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Global patterns of increasing soil organic carbon turnover rates with increasing mean surface temperatures, across different forest biomes, are driven by boreal forests.

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A major component of CO_2 emissions from soils is due to decomposition of soil organic matter by heterotrophic organisms. The balance between these CO_2 emissions and soil organic carbon stocks can be a proxy for the mean residence time of bulk soil organic carbon.

Some studies in the past have suggested an exponentially decreasing turnover time of soil organic matter (and hence a potential increase in soil CO_2 emissions) with projected increases in surface temperatures. If true, this could pose a positive feedback of soil CO_2 emissions on global warming in the future.

We analyzed the relationship between mean climate variables and rates of bulk soil organic matter turnover across a number of different forested sites globally. The turnover times were estimated as the ratio of soil organic carbon stocks to annual soil CO_2 efflux rates derived from field-based observations.

When the data was analyzed collectively, as a whole, we indeed observed an exponential decrease in the computed turnover times with increasing mean annual temperature for the respective sites. However, once this relationship was analyzed within the context of different climatic biomes, we found that the exponential relationship was maintained solely due to the difference between the turnover rates within the boreal forest biome and the rest of the biomes studied (i.e. temperate, Mediterranean, subtropical and tropical), and due to the large range of turnover values in the boreal zone. The large range of turnover values in the boreal forests was found to be related to the clay content of the soil. Within each biome, no strong relationship between soil organic carbon turnover and mean annual temperature existed.

We compared the above observed patterns to simulations of global terrestrial biosphere models. The models could not reproduce the magnitudes or functional relations of temperature and soil organic carbon turnover patterns.

Our study stresses the importance of considering spatial heterogeneity when analyzing global patterns of greenhouse gas emissions to climatic variables. It also highlights the complexity of the relationship between soil CO_2 efflux and climatic variables at ecosystem scales.