The application of probabilistic route based road weather forecasting

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In recent years road weather information systems have developed to the point that site specific forecasts are available to highway engineers to aid their decision making. Route based forecasting is now being used to help the decision making ensuring that the roads are safe while minimising costs. Traditionally, forecast models using a surface energy balance equation in combination with the heat equation were deterministic in nature. Probabilistic forecasting models are able to provide more information than purely deterministic models. In this work we describe the application of an ensemble forecast model for road surface temperature, which is illustrated along the Hagley Road in Birmingham, UK. This route encompasses a large variety of conditions, as it goes from the city centre, through the suburbs and out into a rural area.

The forecast model for road surface temperature developed uses a surface energy balance equation. The meteorological input parameters are forecasts taken from the Met Office Datapoint website, and other parameters in the model are derived from the literature, GIS data, and traffic flow information. All parameters in the model have an associated uncertainty. A distribution is placed over the input parameters of the model based on the error of the forecast when compared with observation data or ranges determined from the literature. Sampling from this distribution we generate an ensemble of each of these parameters and run the model for each ensemble member. The output of the model is an ensemble of road surface temperature forecasts at each point.

The spatial aspect of the model is dependent upon the different meteorological forecasts taken at different areas along the route of the Hagley Road and also the geographical parameters. These are included as a layer in a GIS and so the appropriate value can be included in the model at each point along the route, including associated uncertainty. A global sensitivity analysis is used to show which of the input parameters are the most important in this model across the range of conditions experienced therefore indicating which sources of uncertainty we should be aiming to reduce on average. We also investigate the forecast sensitivity and show that under different conditions different factors become important in determining the model response. We demonstrate the probabilistic forecast system, and show that constructing a statistical emulator of this probabilistic model will allow the forecasts to be made more quickly, allowing dynamic updating of route based forecasts using a near real time data assimilation approach.

Acknowledgments: this work was funded by EPSRC and Amey Ltd. under a CASE studentship. We would like to acknowledge the assistance of Chris Lucas at Amey Ltd. who provided the validation data used to calibrate the model.