

Application and verification of ECMWF products 2013

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1. Summary of major highlights

Within the past year, DMI has launched a new website (Figure 1). The new dmi.dk is featuring web-television, forecaster based forecasts and automatic forecasts based on DMI's operational Hirlam model-suite and ECMWF IFS. DMI also has a smart-phone app with directly television transmissions featuring the duty forecaster at the central DMI weatherservice. The forecaster is using the NinJo presentation system for preparing the weather maps, which is directly based on ECMWF data for the medium range charts. ECMWF IFS output is the basis for the two build in applications 'City Weather' and 'the early warning of hazardous weather'.

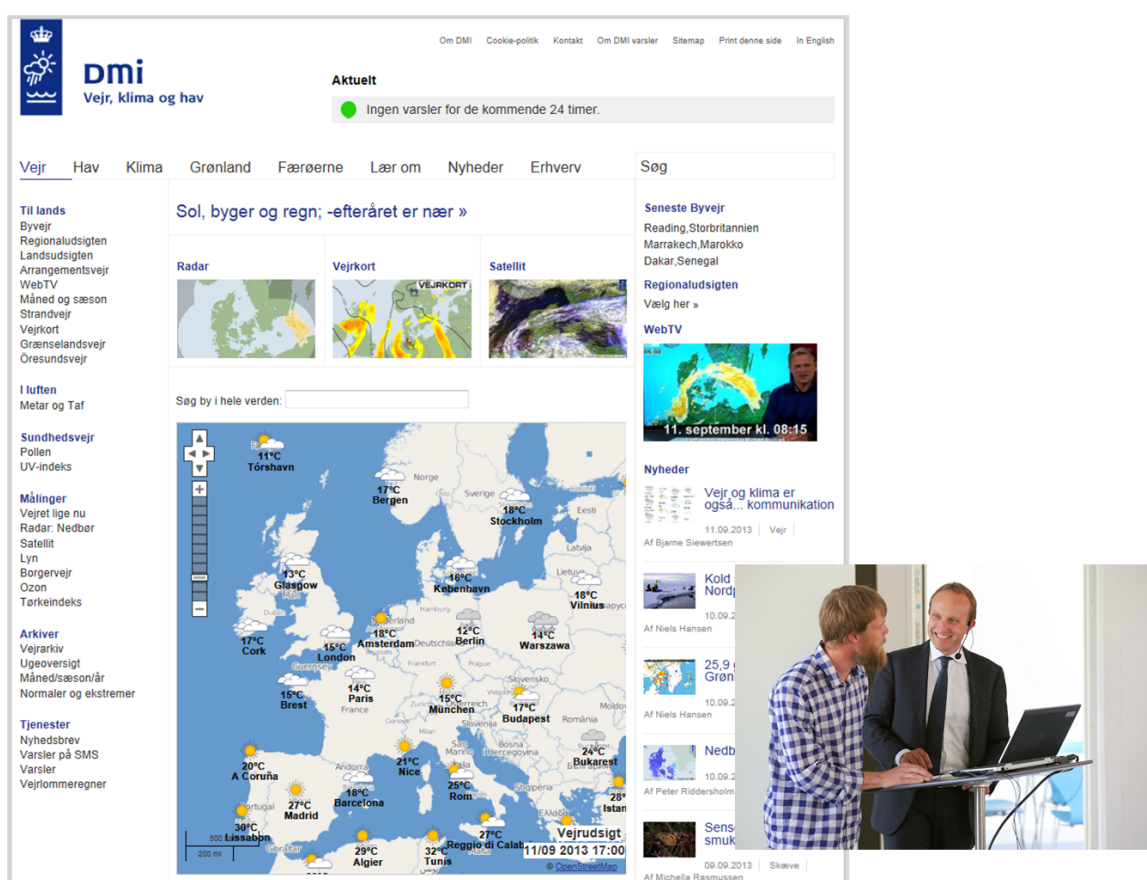


Figure 1: Figure 1 The remake of dmi.dk is featuring ECMWF-based world city weather with 150.000 sites. The small picture inserted is the Danish Minister for Climate, Energy and Buildings Martin Lidegaard, at the official launch of the new website on June 12th 2013.

The new web-site has improved graphic presentation of prognosis charts and weather maps, including an IFS based world weather map for travellers (Figure 2).

In March 2013 DMI had a member state visit from ECMWF. We highly appreciate these visits and we think that both the forecasters and developers benefits greatly by discussing the development and improvements of the ECMWF model system over the latest years.

2. Use and application of products

DMI has in 2012 introduced early warning of hazardous weather in the medium-range weather forecasts. The categories of hazardous weather follow the same criteria as the well-known warnings of hazardous weather, as DMI have been broadcasting to the authorities and the public up to 24 hours before a phenomenon is expected to occur. If the duty forecaster expects warning criteria to be exceeded, the phenomenon is discussed in the 7-day forecast and there will be a flag with brief information of the expected phenomenon in the warning box at dmi.dk. The duty forecaster is using both HIRLAM and HIRLAM EPS as well as ECMWF ENS as a basis for deciding whether to broadcast a warning. The forecasters are also using the ECMWF Extreme Forecast Index (EFI).

Most of the DMI operational production on the medium range timescale is based on ECMWF IFS data. The forecasters at the public weather service are using ECMWF data for both text forecast and graphics. Also the automatic generated forecasts are based on ECMWF after the first 48 hours.

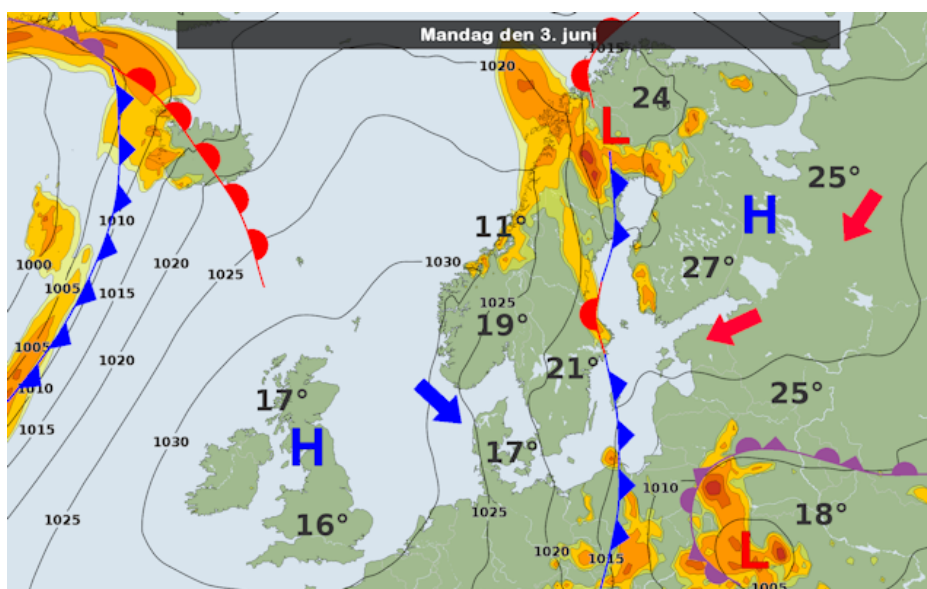


Figure 2: NinJo generated weather chart with ECMWF isobars and precipitation and additional fronts and graphics for the DMI Web-TV.

The DMI Web-TV has been around for a couple of years and are designed for smart-phone, tablet computers and standard internet browsers. The broadcasts are updated 2 times a day. Some of the content is based on ECMWF output, which can be manipulated in the NinJo presentation system. Many graphical features as for instance weather symbols and fronts can be added by the forecasters, see figure 2.

Every week the ECMWF IFS extended range forecast are used for a text forecast to the public at dmi.dk as well as different commercial products for the energy supply business.

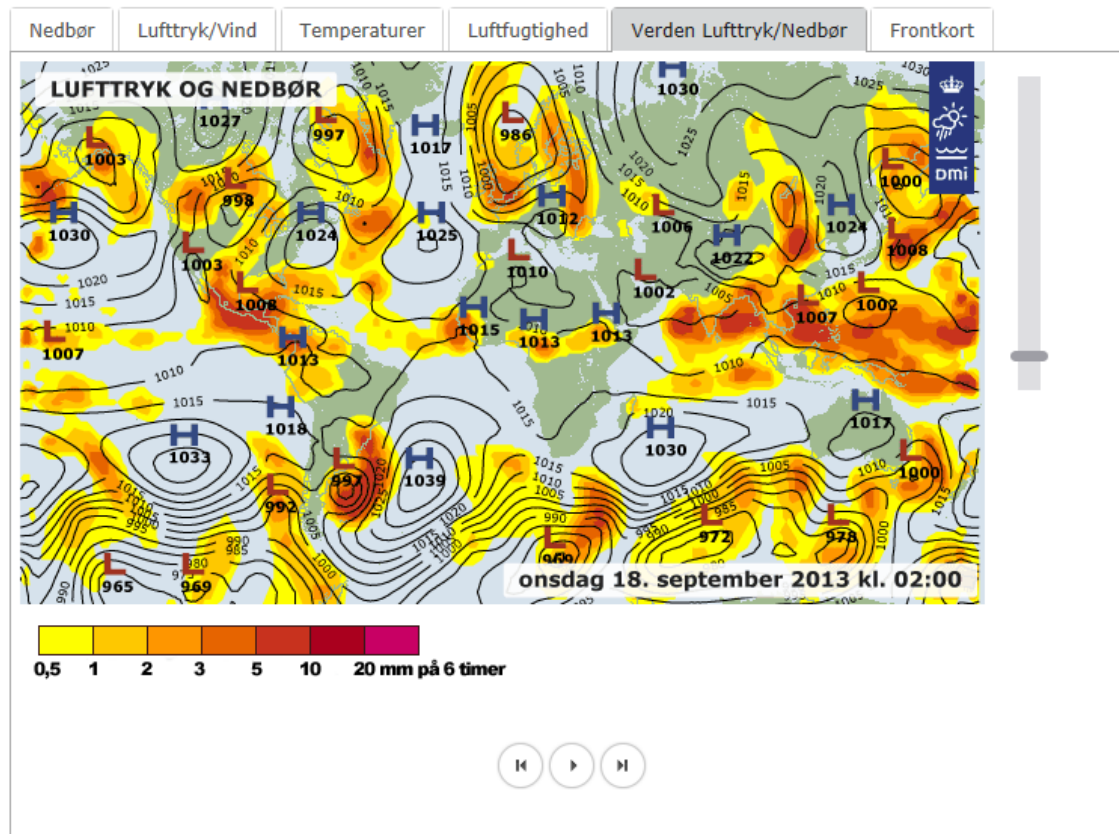


Figure 3: Animation frame for the World weather chart with pressure and acc. precipitation. IFS HRes model delivers the input to the chart.

DMI are generating point forecasts based on ECMWF for 150.000 cities worldwide especially targeted to Danish travellers. These forecasts have been supplemented with a graphic presentation of the world weather which is displayed in figure above.

The new on-line presentation system Eccharts looks fine and is quite usable for us. A wish for future developments is to include some more ENS data. The forecasters are interested in IFS percentile and ensemble mean fields, and we hope to see some fields for instance precipitation and cloud cover. Our primary interest is the Danish territory, including Greenland and the Faroe Islands.

In addition to the anomaly fields on Eccharts we would like a presentation of the running model mean for the latest 18 years, which are the reference for the presentations.

When using the Eccharts dashboard we would like pop-up windows for new charts, instead of redirecting the browser for the desired charts/presentations.

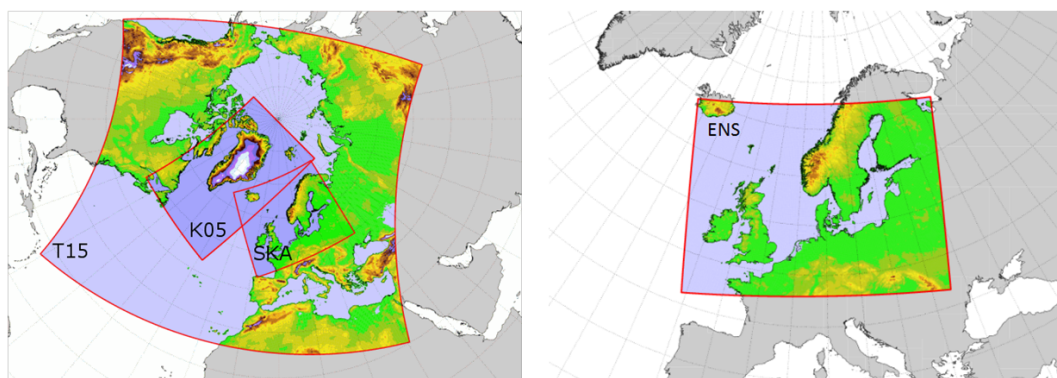
2.1 Post-processing of model output

2.1.1 Statistical adaptation

Filtering and statistical treatment of model data are not used in any products.

2.1.2 Physical adaptation

The HIRLAM model suite consists of three domains with different resolutions between 3 and 15 kilometres. All models are now running ECMWF boundary conditions as the nested HIRLAM models have been phased out (Figure 4).

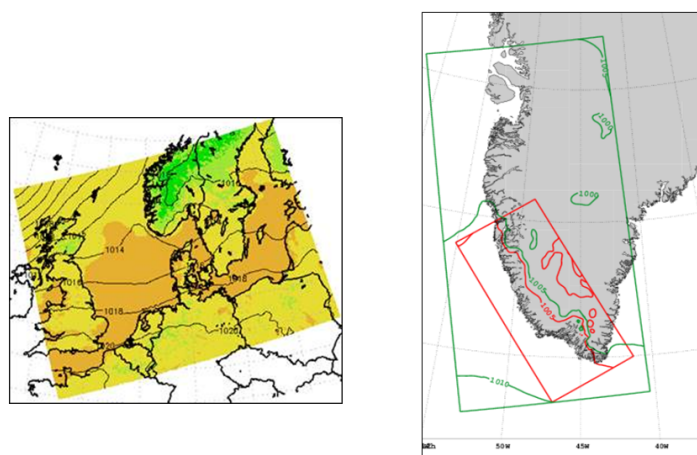


	T15	K05	ENS	SKA
Vertical layers	40	40	40	65
Horizontal res.	0,15° (16 km)	0,05° (5 km)	0.05°	0,03° (3 km)
Time step	400 s	150 s	150 s	90 s
Boundary	ECMWF	ECMWF	ECMWF	ECMWF
Lead time	60 hrs.	48 hrs.	54 hrs.	54 hrs.

Figure 4: DMI operational HIRLAM model-suite

DMI is also operating Harmonie non-hydrostatic models for both Denmark and Greenland, all running on ECMWF boundaries (Figure 5).

An important element of the Danish disaster preparedness setup is a dispersion model (DERMA) which is based on ECMWF input. This model is able to make a trajectory calculation of pollutants as volcanic ash and radioactive emissions.



	DKA37	GLA	GLB
Vertical layers	65	65	65
Horizontal res.	2 km	2 km	2 km
Boundary	ECMWF	ECMWF	ECMWF
Lead time	51 hrs.	51 hrs.	51 hrs.

Figure 5: DMI Harmonie model-suite

2.1.3 Derived fields

DMI is not using any derived fields from ECMWF NWP data, except for the seasonal temperature anomaly chart for North-western Europe, which are sometime used for energy briefings of commercial customers. The Danish City Weather product is using ECMWF Hres and ENS data without any filtering.

2.2 Use of products

The ECMWF IFS products are used as a primary source of information in the public weather service. In potential severe weather situations the preferred models are the high resolution DMI-HIRLAM models, the DMI-WAM model and our 3-D ocean model DKSS 2010. The in-house models are our primary source for information in severe weather situation, but also the ECMWF IFS and EFI are used as important tools for the disaster preparedness.

DMI's commercial service is highly dependent of both the HiRes forecast worldwide as well as the ECMWF WAM model. The forecasters of the DMI Maritime Service are using the ECMWF products worldwide in order to produce forecasts and provide routeing for commercial ships.

The onboard system SeaPlanner is supported with ECMWF GRIB data as part of the service provision. This system is also provided with ocean currents from an external supplier, and we would be happy to switch to ECMWF data. DMI Maritime Service is also running a web-based Maritime Forecast System for the off-shore costumers. The parameters of interest are surface pressure, 10m wind, gusts and sea state with sea and swell.

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both HiRes and ENS)

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 and minimum temperatures over Denmark are estimated as the 80 % quantile of all synop observations. This technique filters errors and outliers and provides some representative extreme values. The shown figures for the extreme temperatures are Hit Rate for ± 2 degrees. The score is valid for the entire Danish area, and is not taking the Faroe Islands and Greenland into account.

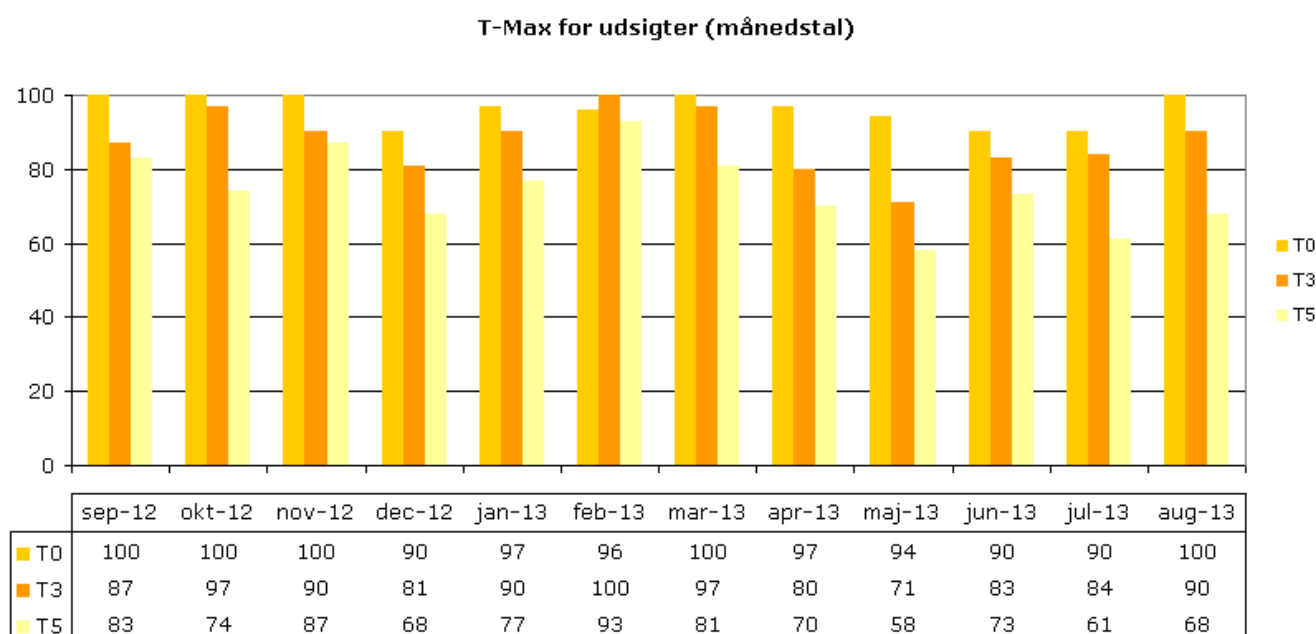


Figure 6: Monthly HR ± 2 for T max. of modified ECMWF HiRes output verified against the Danish synop network. T0, T3 and T5 corresponds to +12hrs, +84hrs and +132hrs. The scores show rather steady and rather high scores, however day 5 shows a lack of quality in December and May to July.

T_max udsigter (løbende 12 mdr.)

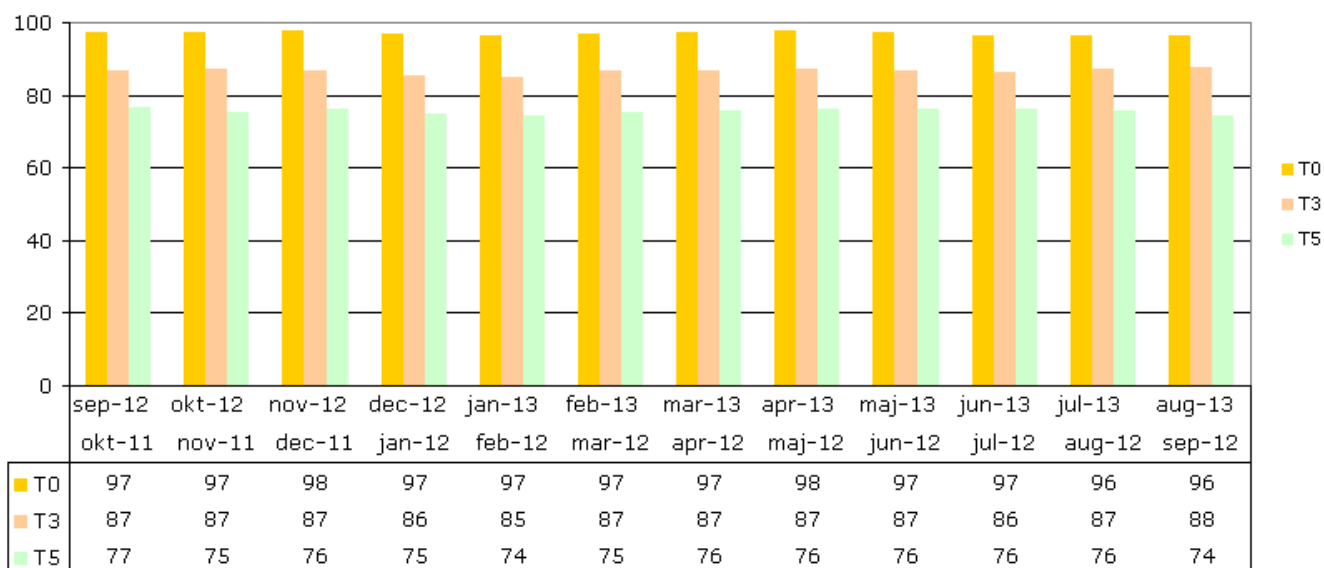


Figure 7: Running mean HR ± 2 for T max. of modified ECMWF HiRes output verified against the Danish synop network. T0, T3 and T5 corresponds to +12hrs, +84hrs and +132hrs. The scores are steady at a high level during the latest year.

T-Min for udsigter (månedstal)

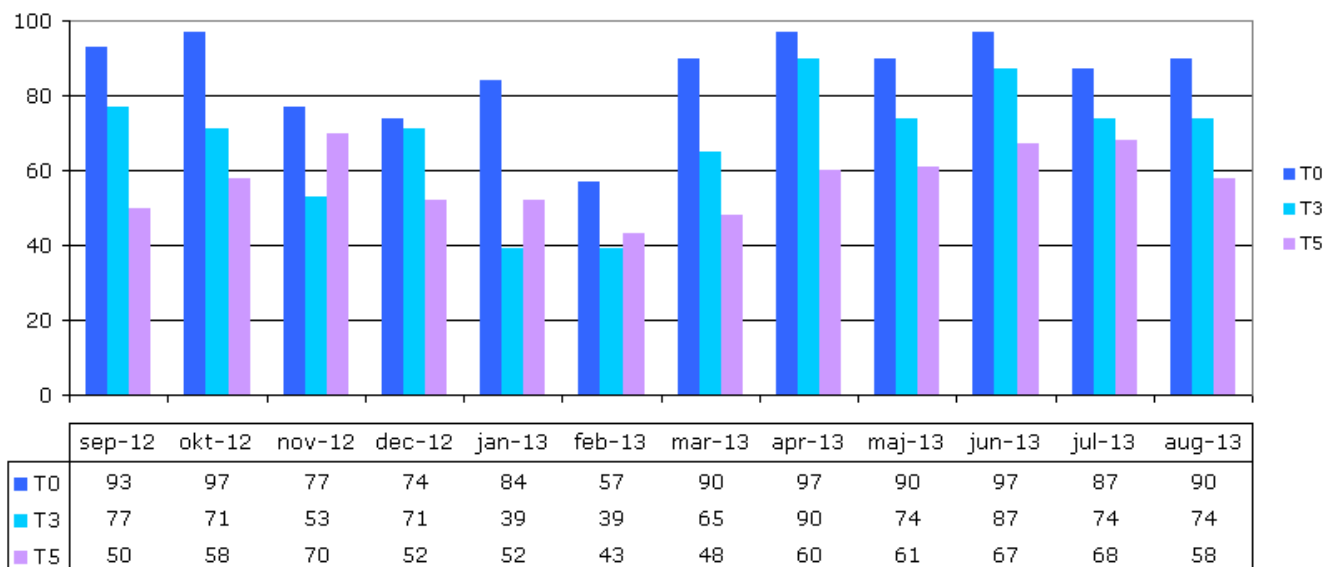


Figure 8: Monthly HR ± 2 for T min. of modified ECMWF HiRes output verified against the Danish synop network. T0, T3 and T5 corresponds to +12hrs, +84hrs and +132hrs. The scores are not at the same level as the maximum temperatures. The winter the scores have improved, the summer scores needs further improvement.

T_min udsigter (løbende 12 mdr.)

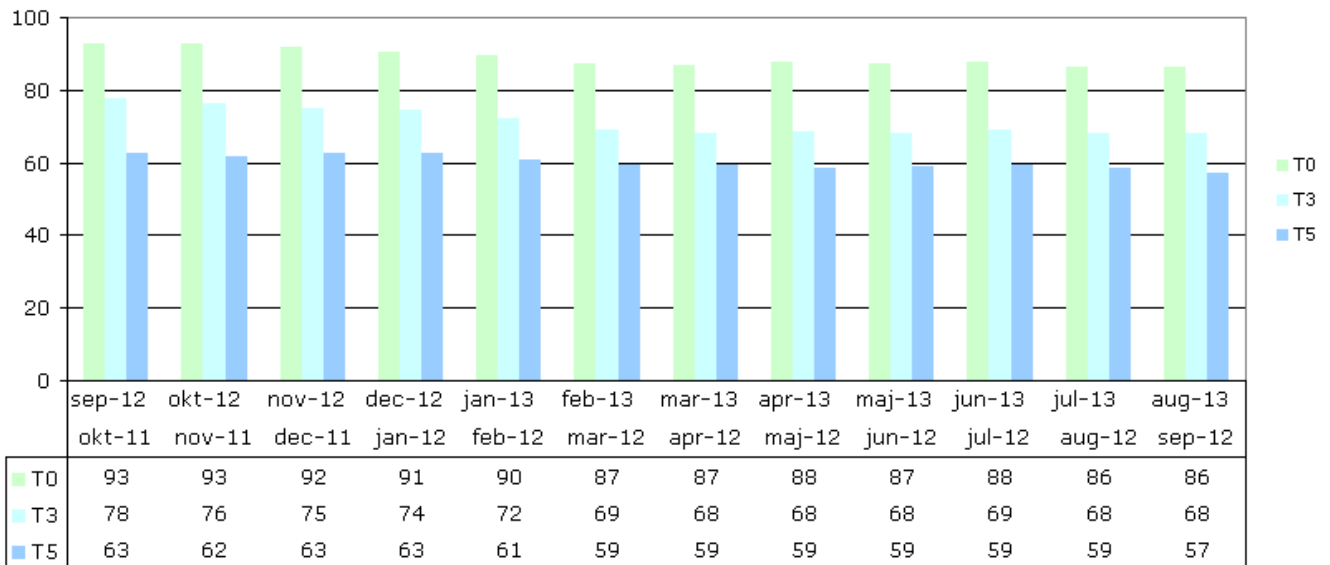


Figure 9: Running mean HR ± 2 for T min. of modified ECMWF HiRes output verified against the Danish synop network. T0, T3 and T5 corresponds to +12hrs, +84hrs and +132hrs. The scores show a little loss in quality during the latest year.

3.1.2 ECMWF model output compared to other NWP models

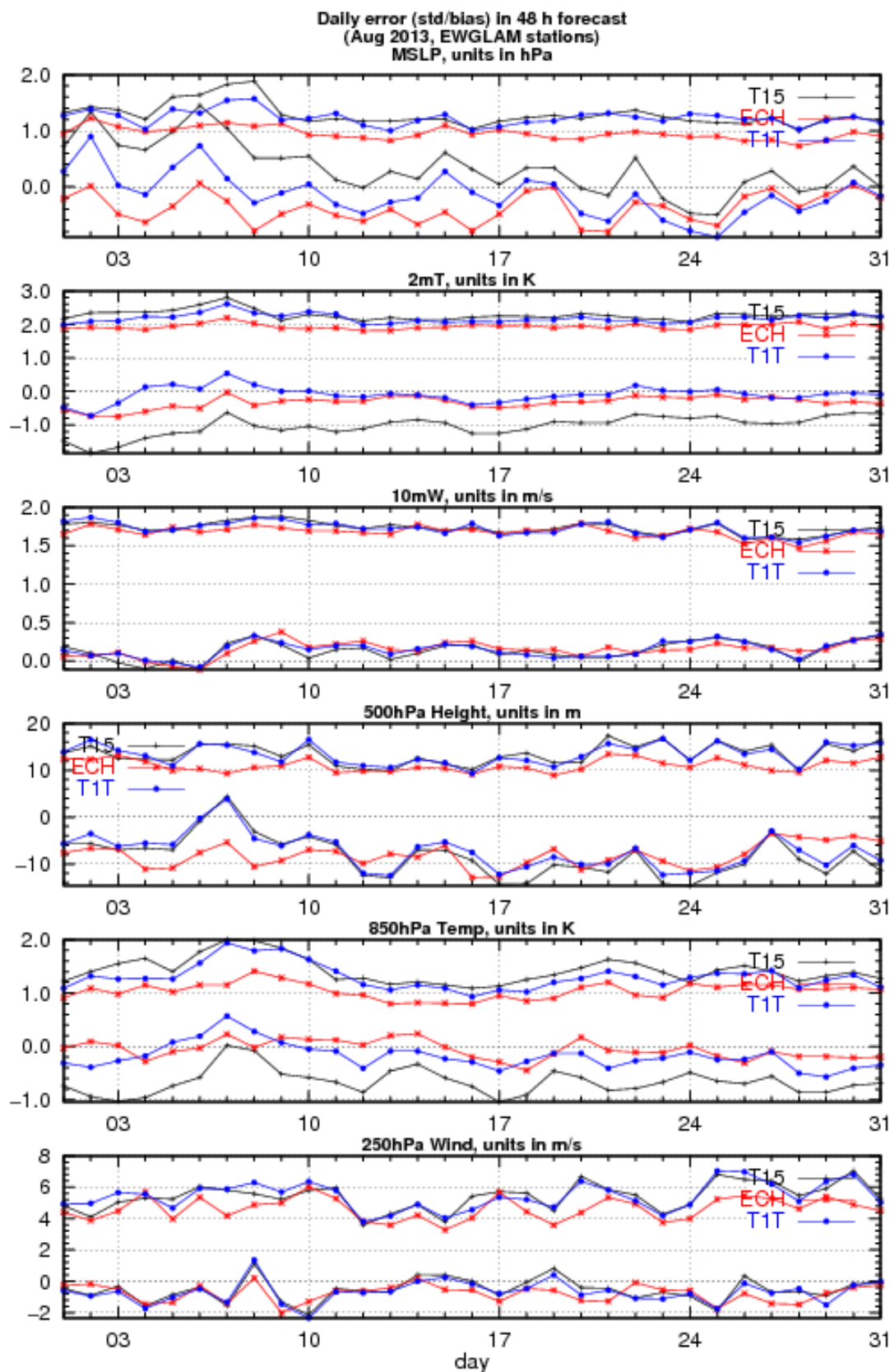


Figure 10: Daily verification of 48 hour forecast for selected parameters in August 2013. T15 is a coarse resolution HIRLAM (see Figure 4), T1T is a 1 km HIRLAM for research and ECH is EC-HiRes. EWGLAM station list and ECMWF analysis for acceptance / rejection of observations is used.

3.1.3 *Post-processed products*

DMI has phased out filtering and calibration of model output, as this is no longer needed due to improved quality and resolution of the models.

3.1.4 *End products delivered to users*

No verification.

3.2 **Subjective verification**

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

The forecasters are very pleased with the performance of the ECMWF IFS in general and especially the cloud cover, thus they also have noted a drop in quality of the winter minimum temperatures (see figure 8).

- Drop in quality of winter minimum temperature
- Clouds on Eccharts have improper black/white coloration, which makes it difficult to tell if there are any low clouds. The forecasters prefer the cloud coloration from the ECMWF website
- Eccharts has new prognosis runs around 1 hour before they appear in the DMI in-house presentation system NinJo
- Eccharts shows clouds in a 3 hours resolution which is better than the NinJo presentation

Wishes for the future:

- ECMWF website is used for the extended range (month) prognosis but the forecasters are missing a presentation of the models running mean climate, which are very important in addition to the anomaly fields
- More parameters for the monthly ENS extended forecasts on Eccharts
- Operational ocean currents

3.2.2 *Synoptic studies*

Reactions from the forecasters:

- ECMWF considered as the best global model
- Very good cloudcover
- Drop in quality of winter minimum temperature
- The presentations at the ECMWF website is nice and very usable

4. **References to relevant publications**

Only DMI internal verification has been used, so no references to publications.