Geophysical Research Abstracts
Vol. 12, EGU2010-10256, 2010
EGU General Assembly 2010

Short-term temperature impacts on soil CO2 fluxes: An incubation experiment with agricultural soil samples.

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Temperature is often considered as the main driver of soil heterotrophic respiration. However, its impacts differ according to the timescale. Long term field experiments tend to show that soil CO2 fluxes return to pre-warming values within several months to years. In the short term, soil respiration increases with temperature.

In this study, an incubation experiment was set up to investigate short term temperature impacts on soil heterotrophic respiration in a crop soil. In June 2009, some samples were taken from the bare soil surface (0-25cm) in the agricultural site of Lonzée (Belgium). They were homogenized and their soil moisture content was kept constant. Three samples (100g of fresh soil) were placed into each of three different incubators whose pre-incubation temperatures were set at 5, 15 and 25°C respectively. After a 5-day pre-incubation period, the incubator temperatures were modified by 10°C-steps between 5 and 35°C, starting from each incubator pre-incubation temperature. Every temperature step, CO2 fluxes were measured with a dynamic closed chamber system. Such a temperature cycle lasted about 22h and it was repeated two days after the first one was over. In August 2009, the same protocol was carried out, except that the samples were divided into two different soil moisture treatments.

During the temperature cycles, we observed a very highly significant increase of the soil CO2 fluxes with temperature in all incubators. The pre-incubation temperature also played an important role. It impacted the CO2 fluxes differently at short and longer terms. Indeed, in the short term, the fluxes were the highest in the incubator set at the lowest temperature. In a longer term (several days), the fluxes were seen to converge towards a same value, whatever the incubator temperature or the soil moisture content. We suggest that labile soil carbon depletion might explain these observations.

Furthermore, important hysteresis effects appeared, higher fluxes being always observed during warming phases. In addition to this, negative fluxes (CO2 absorption into the samples) were measured at 15 and 5°C during cooling phases. They were of the same order of magnitude as the positive fluxes and more important in the moistest samples. We hypothesize that in this case, the hysteresis effect and the negative fluxes might be linked to each other. The most probable explanation is that physico-chemical processes related to pH and temperature-mediated CO2 dissolution changes took place in the samples.

Keywords: Incubation experiment, Agricultural soil, Soil CO2 flux, Temperature, Short-term, Pre-incubation, Physico-chemical processes.