Breaking the ice
The human element
in Met office road ice forecasting

Introduction

A common theme of recent WGCEF meetings has been the need for forecasters to assert their continued vital importance to many meteorological products and services. Indeed, increasing sophistication of models and availability of observations brings us a new set of forecasting challenges, in which we play the critical role in interpreting and communicating the impacts of weather to end users.

This article describes how forecast production processes used in Open Road – the Met Office's road ice forecasting service – have been radically changed to improve flexibility and efficiency, while maintaining quality in an increasingly competitive environment.A combination of structural, procedural and technical improvements have been made to reduce the time forecasters spend on routine production in order to free up time for skilled forecasting tasks.

It is intended that similar methods will be used to enhance performance in other areas of our forecasting operations in the near future.

Backgroud – 'Open Road'

The Met Office's road hazard forecasting service, 'OpenRoad', has been though several incarnations since it was launched across the UK in 1986. But the basic structure of the product remains: a series of site-specific graphs of Road Surface Temperature and Road State covering a 24hr period, together with explanatory text forecasts dealing with conditions across the customer's entire region of responsibility. Forecasts are then monitored overnight, and amended when certain thresholds of forecast accuracy are exceeded.

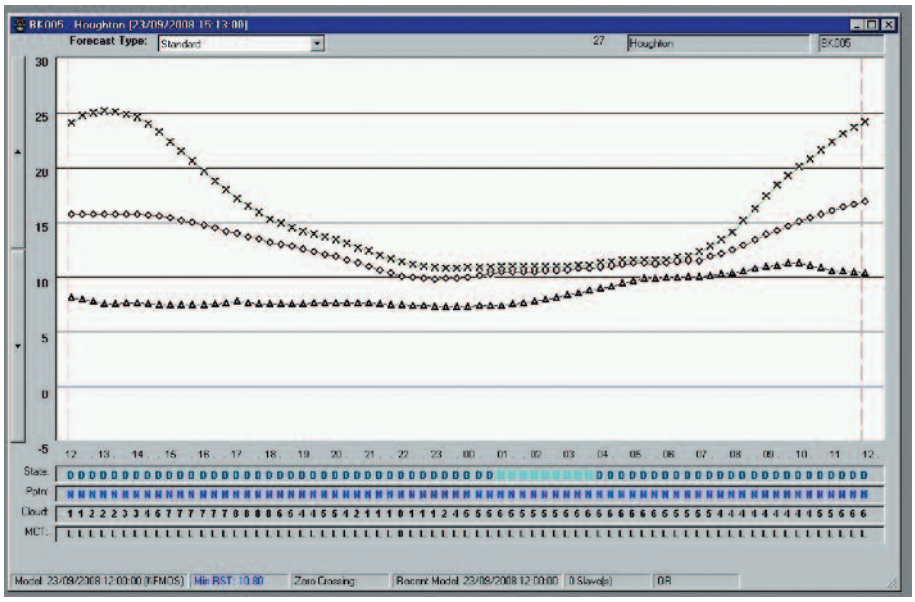
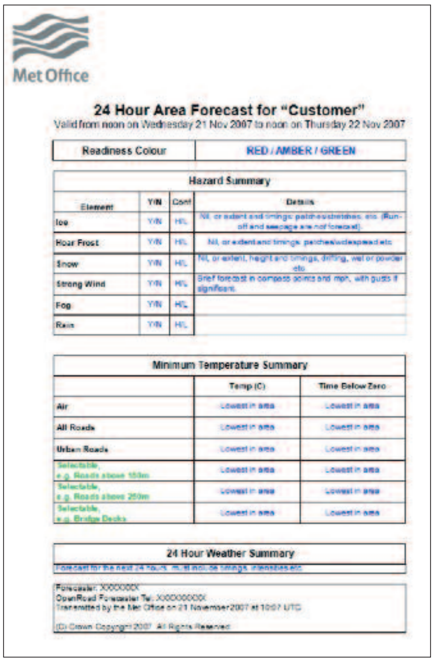


Figure 1: An OpenRoad Ice Prediction Graph, showing Air Temperature (red), Road Surface Temperature (Green) and Dew Point (blue). Road State, Precipitation Type and Cloud Amounts are displayed beneath.


Met Office

24 Hour Area Forecast for "Customer"
Valid from noon on Wednesday 21 Nov 2007 to noon on Thursday 22 Nov 2007

Readiness Colour	RED / AMBER / GREEN

Hazard Summary			
Element	Y/N	Conf	Details
Ice	Y/N	H/L	Nil, or extent and timings: patches/stretches, etc. (Run-off and seepage are not forecast).
Hoar Frost	Y/N	H/L	Nil, or extent and timings: patches/widespread etc
Snow	Y/N	H/L	Nil, or extent, height and timings, drifting, wet or powder etc
Strong Wind	Y/N	H/L	Brief forecast in compass points and mph, with gusts if significant.
Fog	Y/N	H/L	
Rain	Y/N	H/L	

Minimum Temperature Summary		
	Temp (C)	Time Below Zero
Air	Lowest in area	Lowest in area
All Roads	Lowest in area	Lowest in area
Urban Roads	Lowest in area	Lowest in area
Selectable, e.g. Roads above 150m	Lowest in area	Lowest in area
Selectable, e.g. Roads above 250m	Lowest in area	Lowest in area
Selectable, e.g. Bridge Decks	Lowest in area	Lowest in area

24 Hour Weather Summary
Forecast for the next 24 hours, must include timings, intensities etc

Forecaster: XXXXXXX
OpenRoad Forecaster Tel: XXXXXXXXX
Transmitted by the Met Office on 21 November 2007 at 10:07 UTC
(C) Crown Copyright 2007 All Rights Reserved

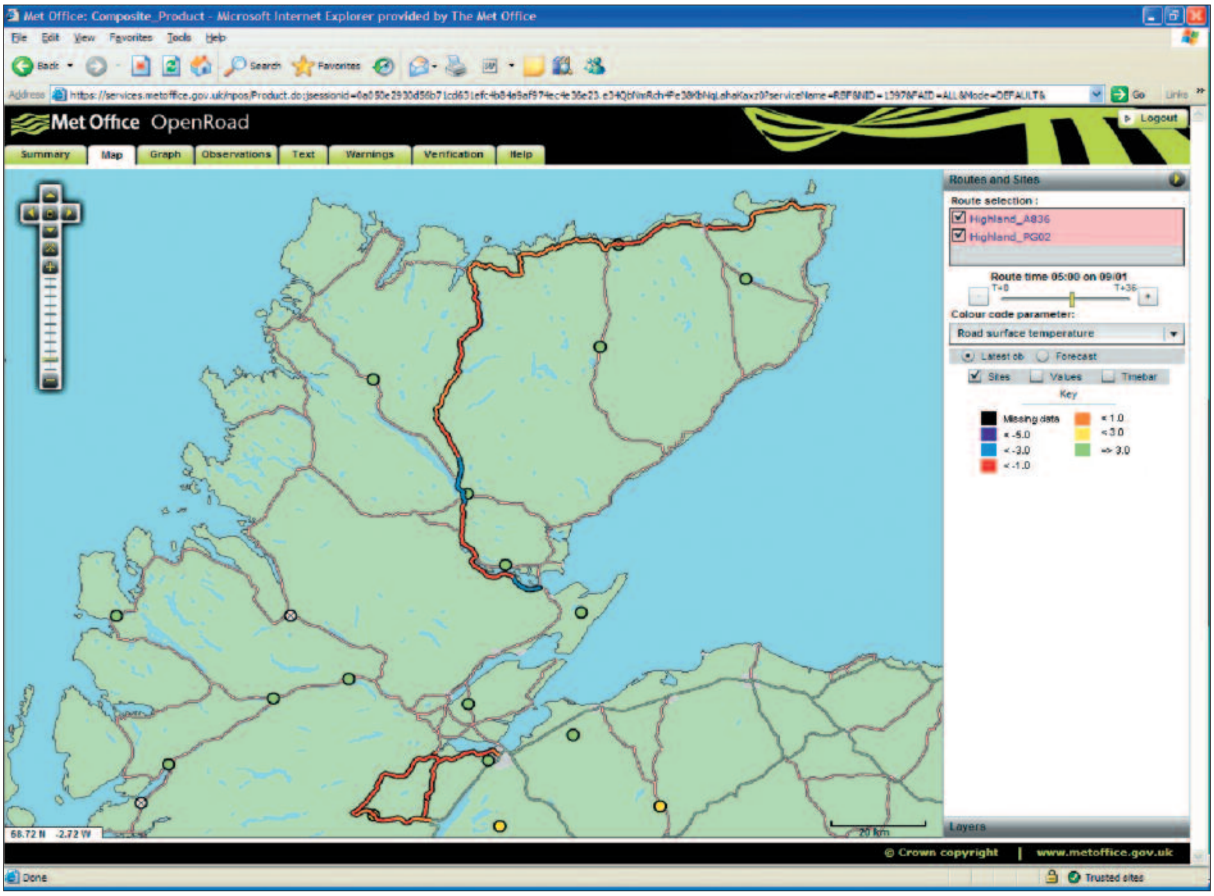
Figure 2: An OpenRoad 24hr text forecast.

In its latest configuration, model 'first guess' curves are created using post-processed output from our 4km mesoscale model. As of the 08/09 winter season, we have around 170 customers, most of whom require 24hr text forecasts. Approximately 350 forecaster-derived graphs are produced, and we monitor the output from ~1000 sensor sites. Production has traditionally been labour intensive – even in trivial 'no hazards' situations - with initial creation of text and graphs each day taking 5 or 6 forecasters up to 5 hours each . Subsequent monitoring, amendment and consultation is highly weather-dependent, and can be particularly stressful in snow or in marginal ice/frost situations.

The road weather market is highly competitive in the UK. The Met Office is required to tender for contracts to the UK Highways Agency, local authorities, and their subcontractors. Various commercial weather companies have offered increasing levels of competition in recent years, using data primarily derived from US models.

OpenRoad ('OR') now incorporates a 'Route-Based' (rather than site-specific) capability, forecasting for many thousands of route segments. The need to monitor and interpret these forecasts, let alone intervene manually, suggested that our past production methods had to change.

Figure 3: Screenshot of the Route-Based Forecasting (RBF) system. Trial routes are colour-coded by RST in this example.



Production changes

The Philosophy

The forecaster is the vital controlling, decision-making element in a complex and technical production system. They are also a relatively expensive resource. They should therefore be able to do their jobs unhindered by technicalities and mundane tasks. By analogy with an airline pilot, or an air-traffic controller, we aimed to provide as much support to the human element in terms of automated systems and decision-making aids as possible.

The new production process is also designed to:

• Enable support of future Route-Based forecasting system.

• Address concerns about excessive workloads and forecaster stress in the busiest situations.

• Design an operation which can be scaled to fit expected weather, increasing efficiency and providing an even workload for all.

• Ensure forecaster intervention is limited to situations in which it is relevant to customer needs.

Structural Changes

Since forecast production was centralised to Exeter several years ago, we have continued to operate in a 'pseudo-regional' structure, with each OpenRoad forecast position working independently and looking after a set geographical area. In the new system, we have introduced a Team Leader who coordinates operations of a much more flexible team of up to 6 production forecasters.

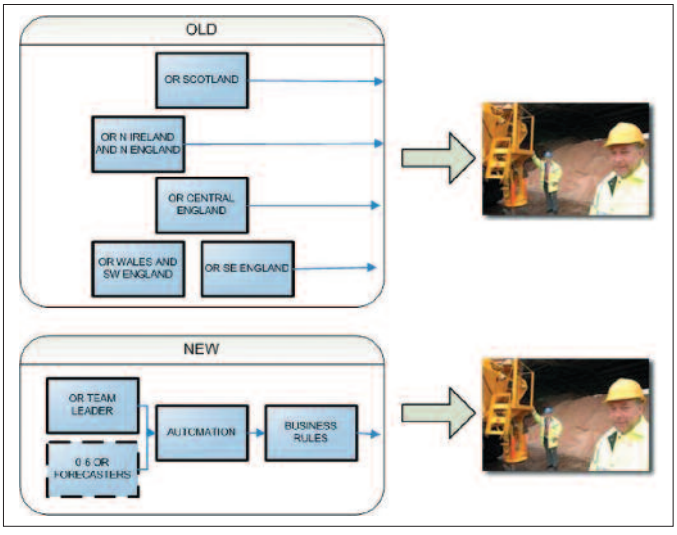
The Team Leader's role is to :

• Decide staffing levels for the coming shifts based on expected weather and workload.

• Decide how to distribute the forecasting team efforts across the different regions of the UK.

• Determine consequences of Chief Forecaster guidance for road hazards and impacts.

• Enforce Best Practice and Business Rules.



• Monitor quality and consistency, and have overall responsibility for OR output.

Within the production team, resources are focussed towards customers in areas likely to experience high-impact weather. Elsewhere, production is semi-automated (see below) and should be accomplished by a single forecaster. Thus the regional model has been abandoned in favour of concentrating forecasters' effort to where it matters most.

Figure 4: Comparison of old and new OpenRoad production team structures, with flexibility and automation replacing fixed regional responsibility.

Technical Changes

A suite of new production tools were developed to automate parts of the forecast process. The primary aim of many of these tools is to make routine forecasts of trivial ('GREEN') forecasts simple, and to make forecasting in other situations much easier. In the case in which conditions across the UK are uniformly mild, it should be possible for one forecaster to produce all the forecasts in very little time. All other forecasters may 'stood down', and deployed in other roles or allowed to go home. At the heart of the system lie applications which create text forecasts based on reusable text elements and first-guess model data. These are accompanied by additional forecast monitoring and intervention tools.

In normal, more complex, weather situations the tools enable us to employ human forecasting skills where they are needed most – leaving 'the machine' to forecast for areas which are milder, or in which the model is deemed to be performing sufficiently well.

Procedural Changes

Ideas of Best Practice were collected, agreed and published, and new forecasters were trained in these methods. But in addition to this, we worked with our scientists and business staff to formulate a set of rules which, when followed, allow the forecasting team to deliver maximum impact for minimum cost, without an excessive workload. For example,these 'Business Rules' include instructions on when forecasters should intervene on automated output, which models to use, and guidelines on how many staff should be used to cover certain weather situations.

Used in a coordinated manner along with the other changes described, Business Rules are a powerful tool in ensuring forecast quality, consistency and efficiency.

Results and conclusions

Winter 08/09 in the UK was the coldest since the mid-1990s. During early February, many areas, including the densely-populated South East, experienced their heaviest snowfall in 18 years. Despite this, we have managed to enhance forecast accuracy and quality, with a significant reduction in production costs. The new working methods have also proved broadly popular with both experienced and with newly-qualified forecasters.

There remain some aspects of the process which are stressful, excessively time-consuming, or are an inappropriate use of a forecaster's time. Further improvements are due to be made before the 09/10 winter season which will seek to address some of these issues.

A general review of the Met Office's forecasting activities is now underway, with a major theme being defining the future role of the forecaster. The benefits of the changes described above have been recognised, and it is hoped that many of the ideas can be applied to other aspects of our forecasting operations.

The authors would like to thank the Winter 08/09 Forecasting Team.

Will **Lang,** Jonathan **Dutton,**
Alison **Eadie** and Baden **Hall**
Met Office, UK