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The emissions and soil concentrations of N2O and CH4 from natural soil temperature gradients in a volcanic area in southwest Iceland

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We studied nitrous oxide (N2O) and methane (CH4) emissions along three natural geothermal soil temperature (Ts) gradients in a volcanic area in southwest Iceland. Two of the gradients (on a grassland and a forest site, respectively) were recently formed (in May 2008). The third gradient, a grassland site, had been subjected to long-term soil warming (over 30 years, and probably centuries). Nitrous oxide and methane emissions were measured along the temperature gradients using the static chamber method and also soil gas concentrations were studied. With a moderate soil temperature increase (up to +5 °C) there were no significant increase in gas flux rates in any of the sites but an increase of 20 to 45 °C induced an increase in both N2O and CH4 emissions. The measured N2O emissions (up to 2600 μg N2O m-2 h-1) from the warmest plots were about two magnitudes higher compared with the coolest plots (less than 20 μg N2O m-2 h-1). While a net uptake of CH4 was measured in the coolest plots (up to -0.15 mg CH4 m-2 h-1), a net emission of CH4 was measured from the warmest plots (up to 1.3 mg CH4 m-2 h-1). Soil CH4 concentrations decreased first with a moderate (up to +5 °C) increase in Ts, but above that threshold increased significantly. The soil N2O concentration at depths from 5 to 20 cm increased with increasing Ts, indicating enhanced N-turnover. Further, there was a clear decrease in soil organic matter (SOM), C- and N concentration with increasing Ts at all sites. One should note, however, that a part of the N2O emitted from the warmest plots may be partly geothermally derived, as was revealed by 15N2O isotope studies. These natural Ts gradients show that the emission of N2O and CH4 can increase significantly when Ts increases considerably. This implies that these geothermally active sites can act as local hot spots for CH4 and N2O emissions.