LACE Working Group for Data Assimilation: Report 2006

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15 February, 2007

Contents

1 Introduction

This paper is a summary of the work realized in 2006 within the LACE working group for data assimilation. 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 2006.

2 Progress in research topics

2.1 Methods

- **Situation dependency of ensemble derived background errors**
  Description: With the ensemble method (observation perturbation in the ARPEGE assimilation system), it is possible to compute a background error statistics for a relatively short period if more than 2 members are taken. This can be interesting because like that, in theory, a B matrix for different meteorological situations can be computed (like for anticyclonic / cyclonic / convective / stratus events).
  Realization: Not done.
  Efforts: 0/3 p x m
  Contributors: Gergely Bölöni (HU)
  Documentation: Not available.

- **Tuning of background and observation error variances**
  Description: The tuning of NMC and ensemble based background error variances was planned. The tuning of observation error variances was also considered.
  Realization: The tuning was based on the a posteriori validation method proposed by Gerald Desroziers and Bernard Chapnik. So far a variable dependent vertically uniform tuning of the background error standard deviations has been done.
  Efforts: 2/2 p x m
  Contributors: Gergely Bölöni (HU)
  Documentation: A report is available at the LACE webpage or from Gergely Bölöni.

- **Experiments with 3D-FGAT**
  Description: Experimentations with FGAT have been continued. The

goal was to test the FGAT configuration with different observation inputs and compare with 3DVAR. Also the timing of the update with the analysis increment was corrected.
Realization: A simple program is applied to add the analysis increment at the middle of the assimilation window. Several OSE (Observation System Experiments) were run for using TEMP, SYNOP, satellite, aircraft measurements both with 3DVAR and 3DFGAT. It was also investigated whether it is beneficial or not to use SYNOP measurements from each time-slot of the assimilation window.
Efforts: 3/3 p x m
Contributors: Sándor Kertész (HU)
Documentation: Available in Newsletter 31 and on the LACE webpage.

2.2 Observations

- **EUCOS impact studies**
Description: HMS joined the EUCOS (EUMETNET Composite Observing System) project, which aims to explore the importance of the different elements of the European (ground and space based) observing system. The goal of the project is to get feedbacks and proposals for the future developments of the observing system. Altogether 8 assimilation experiments were defined by EUCOS to be run for one winter and one summer period. Both periods last for one month (+ 10 days warm up cycling) and include interesting weather events.
Realization: The OSEs are finished and are evaluated. The main conclusions are documented in the EUCOS report.
Efforts: 4/4 p x m
Contributors: Roger Randriamampianina (HU) and Geregely Bölöni (HU)
Documentation: The final EUCOS report will be available around mid 2007.

- **Assimilation of MSG/AMV data**
Description: The aim is to examine the impact of these data on the assimilation system.
Realization: The blacklisting of the data was revised and the used thresholds were updated.

Efforts: 3/3 p x m
Contributors: Roger Randriamampianina (HU)
Documentation: A report is available on the LACE webpage or from Roger Randriamampianina.

- **Assimilation of SEVIRI data**
  Description: Meteo-France obtained encouraging results using these data. The aim is to include these observations into the HMS system as well and validate somewhat again the impact.
  Realization: On the way.
  Efforts: 4/4 p x m
  Contributors: Alena Trojaková (CZ), Michal Majek (SK), Roger Randriamampianina (HU)
  Documentation: A report is available on the LACE webpage.

- **Assimilation of ATOVS/HIRS data**
  Description: These data are used operationally in the most of the global models. They are available in high resolution, which helps to have spatially uniform density of observations in the system. However we do know that the impact of these observations is not very strong.
  Realization: Not yet started.
  Efforts: 0/3 p x m
  Contributors: Roger Randriamampianina (HU)
  Documentation: Not available yet.

- **Assimilation of radar data**
  Description: The long term plan to work out a system that assimilates derived profiles from radar reflectivity is continuing.
  Realization: On the way.
  Efforts: 1/2 p x m
  Contributor: Marian Jurasek (SK)
  Documentation: A ppt documentation is available on the website.

- **Assimilation of SYNOP T2m and RH2m (investigation of local SYNOPs)**
  Description: Meteo-France uses T2m and RH2m observations from SYN-

OPs while in Hungary these observations are not yet included in the analysis. The results are encouraging. (The use of these observations is probably recommended together with SEVIRI radiances as they does not let to propagate the 2m analysis increments to the altitude.) Also the investigation of the impact of local national SYNOPs is on the plans. This study could then be used to support the proposal of local national SYNOPs between the LACE countries.
Realization: On the way.
Efforts: 0/3 p x m
Contributor: Alena Trojaková (CZ), Michal Majek (SK), Roger Randriamampianina (HU) Sándor Kertész (HU)
Documentation: Not available yet.

- **Implementation of VARPACK**
  Description: The CANARI DiagPack is to be replaced by VARPACK.
  Realization: VARPACK has been implemented upon cy28 but no serious validation has been done as even DiagPack became obsolete in the forecasting activity at HMS.
  Efforts: 0.25/1 p x m
  Contributor: Gergely Bölöni (HU)
  Documentation: Not available yet.

2.3 Surface

- **CANARI at CHMI**
  Description: No topic related CANARI was included in the 2006 plans in advance but t is important to mention that CANARI surface analysis was implemented operationally at CHMI together with the upper air DFI blending. (3th August)
  Realization: A bug was removed from the CANARI code (phased into cy31t1) and several previous ARPEGE (2004) changes were introduced (changing the ISBA polynoms, remove increment reduction during the night and winter). A parallel suite was then started analyzing T2m and RH2m. The results show improvements in scores for both of these analyzed variables. Also the order of blending and surface analysis was investigated. Better results were obtained if CANARI is run in advance the upper air blending.

Efforts: 1.5/0 p x m
Contributor: Radmila Brožková (CZ), Alena Trojaková (CZ)
Documentation: Not available yet. (A short note exist in the description of the operational ALADIN/CE.)

3 Summary of means in 2006

Topic	**Efforts**	**LACE support**	**Status**
Situation dependency of errors ensemble derived background	0/3 p x m	none	not done
Tuning of background and observation error variances	2/2 p x m	none	finished
Experiments with 3D-FGAT	3/3 p x m	none	finished
EUCOS impact studies	4/4 p x m	none	finished
Assimilation of MSG/AMV data	3/3 p x m	none	finished
Assimilation of SEVIRI data	4/4 p x m	4 p x m	finished
Assimilation of ATOVS/HIRS data	0/3 p x m	none	not done
Assimilation of radar data	2/2 p x m	none	finished
Assimilation of SYNOP T2m and RH2m (investigation of local SYNOPs)	1/3 p x m	none	on the way
Implementation of VARPACK	0.25/1 p x m	none	obsolete at HMS
CANARI at CHMI	1.5/0 p x m	none	finished
Total	**19/28 p x m**	**4 p x m**	

Table 1: Means in 2006

Workshop	**Participants**	**LACE support**
HIRLAM 4DVAR training	Filip Vana Gergely Bölöni	1 p x m
ALADIN 3DVAR and ODB training	Alena Trojaková	None
Total		**1 p x m**

Table 2: Data assimilation workshops in 2006

4 Presentation of the results

This section gives a bit more detailed explanation of the results obtained in the different topics. Possibly we give also a graphical presentation of the conclusions. The figures can be found at the end of the document.

- **Situation dependency of ensemble derived background errors**
  No results.

- **Tuning of background and observation error variances**
  The aim of this work is to make a posteriori diagnostics of the analysis system and to derive some guidelines for tuning it. Background and observation error variances can be considered as tunable free parameters of the analysis system. This work was done using the a posteriori diagnosis proposed by Desroziers et al. (2005), which consist of observations minus guess and observations minus analysis statistics. These diagnostics were done using both standard NMC and ensemble B statistics but for the tuning we were concentrating on the background error variances of ensemble statistics uniquely. According to the diagnostics the background error variances are underestimated in our ensemble B matrix (not shown) so the tuning aimed to increase them. So far two kind of tunings were tried:

  - Uniform tuning (for all variables and vertical levels together) by a factor of 1.36. (ENS1 on the verification plots)
  - Variable dependent tuning (for all vertical levels together) by the following factors: 1.33 for wind/mass, 1.43 for temperature, 2.35 for humidity (ENS2 on the verification plots)

  Strangely so far the first (simpler) tuning gave better results (the reason is not yet understood). It can be demonstrated by comparing Fig.1 and 2 where where the impact of both tunings is shown for humidity compared to the untuned ensemble statistics (ENS0). The ensemble statistics with the simpler tuning gave also better results in the PBL than the presently operational NMC statistics (Fig. 3). As a next step a height dependent tuning is planned for both the observation and background error variances.

- **Experiments with 3D-FGAT**
  Several experimentations have been done since the end of 2005. First the 3D-FGAT system was implemented and validated through comparisons with 3DVAR (single observation experiments). As a second step the

FGAT scheme was modified in order to add the analysis increment to the trajectory at the middle of the observation window. This males possible a fair comparison with 3DVAR. Several OSE experiments were done for comparison of 3DVAR and 3D-FGAT. These were differing in the observation usage especially the length of the observation window (aircraft and SYNOP observations) and the used parameters (from SYNOP data). Hereby we list the most important conclusions of these experiments:

  - Concerning the temporal distribution of the observations available at HMS, the two systems (3DVAR and 3D-FGAT) could differ only in the usage of AMDAR (aircraft) and satellite radiance (ATOVS AMSU-A and AMSU-B) data.
  - The 3D-FGAT analysis is more advanced in the handling of the data mentioned above if the same observation window lengths are used (+/- 3h in both 3DVAR and 3D-FGAT). This is reflected by the scores shown on Figs. 4 to 7.
  - If the time window for aircrafts is reduced to +/- 1 h in 3DVAR the results of 3DVAR and 3D-FGAT become closer to each other. It implies also that 3DVAR is better when using a +/- 1 hour observation window for aircrafts instead of a +/- 3 hour window.
  - The usage of SYNOPs in all the available time-slots in 3D-FGAT does not improve the forecast.

- **EUCOS impact studies**
  The conclusions of the EUCOS studies are summarized in Tables 3 and 4 (end of the document) where the positive impact of the different observation types are showed in the function of forecast range. As the results are slightly different for the winter and summer periods they are shown separately. A very detailed report will be available after the approval of EUCOS for distribution.

- **Assimilation of MSG/AMV data**
  A slight positive impact was found using the AMV (GEOWIND) data The following impact studies were done with the AMV (GEOWIND) data:

  - No use over land with quality index bigger than 85% (WDEF)
  - No use over land with quality index bigger than 80% (W80P)
  - Use over land with quality index bigger than 85% (WLAN)

The data are used over the see in all the above experiments and in any case (over land or sea) they are used only between 350 and 800 hPa. The reference run was the present operational setting using SYNOP, TEMP, AMDAR, AMSU-A and B data (NAM2). A slight positive impact was found using the AMV (GEOWIND) data compared to the reference (Figs. 8 to 11). The additional data used over land implied a neutral impact on the analysis and forecast.

- **Assimilation of SEVIRI data**

  The work on SEVIRI assimilation started with a set of technical developments:

  - local preparation of the data (quite tough)
  - bias correction for the SEVIRI data
  - single observation experiment

  As a result the SEVIRI data are ready for an operational use at HMS from a technical point of view. As a second step impact studies have been done too. With the first setting these studies reflect a mixed impact of the SEVIRI data with similar magnitude to those of high resolution AMSU-A and AMSU-B. Note that a technical bug was also found in these experiments, namely a large part of the radiosonde data were excluded by blacklisting by mistake (of the HMS colleagues). A detailed report is available about this work. At the beginning of 2007 the impact study experiments have been continued and the newest results are under evaluation. No graphical presentation yet.

- **Assimilation of ATOVS/HIRS data**

  No results.

- **Assimilation of radar data**

  The development of the radar assimilation is focused on the screening. The standard screening quality control rejects too many observations and destroys the reflectivity profiles. As a consequence additional decisions are developed in screening which allows to keep more complete reflectivity profiles. As a result about 5-10% more observations are kept as active by screening. Another problem is that the memory limits are reached on VPP using data from 4 radars. This implies the need of a thinning of the data before converting to ODB.

- **Assimilation of SYNOP T2m and RH2m (investigation of local SYNOPs)**
  Sandor Kertész has explored the amount of non-GTS SYNOP measurements in the LACE region and it was decided that assimilation experiments will be run to see the impact of these additional data. The experiments are on the way. No graphical presentation so far.

- **Implementation of VARPACK**
  The VARPACK tool was implemented at HMS upon cy28t3 as a demonstration tool during the ALADIN 3DVAR training. It was not yet deeply validated as there is no actual need for ALADIN based nowcasting analysis at HMS (The presently used nowcasting system is based on MM5). No graphical presentation.

- **CANARI at CHMI**
  The CANARI surface analysis was implemented together with upper air blending. This change brought improvement in the 2m fields (Fig. 12) compared to the previously used surface blending. As a consequence CANARI was implemented operationally as well.

5 Figures

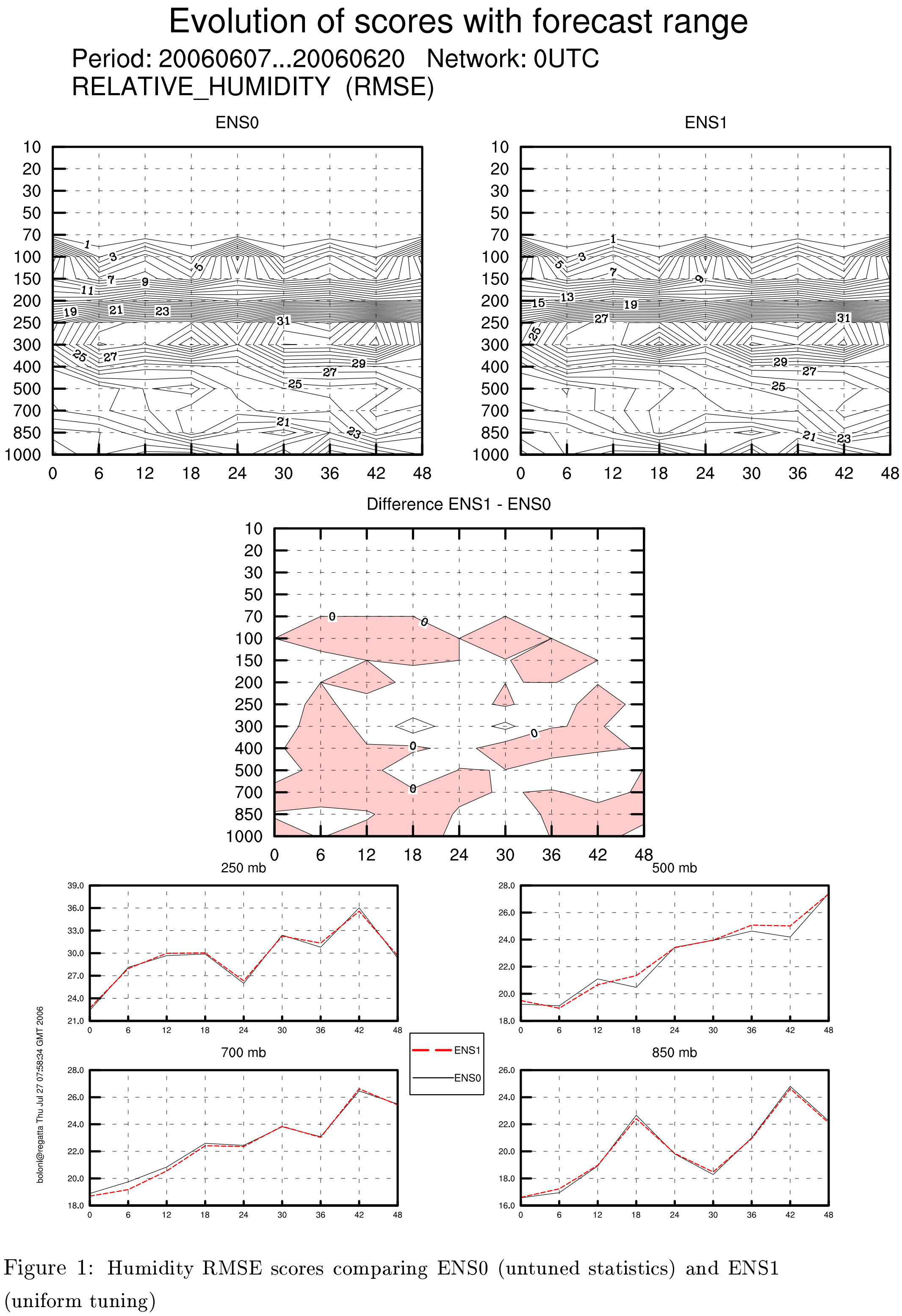

Figure 1: Humidity RMSE scores comparing ENS0 (untuned statistics) and ENS1 (uniform tuning)

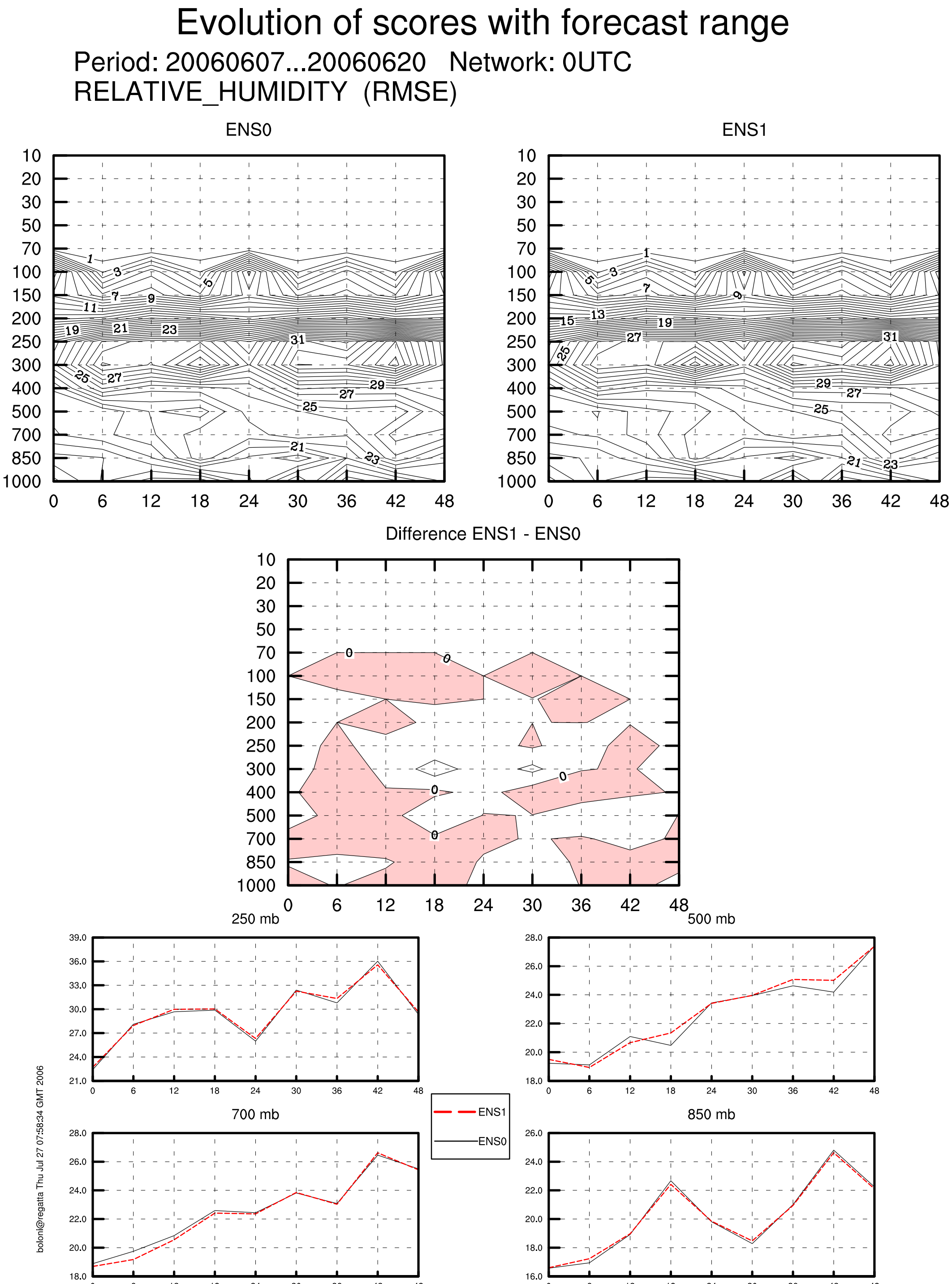

Figure 2: Humidity RMSE scores comparing ENS0 (untuned statistics) and ENS1 (variable dependent tuning)

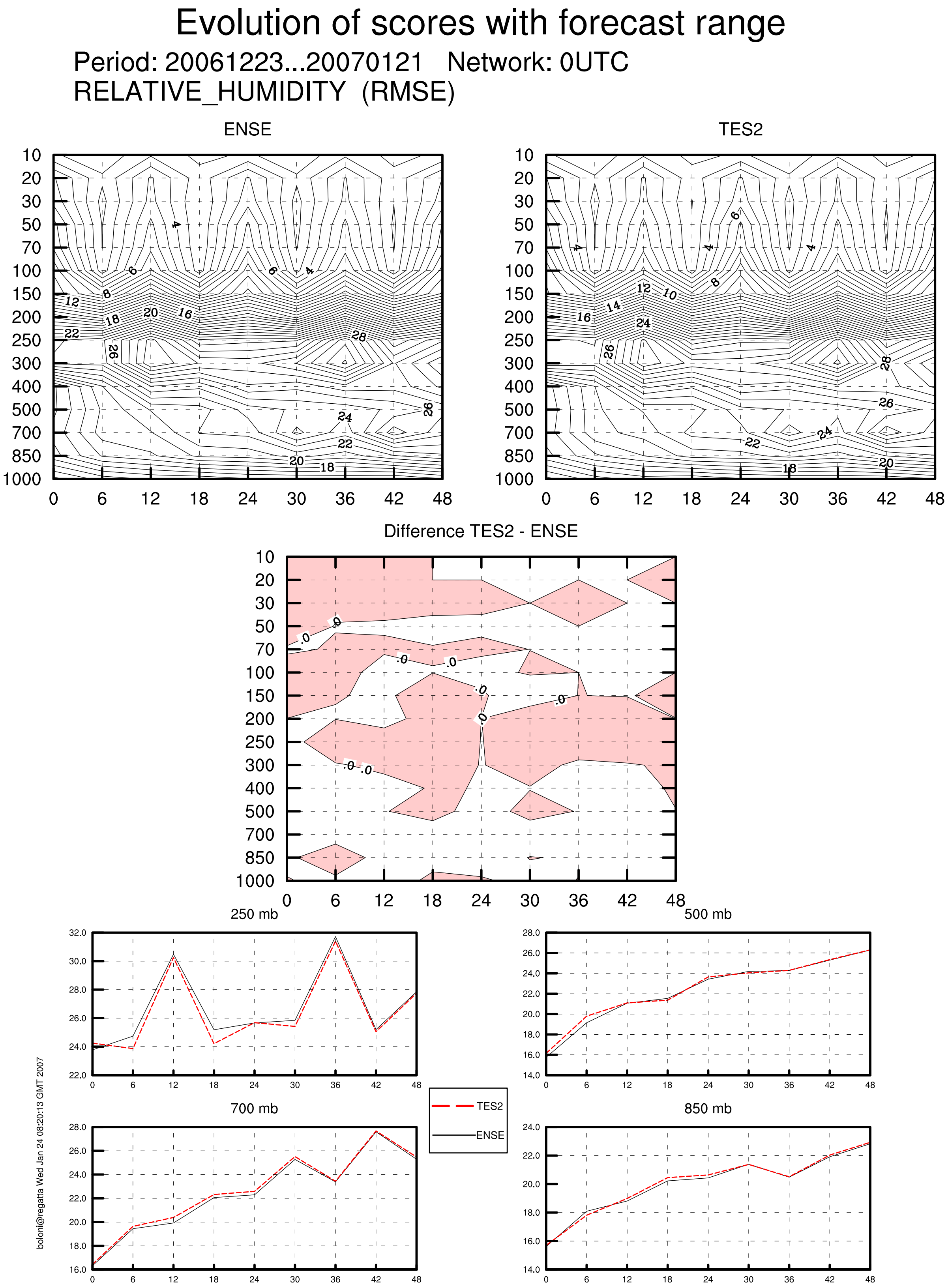

Figure 3: Humidity RMSE scores comparing the impact of ENSE (ensemble statistics with the simpler tuning) and TES2 (the presently operative NMC statistics).

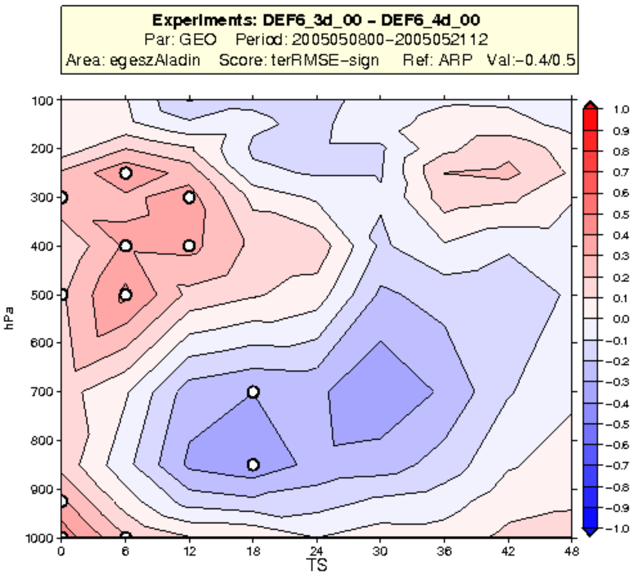

Figure 4: Impact of the FGAT scheme showing RMSE difference of geopotential. Positive values (red) indicate positive impact, negative values (blue) negative impact of FGAT.

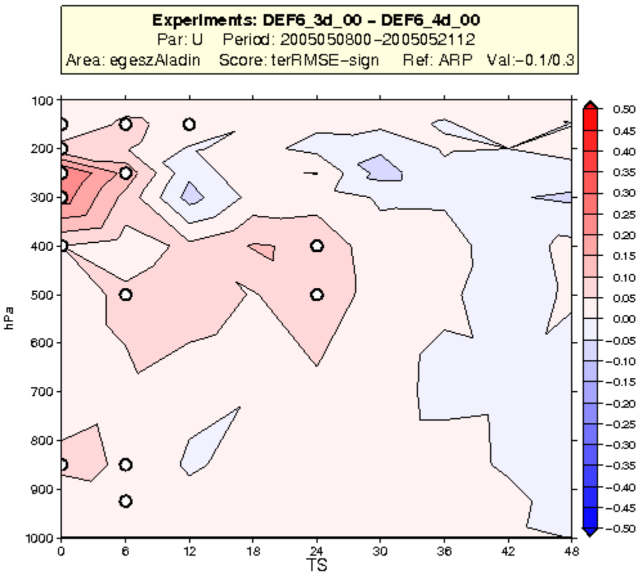

Figure 5: Impact of the FGAT scheme showing RMSE difference of wind (U). Positive values (red) indicate positive impact, negative values (blue) negative impact of FGAT.

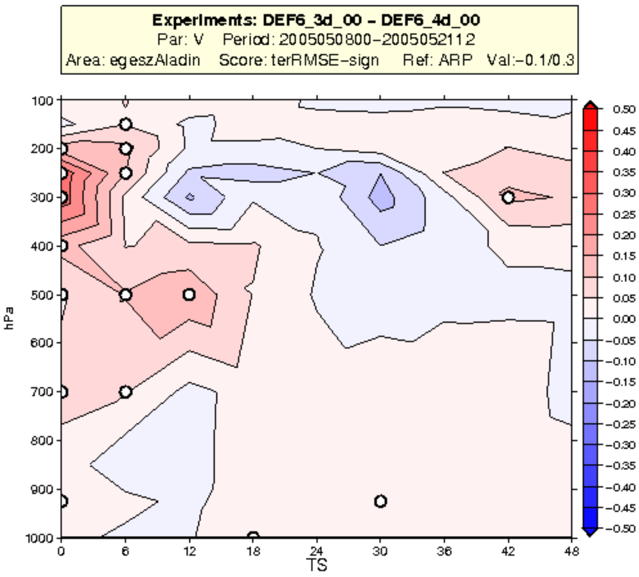

Figure 6: Impact of the FGAT scheme showing RMSE difference of wind (V). Positive values (red) indicate positive impact, negative values (blue) negative impact of FGAT.

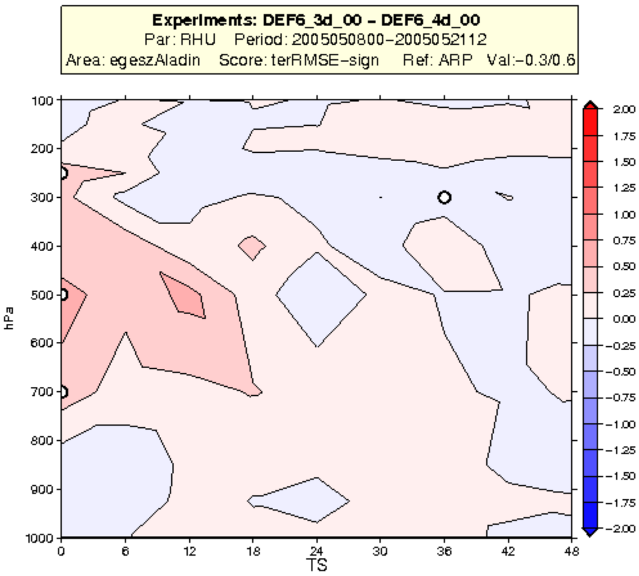

Figure 7: Impact of the FGAT scheme showing RMSE difference of humidity. Positive values (red) indicate positive impact, negative values (blue) negative impact of FGAT.

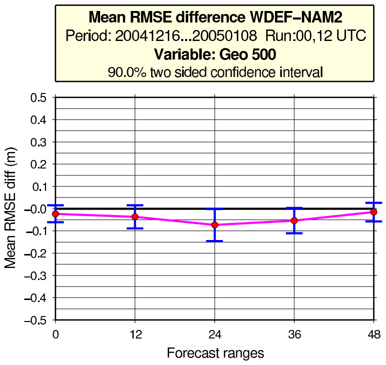

Figure 8: Significance of RMSE differences between the reference (NAM2) and the WDEF experiments for geopotential. RMSE is computed against Arpege analysis. A positive impact should be understood if the curve is under the zero line.

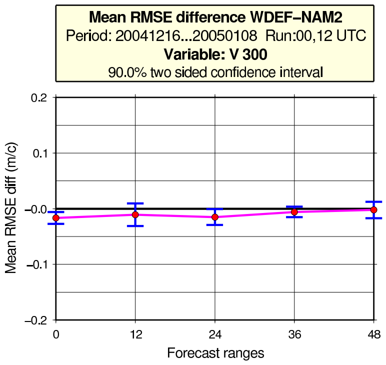

Figure 9: Significance of RMSE differences between the reference (NAM2) and the WDEF experiments for wind. RMSE is computed against Arpege analysis. A positive impact should be understood if the curve is under the zero line.

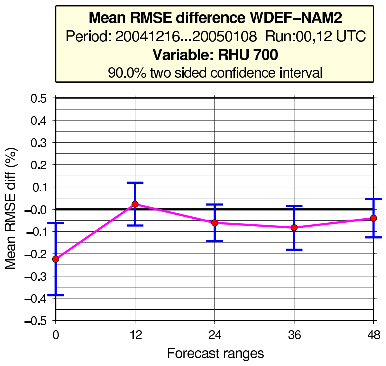

Figure 10: Significance of RMSE differences between the reference (NAM2) and the WDEF experiments for humidity. RMSE is computed against Arpege analysis. A positive impact should be understood if the curve is under the zero line.

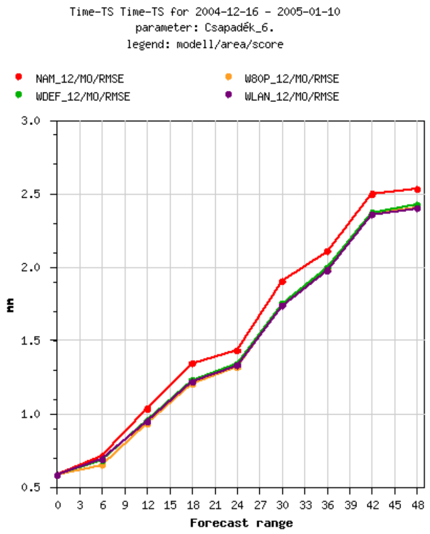

Figure 11: Precipitation RMSE scores computed for the Charpatian Basin for all the 4 experiments NAM2, WDEF, W80P, WLAN

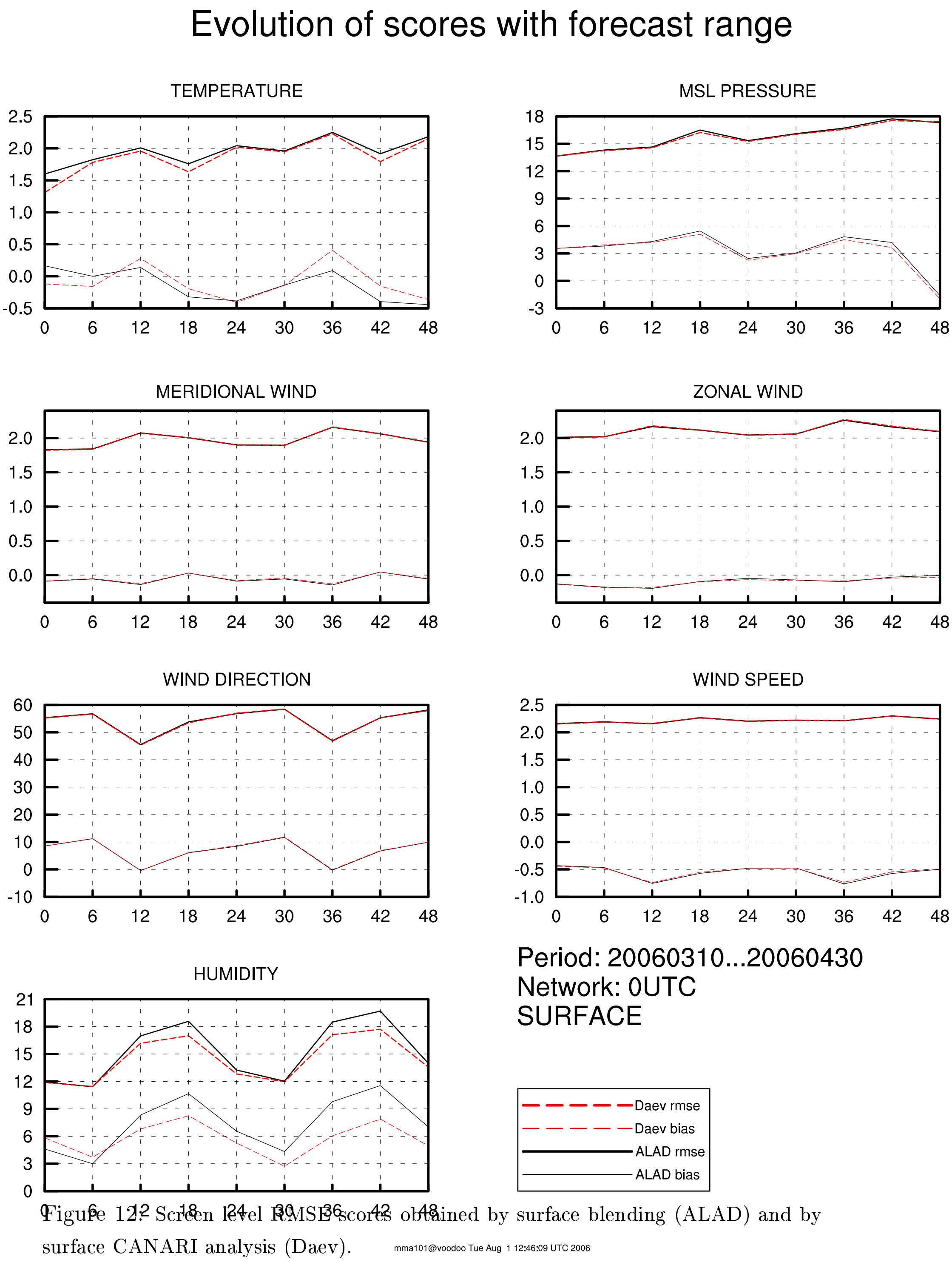

Figure 12: Screen level RMSE scores obtained by surface blending (ALAD) and by surface CANARI analysis (Daev).

6 Tables

Observation	few hours	1/2 day	1 day	1.5 day	2 day
Radiosonde wind	+	+			
Radiosonde temperature	+	+	+		
Radiosonde humidity	+	+	+	+	+
Aircraft wind and temperature	+	+			
Wind-profiler	+				

Table 3: Impact of the observations in the function of forecast range: winter period

Observation	few hours	1/2 day	1 day	1.5 day	2 day
Radiosonde wind	+	+	+	+	
Radiosonde temperature	+	+	+	+	+
Radiosonde humidity	+	+	+	+	
Aircraft wind and temperature	+	+	+	+	+
Wind-profiler	+	+			

Table 4: Impact of the observations in the function of forecast range: summer period