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Increased nitrogen availability counteracts climatic change feedback from increased temperature on boreal forest soil organic matter degradation

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Over the last century, the greenhouse gas concentrations in the atmosphere have increased dramatically, greatly exceeding pre-industrial levels that had prevailed for the preceding 420 000 years. At the same time the annual anthropogenic contribution to the global terrestrial nitrogen cycle has increased and currently exceeds natural inputs. Both temperature and nitrogen levels have profound effects on the global carbon cycle including the rate of organic matter decomposition, which is the most important biogeochemical process that returns CO_2 to the atmosphere. Here we show for the first time that increasing the availability of nitrogen not only directly affects the rate of organic matter decomposition but also significantly affects its temperature dependence. We incubated litter and soil organic matter from a long-term (40 years) nitrogen fertilization experiment in a boreal Scots pine (Pinus silvestris L.) forest at different temperatures and determined the temperature dependence of the decomposition of the sample's organic matter in each case. Nitrogen fertilization did not affect the temperature sensitivity (Q10) of the decomposition of fresh plant litter but strongly reduced that for humus soil organic matter. The Q10 response of the 0-3 cm soil layer decreased from 2.5±0.35 to an average of 1.9±0.21 over all nitrogen treatments, and from 2.2±0.19 to 1.6±0.16 in response to the most intense nitrogen fertilization treatment in the 4-7 cm soil layer. Long-term nitrogen additions also significantly affected the organic chemical composition (as determined by 13C CP-MAS NMR spectroscopy) of the soil organic matter. These changes in chemical composition contributed significantly ($p<0.05$) to the reduced Q10 response. These new insights into the relationship between nitrogen availability and the temperature sensitivity of organic matter decomposition will be important for understanding and predicting how increases in global temperature and rising anthropogenic nitrogen inputs will affect the global carbon cycle and the associated climatic feedback processes.