this interpretation. This interesting exercise in interpreting the IPCC language might, in the future, be better applied as part of the process of constructing the IPCC parlance.

The researchers carry forward their calculation using the average ECS PDF of their ensemble, which serves their purpose for a common framework. However, the deeper uncertainty represented by the ensemble of ECS PDFs is critical and problematic for assessing the long-term risk of dangerous climate change[4].

Rogelj *et al.*[2] identify three pairs of similar scenarios from the old (*Special Report on Emissions Scenarios*, SRES)[6] and new (representative concentration pathways, RCPs)[1,7] sets, the identification of which is useful for the continuity of climate-impact research (Fig. 1). These three pairs (SRES A1F1/RCP8.5, SRES B2/RCP6 and SRES B1/RCP4.5) span the full range of the scenarios considered so far by the IPCC. Their study also considers the new, policy-driven, strong mitigation scenario (RCP3-PD), which requires fossil-fuel carbon dioxide emissions to peak around 2020 and net removal of carbon dioxide from the atmosphere by human activities later in the century.

This mitigation scenario is the rational choice for our planet, but we seem to be heading along the highest emission path[8], which, as Rogelj *et al.* show, leads to catastrophic climate change even with low ECS. It is sobering to remember that the models on which the IPCC so heavily depends may project a too stable outcome, as they are unable to reproduce some of the abrupt climatic changes of the past[9]. However, having been largely responsible for the emissions, corporate business may be forced by economic circumstances to find alternative sources of energy in the short run, but it would be foolish to rely on their continuing self-interest to solve the problem in the long run[10]. ❐

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HEALTH

A new measure of health effects

It has long been known that temperature extremes are associated with an increased risk of death. Research now directly relates future climate warming to people's lifetime.

Patrick L. Kinney

Heatwaves can be fatal, as shown by the August 2003 heatwave that killed upwards of 35,000 people across Europe. Though striking in its intensity, the notion of heat-related deaths is not a big surprise. What is more surprising is the fact that far more deaths occur in winter than in summer, especially for older adults with respiratory and cardiovascular problems. So it seems that temperature can be risky at both cold and warm extremes. But what might happen with increasing temperatures as climate changes? Writing in *Nature Climate Change*, Huang and colleagues[1] suggest that net increases in years of life lost as a result of premature, temperature-related death could become significant if future temperatures exceed 2 °C above pre-industrial levels.

Health effects of extreme temperatures represent the largest and most thoroughly studied weather-related public health issue. Deadly heatwaves are relatively common, and have become the focus of heat warning and response systems. However, although heatwaves capture attention, statistical analyses of long records of daily observations reveal a significant association between both hot and cold weather extremes and mortality in many cities[2–4]. The risk of death as a function of temperature is different depending on local climate; for example, responses to high temperatures are more pronounced in cities that are accustomed to cooler temperatures. Furthermore, considerable evidence[3,5,6] suggests that responses to heat differ depending on individual conditions, including age, race, socio-economic factors, acclimatization to prevailing conditions, and adaptive measures.

Although present-day associations between temperature and mortality are fairly well understood, projecting these effects onto future, warmer temperatures is challenging. One crucial question is that of mortality displacement. How much life is really lost when a person dies in a heatwave? If most heatwave-related deaths were anticipated by just a few days, this would imply minimal impacts on annual death rates and a reduced public health significance than if deaths were anticipated by years. Another challenge is to understand the extent to which the association between cold and death represents a direct temperature effect as opposed to seasonal impacts of influenza and other respiratory diseases[7]. Finally, how might cities adapt as temperatures become warmer? Will the heat effect decrease and the cold effect increase?

Huang *et al.*[1] extend our understanding of temperature effects on health in an interesting new direction by analysing temperature in relation to a new measure of health impact: years of life lost (YLL). In contrast to the conventional daily death count, which makes no distinction between deaths occurring for persons of differing ages, YLL accounts for the remaining years of life that are lost when an acute death occurs, thus weighting more heavily deaths occurring in younger individuals. They computed YLL for each day by integrating daily death counts with life expectancy per death, based on standard life tables. Using time-series analysis, the researchers observed a U-shaped relationship between daily YLL and daily temperatures from 1996 to 2004 in Brisbane, Australia (Fig. 1), accounting for long-term and seasonal trends in the data. They then calculated future YLL under 1 °C, 2 °C and 4 °C average warming above year-2000 levels. Although reduced health impacts in winter outweighed increases in summer under the 1 °C scenario, at 2 °C there were 381 YLL and at 4 °C this figure increased to 3,242 YLL.

By giving more weight to temperature-related deaths occurring in younger people, these findings provide decision-makers with a potentially useful new tool. However, the

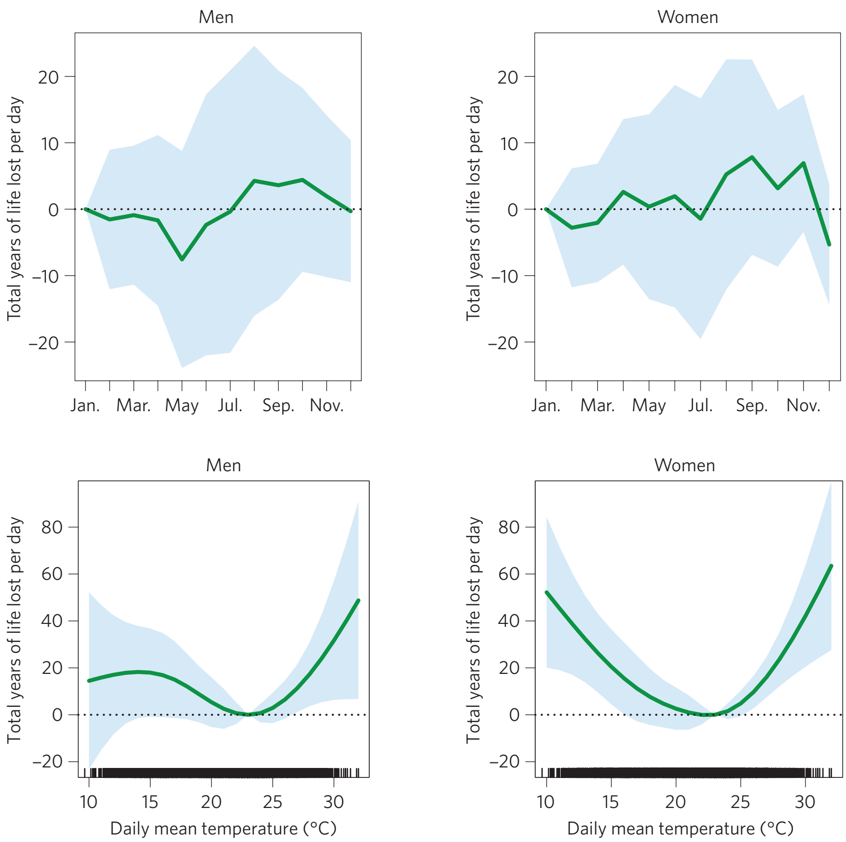

Figure 1 | Total years of life lost in Brisbane, Australia, 1996–2004. Huang and colleagues[1] estimated the effects of both season and temperature on the total number of years of life lost (YLL). The upper panels show the effect of season. January is the reference month. As it can be observed, no seasonal pattern in YLL for both men and women emerges. The lower panels show the effect of temperature. The fine lines show the observed daily mean temperatures. The reference temperature is 23 °C. The researchers observed a U-shaped relationship between daily YLL and daily temperatures over the period considered. Solid lines show the mean; grey areas show the 95% confidence interval. Reproduced from ref. 1.

calculation of the years of life prematurely lost is based on standard life tables with a possible risk of overestimating YLL. This is because people at risk of dying from heat would most likely have life expectancies much shorter than normal for their age group[5]. This limitation could be addressed by adjusting age-specific life expectancies downwards to reflect greater frailty. Another challenge not fully addressed by Huang and colleagues is that of adaptation. Empirical studies[2,3] compare the magnitude of health responses with extreme temperatures across cities characterized by different average temperatures. These studies suggest that, in cities where average temperatures are higher, the heat health effects per unit temperature are lower (and the cold health effects higher) than in areas with lower average temperatures[3]. Although the researchers do not account for this phenomenon in their YLL projections, they present useful sensitivity analyses that quantify the amount of adaptation that would be needed to eliminate future impacts on YLL as a result of heat.

The impacts of temperature extremes are the most significant source of weather-related adverse health outcomes that have been documented so far. They are also the most direct and well-understood of potential climate change impacts on human health. Huang *et al.*[1] offer a unique framing of the negative effect that climate change may have on humans through the lens of years of life prematurely lost as a consequence of warming temperatures. This new measure can help to better understand the public health consequences of future climate change and help to target adaptation strategies so that their effectiveness is maximized. ❐

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SOIL SCIENCE

Fungal friends against drought

Fungal-based food webs of undisturbed grasslands resist and adapt to the effects of drought more than bacterial-based food webs of agricultural soils, indicating how soil biota might be able to withstand long-term climate change.

Johan Six

There are still many unknowns about how the earth under our feet will respond to future changes in climate. At the heart of the issue lies the question of how much or even if soil-living creatures and their functions will be able to resist and/or adapt and/or bounce back from the perturbation caused by droughts. This question is extremely important, because if soil biota can withstand drought in the longer term, then we as a society have one less worry within the realm of climate change. Writing in *Nature Climate Change*, Frankiska de Vries and colleagues[1] provide such a reassurance, provided that we manage our lands sustainably. Their study shows that soil biota can resist and adapt to prolonged drought, but only if we maintain diverse and fungal-based food webs in our soils by reducing anthropogenic disturbances such as tilling and over-fertilizing.