Citizen science for multi-scale climate assessment: integrating distributed modelling and crowdsourced observations to inform urban heat adaptation

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ABSTRACT

Cities require improved climate information to anticipate rising temperatures and increasingly variable local conditions. This study examines the contribution of citizen science to this objective through two complementary methodologies that together span global to neighbourhood scales.

The first methodology employs volunteered distributed computing to run the HadAM4 climate model via the climateprediction.net platform for high-resolution climate change projections. This approach leverages the unused computational capacity of thousands of personal computers to generate very large, high-resolution climate ensembles that would otherwise be prohibitively expensive to produce on conventional supercomputers. The second methodology uses crowd-sourced weather observations obtained from privately owned, low-cost weather stations connected to platforms such as Netatmo and Wunderground. Using London as a case study, time series from 1,823 citizen weather stations were quality-controlled and analysed to characterise urban climate dynamics at high resolution. The results from both methodologies are compared using Cooling Degree Days (CDD), a widely used indicator of heat intensity and cooling demand.

The distributed computing experiments provide a global perspective on the impact of global climate change on cooling needs using CDD at approximately 60 km at mid-latitudes. The results identify areas where increases in CDD intensity are greatest under future warming and indicate regions likely to experience substantial absolute and relative changes. The analysis further shows that changes in CDD intensity are non-linear, with the most significant increases occurring early in the warming trajectory, particularly as global temperatures approach 1.5ºC, underscoring the urgency of near-term adaptation planning.

The crowdsourced weather observations complement these findings by providing high-resolution, city-scale evidence of heat exposure. They resolve spatial and temporal temperature variability at 1 km resolution, revealing micro-climatic patterns that exceed surrounding temperatures by more than 6°C and indicating areas where adaptation interventions should be prioritised. These results also enable the assessment of local interventions, supporting the identification of effective heat-mitigation strategies.

Together, the two techniques demonstrate how citizen participation can generate scientifically robust climate information across scales. The integration of distributed computing and dense observational networks highlights the potential of citizen science to enhance climate projections, refine local risk assessments, and inform targeted adaptation strategies for more climate-resilient cities.

KEYWORDS

Citizen science, Climate change, Urban overheating, Climate adaptation, Cooling Degree Days