Geophysical Research Abstracts,
Vol. 10, EGU2008-A-10492, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-10492
EGU General Assembly 2008

Short-term evolution of the basal respiration of forest soils heated at different temperatures

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It is well recognized that the short-term effects of fire on soil properties are largely dependent by the fire's intensity and severity. The quantification of the effects on physical, chemical and microbiological soil properties can help to decide the most appropriate planning of rehabilitation and decide strategies to avoid degradation processes.

Soil respiration has been typically used as an indicator of the total heterotrophic microbial activity. But extremely different results could be obtained depending of the moment when the burned soil is sampled because an ephemeral increase in respiration is typically observed after rewetting. This is one of the reasons of the apparent contradictory findings which can be observed in literature about the short-term effects of fire on basal respiration (controlled conditions) and soil respiration (field measurements).

The aim of this work is describe the magnitude and the temporal pattern of the increments of basal respiration after rewetting heated soils.

For this, several soils were heated at different temperatures under laboratory controlled conditions. Three sets of data were used:

-Set A: Samples of one forest soil affected by a wildfire (6 years ago) and the adjacent unburned soil were heated at 100, 200, 300, 400, 500 and 600ºC during 15 minutes.

-Set B: Samples of four forest soils were heated at 70, 160, 250, 340, 430, 520, 610 and 700ºC during 20 minutes.

-Set C: Samples of one forest soil was heated at 100, 200, 300, 400, 500, 600 and 700ºC during 15 minutes.

After heating, the soils were rewetted (with the aim to simulate the first post-fire rainfall) and incubated. The basal respiration hourly-rates (BRR) and accumulated respired (AR) values were measured during four days of incubation in all soils. After 22 days of incubation, the BRR and AR were measured in samples from set A. After one month of incubation, BRR was also measured in samples of two of the four soils of set A and in all samples from the set B and C. After 100 days of incubation, the BRR was also measured in samples from set C.

During the first four days, the BRR and AR were increased, being related with the temperature of heating, reaching to maxima values in samples heated at temperatures around 300-340ºC. Above 340ºC, the BRR and AR started to decline. The BRR changed considerably during these days. A pulse of respiration (BRR) occurs during the first 24-48 hours. During these four days, these maxima peaks in BRR in heated samples were ranking from 2 to 16-folds higher respect unheated samples. Prior to this sharp increase, a lag phase without activity was observed. The magnitude of the lag phase was related with the temperature, indicating the degree of sterilization. After this period, the BRR decreased with time, being more evident in severely heated samples. After 1 month, the BRR in some heated samples was still higher than unheated samples, but in general a negative correlation between BRR and temperature of heating was observed in most cases. After some weeks, the RQ (ratio of evolved CO_2 to consumed O_2) trended to be lower in samples severely heated, indicating that the organic matter remaining have increased the degree of recalcitrance.

Soluble organic carbon was measured in some samples, and a certain correlation with respiration was observed. But the most accurate estimations of the AR was obtained using near-infrared (NIR) spectroscopy. NIR spectrum could be considered as a fingerprint of the soil sample, and contains integrated information about physical, chemical and biological properties. NIR spectroscopy could be used as a rapid, easy and inexpensive tool for the measurement of basal respiration.

Our data suggest carefully interpretations of the basal respiration data as a measurement of the microbial activity in recently burned soils.