Scientists predict that average temperatures may rise globally up to 4°C by 2100. In a warming world with increasingly extreme summers and winters, which organisms may be susceptible to, and threatened by, thermal stress? Answering this question is of paramount importance to predict, quite literally, who lives and who dies as a direct result of temperature changes in the forthcoming years.

The general approach to address this question has been to measure the highest or lowest temperature that an organism can tolerate. In practice, this involves subjecting the animal to increasingly warmer or colder temperatures, often in an oven or a freezer, until it can no longer respond. The temperature at which the animal eventually collapses in known as a critical thermal limit, and the temperature range that this animal can tolerate lies within the boundaries set by the hottest and coldest temperature it can cope with (that is, its upper and lower critical thermal limits).

Critical thermal limits have been measured in hundreds of species (mostly insects, and many fishes, amphibians and lizards), and results are puzzling. The hottest or coldest temperature that an organism can tolerate varies depending on how it is measured. With one protocol, a fly can tolerate 45°C whereas with a different protocol it might collapse at 39 °C, jeopardizing any attempt to predict the conditions in which this fly could be under thermal stress in nature.

In our perspective paper we discuss the limitations of this approach. The question is not only which temperature can an organism tolerate, but also for how long? In a sauna bath, just as the fly, a human being can tolerate 45 °C for several minutes but would be in great danger if the exposure lasted hours or days. Because the harmful effects of temperature accumulate over time, the length of the exposure to stressful conditions matters. We quantify how much it matters and, by doing so, describe how temperature draws the thin line between life and death as exposure times change.