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Variation of soil respiration and its environmental factors in Hulunber meadow steppe



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ABSTRACT

In order to understand the variations of soil respiration with the controlling environmental factors, continuous monitoring was carried out in Hulunber meadow steppe by an automated chamber system, LL-8150, from 2009 to 2011. The results showed that soil respiration exhibited an apparent diurnal variation and seasonal dynamics. Diel maximum soil respiration often appeared between 13:00 and 14:00, while the minimum occurred between 4:00 and 5:00 in the morning. Soil respiration in the growing season from May to September was higher than that in the non-growing season. The peak value often occurred in July and August and the lowest was close to zero in winter. Soil respiration had a significant exponential relationship with soil temperature at 5 cm depth ($P < 0.01$), which could explain the 86.1–91.1% variation in soil respiration. A significant linear relationship was indicated between soil respiration and soil water content at 10 cm depth ($P < 0.05$). Soil respirations in 2009, 2010 and 2011 were estimated to be 465.0 gC m⁻², 539.2 gC m⁻² and 553.2 gC m⁻² respectively. In addition, the temperature sensitivities of soil respiration (Q_{10}) were calculated as 3.32, 3.55 and 4.05, respectively. The value of Q_{10} could cause a lower evaluation derived from observation in a short time, such as considering only the growing season. Field observation of soil respiration should cover all the possible time in the whole year, including the growing and non-growing seasons.

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1. Introduction

Grassland is one of the main types of territorial ecosystem, occupying 25% of the land area [1]. The total carbon storage of grassland is about 266.3 Pg and 89.4% is stored in soil [2]. Soil respiration is the main approach for soil organic carbon (SOC) to release from soil. It is a crucial linkage of the carbon cycle and playing an important role for climate change [3]. It is very important to explore the variation of soil respiration with its controlling factors for deep understanding of the mechanism of carbon cycle in grassland and quantifying carbon balance in region [4].

The grassland occupies 41% of the total land area in China, and have strong spatial heterogeneity in vegetation, soil, water and heat conditions, which cause a distinct spatial heterogeneity of soil respiration, thus enhanced the difficulty for the accurate estimation of soil carbon flux in large scale. Therefore, further research on soil respiration should be carried out in different regions and different grassland types. At present, although there have been much domestic research on soil respiration of grassland ecosystem [5–11],

the study and long-term observation on soil carbon flux remains insufficient in Hulunber meadow steppe, as China's largest temperate meadow steppe, based on 3 years continuous observation on soil respiration by soil carbon flux automatic measurement system in Hulunber Grassland Ecosystem Research Station. This study focused on the characteristics of soil respiration with its environmental controlling factors in Hulunber temperate meadow steppe, which may provide scientific basis and data support for accurate estimation of regional carbon budget.

2. Materials and methods

2.1. Site description

Hulunber meadow steppe is located in gentle hilly area of the greater Khingan Range, with a temperate semi-arid continental climate characterized with a long cold winter, short cool summer, dry windy spring and fall of early frost and sudden drop in temperature. Annual average temperature is from -5 to 0 °C, with great temperature difference between day and night and large annual temperature range. The average temperature of the coldest month (January) is between -18 and 30 °C, and that of the hottest month (July) is between 16 and 21 °C. The accumulated temperature (≥ 10 °C) is 1780 – 1820 °C, frost-free period 85 – 155 d. The precipitation is

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