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Below-ground N responses to warming in cold ecosystems

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Warming can alter the biogeochemistry and ecology of soils. These alterations could be particularly large in ecosystems experiencing the most intense warming globally i.e. cold ecosystems such as tundra and boreal forests. In this meta-analysis, we investigated global trends in the ways experimental warming, within ranges projected for the following decades, is altering the cycling of nitrogen (N) – arguably the most common limiting nutrient for life on Earth – across cold ecosystems. We also analyzed the effects of warming on N-relevant genes and enzymes, as well as on the abundance of below-ground organisms. Together, our findings suggest that warming in cold ecosystems accelerates N mineralization and denitrification and does not affect, at least not in a consistent way across biomes and conditions, N fixation. Warming-caused changes in below-ground N fluxes lead to an accumulation of N in the forms of organic and root N. These changes seem to be more closely linked to increases in the activity of some enzymes, particularly those that target relatively labile N sources, than to changes in the abundance of N-relevant genes. Finally, our analysis suggests that warming in cold ecosystems favors plant roots, fungi and (likely in an indirect way) fungivores, and does not affect archaea, bacteria or bacterivores. In summary, our findings highlight global trends in the ways warming is altering the biogeochemistry and ecology of soils in cold ecosystems, and provide information that can be valuable for the predicting and managing of such ecosystems.