Geophysical Research Abstracts
Vol. 17, EGU2015-561, 2015
EGU General Assembly 2015

The temperature response of methane emission in Arctic wet sedge tundra

Edward Lim (1) and Donatella Zona (1,2)

(1) Department of Animal and Plant Sciences, University of Sheffield, Sheffield, United Kingdom, (2) Department of Biology, San Diego State University, San Diego, CA, USA

Since the last glacial maximum Arctic tundra soils have acted as an important carbon sink, having accumulated carbon under cold, anaerobic conditions (Zona et al. 2009). Several studies indicate that recent climate warming has altered this balance, with the Arctic tundra now posited to be a significant annual source of atmospheric methane (CH4) (McGuire et al. 2012).

Nonetheless, the response of Arctic tundra CH4 fluxes to continued climate warming remains uncertain. Laboratory and field studies indicate that CH4 fluxes are temperature sensitive, thus accurate calculation of the temperature sensitivity is vital for the prediction of future CH4 emission. For this, the increase in reaction rate over a 10°C range (Q10) is frequently used, with single fixed Q10 values (between 2 and 4) commonly incorporated into climate-carbon cycle models. However, the temperature sensitivity of CH4 emission can vary considerably depending on factors such as vegetation composition, water table and season. This promotes the use of spatially and seasonally variable Q10 values for accurate CH4 flux estimation under different future climate change scenarios.

This study investigates the temperature sensitivity (Q10) of Arctic tundra methane fluxes, using an extensive number of soil cores (48) extracted from wet sedge polygonal tundra (Barrow Experimental Observatory, Alaska). 'Wet' and 'dry' cores were taken from the centre and raised perimeter of ice-wedge polygons, where the water tables are 0cm and -15cm respectively. Cores were incubated in two controlled environment chambers (University of Sheffield, UK) for 12 weeks under different thaw depth treatments (control and control + 6.8cm), water tables (surface and -15cm), and CO_2 concentrations (400ppm and 850ppm) in a multifactorial manner. Chamber temperature was gradually increased from -5°C to 20°C, then gradually decreased to -5°C, with each temperature stage lasting one week.

Average CH4 fluxes from 'dry' cores were consistently low and did not change significantly with temperature, indicating that CH4 emission from drier Arctic tundra soils is not particularly temperature sensitive. Average CH4 emission from 'wet' cores increased with increasing temperature between -5°C and 20°C. Interestingly, continued increases in average CH4 emission as chamber temperature decreased (20°C to 0°C) were observed. Importantly, when chamber temperature was increased (-5°C to 20°C), average CH4 emission in the 'wet' cores was consistently lower at the end of each week-long temperature stage compared to at the start. This suggests that the response of CH4 emission to climate warming might acclimate. Overall, this study is critical for refining the temperature sensitivity of Arctic tundra CH4 emission, and thus improving model predictions of the response of CH4 fluxes to climate change.

References

McGuire, AD; Christensen, TR; Hayes, D. et al. (2012). An assessment of the carbon balance of Arctic tundra: comparisons among observations, process models, and atmospheric inversions. Biogeosciences. Vol.9, p.3185–3204, doi:10.5194/bg-9-3185-2012.

Zona, D; Oechel, WC; Kochendorfer, J. et al. (2009). Methane fluxes during the initiation of a large-scale water table manipulation experiment in the Alaskan Arctic tundra. Global Biogeochemical Cycles. Vol.23, GB2013, doi:10.1029/2009GB003487.