FMI/Weather and warnings
M Seppänen
10.7.2007

ANNEX D

Short description of near gale warnings verification at FMI

1. Introduction

   Ministry of Communication and Transport (MCT) set result goals for FMI and one of the goals is the reliability of our forecasts. In this document you will find a simple description of our verification system, which generate statistic information of the reliability level of our near gale warnings for Finnish coastal waters.
   Verification results are used to give feedback for meteorologists and as quality information for our authorities and customers.
   This kind of verification system has worked in FMI daily already about 20 years.

2. Harmonization and correction of wind observations

   FMI has about 40 coastal observation stations.
   Every station is located so well as possible to measure wind speed and direction, but always we find some factors, which make comparison of measurements difficult between surrounding stations.
   Our experts has worked out a correction method for wind speed, which can handle varying wind measuring height (reduction to 10 m) and the effect of different obstacles (islands, trees, buildings etc) in the surrounding of a single measurement station.
   The target of this correction is to make the wind measurement more representative for the surrounding sea area and make measurements more comparable with other measurements on the same sea area.

   $$Wcor = C * Wobs,\ C = \text{station and wind direction-specific correction coefficient}$$

   Correction system works in real time and we save all measured and corrected observations in our database for upgrading.

3. Max-wind observation for every sub-area of sea

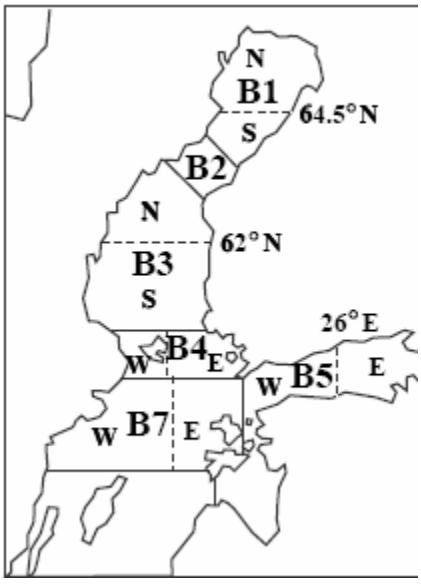
   FMI verify near gale warnings always against maximum corrected wind speed on every sea area. Maximum wind speed for a certain sub-area is easy to point out of database, when we know which stations represent that sea area.

Maximum wind speed is the highest 10 min average in database for that time period and sub-area. So at present we are neither forecasting nor verifying max gust speeds of wind on sea areas.
.

4. FMI wind forecasting system

Wind forecasting system consist of wind table for next 48 hours, which we generate manually at least sex times per day. In this wind table we have one average wind direction and speed and max speed (and also visibility and weather) for every 6 h period and for all 10 sub-areas. All our text forecasts and warnings for mariners are based on these wind table values. Limit value for our near gale warning is 14 m/s.

		Pe/Fr 09			Pe/Fr 15			Pe/Fr 21			La/Sa 03		
		DDD	FF	FX	DDD	FF	FX	DDD	FF	FX	DDD	FF	FX
B1N	Perämeren pohjoisosa	Ne	7	10	Nne	10	12	Ne	10	14	Ene	10	14
B1S	Perämeren eteläosa	Ne	7	10	Nne	11	14	Ne	10	14	Ne	10	14
B2	Merenkurkku	Ne	7	10	Nne	11	14	Nne	11	14	Ne	10	14
B3N	Selkämeren pohjoisosa	Nne	6	9	Nne	10	12	Nne	10	12	Nne	8	12
B3S	Selkämeren eteläosa	Ne	6	9	Nne	7	10	Nne	6	10	Nne	7	10
B4E	Saaristomeri	Nne	4	7	Nne	6	9	Nne	6	9	Nne	7	10
B4W	Ahvenanmeri	Ne	6	9	N	8	10	N	9	12	N	7	10
B7W	Pohj.Itämeren länsiosa	Ne	5	8	N	7	10	N	9	12	N	9	12
B7E	Pohj.Itämeren itäosa	Nne	5	8	Nne	9	12	Nne	9	12	Nne	9	12
B5W	Suomenlahden länsiosa	Ene	7	10	Ene	9	12	Nne	9	12	Ene	6	9
B5E	Suomenlahden itäosa	Ne	7	10	Ne	9	12	Ene	9	12	E	6	9



FMI/Weather and warnings
M Seppänen
10.7.2007

5. Verification of near gale wind warnings

Near gale warnings are one example of so called dichotomous (yes/no) forecasts. We have also two possibilities: yes, wind speed will be over 14 m/s or no, wind is less than 14 m/s.
First we can make a contingency table, that shows the frequency of "yes" and "no" forecasts and occurrences. We have four combinations:

hit = forecast and observation will be 14 m/s or more
miss = not forecasted, but it occurred
false alarm = forecasted near gale, but did not occur
correct negative= near gale neither forecasted nor observed

Now we can make a so called contingency table:

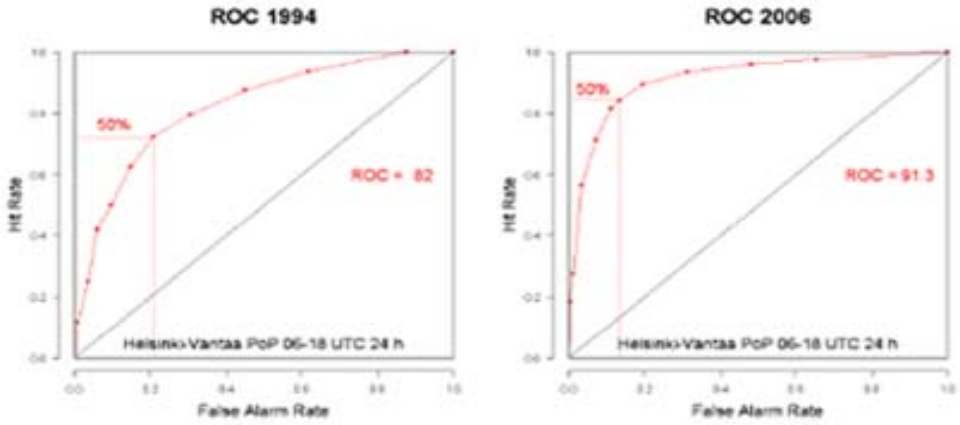
	Observed		Total
	Yes	No	
Forecast Yes	hits	false alarms	forecast yes
No	misses	correct negat	forecast no
Total	observed yes	observed no	total

This contingency table show us easily what types of errors we have in our forecasting. If our meteorologists or models produce 100 % forecasts, then we have numbers only in boxes "hits" and "correct negative".
After contingency table we get two useful parameters for verification of these kind yes/no-forecasts: probability of detection (PoD) and false alarm rate (FAR):

PoD = (N of hits)/(N of hits + N of misses)

FAR = (N of false alarm)/(N on hits + N of false alarms)

FMI is presenting the reliability of our near gale warnings for our MCT with only one number and here we need ROC-parameter, which connect PoD and FAR-values to each other.
We can find a point for every single forecast in a coordinate system, where PoD-values are in y-axis and FAR-values on horizontal axis. When we put all PoD-FAR values of examined time period on this coordinate system, we can draw a graph over these points. ROC-value for these forecasts is now the area, which is confined between axis and this graph. ROC-value for comprehensive forecasts is 100 % and for worthless forecasts 50% of this area.



Example of the use of ROC-graph: Reliability of rain probabilistic forecasts in Helsinki-Vantaa airport. (FMI/Matias Brockmann)

Our MTC has set for FMI a reliability goal for near gale warnings 2007: ROC-value for first 24 hours is 84 % and for second day 80 %. Let's see how it goes for FMI

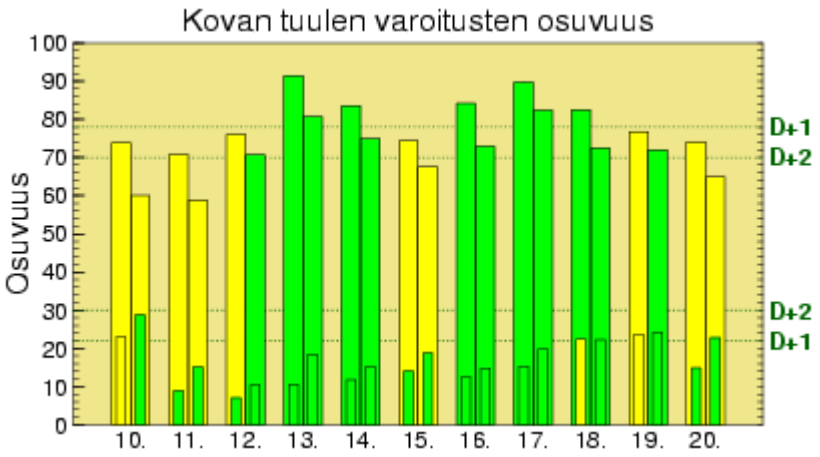
6. Examples of verification results

Reliability of near gale warnings on Finnish coastal waters,
Jan-June 2007

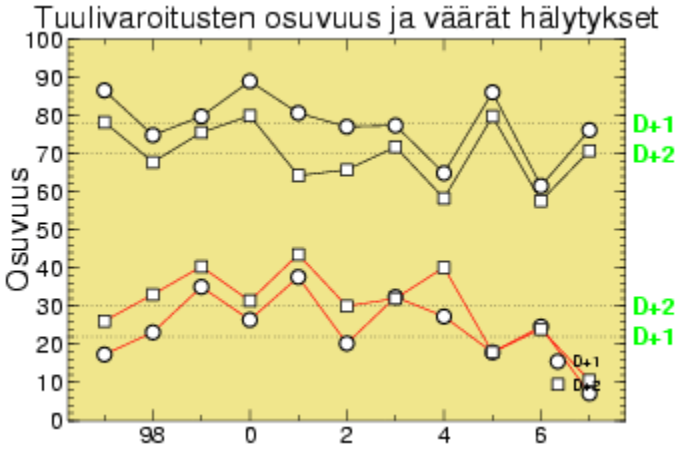
		POD	ROC	FAR	POD	ROC	FAR
10.	Suomenlahden itäosa	73.9	82.7	23.1	60.1	76.3	28.8
11.	Suomenlahden länsiosa	70.8	83.4	9.0	58.8	76.9	15.2
12.	Pohjois–Itämeren itäosa	76.1	86.1	7.1	70.7	83.0	10.5
13.	Pohjois–Itämeren länsiosa	91.5	93.2	10.6	80.6	86.7	18.5
14.	Ahvenanmeri	83.6	89.2	11.8	74.9	84.8	15.3
15.	Saaristomeri	74.3	84.7	14.1	67.5	81.0	18.9
16.	Selkämeren eteläosa	84.2	89.1	12.6	72.9	83.9	14.8
17.	Selkämeren pohjoisosa	89.7	90.8	15.3	82.3	87.1	19.8
18.	Merenkurkku	82.5	87.1	22.4	72.6	83.3	22.2
19.	Perämeren eteläosa	76.8	84.9	23.7	72.0	83.2	24.3
20.	Perämeren pohjoisosa	74.2	85.1	14.8	64.9	80.0	22.8
	Keskiarvo	79.2	86.6	14.5	70.2	82.2	18.6

Same story as bar chart

FMI/Weather and warnings
M Seppänen
10.7.2007



Example of the development trend in reliability of FMI´s near gale warnings on Northern Sea of Baltic



Limitation of this kind of verification method:

- The threshold value for near gale warning forecasts is too strict. If you have forecasted 15 m/s and the observed/corrected wind maximum is 13.4 m/s, you get miss. In fact this is for user's very useful information. Threshold value should soften somehow.
- Examined forecasted cases should be limited for instance between 14 and 18 m/s. Now for example a forecast with 15 m/s and observed 20 m/s gives you a hit, but the usefulness for mariner is poor.

FMI/Weather and warnings
M Seppänen
10.7.2007

7. Questions for our Working Group

   FMI´s public web pages are now totally free of verification results and I have only few questions in my mind without answers:
   - Situation in your country: how you are performing reliability of MMS's forecasts for public?
   - What are the relevant results to publish? ME, MEA, PoD, FAR, ROC??
   - Updating frequency: daily, monthly, yearly?
   - Usage of probabilistic forecasts in public weather services? Potentials and difficulties?