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# Stickiness: A New Variable to Characterize the Temperature and Humidity Contributions toward Extreme Humid Heat

**Catherine Ivanovich**[1,2], Colin Raymond[3,4], Radley Horton[2], and Adam Sobel[1,2,5]
[1]Department of Earth and Environmental Sciences, Columbia University, New York, United States
[2]Lamont-Doherty Earth Observatory, Columbia University, Palisades, United States
[3]University of California, Los Angeles, United States
[4]NASA Jet Propulsion Laboratory, Pasadena, United States
[5]Department of Applied Physics and Mathematics, Columbia University, New York, United States

Extreme values of wet bulb temperature are often used as indicators of heat stress for humans and other animals. However, humid heat extremes are fundamentally compound events, and a given wet bulb temperature can be generated by various combinations of temperature and humidity. Differentiating between extreme humid heat driven by anomalous temperature versus anomalous humidity is essential to identifying these extremes' distinct physical drivers and preparing for their individual impacts. Extreme dry heat tends to occur due to processes such as blocking events and land surface feedbacks, and it has the potential to prime regions for wildfires and crop damage. In contrast, extreme humid heat depends more on strong moisture fluxes and vertical stability to moist convection, and it poses high risk for human health through its influence over heat stress.

Here we explore the variety of combinations of temperature and humidity contributing to heat extremes across the globe. In addition to using traditional metrics, we derive a novel thermodynamic state variable named "stickiness." Directly analogous to oceanographic spice (which quantifies the relative contributions of temperature and salinity to a given seawater density), stickiness quantifies the relative contributions of temperature and specific humidity to a given wet bulb temperature.

Consistent across metrics, we find that extreme humid heat — that is, the occurrence of wet bulb temperatures sufficiently high to impact human health — tends to occur in the presence of anomalously high humidity. Although theoretically humid heat extremes can be achieved at low humidities if temperature is high enough, this tends not to happen in practice. Using stickiness allows for the direct evaluation of the spatial and temporal variability in the temperature- and humidity-dependence of humid heat events, a task that is more complicated and subjective using traditional variables. We identify locations with high variability in stickiness: these include the Persian Gulf, the western United States, and southeast Australia. These locations are key areas where the predictive skill for heat stress-related mortality may improve by considering fluctuations in atmospheric humidity in addition to dry bulb temperature.