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Effects of experimental warming and mowing on greenhouse gas fluxes in an alpine meadow on the Tibetan Plateau

Jinsong Wang, Quan Quan, Jian Sun, and Shuli Niu

Key Laboratory of Ecosystem Network Observation and Modeling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China

Rapid climate change and intensified human activities on the Tibetan Plateau may alter the magnitude and direction of greenhouse gas (GHG) emissions, affecting the climate change impact on these fragile ecosystems. We conducted a controlled experiment to investigate the effects of warming and mowing (simulation of grazing) on soil CO_2, CH4 and N2O fluxes in an alpine meadow in eastern Tibetan Plateau between August 2015 and July 2016. Three levels of temperature (C, ambient temperature; W1, < 2 °C warming at 5 cm soil depth by infrared heaters; and W2, > 2 °C warming) were combined with two levels of mowing treatment (UM, un-mowing; and M, mowing). GHG fluxes were measured once an hour using static chamber. Both CO_2 emission and CH4 uptake rates showed a seasonal fluctuation, with the maximum value occurred in late summer and the minimum in winter. However, N2O flux did not show a strong seasonal pattern. High level of warming (W2) regardless of mowing significantly increased CO_2 emission and CH4 uptake by 15.4 % and 38.2 % averaged over the year, compared with no-warming (C). Moderate warming (W1) did not have significant effects on either CO_2 or CH4 fluxes. N2O flux was reduced by 54.1% by W2 and 15.7% by W1 warming. Mowing alone increased CH4 uptake and N2O emission by 18.0 % and 12.7%, respectively, but had no significant effect on CO_2 flux. The interactions between warming and mowing were detected in CO_2 and CH4 fluxes. Among all treatments, W2UM in general had the highest rates of CO_2 emission and CH4 uptake but the lowest rate of N2O flux, while CUM and CM showed the opposite. In addition, warming induced increase in CH4 uptake and decline in N2O release had very limited ability to offset the enhanced CO_2 emission, resulting in a net positive feedback of the three GHGs to climate warming. Furthermore, daily CO_2 flux increased exponentially with soil temperature at 5 cm. CH4 flux correlated negatively with soil temperature but positively with soil moisture.