Finnish Meteorological Institute

Some aspects of recent weather forecasting procedures at the Finnish Meteorological Institute

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The forecasting process and NWP models

The Finnish Meteorological Institute (FMI) uses ECMWF deterministic and ensemble forecasts a lot in its daily operational forecasting. FMI also operates two high resolution limited area models, which use ECMWF data as forcing at the forecasting area boundaries (Fig. 1). The operated models are:

♦ HIRLAM ("Reference model version of the international HIRLAM consortium"): horizontal resolution 7.5 km, four runs per day, 54h forecast

♦ HARMONIE: horizontal resolution 2.5 km, eight runs per day ("Rapid Update Cycle"), 54h forecast

The NWP model data can be processed at the meteorological work stations by manual edition or using the so called SmartTools, which are post-processing scripts developed by FMI forecasters (Neiglick et al., 2014). The edited NWP data forms the basis of various customer products.

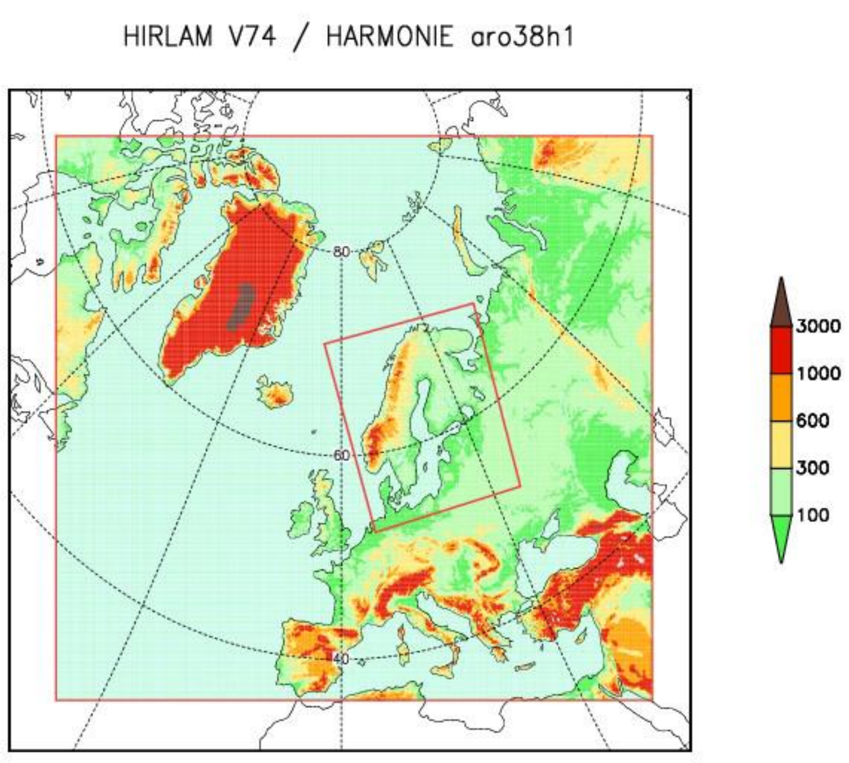

Fig. 1. Forecasting areas for HIRLAM (larger area) and HARMONIE (smaller area). Forecast data at boundaries come from the ECMWF .

Operational verification at FMI

Forecast verification has been carried out at FMI during ca 35 years. The HIRLAM system has been run operationally from 1990 on and the verification results show e.g. that the RMS errors of surface pressure and 500 hPa height in 2-day forecasts were in year 2012 lower than the corresponding values of 1-day forecasts 20 years earlier (Eerola, 2013).

The present verification system is versatile and flexible producing the yearly scores for administrative use (e.g. reports to ministry) as well as various scores and information to be used by duty meteorologists and researchers.

As an example, Fig. 2 shows the verification of ECMWF 60h temperature forecasts in 2014 for Helsinki-Vantaa airport. In general, the result seems good, the bias is small and the values are mostly near the diagonal of the scatter plot. However, at the cold side (wintertime temperatures, -5…-15 °C) there is more scatter. Also, the observed highest summertime temperatures (25…30 °C) were mostly somewhat underestimated in the forecasts. The forecast errors of temperature have a seasonal dependence, on average the errors are smallest in the autumn and largest in the winter or spring.

Early warnings and outlooks

Weather warnings form an important component in the "toolbox" of the meteorologist. The significant information about high-impact weather phenomena can be disseminated to general public and different authorities, to allow mitigating action to be taken. Warnings are issued on TV, radio and FMI's website.

In addition to the basic weather warnings, FMI has issued special warnings since year 2005. The so called **"Luova-outlook"** consists of a short alert e-mail, which describes briefly the expected weather event and there is also a link to a special warning webpage, where there is a comprehensive description of the event (and the related impacts):

- ♦ Reason for the outlook and probable hazard area
- ♦ Severity and timing of the weather event
- ♦ The development of the weather situation
- ♦ **Uncertainty** of the forecast (e.g. concerning the track of the storm or intensity of the weather event)
- ♦ When updating, changes compared to earlier outlooks
- ♦ Attachments (a warning map, radar image (see Fig. 3) etc.)

The first outlooks are issued up to 3 days prior to the event. A lot of different users have subscribed into the mailing list, e.g. road maintenance personnel, railway managers, Rescue Service and the Police etc.

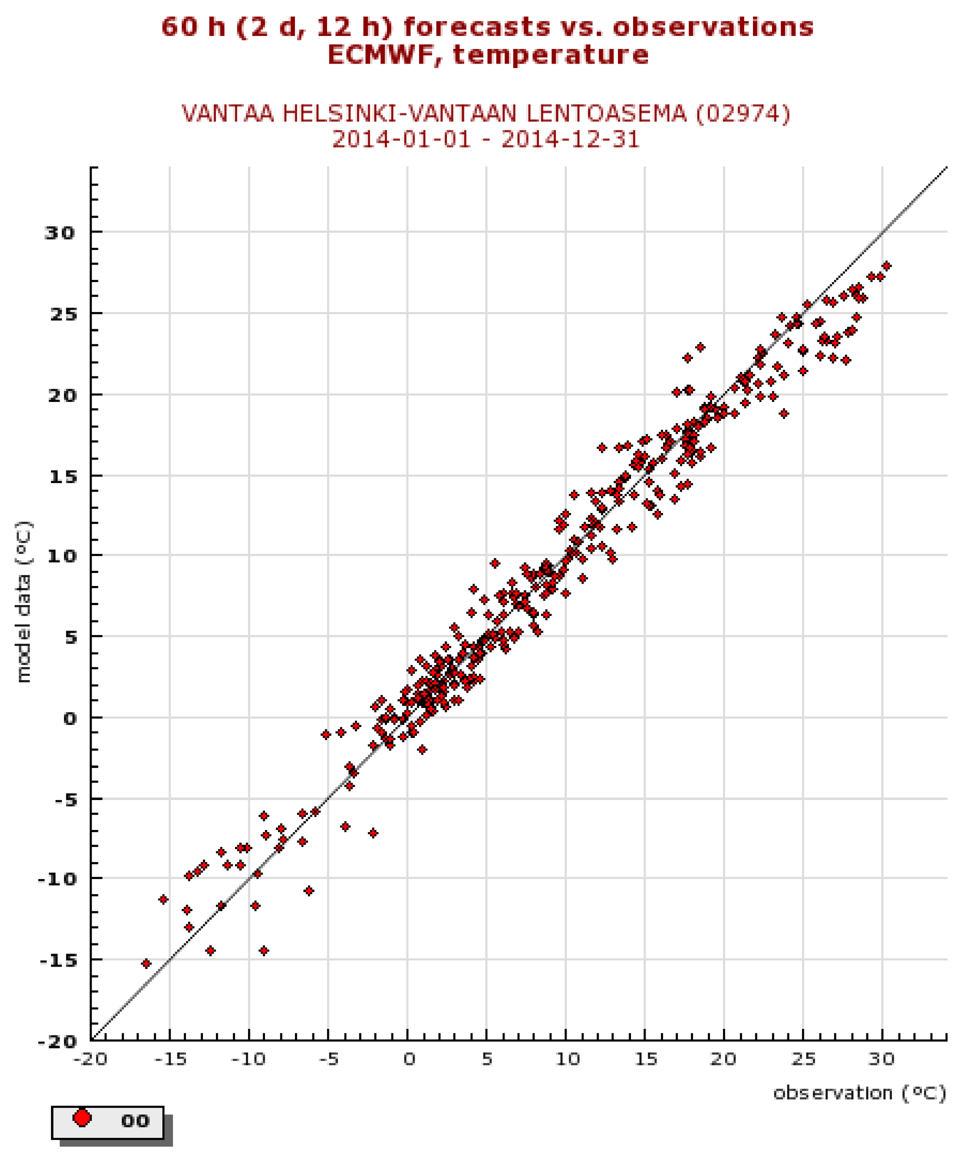

Fig. 2. Scatter plot of ECMWF deterministic 60h two metre temperature forecasts (vertical axis) against observations at Helsinki-Vantaa airport in Southern Finland. The forecasts are from the 00 UTC run and cover the whole year 2014. Scores: MAE=1.35 °C, ME=-0.15 °C.

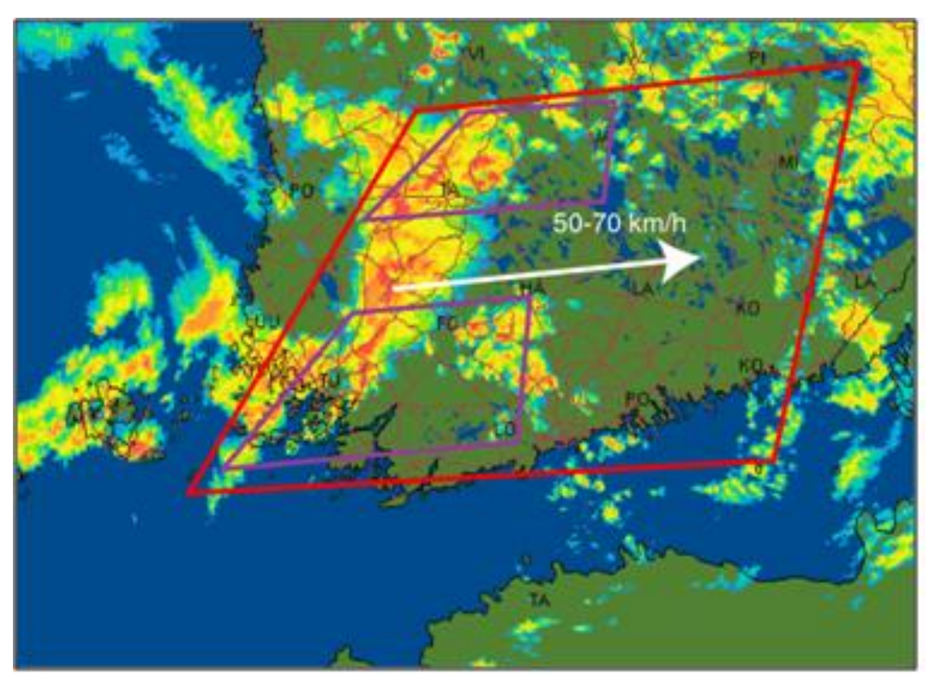

Fig 3. An example of an attachment in FMI's special warning, the "Luova outlook": Thunderstorm wind gust risk area during the next 3 hours (the larger area marked off with the red line) and two areas having highest probability for wind damage during the next hour (marked by violet line).

Related projects: EU FP7 project RAIN

RAIN project (Risk Analysis of Infrastructure Networks in response to extreme weather) studies the impacts of hazardous weather phenomena on critical infrastructure, i.e. transport, energy and telecommunication networks. The project will develop early warning systems, decision support tools and engineering solutions to ensure rapid reinstatement of the network (more info: www.rain-project.eu).

FMI is a partner in the project and focuses on winter phenomena, e.g. snow storms and snow loading. One important task is to study the skill of NWP models to predict high impact weather phnomena 2-5 days ahead, i.e. in the timescale of early warnings.

Fig. 4 shows an example of heavy snowfall events during four winters in southern Finland and the corresponding ECMWF +54h forecasts of 24h accumulated precipitation. The selection of cases is based on following criteria in the Helsinki-Vantaa airport observations: Daily mean temperature ≤0 °C, 24h precipitation ≥6 mm (the definition for heavy snowfall used in the RAIN-project).

The ECMWF "two day" forecasts were mostly successful in these cases (Fig. 4). Heavy snowfall events are mostly related to large scale low pressure systems and can be captured quite well a couple of days ahead by present NWP model versions. In the medium range it is better to use the ensemble forecasting system to produce probabilistic forecasts of different high-impact weather phenomena.

References:

Eerola K. 2013. Twenty-One Years of Verification from the HIRLAM NWP System. Wea. Forecasting 28, 270-285.

Neiglick S, Korpela P, Punkka A-J. 2014. Improving wind gust and precipitation form forecasts by post-processing ECMWF data. Book of Abstracts, UEF2014.

Acknowledgements:

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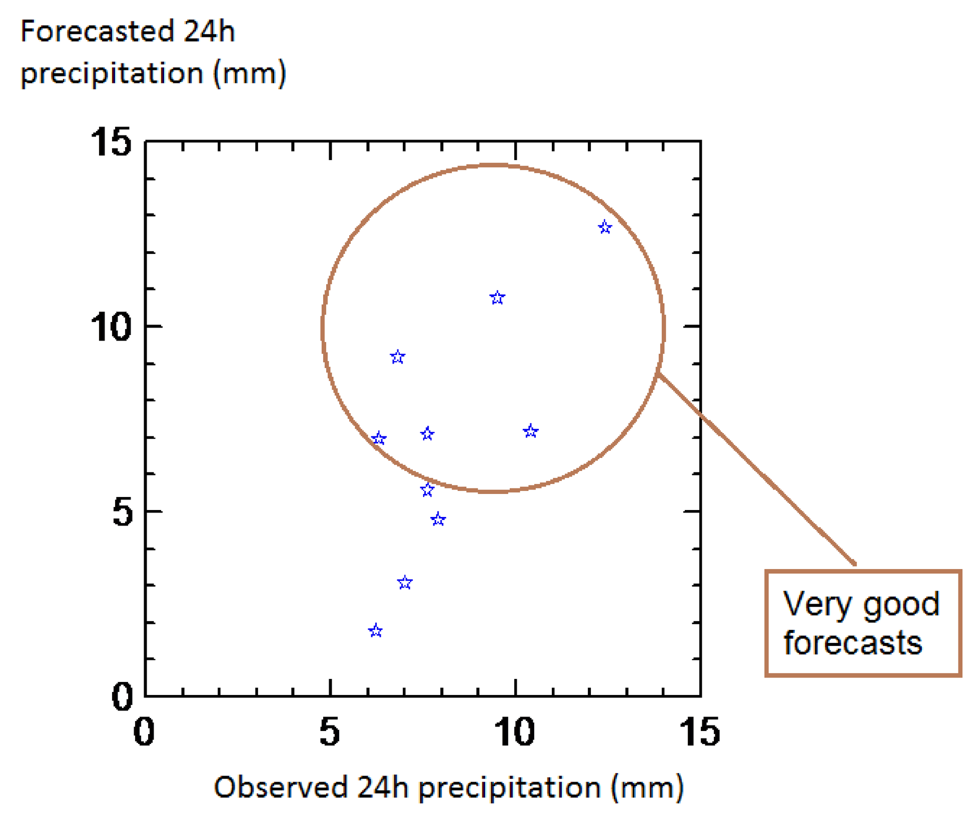

Fig. 4. Scatter plot of heavy snowfall events at Helsinki-Vantaa airport during four winters (2011/12-2014/15, November-March), showing observed precipitation amount (on horizontal axis) against ECMWF deterministic +54h forecast (from 00 UTC run) of accumulated 24h precipitation (vertical axis).

Public weather services on FMI's website

The FMI website (www.fmi.fi) includes up to date weather forecasts, warnings and observations. In June 2014 FMI started to issue local weather forecasts for the next 10 days (Fig. 5). Based on the probability distribution predicted by the ECMWF ensemble prediction system, uncertainty in the forecast is visualized by using the 50% and 80% ranges, both for temperature and precipitation. The user can select the location for information.

The example in Fig. 5 is interesting, because already on the third forecast day there happened to be a lot of uncertainty in the temperature forecast, and on that day general election took place in Finland.

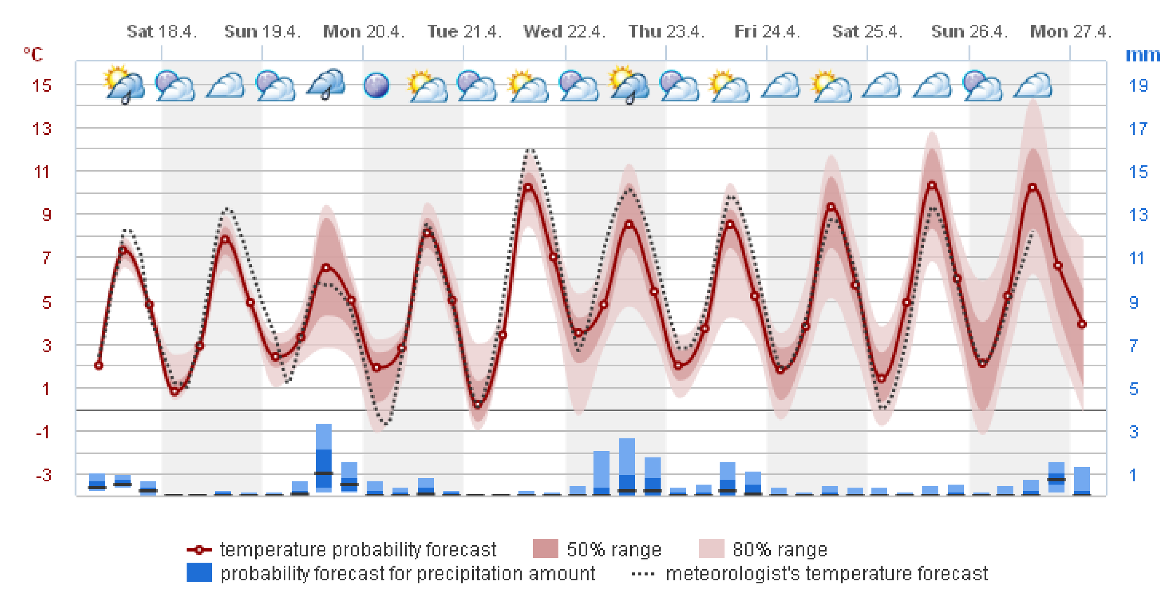

*Fig. 5. A ten day forecast for Vantaa, in Southern Finland, picked from the "menu" at FMI's website. Based on ECMWF ensemble forecasts, **uncertainty is visualized** by using the 50% and 80% ranges, both for temperature and precipitation.*

Increasing need for seasonal forecasts

There are plenty of customers who could make use of seasonal forecasts, e.g. energy firms, shipping companies and various contractors responsible for the maintenance of roads, railways and airfields. FMI has recently piloted seasonal (wintertime) sea-ice cover forecasts for some customers.

The skill of seasonal forecasts has been low in Europe up to now. FMI has followed up the usability of ECMWF system 4 seasonal forecasts in Finland (from August 2011 on). The model did not manage to predict the (few) observed negative temperature anomalies well, but was more successful in predicting positive anomalies. The amount of "no signal" forecasts was still far too large.

Conclusions

Forecast skill has improved substantially in the short and medium range during the last 20 years while the model resolution has improved. The increasing computer capacity has made it possible to run FMI's high resolution limited area model in a "rapid update cycle", i.e. eight times a day.

All this enables effective warning services: Early warnings and outlooks, accurate warnings in the 24h range with continuous follow-up and updates, and also impact forecasting when possible.