Comparison of the variation of soil respiration in carbon cycle in temperate and subtropical forests and the relationship with climatic variables

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INTRODUCTION

Soil carbon (C) is the largest terrestrial pool of carbon, possessing 3.3 times as much C as the atmospheric pool and 4.5 times the C of the biotic pool ( Lal 2004). Small changes to the soil C pool result in large fluctuations in atmospheric CO₂, which will affect the stability of global climate ( Friedlingstein et al. 2006). Soil respiration (SR) is one of the main fluxes in the global C cycle, and the second-largest terrestrial carbon flux after gross primary production. Soil respiration has become a central issue in global change ecology because of its critical role in global warming processes. However, SR remains the least understood component of the terrestrial carbon cycle because of its high spatial–temporal variability, inaccessibility of the soil substrate, and the high cost of measurement equipment. This study investigated the spatial and temporal variations of SR in six temperate and subtropical forest sites in eastern China. Seasonal variations of SR, the relationship between SR and soil temperature (ST) and volumetric water content (SW) were analyzed. Mean monthly SR varied seasonally and peaked in summer. SR varied temporally with ST (R² = 0.43–0.79) in different sites and varied spatially with latitude (R² = 0.68). The responses of SR to the changes of SW varied across different sites and forest types. Their relationships were simulated by piecewise functions in the north three sites. The modules of ST and SW showed that ST is the dominant environmental factor in regulating seasonal dynamics of SR. This study is the first to examine the temporal and spatial variations of SR using a consistent method in situ in temperate and subtropical forests in eastern China. The results provide a scientific basis for accurately assessing future soil CO₂ efflux as a result of climate changes, and aid predictions of the changes of forest SR.

ABSTRACT

Forest soil respiration (SR) has become a vital issue in global change ecology because of its critical role in global warming processes. However, SR remains the least understood component of the terrestrial carbon cycle because of its high spatial–temporal variability, inaccessibility of the soil substrate, and the high cost of measurement equipment. This study investigated the spatial and temporal variations of SR in six temperate and subtropical forest sites in eastern China. Seasonal variations of SR, the relationship between SR and soil temperature (ST) and volumetric water content (SW) were analyzed. Mean monthly SR varied seasonally and peaked in summer. SR varied temporally with ST (R² = 0.43–0.79) in different sites and varied spatially with latitude (R² = 0.68). The responses of SR to the changes of SW varied across different sites and forest types. Their relationships were simulated by piecewise functions in the north three sites. The modules of ST and SW showed that ST is the dominant environmental factor in regulating seasonal dynamics of SR. This study is the first to examine the temporal and spatial variations of SR using a consistent method in situ in temperate and subtropical forests in eastern China. The results provide a scientific basis for accurately assessing future soil CO₂ efflux as a result of climate changes, and aid predictions of the changes of forest SR.

ARTICLE INFO


KEY WORDS
spatial-temporal variation
soil respiration
soil temperature
soil water
ecosystem types

DOI
10.3161/15052249PJE2015.63.3.007

FOREST ECOLOGICAL JOURNAL