Limited Area Modelling Activities in Slovenia

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Environmental Agency of the Republic of Slovenia is a partner in the international projects ALADIN and RC LACE. Small NWP group is temporaily enlarged by two young researchers (PhD students in the scope of ALADIN training Network (ALATNET)): Klaus Stadlbacher (Austria, 4 months) and Raluca Radu (Romania, 8 months).

The main research and development topics are dealing with coupling problems, evaluation of the model skills in high resolution and in non-hydrostatic version. Besides looking after operational ALADIN model application some work was done in the field of objective verification.

Event

Third ALATNET Seminar on the Numerical Methods and NWP Applications took place in Kranjska gora, Slovenia, in May 2002. For one week 59 participants from 14 countries were attending the lectures: basis of numerical analysis, dynamical aspects, physical aspects, variational methods, numerical filters and stochastic aspects.

Operational ALADIN application

Operational suite of the local model version ALADIN/SI has not been changed since last year. It is running on cluster of workstations (5 Alpha processors) under Linux. Products are regularly available over 800 km by 800 km domain twice a day for next 48 hours. Besides products of local application also products of ALADIN/LACE, running in Prague, are available.

New computer system

Procurement for buying new computer system started in May 2002 and system was delivered and installed in October. It is a cluster based on Intel Xeon processors, has 14 dual processor boxes with 2.4 GHz processors (28 all together), 28 GB of memory and 0.5 TB of disk space. Processors are connected via gigabit fiber ethernet. It runs Linux OS (RedHat 7.3) + SCore global OS.

Local ALADIN application has to be redesigned till the end of the year, taking into account new computer power and ending of common computing ALADIN/LACE in center in Prague.

Spectral coupling

The failures of the forecast of LAM in some cases, as Christmas storm 1999, determined a deeper investigation of weakness of the present coupling scheme and its improvement. A spectral method for coupling is under development and will be used as an additional coupling step to the Davies-Kallberg relaxation. The main goal is to better capture incoming signals without losing the sponge effect of Davies scheme to damp out spurious wave reflections or wave re-entering. In spectral coupling the information contained in coupling files is interpolated in time in spectral space over limited area domain and combined with the spectral information of the coupled model, rather than just in the gridpoints values of coupling zone as in the classic one. By combining spectral and classic coupling it is expected to combine positive advantages of both: to catch the small scale features no matter where they are located inside the limited domain and to eliminate the spurious inward propagation in lateral boundaries.

Non-Hydrostatic modelling on High-resolution

Going to higher and higher resolution it seems obvious to change to non-hydrostatic dynamics. Nevertheless one question should be tried to answer: Which resolution already requires the use of hydrostatic dynamics? Comparative experiments have shown, that the introduction of the non-hydrostatism in the Aladin-model might just become relevant for resolutions around 5 kilometres. The positive influence of the non-hydrostatism is rather small compared to changes in the resolution of the coupling model and the use of NH or Hydrostatic dynamics, which either means a direct coupling of the prognostic non-hydrostatic variables or treating them in a diagnostic way for coupling purposes. Further and more general evaluation of the non-hydrostatic dynamics will be done. Another problem which occurs when going to high resolution concerns the treatment of orography. The description of orography as well as the connected parametrisations are undergoing intensive investigations. The orography problems are naturally independent of the used dynamics. Improved forecast fields (e.g. for precipitation) can be obtained by smoothing the orography, namely to use lower truncation numbers for spectral description of the orography compared to the other fields, which leads to more realistic precipitation fields in areas with high and steep mountains and diminishes the well known effect of precipitation peaks at the windward side of the mountain and the summit, respectively.

Improving ALADIN's 2m temperature forecast with machine learning

A method of using machine learning for improving ALADIN's 2m temperature forecasts has been tested. Regression tree learning is used to build a predictor from learning data.

The predicted variable is the 2m temperature at a given time and place. Our training set that is imported to the learning algorithm is based on data collected over two years (1999, 2000) and the data for 2001 is used as a test set. The initial attribute

set consists of ALADIN's predictions (ALADIN LACE pseudotemps for 5 different locations in Slovenia), for various meteorological variables at different places, height levels and time, and measured data (several synop station measurements in Slovenia and radiosounding measurements in Ljubljana, Udine and Zagreb). For purpose of machine learning data have to be reduced by carefully choosing the most informative attributes only. Several attribute selection algorithms are used, as well as expert opinion. So the initial set is reduced to typically between 5 to 20 attributes.

The results obtained with decision tree correction method and with further modified method with bagging are also compared to Kalman-filtered predictions (example in Table 1). The results show a statistically significant improvement of ALADIN's predictions. The improved predictions are of special interest in cases when ALADIN's error is large.

Table1: Comparison of accuracy of 2m temperature forecast for noon of the following day at Ljubljana airport (Brnik) - data from year 2001. (Abbreviations used: ME=mean error, MAE=mean absolute error, RMSE=root mean square error)

	ALADIN's forecast	Kalman correction	Decision tree correction	Decision tree correction with bagging
ME	1,566	0,121	0,240	0,226
MAE	2,199	1,988	1,767	1,718
RMSE	2,939	2,531	2,335	2,251

Verification of ALADIN/SI precipitation

Forecast of precipitation from ALADIN model are used by hydrologists for hydrological prediction of runoff. We were interested to what degree forecast precipitation amounts can be trusted, especially on high precipitation events. Precipitation measurements were interpolated using kriging method and compared with ALADIN/SI results for some typical precipitation events. It was noticed that there is constant overestimation of precipitation for some regions (mostly windward slopes) and underestimation for other regions (mostly lee slopes), while the total amounts of precipitation from the model in most cases agree with measurements within 30%. We concluded that regions with constant precipitation error are mostly due to the lack of liquid water parameterization scheme in a model.

ALADIN Verification project

In the ALADIN community a common project for objective verification at the synoptic scale was started this year where Slovenian group has the leading role. The aim is building of a coordinated centralized procedure which would produce time evolution and comparison of classical scores over various domains and for various model configurations. The application consists of: collecting forecast values from models and observations (for selected meteorological variables and stations), storing them to a relational database and a web interface to get on-line verification products of interest.