Microbe-mediated attenuation of soil respiration in response to soil warming in a temperate oak forest

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Introduction: Soil respiration (Rs) in response to climate warming received wide concerns thank to its role in terrestrial ecosystem carbon (C) cycling. But the warming induced effects of soil microbes on soil respiration are still less understood, especially over time. Our study aims to understand the long-term warming induced effects of soil microbes on Rs.

Materials: A field soil warming experiment was conducted in a naturally regenerated oak forest (*Quercus aliena*) in central China from 2011 to 2015.

Results: Soil temperature was a main factor in regulating Rs in a temperate oak forest, but soil water content only determined Rs in natural dry year. The positive effect of soil warming on Rs that was observed with the significant increase (i.e. 37.5 to 42.0% in the first two years) gradually diminished in the following three years (i.e., 0.9-15.4% in the last three years). Significant positive warming effect on temperature sensitivity of Rs (Q_{10}) only occurred in the second year. Continuous soil warming caused the decline in nitrogen (N) availability, but with the significant increase in microbial biomass-specific enzyme activities for N-acquiring. The attenuation of microbial biomass increment and the deceased ratio of enzymatic C:N acquisition contributed to the diminished warming effect on Rs over time. Our study suggests that microbe-mediated attenuation of Rs accompanied by the concomitant decline in soil N availability in response to warming should be taken into consideration in global C cycle modeling.

Conclusion: 1.Warming induced a positive response of soil respiration attenuated over time with the concomitant reduction in microbial biomass; 2.Warming attenuated soil nitrogen availability over time, leading to the N limitation for microbial biomass growth; 3.The change of N-acquiring specific enzymes activities was induced by the decreasing N availability under warming, and varied microbial C or N investment strategy contributed to the attenuation of soil respiration with time.

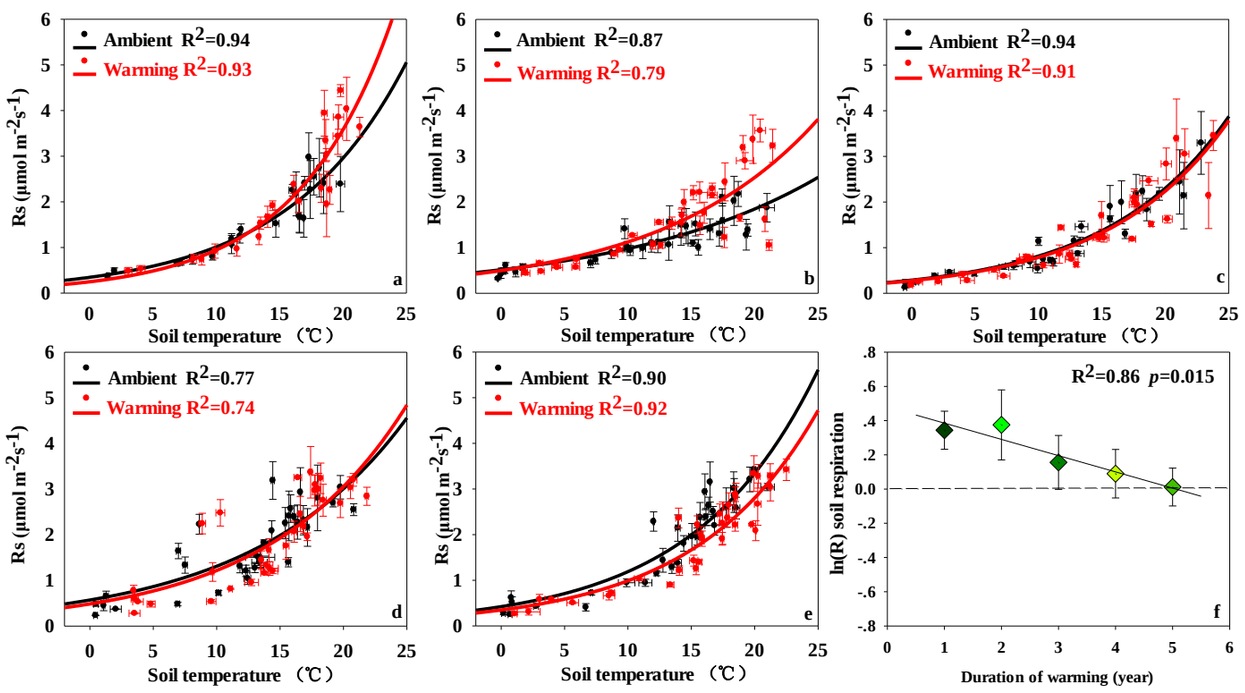

Figure 1. Variations of relationships between soil respiration (Rs) and soil temperature (T) from 2011 to 2015 with standard errors.

Year	T	SWC	Rs
2011	0.002	0.022	0.01
2012	<0.001	0.017	0.045
2013	0.001	n.s.	n.s.
2014	0.01	0.028	n.s.
2015	<0.001	n.s.	n.s.

Table 1. Results (*p*-values) of t-Test on the effects of soil warming on changes of soil temperature (T), soil water content (SWC), soil respiration (Rs) in 5 years (n.s. denotes not significant).

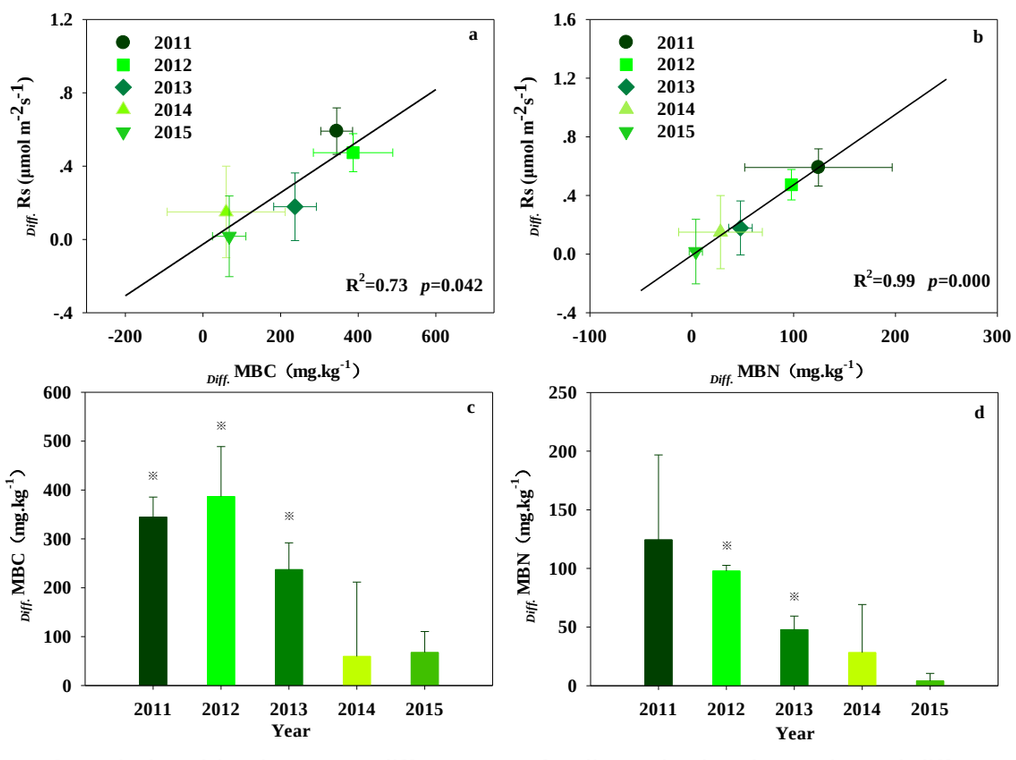

Figure 2. Relationships between differences of soil respiration ($_{Diff.}$ Rs), and differences of microbial biomass carbon ($_{Diff.}$ MBC), and differences of microbial biomass nitrogen ($_{Diff.}$ MBN) in the ambient and warming plots with standard errors.

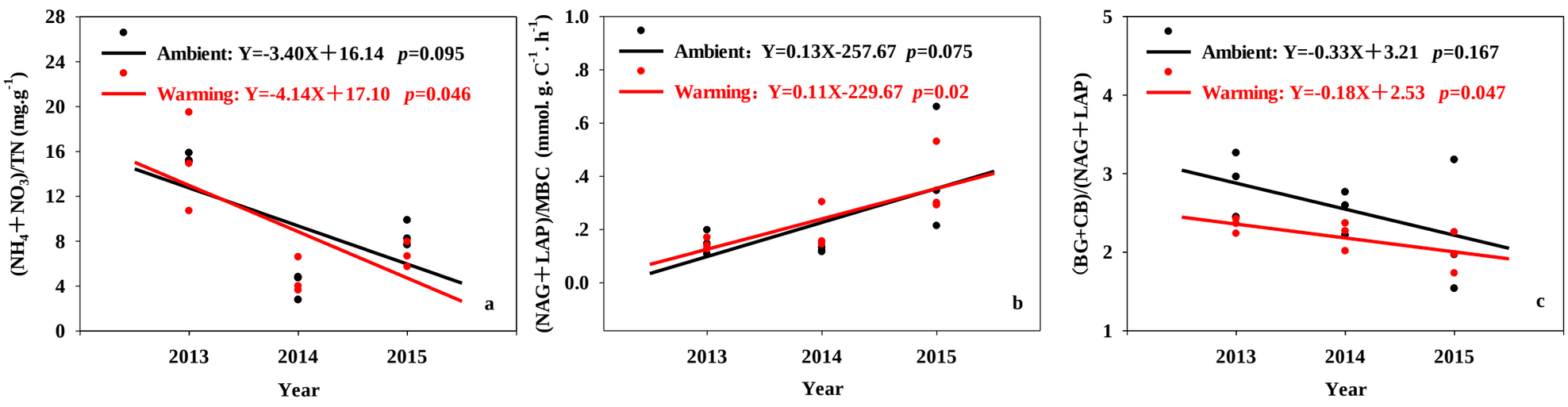

Figure 3. Changes of nitrogen availability , microbial biomass-specific enzyme activities and the stoichiometry of potential enzyme acquisition activities from 2013 to 2015 in the warming and ambient plots.

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