Questions & Answers Part 4

Please type your questions in the Question Box. We will try our best to get to all your questions. If we don't, feel free to email Cascade Tuholske (cascade@ciesin.columbia.edu) or Sean McCartney (sean.mccartney@nasa.gov).

Question 1: What is the difference between WBGT and Wet Bulb Temperature? How is Wet Bulb Temperature measured and used?
Answer 1: WBT is the temperature read by a thermometer with a wet cloth over it. At a 100% relative humidity, it is equal to the air temperature. Or in other words, WBT is the lowest temperature a parcel of air can reach by evaporative cooling under a given condition. For more details on WBT, see:

Raymond, C., Matthews, T., & Horton, R. M. (2020). The emergence of heat and humidity too severe for human tolerance. Science Advances, 6(19), eaaw1838.

Wet Bulb Globe Temperature (WBGT) is a combination of radiated heat, 2m air, wind, and relative humidity. It was overviewed in this webinar.

Question 2: The health burden of heat varies by climate region, population characteristics and adaptation capacity. Are you not generalizing too much when you use one same threshold for the entire globe? What is a 'hot day' for Alaska may not be in Tanzania, for example.

Answer 2: This is a great point. It is well known that extreme heat impacts need local context. That is why the dataset uses several different approximated WBGT thresholds based on ISO standards. But the thresholds we use are really designed to identify the most extreme temperatures that can impact human health and well-being.

A few suggested readings on this are:

Vanos, J. K., Baldwin, J. W., Jay, O., & Ebi, K. L. (2020). Simplicity lacks robustness when projecting heat-health outcomes in a changing climate. Nature communications, 11(1), 1-5.

Kent, S. T., McClure, L. A., Zaitchik, B. F., Smith, T. T., & Gohlke, J. M. (2014). Heat waves and health outcomes in Alabama (USA): the importance of heat wave definition. Environmental health perspectives, 122(2), 151-158.

Question 3: Can we use Urban Heat Exposure (UHE)-daily dataset on a neighborhood scale? Which scale best fits to use this methodology?
Answer 3: UHE-daily dataset can't be used on a neighborhood scale. The finest unit of analysis is an "urban settlement" which admittedly is very broad brush. The second dataset allows for some neighborhood scale analysis, but it is still only available at 5km resolution.

Question 4: Is there a particular reason for the 28C benchmark for the days per year WBGTmax on page 27?
Answer 4: Yes, this is based on ISO labor standards for health risks to hot humid heat. For more details, see:
Parsons, K. C. (1999). International standards for the assessment of the risk of thermal strain on clothed workers in hot environments. Annals of Occupational Hygiene, 43(5), 297-308.

Question 5: When should we use land surface temperature (LST) or wet bulb globe temperature (WBGT) to create heat maps?
Answer 5: Land surface temperature does offer a good understanding of deriving radiated temperature across a given geography. But as I overview in my presentation, LST it is not as applicable on a human scale because we do not live at the surface of the earth, rather we live 1-2 meters above and thus air temperatures (plus humidity, and wind) more precisely relate to heat health impacts. It also is a matter of opinion based on research and the researcher.

Question 6: How do we complement satellite derived LST and WBGT calculated from gridded daily temperature/humidity?
How good is the extreme temperature represented in the gridded data (assuming gridded data is interpolated)?
Answer 6: Gridded data is a blend of station observations and satellite observations. CHIRTS maps involve monthly maximum temperature, and blend ground observations to measure monthly maximum temperature. The data is not interpolated. Refer to the publication below for more information.

Link to CHIRTSmax paper (Monthly tmax):
Funk, C., Peterson, P., Peterson, S., Shukla, S., Davenport, F., Michaelsen, J., ... & Mata, N. (2019). A high-resolution 1983–2016 T max climate data record based on infrared temperatures and stations by the Climate Hazard Center. Journal of Climate, 32(17), 5639-5658.
https://journals.ametsoc.org/view/journals/clim/32/17/jcli-d-18-0698.1.xml

Like to CHIRTS-daily paper(daily tmax):
Verdin, A., Funk, C., Peterson, P., Landsfeld, M., Tuholske, C., & Grace, K. (2020). Development and validation of the CHIRTS-daily quasi-global high-resolution daily temperature data set. Scientific Data, 7(1), 1-14.
https://www.nature.com/articles/s41597-020-00643-7

Question 7: Can we use what was discussed here as an exposure component in formulating our heat vulnerability indices (HVIs)?
Answer 7: Depending on the spatial extent of the HVI, both datasets can be used. The Urban Heat Exposure (UHE) dataset is a broad dataset involving population exposure to extreme heat but cannot be used to look at the vulnerability to specific populations within cities. Annual Global High-Resolution Extreme Heat Estimates can be combined with spatial socioeconomic data to understand vulnerability to extreme heat.

Question 8: How is WBGT and WBT different from thermal indices such as PET, UTCI and PT?
Answer 8: Here are a few papers that overview the differences:

Blazejczyk, K., Epstein, Y., Jendritzky, G., Staiger, H., & Tinz, B. (2012). Comparison of UTCI to selected thermal indices. International journal of biometeorology, 56(3), 515-535.

Spangler, K. R., Liang, S., & Wellenius, G. A. (2022). Wet-Bulb Globe Temperature, Universal Thermal Climate Index, and Other Heat Metrics for US Counties, 2000–2020. Scientific Data, 9(1), 1-9.

Question 9: Are there any open source models to predict heat waves and heat stress?

Answer 9: Many meteorological models from NOAA and NASA have been written in Fortran and may be open source. GEOS-5 does provide prediction of temperatures as well, but resolution has to be accounted for.

Question 10: Why does the data set stop in 2016? Is the data up to 2016 only or is it more updated?
Answer 10: It stopped in 2016 due to labor availability of the researchers involved. University of California, Santa Barbara (UCSB) will be updating this dataset and hopefully v2 will be out sometime next year.

Question 11: When you cite this as the most accurate and highest resolution is that when looking at datasets that cover the whole world, or in other words if you are only looking at US data are other data sets better or equivalent to CHIRTS?
Answer 11: Yes, this is referring to CHIRTS as a quasi-global (60°S – 70°N), high-resolution (0.05° x 0.05°, approx. 5km) daily product. To learn more about CHIRTS refer to the link below:
https://www.chc.ucsb.edu/data/chirtsdaily

Question 12: Can we determine the accuracy or margin of error of the temperature data without ground measurements?
Answer 12: Ground measurements are vital to calibrate and validate any satellite Earth observations or modeled data. In the case of CHIRTS, the product uses thousands of station-based data to derive statistics on accuracy and margin of error. To learn more about how the dataset is constructed, refer to the link below:
https://journals.ametsoc.org/view/journals/clim/32/17/jcli-d-18-0698.1.xml?tab_body=fulltext-display

Question 13: What is the difference between "average intensity" and "total intensity"?
Answer 13: Intensity is the amount of excess heat on a given day (e.g. if the threshold is WBGTmax 30°C, and a day's WBGTmax is 31°C, then the intensity is 1°C).

Average intensity is the average of excess heat over a given heat wave (e.g. a three day heat wave with intensity of 1.5°C, 2°C, 2.5°C, then average intensity is 2°C). The total intensity is the exceed heat loading for an entire heat wave, or the summed intensity (e.g. a three day heat wave with intensity of 1.5°C, 2°C, 2.5°C, then total intensity is 6°C).

Question 14: What's the temporal resolution of the underlying dataset to calculate avg_temp? Are these daily max?
Answer 14: Yes, approximated daily maximum wet bulb globe temperature values.