Application and verification of ECMWF products 2010

1. Summary of major highlights

ECMWF products, especially the medium range forecasts, are extensively used at SMHI. For the short range, ECMWF forecasts are used together with products from the Hirlam and Alaro models. Alaro is used with 5 km resolution and 60 levels. The Hirlam model is used with three different resolutions, 22, 11 and 5 km. 40 vertical levels is used for the coarse resolution and 60 levels for the others. Alaro has 5 km resolution and 60 levels. ECMWF data is used for boundaries for the 22 and 11 km runs while Hirlam 11 provides boundaries for Hirlam 05. ECMWF boundaries are also used for Alaro.

Surface parameter verifications of ECMWF forecasts from July 2009 to July 2010 show good results for 2 meter temperature, 10 meter wind speed and precipitation, which is the same results as for previous years. The verification results will be presented in more detail below. The quality of the 2-metre temperature and 10-metre wind speed is further increased by a statistical adoption with a Kalman filtering technique.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

A Kalman filter is used for adjusting 2 meter temperature and 10 meter wind speed forecasts. The correction increments are derived station-wise and then interpolated to a grid in the forecast database using optimal interpolation and utilizing the original forecast as a background field.

ECMWF data is used for creating wind gust forecasts and thunderstorm probabilities. The wind gust forecasts are used together with wind gust forecasts provided as DMO by ECMWF. The thunderstorm probabilities are valid for forecast length up to five days.

2.1.2

Physical adaptation

The ECMWF model data is used to provide lateral boundary conditions for limited area modelling. There are two different areas. The larger area has a horizontal resolution of 22 km and experimentally also for 11 km. It covers Europe and the north Atlantic and the smaller area covers northern Europe with 11 km or 5.5 km resolution. The one with 5.5 km resolution is used for Alaro, the others are used for Hirlam. The purpose of the small area is to provide a somewhat more detailed forecast than from ECMWF for the short range and a smooth transition to ECMWF forecasts for the medium range.

HIROMB is an oceanographic circulation model including ice. This model is forced by model data from ECMWF and Hirlam and is run up to 15 days. Hydrological models, dispersion models etc. are also using ECMWF model data as input.

2.1.3 Derived fields

There are a lot of such products. The most important ones are probabilities for thunderstorms, near gale, storm and hurricane force winds. Those probabilities are derived from deterministic ECMWF forecasts.

2.2 Use of products

Many ECMWF products are used for public warnings. The deterministic runs from 00 UTC and 12UTC are used for our quality controlled forecast database, which covers forecast lengths from 0 to 240 hours. Normally the deterministic forecasts above 30 – 42 hours are used. (Limited area models are selected for shorter forecast lengths.) Sometimes ECMWF is selected already from 6 hours. If the ECMWF forecasts show a large degree of 'jumpiness', a 12 hour older ECMWF forecast may be considered as more reliable. Then this older forecast may be used instead. An important application is warnings for severe weather for both short and medium range forecasts. ECMWF forecasts have a good reputation as a guideline for those warnings.

The EPS products from the ECMWF web page are also used for public weather warnings. Most common are wind- and precipitation products, but also plume charts for different places. The monthly forecast is used to obtain signals of a possible change of the general weather situation. An experimental product is the so-called lagged EPS. It is based on the last four deterministic runs from ECMWF and weight them. A more extensive study of the best way to used lagged EPS have be done this winter in order to get the best weights for the older forecasts. Also multi-model lagged EPS have be studies. It is found that combining the limited area model Hirlam with ECMWF gives extra value for probabilities also for such long forecasts as 60 hours.

3. Verification of products

3.1 Objective verification

3. Direct ECMWF model output (short range deterministic)

2 metre temperature

The quality of the ECMWF 2-metre forecast is high and for the short range essentially the same as for the Hirlam model (figure 1). The largest errors occured during winter and a positive bias were observed during that period. The mean absolute error is marginally larger for Hirlam than for ECMWF, but the potential economic value, as expressed by Kuipers Skill Score, is higher for Hirlam for low temperatures.

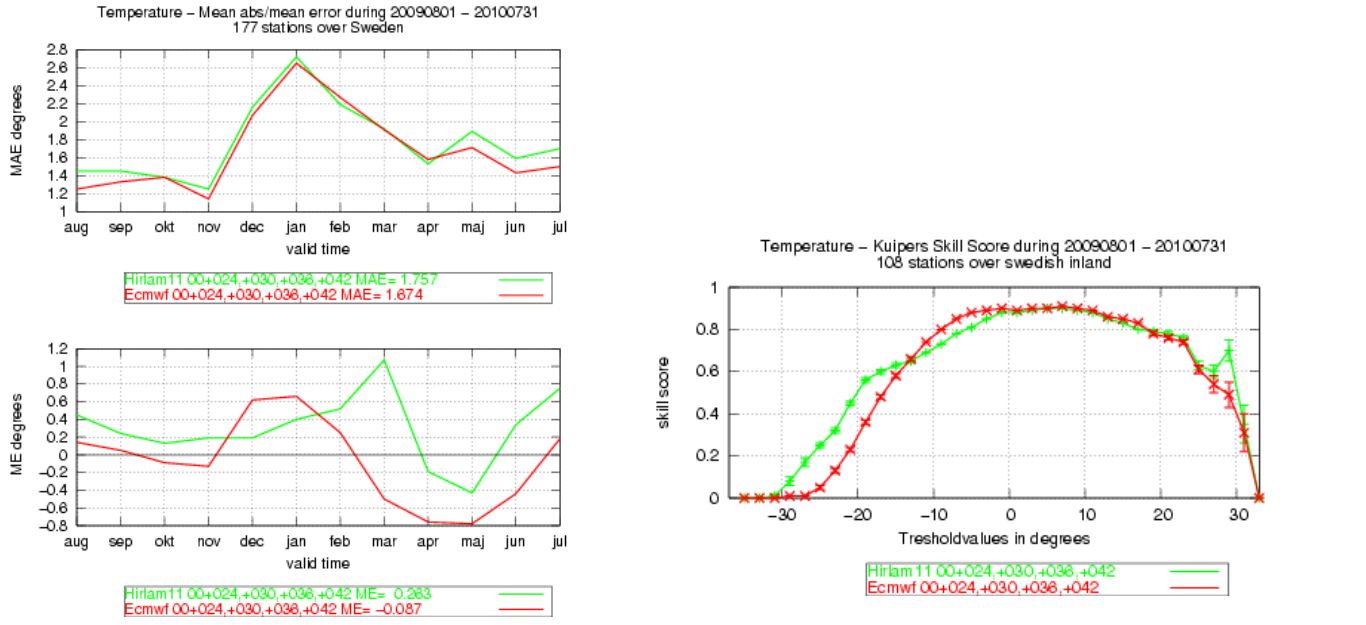

Fig 1. Left panels: mean absolute error and bias (mean error) for ECMWF (red) and for HIRLAM (green). Right panel: Kuipers Skill Score for different threshold values.

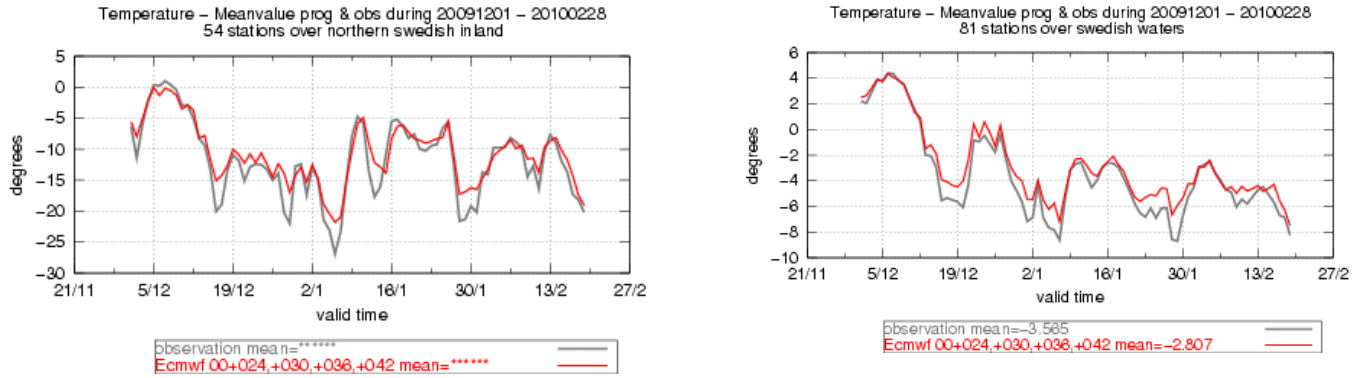

Figure 2. Observed (grey) and forecast (red) mean temperature for the winter season. Left panel: for inland stations in northern Sweden. Right panel: for coastal stations.

During winter time (figure 2) the largest temperature forecast errors were observed in the northern part of Sweden and and in coastal areas and during periods of observed low temperatures.

10 metre wind

For inland stations ECMWF overestimates the 10 metre wind with up 1 m/s (figure 3). This is specially true for night-time conditions where the positive bias is present both during winter- and summertime. During daytime the overestimation is present in the colder part of the year.

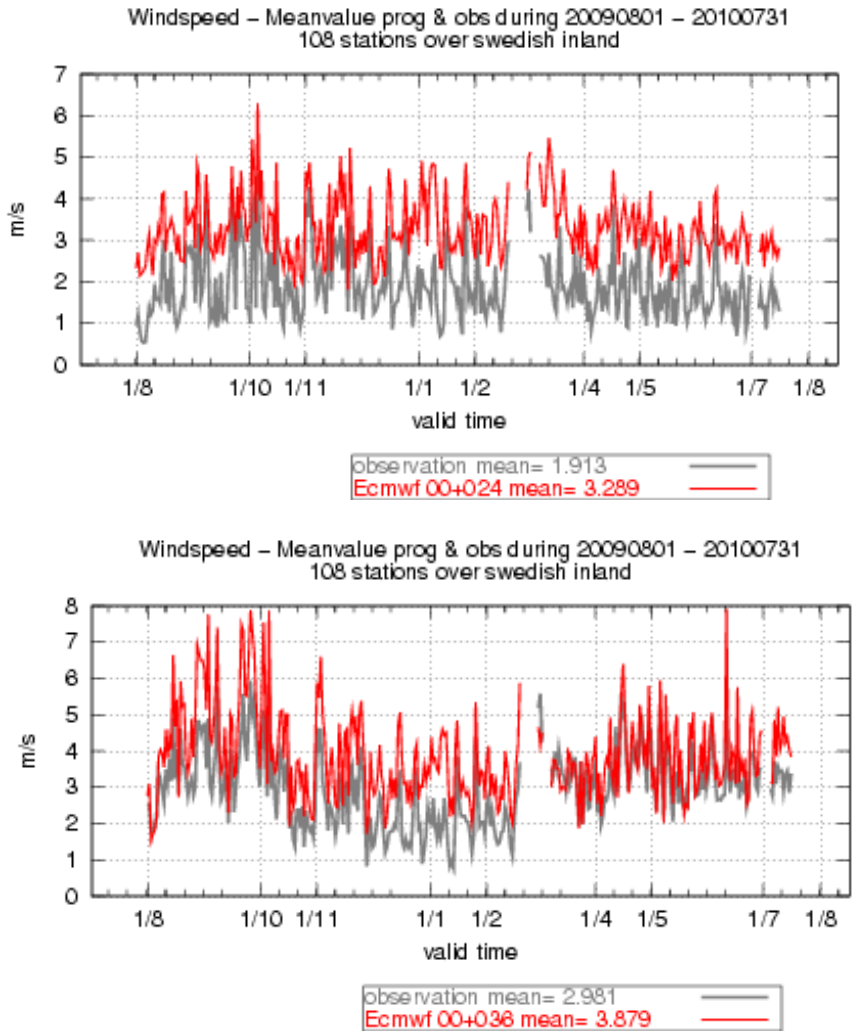

Figure 3. Observed (grey) and forecast (red) mean 10-metre wind speed for Swedish inland stations. Above a 24 hour forecast valid at 00z and below a 36 hour forecast valid at 12z.

Precipitation

The capability of different models to predict the probability of precipitation over certain threshold values and for different areal sizes can be monitored by using the Fractional Brier Skill-Score (FBSS). The observed and predicted 24 hour precipitations in this study are from May 2009 to April 2010. Observations from the Swedish climate station network (770 stations) have been used. The models are ECMWF, Hirlam and the Unified Model. (UM, Met Office model, but the UM-model forecasts have been produced by Met.no.) The sample climatology has been used as reference forecast. It is the observed relative frequencies of precipitation during this test period.

Sweden was divided into areas of a specified size. The fraction of observations over a threshold value and corresponding forecast fractions were calculated. Areas with less then 3 observations were not used. The observed sample frequency was used as the reference value in the FBSS calculations. The computation was made for different threshold values and area sizes. The result is seen in Figure 4.

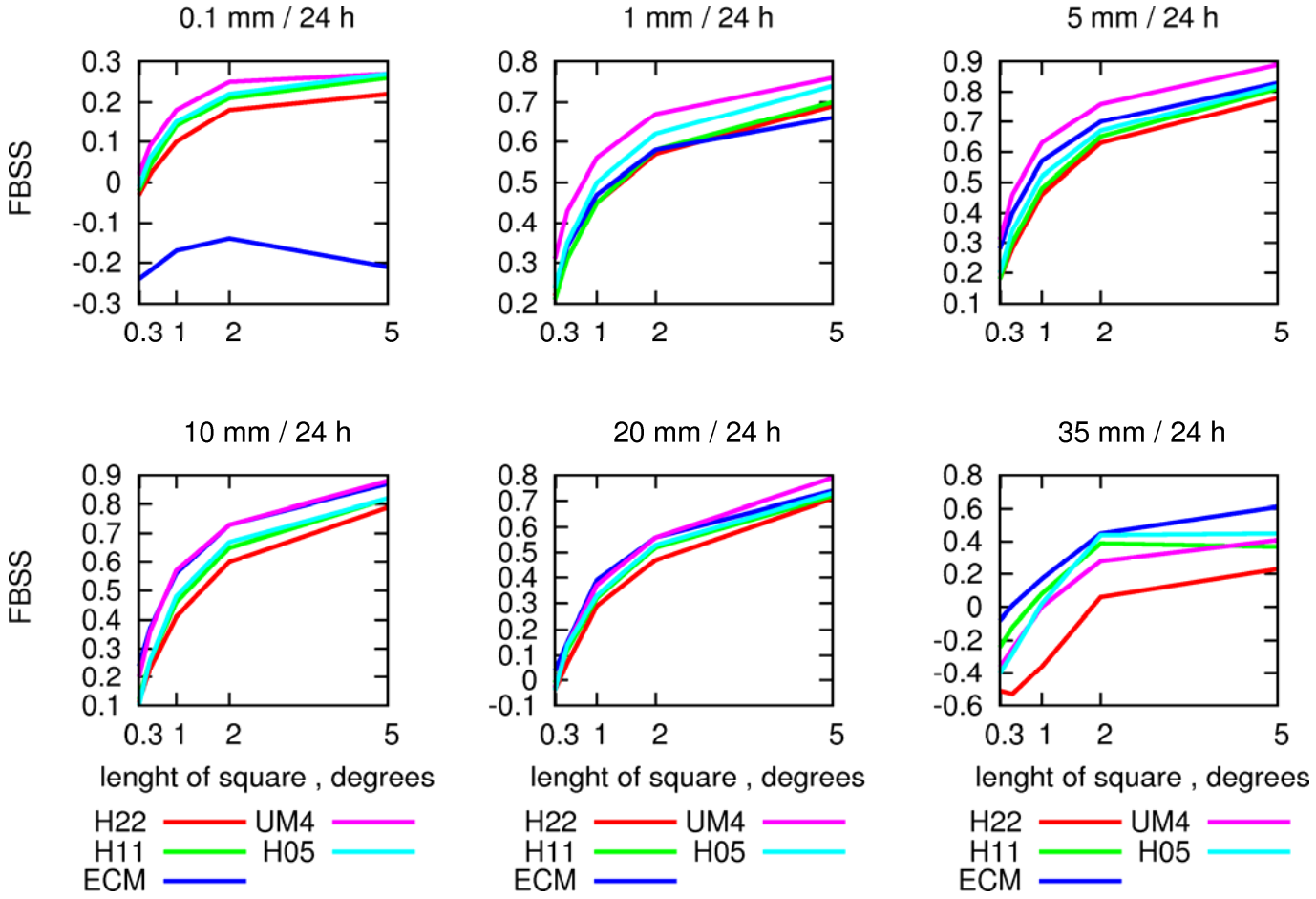

Figure 4: FBSS for different precipitation thresholds and areas. H22 (red), H11(green), and H05(light blue) are Hirlam with different horizontal resolutions in km. UM4 (rose-red) is unified model with 4km resolution and ECMWF (dark blue). The forecast length is 30 hours and 24 hours precipitation is verified.

ECMWF has the highest skill for most of the area sizes for 35mm, but for the smallest areas (square of 0.3 degrees) all models have negative skill. For smaller amounts the UM-model is the best. As for 2008 ECMWF forecasts are not that skill full for small amounts of precipitation. These amounts occur too often in the forecasts and this is the main reason for the negative skill for 0.1mm and the less good result for 1mm.

3.1.4 End products delivered to users

3.2 Subjective verification

One important forecast variable is the amount of low clouds. Generally, the quality of the low cloud forecast from ECMWF are good, especially in winter. But in very cold conditions, (2-metre temperatures -25 C or lower) low clouds are over predicted. In spring there is some under prediction. Those errors have been seen for several years.

The wind gust speed is over predicted over land. This may be good as a warning in some cases, but generally it creates to much false alarms for severe gusts.

4. References to relevant publications