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Quantifying soil microbial thermal adaptation

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Thermal adaptation of soil microbial respiration has the potential to greatly alter carbon cycle-climate feedbacks through acceleration or reduction of soil microbial respiration as the climate warms. However despite its importance, the relationship between warming and soil microbial activity remains poorly constrained. Part of this uncertainty stems from persistent methodological issues and difficulties isolating the interacting effects of changes in microbial community responses from changes in soil carbon availability. To address these challenges, we sampled nearly 50 soils from around New Zealand, including from a long-term geothermal gradient, with mean annual temperatures ranging from 11-35°C. For each of these soils we constructed temperature response curves of microbial respiration given unlimited substrate and estimated a temperature optima (T_{opt}) and inflection point (T_{inf}). We found that thermal adaptation of microbial respiration occurred at a rate of 0.29°C ± 0.04 1SE for T_{opt} and 0.27°C ± 0.05 1SE for T_{inf} per degree of warming, demonstrating that thermal adaptation is considerably offset from warming. These relatively small changes occurred despite large structural shifts in microbial community composition and diversity. We also quantitatively assessed how thermal adaptation may alter potential respiration rates under future warming scenarios by consolidating all of the temperature response curves. Depending on the specific mean and instantaneous soil temperatures, we found that thermal adaptation of microbial respiration could both limit and accelerate soil carbon losses. This work highlights the importance of considering the entire temperature response curve when making predictions about how thermal adaptation of soil microbial respiration will influence soil carbon losses.