Concerns over projecting temperature-related deaths associated with injuries

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Parks et al[1] reported projections of an additional 1601 temperature-related deaths associated with injuries in the United States under the Paris Agreement climate goals. However, we believe that these analyses misinterpret the Paris Agreement and have potential flaws in the epidemiological modelling that limit validity of the findings.

The Paris Agreement goals refer explicitly to “the increase in global average temperature … relative to pre-industrial levels”, further clarified by the Intergovernmental Panel on Climate Change Special Report on 1.5ºC (SR1.5) as “an increase in multi-decade global mean surface temperature above pre-industrial levels”[2], with the pre-industrial era defined as 1850-1900. However, the 1.5ºC and 2ºC temperature variations used in the main analyses of Parks et al were local temperature changes, relative to those of 1980-2017. Two issues are noted here, the first is that local temperatures can differ substantively from global averaged temperatures, especially over land which warms faster than the global mean. The second is that the increase in global mean surface temperature between the used baseline period (1980-2017) and preindustrial times is ~0.7ºC [3], meaning that Parks et al. use a substantially warmer baseline period than that defined in the Paris Agreement.

In the USA, local temperature changes in a 1.5ºC future climate relative to 1980-2017 could vary between 0ºC and 2.5ºC depending on location and month (Figure 1). Extreme high temperatures are rising faster than mean temperatures in many land regions as temperature distributions change with global warming[4], and we believe that simply considering a uniform 1.5ºC change at all locations and in all months is inappropriate.

Further, the hypothesis of a causal relationship with temperature for some categories of injuries is unsupported. A range of environmental variables are likely to play a role, for example rainfall for transport accidents[5]. The temperature associations in the study did not control for these variables or for changes in associations with additional climate change and adaptation. Temperature and health relationships are often non-linear[6,7]. Assuming linearity would substantially bias the results. For instance, it can explain the different age patterns in the category ‘falls’, given the elderly can be more at risk during icy weather conditions for falls outside their residence (which were not differentiated from ‘all falls’).

The use of monthly averaged temperature and health data is of concern because exposure occurs on shorter timescales. The use of daily data would provide more power (there is very limited variability in exposure defined by monthly anomalies) and, more importantly, make the analysis less prone to ecological biases. The choice by Parks et al. was justified by computational limitation of the Bayesian model used, although two-stage designs and modelling tools are available that would increase confidence[9].

In summary, the authors motivate their analysis as relevant for the Paris Agreement climate goals, but we believe their interpretation and experimental design are inaccurate, which could lead to the use of erroneous climate data as input into the heat-injury assessment. We also raise concerns about several assumptions and approaches in the epidemiological analyses, which could have implications for the validity of the overall conclusions.

Data Availability

The data in this study is freely available through the HAPPI consortium (www.happimip.org), or through contacting the corresponding author directly.

Author Contributions

All authors designed the paper by discussing the key concerns to be included. DM wrote the initial draft. MA, KE, AG, CH, and AV adapted the draft. EL made the figure. All authors approved the final draft.

Competing interests

The authors declare no competing interests.

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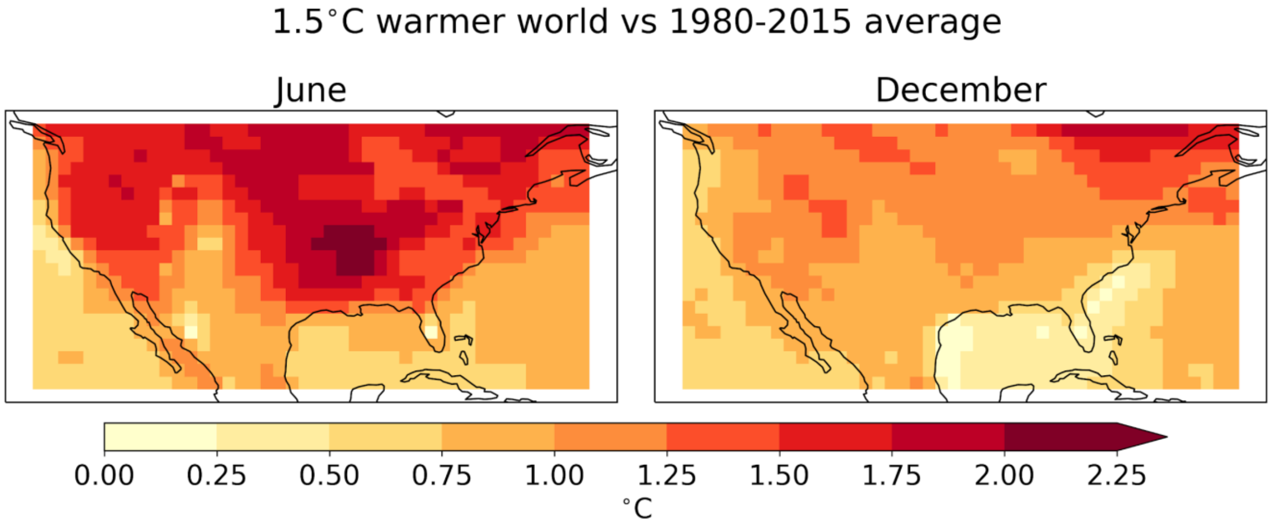

Figure 1: An example of monthly averaged temperature anomalies over the contiguous USA between 1980-2015 and a 1.5°C world. Left panel is for June, and right is for December. Data is taken from the first 10 ensemble members of the MIROC5 model as part of the HAPPI project[9].