Application and verification of ECMWF products 2010

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1. Summary of major highlights

In 2009 there were two new developments at KNMI concerning the use of the ECMWF model. The first item is the development of 100% stacked column diagrams for several parameters, e.g. maximum temperature, using the operational 15-day EPS -forecasts. These graphs are available on intranet, for the forecasters and other internal interested persons.

The second development was the first attempt to forecast a 10-day de-icing capacity for airplanes. Different de-icing phases in relation to the chance of de-icing capacity needed are distinguished. The graphs were made available to the "iceman" for the 10-day planning at Schiphol Airport. At the moment this product has a semi-operational status.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaptation

2.1.2 Physical adaptation

2.1.3 Derived fields

2.2 Use of products

The forecasters at KNMI are used to work with the 10 and 15 days EPS-plumes. However, the spread of absolute values of the parameters were hard to distinguish. That's the reason why 100% stacked columns graphs are made. These 100% stacked columns graphs are available via intranet to the forecasters for several parameters: maximum – and minimum temperature, maximum gust in 24 hrs, maximum Cape in 24 hrs (summer), 24 hr snow accumulation (winter) and 24 hrs cumulative precipitation. Examples of diagrams used at KNMI are seen in **Fig 1 and 2**.

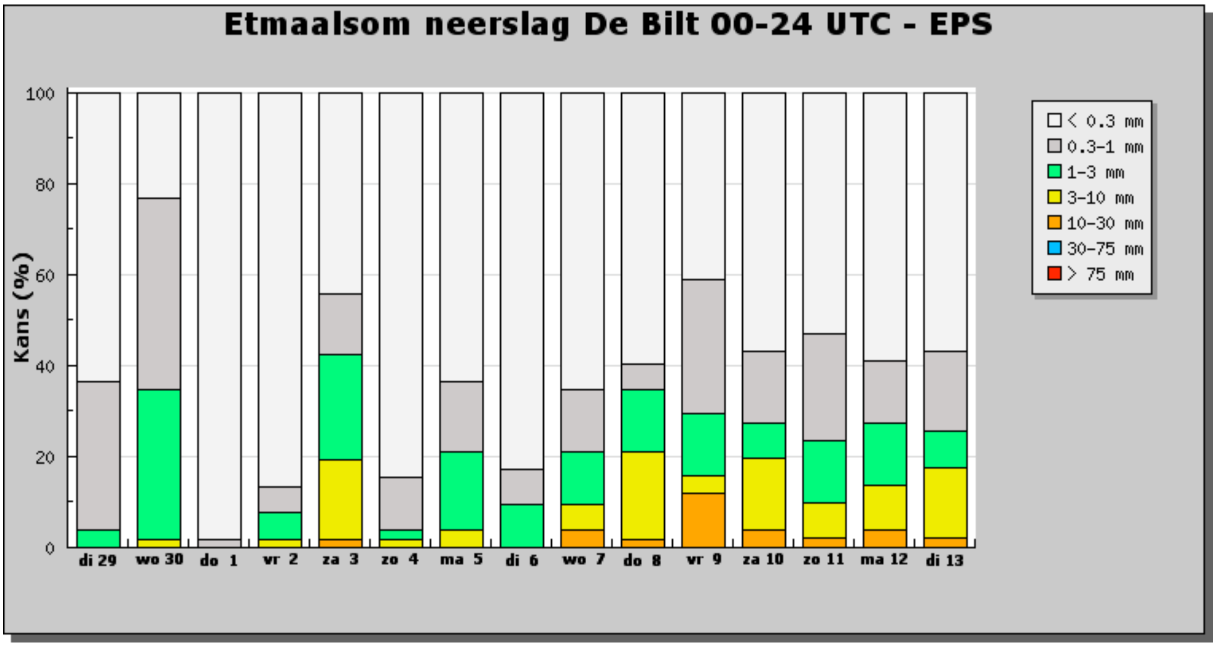


Fig. 1 Cumulative precipitation from 00- 24 UTC in De Bilt: 100 % stacked column graph, based on EPS September 29th 2009 00 UTC run

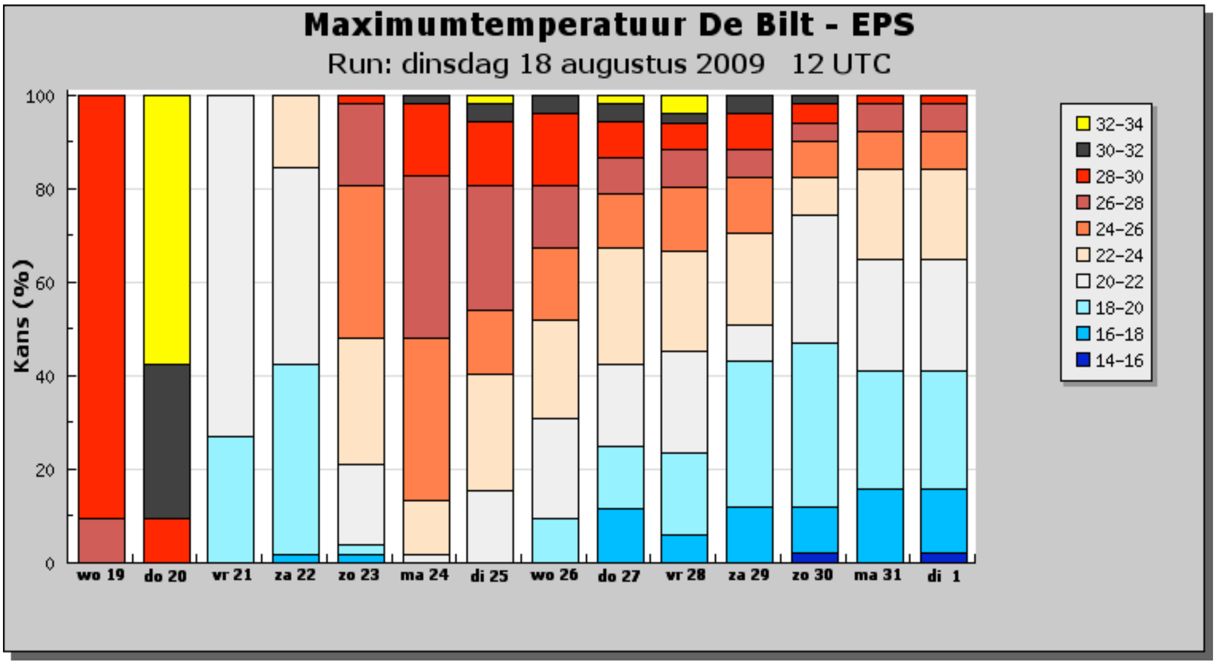


Fig. 2 An example of the 100 % stacked column graph of the maximum temperature in De Bilt, based on EPS, August 18th 2009

Another new product is the development of a de-icing capacity model which gives the chance of needed capacity (physical places to de-ice airplanes and staff) to de-icing airplanes at Schiphol Airport. This product is used for 10-day planning at the airport. For short-term planning other methods are used.

RH (%)	>98	D	C2
	90-98	C1	B2
	<90	B1	A
		T<-2	-2<T<2
		Temperature	

Table 1 De-icing Capacity Level (DCL)

On base of the 10-days EPS data for grid point Schiphol the relative humidity and temperature combination shown in **Table 1** is used to make an uncalibrated distribution of probability. The chance is simply calculated by counting the amount of EPS-members in a class (DCL phase = De-icing Capacity Level).

Phase A stands for low capacity needed and phase D means high capacity. The forecast range is from h+6 until h+240 (h is the starting time of model)

This product is available twice a day: 8.30 and 20.30 UTC and is distributed to the responsible authority ("iceman") at Schiphol Airport. In **Fig 3** the situation is shown for 20th December 2009 until 30th December 2009, based on the 00 UTC run of 20th December.

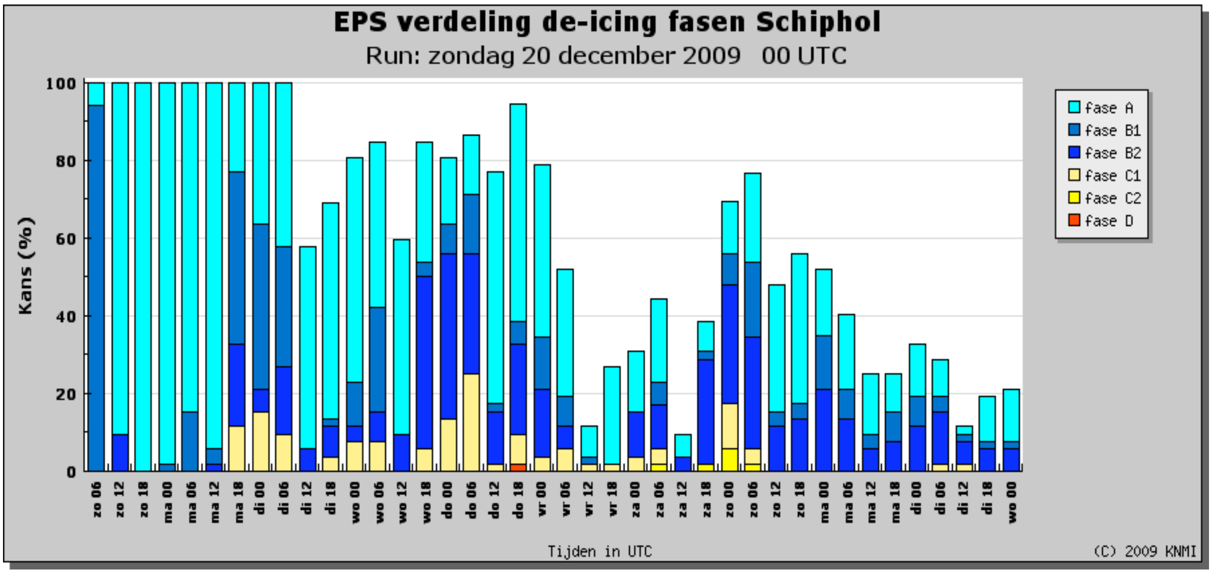


Fig. 3 De-icing phases for Schiphol Airport based on ECMWF 00 UTC at 20 December 2009 for the period 20 December – 30 December 2009

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

Lightning verification

The statistical scheme for the forecast of lightning intensity is based on Model Output Statistics (MOS; Wilks, 2006) and gives the (conditional) probability of (severe) thunderstorms in the warm half-year (mid-April to mid-October). This system has been developed to be used by forecasters as a tool to decide whether a weather alarm for severe thunderstorms should be issued. Forecasts are given 8 times a day for **12 regions** of about 90 by 80 km each (see **Fig. 4**) for 6-h periods and for projections out to 12 h in advance. The MOS system has been extended to include the 12-48 h projections. Two predictands are defined for each region and time period; the first is the probability of a thunderstorm (≥ 2 lightning discharges) and the second is the conditional probability of a severe thunderstorm (≥ 50, and possibly ≥ 100 and ≥ 200 discharges/ 5 min.) under the condition that ≥ 2 discharges will be detected. The predictor set not only consists of (post-processed) output from both the ECMWF and Hirlam model (e.g. several severe weather indices), as in *Schmeits et al*. (2005 and 2008), but contains predictors from an ensemble of advected radar and lightning data for the 0-6 h projections as well. Example forecasts are given in **Fig 4 – Fig 9**. In **Fig 10** as result for the "Kouw" (lightning forecast for a weather alarm) verification the Brier Skill Scores against the sample climatology are given.

An objective verification in terms of reliability diagrams is shown in **Fig 11** and **Fig 12** for the period of 16 April 2009 to 15 October 2009. More details are given in *Schmeits et al*. (2008).

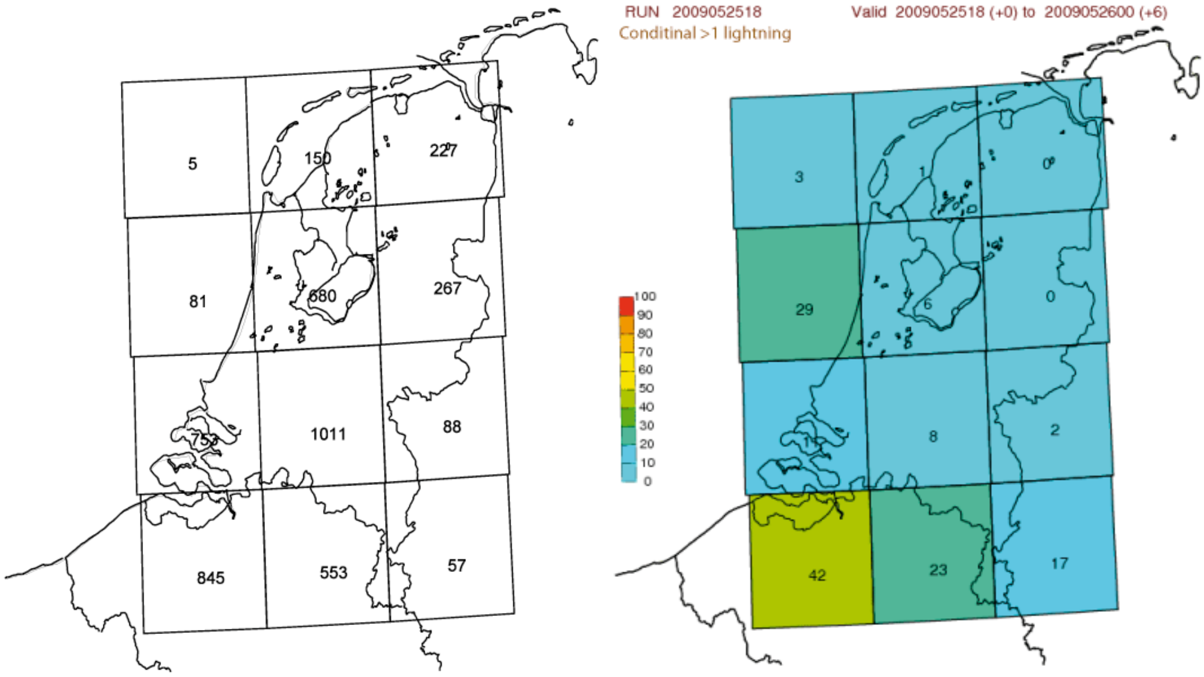


Fig. 4 Left: 6-12 h conditional probability forecast (%) of maximum lightning intensity ? 200 discharges/ 5 min. valid for 18-00 UTC on May 25th , 2009. The forecast is based on the 18 UTC run of the MOS system. Right: Maximum 5-min. lightning intensity, as detected by the FLITS network, during the same period.

Examples of consecutive forecast of the KOUW- system from 06 UTC on May 25th until 00 UTC May 26th are shown in Fig 5 – Fig 9

06UTC:

6 to +12 hr

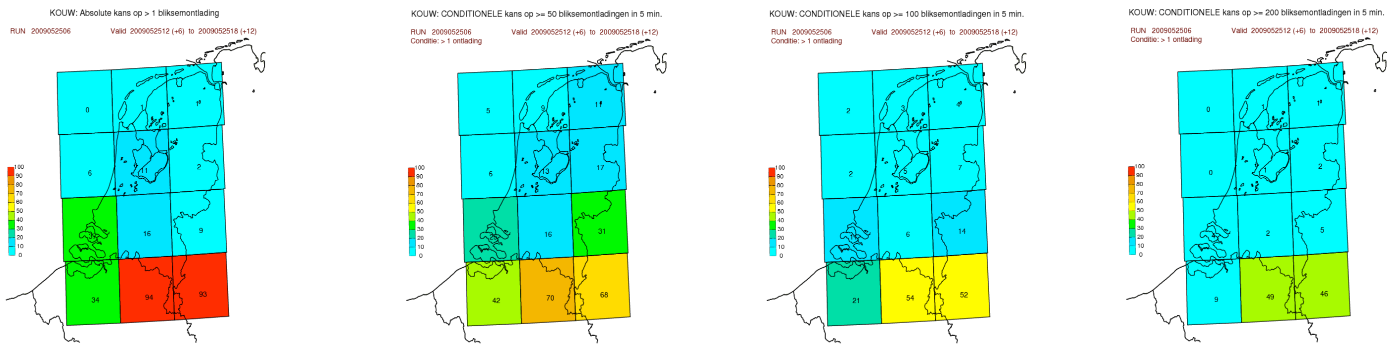
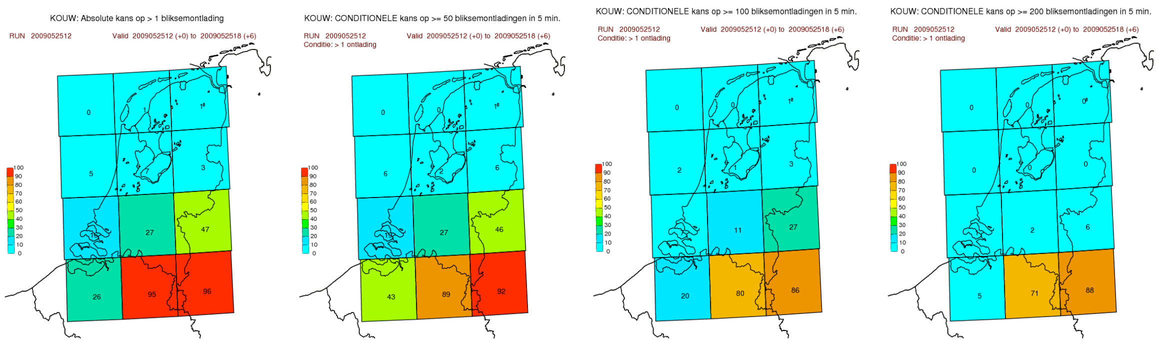


Fig. 5 Absolute probability forecast (%) of >1 lightning/6 hrs, conditional probability forecast (%) of > 50, >100 and > 200 discharges / 5 min (between 12 and 18 UTC)

12UTC:

0 to +6 hr



+6 to +12 hr

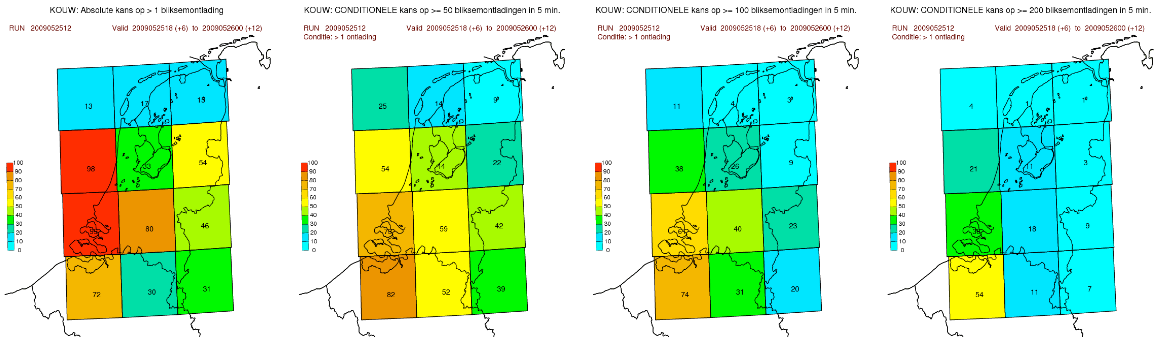
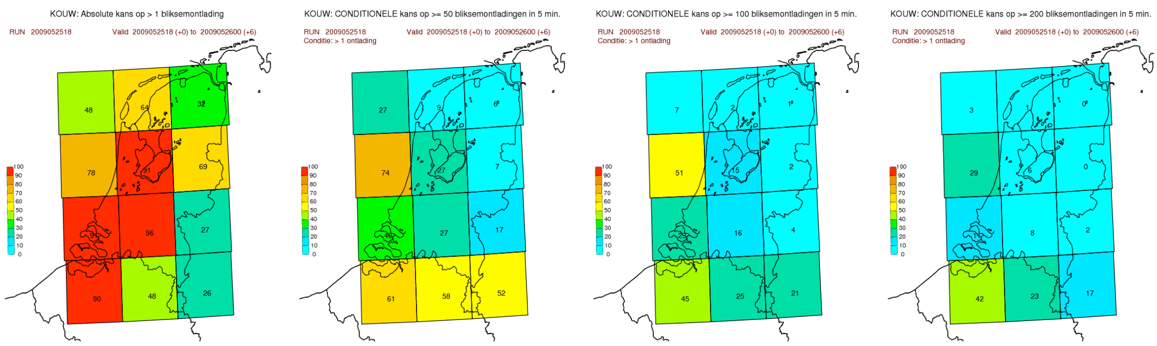


Fig. 6 Absolute probability forecast (%) of >1 lightning/6 hrs and conditional probability forecast (%)of > 50, >100 and > 200 discharges / 5 min respectively (above: between 12 and 18 UTC; bottom: between 18 and 00 UTC)

18 UTC:

0 to + 6 hr



+6 to +12 hr

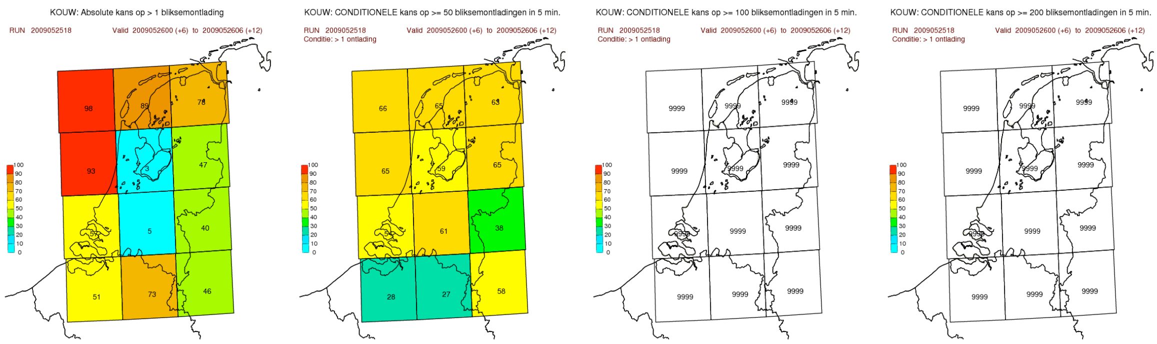


Fig. 7 Absolute probability forecast (%) of >1 lightning/6 hrs and conditional probability forecast (%) of > 50 , >100 and > 200 discharges / 5 min respectively (above: between 18 and 24 UTC; bottom: between 00 and 06 UTC)

21 UTC:

0 to +6 hr

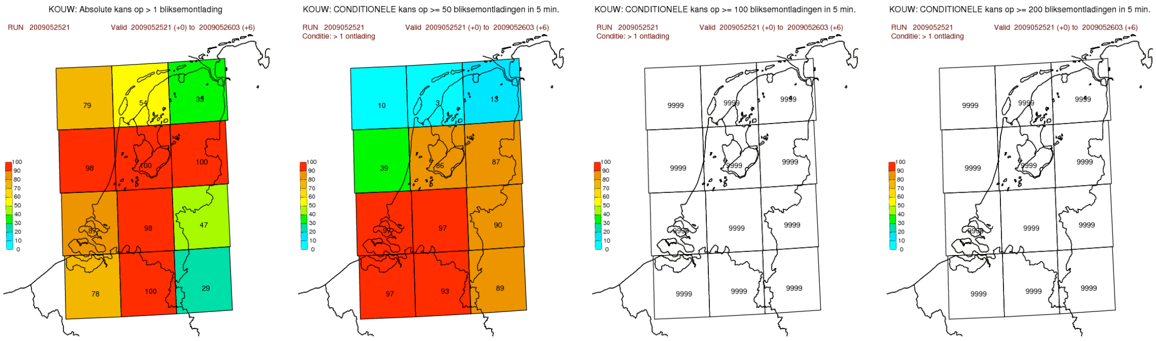


Fig. 8 Absolute probability forecast (%) of >1 lightning/6 hrs and conditional probability forecast (%) of > 50, >100 and > 200 discharges / 5 min respectively (between 21 and 03 UTC)

00 UTC:

0 to +6 hr

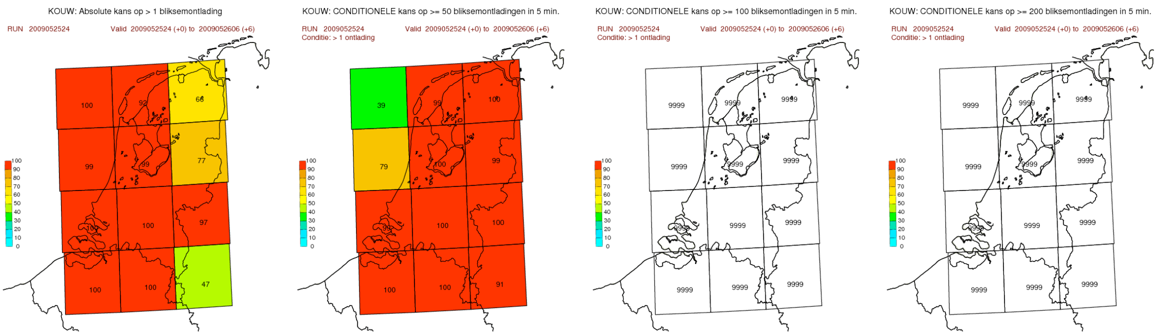


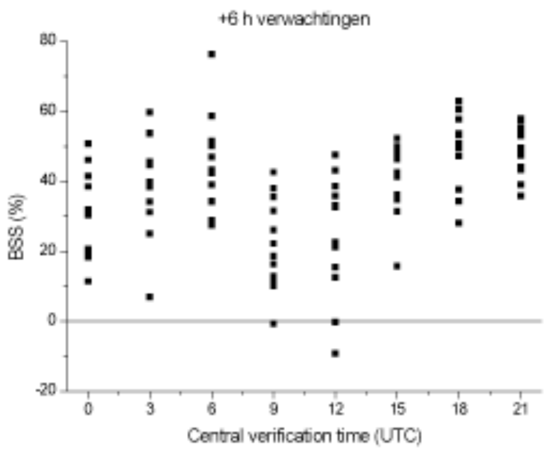
Fig. 9 Absolute probability forecast (%) of >1 lightning/6 hrs and conditional probability forecast (%) of > 50, >100 and > 200 discharges / 5 min respectively (between 00 and 06 UTC)

In the figures below the verification as Brier Skill Score and reliability diagrams for forecast periods of 0-6 hrs and 06 -12 hrs are shown in figures below (see Wilks, 2006). The Skill score is calculated against the sample climatology.

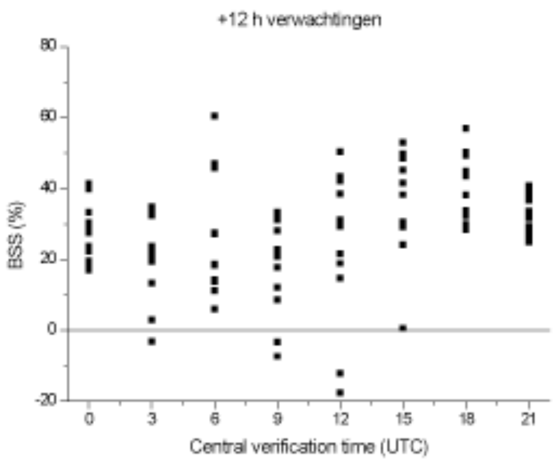
"KOUW" verification 2009:

≥ 2 discharges

+6 h forecasts



+12 h forecasts



≥ 50, 100 en 200 discharges/ 5 min.

+6 h forecasts +12 h forecasts

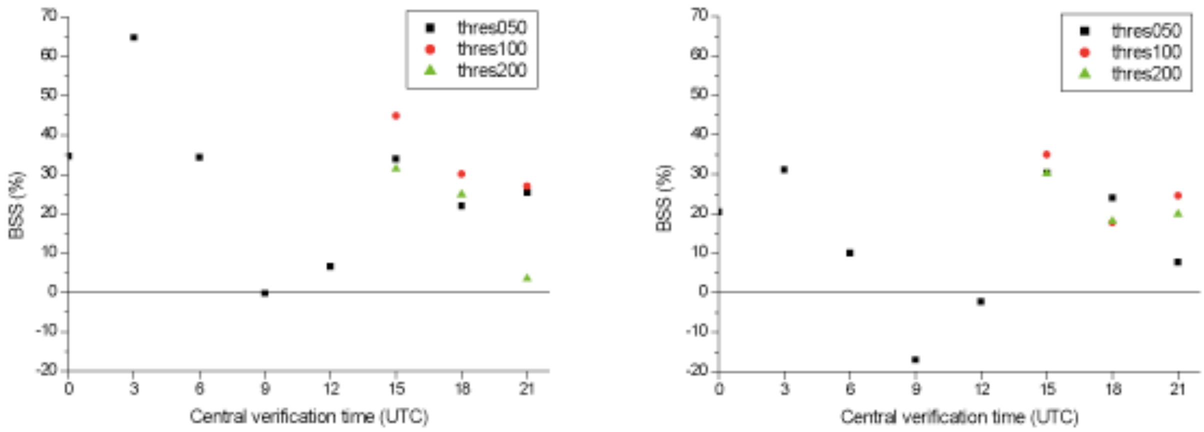
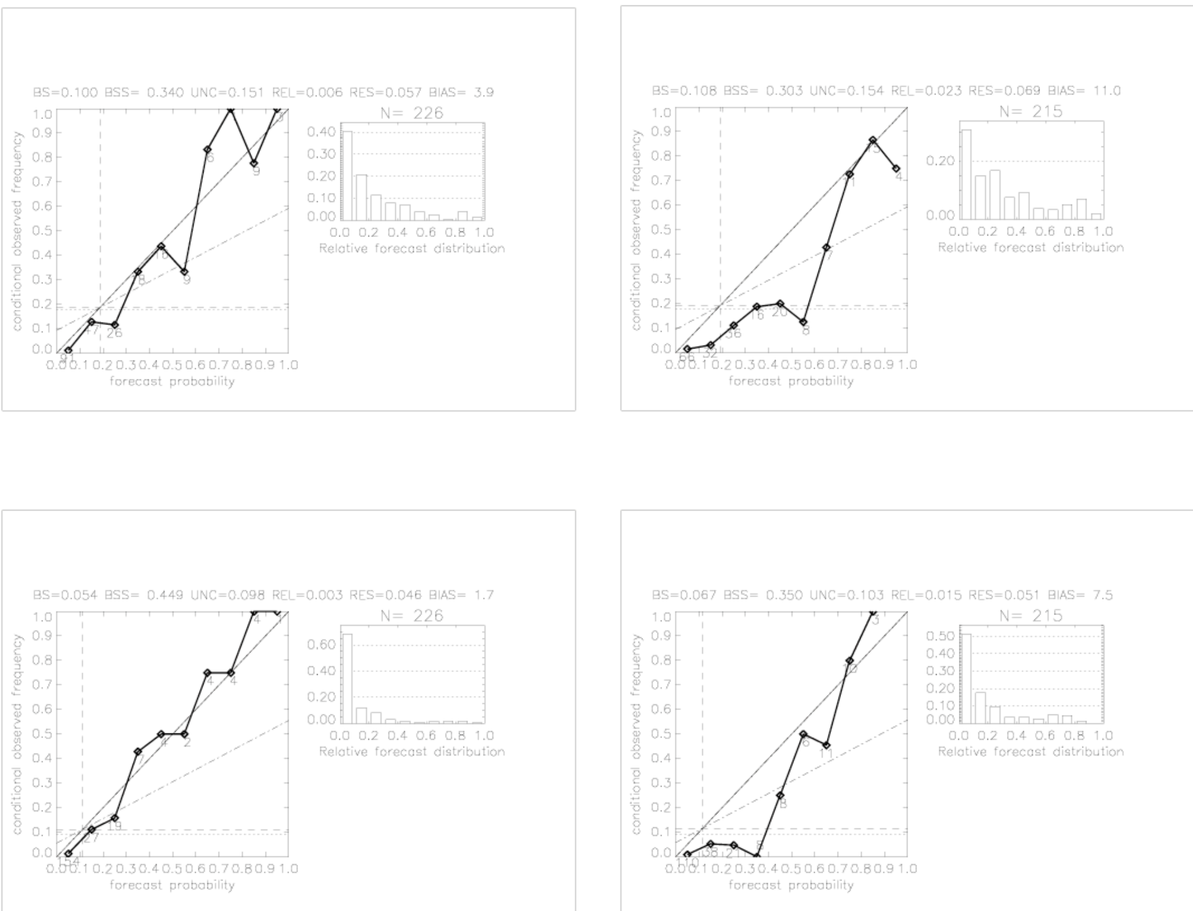
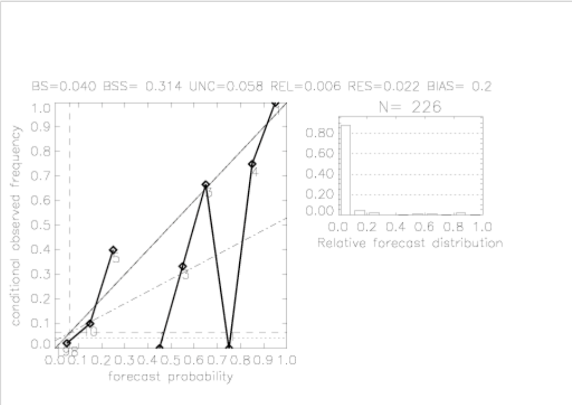


Fig. 10 Brier skill scores (BSS) for +6 and +12 h forecasts of chance at ≥ 2 discharges for all 12 regions (upper panels) and the conditional chance on ≥ 50, 100 en 200 discharges/ 5 min. (below) under the condition of at least 2 discharges. In the lower two panels the 12 regions are pooled.

12-18 UTC:

+6 h forecasts +12 h forecasts





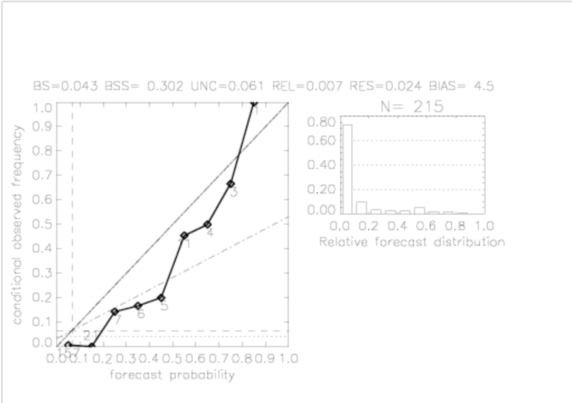
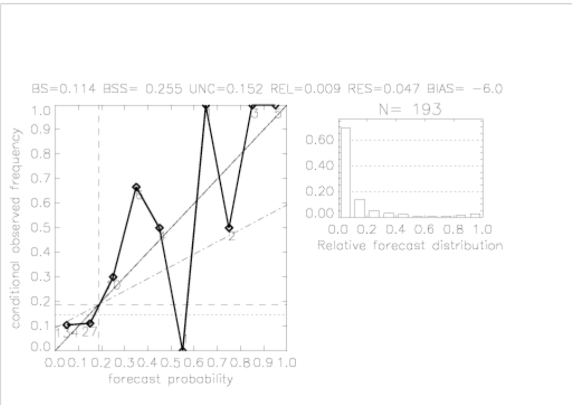
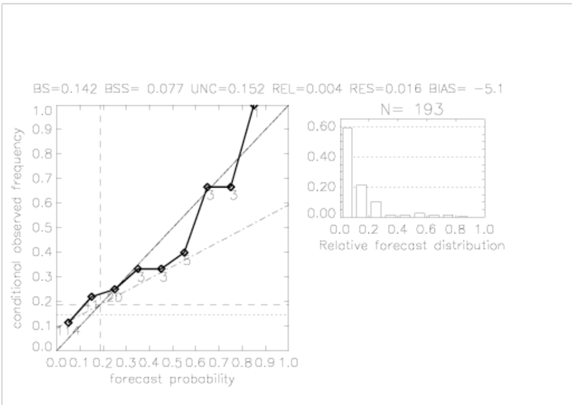


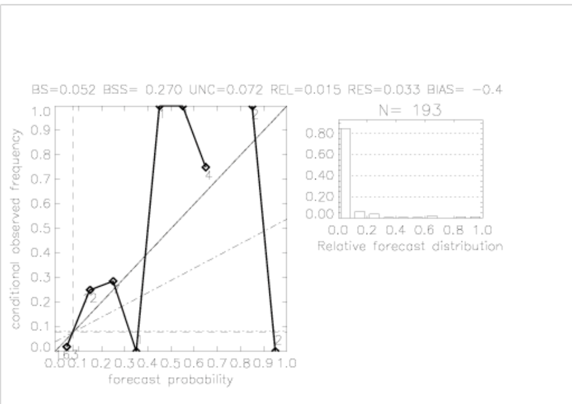
Fig. 11 Reliability diagrams for 12-18 UTC: Left +6 h and right +12 h forecasts with conditional chances on ≥ 50, 100 en 200 lightning's / 5 min.

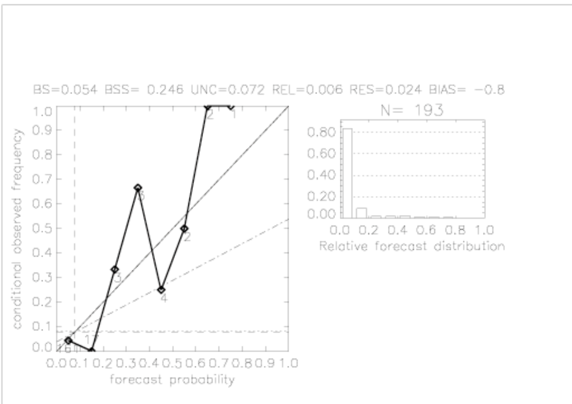
18-00 UTC:

+6 h verwachtingen +12 h verwachtingen









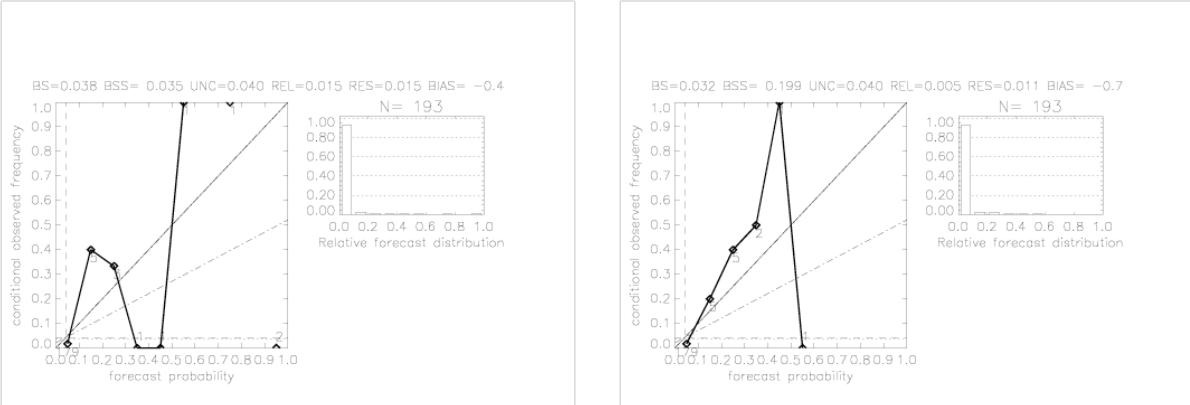


Fig. 12 Reliability diagrams for 18-00 UTC: Left +6 h and right +12 h forecasts with conditional chances on ≥ 50, 100 en 200 lightning's / 5 min.

3.1.2 ECMWF model output compared to other NWP models

3.1.3 Post-processed 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)

3.2.2 Synoptic studies

4. References to relevant publications

Schmeits, M. J., **C. J. Kok** and **D. H. P. Vogelezang** (2005). Probabilistic forecasting of (severe) thunderstorms in the Netherlands using model output statistics. *Wea. Forecasting*, **20**, 134-148.

Wilks, D.S. (2006). Statistical methods in the atmospheric sciences. Academic Press.

Schmeits, M.J., **C.J. Kok**, **D.H.P. Vogelezang**, and **R.M. van Westrhenen**, 2008: Probabilistic forecasts of (severe) thunderstorms for the purpose of issuing a weather alarm in the Netherlands. *Wea. Forecasting*, **23**, 1253-1267

C.J. Kok, M Stam (2010). Verificatie rapport Zomerhalfjaar 2009. Internal report KNMI