Elevated CO_2 alleviates positive feedback between warming and methane emissions in a peatland

ECOLAB OF DR. YIQI LUO

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SPRUCE

Motivation

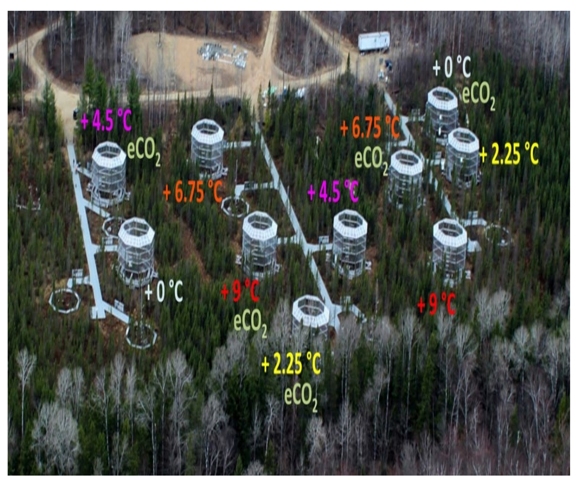
Methane (CH_4) is one of the most important greenhouse gases (GHGs) whose warming impact is second only after carbon dioxide (CO_2). Peatlands are one of the largest natural sources for atmospheric CH_4. However, large uncertainties exist in predicting responses of peatland CH_4 fluxes to future climate change. Especially, responses of peatland CH_4 emissions to warming and elevated CO_2 and its interactions with plants still remain unclear.

Methods

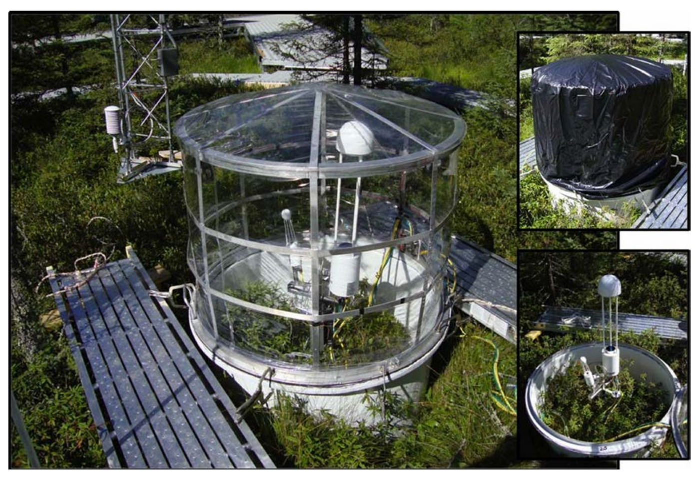
Here we used SPRUCE large-collar In Situ CH_4 flux data across five warming levels (+0, +2.25, +4.5, +6.75, and +9 ℃) belowground since 2014 and aboveground since 2015, each under two CO_2 levels (+0 and +500 ppm) since 2016.

Fine-root length productivity data used in this study were measured by the ingrowth core approach during growing season for 2016, 2017 from Malhotra et al. (2020).

Warming effects here were calculated as the difference between methane emissions from warming treatment and ambient; CO_2 effects were calculated as the difference between methane emissions from elevated CO_2 and ambient under the same warming treatment.



SPRUCE experiment



Large-collar chamber observation systems on CO_2 and CH_4 fluxes

Results

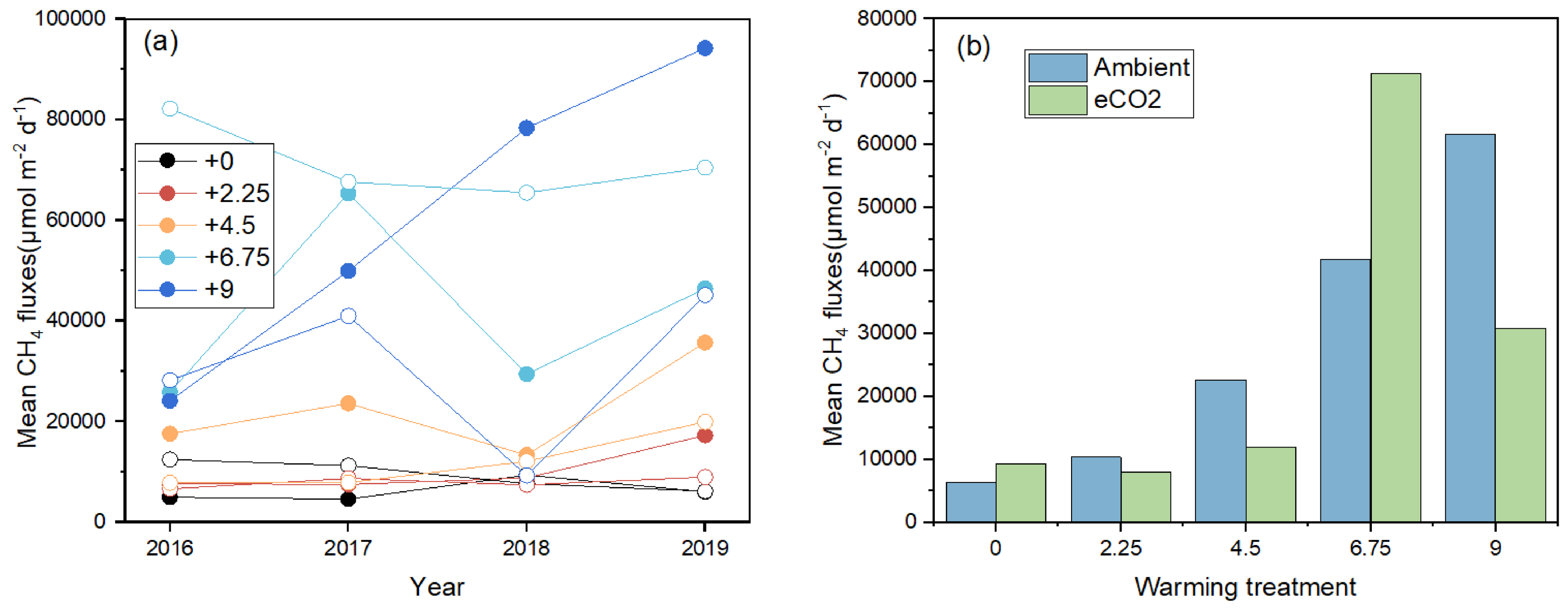


Figure 1 | CH_4 emissions in different warming treatment with and without elevated CO_2

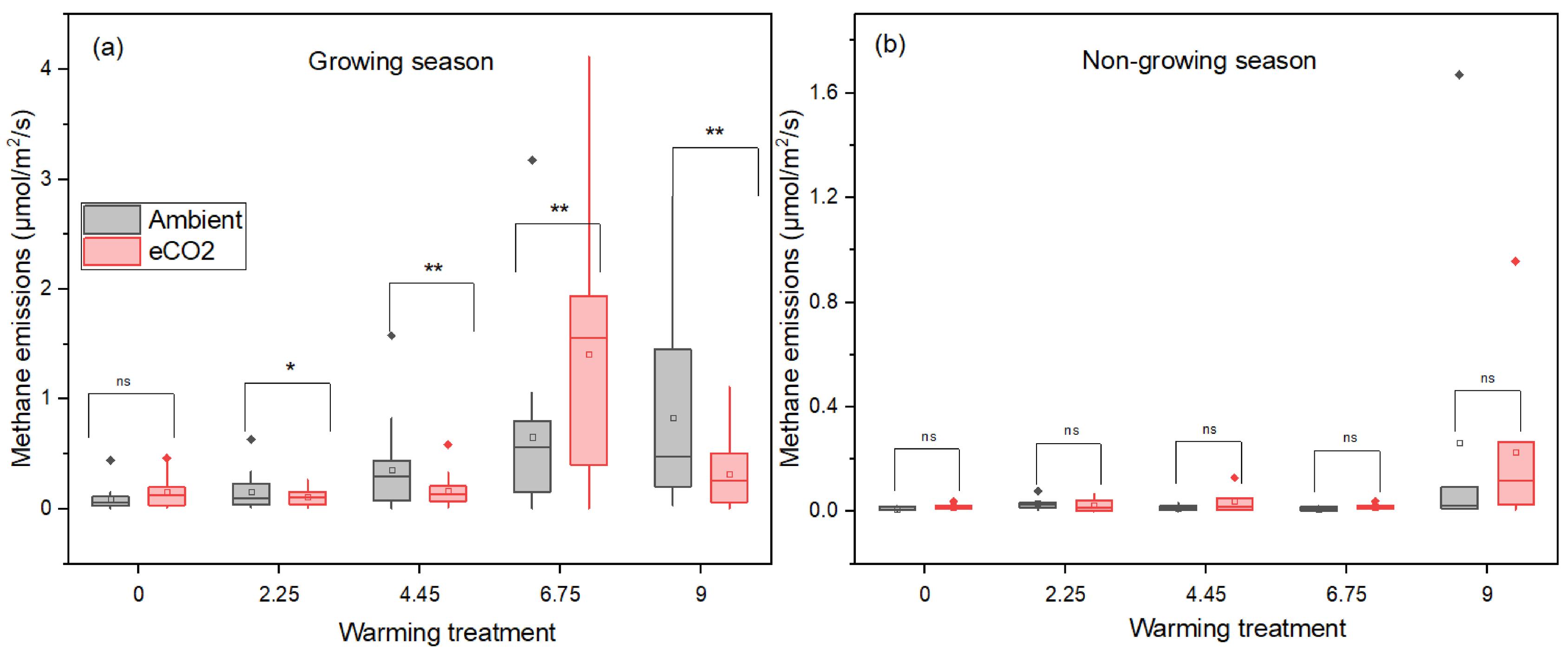


Figure 2 | CH_4 emissions under Ambient versus elevated CO_2 during growing season and nongrowing season across different warming treatments

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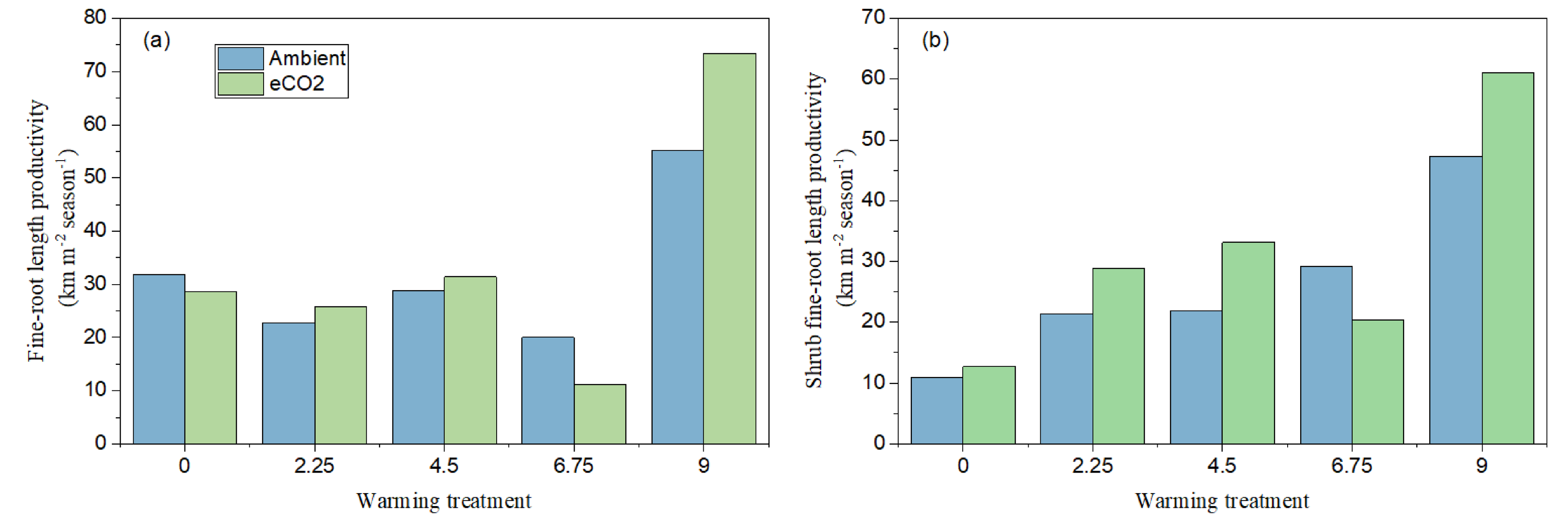

Figure 3 | Fine-root length productivity in different warming treatments with and without elevated CO_2

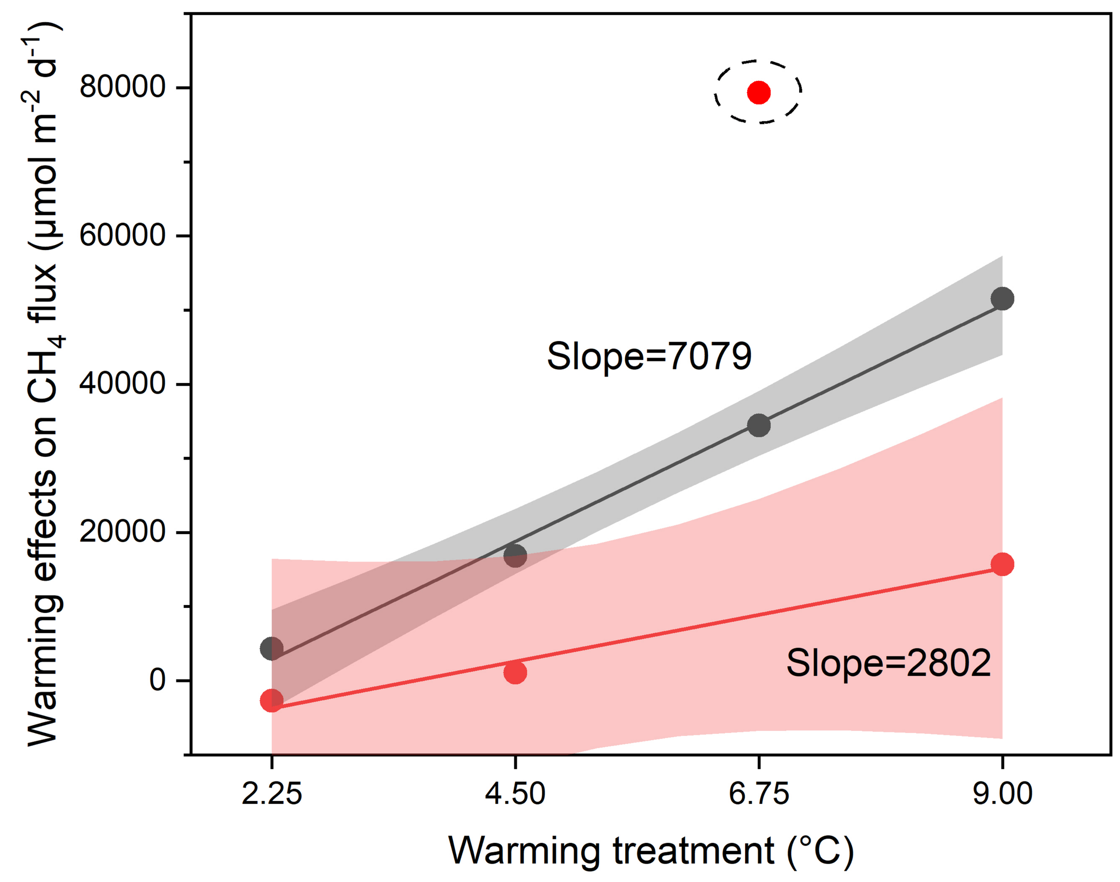

Figure 4 | Warming effects on methane flux under different warming treatments with and without CO_2; Warming effects here were calculated as the difference between methane emissions from warming treatment and ambient

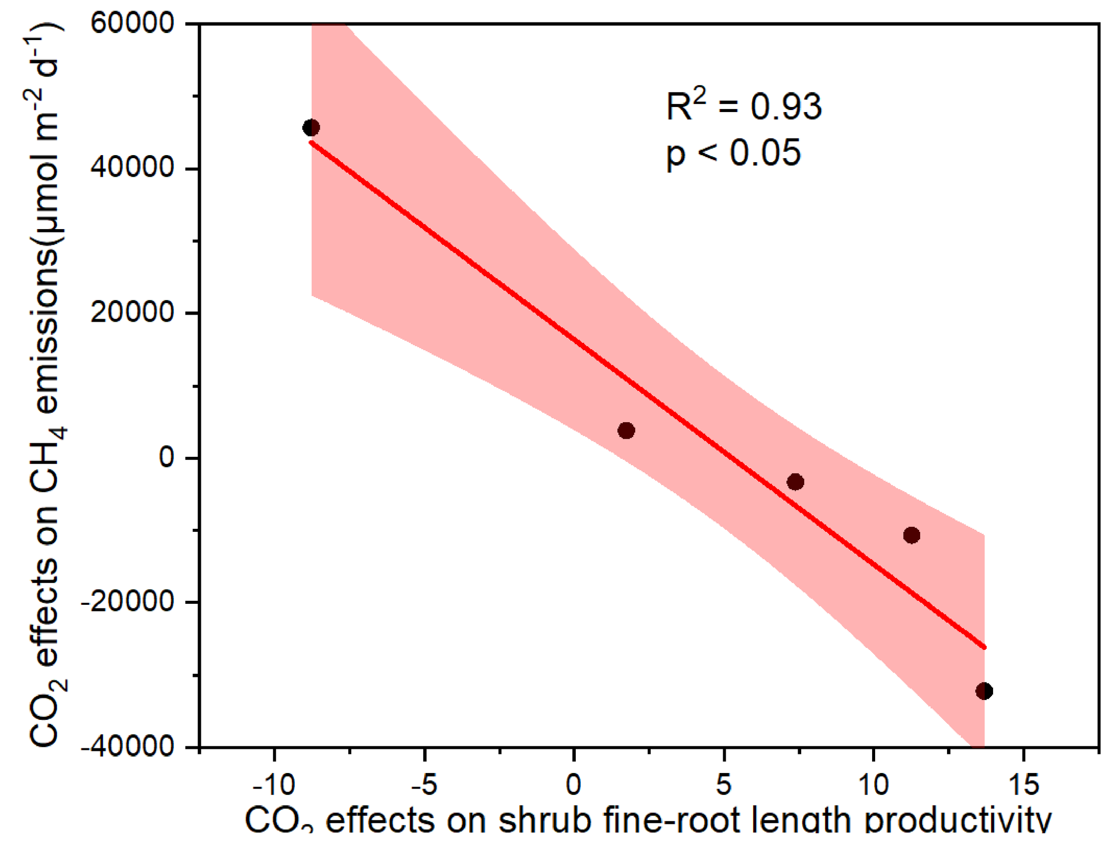

Figure 5 | The relationship between CO_2 effects on CH_4 emission and shrub fine-root length productivity; CO_2 effects were calculated as the difference between methane emissions from elevated CO_2 and ambient under the same warming treatment

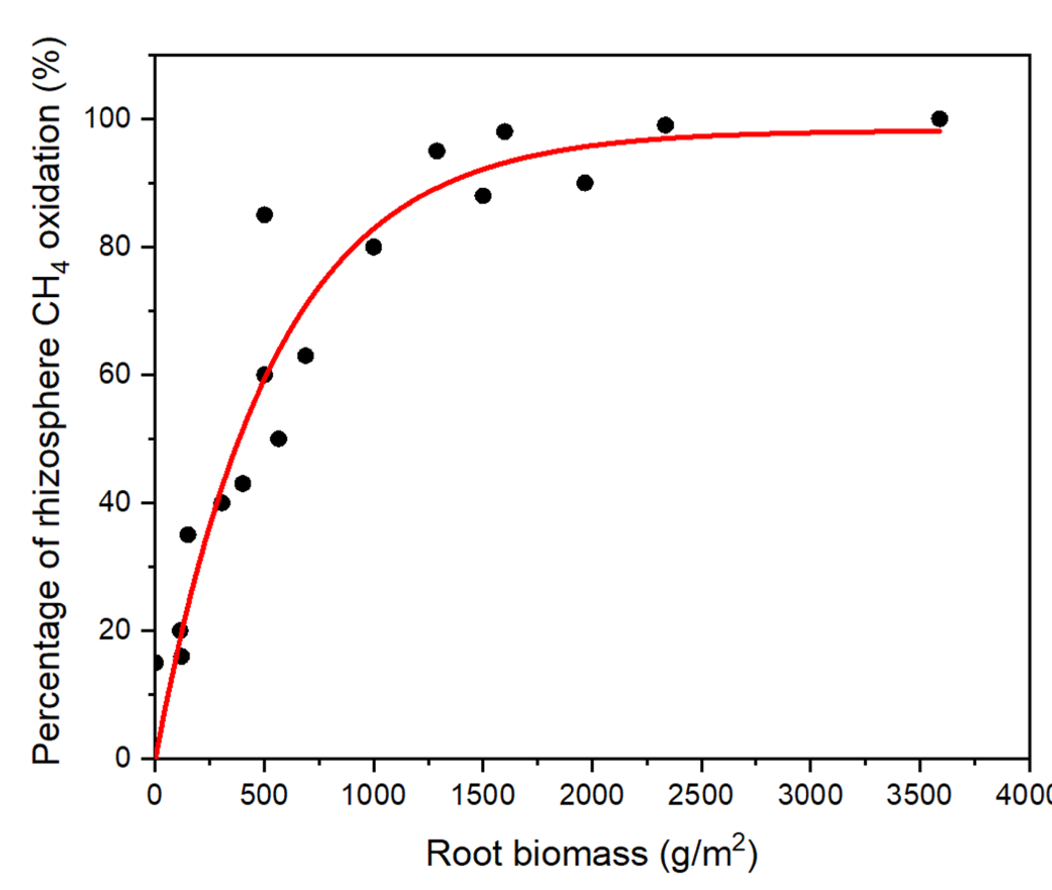

Figure 6 | Relationship between Percentage of rhizosphere methane oxidation and Root biomass: based on a meta-analysis from previous literatures

Take home messages:

- **Elevated CO_2 combined with warming reduced methane emissions under warming, only during the growing season;**
- **Elevated CO_2 mitigates the magnitude of warming effects increasing with the warming gradients;**
- **Shrub fine-roots seem to play a dominant role in mediating the effects of eCO_2 on methane emissions;**
- **It is inferred that root traits modulate methane's response to global change by influencing soil redox conditions, which in turn regulate rhizosphere methane oxidation processes.**