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Response of terrestrial N2O and NOx emissions to abrupt climate change

M. Pfeiffer and J. O. Kaplan
Ecole Polytechnique Fédérale de Lausanne, Switzerland (mirjam.pfeiffer@epfl.ch)

Being a potent greenhouse gas, N2O emitted by the terrestrial biosphere during abrupt climate change events could have amplified externally forced warming. To investigate this possibility, we tested the sensitivity of terrestrial N2O emissions to an abrupt warming event by applying the ARVE-DGVM in combination with a novel scheme for process-based simulation of terrestrial N2O and NOx emissions at the Gerzensee site in Switzerland. In this study, we aim to quantify the magnitude of change in emissions for the abrupt climate change event that occurred at the transition from Oldest Dryas to Bølling during the last deglaciation. Using high-resolution multiproxy records obtained from the Gerzensee that cover the Late Glacial, we apply a prescribed vegetation change derived from the pollen record and temperature and precipitation reconstructions derived from delta 18O in lake sediments. Changes in soil temperature and moisture are simulated by the ARVE-DGVM using the reconstructed paleoclimate as a driver. Our results show a pronounced increase in mean annual N2O and NOx emissions for the transition (88% and 62%, respectively), with highest amounts generally being emitted during summer. These findings suggest that summertime emissions are limited by soil moisture, while temperature controls emissions during winter. For the time between 14670 and 14620 cal. years BP, our simulated N2O emissions show increase rates as high as 1% per year, indicating that local reactions of emissions to changing climate could have been considerably faster than the atmospheric concentration changes observed in polar ice.