DEVELOPMENTS IN ROAD WEATHER FORECASTING

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ABSTRACT

Using a route based forecast as part of the winter maintenance decision making process allows for a network to be treated route by route and ultimately for variable treatments to be applied within a particular route. Route Based Forecasting (RBF) offers customers an improved road forecasting product, not only in terms of science, but also visualisation and user friendliness which enable them to make safe decisions more efficiently.

The benefits of RBF include:
- Ability to treat individual routes
- Ability to identify cold routes more easily
- The potential to selectively treat along a route
- Clear, unambiguous and concise information
- Web delivery
- Increased confidence for decision makers
- Route optimisation and operational efficiency

The Met Office has been trialling a route based forecasting system with a number of users to gain vital feedback from the customer. Further development of RBF will be based not only on the results of the trials but also on expected improvements in numerical modelling over the next year or two.

KEYWORDS

RBF/TRIALS/FEEDBACK/VISUALISATION/SEGMENTATION

1. INTRODUCTION

In recent years, environmental pressures and the need to make best use of resources whilst maintaining safety has seen highways authorities investigating newer ways of undertaking their winter services. Customer research and feedback indicates that within the next few years more road maintenance organisations in the UK may be looking to move to using route based forecasting as their preferred decision-making tool. The ability to provide forecasts of road surface temperature (RST) and road state along a route is therefore of growing customer importance.

RBF is a sophisticated route-based winter maintenance planning and decision-making tool which can be used as a stand-alone product, or

in conjunction with a standard site-specific forecast service, to provide improved visualisation and detail of road states at specific points along the selected routes. The performance of numerical weather prediction (NWP) models has been steadily improving over the years and the move to much higher resolution models offers the prospect of more accurate forecasts in a regional sense, and a better representation of the variability that is important for route-based forecasting.

RBF therefore offers customers an improved road forecasting product, not only in terms of science, but also visualisation and user friendliness, which enable them to make safe decisions more efficiently. An accurate, reliable and proven RBF system could potentially allow crews to prioritise which routes to grit or re-evaluate routes to suit climatic zones or improve operational efficiency. Using a route based forecast as part of the decision making process allows for a network to be treated route by route and ultimately for variable treatments to be applied within a particular route.

2. RBF TRIALS

The Met Office has been trialling a route-based forecasting system with a number of users during winters 2007/08, 2008/09 and 2009/10 to gain vital feedback from our customers. The primary focus of the customer trials has been to understand and develop our scientific capability, the value that customers derive from high resolution forecasts, and how best to visualise the information so that the key benefits of RBF are realised.

The 2008/09 winter trial was an enhanced version of the 2007/08 trial and involved more customers and more routes, around 50 individual routes in total across the whole of the UK (see figure 1). Additionally, an improved scientific approach was used in modelling the physical characteristics that are likely to influence road surface temperature variations along each route.

Trial customers were asked to provide feedback on specific aspects of the RBF system, such as route segmentation, system visualisation and user-friendliness. In addition, overnight car surveys were conducted on a number of routes on suitable nights to evaluate some of the science used, such as skyview and shading techniques, and also to provide verification data to evaluate the complete system. The surveys provided high spatial resolution measurements of air and road temperature making it easier to decouple orographic effects (which typically affect both) from shading, sky view and road construction effects (which have little effect on the air temperature). Repeated legs through a number of nights were also performed in order to examine the development of along-route temperature variations.

Figure 1 – Map showing location of Met Office trial routes winter 2008-09.

3. VARIABLE SEGMENTATION

On some nights, small-scale variations along a route can be crucial in determining whether a road needs treatment or not. It is therefore not considered acceptable to only display output data over the whole route (typically 50-100km) and indeed this approach was confirmed by customer feedback. However, it is equally unacceptable to provide levels of detail that can't be scientifically justified, nor can be used operationally by the customer. In order to maintain this balance we

have the capacity to split each route into segments of variably length, with numerous modelling points in each segment (see figure 2). Modelling points can be created automatically at a predefined interval to reflect adequately the variability within the segment.

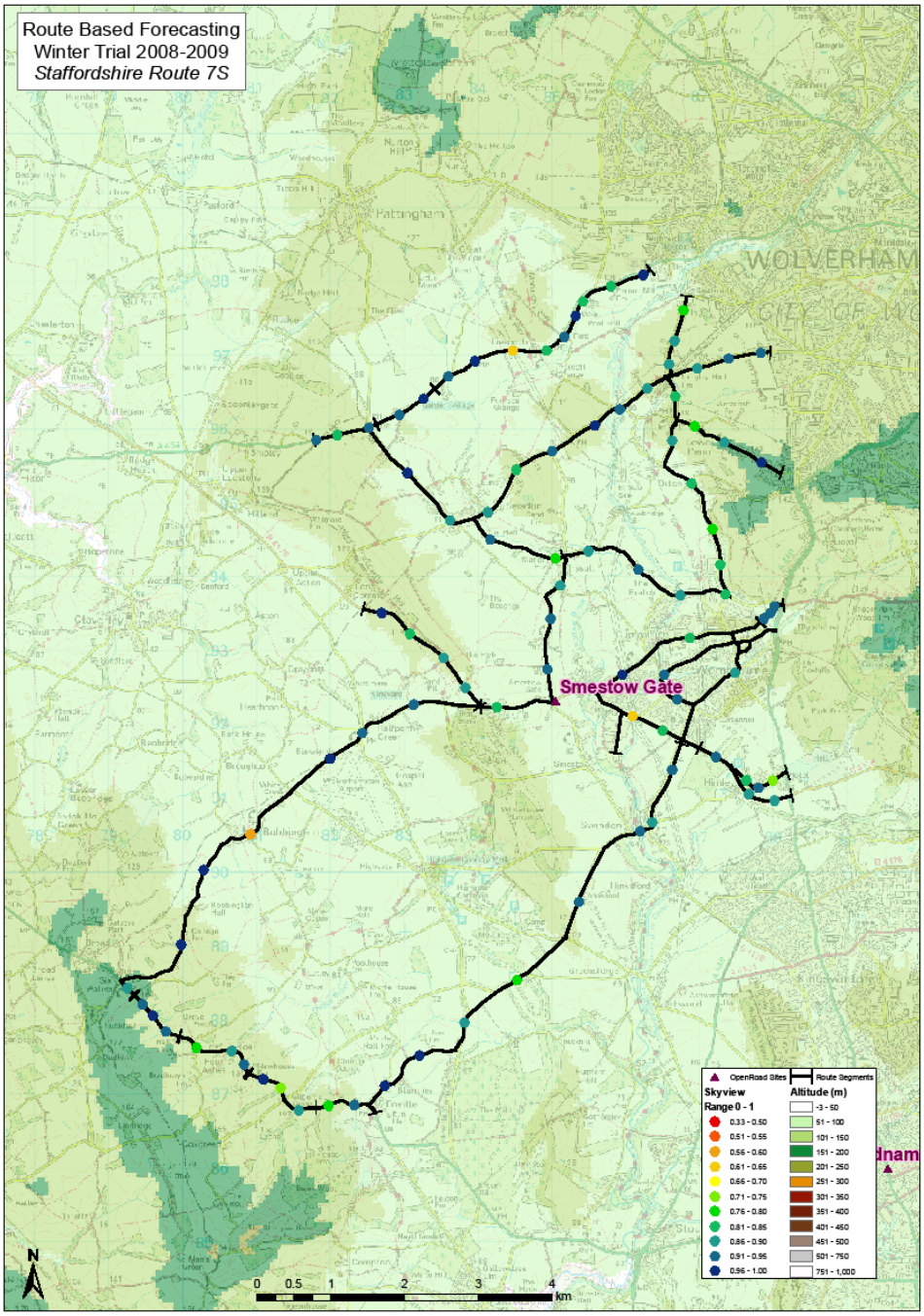

Figure 2 – Route map for Staffordshire route 7S, showing segmentation and modelling points.

Feedback on route segmentation from trial users was generally positive, with many customers commenting that between-segment variation along a route accurately reflected their perception of the variation of RST along that route based on and their own experience and crude measurements taken with portable thermometers. Route

segments which were consistently forecast to be colder than others were usually found to contain sections of road which experienced users knew as ‘cold spots’, those sections of road which often require additional salting runs or an increased spread rate. Continual dialogue between users and modellers ensures that the benefits of variable segmentation is maximised, with segmentation then being driven not only by changes in land use etc, but also by the user’s experience and route knowledge.

4. VISUALISATION

One of the most important objectives of the winter 2008/09 trial was to gauge user feedback regarding visualisation and user-friendliness of the RBF web-based system. This was achieved by a number of different means – monthly feedback forms, regular one-to-one meetings and a series of customer focus group meetings at different locations around the country, both during the winter and post-season.

Having logged on to their own password-protected ‘landing page’, the user can choose from the following display options:
- Summary of all routes in tabular form
- Summary graph for each route. One of the key abilities of the RBF visualisation is to allow users to view a sophisticated graph which shows best and worst conditions along the whole route.
- Forecast of RST, dew point temperature, road state, air temperature, precipitation type for each segment for the next 36 hours at one hour intervals, showing variation across a route for each time step. The user can select which routes to plot, and variations in RST, road state and precipitation type are shown in different colours. (see figures 3 and 4)

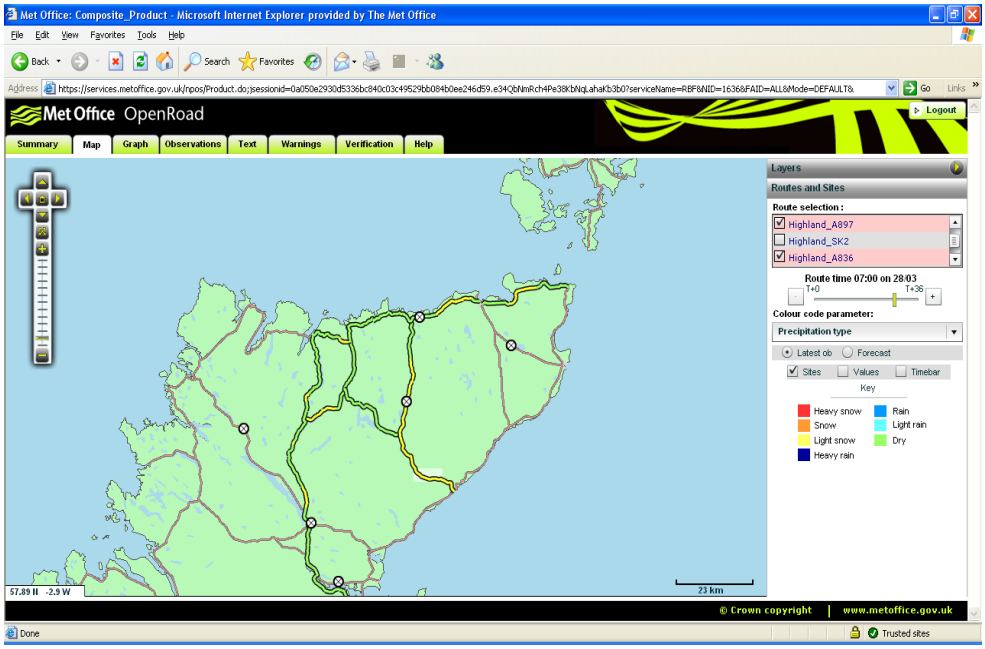

Figure 3 – Route map showing colour-coded variations of precipitation type by route segment.

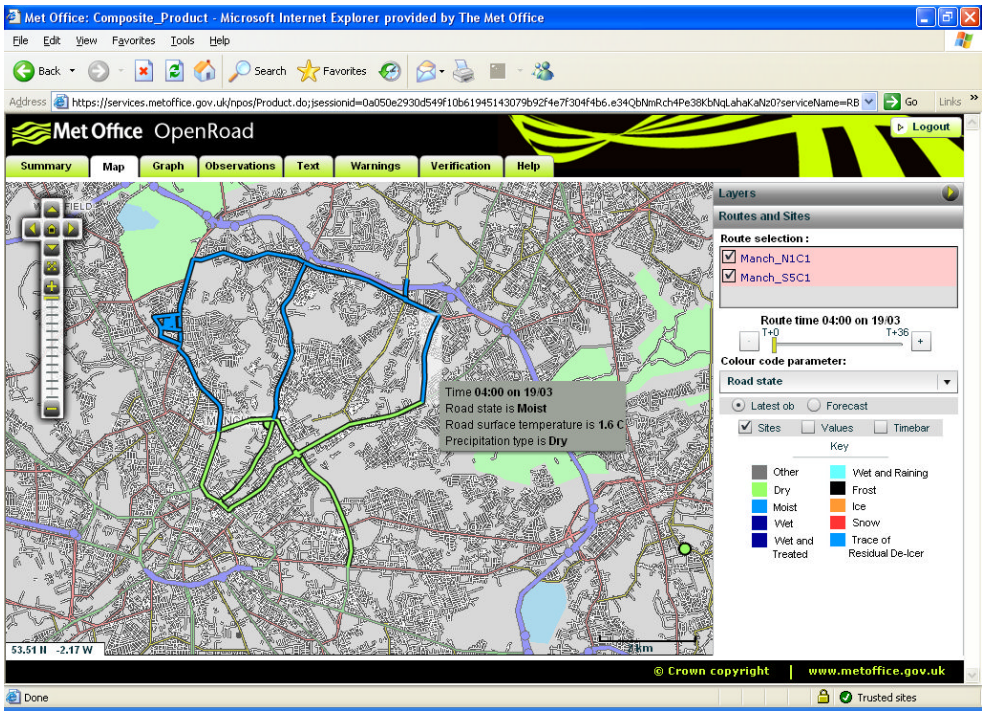

Figure 4 – Detail of route showing colour-coded variation of road state along route by segment

It is planned to adapt the system so that routes can be grouped in a manner appropriate to the users (for example by depot, climatic domain or road maintenance authority). Users will have the ability to order the groupings and also filter groupings. Users will also be able to configure their groupings individually and save the groupings locally to the PC using shared objects.

Following user feedback, the system will also be adapted so that the entire route can be coloured according to the worst condition during the forecast period regardless of where on the route this condition occurs.

5. VERIFICATION

Model validation and forecast accuracy are crucial to the success of route based forecasting and it is accepted that a standardised set of verification techniques are required for route based forecasts if the goal of selective salting is to be realised. However, the trials provided an opportunity for the verification of RBF through comparison of actual sensor site data with forecast RBF data for the segment within which the site was located. This verification was carried out on a regular basis for a number of sites and segments across the UK and can be used to give users a general idea of the accuracy of the product.

In addition, data from the car surveys were used to show that the model operates credibly in between the routinely observed sites. The main aim was to validate that the science that has gone in to the model is correct – can shading and sky-view effects be predicted in the right places? Do valleys correctly become cold relative to their surroundings on extreme nights but not on damped nights etc etc.

Several trial customers also verified route based forecasts on selected nights by using portable thermometers or by using gritting vehicles equipped with RST sensors. On most occasions these readings verified reasonably well when compared to the forecast and feedback was generally favourable. Indeed, one customer even found that one part of a route that they had previously suspected as being generally warmer (being suburban in nature) than the rest of the route (which is rural) was, on several nights, forecast to be the coldest section of the route. This was not something they expected to see but on closer inspection and by using portable thermometers, they found that the route based forecast was actually correct.

6. CONCLUSION

RBF output, like any other forecast product, is obviously constrained by the accuracy of the driving large-scale weather forecast. Therefore, on occasion and depending on the nature of the forecast error, human intervention is likely to be required at some point along the production chain at least in the short term. In addition to the developments outlined in this paper, it is anticipated that the operational RBF product will also involve an element of forecaster intervention.

The Met Office RBF trials during the winter season 2008-09 provided positive and extremely useful customer feedback on several significant aspects of the RBF web-based system. The combination of feedback-inspired changes to the system and other new developments such as a more detailed map viewer and higher resolution modelling will together ensure that customers are able to derive maximum benefit from the operational RBF system.

REFERENCES

[1]. Andrew Brown, Simon Jackson, Peter Murkin, Peter Sheridan, Alasdair Skea, Samantha Smith, Anthony Veal and Simon Vosper (2008) New techniques for route-based forecasting SIRWEC proceedings (ID:17)