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Effects of soil warming, rainfall reduction and changing water table level on CH_4, CO_2 emission and pore water DOC concentration of Zoige peatland in China

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The Zoige Plateau features approximately 4605 km^2 of peatlands, making it the largest peatland area in China. This area stored 2.9 Pg peat during the Holocene, yet little is known about carbon (CH_4, CO_2) emissions and pore water DOC concentration from this region. We designed a mesocosm experiment to measure CH_4, CO_2 emissions and DOC concentration during the growing seasons under different scenarios involving soil warming, 20% reduction in rainfall and changeing water table level. This research aimed to understand how climate change affect CH_4 and CO_2 emissions and whether the trends of changes in CH_4 and CO_2 emission are consistent with those of DOC concentration. Our results showed soil warming treatment increased average CH_4 emissions by 28%, while rainfall reduction increased it by 30%; however, neither increase was statistically significant. In contrast, the combined effect of soil warming and rainfall reduction significantly decreased CH_4 emissions by an average of 58%. Extending this result across the entire peatland area in the Zoige Plateau translates into approximately 5.3 Gg of CH_4 uptake per year. For CO_2 emission, we found temperature at 5 cm depth have positive linear relationship with CO_2 emission. The combined effect of soil warming and rainfall reduction increased CO_2 emission by 96.8%. Extending this result to the entire peatland area in Zoige Plateau translates into 0.45 Tg CO_2 emission per year over a growing season. These results suggest that a drier and warmer Zoige Plateau will become a CH_4 sink and an increasing CO_2 source. We also found a positive relationship between water table level and CH_4 emissions. Average CH_4 emissions decreased by approximately 82% as water drawdown varied from 0 to -50 cm. However, there is no significant relationship between water table and CO_2 emission or DOC concentration. When we simultaneously examined the effect of all three factors of water table level, soil warming and rainfall reduction on CH_4 emissions, we found soil warming and rainfall effect on CH_4 emissions varied with water table levels. However, none of the three factors significantly affected CH_4 emissions at a water table depth of 30 cm below peat depth. We also found the contribution rate of DOC concentration to CO_2 emission was increased by 12.1% in the surface layer and decreased by 13.8% in the subsurface layer with combined treatment of soil warming and rainfall reduction, which indicated that the warmer and dryer environmental conditions stimulate surface peat decomposition process and the subsurface peat layer is insensitive to climate change.
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