The HumanIndexMod and New Calculations Demonstrating Heat Stress Effects All Aspects of Human Life Through Industry, Agriculture, and Daily Life.

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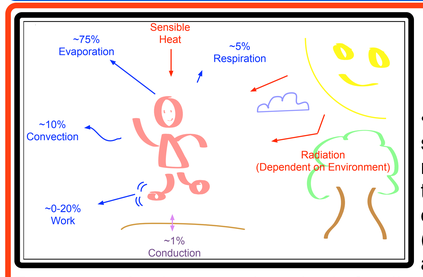
Abstract

- The HumanIndexMod calculates 13 heat related metrics using meteorological inputs of temperature, pressure, and moisture. The heat stress metrics are commonly used metrics around the world. The module is implemented into the CLM4.5, which is a component model of CESM, and is maintained by NCAR. Instantaneous moisture-temperature covariance is calculated every model time step. The heat stress metric changes show that many portions of the world switch from moderate levels for the top 3 days of a year to severe heat stress for the top 3 days of a year.



What is Heat Stress?

- Heat stress is the measure of thermal load on humans (and animals).

For mammals, there are 4 methods for dissipating heat: Convection, Conduction, Radiation, and Evaporation. In hot climates, ~75% of heat dissipation occurs through Evaporation. For humans, a sustained change of 3˚C in core temperature in humans can be lethal (Simon, 1993), and mammals suffer from heat stroke at core temperatures above 42˚C, due to mitochondria failure. Heat dissipation may not be in equilibrium.

Methods

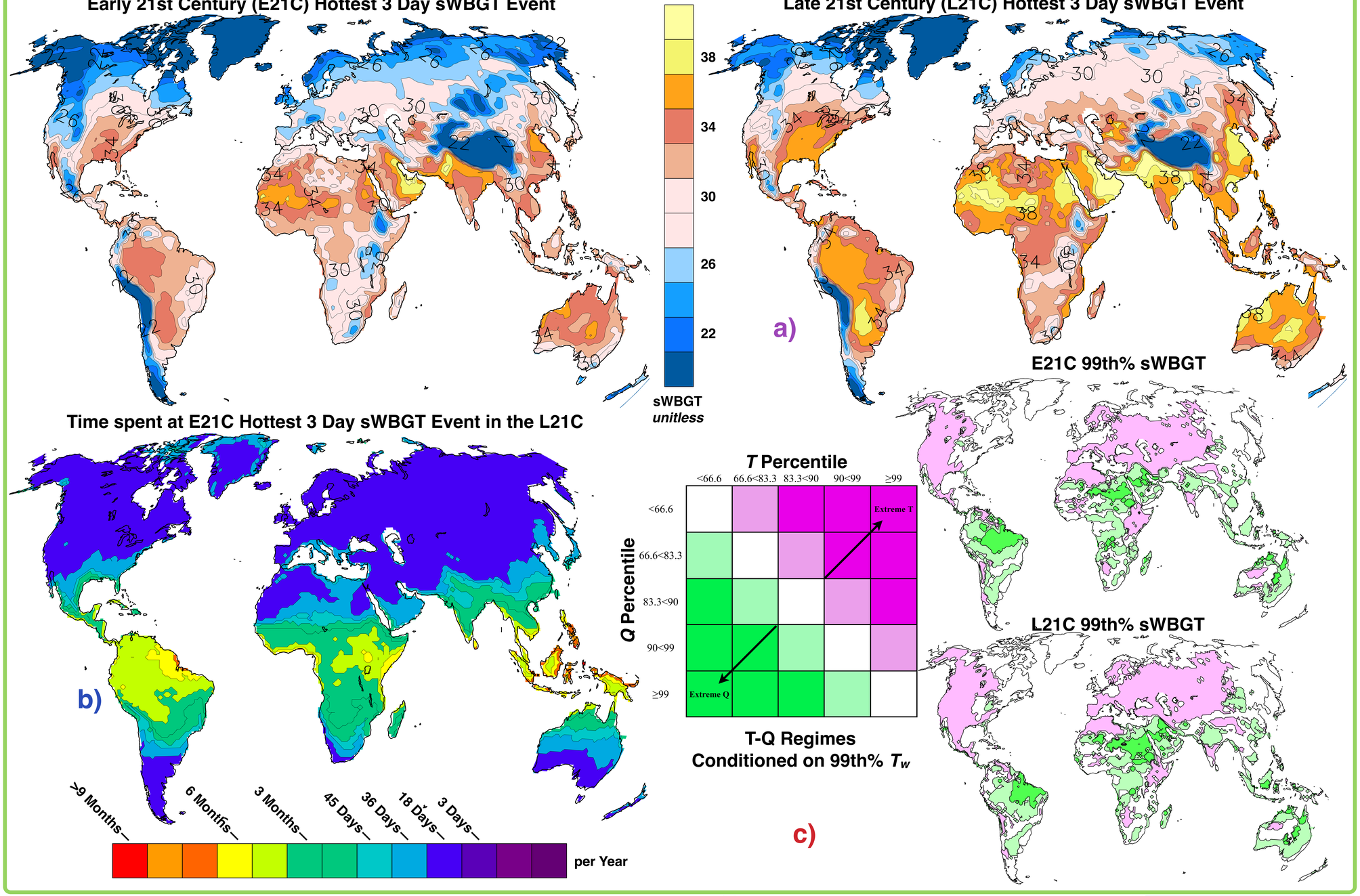
- We use CESM RCP8.5 (Taylor et al., 2012) output to drive the Community Land Model 4.5 (Oleson et al., 2013) (CLM4.5).
- We implemented the HumanIndexMod into CLM4.5 to calculate 13 different metrics; 4 moist thermodynamic variables and 9 heat stress metrics.
- We used 1°x1° resolution, and years 2005-2100, to output 4x daily and analyze the characteristics of the Simplified Wet Bulb Globe Temperature (sWBGT).

Results/Discussion

- **a)** Early and Late 21st Century sWBGT extremes. sWBGT exceeds 33 for the majority of the world by L21C. 33 is a limit for labor capacity (Dunne et al., 2013).
- **b)** The 99th Exceedance event from the Early 21st Century is up to two orders of magnitude longer at the Late 21st Century.
- **c)** What causes peak heat stress? We calculate conditional regime maps. All temperatures and humidities associated with heat events are compared to each other via their climatological percentiles.

Early 21st Century (E21C) Hottest 3 Day sWBGT Event

Late 21st Century (L21C) Hottest 3 Day sWBGT Event



Time spent at E21C Hottest 3 Day sWBGT Event in the L21C

E21C 99th% sWBGT

L21C 99th% sWBGT

Future Work

- Implementation of additional heat metrics (wet bulb globe temperature and radiant temperature of humans) to further characterize estimate heat stress trends.
- Dynamically downscale CLM4.5 results for NSF-Funded New Hampshire EPSCoR Ecosystems and Society project.

References

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