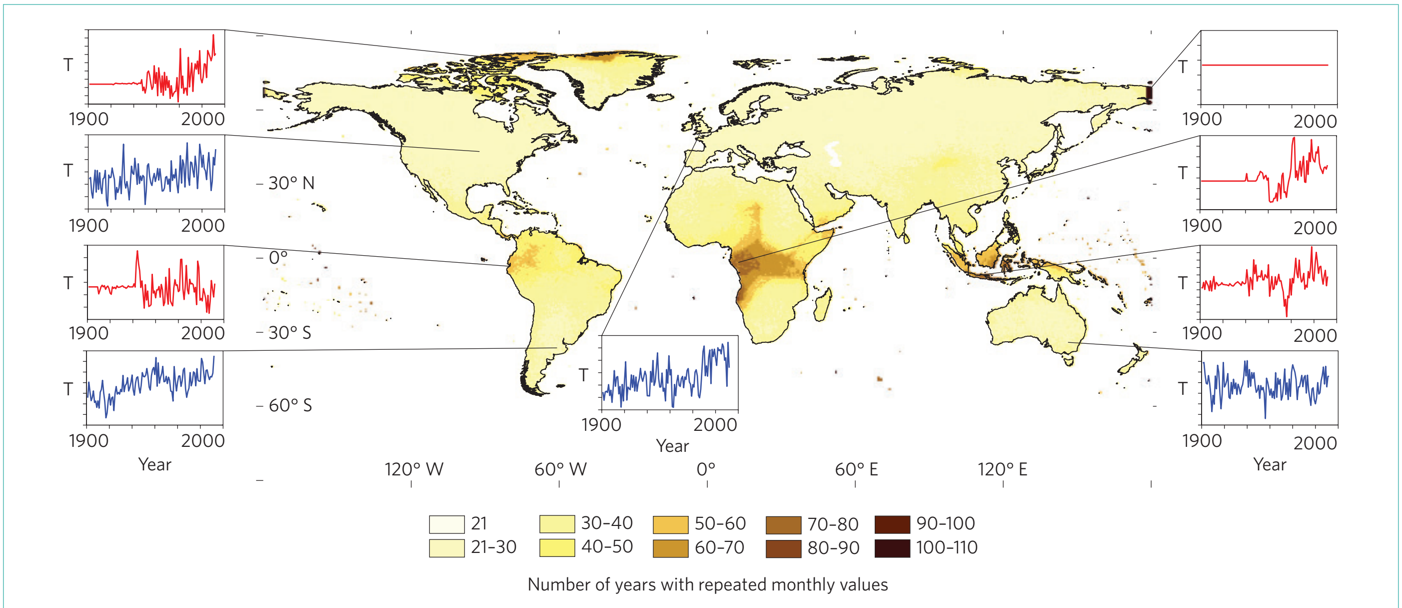


**Figure 1 |** Number of years with repeated monthly temperature values per 0.5° land grid cell (for example, repeated March temperature values over different years; period 1901–2012). Note the large area in which many repeated values are found, strongly suggesting the substitution of missing values with the corresponding Climatic Research Unit 0.5° 1961–1990 mean monthly climatology[4,5], especially in the initial decades of the twentieth century. Inset: the temperature time series show the consequences of this on climatic variability for grid cells with good coverage (in blue) versus grid cells with poor coverage (in red; T, normalized temperature). The indiscriminate use of all time series invalidates the frequency approach used in Ji *et al.*[1].

over the first half of the twentieth century in many tropical and Arctic regions can be attributed to the lack of climatic information and the corresponding flattened time series representing a succession of climatological means. Likewise, station availability corresponds with early-warming signals in the mid-southern and mid-northern latitudes. Consequently, early-warming hotspots (between 1900 and 1950) — and their delayed-warming counterparts — share the spatial patterns of meteorological station availability: that is, early-warming regions largely coincide with the availability of climatic data. It is of concern that many of the regions with the highest observed lag-1 autocorrelation in Ji *et al.*[1] (Supplementary Fig. 6 of Ji *et al.*[1]) occur in tropical regions with many repeated values (Fig. 1). The frequency decomposition method shown in Supplementary Fig. 4 of Ji *et al.*[1] for three grid cells in North America would reveal the above-mentioned limitations if applied to many tropical regions.

We suggest it is very likely that the spatiotemporal temperature patterns described in Ji *et al.*[1] are strongly contaminated by the spatial and temporal heterogeneities of the CRU database. Independently of the high spatiotemporal locality of the statistical procedures used in Ji *et al.*[1], this problem affects the whole analysis, as this consists of a global comparison between all regions (that is, comparisons between regions with adequate data and regions with poor data are biased) and time periods (that is, artificially flattened trends in the early twentieth century will reflect slower warming trends than observed trends in late twentieth century).

Reliable results using this approach may be obtained by restricting the analysis to periods and areas over which it can be carried out: this can be transparently achieved by removing all points falling outside the search radius for each month (available from the CRU). If the aim is global coverage, the optimal period should not start before the 1950s (see, for example, Burrows *et al.*[6]), although this would compromise the authors' aim to capture long-term trends[1]. ❐

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Additional information

Supplementary information is available in the online version of the paper.

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## Reply to 'Spatiotemporal patterns of warming'

**Wu *et al.* reply** – Macias-Fauria *et al.*[1] highlight deficiencies in the high-resolution gridded climate database[2,3] prepared by the Climate Research Unit (CRU). In our analysis[4], yearly averaged land surface air temperature (SAT) at each grid from this database was decomposed using the multidimensional ensemble empirical mode decomposition[5–8] (MEEMD) and these nonlinear secular trends from all grids were then pieced together into the spatiotemporal evolution of land SAT trends. Land SAT was independently decomposed grid by grid. The spatial and temporal biases of land SAT in the equatorial and Arctic coastal regions therefore do not impact the results derived for other regions.

Replacing unobserved data at an isolated temporal location with climatological values does not affect the determination of the trend (see methodology papers[5–8] and Supplementary Information accompanying Ji *et al.*[4]). Therefore, only those regions with an extended period of climatological values need extra attention. Because the trend derived for each spatial grid is local in time, the land SAT trends of later decades are not sensitive to earlier data bias as previously demonstrated[8]. This spatiotemporal locality of the MEEMD-determined trends can be verified using the MEEMD code and detailed computational information (Supplementary Information for Ji *et al.*[4]).

To assess whether our conclusions[3] are affected by the data bias, we have repeated our analysis after removing regions lacking sufficient coverage before 1950. We identified these regions by plotting the standard deviation of the yearly mean SAT for the time periods 1901–1950 and 1951–2009 (Supplementary Fig. 1) and using a standard deviation of <0.05 K as the threshold. This threshold is a good indicator for identifying the non-interpolatable locations as they are filled with some spatially local and temporally optimized mean monthly climatology in the CRU database and therefore the land SAT values have a standard deviation close to zero for an extended period dominated by climatological filling. Supplementary Fig. 1 is in agreement with Fig. 1 of Macias-Fauria *et al.* Our new figure (Fig. 1b) does not differ much from the original Fig. 3 of Ji *et al.*[4] (Fig. 1a) and our conclusions remain valid.

Figure 1 also clearly shows that the patterns in Supplementary Fig. 2 of Macias-Fauria *et al.*[1] (Fig. 1c) are quite dissimilar to those in Fig. 3 of Ji *et al.*[4] (Fig. 1a). We do not agree that "early-warming hotspots … — and their delayed-warming counterparts — share the spatial patterns of meteorological station availability" because it implies that the fast climate change over the global land, dominated by warming, is being caused by denser observations both in space and time. The interpolation method[2,3] does not generate artificial trends in regions of abundant observation, and the greater availability of the observed land SAT data in the CRU database for later decades only serves to increase our confidence in the extracted climate change information.

Finally, it is noted that we were aware of the deficiencies of the CRU

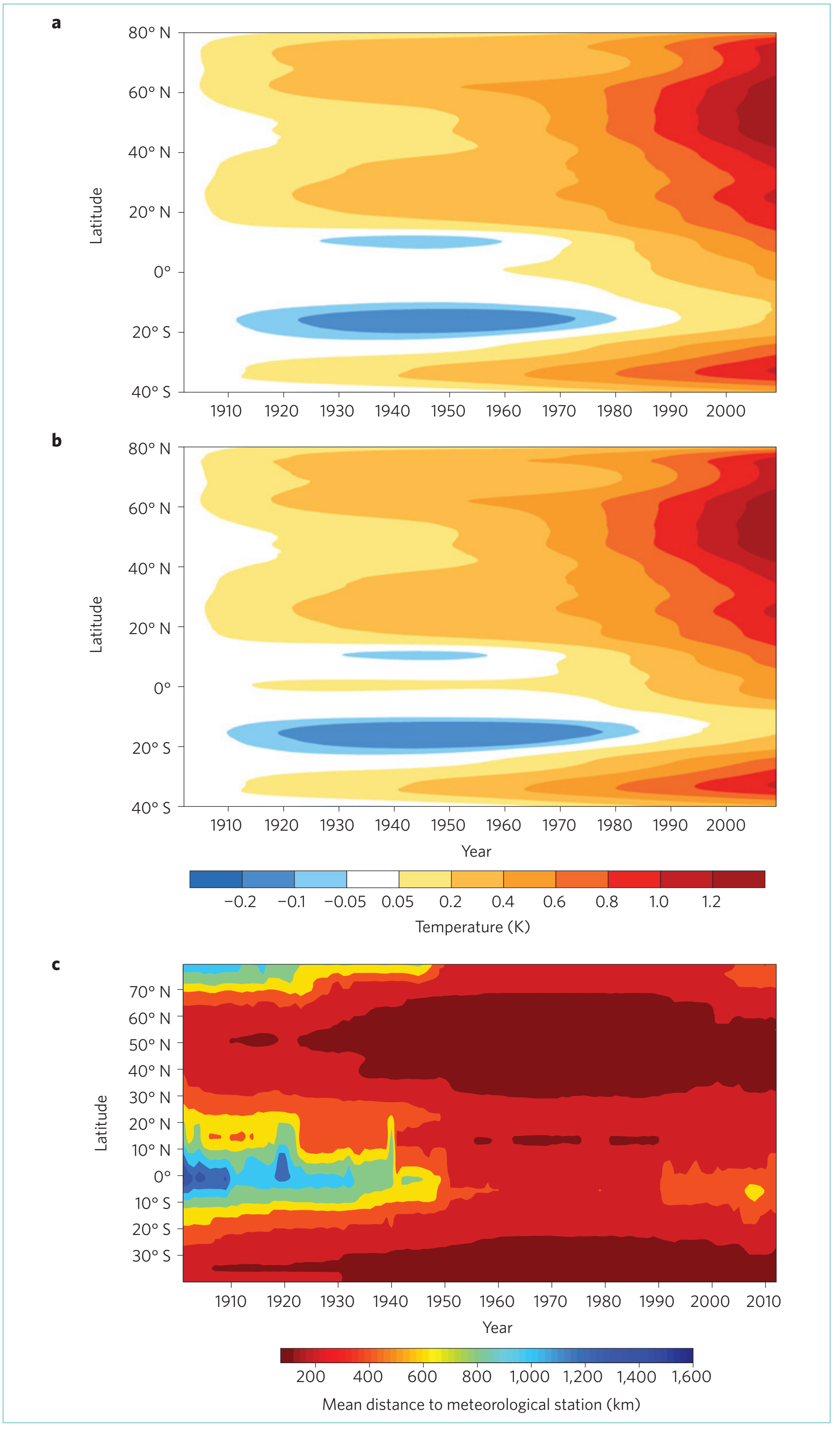


**Figure 1 |** Temporal evolution of the zonally averaged trend of surface air temperature and of zonally averaged spatial coverage of data. **a**, Fig. 3 of Ji *et al.*[4] showing the temporal evolution of the zonally averaged trend of surface air temperature. **b**, Same as panel **a** but with the low-standard-deviation areas removed in the averaging process. Note that the colour intervals are uneven. **c**, Supplementary Fig. 2 of Macias-Fauria *et al.*[1] showing the temporal evolution of the zonally averaged minimum distance to a meteorological station.

database; hence, we were cautious not to even mention the trend of tropical land surface temperature in the context of Ji *et al.*[4] and the accompanying Supplementary Information. □

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Additional information

Supplementary information is available in the online version of the paper.


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COMMENTARY:

# Practitioners' work and evidence in IPCC reports


David Viner and Candice Howarth



**The Intergovernmental Panel on Climate Change reports provide the most reliable and robust assessment of understanding of the climate system. However, they do not include practitioner-based evidence, which is fundamental to make the reports a relevant source of information for decision-making.**


The Intergovernmental Panel on Climate Change (IPCC) is increasing efforts to communicate its results more clearly to a wide audience in a way that limits confusion and increases their use. A clear example is offered by the 'headline statements' from the *Summary for Policymakers* of the Working Group I (WGI) contribution to the fifth assessment report (AR5)[1], which summarizes the overarching conclusions. The IPCC WGI report provides the scientific evidence for international negotiations on mitigation targets, from which individual countries drive national policies and their own negotiating positions (Fig. 1). Increasingly, they are used by engineers, policymakers and other practitioners to develop climate change risk frameworks and vulnerability assessments.

The issue of what is currently termed climate change adaptation is becoming increasingly important, as extreme events witnessed across the globe are increasing[2]. The latest Working Group II (WGII) report, on impacts, adaptation and vulnerability, released in March this year, comprised 30 chapters, predominantly split on a sectoral and regional basis. Five of these chapters explicitly mention climate adaptation in their headlines. However, a close look at the content, author lists and references shows that the 'adaptation' chapters lack practitioner experience, evidence and case studies that demonstrate how adaptation is being carried out on the ground. In other words, they provide an observational, top-down account rather than a practitioner-led evidence base. We question the extent to which this approach goes beyond exercises of observation and interpretation and whether it provides practical applications of climate change adaptation knowledge. Where this is not the case, the role of practitioner-based experience and reporting should be carefully considered.

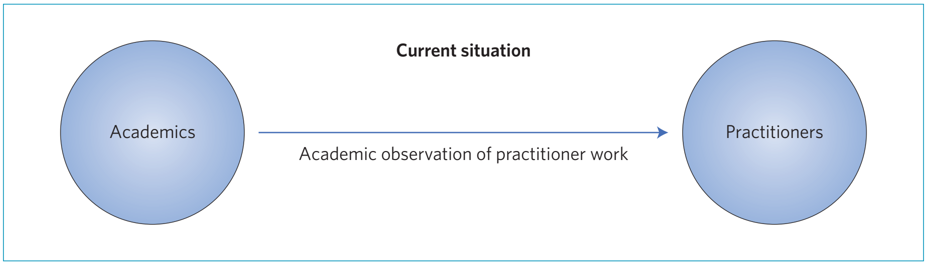


**Figure 1 |** The academic community merely observes practical actions to address climate change resilience but does not include the practitioner community in the process of systematic review of evidence, such as the IPCC process. This lack of integration hinders a full and realistic assessment of available evidence with the risk of developing potentially less effective policies.

Although increasing efforts are being made to better the science–policy interface, the disconnection between science and practitioners remains a key barrier to progress in the field of climate change adaptation. How practitioners, engineers, ecologists, landscape planners and investors could input into and use the results of the IPCC WGII report in the same way that the WGI report is used in international policy is key to understanding the effectiveness and real impact of climate change in the future. One could argue that the process and flow of information and expertise