LACE Working Group for Data Assimilation: Report 2003

Gergely Bölöni

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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 2003. Each 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 2003 itself.

2 Progress in research topics

2.1 Methods: algorithmic aspects

- **Biperiodic 3d-var analysis increments**
  Description and objectives: The ALADIN 3d-var system provides biperiodic analysis increments which is a spurious feature. The cure of this problem has a high priority. The aim of this work was to find the exact reason of the problem and to eliminate or reduce the magnitude of the unrealistic biperiodicity.
  Realisation: The contribution of the LACE Data Assimilation working group to this work consisted in a few complementary technical testing of the 3d-var system relating the biperiodicity of the gradJo field and the discretization of the homogeneity and isotropy assumption of background error statistics. A tool for measuring the (an)isotropy of analysis increments was also prepared.
  Efforts: 1.5 person x months
  Contributors: Gergely Bölöni (HU), supervision by Claude Fischer (FR) and Loïk Berre (FR)
  Documentation: In the next ALADIN newsletter.

- **Moving to 3d-FGAT**
  Description and objectives: 3d-FGAT (FGAT stands for First Guess at Appropriate Time) is a tool based on 3d-var which can take into account observations in a more realistic way (treating them rather at observation times). In theory moving to this tool would ameliorate the quality of the analysis, moreover it would be a step towards 4d-var.
  Realization: Not realised due to lack of manpower. The plans were not enough careful in this question.

- **Study of vertical structure of 3d-var analysis increments**

  Description and objectives: The vertical structure of analysis increments is determined by the vertical structure functions of background error statistics. Earlier experiments showed erroneously large vertical spread of analysis increments using surface humidity observations.

  Realisation: The work was done in the frame of a one month stay in Budapest. The main outcome of the work is a systematic catalogue of analysis increment cross-sections covering all statistical balance couplings described by the present B matrix used in the 3d-var system. Also, the differences between standard and lagged NMC statistics were further studied.

  The final stay report is available.

  Efforts: 3 person x months

  Contributors: Kristian Horvath (CRO), Gergely Bölöni (HU)

  Documentation: Available soon on the LACE web page.

- **Design of an explicit blending**

  Description and objectives: Explicit blending of ARPEGE/ALADIN fields was proposed to try in assimilation/blending cycle. The explicit blending's idea was based on an already existing simple program but it needed some tuning.

  Realisation: Experiments have been done to tune the essential parameters of the basic blending program and a script environment have been written around.

  Efforts: 1 person x month

  Contributors: Helga Töth (HU), Gábor Radnöti (HU), Gergely Bölöni (HU)

  Documentation: Does not exist so far.

- **Variational quality control**

  Description and objectives: Variational quality control (VarQC) is a new and more robust method to check to be used in the assimilation. The development and validation of this method is under way in the ARPEGE/ALADIN software. Note, that this topic was not included in the pans at the beginning of the year but the possibility of LACE contribution came up later during the year.

  Realisation: The fresh results of a work on VarQC are under evaluation.

  Efforts: 1.5 person x month

Contributors: Marian Jurasek (SK)
Documentation: Available soon on the LACE web page.

2.2 Methods: cycling

- **Comparison of ”dfi” and ”explicit” blending**
  Description and objectives: Dfi-blending is a sophisticated tool to blend ARPEGE/ALADIN files. It is efficient but its implementation is complicated. The aim of this experiment was to explore the applicability of the cheaper explicit-blending comparing to the already well working dfi-blending.
  Realization: The work was done in Prague in the frame of a one month stay. The explicit blending was implemented in Prague and a systematic comparison with the dfi-blending was performed. Score comparisons of parallel cycling tests showed very similar performance of the two system. A case study comparison have been performed too, of which the results were significantly different for the two methods, but no straightforward conclusions were made about the performances.
  Efforts: 2 person x months
  Contributors: Helga Töth (HU), Radmila Brožková (CZ)
  Documentation: Available soon on the LACE web page.

- **BlendVar cycling experiments (L-H statistics)**
  Description and objectives: BlendVar means the combination of dfi-blending and 3d-var. It turned out to be a promising tool for meso scale data assimilation purposes. The proposal for further development in this field was to find a way to control the blending and 3d-var increment of this analysis system.
  Realization: The work was done within a stay in Prague. For weighting the blending increment the statistical estimation of blending errors was proposed. The 1st step to estimate blending errors consists in the development of a simple ”Lonnberg-Hollingsworth” program that computes error statistics on observation minus model sets. The prototype of this program has been written. Note, that no real BlendVar experiments have been done in the frame of this work.
  Efforts: 2 person x months

Contributors: Helga Töth (HU), Claude Fischer (FR), Radmila Brožková (CZ)
Documentation: Available soon on the LACE web page.

- **3d-var cycling experiments to elaborate stratus cases**
  Description and objectives: This topic was initiated by Austrian colleagues. The motivation was given by the quite regular miss-forecast of low level inversions during the winter season in the Carpatian-basin. This can partly come from the fact that in most of the cases even the initial field (in fact the ARPEGE analysis) does not recover the low level inversion.
  Realization: In order to try to reproduce the real temperature profile in the initial state of the forecast, 3d-var assimilation cycles have been run first. However, it turned out soon that it is not easy to keep the inversion in the assimilation-model system (assimilation cycle). Simply saying, if the model is not able to give a good quality first guess the 3d-var is not able to correct the model field with the observations and vice-versa. Modifying the observation handling in the analysis procedure we were able to force the analysis close to the observations, however this was made in quite an artificial way that can not be considered as a final solution. The conclusions of the experiments are that the model (parametrisation of lowstratus) should be improved and maybe the screening (quality control of the observations) should be revisited to achieve an efficient system.
  Efforts: 2 person x months
  Contributors: Thomas Haiden (AT), Harald Seidl (AT), Helga Töth (HU), László Kullman (HU), Steluta Alexandru (RO), Gergely Bölöni (HU)
  Documentation: Does not exist so far.

2.3 Observations

- **Implementation of ODB**
  Description and objectives: ODB is the observational data base used in the model. It's new and the implementation of softwares dealing with it is complicated. Moreover as it is foreseen the implementation of new model cycles (concerning configurations using observations) will require the implementation of new ODB versions as well.

Realization: The newest version of ODB has been implemented together with the new model cycle (CY25T1) in Budapest. After the successful implementation, a training course has been organised at HMS. Six participants attended the lectures from 4 countries (Austria, Czech Rep., Croatia, Romania). The training lectures covered the implementation of ODB, the use of ODB related programs and the use of ODB in ALADIN.
Efforts: 2 person x months all together
Contributors: Sándor Kertész (HU) (implementation and teacher), Stjepan Ivatek-Šahdan (CRO), Martina Tudor (CRO), Kristian Horvath (CRO), Yong Wang (AT), Frantisek Meszaros (CZ), Simona Stefanescu (RO)

- **Assimilation of ATOVS data**
  Description and objectives: Assimilation of ATOVS data was already working technically in ALADIN at the beginning of 2003. The aim of further developments was to validate the system, to tune it to be efficient for meso-scale analysis and to use the maximum amount of ATOVS data in addition to what is used in the global analysis of ARPEGE.
  Realization: The system was validated in Hungary, first via a set of simple tests (obs-guess, obs-analysis comparisons), then several assimilation cycles have been run in comparison with the quasi-operational 3d-var suite of ALADIN/HU. The conclusions are that in ALADIN the ATOVS data can be used with a weaker thinning than in ARPEGE. The impact of ATOVS data is quite neutral in general, however for a few variables a slight improvement of the forecasts could be noticed.
  Efforts: 6 person x months
  Contributors: Roger Randriamampianina (HU), Regina Szöták (HU)
  Documentation: Available soon on the LACE web page.

- **Assimilation of radar data**
  Description and objectives: Assimilation of radar data is a new topic not only within the LACE project but even in ALADIN. In many other LAMs the assimilation of doppler radar wind data is developed. However, both for AROME and ALADIN, Météo-France will put the emphasis on radar reflectivity assimilation. This decision has been made keeping in mind two main statements. One rather technical statement is the radar instrument capacity of ALADIN member states (there are much more

conventional, than doppler radars in Europe). The other statement is the certain need of high resolution humidity (cloud water) assimilation in the future AROME system.

Realization: An ALADIN/LACE contact person has been nominated (Slovakia), who was studying the detailed research plan for reflectivity assimilation written by the head of the AROME project. The contact person was also spreading the knowledge about the plans within the ALADIN community, and has started to frame an ALADIN team for contribution to the developments.

Efforts: 1 person x months

Contributors: Marian Jurasek (SK) (contact person)

Documentation: The AROME research plan for assimilation of reflectivities will be available soon on the LACE web page.

- **Assimilation of AMDAR data**

  Description and objectives: Assimilation of AMDAR aircraft data is technically possible in ALADIN, but its impact have never been studied before. The aim of the research in this field consists of the optimal usage of data (again the highest amount in addition to the ARPEGE analysis).

  Realization: First the data conversion into ODB has been developed, then the impact of data on the forecasts was studied, namely assimilation cycles were run using different thinning distances and the forecast results were compared with the ALADIN/HU quasi-operational 3d-var. The impact turned out to be quite neutral in general, that means very slight improvement for some variables and very slight worsening for others. It is also a conclusion that going towards weak thinning (high resolution data) does not make harm, it even improves the impact. All the experiments were run in Hungary.

  Efforts: 4 person x months

  Contributors: Gabriella Csima (HU), Roger Randriamampianina (HU), Regina Szoták (HU)

  Documentation: Available soon on the LACE web page.

- **Assimilation of 10m wind data**

  Description and objectives: 10 m wind data are presently used only over sea in ARPEGE from SYNOP reports. This is due to the fact that 10 m wind observations are highly erroneous over land because of the deviation of the real and model orography. The goal of the study was to find a good

criteria for the selection of reasonably good data and see the impact on forecasts.

Realization: The work has been done in Toulouse in the frame of a Météo-France stay. After many trials a blacklist has been set up for 10 m wind data according to the obs-guess RMSE. The impact of data was studied in ARPEGE forecasts. Slight improvement has been shown in some regions for temperature at low levels.

Efforts: 1.5 person x months

Contributors: Marian Jurasek (SK)

Documentation: Available soon on the LACE web page.

2.4 Surface

- **Implementation of CANARI/Diag-pack**

  Description and objectives: CANARI/Diag-pack is a tool to perform hourly surface analysis. The experience shows that forecasters are willing to use it and that it can serve as a basis of nowcasting systems. Diag-pack is already implemented in Austria and Hungary and other LACE countries were planning to implement it too.

  Realization: Diag-pack has been implemented in the Czech institute and it is being validated.

  Efforts: 2 person x months

  Contributors: Alena Trojakova (CZ)

- **Smoothing of Soil Wetness Index (SWI)**

  Description and objectives: The ARPEGE/ALADIN surface temperature analysis and forecast fields result in unrealistic, big horizontal gradients in hot summer weather situations. This influences the 2 m temperature fields as well. The model surface and 2 m temperature highly depend on the model soil moisture. It was shown in ARPEGE that the spatial smoothing of the model soil moisture (SWI is a kind of measure of it) smoothes the spurious gradients. The smoothing procedure is going to be applied in ARPEGE in the future. The work was initiated in order to figure out whether the smoothing should be applied in ALADIN too, and if yes do tests to see the impact.

  Realization: Experiments have been performed applying the smoothing in ALADIN/LACE. The conclusion is that there is a notable impact of the SWI smoothing to the 2 m temperature field, which means more realistic

fields by the eyes, but not a systematic improvement in terms of scores. Useful discussions took place both during the ALADIN/LACE data assimilation (Budapest) and the ALADIN workshop (Prague) about this problem. The outcome is that if the smoothing will be applied in ARPEGE, the ALADIN members do not have to apply it locally for dynamical adaptation. In case of local surface analysis (CANARI), the smoothing should be applied locally too. As the tool for the smoothing is a simple external program it is recommended to port it for local applications for the near future as far as it is not implemented in ARPEGE yet.

Contributors: Stjepan Ivatek-Šahdan (CRO)

Efforts: 1.5 person x months

2.5 Further Actions

- **LACE Data Assimilation Workshop**

  Description: During the year many work have been done on different topics and in different places. It was important to discuss them at some stage and make conclusions together in order to be able to go on in the right direction. A very good occasion to organise a data assimilation workshop was given by the ALATNET constraint to come to Hungary for not only the colleagues from the LACE but from the ALADIN community as well.

  Realization: A 2 and a half day meeting has been organised indeed in Budapest right after the ALATNET seminar in Kiralyrét. Altogether 24 ALADINists attended the workshop. The program was busy which consisted of presentations of scientific works and discussions of past and future work.

  Efforts: app. 1 person x months for organisation

  Contributors: 24 person from different countries.

3 Summary of means in 2003

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

Topic	**Real/Estimated efforts**	**LACE support**
Biperiodic 3d-var increments	1.5/3 p x m	none
Moving to 3d-FGAT	0/3 p x m	none
Study of vertical structure of 3d-var analysis increments	3/1 p x m	1 p x m (stay in Budapest)
Design of an explicit blending	1/2 p x m	none
Variational quality control	1.5/0 p x m	none
Comparison of ”dfi” and ”explicit” blending	2/2 p x m	1 p x m (stay in Prague)
BlendVar cycling experiments	2/2 p x m	1 p x m (stay in Prague)
3d-var cycling experiments to elaborate cold air-pad-cases	2/2 p x m	none
Implementation of ODB	2/2 p x m	1.5 p x m (stays in Budapest)
Assimilation of new observation types: ATOVS data Radar data AMDAR data	 6/3 p x m 1/2 p x m 4/3 p x m	 none none none
Implementation of CANARI/Diag-pack	2/2 p x m	none
Smoothing of Soil Wetness Index	1.5/1 p x m	none
Assimilation of 10m wind data	1.5/1	none
LACE Data Assimilation Training and Workshop	1/1 p x m	? p x m
Total	**32/30 p x m**	**4.5 p x m + DAWS**

Table 1: Means in 2003.