Abstract

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ABSTRACT

The land biosphere contributes most to the natural source of the long-lived greenhouse gas nitrous oxide (N_2O), with N_2O emissions being dependent on the turnover rate of both the terrestrial nitrogen (N) and carbon (C) cycle. The C:N stoichiometry of vegetation and soil organic matter links the cycles intimately. Sustained plant productivity increase must be supported by biological N fixation. Intensified N cycling in turn enhances N loss and thereby N_2O emissions. The temporal and spatial dynamics of terrestrial N and C cycles and related terrestrial N_2O emissions are poorly constrained over the glacial-interglacial transition and the Holocene. Here we reconstruct increased terrestrial N_2O emissions since the Last Glacial Maximum based on N_2O concentration and isotope measurements on several ice cores and show that this N_2O increase can be explained by N cycle modelling – provided N fixation is allowed to respond dynamically to increasing N demand and turnover. The Ice core reconstructions suggest a deglacial increase of

1.1 ± 0.4 Tg N/yr in terrestrial and 0.6 ± 0.4 Tg/yr in oceanic N2O emissions, but relatively constant terrestrial emissions over the Holocene. Transient simulations with a Dynamic Global Vegetation Model are shown to represent the climate and CO_2 induced changes in terrestrial N_2O emission, and suggest a deglacial increase in biological N fixation by 20%, independently of its absolute magnitude. Deciphering the response of biological N fixation during climatic changes is an important factor for our understanding of plant growth and the land carbon sink, alongside anthropogenic greenhouse gas emissions.