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Warming experiments underpredict plant phenological responses to climate change

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Warming experiments are relied on increasingly to estimate plant responses to global change. For experiments to provide meaningful predictions of future responses, they should reflect the empirical record of responses to temperature variability and recent warming, including advances in timing of flowering and leafout. We compared observational phenology studies with warming experiments spanning four continents and 1,634 species. Using a common measure of temperature sensitivity (change in days per degree C), we show that experiments underpredict advances in timing of flowering and leafing by 8.5X and 4.0X, respectively, compared to long-term observations. For species common to both study types, experimental results did not match observational data in sign or magnitude. The observational data also show highest sensitivity for species that flower earliest in the spring, but this trend was not reflected in the experiments. These significant mismatches appear unrelated to study length or to the degree of manipulated warming in experiments. The discrepancy between experiments and observations, however, could arise from complex interactions among multiple drivers in observational data or from remediable artifacts in the experiments that reduce irradiance, dry soils, and thus dampen phenological responses to manipulated warming. Our results introduce uncertainty in ecosystem models informed solely by experiments, and suggest predicted responses to climate change from such models should be re-evaluated.