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

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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.