

The application of probabilistic route based road weather forecasting

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Summary

Ensemble model for road surface temperature.

- Surface energy balance equation
- Meteorological parameters included
- Spatialisation

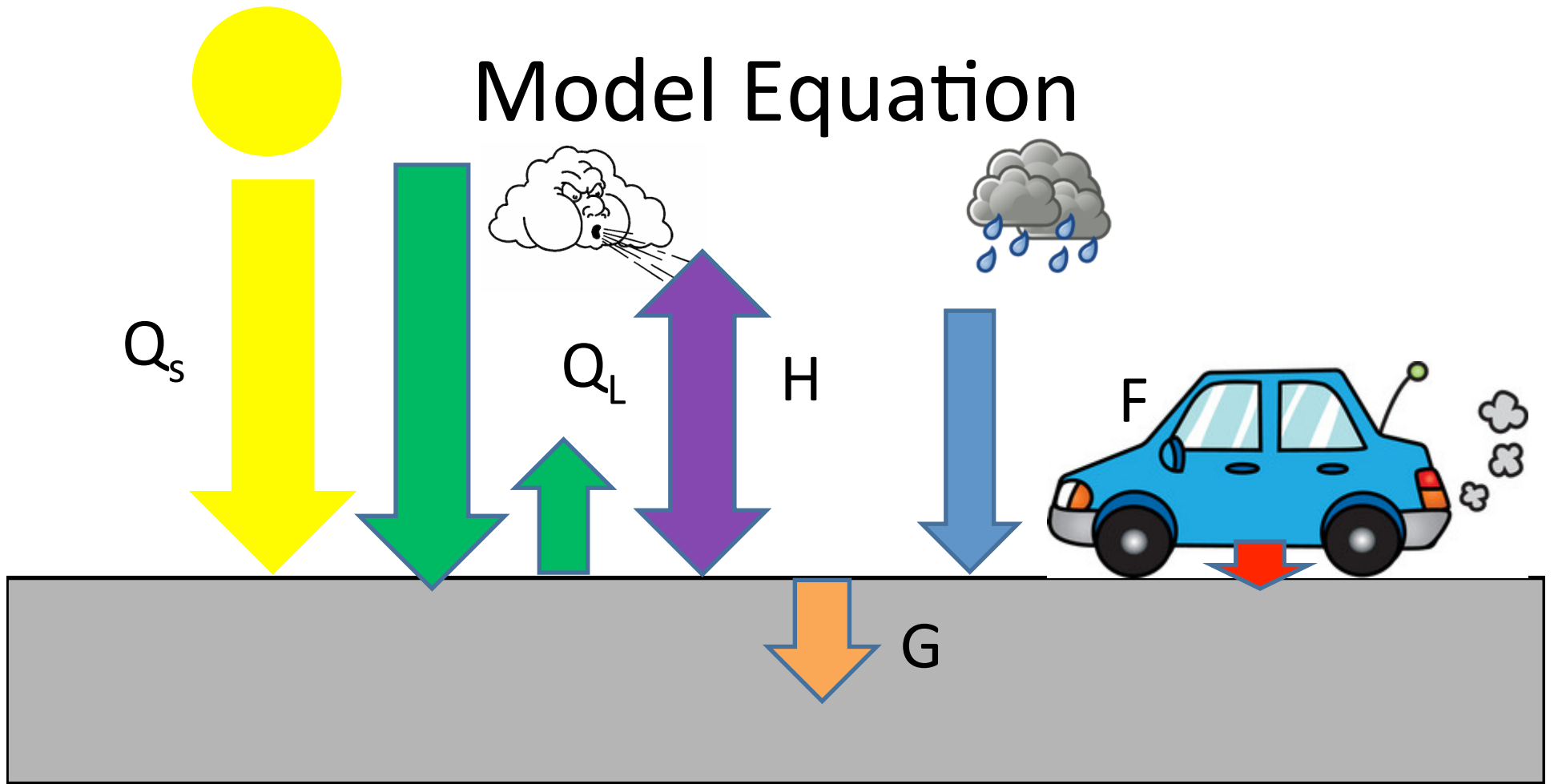
Verification

- Sensor Data
- Time series comparison
- Plots

Sensitivity Analysis

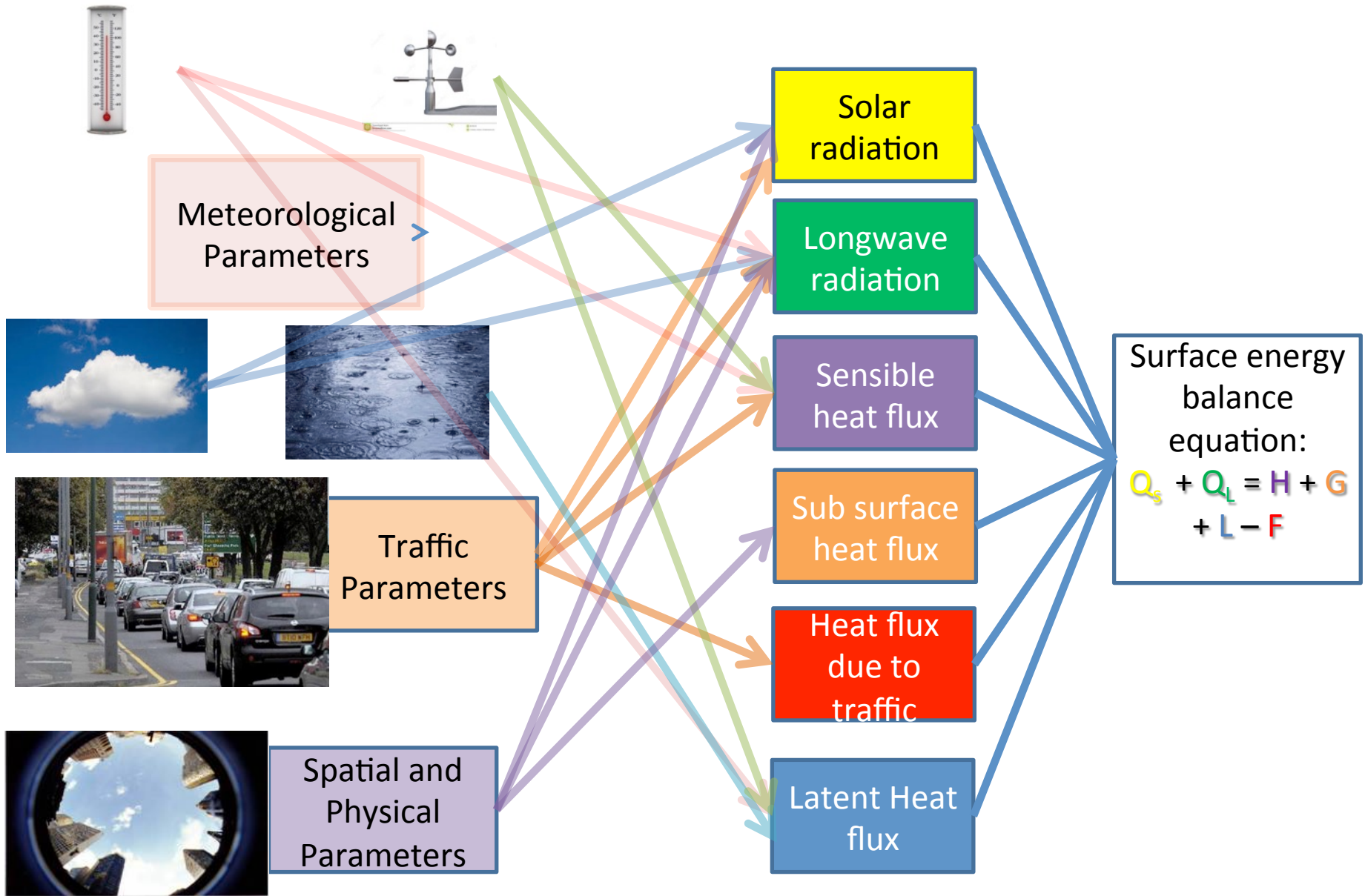
- Morris Method
- Full sensitivity
- Forecast sensitivity

Model Equation



$$Q_s + Q_L = H + G + L - F$$

Ensemble Model For Road Surface Temperature



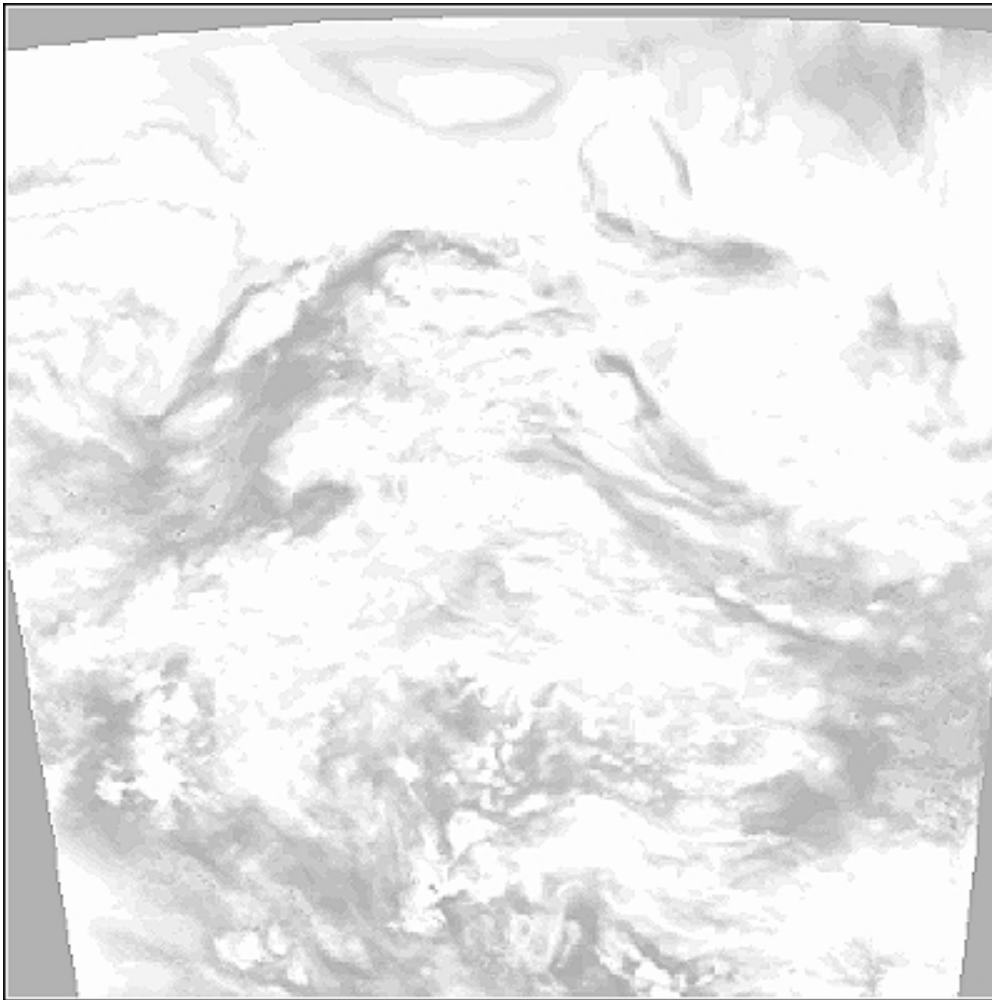
Weather inputs – Met Office DataPoint

< Birmingham last 24 hours

Fri 22 Apr		Sat 23 Apr		Sun 24 Apr		Mon 25 Apr		Tue 26 Apr		Wed 27 Apr		Thu 28 Apr	
10 °C		10 °C		9 °C		10 °C		8 °C		9 °C		10 °C	
3 °C		2 °C		5 °C		1 °C		1 °C		1 °C		1 °C	
12 ⁰⁰	13 ⁰⁰	14 ⁰⁰	15 ⁰⁰	16 ⁰⁰	17 ⁰⁰	18 ⁰⁰	19 ⁰⁰	20 ⁰⁰	21 ⁰⁰	22 ⁰⁰	23 ⁰⁰		
8 °	9 °	9 °	9 °	10 °	10 °	9 °	9 °	8 °	8 °	7 °	7 °		
Feels like temperature (°C)													
6 °	6 °	7 °	7 °	7 °	8 °	7 °	7 °	6 °	5 °	5 °	4 °		
Precipitation probability													
10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	<5%	<5%	
Wind direction, speed & gust (mph)													
ENE	ENE	ENE	ENE	E	E	ESE	ENE	ENE	ENE	ENE	ENE	ENE	ENE
19	19	18	16	15	14	12	16	18	17	17	17	17	17
Visibility (E = Excellent, VG = Very Good, G = Good, M = Moderate, P = Poor, VP = Very Poor)													
G	G	G	G	G	G	G	G	VG	VG	VG	VG	VG	VG
Humidity													
72%	68%	64%	59%	57%	57%	63%	61%	61%	61%	61%	61%	61%	61%
UV index													

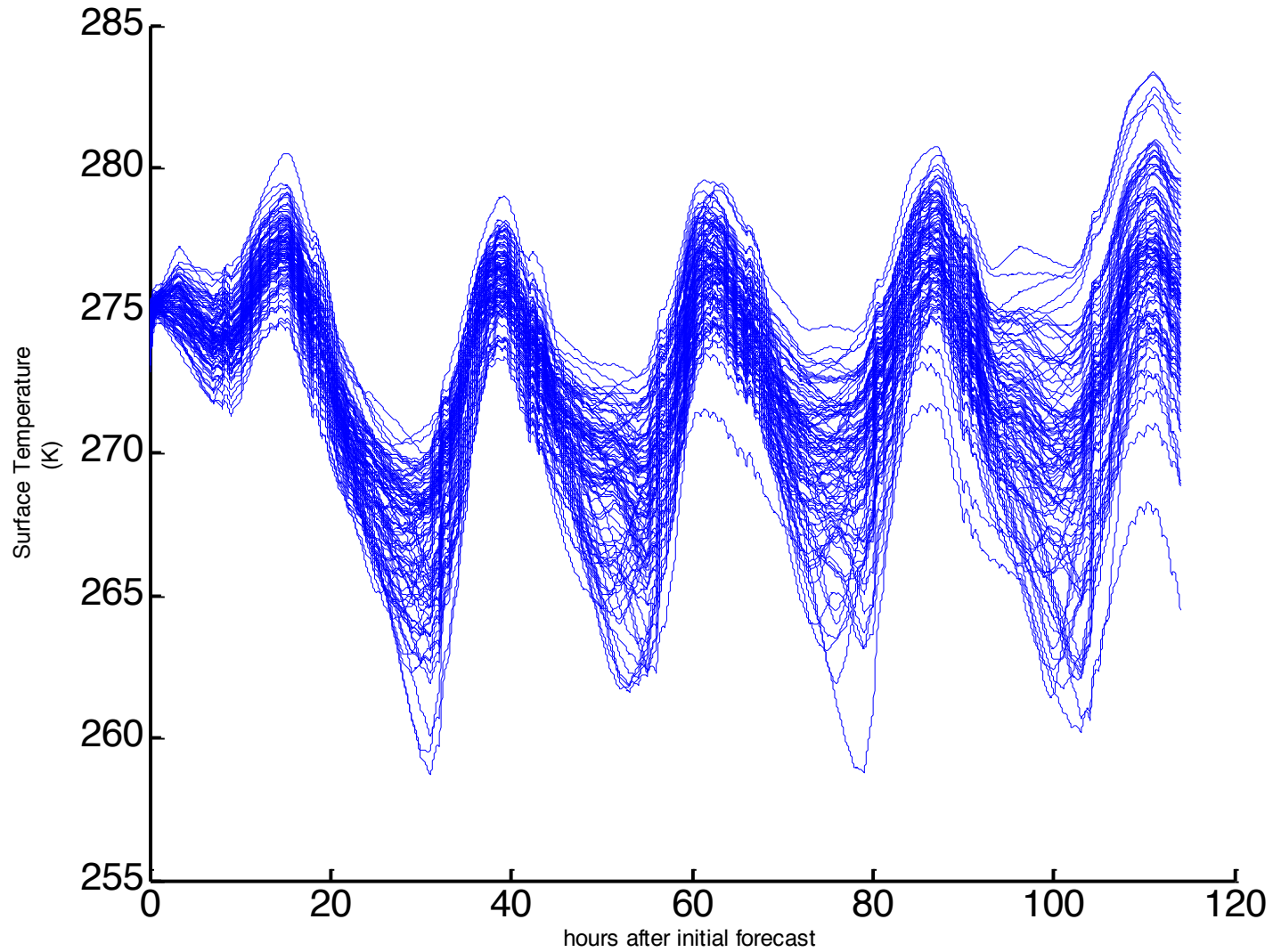
Ensembles are generated from the deterministic forecasts using historical forecast – observation differences, accounting for temporal and variable correlations.

Cloud Cover – a key input

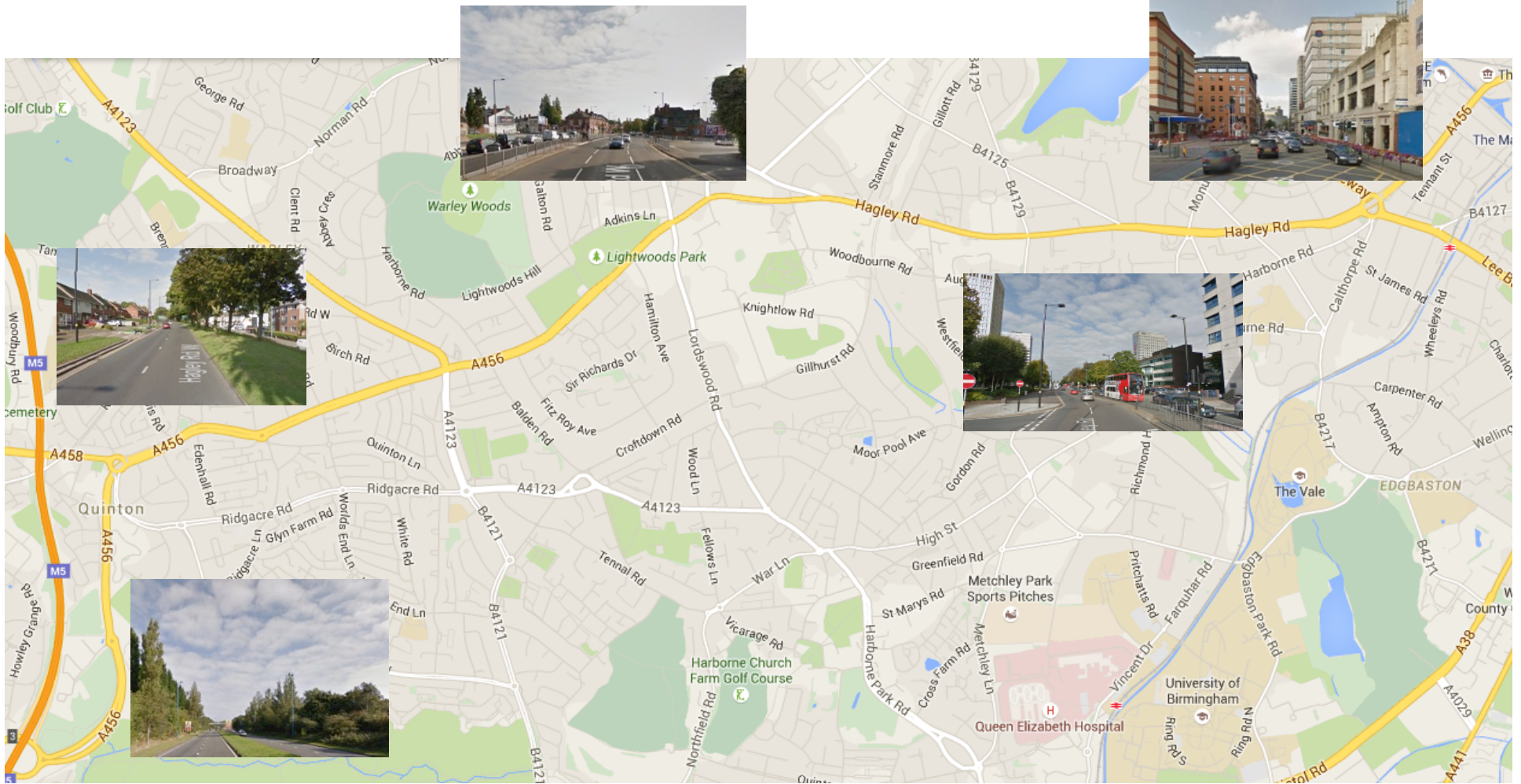


- Cloudiness affects incoming longwave radiation.
- Forecast from Met Office Datapoint system.
- Section of image covering Birmingham taken and spatial mean and standard deviation of forecast cloudiness calculated.

Ensemble Forecasts

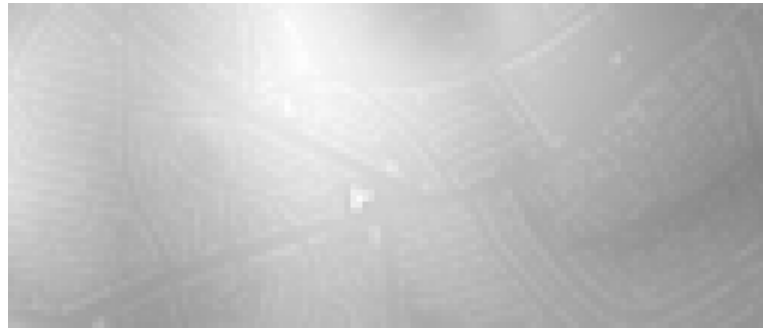
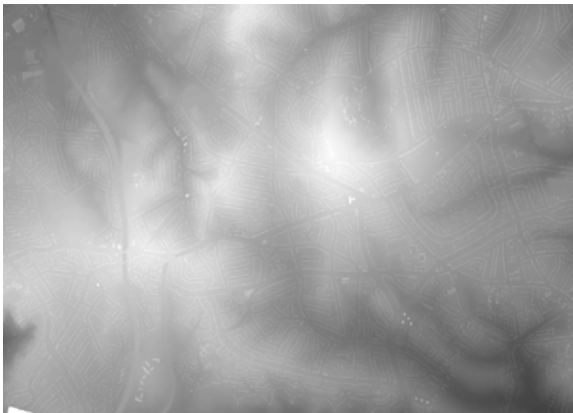


Hagley Road, Birmingham

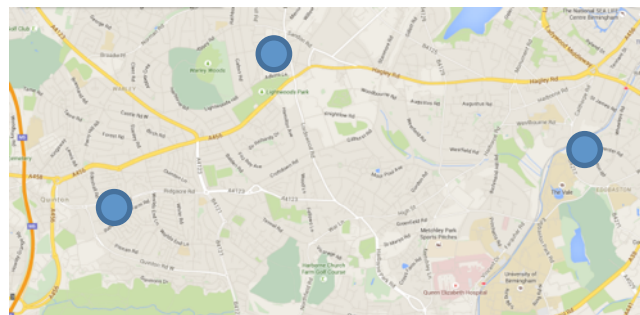


Spatialising

- Lidar data used for sky view factor and shading

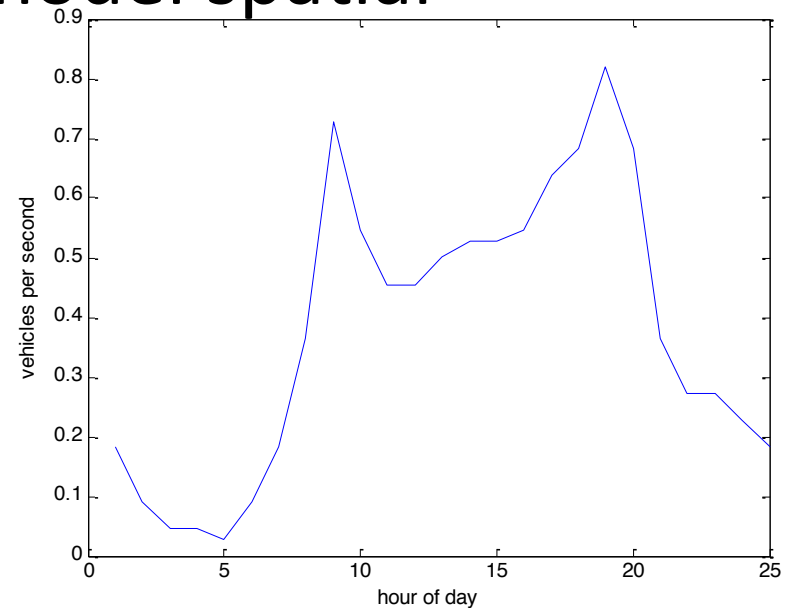
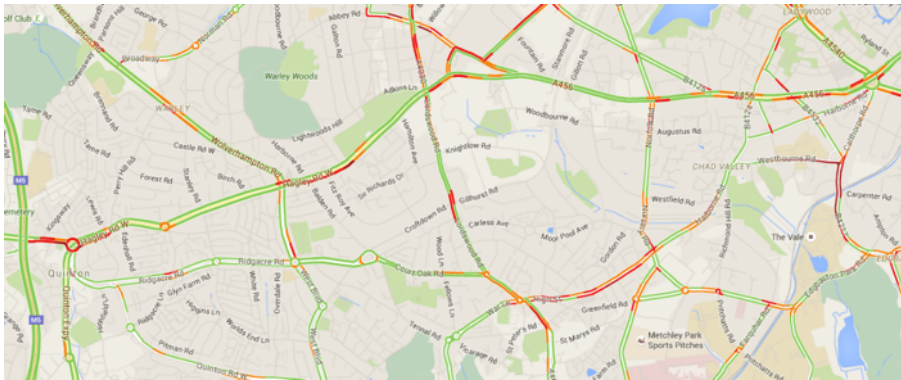


- Meteorological forecasts used for different areas

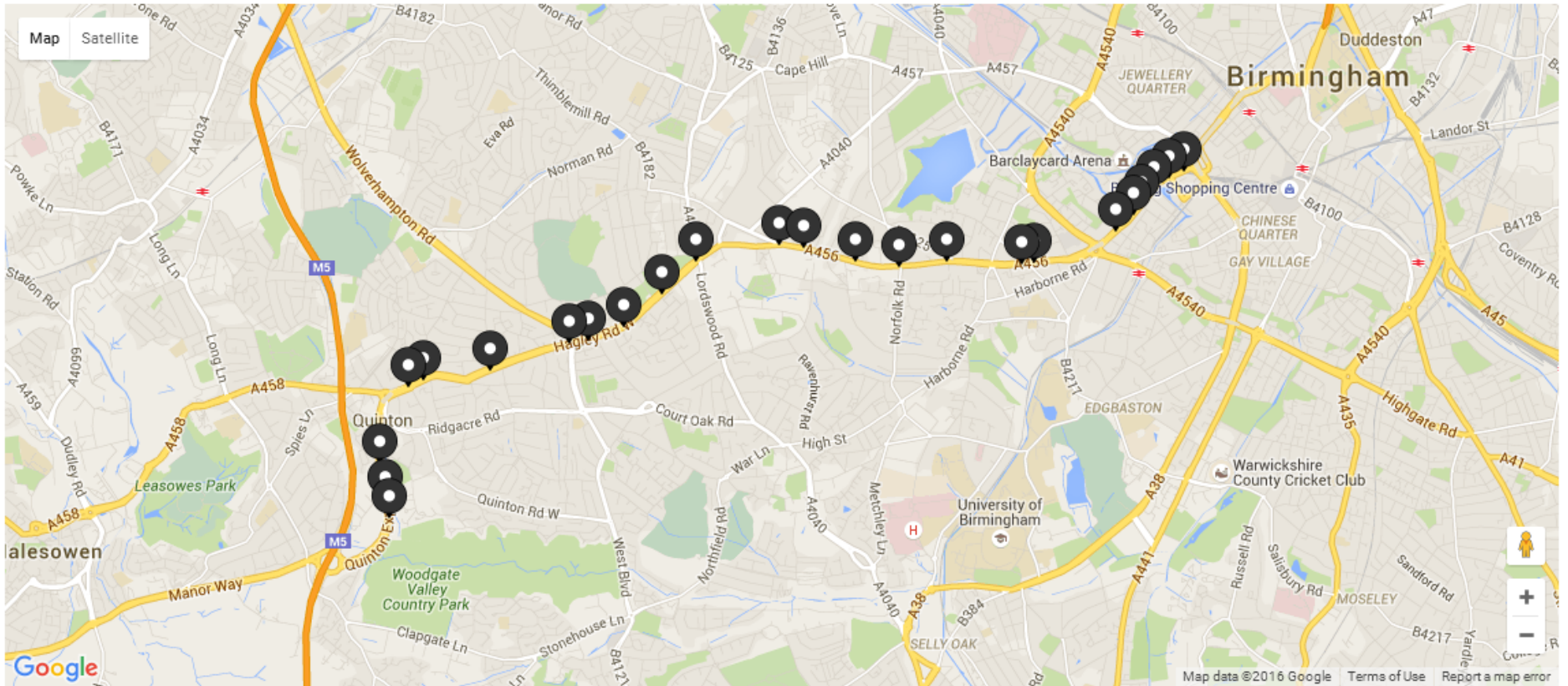


Traffic

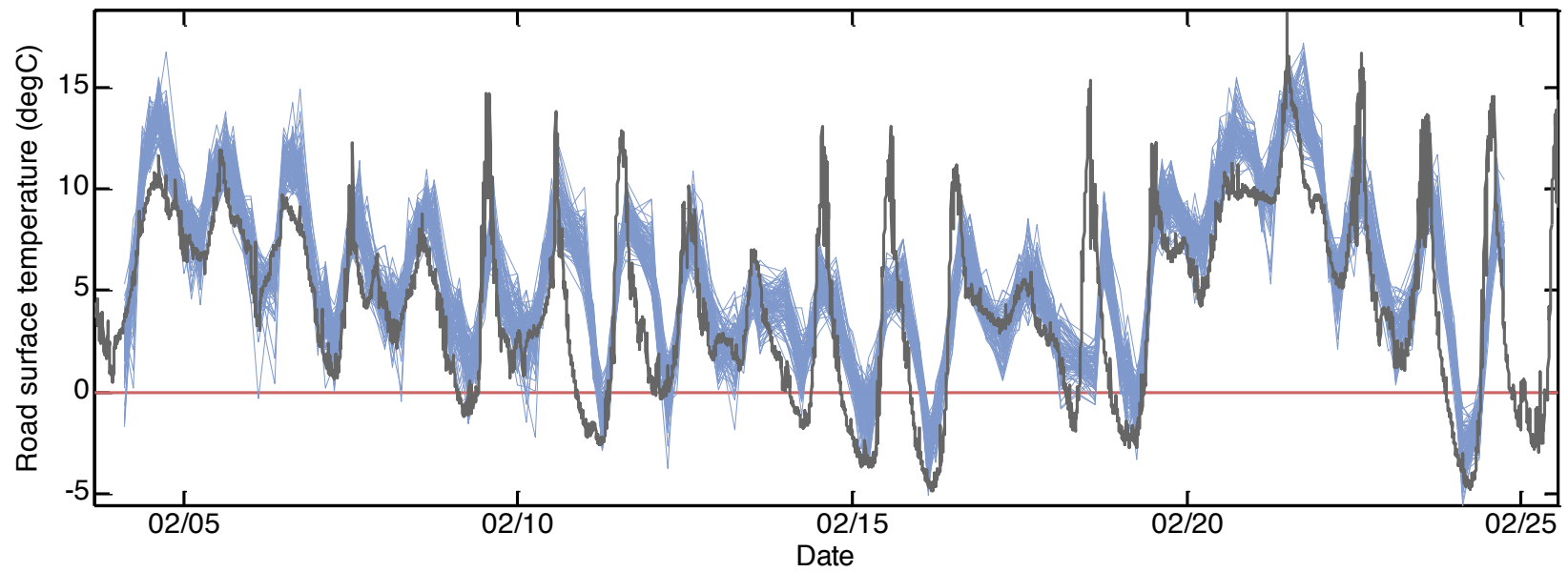
- Spatial variation not yet included.
- Change in traffic flow over 24 hour period is modelled.
- Use data from council to model spatial variation



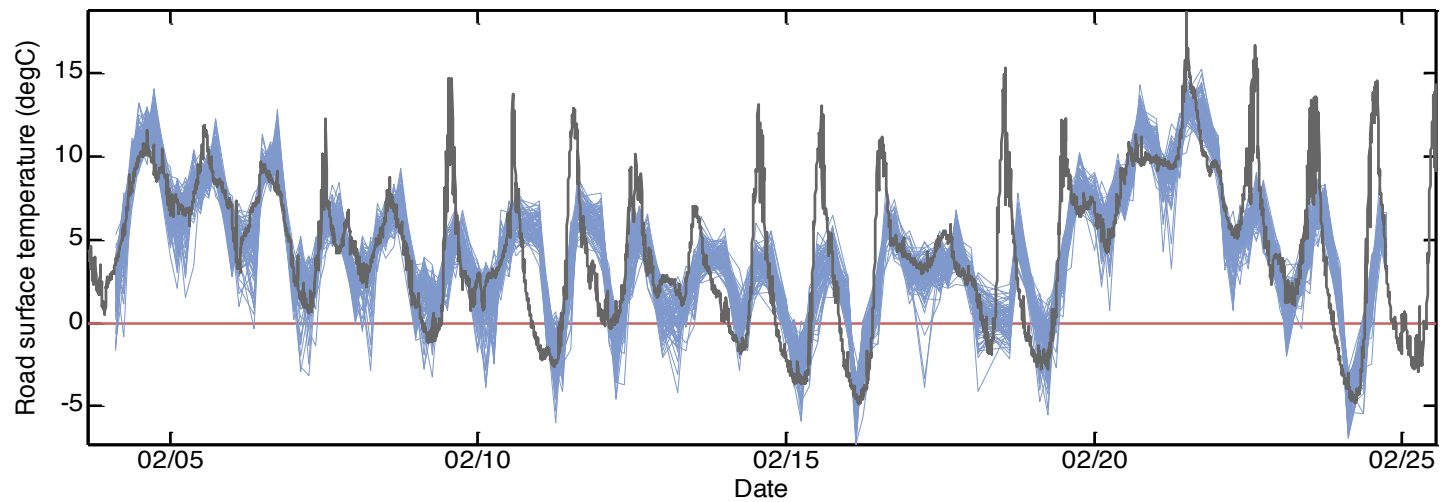
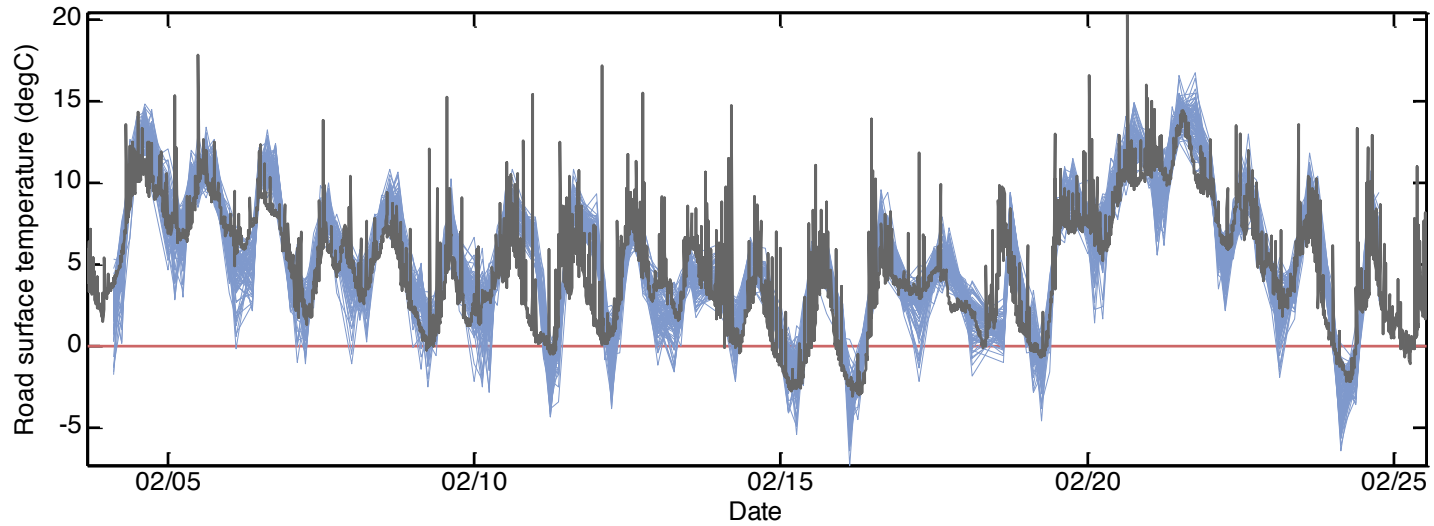
Wintersense Hagley Road sensors



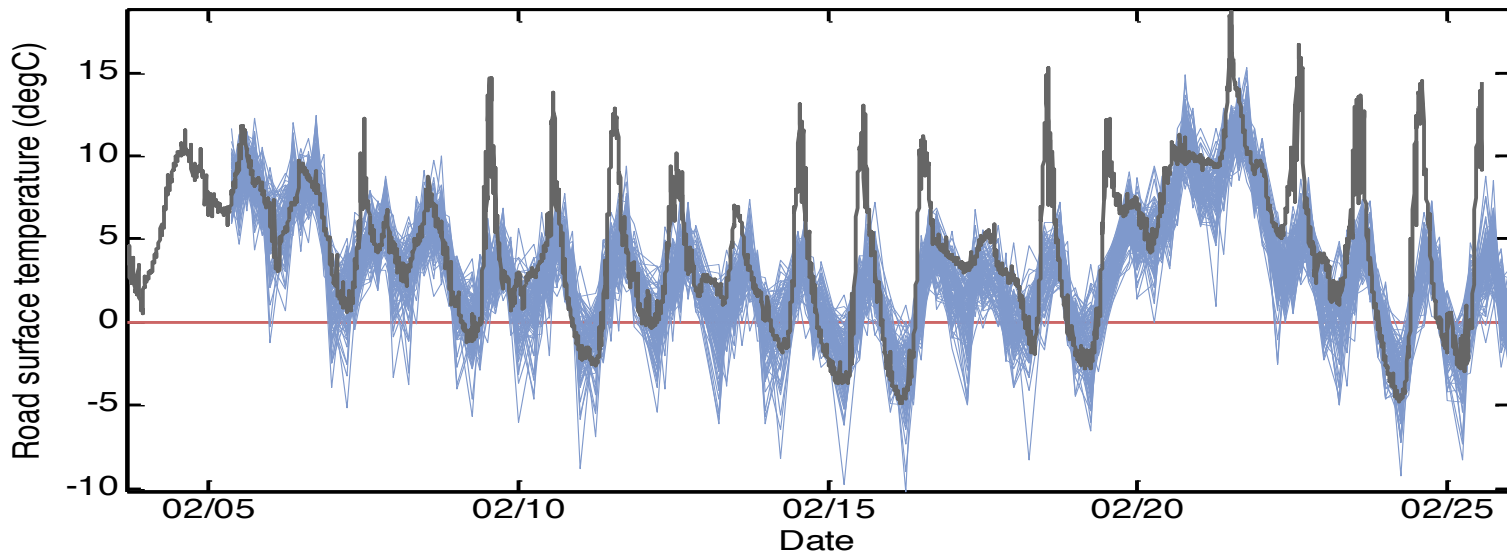
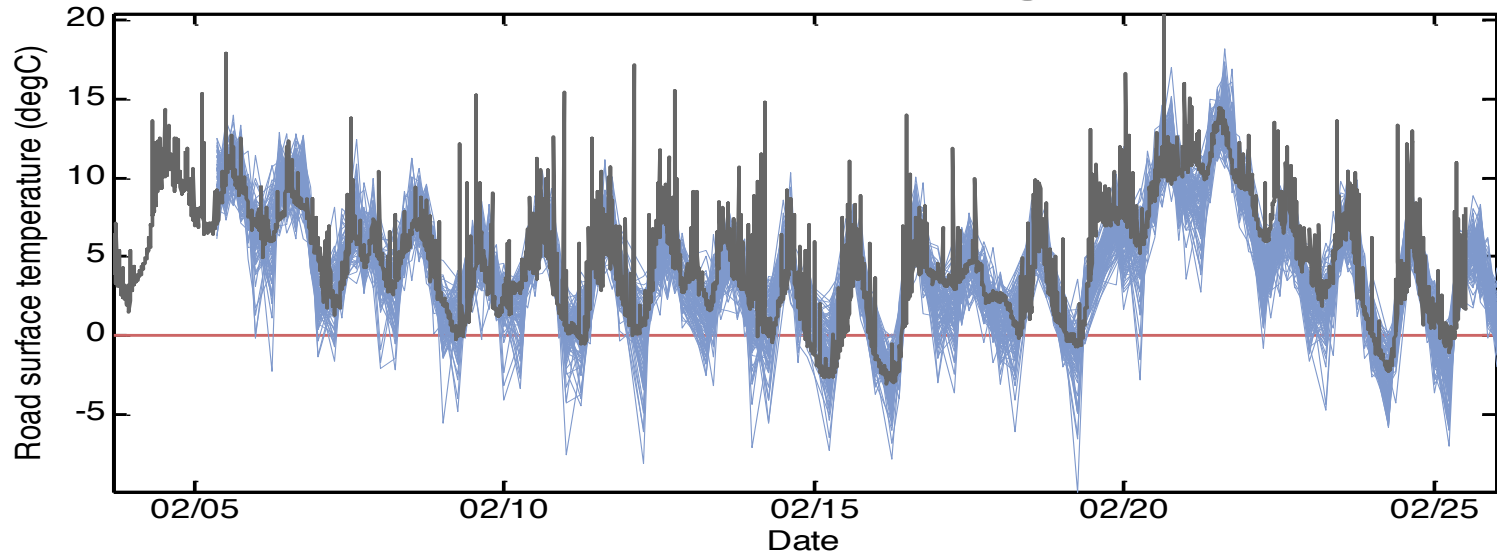
Verification of model



Comparing city centre forecast with rural forecast

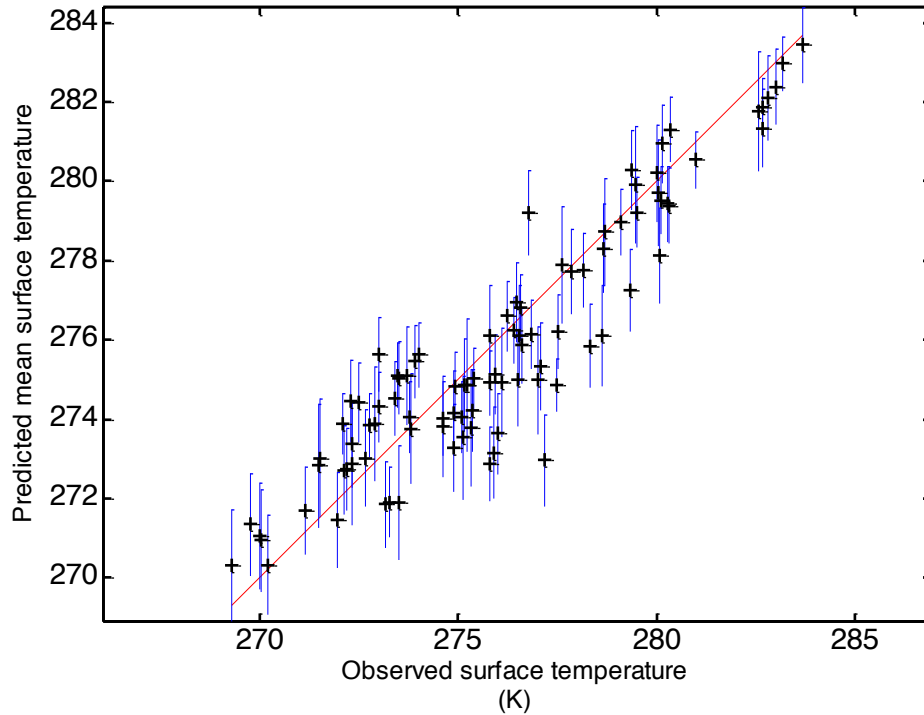


Comparing city centre forecast with rural forecast at for a longer lead time

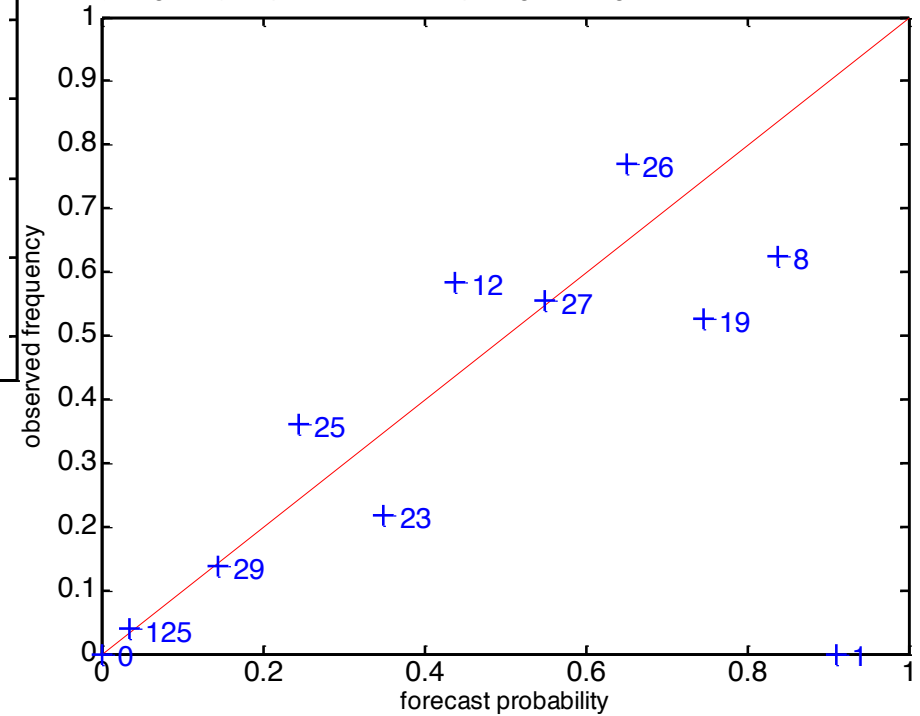


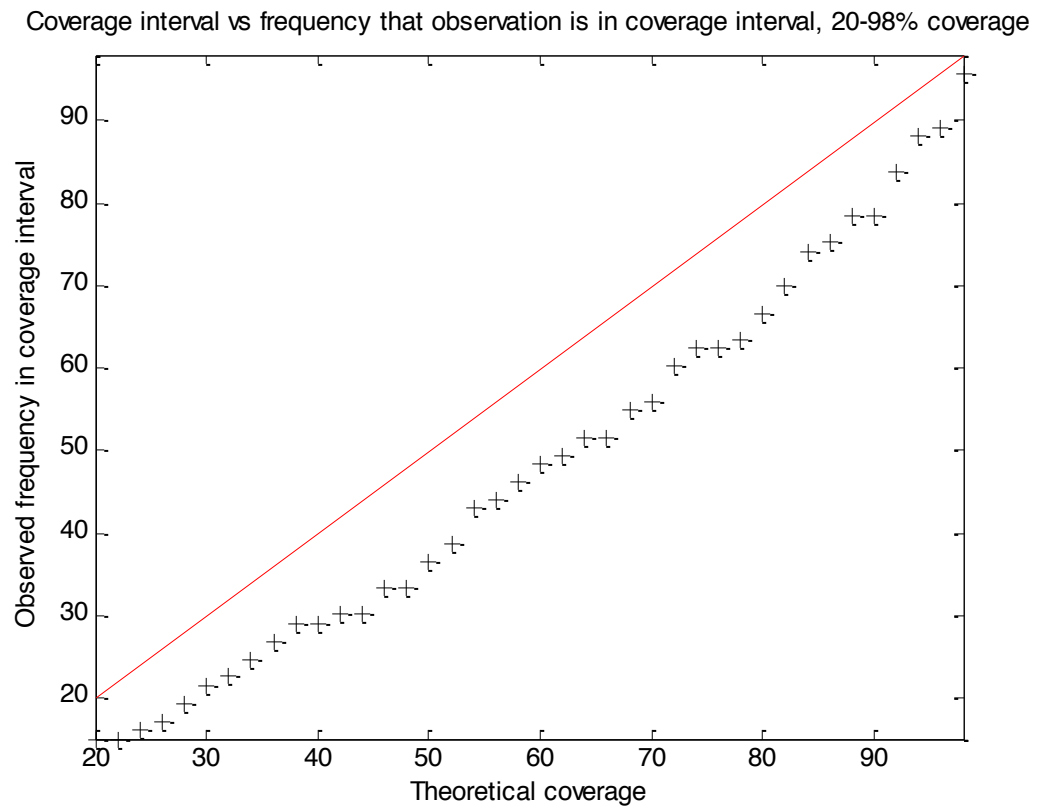
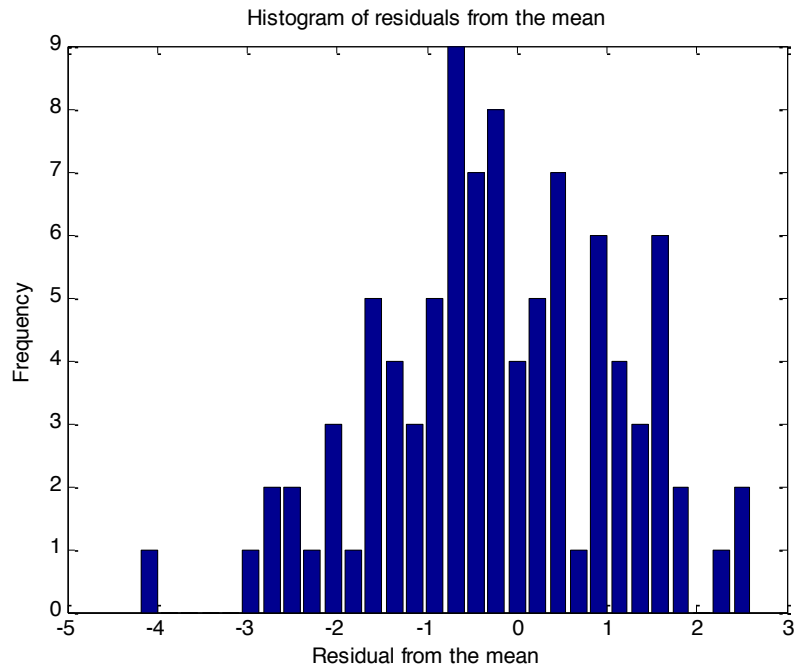
Excluding Midday forecasts

Observed versus predicted mean, with error bars ± 1 standard deviation



Reliability diagram (computed based on splitting the range of observations into 10 classes)

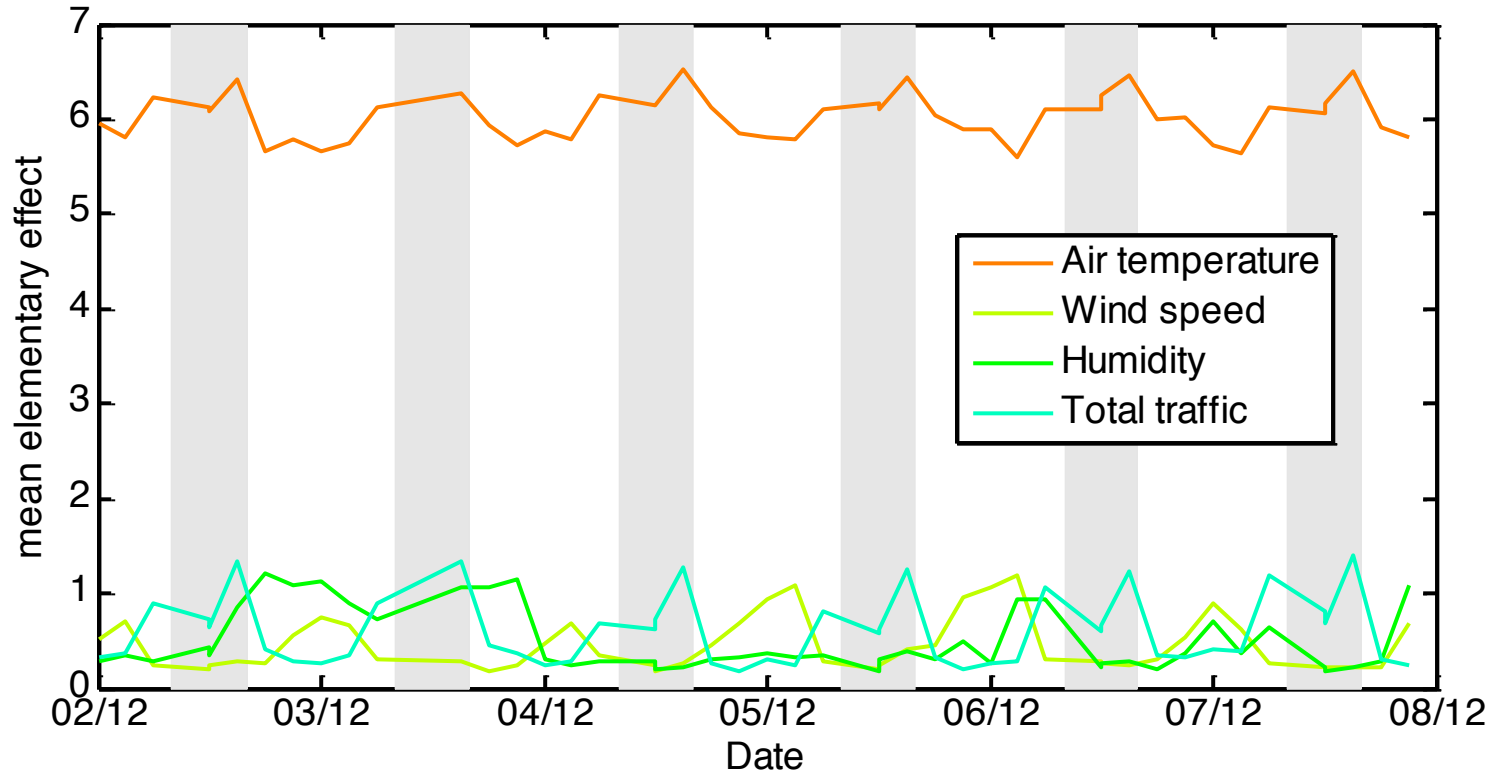




Sensitivity Analysis

- Morris Method used.
- One at a time method.
- Select range for each parameter,
- change each parameter one at a time and measure the effect on the output of the model.

Sensitivity time series



Conclusions

- Ensemble forecast for road surface temperature
- The uncertainties of the model are underestimated!
- Midday road surface temperature forecasts have a large cold bias
- The meteorological parameters are seen to be the most important.

