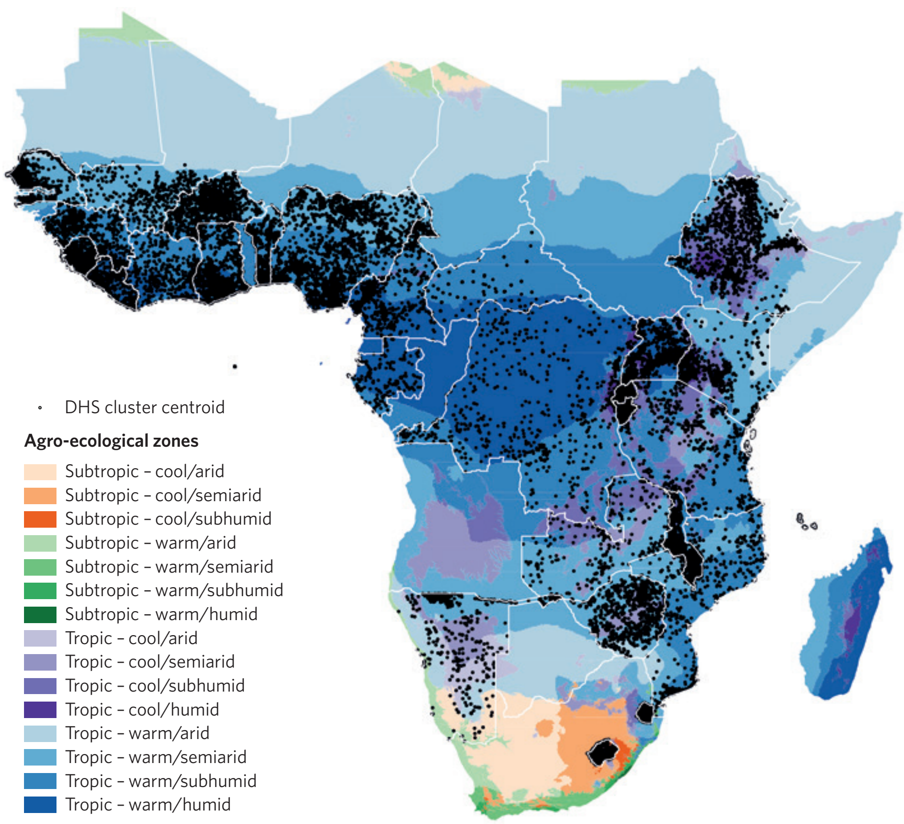

Figure 1 | Subnational Demographic and Health Surveys (DHS) data showing centroids of DHS clusters overlaid on Agro-ecological Zones.

Health Surveys (DHS)[7]. The first map (Fig. 1) illustrates the spatial distribution of DHS clusters overlaid on Agro-Ecological Zones (AEZs) in Sub-Saharan Africa. Supplementary Fig. 1a zooms in for a more detailed look at Nigeria and neighbouring countries and shows the prevalence of wasting among children under five. Finally, the spatial relationship between prevalence of wasting and AEZ shown in Supplementary Fig. 1b is confirmed by the first-order stochastic dominance depicted in Supplementary Fig. 1c. Overall, results show that early childhood wasting is significantly more prevalent in the arid and semi-arid zones of Sub-Saharan Africa. These types of granular dataset, especially those harmonized on high-resolution global grids, have already been used and will be increasingly used in economic and biophysical modelling analyses that explore future consequences of climate change scenarios[8,9]. More work surely needs to be done to address the world's key challenges of food insecurity and climate change, but the paradigm shift is alive and kicking already. ❐

References

1. Otto, I. M. *et al. Nature Clim. Change* **5,** 503–506 (2015).
2. Open Data Census project; http://global.census.okfn.org
3. Agricultural Model Intercomparison and Improvement Project (AgMIP); http://www.agmip.org
4. WorldPop; http://www.worldpop.org.uk
5. World Bank Integrated Surveys on Agriculture (LSMS-ISA); http://go.worldbank.org/BCLXW38HY0
6. HarvestChoice (International Food Policy Research Institute and University of Minnesota); http://harvestchoice.org/products/data
7. Demographic and Health Surveys Program; http://dhsprogram.com/data
8. Rosegrant, M. W. *et al. Food Security in a World of Natural Resource Scarcity: The Role of Agricultural Technologies* (International Food Policy Research Institute, 2014).
9. Nelson, G. C. *et al. Proc. Natl Acad. Sci. USA* **111,** 3274–3279 (2014).

Additional information

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

Carlo Azzarri, Melanie Bacou, Cindy M. Cox, Zhe Guo and Jawoo Koo*
International Food Policy Research Institute, 2033 K Street, NW Washington, DC 20006-1002, USA.
*e-mail: j.koo@cgiar.org

CORRESPONDENCE:

Ocean temperatures chronicle the ongoing warming of Earth

To the Editor — The global ocean has absorbed 93% of the extra heat trapped by the Earth since 1970[1] and the rate of change in ocean heat content is a good estimate of the radiation imbalance at the top of the atmosphere[2]. Previously we reported[3] a robust warming rate over the Earth's area of 0.5–0.7 W m^{-2} during 2006–2014 using the global ocean data from the Argo array and three contrasting mapping methods: an optimal interpolation (OI), reduced space optimal interpolation (RSOI) and robust parametric fit (RPF). We have extended these analyses over the additional 23 months of data from Argo to probe ocean heat content evolution through to November 2015.

Owing to its immense heat capacity, the global ocean is the fly-wheel of the climate system, absorbing, redistributing and storing heat on long timescales and over great distances. On the global average, ocean temperatures are less volatile than land temperatures, which can swing wildly from year to year (Fig. 1a). In 2015, global average ocean surface temperature was driven by the tropical Pacific to a new record high associated with the current El Niño (Fig. 1a). While the surface ocean both warms and cools in synchronization

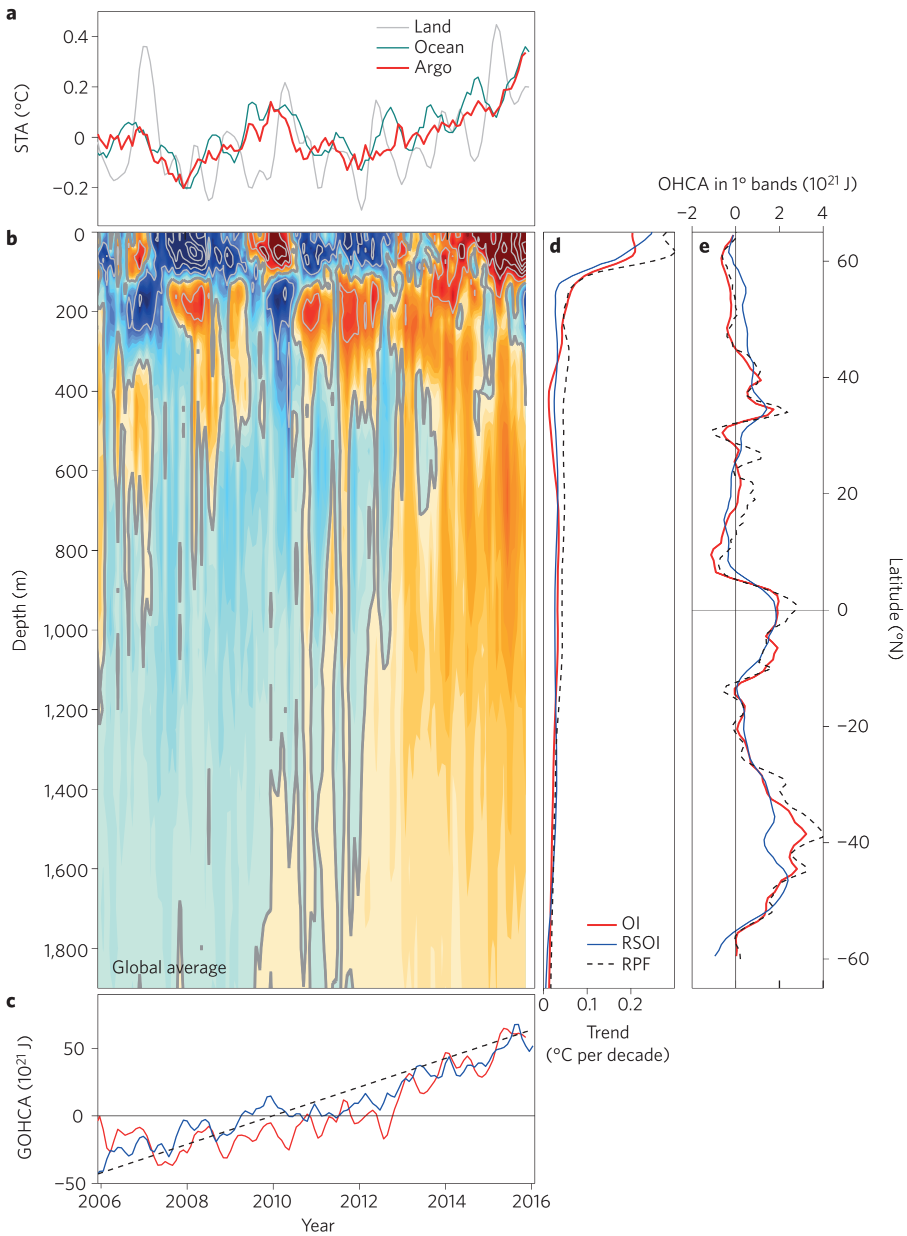

Figure 1 | Ocean warming rates and distributions. **a**, Globally averaged surface temperature anomaly (STA, °C), from 5 m Argo OI temperature (red), NOAA (National Oceanic and Atmospheric Administration) global ocean (turquoise) and a 6-month running mean of NOAA global land averages (grey) (retrieved on 20 December 2015 from http://www.ncdc.noaa.gov/sotc/global/201511). **b**, Global average ocean temperature anomalies from the Argo OI (contour interval is 0.01 for colours, 0.05 °C in grey). **c**, Global ocean 0–2,000 m heat content anomaly as a function of time, with the OI version a 4-month running mean. **d**, Global average 2006–November 2015 potential temperature trend (°C per decade). **e**, Zonally integrated heat content trends in 1° latitude bands from the three mapping methods. For line plots **c**, **d** and **e**, the sources are: OI (red), RSOI (blue) and RPF (black-dashed); see text. All figures are monthly means unless otherwise noted.

with the El Niño cycle, there is an offsetting oscillation in temperatures between 100–250 m depth, which largely cancels this shallow heat storage in the tropical Pacific (Fig. 1b)[4]. Below 300 m the ocean shows a consistent warming, which reaches down to 2,000 m, the current limit of Argo sampling (Fig. 1d). In the global integral, this ocean warming has been remarkably steady since Argo achieved global coverage in about 2006 (Fig. 1c), and it implies a near constant planetary radiation imbalance over this period of around 0.65–0.80 W m^{-2} (0.50–0.65 W m^{-2} range from the three 0–2,000 m analyses with an additional 0.15 W m^{-2} due to deep ocean warming and ocean areas not sampled by Argo[3]). While slightly larger than the heating rates obtained previously[3], given the ±0.16 W m^{-2} 95% error from ocean analyses[3], they are statistically indistinguishable. Thus, in contrast to the highly variable global average surface temperature, we continue to find that the ocean heat content is steadily rising, consistent with its dominant role in the Earth's radiation imbalance. In addition, the planetary warming rates we find are about equal to the coupled model projections made for the 2006–2015 period[2] of 0.81 ± 0.2 W m^{-2}.

The 0–2,000 m ocean heat anomaly pattern features an intensifying hemispheric asymmetry, with 75–99% of the heat accumulating south of the Equator, predominately in the 30°S–50°S latitude band (Fig. 1e). Thus, in equivalent rates by planetary surface area, the southern hemisphere continues to heat at a rate about four times faster than the northern hemisphere. This pattern remains unexplained. It may reflect the impact of natural decadal variability or involve the cooling effect of anthropogenic aerosols, which are largely found in the temperate northern hemisphere. In comparison, the southern hemisphere atmosphere is relatively clear and greenhouse-gas forcing is not greatly offset there. As both natural and anthropogenic aerosols and greenhouse-gas forcing vary in the future, it will be essential to provide estimates of the Earth's total warming for evaluation of Earth system projections and to track whether or not the Earth continues to warm in line with these projections. The Argo Programme, with its short but growing record and its near-global and expanding areal and depth coverage, provides the observational foundation for tracking and understanding the ocean's role in the planetary energy balance. The continuing growth and improving quality, as well as the sustained implementation of Argo, are critical elements of the international climate observation strategy. ❒

References

1. Rhein, M. *et al.* in *Climate Change 2013: The Physical Science Basis* (eds Stocker, T. F. *et al.*) 255–316 (Cambridge Univ. Press, 2013).
2. Church, J. A. *et al.* in *Climate Change 2013: The Physical Science Basis* (eds Stocker, T. F. *et al.*) 1137–1216 (Cambridge Univ. Press, 2013).
3. Roemmich, D. J. *et al. Nature Clim. Change* **5,** 240–245 (2015).
4. Roemmich, D. & Gilson, J. *Geophys. Res. Lett.* **38,** L13606 (2011).

Acknowledgements
The Argo data used here were collected and made freely available by the International Argo Programme and by the national programmes that contribute to it. D.R. and J.G., and their part in the Argo Programme, were supported by US Argo through NOAA Grant NA10OAR4310139 (CIMEC/SIO Argo). J.C., D.M. and S.W. were partly funded by the Australian Climate Change Science Program. Australia's contribution to Argo is part of the Australian Integrated Marine Observing System.

Author contributions
All co-author contributions were equal, consisting of the three interpolated forms of the Argo dataset plus many thoughts, suggestions, and revisions improving the manuscript. The first author assembled the interpolated datasets, created the figures and drafted the manuscript.

Susan Wijffels[1*], Dean Roemmich[2], Didier Monselesan[1], John Church[1] and John Gilson[2]
[1]CSIRO Oceans and Atmosphere, Hobart Tasmania, Australia. [2]Scripps Institute of Oceanography, University of California, San Diego California, USA.
*e-mail: Susan.Wijffels@csiro.au

COMMENTARY:

Climate change stories and the Anthroposcenic

David Matless

Social sciences and the humanities can utilize the concept of the Anthropocene to add meaning to climate research.

Writing in *Nature Climate Change* five years ago, Mike Hulme[1] opined that the analysis of anthropogenic climate change was dominated by positivist disciplines at the expense of interpretative ones, and argued that storytelling should complement fact-finding. More recently, Castree *et al.*[2] have argued that positivism offers "little or no sense of humans as diverse, interpretive creatures who frequently disagree about values, means and ends". Furthermore, Hackmann *et al.*[3] urge social scientists "to conduct analyses, offer interpretation and help society create meaning", with humans viewed as an "integral and differentiated part" of the Earth system. Such sentiments have led to calls for the humanities and social sciences to play a more active role in shaping the climate change debate. The concept of the Anthropocene provides a possible framing for this contribution.

The organization Cape Farewell (www.capefarewell.com) has shown that artists can engage the public in the climate change debate, not least through its expeditionary activities[4]. Exhibitions such as the Munich Deutsches Museum's Welcome to the Anthropocene[5] have further helped bring climate change into the cultural domain. The very term Anthropocene has "a resonance that goes beyond the modification of a geological classificatory scheme"[6], and one contribution of the humanities can be to analyse the power of scientific language and narrative. In setting out the challenges of the Anthropocene for his own discipline, Castree has called for geographers, with their peculiar breadth of concerns, from the natural sciences to the humanities, to be "semantic weather makers"[7].

JULIAN PERRY

Figure 1 | *Caravan Holiday* (2010), oil painting by Julian Perry, 31 x 26 cm; reproduced by permission of the artist. The image also appears in ref. 14. Perry's work is presented at www.julianperry.info

It is in this spirit that I, as a cultural geographer, offer the 'Anthroposcenic' as a semantic proposal. The term foregrounds the way in which landscape becomes emblematic of environmental transformation. Attention is drawn to those scenes through which processes interrogated under Anthropocene and climate change rubrics become evident; coastlines, glacier snouts, ice sheet edges, felled forest and the like. Such scenic concentration provides stepping points for the humanities as a teller of Anthoposcenic stories, and meeting points with science.

The idea of landscape works differently here from the use of the term in, for example, a recent collection of studies Landscapes in the Anthropocene, which seek to quantify "the effects of human disturbances on Earth surface processes"[8]. From a humanities perspective, landscape as a concept gains value from the way it migrates between different frames of reference; the material landscapes of, say, agriculture and environmental management, and the imaginative landscapes of, say, landscape painting and poetry. Work in the humanities has demonstrated that the power of landscape derives from its capacity to shuttle between such different registers, to act as a meeting point for imaginative and material worlds, and to signal their interconnections. Landscape also moves between different forms of value, notably the emotional and financial, with tensions over landscape often emerging where money and sentiment conjoin[9].

The coast is a key landscape of climate change and can be used to illustrate Anthroposcenic possibilities. I focus here on eastern England, where the coast has been