Reply to 'A note of caution about the excess winter deaths measure'

Staddon *et al.* reply — Hajat and Kovats[1] question our conclusion that climate change may no longer be assumed to bring a health dividend due to the warming of winters[2]. We accept that the excess winter deaths (EWDs) measure is not perfect; more work is required to develop better temperature and health metrics relevant to seasons and years (rather than extrapolating from daily observations) as has been done for air pollution[3]. However, we do not agree that the EWDs measure is so flawed as to prevent its use in drawing conclusions about relationships between weather and mortality. Cold-related deaths that occur outside the December–March period are irrelevant because our study has focussed on winter deaths. We did this specifically because winter deaths have been predicted to fall as winters warm. The Health Protection Agency stated that "the number of cold-related deaths will likely decrease due to milder winters"[4]. The *UK Climate Change Risk Assessment*[5] concluded that "increased winter temperatures may lead to decreased levels of mortality and morbidity due to cold". The estimate made by Hajat and Kovats that 70% of all cold-related deaths occur on days warmer than the 5 °C threshold is misleading: this conclusion is based on the assumption that deaths occurring on days below 20 °C are cold-related and deaths on days above 20 °C are warm-related[6]; by this definition, most UK deaths are cold-related. However, we would challenge the simplicity of this notion given that temperature–mortality relationships show two inflections points, not one.

That the excess in winter deaths relative to those in summer may fall if summer heat-related death-rates rise is obvious, but is not germane to our observations of past trends. Indeed, we know of no evidence to suggest that summer heat-related deaths have significantly risen in the past couple of decades; the exception was the 2003 heatwave that caused 2,000 deaths in England and Wales[7] — which is small compared with the 25,000 expected annual EWDs. This heatwave event, which has garnered so much attention, had no discernible effect on the following winter's EWDs.

The publications of Hajat and Kovats[7,8] — which they cite to support the role of future winter warming in decreasing winter deaths — quantify the average relationship across years between temperature and mortality: they then extrapolate to determine the impact of warmer weather mortality. However, they assume that the daily temperature–mortality relationship is stable when, in fact, it changes both spatially and temporally, making it unreliable for projecting future cold-related mortality. Recent independent research by Ebi and Mills[9] also concludes that "climate change […] is unlikely to dramatically reduce overall winter mortality rates", and confirms our finding that influenza activity is now a key driver of year-to-year fluctuations in winter mortality[2,9,10].

We agree, that "climate change is an important public health challenge for the UK" and that "policymakers need to be informed by the best available evidence on the probable harms and benefits to human health." This was the motivation for our work. Our findings[2], corroborated by others[9,11], indicate that future warmer winters are unlikely to decrease winter mortality[2,9,11], especially if temperature volatility increases[12]. ❐

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CORRESPONDENCE:

Missing tree rings and the AD 774–775 radiocarbon event

To the Editor — Büntgen *et al.*[1] describe radiocarbon data from a subfossil pine tree in the Austrian Alps as an example of an event and method that might strongly support or strongly refute our missing-ring hypothesis[2,3]. Our hypothesis is that some trees growing near their thermal limits can fail to produce an annual ring during unusually cold growing seasons that can follow large volcanic eruptions. The missing ring causes the year preceding the eruption to masquerade as the eruption year. This has two potential impacts. First, the resulting chronology would not record the effects of the eruption because the ring from that year would be missing. Second, all previous years in the chronology would be shifted forward in time by the number of missing rings. This means that, even if the tree produced a growth ring following an older eruption, that ring would indicate the wrong year. In both cases, the hemispheric or global average temperatures derived from the records would underestimate the actual cooling. Thus, our hypothesis could explain the discrepancy between modelled and reconstructed responses to large eruptions[3].

An independent date is needed to confirm that all chronologies are complete, or that some are missing rings. The AD 774–775 radiocarbon event is unique in the time

period of interest and ought to be globally synchronous[4,5]. Therefore, it should provide the independent time-marker necessary to directly test our hypothesis.

The date of the AD 774–775 radiocarbon event was initially established using tree rings from two trees in Japan[4]. Subsequently, Usoskin *et al.*[5], Wacker *et al.*[6] and Büntgen *et al.*[1] established that the event occurred at the same year in two tree-ring records from Germany and two from the Alps. This illustrates that the dating of these trees is consistent and accurate.

Based on our previous results[3], we can make predictions that are consistent with our hypothesis and that can be tested using the AD 774–775 radiocarbon event and existing tree-ring chronologies. First, regarding the Alps series, our results predict that there will be no missing rings in this region. The Alps regional series we used[3] — taken from D'Arrigo *et al.*[7] — begins in AD 1350, and was included in our analysis of the climate response to the 1815–1816 Tambora eruption sequence. Our resulting 'best match' surrogate ensembles for this eruption (Fig. 2 in ref. 3) use the Alps series on its original timescale. Thus, our results are consistent with those of Büntgen *et al.*[1]. Second, of the 19 regional series used in D'Arrigo *et al.*[7] and Mann *et al.*[3], only three — coastal Alaska, Tornestraesk and Taymir — begin before AD 774 and can be directly tested by the AD 774–775 radiocarbon event. Our results[3] predict the following minimum offsets for the AD 774–775 radiocarbon event in these three series: the coastal Alaska series is four years too young, the Tornestraesk series is between one and five years too young (any offset in that range would be consistent with the AD 1258 eruption, though perhaps a one year offset is the most probable), and the Taymir series is one year too young (Fig. 1). In addition, we predict that the Icefields tree ring series[8] is correctly dated, but it starts in AD 918 and cannot be directly tested using this method.

The discovery of the AD 774–775 radiocarbon event seems to be the key to testing our missing-ring hypothesis. As proposed by Büntgen *et al.*[1], a systematic analysis of material from tree-line sites will show if the missing-ring hypothesis is correct, or if the cause of the difference between model-based estimates of post-volcanic cooling and proxy-based reconstructions of past climate lies elsewhere. ❐

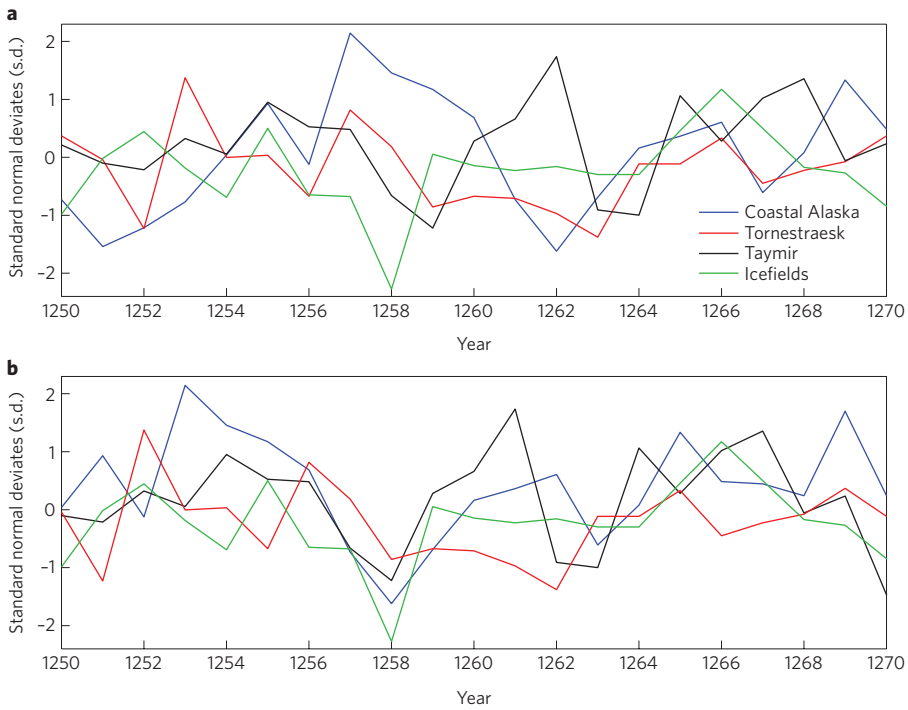

Figure 1 | Tree-ring records over the AD 1258 eruption displayed as standard deviations (s.d) about a normalized value. **a**,**b**, The three D'Arrigo *et al.*[7] regional series that begin before AD 774 — coastal Alaska (blue), Tornestraesk (red) and Taymir (black) — and, for reference, the Icefields series (green), are displayed with their original timescales (**a**) and age-adjusted timescales, consistent with our hypothesis[3] (**b**). The Icefields series is unaltered, the coastal Alaska series is shifted by −4 years (~0.6%), and the Tornestraesk and Taymir series are both shifted by −1 year (~0.1%).

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Power to the people

To the Editor — Sonja van Renssen[1] sets out a compelling case for the adoption of demand-side management (DSM) in the energy sector. However, despite invoking 'people power', her appraisal of DSM does not address the important role of end users. If DSM's potential is to be met, then citizens must be considered alongside generators and distributors, policy makers, industrialists and technologists[2].

Unless existing social roles are changed, considerable danger lies in DSM being implemented as a purely regulatory and technical innovation. Within the existing energy system, the end user is simply a