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Road surface temperature estimation by utilizing air temperature observations

Virve Karsisto and Pentti Pirinen
Finnish Meteorological Institute

Accurate road condition forecasts increase traffic safety. With precise forecasts road maintenance actions can be planned well beforehand to prevent the roads becoming slippery. To produce accurate forecasts, it is essential to have information about the initial road conditions. Road weather stations (RWS) have traditionally been the source of road weather information, but they are expensive and sparsely located in less populated areas. Nowadays it is possible to gather road weather observations also from vehicles that provide observations with much denser spatial scale. The road surface temperature can vary considerably in different parts of the road network, so vehicle observations are essential to catch cold anomalies on roads. However, although the majority of cars have air temperature sensors, surface temperature measurements done by the vehicle's own instrumentation are rarer. Nevertheless, surface temperature observations are more beneficial for road weather forecasting than the air temperature observations. The Finnish Meteorological Institute's road weather model (RWM) uses a method called coupling, which adjusts the initial state of the model to fit to the latest observed surface temperature. Air temperature values cannot be used in the same way, because air temperature is not forecasted by the RWM but is given to it as an input value. For road points without surface temperature observations, surface temperature values are obtained by interpolating observations from the RWSs. Interpolation is done with a universal kriging method, in which some other variable, like elevation, can be used as explanatory variable to improve the interpolated values. The explanatory variable should have strong correlation with the interpolated variable. The objective of the present study is to find out whether air temperature could be used as explanatory variable to improve the interpolated surface temperature values. If the results would be positive, mobile air temperature observations could be used in surface temperature kriging. Air temperature and surface temperature are naturally very correlated as heat is transferred between air and the surface, but they may also behave rather differently depending on the weather situation and specific local conditions. The study utilized road weather station measurements in Finland. Surface temperature kriging analysis was performed multiple times by leaving always one station out of the interpolation. This station's measurements were used in the verification of the analysis. Kriging was done separately with and without air temperature as explanatory variable for each hour with enough data between period 1 October 2017- 31 March 2018. According to the results, including air temperature as explanatory variable improved the surface temperature kriging in most cases. As the study showed positive results with road weather stations, the next step would be to include actual mobile observations to the kriging analysis.