More data but no new answers yet

Crowther, T.W.[1], Machmuller, M.B.[2], Carey, J.C.[3], Allison, S.D.[4,5], Blair, J.M.[6], Bridgham, S.D.[7], Burton, A. J.[8], Dijkstra, F. A.[9], Elberling, B.[10], Estiarte, M.[11,12], Larsen, K.S.[13], Laudon, H.[14], Lupascu, M.[15], Marhan, S.[16], Mohan, J.[17], Niu, S.[18], Peñuelas, J.[11,12], Schmidt, I.K.[19], Templer, P.H.[20], Kröel-Dulay, G.[21], Pendall, E.[22], Frey, S.[23], & Bradford, M.A.[24]

1. Institute of Integrative Biology, ETH Zurich, Universitätstrasse 16, 8006 Zürich, Switzerland.
2. Natural Resource Ecology Laboratory, 1499 Campus Delivery, Colorado State University, Fort Collins, CO, 80523-1499, USA
3. Division of Math and Science, Babson College, MA 02457, USA
4. Department of Earth System Science, University of California Irvine, Irvine, CA 92697, USA
5. Department of Ecology & Evolutionary Biology, University of California Irvine, CA 92697, USA
6. Division of Biology, Kansas State University, Manhattan, KS 66506, USA
7. Institute of Ecology & Evolution, University of Oregon, Eugene, OR 97403, USA
8. School of Forest Resources & Environmental Science, Michigan Technological University, Houghton, MI 49931, USA
9. Centre for Carbon, Water & Food, The University of Sydney, Camden, 2570 NSW, Australia
10. Center for Permafrost (CENPERM), Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen K., Denmark
11. CSIC, Global Ecology Unit CREAF-CSIC-UAB, Cerdanyola del Vallès, 08193 Catalonia, Spain
12. CREAF, Cerdanyola del Vallès, 08193 Catalonia, Spain.
13. Department of Geosciences & Natural Resource Management, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark
14. Department of Forest Ecology & Management, Swedish University of Agricultural Sciences, 90183 Umeå, Sweden
15. Department of Geography, National University of Singapore, 1 Arts Link, 117570, Singapore
16. Institute of Soil Science & Land Evaluation, University of Hohenheim, 70593 Stuttgart, Germany
17. Odum School of Ecology, University of Georgia, Athens, GA 30601, USA
18. Key Laboratory of Ecosystem Network Observation & Modeling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101, China
19. Department of Geosciences & Natural Resource Management, University of Copenhagen, Rolighedsvej 23, 1958 Frederiksberg C, Denmark
20. Department of Ecology & Evolutionary Biology, University of California Irvine, CA 92697, USA

21. Institute of Ecology & Botany, MTA Centre for Ecological Research, 2-4. Alkotmany U., Vacratot, 2163-Hungary
22. Hawkesbury Institute for the Environment, Western Sydney University, Penrith, 2570 NSW, Australia
23. Department of Natural Resources & the Environment, University of New Hampshire, Durham, NH 03824, USA
24. School of Forestry & Environmental Studies, Yale University, 195 Prospect Street, New Haven, Connecticut 06511, USA.

Response

In a letter to Nature, we compiled a global dataset of field warming experiments, which suggested that climate warming could cause the loss of carbon from high-latitude soils, with the potential to drive a positive feedback that stimulates further warming[1]. This conclusion was based on an observation that areas with larger soil carbon stocks are likely to lose more soil carbon under warming. However, having compiled data from even more warming experiments, van Gestel et al.[2] no longer find support for this relationship.

In their response, van Gestel et al.[2] suggest our findings may be the result of having few data points at high-latitude regions with large soil carbon stocks. To check that this was not the case, we used extensive statistical cross-checking, showing that this relationship was consistent throughout our dataset, even after the random removal of ~77% of the studies. Nevertheless, with data from a greater number of sites, the van Gestel et al.[2] study can certainly provide a more robust test of the relationship between carbon stocks and warming-induced soil carbon losses. Of course, more data still might provide the statistical power needed to detect such effects, but we agree that this relationship is unlikely to be as strong as expected based on our initial synthesis. However, this analysis does not dispute our conclusions about global changes of soil carbon under warming, because the van Gestel et al.[2] analysis does not represent a thorough exploration of the spatial patterns in soil carbon changes under warming.

In our initial analysis[1], there was considerable variation in the response of soil carbon under warming, with both increases and decreases observed across sites. We examined five possible drivers of this variation (standing soil carbon, annual temperature, annual precipitation, pH, and clay content), finding that 'standing carbon stock' was a strong predictor. Of course, the size of the standing carbon stock is known to correlate with various other climatic and geological characteristics, which may ultimately be the underlying drivers of the relationship that we detected[3]. Yet this relationship suggested that areas with large soil carbon stocks are more likely to lose carbon under warming. As in our study, the site-level responses to warming in the van Gestel et al.[2] dataset were also highly variable, supporting the idea that large changes occur in some geographic regions. However, unlike our analysis, the same five predictive variables were not sufficient to explain the variation in the soil carbon response, so it was not possible to predict which ecosystems are most responsive. A wider range of predictive variables are therefore necessary to explain these large-scale patterns[4]. Until this variation is explored using a wider range of predictive variables, it is impossible to understand the spatial patterns in soil carbon changes under warming that are necessary to comprehend the net global balance.

We stress that this exchange should not lead to the conclusion that researchers are divided on this topic. We certainly do not disagree with the findings of van Gestel et al.[2]. These new data provide a new perspective on the relationship we observed, but the analysis does not yet address the extent of global soil carbon losses under warming. We are highly supportive of the work by van Gestel et al.[2], and encourage the inclusion of more data, particularly in under-sampled regions of the globe, to comprehend the extent of warming-induced changes in global soil carbon stocks[5].

References

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