Road weather forecasting – ICEWARN model

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1. Introduction

What is the ICEWARN project?
The full name of the project is "Forecast of Winter Road Conditions and Temperature in Prague". The project started in January 2017 and is scheduled for 2 years. The project holder is the Institute of Atmospheric Physics CAS, the project partner is the Czech Hydrometeorological Institute (CHMI).
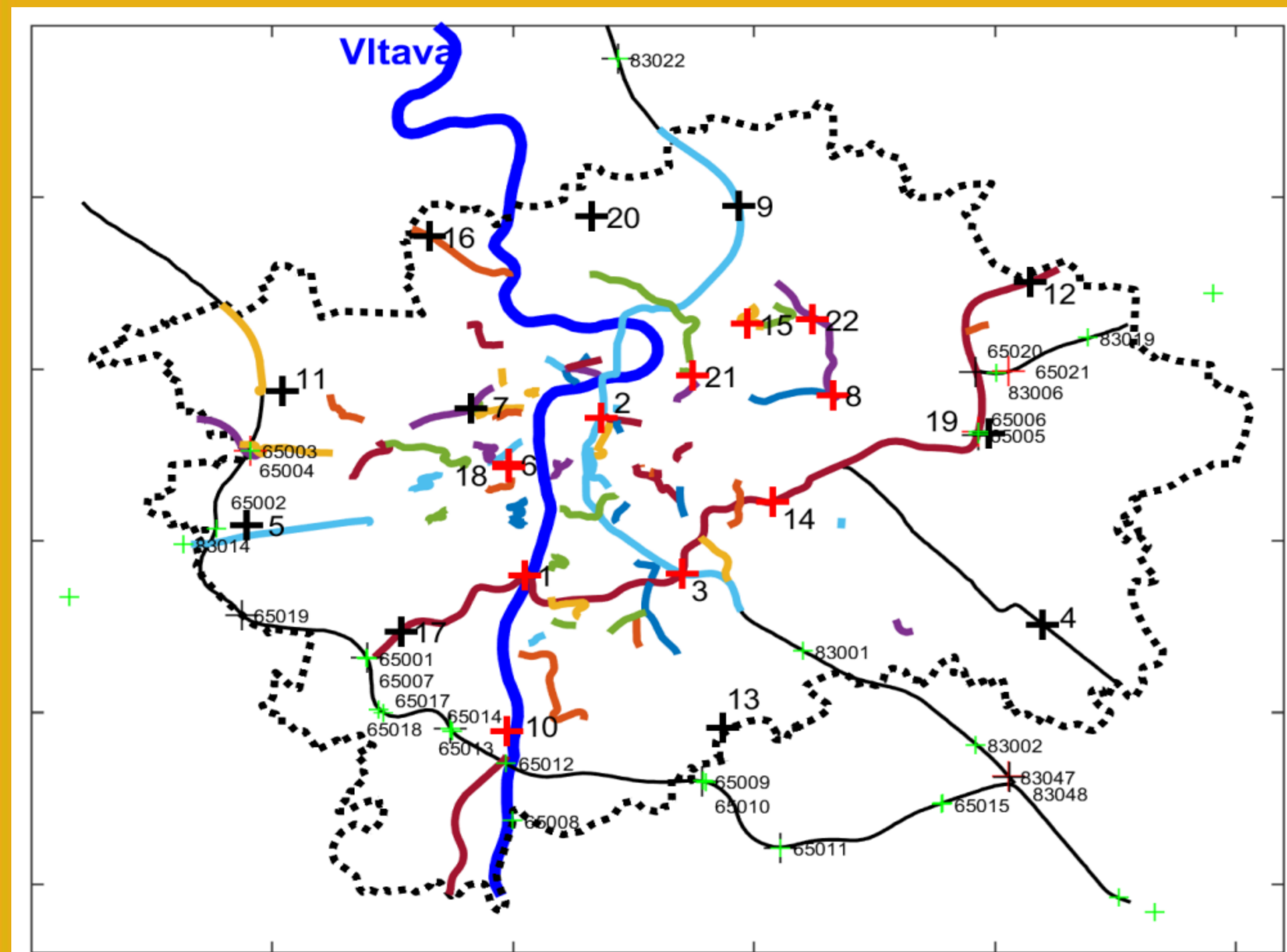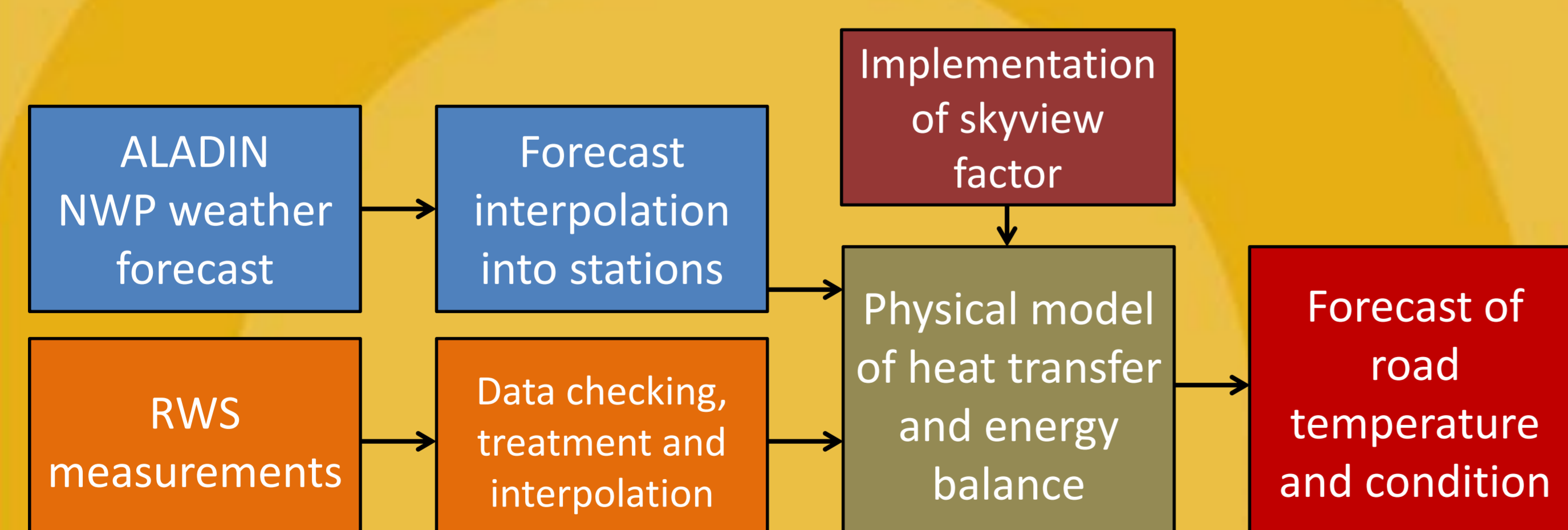
Target area – capital city of Prague

Fig. 1. Schematic view of main Prague roads with marked sections with high priority for winter maintenance (thick colour lines). Large crosses depict the road weather stations (RWS) of Technical Administration of Roadways (TSK) Prague. Small crosses represent the road weather stations of the Road and Motorway Directorate of the Czech Republic (RSD CR). The thickest blue line is the Vltava river.

Time schedule of ICEWARN project

2017												2018											
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1st project phase – ICEWARN feasibility study																		2nd project phase – preparation of commercialization					
1st period				2nd period				3rd period				4th period											
adaptation of ICEWARN model for Prague road weather stations				preparation of ICEWARN system				ICEWARN run				ICEWARN run		ICEWARN adaptation				ICEWARN adaptation				ICEWARN operation	
creating the data flow				tests of (i) data flow, (ii) quality control and (iii) ALADIN data processing				verification of forecasts						verification of forecasts									
preparation of data quality control								repeated runs of ICEWARN model						ICEWARN transfer to CHMI									
preparation of processing the ALADIN NWP data								development of visualization SW						visualization of ICEWARN output									
				archiving of measured data				archiving of measured data				archiving of measured data											

2. ICEWARN forecasting system

ALADIN NWP weather forecast → Forecast interpolation into stations

Implementation of skyview factor

RWS measurements → Data checking, treatment and interpolation → Physical model of heat transfer and energy balance → Forecast of road temperature and condition

Model ICEWARN: The model for the forecast of road surface temperature and road surface conditions is the core of the ICEWARN forecasting system. It stems from the Model of the Environment and Temperature of Roads (METRo) developed by the Environment and Climate Change Canada (Crevier and Delage, 2001). An adaptation to conditions in the Czech Republic had to be 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.

Forecast methods

- **Deterministic forecast** (Sokol et al., 2014) – for the lead times up to 24 hours
- **Probabilistic forecast** of the road surface temperature, based on our ensemble forecast method (Sokol et al., 2017) – for the lead times up to 6 hours.

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

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 2 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 Czech Hydrometeorological Institute: the resolution of the model is 4.7 km, data are interpolated to the positions of RWS.
- **Road weather station (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.

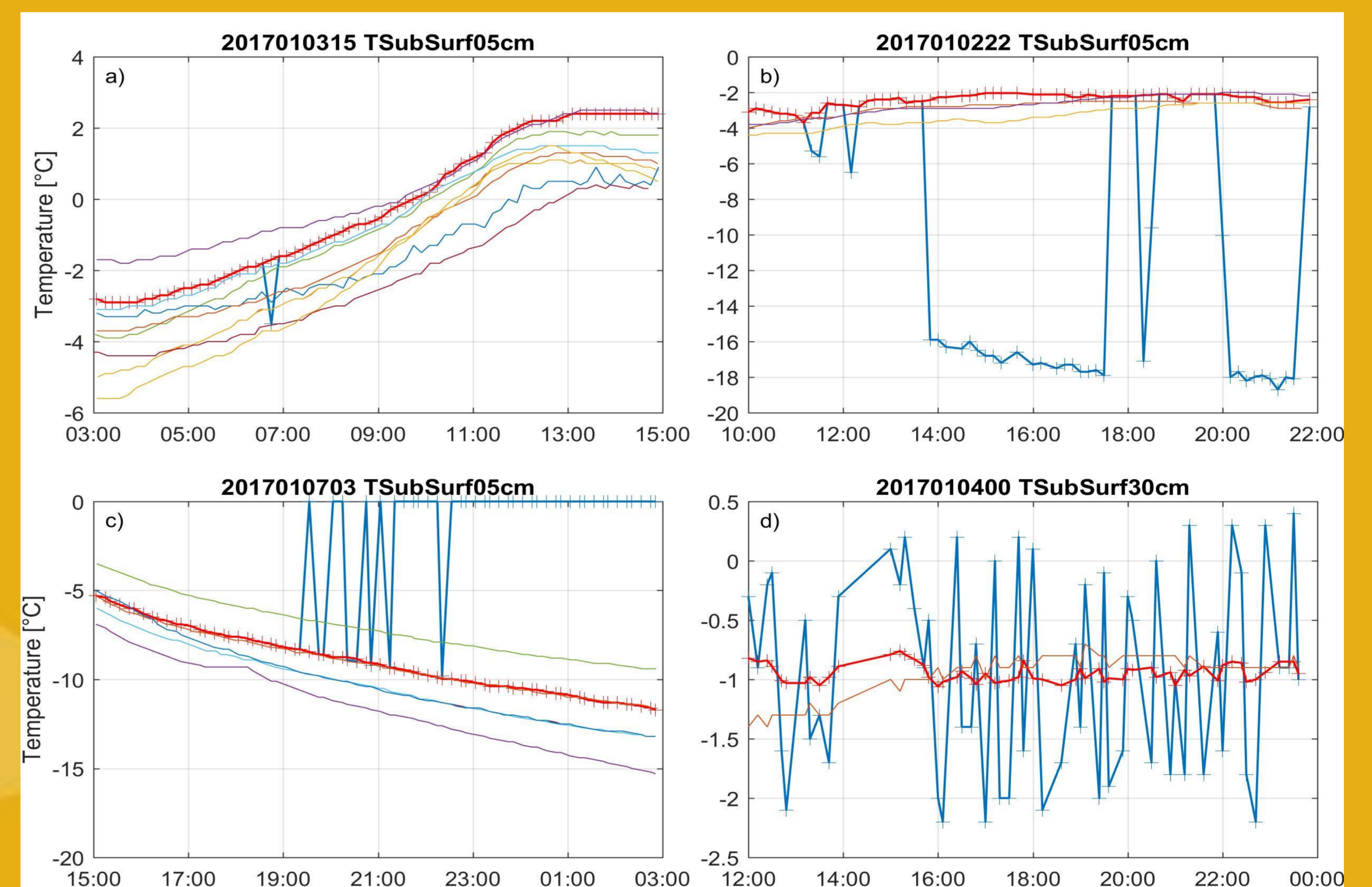**Fig. 2.** View of the road weather station No. 7 in Prague.

Fig. 3. An example of data treatment of four typical data errors for the road temperature in 5cm depth (TSubSurf05cm) and 30 cm depth (TSubSurf30cm). The thick blue line represents the original RWS measurement, thick red line shows the corrected measurement, and thin colour lines show the measurements of stations situated near the corrected one (used for comparison).

3. Implementation

Project output: operational information created by visualization software, which will be developed
Target users: Technical Administration of Roadways of the Capital of Prague, Road and Motorway Directorate of the Czech Republic, Prague Public Transit Company
Sustainability phase (2019-2023): continuous ICEWARN operation in the Czech Hydrometeorological Institute and transfer of its output to the users
Positive impact: reducing the weather risks, and making the winter maintenance activities as well as the whole Prague transport economically more effective and more environmental-friendly

References

Crevier, L.-P., Delage, Y., 2001. METRo. A new model for road-condition forecasting in Canada, *J. Appl. Meteor.*, **40**, 2026-2037.
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Sokol, Z., Bližňák, V., Sedlák, P, Zacharov, P., Pešice, P., Škuthan, M., 2017. Ensemble forecast of road surface temperature, *Atmos. Res.*, **187**, 33-41.