

HIRLAM EPS work at the Norwegian Meteorological Institute

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1 Introduction

At the Norwegian Meteorological Institute we have run a limited area ensemble prediction system (LAMEPS) since mid-February 2005. LAMEPS is run with the Norwegian version of the HIRLAM model and it is driven by members of the ECMWF EPS which are targeted to northern Europe and adjacent sea areas after 48 hours (TEPS). A multi-model ensemble system (NORLAMEPS) is also produced which simply combines LAMEPS and TEPS by using all ensemble members from both systems simultaneously. This combination gives a larger ensemble without extra model runs. In this way NORLAMEPS is designed to partly account for forecast errors caused by model imperfection.

2 Model setup

LAMEPS is an ensemble of runs with the Norwegian version of the limited area model HIRLAM with horizontal resolution 0.2° with 40 levels in the vertical (see Figure 1 for the integration area of LAMEPS). It uses ensemble members from TEPS to perturb both the initial and the lateral boundary conditions. LAMEPS is run at 18 UTC every day and the forecast length is 60 hours.

TEPS uses the same model version and the same setup as used for the operational EPS at ECMWF. Only 20 ensemble members are computed as opposed to 50 for EPS. The singular vectors are targeted to maximize the total energy at final optimization time (48 h) in the chosen target area (see Figure 1). The TEPS forecast length is 72 hours and it is run at ECMWF once per day at 12 UTC.

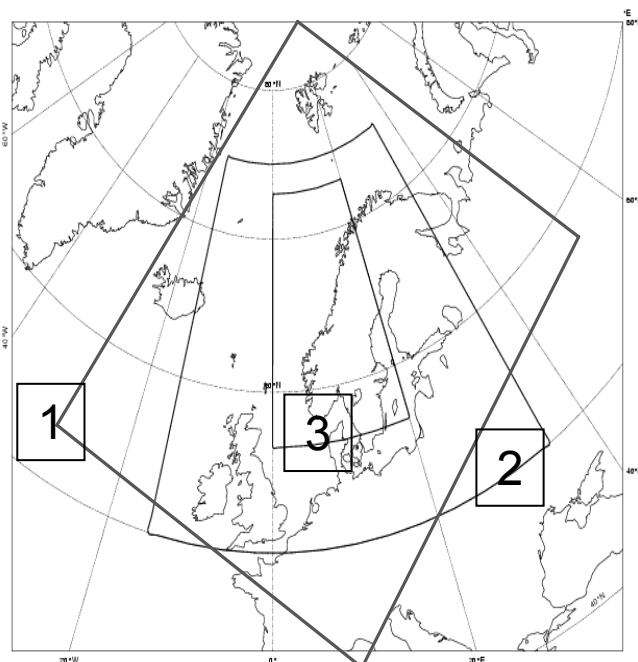


Figure 1 Areas referred to in the text. Area 1 is the HIRLAM integration area, area 2 is the target area for singular vectors used by TEPS, and area 3 is the verification domain.

NORLAMEPS combines the forecasts from TEPS and LAMEPS to provide a single statistics for events, even though they are not entirely independent of each other. Without extra cost, the total number of ensemble members is then 41 in addition to the HIRLAM control forecast.

3 Products

Every day several products from LAMEPS and NORLAMEPS are made available to forecasters at the Norwegian Meteorological Institute (met.no). This includes probability maps of temperature, wind and precipitation, plumes of MSLP, wind, temperature and precipitation as well as maps of mean and standard deviation of a few parameters. In figure 2 an example of the mean of MSLP from NORLAMEPS is shown together with the standard deviation of the same parameter (in colour). These kinds of maps quickly gives the forecaster an impression of where the uncertainty is the largest in the prognosis and how large it is.

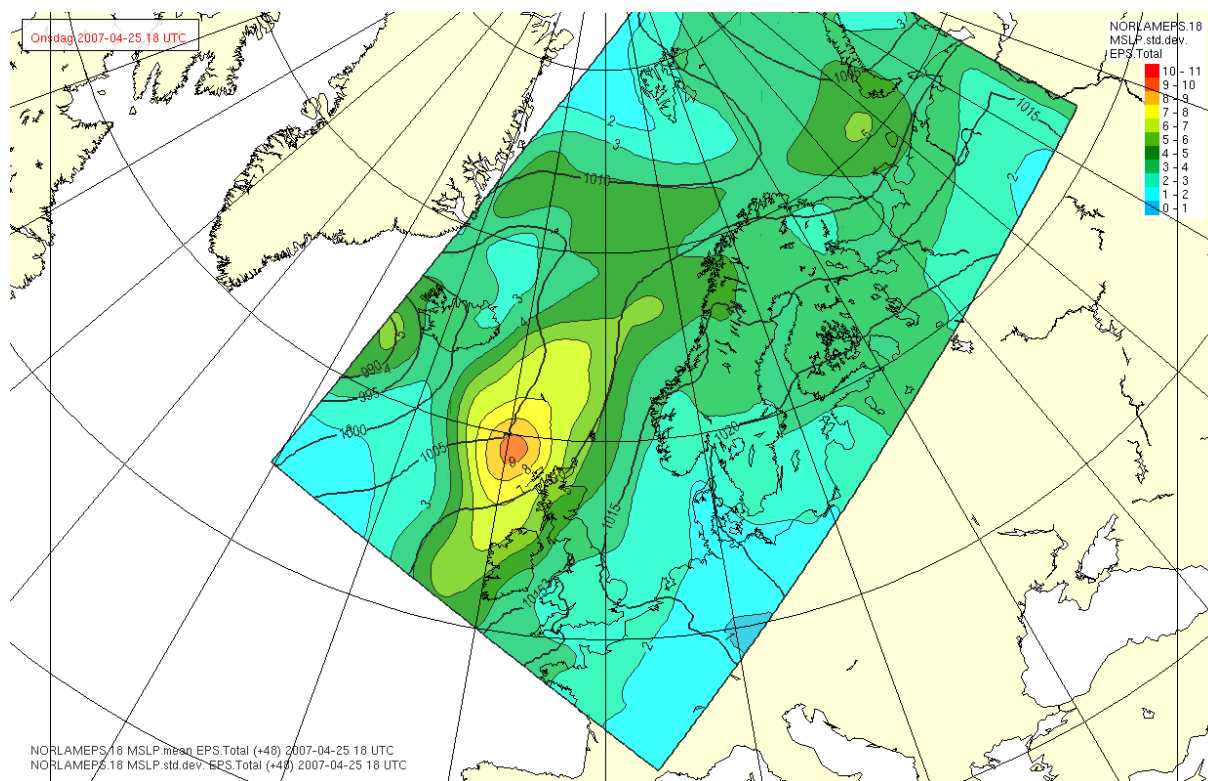


Figure 2 An example of a daily product from NORLAMEPS. Shown is the ensemble mean of MSLP (black solid line) and the standard deviation of MSLP (colour).

4 Verification

The main focus of the NORLAMEPS system has been on weather parameters, such as precipitation. Special emphasis has been on severe events. Extreme weather events are often associated with structures that are localized in space and time. Although the global ensemble prediction systems gradually increase their resolution, many mesoscale processes are not well represented in these models. A system based on a limited-area model with higher resolution could therefore improve the

forecasts. As an example of verification of our LAMEPS and NORLAMEPS systems, the area under the ROC-curve for these two systems is shown in Figure 3 for the verification area shown in Figure 1 together with TEPS and ECMWF EPS (all 50 + 1 members). More verification results can be found in Frogner et al. (2006) and Jensen et al. (2006). Although the LAMEPS system has the lowest score, the combination ensemble NORLAMEPS has the highest score for all thresholds. EPS and TEPS are comparable up to medium thresholds, despite the different ensemble sizes.

For precipitation LAMEPS is for most verification times and verification measures inferior to the global ensemble prediction systems (EPS and TEPS). This is in contradiction to earlier results (Frogner and Iversen 2002). One possible reason is that the EPS has been considerably improved since 2002. Another reason is believed to be the mismatch between the ensemble spread and the error of the ensemble mean that TEPS suffers from at the moment (not shown). The spread for TEPS is at the moment too big, and we need to do a retuning of the initial amplitude perturbations. This work is in progress, as well as several other updates to our system (see section 5 of this paper).

Although the performance of LAMEPS is disappointing, the performance of the combination ensemble (NORLAMEPS) is much better. The combination of LAMEPS and TEPS is able to add value to the two individual systems. As the spread of NORLAMEPS is larger than the spread of the two individual systems (not shown), LAMEPS describes a different subset in phase space than TEPS, although the individual ensemble members of LAMEPS are from TEPS. The improvement of NORLAMEPS can partly be due to increased resolution of LAMEPS, and partly from the fact that NORLAMEPS combines results from two different models.

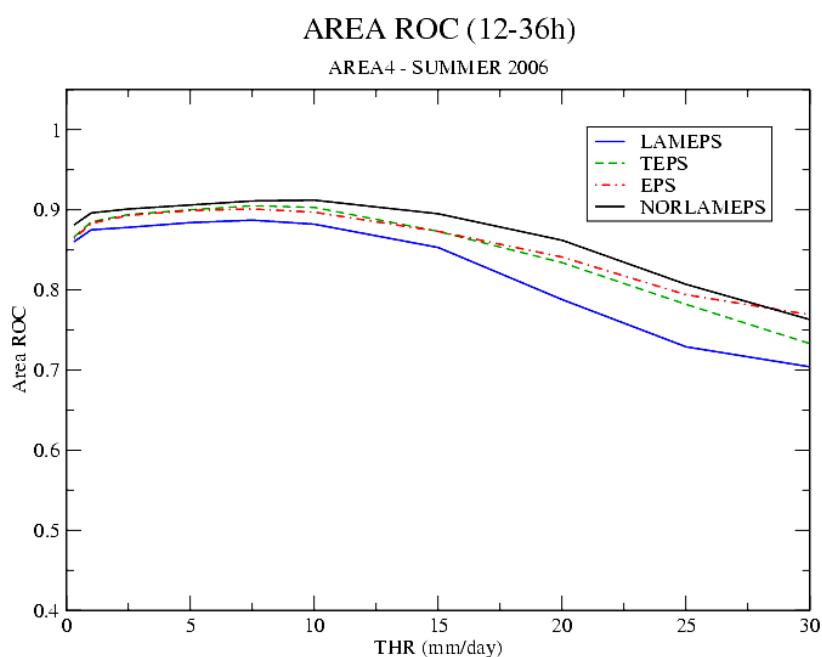


Figure 3 Area under ROC-curve for precipitation accumulated over 24 h as a function of threshold value (THR). 12 h – 36h.

5 Options for improving the systems

Work is under way to improve the systems, both TEPS and LAMEPS. When it comes to TEPS we are now testing to run the targeted singular vectors orthogonal to the operational, hemispheric singular

vectors and with a higher resolution (T159 as opposed to T42), shorter optimization time (24 h as opposed to 48 h) and for different target areas that will cover different parts of Europe. The amplitude of the perturbations will be tuned to best match the error of the ensemble mean.

LAMEPS will be given higher resolution, possibly 12km (now about 20km) and the HIRLAM version will be updated to 7.1 (now 6.4).

6 References

Frogner, I.-L. and Iversen, T. (2002). High-resolution limited-area ensemble predictions based on low-resolution targeted singular vectors. *Q. J. R. Meteorol. Soc.*, **128**, 1321-1341.

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