

ISBA tests in a Nordic area - an update

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1 Introduction

The ISBA surface scheme together with the related surface analysis and soil assimilation package is approaching the acceptance into the HIRLAM Reference system. It has been debugged, tuned and tested during the last couple of years, as have been reported recently in, e.g., Rodrigues et al. (2001), Rodrigues et al. (2002), Navascues et al. (2002) and Järvenoja (2002).

This report summarizes the latest results from parallel tests for a Nordic test area and for three different seasons using the present reference surface scheme and the ISBA scheme.

2 Parallel tests

Parallel runs have been carried out using the present HIRLAM Reference version (5.1.2) and the β version (5.1.4) for 'reference' and 'ISBA' runs, respectively. The runs have been carried out at ECMWF. Two parallel experiments, differing only in the surface treatment, are as follows:

- REL : reference surface scheme (HIRLAM 5.1.2)
- ISL : ISBA surface scheme together with the new surface analysis and soil assimilation (HIRLAM 5.1.4)

The common features for the two experiments are:

- Domain: Area corresponding to the FMI operational European suite (ENO) with a 0.2° horizontal resolution
- $198 * 140$ grid points; 31 levels in the vertical
- Semi-Lagrangian advection, $dt = 5$ min
- Each suite with its own data assimilation (OI, 6 h cycling)
- Lateral boundary conditions: ECMWF analyses
- 48 h forecasts from 12 UTC analyses only
- Periods: 1-15 January 1996, 12-26 April 1998 and 6-17 June 1997

The present status and a short description of the ISBA surface scheme and the related surface analysis and soil assimilation for HIRLAM can be found in Rodrigues et al. (2002) and Navascues et al. (2002). The three test periods are the same as used earlier by Järvenoja (2002).

3 Results

In the following, some results from the parallel experiments are presented for each test period: winter, summer and spring. The focus in the results is the near-surface parameters: the 2-metre temperature (T_{2m}) and the 2-metre relative humidity (RH_{2m}).

3.1 Winter: January 1996

The observation verification scores, bias and standard deviation as computed against EWGLAM stations for the January 1996 period are shown in Figs. 1 and 2 for T_{2m} and RH_{2m} , respectively. Both experiments, REL and ISL show a negative bias (Fig. 1), but the bias is smaller in case of the ISL experiment. The standard deviation is also smaller in ISL, especially at shorter forecast lengths. Both experiments show a small positive RH_{2m} bias (Fig. 2), with ISL being less biased. On the other hand, the REL experiment shows a smaller standard deviation compared to ISL. As a whole, the ISL experiment is slightly better than REL in terms of these two near-surface variables.

Figures 3 and 4 show the geographical distribution of T_{2m} forecast error (forecast - analysis) in 48 h forecasts (valid at daytime) for REL and ISL experiments, respectively. The same verifying T_{2m} field, that from the new surface analysis (ISL), is used for both experiments. Apart from the boundary zone, the ISL experiment has generally smaller bias than REL. The cold bias over Russia north of the Black Sea and over Finland and Karelia has been reduced in ISL compared to REL. Furthermore, the positive bias over Scandinavian mountains is not as large in ISL as in REL. There is exceptionally large negative bias in the boundary zone over land areas in both experiments. This kind of feature was not found in earlier experiments, e.g., in Järvenoja (2002). Different boundary conditions are used in Järvenoja (2002) and in the present study: FMI HIRLAM analyses in the former and ECMWF analyses in the latter. Therefore, the ECMWF boundary conditions are the most likely explanation for the cold bias in boundary regions.

3.2 Summer: June 1997

Figures 5 and 6 demonstrate the observation verification scores for the June 1997 period. Both experiments show a slight positive bias on average, but there is a clear diurnal cycle as well. There is a positive T_{2m} bias of 0.5°C in the REL experiment (Fig. 5) at night-time (12 and 36 h), while the ISL experiment shows a similar bias in the morning (18 and 42 h). The ISL run shows a slight negative bias at night-time (12 and 36 h). The ISL run is somewhat better in terms of the standard deviation. Figure 6 shows that there is a negative RH_{2m} bias in the REL experiment at all verifying times, while there is diurnal cycle (centered around zero) in the ISL run, at the opposite phase to the T_{2m} bias. In terms of the standard deviation, the ISL run is again superior.

Examples of systematic differences between ISL and REL forecasts are given in Figs. 7 and 8, which demonstrate differences of accumulated precipitation and cloud cover in 48 h forecasts (ISL-REL), respectively. The ISL experiment gives about 2 mm more precipitation in 48 hours (corresponding to 30 mm in a month) over Russia north of the Black Sea than REL (Fig. 7), on average. This feature coincides with a larger (1 to 2 octas) daytime cloud cover in ISL as shown in Fig. 8. The ISL experiment generally has a slightly larger cloud cover than REL.

3.3 Spring: April 1998

The observation verification scores for the April 1998 case are shown in Figs. 9 and 10. The T_{2m} bias (Fig. 9) for REL varies between -0.5 and -1 °C, being more negative during daytime. The bias of the ISL experiment is centered around zero, but has a diurnal cycle being positive during daytime and negative during night-time. The standard deviation is smaller in case of ISL compared to REL. The RH_{2m} bias (Fig. 10) is positive for both runs, but the REL bias is clearly larger, more than 10% during daytime. In terms of the standard deviation, the REL experiment seems to be better than ISL. As a whole, due to the smaller biases, the ISL experiment is superior to REL.

Figures 11 and 12 demonstrate the T_{2m} forecast errors (forecast - observation) of the 24 h forecasts valid at 12 UTC 26 April 1998 for REL and ISL experiments, respectively. Figure 11 shows that the REL forecast gives far too low predicted T_{2m} over large areas in northern Europe, for example in Finland. The forecast errors of the order of -10...-15°C can be considered unacceptable. This kind of problem has been a long-lasting feature in the HIRLAM Reference system, and has been harmful for HIRLAM's reputation. Figure 12 shows the corresponding T_{2m} forecast error for the ISL experiment. The error structure differs much from that of the REL experiment. The forecast errors in northern Europe are much smaller (though still negative) than in REL. It seems that the ISBA scheme (aided by the surface analysis) is able to remove the cold springtime bias in predicted T_{2m} in northern Europe. Both experiments have a similar positive bias in central Europe.

The different behavior of the REL and ISL runs can be highlighted with the aid of model profiles (soundings) from 24 h forecasts of respective experiments for a grid point close to the Luonetjärvi station (62° 24'N, 25° 41'E) in central Finland for 12 UTC 26 April 1998, as shown in Fig. 13. In the REL profile, there is an inversion at 925 hPa and below 950 hPa saturation occurs. The low-level cloud deck prevents the SW radiation from reaching the ground and thus results in low near-surface temperatures. The predicted surface temperature (or T_{2m}) is only 4°C, which is about 10°C colder than observed (cf., Fig. 11). The ISL profile is very different. There is no sign of an inversion, the temperature and the dewpoint temperature are well separated from each other and the temperature profile below 900 hPa follows the dry-adiabatic. The predicted surface temperature is 15°C, which is in a good agreement with the observation.

4 Summary

Parallel tests with the present HIRLAM reference surface scheme (HIRLAM version 5.1.2) and the ISBA scheme (version 5.1.4) have been carried out for three different seasons in a Nordic area. The main focus in the forecast validation has been the near-surface parameters, the 2-metre temperature and 2-metre relative humidity.

The results of the present study agree with those of Järvenoja (2002) to a great extent. The signal is such that the ISBA scheme results in better or at least in as good T_{2m} and RH_{2m} forecasts compared to the reference surface scheme. The superiority of the ISBA scheme is very clear in springtime, but some positive impact can be seen also in winter and summer.

References

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- Navascues, B., Rodrigues, E. and J. J. Ayuso, 2002: The new HIRLAM surface analysis. Proceedings of the SRNWP/HIRLAM Workshop on Surface Processes, Turbulence and Mountain Effects, INM, Madrid 22-24 October 2001, 37-44.
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- Rodrigues, E., Navascues, B. and J. J. Ayuso, 2002: The tiling surface scheme for HIRLAM5: features and latest results. Proceedings of the SRNWP/HIRLAM Workshop on Surface Processes, Turbulence and Mountain Effects, INM, Madrid 22-24 October 2001, 55-63.

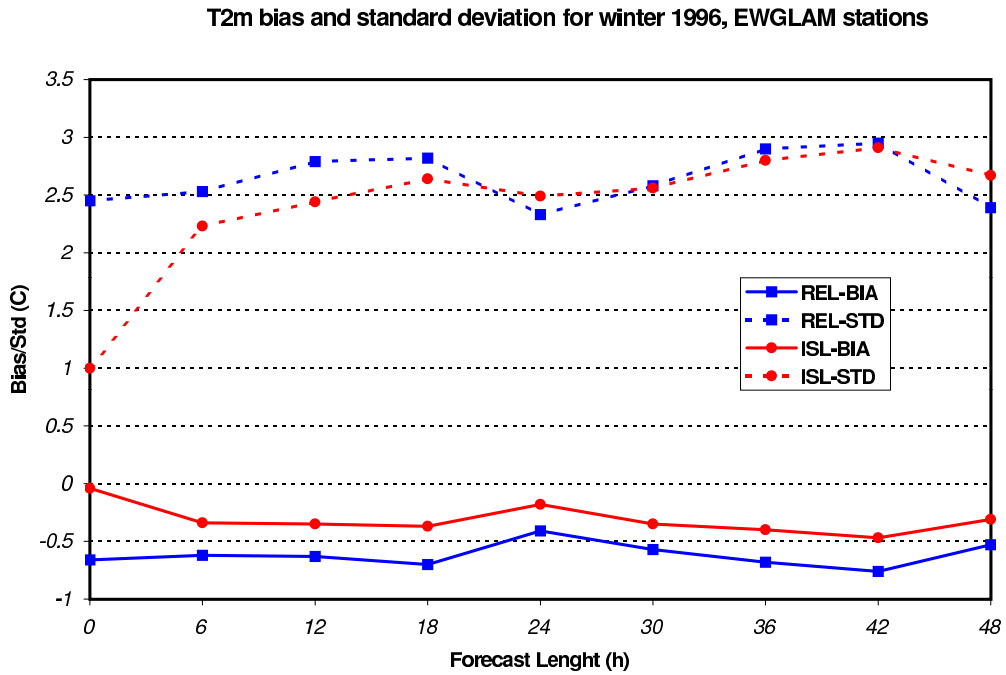


Figure 1: T_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 1-15 January 1996.

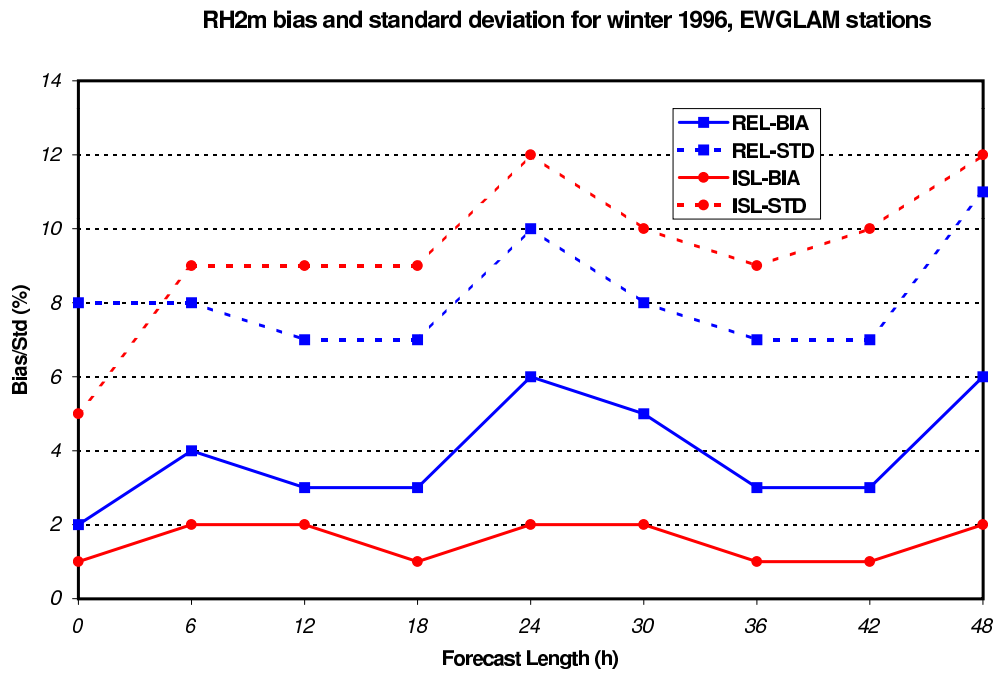


Figure 2: RH_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 1-15 January 1996.

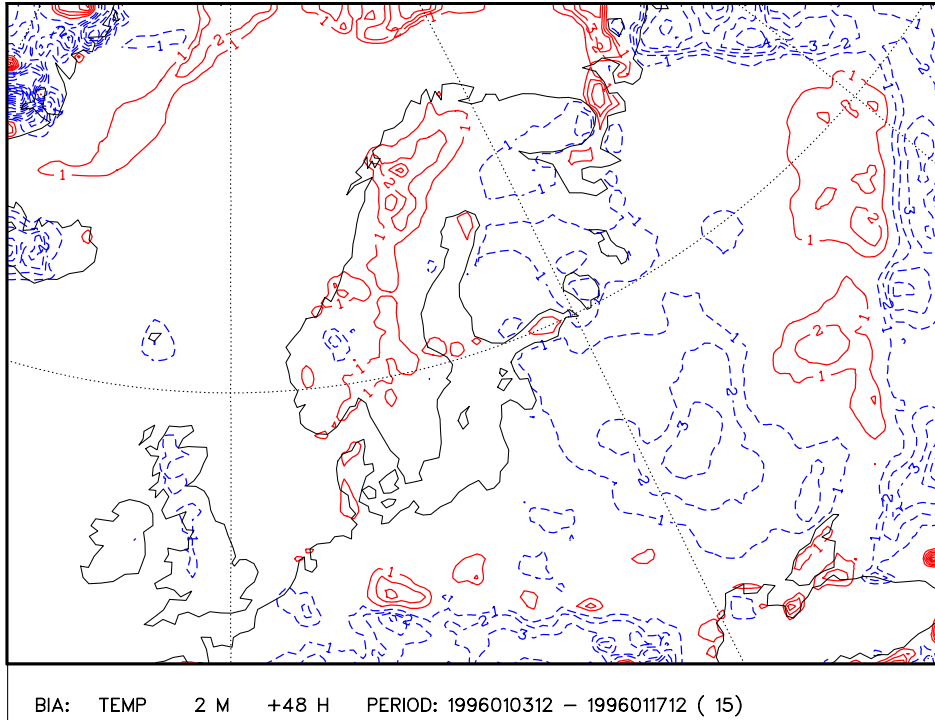


Figure 3: T_{2m} forecast error (forecast-analysis) in the 48 h forecasts (valid at daytime) for REL experiment, 1-15 January 1996. Contour interval: 1°C . The zero isoline not plotted, negative values indicated with dashed lines.

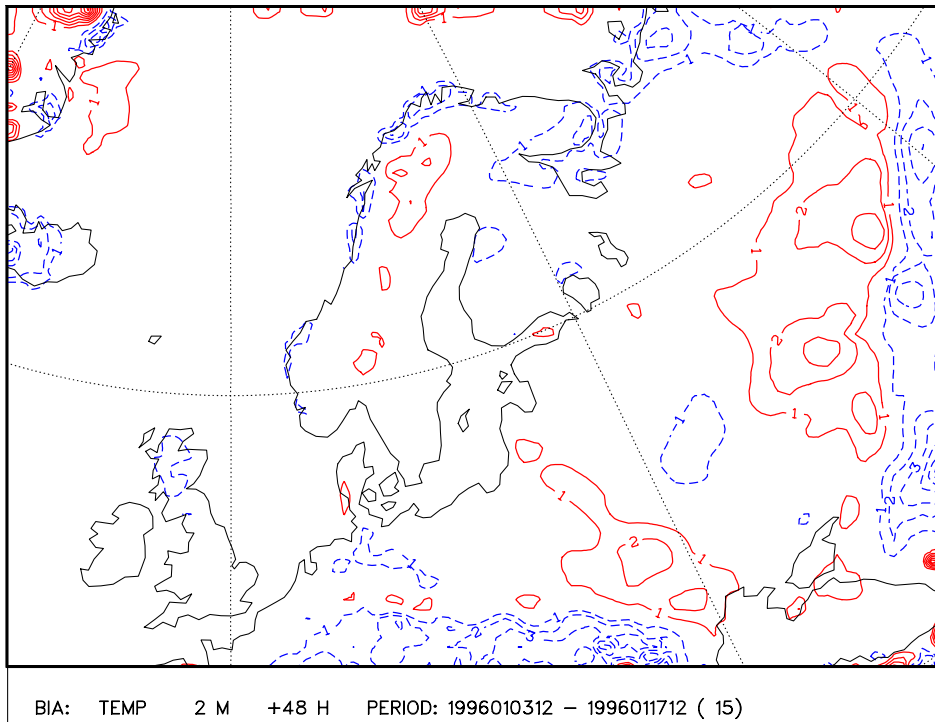


Figure 4: T_{2m} forecast error (forecast-analysis) in the 48 h forecasts (valid at daytime) for ISL experiment, 1-15 January 1996. Contour interval: 1°C . The zero isoline not plotted, negative values indicated with dashed lines.

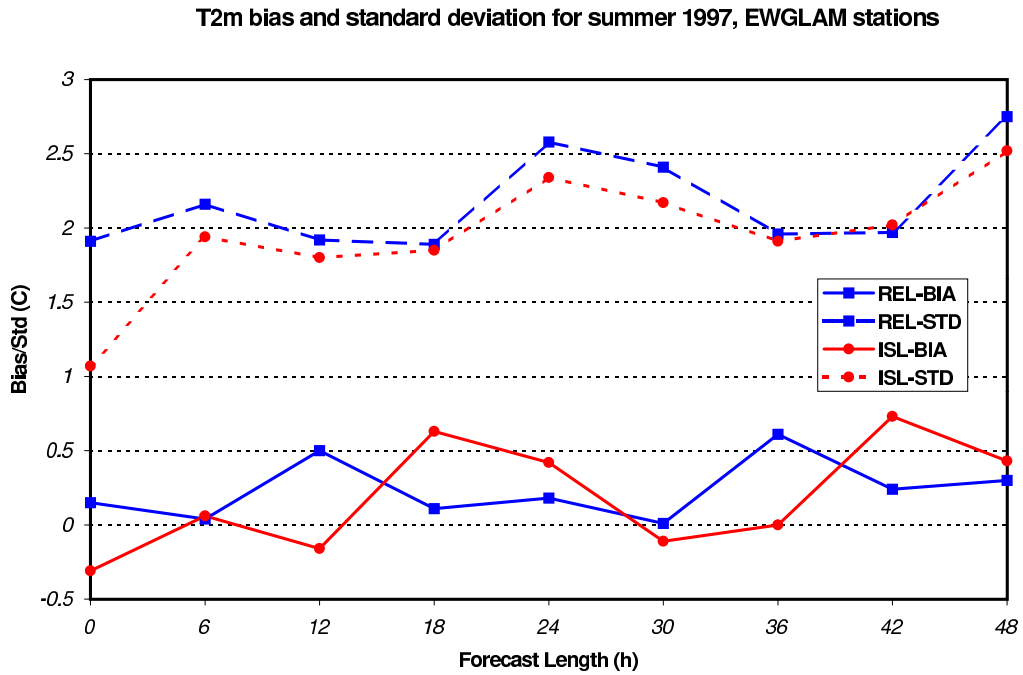


Figure 5: T_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 6-17 June 1997.

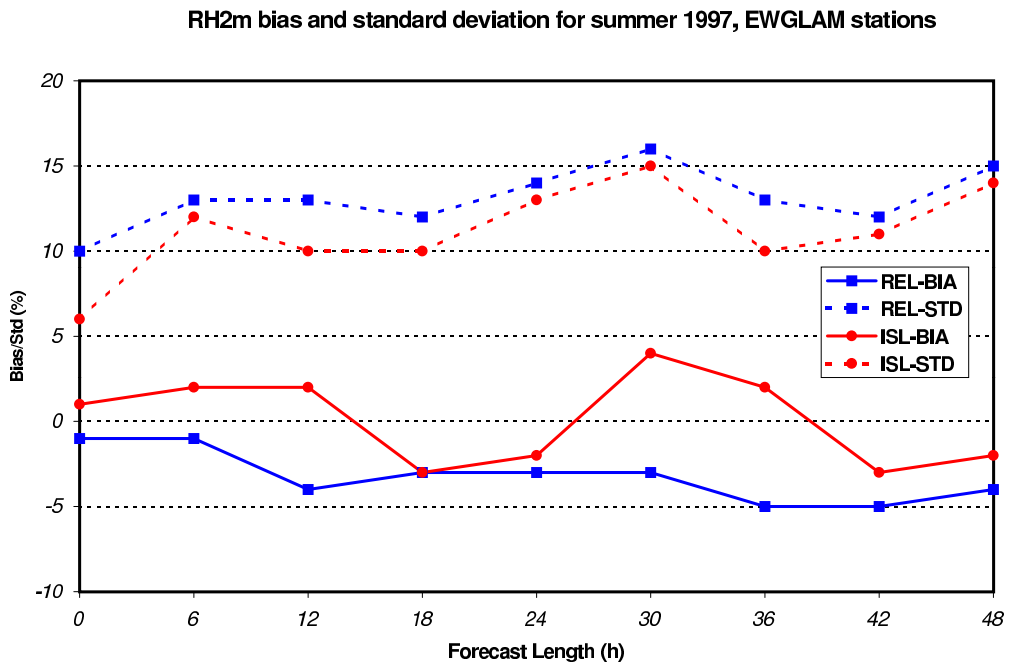


Figure 6: RH_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 6-17 June 1997.

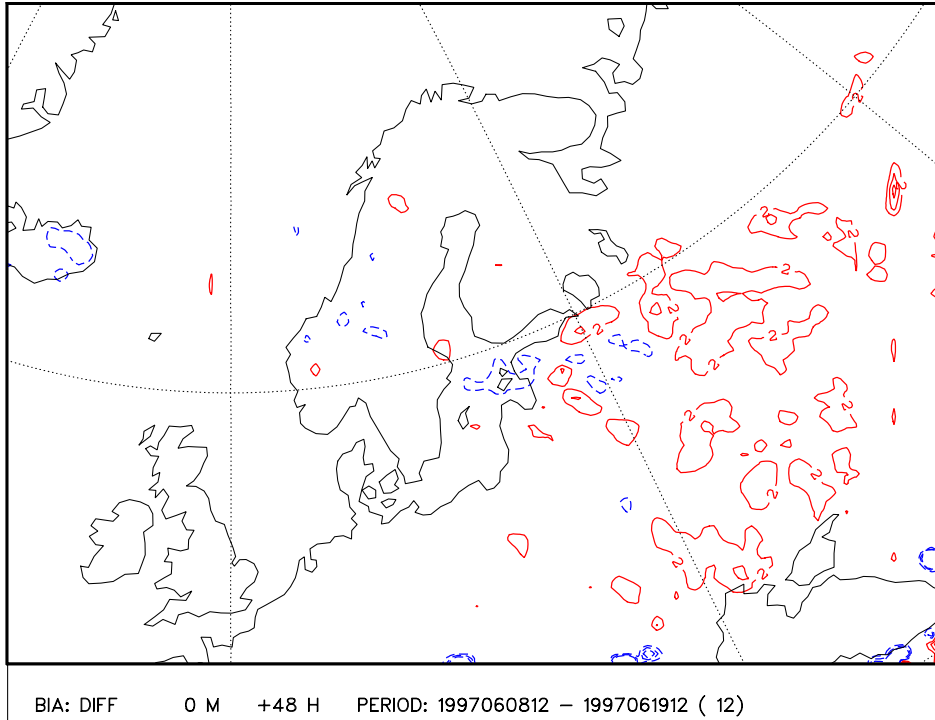


Figure 7: Systematic difference in 48 h accumulated precipitation between ISL and REL (ISL-REF) experiments, 6-17 June 1997. Contour interval: 2 mm. The zero isoline not plotted, negative values indicated with dashed lines.

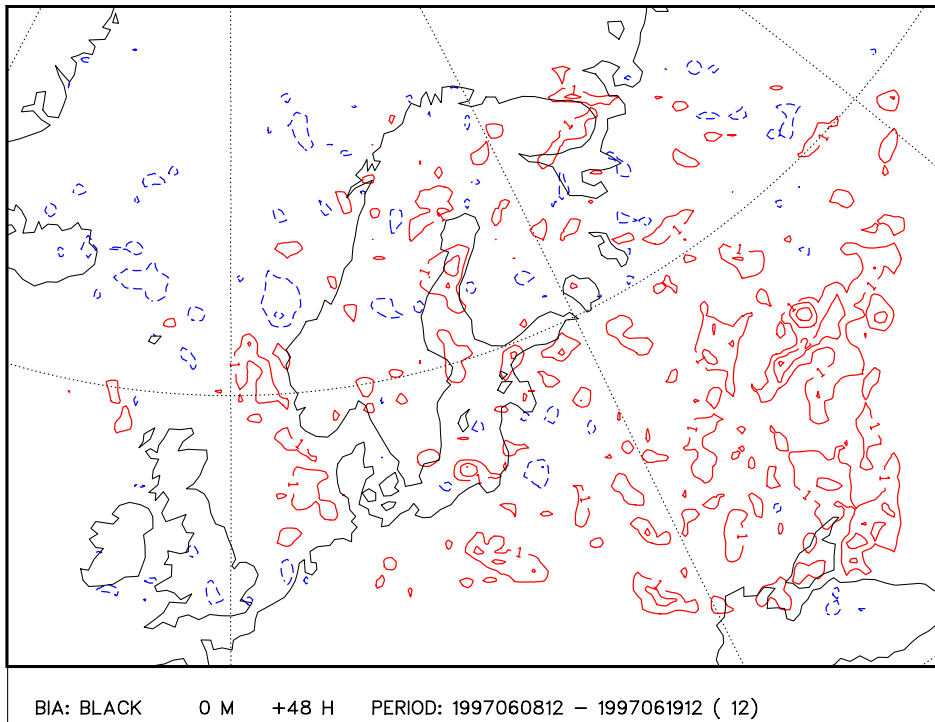


Figure 8: Systematic difference in 48 h (daytime) total cloud cover between ISL and REL (ISL-REF) experiments, 6-17 June 1997. Contour interval: 1 octa. The zero isoline not plotted, negative values indicated with dashed lines.

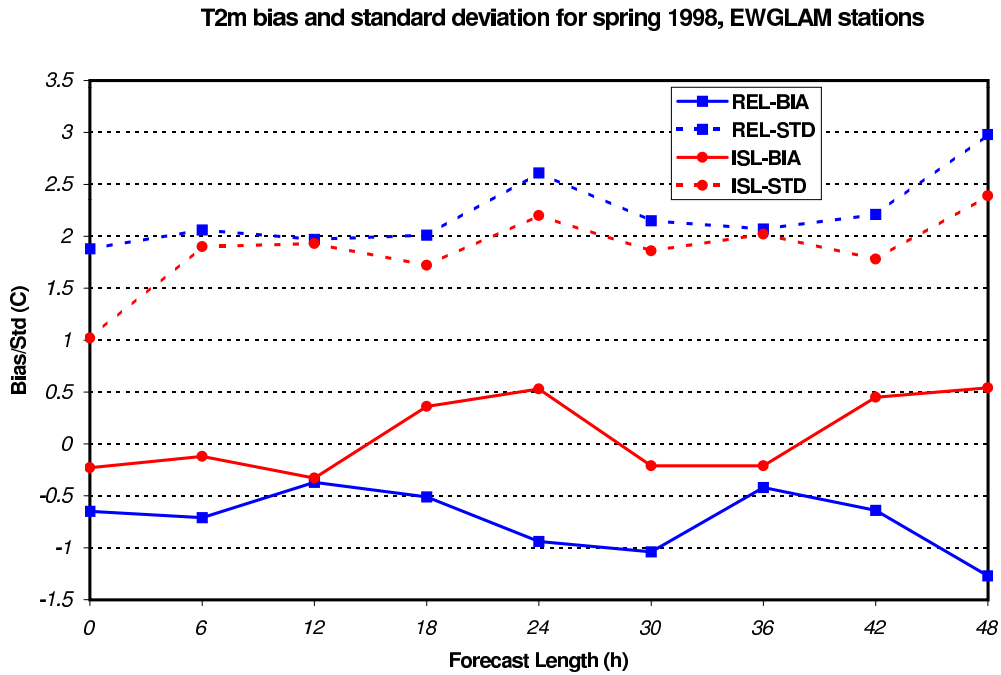


Figure 9: T_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 12-26 April 1998.

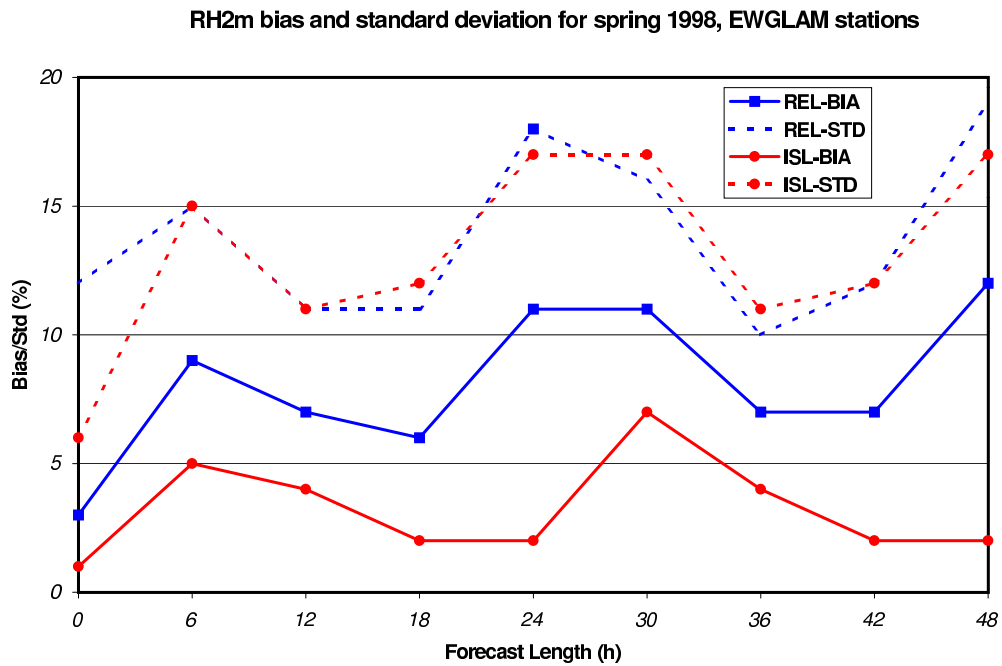


Figure 10: RH_{2m} bias (full lines) and standard deviation (dashed lines) as a function of forecast length for REL (square) and ISL (circle) experiments, 12-26 April 1998.

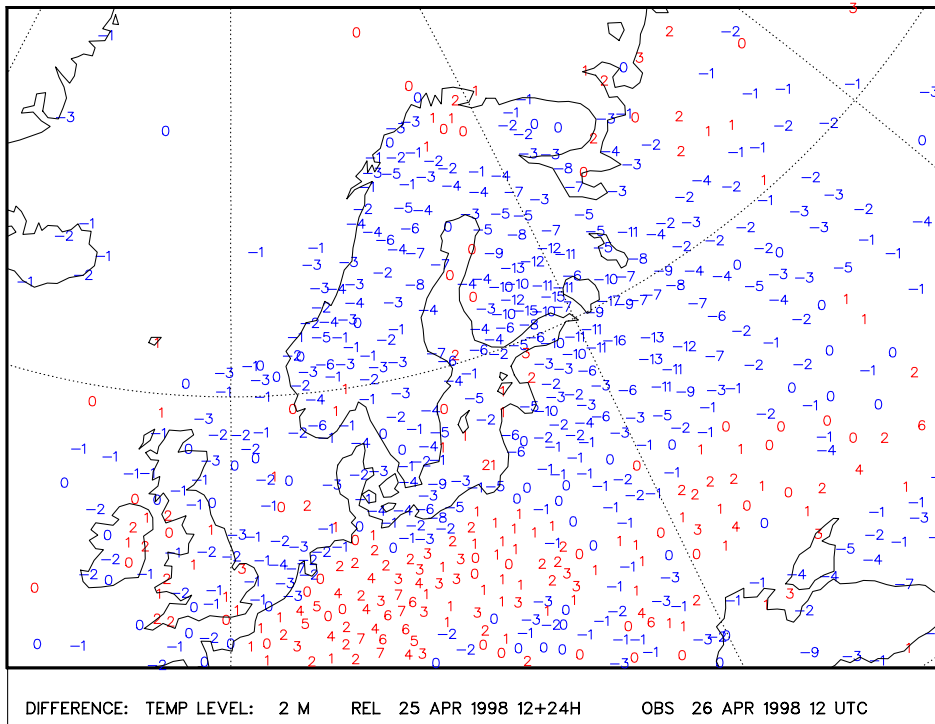


Figure 11: The T_{2m} forecast error (forecast-observation) for the 24 h REL forecast valid at 12 UTC 26 April 1998.

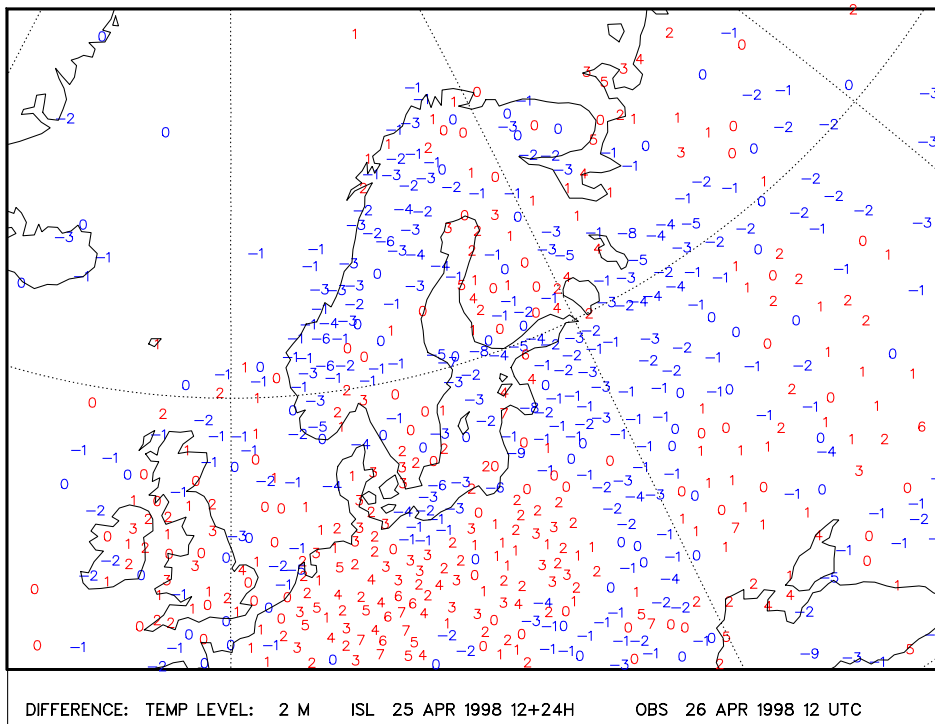


Figure 12: The T_{2m} forecast error (forecast-observation) for the 24 h ISL forecast valid at 12 UTC 26 April 1998.

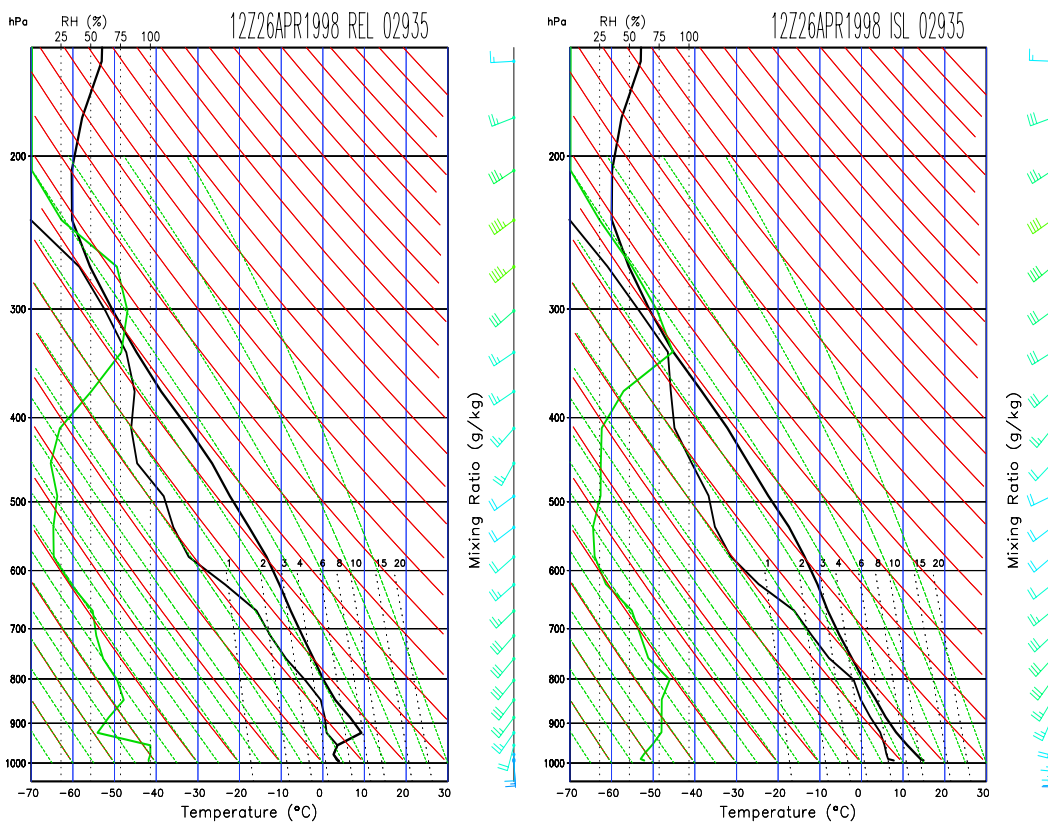


Figure 13: Forecast (+24 h) model profiles valid at 12 UTC 26 April 1998 for a grid point close to the Luonetjärvi station in central Finland, REL (left) and ISL (right).