequence was performed off-line – the albedo values where kept unchanged during an integration period and only initial conditions were modified.

Initially the system was designed to use ECOCLIMAP II values for background (vegetation fraction and two albedoes – for bare soil and for vegetation). In spite of slight inconsistency between the ECOCLIMAP II and ALADIN climatological values, the results obtained showed a non negligible improvement, particularly in 2m temperature scores.

The verification was performed over a six month period: from February to July 2007. The improvement is the greatest in March and is most clearly seen on 2m temperature scores (see Figure 1). The scores are neutral in warmer period (May, June, July).

After these encouraging results the system was adopted and recoded to use the consistent background values (vegetation fraction and both albedoes from ALADIN climatology). The (partial) verification for this latter experiment showed that the differences with the „inconsistent" set-up are negligible.

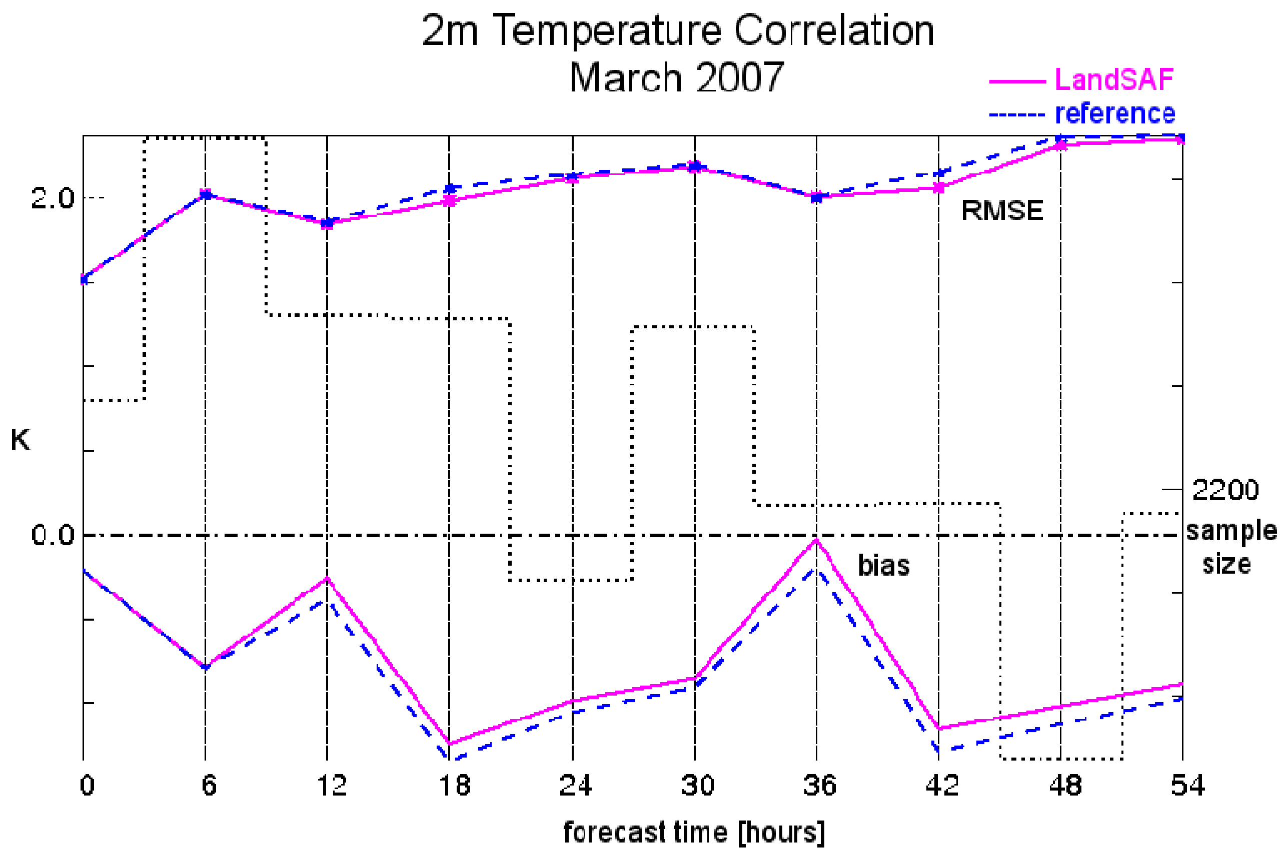


Figure 4: Statistics for 2m temperature for experiment with LandSAF albedo assimilation [full magenta line] and reference run [broken blue line].

3.4.4. ALARO physics validation

ALARO physics is already used in the operational ALADIN system. We want to examine model performance also on higher resolution. For this purpose, the model configuration at 4.4 km resolution is prepared. Since July 2008 there are regular daily runs in parallel suite (subjective evaluation, verification scores are inserted into AVP), additionally a database with one year of simulations for the whole of 2007 has been created.

There is also an opportunity in high resolution modeling and need for new products for the forecasters, so methods were prepared for the computation radar reflectivity Zmax, freezing level, and icing. With the visualization in the short time intervals (less than 1 hour) processes can be easier identified.

Classic statistics for chosen precipitation classes were done by Nuno Lopez during a one month stay in Ljubljana. Daily precipitation (24 h - from 00+06 till 00+30) data of forecasts for the year 2007 and observations from 38 climatological station over Slovenia were used as the dataset for the computation of the verification scores: Proportion Correct, Heidke Skill Score (HSS), Pierce Skill Score (PSS), Bias, Probability of Detection, False Alarm Ratio and Rate, Critical Success Index and Equitable Threat Score.

General results showed some skill for ALARO, with relatively high values of around 0.4 for HSS and PSS. The stratification of data in threshold classes revealed above average results for precipitation over 20 mm and poor results for classes 0.2 mm to 3 mm, 3 mm to 10 mm and 10 mm to 20 mm.

In the subjective verification, four typical synoptic situations were chosen for evaluation and identified as cold front cases, south-west flow cases, cyclones cases and convection cases. ALARO managed to give good results in south-west flow cases; there is a dual behavior with good and bad forecasts for cold fronts; for convection cases, the model misses were superior to the model hits, which is not surprising given the inherent poor predictability of the location of separate convective storms; for cyclonic cases the overall results were quite poor.

More can be found in the report on http://www.rclace.eu/?page=12 (Nuno Lopez, 2008, Verification of ALARO 3MT on 4.4 km resolution, report from stay 13 October - 7 November 2008 in Ljubljana)

4. PAPERS and ARTICLES

4.1. Evolution of the physical parametrisations of ARPEGE and ALADIN-MF models

Bouteloup Y., E. Bazile, F.Bouyssel and P. Marquet[2]

4.1.1. General description

A major change of the ARPEGE and ALADIN-MF models's physical parameterisations has been tested in an experimental suite during the second half of 2008 and it became operational on the 4th of February 2009. This development, which is characterised by a broad convergence between the parameterisations of hydrostatic models with those of AROME, was a fruitful collaboration between all units of the CNRM, especially with the climate team.

These changes include an increase to 6 spectral intervals in the short wave radiation scheme, the use of a new stratospheric ozone's climatology, the use of ECUME scheme to compute oceanic fluxes and a new approach for the parameterized subgrid vertical exchange treatment. The latter involves a combination of a prognostic turbulent kinetic energy turbulence scheme, a parameterisation of the boundary layer top entrainment and a mass flux shallow convection scheme.

4.1.2. Radiation modifications

- a : 6 spectral intervals in the short wave radiation scheme.

The short wave radiation scheme used in the Météo-France's models (ARPEGE ALADIN AROME and Méso-NH) comes from the works of Fouquart and Bonnel (1980) and has been improved at the European Centre by Jean-Jacques Morcrette (Morcrette (1991), Morcrette and Fouquart (1986)) It can work with 2, 4 or 6 spectral intervals. The 6 spectral intervals option (already used in AROME and Méso-NH) allows a better treatment of ozone interaction in the UV and now, a differentiation between water vapour and CO2 in the infra-red. As it is shown in figure 1, the impact in ARPEGE is a cold bias in the middle troposphere which requires a tuning of the other parametrisations. In IFS, this code has been replaced recently by the new SRTM k-distributions scheme.

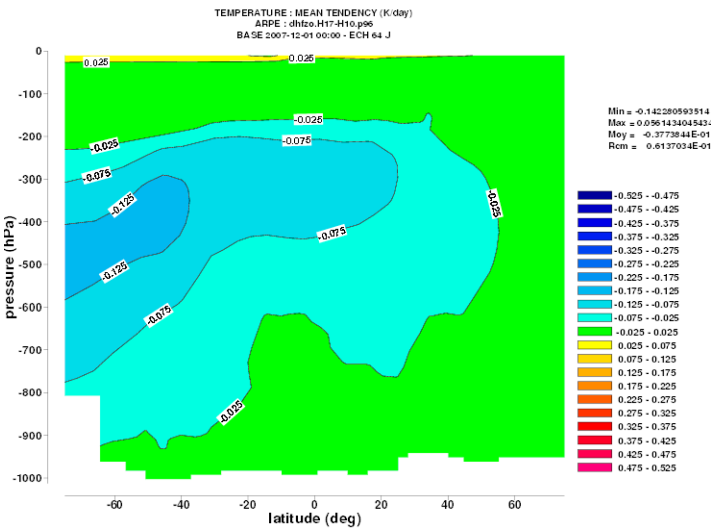


Figure 1 : Zonal mean temperature difference between two ARPEGE simulations along December 2007 and January 2008. The first one with the 2 spectral intervals option the second one with the 6 spectral intervals option. A cold bias is observed, more important in the summer hemisphere

2 Dprevi/LABO

❑ b : New ozone climatology

Ozone profiles of the old operational version of ARPEGE and ALADIN models are adjusted by an analytical function of three parameters. The 3 parameters are geographical and monthly dependent. A description of the technique is given in Bouteloup & Toth (2003)

It was observed that 3 parameters are not sufficient to take into account the variability of the profiles. As there are 3 degrees of freedom, 3 constraints to be respected were chosen. The first one is the ozone contents integrated on the vertical, the second is the height of the maximum and the third is the value of this maximum. The ozone contents of the upper atmosphere are then not perfectly respected. It was decided to test the zonal climatology of Fortuin and Langematz (1994) already used by IFS. As it is shown in figure 2, the impact is very strong for the temperature in the stratosphere, with the correction of the warm bias. This is important for assimilation of radiance data.

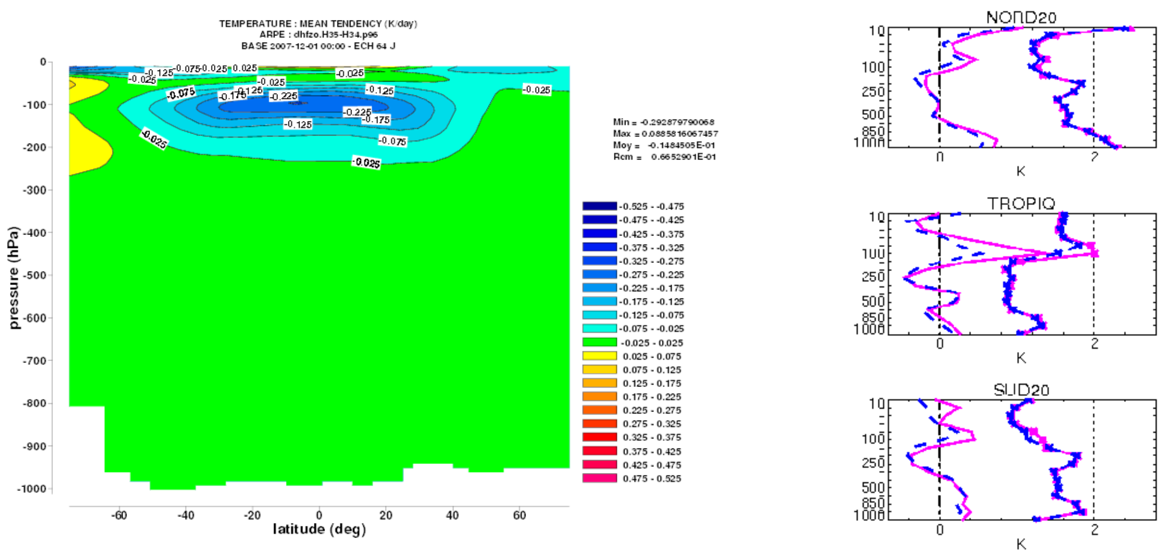


Figure 2 : On the left, zonal mean temperature difference between two ARPEGE simulations. The first one with the old operational ozone representation the second one with the Fortuin and Langematz (1994) zonal climatology. On the right in red the old-operational model, in blue with the new ozone climatology. One can see that the warm tropical bias around 100 hpa is partially corrected.

4.1.3. Description of the ECUME (Exchange Coefficients from Multi-campaigns Estimates) scheme

ECUME is an iterative bulk sea surface parameterization for the turbulent exchange coefficients for wind, temperature and moisture. The formulation is derived from an extended consistent database gathering 10 years of measurements issued from five experiments dedicated to air-sea flux estimates in various oceanic basins (from Northern to equatorial Atlantic). The available data (more than 6000, 4600 and 2100 values for the momentum, heat and moisture exchange coefficients respectively) cover the widest range of atmospheric and oceanic conditions, from very light (0.3 ms-1) to very strong (up to 20 ms-1) wind speeds, and from unstable to extremely stable atmospheric boundary layer stratification. For a more detail description of the scheme see Belamari (2005)

The main impact in the global model ARPEGE is a strong decrease of evaporation and precipitations. This reduction of the ARPEGE global hydrological cycle is shown in Table 1. In ALADIN, it has been noticed by the cyclone research team (CRC) in La Réunion that the impact of the ECUME scheme is a better cyclone life cycle (not shown). The counterpart is the apparition of a cold bias in the middle troposphere.

	Precipitation	Evaporation
Climatology	2.70	2.70
Operational	3.13	2.99
E-suite V1	2.83	2.56
E-suite V2	2.97	2.76

Table 1 : Global evaporation and precipitation (mm/day) in 6 hours forecasts of an ARPEGE 4DVAR assimilation cycle during a one month period for operational, first version of e-suite and second version of e-suite. Climatology is done as a magnitude evaluation but due to the short period of simulation it's not an absolute reference. One can see an improvement (reduction) of the hydrological cycle.

In order to reduce this cold bias, in the second version of the e-suite we used as moisture exchange coefficient a linear combination of heat (0.25) and moisture (0.75) coefficients.

4.1.4. Vertical diffusion and mass flux shallow convection in ARPEGE/ALADIN-MF

An important modification of the turbulent scheme of ARPEGE/ALADIN-MF has been done. The old Louis scheme (Louis 1979) modified in 2005 (Bazile et al., 2005) associated to a pseudo-shallow convection parameterization (Geleyn, 1987) has been replaced by a prognostic Turbulent Kinetic Energy scheme (TKE) associated to a mass flux shallow convection scheme. An important connection between the two schemes has been established. This connection is necessary in the global model ARPEGE and improves also significantly the forecasts of the limited area model ALADIN.

The prognostic TKE scheme comes from the formulation of Redelsperger and Sommeria (1981). The initial setting comes from the works of Cuxart et al (2000) (CBR in the following). Rapidly, in order to have a good dynamical behaviour in the global model ARPEGE, it was decided to increase the mixing of wind. To do that, the mixing coefficients of the article of Cheng et al (2002) were used. The mixing length is computed using the formulation of Bougeault and Lacarrère (1989) (BL89 in the following) but using a combination between L_{up} and L_{down}, described below, different from the original article. To improve the representation of strato-cumulus, the scheme uses a top-Planetary Boundary Layer (PBL) entrainment parametrization following the ideas of Grenier and Bretherton (2001) and Grenier (2002). A full description of the scheme has been made by Pascal Marquet (Marquet, 2008)

The TKE scheme has been evaluated in many 1D cases, before and after the modifications needed to obtain a correct behaviour in the global model. One of the first tests of the scheme took place in the framework of an inter comparison study in the case of the simulation of shallow cumulus cloud over land (Lenderink et al, 2004). The subject of this paper is not to present all 1D results. But it seems interesting to show that the results of the TKE scheme in the academic GABLS1 case (Cuxart et al., 2006) are always better than those of the old parametrization (figure 3). In this figure, it is also interesting to note that the main degradation of the TKE with operational tuning is due to the use of a 10-meter minimal mixing length in the free atmosphere. With the modifications described below, this constraint, introduced during the first 3D tests, seems to be now unnecessary and it is expected to be removed for the 2009 high resolution (T800) e-suite of ARPEGE.

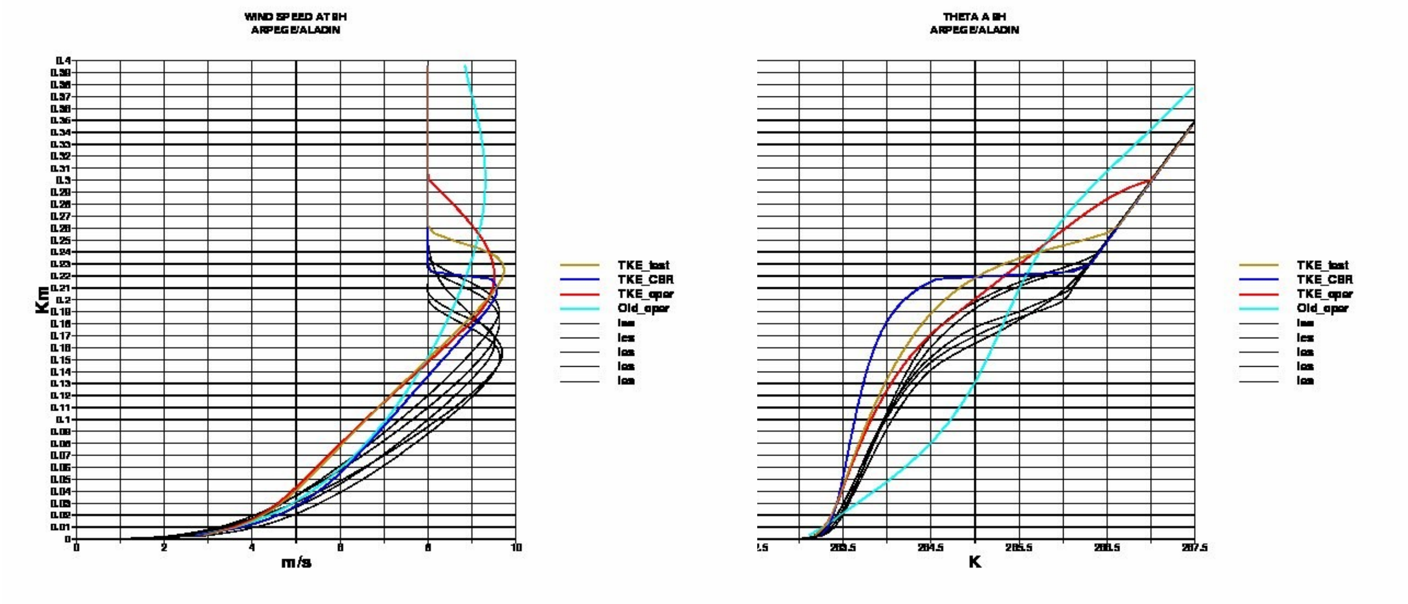


Figure 3 : Wind (left) and □ (right) for simulation of the GABLS1 case (see text). Large Eddy Scale (LES) models are in black, present operational in red, operational without minimal mixing length in brown and old operational (Louis scheme) in cyan.

The shallow convection mass flux scheme comes from the approach of Kain and Fritsch (1993) and was written for Meso-NH by Peter Bechtold (Bechtold et al., 2001). It is noted KFB in this paper. To avoid a double counting, the fluxes coming from the deep convection scheme are set to zero when the deep cloud has a height less than 3000m. Finally the condensation coming from the KFB scheme is an input to the micro-physics scheme, which means that the shallow convection scheme can indirectly generate precipitations. These two points have a very interesting impact on the quality of the precipitation forecast, mainly in summer.

During the first tests too much wind was observed, especially in the PBL (figure 4). The first adjustment was to increase the wind mixing by the deep convection scheme. But there was always a too small mixing at the top of the PBL, especially in the cloud layer in shallow convection area. This insufficient mixing is not due to a wrong Prandlt number because it also affects the temperature and humidity. It was rapidly discover that the BL89 mixing length and the TKE become very small in the top PBL cloud layer.

It seems that the mixing in the cloud layer (and also at the top of the cloud layer) is due to non-local processes. The shallow convection scheme is non-local and resolves a part of the above problem, but only a part. The main idea of the connection between the two schemes is to suppose that in a real PBL, where shallow convection occurs, the turbulent mixing is enhanced by the presence of clouds. The exchange coefficients are function of the TKE and the mixing length :

$$K \propto l\sqrt{e}$$

Where e is the TKE and l the mixing length.

Following Lock and Mailhot (2006) which have shown the impact of the enhancement of the turbulence length scales and the buoyancy production of TKE, it was decided to amend both the mixing length and the TKE. First, a thermal production term of TKE coming from the KFB scheme is computed. In CBR prognostic TKE scheme the thermal production term is given by the following equation : $P_\theta=\beta\left(E_\theta\overline{w'\theta'_l}+E_q\overline{w'q'_t}\right)$

The determination of the coefficients is non-trivial, see Marquet (2008) for a detailed explanation.

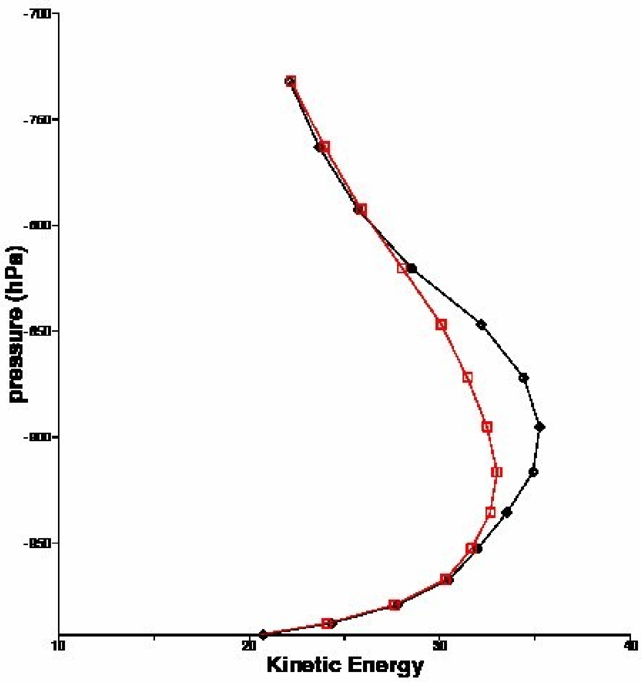


Figure 4 : Zonal mean over the tropical area of the Kinetic energy (J/kg) with (red) and without (black) the connection between turbulence scheme and mass flux shallow convection scheme. The beneficial effect in the cloud layer is shown.

In the new formulation, a new term is added, coming from the shallow convection scheme :

$$P_\theta=\beta\left(E_\theta\overline{w'\theta'_l}+E_q\overline{w'q'_t}\right)+\beta\left(\overline{w'\theta'_l}\right)_{KFB}$$

Secondly, different solutions have been tried to increase the mixing length in the cloud layer. Lenderink and Holtslag (2004) mixing length was tested without any success. The interest of the Lenderink's mixing length is a local formulation based on the Richardson number (Ri). To avoid the problem of a too small mixing length in the cloud layer the Geleyn's modified Ri (Geleyn, 1987) was used in the formulation of the Lenderink's mixing length, without any success.

A local modification of the BL89 mixing length was then tested. The BL89 mixing length is a combination of a $l_{\_up}$ and $l_{\_down}$ length following :

$$L_{BL89}=\left[\frac{\left(L_{up}\right)^{-\frac{2}{3}}+\left(L_{down}\right)^{-\frac{2}{3}}}{2}\right]^{-\frac{3}{2}}$$

For the current level j $l_{\_up}$ and $l_{\_down}$ are then modified in the cloud according to :

$$l_{up}^{new}=max\left(l_{up},z_{top}^{shallow}-z(j)\right)$$

$$l_{down}^{new}=max\left(l_{down},z(j)-z_{bottom}^{shallow}\right)$$

Where z(j) is the altitude of the current level j, $z_{\_top}$ the altitude of the top of the shallow convection cloud and $z_{\_bottom}$ the cloud base.

Finally, to reduce the remaining problems of the strong wind around the Somali jet (versus ECMWF analysis), it is necessary to use a similar formulation with the deep convection scheme. The $l_{\_up}$ and $l_{\_down}$ length are updated in the deep cloud according to :

$$l_{up}^{final} = max\left(l_{up}^{new}, min\left(1000, z_{top}^{deep} - z(j)\right)\right)$$

$$l_{down}^{final} = max\left(l_{down}^{new}, min\left(1000, z(j) - z_{bottom}^{deep}\right)\right)$$

4.1.5. Results in ARPEGE and in ALADIN-France

As shown in figure 5, large scale scores of geopotential are improved. But the main result is a better representation of the thermodynamic structure of the PBL (figure 6 and 7).

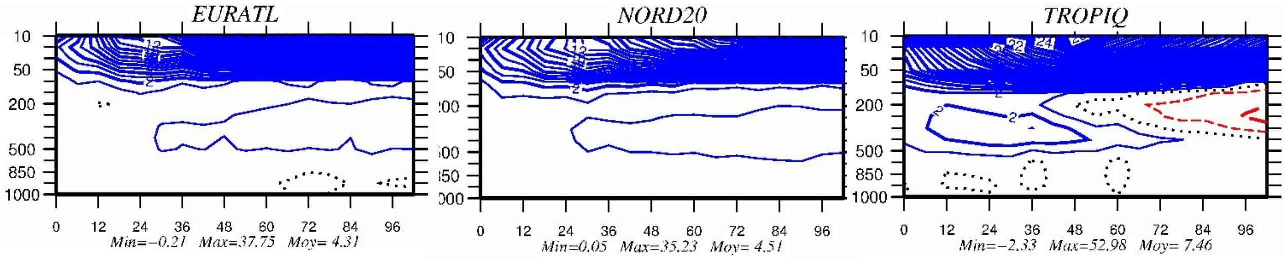


Figure 5 : Score of geopotentiel over 135 days of the e-suite between the new operational model ARPEGE and the old one. Blue = improvement. Improvement in the strastophere is due to the impact of the new ozone climatology.

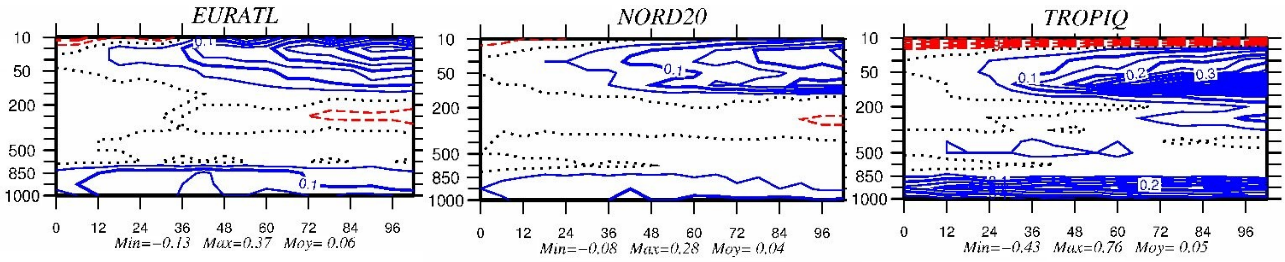


Figure 6 : As figure 4 for temperature One can see the improvement of the PBL, mainly in the tropic..

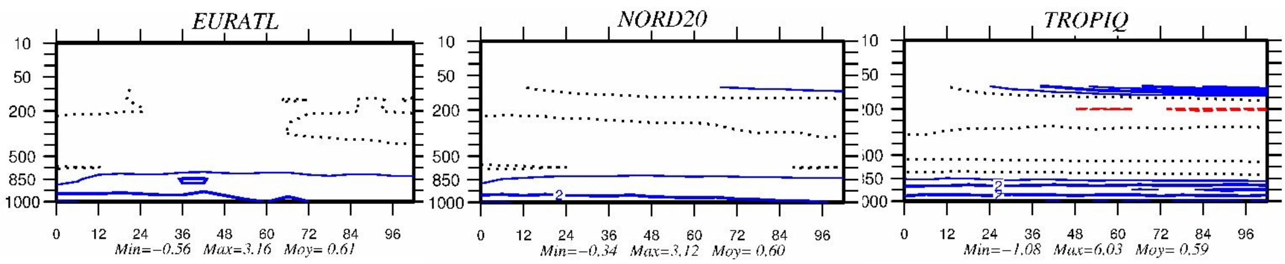


Figure 7 : As figure 4 but for relative humidity. One can see the improvement of the PBL, mainly in the tropics.

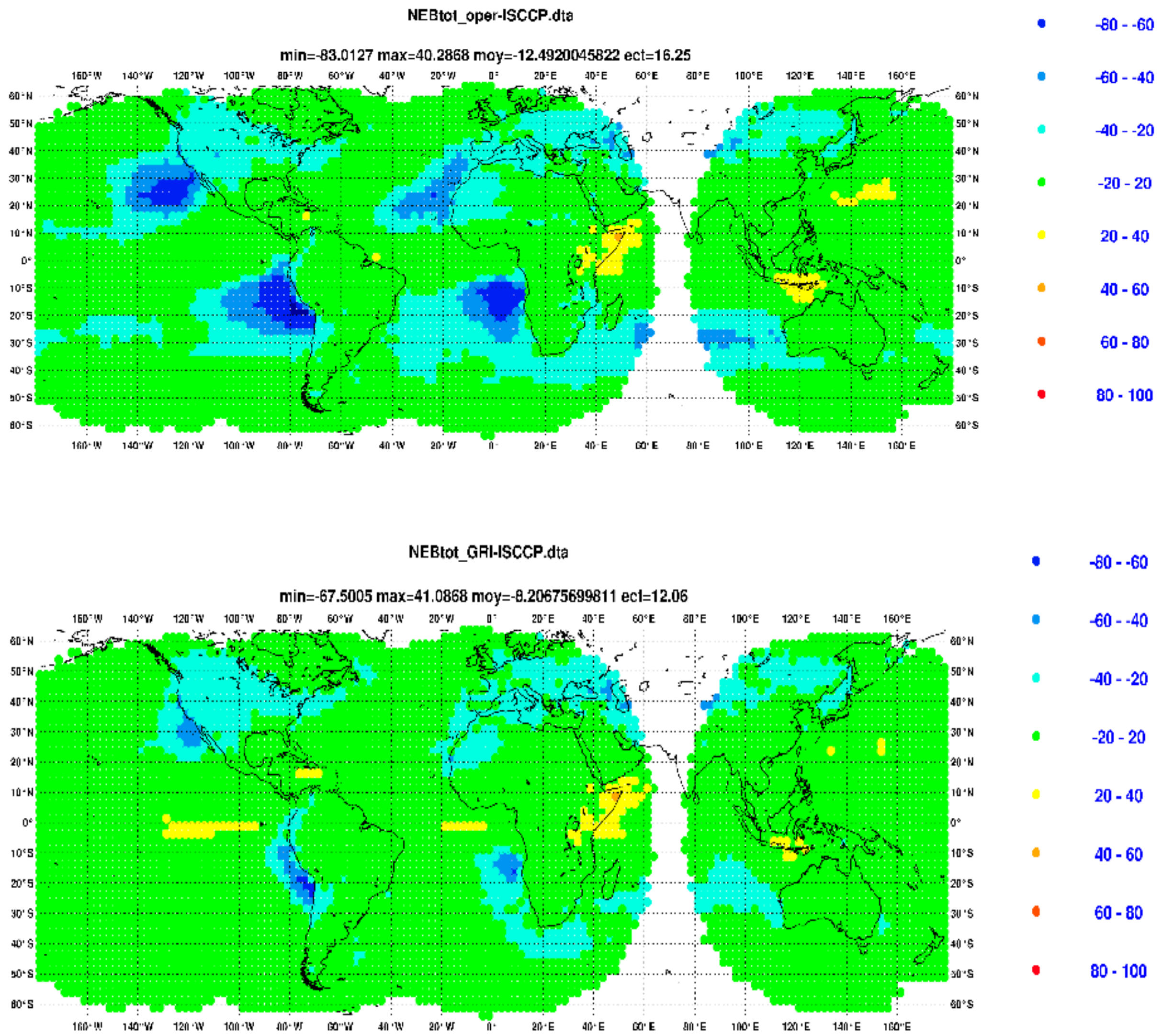


Figure 8 : Average over December, January, February, June, July and August of the ARPEGE (T224 C=2.4 L60) total cloudiness minus ISCCP satellital climatology. Top panel old-operational model, bottom new operational model. The lack of stratocumuli is much alleviated.

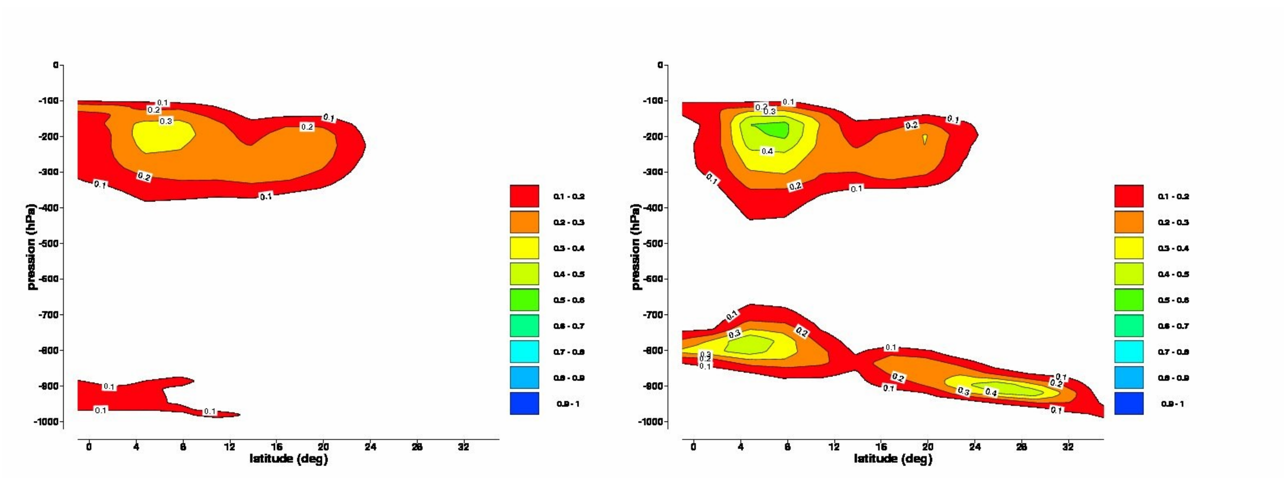


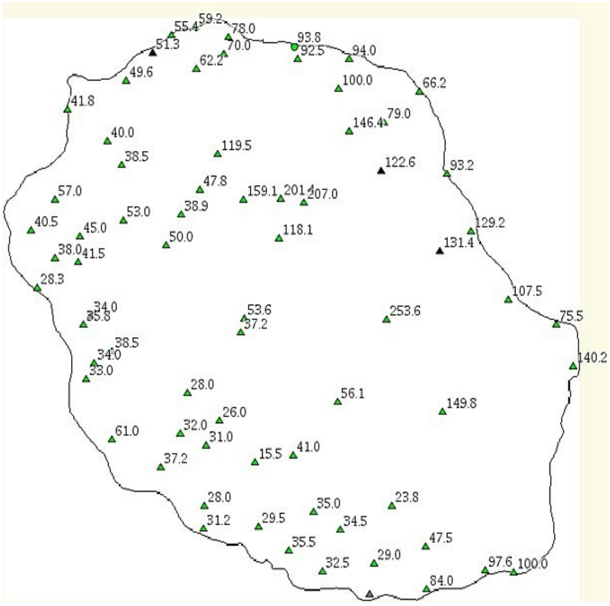
Figure 9 : Cloud cover of the old_operational ARPEGE model (left) for June 2007 along the GEWEX Pacific cross -section which starts from the Equator at 190° East to end by 35° north and 235° East close to Californian coast. Eastern stratocumuli are absent. Right : Same but with the operational model. Eastern Pacific stratocumuli are now predicted.

This improvement leads to a good representation of low cloud (figure 8 and 9). In figure 8 the anomaly of total cloudiness against the ISCCP climatology is shown. The new physical package gives a better representation of stratocumulus over the tropical oceans. This can be more clearly seen in figure 9 along the GEWEX Pacific cross section. With the new operational model the stratocumuli are present and the slope of the base of the cloud from East to West is correctly simulated. This improvement of the PBL structure has also an impact on the quality of the precipitation fields.

In ALADIN a major improvement of the precipitation is observed. Subjective improvement of precipitation fields was highlighted by forecasters feedback and is illustrated in figure 10 over the La Réunion island. This case is one of the cases highlighted by the local forecasters where the precipitations fields of the old-operational model are completely wrong with the major part of the precipitations over sea. The new physical package gives a better forecast with more precipitation over the island's mountains. The forecast is not perfect but it was noticed by the forecasters that the improvement of the behaviour is quite systematic.

This subjective improvement can be quantified by objective scores. As it is shown in figure 11, the Heidke Skill Score, computed over France during August, September and October 2008, is largely improved.

The last important point is the good behaviour of ARPEGE e-suite, better than the operational model, during the storm event of 24 of January 2009 which hit the south-west of France. In figure 12 the operational analysis is plotted with two 54 hours forecasts. The forecast of the e-suite is quite good at this range. This is not the case for the old-operational model which does not see the storm.



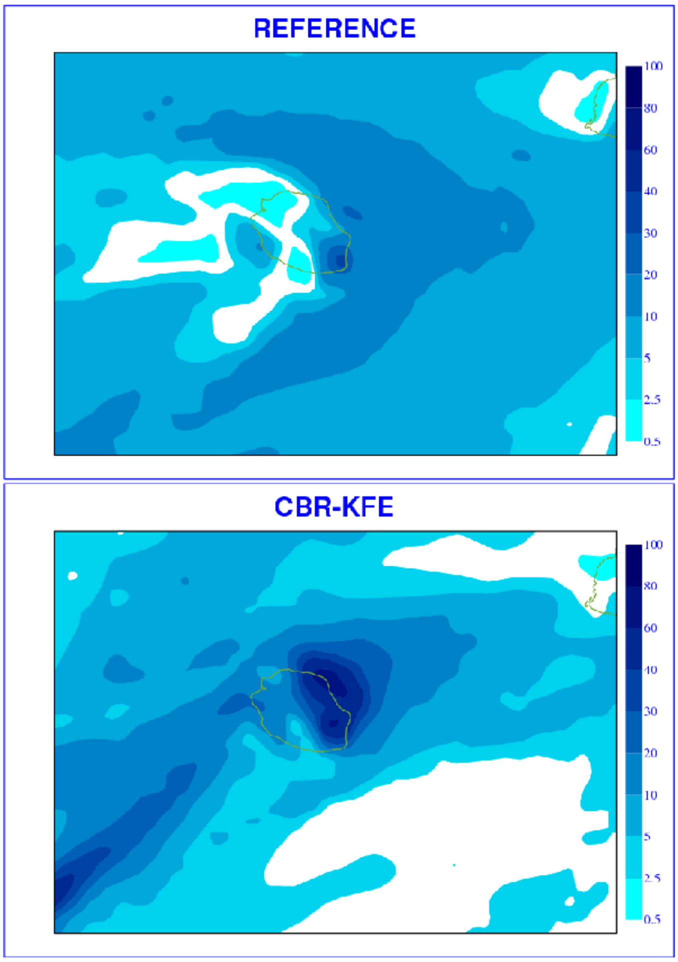


Figure 10 : Precipitation event over the La Rèunion island. Upper right, old-operational model, bottom right the new operational model and on the left, rain-gauge observations. The new forecast is not perfect but now precipitations are present over the land that's not the case with the old-operational model where the precipitations are on the sea around the island.

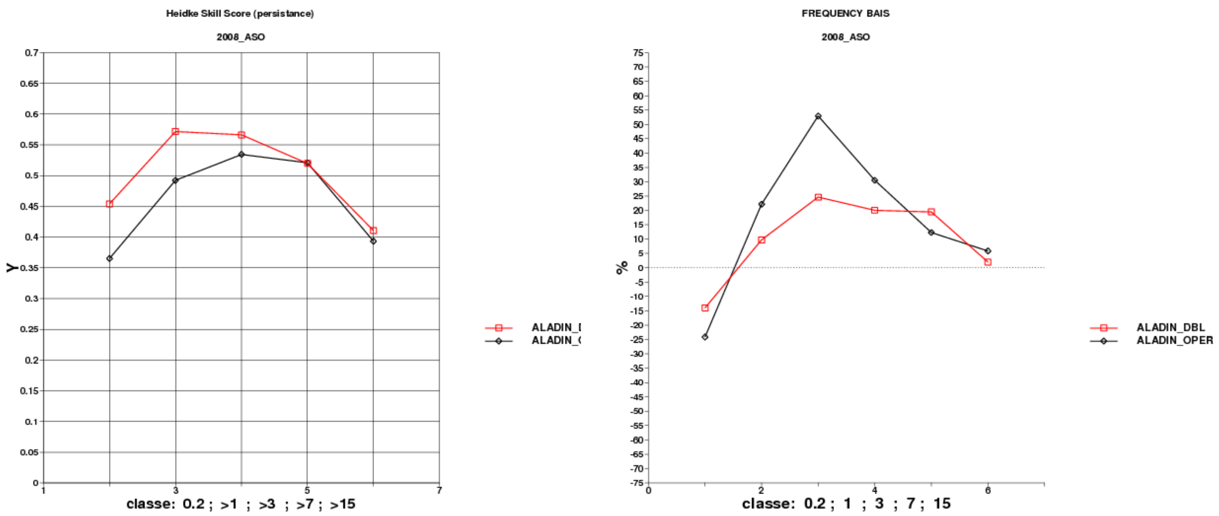
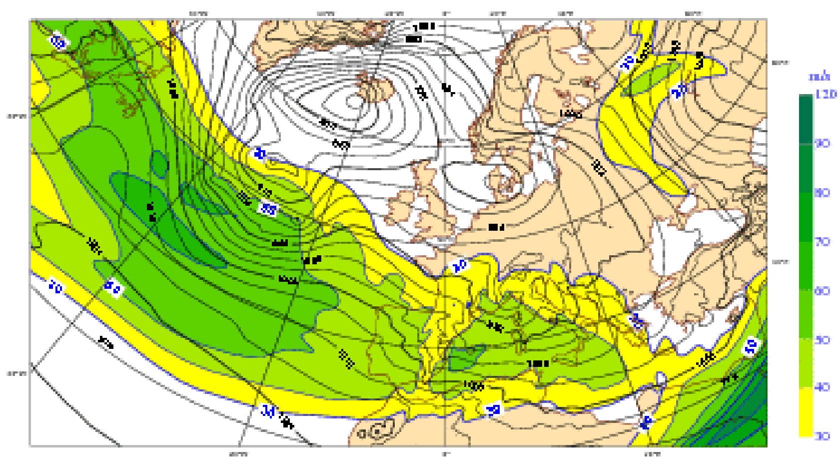
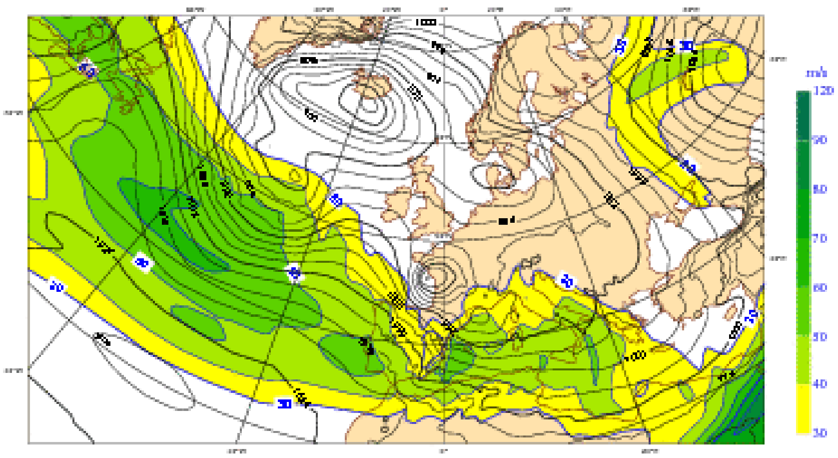


Figure 11 : Precipitation Frequency biais (right) and Heicdke Skill Score (left) of the e-suite (red) and the old-operational (black) ALADIN France model during August, September and October 2008. All the precipitation classes are improved in the HSS graph, mainly for small precipitation classes.





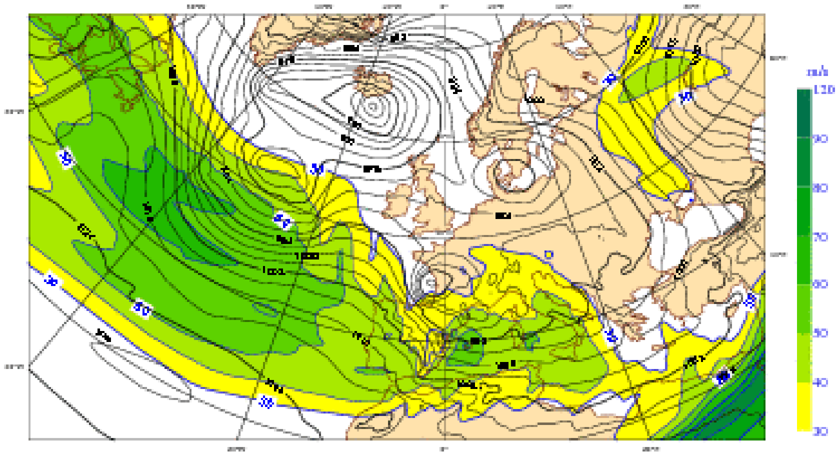


Figure 12 : MSL pressure and wind at 200 hpa for the storm of 24 January 2009 6UTC. Bottom operational analysis. Up old-operational 54 hours forecast from 22 of January 0UTC. Middle same as up but for the e-suite l. Old-operational model has a very bad behaviour. New version is quite good.

4.1.6. Conclusions and perspectives.

Changes outlined in this paper have a very important impact on the behaviour of the global model ARPEGE. The main result is a better thermo-dynamical representation of the PBL, with a major improvement of the low-cloud forecast. The modifications in radiation reduce the temperature bias in the stratosphere which is very important to have a correct assimilation of radiative satellite data. Finally, the hydrological cycle of ARPEGE is reduced by the use of the ECUME scheme. In ALADIN the most remarkable improvement is on the precipitations, with a better qualitative representation of the precipitations fields, but also with an increase of the objective HSS score. The behaviour of the hydrostatic models seems now to be more coherent with AROME, which is important for the coupling between the models. It is important to note that these physical parametrisations, excepted the connection between TKE and KFB, are already usable by ARPEGE-CLIMAT. The last modifications needed by ARPEGE are being tested by the climate team. It was a challenge to use the same physical parametrisations from the climate resolution to a 8km mesh model.

The new prognostic turbulence is also more independent of the vertical resolution. The behaviour of the scheme is identical with a 70 levels discretisation. This was not the case with the Louis's scheme. First tests have shown that there is no problem to run a new configuration of ARPEGE T800 C=2.4 (10km over France) with 70 levels. It is expected to start an e-suite with this configuration during spring. It is also expected to test in ARPEGE the new EDKF shallow convection scheme of Meso-NH/AROME. Finally, an important work has been started to implement in ARPEGE the 3MT deep-convection/microphysics scheme developed by ALADIN's partners in the framework of the ALARO project.

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4.2. Operational implementation of CANARI OI for surface assimilation and coupling with ECMWF in ALADIN/Hungary

Gergely Bölöni, László Kullmann, András Horányi

4.2.1. Introduction

At the beginning of October 2008, two important changes has been done within the operational ALADIN model in Hungary. On the one hand, the CANARI optimal interpolation (OI) was implemented for surface assimilation, in this way providing fully local initial conditions for the model together with the atmospheric 3DVAR data assimilation. Namely earlier, the atmospheric analysis provided by the local 3DVAR was completed with the interpolated ARPEGE analysis for the surface fields. The other important change done is the use of the ECMWF forecasts as lateral boundary conditions for our operational model. The two modifications were implemented at the same time after a careful evaluation of their common impact. The article first describes the specifications of both implementations, then the results of the related impact studies are presented.

4.2.2. Implementation of the CANARI OI surface assimilation

The CANARI OI analysis was implemented on CY30T1 and was validated in comparison with the Czech implementation that runs operationally since 2006 (Brozková and Trojáková, 2006). This implies that a local OI analysis is done over land using temperature and relative humidity observations at 2m, and the global analysis is taken over the sea (SST). The CANARI analysis is done before the atmospheric 3DVAR analysis but after replacing the SST fields in the ALADIN first guess (simple 6 hour forecast in case of ALADIN/Hungary) with those of the global analysis (Fig.1.).

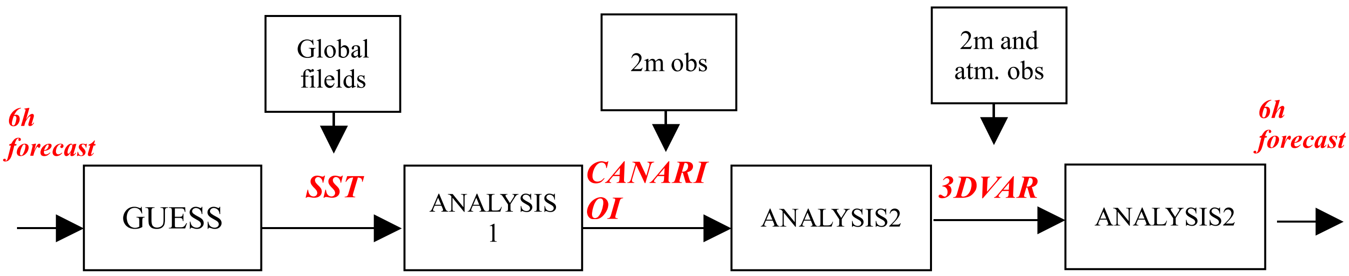


Fig. 1: The implementation of CANARI surface assimilation in the Hungarian operational ALADIN model (ANALYSIS1: ALADIN 6-h forecast with updated SST analysis of the global model, ANALYSIS2: ALADIN 6-h forecast with fully updated surface analysis partly from the global SST analysis and partly from the OI analysis using local observations, ANALYSIS3: fully updated analysis both for the surface (SST+OI) and the atmosphere (3DVAR) using all the possible local observations.

4.2.3. Use of ECMWF LBC data

The operational ALADIN model at the Hungarian Meteorological Service (OMSZ) has been coupled with the ARPEGE global model for its lateral boundary conditions (LBC) since summer 2002. Even before, between 1998 and 2002, it was coupled to ALADIN/LACE, which was run in Prague. Several attempts to use LBC data from the ECMWF (IFS) model have been made in the past 2 years in Hungary in an experimental framework, i.e. in a non-real-time manner (Kertész, 2007). These investigations were mostly done as part of the ECMWF "SPFRCOUP" Special Project led by Météo-France with the participation of several ALADIN partners. These preliminary results suggested a potential improvement of our ALADIN forecasts when using LBC data from the ECMWF (IFS) model.

The preparation of ALADIN LBC data from ECMWF forecast information consists of running appropriate configurations of the ARPEGE/ALADIN software (see Fig. 2.). First, one has to prepare a global ARPEGE file from the global ECMWF one (ARPEGE configuration 901) and then to interpolate it to the limited area LBC geometry (ARPEGE/ALADIN configuration e927). Beside the format change (ECMWF grib --> ARPEGE FA file format), the first step includes an adjustment of the surface fields in order to convert the ECMWF (TESSEL) surface variables into ARPEGE/ALADIN (ISBA) surface variables because the surface schemes in the two global models are rather different (for instance different number of surface layers). We refer to Saez (2008), Sahdan and Bölöni (2005) and Kertész (2006) for more detailed technical descriptions of the ALADIN LBC data preparation from ECMWF data. The procedures above were implemented and tested at ECMWF (HPCE), which made possible that following a request from OMSZ, ECMWF started to provide LBC data for Hungary on a daily basis for pre-operational testing (May 2008). This enabled us to run real-time parallel tests at OMSZ in order to compare the forecast accuracy with ARPEGE and ECMWF LBC data.

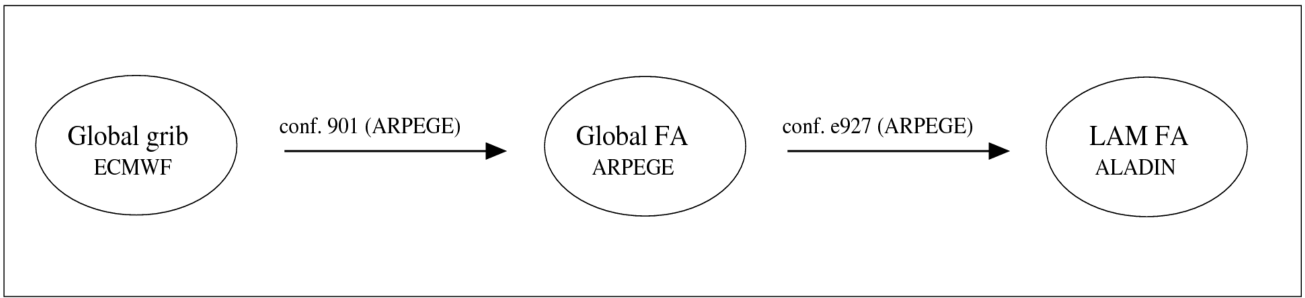


Fig. 2: Main steps to prepare ECMWF LBC data for the ALADIN limited area model

4.2.4. Parallel tests

During the summer of 2008 three tests have been run using the regular real-time LBC data from ECMWF. All of them included a local three-dimensional variational (3D-VAR) atmospheric data assimilation cycle and 48 hour production forecasts starting from 00 and 12 UTC analyses. Due to data availability constraints, our ALADIN production integrations used LBC files from the previous ECMWF BC run, that is, with a shift of 6 hours. All the three experiments were compared to our operational (control) run. Verification of the forecasts has been done against SYNOP and TEMP observations over the whole operational model domain. The experiments and the discussion of the results are detailed below.

- Control run (HUN2)

The reference is our former operational run which includes a 3D-VAR atmospheric assimilation cycling with a 6 hour analysis frequency. LBC data are used from ARPEGE both in the assimilation cycle and in the production runs. No local surface analysis was included at that moment, which implies that the interpolated ARPEGE analysis was used as surface initial condition (IC) both in the assimilation cycle and the production forecasts. The atmospheric analysis includes the assimilation of the following observation types: SYNOP, SHIP, TEMP, AMDAR, Wind Profilers, MSG2/GEOWIND, NOAA(15/16/17/18)/ATOVS (AMSU-A, AMSU-B and MHS). For more details on the former operational ALADIN model of HMS we refer to Randriamampianina (2006) and Bölöni (2006).

- Surface and lateral boundary conditions from ECMWF (ECM1)

In this experiment all ARPEGE fields have been replaced by ECMWF fields. It means that ECMWF fields have been used both for surface ICs and LBCs. In all other aspects the experiment is the same as HUN2. The parallel test has been run for the period 17/07/2008 - 29/07/2008. Verification results reflect a degradation of the forecast for ECM1 compared to HUN2 near the surface (2m), which is illustrated on Fig. 3. The degradation is most pronounced for temperature and humidity. This feature has been found also in our earlier tests (Kertész 2006) and the degradation in our understanding is purely due to the surface ICs, and this is consistent with the fact that far from the surface (above 850 hPa) ECM1 over-performs HUN2 for most of the variables. An example is shown for geopotential on Fig. 4. The reason for the inferior results while using surface ICs generated from ECMWF fields most probably originates from the different surface schemes applied in ARPEGE and ECMWF (ISBA and TESSEL respectively). The applied surface schemes differ in several aspects and a detailed investigation would be needed in order to figure out from where exactly the problem is coming and to improve configuration 901 of the ARPEGE/ALADIN software in this aspect. It is to be mentioned that both Fig. 3. and Fig. 4. are based on the 00 UTC runs but results from the 12 UTC runs are very similar.

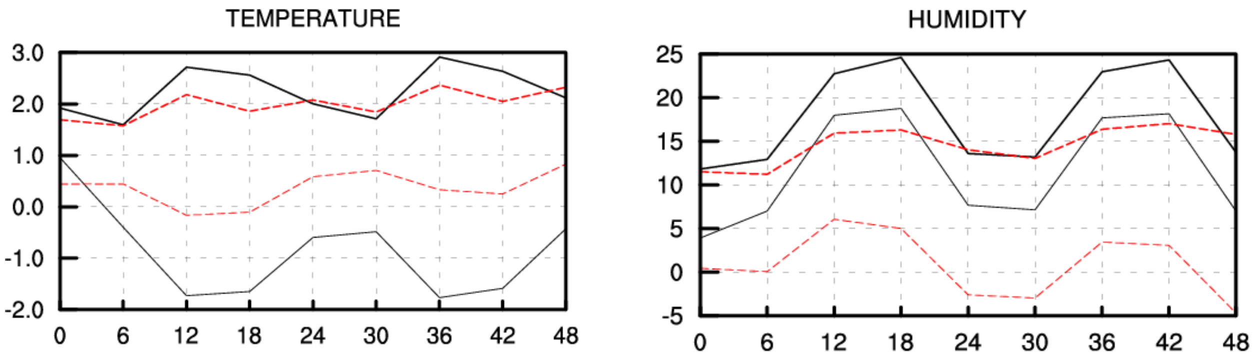


Fig. 3: Temperature and relative humidity scores (bias and rmse) for the experiments ECM1 (black-solid) and HUN2 (red-dashed) on 2m.

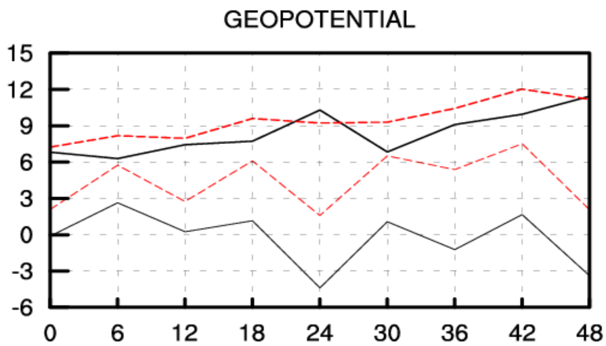


Fig. 4: Geopotential scores (bias and rmse) for the experiments ECM1 (black-solid) and HUN2 (red-dashed) on 700 hPa.

- Surface conditions from ARPEGE and lateral boundaries from ECMWF (ECMW)

This experiment is the same as ECM1 except that it uses surface ICs from ARPEGE just like in HUN2. In other words, this experiment differs from HUN2 only in the use of the LBCs and not in the use of the ICs. The experiment has been run for the period 01/08/2008 - 14/08/2008. Results at 2m are rather neutral for most of the parameters, however some improvement for temperature bias and mean sea level pressure RMSE can be seen (Fig. 5.). Higher in the atmosphere ECMW has a smaller error than HUN2 for most of the variables. An example for 700 hPa temperature and humidity is shown on Fig. 6. Results based on the 12 UTC are again very similar.

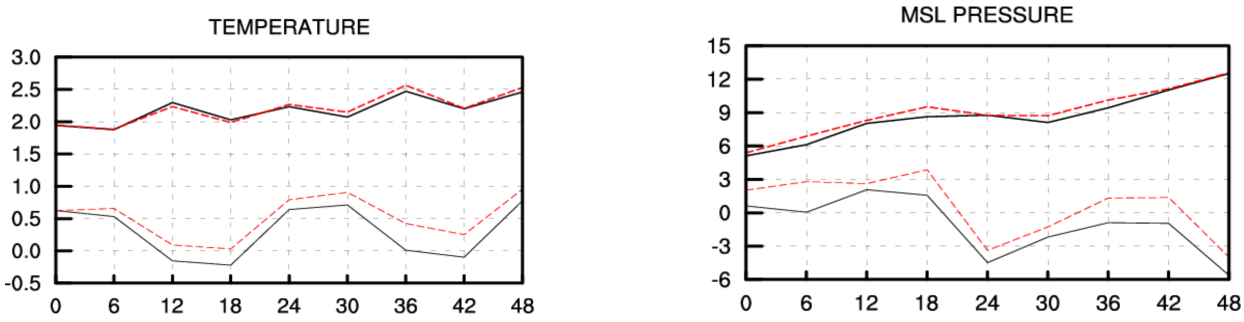


Fig. 5: Temperature and mean sea level pressure scores (bias and rmse) for the experiments ECMW (black-solid) and HUN2 (red-dashed) on 2m.

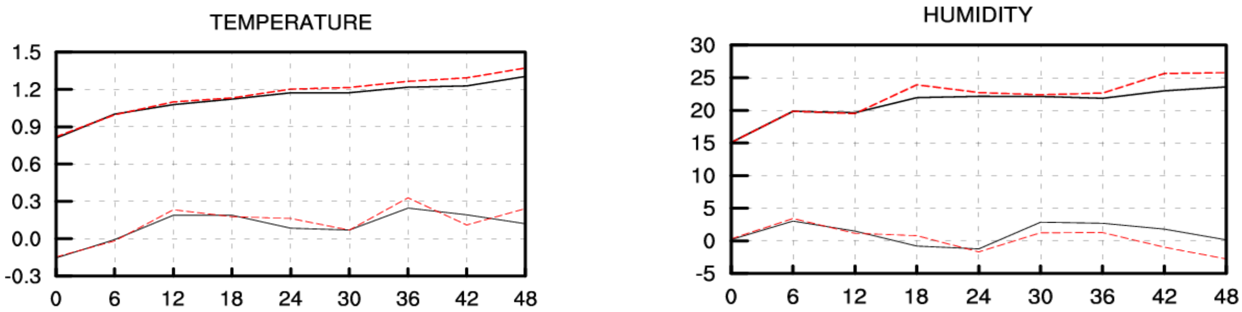


Fig. 6: Temperature and relative humidity scores (bias and rmse) for the experiments ECMW (black-solid) and HUN2 (red-dashed) on 700 hPa.

- ❑ Optimal interpolation (OI) surface assimilation and lateral boundaries from ECMWF (ECCA)

This experiment differs from the previous two again in the treatment of surface ICs, namely by running a local OI assimilation for the surface instead of using either interpolated ARPEGE or ECMWF analysis fields. Previously to our LBC tests described above, the local surface assimilation was found to improve the forecast at 2m and a decision has been taken to implement it operationally. However, before this operational implementation, we wanted to repeat the surface assimilation test using LBCs from ECMWF instead of ARPEGE to see the interaction of both modifications compared to our operational suite. Results from this test show an improvement in the 2m forecast, which is mostly due to the surface assimilation (Fig. 7.) and also higher in the atmosphere, which is mostly due to the use of LBCs from ECMWF (Fig. 8.). One should notice that 2m humidity bias is degraded during the day (forecast ranges +12h, +36h in the 00 UTC runs), which seems to be a shortcoming of the local surface assimilation, and certainly this needs further investigation in the future (at the same time the RMSE of humidity for the 2m had been improved).

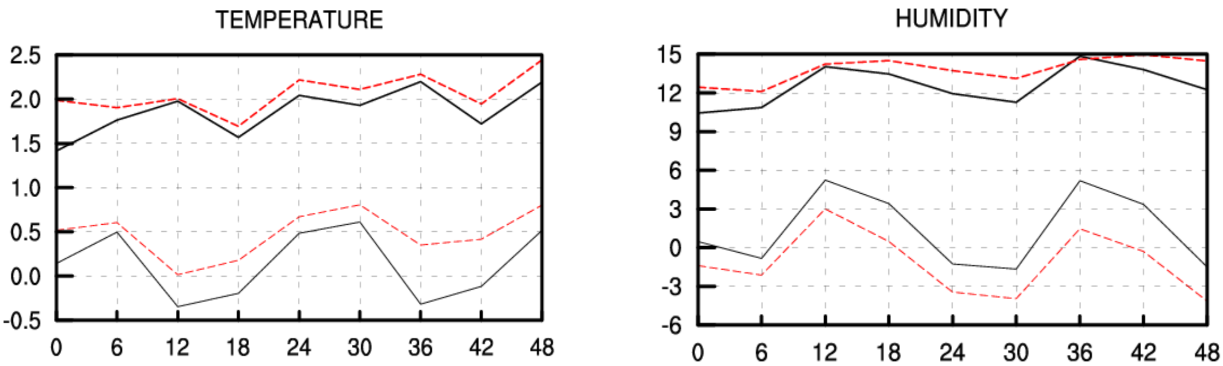
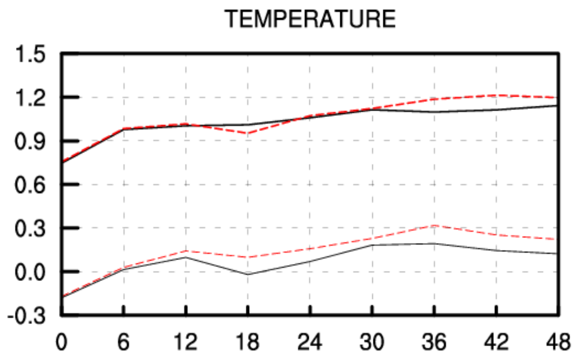


Fig. 7: Temperature and relative humidity scores (bias and rmse) for the experiments ECCA (black-solid) and HUN2 (red-dashed) on 2m.



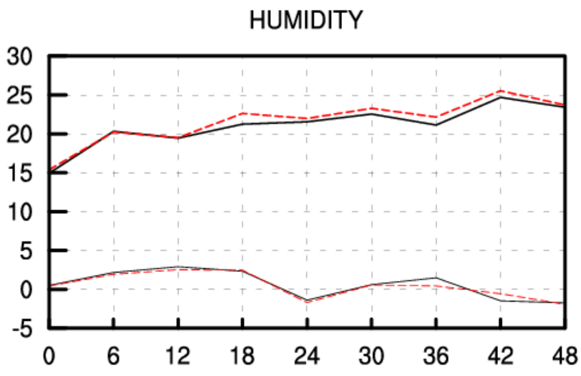


Fig. 8: Temperature and relative humidity scores (bias and rmse) for the experiments ECCA (black-solid) and HUN2 (red-dashed) on 700 hPa.

4.2.5. Conclusions

The parallel tests of the experimental phase reflect that ALADIN forecasts can be improved by using LBC data from the ECMWF model if a local atmospheric and surface assimilation provides the initial conditions. Following our tests, ECMWF data are not recommended to be used as ICs for surface fields, at the moment, because such data are very model dependent (this problem might be solved during the SRNWP Interoperability Programme of EUMETNET). Due to the lagged use of ECMWF LBC data (LBC fields are used from the 6 hour earlier run) we do not recommend to use ECMWF fields as atmospheric ICs neither, as in this case ECMWF 6 hour forecasts would be used as ICs for ALADIN (Kertész, 2007). As the most obvious cure, we propose to run a local atmospheric analysis within the ALADIN model itself. The use of ECMWF LBC data together with surface assimilation was implemented operationally in Budapest at the beginning of October due to the promising results found in the parallel tests.

Acknowledgements

First of all we are very grateful for all the members of the ARPEGE/ALADIN developers who contributed to the technical work enabling the preparation of FA files from ECMWF fields. Many thanks are also devoted to the SPFRCOUP Special Project of ECMWF in general and to Claude Fischer in particular for supporting the idea of Special Project for the ALADIN partners and taking care about its coordination. The first exploratory work by the use of ECMWF lateral boundary conditions was realised by Sándor Kertész, which is highly appreciated and acknowledged. Last, but not least, we are very grateful to the ECMWF staff for making possible to realize the tests described above and also for providing the LBC data with a very high reliability in the last 9 months.

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4.3. The limited area ensemble prediction system of the Hungarian Meteorological Service

Edit HÁGEL* Máté MILE

4.3.1. Introduction

At the Hungarian Meteorological Service (HMS) a LAMEPS system has been running quasi-operationally since February 2008. It is run with the ALADIN model and it is driven by the members of the global PEARP (Prévision d'Ensemble ARPege) system.

For information about the pre-operational research the reader is referred to [7], [1] and [5] in past issues of the ALADIN Newsletter as well as to [4] and [6]. The aim of this article is to present the quasi-operational LAMEPS system. The characteristics are described in section 2, followed by the short description of the visualization in section 3. Verification results are presented in section 4. Finally, conclusions and future plans are outlined in section 5.

4.3.2. Characteristics of the system

The quasi-operational LAMEPS system of HMS is based on the ALADIN model, and it is driven by the members of the global PEARP system.

PEARP is the global, short-range ensemble prediction system of Météo-France. It is based on the ARPEGE global model and it is using singular vectors to create the initial condition perturbations. Singular vectors are computed for four different target areas (Europe-North Atlantic, Northern Hemisphere, Southern Hemisphere and the Tropics) with an optimization time of 12 hours. The total energy norm is used both at initial and final time. Singular vectors at initial time and 24 hours evolved perturbations from the previous run of PEARP are combined to form 5 initial perturbations. These are added to and subtracted from the analysis. The amplitude of the perturbations is scaled with a flow dependent background error estimate. The PEARP system has 10 perturbed members and a control (which is started from the unperturbed analysis). The system is running once a day at 18 UTC up to 60 hours with a truncation of T358c2.4 (approx. 23 km resolution over Europe) and 55 vertical levels.

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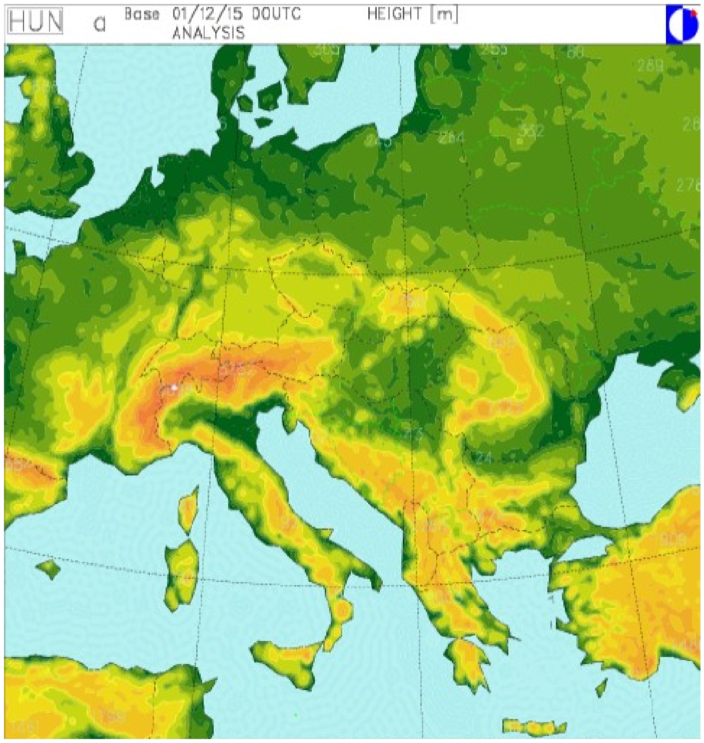

Figure 1: The integration domain and the orography of the ALADIN limited area model used for the LAMEPS (240×216 points, 12 km horizontal resolution).

At HMS the simple downscaling approach is used with the ALADIN model. No local data assimilation or generation of local perturbations is applied for the LAMEPS. Each member of the global PEARP system provides initial and lateral boundary conditions for one member of the limited area system, hence the LAMEPS also has 10+1 members. The system is running with 12 km horizontal resolution on the so-called LACE domain (Fig. 1). In the vertical 46 levels are used. The coupling frequency is 6 hours. Just like PEARP, the LAMEPS is also running once a day at 18 UTC, up to 60 hours. The system is running on the IBM p655 cluster server using cycle 28 of the ALADIN model.

4.3.3. Visualization of the forecasts

After performing post processing to a latitude-longitude grid, the outputs of the LAMEPS system are mainly visualized using HAWK (Hungarian Advanced WorKstation). HAWK is used in the everyday work of the forecasters to visualize the outputs of several NWP models (both deterministic and probabilistic), observations, radar and satellite data, etc. The available products from our LAMEPS system are the ensemble mean, the ensemble spread (computed around the mean), individual ensemble members and probability fields for several parameters (Fig. 2). The individual members can be visualized in the form of spaghetti diagrams. In addition, plume diagrams are also plotted (using the ECMWF software Metview) for several parameters and selected Hungarian locations (Fig. 3).

4.3.4. Verification results

Verification of the quasi-operational LAMEPS system was performed for a longer period using the common LACE verification package ([3], [9] and [8]).

- Verification against observations

Some verification results (scores and plots) are shortly presented for the 2m temperature. Data used in this section are collected from observations, during the period extending from May 1 to June 30, 2008. The observed data are derived from 22 Hungarian synoptic stations and the amount of data is not fully sufficient for the optimal verification. The following scores and diagrams are selected from the outputs of the verification package to this section: BIAS and RMSE, Spread, Ranked histogram and percentage of outliers, ROC and Reliability. First two figures (Fig. 4 and Fig. 5) show some characteristics for the representation of the ensemble spread and the last two figures (Fig. 6 and Fig. 7) show the skill of the LAMEPS system for 2m temperature. For the surface fields (like 2m temperature) the diagrams show the lack of spread and the LAMEPS system is less skillful than for the upper levels (not shown).

- Verification against model analysis

In the previous section verification results were presented using observations as the ”truth”. However, the number of observations is limited, and variable in time and space, which means that over specific areas and/or in specific synoptic times (e.g. at 06 and 18 UTC) our knowledge about the atmosphere might be insufficient. Therefore verification was performed against model analysis as well. For this the ECMWF analysis was used and scores were computed for almost four months from 01 April 2008 to 20 July 2008.

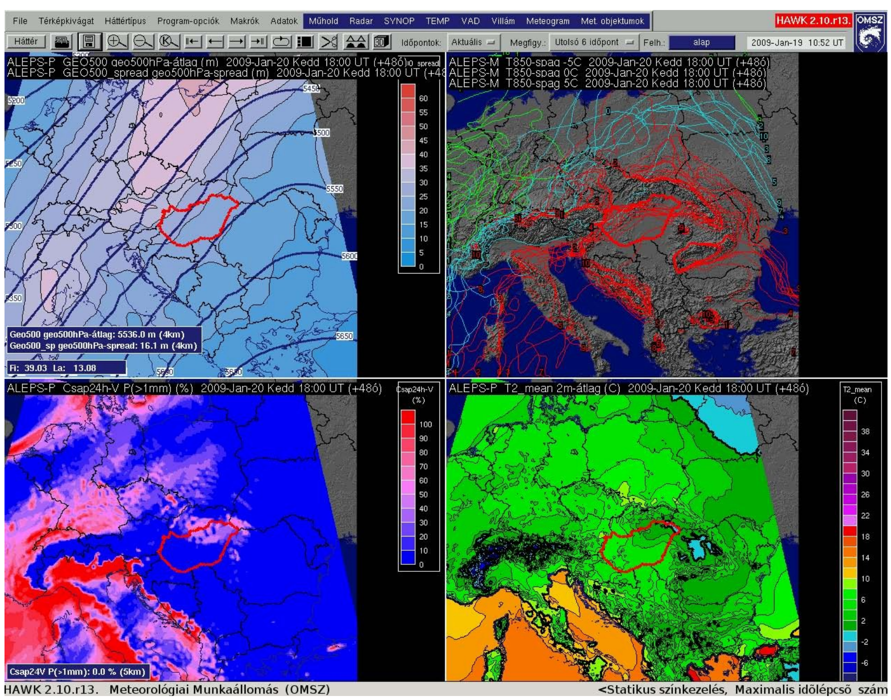

Figure 2: Example of visualization with HAWK based on the LAMEPS forecast started on 18/01/2009, 18UTC. Plots are valid at T+48h. Top left: Ensemble mean (isolines) and spread (shading). Parameter is 500 hPa geopotential. Top right: Spaghetti diagram. Parameter is 850 hPa temperature, isolines are plotted for -5, 0 and 5 Celsius. Bottom left: Probability map for total precipitation exceeding 1 mm/24h. Bottom right: Ensemble mean for 2 meter temperature.

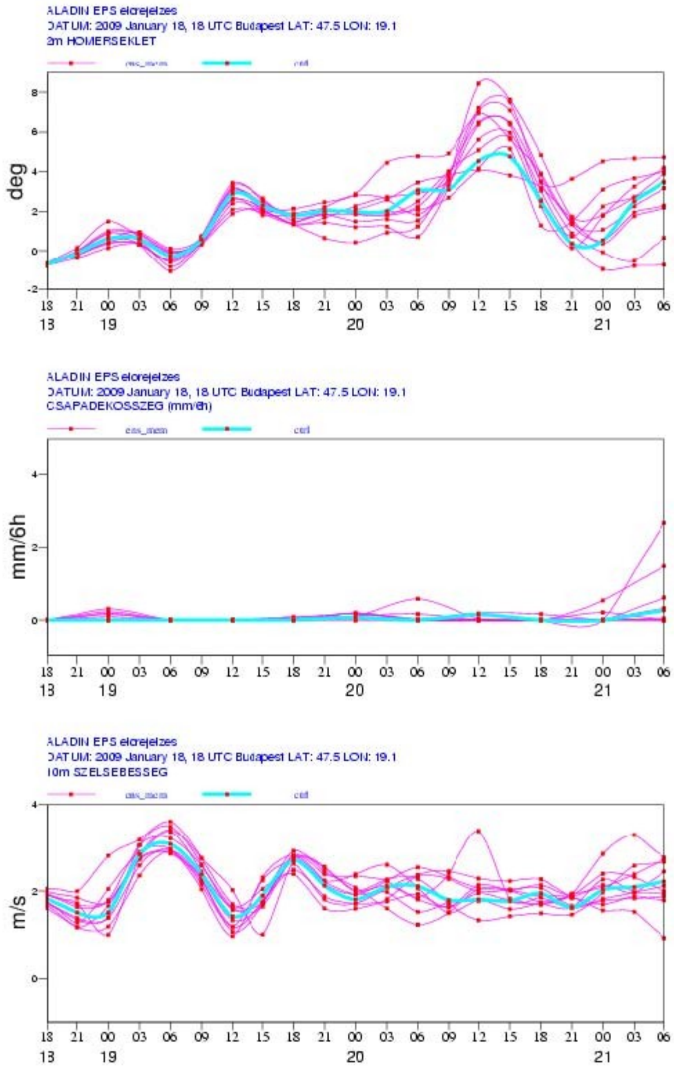

Figure 3: Plume diagram for Budapest based on the LAMEPS forecast started on 18/01/2009, 18UTC. It displays the time evolution of the distribution of 2 meter temperature (top), total precipitation (middle) and 10 meter wind speed (bottom). Values are plotted for all ensemble members, including the control member.

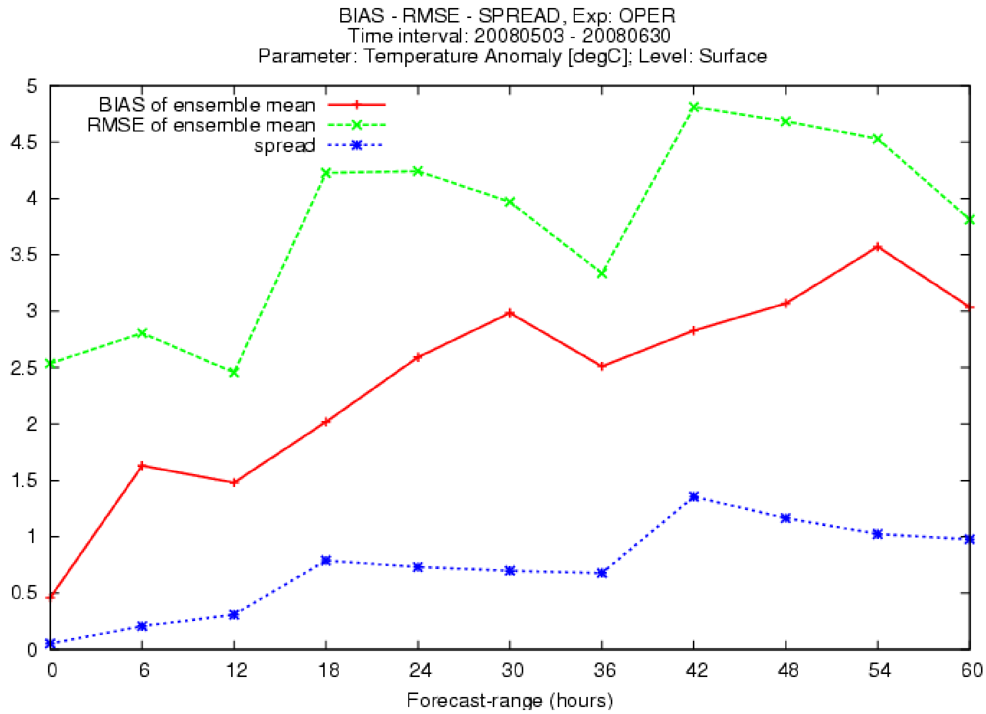

Figure 4: BIAS (red), RMSE (green) of the ensemble mean and Spread (blue) for 2m temperature. LAMEPS system verified by observations. Verification interval: 03/05/2008 – 30/06/2008.

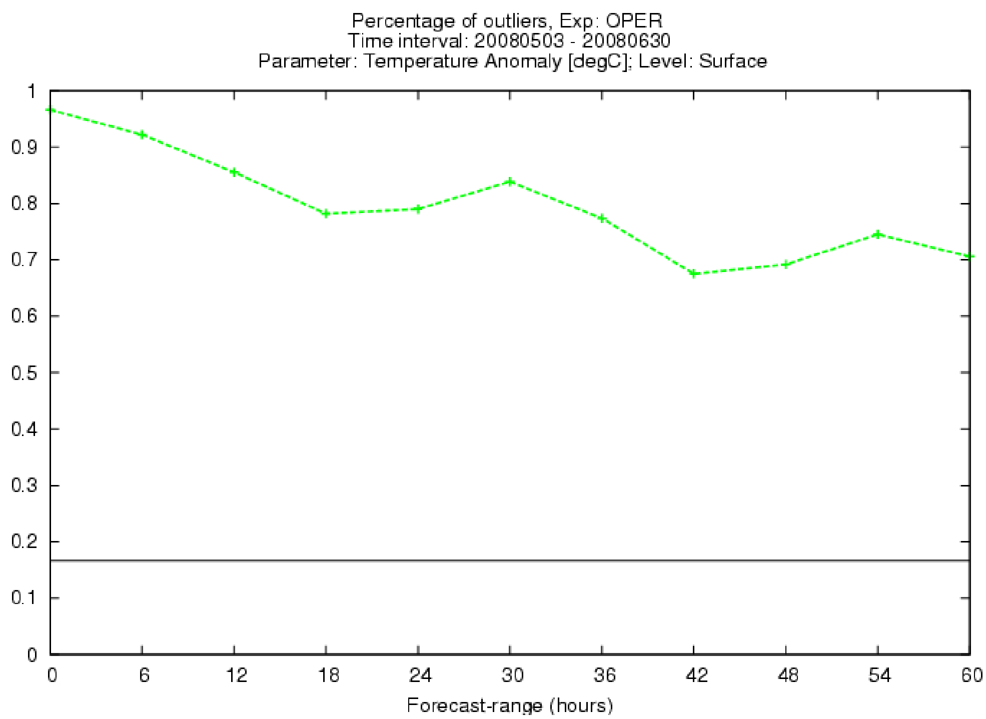

Figure 5: Percentage of outliers for 2m temperature. Horizontal black line is showing the expected value. Verification interval: 03/05/2008 -30/06/2008.

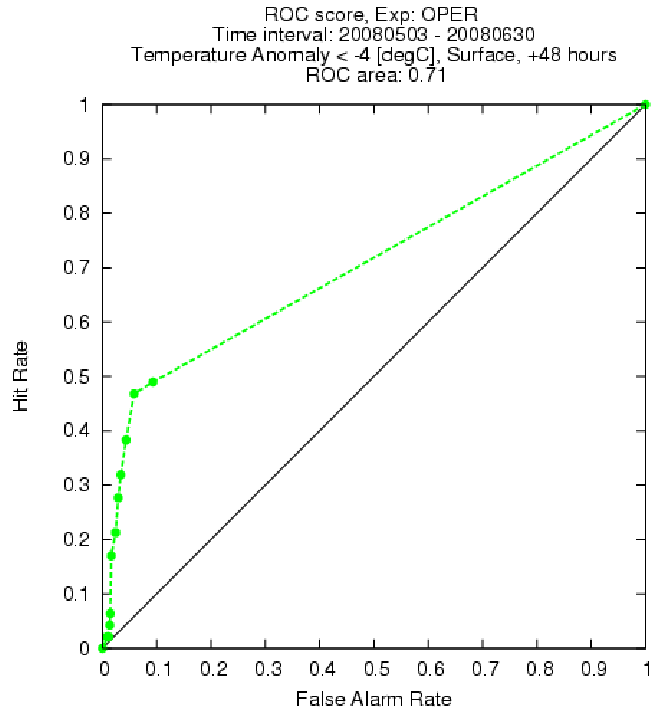

Figure 6: Relative Operating Characteristic (ROC) curve for 2m temperature, forecast range +48h and -4 celsius temperature anomaly threshold. Verification interval: 03/05/2008 -30/06/2008.

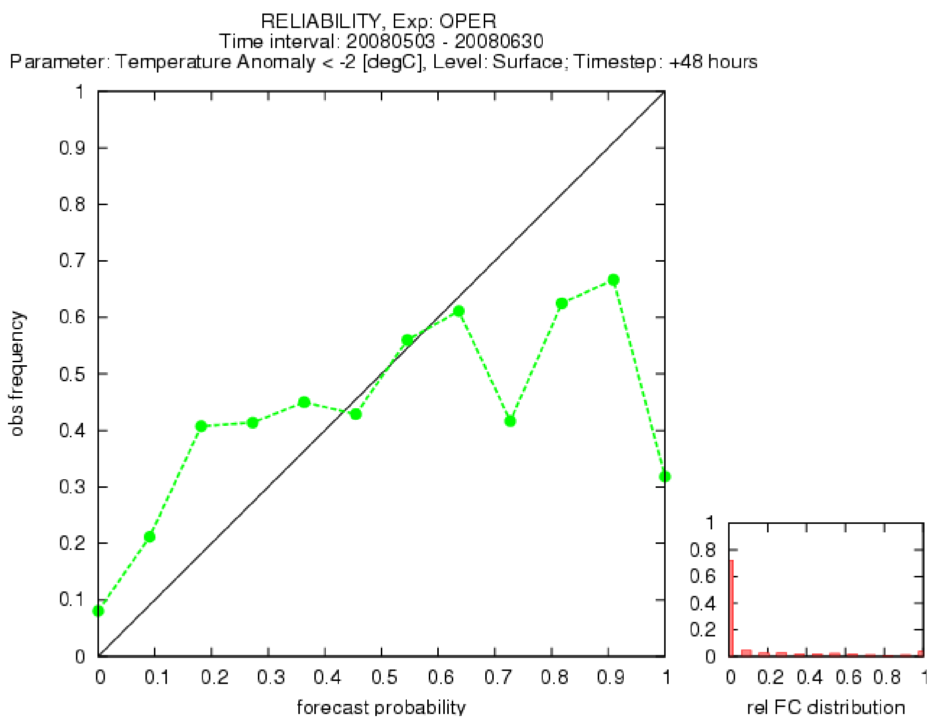

Figure 7: Reliability diagram for 2m temperature, forecast range +48h and -2 Celsius threshold. Verification interval: 03/05/2008 -30/06/2008.

Fig. 8 shows percentage of outliers diagrams for geopotential and temperature, respectively. Values are plotted for different levels: 500, 700, 850, 925 and 1000 hPa. It can be realized immediately, that results are better for higher levels. Best scores were obtained for 500 hPa, but even for this level the spread of the system is not satisfactory, the verifying analysis falls out of the ensemble too often. This is true for both parameters, but it is more pronounced for temperature than for geopotential.

Another important feature is the spread-skill relationship. The spread of the ensemble should be in good agreement with the forecast error (e.g. the RMSE of the ensemble mean). Fig. 9 shows the relationship between the RMSE error of the ensemble mean and the spread of the ensemble for temperature at two levels, 500 and 850 hPa. In both cases the spread is smaller than the error, which means that the system is under dispersive. This is in agreement with the results obtained from the percentage of outliers diagrams.

To understand this behaviour better, one has to keep in mind that the maximum of the energy of the singular vectors[3] is located around 700 hPa and during their evolution the energy propagates upwards, rather than downwards. In addition, no surface parameters are perturbed, except for surface pressure. Therefore the spread of the ensemble will be larger for higher levels and smaller for lower levels, especially for the surface.

4.3.5. Conclusion and future plans

Verification results have shown that the spread of the ensemble is better for higher levels than e.g. for the surface. However, it is important to have skilful predictions of surface parameters -such as 2 meter temperature -as well. It would also be desirable to compute perturbations that are targeted for the area of our interest (Central Europe, particularly Hungary). For these reasons it was decided to work on the computation of local perturbations. Experiments have already started to compute singular vectors with the ALADIN model ([2]). At present, the aim of the experiments is to generate perturbations from the ALADIN singular vectors, and use them to perturb locally the initial conditions of the LAMEPS system. As lateral boundary conditions PEARP or ECMWF EPS members will be used. Perturbation of surface fields is also an issue to be solved.

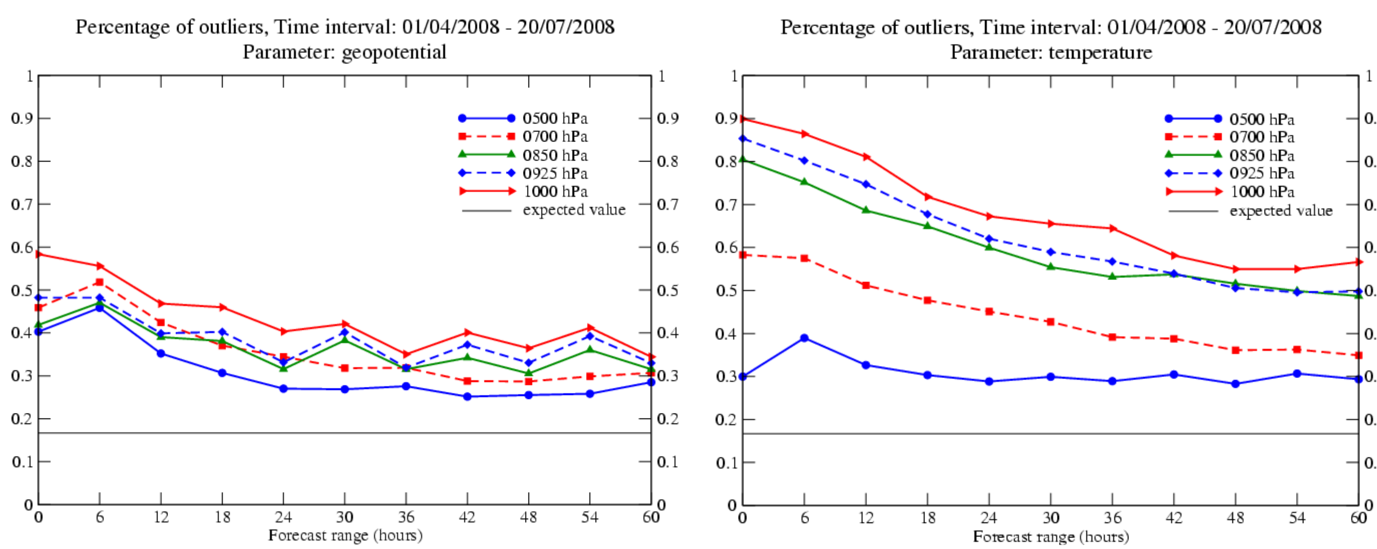

Figure 8: Percentage of outliers diagram for (a) geopotential and (b) temperature at 500, 700, 850, 925 and 1000 hPa. Verification interval: 01/04/2008 -20/07/2008. The thin horizontal line is the expected value.

3 In PEARP the singular vector technique is used to generate the initial perturbations.

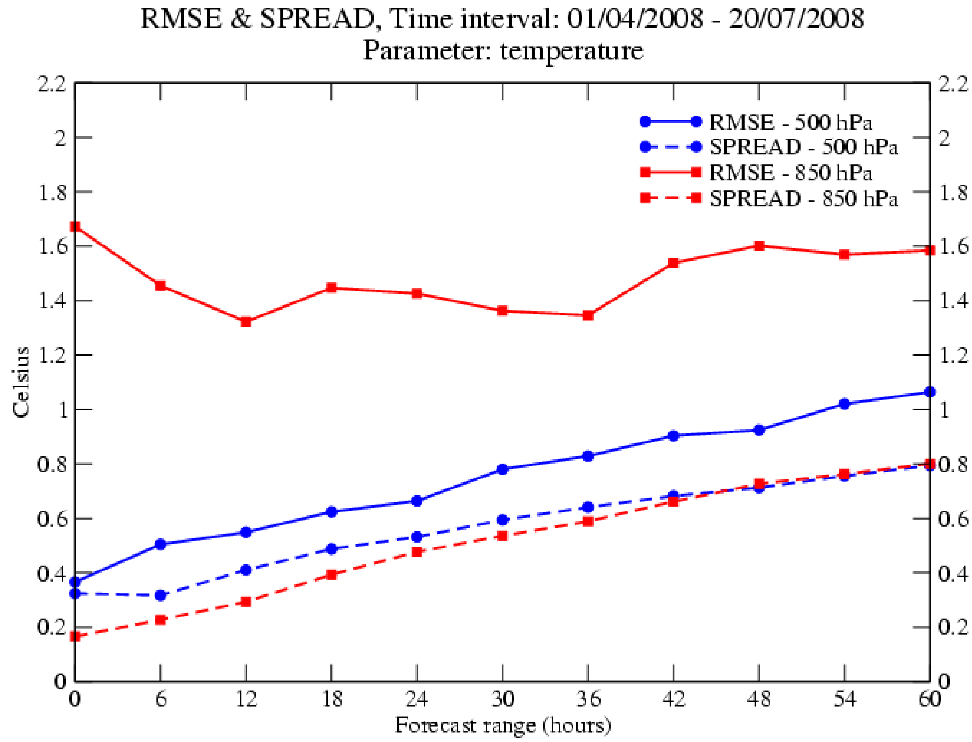

Figure 9: RMSE of the ensemble mean (solid lines) and spread of the ensemble (dashed lines) for temperature at two levels, 500 hPa (blue curves) and 850 hPa (red curves). Verification interval: 01/04/2008 -20/07/2008.

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4.4. Simulation of emission and dust transport with ALADIN model: Case of the 06th March, 2006

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This paper recapitulates the different spots carried out until now in the frame of the Aladin consortium project research concerning the emission and the transport of desert aerosols modelling which is achieved by the Algerian Meteorological Office with the cooperation of Meteo France (CNRM/GMAP).

4.4.1. Introduction

Dust aerosols emissions, whose major sources corresponds primarily to the desert areas of our planet, account for approximately 40% of the total emissions of the tropospheric aerosols. In spite of a time of residence relatively short in the atmosphere, but by mobilizing enormous quantities of mineral dust. The dust plumes can extend during their transport over great continental or oceanic surfaces. Besides, the desert aerosols in suspension in the atmosphere retro diffuses a part of the terrestrial radiation, which induces a cooling at the surface, or absorbs a part of the infra-red telluric radiation.

The desert emissions of the aerosols also have direct consequences on their environment. The depletion of the fine fraction of the ground, under the wind action, leads sometimes to a loss of nutrients in source areas involving an impoverishment of the fertile grounds. On the other hand, in areas continuously or periodically limited in nutrients, the deposit of the desert aerosols can be a very important source of supply in some components, like iron or phosphorus. It is the case of the Amazon forest [Swap and Al, 1992].The natural availability of the iron via the desert aerosols would allow the development of the phytoplankton, which contributes to the increasing of the sequestration of significant amounts of carbon dioxide [Duce, 1986; Jickells and Al, 2005].

On a more practical level, at the regional levels, desert dust emissions can paralyse all the socio-economic activities of an area. Through these various impacts, one understands that a specific knowledge of dust life cycle is needed to describe and understand at the same time the bio geochemical exchanges and the evolution of the climate. For that, it is necessary to be able to represent the dust emissions which change continuously in time and space, both in intensity and frequency. This implies necessarily the use, as explicit as possible, of the erosion physical processes and of the surface/atmosphere interactions. Such representations has been developed by Marticorena and Bergametti in 1995 (MB95) and was coded in the externalized surface (SURFEX) by A. Grini (2003). For this purpose, the coupling of the externalized surface (SURFEX) to Aladin made possible the integration of dust emission in Aladin model.

The vertical diffusion, the transport and the dry deposition of the desert aerosols will be treated in the Aladin model.

In this paper we describe the MB95 dust emission model, coupled to SURFEX and the vertical diffusion modelling part which is the main aim of the present paper.

4.4.2. Dust emission in SURFEX.

Basically, the dust emission follows a process with threshold effect. Indeed, it was noted that the dust particles are displaced when the surface wind speed reaches or exceeds a minimal value, called “threshold friction velocity”. In this paper, we will describe the MB95 dust emission model used in SURFEX and we will present the necessary databases used in SURFEX for dust emission processes in the case of North Africa.

- Threshold friction velocity

The mass flux of particles salting G depends on the excess of the wind friction speed u_* over the threshold wind friction speed for saltation, u_{*t}. In the MB95 model, the threshold friction velocity is mainly a function of the diameter of particles, the surface roughness and the soil moisture.

$$u_{*t}\left(D_p, Rug, w, \ldots\right) = u_{*t}(D_p)\, f_R\left(Rug\right) f_w\left(w\right) \qquad \textbf{(1)}$$

Where $u_{*t}\left(D_p\right)$ expresses the dependence of the threshold friction velocity with respect to the diameter particles.

D_p, f_R et f_w are the weight functions of the influence of the surface roughness and soil moisture.

- Threshold friction velocity over a smooth surface

Considering a conventional land, with densities of air and dust particles respectively equal to: $\rho_a = 0.00123$ et $\rho_p\, 2.65\ g/cm^3$, Marticorena and Bergametti adjusted empirically expression of Rt based only D_p in order to propose a formulation of u_{*t} depending only on D_p.

$$u_{*t}(D_p) = \begin{cases} \left[\dfrac{0{,}129\ K}{(1{,}928\ \mathrm{Re}_{*t}^{0{,}092} - 1)^{0.5}}\right] & : 0{,}03 \le \mathrm{Re}_{*t} \le 10 \\ . & \\ \left[0{,}129\ K\left(1 - 0{,}0858\ e^{-0{,}0617(\mathrm{Re}_{*t} - 10)}\right)\right] & : \mathrm{Re}_{*t} > 10 \end{cases} \qquad \textbf{(2)}$$

$$\mathrm{Re}_{*t} = aD_p^x + b\ ; a = 1331\ cm^{-x}\ ; b = 0.38\ ; x = 1.56\ ; K = \left(\frac{2\rho_p g D_p}{2\rho_a}\right)^{0.5}\left(1 + \frac{0.006}{\rho_p g D_p^{2.5}}\right)$$

- Threshold friction velocity over a roughness surface

A drag partition parameterization is applied to represent the sink of the atmospheric momentum into non erodible roughness elements [Raupach, 1992]. In MB95 model two pertinent roughness lengths of dust emissions from erodible surface was considered. The first one is the aerodynamic roughness length of the bare ground including the non erodible elements such as pebbles, rocks, and vegetation. This is traditionally known as the roughness length for momentum transfer, Z_0. The second roughness length is the so-called “smooth” roughness length, z_{0s} [Marticorena and Bergametti, 1995]. z_{0s} is the length of a bed of potentially erodible particles without any non erodible elements. Wind tunnel experiments over uniform beds comprised of known particle sizes show that:

$$z_{0s} = \frac{D_p}{30} \qquad \textbf{(3)}$$

The efficiency with which drag is partitioned between erodible and non erodible soils is expressed as an increase of f_R in the threshold friction speed for saltation u_{*t} [Marticorena and Bergametti, 1995]

$$f_R(Z_0, z_{0s}) = 1 - \frac{\log\left(\frac{Z_0}{z_{0s}}\right)}{\log\left(0{,}7\left(\frac{0.1}{z_{0s}}\right)^{0{,}8}\right)} \quad \textbf{(4)}$$

with Z_0, z_{0s} et D_p in *cm*

The threshold friction velocity is expressed as follow:

$$u_{*t}(D_p, Z_0, z_{0s}) = \frac{u_{*t}(D_p)}{f_{eff}(Z_0, z_{0s})} \quad \textbf{(5)}$$

- Soil moisture effect

The MB95 scheme uses the parameterisation developed by Fecan et al. (1999). The latter relates the residual soil moisture to the soil clay content. In MB95, the capillary force is allowed to suppress dust deflation when the near-surface soil gravimetric water content *w* exceeds a threshold *w'* determined by :

$$w' = 0{,}0014(\%\,\text{argile})^2 + 0{,}17(\%\,\text{argile}) \quad \textbf{(6)}$$

The increase of f_w in the threshold friction velocity for saltation u_{*t} due to the soil water is given by the following expression [Fecan et al., 1999] :

$$\begin{cases} \text{pour} \quad w < w' : & f_w = \dfrac{u_{*t}^w}{u_{*t}^d} = 1 \\ \text{pour} \quad w > w' : & f_w = \dfrac{u_{*t}^w}{u_{*t}^d} = \left[1 + 1{,}21\left(w - w'\right)^{0{,}68}\right]^{1/2} \end{cases} \quad \textbf{(7)}$$

- Horizontal dust flux

Saltation is the main process responsible for release of dust particles into the atmosphere. The MB95 scheme uses the White (1979) saltation formulation:

$$G = \frac{c_s\,\rho\,u_*^3}{g}\left(1 - \frac{u_{*t}}{u_*}\right)\left(1 + \frac{u_{*t}^2}{u_{*t}^2}\right) \quad \textbf{(8)}$$

Where, $c_s = 2.61$, ρ is the atmospheric density and *g* is the gravity acceleration.

The horizontal mass flux *G* is converted into a vertical dust mass flux *F* with an efficiency α, called the sandblasting mass efficiency [Alfaro et al., 1997]:

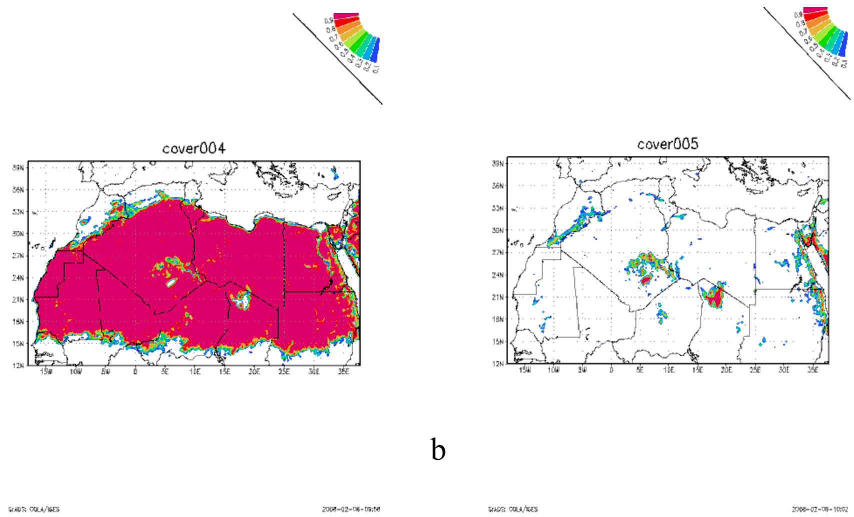
$$\alpha = \frac{F}{G} = 100\ \exp\left[\left(13{,}4 M_{clay} - 6{,}0\right)\ln 10\right] \quad \textbf{(9)}$$

4.4.3. Databases necessary in input for MB95

Any parameterization scheme of the surface processes and of the interaction soil/atmosphere is conditioned by the databases concerning this surface. In this section we will expose the databases witch was used in MB95 coupled to SURFEX for the north Africa.

- Erodible surface

The distinction of the desert erodible surface in SURFEX is made with reference to 255 covers derived from ECOCLIMAP database with 1 km horizontal resolution. Among these covers, only two categories are concerned by the dust emission processes: COVER004 and COVER005, representing respectively, the bare and rock soils showed in the figure 1:



a b

Figure 1: Maps of cover004 and cover005, respectively, bare soil (a) and rock (b).

- Soil type

The mineralogical classification of the ground is given in SURFEX while referring to FAO databases with 2 minutes horizontal resolution. These databases contains informations on the percentage of: SAND, CLAY and SILT in the ground. The map below represents the percentage of these three categories:

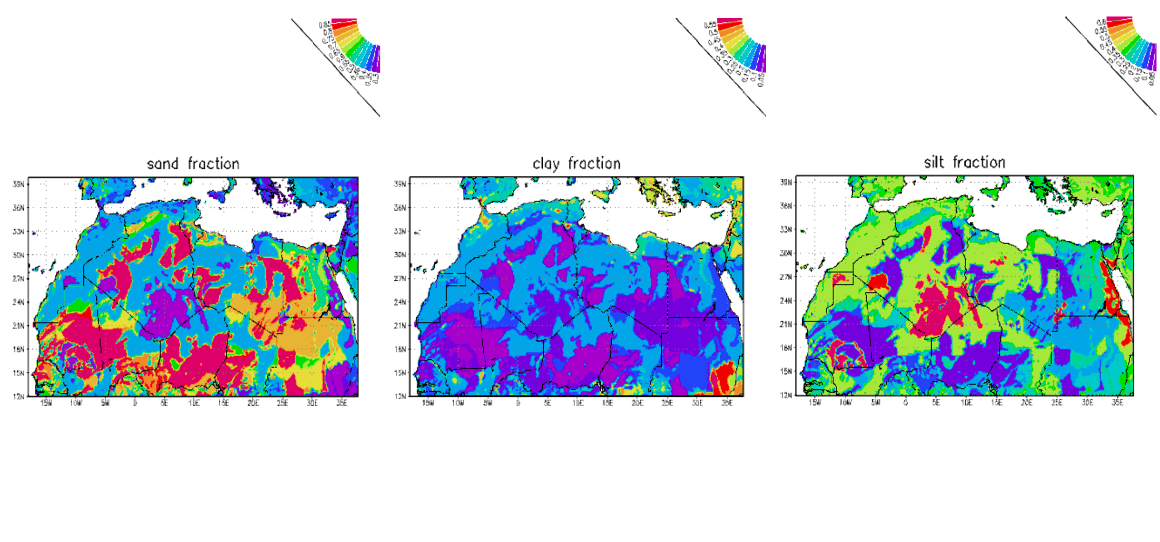


Figure 2: maps of: SAND, CLAY and SILT for North Africa

4.4.4. Vertical diffusion

In this section the vertical diffusion method used in Aladin model is described. In order to permit the vertical exchange of the desert aerosol in the atmospheric model, the same method as the one for the temperature and humidity is applied. For passive scalar the same exchange coefficient as temperature and moisture, is used. The treatment of the vertical diffusion is quite detailed in the paper of A.L. Gibelin, "Externalisation of the diagram of surface ISBA of the model of general circulation ARPEGE-CLIMAT", 2003. While referring to this paper we will expose the main features of this method by indicating the modifications of the Aladin software.

For the conservative quantity X, the turbulent vertical diffusion equation is written as follow:

$$\frac{\partial X}{\partial t} = -g\frac{\partial F_X}{\partial P} \quad \textbf{(10)}$$

with: $F_X = -\rho\left(\overline{\omega' X'}\right)$. We take: $F_X = -\rho g K'_X \frac{\Delta X}{\Delta}$ Then: $K_X = \frac{\rho g K'_X}{\Delta}$ and $F_X = -K_X \Delta X$

For numerical stability, the temporal discretisation of the equation (10) uses an implicit numerical scheme. $X_i^+ - X_i^- = -g\frac{\Delta t}{\Delta P_i}\left(F_{X,i}^+ - F_{X,i-1}^+\right)$ where $\Delta P_i = P_i - P_{i-1}$

$$F_{X,i}^+ = -K_{X,i}^-\left(X_{i+1}^+ - X_i^+\right) \quad \textbf{(11)}$$

The exchange coefficient $K_{X,i}$ is computed in explicit way.

The X_i variable is computed at the *i* level of the model, but the $F_{X,i}$ flux is computed at the *i* half-level.

The computation of the vertical diffusion and of the energy balance is achieved in three consecutive steps. The first step is to compute the coefficients witch will be used in the substitution, from the top to last level of the model. The coefficients of the last level are taken into account by the surface scheme to resolve the energy balance equation and to compute the surface turbulent fluxes. The third and last step is to compute the diffusion fluxes, going back at the last summit level of the model.

- Down step: computation of the A and B coefficients:
- **Altitude Level *(i < N)***

Following Polcher et al. (1998), X_i^+ is expressed by:

$$X_i^+ = A_{X,i}^- X_{i+1}^+ + B_{X,i}^- \quad \textbf{(12)}$$

At the first level, the condition at the upper limit is:

$$F_{X,0} = 0 \quad \text{and} \quad X_1^+ - X_1^- = -\frac{g\Delta t}{\Delta P_1}K_{X,1}^-\left(X_2^+ - X_1^+\right)$$

For the level $i \in$ *(2, N-1)*, we have: $X_i^+ - X_i^- = -\frac{g\Delta t}{\Delta P_i}\left(-K_{X,i}^-\left(X_{i+1}^+ - X_i^+\right) + K_{X,i-1}^-\left(X_i^+ - X_{i-1}^+\right)\right)$

We consider: $\omega_{i,j} = \frac{g\Delta t}{\Delta P_j}K_{X,i}^-$

Consequently, for $i=1$:

$$A^-_{X,1} = \frac{\omega_{1,1}}{1+\omega_{1,1}} \tag{13}$$

$$B^-_{X,1} = \frac{X^-_1}{1+\omega_{1,1}} \tag{14}$$

For the levels $i \in (2, N-1)$, we have:

$$A^-_{X,i} = \frac{\omega_{i,i}}{1-\omega_{i-1,i}\left(A^-_{X,i-1}-1\right)+\omega_{i,i}} \tag{15}$$

$$B^-_{X,i} = \frac{X^-_i + \omega_{i-1,i}B^-_{X,i-1}}{1-\omega_{i-1,i}\left(A^-_{X,i-1}-1\right)+\omega_{i,i}} \tag{16}$$

- **Last level of the model *(i = N)***

At the last level, the condition at the upper limit is:

$$X^+_N - X^-_N = -\frac{g\Delta t}{\Delta P_N}\left(F^+_{X,S} + K^-_{X,N-1}\left(X^+_N - X^+_{N-1}\right)\right)$$

Following Polcher and Betts (2002), X^+_N is expressed by:

with: $X^+_N = A^-_{X,N}F^+_{X,S} + B^-_{X,N}$ **(17)**

$$A^-_{X,N} = -\frac{g\Delta t}{\Delta P_N}\frac{1}{1-\omega_{N-1,N}\left(A^-_{X,N-1}-1\right)} \tag{18}$$

$$B^-_{X,N} = \frac{X^-_N + \omega_{N-1,N}B^-_{X,N-1}}{1-\omega_{N-1,N}\left(A^-_{X,N-1}-1\right)} \tag{19}$$

The solving of the downloading step and the computation of the A and B coefficients is done by the « ***acdifv1.F90*** » subroutine**.** It's called by ***« aplpar.F90 »,*** witch is in the following tree:

arp/phys_dmn/aplpar.f90 =>
arp/phys_dmn/acdifv1.f90

The A and B coefficients related to the passive scalars are, respectively found in the «***acdifv1.F90***» subroutine and identified by the *PCFASV* and *PCFBSV* variables*,* but the same exchange coefficients related to the temperature and humidity are duplicated for there use in the frame of the passive scalars. The added part to the «***acdifv1.F90***» subroutine is protected a dual-key: *LDSTALD*: new key reported in ***YOMARPHY*** for treatment of desert aerosols by Aladin *(NGFL_EXT/ =0)*.

- Uploading step : substitution and diffusion

The second step is to resolve the energy balance equation and to compute the surface fluxes. This calculation is made by the externalized surface ***«aro_ground_param.mnh» in*** méso-NH project«***mse***». The surface fluxes of the dust are computed by the routine ***«coupling_dst_n.mnh»*** subroutine, witch is called in the ISBA scheme by the externalized surface. It is called under the following tree:

arp/phys_dmn/aplpar.f90=>
mse/externals/aro_ground_param.mnh=>

mse/internals/coupling_surf_atm_n.mnh=>
mse/internals/coupling_nature_n.mnh=>
--
mse/internals/coupling_isba_n.mnh=>
mse/internals/coupling_dst_n.mnh=>

The third step is to compute the variables at the i level by substitution, and then to compute the diffusion fluxes. At the last level, we compute X_N^+ following the equation 3.8:

$$X_N^+ = A_{X,N}^- F_{X,S}^+ + B_{X,N}^-$$

- **Altitude levels *(i < N)***

At the upper levels, X_i^+ is computed following 3.3:

$$X_i^+ = A_{X,i}^- X_{X,i+1}^+ + B_{X,i}^-$$

The diffusion flux is finally obtained by the equation 3.2:

$$F_{X,i}^+ = -K_{X,i}^- \left(X_{i+1}^+ - X_i^+ \right)$$

The uploading step is resolved by the subroutine ***«acdifv2.F90».*** It's called the subroutine dedicated for parametrization in Aladin ***«aplpar.F90»***, under the following tree:

arp/phys_dmn/aplpar.f90 =>
arp/phys_dmn/acdifv2.f90

The scalar fluxes are respectively, reported in : ***«acdifv2.F90»*** by the variable: ***PDIFSV***. The added par to the subroutine ***«acdifv2.F90»*** is protected by a dual-key: *LDSTALD* and *(NGFL_EXT/=0)*. It's as follow :

Under ***aplpar.F90***, all the outputs are kinds of arguments as fluxes. The passive scalars tendancies are computed by the subroutine: ***cptend_new.F90.*** The added part to cptend_new.F90 is protected by a dual-key: ***LDSTALD*** *and* ***(NGFL_EXT/=0).***

The calculation of the evolution of the passive scalars at the moment **t+dt** is done by the subroutine : «***cputqy.F90***». This subroutine ***«cputqy.f90»*** is protected by a dual-key ***LDSTALD et (NGFL_EXT/=0).***

The passive scalars are reported as arguments ***«mf_phys.f90»*** and archived in buffer format or in GFL variable.

The transport of the passive scalars is a common part between Arome and Aladin. This part is coded both for Arome and Aladin.

4.4.5. Simulation of the 06th march, 2006 meteorological situation

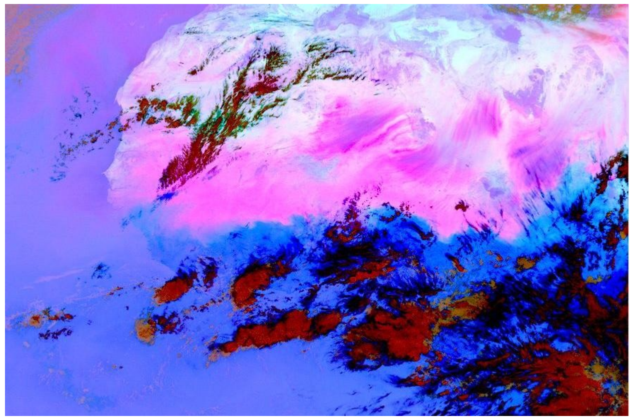


Figure11: MSG-SEVIRI satellite image over West Africa for March 8, 2006 at 12 UTC. Pink color represent for dust, black for cirrus, red for high level cloud, brown for the mid level cloud, and white for desert surface.

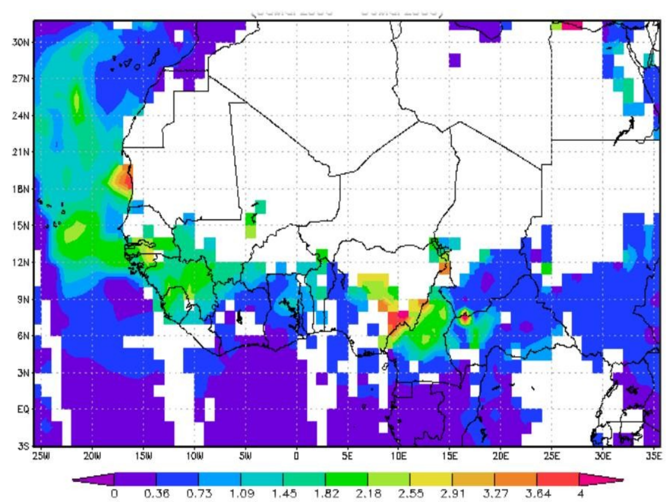
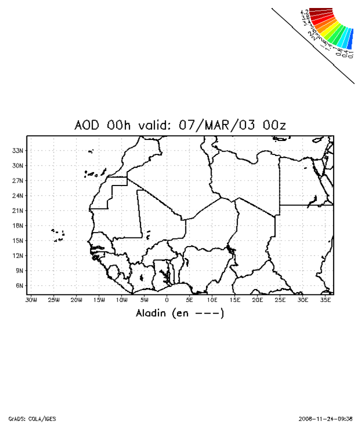
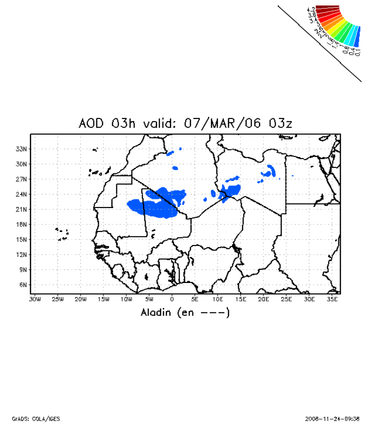
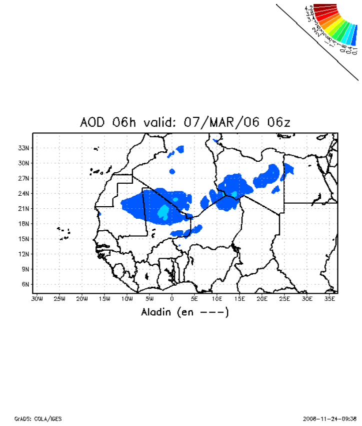


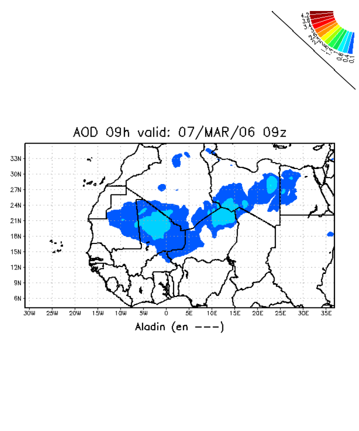
Figure 12. The daily mean AOD from MODIS/AQUA satellite image on March 8, 2006 at 12 UTC.

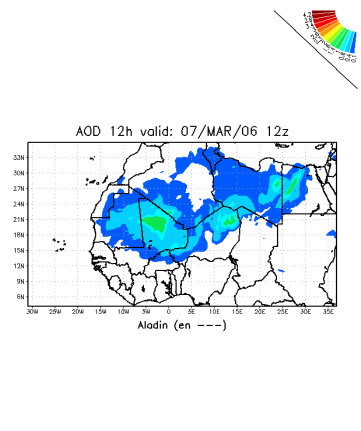
❑ Results of the simulation

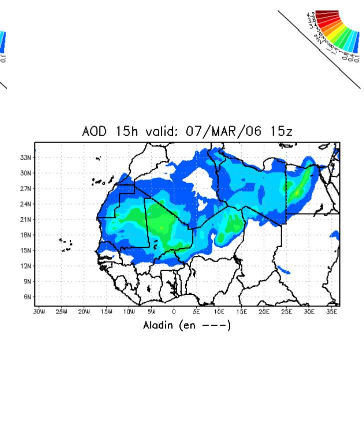


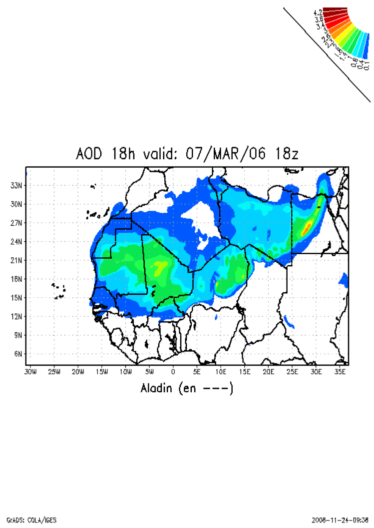








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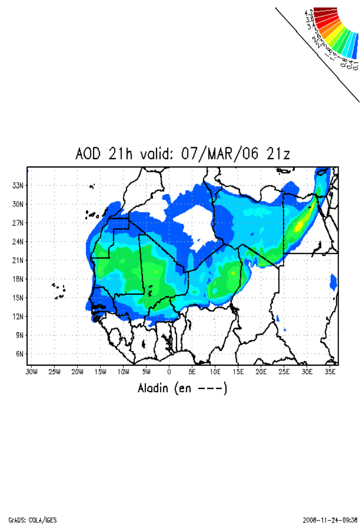
Aladin (en ---)
GrADS: COLA/IGES
2008-11-24-09:38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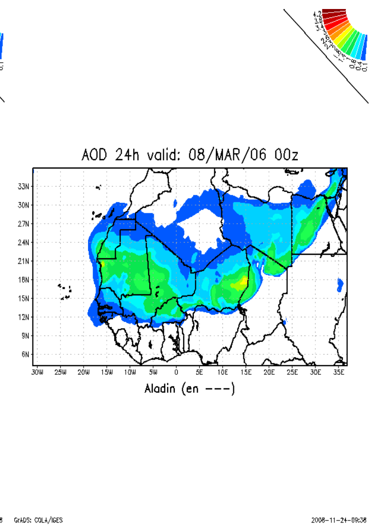
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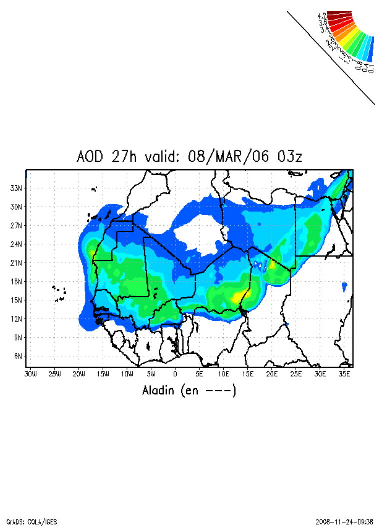
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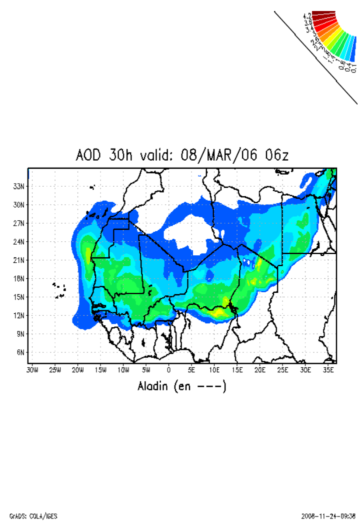
Aladin (en ---)
GrADS: COLA/IGES
2008-11-24-09:38


AOD 30h valid: 08/MAR/06 06z
Aladin (en ---)
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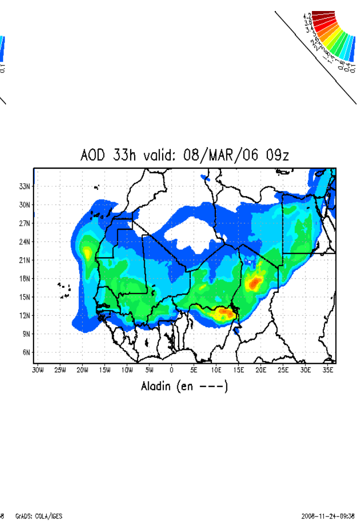
2008-11-24-09:38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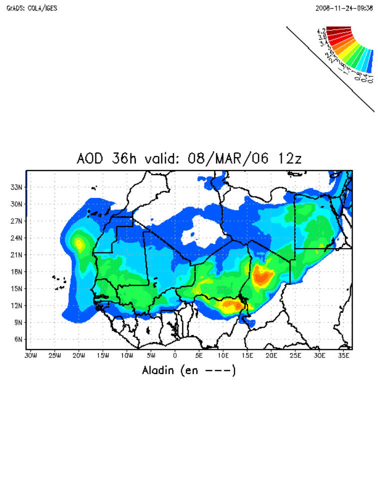
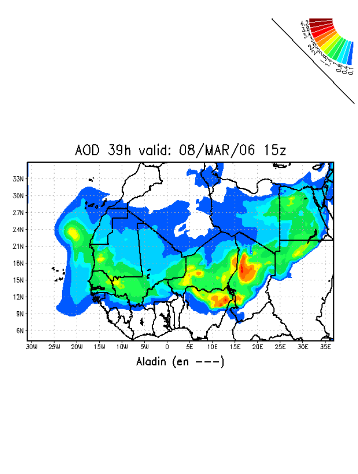
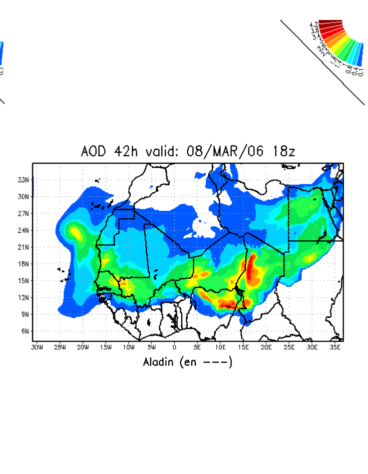
Aladin (en ---)
GrADS: COLA/IGES
2008-11-24-09:38


AOD 36h valid: 08/MAR/06 12z
Aladin (en ---)
GrADS: COLA/IGES
2008-11-24-09:38


AOD 39h valid: 08/MAR/06 15z
Aladin (en ---)
GrADS: COLA/IGES
2008-11-24-09:38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2008-11-24-09:38

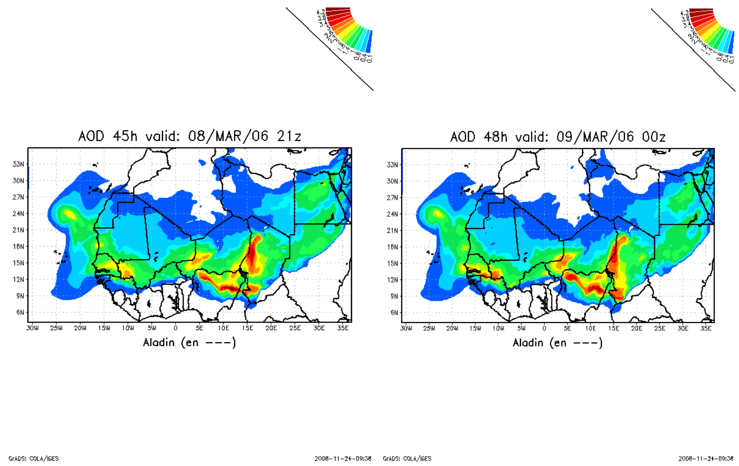

Figure 13: AOD simulated by Aladin (24 km of resolution) on 06 th, 07th and 08th march, 2006.

4.4.6. Conclusion

This paper summarizes the work carried out so far and those remaining in the research project of the Consortium Aladin on modelling the emissions and transport of desert dust, which id taken in charge by the Algerian National Meteorological Office in cooperation with Météo-France.

Like all substances transported in the atmosphere, the desert dust life cycle can be described into three phases: the emission from some surfaces, the atmospheric transport and the deposition (dry or wet). The modelling of this cycle requires two main steps: the first is the assessment of the emissions in the treatment of the surface processes. This part is addressed during the 2007 training (GMAP), achieving the coupling of externalized surface to Aladin and the activation of the emission issuance processes in the latter. The second part of this part, which represents the main objective of this project, is the treatment by the atmospheric model in terms of advection, vertical diffusion and wet or dry deposition.

We started with a chapter narrative in which we presented the theoretical model MB95 that manages the emission processes in SURFEX. Then, we presented in the form of maps, the necessary databases for this scheme and we chose an area centred on North Africa.

The segment devoted to modelling the vertical diffusion is detailed in this paper and is coded in the Aladin model. To facilitate reading the code we presented the added parts to the code and protect them by introducing a dual-key via the namelist.

To validate the vertical diffusion, we simulated the situation of 06 March 2006, which is characterized by strong uprisings of desert dust over North Africa.

The results are in good agreement with the observations, as shown in Figures 13 and 14.

Under this project, it remains to deal with the wet deposition and the impact of desert aerosol on the radiation balance.

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