A High-Resolution and Computationally Efficient Forecasting System for Urban Temperatures: Validation against Intensive Field Campaigns in two Cities in the Italian Alps

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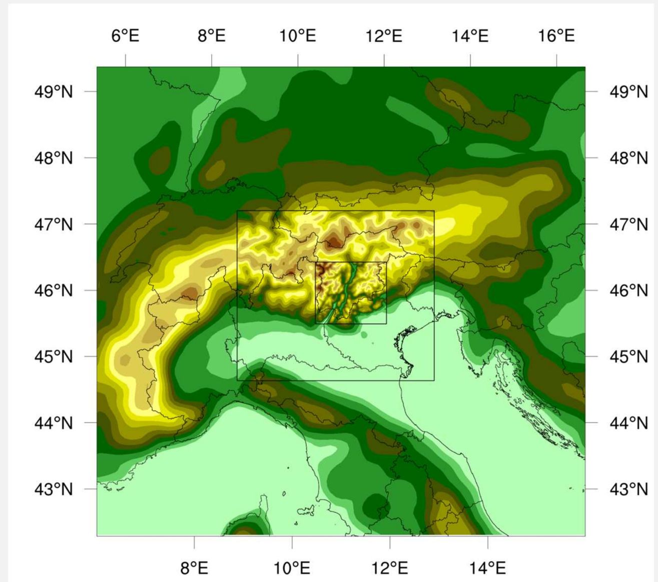
FONDAZIONE CARITRO
CASSA DI RISPARMIO DI TRENTO E ROVERETO

1. Introduction

- A forecasting system composed of the WRF model coupled with a single-layer urban canopy parameterization scheme (Giovannini et al. 2013) is implemented to perform high-resolution forecasts of the thermal field in the urban areas of Trento and Rovereto, in the Italian Alps.
- The single-layer urban parameterization scheme is applied offline to downscale the WRF forecasts inside the urban area, taking into account the local characteristics of the city morphology, down to a final horizontal resolution of 100 m.
- Results from the modeling system are validated against measurements performed during intensive field campaigns in the two cities during the summer 2016.
- Results show that the modelling system is able to capture microclimatic conditions peculiar of the urban canopy layer.

2. Methods

WRF model



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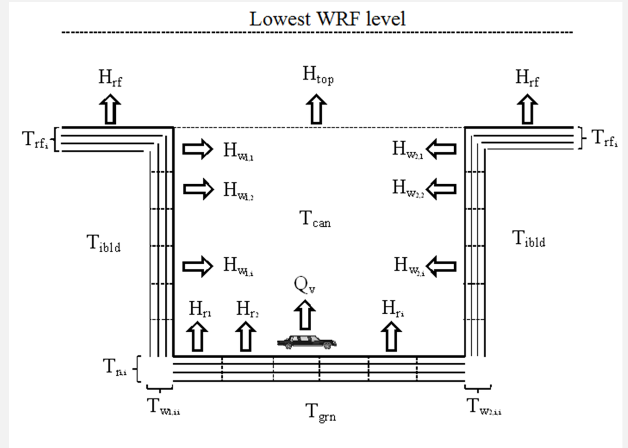
Canyon model



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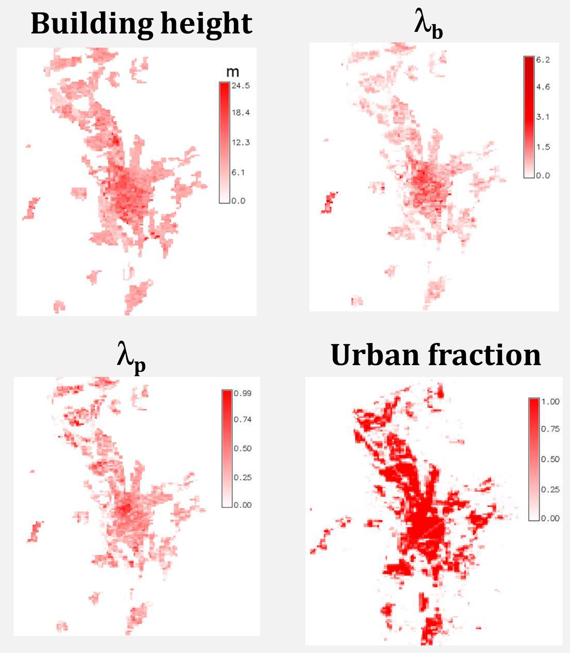
Urban morphology



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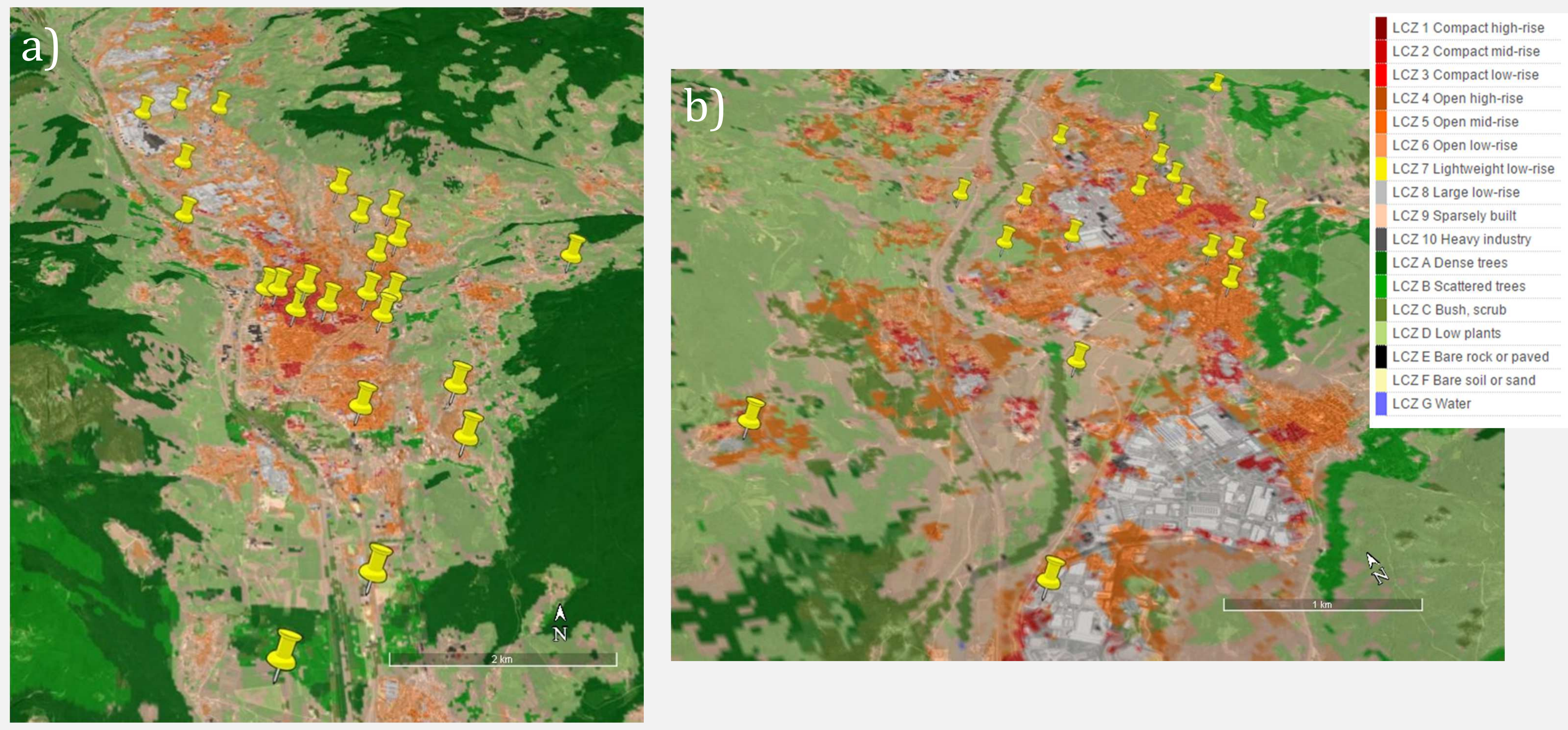
Temperature forecast in the urban area

48-h forecasts with the WRF model:

- Global Forecast System (GFS) 0.25° resolution meteorological initial and boundary conditions.
- 3 two-way nested domains with a resolution of 9-3-1 km and 27 vertical levels.
- WRF forecasts are downscaled to a resolution of 100 m in the urban area of Trento using a single-layer urban canopy model (Giovannini et al. 2013).
- Detailed information on urban morphology from 1-m resolution lidar data.

3. Field Measurements



Data from a very dense network of portable sensors and permanent stations in the urban areas were analyzed to evaluate intra-urban differences in microclimatic conditions. The selection of the measurement sites was based on Local Climate Zone (LCZ) maps developed for both cities.

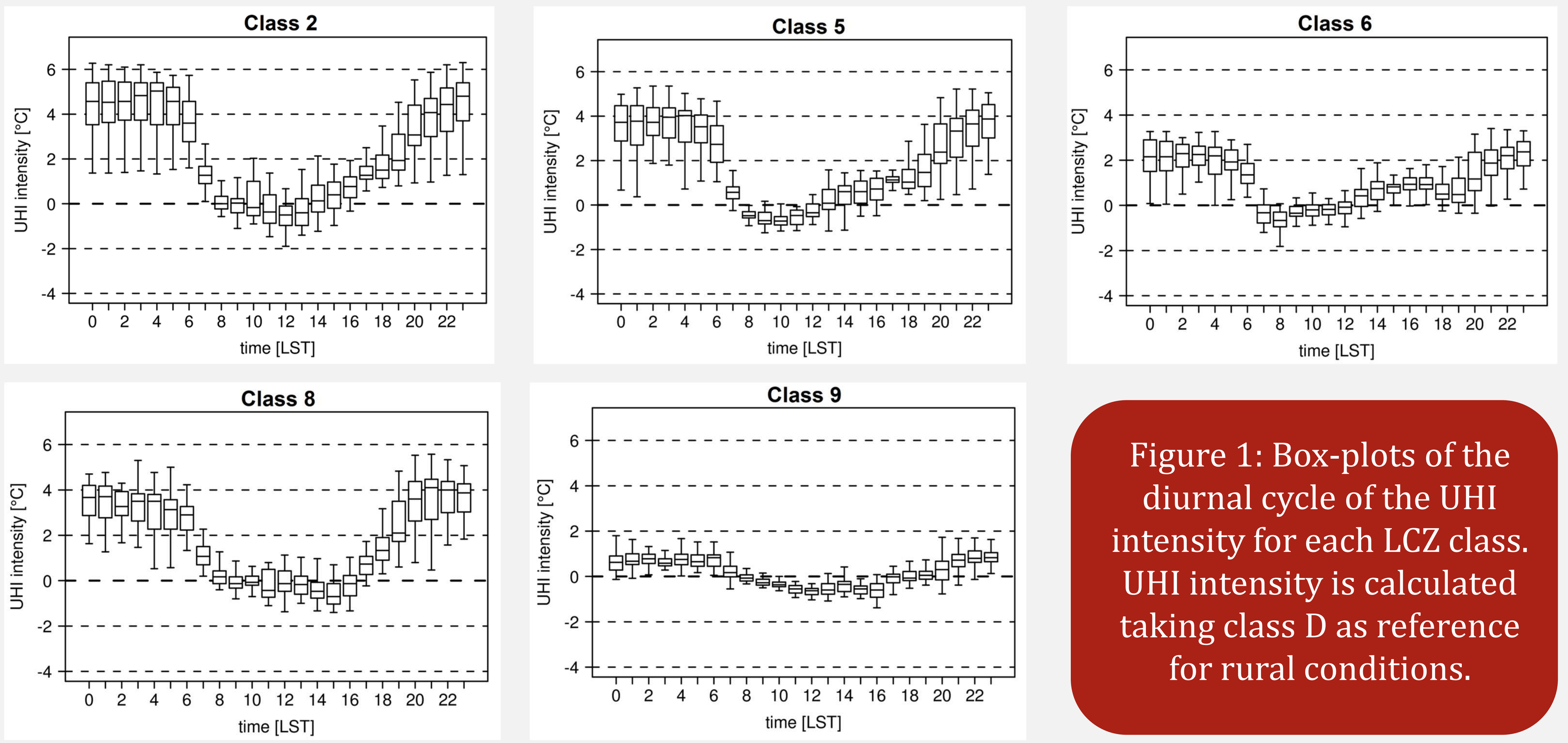


Figure 1: Box-plots of the diurnal cycle of the UHI intensity for each LCZ class. UHI intensity is calculated taking class D as reference for rural conditions.

4. Model Validation

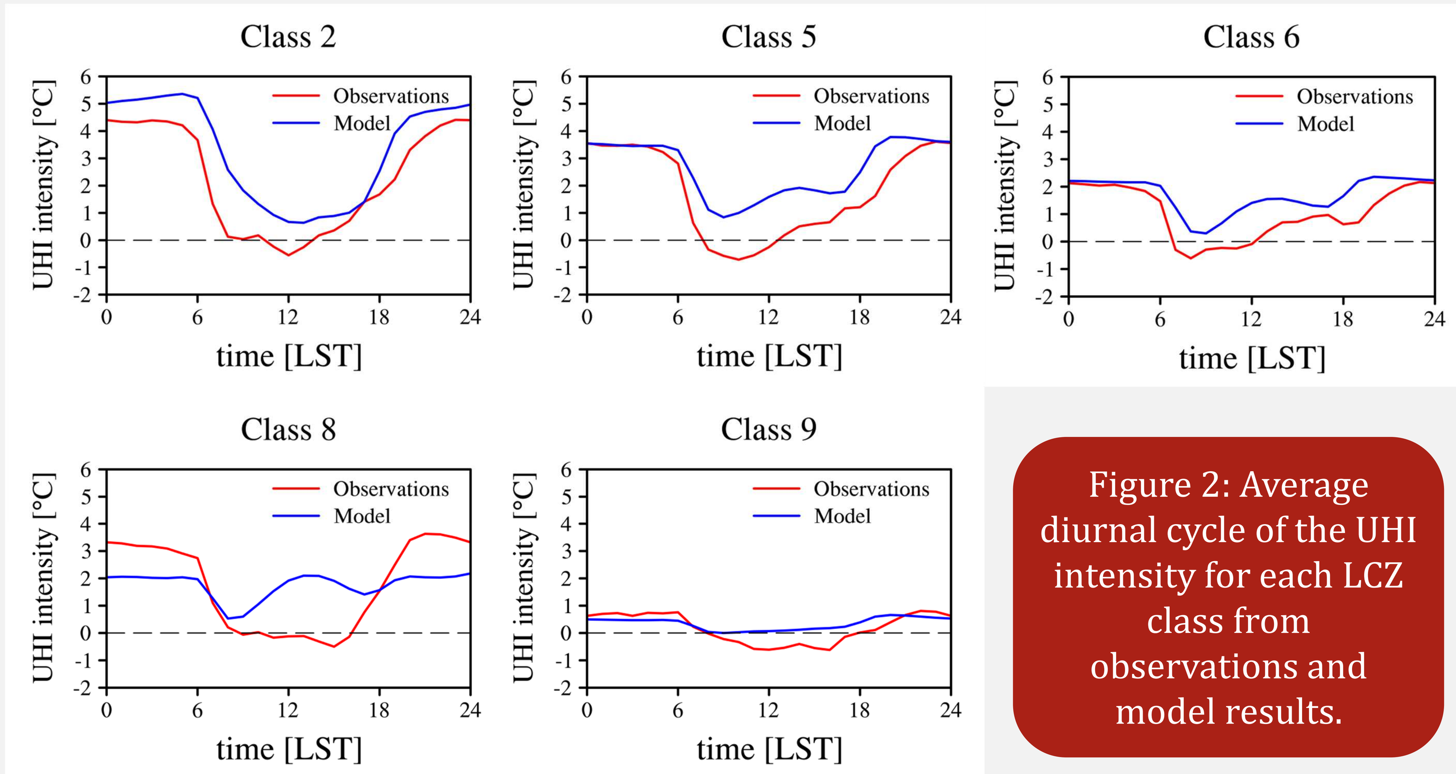


Figure 2: Average diurnal cycle of the UHI intensity for each LCZ class from observations and model results.

The model is able to capture the average diurnal cycle of the UHI in the different LCZ, with greater errors in the industrial area.

Fig. 3 shows that the UHI intensity variability simulated by the model is limited compared to observations, especially in classes 8 and 9.

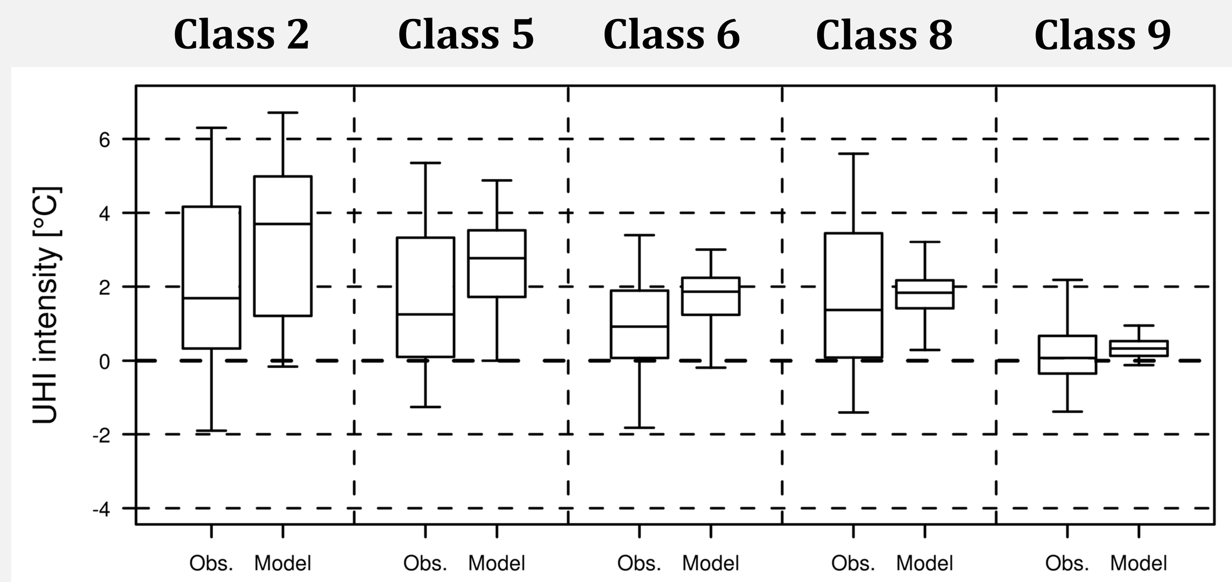
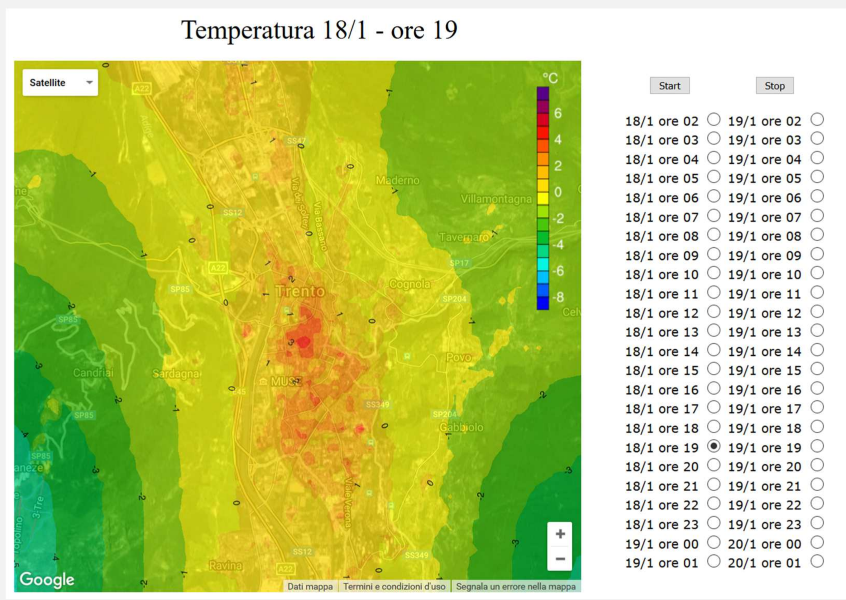


Figure 3: Box-plot of the UHI intensity for each LCZ class from observations and model results.

5. Web Site

Forecasts of the temperature field are updated twice a day and are available on a dedicated website.



https://sites.google.com/site/trentinoweather/home/aree-urbane/trento

6. Conclusions

- Intensive field measurements in two urban areas of the Italian Alps highlight the strong dependence of the nocturnal UHI on local urban morphology.
- Measurements are used to validate a modelling chain used to forecast urban temperature with a resolution of 100 m.
- Good agreement between model results and observations, but with an underestimation of the UHI variability.

7. References

Giovannini L., D. Zardi, M. de Franceschi, 2013: Characterization of the thermal structure inside an urban canyon: field measurements and validation of a simple model. *J. Appl. Meteor. Climat.*, 52, 64-81.

8. Acknowledgments

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