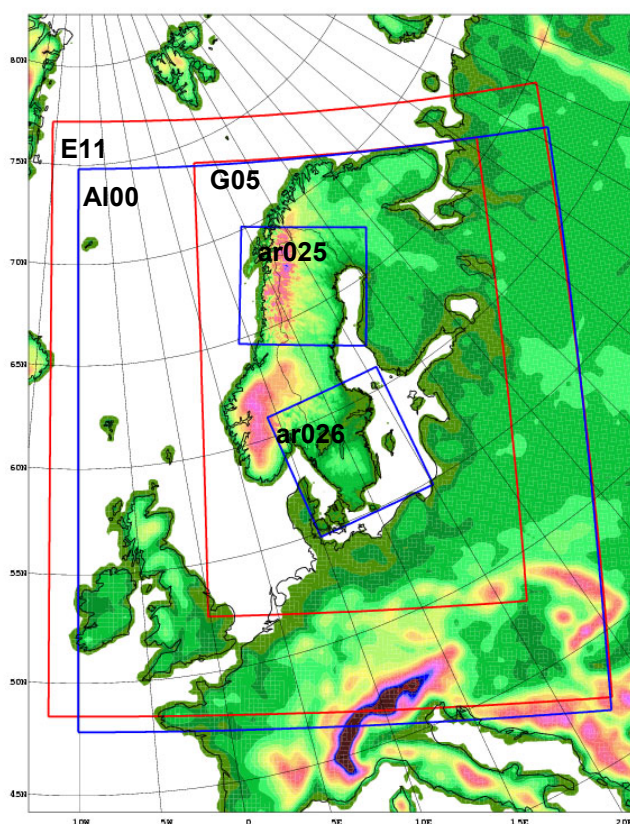


# SMHI ALADIN implementation

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## 1 Introduction

The first experiences with the ALADIN model at SMHI are described in Andrae (2005). It was concluded based on statistics from two autumn months that ALADIN and HIRLAM behave very similar with some favourable scores for ALADIN on near surface temperature and humidity and precipitation. There was a clear unrealistic underestimation of the diagnostic cloud cover in ALADIN. This was due to a mixture of old and new physics options in the namelists. The physics settings were corrected with the introduction of CY30t1 in February 2006.



*Figure 1 Model domains mentioned in the text.  
For further description see Table 1.*

In this case we have evaluated two months from spring 2006. Since most of the conclusions from the autumn hold for this period as well, only some results will be presented with figures. The results are valid for the E11 and a100 domains shown in Figure 1. Both have the same horizontal and vertical resolution. Further information of the model setup can be found in Table 1. Two versions of ALADIN have been running: a100\_mf which corresponds to Meteo France physics and a100\_ce which corresponds to options chosen for the ALARO setup. Here we will focus on the a100\_mf experiment and it shall hereafter be considered as the ALADIN model when mentioned in the text.

The cloudiness during the spring is now very similar in HIRLAM and ALADIN, both in terms of daily evolution and the distribution between clear sky and overcast as can be seen in Figure 2. The surface winds are overestimated during nights in HIRLAM and underestimated daytime in ALADIN. Both models reproduce the screen level temperatures with about the same quality. It is clear however, that ALADIN has problems at very low temperatures. If we look at the geographical

distribution of the temperature errors it is clear that ALADIN has a large north-south component in the temperature bias, Figure 3. In Andrae (2005) the precipitation was considered more realistic in ALADIN than in HIRLAM. The same holds for the spring period. The latest statistics for the 10 km comparison between ALADIN and HIRLAM can be found at [www.smhi.se/sgn0106/if/hirald/WebgraF/OPER](http://www.smhi.se/sgn0106/if/hirald/WebgraF/OPER).

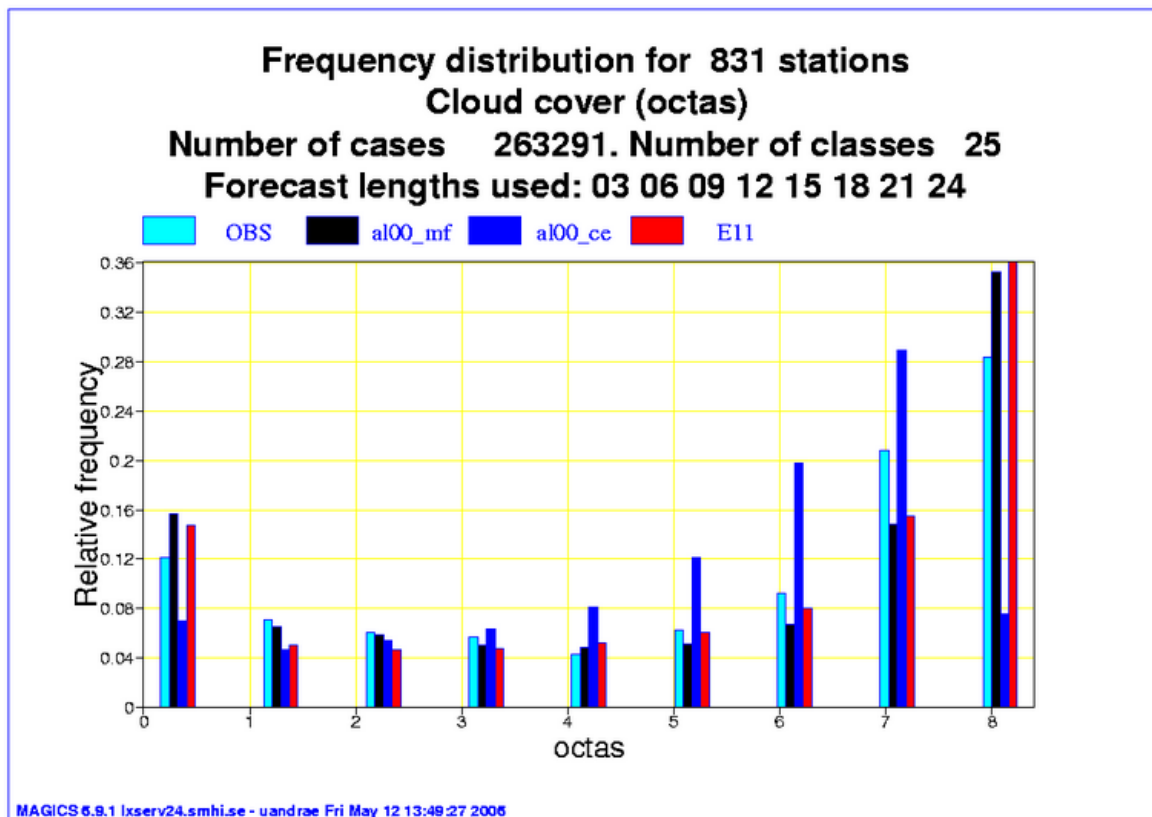
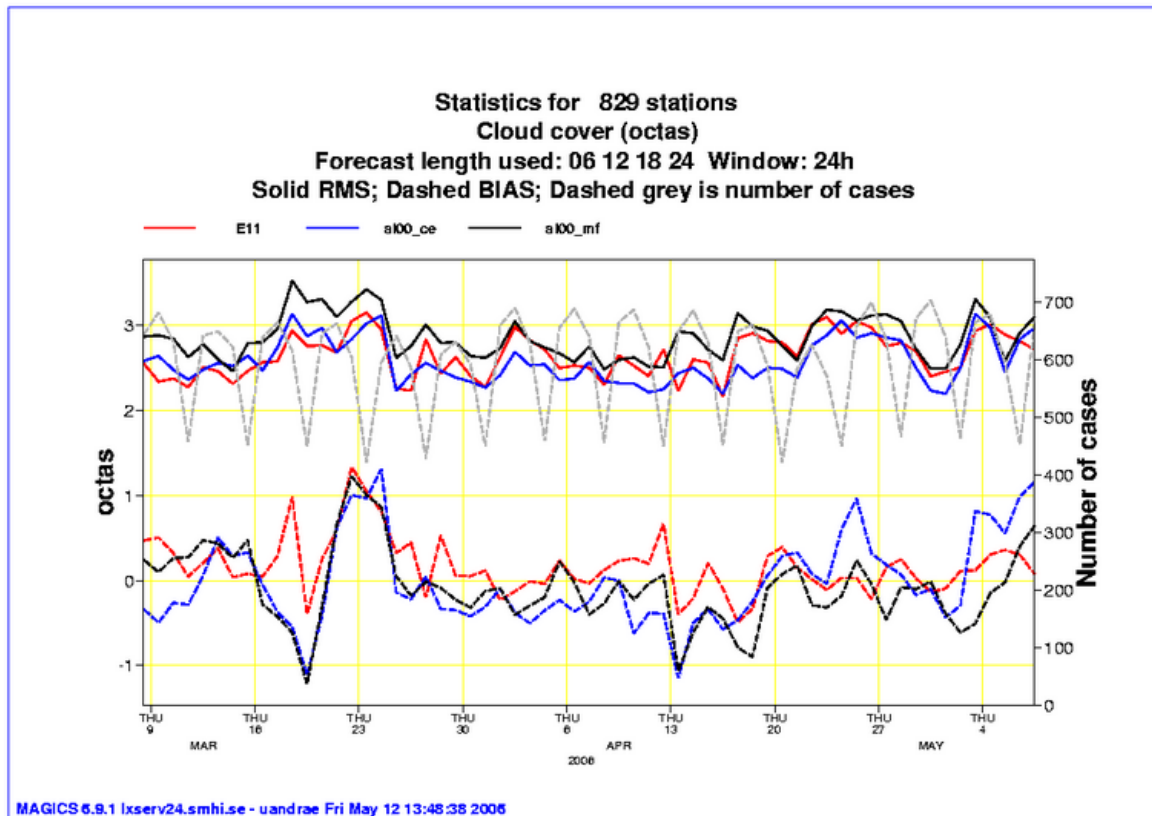


Figure 2 Top: time series of cloud cover for HIRLAM (E11) and ALADIN (al00\_mf/al00\_ce). Bottom: frequency distribution of cloud cover.

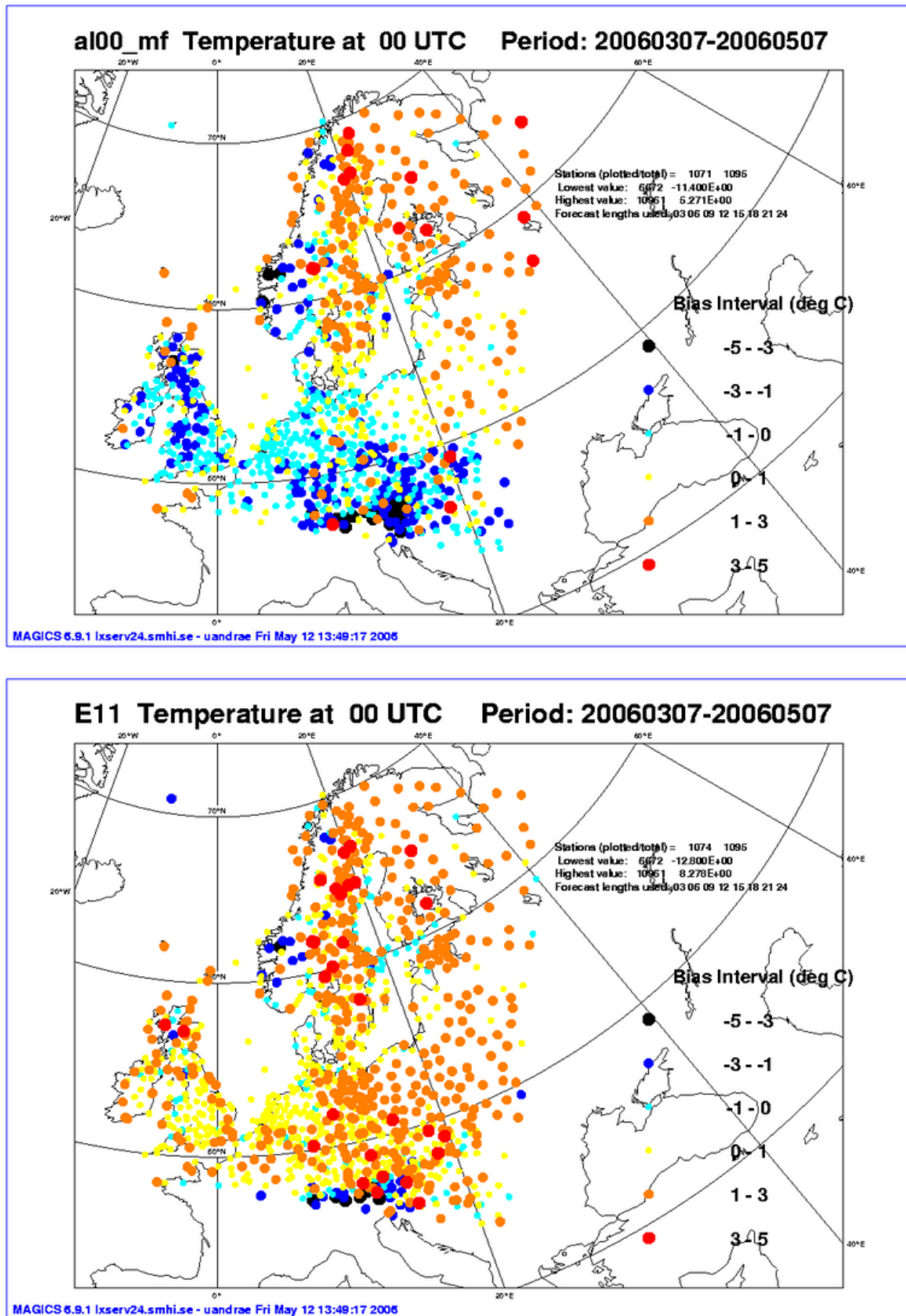


Figure 3 Geographical distribution of bias at 00UTC for ALADIN (top) and HIRLAM (bottom).

## 2 High resolution ALADIN

Two high resolution domains, 2.5km, have been setup over north (al025) and south (al026) of Sweden respectively; see Figure 1 and Table 1 for description. The model has been running in non-hydrostatic mode but without any adaptations in the physics to the higher resolution. It's clear from the precipitation pattern (not shown) produced over the northern mountainous part that this is an unrealistic way of running the model. There is however some interesting information reproduced in the wind field. A few weeks of data in November – December 2005 have been used to evaluate wind power forecasts. It was clear already from a comparison with HIRLAM that increasing resolution clearly yields better scores. Figure 4 shows that going from HIRLAM 5km to ALADIN NH 2.5km gives a better representation of the produced wind power.

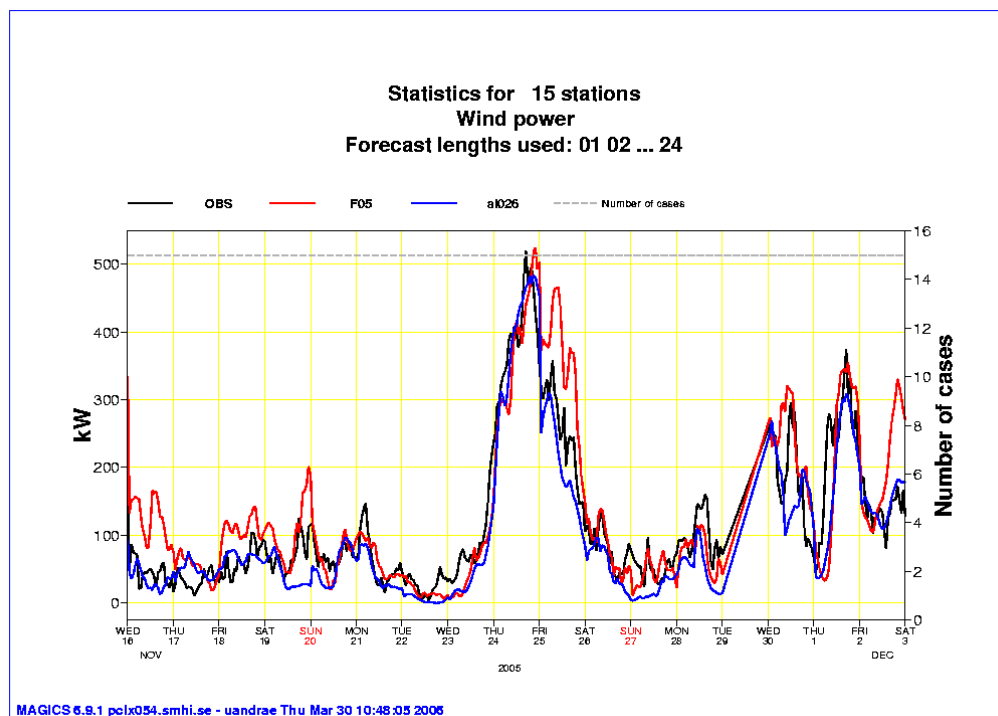


Figure 4 Time series of produced wind power for 15 stations in southern Sweden. Black is observations, red is HIRLAM 5km and blue is ALADIN-NH 2.5km.

## 3 AROME

The possibility to run AROME in a clean way using fullpos, the ALADIN/IFS postprocessing tool, was introduced in CY30t1. The two high resolution domains were then switched to AROME and the model has been running on daily basis since April with forecasts from al00\_mf on the boundaries.

Some statistics from June and July shows that the results for AROME are worse than those produced by HIRLAM at 5km. Figure 5 presents some scatter plots for mean sea level pressure, screen level wind and temperature. The pressure correlation and bias is very similar between HIRLAM and AROME, but temperature and wind is much more scattered in AROME. The reason for the poor performance remains to be explored. However, since these are the very first runs it fair to believe that some settings are wrong in the setup.

One reason to run high resolution models is to get a better representation of the convection. AROME has no convective parameterization and HIRLAM at SMHI is running with Kain-Fritsch convection scheme. An example of the precipitation produced on the 11<sup>th</sup> of May is shown together with a radar composite in Figure 7.

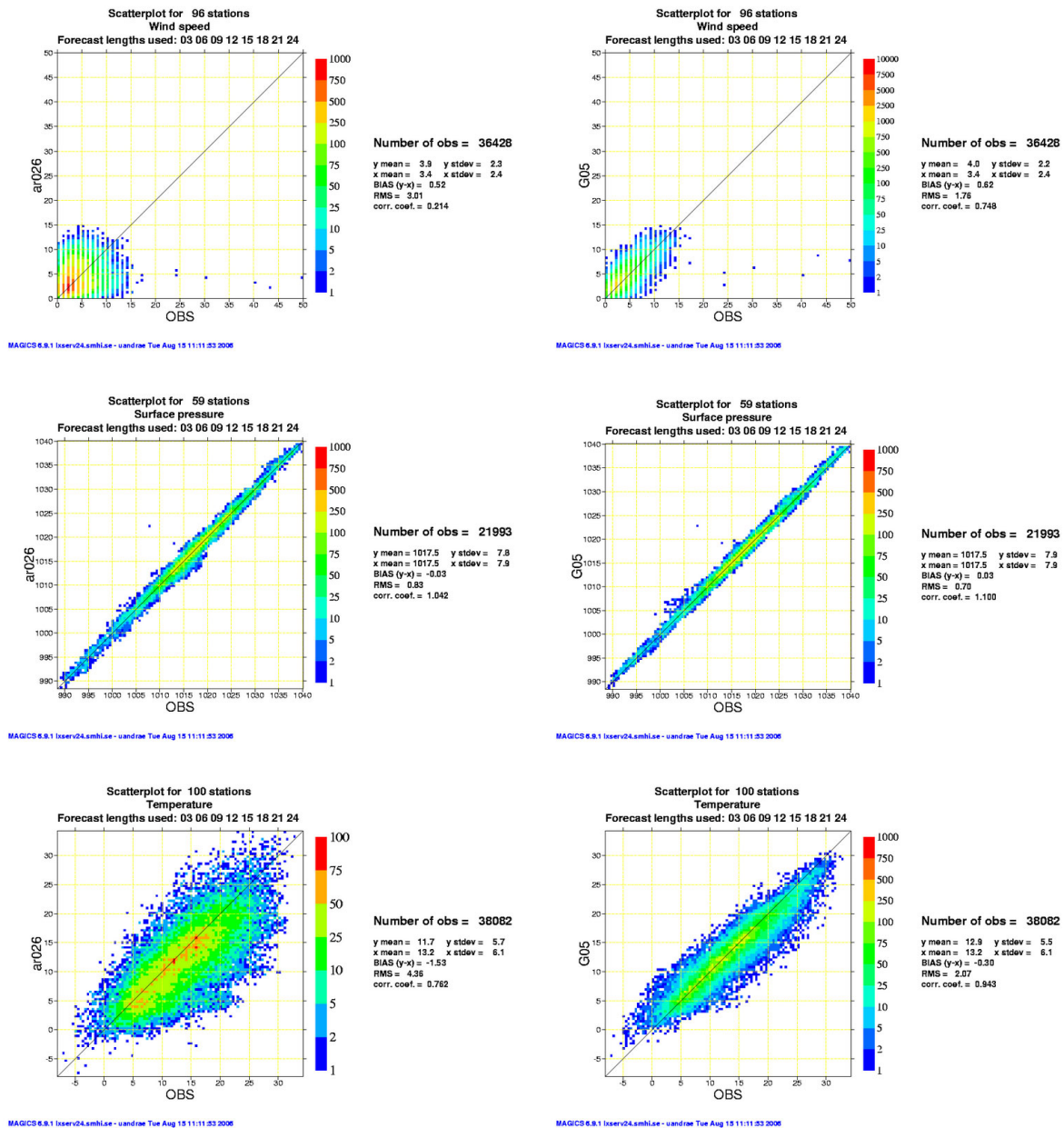


Figure 5 Scatter plots for various surface variables. Left is AROME and right is HIRLAM. Top panel is wind speed, middle panel is surface pressure and bottom panel is temperature.

#### 4 Performance

At SMHI ALADIN is running on Dunder, a 50 node 64-bit linux cluster with InfiniBand communication. The parallel speed up of ALADIN/AROME is shown in Figure 6. We see that NH-ALADIN scales worse than the hydrostatic version. This is since in the non-hydrostatic ALADIN more time are spent on communication intensive tasks such as the SL interpolation and spectral transforms. When we run AROME the relative cost of the physics balance these cost even though we have even more moist variables to advect. The time for a 24h forecast with the hydrostatic ALADIN is 23 minutes which is comparable to HIRLAM. The time for a AROME forecast with the same number of gridpoints and processors is about 9 hours. Thus, running AROME in a operational context is still beyond what is feasible with the current computer.

### 5 Latest development

CY31t0 was recently installed at SMHI. It includes a full introduction of SLHD and also includes a prognostic cloud scheme in ALADIN. The AROME part contains mostly technical changes and some bug fixes. It has been seen that the 2.5km resolution model is very noisy over mountainous terrain since the orography has not been filtered. This will be solved by producing an orography for a quadratic grid giving a higher truncation and then use it in the linear grid. This is the same way it is done in the other ALADIN countries. After discussion at ASM in Sofia it was decided to shift the northern AROME area slightly to get a better cover over the Sodankylä site which gives an opportunity to compare the model surface fluxes with observed ones. A set of scripts have been put together to make it easy to get started with ALADIN and in particular at ECMWF. The possibility to run directly from ECMWF boundaries have been introduced, but the meteorological performance remains to be explored.

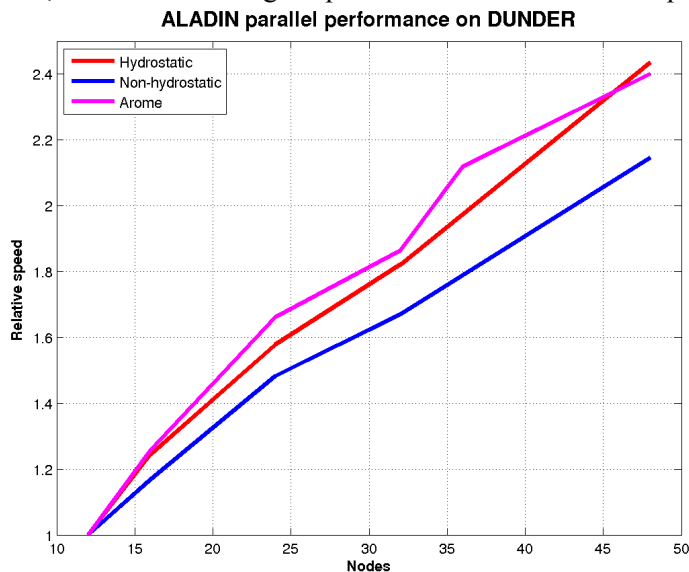


Figure 6 Parallel performance for ALADIN on the SMHI linux cluster DUNDER.

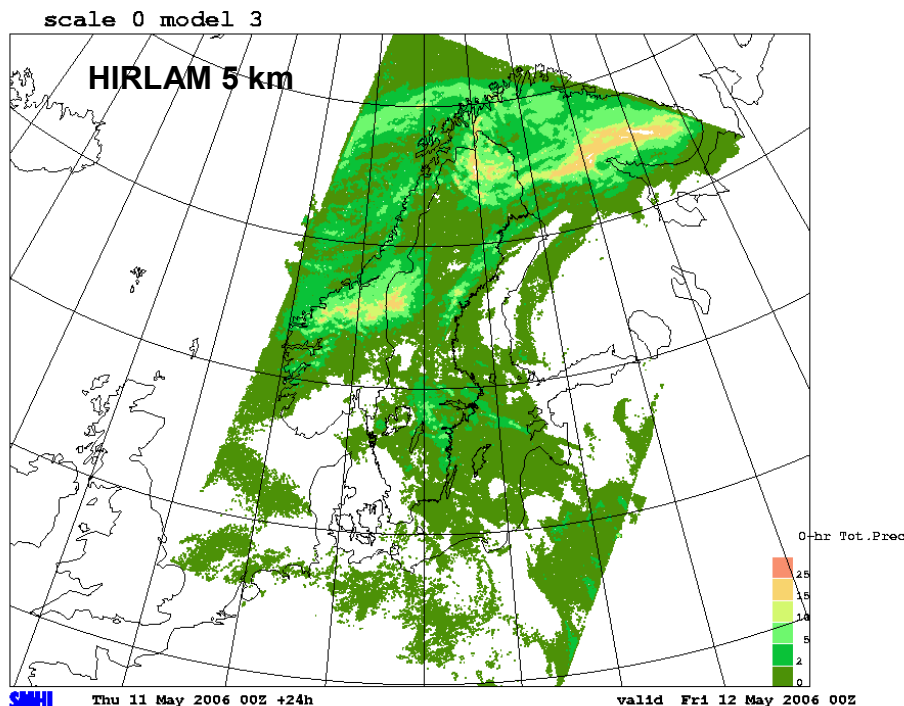


Figure 7 Example of 24h accumulated precipitation as produced by AROME and HIRLAM for the 11<sup>th</sup> of May 2006. A radar composite is shown as a reference.

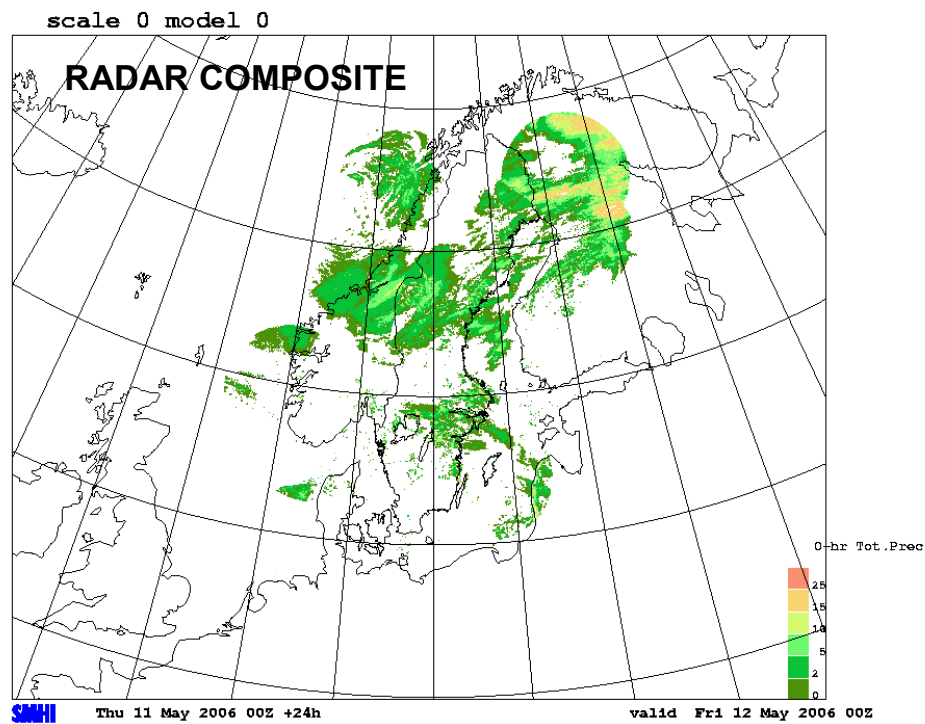
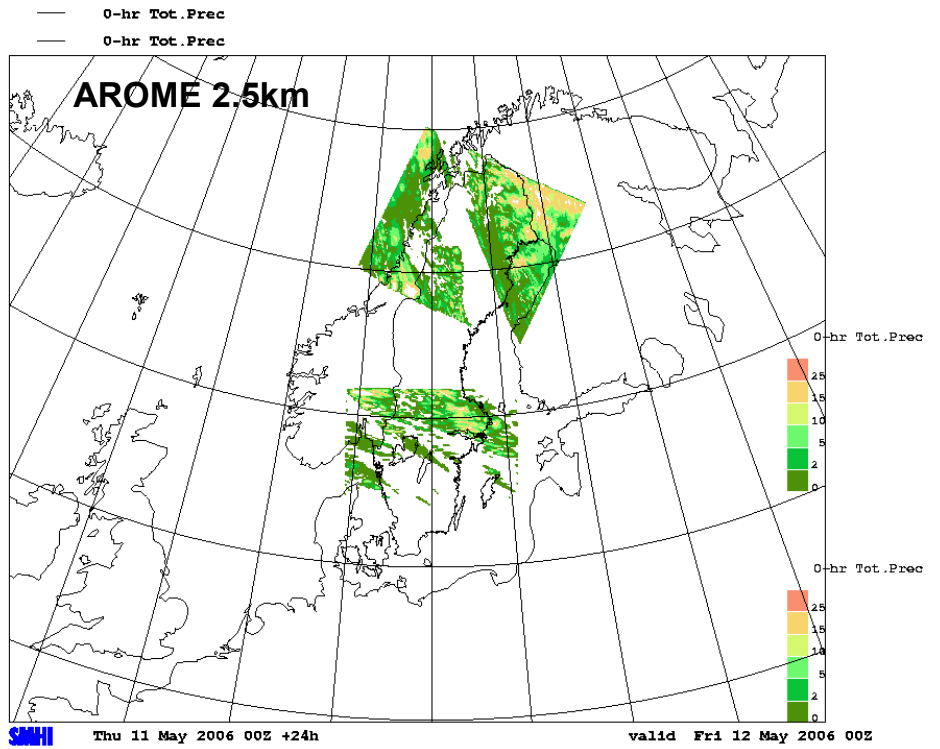


Figure 7 (Continued). Example of 24h accumulated precipitation as produced by AROME and HIRLAM for the 11<sup>th</sup> of May 2006. A radar composite is shown as a reference.

Table 1 Description of the different models experiments and resolutions described in the text

Model Area	Resolution Nlon × Nlat × Nlev	Forcing/frequency	Timestep	Forecast cycle and forecast length
<b>HIRLAM</b>				
C22 North Atlantic	22km 306 × 306 × 40	ECMWF/3h Assimilation	600 s	00/06/12/18+48h
E11 Scandinavia	11km 256 × 288 × 60	ECMWF/3h Assimilation	300 s	00/06/12/18+48h
G05 Southern Sweden	5.5km 294 × 241 × 60	E11/1h Assimilation	150 s	00/06/12/18+24h
<b>ALADIN</b>				
al00mf / al00_ce Scandinavia	11km 256 × 288 × 60	C22/3h	300 s	00/12+48h
al025 / ar025 North Sweden	2.5km 288 × 270 × 60	al00_mf/1h	60 s	00+30h
al026 / ar026 South Sweden	2.5km 270 × 288 × 60	al00_mf/1h	60 s	00+30h

## 6 References

Andrae, U. 2005: *Daily runs with ALADIN at SMHI*. HIRLAM Newsletter, No. 49, December 2005. 89-104