EXPERIMENTAL ROAD WEATHER FORECASTING IN HUNGARY

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In winter, cold temperature, freezing rain or blowing snow is often observed in several parts of Hungary. Currently, the Hungarian Meteorological Service (OMSZ) provides forecasts of several meteorological parameters (e.g. 2m and surface temperature, precipitation, precipitation type and probability of its occurrence) which are used for road safety and road maintenance purposes. These parameters are mostly outputs of numerical weather prediction (NWP) models, like the ECMWF or AROME. In the recent years, also experimental forecasts were prepared with use of the METRo road weather forecasting model [1], which were coupled with the ECMWF and WRF model data. The feasibility and accuracy of the road surface temperature (RST) forecasts was tested on case studies and also statistically verified.

The METRo model (version 3.2.7) was applied on 165 road weather station (RWS) data of the Hungarian Public Road. For the verification, we selected 25 days of the December 2014 with usual winter road conditions in Hungary. The NWP input data were derived from the 12 UTC ECMWF model runs (at nearly 9 km horizontal resolution). We performed 24 h forecasts starting at next day 00 UTC (this was preceded by an 8h coupling period). The results were evaluated with use of standard statistical parameters (BIAS, MAE, RMSE, POD, FAR, Random Correct, Heidke Skill Score, etc.). For case studies, the outputs were depicted with the use of the Hungarian Advanced WorKstation (HAWK), developed at OMSZ [2], which enables overlapping of road weather data with many kinds of meteorological observations and forecasts.

The results of the verification showed that the average mean absolute error (MAE) is about 1.5 °C (all stations, whole forecasting period) and the root mean square error is about 2 °C. For 94 RWS the MAE was below 1.5 °C and for 86 RWS the RMSE did not exceed 2 °C, which is not much higher compared to usual 2m temperature errors of the input ECMWF model over Hungary in wintertime. The forecast RST was mostly underestimated (mean BIAS was -0.3°C). The underestimation was typical for the morning and evening period but the RST was overestimated at noon (**Fig. 1**).

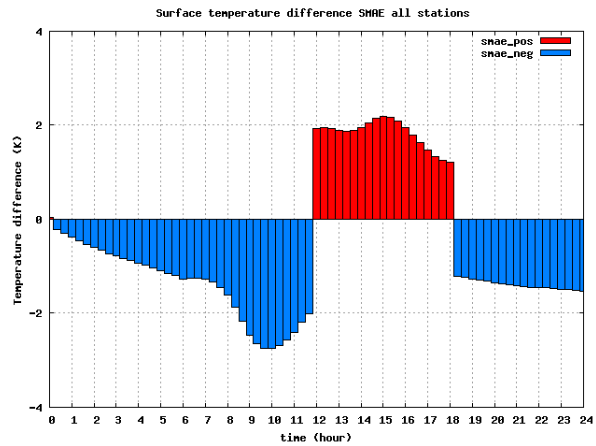

Fig. 1. Daily course of SMAE (MAE multiplied by signum of BIAS) of the road surface temperature for all verified stations and for the period of 02.12.-30.12.2014.

The case studies indicated that the spatial distribution and accuracy of the forecast RST is largely determined by the precision of the NWP forecasts of cloudiness and radiation fluxes (**Fig. 2**). The areal distribution of RST was similar to the ECMWF surface temperature field but the RST usually exhibited much higher amplitudes in its daily course. Occasionally, large errors (exceeding 6 °C) were detected, for example in a test forecast using the high-resolution (2.5 km) WRF model as input. This example demonstrated high sensitivity of the RST forecast on the NWP input precision, mainly in situations with delays or displacements of precipitation bands. Errors in the predicted 2m temperature, 10m wind etc. caused a rapid deviation of the forecast RST from the observed one. However, experiments, in which the input data were set close to observations, predicted the RST correctly. Nevertheless, there were also many examples of successful forecasting of sudden RST cooling (of 8-10 °C in 12 h) caused by cold weather outbreaks in January 2016 and March 2018. In such cases the model RST forecasts could be the most valuable for the users, while outperforming the linear extrapolation methods or persistence significantly.

A special parameter has also been developed to predict the occurrence and intensity of blowing snow. The Blowing Snow Index (BSI) was based on observations of blowing snow events in Hungary and constructed as a function of 2m temperature, wind, wind gusts, snow depth, snow density and skin (snow surface) temperature [3]. The index is calculated from the ECMWF model forecasts and it was successfully used during intense blowing snow events in March 2013 and 2018, which caused large traffic problems on the roads.

The experiences with RST or BSI forecasts showed high sensitivity of these parameters on the quality of the input NWP forecast, which would suggest application of an EPS system (e.g. ECMWF-EPS, AROME-EPS) in the future. The case studies showed that these tools can be effectively used in everyday forecasting of road weather, even in difficult conditions, but recognizing and filtering the sources of systematic errors requires experience and a good knowledge of the meteorological models and processes in the background.

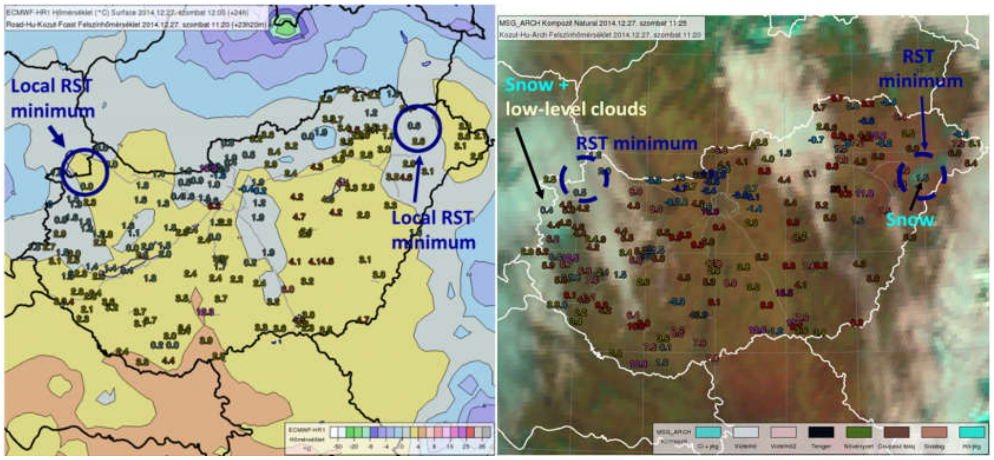

Fig. 2. Left: Forecast RST (numbers, °C) valid for the 27.12.2014 11:20 UTC and corresponding ECMWF surface temperature (color shades) forecast for the area of Hungary. Right: Observed RST (numbers) and the METEOSAT Natural Color Composite satellite image showing areas with snow (turquoise color) and low-level clouds (light blue and pink color) at 11:20 UTC.

References:

1. Crevier, L.-P., and Y. Delage, **2001**, METRo: A New Model for Road-Condition Forecasting in Canada, *J. Appl. Meteor.*, *40*, 2026-2037.
2. Vörös, M., Rajnai, M., **2010**, Recent developments at OMSZ. HAWK-3., *21st meeting of the European Working Group on Operational meteorological Workstations (EGOWS) Programme*, 1-4 June 2010, ECMWF.
3. Somfalvi-Tóth, K. et al., **2015**, Forecasting of wet- and blowing snow in Hungary, *Időjárás*, *119*, 277–306.