

Urban heat stress: why WBGT can vary by up to 8.5 °C within the same area



How much can heat exposure change as we move through the same urban area? A study published in Discover Hazards in August 2026 by Andrew Robinson and colleagues at NOAA's Southeast Regional Climate Center (US) estimated WBGT differences of up to 8.5 °C within the same study area on the same day. The finding highlights the variability of urban microclimates and the need to assess conditions at the scale people actually experience. Read the study.

Why air temperature alone is not enough

When discussing hot weather, air temperature is usually the first measure we turn to. Assessing heat stress, however, also requires us to consider the conditions that influence heat exchange between the human body and its surroundings.

Humidity affects the evaporation of sweat; air movement influences convective and evaporative heat exchange; and radiation adds a thermal load that an air temperature sensor alone cannot capture. Even at the same air temperature, heat exposure can therefore vary considerably depending on the other environmental conditions.

WBGT, or Wet Bulb Globe Temperature, provides a more meaningful

indication of environmental heat stress than air temperature alone. It accounts for these effects through natural wet-bulb temperature, globe temperature and air temperature. The resulting value must then be interpreted alongside the individual's physical activity, clothing and acclimatisation: it does not, on its own, describe a person's physiological response to heat stress.

Forty-four monitoring campaigns to map urban heat exposure

Researchers carried out 44 mobile monitoring campaigns during the warm seasons of 2024 and 2025 in Carrboro, Chapel Hill and South Durham, North Carolina. Measurements of air temperature, humidity and solar radiation collected on foot, by bicycle and by car were combined with data from a fixed weather station and satellite-derived land-cover information. These inputs were used in models to produce microscale WBGT maps.

The analysis revealed marked differences in WBGT within the same study area, depending on local exposure, vegetation, paved surfaces, proximity to water bodies, and the size and spatial arrangement of buildings.

The maximum difference of 8.5 °C between locations within the same urban area occurred on 26 September 2025, a day that was only moderately hot compared with the rest of the season. Local conditions were therefore important even when the broader weather picture did not appear extreme. The finding highlights how general assessments, large-scale forecasts or measurements at a single location may fail to capture the heat risks people actually face.

Urban design is part of the microclimate

The study reinforces how strongly the built environment influences the thermal conditions to which people are exposed. Building materials and paved surfaces absorb and release heat differently; building height and spacing affect natural ventilation; and the layout of urban spaces determines patterns of sunlight and shade. Human activities, from traffic to air-conditioning systems, can also release heat into the urban environment.

The study also highlights a less intuitive interaction: depending on its arrangement and density, vegetation can increase humidity and restrict ventilation without providing sufficient shade or cooling. Its effect on WBGT is therefore not uniform, but depends on the configuration of the green space.

For those assessing microclimates, this means considering meteorology, urban design and the layout of public green spaces together. A paved square, a tree-lined path and a street flanked by tall buildings can produce very different WBGT conditions, with implications for the people using those spaces.

WBGT is useful when its inputs are reliable

The index's ability to describe heat stress makes the method used to determine it particularly important. A value labelled "WBGT" does not, by itself, guarantee an accurate result.

For example, estimating natural wet-bulb temperature indirectly rather than measuring it can introduce uncertainty, particularly when air movement is weak or inadequately measured. Using globe thermometers with dimensions that differ from the reference specification also requires appropriate corrections. Overlooking these factors can affect the final result.

We explore these issues in the LSI LASTEM article WBGT: when simplifications undermine reliability, which examines how simplified approaches can compromise the reliability of the calculation.

In this study, WBGT was calculated using the Liljegren method, rather than determined from direct measurements using the required set of

sensors—air temperature, natural wet-bulb temperature and black globe temperature—at every location. Local wind speed was also estimated, a limitation to consider when interpreting the values.

A multipoint network to capture population heat exposure

The study highlights the importance of monitoring local conditions across several critical locations within an urban area. General forecasts and individual reference stations provide context for the area as a whole, while a multipoint network can add the detail needed to distinguish local exposure conditions and heat risks.

A WBGT monitoring network should cover settings with different levels of shading, ventilation, land cover and building density, as well as different uses: outdoor workplaces, public transport stops, pedestrian routes, cycle paths, sports facilities, and industrial or commercial areas. Preliminary mobile monitoring campaigns can also help inform the network design and identify fixed locations for long-term monitoring.

A growing need as the climate changes

Climate change is making extreme heat events more frequent, placing increasing pressure on community health. As global warming continues, managing urban heat exposure is becoming even more important, particularly because the cities we live in were designed for different temperature and humidity conditions from those we face today.

Climate-conscious urban design can help reduce heat risks by providing shaded spaces for people, planning vegetation appropriately, selecting suitable materials and maximising natural ventilation. However, the effectiveness of these interventions must be assessed after implementation, under the conditions in which people actually use the spaces.

This is where monitoring supports understanding, design and the evaluation of completed interventions: reliable, representative measurements help identify where action is needed and establish whether the measures introduced actually improve the conditions people experience.

