ICEWARN – Road Weather Forecasting for Prague City

Poster no. 2

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1. Introduction

The Institute of Atmospheric Physics (IAP) CAS in Prague, and the Czech Hydrometeorological Institute (CHMI) have developed and currently run **FORTE** (**FO**recast of **R**oad **TE**mperature and condition) model for Road Surface Temperature (RST) and Road Surface Condition (RSC) forecasts within the **ICEWARN** project. The goal of the project is to develop a method for a linearly continuous forecast of RST and RSC in Prague city. The model FORTE stems from the METRo model (METRo, Crevier and Delage, 2001) and is based on solving the energy balance and heat conduction equations. An adaptation to local conditions in the Czech Republic was done (Sokol et al., 2014). More recently, the parametrization of radiation fluxes was modified together with inclusion of the sky-view factor, which is necessary for applications in urban areas.

Target area – capital city of Prague

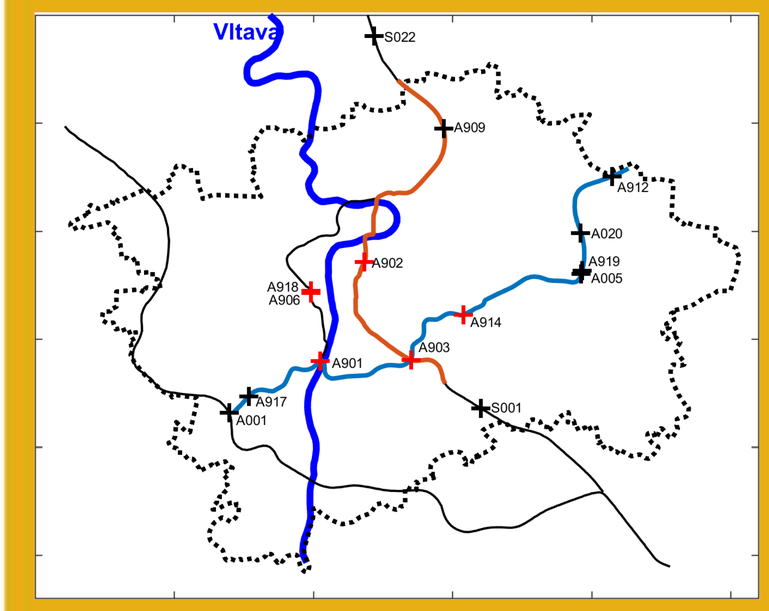

Fig. 1. Schematic view of two main Prague roads (i.e., Jižní spojka by blue line and Magistrála by brown line). The red and black crosses depict a location of the road weather stations (RWS) on and out of bridges, respectively. The Vltava river is represented by the thickest blue line.

Fig. 2. View on one of the road weather stations in Prague.

2. ICEWARN forecasting system

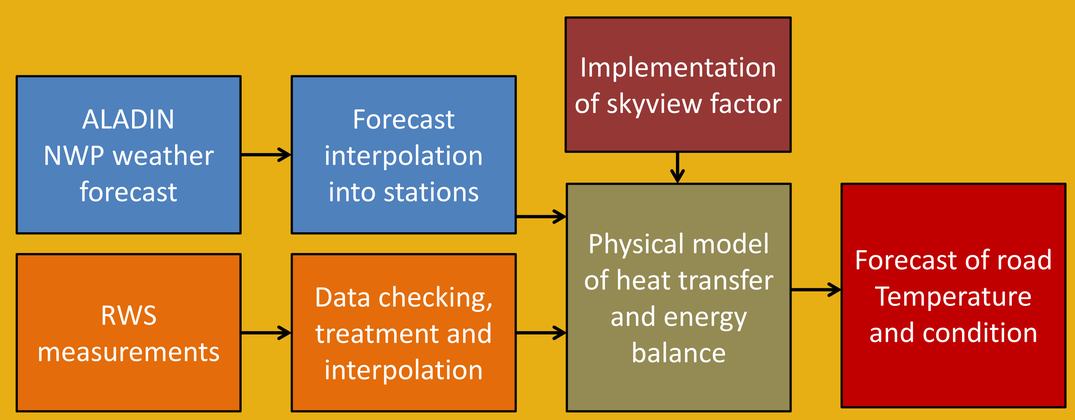

Fig. 3. Block diagram of ICEWARN forecast process.

Preparation of input data

- ✓ **Sky-view factor** and data for computation of the direct solar radiation shading: Based on the detailed information on terrain, building positions and heights in Prague, a dataset was pre-calculated for the roads with 20 m horizontal step and 5 deg step in azimuth.
- ✓ Forecast **data of the numerical weather prediction model** ALADIN, which is the operational model of the CHMI: the resolution of the model is 4.7 km, data are interpolated to the positions of RWS.
- ✓ **RWS data:** 21 RWS (TSK Prague) and about 20 RWS (RSD CR) measuring mainly road surface and air temperature, often also wind speed, subsurface temperature, humidity and precipitation are checked by set of procedures correcting and/or eliminating erroneous or unrealistic measured data values before the model run.

Forecast methods

- ✓ **Deterministic forecast** of the RST and RSC for the lead times up to 24 hours (Sokol et al., 2014)
- ✓ **Probabilistic forecast** of the RST based on our ensemble forecast method for the lead times up to 6 hours (Sokol et al., 2017)

Forecast is computed for the priority roads with high horizontal resolution.

3. Verification of road surface temperature

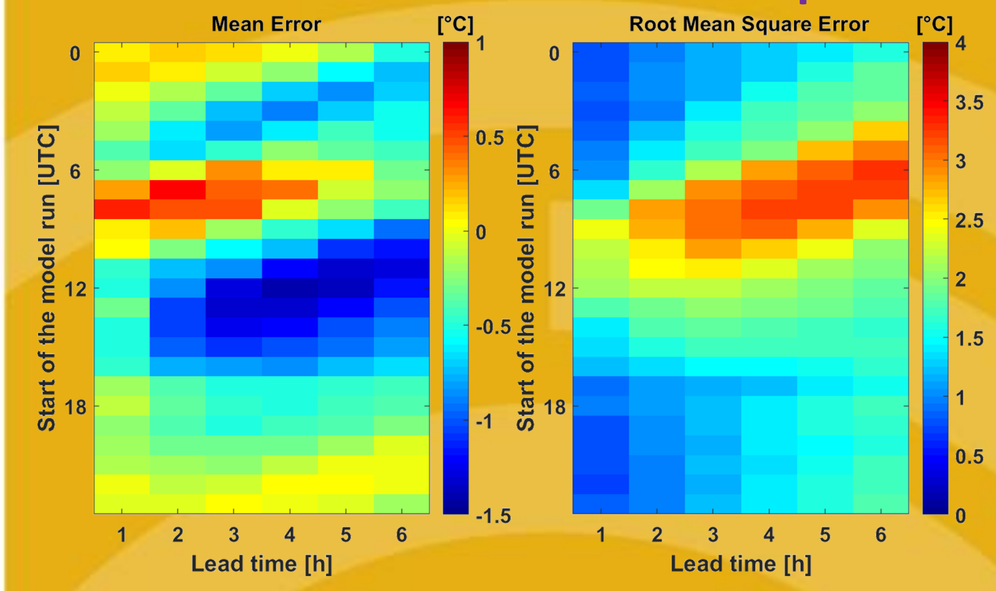

Fig. 4. Mean Error (1st panel) and Root Mean Square Error (2nd panel) of forecasted RST averaged over all RWS data located on Jižní spojka road (blue line in Fig. 1) during the winter season 2018 (1st January 2018 – 31st March 2018) in dependence on a start of the model run (*y*-axis) and lead time of the forecast (*x*-axis).

Case study 4th February 2018

Brief description of the case study:
Prague roads were hit by rainfall occurred during the night from 3rd to 4th February 2018 and in combination with temperatures around 0°C caused slippery roads and transport complications in the morning hours of the 4th February 2018 in Prague city. Several transport accidents including public transport were recorded.

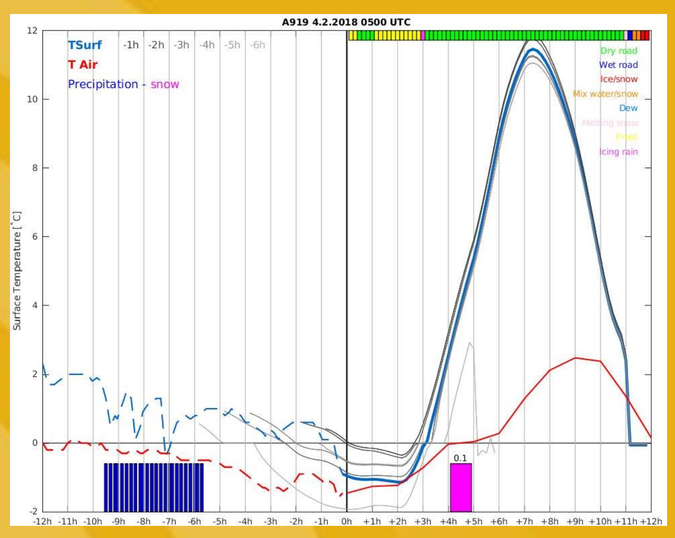

Fig. 5. Measurements (dotted lines) and forecasts (full lines) of model FORTE from 4th February 2018, 0500 UTC at the A919 RWS. Blue line depicts RST, red line shows air temperature at 2 m, and grey lines show previous model forecasts of RST so that the brighter is the colour the older is the forecast (see legend in the upper left corner). The bars on the bottom show observed (binary format, before 0h) and forecasted precipitation (total 1-h amount, after 0h) in a state given by colour (see legend in the upper right corner). The forecast of RSC is marked by small rectangles on the right top (see legend in the upper right corner).

4. Conclusions and outlook

- ✓ The FORTE model forecasting a RST and RSC on continuous road sections has been successfully developed for main Prague roads
- ✓ An effect of shading of the RWS is a matter of research (see poster 10 - Sedlák et al., 2018. Influence of shading and sky-view factor on road temperature forecast)
- ✓ A visualization software ICEVIEW displaying forecasted RST and RSC in a operational mode will be developed
- ✓ An operational run of the ICEWARN system is planned since 2019

References

Crevier, L.-P., Delage, Y., 2001. METRo. A new model for road-condition forecasting in Canada, *J. Appl. Meteor.*, **40**, 2026-2037.
Sokol, Z., Zacharov, P., Sedlák, P., Hošek, J., Bližňák, V., Chládová, Z., Pešice, P., Škuthan, M., 2014. First experience with the application of the METRo model in the Czech Republic, *Atmos. Res.*, **143**, 1-16.
Sokol, Z., Bližňák, V., Sedlák, P, Zacharov, P., Pešice, P., Škuthan, M., 2017. Ensemble forecast of road surface temperature, *Atmos. Res.*, **187**, 33-41.

Acknowledgement

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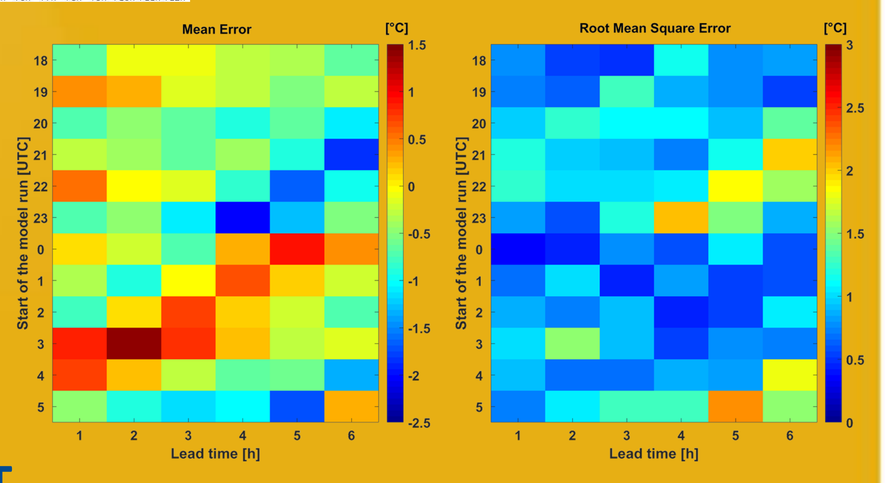

Fig. 6. Mean Error (1st panel), and Root Mean Square Error (2nd panel) of forecasted RST averaged over all RWS data located on Jižní spojka road (blue line in Fig. 1) during a case study 4th February 2018.

Linear forecast of RST

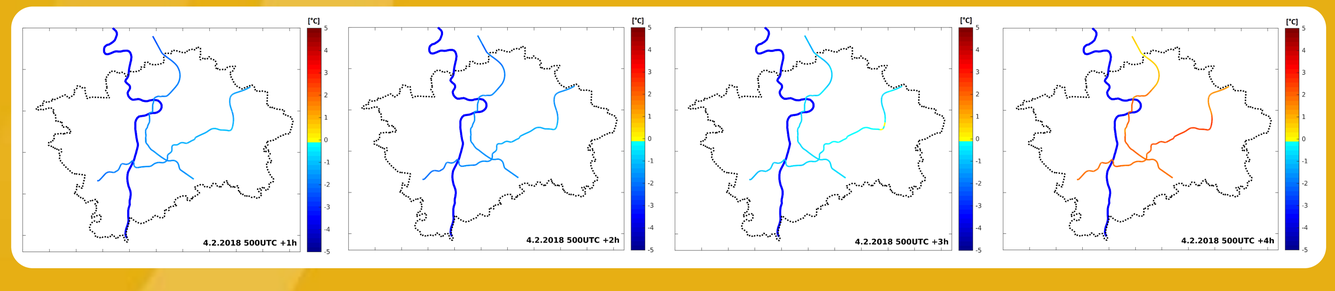

Fig. 7. An example of linear forecast of RST (1st row) and RSC (2nd row) issued on 4th February, 0500UTC for the following 4 hours on 2 main roads in Prague – Jižní spojka (blue line in Fig. 1) and Magistrála (brown line in Fig. 1). The Vltava river is depicted by thick blue line.