Report on experiments with CANARI surface assimilation in ALADIN/SHMU system

M. Derkova, M. Bellus

March 2012

Introduction

The surface data assimilation using CANARI is being tested in ALADIN/SHMU system. Generally positive impact has been found in the analysis and subsequent forecasts, mainly in terms of the scores of 2m temperature and relative humidity. However, there is evident problem with the forecast scores during day time in summer (namely for those parameters).

Setup of experiment

Reference system is current operational version of ALADIN/SHMU (36t1.bf10) using blending by DFI pseudo-assimilation for upper air parameters. There is a simple copy of ARPEGE analysis for surface fields (no surface blending). No initialization is applied prior the forecast. Parameters of ALADIN/SHMU are summarized in Table 1.

ALADIN/SHMU	**ALADIN/SHMU**
horizontal resolution	9.0km
spectral truncation	106 x 95
blending spectral truncation	53 x 48
number of grid points	320 x 288
vertical levels	37
operational time step	400s
coupling frequency	3h
forecast length	72h (60h at 18UTC)
model version	36_t1.10 (ALARO+3MT)
assimilation frequency	6h

In the experimental version the surface initial state is obtained from CANARI analysis. CANARI is using SYNOP data only (combination of OPLACE and local SYNOP database). Due to technical reasons the short cut-off data were used. Off-line tests showed that there was no significant difference observed when using late cut-off data (there were only few more SYNOPs available with negligible impact on the analysis). 2m temperature and 2m relative humidity are analyzed, using 2m T and 2m RH measurements.

The surface analysis is applied on 6h guess, which is ALADIN forecast initialized by DFI blending. CANARI step is preceded by a copy of SST (sea surface temperature) field from ARPEGE analysis into INIT file. After surface analysis there was no further initialization (DFI) used prior the forecast (nor in the assimilation cycling nor in the production forecast).

The parallel suite has started on 01/08/2011. Results for 6 months (till 30/01/2012) are presented.

Results

Generally there was positive impact found on the analysis and subsequent forecasts; on the surface and also in lower levels; namely for temperature and humidity. The impact is more pronounced in summer period.

The BIAS scores of analysis for 2m temperature and 2m relative humidity, for 00UTC network time, are shown on figure 1. The reference operational suite is in solid black (OPar), the experimental CANARI surface analysis in dashed red (SSST).

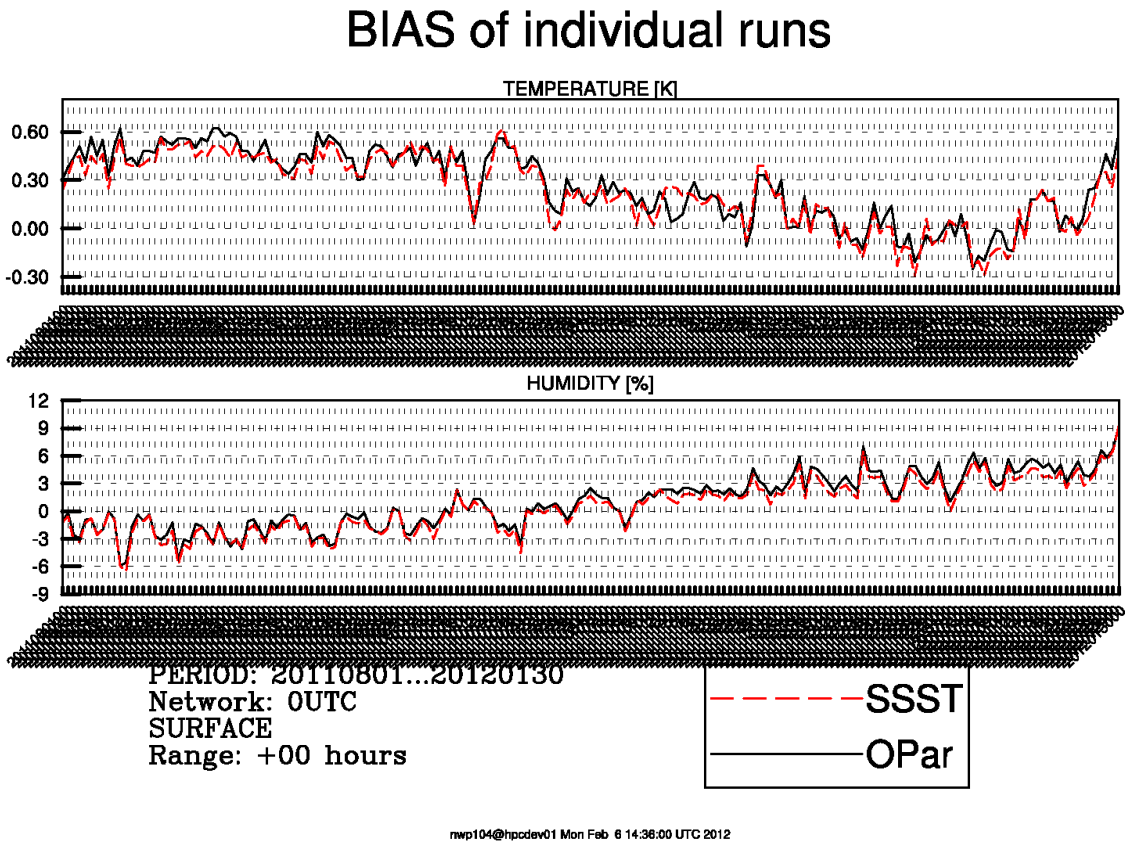
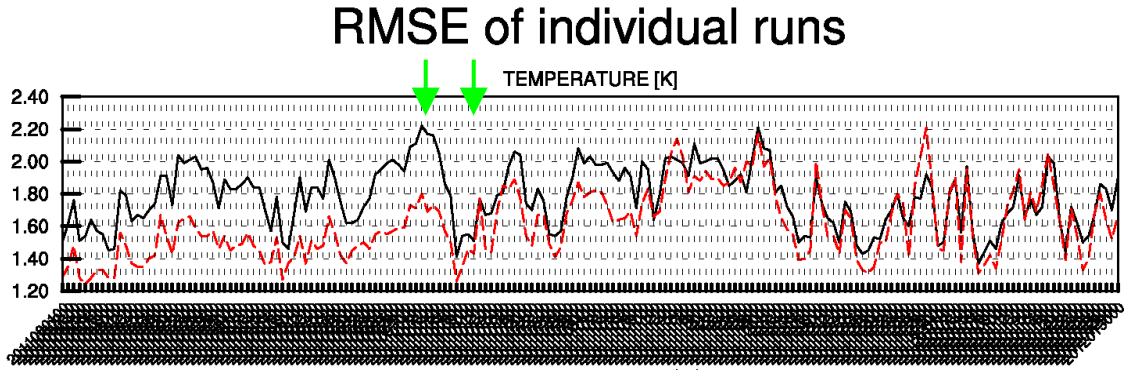


Figure 1: BIAS of 2mT and 2mRH analysis, 00UTC

The same as previous figure, but for RMSE:



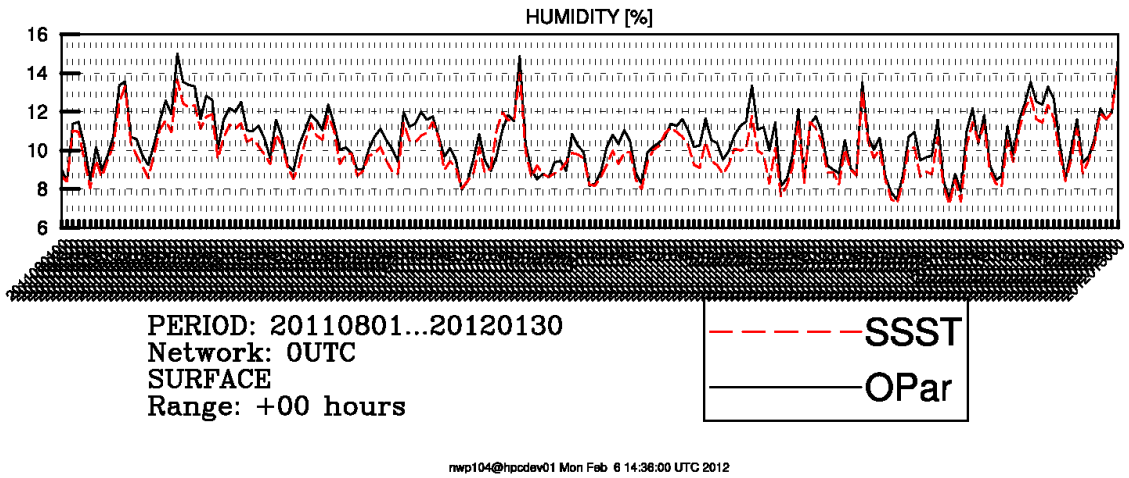


Figure 2: RMSE of 2mT and 2mRH analysis, 00UTC

The same analysis scores but for 12UTC network time are displayed on figure 3:

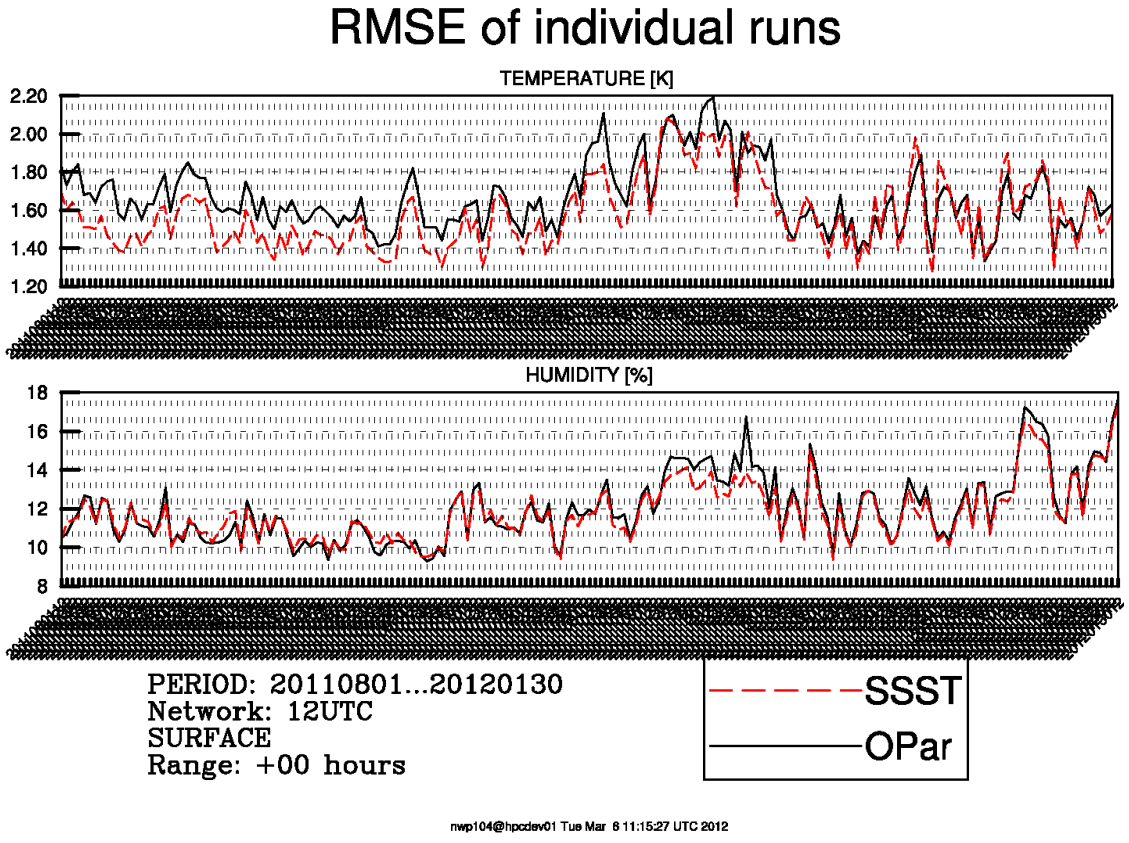


Figure 3: RMSE of 2mT and 2mRH, analysis, 12UTC

The improvement is pronounced for whole forecast length: RMSE scores of the 72h forecast of 2mT are shown on figure 4.

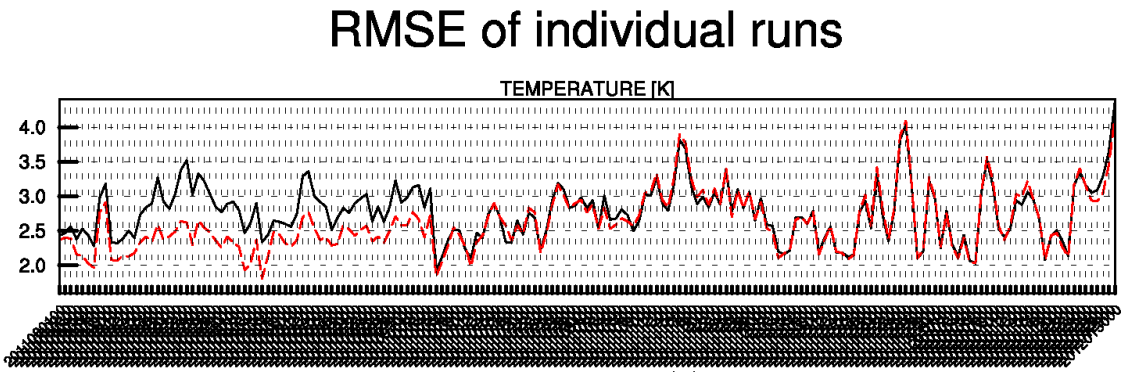


Figure 4: RMSE of 2mT, +72h forecasts starting from 00UTC

Improvements also spread for higher levels: RMSE scores of the 12h forecast of temperature at 1000hPa are shown on figure 5.

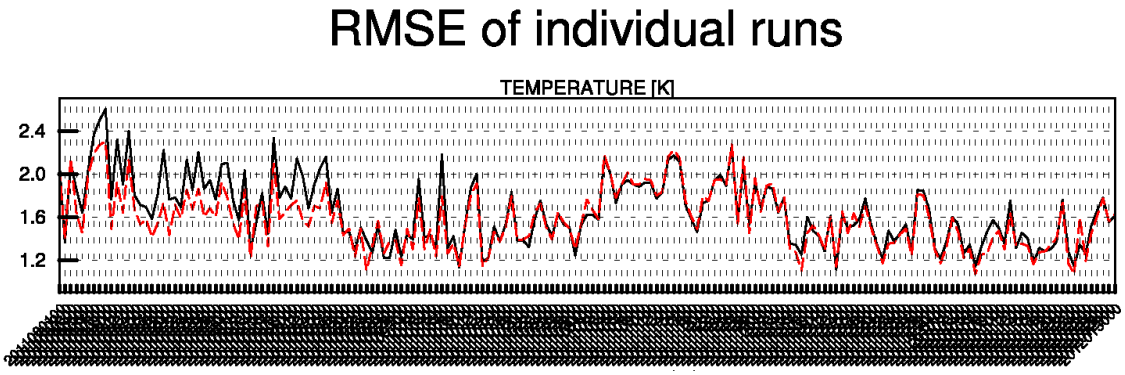
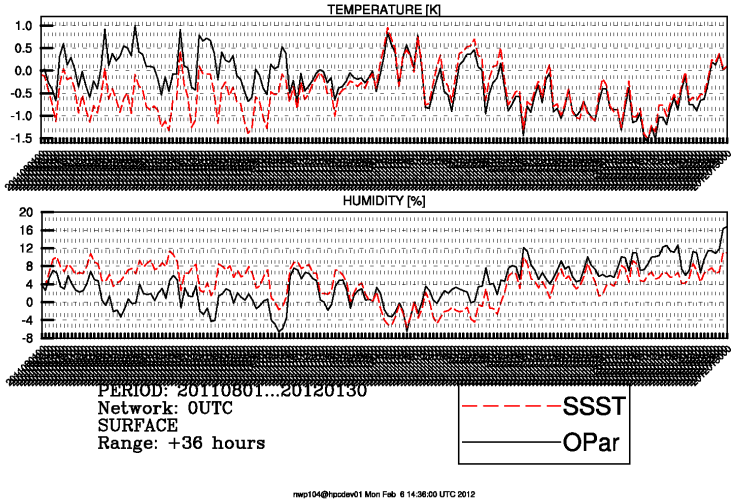


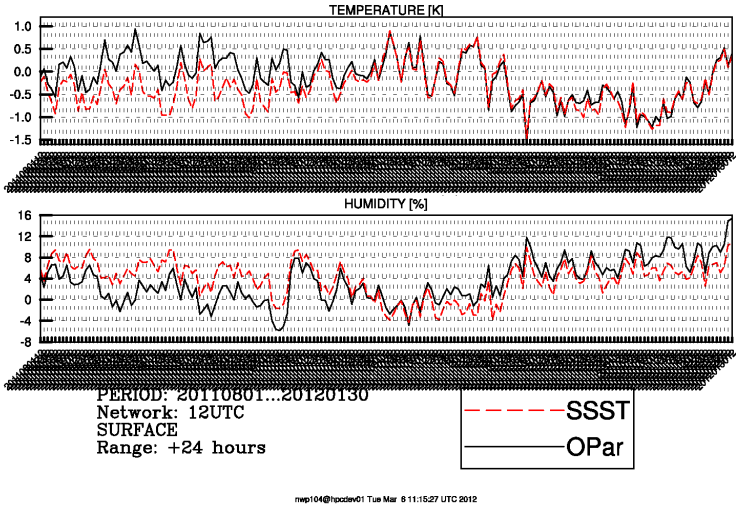
Figure 5: RMSE of 12h forecast of temperature at 1000hPa

However, worsening of the daytime scores in the summer was observed. As shown on figures above, experimental CANARI analyses and forecasts are generally better than the operational ones. But there is obvious problem in the forecasts for 12 and 18h day time, for any starting analysis time and any forecast length. As an example the 2m scores of temperature and relative humidity of 36h forecast starting from 00UTC analysis are shown (next page, on the left) together with +24h forecast starting from 12UTC analyses (right). I.e. both forecasts are valid at the same time. Here one can see that especially during the summer the forecasts based on CANARI analyses are worse than the reference run. There is negative BIAS of 2mT, and the RMSE both for 2mT and 2mRH are generally worse compared to operational runs. Nothing significant was noticed on the scores of other parameters.
The same behavior was observed for other forecast lengths (starting from analyses of any NT) at the day time (not shown).

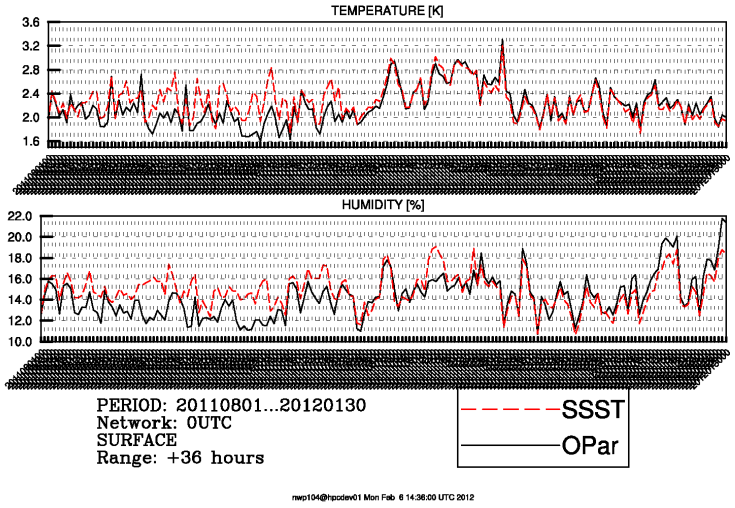
BIAS of individual runs



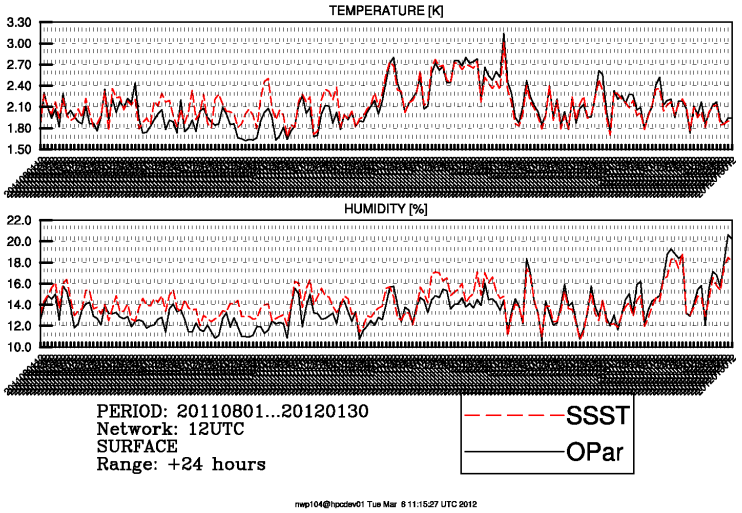
BIAS of individual runs



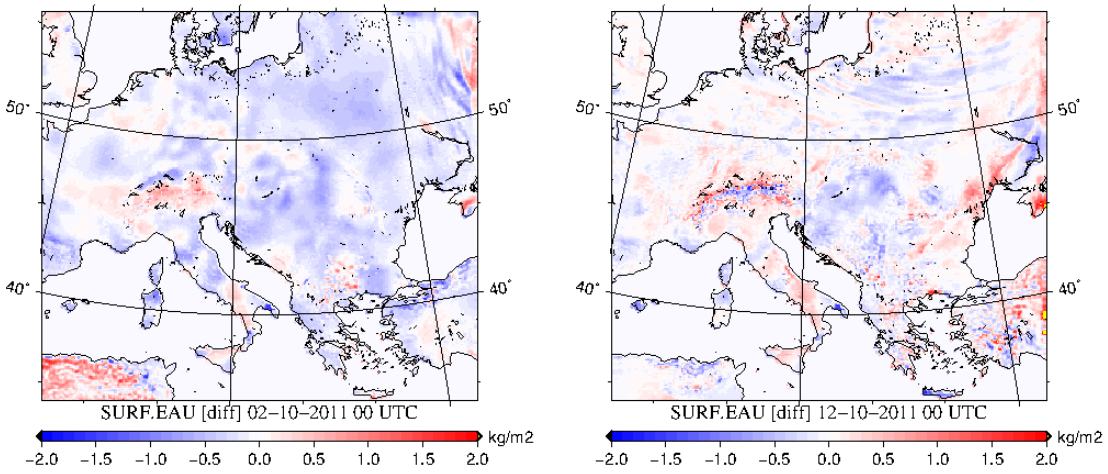
RMSE of individual runs



RMSE of individual runs



This problem seems to be related to surface humidity, but needs further investigation. One can compare the difference of surface soil wetness in analyses between operational and parallel run for two dates marked on Figure 2. The left picture is for 02/10/2011, where the score difference was big; the difference of the surface soil wetness is also big. The right picture is for 12/10/2011, the differences are not so obviously “biased”.



In winter the problem of daytime scores disappears, but the overall impact of surface assimilation is much smaller in this period.

Checking the scores evolution over the forecast lengths it was found that there is a negative temperature BIAS in general for whole integration period near surface (figure 6). From figures 7 and 8 one sees that the temperature BIAS is negative mainly in winter season, but the fact, that it is generally worse for forecasts based on CANARI analyses comes from the warmer part of the testing period.

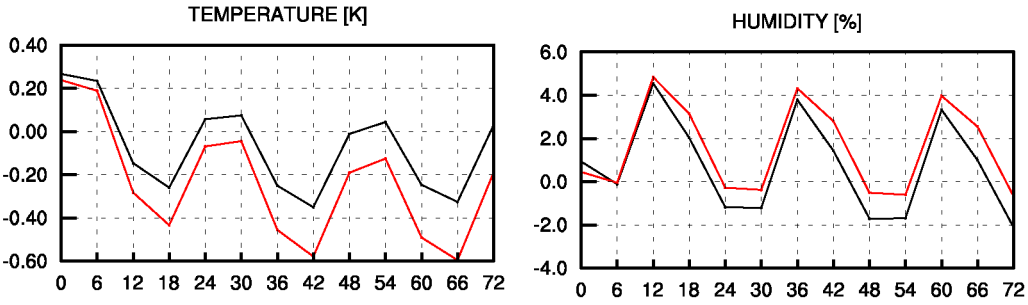


Figure 6: BIAS of 2m temperature (left) and 2m relative humidity for the period 01/08/2011-30/01/2012, forecasts starting from 00UTC. Operational reference run in black, CANARI in red

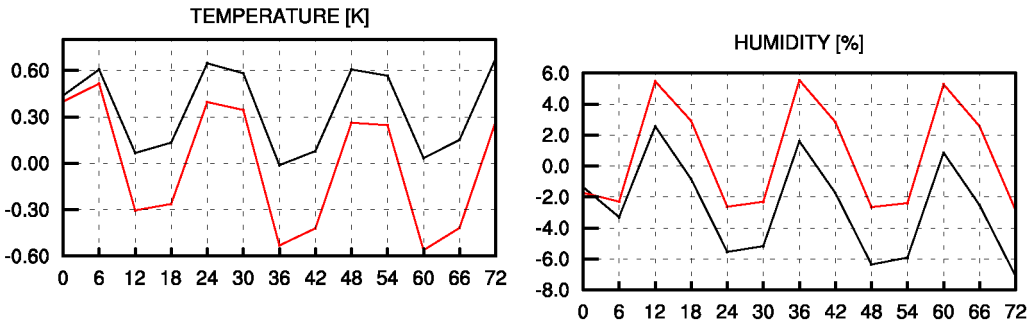


Figure 7: The same as the previous figure, but for period 01/08/2011-31/10/2011

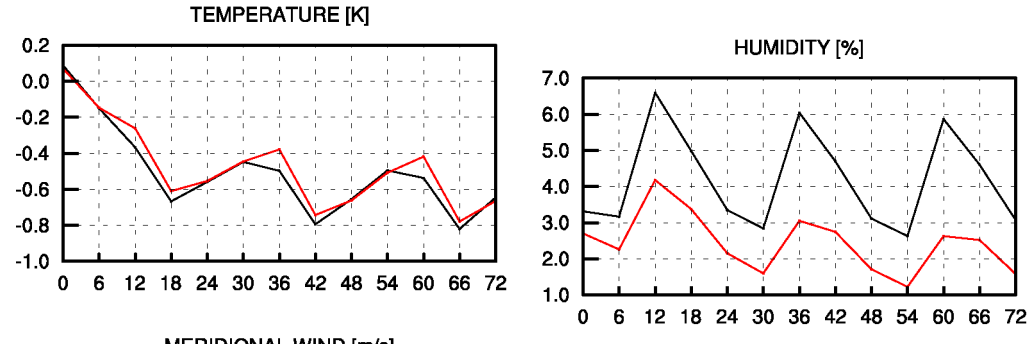


Figure 8: The same as the previous figure, but for period 01/11/2011-30/01/2012

For RMSE, an interesting feature (connected with the phenomenon described above) was observed in diurnal cycle, where CANARI-based forecast (in red) is better than the operational one (black) in all ranges except the noon ones. This is illustrated on 2mT and 2mRH scores for analyses starting from 00UTC, again for whole half year period (figure 9), summer-autumn 3months (figure 10) and winter 3months (figure 11). Then those scores for whole half year period for forecasts starting from 12UTC analyses are displayed on figure 12 (so the “switch” appears at +24, +48 and +72h corresponding to noons).

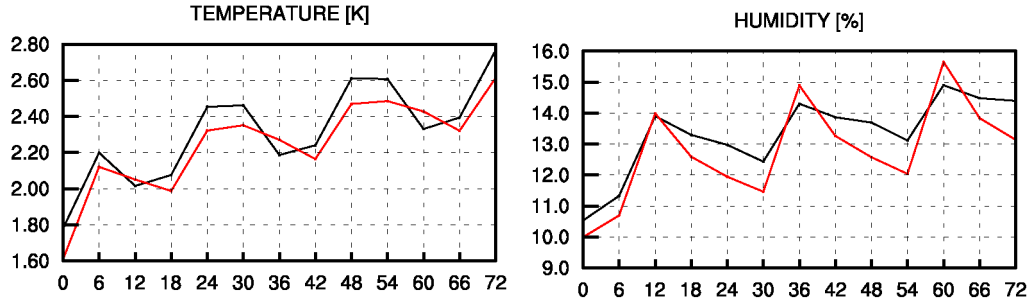


Figure 9: RMSE of 2m temperature (left) and 2m relative humidity for the period 01/08/2011-30/01/2012, forecasts starting from 00UTC. Operational reference run in black, CANARI in red

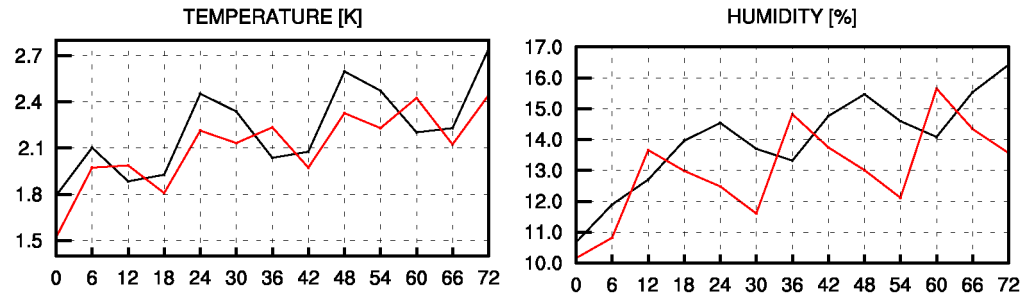


Figure 10: The same as the previous figure, but for period 01/08/2011-31/10/2011

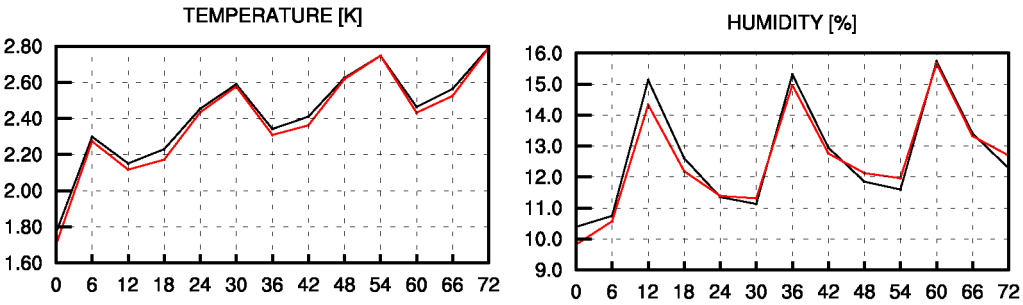


Figure 11: The same as the previous figure, but for period 01/11/2011-30/01/2012

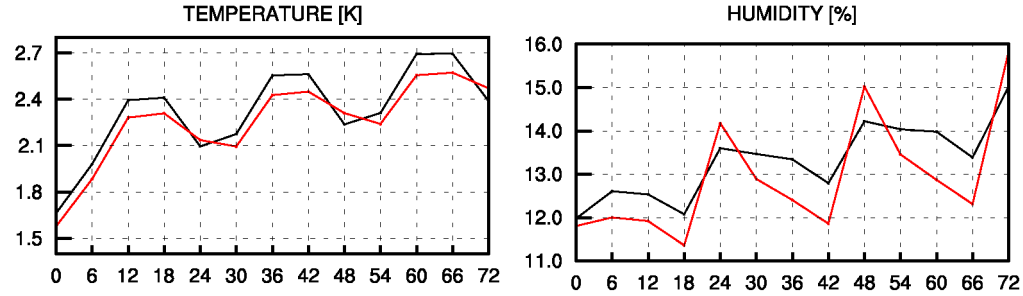


Figure 11: The same as figure 9, but for the forecasts starting from 12UTC analyses (i.e. the "switch" is now at +24h, +48h, +72h)

Conclusion

The experiments with surface assimilation using CANARI in ALADIN/SHMU brought expected improvement on the scores of screen level parameters, but there is a problem with the daytime forecasts during summer. Any hints how to solve it?