Investigation of the use of non-GTS SYNOP reports in the ALADIN/HU 3D-VAR system

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1. Preface

The main purpose of this study was the investigation of the possible use of local SYNOP reports available only at LACE members (i.e. non-GTS SYNOP reports) in the ALADIN/HU 3D-VAR data assimilation system. For the experiments a 10-day period was chosen for which all the available local SYNOP observations were provided by LACE members. In order to see the impact of these data two sets of experiments were performed: one with the non-GTS SYNOP data and another one without them.

2. Non-GTS SYNOP observations

In this study the term of non-GTS is used with respect to the data available at HMS. So all the observations that are not available operationally in the recent ALADIN/HU 3D-VAR system at HMS were regarded as non-GTS type. A former study (Kertész, 2006) revealed that there are significant number of non-GTS SYNOP observations at LACE members: the largest number of non-GTS SYNOP data is available in Austria and the Czech Republic, a smaller number of non-GTS data is available in Croatia and Slovakia, and there are no local SYNOP observation in Slovenia (so all the data is available via the GTS).

3. Description of the experiments

The experiments were carried out for the period of 10-20 May, 2005 with the ALADIN CY28T3 model version using an 8 km horizontal resolution with 49 vertical levels (up to 5 hPa). The integration domain is shown in Figure 1. In each experiment a 6 hour assimilation cycle with a ±3 hour observation window was used and two 48 hour model integrations were performed at 00 and 12 UTC. The B-matrix statistics were derived by the standard NMC method.

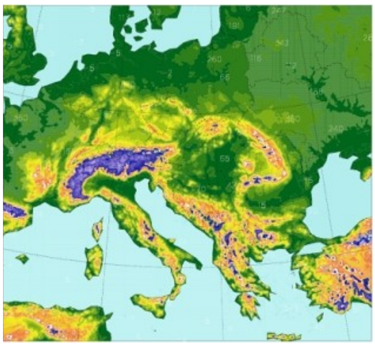

Figure 1: The integration domain and orography of the ALADIN/HU model

An important feature of the recent data assimilation system at HMS that it does not perform a surface analysis (there is no CANARI run). Instead, the surface fields from the ARPEGE analysis are copied into the ALADIN background. Nevertheless, SYNOP observations such as Z, T2 and RHU2 are (can be) still used in 3D-VAR but it provides analysis only for the upper-air fields.

Altogether four experiments were carried out in the study. In the experiments not only the impact of the non-GTS SYNOP data was investigated but the possible choice of the SYNOP parameters was tested, as well. The experiments are summarized in Table 1.

Experiment	*Used SYNOP parameters*	*non-GTS SYNOP data*
DEF	Z	not used
NG_DEF	Z	used
TRH	Z, T2, RHU2	not used
NG_TRH	Z, T2, RHU2	used

Table 1: The description of the experiments

Beside the SYNOP observations all the other observation types available at HMS were used in the experiments : AIREP, AMV winds (from MSG), TEMP, Wind profiler observations and NOAA AMSU-A and AMSU-B sensors (see Table 2) .

Observations	*Parameters*	*Temporal usage*
SYNOP (land)	Z, (T2, RHU2)	one report per station
AIREP	U, V ,T (thinning: 25 km)	±1h observation window
AMV	U, V (thinning: 25 km)	reports 15 min. before the analysis time
TEMP	T, U, V, Q, Z	one report per station
Wind profiler	U, V	one report per station
AMSU A,B	T_b (thinning: 80 km)	all the reports in the observation window

Table 2: The list of the observations used in the experiments

4. Results

4.1 Observation distribution

The typical distribution of the SYNOP observations in Central Europe is shown in Figure 2. It can be seen that the most non-GTS SYNOP reports are available in Austria and significantly less data can be found in Croatia, in the Czech Republic and Slovakia. In the case of the Czech Republic the available number of non-GTS data is much less than it was expected from a former study (Kertész, 2006).

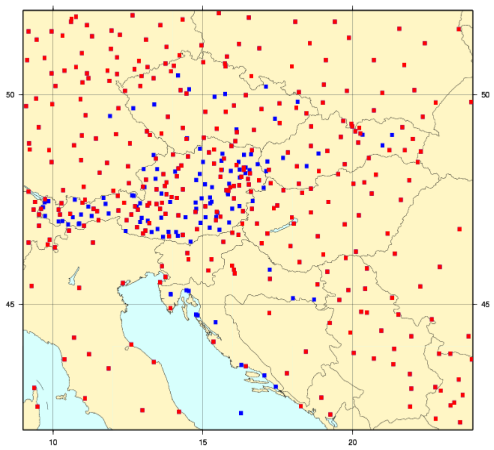

Figure 2: The distribution of the active SYNOP reports on 8 May, 2005 at 00 UTC. The blue squares denote the additional non-GTS SYNOP reports on top of the GTS ones (red squares).

The total number of active SYNOP reports was 34030 in the GTS experiments and 39020 in the non-GTS experiments. It means that on average there were 116 (by 15%) more SYNOP reports used in the non-GTS experiments.

4.2 Verification of the default experiments

The verification of the surface parameters exhibited extremely small differences between experiment **DEF** and **NG_DEF** on the whole forecast domain. Observable difference was obtained only when the verification area was reduced to smaller Central European domains. As an example the scores for T 2m for the Carpathian Basin are shown in Figure 2. It can be seen in this figure that the impact of non-GTS SYNOP reports is rather neutral.

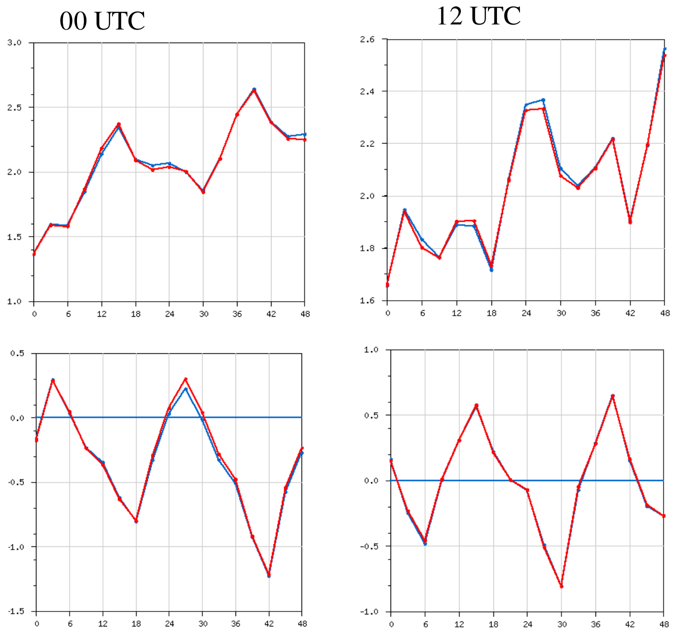

Figure 3: RMSE (upper row) and bias (lower row) scores for the T 2m forecasts of experiments DEF (red curve) and NG_DEF (blue curve). The verification was performed against (GTS) SYNOP observations in the Carpathian Basin. The first column represents the 00 UTC results while the second one the 12 UTC ones.

For other surface parameters (RHU 2m, MSLP, wind 10m) the results were similar. The subjective evaluation of the forecast fields (visual comparison) showed little difference as well.

The verification of the upper air fields yielded similar results as in the case of surface parameters. Figure 4 shows the difference of the upper air RMSE scores of the two experiments for the 00 UTC runs. It can be seen that there is hardly any difference between the experiments regardless of the examined parameters.

5. Verification of the experiments using T 2m and RHU 2m

The verification exhibited the same extremely small differences between experiment **TRH** and **NG_TRH** as in the case of the default experiments. Again, neutral results were obtained both for the surface parameters and the upper air ones. Here only the RMSE scores of the upper air parameters for 00 UTC runs is shown (Figure 5) for the comparison with the default case (Figure 4). It can be seen that the difference for Z and RHU is a little bit larger but these RMSE differences are still extremely small: 0.2 m for Z and 0.3 % for RHU.

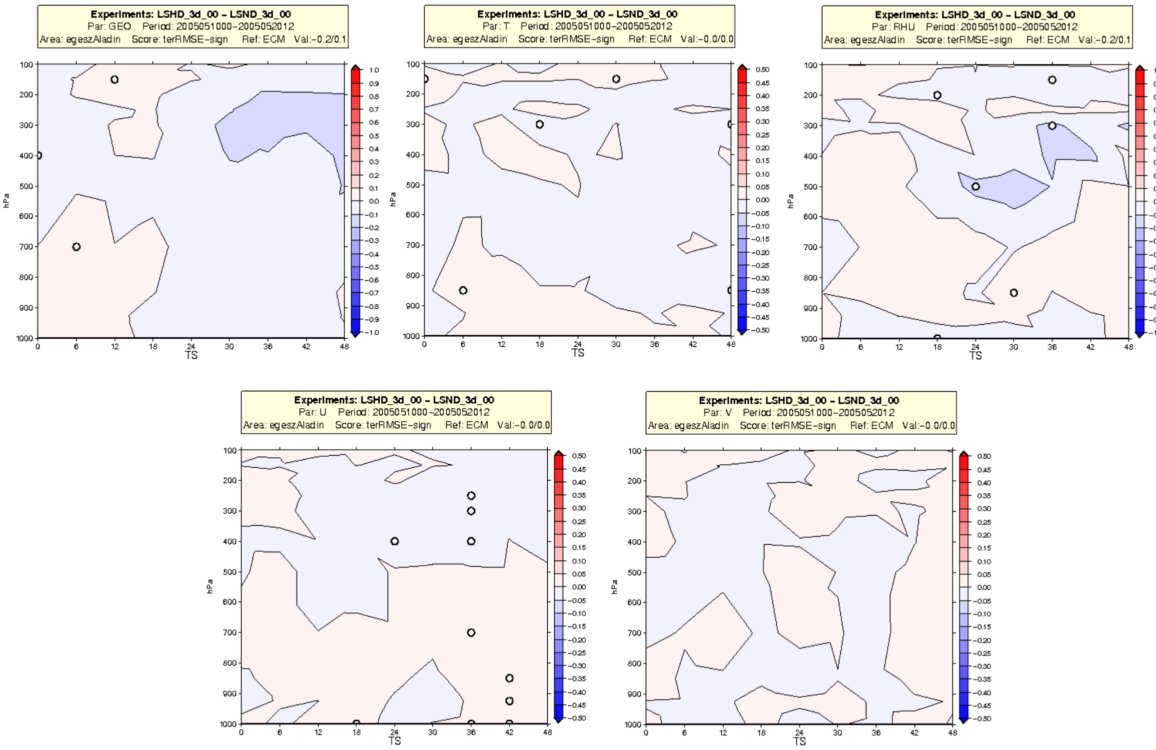

Figure 4: Difference of RMSE scores of the 00 UTC forecasts of DEF and NG_DEF. Red shades indicate that NG_DEF is better, while blue shades indicate the opposite. White circles show that the difference is significant on a 90% confidence level. The verification was performed against ECMWF analyses. The figure order is the following (from left to right): Z, T, RHU, U and V.

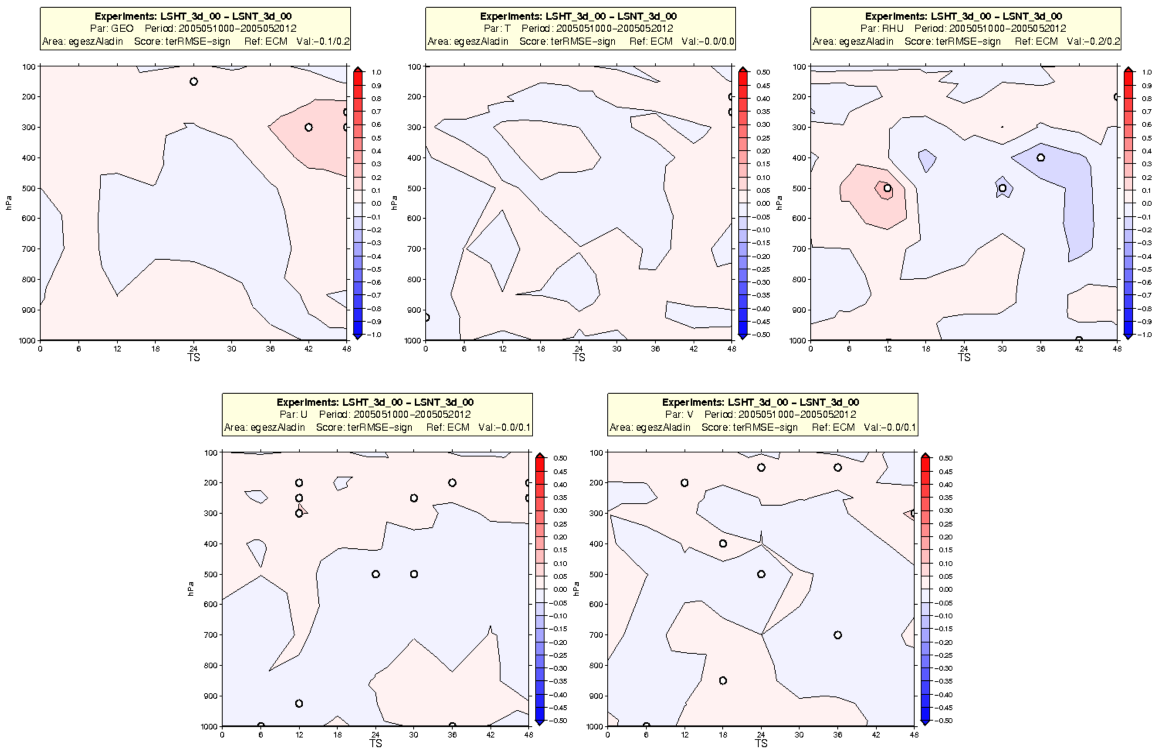

Figure 5: Difference of RMSE scores of the 00 UTC forecasts of TRH and NG_TRH. Red shades indicate that NG_TRH is better, while blue shades indicate the opposite. White circles show that the difference is significant on a 90% confidence level. The verification was performed against ECMWF analyses. The figure order is the following (from left to right): Z, T, RHU, U and V.

5. Conclusions

The main conclusion of this study is that the usage of the additional non-GTS SYNOP observations in the ALADIN/HU 3D-VAR system cannot improve the analysis/forecast quality. The results are mainly neutral regardless of the assimilated SYNOP parameters (Z, T 2m and RHU 2m were used). The possible reason can be that the applied system does not perform a surface analysis so the usage of the SYNOP observations cannot be regarded as optimal. The improvement of this feature can be be achieved by completing the data assimilation system with the CANARI surface assimilation. Another reason for the neutral impact can be that the distribution of the additional observations is not optimal either: they are available in regions where the observation density is originally high. Thus, they cannot give significant spatial information to the system (at least on the applied resolution). So presumably with higher model resolution their effect would be more significant.

6. References

[1] Kertész S., 2006: Status document on non-GTS SYNOP reports available at RC-LACE members. Available online at: http://www.rclace.eu in the Documents -> Local Documents menu

7. Acknowledgements

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