

THERMAL MAPPING AS A VALUABLE TOOL FOR ROAD WEATHER FORECAST AND WINTER ROAD MAINTENANCE

An example from the Italian Alps

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INTRODUCTION

- During the winter period **ice is likely to form on roads**, making pavement surfaces slippery and increasing accident risk.
- Thermal mapping (TM) road surface temperature (RST) is the road thermal fingerprint obtained by a radiometer set on a survey vehicle tow hook.

The LIFE+ "CLEAN-ROADS" project aims to **forecast RSTs in advance** in order to support road maintenance services in the timely and effective preparation of preventive anti-icing measures. This support is provided through a novel MDSS (Maintenance Decision Support System).

TM was carried out in **Trentino Region**, a mountainous area in the Northeast Alps of Italy characterized by severe winter weather.

Test routes

- Adige Valley route** 14-km long, 200m altitude
- Valsugana Valley route** 10-km long, 500m → 200m altitude

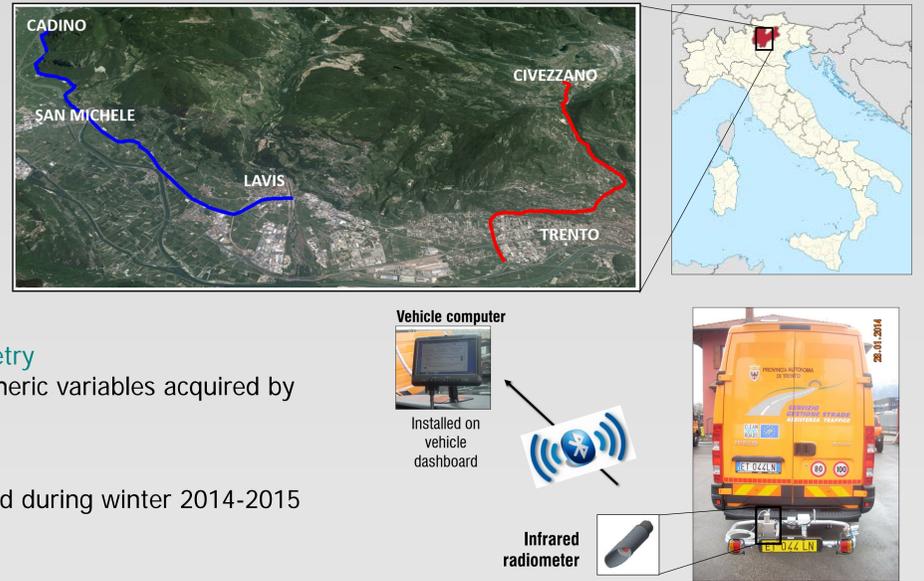
Equipment

- Mobile RST measurements through **IR thermometry**
- Site-specific measurements on road and atmospheric variables acquired by automatic road weather stations, **RWIS stations**

Dataset

- TM RSTs and site-specific measurements acquired during winter 2014-2015 and winter 2015-2016
- Number of TM surveys: 23 + 16

STUDY AREA AND EQUIPMENT



METHODOLOGY

During winter seasons 2014-2015 and 2015-2016 "extreme" thermal fingerprints were collected along the Adige Valley route and the Valsugana Valley route, and corresponding data were properly processed and analysed.

Meteorological conditions:

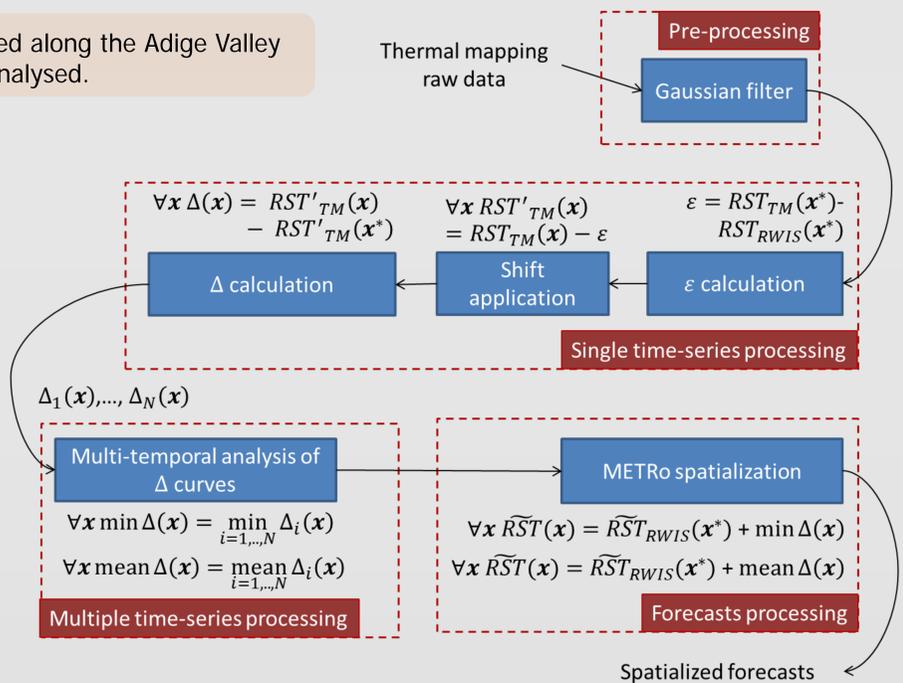
- stable, clear and calm nights
 - wind speed ≤ 2 m/s
 - cloud cover $\leq 1/8$
 - near sunrise (i.e. when RSTs usually reach the lowest values)
 - mean RST $< 0^\circ\text{C}$ over the entire sampled route
- Extreme conditions

Pre-processing stage: noise removal

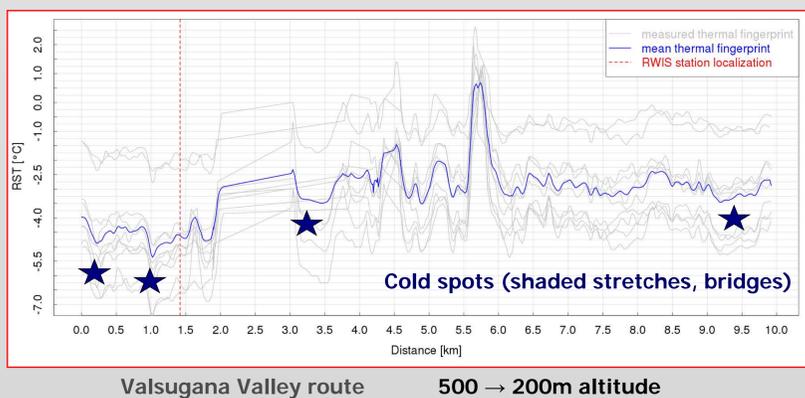
- A **signal noise** in thermally-mapped RST data might be due to different pavement emissivity, to the presence of dirty soil on the road surface or to electronic noise
- A **low-pass Gaussian filter** (window length equal to 200 m) has been applied to remove this noise and correctly identify features due to a real change in RST

Processing stage: characteristic thermal fingerprint and spatialized forecasts

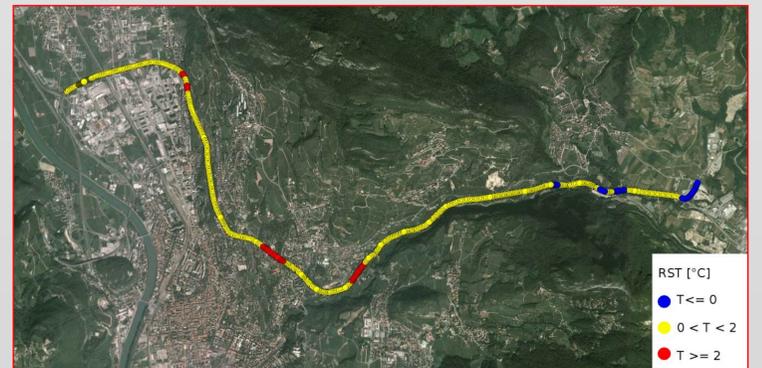
- Thermal fingerprint were **referenced to RWIS stations** via the calculation of the difference Δ between the RST value at point x along the route and the RST value at the station position x^*
- The historical dataset of Δ RST differences were compared point by point along the route by calculating the **minimum and the mean Δ RST values**. These were used to build the "characteristic" fingerprints for that route.
- RSTs measured by RWIS stations were used to **predict overnight RSTs via METRo**, the Model of the Environment and Temperature of Roads



RESULTS



The combination of METRo forecast with the "thermal map" of the study area were used to **predict RSTs** over the entire road network at selected times.



References

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We have applied thermal mapping to successfully

CONCLUSIONS

- identify cold spots** along a road network
- extend site-specific RST forecasts** to an entire road stretch in a test area in the Italian Alps.

We have demonstrated that **thermal mapping** can be made **part of a maintenance decision support** system that can help road engineers and maintenance authorities in deciding whether, where and when to spread anti-icing salt.