



High-density thermo-hygrometric observations for urban heat and thermal exposure assessment in Valencia (Spain)

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Urban heat is a major climate-related hazard in cities, with direct impacts on public health, energy demand, and social vulnerability. A robust and spatially detailed observational basis is essential to characterize the spatio-temporal variability of urban thermal environments and to support climate services for heat risk management and urban adaptation. In this contribution, we present a newly deployed high-density thermo-hygrometric monitoring network designed to observe urban heat and thermal exposure at high spatial and temporal resolution in Valencia (eastern Spain), a **Mediterranean** metropolitan area identified as a **climate change hotspot**.

The network comprises more than **70 fixed monitoring stations** distributed across the metropolitan area at an average density of approximately one station per 2 km². Near-surface air temperature and relative humidity are measured at 3 m above ground level across a wide range of urban morphologies, including compact city centers, residential neighbourhoods, industrial areas, urban green spaces, and peri-urban zones. Sensors are installed following standardized exposure criteria to ensure data quality and inter-site comparability, with hourly sampling that allows the characterization of diurnal cycles, heatwave conditions, and intra-urban thermal heterogeneity. The system includes centralized data acquisition, quality control, and long-term data storage, enabling both operational applications and climatological analyses.

This observational framework is conceived as a **multi-purpose tool** for urban climate science and services. It enables a detailed assessment of urban heat patterns, including urban heat island (UHI) intensity, nocturnal heat retention, and thermal contrasts associated with different urban fabrics and land uses. Furthermore, the dataset provides an empirical basis for the evaluation and calibration of urban climate models and downscaled reanalysis products, improving the representation of local-scale thermal processes. The network also supports the development of **climate services** focused on heat exposure and risk assessment, contributing to the identification of priority areas for targeted adaptation measures.

Preliminary analyses reveal **pronounced intra-urban thermal contrasts**, with daytime near-surface air temperature differences of several kelvin between densely built or industrial areas and nearby vegetated or less urbanized locations. Results further indicate that industrial areas tend to cool more rapidly during nighttime compared to compact urban fabrics, leading to sustained nocturnal heat exposure in specific neighbourhoods. These patterns are particularly evident under clear-sky and heatwave conditions. A comparison with satellite-derived land surface temperature

(LST) shows amplified spatial contrasts during daytime, linked to surface radiative heterogeneity, while nighttime LST provides a closer proxy for near-surface thermal patterns. Overall, the network provides a robust observational foundation to advance urban heat research and to inform evidence-based strategies for climate-resilient cities.