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Dear Dr. Sudgen:

Please consider our manuscript, entitled “A simple explanation for declining temperature sensitivity with warming,” for publication as a Report in *Science*.

Climate change has shifted many biological events (1), and recent observations that organisms’ sensitivity to temperature is declining has raised concerns that fundamental biological processes are now also changing. Studies suggest warming has altered the main drivers of leafout in temperate plants (2; 3; 4; 5) and altered carbon uptake in the tundra due to potentially increased light limitation or shifts in photosynthesis (6; 7). Such possible changes are alarming, but they are rarely reported with strong evidence beyond declines in temperature sensitivity.

Here we provide a simpler, alternative explanation for declining temperature sensitivity with warming: the use of linear models to model non-linear temperature responses. We show theoretically, then through simulations and empirical data (using the same dataset used in 2), that observations of declining sensitivities are the default given current methods and the non-linearity of temperature responses. Because many biological events are threshold processes they are inherently non-linear and thus will occur more quickly given warming, even with no change in the underlying biology. We show that warming acts to step on the biological accelerator and makes the use of classic calendar time precarious.

We believe this issue is currently rampant throughout the phenological (e.g., 2; 4; 5; 8) and related literature (e.g., 6) and may apply more broadly to many fields using linear methods with warming. Understanding this problem only came through close collaboration between biologists (Wolkovich group) and statisticians (J. Auerbach and A. Gelman).

We have suggested three potential reviewers through the online submission site (Theresa Crimmins, Alison Donnelly, Mark Schwartz). Prior to submission Jonathan Davies, David Lipson and Christy Rollinson reviewed the manuscript. This manuscript is not under consideration elsewhere, nor has it been previously submitted. Empirical data are already publicly available through the PEP 725 portal, and we provide a link in the main text to our simulation code. All authors approved of this version for submission.

Sincerely,

A handwritten signature in black ink, which appears to read 'E. Wolkovich', is positioned below the word 'Sincerely,'.

Elizabeth M Wolkovich
Associate Professor of Forest & Conservation Sciences

References

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