Finnish Meteorological Institute

17TH INTERNATIONAL ROAD WEATHER CONFERENCE IN ANDORRA

ID: 0009

The effect of local features to road surface temperature

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Introduction

Many local parameters affect the road surface temperature. These can be divided into meteorological, geographical and road construction parameters (table 1).

Meteorological	Geographical	Road construction
Solar radiation	Latitude	Depth of construction
Earth radiation	Altitude	Heat conductivity
Atmosphere radiation	Topography	Heat diffusivity
Air temperature	Screening	Emissivity
Cloudiness	Sky view	Albedo
Wind speed	Land use	Traffic
Humidity/ dew point	Topographical exposure	
Precipitation		

Table.1. Local parameters affecting road surface temperature. Based on Thornes and Shao (1991) [1] with some modifications.

In this research the studied local features were:

- road surface albedo
- asphalt depth
- slope angle
- screening
- bridges

The road weather model was run for 16 road points using different values for variables describing the different features. Also the reliability of road weather forecasts was tested.

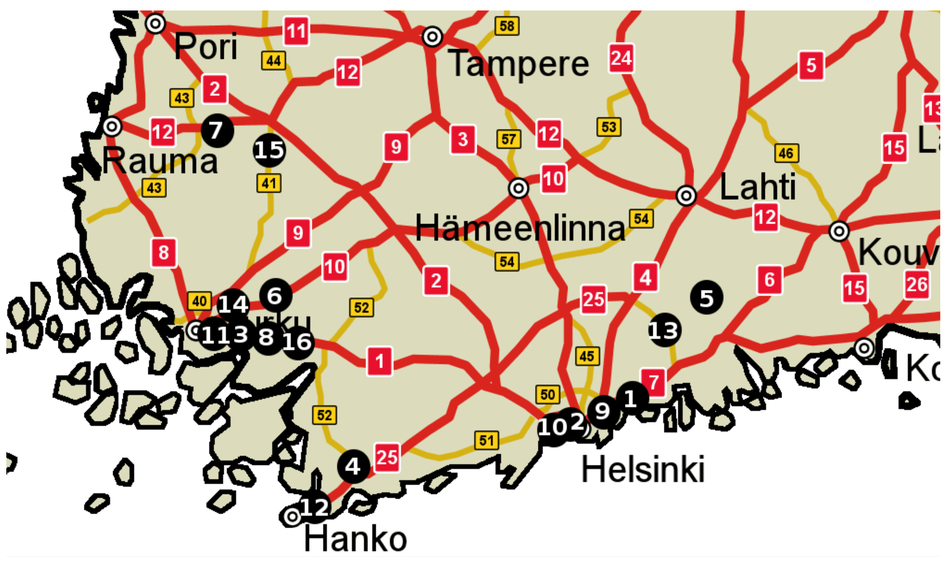

Figure 1. Locations of the road weather stations. Stations 1-3 are on a bridge, 4-8 are on slightly sloping hills and 9-16 are reference stations.

Methods and results

Reliability of forecast for different stations

- RMSE (Root Mean Squared Error) was calculated each day
- RMSE were compared between stations on bridges and on sloping surfaces with to the nearby stations on flat ground (Figure 2)
- No significant differences were found for most of the station pairs

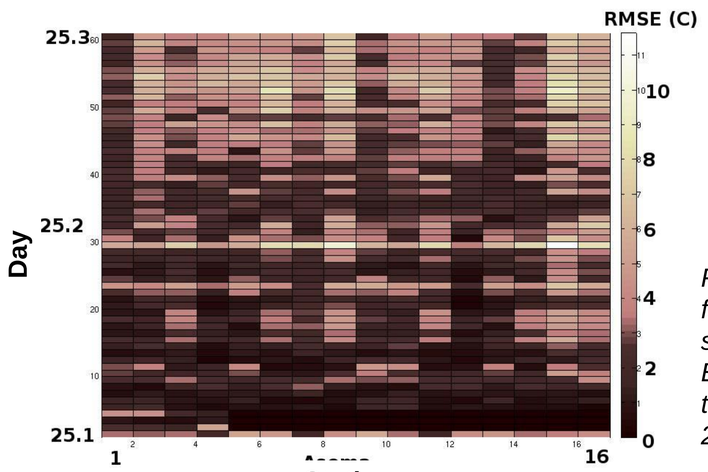

Figure 2. RMSE values of forecasts made for 16 stations 25.1.-25.3.2013. Each square describes the mean RMSE during 24 hours for one station.

Sloping surface

- Temperature simulations on sloping surfaces were done by changing the long and short wave radiation input values
- On south facing surface the temperature increase was 0.40 °C when increasing angle of slope by 1 ° and on north facing surface it was -0.46 °C

Asphalt depth

- Model was run with asphalt depths ranging between 2 cm and 21 cm during seven days, with different weather conditions
- Differences for highest and lowest temperature was calculated for each run.
- The temperature variation differed from 1 to 5 ^{0}C on different days between asphalt thicknesses of 2 cm to 21 cm .
- increasing the asphalt depth between 2 cm to 6 cm decreased the temperature variation 2 °C during 24 hours on a sunny day

Albedo (reflectivity of the surface)

- Used albedos for road surface in the model: 0.04 and 0.12
- Seven days with different weather were studied
- Day time (10 a.m. – 2 p.m.) means of 16 stations were calculated (Table 2)
- Biggest temperature difference between surfaces with different albedos was 1.13 °C
- Smallest significance to the road temperature of the tested features

Date	T(α=0,04)-T(α=0,12)(K)
18.1.2013	0,28
30.1.2013	0,02
9.2.2013	0,24
3.3.2013	0,34
6.3.2013	0,44
15.3.2013	1,13
20.3.2013	0,58

Table 2. The day time mean differences of surface temperatures in forecasts made with different surface albedos. Values are averages over 16 stations.

Screening

- Simulation of the barrier which obscured the full southern horizon.
- Model runs with different obscuring times, when surface gets only indirect radiation (Figure 3)
- In the model run when the sun was obscured for the full day the temperature difference compared to the normal run was even 13 ^{0}C at 14 o'clock Finnish time
- The most important of the tested features

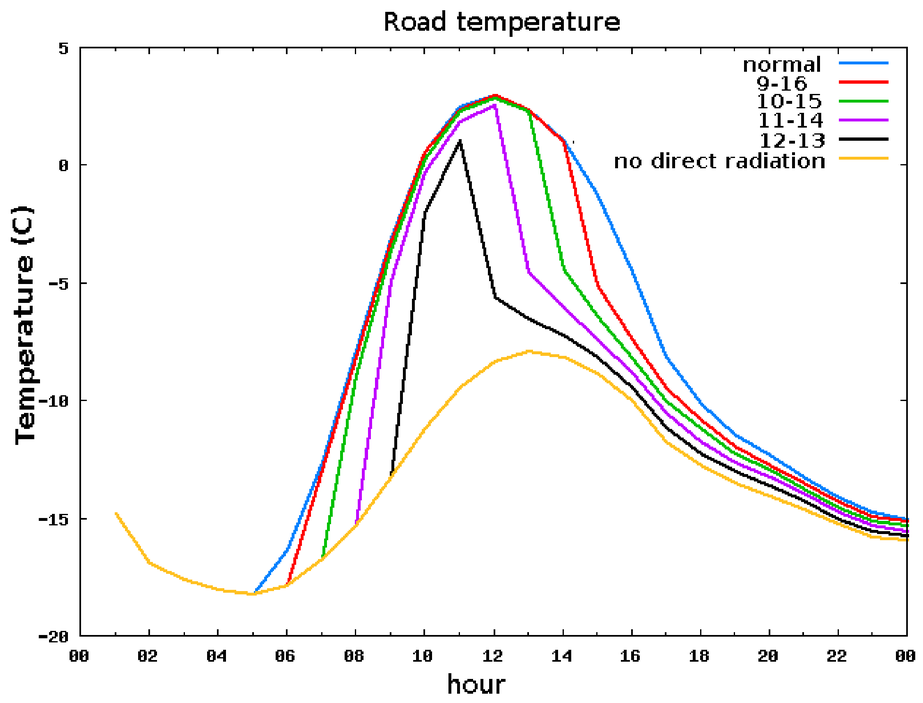

Figure 3. Forecasted temperatures for Kaarina road station (number 11 in figure 1), 17.3.2013, when sun was obscured part of the day. Blue line represents forecast when sun was not obscured. Obscuring times were 09-16 Finnish time for simulation on red line, 10-15 for simulation on green line, 11-14 for simulation on violet line and 12-13 for simulation on black line. Yellow line represents simulation when sun was obscured full day. Hours are in UTC time on the x-axis.

Bridge

- Depth and properties of ground layers were modified to describe bridges with thicknesses 1 m, 0.5m and 0.2 m
- The biggest temperature difference between bridge simulation and normal simulation was only 1.5 °C
- Different surroundings of the bridge were not taken into account, which can be the reason for the differences.

References

[1] Thornes, J.E. and J. Shao, 1991: A comparison of UK ice prediction models. *Meteorolog. Mag*. **120**, 1424 p.51-57