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Seasonal variability and magnitude of soil CO_2 fluxes in a warming experiment in a secondary subtropical forest in Hong Kong

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The increase of CO_2 in the atmosphere has led to warming of the Earth's surface and other climate changes. As heterotrophic respiration has great potential to increase atmospheric CO_2 concentrations, it is important to quantify the variation in soil CO_2 emission and to find its control factors under climate change. Though there are numerous studies about the warming effect on soil CO_2 fluxes, the duration and variation of the effect remains unclear in subtropical forests. Here, we conducted a soil warming experiment with a multichannel automated chamber system in a secondary subtropical broad-leaved evergreen forest in Hong Kong. 15 chambers were set up in forest and were divided into 3 treatments, including a control, a root trenching, and an infrared-warming with root trenching chamber to determine the effect of warming on soil heterotrophic respiration in forest.

So far, after 3-year warming, soil temperature at 5 cm depth was increased by 2.47 °C, compared with the control chambers. Soil CO_2 fluxes in experimental warming chambers have been significantly stimulated by 33.06%. There is significant relationship between soil temperature and soil CO_2 fluxes in all the treatments, while in heating chambers, the relationship was weaker. The warming effect on soil CO_2 emission was high in hot and humid summer, indicating that summer precipitation and the resulting soil moisture level also strongly influenced the soil warming effect in this forest. A moderately strong relationship was only found between soil moisture and temperature-normalized CO_2 flux data in trenched chambers in 2020, when annual precipitation was the highest among 3 years. We found a significant reduction in the warming effect on soil respiration and highest Q_{10} values for soil respiration and its components in 2021, when annual precipitation was the lowest. Experimental warming significantly decreased Q_{10} value for heterotrophic respiration, which may be due to the reduction of soil moisture. Cross-correlation analysis showed that there was evident diel hysteresis between CO_2 and soil temperature, while no significant seasonal hysteresis was observed. Longer-term monitoring on soil respiration under warming conditions is still needed to confirm if the reduction of warming effect is caused by microbial acclimation in our site.