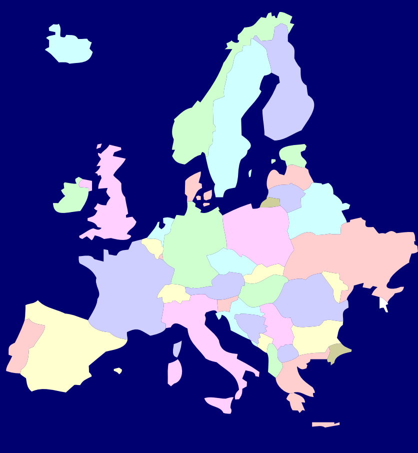
27th EWGLAM / 12th SRNWP meetings

NEWSLETTER



3-5 October 2005, Ljubljana, Slovenia

27-th EWGLAM / 12-th SRNWP MEETINGS

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Contents

1 Introduction

1.1 Foreword

In the year 2005, the Environmental Agency of Slovenia (EARS) had the privilege to host the 27-th meeting of the European Working Group on Limited Area Modelling (EWGLAM) and the 12-th meeting of the Short-Range Numerical Weather Prediction network (SRNWP). The meetings took place in the premises of EARS in Ljubjana on 3-5 October. This could not possibly happen without great help from all involved colleagues from EARS. We also thank the participants who made the meetings so interesting.

This Newsletter has been traditionally put together. It contains the list of participants and also the reports of the LAM consortia, National status reports and a handfull of scientific contributions.

The reader is invited to pay special attention to the last chapter of this Newsletter, the report of the final EWGLAM discussion (compiled by D.Giard). As the principal outcome of the discussion, it has been agreed that the format of the meeting is going to significantly change in the future.

Ljubljana, January 2005

Mark Žagar, Neva Pristov

1.2 List of Participants

Alica	Bajić	bajic@cirus.dhz.hr
Gergely	Bőlőni	boloni.g@met.hu
Massimo	Bonavita	bonavita@meteoam.it
Mike	Bush	mike.bush@metoffice.gov.uk
Gerard	Cats	cats@knmi.nl
Jure	Cedilnik	jure.cedilnik@rzs-hm.si
Maria José	Correia Monteiro	maria.monteiro@meteo.pt
Maria	Derkovà	maria.derkova@shmu.sk
Richard	Forbes	richard.forbes@metoffice.gov.uk
José A.	García-Moya	j.garciamoya@inm.es
Dominique	Giard	dominique.giard@meteo.fr
James	Hamilton	james.hamilton@met.ie
András	Horányi	horanyi.a@met.hu
Mariano	Hortal	Mariano.Hortal@ecmwf.int
Stjepan	Ivatek-Šahdan	ivateks@cirus.dhz.hr
Jure	Jerman	jure.jerman@rzs-hm.si
Markku	Kangas	markku.kangas@fmi.fi
Dijana	Klarić	dijana@cirus.dhz.hr
Lars	Meuller	lars.meuller@smhi.se
Tiziana	Paccagnella	tpaccagnella@arpa.emr.it
Neva	Pristov	neva.pristov@rzs-hm.si
Jean	Quiby	jean.quiby@meteoswiss.ch
Raluca	Radu	raluca.radu@meteo.inmh.ro
Rein	Rőőm	Rein.Room@ut.ee
Jožef	Roškar	jozef.roskar@rzs-hm.si
Kai	Sattler	ksa@dmi.dk
Francis	Schubiger	francis.schubiger@meteoswiss.ch
Jan-Peter	Schulz	Jan-Peter.Schulz@dwd.de
Gregor	Skok	Gregor.Skok@fmf.uni-lj.si
Niko	Sokka	niko.sokka@fmi.fi
Philippe	Steiner	philippe.steiner@meteoswiss.ch
Jurgen	Steppeler	Juergen.Steppeler@dwd.de
Martina	Tudor	tudor@cirus.dhz.hr
Per	Undén	Per.Unden@smhi.se
Filip	Vána	filip.vana@chmi.cz
Josette	Vanderborght	josette.vanderborght@oma.be
Christoph	Wittmann	christoph.wittmann@zamg.ac.at
Mark	Žagar	mark.zagar@rzs-hm.si
Nedjeljka	Žagar	nedjeljka.zagar@fmf.uni-lj.si

1.3 Programme

MONDAY, 3 October		
09:00	opening and org.matters	
	Group presentations	chair: Jürgen Steppeler
09:30	Dominique Giard	ALADIN
10:00	Tiziana Paccagnella	COSMO
10:30-11:00	coffee break	
11:00	Mike Bush	UKMO
11:30	Dijana Klarić	LACE
12:00-14:00	Lunch	
14:00	Mariano Hortal	ECMWF
	Introduction to national posters	chair: Mariano Hortal
14:30	-	Austria
	Josette Vanderborght	Belgium
	Stjepan Ivatek-Šahdan	Croatia
	Filip Vána	Czech Republic
	Kai Sattler	Denmark
	Rein Rõõm	Estonia
	Markku Kangas	Finland
	Dominique Giard	France
	Jan-Peter Schulz	Germany
	András Horányi	Hungary
	Massimo Bonavita	Italy
15:30-16:00	coffee break	
16:00	James Hamilton	Ireland
	Gerard Cats	The Netherlands
	Maria José Correia Monteiro	Portugal
	Raluca Radu	Romania
	Maria Derkovà	Slovakia
	Jure Cedilnik	Slovenia
	José A. Garcia-Moya	Spain
	Lars Meuller	Sweden
	Philippe Steiner	Switzerland
	Mike Bush	Unified Model
17:00	Poster session	
18:30	guided tour to Ljubljana center	

TUESDAY, 4 October		
	Group presentations (cont.)	chair: Andras Horanyi
09:00	Per Undén	HIRLAM
	Scientific presentations	chair: Andras Horanyi
09:30	Richard Forbes	Results from 1km grid resolution UM forecasts over the UK
10:00	Mark Žagar	Meso-gamma simulation of an extreme precipitation event
10:20	Jan-Peter Schulz	Introducing the Lokal-Modell LME at the German Weather Service
10:45-11:15	coffee break	
11:15	Jürgen Steppeler	Finite volume and finite difference approaches to z-coordinate modelling
11:40	Martina Tudor	New ALADIN Physics and Semi-Lagrangian Horizontal Diffusion
12:00-14:00	Lunch	

	Scientific presentations (cont.)	chair: Tiziana Paccagnella
14:00	Gergely Bölöni	ALADIN 3DVAR at the Hungarian Meteorological Service
14:20	José A. Garcia-Moya	Short-Range Ensemble Prediction System at INM
14:40	Jure Jerman	Operational computing environment at EARS
15:00	Nedjeljka Žagar	Verification of the dynamical downscaling of ERA40 by ALADIN
15:20-15:50	coffee break	
15:50-17:30	Final EWGLAM discussion	chair: Philippe Steiner

Points to be discussed (among others):

- Future role and format of the "EWGLAM/SRNWP Annual Meetings"
- Publication of a "Newsletter" ?
- Date and place of the 2006 EWGLAM/SRNWP Meeting
- Date and place of the 2007 EWGLAM/SRNWP Meeting

WEDNESDAY, 5 October

09:00	Final EWGLAM discussion (cont.)	chair: Philippe Steiner
	Report of the SRNWP Lead Centres	chair: Per Undén
09:30	HIRLAM (José A. Garcia-Moya)	Surface Processes
09:40	COSMO (Massimo Bonavita)	Short ranges EPS
09:50	ZAMG (Christoph Wittmann)	Statistical and Dynamical Adaptation
10:00	Météo-France (Dominique Giard)	Numerical Techniques
10:10	DWD (Jürgen Steppeler)	Nonhydrostatic Modelling
10:20	HIRLAM (Gerard Cats)	Verification Methods
10:30	MetOffice (Mike Bush)	Variational Data Assimilation
10:40-11:00	coffee break	
11:00-12:30	SRNWP business meeting	chair: Jean Quiby

- Composition of the Consortia: present state
- Information about EUCOS
  - Programme OPERA: data hub and radar composite
  - Migration to BUFR for soundings of EUMETNET stations
  - EUCOS 2 (2007-2011): We have to become active
- Progress made in the realization of the Recommendations put forward in the last SRNWP Workshops:
  - GPS Zenital Total Delays
  - Data hub for the high resolution precipitation observations (non-GTS data)
  - Dissemination of hourly SYNOPs in Europe
  - Velocity Azimuth Display (VAD) Radar Winds
  - Coding of snow depth in the SYNOPs
- State of the Project PEPS (Poor-man EPS)
- STORMNET: the second try
- State of the endeavour "model comparison"
- Any other business

12:30-14:00	Lunch
14:00	excursion with dinner (Škocjanske cave, dinner in Šepulje)

2 Group reports

2.1 ECMWF

Some developments at ECMWF during 2005

M. Hortal
(ECMWF)

1. Introduction

Three are the most important developments having found its way into the operational system in 2005 or early 2006, namely

- A new moist PBL scheme
- A wavelet formalism to compute and apply the background cost function J_b in the 4D-Var assimilation system
- An increase in the horizontal resolution to T_L799 and an increase in the number of vertical levels to 91

On top of that, the first tests at the horizontal resolution of T_L2047, in which the distance between grid points in the Gaussian grid is ~10km, have been run and archived, and a very limited number of diagnostics applied to the runs.

2. The new moist PBL scheme

(M. Köhler 2005: A new PBL parameterization to improve low clouds, ECMWF RD Tech Memo 518)

We have developed a new PBL parameterization that unifies and improves the treatment of clouds in the PBL.

In the previous ECMWF model the boundary layer scheme is formulated in dry variables (dry static energy and specific humidity) and the cloud generation relies on the shallow convection scheme, which is not adequate for the stratocumulus regime. The result is that stratocumulus is systematically underestimated and that too much solar radiation reaches the surface.

Given the problems with that scheme in stratocumulus regions it was decided that an entirely new unified treatment of boundary layer clouds was needed. The main ingredients deemed necessary were: (i) moist conserved variables used throughout the PBL parameterization, (ii) a combined mass-flux/K-diffusion solver, (iii) a treatment of cloud variability and (iv) a treatment of the transition between stratocumulus and shallow convection with typically high and low cloud cover respectively.

The concept behind the combined mass-flux/K-diffusion approach is to describe the strong large-scale organized updraughts with mass fluxes and the remaining small-scale turbulent part with diffusion.

For the description of cloud within the PBL a total water variance framework was chosen with a generation term from down-gradient transports and a decay time scale of boundary layer height divided by updraught velocity.

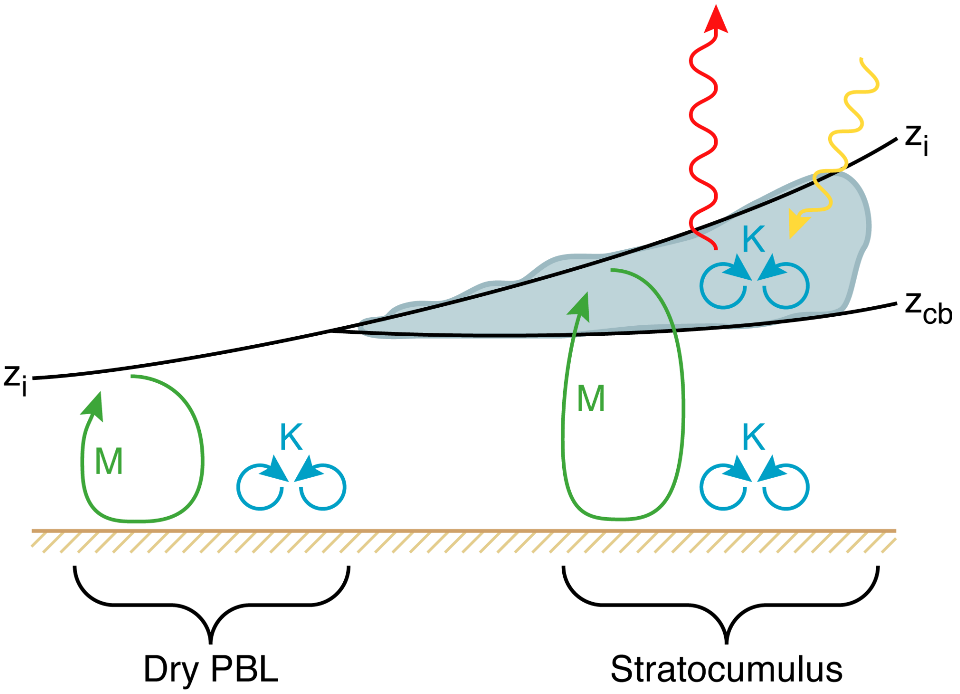

Figure 1: Transition of a dry PBL to stratocumulus. The parameterization of the associated convective transports in the new scheme are illustrated in turquoise for the diffusion component and in green for the mass flux component.

Figure 1 illustrates the transition between a dry PBL and a stratocumulus topped PBL, where the cloud base z_{cb} is above or below the inversion height z_i respectively. M denotes the PBL penetrative mass flux term. K describes the surface driven turbulent eddies, while in the stratocumulus regime there is an additional K term based on cloud top cooling initiated turbulence. Terrestrial radiative cooling and solar heating near cloud top are indicated with red and yellow waves respectively.

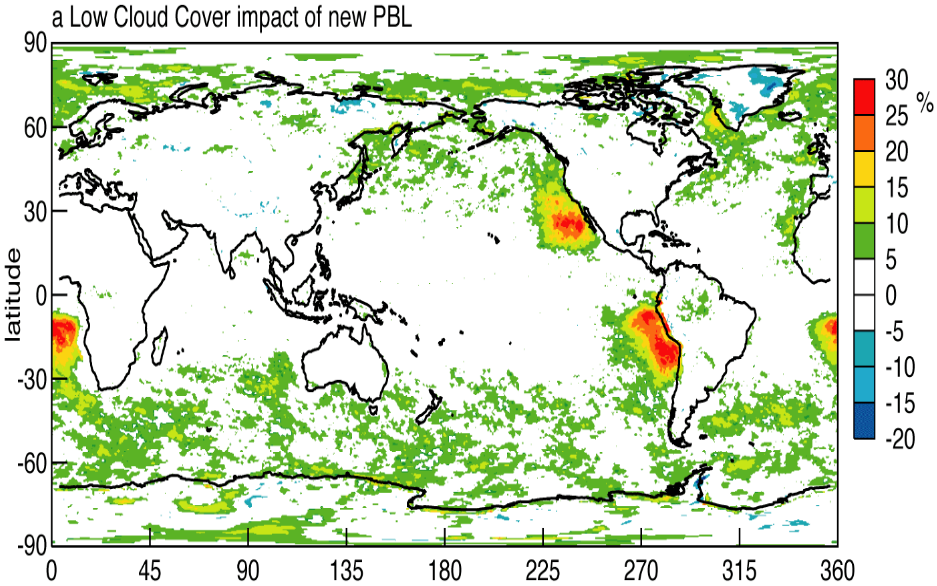

Figure 2: Low cloud cover difference for analysis/forecast experiments with and without the new PBL scheme. The figure displays the impact of the new MK-PBL scheme. 9.5 and 10 day forecasts from six test periods are used covering 7-27 July 2001, 9-22 October 2001, 1 February - 1 March 2004, 1-31 July 2004, 1-31 October 2004, 3-15 December 2004. This amounts to 140 days.

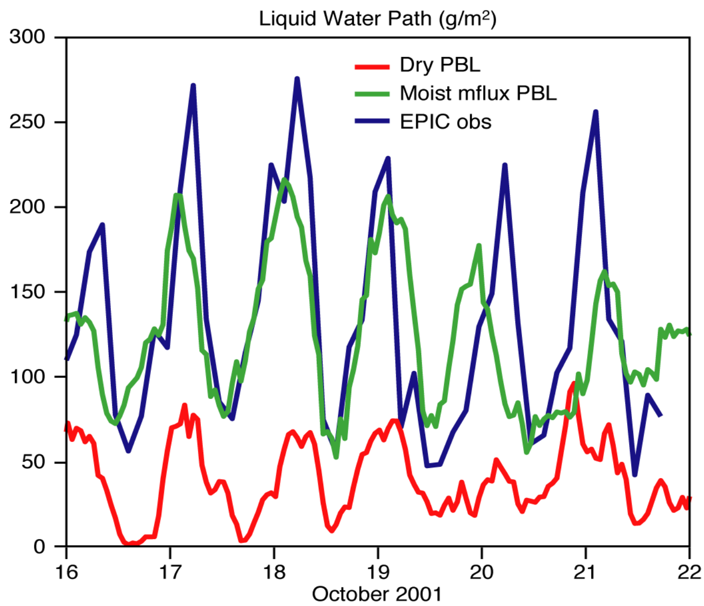

Figure 3: Liquid water path evolution during the Eastern Pacific Investigation of Climate (EPIC). It included a stationary observation period at 85West, 20 South during 16-21 October 2001. Here we show the observed liquid water path (blue) and the 3-hourly forecast data using the old (red) and the new MK-PBL (green). The day 1,2 and 3 forecasts were averaged according to verifying time to obtain a smooth curve.

3. Wavelet J_b

(M. Fisher: Background error covariance modelling. ECMWF seminar proceedings. September 2003)

The modelling and specification of the covariance matrix of background error are important elements in any data assimilation system, since it is primarily the background error covariance matrix that determines how information from observations is spread to nearby grid-points and levels of the assimilating model, that allows observations of the wind field to be used to gather information about the mass field, and *vice versa*.

The state vector of a typical analysis system for NWP has a dimension of around 10^6. Consequently, the background error covariance matrix contains roughly 10^{12} elements. This is too large to be stored in the memory of current computers.

Using the spectral technique we ca arrive at a block-diagonal matrix with one block for each total wavenumber *n*, and for each variable. Each block has dimension Nlevels×*N*levels, where *N*levels is the number of model levels, and represents the vertical correlation for a particular variable and wavenumber.

The advantage of the spectral approach is that it reduces the horizontal correlation matrix to a diagonal matrix. The disadvantage is that, by assuming the correlations to be equivalent to a convolution, the resulting correlations are homogeneous and isotropic.

At the opposite end of the spectrum, it is possible to specify vertical and horizontal correlations in the grid-space of the model, as a function of horizontal location. This approach allows full spatial resolution, but provides no spectral resolution. In particular, with this approach, the same vertical correlation matrix is applied, regardless of the horizontal scale of the features involved.

Clearly, a compromise between the two extremes of spatial and spectral resolution is required. It is well know that wavelet methods allow simultaneous resolution of spatial and spectral features, making them attractive for use in background covariance modelling.

Wavelet Jb defines the analysis' "change-of-variable" and the background cost function as:

$$\mathbf{x}-\mathbf{x}_b = \sum_{j=1}^{K} \mathbf{\Psi}_j \otimes \mathbf{V}_j \boldsymbol{\chi}_j \quad \text{and} \quad J_b = \frac{1}{2}\sum_{j=1}^{K} \boldsymbol{\chi}_j^{\mathrm{T}} \boldsymbol{\chi}_j$$

where

- index j denotes "scale" (wavenumber band).
- the functions Ψ_j are localized spatially, and in wavenumber.
- the V_j are block-diagonal, with vertical covariance matrix blocks, and one block per gridpoint.

Convolution with $\mathbf{\Psi}_j$ limits the influence of $\mathbf{V}$j to a band of wavenumbers and to nearby gridpoints. The result is a covariance model that allows both spatial and spectral variation of covariances.

The ability of the wavelet Jb formulation to produce inhomogeneous horizontal correlations is demonstrated in Figure 5, which shows the effective horizontal structure functions for points over north America and over the equatorial Pacific. The length scale for horizontal correlation is clearly larger in the equatorial Pacific than over North America. The centre and right panels show the effective wavenumber-averaged vertical correlation matrix for a point over North America and the corresponding matrix for a point in the equatorial Pacific Ocean. Clear differences in boundary-layer structure and tropopause height are apparent.

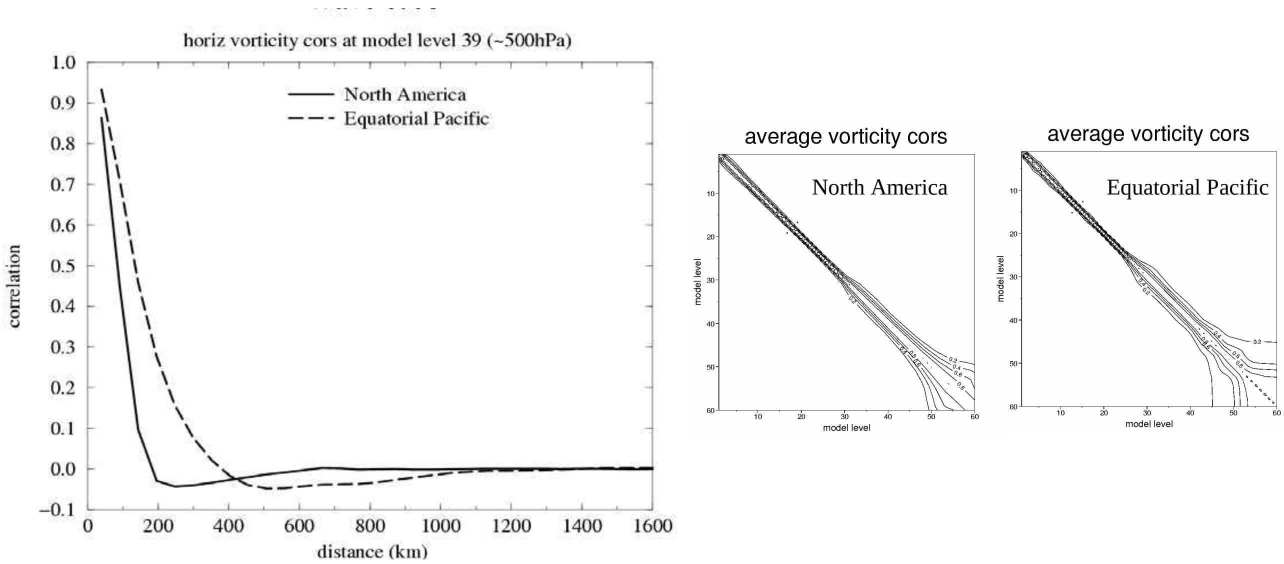

Fig 4 Effective horizontal structure functions and effective wavenumber-averaged vertical correlation matrix for vorticity for a point over North America and a point in the equatorial Pacific.

4. Increase in vertical and horizontal resolutions

Fig 6 shows the distribution of vertical levels in the old (60 level) and new (91 level) operational distributions. The new distribution is due to become operational in February 2006. The vertical resolution is increased everywhere but mainly near the tropical tropopause where it is doubled. The top of the model is also raised from 0.1 to 0.01 hPa.

The horizontal resolution will be increased at the same time from T_L511 to T_L799, a factor of more than 50%. That means that the number of points per level in the corresponding reduced Gaussian grid is a factor of 2.4 larger in the new resolution than in the old resolution. The largest expected increase in computational cost in the forecast model are the Legendre transforms, for which the cost increases as the cube of the spectral resolution, while the rest of the computations in the model scale with the number of grid points which is roughly proportional to the square of the spectral truncation. The cost of the radiation parameterization will be relatively less expensive as the full radiation computations are called only every 3 hours, which means a smaller frequency in terms of number of time steps as the time step of the T_L799 will be smaller that the one used at T_L511 (12 minutes for the higher resolution and 15 minutes for the lower).

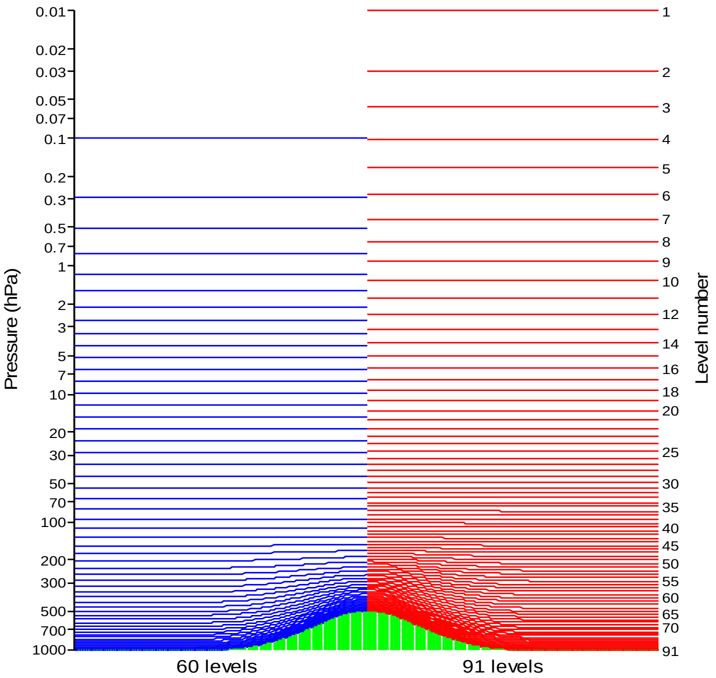

Fig. 5 Distribution of vertical levels in the old (60) and in the new (91) vertical resolutions.

Corresponding to the new horizontal resolution, the resolution in the second minimization of the 4D-Var assimilation has been increased to T_L255 from its previous value of T_L159.

After fixing some problems of dependency of the physical parameterizations with the vertical resolution and one instability in the T_L255 tangent-linear model coming from the way the reference trajectory was interpolated from the 799 to the 255 resolution, a large number of assimilation-forecast experiments have been run, in both research and pre-operational mode.

At the meeting a particular case was shown: the forecast of hurricane Katrina, which performed much better with the new than with the old resolution in all respects: position, intensity, structure and amount of rainfall.

All the mean verification scores of the set of cases run, except a warm bias in the upper tropical troposphere, which is increased with the new resolution, are significantly better in the experiments run with the new resolution that the corresponding ones using the old resolution. The new higher resolution will therefore be operationally implemented on February 1st 2006.

5. Runs at T_L1279 and T_L2047 resolution

The orography and other surface fields necessary to run the forecast model at a given resolution have been computed at the resolutions T_L1279 and T_L2047 using the reduced linear Gaussian grid. The number of points per level is 2,140,704 and 5,447,538 resp. in each of these two resolutions. A 36-hour forecast was run at these resolutions and its computational efficiency compared with the corresponding one run at the old operational (511) and new operational (799) resolutions. The results are displayed in Table 1 which shows that the ECMWF forecast model runs at a remarkable speed for a scalar computer of more that 9% of peak, except at T_L511 where the start-up period is relatively more important for that short forecast.

Resolution & time-step	CPUs	Wall time for 1-day forecast (minutes)	Gflops on IBM p690+	% of Peak*
T511 L60 900 sec	128	7	81	8.4
T799 L91 720 sec	256	16	177	9.1
T1279 L60 450 sec	512	23	354	9.1
T2047 L60 300 sec	768	68	537	9.2

Table 1: Timing results in the IBM p690+ for the forecast model run at different horizontal resolutions. (*peak is 7.6 Gflops per PE for IBM p690+)

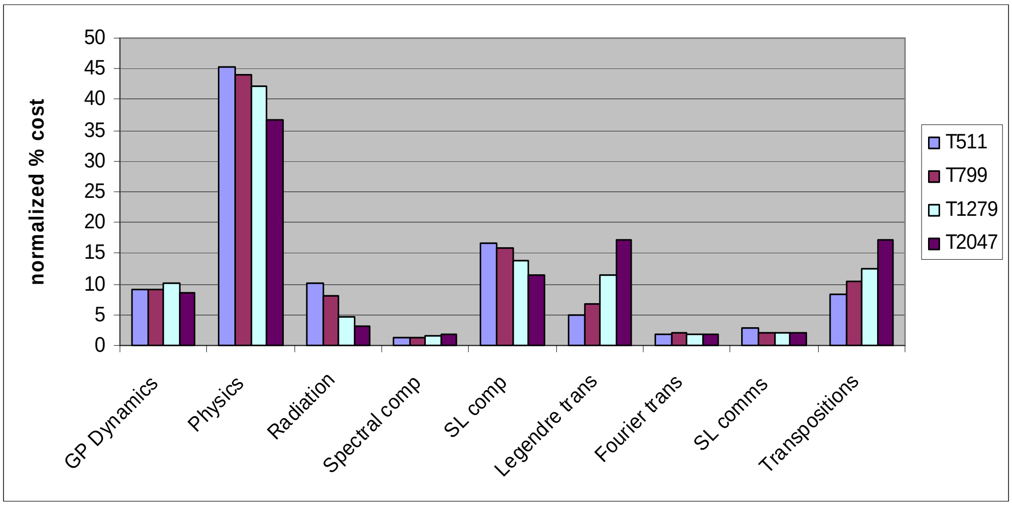

Fig 6 Distribution of the cost of the forecast model at four different horizontal resolutions

As expected, the Legendre transforms increase their relative cost with resolution but even at the highest resolution run (distance between Gaussian grid-points ~10km) they take less than 20% of the total time.

Another case was run at T_L2047, starting at 7 September 2002 which corresponds to a heavy rainfall event in southern France. The correlation between the measured rainfall and the interpolated forecast to the measurement locations is shown to increase monotonically with resolution.

2.2 ALADIN

ALADIN Group Report : 2004-2005

Dominique Giard, CNRM/GMAP

1. ALADIN-HIRLAM : a close cooperation did start !

New MoUs are under finalization for both consortia, which explicitly consider the new "code collaboration" between the two groups. There are to be signed, as well as a common agreement, within the end of the year. In the meantime, scientists are identifying common objectives and research topics. Work started in April with data assimilation, with discussions besides the WMO meeting in Prague, resumed in June besides the ALADIN workshop in Bratislava, and was pursued all along summer 2005 with the drafting of a common research plan to be finalized in October. In fact, cooperation didn'twait, and there have been many common scientific workshops, training actions, meetings organized or scheduled since the beginning of 2005.

Besides, an extensive evaluation of ALADIN is performed by the *mesoscale* HIRLAM group since summer 2004, using the *hirald* setup at ECMWF or local implementations (at DMI and SMHI mainly). *hirald* provides a common environment for running ALADIN, to both HIRLAM and ALADIN partners, with up-to-date libraries and an increasing number of configurations, far to be complete however. The first experiments used the 3 ALADIN domains shown in Figure 1, and daily runs are performed with the 11 km model since July 2005, with initial and lateral boundary conditions from HIRLAM-C22, and comparisons to HIRLAM-E11 (SMHI). Maps and diagnostics are available at : http://www.smhi.se/sgn0106/if/hirald/WebgraF/OPER/index.html . Sensitivity experiments were also performed at high resolution. Developments have been undertaken to couple ALADIN to HIRLAM, and to make the HIRLAM physical package available in the ARPEGE/ALADIN/AROME framework.

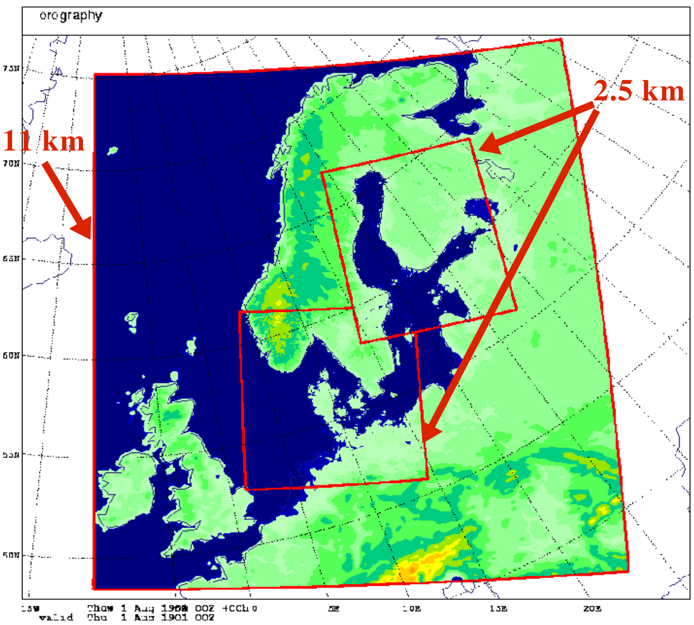

Figure 1 : HIRLAM domains available via *hirald*

2. Operational challenges

Main events

Two ALADIN 3d-var assimilation suites became operational recently : in Hungary in spring, in France during summer. They differ both in Jb (reference background error statistics) and Jo (using "standard" observations at higher resolution versus using new types of observations).

A prototype version of ALADIN-Algérie is running daily since September 22nd, setup by 3 scientists trained on ALADIN in June : an efficient team !

Summer challenge

All summer was necessary to collect a complete set of informations on the ALADIN operational applications, in order to prepare a common update. There are now at least 60 domains used in operations : 8 for the transmission of coupling data from ARPEGE or ALADIN-France, 20 for the reference forecasts (see Fig. 2), 14 for local high-resolution dynamical adaptation of low-level wind and precipitations, 18 for post-processing (including the interface to downstream models). The size of the main domains ranges from ~ 900 km x 900 km for the Romanian and Bulgarian models to 6300 km x 9700 km for ALADIN-NORAF, while very high resolution applications cover distances from 150 to 700 km.

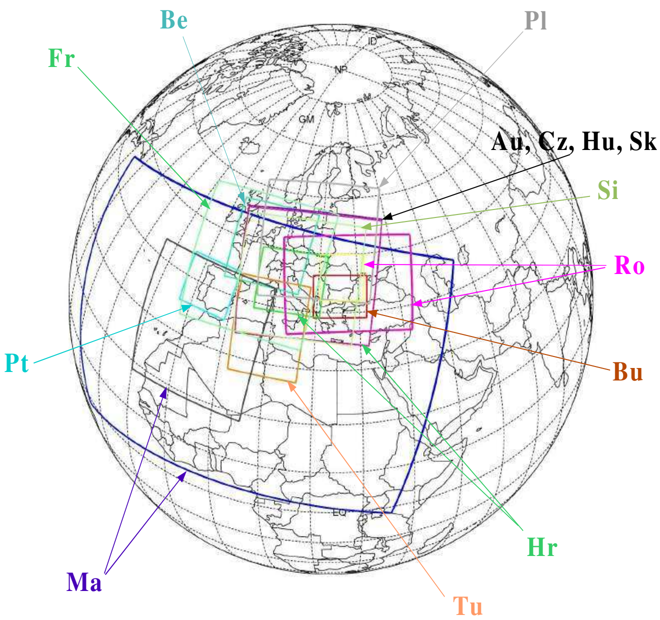

Figure 2 : Main operational ALADIN domains

Diversity lies also in horizontal resolution, from 7 to 31 km for synoptic forecast (2-3 km for local adaptation), in vertical discretization, with now 6 different grids used in operations (see Fig. 3), in choices for dynamics (linear versus quadratic spectral truncation, horizontal diffusion), for physics (envelope orography or not, radiation scheme, parametrization of cloudiness, etc ...), data assimilation, post-processing, ... : a big step since beginning ! Unluckily the dispersion keeps wide also for model versions, despite efforts.

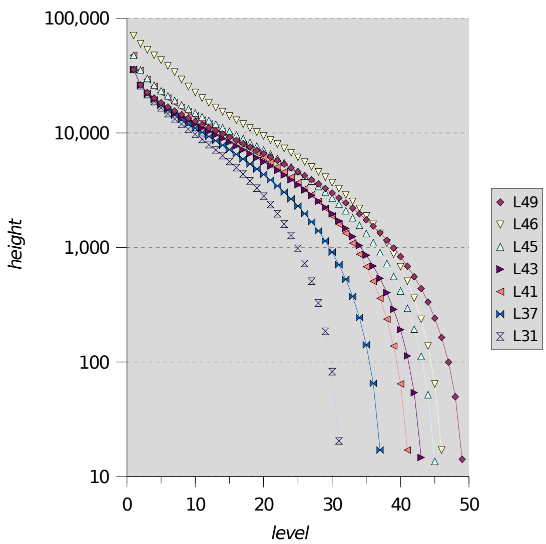

Figure 3 : ALADIN (pre)operational vertical grids

Autumn challenge

The task to face now is the quasi-simultaneous update of all the corresponding files, as concerns surface characteristics, file format, geometry description, and available fields.

3. Research : an overview of progress, problems and plans

Background

This year was marked by an intensification of the decentralization of research and of cross-exchanges with HIRLAM, but was still poisoned by "misunderstandings", as along the previous one. And research did suffer from this, especially in some sensitive domains.

Coupling

The main problem addressed is the implementation of transparent lateral boundary conditions in a spectral model. This is not an easy task at all in ALADIN, with difficulties arising from the presence of an extension zone. These led to even question the Machenhauer approach, and consider searching for an alternative solution for biperiodization.

Besides, a few studies addressed the nesting and initialization strategy, when going to higher resolution and to more sophistication in models. More effort is clearly required in this domain, too much left aside for the while.

Physics

The situation in this domain is best represented by a "?". There was progress indeed, but partners had to face several rather drastic changes of strategy, and significant divergences in interest.

LEPS

Work did start, with several approaches addressed by several teams, mainly Hungary, Austria and Morocco. However more coordination is required.

Data assimilation

A first important step has been reached, with the operational implementation of two 3d-var assimilation suites. Some improvements are already scheduled, through :

- combination with spectral blending : either "blendvar", i.e. "external" explicit or dfi-blending of the ALADIN first guess with the ARPEGE analysis before 3d-var (in test in Hungary and Morocco) or variational blending, i.e. using the so-called Jk cost-function to restore the largest scales towards the global model.

- implementation of data assimilation for soil and surface variables, before or after the setup of an "upperair" assimilation : based on optimal interpolation as in ARPEGE, with retuning of the statistical model for higher resolution (already under test in Czech Republic, with a positive impact).

- introduction of new observations : GPS and maybe radar data.

For the "longer" term, the following issues are considered : time-dimension (shorter assimilation cycles, comparison between frequent analyses and 3d-FGAT), the "HIRLAM challenge", i.e. building together an ALADIN 4d-var, combination between EPS and data assimilation, ...

An efficient and flexible toolbox !

To be able to effectively combine all the available options (see Fig. 4), a careful design of interfaces is required. Along the last year, work focussed on equations, in order to define a general physics-dynamics interface and common diagnostics, and on the interfaces with an externalized surface module (based on Bests' approach).

4. Towards very high resolution

There are already several operational applications running, for years, at an horizontal resolution of 2-3 km, mainly for the dynamical adaptation of wind to orography (based on the work of Mark Zagar). Slovenia was the ALADIN pioneer in this domain.

Besides, many sensitivity studies at high resolution were performed along the last year, using either ALADIN or AROME (the difference is only in the physical package) : impact of hydrostatic versus non-hydrostatic dynamics, of coupling (coupling model, coupling or not some fields, ...), of initial conditions, of horizontal diffusion, etc...

The AROME prototype is running daily from June 2005, up to 24 h, on a sub-domain of ALADIN-France (600 km x 600 km), with initial and lateral boundary conditions from ALADIN. Horizontal resolution is 2.5 km, time-step 60 s, and the vertical grid is the same as in ARPEGE. Some fields are available on the ALADIN web site (output every 3h, at the same resolution as for ALADIN-France, i.e. ~10 km). This experiment will enable people to get more familiar with the model, and to better detect its strengths and weaknesses. To end with, let's recall the dedicated training course, to be held in Romania, at the end of November (21-25).

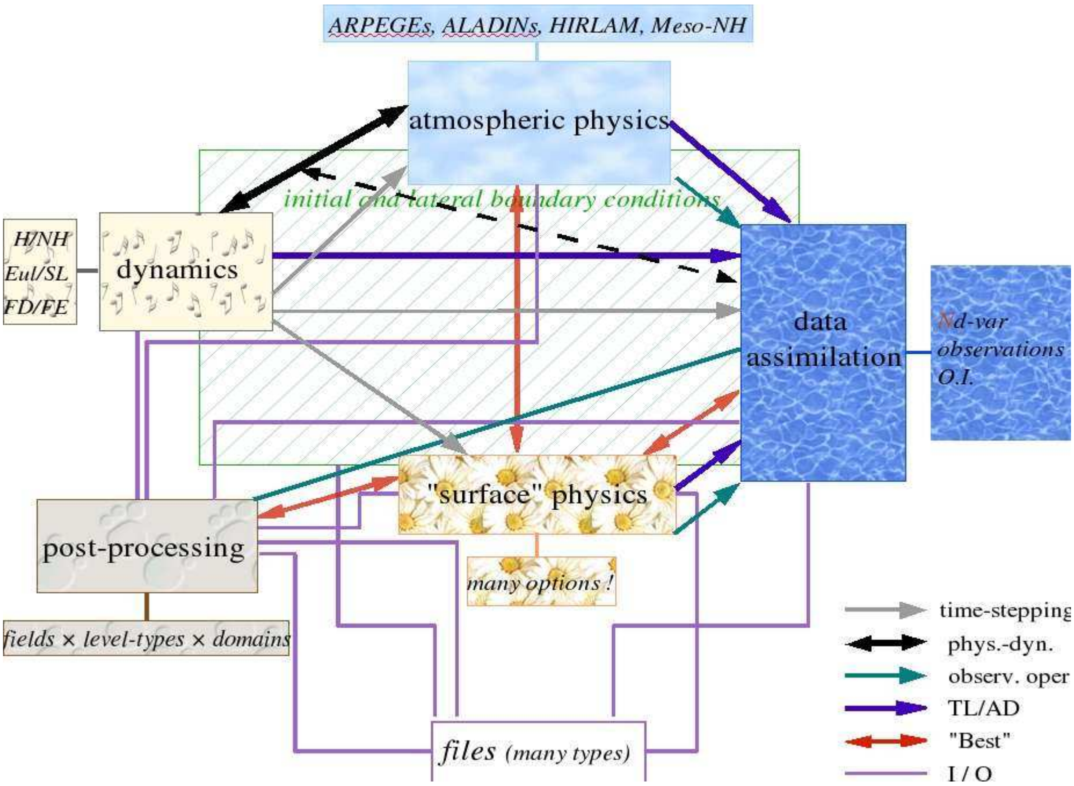

Figure 4 : Examples of tools *(internal or external, in fact "sub-toolboxes")* of the toolbox and of interfaces

2.3 COSMO

The COSMO Consortium in 2004-2005

Tiziana Paccagnella

ARPA-SIM, Viale Silvani 6, 40122 Bologna, Italy
Phone: --39 51 525929, e.mail: tpaccagnella@arpa.emr.it

Most of the information included in this report are taken from the COSMO Newsletter N° 5, edited by U. Schaettler and A. Montani, available on the COSMO web site (www.cosmo-model.org also mirrored at http://cosmo-model.cscs.ch).

1. Organization and structure of COSMO

The Consortium for Small-Scale Modelling (COSMO) aims at the improvement, maintenance and further development of a non-hydrostatic limited-area modelling system to be used both for operational and for research applications by the members of COSMO. The emphasis is on high-resolution numerical weather prediction by small-scale modelling based on the "Lokal-Modell" (LM), initially developed at DWD, with its corresponding data assimilation system. At present, the members of COSMO are following national meteorological services:

DWD	Deutscher Wetterdienst, Offenbach, Germany
HNMS	Hellenic National Meteorological Service, Athens, Greece
IMGW	Institute for Meteorology and Water Management, Warsaw, Poland
MeteoSwiss	Meteo-Schweiz, Zurich, Switzerland
UGM	Ufficio Generale per la Meteorologia, Roma, Italy

Additionally, these regional and military services within the member states are also participating:

ARPA-SIM	Servizio IdroMeteorologico di ARPA Emilia-Romagna, Bologna, Italy
ARPA-Piemonte	Agenzia Regionale per la Protezione Ambientale-Piemonte, Italy
AWGeophys	Amt für Wehrgeophysik, Traben-Trarbach, Germany

NMA, the Romanian Meteorological Service, has applied for membership in COSMO and started its cooperation with the consortium in 2004.

All internal and external relationships of COSMO are defined in an Agreement among the national weather services, which was signed by DWD, HNMS, MeteoSwiss and UGM on 3 October 2001. The national weather service IMGW of Poland joined the consortium on 3 July 2002. There is no direct financial funding from or to either member. However, the partners have the responsibility to contribute to the model development by providing staff resources and by making use of national research cooperations. A minimum of two scientists working in COSMO research and development areas is required from each member. In general, the group is open for collaboration with other NWP groups, research institutes and universities as well as for new members.

The COSMO's organization consists of a STeering Committee (STC, composed of representatives from each national weather service), a Scientific Project Manager (SPM), Work-Package Coordinators (WPCs) and scientists from the member institutes performing research and development activities in the COSMO working groups. At present, six working groups covering the following areas are active: Data Assimilation, Numerical Aspects, Physical Aspects, Interpretation and Applications, Verification and Case Studies, Reference Version and Implementation. The organisation of COSMO is reported in the following:

Steering Committee Members:

Gerard Adrian	DWD	(Germany)
Mathias Rotach **(the Chairman)**	MeteoSwiss	(Switzerland)
Massimo Ferri	UGM	(Italy)
Ioannis Papageorgiou	HNMS	(Greece)
Ryszard Klejnowski	IMGW	(Poland)

Scientific Project Manager:

Tiziana Paccagnella	ARPA-SIM	(Italy)

Working Groups/Work Packages Coordinators:

Data assimilation /	Christoph Schraff	DWD
Numerical aspects /	Jürgen Steppeler	DWD
Physical aspects/	Marco Arpagaus	MeteoSwiss
Interpretation and Applications/	Pierre Eckert	MeteoSwiss
Verification and case studies/	Adriano Raspanti	UGM
Reference Version and Implementation/	Ulrich Schättler	DWD

COSMO activities are developed through extensive and continuous contacts among scientists, work-package coordinators, scientific project manager and steering committee members via electronic mail, special meetings and internal mini-workshops. Twice or three times a year the Scientific Advisory Committee (SAC), composed by the SPM and the WPCs, meets togheter with the chairman of the STC to discuss about ongoing and future activities. The STC also meets 2 or three times a year and once a year there is the General Meeting of the COSMO group in order to present results, deliverables and progress reports of the working groups and to finalize a research plan with new projects for the next annual period. Several inter & intra working groups workshops are also organized during the year.

The procedure to define the COSMO work-plan has been recently revised to improve the efficiency of COSMO cooperation. COSMO strategy is defined by the STC and discussed with SAC. Priority Projects are then identified by the SAC and are finalized during the general meeting collecting contributions and proposals from all the COSMO scientists. After the final approval of the Priority Projects by the STC, resources from the different countries (national weather services and other cooperating institutions) are allocated on these projects and the work plan for the new year is defined including both Priority Projects and all the other activities of the different working groups.

Every year a LM-User Seminar is organized to illustrate the activities carried on by groups and people using LM. The next LM-user seminar will be held from 6 to 8 March 2006 in Langen, Germany.

2. Model system overview

The key features of LM are reported below in tables 1 and 2:

Table 1

Dynamics	
Basic equations:	Non-hydrostatic, fully compressible primitive equations; no scale approximations; advection form; subtraction of a stratified dry base state at rest.
Prognostic variables:	Horizontal and vertical Cartesian wind components, temperature, pressure perturbation, specific humidity, cloud water content. Options for additional prognostic variables: cloud ice, turbulent kinetic energy, rain, snow and graupel content.
Diagnostic variables:	Total air density, precipitation fluxes of rain and snow.
Coordinates:	Rotated geographical coordinates (λ,φ) and a generalized terrain-following coordinate ς. Vertical coordinate system options: – Hybrid reference pressure based σ-type coordinate (default) – Hybrid version of the Gal-Chen coordinate – Hybrid version of the SLEVE coordinate (Schaer et al. 2002)
Numerics	
Grid structure:	Arakawa C (horizontal) Lorenz vertical staggering
Time integration:	Second order horizontal and vertical differencing Leapfrog (horizontally explicit, vertically implicit) time-split integration including extension proposed by Skamarock and Klemp 1992. Additional options for: - a two time-level Runge-Kutta split-explicit scheme (Wicker and Skamarock, 1998) - a three time level 3-D semi-implicit scheme (Thomas et al., 2000) - a two time level 3rd-order Runge-Kutta scheme (regular or TVD) with various options for high-order spatial discretization (Förstner and Doms, 2004)
Numerical smoothing:	4th order linear horizontal diffusion with option for a monotonic version including an orographic limiter (Doms, 2001); Rayleigh-damping in upper layers; 3-d divergence damping and off-centering in split steps.
Lateral Boundaries:	1-way nesting using the lateral boundary formulation according to Davies and Turner (1977). Options for: - boundary data defined on lateral frames only; - periodic boundary conditions Driving models: GME, IFS/ECMWF or LM.

Physics	
Grid-scale Clouds and Precipitation:	Cloud water condensation /evaporation by saturation adjustment. Cloud Ice scheme HYDCI (Doms,2002). Further options: - prognostic treatment of rain and snow (Gassman,2002; Baldauf and Schulz, 2004, for the leapfrog integration scheme) - a scheme including graupel content as prognostic variable - the previous HYDOR scheme: precipitation formation by a bulk parameterization including water vapour, cloud water, rain and snow (rain and snow treated diagnostically by assuming column equilibrium) - a warm rain scheme following Kessler

Subgrid-scale Clouds:	Subgrib-scale cloudiness based on relative humidity and height. A corresponding cloud water content is also interpreted.
Moist Convection:	Mass-flux convection scheme (Tiedtke) with closure based on moisture convergence. Further options: - a modified closure based on CAPE within the Tiedtke scheme - The Kain-Fritsch convection scheme
Vertical Diffusion:	Diagnostic K-closure at hierarchy level 2 by default. Optional: a new level 2.5 scheme with prognostic treatment of turbulent kinetic energy; effects of subgrid-scale condensation and evaporation are included and the impact from subgrid-scale thermal circulations is taken into account.
Surface Layer:	Constant flux layer parameterization based on the Louis (1979) scheme (default).Further options: A new surface scheme including a laminar-turbulent roughness sublayer
Soil Processes:	Two-layer soil model including snow and interception storage; climate values are prescribed as lower boundary conditions; Penman-Monteith plant transpitration. Further options: a new multi-layer soil model including melting and freezing (Schrodin and Heise, 2002)
Radiation:	δ-two stream radiation scheme after Ritter and Geleyn (1992) for short and longwave fluxes; full cloud-radiation feedback
Initial Conditions:	
Interpolated from GME, IFS/ECMWF or LM. Nudging analysis scheme (see Table 2). Diabatic or adiabatic digital filtering initialization (DFI) scheme (Lynch et al., 1997).	

Physiographical data Sets:
Mean orography derived from the GTOPO30 data set(30"x30") from USGS. Prevailing soil type from the DSM data set (5'x5')of FAO. Land fraction, vegetation cover, root depth and leaf area index from the CORINE data set. Roughness length derived from the GTOPO30 and CORINE data sets.
Code:
Standard Fortran-90 constructs. Parallelization by horizontal domain decomposition. Use of the MPI library for message passing on distributed memory machines.

Table 2

Data Assimilation for LM	
Method:	Nudging towards observations
Implementation:	Continuous cycle
Realization:	Identical analysis increments used during 6 advection time steps
Balance	1. hydrostatic temperature increments (up to 400 hPa) balancing 'near-surface' pressure analysis increments 2. geostrophic wind increments balancing 'near-surface' pressure analysis increments 3. upper-air pressure increments balancing total analysis increments hydrostatically
Nudging coefficient	$6.10^{-4}\ s^{-1}$ for all analyzed variables except pressure $1.2\ 10^{-3}\ s^{-1}$ for “near-surface” pressure
Analyzed variables	horizontal wind vector, potential temperature, relative humidity, 'near-surface' pressure (i.e. at the lowest model level)
Spatial analysis	Data are analyzed vertically first, and then spread laterally along horizontal surfaces.Vertical weighting: approximately Gaussian in log(p); horizontal weighting: isotropic as function of distance.
Temporal weighting	1.0 at observation time, decreasing linearly to 0 at 3 hours (upper air) resp. 1.5 hours (surface level data) before and 1.0 resp. 0.5 hours after obs. time;
Observations:	SYNOP, SHIP,DRIBU:

	-station pressure, wind (stations below 100m above msl) -humidity TEMP,PILOT: -wind,temperature: all standard levels up to 300 hPa -humidity:all levels up to 300 hPa - geopotential used for one "near-surface" pressure increment. AIRCRAFT - all wind and temperature data WIND PROFILER -all wind data (not included in blacklisted stations)
Quality Control:	Comparison with the model fields from the assimilation run itself.

3. Operational applications

The LM runs operationally in five centres of the COSMO members (ARPA-SIM, DWD, HNMS, IMGW, MeteoSwiss) and, since early 2005, also at NMA, the Romanian Meteorological Service.

ARPA-SIM, HNMS, IMGW and NMA use interpolated boundary conditions from forecasts of the global model GME of DWD. Only a subset of GME data covering the respective LM-domain of a centre are transmitted from DWD via the Internet. HNMS, IMGW and NMA start the LM from interpolated GME analyses. In this case it is possible to smooth the initial fields using the digital filtering scheme of Lynch et al. (1997). At DWD, a comprehensive data assimilation system for LM has been installed,comprising the LM nudging analysis for atmospheric fields, a sea surface temperature (SST) analysis, a snow analysis and the soil moisture analysis according to Hess (2001). A data assimilation system based on the LM nudging scheme is also used at MeteoSwiss (since November 2001) and at ARPA-SIM (since October 2003).
Since September 2003, MeteoSwiss uses lateral boundaries from interpolated IFS-forecasts.

The national weather service of Italy, UGM in Rome, runs the LM at the ECMWF computing centre for a bigger (european) domain with respect to the one operated by ARPA-SIM in Bologna. The lateral boundaries for these runs are taken from the IFS.

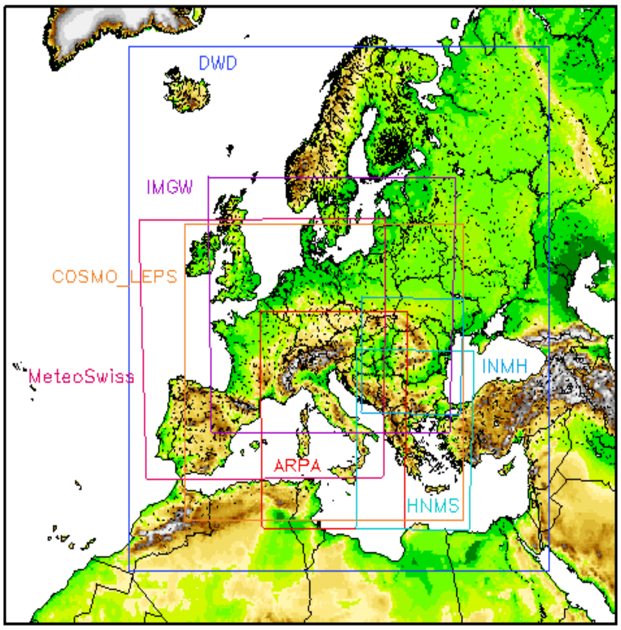

Figure 1: integration domains of the LM operational implementations in the different COSMO countries.

MeteoSwiss, ARPA-SIM and UGM have renamed the model within their services: the LM application in Switzerland is called aLMo (Alpine Model), the LM application in Italy is called LAMI (Limited Area Model Italy) and the LM run by UGM at ECMWF is called Euro-LM.

In Figure 1, the integration domains of the different operational implementations are shown.

In Table 3 the operational settings of LM are reported for the different COSMO countries.

LM configurations	ARPA-SIM	DWD	HNMS	IMGW	MeteoSwiss	UGM	NMA	COSMO-LEPS
Grid Points	234x272	665x657	189x225	193x161	385x325	465x385	81x73	306x258
Hor. Res.	0.0625° (7 km)	0.0625° (7 km)	0.0625° (7 km)	0.125° (14 km)	0.0625° (7 km)	0.0625° (7 km)	0.125° (14 km)	0.09° (10 km)
N° Layers	35	40	35	35	45	35	35	32
Time Step	40 sec	40 sec	30 sec	80 sec	40 sec	40 sec	80 sec	60 sec
Frcst Range	72 hrs	78 hrs	48 hrs	72 hrs	72 hrs	60 hrs	48 hrs	120 hrs
Start Time	00, 12 UTC	00, 12, 18 UTC	00,06,12,18 UTC	00, 12 UTC	00, 12 UTC	12 UTC	00,12 UTC	12 UTC
Lateral BCs from	GME	GME	GME	GME	IFS	IFS	GME	IFS-EPS
LBCs Upd. Freq.	1 hour	1 hour	1 hour	1 hour	3 hours	3 hours	3 hours	3 hours
Initial State	Nudging	Nudging	GME	GME	Nudging	EuroHRM 3-DVAR	GME	IFS-EPS
Initialis.	None	None	None	None	None	None	None	None
External Analysis	None	SST, Snow Depth, Soil Moisture Analysis	None	None	Snow Depth from DWD	None	None	None
Dynamics	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit	3 TL; split-explicit
Physics options	TKE; new surface layer scheme; Cloud ice; Prog. Prec.	TKE; new surface layer scheme; Cloud ice; Prog. Prec.; multi-layer soil model	TKE; new surface layer scheme; Cloud ice;	TKE; new surface layer scheme; Cloud ice;	old Turbulence scheme	TKE; new surface layer scheme	TKE; new surface layer scheme	TKE; new surface layer scheme
Hardware	IBM SP pwr5	IBM SP pwr5	CONVEX	SGI Origin 3800	NEC SX-5	IBM SP pwr4	Linux Cluster	IBM SP pwr4
No.Procs.	64	176	14	88	14	112	26	90

Table 3: operational settings of LM in the different COSMO countries

4. Progress report and Research activities

This section gives a brief description of the main research activities carried on during the last COSMO year (Oct.2004-Oct.2005) within the different working groups.

Working group 1: Data Assimilation coordinated by Christoph Schraff from DWD

- Latent Heat Nudging has been further developed and main problems related to the inclusion prognostic precipitation have been mostly solved;
- Multi-Sensor Humidity Analysis including GPS observations with GPS tomography;
- Use of 1dVar Satellite Retrievals both for MSG and ATOVS data has been partly developed through a good and efficient cooperation among Germany, Italy and Poland;
- Assimilation of Scatterometer Wind is in progress with first tests with LM planned for the end of 2005
- Evaluation / Monitoring / Tuning of LM Nudging scheme has been continued
- Soil Moisture Initialisation after the results from the ELDAS has been implemented for the new multi-layer soil model in LME with good results.
- Snow Cover Analysis has been improved by means of a snow mask derived from satellite (e.g. SEVIRI) data. Snow mask products and their impact need to be evaluated for longer periods.

A 1-day workshop was held in Zurich, the day before the general meeting, to discuss the COSMO strategy about Data Assimilation. The discussion was based on the awareness that in 10 years global models will be run at horizontal resolution of about 10 km and fine-mesh models will be run at 1 km horizontal resolution.
The use of PDFs, as a complement to deterministic forecast, will assume a fundamental role particularly for the convective scale. The use of indirect observations at high frequency will be even more important expecially for high-frequency update Data Assimilation~Forecast cycles.
More and more emphasis on ensemble techniques will be given both as regards probabilistic information to complement numerical forecats and as regards statistical support to Data Assimilation methodologies.
Due to special conditions in convective scale, separate DA methodologies will be developed by COSMO for such applications (SIR Priority Project, listed in the following,by means of a sequential Bayesian weighting and importance re-sampling).

Working group 2: Numerical Aspects coordinated by Juergen Steppeler from DWD

- Further development of the Z-coordinate version (Steppeler et Al. 2002) of LM both as regards the eulerian version and the SI/SL one (Rosatti et Al. 2005)
- Further developments and Evaluation of Runge-Kutta method.
- Revision and testing of several aspects of LM numerics in the framework of LMK (**LM Kürzestfrist)** development. LMK, a project designed and carried on at DWD during the last couple of years, is aimed to the development of a very short range forecasting system based on the integration of LM, at 2.8 km hor. res. The system will be run every three hours, with a short cut-off time, for 18 hours of integration. Developments related to LMK project are now available also in LM for the COSMO members.

Working group 3: Physical Aspects coordinated by Marco Arpagaus from MeteoSwiss

- Surface transfer scheme and turbulence scheme: single column model developed
- Soil processes
    - Multi-layer soil model

        - Operational implementation of the multi-layer soil model
        - Usage of satellite derived (weekly updated) plant cover
        - Revision of external parameters for plants
    - Implementation of the lake model into LM
    - Intercomparison of soil models in the framework of soil moisture validation
- Shallow convection on the meso-γ scale
    - some tests with LMK
- Microphysics
    - Three-category ice scheme included
- Radiation
    - Cloud-radiation interaction: some tests
    - Evaluate possible inclusion of 3-d effects in current scheme
        - Gridscale parameterization of topographic effects on radiation. Some sensitivity case studies have been carried out. The impact of the topographic effects is substantial at high resolution.
        - Radiation calculation on a coarser grid – very first results with LMK

Working group 4: Interpretation and Applications coordinated by Pierre Eckert from MeteoSwiss

- The COSMO-LEPS (COSMO-Limited Area Ensemble Prediction System, Montani et Al. 2003) is now composed of ten members with a forecast length of 132 hours. COSMO-LEPS will be included in the “time critical applications” at ECMWF since November this year.
    - Core products:
        - 10 perturbed LM runs (ICs and 6-hourly BCs from 10 EPS members) to generate probabilistic output (start at 12UTC; $\Delta t = 132h$);
    - Additional products:
        - 1 deterministic run (ICs and 3-hourly BCs from the high-resolution deterministic ECMWF forecast) to assess the relative merits between deterministic and probabilistic approach (start at 12UTC; $\Delta t = 132h$);
        - 1 proxy run (ICs and 3-hourly BCs from ECMWF analyses) to “downscale” ECMWF information (start at 00UTC; $\Delta t = 36h$).

  Since 1st July 2005, COSMO-LEPS forecasts are archived on MARS at ECMWF.

- Case studies to see the impact of moist singular vectors and ensemble size on predicted storm tracks for the winter storms Lothar and Martin
- Use of Multi-Model Super-Ensemble Technique for complex orography weather forecast
- First experiments toward the new COSMO-SREPS (Short Range EPS) system based on LM by perturbating Physics.
- Interpretation of the new high-resolution model LMK
    - Using information of a single model forecast by applying the Neighbourhood Method
    - Using information resulting from LMK forecasts that are started every 3 h (LAF-Ensemble)

Working group 5: Verification and Case Studies coordinated by Patrizio Emiliani (now by Adriano Raspanti) from UGM.

The activities of this group focus mainly on coordination in order to have some objective measures of how well LM forecasts are performing, and on an scientific viewpoint, in order to have detailed assessment of the strengths and weaknesses of the model. Thus, at the moment, the main activities of the working group deal with the following issues:

- The verification of operational model forecasts,
- The verification with feedback on the physical parameterizations (which means verification of new LM versions on a set of test cases)
- The development of new verification methods and diagnostic tools
- The collection of LM case studies.

As regards the observations data-set, precipitation is also verified against a "common" data-set of high density stations provided by local networks of the different COSMO Countries.
Verification is also performed employing remote-sensing data.
A summary of the verification highlights of each season is also produced by the work-packages coordinator and it is now regularly discussed during the SAC meetings.

Working group 6: Reference Version and Implementation coordinated by Ulrich Schaettler from DWD

- Four versions of LM have been released during this year.Version 3.16 has been implemented in July 2005. All developments done for the LMK up to now have been incorporated in the official LM library.
- INT2LM is now the official interpolation program to extract Boundary Conditions (and Initial Conditions) from GME, IFS and LM for one way nesting.
- Documentation has been partially updated.

Operational implementation are described in the first part of this report.

5. Planned developments for the LM NWP system

COSMO scientific longer-term perspectives (3-5 years) are mainly addressed to :

- High-resolution, short-range EPS available
- Assimilation of 'all' available data
- LM performance known and critically discussed

During the last year it has been recognized the importance of reinforce the COSMO cooperation by introducing a project management, more structured and controlled, where only contributions to "priority projects" are taken into account when considering the obligatory commitment of each COSMO member. The Priority Projects are addressed:

- To better concentrate joint COSMO efforts
- To optimize the use of COSMO human resources
- To facilitate management related to goals which are considered to be prioritary

Starting this year (2005-2006) the work plan is then organized in:

<u>Priority Projects (PPs):</u>

- Proposed by SAC (WP Coordinators and SPM)
- Discussed/completed/modified with COSMO scientists
- Approved by STC which is also responsible of allocating the required human resources
- Coordinated by Project Leaders

PPs can be composed by tasks belonging to one specific working group but also by tasks from different workin groups.

<u>Activities:</u>
Not structured as projects and carried on if extra-resorces are available

Priority Projects selected and starting in 2006:

1. **Support Activities:**
   Includes many of the activities of WG6 Implementation and Reference Version (Source codes managment, documentation, editing of newsletters, tech. Reports, WEB site)
   Project Leader: Ulrich Schaettler (DWD)
2. **SIR: Sequential Importance Resampling filter :**
   The aim of the project is the development of a prototype for a new data assimilation system for the convective scale by means of a sequential Bayesian weighting and importance re-sampling (SIR) filter.
   Project Leader: Christoph Scraff (DWD)
3. **Retrievas for nudging: 1dVar for satellite radiances:**
   Operational assimilation of ATOVS and SEVIRI data for LM
   Project Leader: Reinhold Hess (DWD)
4. **Further development of LM_Z**
   To make LM_Z ready for complete testing. Decision about LM_Z will be taken at the next general meeting based on results produced during 2006 by this project.
   Project leader: Juergen Steppeler (DWD)
5. **Further development of the Runge Kutta method:**
   Create an improved and properly checked Version of RK in the timescale of 3 years.
   Project leader: Michael Baldauf (DWD)
6. **UTCS: Towards Unified Turbulence-Shallow Convection Scheme**
   Implementation of Transport Equations for the Sub-Grid Scalar Variance
   Coupling with Convection, Turbulence and Cloud Diagnostic Schemes
   Project leader: Dmitrii Mironov (DWD)
7. **Tackle deficiencies in precipitation forecasts:**
   Project leader: Marco Arpagaus (MeteoSwiss)
8. **Development of Short Range ensemble based on LM**
   Project Leader: Chiara Marsigli (ARPA-SIM)
9. **Advanced Interpretation of LM output**
   Project leader: Pierre Eckert (MeteoSwiss, Genève)
10. **Implementation of a Common Conditional Verification (CV) library**
    Development of a common and unified verification "library" including a Conditional Verification tool.
    Project Leader: Adriano Raspanti (UGM)

For 2006 these Priority Projects will see the cooperation of many COSMO scientists for a total of about 22 man/year (sum of scientists percentages) made available by the participating Countries.
The two Projects related to numerical aspects (4 and 5) will be mostly completed in 2006. Advanced numerics will be the topic of a 1-day workshop to be held in Langen next March just the day after the next LM-USER seminar.
Projects 1 and 6, which are designed thinking about LM at cloud resolving scale, are planned on a 5 year time range. The other projects are designed on a 2-3 years schedule.
Projects will be monitored on a quarterly basis and main results will be presented at the next SRNWP/EWGLAM meeting.

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2.4 HIRLAM

The HIRLAM-6 Project and HIRLAM-A Programme

Per Undén

Project Leader, HIRLAM-6

Introduction

The HIRLAM-6 Project is in its 3rd and final year. During the last year there have been intensive preparations and investigations for continuing HIRLAM co-operation between the existing members (Denmark, Finland, Norway, Sweden, Iceland, Ireland, the Netherlands, Spain and France for research co-operation). Following an Evaluation of the HIRLAM Projects and of the options for the future, there is a definite intention to enter into a new HIRLAM Programme. It will be set up for a longer period than before under a quite general Memorandum of Understanding. Projects may be changed during the course of the Programme and the scope of the Programme will probably extend with new Projects or optional Projects. The meso-scale modelling at the km scale will become more and more the highest priority and collaboration with the ALADIN consortium and Météo-France around the AROME system will be the focus of this work.

The Evaluation pointed out major advantages of HIRLAM for its members and that the institutes really depended on HIRLAM a lot. There were a number of weaknesses, both in the modelling development and in the organisation. Many major achievements have been met but some forecasting problems have been difficult to solve. The lack of authority and clearly dedicated resources has been a problem. This will be addressed in the new HIRLAM-A Programme to a great deal. Increased resources will be needed because we will continue to need a synoptical modelling system while we also need to develop the meso-scale system quickly. Furthermore, probabilistic forecasting and ensembles are important. There are synergy effects across the scales, but the convergence with ALADIN will help and it was supported by the Evaluation (without taking any position that this was the only alternative or that is guaranteed to be the best model).

A significant work on both the ALADIN and HIRLAM sides has taken place to form a co-operation between the two consortia. It is foremost based on the meso-scale modelling and activities on both formal and practical coordination has taken place. There is a common research plan for the areas that are agreed to share the work on (whereas there will still be individual scientific plans for each consortium and areas that are worked on separately). The cooperation is based on a code collaboration, so the meso-scale modelling is done with common code, IFS based, but with individual options for ALADIN and HIRLAM (at least optionally).

Operational co-operation may become established in the future between some HIRLAM members, but so far and also in future, the role of a quality assured Reference System release of HIRLAM is paramount. Members are striving to use the latest Reference system as far as possible and as fast as they can implement it after own testing. The Reference system is run as one of the operational HIRLAM installations, at FMI currently. It can also be run at ECMWF, where the Reference is installed and maintained. Data from this Regular Cycle of the Reference system (RCR) are mirrored at ECMWF for HIRLAM members to use for research in diagnostics and for Data Assimilation statistics e.g.

Data Assimilation

The work on enhancing the background error statistics used in 3D-VAR (and 4D) has continued. Several options have been explored and different HIRLAM implementations used. New statistics have been derived for analytical and for statistical balance and for the statistical one more advanced balance is being developed. Ensemble assimilations also give good or better estimates as the new methods from innovation and observation statistics. Flow dependency has been tried through an Eady index normalisation and at least the climatological flow should be represented through a horizontal index. The new control variable based on first guess relative humidity has been developed following ECMWF.

4D-VAR has been run extensively over the last year using the earlier developments with semi-Lagrangian and multi-incremental schemes. It is rather efficient although some further optimisation for vector processors still is done. It is feasible to start pre-operational or parallel runs in some configurations in some of the HIRLAM institutes. Several of the institutes use ATOVS AMSU-A data with a clear positive impact and research is ongoing to use AMSU-B. There is research on radar VAD and radial winds with a novel de-aliasing teqnique. Scatterometer winds are also possible to use. GPS zenith delay data can now be used slant-wise since the operators have been implemented for this.

For the surface analysis, the activities are mainly for snow and ice and SST. A new snow OI analysis was implemented and work is ongoing to introduce the data from the Ocean Sea Ice SAF into HIRLAM (already used in some countries).

Forecast modelling

A large number of changes to the physics parameterisation of the HIRLAM model have been implemented in the Reference system during the period. The combined set results in significantly improved forecast parameters and particularly of temperature and humidity. (Also wind direction and pressure are much improved). There has been a lot of attention to the turbulence scheme for many years and extensive work on tuning of both surface roughness (increase) and stable stratification mixing (increase but not as much as first tried) and a turning of the surface stress vector have all contributed to an improved performance. For the surface fluxes, the effective roughness length for heat and moisture is now much smaller than for momentum, as it should be, and this reduces systematic errors particularly for spring and summer situations, where too much evaporation held the day time temperatures down.

An explicit snow modelling for the tiled surface scheme has been developed and tested over several years. It has now also a treatment for forest and snow, which is dominating in Scandinavia. This is important to cure the frequently poorly simulated cold episodes with clear skies over snow in the Nordic countries. A lot of work has also gone into investigations and diagnostics and the use of 1D simulations is very effective. The formulation of evaporation, condensation and radiation all interact in this problem. The Rash-Kristjanssen condensation scheme has less cloud water and shows less of a problem than the Reference. The Kain-Fritsch and the Reference Straco scheme have both been developed somewhat, e.g. with statistical cloud formulation. The KF scheme needs considerable optimisation in order to be used on vector machines and it is planned that experts from NEC will do this for HIRLAM.

The dynamics has also been enhanced with some earlier developments to the semi-Lagrangian scheme implemented and also a new coupling to the physics. (Both fairly similar to what has been done at ECMWF). The work on the transparent lateral boundary conditions has progressed well with a few important issues solved. It is based on normal mode and eigenfunction decomposition and proper treatment of incoming or outgoing waves. With the normal modes it has now been done in a multi-level (z) model, although a simpler one than HIRLAM.

A meso-scale modelling group was set up in 2004 in order to work with the ALADIN dynamics and implement it with HIRLAM physics and later with the AROME physics. This work has concentrated on a setup of ALADIN at ECMWF, which has been convenient for symmetrical access from the different HIRLAM institutes and Météo-France (a current drawback is that only some ALADIN members are full members of ECMWF since there is considerable interest of the work also in these other ALADIN countries). The ALADIN model is now possible to run coupled with HIRLAM and a number of runs and relatively long tests have been performed. Some of the HIRLAM physics is interfaced and HIRLAM takes part in the design of the general physics interfaces for ALADIN.

Probabilistic forecasting is carried out in some HIRLAM institutes through ensemble runs with HIRLAM either using perturbations from ECMWF or using a multi-model technique.

System developments

The hitherto very different set-ups in the HIRLAM variational system (HIRVDA) and the rest of the HIRLAM system have now been unified around a CVS bases source code maintenance. New procedures to make the libraries and executables have been developed in a consistent way and this work is almost ready for full implementation.

2.5 LACE

RC LACE Status Report 2004-2005

Dijana Klaric
RC LACE Project Leader

MHS Croatia, Gric 3, HR-10 000 Zagreb, Tel: +385 -1- 4565-616
E-mail: dijana@cirus.dhz.hr

Introduction

Regional Cooperation for Limited Area modelling in Central Europe (RC LACE) has gathered the meteorological services of Austria, Czech Republic, Croatia, Hungary, Slovakia and Slovenia under the common goal to coordinate operational ALADIN applications development and to optimize the research with common human and budget resources. LACE Memorandum of Understanding defines the relations between LACE Council, LACE Steering Committee and LACE Management Group. Since year 2003, operative ALADIN applications and R&D have been organized at decentralized mode, at each Member service.

1 Life of the Project

The main highlights of LACE project during the 2004-2005 period were:
- Coordination of ALADIN and HIRLAM actives toward the future common-code development
- Development and harmonization of **AAAA** (ARPEGE/ALADIN/ALARO/AROME) chain of models.

The LACE R&D affords for 2004 has reached 100 person/months, and actions at 2005 would fulfil 110 person/months of coordinated research. LACE Budget has financed the mobility of the scientists with the funds for the 15 person/months missions and workshops.

2 Operational Applications

ALADIN applications are operative at all LACE services. ALADIN has been coupled with ARPEGE LBC with 3h coupling frequency. 00 and 12 UTC runs are standard while 06 and 18 runs are started on demands. Dynamical adaptation initialization has been replaced with 3DVAR initialization at Hungary, while CHMI has running a blending type of initialization.
Standard horizontal resolutions are 12-7km, while some services also run separate small domains with dynamical adaptations up to 2.5 km for high-resolution wind fields.

3 Research activities

Working group on Dynamics and Coupling

ALADIN Non-Hydrostatic dynamic is in the scope of interest. The stability of the ALADIN NH has been tested on 10, 5, 2 and 1 km resolutions. The further code cleaning and tests have been performed. The Semi Lagrangian Horizontal Diffusion (SLHD) system has been documented, tuned and tested at various cases.

- Iterative schemes for non-hydrostatic ALADIN

The further development of NH ALADIN system has been performed. After the main iterative 2TL SL P/C (ICI) development, the 3TL Eulerian ICI scheme has been phased into the CY29T2. Its existence allows inter-comparison between semi-Lagrangian (SL) and Eulerian version of time stepping procedures. The 3D ALPHIA tests with physical forcing have been performed at 4km resolution. The implementation of SLHD into 3TL Eulerian scheme is planed.

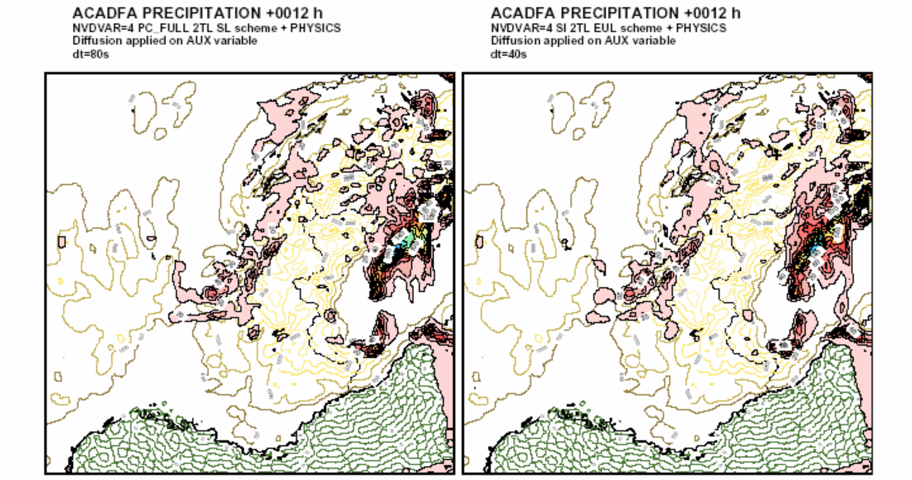


Fig. 1: ALADIN NH at 4km resolution, Alpine region, +12h precipitation forecast, left: 2TLSL, Δt = 80s; right: 3TL Eulerian Δt = 40s.

- Bottom boundary condition (BBC) tests in the academic environment

The exact treatment of BBC formulation and origin of diffusive chimney has been examined. The horizontal diffusion numerical filtering has been replaced with SLHD.

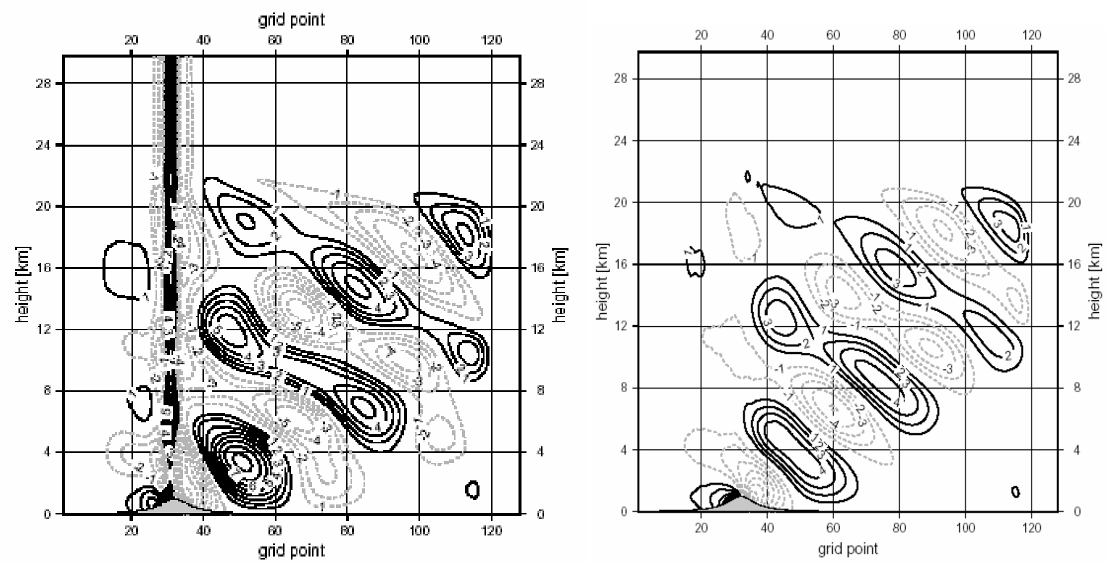


Fig.2: NH vertical velocities, Bell-shaped 2D tests, left: Horizontal diffusion, right: SLHD.

Working group on Physics

The developments in physics has been targeting to the sustain improvements of ARPEGE/ALADIN physics, as well toward the development of the new physics for the 10-5km scales.

- PBL Cloudiness - Convergence Xu-Randall and Seidl-Kann scheme

The problem of too strong 2m temperature diurnal cycle during a winter anti-cyclonic conditions has been studied in Prague. The problems were detected by large errors in 2m temperature forecasts. Method based on diagnostic of temperature inversion layers and temperature vertical gradients has been applied. «Critical Humidity Profile" computation has been modified by lower values for computation for saturation for cloud. The new cloudiness geometry has been applied.

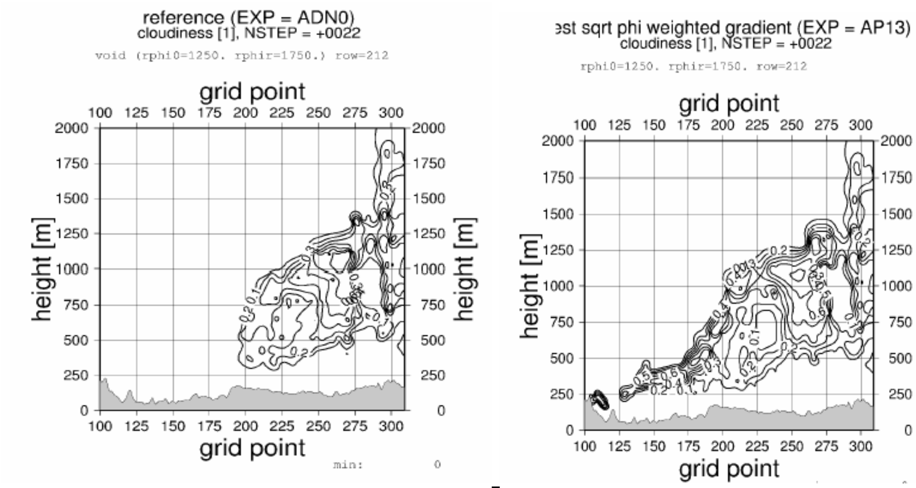


Fig.3: Vertical cross sections of cloudiness: left reference, right with the modifications

- ALARO prototype development

ALARO application (10km model) tends to bridge the ALADIN (10km) and AROME (3km) models by harmonizing the system of equations and variables at the closest possible way. The physical parameterizations would be tailed for 10 km horizontal resolution scale, with the further developments toward the parameterization for 4-5 km scale. The highlights of ALARO developments are:

  - gravity wave drag parameterization down to the 5km sub-grid effects
  - improvements of thermal radiative fluxes
  - semi-prognostic treatment of TKE
  - prognostic treatment of liquid and solid cloud water and precipitation
  - simplified microphysics scheme
  - Bulk Convective Condensation approach

The work is in progress, final tests are planned for the end of 2005.

Working Group on Data Assimilation and Predictability

ALADIN Data Assimilation R&D were focused on theoretical methods and observations. The influence of non-classical observations (MSG/AMV, AMDAR, wind profilers, radar radiances) at the performance of meso-scale 3DVAR has been studied. The core of the activities were performed in HMS-Budapest, where the first operational ALADIN 3DVAR has started at May 2005.

- 3d VAR ALADIN e-suites and comparisons vs. Dynamical adaptation initialization

Since 2002 a development of 3DVAR has been in the scope of HMS activities. 6-hour assimilation cycle has been based on SYNOP, TEMP, ATOVS/AMSU-A satellite data observations. The subjective and objective scores have shown the positive impact of 3DVAR system in the first 12 hours of model integration. At several cases the forecast based on 3DVAR provided the more reliable precipitation fields in the comparison with precipitation forecast based on dynamical adaptation initialization (see more details at HMS report).

- Tuning of the multivariate humidity formulation of the B matrix

The tuning of the humidity error variances for stratosphere and troposphere levels was performed. The tests aimed to examine the negative impact of the multivariate humidity formulation to the humidity 3DVAR analysis. While the single observation experiments show encouraging results, the full observation assimilation cycle experiments (TEMP, SYNOP, AMDAR, ATOVS data) tend to have a small impact on the humidity analysis.

- Assimilation of 10 m wind

The impact of 10m wind assimilation has been studied with the goal to improve 10m wind assimilation over the land. The impact of “black-list” due to the difference between model orography and the surface stations altitudes has been tested. Even when “black-list” approach has been applied on stations with RMSE>2.5, the 10m wind assimilation showed the almost neutral impact. The further studies would be performed with “no-envelope“ orography.

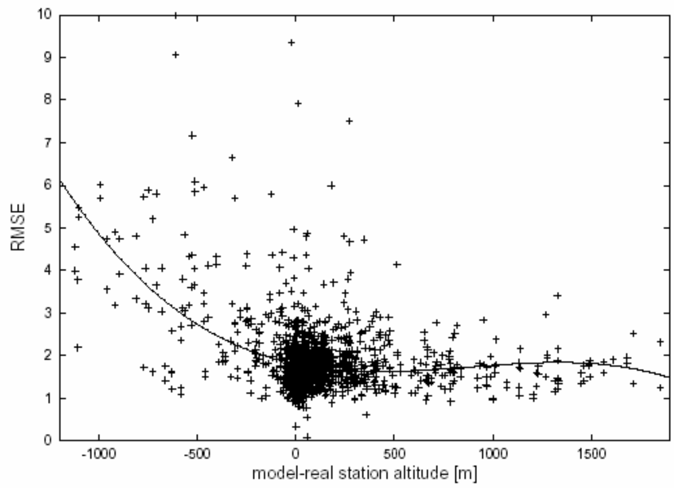
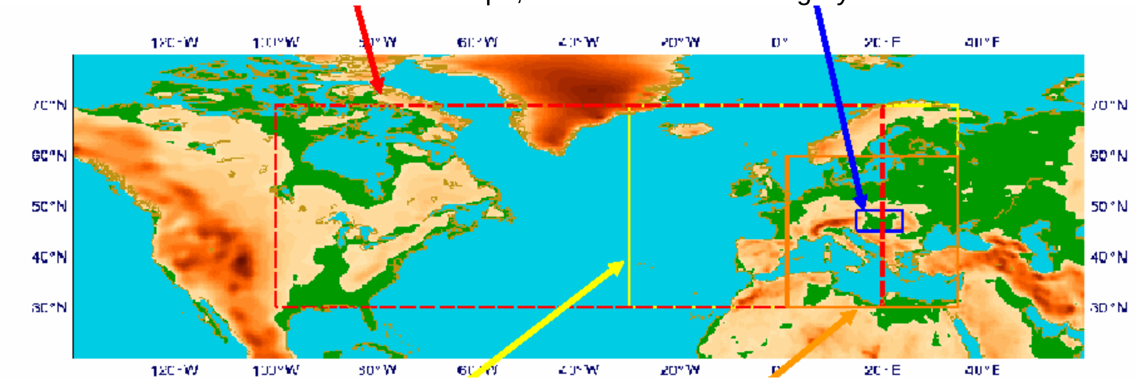


Fig. 4: Relation between 10m wind RMSE and model orography altitude – station altitude, fitted by polynomial function of degree 5 and 3.

Predictability targeting LAM-EPS has been studied at Austria, Hungary at Croatia. The different EPS approaches have been studied: ALADIN EPS based on ARPEGE SV perturbations; Breeding techniques, ETKF -Ensemble Transformed Kalman Filter methods; ALADIN EPS based on the ECMWF EPS system. The diagnostic tools (ROC, Talagrand) for EPS system has been developed at HMS-Budapest.

- ALADIN EPS sensitivity experiments at 4 domains for singular vector (SV) computation



- ALADIN EPS based on downscaling of ECMWF EPS

At Hungary and Croatia, ECMWF EPS products have bee applied as the initial conditions for ALADIN EPS computation. Members of ECMWF/EPS products have been chosen by clustering methods and downscaled to meso-scale resolution. Impact of ECMWF/EPS initial conditions has been studied on the severe weather events.

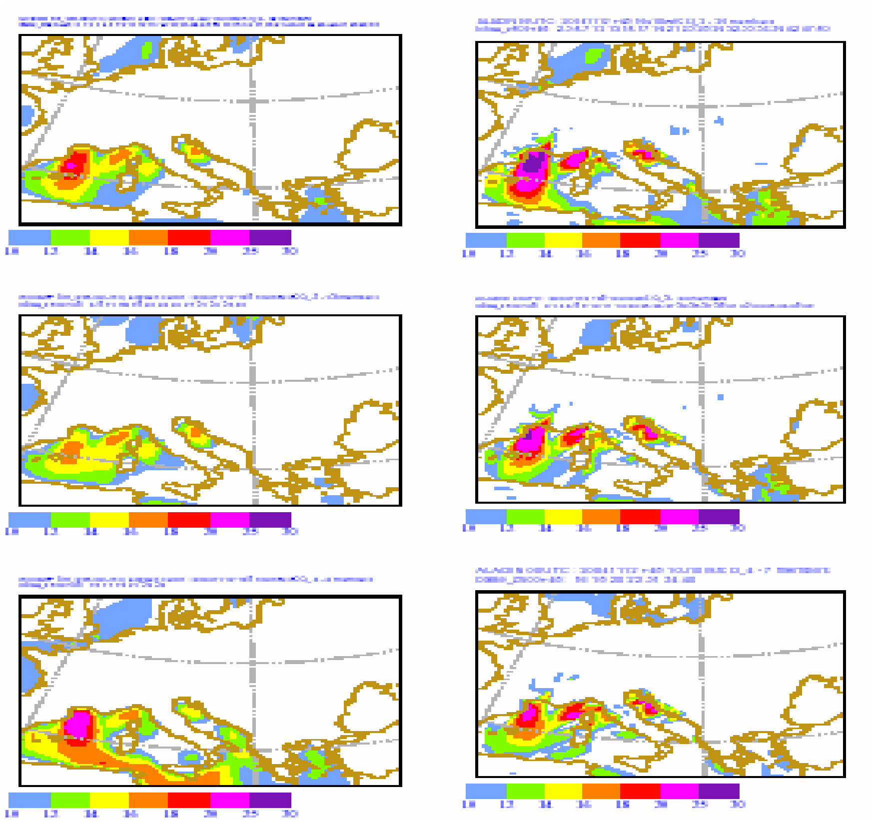


Fig.5: 10m wind forecast for 14 November 2004, measurements of wind velocities over 25m/s, left column: 3 clusters of ECMWF/EPS +48h forecast downscaled to 12km, right column: ALADIN +48 forecasts based on ECMWF/EPS clusters.

4 Plans and Goals 2005-2007

At the recent LACE Steering Committee Meeting, September 2005, the enlargement of R&D has been proposed in the form of the new working group for predictability. In the 2006 LACE project would dedicate the new funds for LAM EPS workshops and research stays. The kick-off ALADIN/EPS workshop is planned for the beginning of 2006, as part of the LACE – HIRLAM cooperation.

Research and development targeted for the new models: ALARO (10km), AROME (3km) would continue. The work would be organized under the common ALADIN-LACE coordination. The first AROME training is planned for November 2005 in Romania. One-month phasing for ALARO prototype development would be organized at Jan/Feb 2006 in Brussels. The porting and validation of ALARO model at LACE member services would be in the scope of the actions at the first half of 2006. The several tests would be performed (stability, objective and subjective verification, case studies, e-suites vs. ALADIN model)

The members of LACE Project have decided to put the last 10 years of LACE Project under the external evaluation procedure. The Evaluation Team has been hired under the leadership of Prof Peter Lynch. The evaluation should be finished till the mid of 2006.
LACE partners decided to prolong the current LACE MoU till the end 2007, with the ambition to apply the evaluation recommendations into the LACE structure till the end of the same period.

2.6 UKMO

Unified Model Developments 2005

NWP Met Office FitzRoy Road Exeter
+44 1392 886098 mike.bush@metoffice.gov.uk

Configurations

The current NWP Model configurations are shown in figure 1.

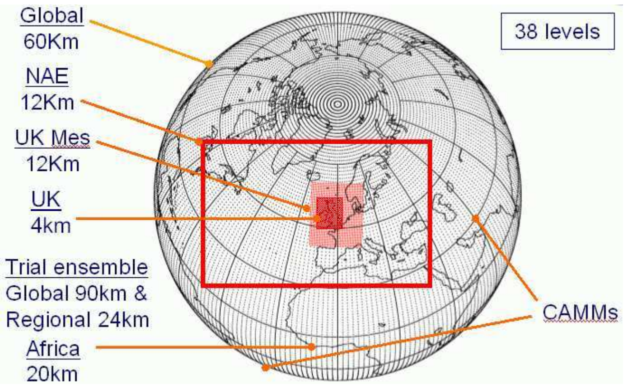


Figure 1: Current NWP Model configurations

Supercomputers for NWP and Climate

In April 2005, there was an upgrade to the twin 15 node NEC SX6 system that had been operational since April 2004. The addition of 4 SX6 nodes plus a 16 node NEC SX8 has given an increase in computing power from 1.86 TFlop to 4.08 TFlop, allowing the introduction of ensembles and increased resolution models (including those used in climate research).

Global model changes

Cycle	Date	Global Model Change
G33	5 Oct 04	Introduction of 4D-VAR
G34	18 Jan 05	HadGEM physics upgrade
G35	8 Feb 05	Data Assimilation upgrade
G36	14 June 05	DA and SA upgrade
G37	17 Aug 05	Implementation of a soil moisture nudging scheme

Introduction of HadGEM physics

An upgrade to the Global model physics was introduced in cycle G34. The package included improvements to the Large Scale precipitation (3C) and Boundary Layer (8B) schemes. There was also a change to the CAPE closure timescale and an increase in Saharan surface albedos. The main benefits were seen in the tropics with an improved circulation and winds. Precipitation over land was increased while precipitation over the ocean was decreased (figure 2). Elsewhere there were beneficial reductions in low cloud (e.g over Iraq) and improved 1.5m temperatures. The main drawback was an increase in the existing warm bias in the extratropics.

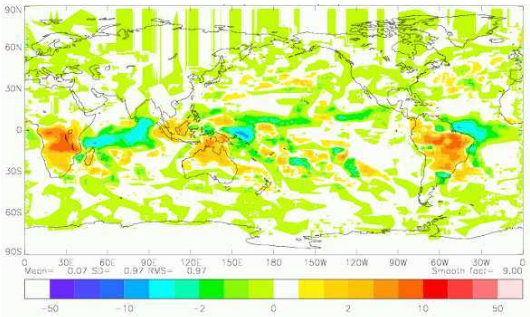


Figure 2: Convective rain amount: 30 min CAPE forecast - 1 hour CAPE forecast

Implementation of a soil moisture nudging scheme

A soil moisture nudging scheme was introduced in cycle G37, replacing the previous weekly reset to climatology. The nudging scheme uses errors in the 6 hour forecasts of screen temperature and humidity to infer (using the physics of the land surface model) corrections to the soil moisture field. Summer trials showed improvements to surface and boundary layer temperature forecasts whilst Winter results were close to neutral.

Planned Global Changes (2005-6)

- Increased horizontal (40km) and vertical (50 levels) resolution (December 2005)
- Convection and Boundary Layer tuning (Spring 2006)
- Introduction of improved AIRS (better humidity, esp SH) (Spring 2006)
- Introduce SSMIS (T only, back-up for N15 AMSU); SSMI introduce TCWV by using stricter thinning to only include cloud-free areas (Spring 2006)
- Upgrade to 4D-VAR including better incremental physics. (Summer 2006)
- Microwave cloudy radiances and less obs thinning (ATOVS) (Summer 2006)

Introduction of the Met Office Global and Regional Ensemble Prediction System (MOGREPS)

Cycle	Date	Ensemble model Change
MOGREPS_G1	14 June 05	Model introduced
MOGREPS_G2	11 Oct 05	Stochastic physics upgrade
MOGREPS_R1	17 Aug 05	Model introduced

Initially forecasters will view output on the internal web. There are also plans to engage in multi-model ensembles with USA and Canada (THORPEX).

Global Ensemble

- 24 member Global Ensemble at N144 (~90km) resolution
- Twice per day (00Z, 12Z) to T+72 hours
- ETKF perturbations, stochastic physics

Regional Ensemble

- 24 member North Atlantic/European Ensemble at 24km resolution
- Twice per day (06Z, 18Z) to T+36 hours
- IC perturbations taken directly from the Global model
- Nested within Global Ensemble for LBCs

NAE model Developments

Cycle	Date	NAE model Change
E5	18 Jan 05	Change in domain
E6	22 Feb 05	Horizontal resolution increased from 20km to 12km
E7	14 June 05	New surface soil moisture analysis
E8	17 Aug 05	Removal of truncation of vertical modes in VAR from 21 to full 38
E9	11 Oct 05	New CovStats based on Global model

New CovStats

New CovStats based on Global model CovStats (generated using the NMC method) replaced the use of U.K Mes covariances in cycle E9. The Global covariances fit less closely to obs but the horizontal length scales are longer and this leads to large improvements to the performance of the model. Ideally we would use NAE covariances but forecast differences are dominated by the use of different lateral boundary conditions.

Planned NAE Changes (2006)

- Upgrade to model physics (Spring 2006)
- Introduction of 4D-VAR (Spring 2006)
- More new satellite data e.g. full resolution AMSU-B, Assimilation of GPS data, MODIS winds etc. (Summer 2006)
- Increased vertical resolution (Autumn 2006)

Crisis Area Mesoscale Models (CAMM's)

Currently a 17km Southern Asia and a 12km Falklands model are run operationally. However new configurations can be set up rapidly as demonstrated by the Bay of Bengal CAMM in response to the 26th December 2004 Tsunami and the USA CAMM (Hurricanes). The extra resolution not only helps to deepen Hurricanes such as Rita but also gives the possibility of a different track forecast.

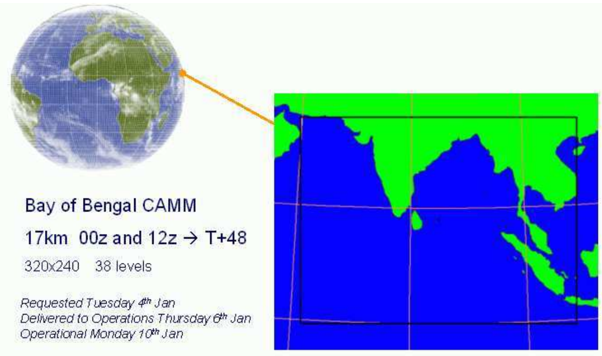


Figure 3: Bay of Bengal CAMM

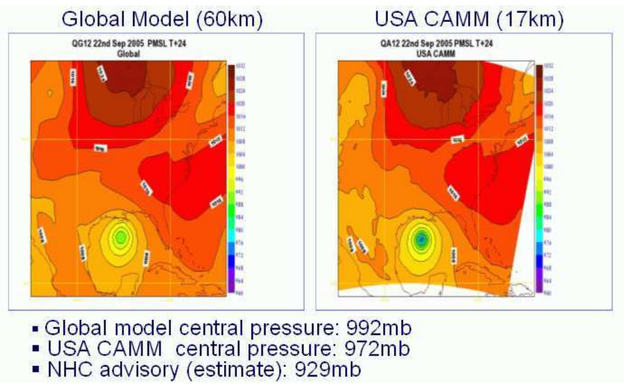


Figure 4: USA CAMM Hurricane Rita

African Model

The 20km resolution Africa model was introduced into the Operational Suite on 13th April 2005 as part of the Met Office vision of increased focus on assisting developing countries and disaster mitigation. Currently there is one forecast per day (00UTC) to T+48 hours, but this will change in early 2006 when data assimilation (6 hour cycle) is introduced. There are also plans for an increase in the model vertical resolution during 2006.

HRTM and UK4 models

The High Resolution Trial Model (HRTM) has been developed over a number of years and is the basis for the now operational UK4 model. However development of the HRTM has continued and it is used as a testbed for planned UK4 upgrades.

The UK4 model became operational in April 2005 and there have been encouraging results from both pre-operational tests and the first few operational months. Objective verification scores have been slightly worse than other operational models and some problems have been identified. Several upgrade packages are scheduled for implementation in the near future.

HRTM Scientific Options

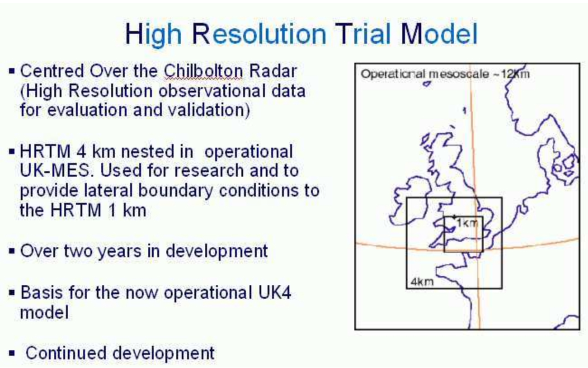


Figure 5: HRTM

Like other Met Office operational models, the HRTM has non hydrostatic dynamics with Semi-Lagrangian advection and Semi-Implicit time integration. The Boundary Layer scheme is a 1st order non-local K scheme with explicit entrainment and the radiation is a two stream scheme with 5 spectral bands for short wave and 5 for long wave. It differs from other models in that is uses a Del-4 operator in U,V,Q and Theta for Horizontal diffusion and a mixed phase scheme + 3D advection of precipitation products for the microphysics.

Convection: Deep convection explicitly resolved and shallow convection parametrised. Solution based on the operational mass flux scheme with CAPE closure. The CAPE reduction timescale is dependant on the CAPE such that for large values of CAPE, the CAPE timescale increases, reducing the activity of the convection scheme and allowing explicit deep convection. For small CAPE, a minimum CAPE timescale is fixed and shallow convection processes are taken into account. It has been seen that there is a delay in the onset of convection as the convection scheme is made less active.

UK4 model

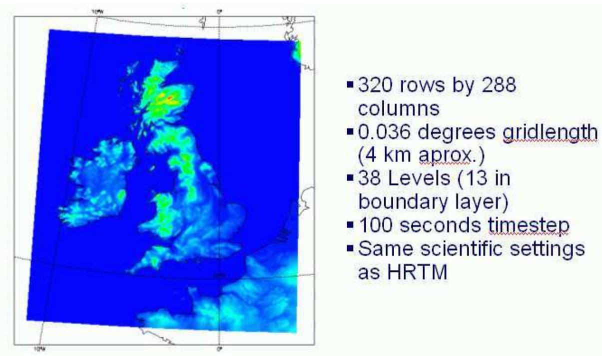


Figure 6: UK4 model

UK4 Model - Pre-operational tests

21 case studies were run covering of all the main weather regimes, (although biased towards severe weather events) with the lateral boundary conditions being provided by the UK Mesoscale model. A continuous trial was run from 1st March to 1st April 2005 with forecasts at 00UTC and 12UTC. There was varied weather through the period and this time the lateral boundary conditions were provided by the NAE model.

The model proved to be very robust and there were a number of positive points such as the better forecasting of fog than other coarser resolution operational models. However a number of problems were also identified. The 11th August 2004 organised convection case showed that although the banded structure in the 6hr precipitation accumulation compared well with the radar (figure 7), the small structure of precipitation was found to be too persistent (figure 8). There was better agreement when averaged to a 12km grid. The model also had unrealistically large row/point precipitation rates (grid point storms) as seen in the 03rd August 2004 Borders Grid Point Storm case (figure 9). A negative cloud bias (operational models use a cloud enhancement scheme) was found to be the cause of the diurnal cycle in the screen temperature bias (figure 10). Finally, PMSL errors were found to be strongly linked to errors in the driving model.

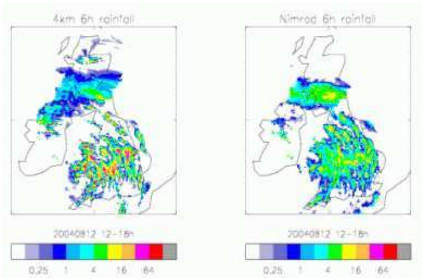


Figure 7: Banded structure in the 6hr precipitation accumulation (left) compares well with the radar (right).

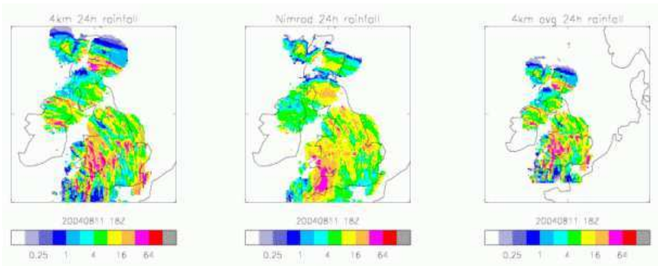


Figure 8: Small structure in 24hr precipitation accumulation (left) too persistent compared to radar (centre). Better agreement when averaged to a 12km grid (right).

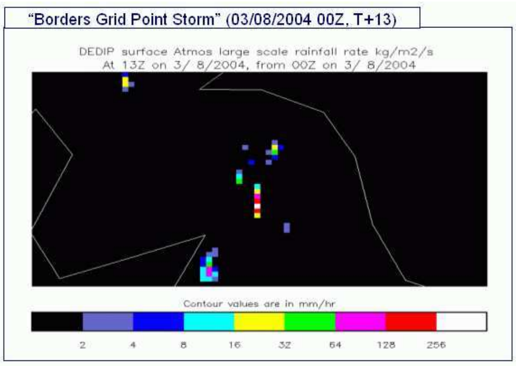


Figure 9: Borders Grid Point Storm - a row of unrealistically large precipitation rates at T+13 on 03rd August 2004.

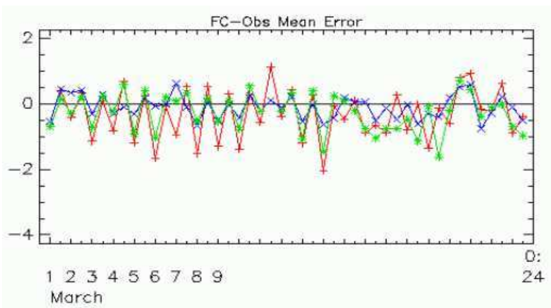


Figure 10: Diurnal cycle in screen temperature bias (UK4 in red,U.K Mes in blue and NAE in green) due to negative cloud bias.

UK4 Model - Introduction into operations

Cycle	Date	UK4 model Change
U4.01	13 April 2005	Model introduced. One forecast per day to T+36 at 00UTC
U4.02	14 June 2005	Extra T+36 forecast at 12UTC added
U4.03	11 October 2005	Upgrade to the model science.

The feedback from forecasters was generally positive although there was concern at the number of false alarms of heavy precipitation events and the excessive amount of light precipitation. There was a high profile severe weather event in North Yorkshire on the 19th July 2005. Intense precipitation caused flooding of the Rye Valley and the model gave good guidance in terms of timing, intensities and location (figure 11).

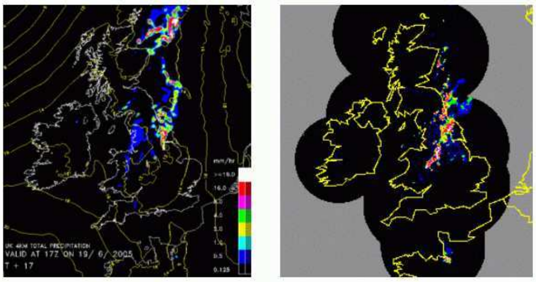


Figure 11: Rye Valley floods

Upgrade to the model science

A science package was implemented in cycle U4.03 of the UK4 model on 11th October 2005. The package included an upgrade of the convection scheme to the current operational version (4A), but keeping the CAPE dependent CAPE closure. The microphysics was tuned to reduce excessive light precipitation and the empirically adjusted cloud fraction was enabled to enhance cloud amounts. Finally the horizontal diffusion of moisture was replaced by the targeted diffusion of moisture.

Planned UK4 model Changes (2006)

- Introduce 3D-VAR assimilation system (plus Analysis Correction scheme for cloud and precipitation)
- Introduce orographic gravity wave drag parametrization
- Introduce anthropogenic urban heat source
- Introduce daily initialisation of soil moisture
- Increased vertical resolution
- Introduce seasonal variability into the Leaf Area Index
- Split urban tile type into rooftops and street canyons

3 National status reports

3.1 Austria

STATUS REPORT AUSTRIA

1. The operational LAM system: ALADIN AUSTRIA

In May 2004, the spectral limited area model ALADIN has changed from two Central European domains (LACE & VIENNA) to one domain (ALADIN AUSTRIA). The system merges the benefits of its operational predecessors, which are the domain size on one hand side and horizontal resolution on the other hand side. Further it could be mentioned that the change to one domain brought a simplification and reduction of the operational procedure, which has positiv effects on the availability of the customer-products. The specifications of the operational LAM system are:

- CY25T2, 289x259 gridpoints
- Timestep: 415s
- Horizontal resolution: 9.6km
- 45 vertical levels
- Coupling model: ARPEGE, coupling frequency: 3h

A newer model version (CY29T2) has been recently installed and is supposed to become operational in the beginning of 2006.

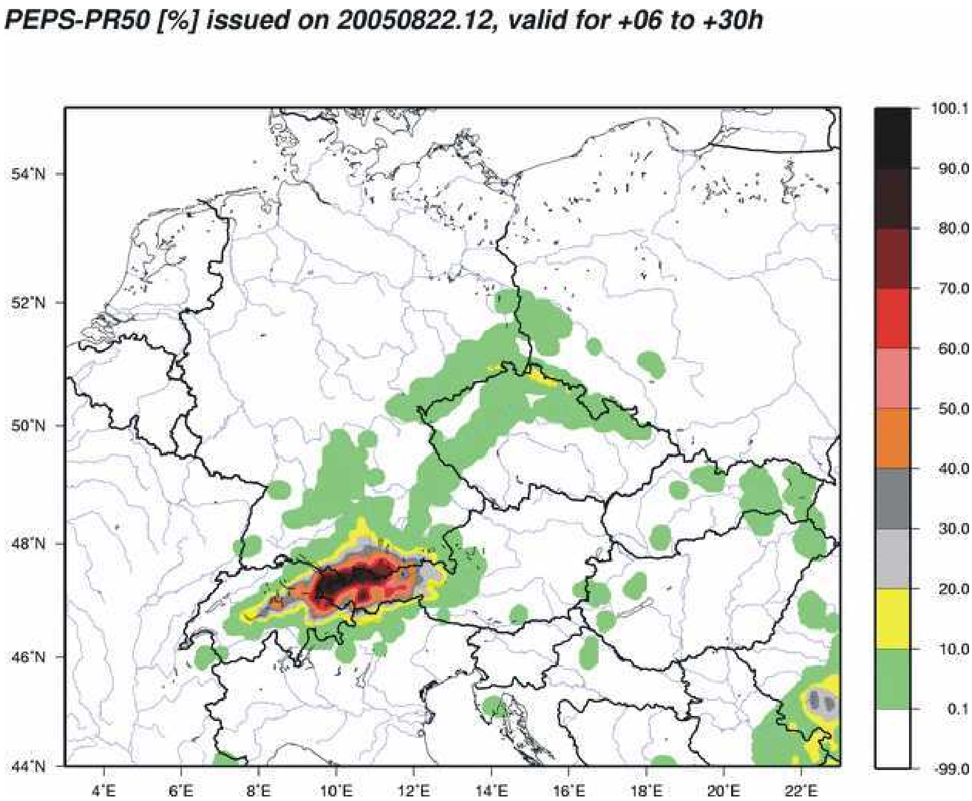


Figure 1.1.: Result of a PEPS precipitation forecast (probability of precipitation exceeding 50mm) for a period in August 2005, when several floodings caused a lot of damage in western Austria, parts of Switzerland and Bavaria.

ALADIN-AUSTRIA is also one member of PEPS (Poor Man Ensemble Prediction System) which tries to make predictability forecasts based on several different LAMs (see Figure 1.1.).

2. Verification

ALADIN forecasts are verified against ALADIN analysis and against point observations at several locations in Austria. Parts of the verification are run operationally and the results are made available via Intranet to help the forecasters in analysing forecast errors of previous days.

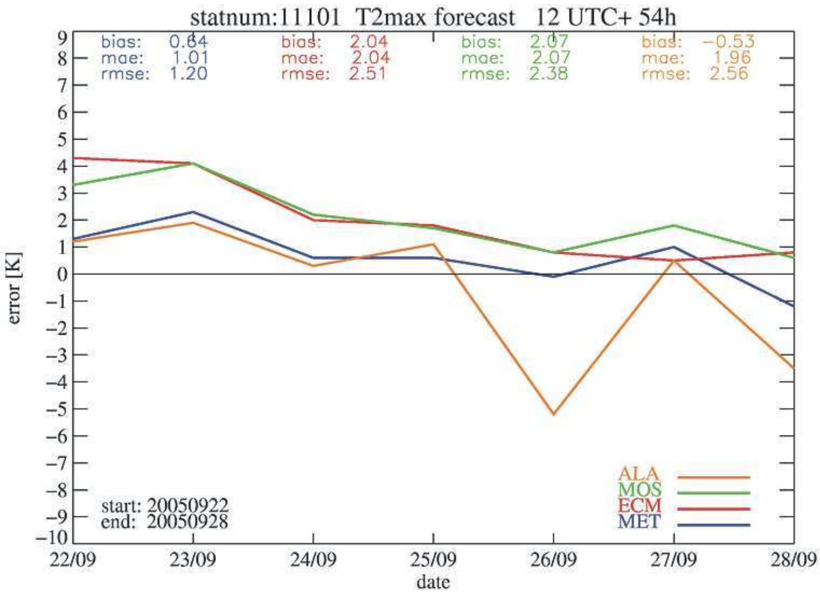


Figure 2.1.: Comparison of point forecasts (T2max) for station Bregenz (22.9.05-28.9.05). Orange: ALADIN, red: ECMWF, green: MOS, blue: Forecaster.

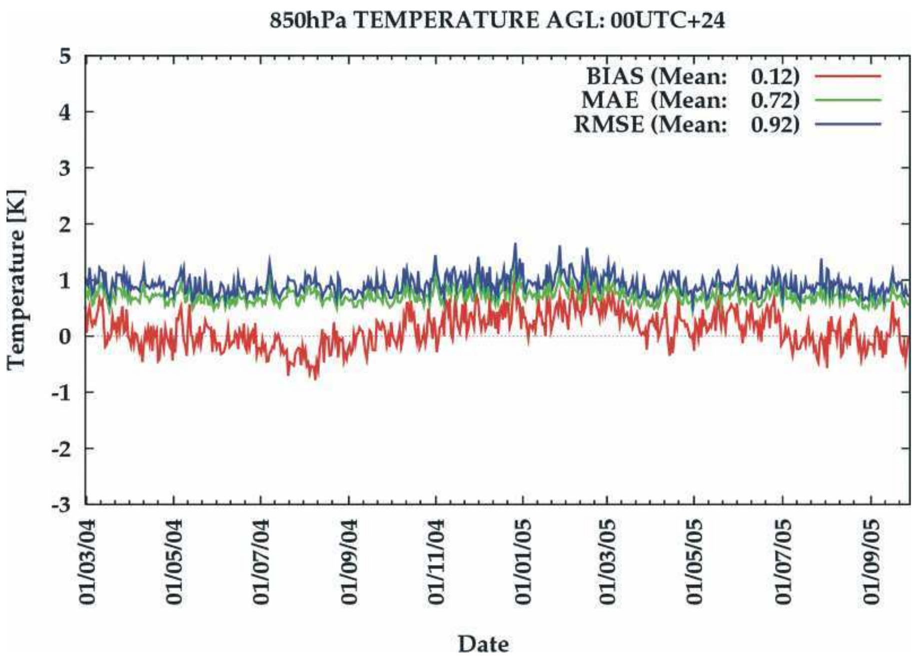


Figure 2.2.: Result of 850hPa temperature verification.

Additionally an internal verification report is issued by ZAMG every two years including long term verifications as well as verification of special events like flooding or strong wind periods.

3. INCA (Integrated Nowcasting through Comprehensive Analysis)

A high-resolution analysis and nowcasting system is being developed at the Austrian national weather service. It provides three-dimensional fields of temperature, humidity and wind on an hourly basis, and two dimensional fields of precipitation rate and cloud cover. The system operates on a horizontal resolution of 1km and a vertical resolution of 200m. It combines station data, remote sensing data (radar, satellite), forecast fields of a numerical weather prediction (NWP) model, and high resolution topographic data in order to generate analysis fields.

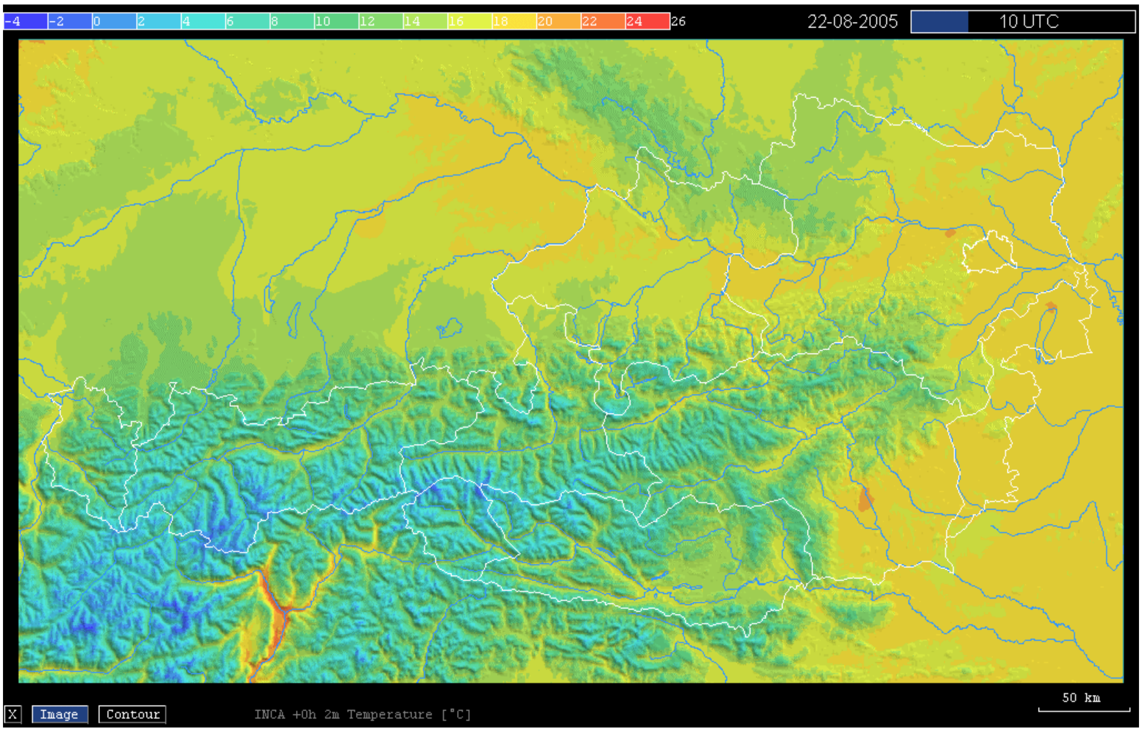


Fig 3.1.: INCA T2M Analysis, 22.08.2005 10 UTC.

For temperature, humidity and wind, the NWP model output is used as a first guess on which corrections derived from observations are superimposed. In the case of temperature and humidity, the spatial interpolation of the correction is three-dimensional, because the station network covers most (from 150m to 3400m) of the elevation range in the Austrian alps.
A mass consistent high resolution wind-field is obtained from NWP model output by using a sequential relaxation procedure. During the relaxation algorithm, the wind at the station locations is kept at its observed value.
The current method of predicting temperature in the nowcasting range makes use of the fact that much of the temperature error in the NWP forecast is due to errors in the cloudiness forecast. Starting from analysis, nowcasting is done by reducing or increasing the temperature amplitude of the model by a factor depending on the cloud fraction error.
The INCA precipitation forecast consists of two components, which are observation-based extrapolation, and NWP model forecasts. The extrapolation method is based on motion vectors determined from previous analyses. The model forecasts are output fields of the limited area model ALADIN and the global ECMWF model.
An important application of INCA fields is nowcasting of convective cell initiation and development. This requires detailed analysis of the state of the mountain convective boundary layer (CBL). Derived from INCA analyses, a number of fields pertinent to deep convection

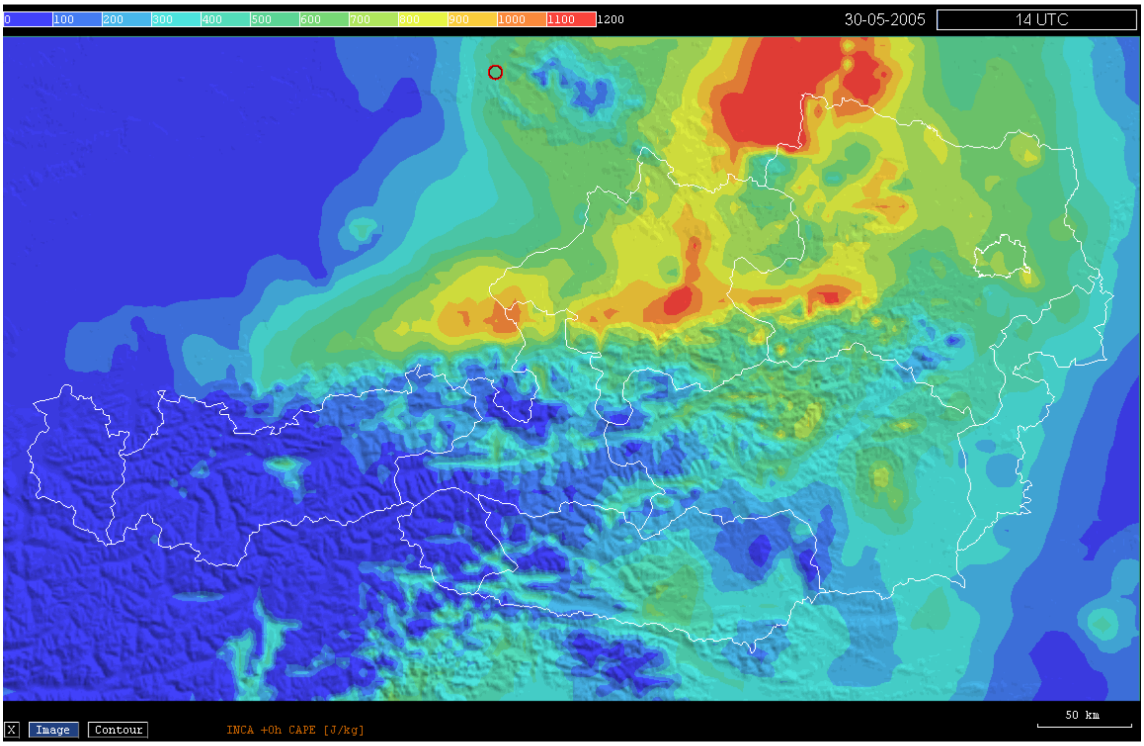


Fig 3.2.: INCA CAPE analysis, 30.05.2005 14 UTC

initiation are routinely generated and their predictive potential evaluated. These fields include flow convergence and specific humidity within the CBL, LCL, CAPE, CIN, several stability indices and the difference between temperature and trigger-temperature.

3.2 Belgium

Alex Deckmyn, Luc Gerard, Olivier Latinne, Piet Termonia

Josette.Vanderborght@oma.be

Complex Wavelets for representations of 3D structure functions

The purpose of this work is to improve the representation of background error covariances in a the 3d-Var assimilation of a limited area model (LAM). In particular, we want to include local variations in variance, heterogeneity and anisotropy of the structure functions. In 3 dimensions, the model should be able to represent locally tilted structure functions.

Due to the very large size of the background state vector (around 10^7), it is not possible to represent the full background error covariance matrix $\mathbf{B}$. (Many 3d-Var schemes actually implement $\mathbf{B}^{-1/2}$.)

By diagonalising a 2D covariance matrix in *grid point space*, we would get a perfect representation of local variances but no covariances at all. On the other hand, a diagonalisation in *Fourier space* yields the mean variance and structure function at every location.

A kind of intermediate solution is to diagonalise $\mathbf{B}$ in a *wavelet basis* . In [1] a hybrid method was used that combines an orthogonal basis of Meyer wavelets with further diagonalizations in grid point and Fourier space. This showed a much improved representation of correlation length, but only limited anisotropy. We are now researching a new approach using **Dual Tree Complex Wavelets** [2].

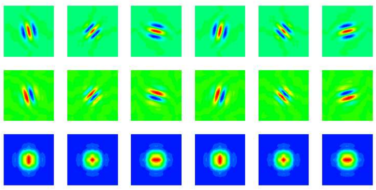


Figure 1: Complex wavelets. row 1: real part; row 2: imaginary part; row 3: modulus

3D structure functions

Compared to orthogonal 2D wavelet transforms as used in [1], these functions have several advantages:

- **Directional resolution**: the functions have 6 different orientations at intervals of approximately 30^o.
- **Near shift invariance**: The 4-fold redundancy results in a wavelet decomposition that has much less artefacts. It also implies that local variations are better captured.

In Figure 2 a vertical profile is shown for a chosen location. While the wavelet diagonalisation obviously eliminates many details, some salient features are retained. Most notably, the vertical profiles are tilted.

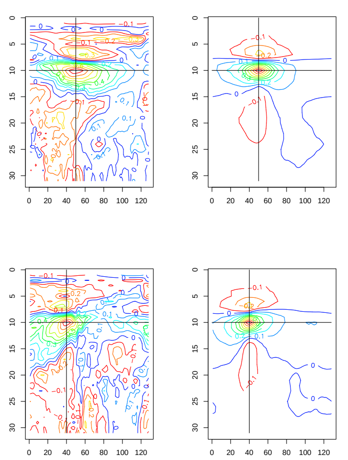


Figure 2: Zonal and meridional cross sections of correlation functions from original data and from complex wavelet diagonalisation.

Neural Networks for Model Output Statistics

We are currently researching the use of artificial neural networks for Model Output Statistics (MOS) of temperature forecasts. Figure 3 shows the improvements in monthly RMSE scores of a simple linear model (LM) and a neural network.

Both (experimental) MOS systems were trained on 3 years of forecasts of the ALADIN model (cycle 15) and tested on a fourth year.

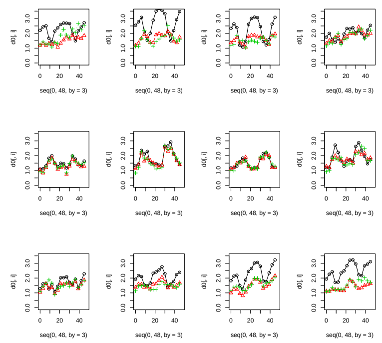


Figure 3: Monthly RMSE for plain forecasts (black), a simple linear MOS (green) and a neural network (red).

New approaches to deep convection parametrisation and its binding to a microphysical scheme

It has been a long practice in operational NWP models to separate the saturation processes between a 'resolved' part (i.e. which can be considered homogeneous when seen at the scale of the grid box), associated to stratiform or frontal events and a 'subgrid' part, linked to deep convection. For the 'resolved' part, statistical considerations may address the smaller scale inhomogeneities; this is the starting point of most microphysical packages. However, at all resolutions with grid boxes greater than 2 or 3 km, the effects of deep convective systems cannot be represented satisfactorily without a dedicated scheme. Then, combining the output of this scheme – condensation, precipitation, cloudiness – with the main microphysical scheme is not straightforward. Keeping a separate convective scheme, directly producing its own precipitation, which should be added to the one of the resolved scheme poses several problems, and induces mesh size and time step dependencies.

The problem is especially acute for the resolutions between 7 km and 2 km, where the convective clouds are partly resolved, partly subgrid. This is now often referred to as a 'grey zone' of resolutions, which 'should be avoided'.

Still, being able to handle the grey-zone resolutions is very desirable, because:

- They may be interesting in many circumstances.
- Jumping over this grey zone is very expensive.
- The parametrisation effort increases our understanding of the natural phenomena.

Moreover, having a scheme which results are not dependent of the resolution thanks to a smooth combination of resolved and subgrid parts represents a considerable advance. The present version of our scheme (details to be published soon) uses a modified version of the microphysical scheme developed by Lopez [4], with prognostic variables for cloud ice and liquid water, but not for the precipitating species. Various enhancements were brought to this scheme, as modelling the Bergeron effect, and a better representation of the phase changes of the condensates.

A new method has been developed for combining the subgrid and resolved contributions of cloud condensation and precipitation. The convective updraught routine is an extension of the one described in [3]. It includes prognostic variables for the updraught velocity and mesh fraction, and now it detrains condensates instead of producing precipitation fluxes.

We also use a proposition of J.M. Piriou (PhD-thesis 2005) to calculate the contribution of the updraught to the model fields. The convective scheme is completely integrated with the microphysical routines; an external downdraught is applied at the end, driven by the cooling accompanying the total precipitation.

This new version of the integrated scheme yielded significantly better predictions than the operational Aladin model for various convective events. Tests at different resolutions also show a good independence of the forecast precipitation amounts to the model grid-box length and to the time step. Figure 4 shows an episode of very intense showers over Belgium on Saturday 10 September 2005. The model fields are the 1-hour-accumulated precipitation at 19:00 and 20:00 utc, the mean-sea-level pressure (hPa), the 2m-temperature (ºC). On the composite radar images (here at 19:00 and 20:00 utc), several cells show very few motion for several hours. The operational model (above) missed the strong convective events (this model uses a diagnostic convection scheme and a diagnostic representation of cloud water). On the contrary, our new integrated scheme (below) shows very realistic pictures of the situation. Also the total accumulated precipitation between 12:00 and 24:00 utc is very patchy, with amounts up to 80mm, in quite good agreement with the synoptic stations which measured amounts between 50 and 100mm.

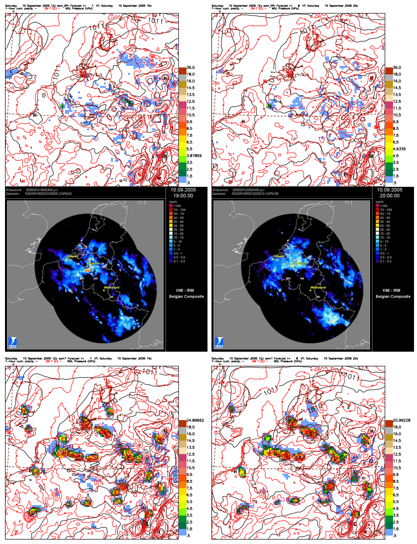


Figure 4: Top: operational Aladin 29. Centre: composite radar images. Below: new integrated scheme for convection and microphysics (see text).

Other Research Subjects

Other research in the ALADIN group currently includes:

- physics/dynamics interfacing
- externalisation of surface scheme

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[1] Deckmyn, A. and L. Berre, 2005: Wavelet Approach to Representing Background Error Covariances in a Limited Area Model, *Mon. Weath. Rev.* **133** (2005), pp 1279–1294.

[2] Kingsbury, N., 2001: Complex Wavelet analysis for shift invariant analysis and filtering of signals, *Applied and Computational Harmonic Analysis* **10**, 234–253.

[3] Gerard, L. and Geleyn, J.F., 2005: Evolution of a subgrid deep convection parametrization in a Limited Area Model with increasing resolution, *Q.J.R. Meteorol. Society* **131**, (in press).

[4] Lopez, Ph., 2002: Implementation and validation of a new prognostic large-scale cloud and precipitation scheme for climate and data assimilation purposes, *Q. J. R. Meteorol. Soc.* **128**, 229–258.

3.3 Croatia

NWP in Croatian Meteorological and Hydrological Service

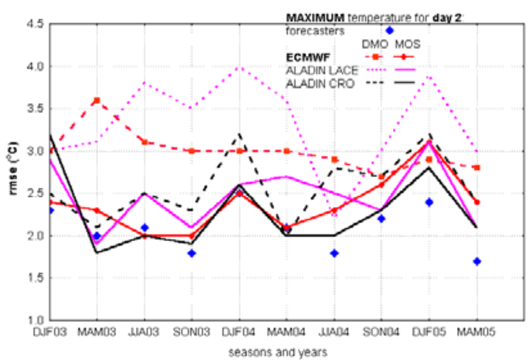
presented on 27th EWGLAM & 12th SRNWP meetings
3rd - 5th October 2005, Ljubljana, Slovenia

Zoran Vakula, Lovro Kalin, Martina Tudor, Ivana Stiperski, Vlasta Tutiš, Dunja Drvar,
Lukša Kraljeviü, Kornelija Špoler ýaniü, Branka Ivanþan-Picek and Stjepan Ivatek-Šahdan
Meteorological and Hydrological Service, Griþ 3, HR-10000 Zagreb, Croatia
for more information ivateks@cirus.dhz.hr

Current status of Operational NWP Suite

In the Croatian meteorological service ALADIN is operationally run twice a day, for 00 and 12 UTC. Coupling files are retrieved from ARPEGE (Meteo-France global model) via Internet and RETIM2000. The execution of the suite is controlled by the OpenPBS (Portable Batch System) as the queuing system. Horizontal resolution of the LACE domain is 12.2 km, 37 vertical K-levels, time-step 514 sec, 229x205 grid points (240x216 with extension zone). Horizontal resolution of Croatian domains is 8 km, 37 vertical K-levels, time-step 327 sec, 169x149 grid points (180x160). Initialisation of ALADIN on LACE domain is provided by Digital Filter Initialisation (DFI). Coupling frequency and frequency of output files for the LACE and Croatian domains are 3 hours. When the 48 hours forecast on LACE domain is finished 48 hours forecast for Croatian domain starts without initialisation with coupling files from LACE. 6 domains for the dynamical adaptation of the wind field in the lower troposphere to 2-km resolution orography for mountainous parts of Croatia. Dynamical adaptation is run sequentially for each output file, with 3 hour interval. In the dynamical adaptation meteorological fields are first interpolated from input 8-km resolution to the dynamical adaptation 2-km resolution. The same file is used as a initial file and as a coupling file that contains boundary conditions for the model.
Visualisation of numerous meteorological fields are done on LINUX PC. Comparison of forecasts with SINOP data are done hourly for today's and yesterday's forecast. The products are available on the Intranet & Internet. Internet address with some of the ALADIN products, total precipitation and 10 m wind: http://prognoza.hr/aladin_prognoza_e.html & http://www.dhmz.htnet.hr/prognoza/aladin_prognoza_e.html.

Operational forecasts verification



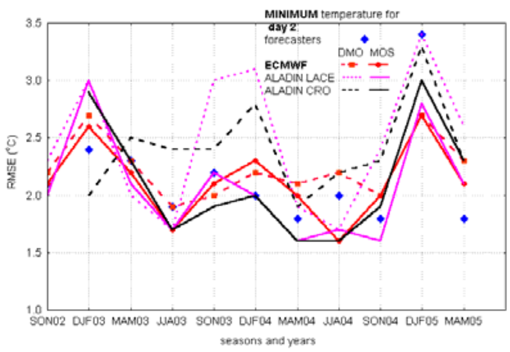


Figure 1. Root-mean-square errors of maximum temperature for day 2 (left) and minimum temperature for day 2 (right) forecast of forecasters and models: ECMWF, ALADIN LACE and CROATIA for direct model output and model output statistics, for Zagreb Maksimir (14240), from winter 2002/03 to spring 2005. MOS were done using regression equations (y=ax+b) which were calculated from historic data.

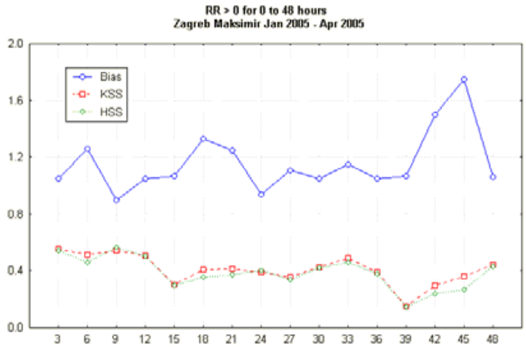
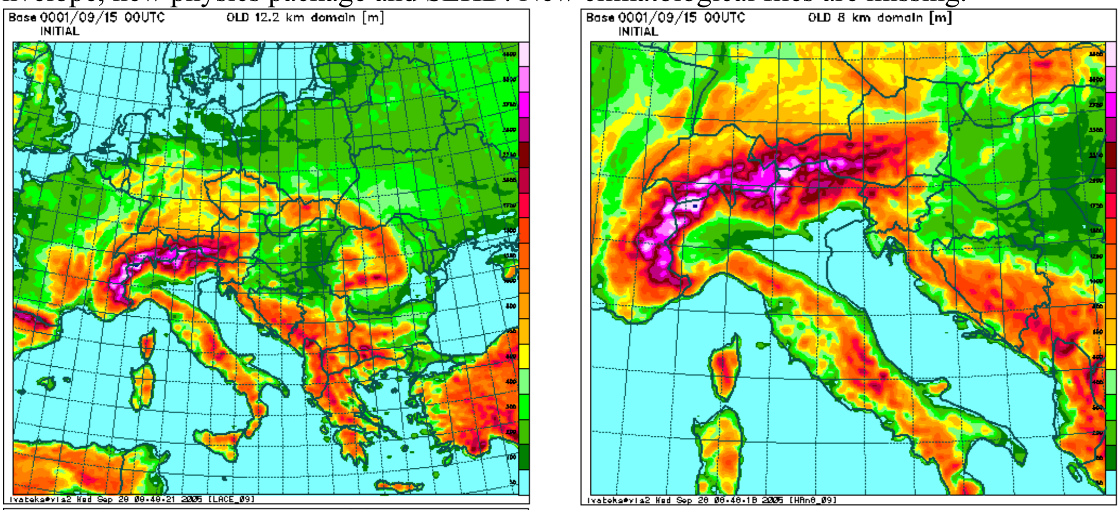


Figure 2. Precipitation verification for 3 hour periods for Zagreb Maksimir (14240), bias, Hansen-Kuipers Skill Score (KSS) and Heidke Skill Score (HSS) ALADIN CROATIA (8-km) were made from contigency table.

Changes in near future

Before the end of the year it is planed to make a lot of changes in operational suite simultataneously. At the time the new set-up is in parallel suite. Replace the operational model version 25T1 with 28T3 Prague version. Switch to a single big domain (one large 8km resolution domain in the place of the LACE and the current operational Croatian domain), no envelope, new physics package and SLHD. New climatological files are missing.



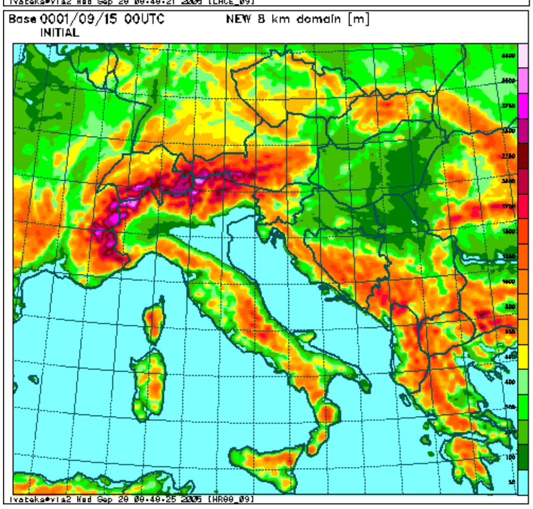


Figure 3. Old domains LACE (top left) and Croatian (top right). New bigger domain at 8 km resolution HR88 (left), 37 vertical K-levels, time-step 327 sec, 229x205 grid points (240x216 with extension zone). Corners: SW (36.18,3.90), NE (50.68,26.90). Initialisation of ALADIN on HR88 domain is provided by Digital Filter Initialisation (DFI). Coupling frequency and post processing frequency will remain on 3 hours. Forecast range will be 54 hours.

Research topics in 2005

SLHD: Semi-Lagrangian Horizontal Diffusion shows beneficial impact on the reduction of the overestimated cyclone intensity, correction of cyclone position while not altering a good intensity prediction and improvement of fog forecast in the valleys in an anticyclone.

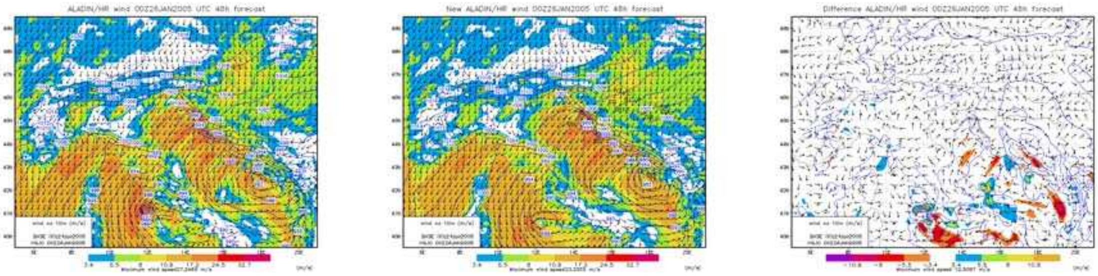


Figure 4. 10m wind and mean sea level pressure obtained with classical numerical diffusion (left), SLHD (centre) and their difference (right), 48hr fcst from 00 UTC 24th January 2005.

Radiation and cloudiness: Unsatisfactory model forecast in fog has encouraged a study of alternative radiation and cloudiness schemes combined with diff. cloud overlap assumptions.

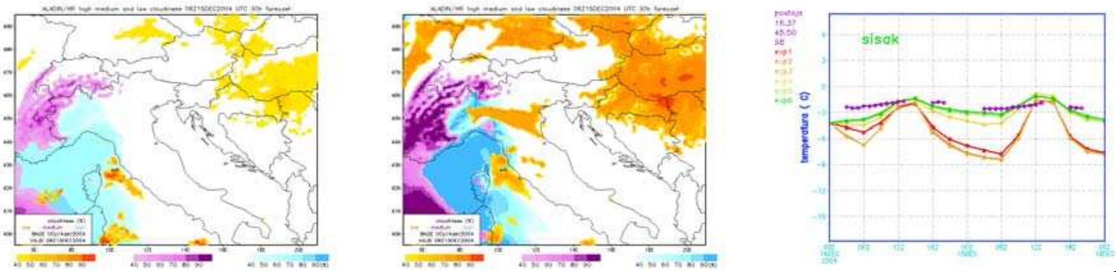


Figure 5. Low, medium and high cloudiness, 30 hour forecast starting at 00 UTC 14th December 2004, with the operational radiation scheme, operational critical relative humidity profile and operational cloudiness parametrization with random overlap (left) and Xu-Randall cloudiness scheme with random overlap (centre). Comparison of the modelled 2m temperature evolution (right) for same run with measured data from synoptic station with operational radiation scheme exp1-operational exp2-max. overlap in cloud scheme exp4-new vert. humidity profile Xu-Randall cloudiness scheme with max. overlap and exp6-operational vert. humidity profile Xu-Randall cloudiness scheme with random overlap (as in the centre).

Envelope or not?: Removal of envelope and changes in gravity wave drag parametrization result in stronger winds on the windward and generally weaker winds on the leeward side of the obstacles, as well as mountain wave amplitude reduction and smoothing.

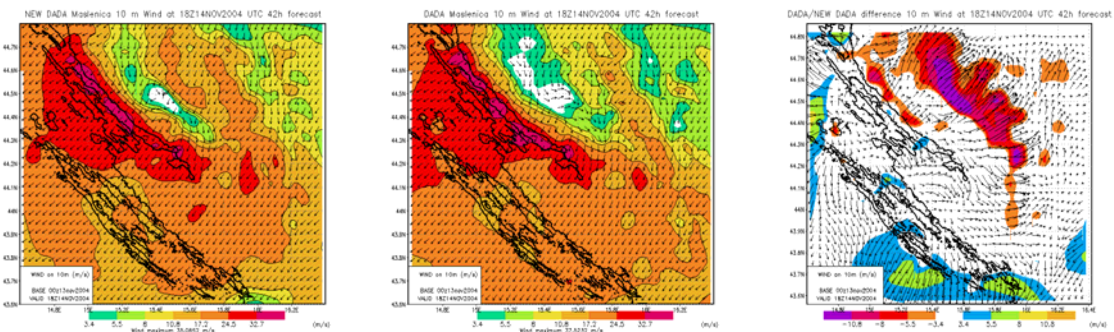


Figure 6. 10m wind in the operational (left) and mean orography (centre) model version, and difference (right), for the 2-km model resolution, 42hr fcst from 00 UTC 13th November 2004

Intercomparison of MM5 and Aladin: High resolution simulations of a severe Bura event from 22nd to 26th December 2003. The maximum measured wind gust was 62.7 m/s and the maximum 10-minute mean wind speed was 40.9 m/s, strongest during the winter 2003/04.

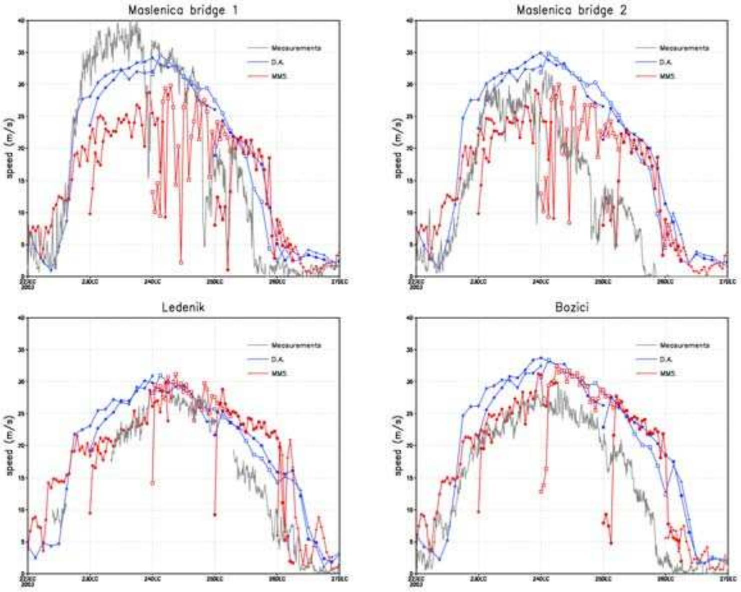


Figure 7. 10-m wind meas. and modeled for 4 stations on the new highway near Zadar, Maslenica bridge 1&2 and 2 stations upslope on the highway Ledenik & Bozic.
The high resolution 1-km MM5 is computationally very expensive, while ALADIN dynamical adaptation on 2-km is computationally very cheap.
Operational ALADIN/HR dynamical adaptation same as MM5 simulation are able to reproduce extreme variability of Bura.

Sensitivity to the initial conditions: Different initial and boundary conditions were used to run the ALADIN forecast: operational ARPEGE form 1999 and ECMWF MAP Re-Analysis from 2003. Results of the numerical experiments show the higher sensitivity to the initial conditions for the MAP IOP 5 heavy precipitation case, especially in Slovenian near Austrian and Italian border and on the Slovenian Croatian border. For MAP IOP 15, different initial conditions do not have a significant influence.

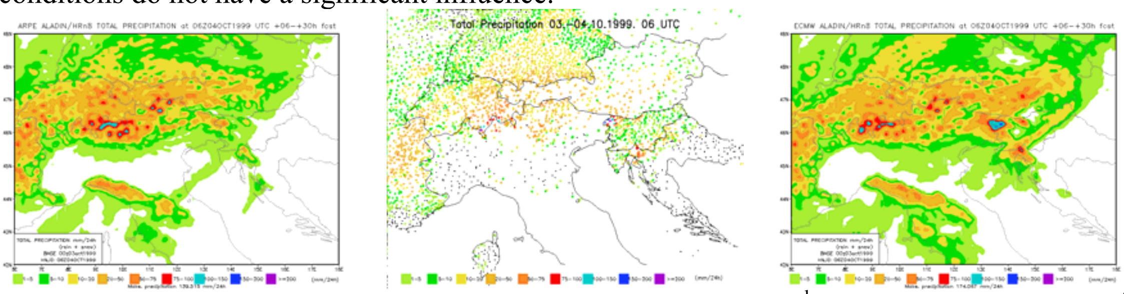


Figure 8. 24-hour accumulated precipitation (in mm) from 3rd October, 06 UTC to 4th October, 06 UTC for: ARPEGE (left) downscaled to ALADIN 8-km resolution, observations (center) and ECMWF MAP Re-Analysis (right) downscaled to ALADIN 8-km resolution.

Intercomparison of Coamps and Aladin: ALADIN 8-km and 2-km resolution Dynamical Adaptation forecasts and COAMPS NH 3-km resolution forecast are compared to the aircraft measurements (ELECTRA) showing that ALADIN is able to reproduce the structure of PV banners and good wind forecast especially the 2-km resolution run.

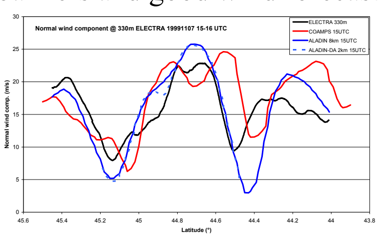
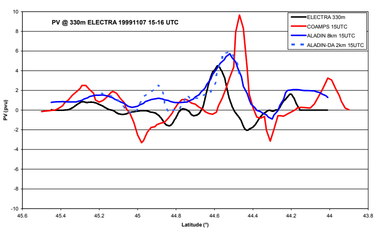


Figure 9. Flight data-black line and simulations ALADIN 8-km-blue line, COAMPS-red line & ALADIN 2-km Din. Adaptation-dashed blue line Normal wind component (left) and PV (right) for 330m.



3.4 Czech Republic

Status report of the Czech Hydrometeorological Institute (CHMI)

(October 2004 - September 2005)

The key NWP application at CHMI is the ALADIN/CE model run on NEC SX6/4B-32 machine. It can be characterized by following:

- LACE domain (309x277 grid points, linear truncation E159x143, Δx=9km)
- 43 vertical levels, mean orography
- time step 360 s
- digital filter spectral blending long cut-off cycle (6h cycle, filtering at truncation E47x42, no DFI in the next +6h guess integration)
- digital filter blending + incremental DFI initialization of short cut-off production analysis
- 3h coupling interval
- based on ARPEGE/ALADIN cycle CY28T3 with the so-called Prague physical package and the SLHD
- 00 and 12 UTC forecast to +54h
- 06 and 18 UTC forecast to +24h
- hourly on-line fullpos

Besides the ALADIN/CE application the other ALADIN configurations are operationally used at CHMI:

- hourly DIAGPACK analysis of T2m, RH2m, v10m, KO-index, CAPE, MOCON (SYNOP observations)
- verification package based on cycle CY22T1/AL12 (CY28 in validation)
- monitoring of SYNOP and TEMP observation based on OI quality control
- post-processing of near-surface parameters into selected localities using obs-operators of OI

The special ALADIN/MFSTEP application (6 hours blending assimilation cycle and once per week 120 hours forecast) is computed for the purpose of the Mediterranean Forecasting System Toward Environmental Predictions EU grant. The special period for this grant has finished (in February 2005) but an interest of several scientific communities to still use such products was identified. CHMI accordingly continues with running this application. However the computational area was dramatically reduced (June 2005) to sub-area of the original domain covering mainly western part of the Mediterranean sea. In numbers this change means that original area of 589x309 grid points has been reduced to 256x200 grid points with consequent change of the linear truncation from 299x159 to 127x99 waves. The 9.5 km horizontal resolution and 37 levels distribution has been preserved.

Plans for close future (already in parallel tests)

1. OI surface analysis based on SYNOP data replacing the surface blending:
The preliminary results are promising improving mainly 2m temperature and humidity. The switch is planned for winter 2005/2006 after experience from all seasons.

2. Replacement of the fixed mixing length profile by the interactive one based on PBL diagnostics after Ayotte and Tudor:
Satisfactory for all PBL except for the 2m temperature. Problem is probably linked to the other physical parameterizations and has to be further studied.

3.5 Denmark

National report 2005 from the Danish Meteorological Institute

Kai Sattler, ksa@dmi.dk

The operational NWP system

The DMI operational NWP system is based on the HIRLAM reference version 6.3.5, and it includes adaptations to the computational and operational environment at DMI. The operational model suite currently consists of the three models DMI-HIRLAM-T15, DMI-HIRLAM-S05 and DMI-HIRLAM-Q05 with horizontal mesh sizes of 0.15°, 0.05° and 0.05°, respectively. The first two models have been running operationally since 14^{th} June 2004, and the DMI-HIRLAM-Q05 model was added at 31^{st} May 2005. This happened in connection with a major upgrade of the system. The most recent upgrade happened at 9^{th} November 2005. The model domains are shown in Fig. 1, and Table 1 lists some properties of the latest model setup.

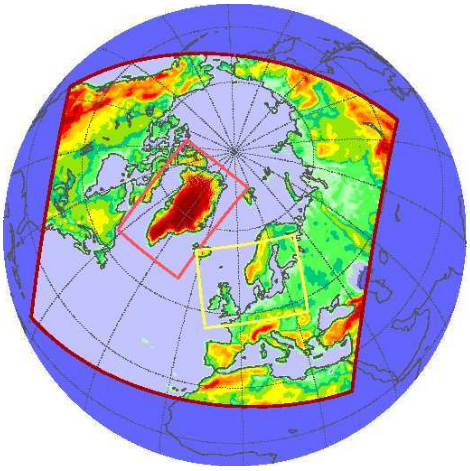


Figure 1. Operational model domains at DMI: T15 (dark red), S05 (yellow) and Q05 (light red).

Model	T15	S05	Q05
gridpoints	610x568	496x372	550x378
vert. levels	40	40	40
mesh size	0.15°	0.05°	0.05°
time step	450s	150s	150s
boundary age (FC)	6 h	0 h	0 h
boundary age (DA)	0–6 h	0 h	0 h
host model	ECMWF	T15	T15
boundary freq.	1/(3h)	1/(1h)	1/(1h)
DA cycle	3 h	6 h	6 h
forecast length	60 h	54 h	36 h
forecasts per day	4	4	2

Table 1. Model setup

Furthermore, the following model features are used in the operational suite at DMI:

- HIRLAM 6.2.3 physics with recent extensions (some of which are mentioned below)
- Semi-Lagrangian dynamics
- Digital Filter initialisation
- 3D-VAR for T15
- Implicit 6^{th}-order horizontal diffusion
- Turbulence parameterization based upon turbulent kinetic energy (TKE): CBR scheme as of HIRLAM 6.2.5
- ISBA (Integrated Soil Biosphere Atmosphere) surface scheme and surface analysis

  However, SST- and ice analysis have been changed, so that ECMWF SST and ice-data are used more efficiently in the SST update and ice cover analysis, which is particularly important at coastal areas. In addition SSTs from the Ocean & Sea Ice SAF are used.
- STRACO convection parameterization scheme
- Adjustment of the diagnosis of 10m wind, 2m temperature and relative humidity

- Improved algorithm for the calculation of the reduction from surface pressure to mean sea level pressure
- Modified *vegetation* roughness and *thermal* roughness over land
- Adaptation of the analysis increment method for the high-resolution models S05 and Q05, using analysis from T15

The most recent operational upgrade at 9$^{\text{th}}$ November 2005 includes among others the following changes:

- Changes in the reassimilation cycle (now 4 times a day, see Table 2)
- incremental spatial filtering in the reanalysis, which blends large scale analysis from ECMWF and high-resolution DMI-HIRLAM analysis
- use of locally derived structure functions based on archived T15 predictions
- increased use of AMSU-A data and more AMDAR from GTS included
- increase of time steps from 360s to 450s (T15) and from 120s to 150s (S05, Q05), possible due to improvements in the time integration scheme
- further tuning of physical parameterization (mixing length, thermal roughness, separation of convective rainfall over land and over sea)

The operational schedule for the daily forecast production is shown in Table 2. The left table shows the old schedule from before the upgrade on 9$^{\text{th}}$ November, and the right table shows the new schedule. The leftmost column in each table shows a time line (UTC) for the start of processing. The other columns in each table depict the models. The specifications read as follows: The first character is the model indentifier, followed by two digits specifying the valid time for the analysis and the initial time of the forecast. This is followed by a "+" and the forecast length. T00+60h thus means the 0 UTC analysis for T15 followed by a 60 hour forecast.

UTC	T15	S05	Q05
1:37	T00+60h		
2:20		S00+54h	
3:05			G00+36h
ECMWF 00 UTC			
7:37	T06+60h		
8:20		S06+54h	
9:05			G06+6h
ECMWF 06 UTC			
11:45	T_E00+05h T03+05h T06+05h T09+05h		
13:37	T12+60h		
14:20		S12+54h	
15:05			G12+36h
ECMWF 12 UTC			
19:30	T18+60h		
20:29		S18+54h	
21:05			G18+6h
ECMWF 18 UTC			
23:50	T_E12+05h T15+05h T18+05h T21+05h		

UTC	T15	S05	Q05
1:37	T00+60h		
2:20		S00+54h	
3:05			G00+36h
ECMWF 00 UTC			
7:00	T_E00+09h		
7:37	T06+60h		
8:20		S06+54h	
9:05			G06+6h
ECMWF 06 UTC			
11:45	T_E06+09h		
13:37	T12+60h		
14:20		S12+54h	
15:05			G12+36h
ECMWF 12 UTC			
19:00	T_E12+09h		
19:30	T18+60h		
20:29		S18+54h	
21:05			G18+6h
ECMWF 18 UTC			
23:50	T_E18+09h		

Table 2. Operational time schedule at DMI before (left) and after (right) the upgrade at 9$^{\text{th}}$ November 2005

The time schedules in Table 2 show that the long forecasts are run 4 times a day for T15 and S05: at 00, 06, 12 and 18 UTC. In the new schedule, there are four reassimilation cycles run daily for T15 instead of two in the old schedule. For S05 and Q05 6-hourly updates are made, and no reassimilation. The reassimilation cycles include the restart run T_E from ECMWF 3D-VAR analysis (0.45°). In the new schedule, this includes blending of the large scale analysis from ECMWF with the high-resolution DMI-HIRLAM analysis.

Other operational activities based on HIRLAM

- road condition model and a road condition observation network
- pollen- and air-pollution modelling and applications
- ocean wave prediction for Danish waters and beyond

Computer environment

The current computer configuration at DMI used for the operational forecasting system consists of an NEC SX-6 supercomputer with an adjoint TX-7 scalar server, and several Linux scalar servers for data processing. The data archive consists of an IBM Hierarchical storage management system (HSM) based on disks and tapes. A sketch of the data flow is shown in Fig 2.

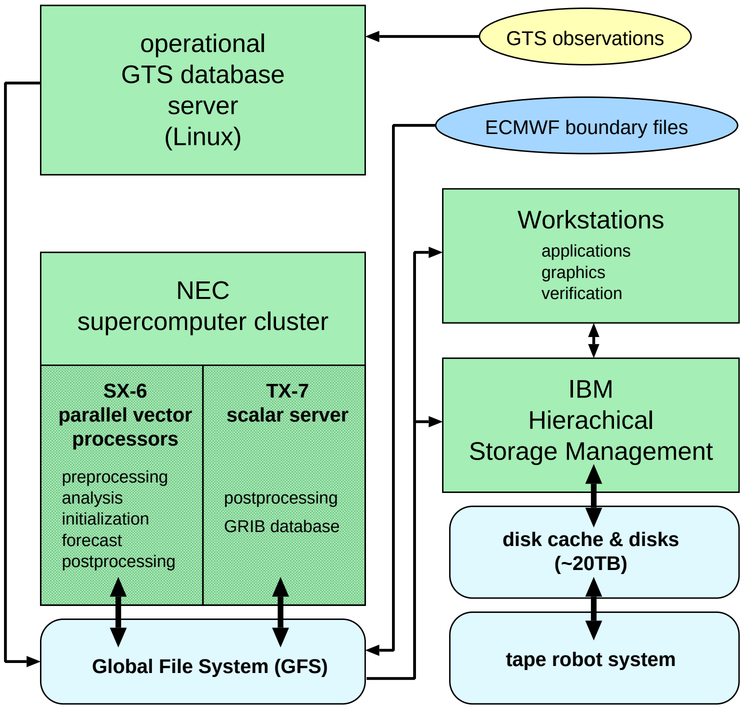


Figure 2. Operational forecasts at DMI: computers and data flow

HIRLAM research activities

The DMI activities within the HIRLAM collaboration comprise:

- data assimilation, 3D-VAR and 4D-VAR
- dynamics, (SL scheme)
- surface (ISBA)
- turbulence
- physiography
- non-hydrostatic model (HIRLAM-ALADIN, HIRALD)

DMI's invlovement in the new collaboration between Météo France and the HIRLAM consortium (HIRLAM-ALADIN, HIRALD) include the following recent activities:

- High resolution ALADIN setup (cycle 29t2) named HIRALD has been established at the hpcd computer at ECMWF
- Climate system for generation of new areas is now also available (implementation by Météo-France)
- HIRLAM work has made it possible to run the system using boundary forcing from HIRLAM instead of ARPEGE
- Setup of a double nested HIRALD system (Fig 3) to be run daily on a test basis at DMI on NEC-SX6. The physics are from standard ALADIN. The innermost model covering southern Scandinavia has a grid size of 2.5 km
- Preparations for parallel daily runs with HIRLAM physics is in progress
- The current status connected to HIRALD including relevant documents can be seen on http://science.dmi.dk

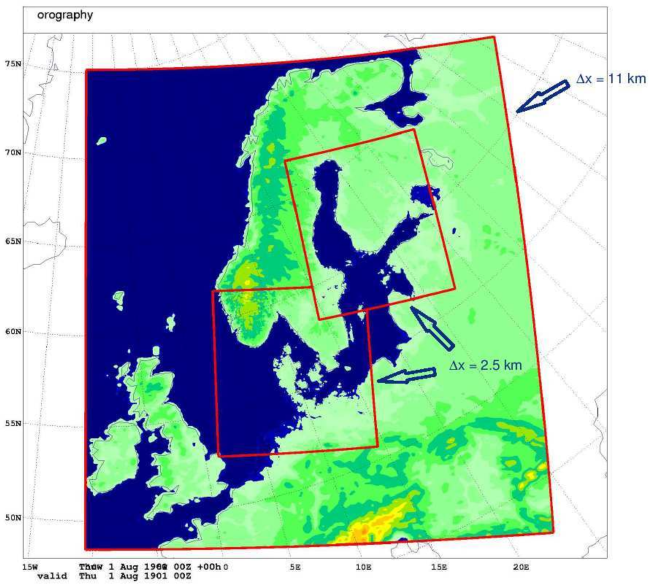


Figure 3. HIRALD model areas.

3.6 Estonia

Nonhydrostatic HIRLAM With Semi-Lagrangian Semi-Implicit Dynamic Core in High-Resolution NWP Environment

R. Rõõm, A. Männik, A. Luhamaa
University of Tartu, Estonia

1. INTRODUCTION

Since 2004 a very high resolution nonhydrostatic NWP system is running in a near-operational regime at Estonian Meteorological Hydrological Institute (EMHI). This is a collaboration effort between University of Tartu (UT), EMHI and Finnish Meteorological Institute (FMI). EMHI hosts the environment, provides communication and computing facilities, and defines the requirements and societal demand to the project. FMI provides boundary and observational data to the forecast model, and delivers its long-lasting limited area modelling and operational forecasting know-how. The role of UT is to maintain the environment, to develop nonhydrostatic core model together with high resolution physics package and ensure its scientific and operational quality.
The project aims for high-precision presentation of local effects and improvement in short range forecasting. The advances are expected mostly in precipitation event or local wind modelling and in increase of severe weather forecasting precision. In addition, it is hoped that the high resolution NWP data is beneficial to wide range of practical and scientific applications like air pollution modelling or coastal research.

2. MODEL DESCRIPTION

The NWP system is based on the NWP model of HIRLAM Consortium, and also on its semi-Lagrangian, semi-implicit nonhydrostatic (NH SISL) extension, developed at UT. The basis for dynamics are the semi-anelastic pressure-coordinate equations of motion and thermodynamics in Lagrangian form (Rõõm, Männik and Luhamaa 2005).
NH SISL uses height-dependent reference temperature and Brunt-Väisälä profiles which results in enhanced stability rates as the nonlinear residuals are minimized in vertical development equations. NH SISL tries to be as close as possible to the parent hydrostatic HIRLAM SISL scheme (McDonald 1995). The existing routines of trajectory calculations and interpolations as well as the interface to physical packages are maintained.

The NWP environment is based on HIRLAM version 6.4.0 with following set of options: Optimum interpolation for data analysis; Implicit normal mode initialization; Semi-implicit semi-Lagrangian dynamics; ISBA scheme for surface parameterization; STRACO scheme for large scale and convective condensation; Savijärvi radiation scheme; CBR-turbulence scheme.

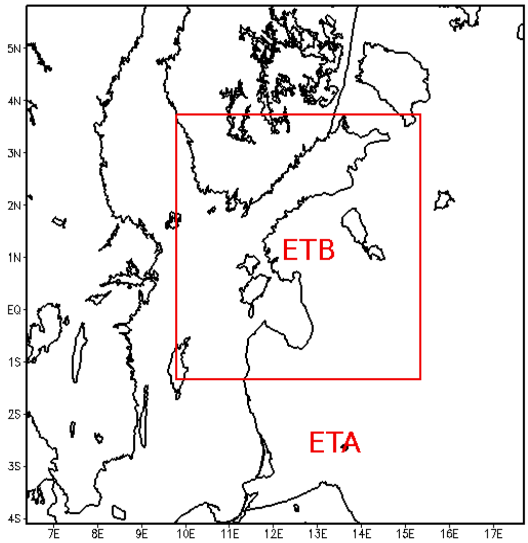


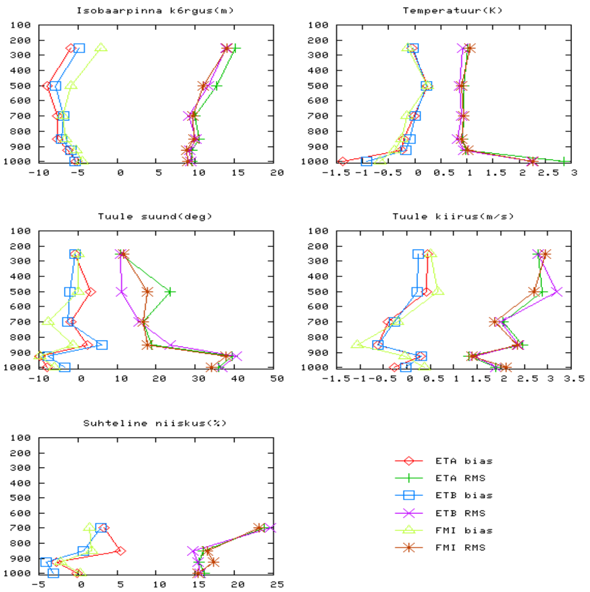
Figure 1. Modelling areas

Low resolution area ETA: Horizontal resolution 11 km, hydrostatic SISL scheme,
400 s time-step, Grid 114x100 points, 40 levels.
High resolution area ETB: Horizontal resolution 3.3 km, NH SISL scheme, 150 s time-step, Grid 186x170 points, 40 levels

ETA area serves as a reference model for comparison. Boundary fields to ETA are provided by FMI from 22 km resolution operational model four times a day with forecasting start-point at 00, 06, 12 and 18 GMT. The time frequency of boundary fields for ETA and ETB is 3h (with option to increase up to 1h for ETB).
Twice a day 36h forecasts are produced in ETA area with start-points at 00 and 06 GMT. To maintain analysis cycle, additional two 6h forecasts are produced by ETA with start at 12 and 18 GMT. Computation of analysis and forecast takes approximately 15 minutes.
The ETB area uses forecasts of ETA area as lateral boundaries. 36h forecasts are produced once per day with start at 00 GMT ETB has its own analysis with interval of 24h. The time spent on computing of forecast is about one and a half hours.

4. EXPERIENCE

To evaluate the WHR NWP system performance, larger ETA model uses standard HIRLAM package, where forecast is compared against the set of standard observations. In the case of former, small ETB domain, time series of observations were compared against forecasts at few selected stations.
Figure 2 presents monthly average of comparison of ETA, ETB and FMI forecasts against sounding station at Harku in April 2005, which was the only station which all three models shared at that period.
Figure 3 presents monthly average of verifications of forecasts of different length for ETA and ETB models against standard observations at Tõravere meteostation in April 2005.



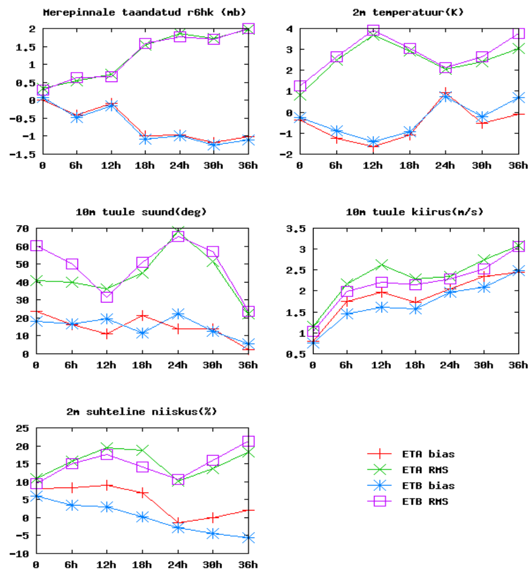
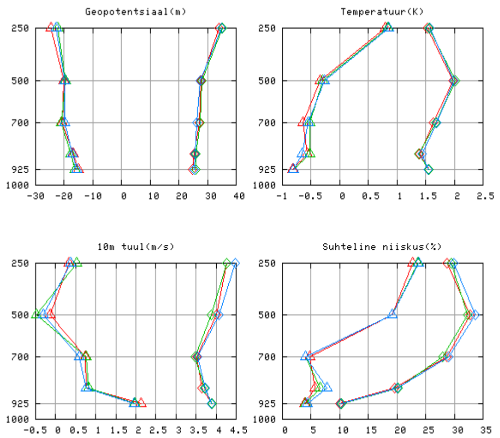


Figure 2. Monthly average of comparison of ETA, ETB and FMI forecasts against sounding station at Harku in April 2005

Figure 3. Monthly average of verifications of forecasts of different length for ETA and ETB models against standard observations at Tõravere meteostation in April 2005.



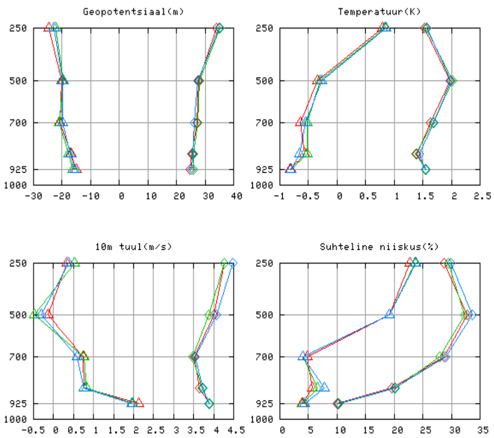


Figure 4. RMS errors (rhomb) and biases (triangle) for sea-level pressure, 2 m temperature, 10 m wind and 2 m relative humidity at different forecast lengths. Red line marks HS SISL with 3.3 km resolution, green line NH SISL at 3.3 km resolution and blue line HS SISL with 11 km resolution.

Figure 5.RMS errors (rhomb) and biases (triangle) for geopotential height, temperature, wind and relative humidity of 36 h forecast at different pressure levels. Red line marks HS SISL with 3.3 km resolution, green line NH SISL at 3.3 km resolution and blue line HS SISL with 11km resolution.

5. CONCLUSIONS

The NH SISL is implemented as the adiabatic core in Estonian B-area model (3.3 km resolution, grid 186x170, 40 levels). Since August 2005, the NH SISL code is ported to the latest official HIRLAM reference version 6.4.0, and its preoperational testing is launched at EMHI.

As the preliminary statistical testing reveals, the NH-specific effect is moderate at these resolutions for the given physical parameterization and lowlands condition. More NH behavior will be expected at very high spatial resolutions (0.5 - 1km, 100 levels), in which case NH SISL will be a suitable tool for development and testing of new physics, including the complex terrain, boundary layer, and moist convection.

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3.7 Finland

27th EWGLAM Meeting 3rd - 5th October 2005, Ljubljana, Slovenia

Operational NWP Activities at the Finnish Meteorological Institute

Niko Sokka, Kalle Eerola, Simo Järvenoja and Markku Kangas
Numerical Weather Prediction, Finnish Meteorological Institute
P.O.Box 503, FIN-00101 Helsinki, Finland
niko.sokka@fmi.fi , markku.kangas@fmi.fi

1. Introduction

Duties as the lead centre for maintaining a regular cycle of the HIRLAM reference system (RCR) and implementation of a new nested meso-β-scale (0.08°) HIRLAM system have dominated the operational NWP activities at FMI. After an extensive testing the RCR system was updated to the HIRLAM reference system version 6.4 [Jär05b][JEF+04]. The new nested meso-β-scale system gained operational status on November 2005 [Jär05a]. A significant effort has also been devoted to the upgrades of the on-line monitoring interface accessible to the whole HIRLAM community. On the computational side, after FMI's decision to move to the utilisation of an in-house high performance computing facility, the long-standing operational co-operation with the CSC (Finnish IT center for science) has been discontinued.

Figure 1 shows the development of peak computing performance in FMI's NWP over the years. In the early years the full computing power of the CSC's supercomputers was utilized in the FMI's operational NWP runs, later only a part of the full power has been used for the operational LAM modelling. The ECMWF performance figures have been given for reference.

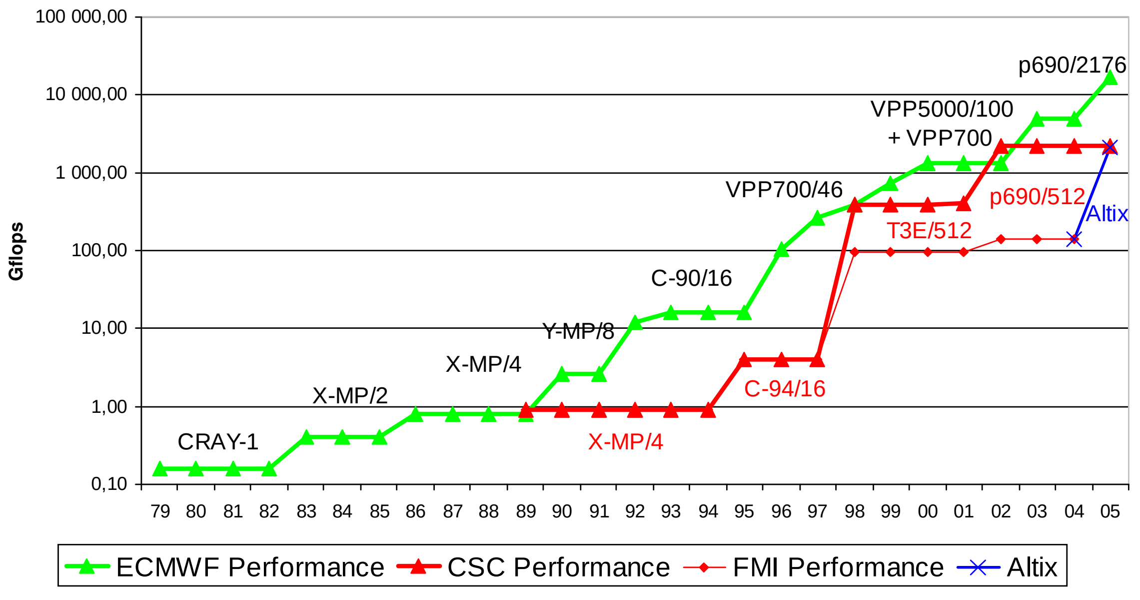

Fig.1 : Development of the peak computing power in FMI's NWP.

2. Technical Environment

The high performance computing parts of the operational LAMs were executed at CSC until June 2005 as before. One IBM p690 node (32 Power4 1.1 GHz CPUs, 32 GB memory) was dedicated to FMI's operational runs only. Since the first of June 2005 an in-house SGI Altix 350 consisting of 16 Itanium2 1.5 GHz processors and offering 64 GB of shared memory has been used for operational runs.

Starting from October 2005, a bigger HPC system, SGI Altix BX2, will be taken into use. The system will consist of 304 1.5 GHz Itanium2 processors with 304 GB of shared memory. With the introduction of the new HPC system, the wall clock time used in the RCR suite will decrease from the 73 minutes spent on IBM system to less than 4 minutes on SGI (3 min for forecast, 30 sec for analysis).

Figure 2 illustrates the technical environment used in the CSC-based RCR system. The observations as well as the Baltic SST/ice data from the Finnish Institute of Marine Research are first collected to the operational UNIX server, Metis, processed, and then transferred to the CSC for the actual computations. The same applies to the boundary data obtained from the ECMWF. After computations at the CSC, the numerical results as well as graphical products are transferred back to the Metis server to be loaded into the real time data base for different uses by duty forecasters, researchers, and automated forecast products. At CSC, an extensive local archiving also takes place. Finally, input and output data are made available to all HIRLAM members by archiving the data to the ECMWF's ECFS using the ecaccess gateway. A graphical interface for monitoring is provided to the whole HIRLAM community through the HeXnet facility [KS05].

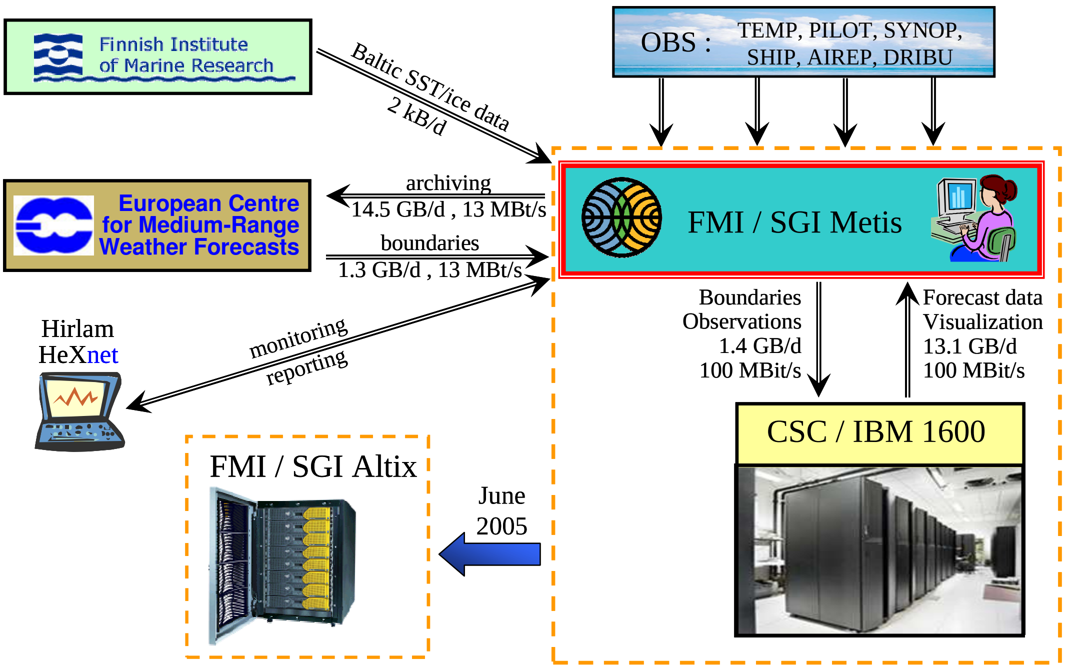

Fig.2 : FMI NWP technical environment.

3. Meteorological Implementation

Starting from June 2005, the HIRLAM 6.3 based RCR suite was replaced by the HIRLAM reference system version 6.4 with default settings (e.g. 0.2^o horizontal resolution), featuring the HIRLAM 3DVAR analysis scheme and the ISBA surface scheme. The main features of the RCR suite are listed in Table 1, and the integration area is shown in Figure 3.

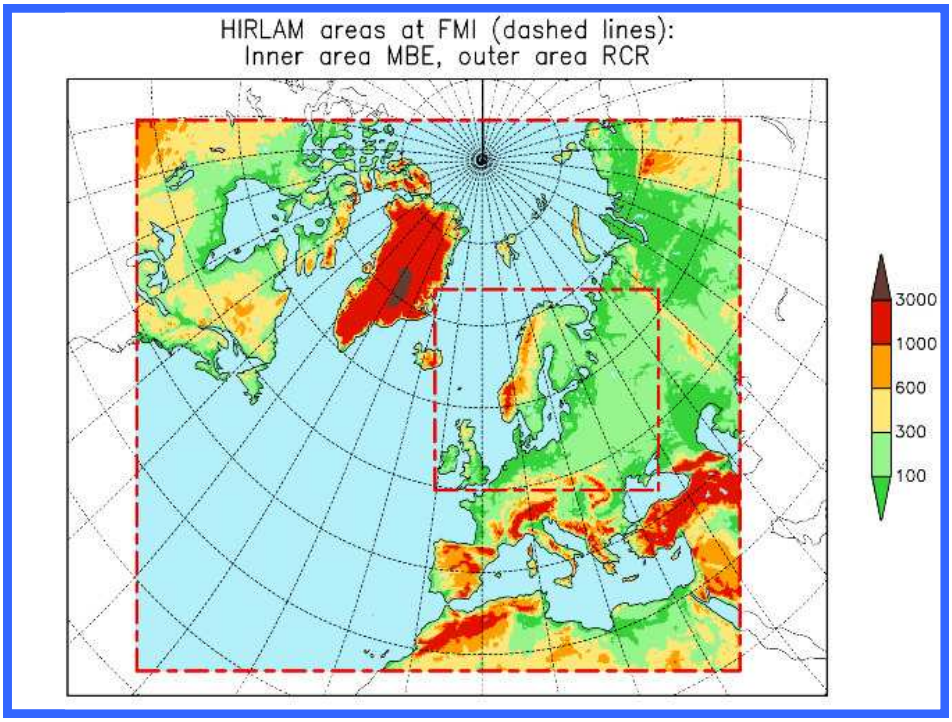

Fig.3 : Integration areas of the operational models at FMI.

In data assimilation, conventional observations are used. The cut-off time of observations is 2 hours for the main synoptical hours (00, 06, 12, and 18 UTC) and 4 hours 20 minutes for the intermediate hours (03, 09, 15, and 21 UTC). Incremental digital filter is used for initialization. The forecast length is 54 hours for 00, 06, 12, and 18 UTC runs. Between them, additional 6 hour forecasts are run to provide an improved first guess for the main runs.

Table 1 : Model configuration

Data assimilation	
Upper air analysis	3-dimensional variational data assimilation
Version	HIRDVA 6.3.2, FGAT option
Parameters	Surface pressure, temperature, wind components, humidity
Surface analysis	Separate analysis, consistent with the mosaic approach for surface/soil processes of - SST, fraction of ice - snow depth - screen level temperature, humidity - soil temperature/humidity (2 layers)
Grid length	0.2° in the horizontal
Integration domain	438 x 336 grid points in a rotated lat/lon grid
Levels	40 hybrid levels defined by A and B
Observation types	TEMP, PILOT, SYNOP, SHIP, BUOY, AIREP
First guess	3 h forecast, 3h cycle
Initialization	Digital filter (IDF)
Cut-off time	2 h for main cycles, 4 h 20 min for intermediate cycles
Assimilation cycle	3 h cycle

Forecast model	
Forecast model	Limited area grid point model
Version	Hirlam 6.4.0
Basic equations	Primitive equations
Independent variables	T, u, v, q, p(s), cloud water, turbulent kinetic energy (TKE)
Discretization	Arakawa C grid
Grid length	0.2° in the horizontal
Integration domain	438 x 336 grid points in a rotated lat/lon grid
Orography	Hirlam physiographic data base, filtered
Physics	- Savijärvi radiation scheme - Turbulence based on TKE - STRACO condensation scheme - Surface fluxes using the drag formulation - Surface/soil processes using mosaic tiles - No gravity wave drag
Horizontal diffusion	Implicit fourth order
Forecast length	54 hours
Output frequency	1 hour
Boundaries	- 0.2° "frame" boundaries from ECMWF - received four times a day - 3h temporal resolutions

A second operational suite, MBE, a meso-β-scale (0.08°) nested HIRLAM model, having been in pre-operational test since 7 May 2004 became operational during the month of November 2004. The integration area of the MBE suite is also shown in Figure 3. The meteorological set-up is close to identical with the hosting RCR suite.

4. Road weather model

The road weather model is a 1-dimensional energy balance model that calculates vertical heat transfer in the ground and at the ground-atmosphere interface, taking into account the special conditions prevailing at road surface and below it. The effect of traffic is also accounted for. Output from a weather forecast model, either directly or with duty meteorologist's corrections, is used as a forcing at upper boundary.

In addition to calculating ground and surface temperature, the model also makes a road condition interpretation. At present, eight different road surface classes, or descriptions, are used: dry, damp, wet, frost, dry snow, wet snow, and partly icy. Additionally, a three-valued index describing the driving conditions more generally is calculated.

The model is run operationally once an hour using the latest available data, including weather radar precipitation. A model version for pedestrian conditions has also been developed and is in operational use. Further, enhanced versions of the model including also road maintenance measures as well as advanced on-line warning system and traffic routing are being developed.

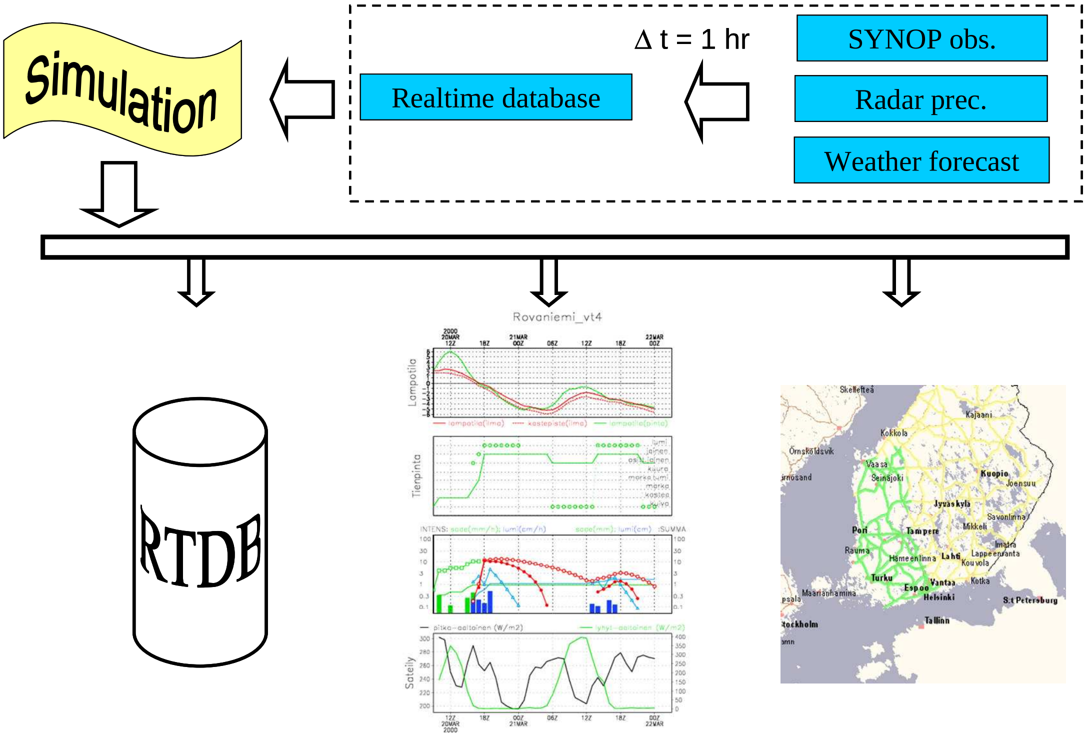

Fig.4: Road weather model operational system.

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3.8 France

The ALADIN-France Limited-Area Model

By Joël Stein, Marc Tardy and Hervé Bénichou
DPREVI/COMPAS Météo-France, 42 av G. Coriolis, 31057 Toulouse Cedex, France

Description of the model configuration

The orography of the ALDIN-France is plotted in Figure 1. The domain extends from (57°N,20°W) to (33°N,18°E). The mesh-size is $\Delta x=\Delta y=9.5$ km on the conformal plane given by a Lambert tranformation. The spectral truncation is E159x159.

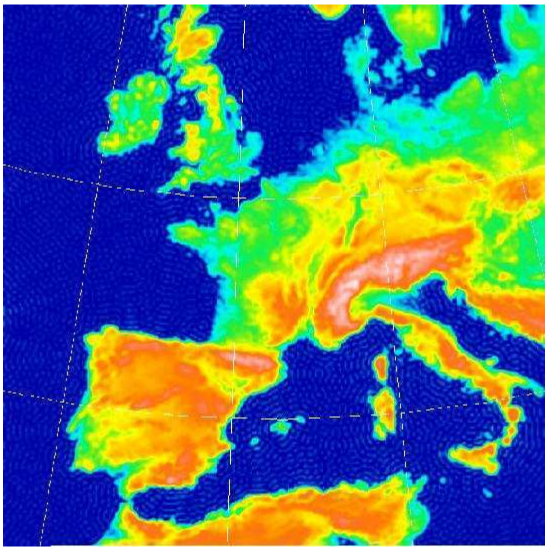


Figure 1: orography of the ALADIN-France model.

The vertical resolution is stretched along the vertical. The 41 levels are displayed in Figure 2 with a comparison with the vertical grid of the ECMWF model. The different features of the model are listed below :
•**New : 3DVAR assimilation, since 25 July 2005**
•Semi-implicit, semi-lagrangian dynamics
•Full physical package:
-ISBA soil scheme
-First order closure turbulence scheme
-FMR15 radiation scheme
-Bougeault mass-flux convection scheme
-Orographic GWD + envelope orography
-Adjustment to the saturation

The organisation in two cycles: one for the assimilation and the other for the forecast production is similar as the ones used for the operational model global ARPEGE. Both cycles are plotted on Figure 3. Of course, the cycles of production for ARPEGE and ALADIN are coordinated because the ALADIN forecast used ARPEGE forecast at its lateral boundary conditions.

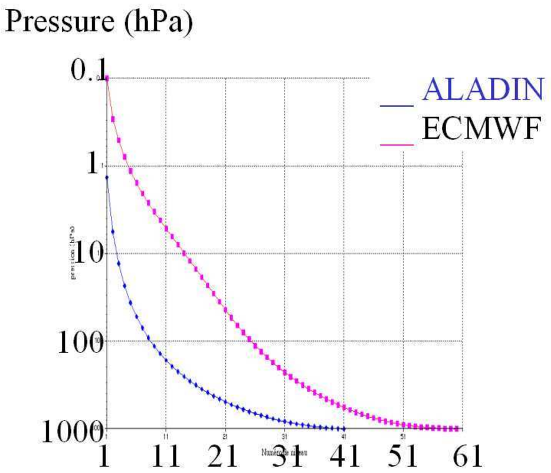


Figure 2: Pressure distribution of the vertical levels of the vertical grid of the ALADIN-FRANCE model

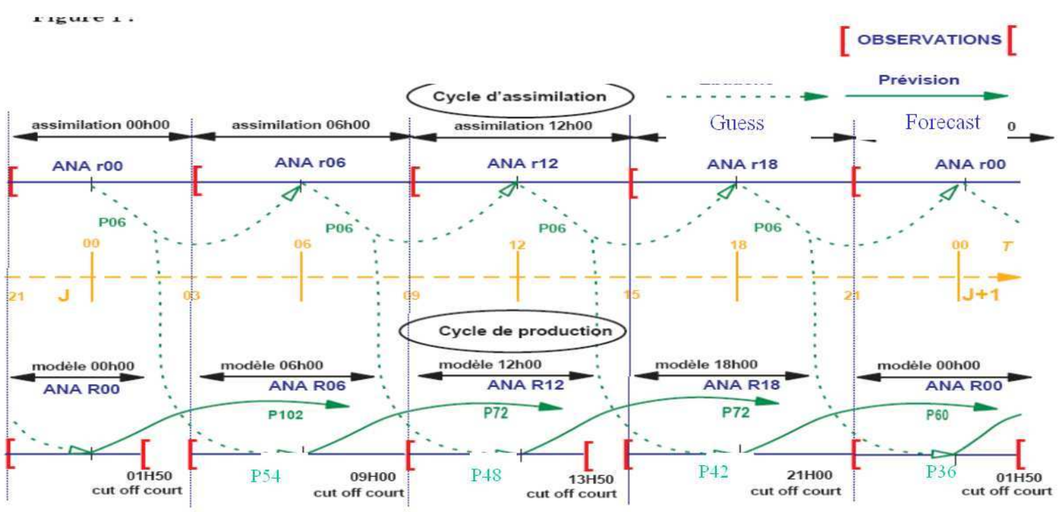


Figure 3 : description of the assimilation and production cycles for the new assimilation scheme 3DVAR for the LAM ALADIN-FRANCE. The cut-off are the same as for the ARPEGE model.

Both analyses use the same observations at the same resolution for the moment. The differences in the assimilation schemes are listed now:

- ALADIN uses a 3DVAR scheme and ARPEGE a 4DVAR one for their assimilations
- ALADIN assimilates temperature and humidity at 2m AGL for the altitude fields analysis and also SEVIRI radiances from Meteosat 8

We report on Figure 4, the different distribution of data in the simulation domain of ALADIN.

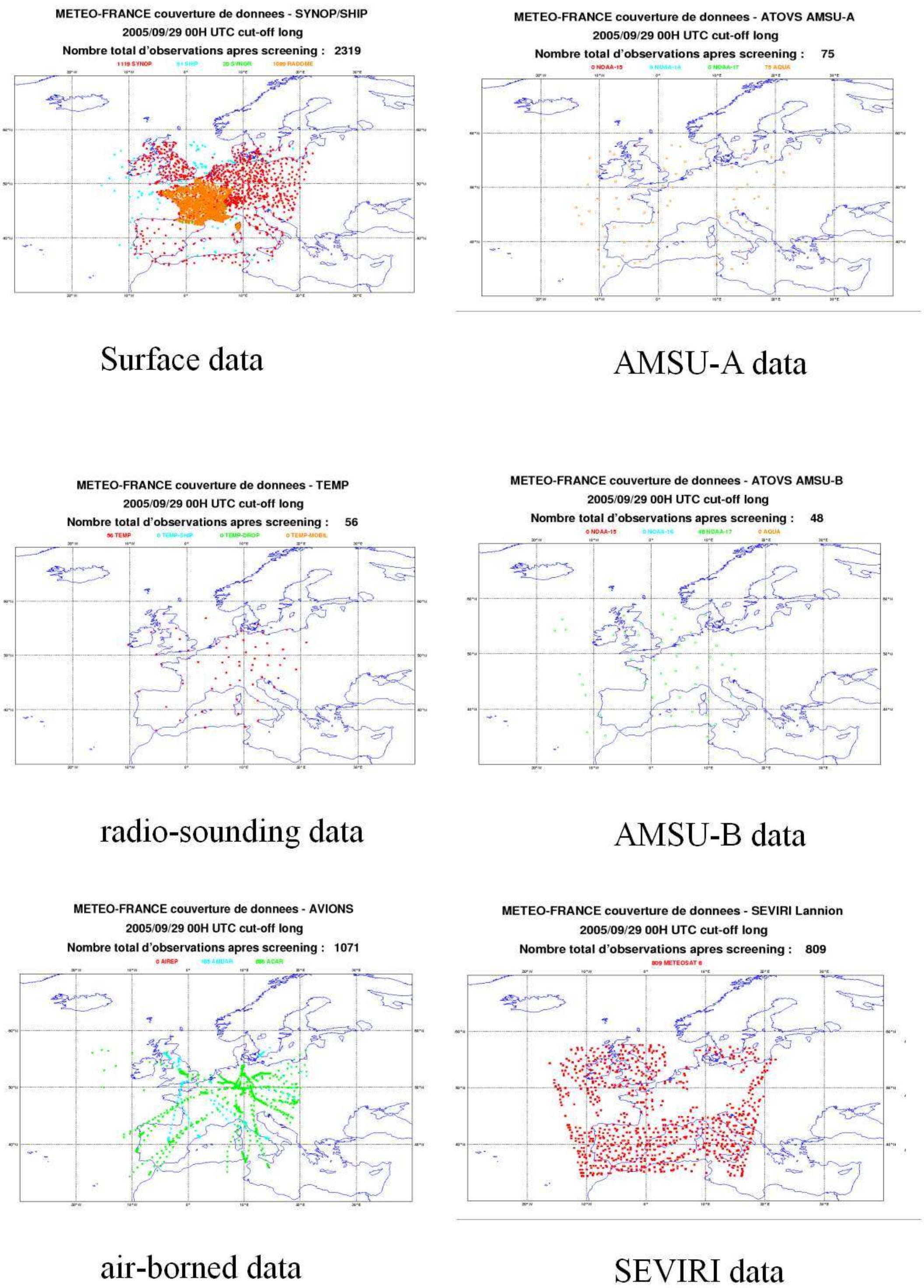
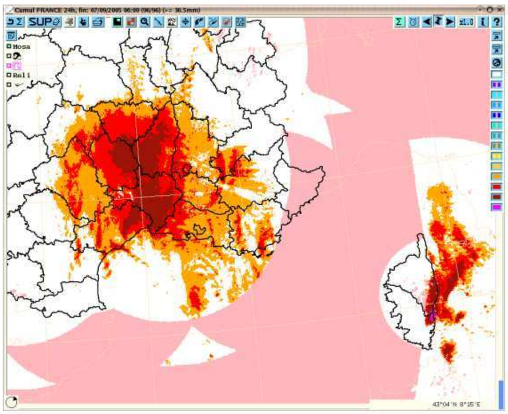


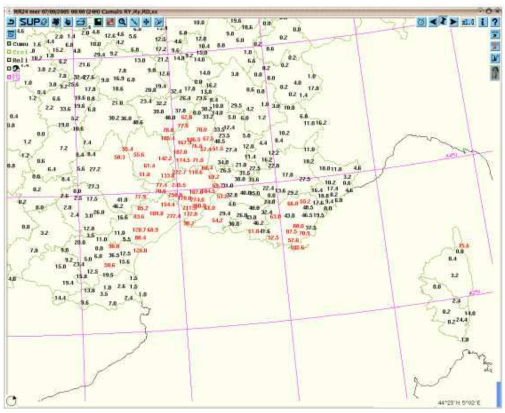
Figure 4 distribution of the data assimilated by the ALADIN 3DVAR scheme for the 29 September 2005.

We note the large amount of SEVIRI data in comparison with the other satellite data. This may help to improve the simulation of the southerly flows passing over the Mediterranean Sea before reaching Europe.

Presentation of the ALADIN performance for a heavy rain case

This case correspond to a very intense southerly case which leads to strong rain amounts in the vicinity of the Cevennes chain. It occurs from the 5 to the 8 September and different convective events happened to provide large amounts of rain, which lead to flood in the region of Nîmes at the end of the period.
The forecasts are presented for the 6 September and can be compared with the Nîmes radar and rain gauges observations (Figure 5).





Nîmes radar 24 h cumul Surface station 24 h cumul

Figure 5: 24 hours accumulated rain measured by the Nîmes radar (left) and surface data for the same data.

The maximum of rain was observed between the Mediterranean Sea and the foothill of the Cevennes. Strong convective cells develop over sea and propagates inshore and provide intense rainfalls. This strong event stops during the night but amounts larger than 200 mm in the Nîmes region. The forecasts of the operational models were very informative about the amplitude of the event as can be checked on Figure 6, showing the forecasted accumulated rains for 2 global models ARPEGE and IFS (ECMWF model) and the LAM ALADIN. It can be noted that the models found a maximum in the Nîmes region but overestimate the rain over the Massif Central at the west of this city. All three models perform a non-detection over the Alps at the west of the Nîmes. Nevertheless, this good concordance between all these models and the quality of the forecast allow the centre of forecast to switch on a major alarm (red level) for this region to limit the consequences of these heavy rainfalls in terms of human and material damages.

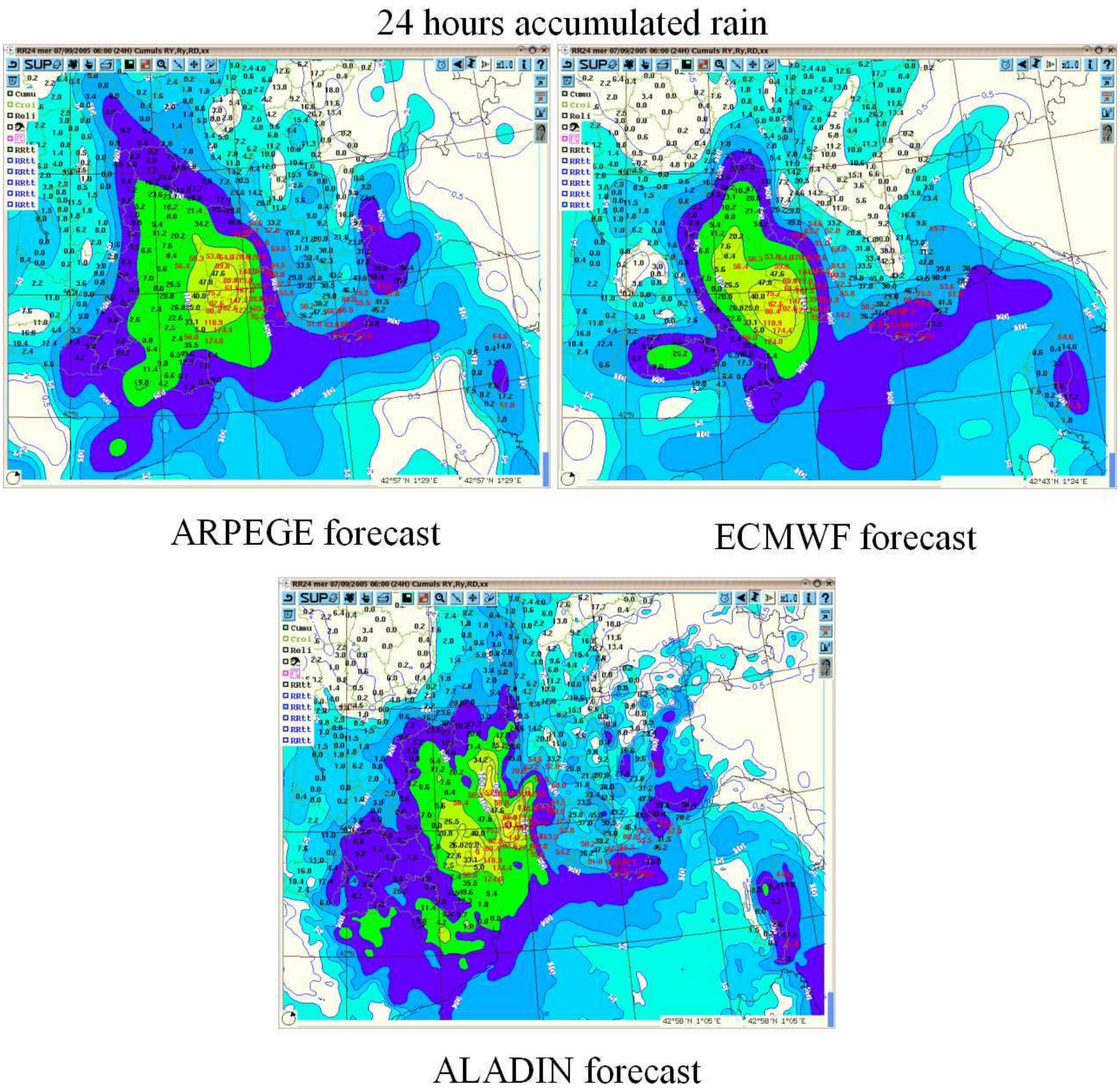


Figure 6 : Operational forecasts of 24 hours accumulated rain superimposed with the observations (Figure 5) from the 5 September at 6 UTC until the 6 September at 6 UTC. Green area correspond to rain exceeding 50 mm

3.9 Hungary

LIMITED AREA MODELLING ACTIVITIES AT THE HUNGARIAN METEOROLOGICAL SERVICE (2005)

András Horányi (horanyi.a@met.hu)
Hungarian Meteorological Service (1525 Budapest, P. O. Box 38.)

INTRODUCTION

The numerical weather prediction (NWP) group of the Hungarian Meteorological Service (HMS) belongs to the Department of Research and Development. The team consists of around 20 people, however the main activities are not only strictly related to NWP (also visualisation and interpretation, post-processing, verification, regional climate modelling and satellite meteorology are part of our work). The main NWP work is certainly concentrating on the work around the ALADIN limited area model. The backbone of the research and development is the operational version and exploitation of the ALADIN/HU limited area model. The most important achievement of the last year is the operational introduction of the ALADIN 3d-var system for the ALADIN model (at the beginning of May, first among the ALADIN partners). The two most important development area of interest are data assimilation and short range ensemble prediction. Hereafter the main progresses of the passing year will be briefly summarised.

ALADIN OPERATIONAL EXPLOITATION: ALADIN/HU

Several changes were encountered for the operational model version: increased vertical resolution, introduction of linear (instead of quadratic) truncation and the application of the 3d-var data assimilation scheme in the operational regime. Hereafter the basic characteristics of the operational model (together with the computer background) will be recalled.

Main features of the operational ALADIN/HU model

- Model version: AL28T3
- Initial conditions: 3d-var data assimilation (see also below)
- 48 hour production forecasts twice a day
- Lateral boundary conditions (LBC) from the ARPEGE global model

Model geometry

- 8 km horizontal resolution (349*309 points)
- 49 vertical model levels
- Linear spectral truncation
- Lambert projection

Assimilation settings

- 6 hour assimilation cycle
- Short cut-off analyses for the production runs
- NMC background error co-variances
- Digital filter initialisation (DFI)
- LBC coupling at every 3 hours

Observation usage

- SYNOP (surface pressure)
- TEMP (T, u, v, q on standard pressure levels)
- ATOVS/AMSU-A (radiances from NOAA 15 and 16 satellites) with 80 km thinning distance
- AMDAR (T, u, v) with 25 km thinning distance and 1 hour time-window; a special filter (that allows only one profile in one thinning-box) is also applied
- Web-based observation monitoring system

Forecast settings

- Digital filter initialisation (DFI)
- 300 s time-step (two-time level semi-implicit semi-Lagrangian – SISL – advection scheme)
- LBC coupling at every 3 hours
- Hourly post-processing in the first 36 hours and 3 hourly afterwards

Operational suite/technical aspects/main steps

- Transfer ARPEGE LBC files from Météo France, Toulouse via Internet (primary channel) and satellite dissemination system (RETIM, backup)
- Model integration on 24 processors
- 3d-var on 26 processors
- Post-processing
- Continuous monitoring supported by a web based system

The computer system

- IBM p690 server (regatta) + IBM (p655) cluster server
- CPU: 2* 32 processors (1,3 Ghz + 1,7 Ghz)
- Peak performance: 5.2 + 10 Gflops/processor
- 64+ 128 Gbyte internal memory
- 1 Tbyte disk space
- Loadleveler job scheduler
- Totalview debugger (on Regatta)

DATA ASSIMILATION RESEARCH AND DEVELOPMENT

The main development areas are related to the introduction to new observation types and the improvement of the treatment of the background error term in the 3d-var cost function.

AMDAR (aircraft measurements)

A new post-thinning technique for AMDAR data has been worked out. It handles all the AMDAR data simultaneously instead of processing them flight by flight as it is implemented in the ARPAGE/ALADIN thinning. The new procedure is applied after the operational thinning algorithm and ensures that at one location only observations belonging to the same flight are kept. This kind of processing has several advantages in a 3d-var system using aircraft measured data (less redundancy in space and in time). A slight positive impact of the new method has been found on the analysis and short range forecasts of the ALADIN/HU model.

ATOVS/AMSU-A
AMSU-A data have been introduced and validated in the system in the last 2 years. A local bias correction has been worked out. Today, they are used operationally in the ALADIN/HU model.

ATOVS/AMSU-B
AMSU-B data are prepared for assimilation in full grid. Impact studies have been carried out investigating different thinning distances (120km, 80km, 60km). According to the tests the AMSU-B data have a positive impact on the forecasts of the ALADIN/HU model, especially using the 80km thinning distance. Recently, the results of a parallel assimilation suite is under investigation.

AMV/GEOWIND
The impact of AMV/GEOWIND (MSG) data have been tested concentrating on different aspects: data use over land, data with different quality indicators, different thinning distances. According to the experiments it is not preferable to use these data over land, and it is useful to take into account the quality indicator. Thinning distance experiments are on the way.

Windprofiler
The work on wind profiler assimilation is in its early stage. It consists of estimating the quality of each European profilers aiming to prepare a blacklist. The quality study is based on comparison with TEMP observations and with the ALADIN background forecasts.

SYNOP/10m wind
Experiments were carried out to explore the impact of 10m wind data from SYNOP stations. Blacklists have been prepared in order to exclude stations not fitting the model orography. The impact of the data turned out to be neutral.

B matrix
The multivariate humidity coupling has been examined. A tuning of the humidity background error covariance profile has been proposed in order to reduce the exaggerated impact of temperature and mass on humidity in the analysis. The tuning is based on the adjustment of the co-variances to those of obtained by the Lönnberg-Hollingsworth method.

LAMEPS RESEARCH AND DEVELOPMENT

At HMS the LAMEPS project started in the second half of 2003. Our aim is to develop a short range ensemble prediction system in order to understand and predict better local extreme events like heavy precipitation, wind storms, large temperature anomalies and also to have a high resolution probabilistic forecast for 2m temperature, 10m wind and precipitation in the 24-48h time range.

Downscaling of ARPEGE ensemble forecast with ALADIN
Experiments started with the direct downscaling of the PEACE system. PEACE is an ARPEGE based global short range ensemble system, which consists of 10+1 ensemble

members and running operationally at Météo-France. In PEACE the singular vector (SV) method is used to generate the initial perturbations. On the one hand we started with direct downscaling of PEACE members and on the other hand sensitivity experiments were carried out to investigate the sensitivity in terms of target domain and target time. We wanted to know what was the impact of using different target domains (four different domains were considered) and target times (two target times were studied: 12h and 24h) during the global SV computation.

Downscaling of ECMWF ensemble forecasts with ALADIN

Encouraged by the success of COSMO-LEPS project, new set of experiments has been launched with the downscaling of ECMWF ensemble forecasts. The system used in this experiment consists of the following steps (the first case studies are under evaluation):

- clustering of ECMWF ensemble forecasts
- selection of 10 representative members (RMs)
- downscaling of the RMs with the use of the limited area model ALADIN

Participating in the SRNWP-PEPS project

Like many other European weather services HMS is also participating in the SRNWP-PEPS project, the main steps of the local application of the PEPS results are as follows:

- GRIB files are sent two times a day and results are downloaded four times a day;
- Visualization is done locally using METVIEW;
- Maps are generated for two areas: the PEPS domain and Hungary;
- Products are available on the Intraweb of HMS;
- Forecasters are asked to test the usefulness and operational applicability of PEPS products.

COMPUTATION OF WIND CLIMATOLOGY OVER HUNGARY

There is an increasing demand to provide high-resolution climatology of wind and precipitation over Hungary. First the wind climatology is investigated (in anticipation also to the future feasibility of computation of precipitation climatology) considering two methods based on the ALADIN model.

Climatology based on operational ALADIN forecasts

The operational ALADIN forecasts are adapted to a high resolution (5 km) orography with a special dynamical adaptation method using a 30-minute quasi-adiabatic integration (ALADIN DADA).

Climatology based on the dynamical downscaling of ECMWF reanalysis

The dynamical downscaling of the ERA-40 reanalysis data was performed for a Hungarian domain of 5 km resolution for a ten-year period between 1992-2001. Due to the resolution jump between the ERA-40 resolution (~125 km) and our target resolution two nested ALADIN integration steps were included on 45 and 15 km resolution, respectively. In the final step a special ALADIN DADA was applied to adapt the wind field to the high resolution target orography.

The implementation of coupling required a trade-off between the shorter and longer integration times because at shorter integration times the spin-up can be significant, while at longer integration times accuracy decreases. As a solution 36-hour integrations on both 45 km and 15 km was performed, but the first 12 hours were not used.

Results

Both methods gave similar spatial distribution for the average wind speed but the method based on the operational ALADIN runs gave systematically lower values. The detailed evaluation of the results is on the way. Preliminary verification of the 10 m wind direction of the ERA-40 results showed the overestimation of wind speed and the good agreement of the wind direction in the lowlands.

VERIFICATION AND POST-PROCESSING

Objective verification

A new interactive web-based verification system has been developed. It provides the verification of NWP forecasts used at HMS against SYNOP observations, including: scatterplots, contingency tables, maps and temporal evolution diagrams (MAE, BIAS, RMSE), probability distributions and wind-direction pie charts. The extension of the system to use TEMP and AMDAR observations is also under development.
The VERAL verification system is also used for ALADIN. In this system the departures from the observations (SYNOP, TEMP) are computed via the observation operators of CANARI (optimal interpolation). VERAL provides temporal evolution diagrams for BIAS and RMSE.

Subjective verification

The main motivation of this kind of activity was to get a complex view about the forecast quality over Hungary, especially for variables, which are hard to evaluate in an objective way (e.g. cloudiness, precipitation). The present system includes the comparison of the 0-48h forecasts of 3 different ALADIN model versions and ECMWF/IFS. The 5-degree quality indices together with some additional data (e.g. synoptic situation) are fed into a database that can be accessed through a web interface.

Post-processing

A MOS-based post-processing system is run in a test mode. MOS is applied to ALADIN and ECMWF forecasts with 3 hour timesteps. Different MOS coefficients were derived via multiple linear regression for each variable, timestep location and month. The involved predictand variables are T 2m, RHU 2m and 10 m wind. Predictands were selected with the forward selection method.

SUMMARY

The main limited are modelling (and related) activities were briefly summarised in this overview: only the main work was recalled without too much details (and figures), therefore the interested readers are kindly asked to contact the author in case of need for further details.

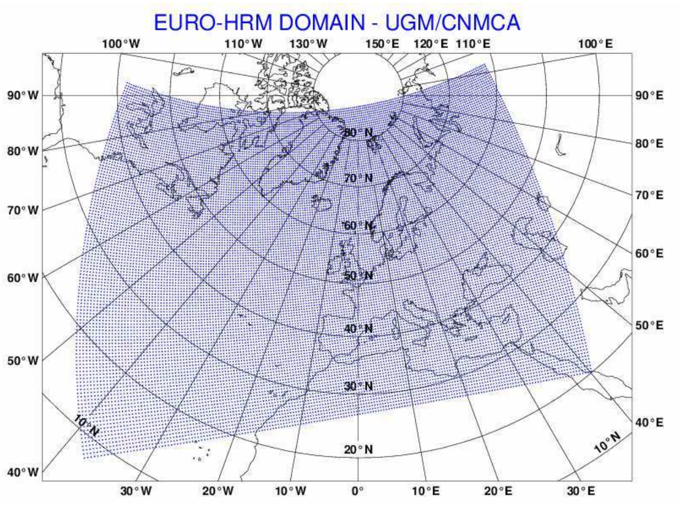
3.10 Italy

Italian Meteorological Service Status Report

Massimo Bonavita, Lucio Torrisi, Fabrizio Ciciulla and Antonio Vocino
CNMCA Pratica di Mare (ROMA)
bonavita@meteoam.it, torrisi@meteoam.it,
ciciulla@meteoam.it, vocino@meteoam.it

Regional Modelling and Data Assimilation

The regional model EURO_HRM, whose main features are summarised in table 1, is operationally run by the Italian Meteorological Service (IMS) over the domain shown in fig. 1. An intermittent 6-hour assimilation cycle is run to provide initial conditions for the model (Bonavita and Torrisi, 2005).
The main focus of activities over the past year has been the operational implementation of the direct assimilation of ATOVS AMSU-A radiances in the IMS objective analysis. This has been made possible by the near real-time availability of the NOAA-1X ATOVS observations through the Eumetsat EARS program and the use of the RTTOV7.1 fast radiative transfer model.
Channels 5 to 10 of the AMSU-A microwave sounder are currently used over the sea after a scan dependent biasa correction, rain contamination check and a 200 Km thinning. Impact studies have shown a moderately positive influence, more noticeable on the wind vector and MSLP fields (fig.2)



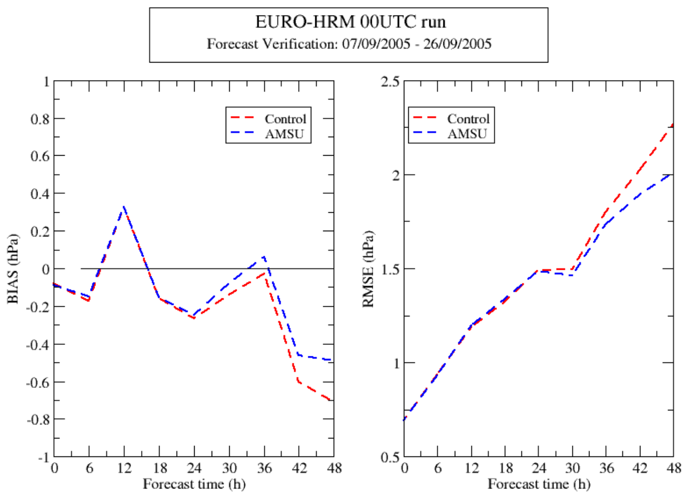


Fig. 1 Integration domain of EURO_HRM model **Fig. 2** Impact on MSLP forecast of AMSU-A obs.

Current development activities in the data assimilation sector involve:
1. the extension of AMSU-A usage over land and experimentation with AMSU-B radiances;
2. the experimental run of a 3-hourly data assimilation cycle in order to make use of the large amount of a-synoptic data which is currently discarded;
3. the experimental run of a parallel data assimilation cycle with an objective analysis based on a hybrid EnKF-3Dvar approach

4. horizontal resolution doubling (0.125 Deg., ~14 Km).

Table 1 Characteristics of EURO-HRM operational implementation

Domain size	385 x 257
Grid spacing	0.25 Deg (~28 km)
Number of layers	40
Time step and scheme	**150** sec, split semi-implicit
Forecast range	72 hrs
Initial time of model run	00/12 UTC
L.B.C.	IFS
L.B.C. update frequency	3 hrs
Initial state	CNMCA 3D-PSAS
Initialization	N.M.I.
External analysis	None
Status	Operational
Hardware	IBM P960
N° of processors used	14 (Model), 60 (Analysis)

Local Modelling

The main features of the operational implementation of the EURO_LM local Model over the Italian domain of integration (EURO_LM) are summarized in Table 2 and Fig. 2.

Table 2 Characteristics of EURO_LM operational implementation

Domain size	465 x 385
Grid spacing	0.0625 (7 km)
Number of layers	35
Time step and scheme	40 s,3 time-lev split-expl
Forecast range	60 hrs
Initial time of model run	00 UTC
Lateral bound. condit.	IFS
L.B.C. update frequency	3 hrs
Initial state	EURO-HRM 3D-PSAS
Initialization	Digital Filter
External analysis	T,u,v, PseudoRH, SP
Special features	Filtered topography
Status	Operational
Hardware	IBM P690 (ECMWF)
N° of processors	120

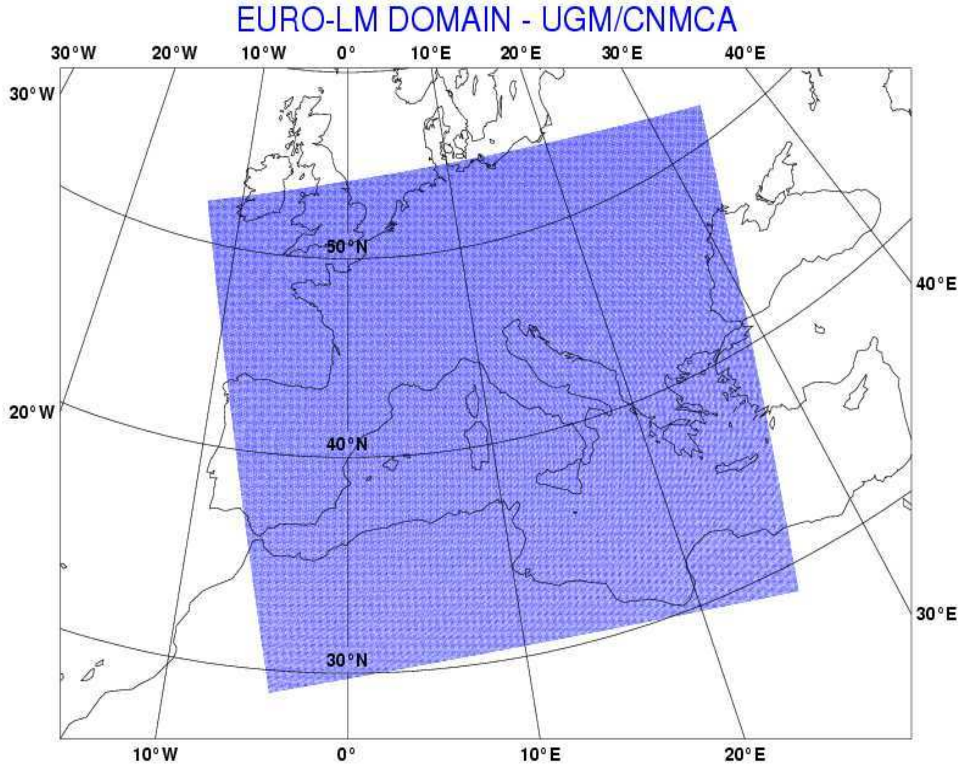


Fig.2 Integration domain for the EURO_LM local model.

Over the past year development for the EURO_LM local model has mainly followed developments and updates in the underlying Lokal Modell code base. This has meant the operational introduction of the new prognostic precipitation scheme and the 7-level soil model.
Current development activities are mainly concerned with the operational challenges of increasing the horizontal resolution to 2.5 – 3 Km.
It must also be stressed that both models (EURO_HRM and EURO_LM) and the underlying data assimilation cycle are in the process of becoming time critical applications at ECMWF, thus achieving an even higher level of operational availability and timeliness with respect to the already satisfactory standard.

References

Bonavita M., and L. Torrisi, 2005: Impact of a Variational Objective Analysis Scheme on a Regional Area Numerical Model: The Italian Air Force Weather Service Experience; Meteorology and Atmospheric Physics, Vol.88, No.1-2, pg. 38-52 (Springer).

www.meteoam.it presents a selection of updated NWP products

3.11 Ireland

NWP at Met Éireann – Ireland – 2005

Introduction

The Hirlam system is used at Met Éireann – the Irish Meteorological Service – to produce operational forecasts out to 48-hours. The model [version 5.0.1 with 3DVAR] is run four times per day using an IBM RS/6000 SP with 9 nodes each with 4 processores sharing 2 Gbytes of memory [i.e. a total of 36 CPUs and 18 Gbytes of memory].

Data Assimilation

Observations : SYNOP, SHIP, BUOY, AIREP, AMDAR, ACARS TEMP, TEMPSHIP, PILOT, SATOB and SATEM observations are used. The data are packed into BUFR format both for storage and for input to Hirlam.

Analysis : Hirlam 3D-Var [3-dimensional variational assimilation]. The analysis runs on 31 hybrid [eta] levels. Upper-air observational data is accepted on all standard and significant levels (10 hPa to 1000 hPa) and interpolated to eta levels.

Assimilation Cycle : Three-hour cycle using the forecast from the previous cycle as a first-guess. [It is also possible to use an ECMWF forecast as a first-guess].

Analysed Variables : Wind components (u,v), geopotential and specific humidity.

Forecast Model

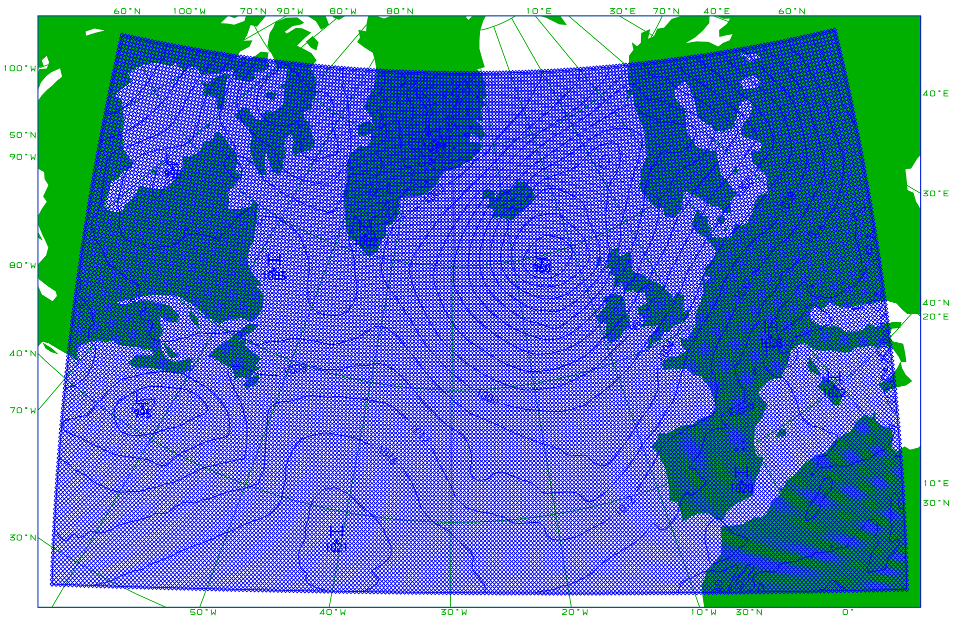
Forecast Model : Hirlam 5.0.1 reference system grid point model.

Horizontal grid : A rotated latitude-longitude grid is used with the South-Pole at (-30^o longitude, -30^o latitude). Fields are based on a 438x284 grid corresponding to a 0.15^o x 0.15^o horizontal Arakara C-grid [see diagram below].

Vertical Grid : Hybrid [eta] coordinate system with 31 levels.

Initialisation : Digital Filter.

Integration Scheme : We use a two time-level three-dimensional semi-Lagrangian semi-implicit scheme with a time-step of 300 seconds.



Filtering : Fourth order implicit horizontal diffusion.

Physics : CBR vertical diffusion scheme; Sundqvist condensation scheme with the 'STRACO' (Soft TRAnsition COndensation scheme) cloud scheme; Savijarvi radiation scheme.

Lateral Boundary Treatment : Davies-Kallberg relaxation scheme using a cosine dependent relaxation function over a boundary zone of 8-lines. The latest available ECMWF 'frame' files are used [based on 4 ECMWF runs per day at 00Z, 06Z, 12Z and 18Z, respectivly]. ECMWF data is received on a 0.3^o x 0.3^o rotated latitude-longitude grid on a selection of the 60 ECMWF eta levels. The data is interpolated both horizontally and vertically to the Hirlam 0.15^o x 0.15^o rotated latitude-longitude grid at [Hirlam] 31 eta levels. [The selected 0.3^o x 0.3^o grid corresponds to half the resolution of the 0.15^o x 0.15^o grid, the line speed is not sufficient to receive the data at full resolution].

In general the ECMWF boundary files are just provided as 'frame' boundaries where the data is not defined in the central section of the grid. However, the ECMWF analysis fields are received on a 'full' grid and so can be used as a 'first-guess' in the case of a 'cold-start'.

Data Monitoring

The analysis departures/flags are fed back to the original BUFR reports to create 'feedback' files which are used to monitor the quality of the data on an ongoing basis and to identify problems [e.g. station elevation errors].

Operational Usage

General Forecasting : Hirlam forecasts are used for general forecasting in Met Éireann out to 48-hours. [ECMWF forecasts are used beyond that period]. Hirlam output can be displayed using an interactive graphics sytem called *xcharts* (developed at Met Éireann).
WAM model : Forecast 10-metre winds from Hirlam are used to drive a WAM wave model.
Roadice Prediction System : Forecast surface parameters [temperature, wind, cloudcover, humidity and rainfall] are used [after forecaster modification] as input to a roadice model.
SATREP : Hirlam output can be overlaid on satellite plots as part of the ZAMG SATREP analysis scheme.

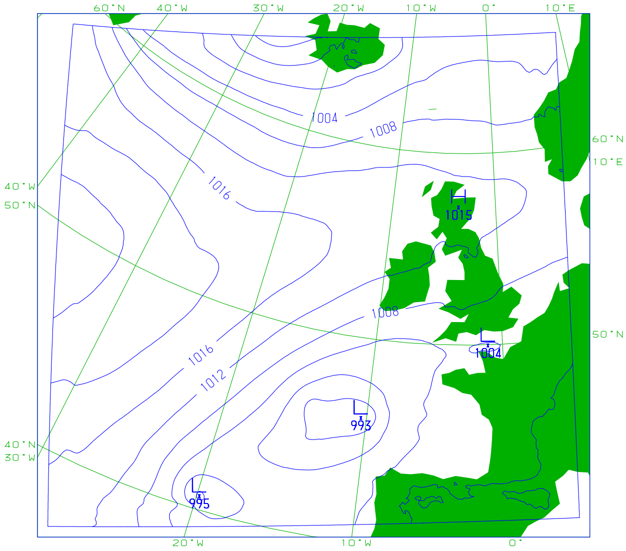
Verification

Verification against Fields : A small number of Hirlam parameters are verified against the corresponding Hirlam analysis fields. [This is to provide continuity with an earlier model which was used before Hirlam became operational].
Verification against Observations : The Hirlam verification system is used to verify forecasts against observations from EGWLAM stations within the area.

Nested Hirlam

A nested version of Hirlam is also run on the IBM RS/6000 SP. It works on a three hour cycle producing 27-hour forecasts at the intermediate hours [viz. 03Z, 09Z, 15Z and 21Z]. It runs on a 222 x 210 grid, with 40 levels in the vertical. [The grid spacing is 0.12^o x 0.12^o which is slightly finer than the main Hirlam grid of 0.15^o x 0.15^o].

It uses a more advanced version of the physics than the main Hirlam i.e. it uses the Kain-Fritsch/Rasch-Kristjansson convection/condensation scheme and the ISBA surface scheme. Many of the outputs of the model are post-processed using MOS. The following diagram shows the area :



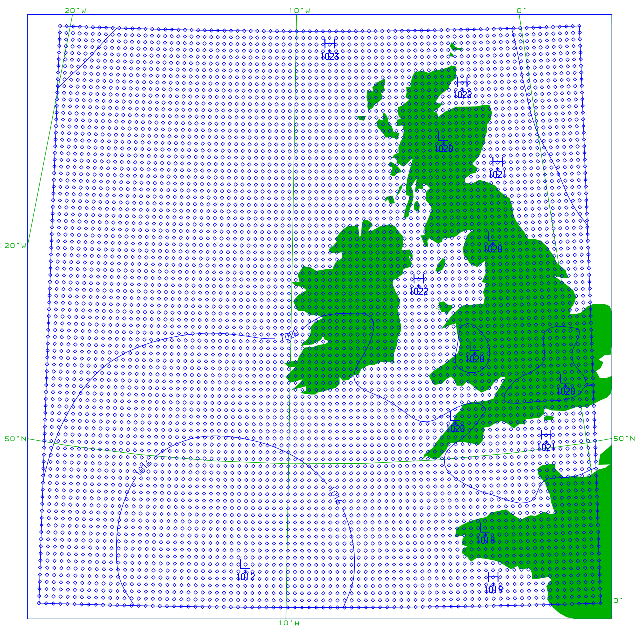
Nested Hourly Analysis

A separate nested version of Hirlam is run every hour on a dual-processor 500Mhz PC running Linux. The run provides an hourly analysis and also a short range [3-hour] local forecast.

Forecast Model : Hirlam 4.3 forecast model in conjunction with the Hirlam 4.8 OI analysis scheme.

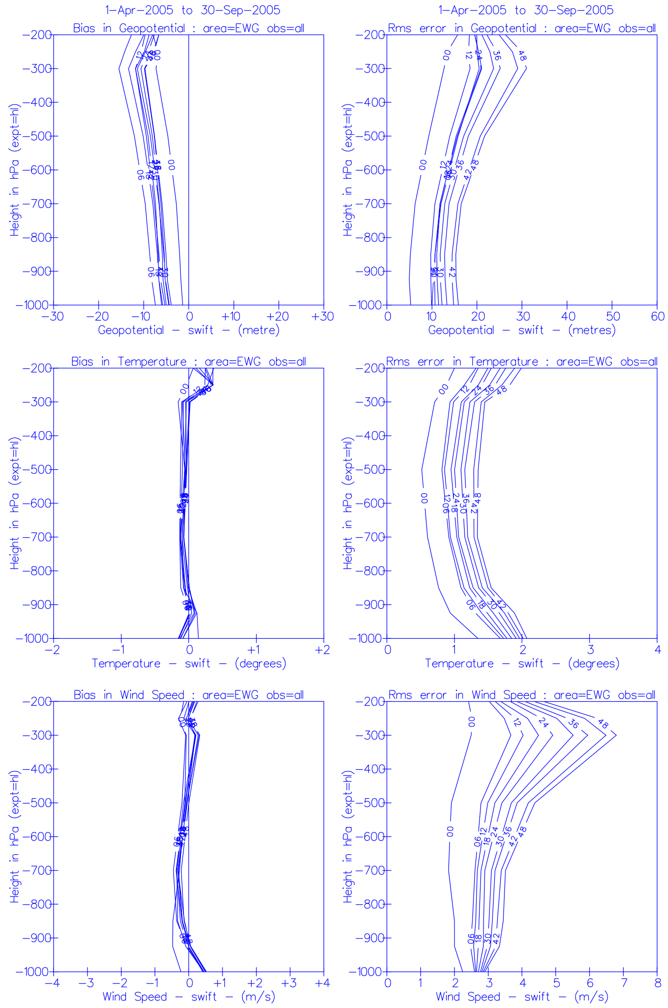
Vertical grid : A set of 24 hybrid [eta] levels.

Horizontal grid : A rotated latitude-longitude grid is used with the South-Pole at (-9^o longitude, -38^o latitude). There are 97x98 grid points with a resolution of 0.15^o x 0.15^o. The following diagram shows the area :



Verification Statistics

The following diagram shows some verification statistics for Hirlam, against the list of EWGLAM stations, coverring the period Apr-Sept 2005 :



Research Activities

Better specification of boundary conditions for NWP models; Operational Implementation of a Nested System; Regional Climate Analysis, Modelling and Preciction Centre [RCAMPC] and Community Climate Change Consortium for Ireland [C4I].

Experiments with Linux Cluster

Met Éireann started to experiment with running Hirlam on a Linux cluster in early 2004. The experiences have been generally good.

Cluster Hardware : The cluster consists of 10 rack mounted Dell Poweredge 1750 nodes (i.e. 1 master node and 9 compute nodes). The master node has dual 2.8GHz Xeon processors with 4 Gigabytes of ECC DDR RAM; each compute node has dual 3.2GHz Xeon processors with 2 Gigabytes of memory. The compute nodes are connected as a two-dimensional torus via 4 Port Dolphin SCI HBA cards.

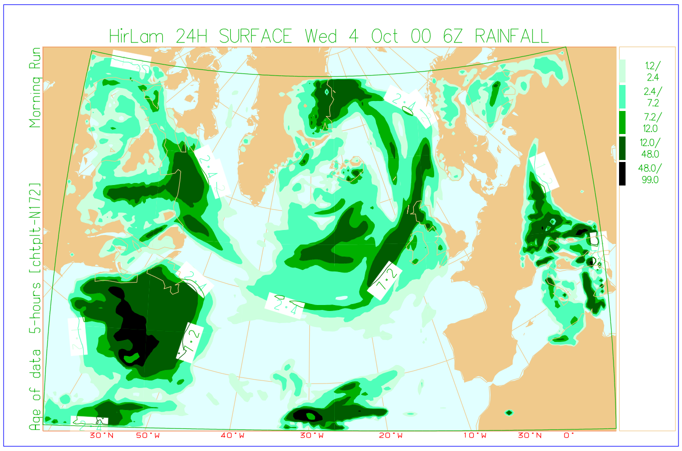
Cluster Software : (a) Operating system: Redhat ES 3.0 / WS 3.0 (b) Networking software: Scali MPI connect, Scali TCP connect, Scali Manage; (c) Compilers: PGI cluster development kit and Intel Fortran compiler.

Forecast Suite : The same as the main operational model viz. Hirlam 5.0.1 with 3DVAR analysis. It runs on the same grid and with the same options. This allows us to make direct performance comparisons between our IBM mainframe and the cluster. [In addition we are implementing Hirlam 6.4].

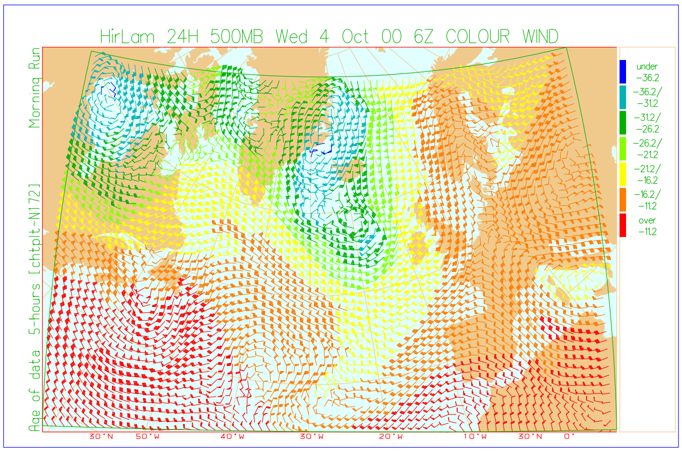
Cluster Performance : A typical 48-hour Hirlam forecast takes 62 mins on the mainframe and 71 mins on the cluster; a typical 3DVAR analysis takes 15 mins on the mainframe and 9 mins on the cluster [the cluster version of the analysis uses fftw]. A total run [analysis+forecast] takes 77 mins on the mainframe and 80 mins on the cluster. All cluster runs are with the PGI compiler.

Sample Output

The following are some examples of typical Hirlam output as displayed on the forecaster's workstation [using the **xcharts** graphics program]. The first chart shows accumulated rainfall :



The next chart shows wind-arrows at 500hPa. The colour of each arrow has been chosen to indicate the temperature at that level :



Future Plans

We hope to continue our experiments with the cluster and investigate the use of the Intel compiler and the Intel mathematics libraries [both of which are said to improve performance]. At present we are in the process of implementing the latest [6.4] version of Hirlam on the cluster.

3.12 The Netherlands

Assimilation of CHAMP radio occultation profiles

John de Vries, KNMI, Po Box 201, 3730AE De Bilt, The Netherlands,
jdevries@knmi.nl

Abstract

Assimilation and forecasting trials with CHAMP radio occultation (RO) data have been performed in HIRLAM. Initial experiments with refractivity profiles show a negative trend in the bias of surface and upper air parameters. RMS scores are only slightly affected.

1. Introduction

RO data can be assimilated in several ways (Eyre [1]). In this study refractivity profiles were selected for assimilation as a compromise between the complexity of forward modeling and the estimation of observation error characteristics. The selection can also be seen as a first step towards future assimilation of bending angle profiles.

2. CHAMP data

RO profiles have a high vertical resolution, ranging from 45m at 5km to 160m at 30km height.

Figure A shows a one-month spatial distribution of RO profiles and one day of profiles in red.

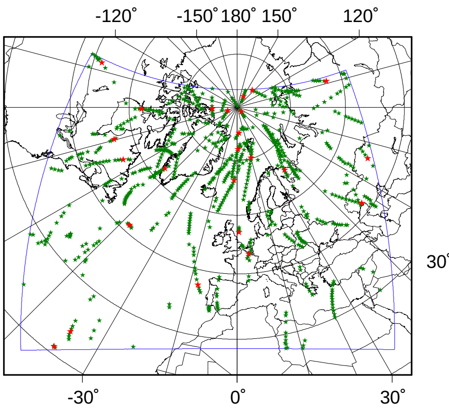


Figure A*. RO profile distribution in the HIRLAM domain for May 2003.*

The penetration depth of RO profiles (figure B) with latitude is closely related to the distribution of atmospheric water vapor and the ability to retrieve good quality observations.

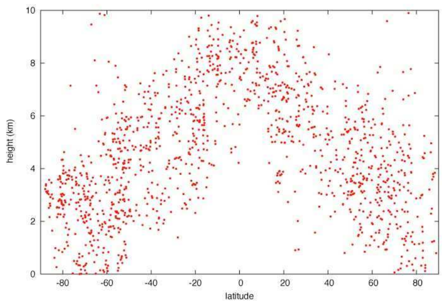


Figure B*. The lowest perigee points in CHAMP profiles for May 2003.*

3.Results

3.1 Observation error study

Systematic and random error estimates were obtained in a comparison between CHAMP refractivity profiles and those computed from HIRLAM analysis fields (figure C). The systematic error estimate is used for bias correction and the random error is used as weight for the observations in the assimilation.

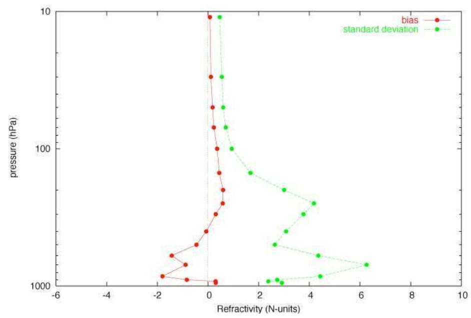


Figure C. *Refractivity bias and standard deviation relative to HIRLAM analyses*

3.2 Impact experiments

Three observation experiments were carried out with HIRLAM.A control run CTL with all conventional observations included. DNL, a model run equal to CTL but with radiosondes excluded. ROC, a run like CTL but with RO profiles included. In the experiments, HIRLAM version 6.3.7 was used at 22km resolution and with 40 layers in the vertical. Model run results were verified against SYNOP and radiosondes. Verification of surface parameters (figure D) shows that the bias in ROC gives a slight improvement for longer forecast ranges relative to CTL (red line), which in turn is much better than DNL, also in RMS. The impact in RMS of ROC is slightly positive in surface pressure but slightly negative in temperature compared to CTL. Changes in the magnitude of the RMS are small between CTL and ROC.

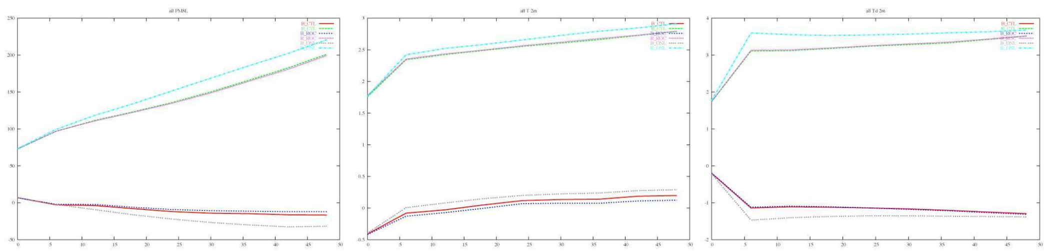


Figure D.*Verification for surface parameters.*

The upper-air bias (figure E) has a negative trend in ROC compared to CTL except for dew point temperature. The trend is beneficial for the warm temperature bias in the boundary layer. The negative bias in geopotential increases near the tropopause. Changes in the magnitude and structure of the RMS (figure F) are small between CTL and ROC.

4. Conclusion

This implementation for RO profiles trades a partly beneficial negative trend in the bias for a slight reduction in skill. Future work will include extending quality control procedures, tuning of observation error statistics and verification of results for the stratosphere

References

[1]Eyre,J.R., Assimilation of radio occultation measurements into a numerical weather prediction system, ECMF Tech. Memo., 1994

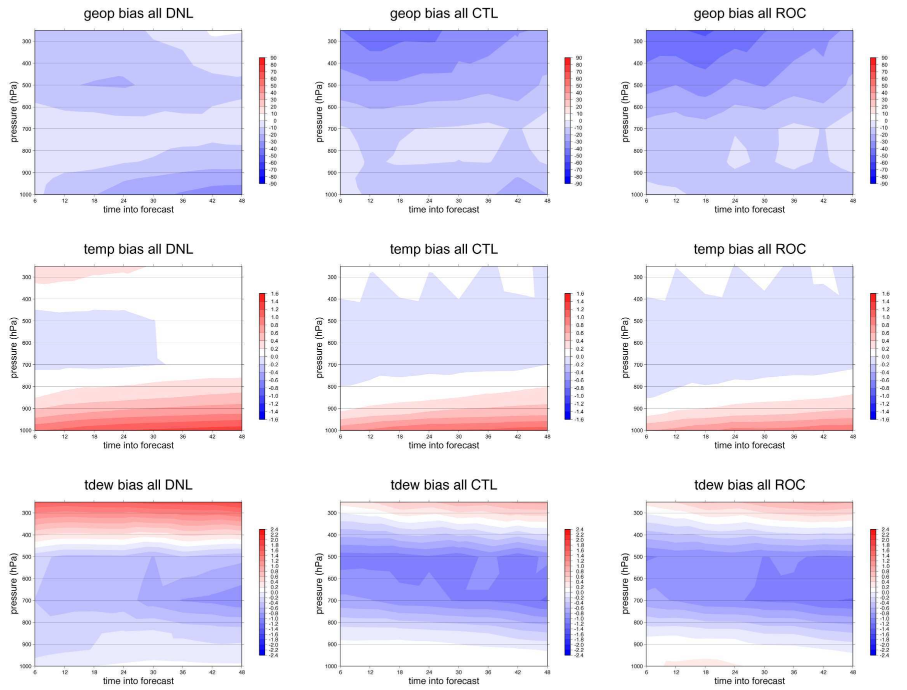
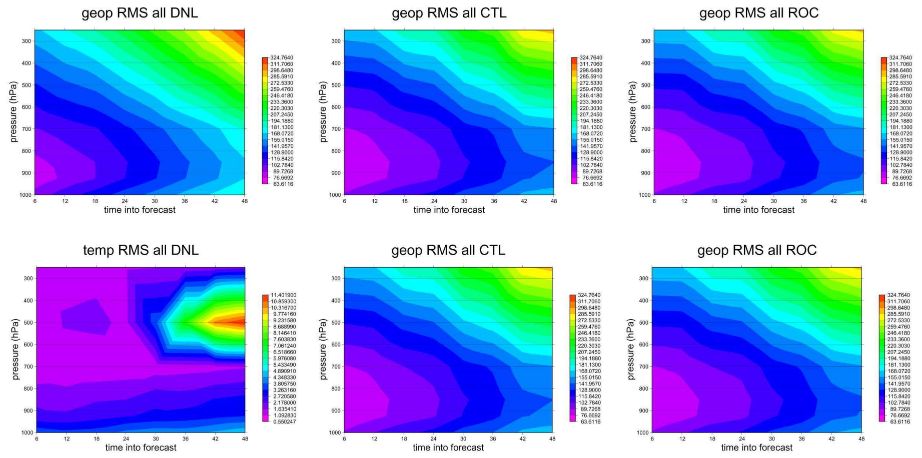


Figure E. *Upper air biases*



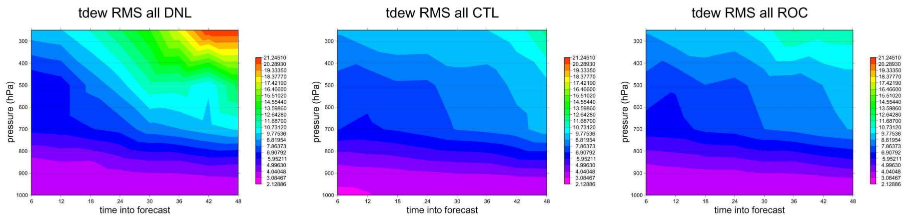


Figure F. *Upper air RMS*

3.13 Portugal

Instituto de Meteorologia (IM)
Rua C, Aeroporto de Lisboa,1749-077 Lisboa, Portugal
Maria.Monteiro@meteo.pt

During the mentioned period the main effort have been put not only on the local maintenance of actual tools but also on the preparatory studies to change our NWP environment, in particular the operational scheme of ALADIN/Portugal. Data pre-processing is now being fully mounted under UNIX environment, a new computer platform is being tested for ALADIN/Portugal and a restricted version of a scientific Live Linux distribution (PaiPix + ECMWF tools) has been created to allow an efficient exploitation of NWP products. Besides, a NWP historical archive has been designed using an open source RDBMS and is under test. The verification tools are being reviewed and prepared to become fully operational. Training has become a priority inside the team since new people joint the group. Frequent general explanatory sessions have also taken place inside our meteorological service. As a final remark we mention that diagnostic tools post-processed from direct model outputs are now fully in use on the weather forecasting room for the identification of severe weather situations and that the ALADIN/Portugal products are continuously disseminated as forcing fields for operational ocean modelling activities.

Since 24 of April 2000, IM has a Limited Area Model (LAM) running in operational mode. This NWP model is a local installation of the ALADIN model, hereafter called ALADIN/Portugal model. As a brief history, we refer the following operational changes:

Apr 2000	cycle AL09
Jun 2000	cycle AL11T2 (CYCORA included)
Jul 2001	cycle AL12_bf02 (CYCORA_bis included)
Apr 2002	change of the time step (540s to 600s)

and some new pre-operational introductions:

Jan 2003	cycle AL12_bf02 (CYCORA_bis included) installed on a DecAlpha cluster
Jan 2005	new geographical configurations for cycle AL12_bf02 (CYCORA_bis included) are being tested

Start of operations of ALADIN/Portugal on a new DecApha cluster
Change of ALADIN/Portugal WS actual operational version to AL28, with a new geographical configuration
Start of a NWP historical archive and improvement of the verification tools
Start of dynamical adaptation for the wind as support of forest fire prevention
Dissemination of coupling fields as support to MATCH

The operational environment and main characteristics of ALADIN/Portugal are:

Computer characteristics

Oper: DEC Alpha XP1000 (Compaq), 1/500, 1 Gb mem., DIGITAL UNIX V4,0; Pre-oper: DecApha cluster ES40 2/667, 3Gb mem., True 64 UNIX V5,1A; In both systems: DIGITAL F90 and 77 Compilers, native C Compiler

Model characteristics

Spectral hydrostatic model; Hybrid vertical co-ordinates; DF initialisation; Semi-Implicit Semi-Lagrangian two-time-level advection scheme; ISBA surface parametrisation scheme; Initial and lateral boundary conditions from the latest ARPEGE forecast; 6 hour coupling frequency from ARPEGE; Integration domain: 100x90 points; Number of vertical levels: 31; Horizontal resolution: 12,7 km; Time step: 600 s; Integration frequency: twice a day; Forecast range: 48 hours; Output frequency: 1 hour

Available configurations

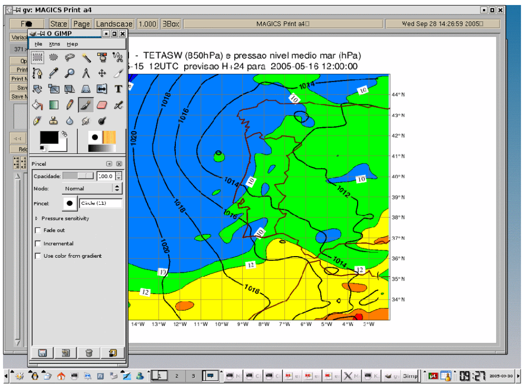
001, e927, e923 and 701

Graphical software

The METVIEW/MAGICS graphical software (ECMWF) is used to display ALADIN/Portugal products under operational and development environments. Besides, a user-friendly visualisation tool for PC's was designed to display up to a maximum of three overlapped meteorological fields coming from the last two operational runs of the model.

(info: Ligia.Amorim@meteo.pt & Joao.Simoes@meteo.pt & Antonio.Amorim@paipix.org)

A new NWP working environment is being designed for each development work position. In order to have a standard and efficient exploitation of NWP products, a PaiPix/IM distribution meant to be used on a meteorological development environment was created.

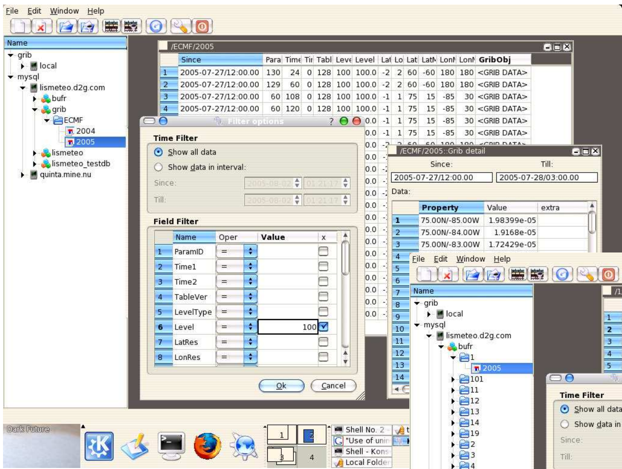


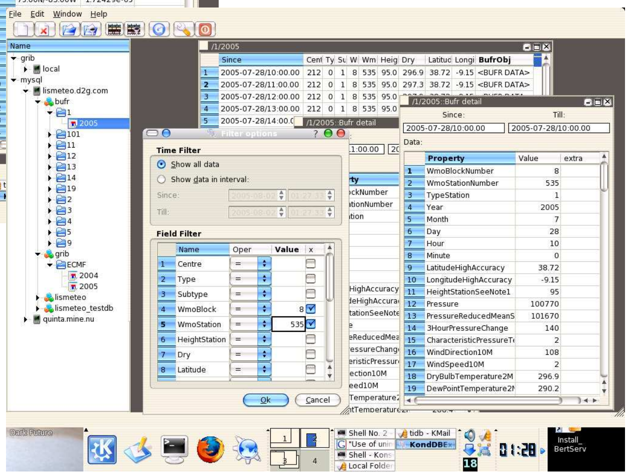
A PaiPix/IM desktop image under a Metview session

Paipix is a bootable Live system on DVD, based on KNOPPIX Live Linux, consisting on a representative collection of GNU/Linux software, automatic hardware detection and support for many graphical cards, SCSI and USB devices and peripherals. It is used as desktop and locally we installed it on a hard disk.

ECMWF basic tools have been included on this distribution (e.g. EMOSLIB and Metview) and the access to our NWP on-line data base have been considered.

With the full migration of our real-time pre-processing system to UNIX, our BUFR and GRIB on-line data base was re-created under the new operating system. The new RDB/FDB (reports data base/fields data base) is being tested as a form of object extensions to an open source RDBMS for meteorological purposes. The expected target of this work is the design and implementation of our NWP historical archive.



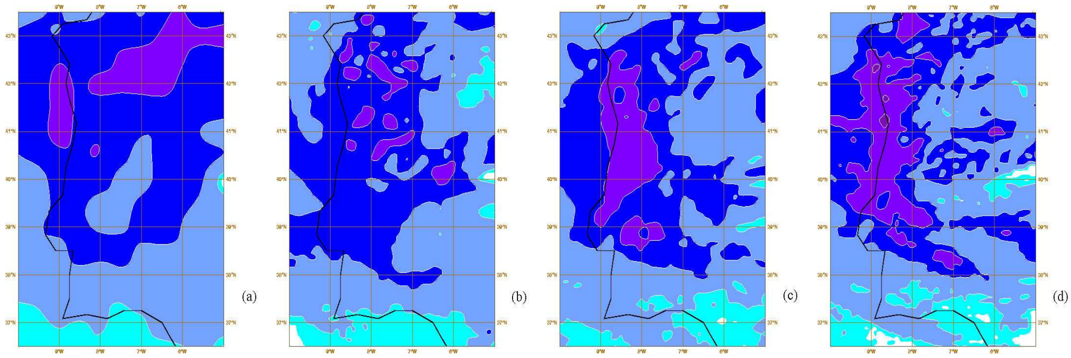


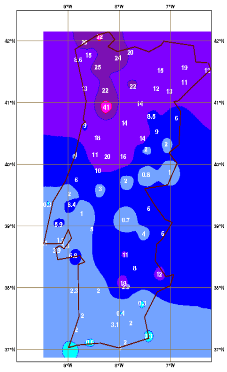
Archive details: above- a GRIB data point; right- a BUFR data point

(info: Margarida.Belo@meteo.pt & Pedro.Sousa@meteo.pt)

The impact of new geographical configurations of the ALADIN/Portugal is being tested in order to prepare a better answer of our operational system. Experimental runs are being performed for 3 different geographical area/resolution pairs of configurations and results are being analysed against ECMWF products and observations: 39 cases from which two third cases of severe precipitation conditions able to cause warning alerts are under analysis, both associated with winter frontal systems and with spring/summer deep convective systems. The following configurations are available:

Oper (44.8N/-12.2W/35.1S/-1.7E & 12,7km)
S33 (45.1N/-16.0W/32.5S/-2.5E & 12,7 km)
S33_8 (45.1N/-16.0W/32.5S/-2.5E & 8.0km)

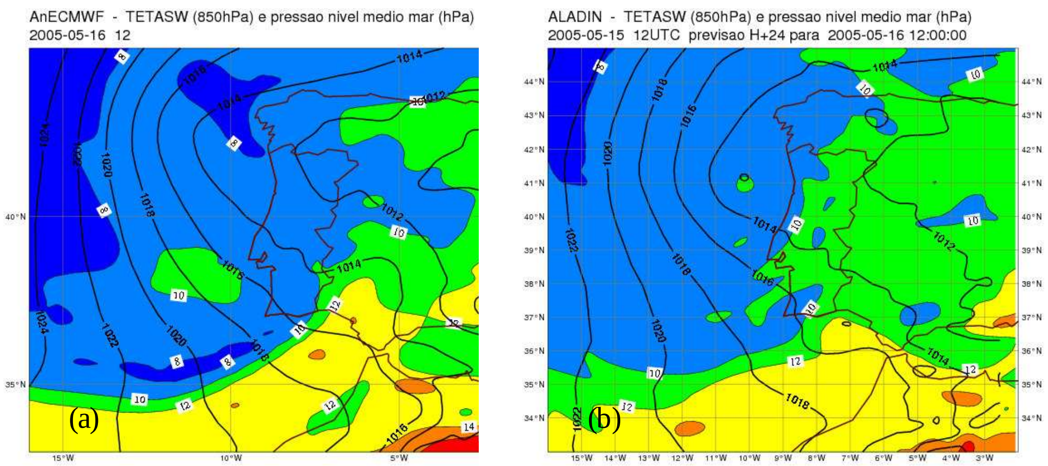


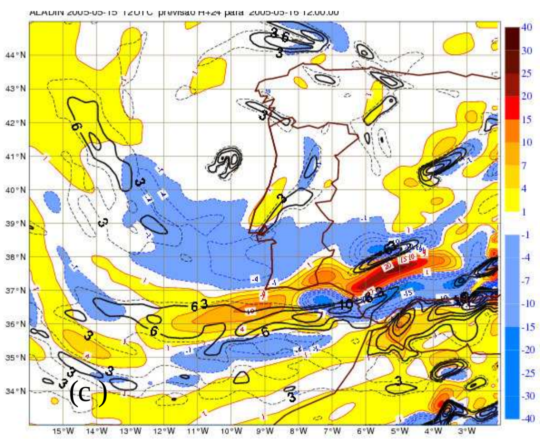


Precipitation field under a frontal system weather conditions. (a) ECMWF model; (b) ALADIN/Oper; (c) ALADIN/S33; (d) ALADIN/S33_8; left- Observations

An objective verification has been performed. Case studies analysis results are positively more conclusive with the increase of Atlantic area of our geographical domain than when we increase resolution.

The diagnostic tools mentioned at 1 were applied to the outputs of the above mentioned experiences and the results for the ALADIN/S33 experience are shown.





Result of the two diagnostic tools, the frontongenic function and Q vector divergence on a frontal system weather condition. (a)- ECMWF analysis; (b)- ALADIN/Oper H+24; (c) frontongenic function and Q vector divergence from ALADIN/S33

3.14 Romania

Limited Area Modeling Activities in Romania

1. ALADIN

(Alexandru S., Banciu D., Caian M., Ibanescu I., Radu R., Soci C., Stefanescu S.)

National Meteorological Administration of Romania is a partner in the international project ALADIN. The main research and development topics in this collaboration are going towards: coupling problems, data assimilation, physical parameterisations, validation and verification and ensemble prediction systems.

1.1 Operational ALADIN

Operational suite of ALADIN-Romania is integrated on a SUN E4500 platform (8-CPU 400GHz, 64 bytes architecture) twice per day over two different domains up to 48h forecast range.

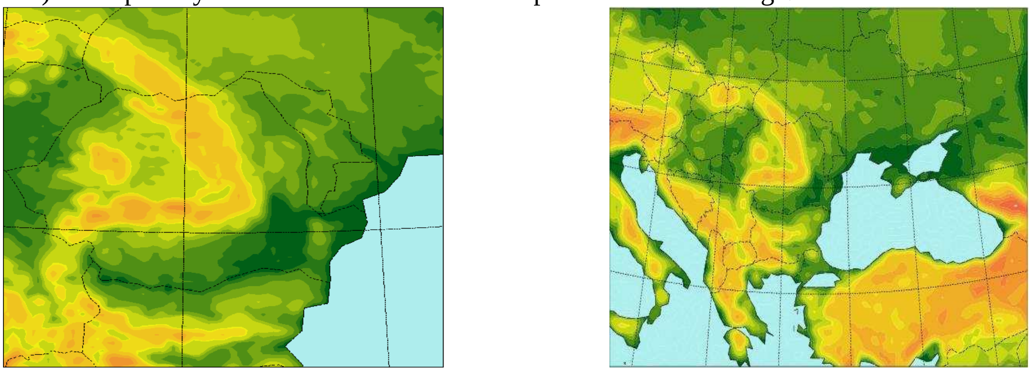


Figure 1. a) Integration domains and orography: Dx=10 km (left) and b) Dx =24 km (right)

The main characteristics of the model are : regular grid using Lambert projection, and resolution of 10km (100x100), soon (144x144)) (Fig.1c) and 24km (120x90), hybrid vertical coordinate , 41 vertical levels, dynamical adaptation mode, ARPEGE supplies initial and boundary conditions, 2TL Semilagrangian scheme with time step of 450s for 10km, 900s for 24 km, time integration for 48h : 40 min (10 km), 22 min (24km).

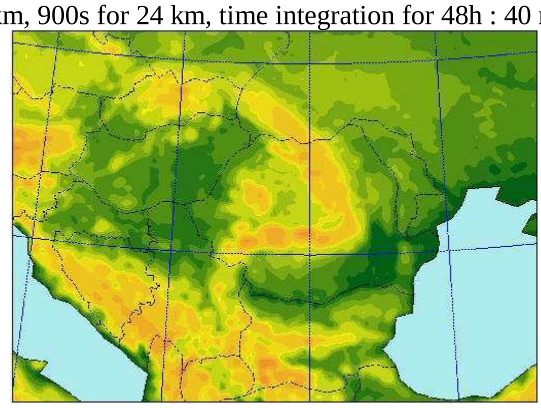


Figure 1. c) Integration domains and orography: Dx=10 km (144x144)

The operational suite includes: the post processing (every 3 hours), the generation of standard outputs (grib format routed towards the visualization systems in Bucharest and to the Regional Meteorological Centers), statistical adaptation (MOS, Kalman filter) of the direct model output and verification procedures. Additional graphical products (meteograms, pseudo – satellite images, hight of specific isotherms, stability indexes, etc) are automatically generated; they are available on the ALADIN- romanian web site. The ALADIN model results are used as input data for the wave models (WAM, VAGROM) and for the diffusion and transport of pollutants models (MEDIA). New is the operational implementation of Aladin-Diagpack - the optimum interpolation method used to obtain an Aladin analysis, using the SYNOP data from the Romanian stations (mean sea level pressure, 2m temperature and humidity, 10m wind and sea surface temperature).

Romania has joint the common ALADIN verification program. The data extraction procedure, developed by the Slovenian colleagues has been installed on a SUN workstation, using the PALADIN package. The surface and upper-air parameters forecasted by the ALADIN-Romania model for the established list of stations are sent by e-mail to Ljubljana to be inserted into the central database.

2. High Resolution Regional Model and Lokal Modell

(Pescaru V. I., Velea L., Dumitrache R.)

2.1 Operational and simulations

HRM is integrated operationally on SUN BLADE 1000 workstation at 28 km resolution. The non-hydrostatic Lokal Modell, implemented firstly on Sgi Altix workstation and then running on Linux Cluster with: multi-processor optimization, pre-operational running procedures at 14 km together with simulations at 7 km and 2.8 km proved its functionality. The model is running twice per day up to 78 hour forecast for a domain covering Romania (16 –32° E, 42 – 51°N).
Tests with the Local Modell (LM) and HRM at 14 km shows that LM improves the forecast, as for instance by reducing the area and amount of precipitation closer to observations (Figure 2). The Lokal Modell was also implemented and tested for the 2.8 km horizontal resolution, using to that aim more representative domains over the Romanian territory. Analysis of the obtained results proved the LM's ability to detect fine scale phenomena.

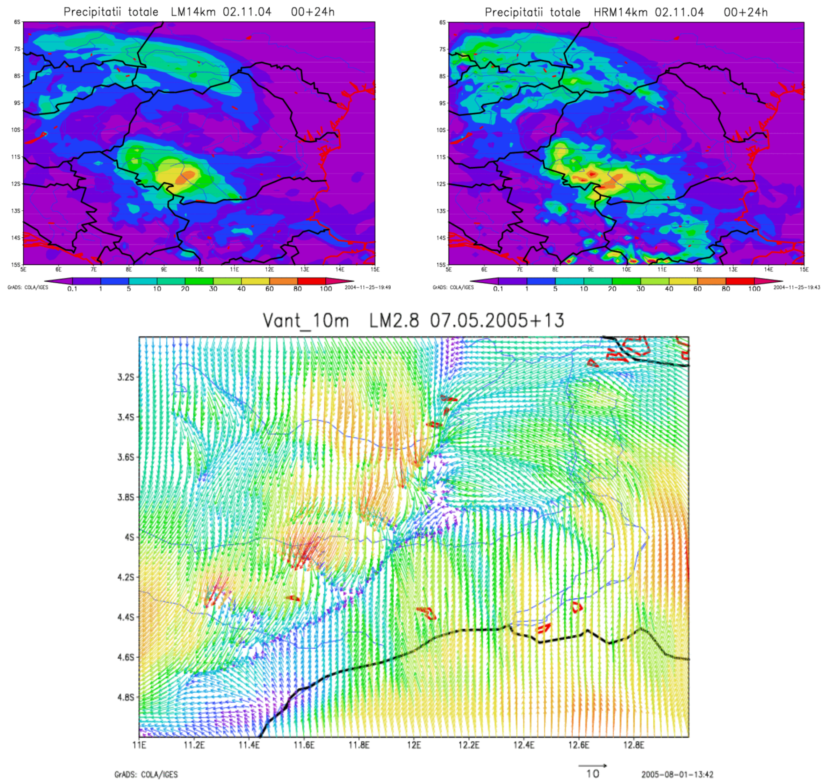


Figure 2 a): Total precipitation LM (left), b) total preciptation HRM (right) at 14 km, and c) 10m wind with LM at 2.8km (bottom).

3. Developments and other applications

The ALADIN research-developments activities (part of them in cooperation with others Aladin teams) were focused on the following topics: spectral coupling, data assimilation and high-resolution simulations (including comparison between ALADIN-NH and AROME) mainly for floods events studies.

3.1 Spectral coupling (Radu R.)

The impact of spectral coupling (method for improving LBC treatment, based on spectral representation), on the forecasted fields in ALADIN was studied in comparison with the operational coupling. A daily data-basis over almost a year was realized in this sense. The validation of this method for ALADIN continued afterwards with aspects concerning its behaviour at finer resolution in extreme local phenomena as the tornado case of Movilita 07.05.2005. The results correlated with observations reveals the capacity of different coupling methods to simulate the both phases of frontogenesis. The conclusion was that the operational coupling was able to better detect the first phase developed by the non-stationarity of surface and PBL forcing, meanwhile only the spectral coupling catches the second phase of regeneration which was born through the interaction between the large and the small scales.

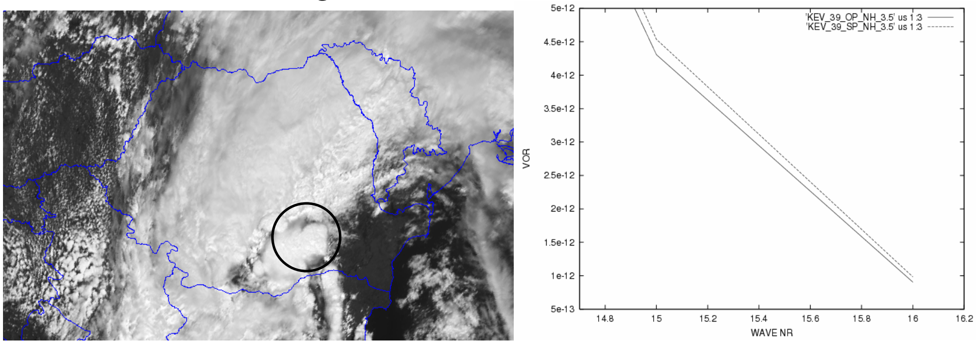


Figure 5: HRV Satellite image on 07.05.2005 (left) and vorticity spectra for ALADIN-NH (3.5km) using operational grid point coupling (contouring line) and spectral coupling (dashed line – right) when tornado produces.

3.2 CONVEX experiment application (11-12th of May 2005) (Barbu A., Banciu D., Pescaru V. I.)

Between 11 – 12th of May 2005 an international exercise named CONVEX-3, a simulation of a nuclear accident at the power plant in Cernavoda (Romania) took place. The coordination was done by IAEA, NEA/OECD (Nuclear Energy Agency/Organization for Economic Co-operation and Development), OCHA (United Nation Office for the Co-ordination of Humanitarian Affairs), WHO (World Health Organization) and WMO (World Meteorological Organization).

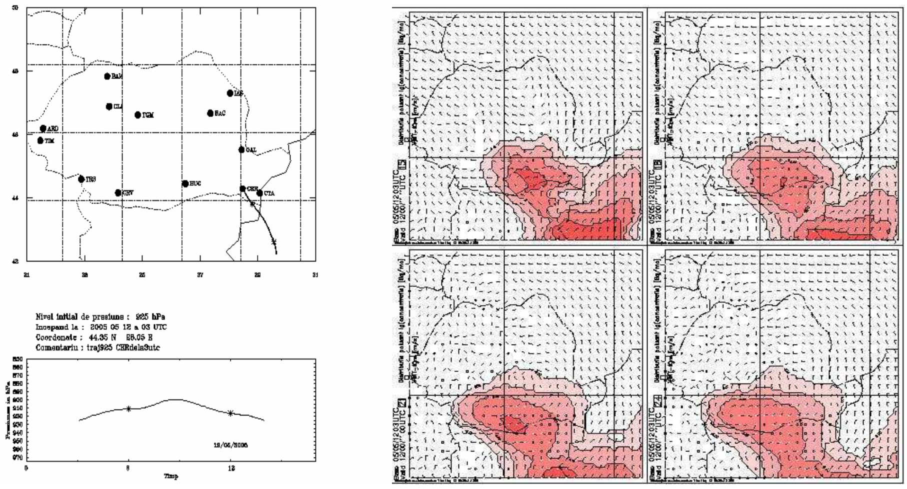


Figure 3: 48 h trajectory with the initial point at 925 hPa (left), and pollutant concentration for 15, 18, 21 and 24 hour forecast ranges (right).

For this exercise the National Meteorological Administration of Romania provided different products as: meteorological forecast by ALADIN model, pollutant concentration forecast obtained by the coupled systems ALADIN model – MEDIA, HRM model-INPUFF, 48 hours trajectories (issued from the trajectory model by using ALADIN forecasted wind).

The maps containing the distribution of the pollutant cloud and trajectories have been communicated to the decision factors and stored on the NMA web page. The outputs were in accordance with those provided by Meteo-France and MetOffice.

3.3 Circulation models (Stefanescu S., Banciu D.)

ALADIN model was integrated over the Black Sea domain at 24 km resolution for 60 h, twice per day. The ALADIN fields: 2m temperature and specific humidity, 10m wind speed and precipitation, evaporation and heat fluxes are used to couple the basin scales and coastal circulation models.

During 22-26 July 2005 a pre-operational forecasting experiment took place in ARENA project framework. The results of the POM model (Princeton Ocean wave Model) were integrated for the Romanian coastal zone.

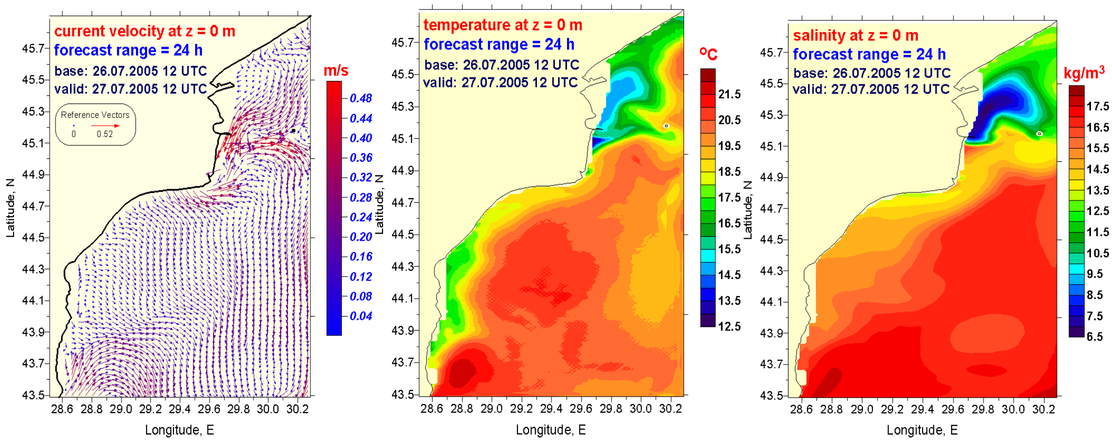


Figure 4: The current velocity (a), sea temperature (b) and salinity (c) 24h forecast of the POM circulation model for the Romanian coastal zone valid on 27.07.2005 12 UTC

3.4 New machine

New Linux cluster platform for research purposes was realized with the following characteristics: 14 nodesX2 processors Intel Xeon, 2,66MHz per node, RAM 30GB, computing power~155Gflops, processors being connected through HP Gigabit Ethernet. As compilers it uses: Intel Fortran 8.2 and C, Portland Group.

Event

First **AROME Training Course** organized by Meteo-France and National Meteorological Administration of Romania will take place in Poiana Brasov between the 21- 25th of November 2005. Around 53 participants will attend lectures on Méso-NH physics, ALADIN-NH dynamics and AROME prototype, including the externalized surface module.

3.15 Slovakia

NWP activities at Slovak Hydrometeorological Institute (2005)

Mária Derková
maria.derkova@shmu.sk
SHMÚ, Jeseniova 17, 833 15 Bratislava, SLOVAKIA

1 Introduction

This report gives a summary of NWP (Numerical Weather Prediction) activities at Slovak Hydrometeorological Institute (SHMI, SHMU) during the year 2005. The highlights are the introduction of 06 and 18UTC runs, prolongation of the model integration up to +54h, upgrade of the model cycle.

2 Operational setup

The NWP operational system at SHMI is based on ALADIN model with 9km resolution (domain covering whole RC LACE area), running on the IBM p690 server. The main characteristics of the supercomputer and the ALADIN/SHMU model features are summarized in tables below and the model domain is also shown.

Model is running four times per day up to 54h; in the dynamical adaptation mode with lateral boundary data provided by the global model ARPEGE. Data are downloaded via Internet, with RETIM2000 system as a backup. Hourly model outputs are available for further postprocessing and visualisation. ALADIN/SHMU model products are the main source of information for the forecasters (short-range forecast), and serve as the basic input for other numerous applications and products (automatic point forecasts, dispersion model, hydrological model etc.). The data for the PEPS project are also operationally provided.

The operational suite is based on the in-house developed system of perl scripts and programs, and enables on-line monitoring and documentation via the web interface. Given the importance of ALADIN/SHMU products, the non-stop human monitoring started on 01/01/2005.

The ALADIN/SHMU outputs are regularly verified: surface parameters at SHMU (recently upgraded to MySQL technology), available on intranet; data are also sent to be used in the common ALADIN verification project.

COMPUTER CHARACTERISTICS and ARCHIVE DEVICE

IBM @server pSeries 690 Type 7040 Model 681 32 CPUs POWER 4+ 1.7 GHz 32 GB RAM Memory IBM FAST T600 Storage Server, 1.5TB AIX 5.2	HW: IBM Total Storage 3584 Tape Library (24TB) SW: IBM Tivoli Storage Manager

MODEL CHARACTERISTICS

domain size	2882 x 2594 km ; 320 x 288 points in quadratic grid
domain corners	[2.19 W ; 33.99 S] [39.06 E ; 55.63 N]
horizontal resolution	9.0 km
vertical resolution	37 layers
time step	400s
length of the forecast	54 hours; 1 hour output frequency
runs	four times per day (00, 06, 12 and 18UTC)
mode	dynamical adaptation
coupling model	ARPEGE global model
coupling frequency	3 hours
code version	AL28T3_czphys

3 Operational suite upgrades

- 01/01/2005: 24/7 human monitoring of the operational suite
- 12/01/2005: switch to +54h integration
- 31/03/2005: new model cycle AL28T3_czphys operational (modifications mainly in the cloudiness and the radiation schemes)
- 25/07/2005: 06UTC run introduced
- 21/09/2005: the dynamical adaptation of the wind field to high resolution orography (2.5km) introduced
- 29/09/2005: 18UTC run introduced

4 Research and development

Local research and development work was focused on

- the observational database software (ODB) was implemented and is currently being tested, with the aim of using it for veral, diagpack and later 3DVAR tools
- the high resolution numerical study of the 19/11/2004 severe windstorm in High Tatras
- the feasibility study of the MOS technique: the T2m error distribution for direct model output and the model output statistics based on ALADIN pseudoTEMPs;evaluated over 9 Slovak SYNOP stations
- the quantitative precipitation forecast (11 river basins, 77 subdomains) and its verification
- the 15th ALADIN workshop was organised, 6-10/6/2005 in Bratislava

In frame of the ALADIN international project following R&D issues were tackled

- optimisation of the content of the coupling files
- new parameterization of cloud optical properties proposed for model ALARO-0
- non-isothermal reference temperature profile in NH dynamics of ALADIN
- radar reflectivity assimilation - assigning of dynamic quality flag
- technical work on phasing and optimisation of the model source code

5 Future plans

- prolongation of the forecast range up to 72h
- test and implement pseudoasimilation cycle using DFI blending technique
- systematic improvement of the operational model quality via ALADIN-2 project: concentration on ALARO-0 prototype
- continue to work on AROME project (NH-dynamics, radar data assimilation)
- cooperation with other RC LACE partners on LAM EPS

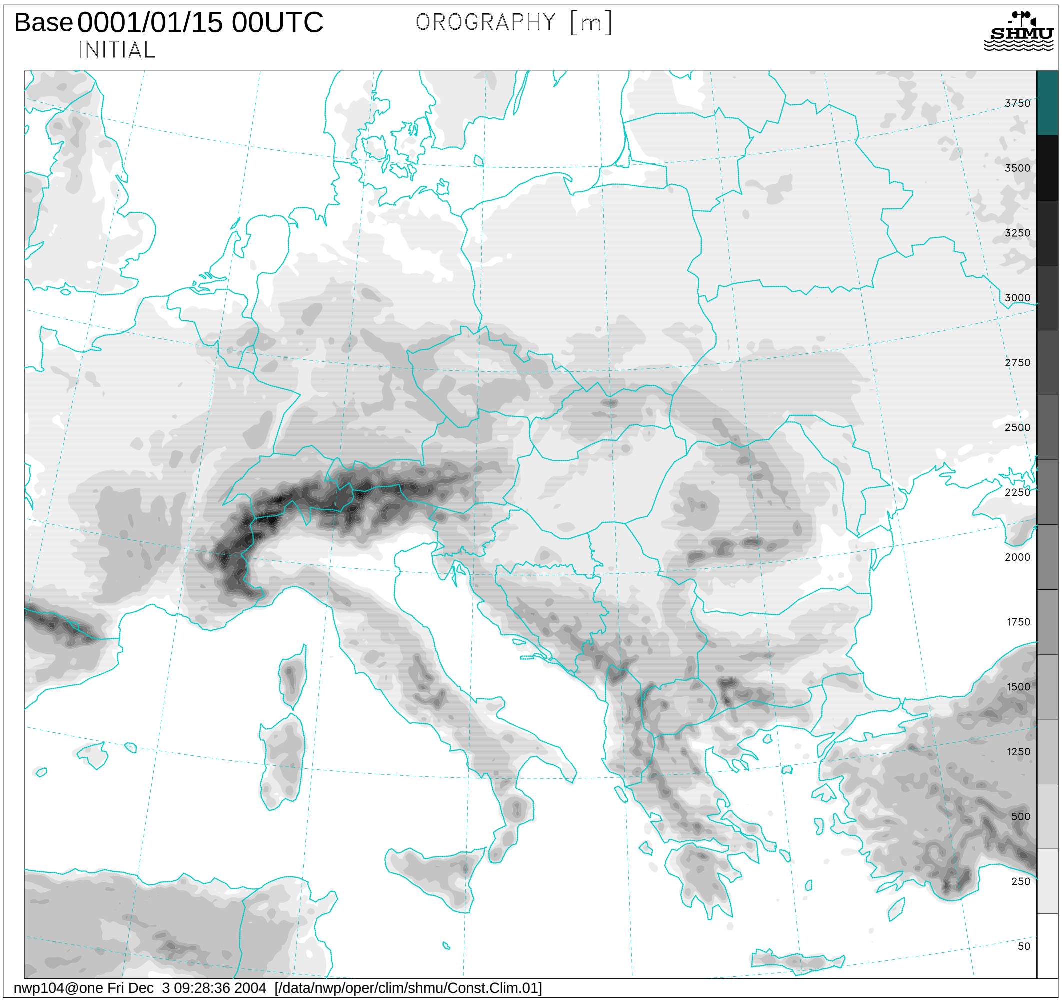


Figure 1: Domain of ALADIN/SHMU

3.16 Slovenia

Limited Area Modelling Activities in Slovenia

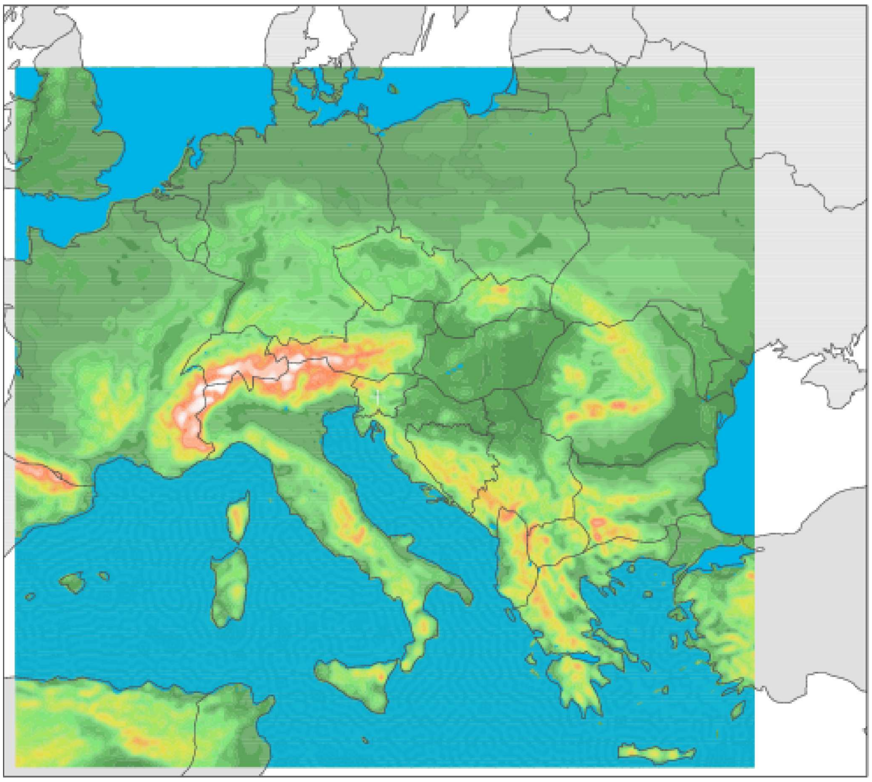
Neva Pristov, Mark Žagar, Jure Cedilnik, Jasna Vehovar
December 2005

Environmental Agency of the Republic of Slovenia is a partner in the international projects ALADIN and RC LACE. Our group is taking care that limited area numerical forecasts are prepared twice a day using ALADIN model. We have the leading role in the common ALADIN verification project for the objective verification on the synoptic scale.
The main research and development topics in last two years were devoted to introduce and test latent heat nudging in the model, to produce a physically consistent spatially complete climatological field of surface wind with numerical model initialised and driven by the ECMWF ERA-40 at the lateral boundaries. Quantile regression method was design for probability forecast of temperature.

Operational ALADIN application (neva.pristov@rzs-hm.si)
Our current ALADIN model configuration started in June 2003 on the new computer system which allowed increase of the computation domain.
Characteristics of the operational ALADIN/SI model configuration are:

- spectral, elliptic truncation E89x84 (258*244 points, with extension zone 270*256)
- Lambert projection,
- 9.5 km horizontal grid spacing on the collocation grid,
- 37 vertical model levels,
- 400 s time-step, range of forecast 54 hour,
- initial and lateral boundary conditions from ARPEGE,
- coupling at every 3 hours,
- digital filter initialization,
- integration twice per day.

Operational suite is running in Supervisor Monitor Scheduler, ECMWF product. Since end of July the whole cluster system and operational suite is controlled by NAGIOS supervision system and failures are reported to e-mails and via SMS messages to mobile phones. Required model products for PEPS project are sent to DWD. On the request of forecasters forecast length was increased up to 54h (20/07/2005).
The computer system is a cluster based on Intel Xeon processors, has 14 dual processor boxes with 2.4 GHz processors, 2 GB of memory per node (28 all together),300 GB primary disk space and additionally 3.5 TB external disks array. Processors are connected via gigabit fiber ethernet. It runs Linux OS enhanced by SCore software (www.pccluster.org). Queuing system, gang scheduling, check-pointing, parallel shell and simplified administration are available by SCore software. Lahey and Intel Fortran compilers, Totalview debugger are used.



The domain of ALADIN/SI (colored) is smaller than the domain with initial and coupling fields prepared from ARPEGE model.

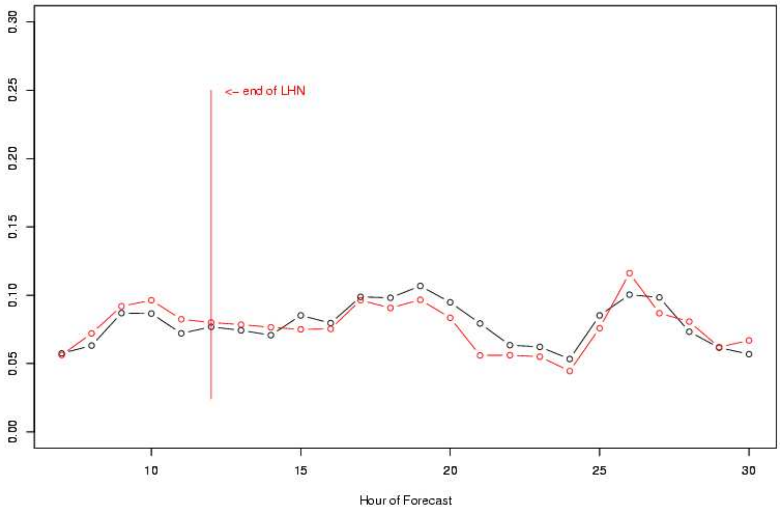
Latent Heat Nudging (jure.cedilnik@rzs-hm.si)

Latent Heat Nudging (LHN) is a method of forcing an NWP model with measured precipitation rate from radar with the aim to improve analysis and short range forecast of precipitation.

Model and measured precipitation rates are used to compute a weighted average according to the distance of measured point to the closest radar. This weighted average can be treated as a first approximation of analysis of precipitation. A ratio of this precipitation analysis and model precipitation is than used to rescale the latent heat cooling or heating part of temperature tendency profile in the model. Radar hourly accumulations is first interpolated into eight times more dense grid than the one of the model and then aggregated into the model grid. In case of no model precipitation, a climatological profile from model control run is used and rescaled according to radar measurement.

Results show that LHN improves model domain averaged precipitation bias. It successfully reposition precipitation systems from model's envelope orography ridges where they typically appear, but is not capable of altering the amount. In a case of only model precipitation and no precipitation measured, the LHN is trying to move the precipitation around instead of reducing the amount of it. However there are many cases of deterioration of the forecast (also) due to known problems of unrealistic model convection.

Impact of LHN after the end of nudging period lasts only up to a two or three hours ahead in time and is only positive when looking at statistical scores at a higher precipitation rate threshold.

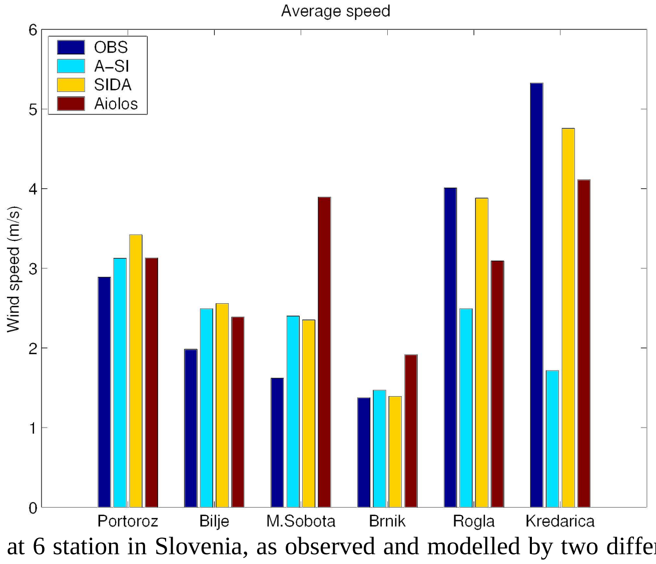


Equitable threat score with the threshold of 1 mm/h statistics for 2002. The red line is with LHN switched on till +12 hours of forecast and the black line is the control run.

Downscaling of the ERA40 data (mark.zagar@rzs-hm.si)

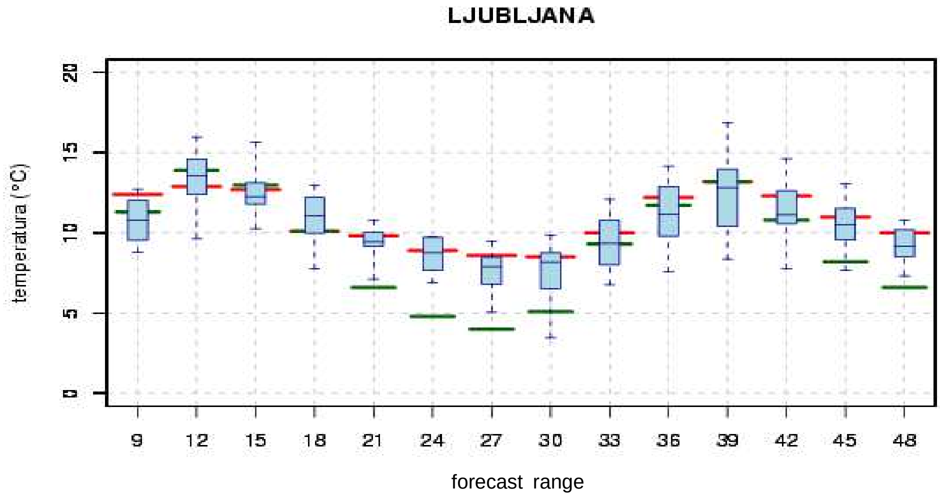
Downscaling of the ERA40 data for the 10-year period (1992-2001) was performed with a goal of obtaining a high-resolution wind climatology for the topographically diverse Slovenian territory. The NWP model ALADIN was used in three steps:

1. 60-hour simulations with 12-hour overlap, forced by the ERA40 fields at the lateral boundaries and with 30km horizontal resolution provided input for the second nest,
2. a 10km resolution run, again 60-hour long integration with 12-hour overlap.
3. In the final step, a 2.5km resolution ALADIN was run on each of 3-hourly output from the second nest and only until the wind field has adapted to the high-resolution orography, i.e. 30 minutes.



The average 10m wind speed at 6 station in Slovenia, as observed and modelled by two different ALADIN configurations (10km and 2.5km) and by one kinematic model with grid spacing of 1 km.

Probability forecast of temperature with quantile regression method (jasna.vehovar@rzs-hm.si)
Probability forecasting can also be done with a statistical model and not only with the ensembles. An advanced regression method, called quantile regression can be used as a statistical model. This method takes into account the true distribution of residuals, and combines probabilistic forecast and statistical adaptation of the NWP direct model output variables to the local conditions. The result is not only the forecast value, we also obtain the estimation of the accuracy of the forecast. This method allows us to produce probabilistic forecast not only for discrete but also for continuous variables. For development of such statistical model a learning data set is needed, sufficiently large to train the model.
The quantile regression method was tested on maximum and minimum daily temperature forecasts and 2 m temperature forecasts for different time ranges and for different locations in Slovenia. As predictors the observations and direct model output parameters from the operational ALADIN model were used. With comparison of verification scores for quantile regression and some other regression methods it was shown that the weighted local linear principle is the most privileged method among the tested.



An example of 2m temperature forecast for up to 48 hours ahead, every three hours. Green dash denotes the direct model output, red dash the observed value and the box with handles the output of the quantile regression method (median, quartile and 95% confidence)

ALADIN Verification project (neva.pristov@rzs-hm.si)
The purpose of the common project for objective verification at the synoptic scale is to inter compare forecasts from the ALADIN models configurations and to easily produce various reports. Centralized procedure is prepared to produce time evolution and comparison of classical scores over various domains and for various model configurations. The application consists of collecting observations and forecast values from models (for selected meteorological variables and stations), storing them to a relational database (built in Ljubljana) and a web interface is used to get on-line verification products of interest. In the year 2005 application is in testing phase, 8 national meteorological services are daily sending data from operational models and parallel suites.

3.17 Sweden

NATIONAL STATUS REPORT
on
Operational NWP at the Swedish Meteorological and Hydrological Institute

EWGLAM 2005 meeting 3 – 5 October 2005, Ljubljana

Lars Meuller, SMHI

Introduction

The Swedish Meteorological and Hydrological Institute (SMHI) is a member of the HIRLAM project. All research and development in the area of numerical weather prediction are done within the HIRLAM project. This report will only describe the operational HIRLAM at SMHI.

Computer system

HIRLAM at SMHI is run on the computer resources at the National Supercomputer Center (NSC) at Linköping University.
SMHI operational models, HIRLAM and an oceanographic model, HIROMB, are run on a dedicated cluster, BLIXT, that consists of:

- Linux operating system.
- 60 nodes.
- dual Intel Xeon processors, 3.2 GHz, 2 GB memory.
- Infiniband Interconnect.
- PCI Express bus.
- Scali MPI connect.
- Intel compilers.
- 5.6 TB disc.
- peak performance 768 Gflops.

SMHI has for a long time also, for backup reasons, been running a complete model setup also at another computer. If BLIXT is down the production can easily be switched to BRIS by just issuing one operator command.

BRIS is also a Linux cluster:

- home made by NSC.
- 16 nodes.
- dual Intel Xeon processors, 2.2 GHz, 1GB memory.
- Scali interconnect.
- ScaMPI.
- Intel compilers.
- 1 TB disc.

HIRLAM system

SMHI runs a HIRLAM model with version number 6.3.5 which in our case means a system with:

- 3D-VAR analysis
- DFI initialization
- ISBA surface scheme
- CBR turbulence
- Kain-Fritsch convection

- Rasch-Kristjansson large scale

SMHI at present runs 3 operational suites of the HIRLAM analysis and forecast model with different horizontal resolutions, C22, E11 and F05. They all have their own separate 6 hour data assimilation cycle.

Domain:	**C22**:	**E11**	**F05**
Horizontal resolution:	0.2×0.2° (22 km)	0.1×0.1° (11 km)	0.05×0.05° (5.5 km)
N:r of gridpoints:	306x306	246x268	294x241
Vertical levels:	40	60	60
Boundaries:	ECMWF 3 hourly	ECMWF 3 hourly	HIRLAM E11 every hour
S.L time step:	10 min	5 min	2.5 min
Forecast length:	+48 hour	+72 hour	+24 hour

E11 is run to +72 hour to give input to a LEPS (Lagged EPS) system

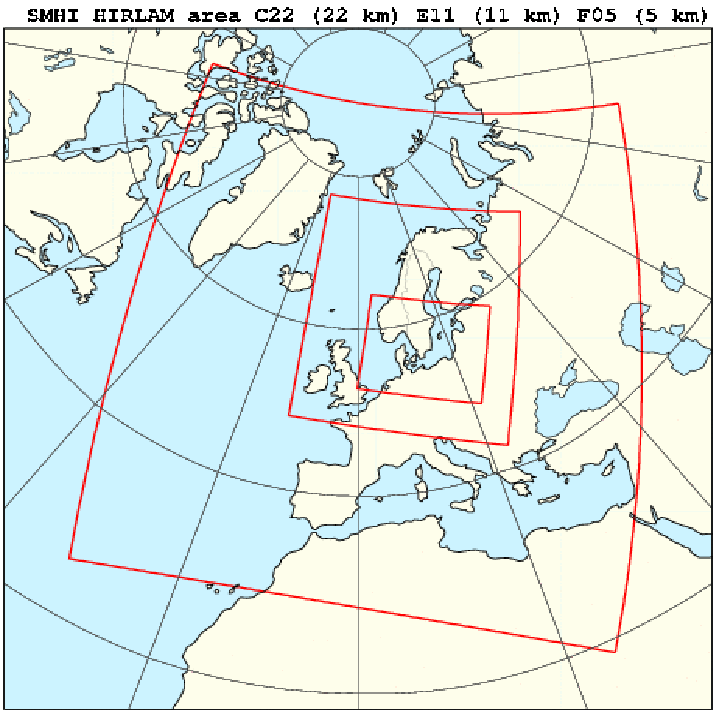


Fig 1. SMHI HIRLAM horizontal domain's

Model input

The observations used for the analysis are SYNOP, SYNOP SHIP, TEMP, PILOT, BUOY, AIREP and AMDAR.
Additional AMDAR in BUFR form from GTS are also used.
ATOVS AMSU-A radiances (EARS) over sea used in HIRLAM C22

A version of ECMWF observational pre processing system is used to convert from WMO alphanumeric code forms to BUFR.

In SMHI version of HIRLAM, the ice-cover in the Baltic Sea from the BOBA sea ice model and pseudo SST observations from manually analyzed SST fields in the Baltic Sea and the North Sea are used in the surface analysis.

Operational schedule

Every 3 hour a preliminary HIRLAM analysis is run with a cut-off time of +0h25m using mainly SYNOPs. The output is mainly used for the automated analysis of weather charts.
Every 6 hour E11 is started with a cut-off time for observations of +1 h 15 min. After E11 have ended F05 is started.
Every 6 hour C22 is started with a cut-off time for observations of +2 hours.

The clock time for all the runs to complete is about 40 – 50 minutes.

Model output files are written every hour and sent to SMHI.

Events

- Nov 2004 **-** Starting to use AMDAR from GTS in BUFR code
- June 2005
    - upgrading of the model from HIRLAM version 5.1.4 to version 6.3.5
    - replacement of the SGI Origin 3800 with Linux cluster BLIXT
    - introduction of a 5.5 km resolution HIRLAM (at present in a test phase)

Plans

- Starting of a near-real time test of HIRLAM 4D-VAR analysis.
  The start of the test is planned for March 2006
- HIRLAM has now started a cooperation with the ALADIN group to develop a non-hydrostatic model and a version of that has been tested at SMHI and very soon near-real time runs will be started

3.18 Switzerland

Numerical Weather Prediction at MeteoSwiss

Philippe A.J. Steiner[1], Francis Schubiger[1], Martijn de Ruyter de Wildt[1and 2] and Matteo Buzzi[1]

[1] Federal Office of Meteorology and Climatology (MeteoSwiss), Zurich, Switzerland
[2] Swiss Federal Institute of Technology, Institute of Geodesy and Photogrammetry, Zurich, Switzerland

1. Current operational configuration

1.1 System run schedule and forecast ranges

The actual short-range forecasting system of MeteoSwiss is the alpine Model aLMo, the Swiss implementation of the non-hydrostatic Local Model developed by COSMO (the Consortium for Small-Scale Modelling currently composed of the national weather services of Germany, Switzerland, Italy, Greece and Poland – see cosmo-model.cscs.ch). It is operational at MeteoSwiss since April 2001, with IFS frames as lateral boundary conditions provided by the ECMWF BC special project.

A continuous assimilation cycle has been implemented, currently ingesting conventional observations only. A main assimilation suite has been defined with a cut-off time larger than 4 hours, implemented with 3-hour assimilation runs; an additional short cut-off suite is also calculated to provide initial conditions for the operational forecasts and for other near-real time requirements. Two daily 72 hours forecasts are calculated, based on the 00 and the 12 UTC analyses, with a 90 minutes cut-off time. The time critical forecast products are available in about 70 minutes.

A sophisticated set of scripts controls the whole operational suite, and allows for a very high reliability of the system, with less than 2% of the forecasts requiring manual intervention. This same environment is also used to run parallel suites, to validate proposed modifications to the system, and to facilitate experimentation by the modelling group.

The computing resources and expertise are provided by the Swiss National Supercomputing Centre (CSCS, see www.cscs.ch). aLMo is calculated on a single node 16 processors NEC SX-5, and achieves a sustained performance of 29 GFlops, or more than 25% of the peak performance of the machine. Pre- and post-processing needs are covered by a 8 processors SGI O3200 front-end platform; a large multi-terabytes long term storage is used for archiving purposes, and a 100 MBit/s link connects the MeteoSwiss main building with the CSCS (on the other side of the Alps!).

1.2 Data assimilation, objective analysis and initialization

Data assimilation with aLMo is based on the nudging or Newtonian relaxation method, where the atmospheric fields are forced towards direct observations at the observation time. Balance terms are also included: (1) hydrostatic temperature increments balancing near-surface pressure analysis increments, (2) geostrophic wind increments balancing near-surface pressure analysis increments, (3) upper-air pressure increments balancing total analysis increments hydrostatically. A simple quality control using observation increments thresholds is in action.

Currently, only conventional observations are assimilated: synop/ship/buoys (surface pressure, 2m humidity, 10m wind for stations below 100 m above msl), temp/pilot (wind, temperature and humidity profiles) and airep/amdar (wind, temperature). Typical 24 h assimilation at MeteoSwiss ingests about 180 vertical soundings, about 7000 upper-air observations and about 25000 surface observations. Assimilation of wind profiler data and GPS derived integrated water vapour, as well as a radar based 2-dimension latent heat nudging scheme are being developed.

The snow analysis made by the German Weather Service is used in aLMo; it is based on a simple weighted averaging of observed values. Effort is currently under way to derive a new snow analysis from MSG satellites combined with dense observations (see chapter 3). All other surface and soil model fields are obtained by interpolating IFS analysis. These fields are updated twice daily by direct insertion in the assimilation cycle. Finally, the ozone and vegetation fields are based on climatic values.

In addition to the MARS retrieving system, the full ECMWF decoding, quality control and database software have been installed on our front end machine. The cut-off time for the main assimilation cycle is at least 4 hours, and the oldest lateral boundary conditions are 3 hours old. Based on this main cycle, additional short cut-off cycles (90 minutes) are calculated to produce the initial conditions for the operational forecasts.

1.3 Model

A thorough description of the Local Model itself can be found on the COSMO web site. aLMo is a primitive equation model, non-hydrostatic, fully compressible, with no scale approximations. The prognostic variables are the pressure perturbation, the cartesian wind components, the temperature, the specific humidity, the liquid water content, cloud ice, rain and snow. There are options for additional prognostic variables (e.g. turbulent kinetic energy) which are currently not used at MeteoSwiss.

The model equations are formulated on a rotated latitude/longitude Arakawa C-grid, with generalized terrain-following height coordinate and Lorenz vertical staggering. Finite difference second order spatial discretization is applied, and time integration is based on a 3 time levels split explicit method. Fourth order linear horizontal diffusion with an orographic limiter is in action. Rayleigh-damping is applied in the upper layers.

At MeteoSwiss aLMo is calculated on a 385x325 mesh, with a 1/16° mesh size (abou t 7 km), on a domain covering most of Western Europe (see aLMo in Figure 1). In the vertical a 45 layers configuration is used; the vertical resolution in the lowest 2 km of the atmosphere is about 100 m. The main time step is 40 seconds.

2. Plans of MeteoSwiss for future high resolution

The development of a high resolution model has started in 2005. The motivation is to get an automatic generation of local forecast products in complex topography being used for general forecast purposes and contributing to the security of the Swiss population by the generation of warnings/alarms e.g. in case of incidents in nuclear power plants, floods, or avalanches. It will also allow MeteoSwiss to develop and maintain its key competence in Alpine meteorology.

The new model called aLMo2 will get its boundary conditions from the actual aLMo, have a mesh size about 1/50°~2.2km and its domain of 480 x 350 grid points with 60 levels will be centered on the Alps. In addition to the current forecast, it will produce 8 times a day 18 hours forecasts. It is planned to be pre-operational in 2007 and operational in 2008.

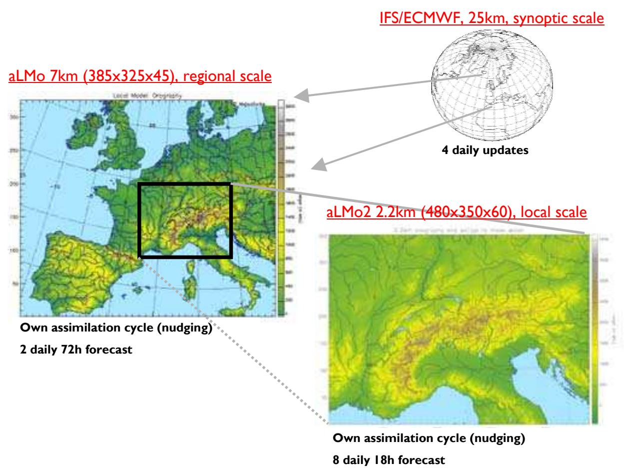


Figure 1 future NWP system of MeteoSwiss

The probable setup will be based on a new numerical kernel, 2-timelevel 3rd order Runge-Kutta, with a main time step of about 15 seconds. It will use improved physics with e.g. new schemes for graupel, 3-d turbulence and shallow convection (the deep convection being resolved), as well as with implementation of the topographic effects on radiation (see 4). New types of measurement will be used for assimilation: radar data (using the latent heat nudging), wind profiler, VAD, SODAR, GPS data (using tomographic methods) and satellite data for snow analysis (see 3).

3. Snow cover mapping in the Alps using multi-temporal satellite data

To improve the snow analysis used in aLMo, satellite data will be combined with the measurements of a maximum of conventional climate stations. Until recently only polar-orbiting satellites, which monitor the surface with low temporal frequencies, possessed the necessary spectral channels to separate snow and clouds. This gap has been closed by a new geostationary satellite, Meteosat-8, launched in 2002 by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). It caries the Spinning Enhanced Visible and Infra-Red Imager (SEVIRI), which has an unprecedented combination of high temporal frequency (15 minutes) and spectral resolution (12 spectral channels). The spatial resolution is rather coarse, about 5 km over central Europe, but this is still higher than the resolution of the actual aLMo. The spectral and temporal capabilities of SEVIRI can be used to avoid a regularly encountered problem in remote sensing of snow, which is the confusion of snow and clouds. This can occur when clouds, which have a similar visible reflectance as snow, also have the same Brightness Temperature (BT) and phase (i.e. ice clouds). Such clouds may not be detected by traditional methods that have been used for remote sensing of snow and clouds. The problem is illustrated by Figure 2, which displays an RGB image of Europe, made from several SEVIRI channels. Snow is red in this image and many clouds are white, but some clouds appear in the same colour as snow.

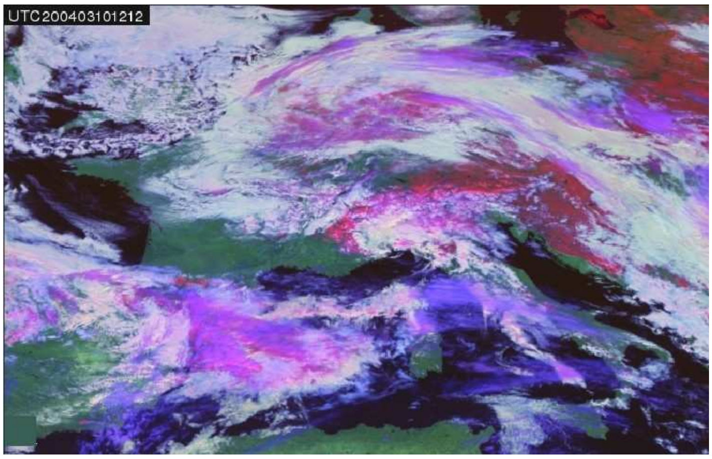


Figure 2 RGB image of Europe, made from SEVIRI channel 1 (0.64 µm), channel 3 (1.6 µm) and a combination of channels 4 (3.9 µm), 9 (10.8 µm) and 11 (13.4 µm). The scene was acquired on March 10th, 2004, around 12:12 UTC

Here we use two improvements for the detection of such clouds, one spectral and one temporal. The first uses the 3.9 µm - 10.8 µm brightness temperature difference, which is a well-known feature for detecting clouds, in combination with the 13.4 µm brightness temperature. This combination of three channels detects more clouds, including many ice clouds, than any other known spectral feature. Over water clouds, the latter feature has high values and appears bright, whereas unclouded regions appear dark. Unfortunately, clouds with high ice content appear as dark as unclouded areas. The combination of $BT_{3.9}$, $BT_{10.8}$ and $BT_{13.4}$ clearly reveals many ice clouds that are not detectable with $BT_{3.9}$ - $BT_{10.8}$ alone.

The second improvement involves the high temporal frequency of SEVIRI. The temporal behaviour of many clouds often makes them recognisable to the human eye: at a time scale of minutes to hours the surface is virtually static, whereas many clouds are dynamic at these time scales. We can simply quantify this dynamic behaviour with the standard deviation in time of a pixel, and then use this to detect clouds. This is possible in each of the SEVIRI channels, and by combining the temporal information from all single channels; many clouds can be detected. Not all clouds have a high temporal variability and can be detected in this way, so the temporal information should always be used in combination with the spectral information. Cloud obscurance can be reduced by combining a series of snow maps into one composite snow map. Figure 3 (left part) displays such a composite map for a three-day period. Relatively small areas were covered by clouds during this entire period and for most of the surface the snow cover could be retrieved. Apart from the above-mentioned low-resolution channels, SEVIRI also contains one high resolution visible channel. In this channel, clouds can be masked by combining its temporal information, which does not detect all cloud cover, with the down-scaled low-resolution cloud mask. Figure 3 (right part) shows that nearly all clouds are detected in this way and that only very few cloudy pixels were missed (visible as very small isolated patches of snow).

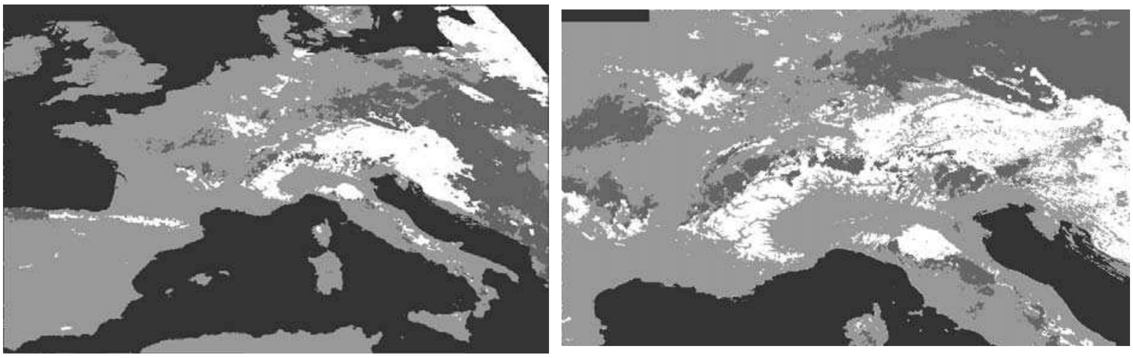


Figure 3 Composite snow map for the period March 8th till March 10th 2004. (left) low and (right) high resolution channel

4. Gridscale parameterization of topographic effects on radiation

At the grid spacing of aLMo2, slope aspect, slope angle or slope inclination, sky view as well as shadowing significantly modify radiation fluxes at the earth's surface. The radiation scheme implemented in the aLMo (Ritter and Geleyn, 1992) computes the surface radiation components on horizontal surfaces and doesn't take into account topographic effects. Before considering a wide reformulation of this scheme in a complex topography environment, a concept based on correction factors for the surface radiation components can give us a simpler way to include this effect in the model.

4.1 The parameterization

The parameterization scheme proposed by Müller and Scherrer (2005) offers a simple approach to compute and introduce topographic effects on radiation in NWP models. It has been implemented into the aLMo and the sensitivity of the model to the introduced radiation corrections has been studied.

This parameterization scheme computes for each model grid cell correction factors for the surface radiation components based on the sunshine conditions and on the model topography. In order to save computing resources all the correction factors are computed prior to the model integration. For each time step of the radiation scheme a correction factor for the direct solar radiation is calculated considering the sunshine conditions (sun elevation and azimuth angle), the slope angle, the slope aspect as well as the possible shadow conditions depending on the horizon (shadow mask). The diffuse downward solar component and the downward thermal component are corrected using the sky view factor. Here also the effect of surrounding grid points is introduced. The correction for the thermal downward radiation has been modified in order to take account also average vertical temperature differences of the adjacent grid points in a chosen horizontal length scale.

4.2 Results

At 7 km grid mesh the effects on the surface temperature of the implemented parameterization scheme in the Swiss alpine region are generally below 1 K (Figure 4). Nevertheless in some few grid points the effect can be higher if the small radiation balance change can modify significantly the snow amount conditions or the turbulence exchange coefficients (in winter with strong temperature inversion, warm air from above can be transported down). These indirect effects are reduced during the summer day case study, where we observe in some grid points from the late morning to the afternoon some interesting indirect changes in the total cloud cover, which influence significantly the surface temperature.

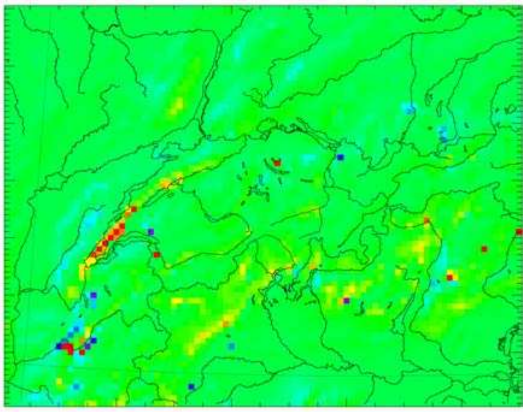


Figure 4 11.12.2004 00 UTC +9h, aLMo 7 km, surface temperature difference between aLMo with and without radiation correction.

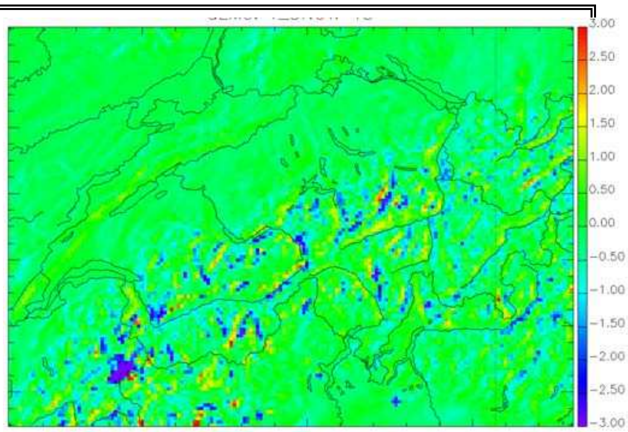


Figure 5 7.8.2003 00 UTC +9h, aLMo 2.2 km, surface temperature difference between aLMo with and without radiation correction.

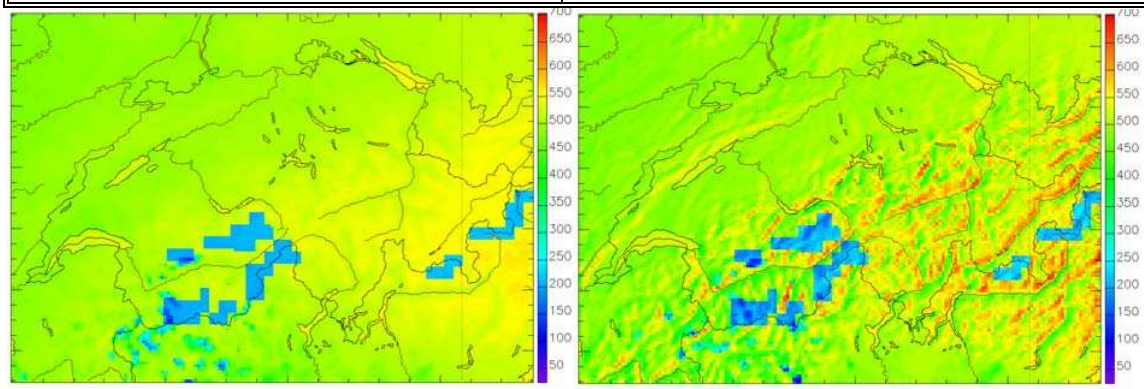


Figure 6 7.8.2003 00 UTC +8h, aLMo 2.2 km, net shortwave radiation, left uncorrected aLMo run, right corrected aLMo run.

By decreasing the grid mesh down to 2 km the effects of the radiation changes become more important. The impact on the net shortwave radiation can be on the order of magnitude up to 200 W/m2 (Figure 6). In the morning and in the evening significant shadowing effects take place. The surface temperature changes in Swiss alpine region is generally below 2 K, but many grid-points have bigger changes up to 3-4 K, even in summer days (Figure 5). Changes in the cloud cover have been also observed either in winter by the high resolution run or in summer. The thermal differences at the surface can generate also some significant changes in the thermal circulations.

4.3 Conclusions

The impact of the topographic effects (shadowing, slope angle, slope aspect and sky view) is substantial at high resolution. Some significant indirect impacts (feedbacks) can be seen even at 7 km horizontal resolution: they are related to snow melt, stability (turbulence) and low clouds. The effect on clouds is more pronounced at 2.2 km and have to be further investigated.

5. References

Müller D. M. and Scherrer D. (2005): A grid- and subgrid-scale Radiation Parameterization of Topographic Effects for mesoscale weather forecast models. *Mon. Wea. Rev*., **133**, 1431-1442.

Ritter B. and Geleyn J.-F. (1992): A comprehensive Radiation Scheme for numerical weather prediction models with potential applications in climate simulations. *Mon. Wea.Rev.,* **120**, 303-325.

4 Scientific presentations

4.1 N. Roberts, R. Forbes, H. Lean and P. Clark: The Convective-scale Unified Model: Evaluating NWP precipitation forecasts

The Convective-scale Unified Model: Evaluating NWP precipitation forecasts

Nigel Roberts, Richard Forbes, Humphrey Lean, Peter Clark

Met Office, UK

JCMM, Met Office, Meteorology Building, University of Reading,
Reading, Berkshire, RG6 6BB, U.K.

November 2005

1 Convective-Scale NWP

Over the past few years, the Met Office has been active in research and development of the Unified Model for convective-scale Numerical Weather Prediction. A trial system was set up (called the High Resolution Trial Model, HRTM) with a 1km grid-resolution version of the UM (centred on the Chilbolton research radar in southern England), nested inside a 4km grid-resolution model for the southern UK, nested in the operational 12km model (See Fig. 1). The focus of the convective-scale UM is forecasting severe convective precipitation, particularly for advanced warnings of potential flood events. Results from a number of mainly summer convective cases during 2003 and 2004 have lead to gradual improvement of the model and in the spring of 2005 the 4km UM went operational for a domain covering the whole of the UK. In the Autumn of 2005, the operational system will be enhanced with a data assimilation cycle with 36 hour forecasts 4 times a day. Research is ongoing to improve the model and data assimilation system, understand the convective-scale processes through observational campaigns such as the Convective Storms Initiation Project (CSIP, summer 2004/2005), and investigate convective-scale predictability issues for forecasting, verification and presentation of the NWP forecasts. This note describes one method of precipitation forecast verification for high resolution models.

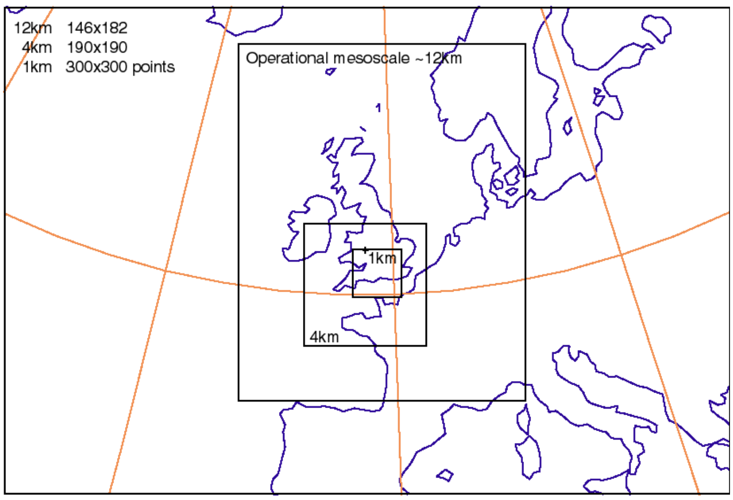


Figure 1. Test 1km and 4km grid-resolution domains for the convective-scale.

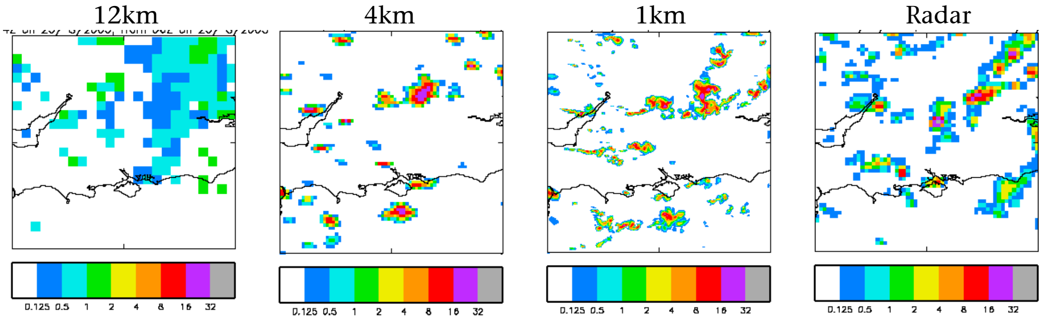


Figure 2. An example forecast of surface rain rate from different resolution models (from left to right, 12km, 4km, 1km) compared with radar-derived rain rate (far right) for a CSIP case study with severe convection (14Z on 25th August 2005). All fields are shown for the 1km domain over the central southern UK. The 12km model has parametrized convection, the 4km and 1km are "resolving" the deep convection and provide a better indication of the shower structures and intensities, but not always the exact locations.

2 Predictability and verification

Although the locations of initiation of some convective storms are more predictable than others (e.g. orographic initiation), predictability of the small spatial scales over the period of an NWP forecast is a major issue. For example, the 1km-gridlength model can not be accurate at the gridscale or even over a few kilometres because features are not properly resolved and predictability is low on those scales. Errors at smallest scales grow fastest and there will always be a scale below which even a good forecast is essentially random in nature. Put another way, individual showers can not be predicted in exactly the correct locations even if a forecast is good (e.g. Fig. 2). This can result in poor verification scores when traditional verification methods based on gridpoint comparisons are used. Although we may not be able to predict the exact location of individual convective cell, we do want the region of shower activity to be well positioned with the right type of structure and intensity. Alternative verification scores that provide information on the skill of a forecast over a range of spatial scales can therefore be more informative.

As far as the convective-scale version of the Met Office Unified Model is concerned, we would like to be able to at least attempt to answer the following questions in an objective way.

1. How accurately can we forecast precipitation over areas the size of counties, river catchments or urban areas using a particular model?
2. How does the predictable scale change with forecast time? This may be in terms of defining the smallest river-catchment area for which forecasts are useful.
3. Does the rainfall analysis agree with the radar picture at the scale of the data assimilation? Data assimilation methods are designed to add observational information to a model over particular spatial scales.
4. What are sensible products to generate for customers?
5. Does a change to either model resolution or formulation make a difference to the predictable scale?

This list of questions justifies the need to have a verification system that can be used to determine the relationship between forecast skill and spatial scale.

3 The verification approach

Figure 3 shows an example of rainfall accumulations measured by radar on a particular day and two NWP forecasts – one with a 12-km grid length and the other with a 1-km grid length (note this is a different case to that shown in Fig 2.). The 1-km forecast produced a great deal more structure than the 12-km forecast and subjectively looks closer to the radar. It gave a much better indication of the higher accumulations that we are most likely to be interested in. It also, correctly, produced rain over the sea in this case because the convection was explicitly resolved rather than parametrised by a convection scheme. However, if Figure 3 is examined more closely, it is clear that the areas of higher accumulations in the 1-km forecast are not in exactly the same place as observed by radar. It is very likely that if a standard grid-square by grid-square verification were performed, the 1-km forecast might come out worse, even though we can see that it is a 'better' (or more useful) forecast. This is the challenge – to be able to objectively verify rainfall forecasts by the same criteria we use in subjective assessment. It is one reason why verification over different spatial scales is necessary.

It was decided to verify threshold exceedance of precipitation accumulations rather than precipitation rates as it is the former that matters most for flooding and it is sensible to smooth in time if we are also smoothing in space. Verifying against radar rather than rain gauges provides a much better spatial coverage.

For every grid square, we compute the fraction of surrounding points within a given area that exceed a particular accumulation threshold over a given period. This will give a fraction for every grid square. The fractions can be considered as probabilities. They give an indication of the chance of an accumulation threshold being exceeded at each grid square, given that we think the model could be in error on a scale of the size of the area used to produce the fractions.

Fractions/probabilities can be generated over different spatial scales by changing the size of the area. For the purposes of verification, squares of different sizes are used to compute fractions for different spatial scales.

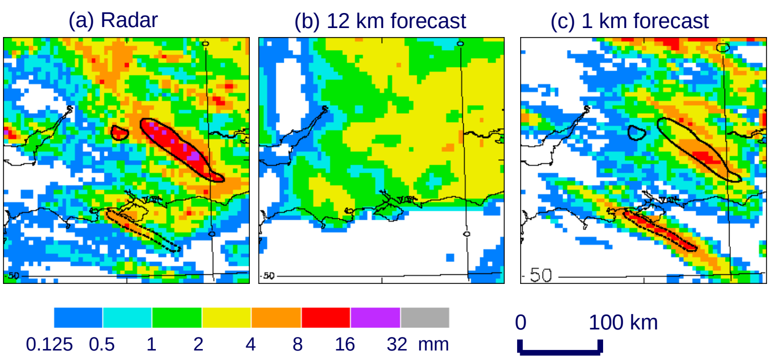


Figure 3. Rainfall accumulations over 6 hours, 13 to 19UTC 13th May 2003 interpolated/averaged to a 5 km grid spacing on a square 300x300km over southern England. (a) Observed by radar, (b) 12 km gridlength model forecast, (c) 1 km gridlength model forecast.

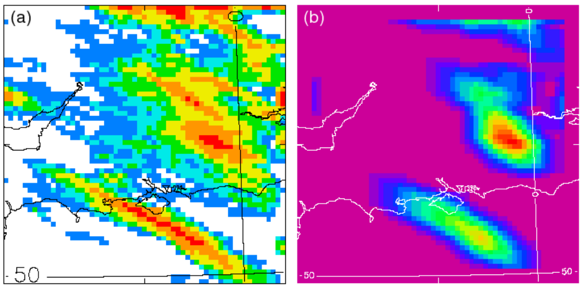


Figure 4. (a) the same as Figure (c). (b) shows the fractions for accumulations > 4 mm computed using squares of 35x35 km.

Figure 4(b) shows how fractions/probabilities have been generated using the approach described at every grid point (except around the edge) for a 1-km forecast (averaged to a 5-km grid). In this example the accumulation threshold used is 4 mm, the squares are 35x35km and the accumulation period is 6 hours.

One of the verification scores to compare forecast fractions over an area between the model and radar is the Fractions Skill Score (**FSS**); a variation on the Brier Skill Score. It is given by: -

$$FSS = 1 - \frac{FBS}{\frac{1}{N}\left[\sum_{j=1}^{N}(p_j)^2 + \sum_{j=1}^{N}(o_j)^2\right]}$$

$0 < p_j < 1$ forecast fraction

$0 < o_j < 1$ radar fraction

where,

$$\underset{\text{(Fractions Brier Score)}}{FBS} = \frac{1}{N}\sum_{j=1}^{N}(p_j - o_j)^2$$

is a version of the Brier score in which fractions are compared with fractions

and,

$$\frac{1}{N}\left[\sum_{j=1}^{N}(p_j)^2 + \sum_{j=1}^{N}(o_j)^2\right]$$

is the worst possible FBS in which there is no colocation of non-zero fractions

The Fractions Skill Score has the following characteristics

- It has a range of 0 to 1; 0 for a complete forecast mismatch, 1 for a perfect forecast.
- If either there are no events forecast and some occur, or some occur and none are forecast the score is always 0.
- As the size of the squares used to compute the fractions gets larger, the score will asymptote to a value that depends on the ratio between the forecast and observed frequencies of the event. I.e. the closer the asymptotic value is to 1, the smaller the forecast bias.
- The score is most sensitive to rare events (or for small rain areas).

As with any verification score, this one has characteristics that are both helpful and misleading. It is not necessarily the best way of comparing fractions with fractions, but it has proved useful for providing the sort of information we are interested in.

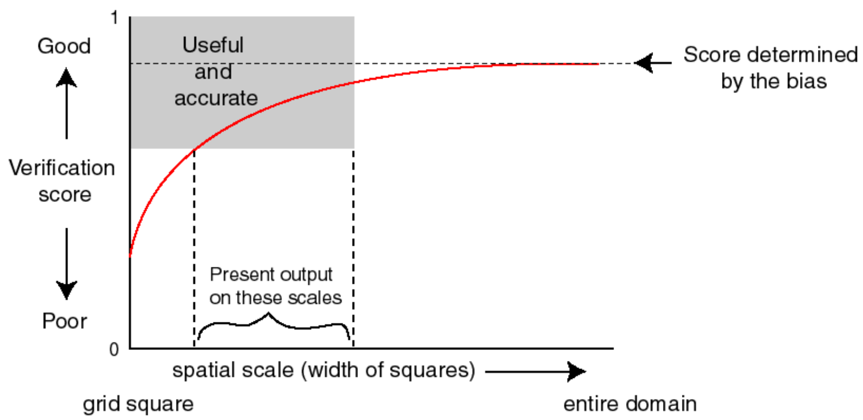


Figure 5. A schematic graph of the behaviour of the Fractions Skill Score with spatial scale.

Figure 5 shows how the Fractions Skill Score is expected to behave over a large number of forecasts for a particular accumulation period and threshold. The least skill is expected to be at the grid scale. Skill should increase with spatial scale (square size) until it reaches an asymptote that is determined by the forecast bias. The grey shading depicts the part of the graph where the score is deemed high enough for the forecast to be regarded as skilful and the spatial scale is small enough for the forecast to be useful. (There is little benefit to be gained from a forecast that is detailed but inaccurate or accurate but lacking detail). We can then, in principle, pick out the range of spatial scales over which the forecast should be presented to users/customers – i.e. the size of squares used to generate probabilities.
For a more detailed discussion, see Roberts 2004(a,b).

4 Some results for summer 2004 convective case studies

A graph of Fractions Skill Scores is shown in Figure 6 for a comparison of 6-hourly rainfall accumulations from seven summer 2004 case studies. The intention here is to show that the verification method can provide useful information about the differences in performance of the models over different spatial scales. All models have the least skill at the grid-scale and asymptote to a value less than one over large spatial scales – an indication that there is a bias (for the particular accumulation threshold). For the relatively small threshold of 4mm/6hours accumulation, the 1km and 4km models have higher skill than the 12km model, but only just. For the higher threshold of 16 mm/6 hr, the level of skill of the 4km and 1km models is much higher than for the 12km model.

Figure 7 shows the Fractions Skill Scores for 1 hour rainfall accumulations for the three models as a function of forecast hour for a spatial scale of 50km. The benefit of the high resolution models becomes clearer for the shorter timescales and higher accumulation thresholds. Note the differences between the high resolution model forecasts “spinning up” from the 12km analysis (which does not have “resolved” convection) (dotted lines in Figs. 6 and 7) compared to the forecasts starting from a 4km resolution analysis (which includes “resolved” convection) (solid lines in Figs. 6 and 7). The skill of the “spin-up” runs is generally slightly higher than the “assimilation” runs for this particular trial, due to a larger bias in the latter. This bias is being addressed. However, Fig. 7 shows the advantage of the high resolution assimilation (3DVAR with latent heat nudging) in the early part of the forecast; models spinning up from the 12km analysis take 2 to 3 hours to reach the same forecast skill as the models with high resolution data assimilation.

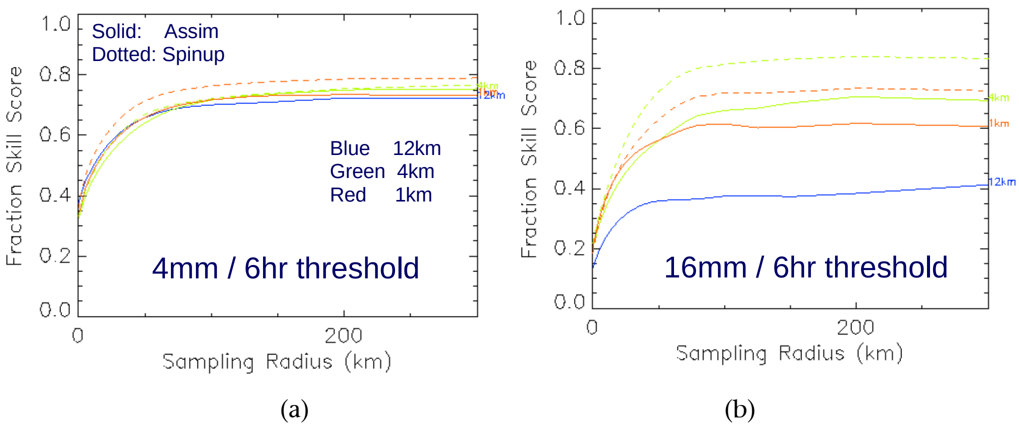


Figure 6. A graph of the variation of the Fractions Skill Score with spatial scale for 6-hour accumulation forecasts (T+0 to T+6) from the 1km, 4km and 12-km gridlength models for seven case studies during the Summer of 2004, compared with radar accumulations. The accumulation threshold was (a) 4mm/6hr and (b) 16 mm/6hr.

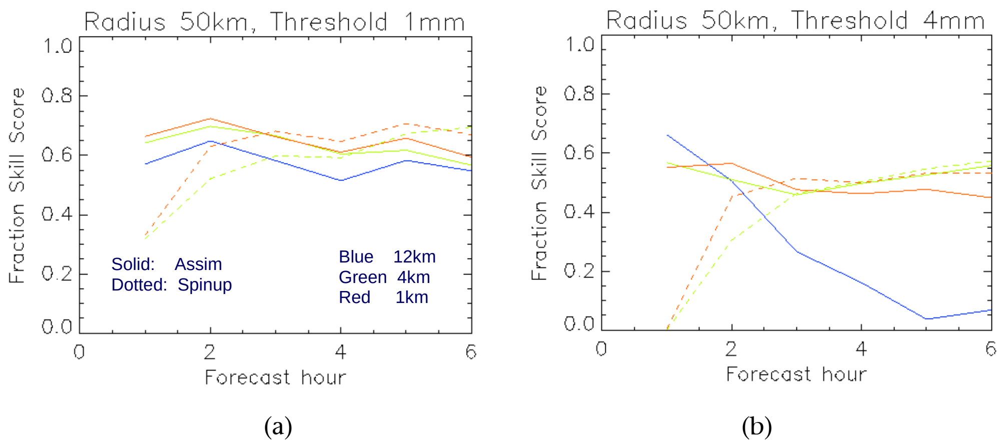


Figure 7. A graph of the variation of the Fractions Skill Score with forecast hour for 1 hour accumulation forecasts from the 1km, 4km and 12-km gridlength models for seven case studies during the Summer of 2004, compared with radar accumulations. The spatial scale was 50 km and the accumulation thresholds were (a) 1mm and (b) 4 mm.

5 Summary

Convective-scale NWP is now operational at the Met Office and one of the questions for high resolution forecasts of convection is how to verify them in a meaningful way. Small scale features such as individual showers are inherently unpredictable and it is not sensible to verify raw model output on a grid point by grid point basis, because we should not expect skill at that scale. We need to be able to assess the accuracy of forecasts over different spatial scales (as a human observer would).

A simple method has been described, in which rainfall accumulation forecasts are compared with radar measured accumulations by converting both fields into fractions/probabilities of a particular accumulation threshold being exceeded. The results from a number of case studies have been encouraging, and importantly, the scores have agreed with subjective evaluation. The methodology is intuitive and should be reasonably easy to convey to users/customers. Verification from seven cases during the summer of 2004 shows there is increasing skill for higher rain accumulations and shorter timescales as the resolution is increased. The impact of an initial implementation of 3DVAR data assimilation with latent heat nudging at 4km resolution is encouraging, resulting in a significant improvement in the early part of the forecast.

There are alternative approaches to verification of precipitation forecasts that could be compared with the approach described here. For example, Casati (2004) describes a technique based on wavelet analysis. The use of "top-hat" wavelet functions in this method is likely to give very similar results. It is also important to examine the behaviour of different verification scores that could be used to compare forecast and radar fractions (e.g. odds ratio). Radar data has so far been regarded as truth, and the issue of incorporating radar error needs to be addressed. A future application might be to investigate how forecast skill varies with spatial scale for different meteorological situations (e.g. scattered convection, organised convection or frontal)

6 References

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4.2 J.-P. Schultz: The new Lokal-Modell LME of the German Weather Service

The new Lokal-Modell LME of the German Weather Service

Jan-Peter Schulz, Deutscher Wetterdienst

1 Introduction

In order to fulfill new requirements of both external and internal customers, for instance in aviation, sea traffic or air pollution modelling, the German Weather Service (DWD) decided to expand the model domain of the operational limited area model, the Lokal-Modell (LM, Doms and Schättler 2002, Steppeler et al. 2003, Schulz 2005). The new version has successfully been introduced in the operational numerical weather prediction system of DWD on 28 September 2005.

2 The model LME

The former version covered basically Central Europe, including Germany and its neighbouring countries. The new version covers almost entire Europe and therefore got the name LM Europe (LME). The integration domain of LME is shown in Fig. 1.

The number of grid points per layer is enhanced from 325 × 325 to 665 × 657, while the mesh size is kept unchanged at 7 km × 7 km. The number of vertical layers is increased from 35 to 40. The additional layers are mainly located in the lower troposphere, the height of the lowest layer is reduced from 33 m to 10 m. This is in accordance with the new 40-km version of the driving global model GME which started operation at DWD in September 2004. The poles of the rotated LME coordinate system are different from the LM system. The LME system is rotated in a way that the equator is located within the center of the model domain. This has the advantage that the grid cells have a similar size and shape throughout the entire domain or, in other words, the divergence of the longitude rows is minimal. The main non-technical model change is the introduction of a new multi-layer soil model, the same that was incorporated into GME in 2004.

3 Results

The introduction of LME at DWD was done in several steps. First of all, two experiments were set up at ECMWF in 2004, namely LME and LM, running daily forecasts driven by GME. Here, the influence of the domain size or the distance between the boundaries and the region of interest, respectively, can be tested. It turns out that in most weather situations there is very little influence. But, there are sporadic cases where for example the development of a cyclone evolves significantly differently. The results of an objective verification show some advantage for LME forecasts for precipitation and gusts and some disadvantage for mean sea level pressure.

In January 2005 a full LME data assimilation cycle has been set up in an operational parallel suite at DWD. This parallel suite also includes two 78h-forecasts (00 and 12 UTC) per day. Hence, LME could be tested in operational mode against LM and GME during spring and summer 2005. All postprocessing procedures had to be adjusted. Preliminary verification showed similar results as the experiments at ECMWF.

More detailed comparison revealed that the evaporation over sea in LME is up to 30% higher than in GME. Furthermore, precipitation in LME tends to show a systematic positive trend during the forecasts, even on a monthly mean basis, while precipitation in observations and also in GME is balanced. This behaviour indicates that evaporation over sea in LME is likely to be overestimated. Some sensitivity tests were carried out at DWD and a parameter tuning led to a LME version with reduced evaporation over sea. Preliminary verification of this version showed some improvement in the simulated moisture budget and also the mean sea level pressure.

A quantity of particular importance is the simlated soil moisture. First of all, it is a component of the new multi-layer soil model of LME and therefore needs to be monitored with great care. This has certainly been done already during the development of the model, but due to the very long memory of the soil with respect to e. g. temperature and soil moisture content, it is hard to run it long enough to

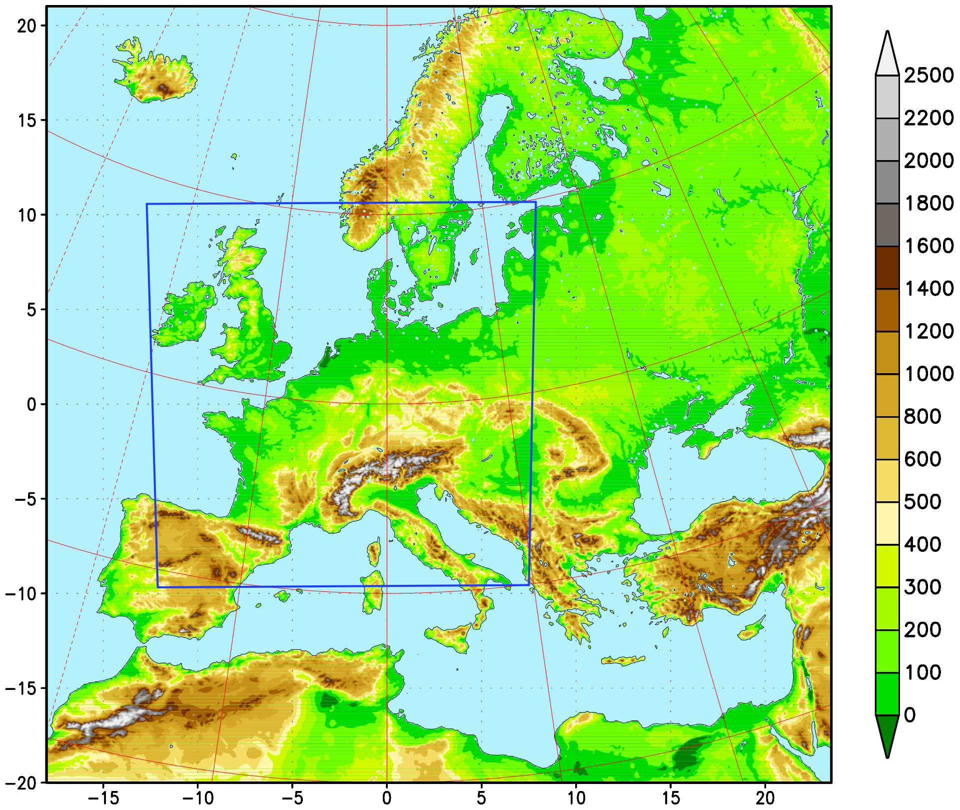

Figure 1: Model domain of LME. Topographical height (m) for land fractions > 50% (for the operationally used filtered orography). The frame in the figure depicts the integration domain of the former LM.

ensure reasonable initial states for all its variables. Secondly, it is affected by the variational soil moisture analysis (SMA) scheme. This external analysis scheme is part of the data assimilation scheme of LME and is run once per day, at 00 UTC. It adjusts the soil moisture in an indirect way by minimizing the model bias of the near-surface air temperature. It has been switched on in LME in mid May 2005.

Figure 2 shows the simulated soil moisture of the third layer of the multi-layer soil model of LME compared to in-situ measurements from January to November 2005. Generally, the simulated soil moisture resembles the observations very well during most of the annual cycle of 2005, in particular during the first half of the year. After about day 205 LME becomes a bit drier than the observation, but the curves tend to converge again later in the year. But during the entire period the tendencies of soil moisture variations are very similar between model and observation which is a good sign for the soil model performance. A likely reason for the difference between model and observation is that there was too little precipitation in the model at the beginning of the second half of the year. A hint for this is that the second model, AMBAV, run off-line with atmospheric forcing is much better able to follow the observed soil moisture evolution during this period.

4 Conclusions

In order to fulfill the requirements of several customers the German Weather Service (DWD) decided to expand the model domain of its operational limited area model, the Lokal-Modell (LM). The new LME, covering almost entire Europe, has successfully been introduced in the operational numerical weather prediction system of DWD on 28 September 2005. Current verification results look reasonable, further subjective and objective verification is carried out.

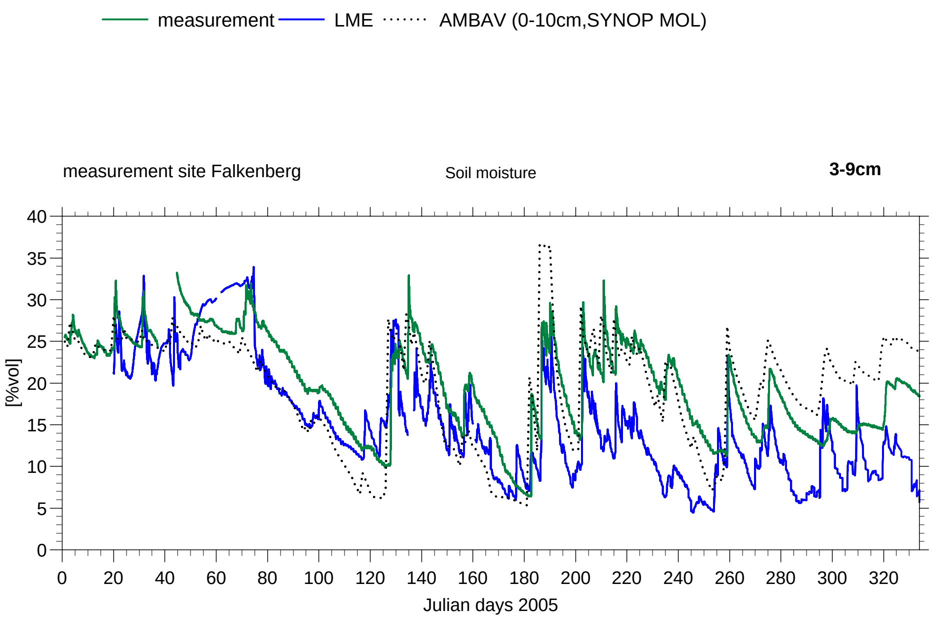

Figure 2: Soil moisture simulated by LME from January to November 2005 compared to measurements at the site Falkenberg (Meteorological Observatory Lindenberg, DWD). Shown is the soil moisture of the third layer (depth: 3–9 cm) of the new multi-layer soil model and a corresponding measurement. The third curve depicts results of AMBAV, which is a land surface scheme used at DWD for agricultural applications. It is more complex than the LME land surface scheme. For this study, it has been run off-line, forced by atmospheric conditions from the Meteorological Observatory Lindenberg which is close to the soil moisture measurement site. This figure was provided by G. Vogel, DWD.

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4.3 M. Tudor: Pre-operational testing of Aladin physics

Pre-operational testing of Aladin physics

Martina Tudor, Vlasta Tutiš, Dunja Drvar, Ivana Stiperski and Filip Vaña

Croatian Meteorological and Hydrological Service, Grič 3, 10000 Zagreb
E-mail: *tudor@cirus.dhz.hr*

Abstract: A modified subgrid scale orography representation was introduced and tested. The envelope was removed and to compensate for the loss of volume, changes in gravity wave drag parametisation were introduced. Unsatisfactory model forecasts of 2m temperature and cloudiness in inversion cases with fog and low stratus clouds have encouraged research of alternative parametrization for radiation processes and cloud parameterizations that could be used in the operational version of the Aladin model. Few computationally cheap modifications are introduced and tested. During intensive cyclogenesis, especially over steep surfaces, the physical horizontal diffusion should not be neglected. A stable and efficient non-linear horizontal diffusion, based on the control of the degree of interpolation needed for the Semi-Lagrangian advection scheme, has been implemented in ALADIN and tested.

Keywords *Radiation, Cloudiness, Xu-Randall Scheme, Fog, Envelope, Gravity Wave Drag, Bura, Semi-Lagrangian, horizontal diffusion, Adriatic cyclone*

1. INTRODUCTION

Unresolved orographic effects have been represented by the enhancement of terrain by adding an envelope (see Wallace et al., 1983), or with a modified parametrization of gravity wave drag and lift. In ALADIN, both methods are implemented. Although the envelope method is proved to give a better representation of the airflow over and around mountain ranges, it artificially increases the mountain height, and therefore gives excessive precipitation on the windward side, stronger katabatic winds in the lee and overestimated amplitude of the mountain waves (see Bougeault, 2001). Because of the exaggerated terrain height, numerous measurements from the stations situated below the envelope are systematically rejected in data assimilation. Furthermore, studies of local behaviour of the ECMWF model near Pyrenees (Lott, 1995) and Alps (Clark and Miller, 1991) have shown that mountain drag is underestimated, and cannot be adequately substituted with the envelope. For those reasons, in a number of NWP models the envelope has been suppressed, and the gravity wave drag parametrization tuned to compensate for the lack of volume. The new sub-grid scale orography representation is tested on a few bura cases.

For the cases of stable atmosphere with low-level inversion, low cloudiness and fog, the operational ALADIN/HR model did not predict the diurnal pattern of the surface temperature nor the low cloudiness well. Although the model initially recognized the existence of the temperature inversion and an almost saturated state of the atmosphere adjacent to the ground, the diagnosed cloudiness was too low and radiation scheme heated the ground and broke the inversion. There are several radiation schemes available in Aladin, the operational one (Geleyn and Hollingsworth, 1979), and FMR (Morcrette 1989). The first one is very simple and computationally cheap and may be used at every time step. The other is computationally expensive, so it is called only every few hours. Alternative versions of cloudiness and radiation schemes have been introduced and tested on a synoptic case marked by a strong temperature inversion, low cloudiness and fog in inland part of Croatia, that lasted for several days.

Main form of horizontal diffusion commonly used in NWP models is the numerical diffusion acting as a numerical filter and selectively damping short waves applied on model levels that often follow orography, thus it is not purely horizontal. Simon and Vaña (2004) have shown that physical horizontal diffusion should not be neglected when the horizontal component of the turbulent mixing is stronger than the vertical one. This could be in situations with strong horizontal wind shear, but also in statically stable situations.

2. METHODS

The operational model version is described in Ivatek-Šahdan and Tudor (2004). The operational model results are compared to the results from the experimental version of ALADIN/HR, without the envelope and with the new gravity wave drag parametrization.

In the operational model, envelope is obtained by adding the standard deviation of the sub-grid scale orography on the mean height. Removing the envelope actually means lowering the mountain peaks as well as the valleys (see Fig 1). The difference is largest in the areas where the orographic variability is highest, e.g. on the mountain slopes.

With the reduction of the mountain volume, the pressure drag decreases, and has to be compensated by parametrization. The pressure drag is addressed by its two components: the lift (perpendicular to the flow), and the drag (parallel to it). In the experiment, the orographic lift is activated and gravity wave drag is tuned.

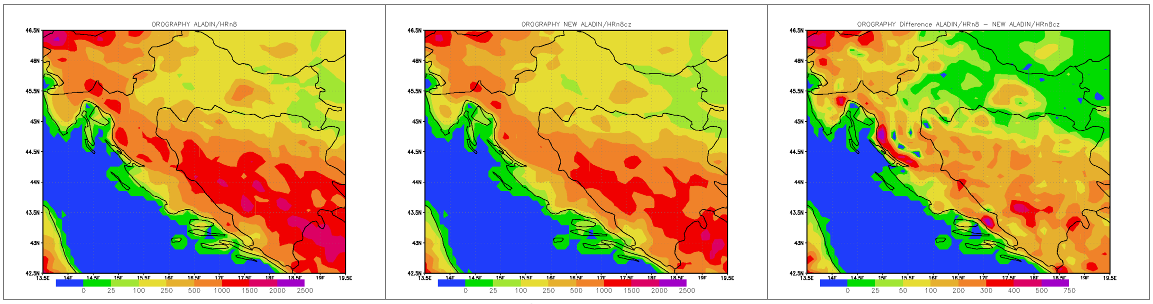

Figure 1. Orography in the operational (left) and experimental (centre) model version, and their difference (right).

Three cases with bura wind are examined. Firstly, a case with generally weak bura (03rd November 2004), when the drainage of air through the mountain-passes was induced by the pronounced difference in the air-mass characteristics in the inland and coastal part of the region. In addition, two extreme events of synoptically induced gale-force bura along the Adriatic coast (24th December 2003 and 13th November 2004) are studied.

The operational cloudiness parametrization results have been compared to the results from the scheme adapted from Xu and Randall (1996). Secondly, the operational radiation scheme has been enhanced (Bouyssel et al. 2003, Geleyn 2004) and the results have been compared to the one without the enhancements. In addition, the effect of different cloud overlap assumptions and modified vertical profile of critical minimum mesh averaged relative humidity producing a cloud has been tested.

The operational cloudiness scheme diagnoses cloudiness in such a way that if a parcel is oversaturated the amount of diagnosed cloudiness depends on oversaturation (cloudiness ranges from 0.7 to 1.0). Therefore e.g. a 0.7 cloudiness allows part of the radiation through. Therefore, the surface cools more during the night and warms more during the day giving pronounced diurnal pattern in surface temperature. In the morning this leads to the temperature rise due to heating, inversion breaking and eventual loss of cloudiness.

In the scheme adapted from Xu and Randall (1996) the oversaturated parcel has cloudiness equal to one. Therefore shortwave radiation is more efficiently reflected and longwave radiation is more efficiently absorbed. This helps in preserving the temperature inversion, fog and low stratus clouds.

If there are several layers of clouds with cloudiness less than one, the maximum overlap will vertically align these clouds in a way that they will be on top of each other, leaving a part of the column without clouds permiting radiation transfer. On the other hand, randomly overlapped clouds produce more total cloudiness and reduce the cloud free area in the grid cell.

The operational ALADIN model is conducted with a 4th order numerical diffusion scheme. A new horizontal diffusion scheme has been developed (Vaña 2003, Vaña et al. 2005) controlling the horizontal diffusion intensity using local physical properties of the flow and acting horizontally. In the Semi-Lagrangian advection scheme, the origin point is found by interpolation. The interpolator characteristics (the degree of interpolation) depend on the local flow yielding a horizontal diffusion based on physical properties of the flow. We will call this new scheme Semi-Lagrangian horizontal diffusion (SLHD).

3. RESULTS AND DISCUSSION

3.1. Orography and gravity wave drag parameterizations

In cases with severe bura, the most obvious feature of the experiment results is the increase of the 10m wind speed on the windward and even more pronounced decrease on the leeward side (Fig 3). The reason for this is found in the reduction of the mountain range height and the slope angle on one, and the increase of the pressure drag related to the orographic lift on the other hand. Due to the removal of the envelope, the pressure gradient across the coastal mountains is reduced. Moreover, the relative difference between the high peaks and low valleys is smaller, hence the canalised structure of the wind is less pronounced. However, there is no significant change in the wind direction.

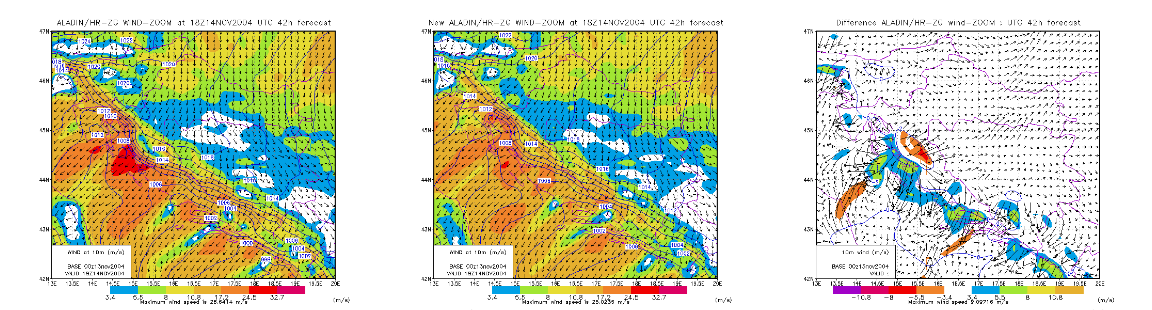

Figure 3. 10m wind in the operational (left) and experimental (centre) model version, and their difference (right), 42 hours forecast starting from 00 UTC 13th November 2004.

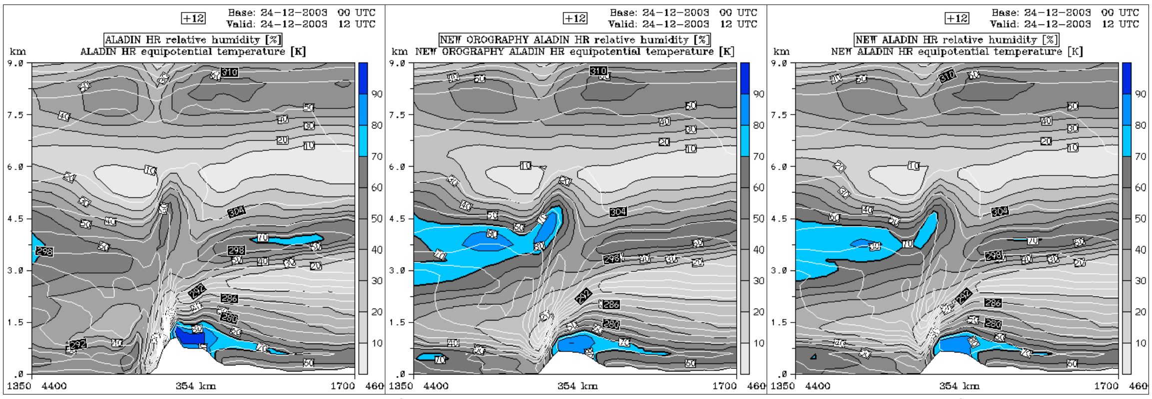

Figure 3. Vertical cross-sections of relative humidity and equipotential temperature fields obtained with old GWD+envelope orography (left), old GWD+mean orography(center), new GWD+mean orography (right), 12 hours forecast starting from 00 UTC 24th December 2003.

Results show a pronounced orographically induced humidity maximum (cloudiness) near the mountaintop. As expected, in the experimental version the wave structure is smoothed. There is a more pronounced downstream momentum transfer leading to the different distribution of vertical motion induced by the obstacle. Therefore, the humidity maximum near the mountain peak is somewhat decreased, while the one in the middle troposphere is more pronounced and closer to the mountain.

3.2. Radiation and Cloudiness

December 2004 has been characterized by long lasting fog in valleys inland. Results are shown for one run covering 2 days during that period. The 2m temperature varied very little during that period and showed no diurnal pattern. The reference forecast (most like the operational one) is the experiment 1 (exp1). The use of random maximum overlap assumption when computing cloudiness significantly reduces the amount of clouds and even amplifies the diurnal variation of temperature. However, the introduction of the Xu-Randall cloudiness scheme gives more clouds and improves the 2m temperature forecast. Finally, the random overlap assumption produces even more clouds. Thus, the scheme with most clouds forecasts surface temperature that is closest to the measured data.

The operational radiation scheme with Xu-Randall cloudiness parametrization and random overlap assumption produces the thickest low cloud layer that reduces the night cooling and heating during the day. It still shows signs of diurnal variation but is closest to the measured data. Radiation scheme using NER increases the amplitude of the diurnal variation of temperature, which gives worse forecast in this case. It seems that the modification in the critical relative humidity profile does not play a significant role.

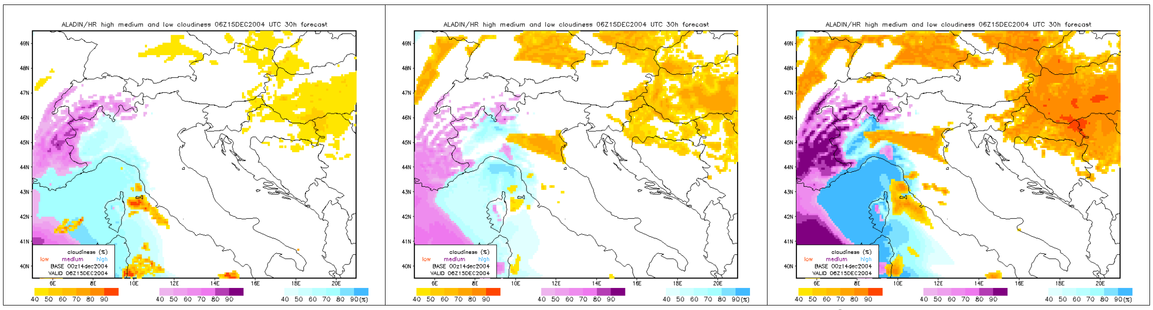

Figure 3. Low, medium and high cloudiness with operational radiation (left and right) and NER (center), random overlap (left and right) and random maximum overlap (center) using operational (left) and Xu-Randall cloudiness scheme with new critical relative humidity profile (center and right), 30 hour forecast starting 00 UTC 14th December 2004.

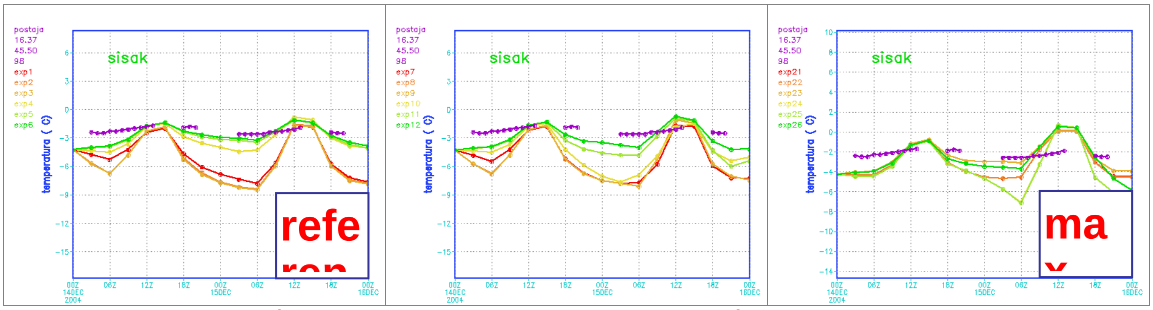

Figure 3. Comparison of the modelled 2m temperature evolution for 00 UTC run on 14th December 2004 with measured data from synoptic station with operational radiation scheme (left) including NER (center) and FMR (right).

3.3. Semi-Lagrangian Horizontal Diffusion

3.3.1. Twin cyclones

There are two cyclones, one above the Adriatic and another above the Tyrhenian Sea,. The strength of the second one was overestimated by the operational model.

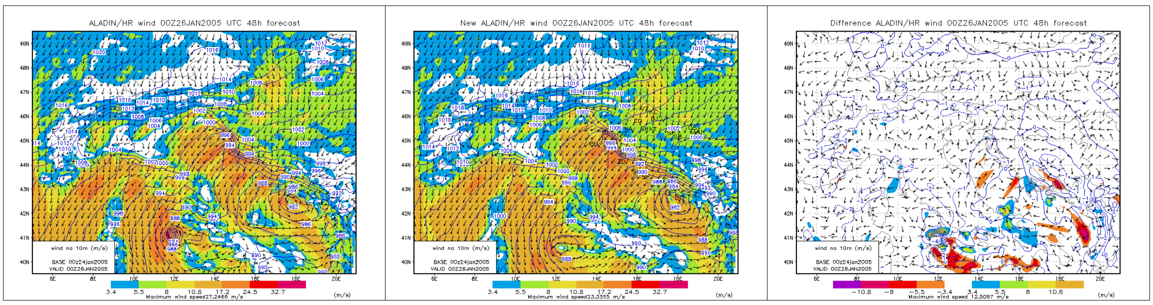

Figure 3. 10m wind and mean sea level pressure obtained with numerical diffusion (left), SLHD (center) and their difference (right), 48 hour forecast starting from 00 UTC 24th January 2005.

3.3.2. Fog case

In the case of fog in an anticyclone, use of SLHD increases the amount of fog in alpine valleys (Fig 4), especially on the border between Switzerland and Germany and in Danube valley in Austria.

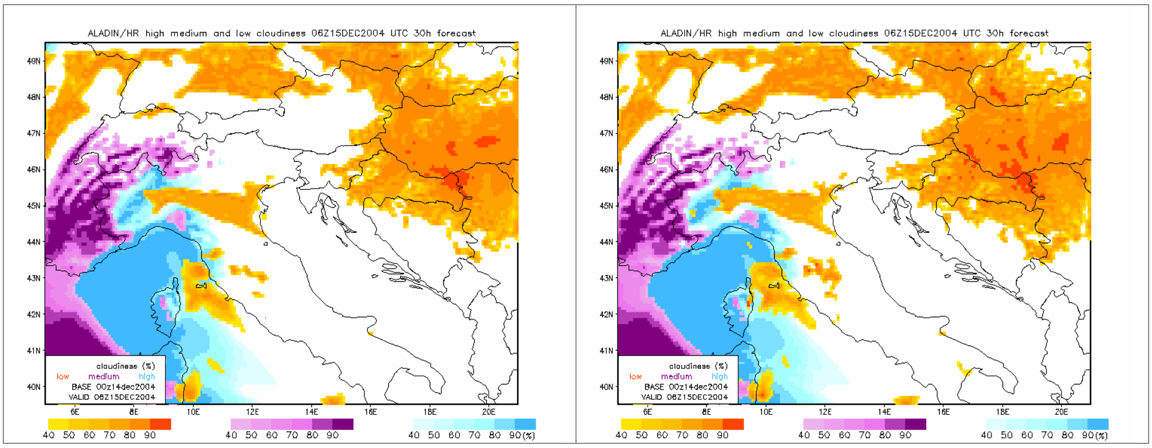

Figure 4. Impact of SLHD on the forecast of low clouds, pure numerical diffusion (left) and SLHD (right).

4. CONCLUSIONS

New orography representation resulted in slight enhancement of upstream and general decrease of downstream wind speed, as well as reduction of mountain wave amplitude. The computationally cheap cloud schemes and cloud overlap assumptions are more important for the low stratus and fog forecast than an expensive radiation scheme. The results show significant improvement in the low cloudiness and the surface temperature (2m AGL) diurnal pattern for certain configurations. SLHD has shown beneficial impact in different cyclonic situations as well as in an anticyclone. The results of several numerical experiments show better simulation of a mesoscale Adriatic cyclones, upper troposphere cyclones and beneficial impact on forecast of low cloudiness in anticyclones.

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4.4 G. Bőlőni: ALADIN 3DVAR at the Hungarian Meteorological Service

ALADIN 3DVAR at the Hungarian Meteorological Service

Gergely Bölöni (HMS)
16.12.2005

Introduction

ALADIN 3DVAR was first implemented at the Hungarian Meteorological Service (HMS) in June 2000 based on the cycle AL13. The first real time experimental assimilation cycle was set up then during the summer 2001 on the formal operational machine (SGI Origin 2000) of the service. That time the system was using only SYNOP and TEMP data over a small domain covering Hungary. As a next step the 3DVAR assimilation cycle was run as a quasi-operational application over the formal ALADIN/LACE domain from November 2002 on an IBM p699 machine. The same time experimentations started in order to use satellite (ATOVS/AMSU-A) and aircraft (AMDAR) data. Since the end of May 2005, ALADIN 3DVAR is used operationally at HMS. This paper describes the operational assimilation system set up recently, and summarises its results based on different verification methods and some case studies. Also, since the beginning of August 2005, a 3DVAR parallel suite has been set up of which the results will be also shortly discussed in this paper.

Main characteristics

The presently used operational domain (the same for assimilation and production) uses linear grid, 8km horizontal resolution and 49 vertical levels. The domain covers roughly the same area as the formal LACE domain. The assimilation cycle is run with a 6 hour frequency which means 4 long cut-off analyses per day (00, 06, 12, 18 UTC) using all the actually available data and 2 short cut-off analyses at 00 and 12 UTC in addition to provide initial conditions for the 48h production runs (figure 1.).

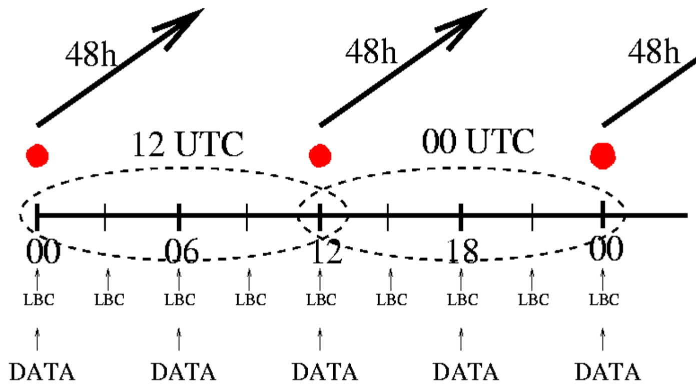

figure 1.: the assimilation cycle

In every assimilation step the surface (soil) analysis is taken from ARPEGE, more exactly the surface (soil) fields of the background are overwritten with those of the actual ARPEGE analysis. The upper air fields are provided by the 3DVAR analysis. The presently used background error covariance matrix is computed following the standard NMC method. The background is a 6 hour forecast of the model which starts from the DFI initialised local analysis. During the integration a 3 hour coupling frequency is used. Namely, at 00, 06, 12, and 18 UTC the ARPEGE long cut-off analyses, at 03, 09, 15, and 21 UTC the 3 hour ARPEGE forecasts starting from the corresponding long-cut off ARPEGE analyses are used as coupling fields.

Observational data

The system presently uses surface, radiosonde, satellite and aircraft observations. The table below summarises all the observed parameters by observation type used in the system.

SYNOP surface reports	surface pressure
TEMP upper air reports	temperature, wind, geopotential, specific humidity
ATOVS satellite observations	AMSU-A radiances
AMDAR aircraft reports	temperature, wind

Table 1.: The observational data entering the assimilation system

It is important to mention, that all the observation types above are used in the ARPEGE 4DVAR assimilation system as well. However, the local assimilation system benefits from some useful additional observational input coming from local SYNOP reports (not disseminated through GTS), and due to weaker thinning of satellite (80km for AMSU-A) and aircraft (25 km for AMDAR) data. Another remark which might be interesting is that a new procedure has been developed for the preprocessing of the AMDAR data allowing a global quality control on the whole aircraft database in one go (the original screening of the data is done flight by flight) in order to avoid problems while using the aircraft data in a non-continuous way in time (3DVAR and not 4DVAR).

Validation & Results

The validation of the assimilation system is being done by plotting objective scores (observation minus model BIAS & RMSE) and performing a subjective verification procedure. The subjective verification consists of an every day briefing comparing the different model versions (i.e. dynamical adaptation and the data assimilation system) performance for the actual situation. Finally, a note (a number from 1 to 5) is given to each model versions by the members of the verification team that includes forecasters and modellers as well. According to the objective scores the impact of the local data assimilation compared to the dynamical adaptation can be summarized as follows (some selected figures are shown for illustration from the period 22.03.2005 – 05.04.2005):

- improvement on temperature and wind on all vertical levels (figure 2)
- improvement on geopotential on high levels (figure 3)
- small negative impact for mean sea level pressure (negative BIAS) (figure 3)
- mixed impact on humidity depending on forecast range (figure 4)
- negative impact on high level humidity

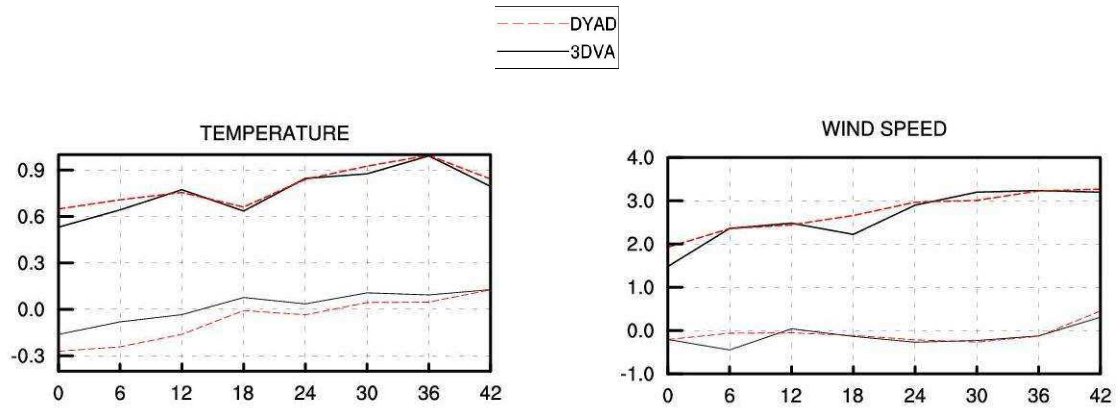

figure 2.: RMSE and BIAS of the temperature and wind forecasts on 500hPa

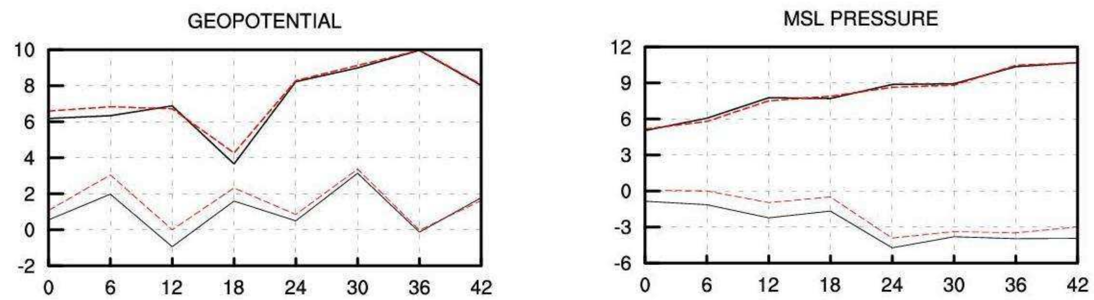

figure 3.: RMSE and BIAS of geopotential on 700hPa (left) and mean sea level pressure (right)

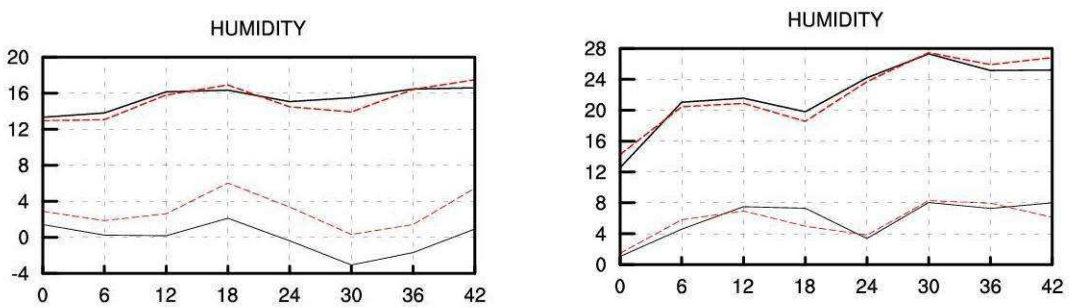

figure 4.: RMSE and BIAS of humidity on the surface (left) and on 500hPa (right)

The conclusions drawn according to the subjective verification, i.e. the every day comparison of the forecasted weather parameters are listed below. For illustration the scores are plotted for a half year period on figure 5.

- improvement in the 2m temperature forecast (0 – 24 h)
- improvement in the precipitation forecast (0 – 48h)
- degradation (0 – 24h) / neutral impact (24 – 48h) in cloudiness
- neutral impact on wind

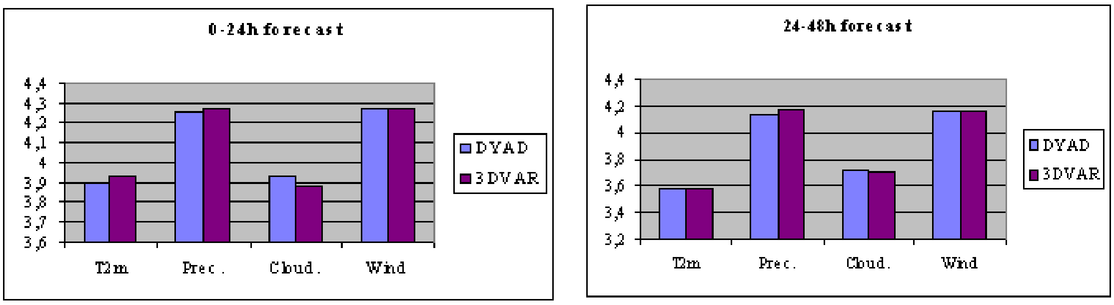

figure 5.: subjective scores of the dynamical adaptation (DYAD) and the assimilation system (3DVAR) for the first (left) and the second (right) day of the forecast (period: 01.07.2004 – 31.12.2004)

To close the presentation of the performance we show a case study. On the 18th of May 2005 a fast moving cold front was passing over Hungary, which was linked to a Mediterranean cyclone. It induced thunder storms, strong wind gusts (>100km/h) and heavy precipitation (~45mm/24h) in several places over the country.

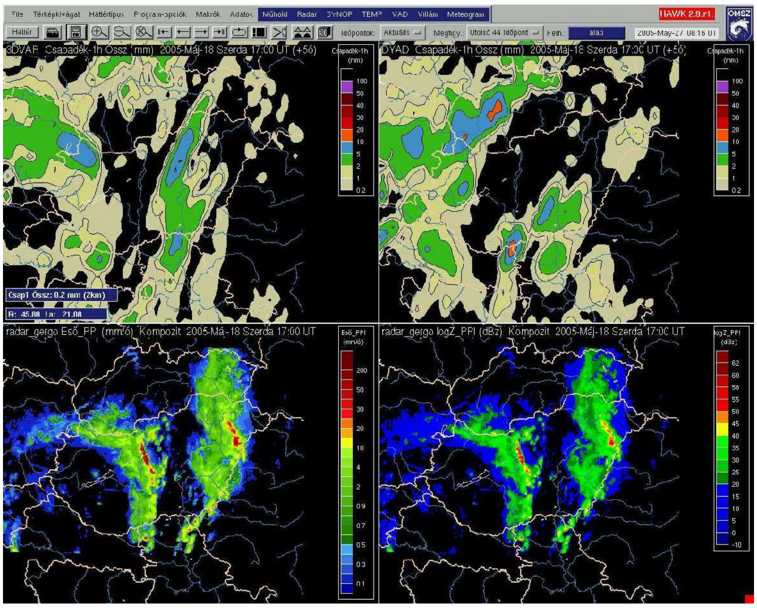

figure 6.: forecasted (top left: 3DVAR, top right: dynamical adaptation) precipitations (+5h) and observed reflectivities (bottom left: precipitable water, bottom right: logZ)

Considering the precipitation forecast, the 3DVAR assimilation system performed much better than the dynamical adaptation that we illustrate on figures 6. There we show the radar reflectivities at an important moment of the event and the corresponding precipitation forecasts. On the figure we try to illustrate, that the structure of the precipitation patterns were better predicted by the assimilation catching both band of precipitations, being present in reality, during the whole integration up to +18h, when system left Hungary and decayed. The comparison of observed and forecasted 6h cumulated precipitations also indicated a better performance of the assimilation system (not shown).

Parallel assimilation suite

As mentioned in the introduction, since the beginning of August, a 3DVAR parallel suite has been started. This parallel suite is very similar to the operational one but uses also ATOVS/AMSU-B data in addition to the other observations used in the operations. The AMSU-B data are used in a very high resolution (80km thinning) compared to the ARPEGE way of use. The impact of the AMSU-B data is validated in the same way as described above for the operational suite, i.e. both an objective and a subjective verification is considered. According to the objective scores the following preliminary conclusions were found:

- Neutral impact for geopotential and wind (not shown)
- There is an improvement in the low level temperatures (figure 7)
- There is a mixed impact on humidity, that is improvement on 700hPa and and slight degradation on 850hPa (figure 8)

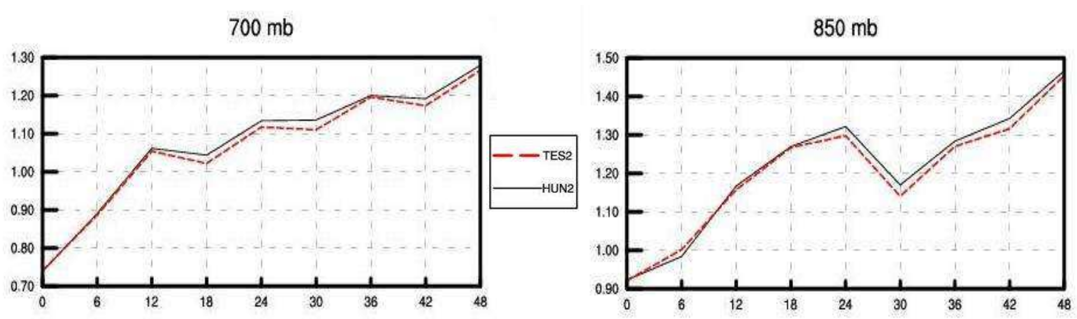

figure 7.: Impact of AMSU-B data on low level temperature (RMSE scores). HUN2: operative model, TEST2: AMSU-B parallel suite

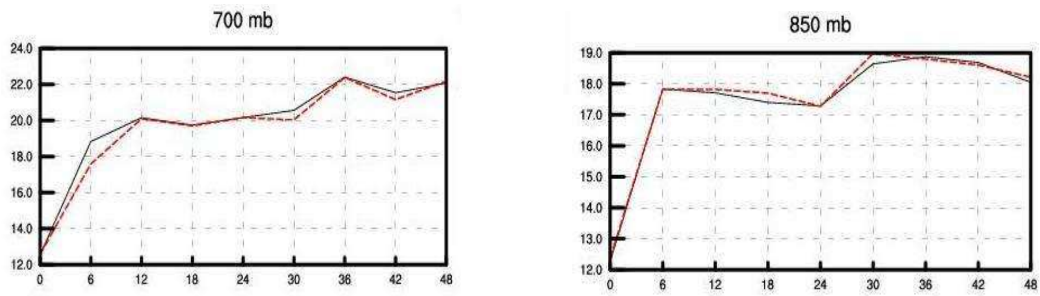

figure 8.: Impact of AMSU-B data on relative humidity (RMSE scores). HUN2: operative model, TEST2: AMSU-B parallel suite

We show also some results of the subjective evaluation. The main conclusions are that in the most of the cases the operational and the parallel suite using AMSU-B predicts very similar precipitation patterns and the amounts are also very close to each other. However, on some days the AMSU-B suite is a little bit improves the forecast (the oppposite also happens in a somewhat fewer cases) On figure 9, the day to day evolution of the subjective precipitation scores are shown (note that the values are multiplied by 2 in for technical reasons relating the visualization, so that 1 is the worse and 10 is the best score). For 2m temperature the subjective evaluation shows an even more similar behavior of the two compared systems. As you can see on figure 10, the values differ only on very few days, where the AMSU-B suite is performing better.

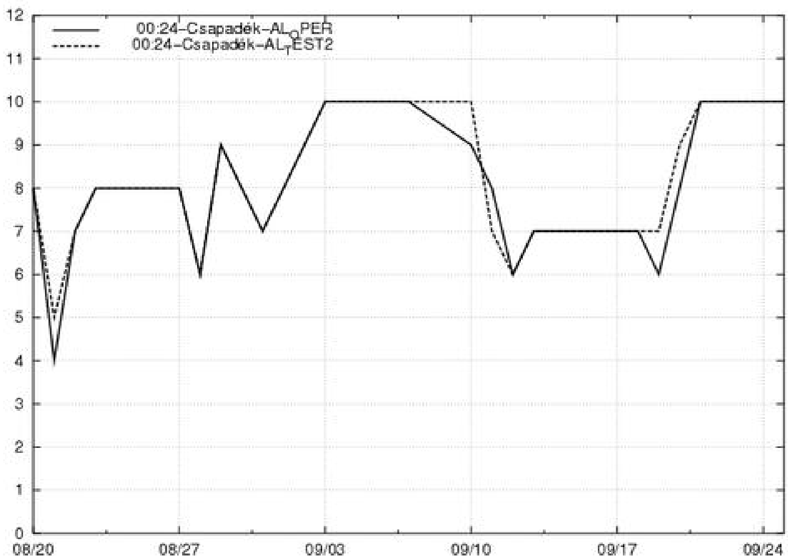

figure 9.: Day to day evolution of the subjective scores for precipitation (+24h), dashed line: operative suite, full line: AMSU-B parallel suite

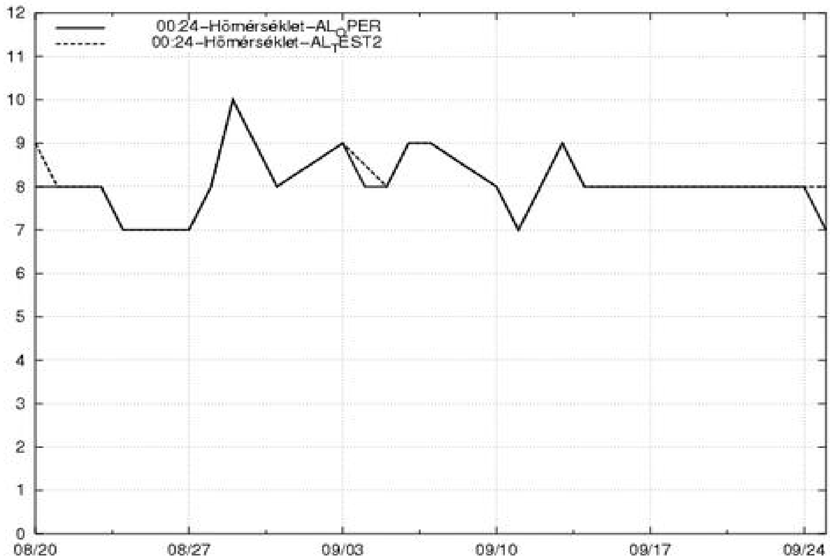

figure 10.: Day to day evolution of the subjective scores for 2m temperature (+24h), dashed line: operative suite, full line: AMSU-B parallel suite

Monitoring of the system

In order to be able to follow the operation of the system a web interface has been developed which makes possible to follow the different steps of the assimilation procedure and model forecast as well as the used observational data base. We put the emphasis on the presentation of the latter as it was a necessary development connected specially to the data assimilation. The observation monitoring system is based on the ODB mandalay viewer, which provides ascii dump of the ODB data base, then space and time statistics are computed on the ascii data (obs – guess, obs – analysis, observation quality flags) in order to represent the quality and availability of the data. Some examples are shown below.

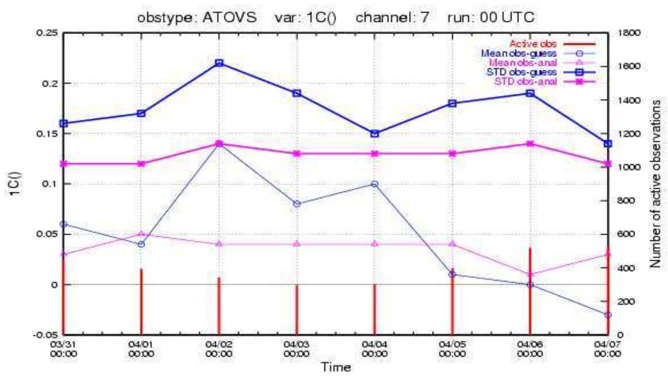

figure 11: time evolution of the different properties (mean and standard deviation of obs – guess and obs - analysis, number of active observations) of the ATOVS/AMSU-A data (channel 7)

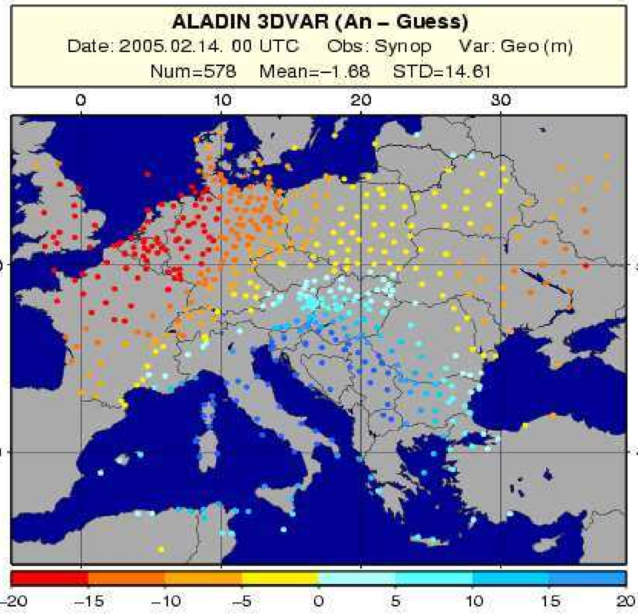

figure 12: horizontal map of the MSLP analysis – guess differences at the location of SYNOP observations, which shows the increments caused by the used observations (in the north-west the guess was corrected by the observation of a low pressure system, in the south-east the guess was corrected by the observation of a high pressure system)

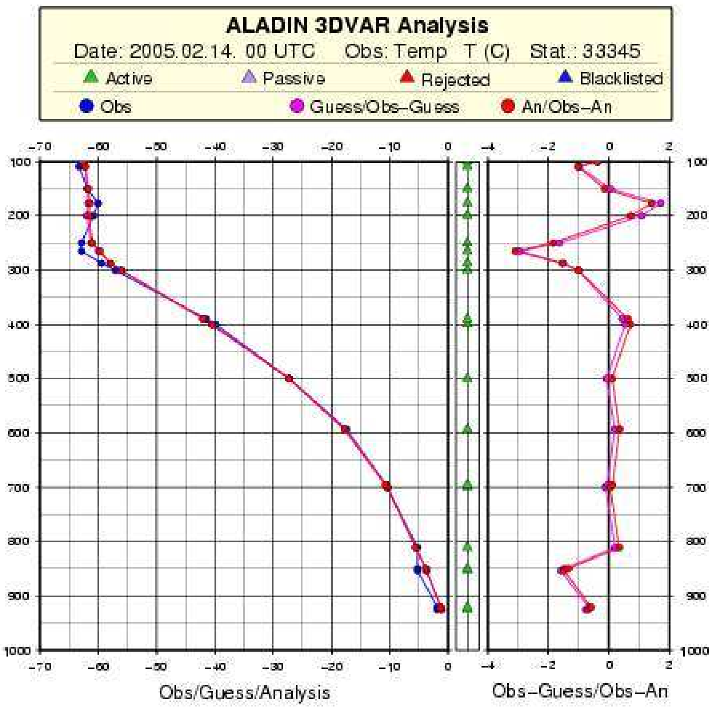

figure 13.: profiles of different quantities (obs, guess, analysis, obs-guess, obs-analysis) for a given analysis at the location of a radiosonde observation. The status of the observations is also indicated.

Conclusions and Outlook

According to the experiences at HMS, the local ALADIN assimilation can be beneficial in the every day forecasting especially concerning the precipitation events and the 2m temperature, in the short range up to 24 hours. However, there is no common improvement for all variables and even some degradation for some variables (high level humidity analysis and forecast, mean sea level BIAS) was noticed in the objective scores compared to the dynamical adaptation, for the concerned periods. This will probably motivate the HMS team for trying to improve the system. We are looking forward to continue to include other new types of observations in the assimilation. In the near future a decision will be made on the possible operational use of AMSU-B data, then other observations will be tested in the system (MSG wind, wind-profilers) Also a work is going on at the moment in order to recompute the background error covariance matrix using the “Ensemble method” instead the NMC one. For longer term even further observation types are considered to be included (SEVIRI radiances, T2m and RH2m from SYNOPs), and the testing and possible application of the so called J_k term or “variational blending” is also foreseen as well as experimentations with 3DVAR-FGAT.

5 EWGLAM final discussion

New format of EWGLAM/SRNWP meetings

Why ?

Initiated by a proposal for in-depth changes from Per Unden in March 2005, a lively debate took place along the last EWGLAM meeting (Ljubljana, October 4th). It was discussed how to make the next annual EWGLAM/SRNWP meetings more attractive and more efficient. The objective is both to provide an overview of the main progress in NWP along the past year over whole Europe and to representatives from all European NMSs, and to allow decision making for enhanced collaboration between consortia. The new joint meeting will include the following :

1. Official presentations

National presentations will keep the form of posters introduced by a 5mn talk presenting the most important issues, in operations or research. Besides a table of operational applications will be updated, each partner filling a predefined standard form (instead of the present maintenance of a list by DWD).

Group reports will be shorter, reduced to 15 mn, and present the main strategic points for each of the five consortia (ALADIN, COSMO, HIRLAM, LACE, UK).

The ECMWF presentation won't change, neither in length (30 mn) nor in content. A similar EUMETSAT presentation could be added in the future.

2. Thematic presentations

They will be divided in scientific domains (data assimilation, dynamics, predictability, physics, ...), shared between consortia (with 2h-2h½ per consortium for all topics), and include general overviews as well as scientific presentations on innovative issues, and discussions (at least 15 mn per topic). Each consortium will define which partition best reflects its achievements along the last year. The consortia leaders, the SRNWP coordinator, and the local organiser will between them agree on the detailed programme and check that relevant area leaders or scientists are invited (a sort of Programme committee).

3. Business meetings

That's where will be decided how to work together. It should take half a day.

The SRNWP meeting, prepared by the SRNWP coordinator, will be kept in more or less the same format.

It will be followed by discussions in small groups, involving mainly part of the management groups of consortia.

4. Participation

The length of the meeting will be increased, by half a day as a beginning (hence 3.5 days in 2006), more if new meetings are a real success, drawing more and more scientists.

Consortia should try to send more persons from the management groups or thematic coordinators. The 2005 SRNWP presentations for Lead Centres were a typical example of what should be avoided.

And young scientists are welcome to EWGLAM/SRNWP meetings : this is a friendly and useful introduction to NWP life for them, and this brings some fresh ideas to the workshops.

6 SRNWP business meeting report

27th EWGLAM and 12th SRNWP Meetings

Ljubljana (Slovenia)

SRNWP Business Meeting of the 5th of October 2005

Report of the SRNWP Co-ordinator

20 NWS were represented:

Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Hungary Ireland, Italy, Netherlands, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom

As every year, the ECMWF has been invited and was represented.

The Co-ordinator has presented his report under the form of an electronic presentation which displayed all the works in progress at the time of the meeting (see http://srnwp.cscs.ch/Annual_Meetings/2005/SRNWPpresentation.ppt).

Agenda of the report:

- The Network of Consortia
- Programme OPERA: Compositing necessary
- EUCOS II (2007 – 2011)
- Upper Air Soundings: Use of the BUFR code besides the TEMP code
- STORMNET
- Model comparison
- Hub for high resolution precipitation observations
- Dissemination of hourly SYNOPs
- GPS Zenital Total Delays
- SRNWP PEPS

Due to lack of time, it has not been possible to present and to discuss all these items.

But the most important ones - placed at the top of the list - have been treated.

The Network of Consortia

The National Meteorological Administration of Romania is next to its full membership by ALADIN also an "Associate Member" of the COSMO Consortium.

Programme OPERA: Compositing necessary

The Assembly acknowledged the creation of a Radar data hub at the Meteorological Office. But the Assembly could not understand that the daily production of a European radar composit has been forbidden by the EUMETNET Council (23rd Council, 14 Dec. 2004).

Radar compositing is needed by the Short-range NWP community for the validation and verification of the precipitations of the meso-scale LAMs. It would be a waste of time and resources if *the same work* (downloading of the radar data from the hub and making a composite) should be done in several NWS.

At unanimity minus one abstention, the Assembly passed the following Recommendation:

The European Short-Range NWP community asks the EUMETNET Council to recall its decision taken at its 23rd Meeting (14th of December 2004 in Reading) to exclude from the OPERA Programme "*any work on compositing*" (Point 1 of the List of Decisions).

EUCOS II (2007 – 2011)

The EUMETNET Council agreed at its 11th Meeting (21st November 2000 in Darmstadt) that "*EUCOS is the ground-based observing system designed to serve the needs of General Numerical Weather Prediction (GNWP) over Europe*"

The aim of the present phase of EUCOS (2002-2006) is to define and deploy a composit observing system for the GNWP.

Considering

- that today in Europe the total amount of money given by the NWS for the short-range, high-resolution NWP (manpower and computer costs for the scientific developments and the operational aspects) is higher than for the GNWP

- that the increase of the spatial resolution of the meso-scale NWP models we observe today will continue and that it is a priority for almost all the NWS to encourage and support NWP developments towards the km-scale resolution,

the Assembly voted at unanimity the following Recommendation:

Considering that the Proposed Revised Design presented in the "Review of the EUCOS Upper-Air Network Design" of 18 May 2005 does not consider the observational requirements needed for the high-resolution short-range NWP models, the European Short-Range NWP community asks the EUCOS Programme Board and the EUCOS Advisory Group to significantly increase the density of observations and to make sure that this density remain sufficient at night.

More generally, the delegates of the 12th Meeting of the SRNWP Programme held the 5th of October 2005 in Ljubljana ask that in the second phase of the EUCOS Programme (2007-2011) the same attention, priority and resources be given for the observation of the meso-scale as it will be done for the observation of the synoptic scale.

Upper Air Soundings: Use of the BUFR code besides the TEMP code

The TEMP code does not fulfil any longer the requirements of the data assimilation for high resolution NWP models: the geographical position of the sonde is unknown and the time of a measurement known only very approximately. Moreover, the format of the TEMP code with its 4 groups (A, B, C and D) is very unpractical for programming.

Thus the WWW Department of the WMO is making efforts to encourage migration to binary based code, i.e. to code the upper air soundings in BUFR format.

The 14th Session of the WMO Regional Association VI (7-15 September 2005 at Heidelberg, Germany) "*noted with concern that the preparation and planning for the transition to the TDCF (Table-Driven Code Forms) was not adequate. Less than 50 per cent of NMCs in Region VI have started to develop migration plans. Many Members still underestimate the challenge involved in a migration and also the benefits to be gained from TDCF*" (Document APP_WP 4).

The necessary software for encoding sounding in BUFR exists. The RA-VI noted in the same Document: *"With a view to assisting NMCs in the migration, WMO encouraged the development and distribution of universal BUFR, CREX and GRIB decoding/encoding software on various platforms to the whole meteorological community. ECMWF was providing BUFR software via free download. The German Meteorological Service (DWD) developed a BUFR edition 3 library. BUFR encoding/decoding software was also offered by NWS/NCEP (USA) and the UK MetOffice as listed in the CBS Software Registry. BUFR/CREX tables and templates for category 1 of TAC data types (SYNOP, TEMP, PILOT, CLIMAT and CLIMAT TEMP) were available in the WMO server".*

At the time of the SRNWP Business Meeting, the documents of the 14th Session of the RA-VI were not yet available. The Co-ordinator had prepared for the SRNWP Meeting a Recommendation (see the electronic presentation) whose wording - now that the policy of the RA VI is known - must be slightly revised. Needless to say that the Assembly was convinced of the superiority of the BUFR code for the dissemination of the upper air soundings.

Recommendation:

At the 12th Meeting of the EUMETNET SRNWP Programme held the 5th of October 2005 in Ljubljana, the NWS delegates asked the EUCOS Manager to take the necessary measures in order to make sure that the dissemination on the GTS of the radiosonde data between the European NWS will take place in BUFR code as encouraged by the WWW Department of the WMO and as strongly recommended by the 14th Session of the WMO-RA VI (5 -15 September 2005 in Heidelberg).

STORMNET

This information has been given by Dominique Giard (Meteo-France).

As the Proposal for an EU Project submitted the 2nd of December 2004 for the financing of a "Research and Training Network on high resolution NWP" has not been accepted, our proposal has been re-submitting the 28th of September 2005, again in the instrument "Human Resources and Mobility".

As for the first submission, Meteo-France has been the proposer for this second submission.

The following 13 NWS, all Members of the SRNWP Programme, are participating in the proposal: ZAMG (Austria), IRM (Belgium), DHMZ (Croatia), CHMU(Czech Republik), FMI (Finland), MF (France), DWD (Germany), OMSZ (Hungary), KNMI (The Netherlands), SHMU (Slovakia), INM (Spain), SMHI (Sweden) and MeteoSwiss (Switzerland).

Together they are ready to host and educate in Numerical Weather Prediction 29 ERS (Early Stage Researchers) in almost all the aspects of the NWP technique: surface, dynamics, numerics, predictability, system, data assimilation and verification. Most of the participating NWS are accompanied by an "Associated partner" which is in the majority of the cases an Institute or a Department of a University.

After the presentation of Dominique, we had according to our schedule to close the meeting. The other points

- Model comparison
- Hub for high resolution precipitation observations
- Dissemination of hourly SYNOPs
- GPS Zenital Total Delays
- SRNWP PEPS

could not be discussed, but their description in the electronic presentation (see URL at the beginning of this report) tells the interested reader what they are about.

It will now be the duty of the Co-ordinator to send with the necessary justifications the Recommendations to the different authorities and to push for their realisation where and when appropriate. It will also be part of his work to continue his effort for the realisation of the actions listed just above.

For the minutes:

Jean Quiby