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研究论文

用于测定陆地生态系统与大气间CO_2交换通量的多通道全自动通量箱系统

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摘要 陆地生态系统与大气间CO_2交换是全球碳循环的最重要组成部分，科学地测定其CO_2交换通量一直是陆地生态系统碳循环研究的核心工作之一。提高观测的效率和减少观测对自然的干扰，是科学精确地估算区域和全球尺度上的陆地生态系统与大气间CO_2交换量的关键。在参考国内外已有的陆地生态系统与大气间CO_2交换通量箱式法观测技术的基础上，发展了一套多通道全自动通量箱系统用来连续观测陆地生态系统或土壤与大气间的CO_2交换通量。在黄土高原中国科学院长武农业生态试验站的麦田和苹果园中进行了系统测试，结果表明，该系统不但能够实现自动、连续、多点观测，而且对自然环境的影响比较小，在田间的实验观测中，该系统运行稳定，能够比较客观地得到陆地生态系统与大气间的CO_2交换通量。

关键词 全自动多通量箱系统；CO_2交换通量；农田生态系统

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Multi-channel automated chamber system for continuously monitoring CO_2 exchange between agro-ecosystem or soil and the atmosphere

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Abstract CO2 exchange between the biosphere and the atmosphere is one of the most important components of the global carbon cycle. The CO_2 exchange should be monitored continuously and at multiple geographical points because of great temporal and spatial variations. A Multi-channel automated chamber system was developed for continually monitoring CO_2 exchange between the agro-ecosystem or the soil and the atmosphere. This system consisted of an automated chamber subsystem and a CO_2 concentration analysis and data logging subsystem. Both subsystems were under the control of a programmable logic controller (PLC). The automated chamber subsystem contained 18 chambers and a compressor. The chambers, 50 cm×50 cm×50 cm, were constructed of clear PVC fixed to an aluminum alloy frame. The chambers had PVC lids hinged at the sidewall and each lid was closed and opened automatically by the push and pull of a pneumatic cylinder mounted on the opposite sidewall. The pneumatic cylinders were controlled by high pressure air from a compressor regulated by the PLC. Fans were fixed on each pneumatic cylinder to mix the air inside the chamber completely when their lids were closed. A buffer pine (L=1.5m) with an inner diameter of 0.4 mm was inserted through the lid to keep the air pressure balanced between the inside and the outside of the chamber. During measurement, one of the 18 chambers wa

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s closed for measuring and the others were kept open to allow precipitation and leaf litter to reac h the enclosure surface, to maintain the soil conditions as natural as possible. Three minutes of clo sure time was needed for each chamber for measurement at separate locations. Regulated by th e PLC, measurements for the 18 chambers were completed in 54 minutes, and another cycle o f measurement began after a six-minute interval. The CO_2 concentration analysis and data loggin g subsystem was composed of a CO_2 analyzer, a multi-channel gas valve and a data logger. Th e multi-channel gas valve was controlled by the PLC to switch gas between the chambers and th e CO_2 analyzer. During the analysis, one chamber was closed and the air inside it was continuousl y withdrawn by a pump through a multi-channel gas valve into the CO_2 analyzer. After the CO_2 c oncentration was measured, the air was returned into the chamber through another multi-channe l valve to minimize changes of the air within chamber. The results of the CO_2 concentration were r ecorded by the data logger at intervals of 10 seconds. In addition, environmental variables were si multaneously measured by sensors and these results were recorded by the data logger. The CO_2 exchange was calculated as the slope of change in CO_2 concentration within chamber, adjuste d for air temperature and pressure.

The reliability of the multi-channel automated chamber system was tested; the system was used t o monitor the CO_2 exchange between a wheat ecosystem and the soil respiration of a wheat fiel d and an apple orchard with the atmosphere. The results showed that the equilibrium of the syste m could be reached within 60 seconds and the turbulence of the fans had no significant effect on t his CO_2 exchange. The changes in air and soil temperature and soil moisture inside the chamber s due to enclosure of the chambers were within the degree of acceptability for field study. The ne t ecosystem CO_2 exchange for the wheat ecosystem was -2.35 μmol•m^{-2}•$s^{-1}$and the soil respirati on was 3.87 μmol•m^{-2}•s^{-1}in the wheat field and 6.61 μmol•m^{-2}•s^{-1}in the apple orchard. In conclu sion, the system was reliable for monitoring CO_2 exchange continuously and automatically at multi ple points, and had little influence on natural conditions.

Key words automated multi-channel chamber system _ CO_2 exchange _ agro-ecos ystem

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