Researchers find future temperatures could exceed livable limits

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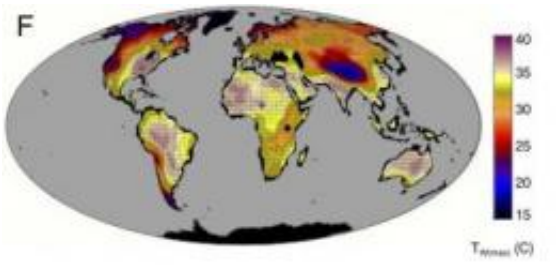

This map shows the maximum wet-bulb temperatures reached in a climate model from a high carbon dioxide emissions future climate scenario with a global-mean temperature 12 degrees Celsius (21 degrees Fahrenheit) warmer than 2007. The white land areas exceed the wet-bulb limit at which researchers calculated humans would experience a potentially lethal level of heat stress. Credit: Purdue University/Matthew Huber

Reasonable worst-case scenarios for global warming could lead to deadly temperatures for humans in coming centuries, according to research findings from Purdue University and the University of New South Wales, Australia.

Researchers for the first time have calculated the highest tolerable "wet-bulb" temperature and found that this temperature could be exceeded for the first time in human history in future climate scenarios if greenhouse gas emissions continue at their current rate.

Wet-bulb temperature is equivalent to what is felt when wet skin is exposed to moving air. It includes temperature and atmospheric humidity and is measured by covering a standard thermometer bulb with a wetted cloth and fully ventilating it.

The researchers calculated that humans and most mammals, which have internal body temperatures near 98.6 degrees Fahrenheit, will experience a potentially lethal level of heat stress at wet-bulb temperature above 95 degrees sustained for six hours or more, said Matthew Huber, the Purdue professor of earth and atmospheric sciences who co-authored the paper that will be published in Thursday's (May 6) issue of the Proceedings of the National Academy of Sciences.

"Although areas of the world regularly see temperatures above 100 degrees, really high wet-bulb temperatures are rare," Huber said. "This is because the hottest areas normally have low humidity, like the 'dry heat' referred to in Arizona. When it is dry, we are able to cool our bodies through perspiration and can remain fairly comfortable. The highest wet-bulb temperatures ever recorded were in places like Saudi Arabia near the coast where winds occasionally bring extremely hot, humid ocean air over hot land leading to unbearably stifling conditions, which fortunately are short-lived today."

The study did not provide new evaluations of the likelihood of future climate scenarios, but explored the impacts of warming. The challenges presented by the future climate scenarios are daunting in their scale and severity, he said.

"Whole countries would intermittently be subject to severe heat stress requiring large-scale adaptation efforts," Huber said. "One can imagine that such efforts, for example the wider adoption of air conditioning, would cause the power requirements to soar, and the affordability of such approaches is in question for much of the Third World that would

bear the brunt of these impacts. In addition, the livestock on which we rely would still be exposed, and it would make any form of outside work hazardous."

While the Intergovernmental Panel on Climate Change central estimates of business-as-usual warming by 2100 are seven degrees Fahrenheit, eventual warming of 25 degrees is feasible, he said.

"We found that a warming of 12 degrees Fahrenheit would cause some areas of the world to surpass the wet-bulb temperature limit, and a 21-degree warming would put half of the world's population in an uninhabitable environment," Huber said. "When it comes to evaluating the risk of carbon emissions, such worst-case scenarios need to be taken into account. It's the difference between a game of roulette and playing Russian roulette with a pistol. Sometimes the stakes are too high, even if there is only a small chance of losing."

Steven Sherwood, the professor at the Climate Change Research Centre at the University of New South Wales, Australia, who is the paper's lead author, said prolonged wet-bulb temperatures above 95 degrees would be intolerable after a matter of hours.

"The wet-bulb limit is basically the point at which one would overheat even if they were naked in the shade, soaking wet and standing in front of a large fan," Sherwood said. "Although we are very unlikely to reach such temperatures this century, they could happen in the next."

Humans at rest generate about 100 watts of energy from metabolic activity. Wet-bulb temperature estimates provide upper limits on the ability of people to cool themselves by sweating and otherwise dissipating this heat, he said. In order for the heat dissipation process to work, the surrounding air must be cooler than the skin, which must be cooler than the core body temperature. The cooler skin is then able to

absorb excess heat from the core and release it into the environment. If the wet-bulb temperature is warmer than the temperature of the skin, metabolic heat cannot be released and potentially dangerous overheating can ensue depending on the magnitude and duration of the heat stress.

The National Science Foundation-funded research investigated the long-term implications of sustained greenhouse gas emissions on climate extremes. The team used climate models to compare the peak wet-bulb temperatures to the global temperatures for various climate simulations and found that the peak wet-bulb temperature rises approximately 1 degree Centigrade for every degree Centigrade increase in tropical mean temperature.

Huber did the climate modeling on supercomputers operated by Information Technology at Purdue (ITaP), Purdue's central information technology organization. Sherwood performed the wet-bulb calculations.

"These temperatures haven't been seen during the existence of hominids, but they did occur about 50 million years ago, and it is a legitimate possibility that the Earth could see such temperatures again," Huber said. "If we consider these worst-case scenarios early enough, perhaps we can do something to address the risk through mitigation or new technological advancements that will allow us to adapt."

More information: Paper: www.pnas.org/content/early/201 … /0913352107.abstract

Provided by Purdue University

https://phys.org/news/2010-05-future-temperatures-livable-limits.html