Annex K

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Probability Forecasts

Outlines for the discussion on probability forecasts

General discussion:

We have to keep in mind that probability forecasts are part of a risk management

Risk management is part of PWS.

Information about risk management is needed by public authorities especially by the alarm centres.

Is the information about risk management focused on rare events or a daily information to the public?

Which thresholds of probabilities are generally useful?

Specific discussion:

Who is using probability forecasts?

Who are the clients?

What is the useful time range in weather forecasting to use probability forecasts?

In which way is the transfer of the information?

Which meteorological phenomena are covered by probability forecasts?

Who will be informed first in cases of an emergency weather situation?

Is it almost useful to inform the public with probability forecasts?

Are probability forecasts an essential information to the public?

Does the public understand the interpretation of extreme weather phenomena by probabilistic values?

Is there an urgent need of a special information about probability forecasts for the public?

Which way of information of probability forecasts is useful to the public?

Should probability forecasts only provided for special clients?

In which way should the probability forecasts to be published, which categories are useful?

Probability Forecasts (Base website UK Met Office)

Introduction

All forecasts suffer from some degree of uncertainty, and with the use of ensemble prediction and also statistical methods we are increasingly developing the capability to estimate this uncertainty objectively. For some forecast users it is sufficient to simply take the standard forecast as the best possible estimate of what will happen, but many users could potentially benefit more by understanding the uncertainty and assessing the risks. One of the best ways to express uncertainty in a consistent and verifiable way is as Probability Forecasts. A probability forecast specifies how likely a defined event is to occur, as a percentage, and can help users to assess the risks associated with particular weather events to which they are sensitive.

Defining probabilities

The most important issue with a probability forecast is that both the forecaster and the user must understand exactly what the probabilities mean. Probabilities must be issued for a clearly defined event which either occurs or does not occur. For example, a statement that there is "a 30% probability of rain in an area" is meaningless because it is not clear whether it is for a specific place or just somewhere in the area. There is no time given and it is not stated how much rain. Examples of well-defined probability forecasts could be:

- 30% probability of more than 5mm of rain at specific place between 12:00 and 18:00. Airport warning!
- 70% probability of wind reaching gale force in at least one place in the areas on Tuesday.
- 10% probability of wind sufficient to cause severe structural damage in a area overnight. Useful?

It is generally easier to define events and verify them unambiguously for specific locations, but as the second example shows it is also possible to define probabilities covering regions. The third example illustrates how even quite a low probability can give a useful warning of a serious event likely to lead to significant disruption for specific clients. Even though there is a 90% probability that the event will not occur, knowledge of the 10% risk enables users to be prepared for the worst case.

Probabilities from Ensembles

Ensembles are designed to estimate probabilities by sampling the range of possible forecast outcomes. We estimate the probability of a particular event by counting the proportion of ensemble members which forecast that event to occur. Taking the first forecast example above 30% would result when 15 out of 50 ensemble members predict more than 5mm of rain to fall at the specified location in the defined period.

In practice this method does not always give reliable probabilities, especially when we look at detailed local weather. For this reason the Met Services has to calibrate applications for probability forecasts from the ensemble to further improve the quality of the information provided.

Probabilities and odds

Use of probabilities can sometimes cause some confusion, and many people are more familiar with odds which are commonly used. The two are very closely related. For example, a probability of 10% means 10 times out of 100, or a 1 in 10 chance. Thus for every 10 occasions the event will *not* occur on 9 occasions and will only occur once. The odds are therefore 9:1 against.

Probabilities and false alarms

As noted above, if the probability is 10% then the event will only occur on 1 occasion in every 10 (or equivalently 10 in 100). This means that on the other 9 out of 10 occasions the event will not occur. Thus if a user asks the Met Office to warn them every time there is a 10% risk of a particular event, then they should expect that 9 times out of 10 that a warning is issued the event will not occur. If the user does not understand this then they are likely to think the Met Service is issuing too many *False Alarms*. On the other hand, if the user is liable to suffer a large loss by being unprepared for the event, then they may have well benefit from putting up with 9 out of 10 false alarms because of the large benefit from being prepared on the 1 in 10 occasions when the event does occur. In USA in areas of hurricanes the public accepts a hit rate of 30 % or in

other words a false alarm rate of 70%. The damage of only 1 hurricane is so high that it is accepted to be prepared for each warning even if it is a false alarm.

Decision-making with probability forecasts

To make best use of the probability forecasts, the user must choose a probability threshold which gives the correct balance of alerts and false alarms for their particular application.

But shall PWS cover all thresholds for the public?

The precise level at which each user should start to react depends on their cost of protection and their potential losses - advices shall be offered by the Met Service in how to maximise the benefit of the forecasts for any particular application.

Verification examples from ZAMG (2 years period)

▪ECMWF EPS Median 2mT▪11035 Vienna, Hohe Warte

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	06			12			18			▪		
	BIA	MAE	RMS	BIA	MAE	RMS	BIA	MAE	RMS			
▪▪D+3	-1.41	1.97	2.47	-0.16	1.96	2.52	-0.81	1.92	2.40			
▪▪D+5	-1.36	2.24	2.88	-0.10	2.37	3.09	-0.75	2.30	2.98	▪▪D+7	-1.39	2.56 3.25
-0.13	2.81	3.62	-0.77	2.72	2.49							
▪▪D+9	-1.48	2.89	3.64	-0.33	3.13	3.97						

▪ECMWF EPS Mean 2mT▪11035 Vienna, Hohe Warte

▪

	06			12			18			▪		
	BIA	MAE	RMS	BIA	MAE	RMS	BIA	MAE	RMS			
▪▪D+3	-1.72	2.17	2.65	-0.75	2.16	2.64	-1.24	2.11	2.55			
▪▪D+5	-1.67	2.42	3.03	-0.69	2.52	3.18	-1.18	2.43	3.08	▪▪D+7	-1.67	2.69 3.36
-0.69	2.92	3.67	-1.18	2.79	3.52							
▪▪D+9	-1.77	3.00	3.71	-0.86	3.21	4.00						