VERIFICATION RESULTS FOR ROAD SURFACE TEMPERATURE FORECASTS UTILIZING MOBILE OBSERVATIONS

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Observations from mobile sources have great potential to improve road weather forecasts in areas with sparse road weather station (RWS) network. Precise road condition forecasts are essential for optimal planning of the road maintenance operations and keeping the roads safe for drivers. The availability of mobile road condition observations have greatly increased in recent years. For example, Teconer Oy's optical sensors (RCM411 and RTS411) [1] installed in vehicles covered globally approximately 200 000 km of roads in a month during period November 2016-March 2017. However, observations made from moving vehicles are more exposed to disturbances than measurements done at RWSs. The behaviour of the used instruments should be studied before implementing the observations to the road weather forecasting system.

In this study, Finnish Meteorological Institute's (FMI) road weather model (RWM) [2] was used to make road surface temperature hindcasts to RWS points along the motorway in southern Finland for the time period 12th October 2017- 28th February 2018. Surface temperature observations made by optical Teconer RTS411 instruments attached to vehicles were used in the model initialization and the observations from the RWSs in verification. The simulations were done with and without statistical correction terms added to the Teconer RTS411 measurements. The verification results were compared to the corresponding scores of the control run not using Teconer measurements to find out the effect of mobile observations to the simulation accuracy.

The FMI's RWM is a one dimensional heat balance model. It requires atmospheric values (e.g. air temperature) as input data and gives road surface temperature and amounts of water, ice, snow and deposit on the road as output. In this study, the model was initialized with atmospheric values obtained from data interpolated from weather stations by using kriging method [3]. Observations from road weather stations were not used in the interpolation. The forecast part of the model run used data from HARMONIE-AROME model configuration that is run four times a day (00, 06, 12 and 18 UTC).

The cases where a vehicle passed a RWS were separated from the Teconer measurements to obtain data for the simulations. The used value for road surface temperature was obtained as an average of the measurements done within 50 m radius from the station during a pass. The station points are shown in Figure 1. The statistical correction terms for Teconer RTS411 instruments were determined by comparing the observations done during previous winter period (November 2016-Apri 2017) to the RWS measurements. The correction term was determined separately for each individual Teconer instrument as the mean difference value between the RWS and Teconer observations.

Three-day RWM simulations were run for time period 12th October 2017- 28th February 2018 with 52 h initialization period and 21 h forecast period. A separate run was done for each HARMONIE forecast. The forecast phase in the RWM started 3 hours after the HARMONIE analysis time. Mobile road surface temperature observations were utilized in the RWM by using coupling method [4]. The idea of the coupling method is to adjust the radiation in the model so that the modelled road surface temperature fits to the latest observation. If there was a mobile observation available within three hours from the HARMONIE analysis time, it was included in the simulation.

Observations from the RWSs were used in the verification of the simulations. The verified value was road surface temperature. Only the simulations which utilized mobile observations were included in the calculation of the verification scores. Figure 1a shows how many such simulations there were for each station. The scores for the control run were calculated using the corresponding simulations, although those did not utilize Teconer measurements. The root mean square error (RMSE) values for the first hours in the forecast were clearly smaller for the simulations using mobile observation than for the control simulations (Figure 1b). The effect is strongest at the beginning of the forecast and decreases gradually until the end of the 21 h forecast period, where the RMSE values are rather similar. When the statistical correction terms are added to the Teconer values, the RMSE values decrease even further. They remain smaller than the RMSE values obtained with the other run using mobile observations during the first seven hours of the forecast phase.

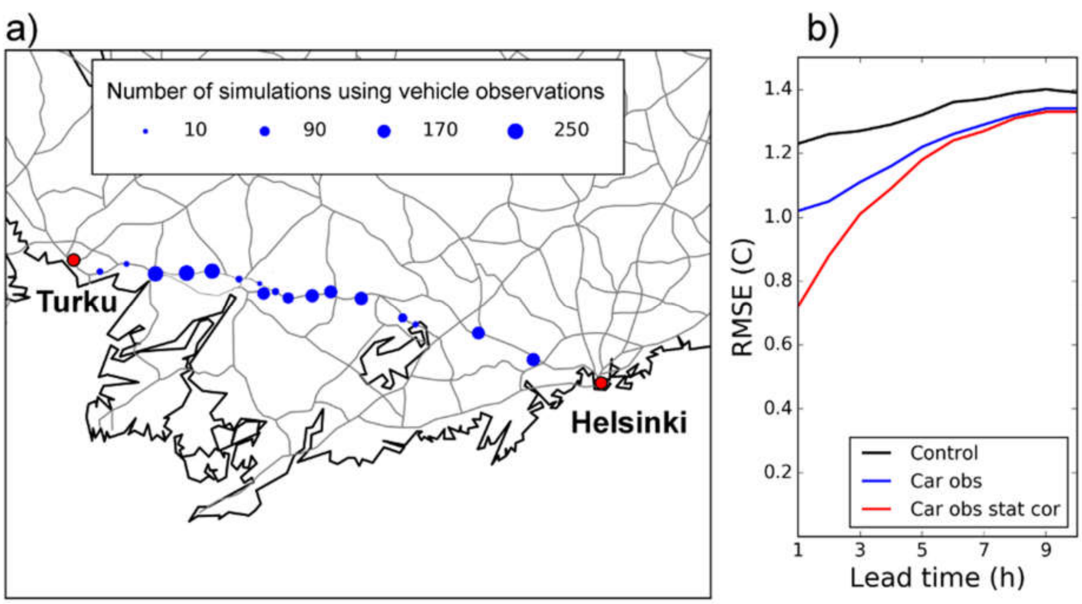

Fig. 1. Panel a) shows simulation points along the Helsinki-Turku motorway. The size of the point indicates how many simulations in that point utilized vehicle observations. Panel b) shows RMSE of surface temperature simulations as a function of forecast lead time. Black line shows results for simulation without mobile observations, blue line for simulation with mobile observations and red line for simulation with statistical corrections added to mobile observations.

As conclusion, utilizing mobile observations clearly improved the simulation accuracy. However, the simulations do not correspond well to an actual forecast case since the RWS observations were not used. Nevertheless, verifying the simulation results would have been difficult in points without RWS because of the lack of independent observations.

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