LACE Working Group for Data Assimilation: Report 2004

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Contents

1 Introduction

This paper aims to summarise and value the research work done in the frame of the working group during the year 2004. The previously planned research topics are listed and the related work is evaluated following the same structure as it is in the research plan proposal for 2004, itself.

2 Progress in research topics

2.1 Methods: algorithmic aspects

- **Isotropy properties of the B matrix**
  Description: Background error covariances used in ALADIN/3d-var are assumed to be isotropic in the horizontal. However, due to the discretization of this assumption some unrealistic anisotropy is implemented in the horizontal structure functions, especially on rectangular domains.
  Realization: Experiments have been started last year to make the discretization more realistic and to provide a tool to measure the anisotropy. The experiments have been finished this year. The targeted problem was solved, however the impact of the improvement is tiny. (Local work)
  Efforts: 1 person x months
  Contributors: Gergely Bölöni (HU), supervision by Claude Fischer (FR) and Loik Berre (FR)
  Documentation: In the 25th ALADIN newsletter

- **Tuning of the multivariate humidity formulation of the B matrix**
  Description: Earlier 3d-var experiments showed (ATOVS experiments in Budapest) that the impact of multivariate humidity coupling in the ALADIN/3d-var Jb is not straightforwardly advantageous. Namely, the impact of humidity on mass analysis is positive but not the reverse; the humidity analysis is spoiled due to its multivariate treatment.
  Realization: There was an idea to tune the observation and background errors so, that the positive impact of the multivariate humidity treatment is being expressed and the impact of its drawback is being diminished. So far, a tuning ratio has been proposed for the background and observation error of specific humidity after the theoretical preparations. The work will continue in 2005 by evaluating the impact of the chosen tuning. (Local work)

Efforts: 2 person x month
Contributors: Gergely Bölöni (HU), Loik Berre (FR), Kristian Horvath (CRO)
Documentation: not available yet

- **LH versus NMC statistics**

  Description: The Lönnberg-Hollingsworth (LH) method is a popular way to estimate the background errors. In its spirit this method is very different from the NMC one (which is one of the presently used methods in ALADIN). It has been always a question whether our NMC estimation gives errors with realistic magnitudes or not. The comparison of the two independent methods could give some more knowledge about it.
  Realization: Horizontal LH covariances and correlations were derived in physical space upon obs - background departures stored in the ODB. As the NMC statistics are derived in spectral space most of the technical work consisted of transforming the NMC spectral correlation functions into physical space for the comparison. Conclusions were derived concerning the horizontal correlation and covariance length scales of LH and NMC (both standard and lagged) statistics. Near the surface suspicious large length scales were found for the LH statistics, for which the reason is still unknown. The derived LH statistics will possibly be used in the continuation of the work listed in the previous point as an independent estimate of the background and observation error variances of humidity (1.5 m. local work + 1.5 m. stay in Budapest).
  Efforts: 3 person x month
  Contributors: Kristian Horvath (CRO), Gergely Bölöni (HU)
  Documentation: The report is available on the LACE web page.

- **3D-VAR tests with rectangular truncation**

  Description: This topic was not planned in advance but was proposed during the year to investigate. The idea was to test whether the 3dvar analysis improves or not regarding the isotropy of analysis increments if one uses bijective Fourier transforms (i.e. rectangular truncation) while running the 3dvar job (during the Jo computations the transforms are called several times). The hope reach better represented analysis increments were based on tests made in Toulouse previously which proved that Fourier transforming a

sharp grid-point function to spectral space and back to grid-point space one single time results in a much noisier field, if the truncation is quadratic, than if it is rectangular.

Realization: The tests were done in Budapest on the ALADIN/FRANCE domain in order to have linear grid (linear grid + rectangular truncation together ensures the bijectivity of the Fourier transform). The ellips routine was modified to represent a rectangle in spectral space and was used in the Jb setup part. The background error statistics for the missing wave numbers were specified as zero. Another technical task was to prepare rectangularly tuncated first guess. The single observation tests did not bring success, the analysis with rectangular truncation gave very similar analysis increments to those prepared with quadratic truncation. (local work)

Efforts: 1 person x month

Contributors: Gergely Bölöni (HU), László Kullmann (HU), Claude Fischer (FR)

Documentation: not available yet

2.2 Methods: cycling

- **E-BlendVar cycling experiments**

  Description: The E-BlendVar method (combination of the explicit blending and 3d-var) was tested.

  Realization: The validation of the E-BlendVar has been performed mainly in 2 steps, first score comparison with the standard 3d-var setup was done to verify roughly the reliability of the system, then an extensive study of some interesting cases was performed. From several possible configurations (use of DFI, order of blending and 3d-var) the one giving the most balanced fields in pre-tests was chosen for further experiments. General score comparisons gave mostly neutral impact of the blending except the analysis where improvement can be found compared to the standard 3d-var results. Detailed case studies showed a better location of precipitating systems with blending than without. However these improvements were found for longer than 6h forecast range which suggest that they possibly might be due to some stochastic reasons and not straightforwardly due to the better initial conditions (?) (stay in Budapest + local work)

  Efforts: 3 person x month

Contributors: Steluta Alexandru (RO), Gergely Bölöni (HU), Helga Tóth (HU)
Documentation: The report is available on the LACE web page.

2.3 Observations

- **Assimilation of ATOVS and MSG data**
  Description: The impact of AMSU-A ATOVS data has been evaluated in 2003. Several tunings were proposed to improve the system (channel selection, observation error tuning, bias correction modifications). New source of information (AMSU-B) was planned to use in 2004. (Note that AMSU-A and -B are different instrument, A is measuring radiances sensitive to the temperature, B is measuring radiances sensitive to humidity.) Also, it was planned to use MSG (Meteosat Second Generation) data during the year.
  Realization: The AMSU-A tunings have been finalised with noticeable improvement in the analysis (they are also used in the quasi-operative 3d-var system of HMS). The research on AMSU-B data was technically bounded to the new cycle of the ALADIN code (cy28), which was ready in September and installed in October at HMS. AMSU-B data can be injected in the ODB at HMS in high resolution (in ARPEGE only every 3th pixel is used) but no further developments were done so far. Feeding ODB by MSG/AMV (Atmospheric Motion Velocity) data has been worked out. Also, first impact studies were performed recently, which did not show a definite improvement so far. (Local work)
  Efforts: 6 person x month
  Contributors: Roger Randriamampianina (HU), Regina Szoták (HU)
  Documentation: available on the LACE web page & 26th ALADIN newsletter (AMSU-A)

- **Assimilation of radar data**
  Description: An ambitious plan for radar reflectivity assimilation has been prepared. The first step was to develop the ODB software and the ALADIN data flow to be able to handle reflectivity data.
  Realization: The ODB modifications have been done in Toulouse with close harmonisation with ECMWF. LACE contributed to this development in the

frame of a stay, which targeted the construction of the ALADIN radar data flow, which was successfully done. (non LACE stay in Toulouse)
Efforts: 3 person x month
Contributors: Marián Jurasek (SK)
Documentation: available in the 26th ALADIN newsletter

- **Assimilation of AMDAR data**
  Description: The impact of AMDAR data has been studied in 2003. In 2004 the thinning technique used for these data was studied in details, and an additional procedure was developed to filter the redundant data.
  Realization: A newcomer student (Miklós Balogh) was studying the thinning code. The application of an external filter program was proposed to use before the screening in order to make the aircraft data selection more optimal (filtering on the whole data set in one go, instead of filtering flight by flight). Impact studies show rather neutral impact. (Local work)
  Efforts: 3 person x month
  Contributors: Gabriella Csima (HU), Roger Randriamampianina (HU), Miklós Balogh (HU)
  Documentation: a short English extraction of the Hungarian documentation is available on the LACE web page.

- **Assimilation of wind profiler data**
  Description: Hungary invested into two wind profilers in 2003. This new source of information is being tried to assimilate in HMS.
  Realization: This work was put aside since the responsible colleague left HMS. The quality of the data was estimated by innovation statistics and by comparison with TEMPs. No impact studies so far. (Local work)
  Efforts: 2 person x month
  Contributors: Regina Szoták (HU)
  Documentation: not available yet

- **Assimilation of 10m wind data**
  Description: The impact of 10 m wind data analysed over land has been studied. A blacklist of stations with high innovation RMSE has been set up.
  Realization: Parallel tests were run in order to evaluate the impact of the 10m wind data. The tests were done both using envelope and non-envelope

orography. The physical parametrization of the orographic drag was changed together with the orography. Non-envelope orography was used in order to decrease the difference of the real and model height of the synop stations in the mountains. The impact of the data is very slight, mostly it is noticeable in the analysis and for some variables (geopotential, temperature) it is even negative.
Estimated efforts: 2 person x month
Contributors: Michal Majek (SK), Gergely Bölöni (HU)
Documentation: available on the LACE web page

2.4 Surface

- **Snow analysis experiments**
  Description: One possible reason for overestimation of 2m temperature is the bad representation of the snow-cover. In 2003 first attempts has been done to use local Canari OI snow analysis. The impact of such local analysis was studied further.
  Realization: An interesting case was selected and many combinations were run using different initial snow analyses and model physics. It was possible to improve this specific analysis and forecast in case of using a local snow analysis + additional physics tunings.
  Efforts: 1 person x month
  Contributors: Helga Tóth (HU)
  Documentation: available on the LACE web page and the 26th ALADIN newsletter

2.5 Nudging

- **Latent heat nudging**
  Description: Latent heat nudging (LHN) is a simple method of precipitation assimilation. It uses nudging of released latent heat from observed precipitation amount - based on radar or satellite. In ALADIN it has never been tried before.
  Realization: In 2004 a simple version of LHN was implemented in the ALADIN model. The brief impact studies performed so far show valuable humidity information in the analysis and in a few hours of integration, due to the nudging. (Local work)

Efforts: 4 person x month
Contributors: Neva Pristov (SI), Gregor Gregori¡c (SI)
Documentation: The results were presented in the frame of a poster presentation. The poster is available on request from Gregor Gregoric.

2.6 LAMEPS

- **Optimisation of ARPEGE singular vector perturbations for Central-Europe**

  Description: The goal is to define a target domain and integration window for which the ALADIN EPS will be run. The singular vector computations (i.e. the preparation of perturbations) should be optimised for this domain and integration time then.
  Realization: ARPEGE singular vector computations were computed for several (4) target domains. The sensitivity of the EPS runs to these target domains was investigated through several case studies. In one of the cases used for the study, improvement was found compared to the simply downscaled PEACE members.
  Efforts: 6 person x month
  Contributors: Edit Hágel (HU), Gabriella Szépszó (HU), Sándor Kertész (HU)
  Documentation: available on the LACE web page and the 26th ALADIN newsletter

- **ALADIN EPS using PEACE perturbations**

  Description: Here the aim is to run ALADIN EPS coupled with the quasi-operational PEACE ensemble members. The PEACE system is run at Météo-France once a day to create a 10 member global ensemble forecast. The coupling domain for the production of coupling files from PEACE should be also defined in the experiments.
  Realization: Several EPS case studies were run using the PEACE members as coupling information for ALADIN. No significant spread was found for neither of the cases investigated. (Local work)
  Efforts: 6 person x month

Contributors: Edit Hágel (HU), Gabriella Szépszó (HU), Sándor Kertész (HU)
Documentation: available on the LACE web page and the 26th ALADIN newsletter

3 Summary of means

The following table is a short abstract of the report above concentrating on the used manpower for each research topic. The used LACE support is attached to each item as well.

Topic	**Estimated efforts**	**LACE support**
Isotropy properties of the B matrix	1 p x m	none
Tuning of the multivariate humidity formulation	2 p x m	none
LH versus NMC statistics	3 p x m	1.5 p x m (Budapest)
3dvar tests with rectangular truncation	1 p x m	none
BlendVar cycling experiments	3 p x m	2 p x m (Budapest)
Assimilation of new observation types: ATOVS and MSG data Radar data AMDAR data Wind profiler data SYNOP 10m wind data	 6 p x m 3 p x m 3 p x m 2 p x m 2 p x m	 none none none none 1.5 p x m (Budapest)
Snow analysis experiments	1 p x m	none
Latent heat nudging	4 p x m	none
Optimisation of ARPEGE singular vector computations for Central-Europe	6 p x m	none
ALADIN EPS using PEACE perturbations	6 p x m	none
Total	**43 p x m**	**5 p x m**

Table 1: means in 2004