USING ROAD STATES FOR SIMPLIFYING COMMUNICATION OF PROBABALISTIC FORECASTS

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Summary

The Met Office's surface transport offering incorporates a 'road state' forecast, which is a one-word summary of the expected road conditions. As part of ongoing improvements we are simplifying the road state calculations to help to clarify each state's meaning, enabling improved decision making. We are also moving from deterministic to probabilistic road states, allowing us to provide richer information about the range of possible conditions and their likelihoods. In this talk we discuss the new road state definitions and how our probabilistic road state forecasts are produced.

Abstract

A key challenge of forecasting is information compression; going from terabytes of observational and forecast data to a single decision, such as whether to pack an umbrella or to grit a road. To assist forecast users in decision making, the Met Office produces a 'Road State' forecast, which condenses the expected road conditions over each hour into a single one-word summary. The seven states are: dry, moist, wet, wet and raining, frosty, icy and snow. A visualisation of the data flows during production of a road forecast is shown in figure 1.

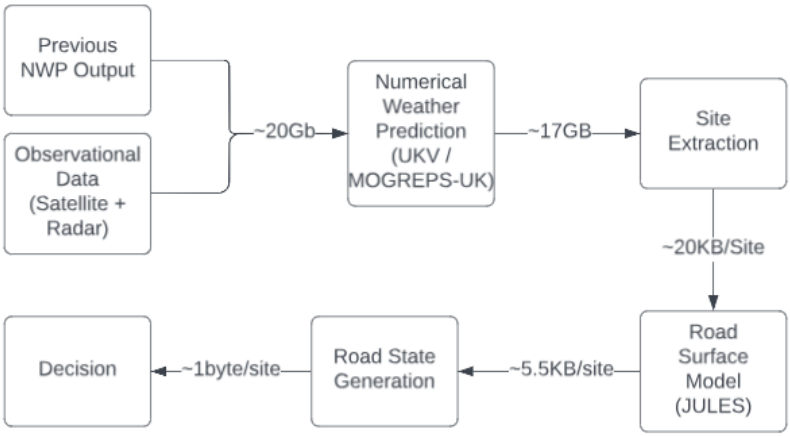

Figure 1: Visualisation of data flows in the production of a road state forecast.

The Met Office is currently overhauling its road forecasting capability, transitioning from a bespoke surface energy and water exchange scheme (MORST) to one based on the Joint UK Land Surface Model (JULES) [1, 2]. We are also moving from deterministic to ensemble forecasting.

In a deterministic forecast, we produce a single 'best guess' for future atmosphere and road states. Having a single answer simplifies communicating forecasts, however due to the chaotic nature of the atmosphere, very small changes in the initial conditions can lead to significantly different forecast outcomes. The resulting uncertainty cannot easily be quantified or communicated with the deterministic method.

Ensemble forecasting addresses this problem by running the model several times in parallel, starting each run with slightly different initial conditions. This results in a set of physically plausible forecasts, all with approximately equal probabilities [3]. Where several of these forecasts agree, we assign that outcome a higher probability. By using ensembles we

can better capture the range of possible road conditions and their probabilities.

As part of this work we are simplifying how road states are calculated. In MORST, road states are calculated based on both the forecast conditions and the previous state. This allows more information to be fed into each decision. However, it complicates the meanings of the states, reducing their usefulness as tools for communicating the forecast. Furthermore, as each state prediction is influenced by the previous one, a single incorrect state prediction can propagate many timesteps into the future, causing the road state forecast to diverge from the model output. Finally, chaining state predictions in this way is incompatible with ensemble forecasting, as there is no clear way to decide which previous states should be allowed to influence which future states from the ensemble.

In the new system, road states will be generated from the forecast only, with no reference to previous states. Thresholds between states will be chosen based on the relevant physics, in a way that is intuitive and easy to communicate. The conditions described by each state are outlined below:

Dry – No rain and <0.001mm of water on the road (this is the resolution of the instrumentation used to measure road water depth).

Moist – Between 0.001mm and 0.05mm of water on the road surface.

Wet – More than 0.05mm of water on the road surface.

Wet and raining – More than 0.05mm of water on the road surface and more than 0.05mm/hour of rain.

Frosty – Between 0.01mm and 0.05mm of water on the road and Road Surface Temperature below 0^oC.

Icy – More than 0.05mm of water on the road and Road Surface Temperature below 0^oC.

Snow – More than 0.5mm of lying snow on the road surface.

Whilst the above thresholds are largely based purely on physical considerations, there is still a judgement to be made for the threshold between moist and wet. This was based on empirical studies of the impacts of standing water on journey times [4] and numerical modelling of the conditions under which hydroplaning can occur [5]. In both cases, the severity of the impact of standing water increases with driving speed. As these states must be applicable to all roads, we chose to evaluate at a speed of 70 miles/hour (113km/h) which is a typical upper bound for speed limits on UK roads. Based on this, a threshold of 0.05mm was chosen as the depth of water likely to cause > 10% disruption to journey times.

In this presentation we will discuss how our road states are defined and forecast and compare ensemble based probabilistic methods with their deterministic counterparts.

References

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