Application and verification of ECMWF products 2009

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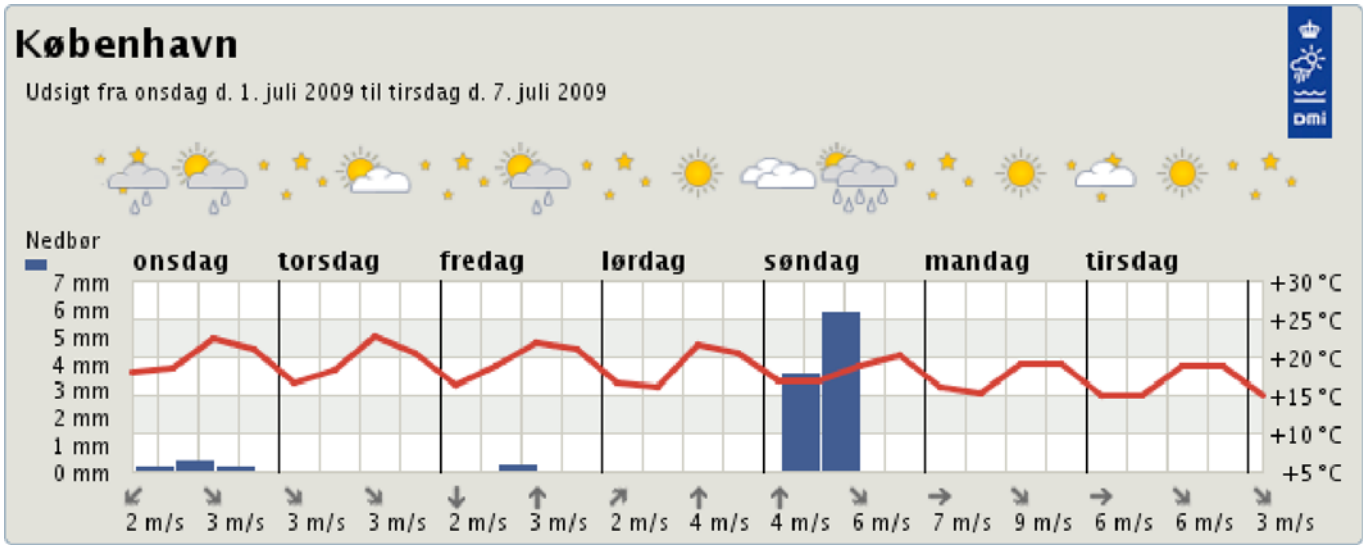
1. Summary of major highlights

The ECMWF deterministic forecasts are used extensively by the duty forecasters and also to produce a wide range of automatic forecasts. The ocean model is primarily used by the Danish Maritime Service, one of the largest ship routing services in Europe.

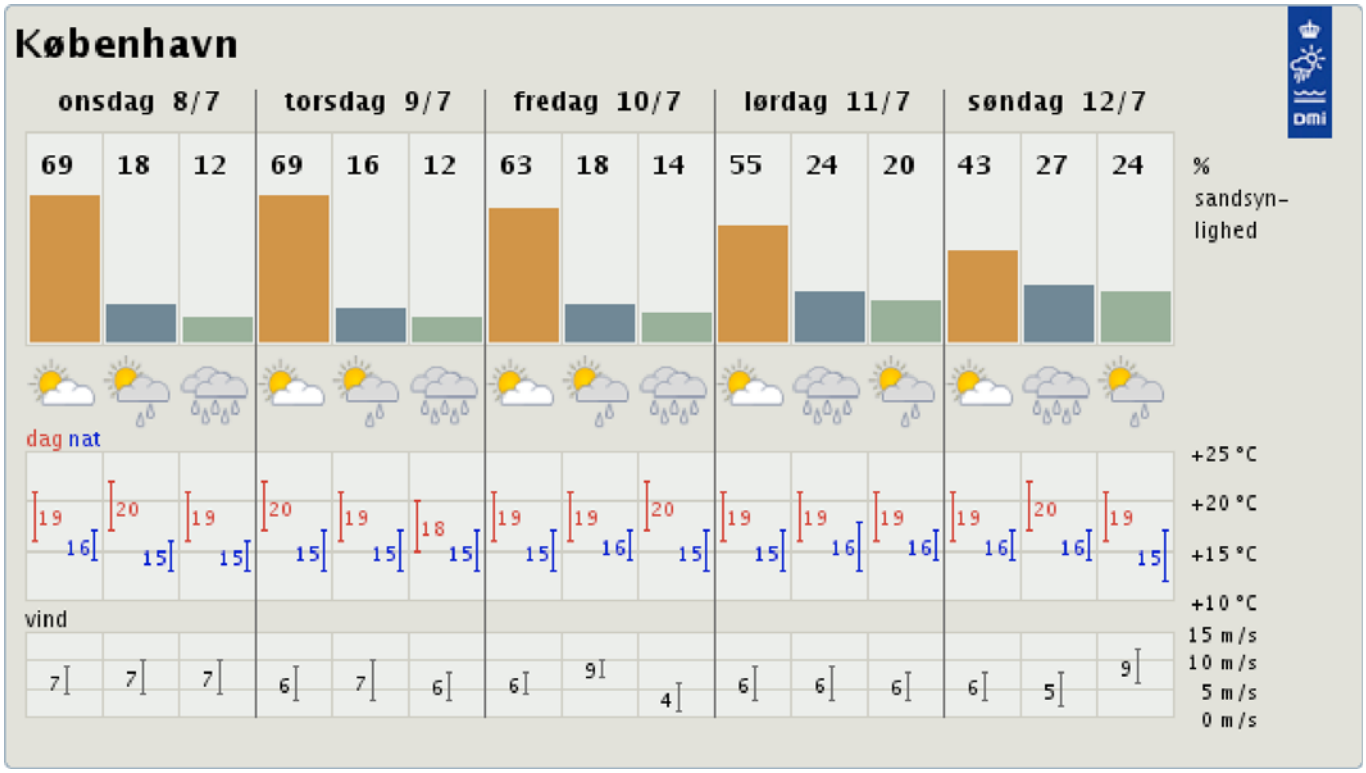
The information on the DMI website http://www.dmi.dk has been improved in geography as well as in time. Information in graphical format is now given for any city or town which has its own zip code. This is true for 536 places in Denmark. The information contains forecasts for the next 48 hours taken from HIRLAM and forecasts for day 3 through 9 based on ECMWF deterministic forecast.



3-9 day forecast for Copenhagen taken from www.dmi.dk

Last but not least probabilistic forecasts for day 10 to 14 based on ECMWF EPS system. Forecasts are given with probabilities for the 3 most likely scenarios based on the combined forecasted temperatures, wind, cloud amount and precipitation from a group of ensemble members with similar forecast values.

These forecasts were introduced in this form in 2008 and have been well received by the public, who apparently understands that the probabilities will not sum up to 100%.

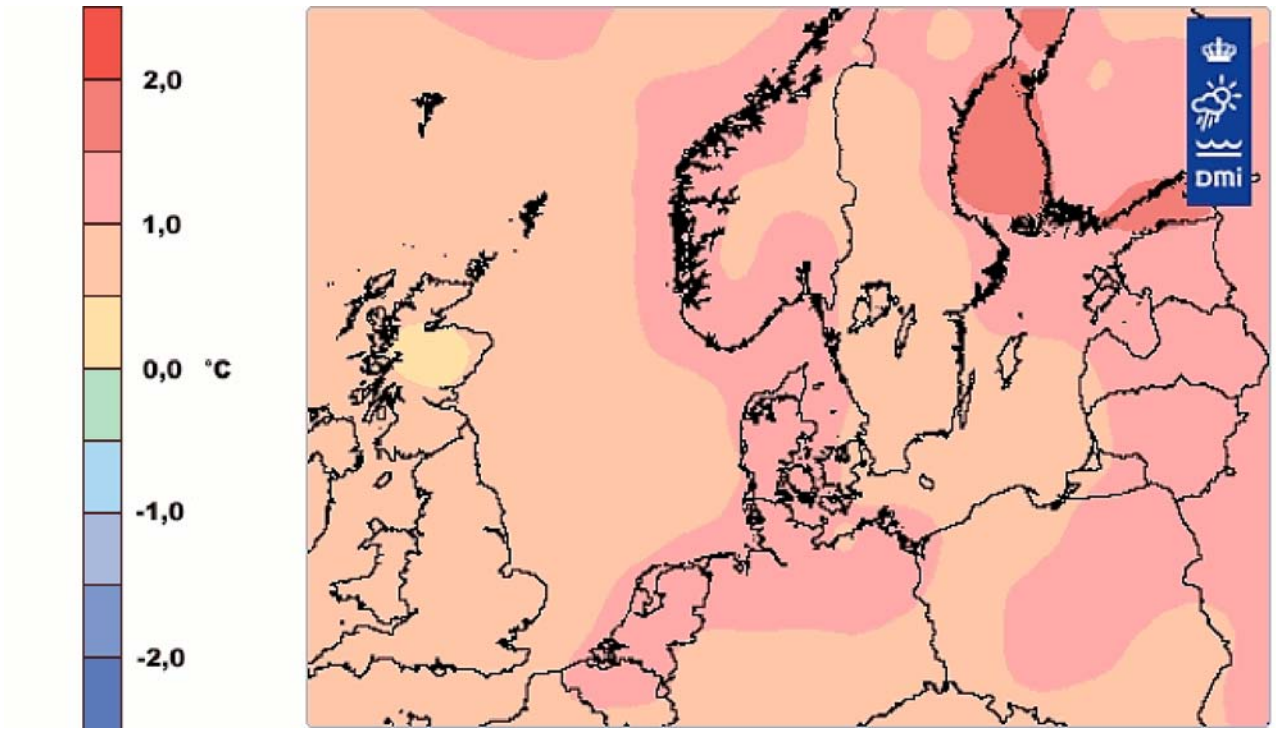


EPS forecast for Copenhagen

2. Use and application of products

Includes medium-range deterministic and ensemble forecasts, monthly forecast and seasonal forecast

A seasonal forecast for the 2m temperature for the Danish area of interest is displayed at our website www.dmi.dk.



Anomaly chart for the 2m temperature for Denmark and Northwestern Europe for July, August and September 2009

As the anomaly map at dmi.dk are based on a 30-years climate normal adapted from 1961-90, the DMI seasonal map differs slightly from the ECMWF presentation, which is based on a 30-years running mean. The seasonal forecast does get a lot of media attention during the spring.

The EPS output is used for a five days extension of our automatically generated deterministic forecasts on day 10-14. We also provide a 30-days probability forecast for the 2m temperature for commercial supply companies. Last the EPS products are used as general guidelines for the confidence of the regular day 1-7 forecast.

Given certain criteria are fulfilled a message is generated to the forecasters containing the highest winds, highest and lowest temperatures, the highest amounts of precipitation forecasted by EPS for a number of Danish locations. Included in the guidance message is the numbers of the ensemble members forecasting the extreme values.

2.1 Post-processing of model output

2.1.1 Statistical adaptation

Not used in any products. All filtering has been removed in 2008. There are several reasons for this. First the quality of the models has been improved to a level where adaptation to surface observations is no more required. Secondly this gives a faster and smoother after treatment of data for our automatic products. The last reason is greater flexibility of our automatic products, as we have become independent of surface observations.

2.1.2 Physical adaptation

Including limited-area models, hydrological models, dispersion models etc. using ECMWF model data as input

The Hirlam model has been upgraded in 2009. The suite consists of 3 different resolutions. ECMWF is used as boundary conditions for the 15 km model, which provides boundary conditions for the nested high resolution models. As an important element of the Danish disaster preparedness setup the weather service are able to make a trajectory calculation of pollutants based on ECMWF data.

2.1.3 Derived fields

None.

2.2 Use of products

Use of ECMWF products in operational duties, in particular in severe weather situations

The ECMWF medium range products including the EPS are extensively used as one of the primary sources of information in the public weather service. Also our commercial service is highly dependent on both the deterministic forecast worldwide as well as the quality of the ECMWF WAM model. The forecasters of the DMI Maritime Service are using the EC-models worldwide in order to produce forecasts and provide commercial ships with routeing advices. The onboard systems of the costumers of Maritime Service are supported with ECMWF GRIB data.

In potential severe weather situations the preferred models are the high resolution DMI-HIRLAM models, the DMI-WAM model and our 3-D seamodel BSH-cmod. As the in-house models are our primary tools in severe weather situation we have not really any experience with the EFI-index, but the deterministic model is quite usable.

3. Verification of products

Include medium-range deterministic and ensemble forecasts, monthly forecast, seasonal forecast. ECMWF does extensive verification of its products in the free atmosphere. However, verification of surface parameters is in general limited to using synoptic observations.

More detailed verification of weather parameters by national Services is particularly valuable.

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

Focus on local weather parameters verified for locations which are of interest to your service

The direct ECMWF model output is verified against observations for day 0, 3 and 5 which is corresponding to forecast lengths of +12hrs, +84hrs and +132hrs. We are making a monthly verification of max- and minimum temperatures. The observed maximum temperature over Denmark is estimated as the 80% quantile of all synoptic observations of the maximum temperature. This technique filters errors and outliers and provides some representative extreme values.

EC 1st qtr. 09	day(0)	day(3)	day(5)
HR 2 (%)	86	77	78
HR 4 (%)	100	98	98

EC 1st qtr.	obs-ec(0)	obs-ec(3)	obs-ec(5)
Bias	-1,0	-1,0	-0,5
MAE	1,1	1,1	1,2

Table 1: Tmax 1st quarter Hit Rate calculated for +/- 2 degrees for ecmwf direct output against observations (left). Right table shows bias and Mean Absolute Error

Table 1 (left) shows an almost perfect Hit Rate for +/- 4 degrees and fine scores for +/-2 degrees as well. The right yellow table shows a slightly negative bias for the maximum temperature. This might be caused by the verification methods as the most extreme values are filtered by the 80% quantile approach.

EC 1st qtr. 09	day(0)	day(3)	day(5)
HR 2 (%)	53	44	41
HR 4 (%)	69	75	65

EC 1st qtr.	obs-ec(0)	obs-ec(3)	obs-ec(5)
Bias	-2,6	-2,7	-3,0
MAE	2,8	2,9	3,7

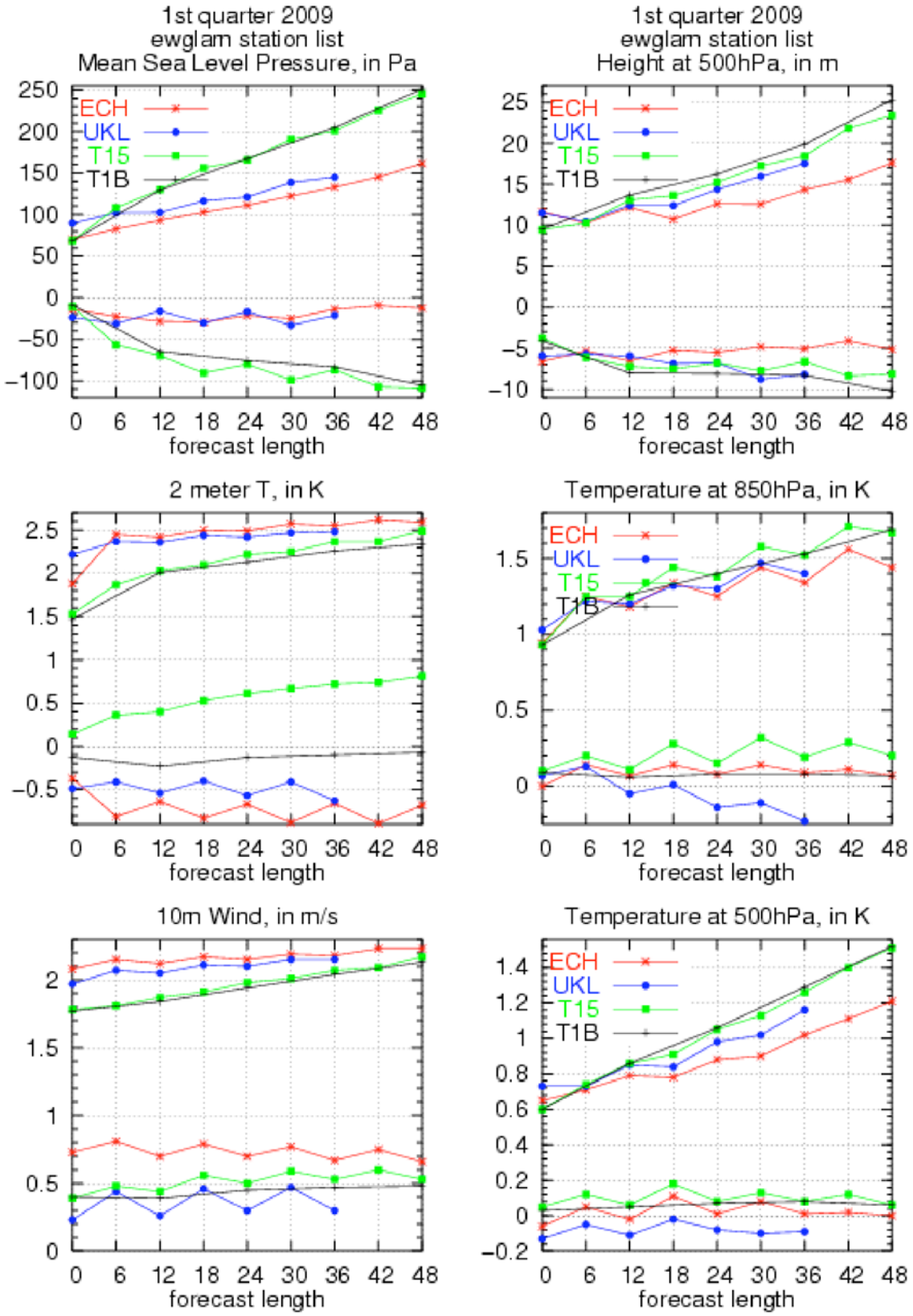
Table 2: Tmin 1st quarter. Hit Rate calculated for +/- 2 degrees for ecmwf direct output against observations (left). Right table shows bias and Mean Absolute Error

Table 2 (left) displays the performance of the model estimation of the wintertime minimum temperature over Denmark. There is so to speak confidence in a +/- 4 degrees prognosis but especially the Hit Rates for the +/-2 degree interval could be improved further. The right blue table shows a negative bias for the minimum temperature which in general can be interpreted as too warm model temperature during the Danish winter nights.

We have worked on a verification method of the forecasted total cloud fraction against automatic synoptic observations based on LIDAR ceilometers. However the project suffered from a general limitation of the quality of cloud fraction observations. The observed cloud fraction of convective clouds showed a high dependency of the wind velocity and we also had problems with proper observations of high semitransparent cirrus, so the project was dropped.

3.1.2 ECMWF model output compared to other NWP models

Comparison of performance of ECMWF model to other NWP models used by your service



Standard deviation (upper curves) and bias (lower curves) for EC, DMI-HIRLAM T15, UKM and T1B (DMI-HIRLAM test version) for various parameters

Verification for 1st quarter 2009 for surface parameters (left) and upper atmospheric values (right) for DMI-HIRLAM T15, ECMWF (ECH) and UKMO (UKL) against Ewglam station list. The included prognosis for T15 and UKL is with initial time 00UTC, 06UTC, 12UTC and 18UTC. For ECMWF the included prognosis is with initial time 00UTC and 12UTC. The upper curves show the standard deviation and the lower curves show the bias. The ECMWF outperforms the other models in the upper atmosphere and for the surface pressure bus scores (not surprisingly) slightly below the high-resolution models for the 2m temperature and the 10m wind.

3.1.3 Post-processed products

e.g. Kalman filtered products, calibrated EPS probabilities, etc.

Filtering and statistical after treatment is not used in any products.

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

In 2008 we conducted a survey of user satisfaction with our maritime forecasts for the Danish Waters, including short- and medium range forecasts. The survey was conducted on our website and the result was that 80 % of the users were very satisfied with the quality of the forecasts while 16 % was quite pleased. Only 4 % were not satisfied.. This was our only subjective survey last year.

3.2.2 Synoptic studies

Including evaluation of the behaviour of the model

Since the introduction of the T35R1 cycle there has been an over forecasting of convective precipitation on a small scale. This occurs especially in weak convective situations where a few grid points show a tiny amount of precipitation. The forecasters estimate that a slight under forecasting of showers has turned into a weak over forecasting.

The cloud prognosis is very good but has a weak point in the representation of low clouds.

4. References to relevant publications

None.