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Tuning of WRF simulations with Local Climate Zones over the urban area of Rome

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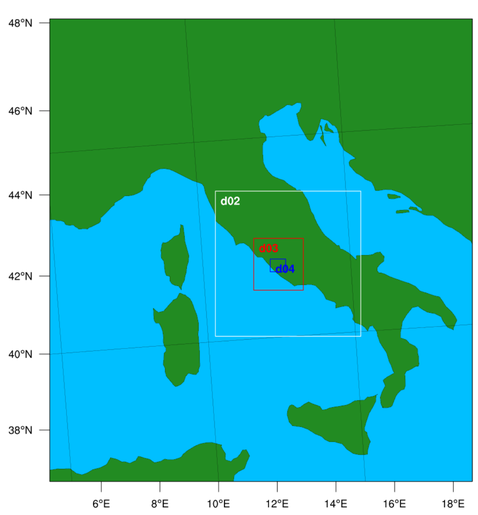
Background and **aim** of the work

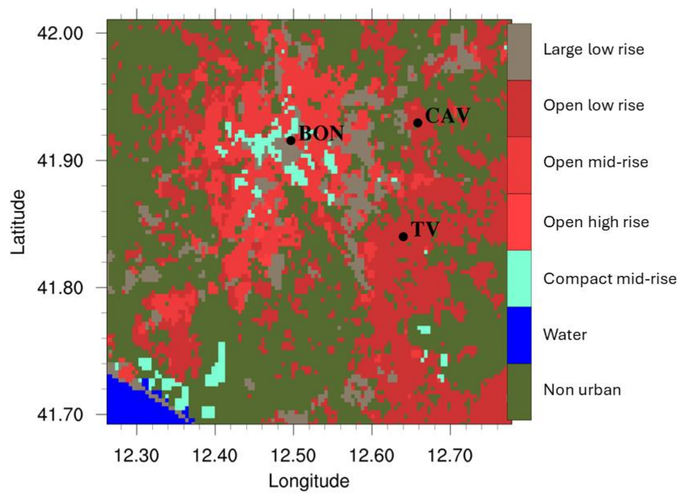
- The realistic reproduction of the urban texture is one of the main open challenges in the field of numerical weather modelling. It is especially challenging for the city of Rome where the urban texture and the characteristics of the building stock are complex and stratified, consequence of a history lasting close to three millennia.
- The Local Climate Zones (LCZ) classification consists in 17 urban zone types for a much more detailed representation of the urban texture (Stewart and Oke, 2012). LCZs can be conveniently translated for WRF runs for cities all around the world (Demuzere et al., 2022)
- An innovative configuration of the Weather Research and Forecasting (WRF) model has been implemented for the city of Rome thanks to the integration of LCZs derived from the WUDAPT dataset. The World Urban Database and Access Portal Tools (WUDAPT) project is a community-based project to gather a census of cities around the world (Ching et al., 2018).
- The **aim** of this work is showing the preliminary results of WRF runs performed with such new WRF-LCZ configuration over Rome

Methodology

The numerical setup of the WRF model



Geographical areas covered by the WRF computational domains



Urban land use categories in the domain over the metropolitan area of Rome according to the LCZ classification in the innermost domain

List of physics options chosen for the WRF runs

Category	Selected option
Microphysics	Single-Moment 6-class
Longwave radiation	RRTM
Shortwave radiation	Dudhia
Surface layer	revised MM5
Land Surface	Unified Noah Land Surface Model
Planetary Boundary Layer	Bougeault-Lacarrère
Urban Physics	Building Effect Parameterization (BEP)

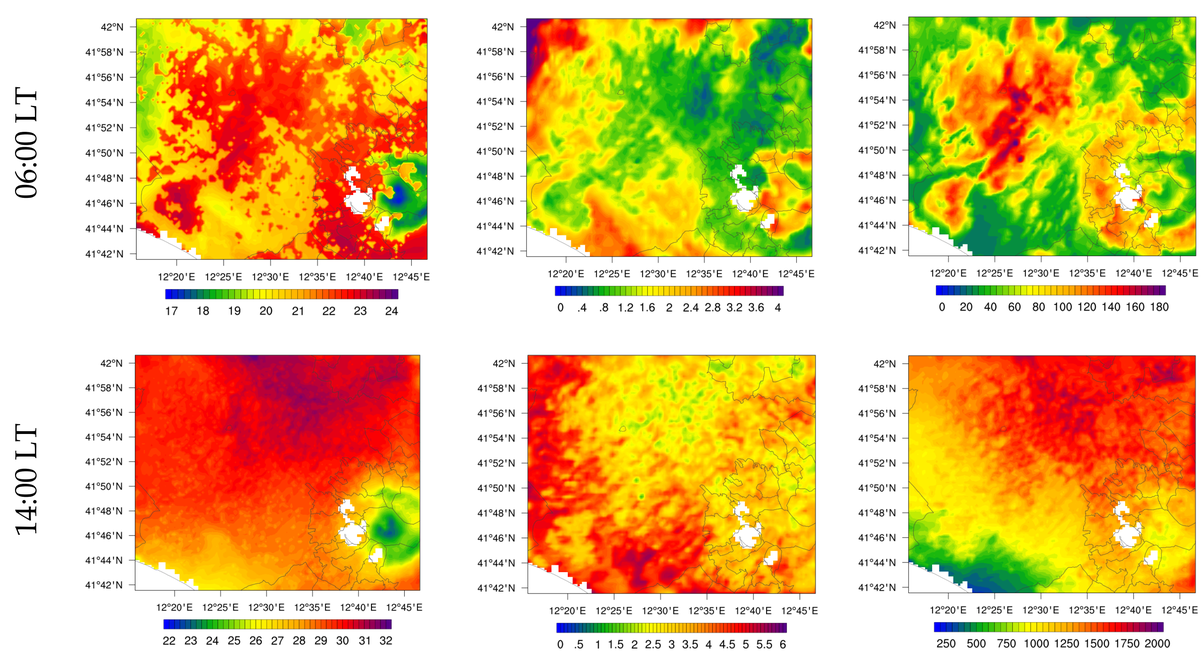
Horizontal resolution of the WRF domains

Geographical Area	Horizontal resolution [km]
Italy	13.5x13.5
Central Italy	4.5x4.5
Lazio Region	1.5x.15
Metropolitan area of Rome	0.5x0.5

Study period → July 2020

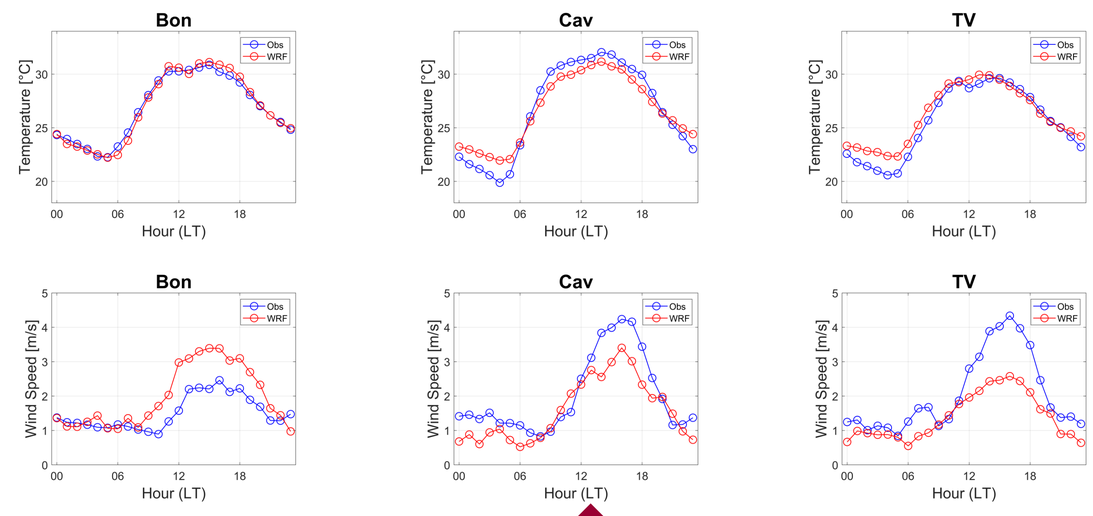
- ✓ Timeseries of temperature at 2 meters and wind speed at 10 meters are extracted corresponding to the locations of three weather stations of the ARPA Lazio network, namely: Boncompagni (BON), Fosso del Cavaliere (CAV) e Tor Vergata (TV).
- ✓ Numerical results are then compared with observations

Results



Averaged spatial distribution of quantities simulated by WRF in the innermost domain

Comparison between WRF results and observations



Averaged daily cycles of temperature and wind speed simulated by WRF and acquired at ARPA sites

Temperature

Statistical Parameter	Site		
	BON	CAV	TV
Mean Bias (MB)	-0.0034	-0.063	0.62
Fractional Bias (FB)	0.00121	5.26*10-5	0.026
Correlation Coefficient (R)	0.96	0.97	0.95
Normalized Mean Square Error (NMSE)	0.0013	0.0034	0.0029
Fraction of predictions within a factor of two of observations (FAC2)	0.99	0.99	0.99

Wind speed

Statistical Parameter	Site		
	BON	CAV	TV
Mean Bias (MB)	0.46	-0.43	-0.66
Fractional Bias (FB)	0.27	-0.23	-0.38
Correlation Coefficient (R)	0.73	0.74	0.66
Normalized Mean Square Error (NMSE)	0.30	0.33	0.48
Fraction of predictions within a factor of two of observations (FAC2)	0.81	0.72	0.62

Statistical summary of the comparison of WRF simulations and observations at the ARPA weather stations for temperature (left) and wind speed (right)

References

- Demuzere, M., Argüeso, D., Zonato, A., & Kittner, J. (2022). W2w: A python package that injects wudapt's local climate zone information in wrf. Journal of Open Source Software, 7(76), 4432.
- Ching, J. et al., (2018). Wudapt: An urban weather, climate, and environmental modeling infrastructure for the anthropocene. Bulletin of the American Meteorological Society, 99(9), 1907–1924.
- Skamarock, W. C. et al., (2019). A description of the advanced research wrf model version 4. UCAR/NCAR.
- Stewart, I. D., & Oke, T. R. (2012). Local climate zones for urban temperature studies. Bulletin of the American Meteorological Society, 93(12), 1879–1900.

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