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DESCRIBING THE IMPACTS OF HEAT STRESS ON HUMANS: FROM SPORTS APPLICATIONS TO HABITABILITY

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Abstract:

Environmental heat stress poses increasing risks to human health, safety, and performance under a warming climate. The wet-bulb globe temperature (WBGT), a versatile heat stress indicator that integrates temperature, humidity, wind, and radiation, is widely used to assess human heat strain in occupational, military, and sports contexts. In this talk, I will present two analyses that utilize 50 years of hourly WBGT data to examine how rising heat stress affects human activities and broader questions of habitability.

Using the Tour de France as a case study, the first analysis indicates that although July heat stress has increased across France, race dates have so far largely avoided the most extreme conditions. However, dangerous heat stress (WBGT > 28 °C) has become more frequent in recent decades, particularly in southwestern cities such as Toulouse, Pau, and Bordeaux, and is increasingly appearing in traditionally milder locations such as Paris and Lyon. With record-breaking heatwaves becoming more common, encounters with conditions that challenge existing safety protocols are becoming increasingly likely.

Beyond Europe, analysis of western Africa reveals rapidly rising exposure to dangerous heat stress levels. Conditions with WBGT ≥ 30 °C, considered hazardous even during light physical activity, have increased by 30–100 hours per decade across much of the region. In key hotspots, including the Senegal-Mauritania-Mali border region and southwestern Niger, the threshold of WBGT ≥ 33 °C (dangerous

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even at rest) is now exceeded for up to 40 hours per year. These extremes arise from both dry heatwaves in late spring and humid heatwaves in autumn, allowing dangerous heat stress to occur across a wide range of air temperatures. Because such conditions can occur across a broad temperature range, relying solely on high-temperature percentiles would have missed 50-90% of WBGT ≥ 33 °C episodes across most of the region during the study period. The usefulness of simpler heat stress indicators that account only for temperature and humidity, such as the heat index or wet-bulb temperature, is region dependent: the heat index performs better in continental areas of Senegal, Mali, Mauritania, and southwestern Niger, whereas wet-bulb temperature is a better proxy in coastal regions.

Interestingly, both analyses highlight a common limitation: the lack of reliable health impact data. For the Tour de France, such data have largely remained confidential, while in western Africa monitoring of heat-related impacts remains limited. As a result, WBGT-based analyses remain an essential tool for bridging applications ranging from safeguarding athletes and outdoor workers to identifying regions where extreme heat increasingly challenges human habitability.

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