Modeling with NH HIRLAM

Aarne Männik
Institute of Environmental Physics, Tartu University

Rein Rõõm
Tartu Observatory

1 Introduction

The nonhydrostatic extension to HIRLAM with explicit time integration scheme, developed at Tartu Observatory, has matured. The code has been parallelized and numerical tests show nice results. Now the nonhydrostatic model has to enter the stage, where its forecasting capabilities must be evaluated and possible remaining issues with the adiabatic core must be resolved. Below we present some results of the test, where the nonhydrostatic model is used in forecasting conditions which are close to operational ones. Main target of the experiment was to obtain first quality estimations for the nonhydrostatic model and to compare the performance with its hydrostatic origin.

2 Description of the experiment

A one week period from 28 August to 4 September 1999 has been selected to perform forecasts in continuous mode. Grid $114 \times 100 \times 31$ with 11 km resolution was used and integration area is presented on figure 1. In experiments the nonhydrostatic model with explicit Eulerian integration scheme is compared to the hydrostatic semi-implicit one. The time step 60 s was used for thenonhydrostatic scheme and 90 s for the hydrostatic model. Analyses of the ENO area of the Finnish Meteorological Institute were used as boundary fields. 24h forecasts were produced every twelve hours and full data assimilation cycle was employed every six hours. For model evaluations

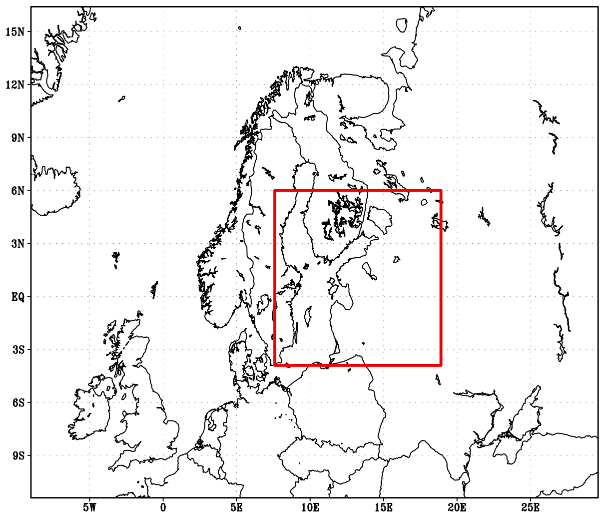

Figure 1: Integration area

we use several verification scores produced with HIRLAM as in reference version. Unfortunately both models failed to complete full period of integration due to technical problems appeared in the surface analysis, but runs for five days were obtained, which makes enough data available for preliminary conclusions.

3 Results

As the nonhydrostatic model assumes ground surface pressure adjustment and therefore treats it differently from the hydrostatic model, the verification scores of the sea level pressure were of special interest. On the figure 2, verifications against observations of six hour forecasts of sea level pressure are presented. As we can see, RMS errors are in general slightly better for the hydrostatic forecast, and biases are slightly better for the nonhydrostatic model. We notice that the hydrostatic model has some sudden peaks, meaning loss in the accuracy of the forecast, while behavior of the nonhydrostatic model seems to be smoother.

To get overall impression about quality of the sea level pressure forecasts, we averaged verification scores over available period for different forecast lengths. Results can be seen on figure the 3. Hydrostatic model has slightly

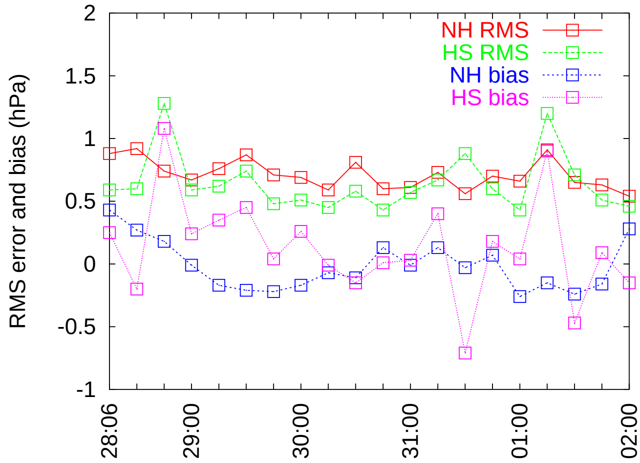

Figure 2: Verification of 6h forecasts against observations

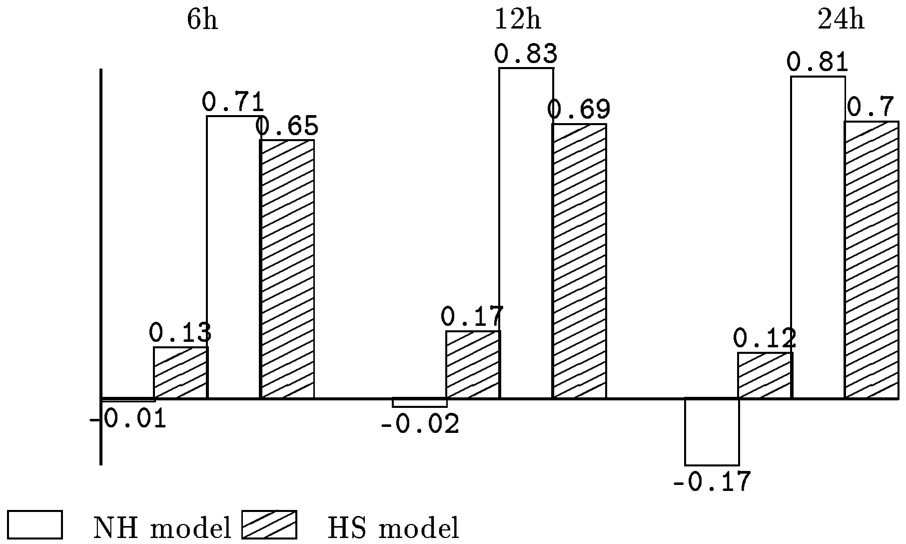

Figure 3: Averaged biases and RMS-s of sea-level pressure for forecasts

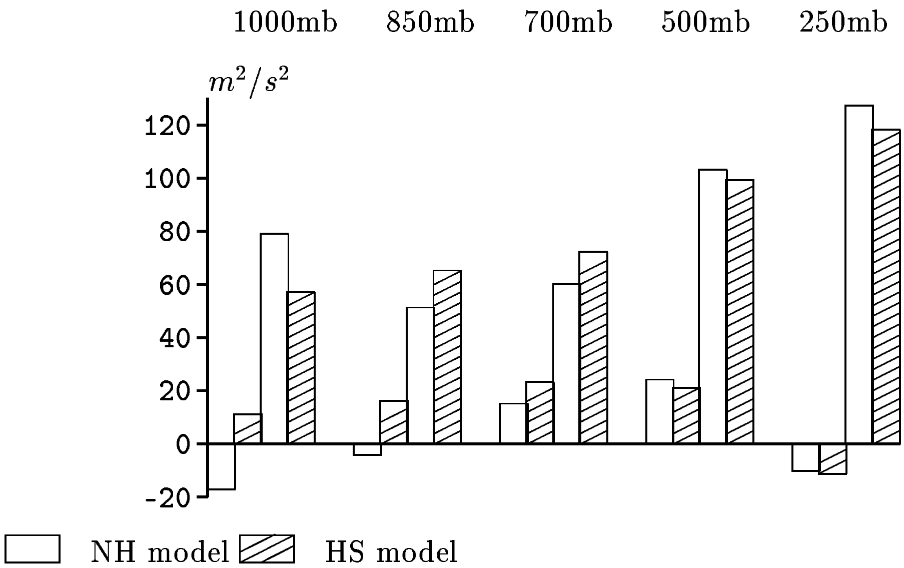

Figure 4: Averaged biases and RMS-s of geopotential for 24h forecasts

better RMS error statistics for all forecast lengths. A possible explanation to the fenomena can be too noisy orography treatment which impact appears to be stronger for nonhydrostatic model. Plots of sea level pressure are not presented here, but they all show more noise for the nonhydrostatic model. The nonhydrostatic model seems to be better with biases, but for 24h forecasts we see unpleasant drop of performance. Reason to the situation is not clear yet.

To show the forecasting quality of other variables, we present on figures 4 and 5 averaged verification scores of 24h forecasts for geopotential and temperature on different pressure levels. We can not draw any clear conclusions from those figures, because on some levels nonhydrostatic model performs better and on other the situation is *vice versa*. Still, in general we can say that the results are of the same quality.

If we do not see in the experiment clear superiority of the nonhydrostatic model, we should keep in mind the location of the integration area. The orography in the domain is actually very flat and no significant nonhydrostatic effects can be expected in the case of 11 km resolution. In the future it is necessary to run experiments with higher resolution and in the montaneous area to see some clear nonhydrostatic effects.

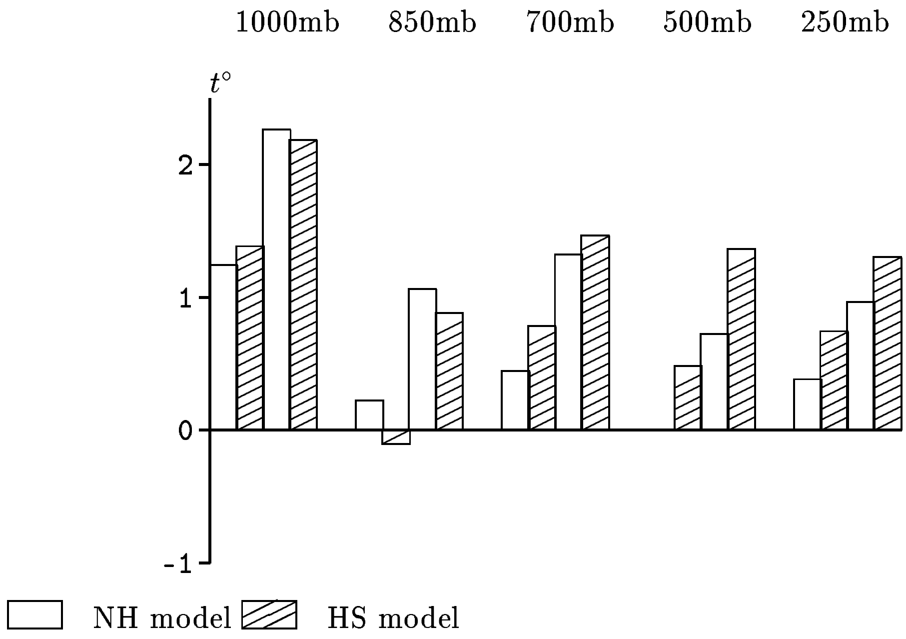

Figure 5: Averaged biases and RMS-s of temperature for 24h forecasts

4 Conclusions

Experiment shows that:

- First quality estimations and statistical verifications are obtained for nonhydrostatic HIRLAM.
- Model produces reasonable forecasts.
- Quality of forecasts is comparable with hydrostatic HIRLAM, but NH has some additional problems possibly originating from HS code.
- More extensive testing is required (especially cases with clear nonhydrostatic impact).