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ABSTRACT TITLE: Reduced soil microbe resilience and respiration after a 17-year climate change experiment

ABSTRACT: Climate change is predicted to profoundly perturb the fundamental processes controlling the balance between soil C accrual and mineralization across landscapes: both reaction rates and products may be affected. To assess the effects of changing climate on soil C cycling, we re-sampled an existing reciprocal soil transplant experiment that was initiated in 1994 at the Arid Lands Ecology Reserve (WA). At that time, 30-cm (diameter) x30-cm (deep) soil cores were transplanted between a hotter, drier location at the base of Rattlesnake Mountain (310 m, 28.5°C air average monthly maximum, 224 mm y^{-1}) and a cooler, moister location near the top of the mountain (844 m, 23.5°C air average monthly maximum, 272 mm y^{-1}). Soils transplanted from the hot, dry, lower site to the cooler and wetter upper site exhibit, after 17 years, almost no respiratory response to temperature (Q10 of 1.1), and have a microbial community structure distinct from non-transplanted soils. These results are at odds with many short-term experiments, suggest a lack of microbial resilience in the lower-site soils even after almost two decades in a changed climate, and cannot be reproduced by current soil models. This study shows that microbial populations responsible for soil heterotrophic respiration may be constrained in surprising ways, with significant consequences for ecosystem-scale carbon cycling.

PNNL's TES research focuses on climate-driven tipping points, specifically microbially-mediated processes destabilizing soil organic carbon. These phenomena are poorly represented in current climate models and are significant sources of uncertainty in predictive models of greenhouse gas flux. Such uncertainty can be reduced only by understanding the fundamental processes underpinning measured fluxes. Resolution of these fundamental biogeochemical processes may be an important bridge between pore-scale reaction models, ecosystem box models, and regional-scale models informing the Community Land Model.