Short-term temperature impacts on soil respiration

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1. Introduction:

- There is still a lack of a good mechanistic understanding of soil heterotrophic respiration.
- Temperature is the most important driving factor and its impacts may be different according to the time scale.
- Despite their considerable importance, crop soils have been less investigated so far.

2. Objectives:

- To bring new elements to get to a better understanding of short-term temperature impacts on respiration of crop soils.

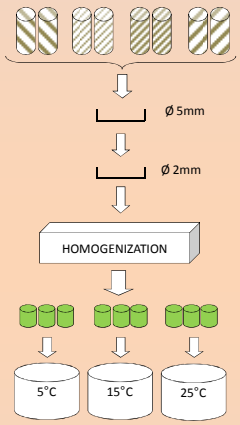
3. Material and Methods:

➢ Experimental site:

- Soil samples were taken at the Carbo-Europe site of Lonzée, Belgium.
- In this 12ha-field, 4 areas of 9m² each were weeded in March 2009 to provide bare areas for soil sampling.
- Soil characteristics:

Parameter	Value
Soil type (FAO)	Luvisol
Soil texture: Silt Sand Clay	 70% 5% 25%
Soil organic carbon content [kg/m²]	6.2
C:N ratio	9.40
Bulk density (0-30cm) [kg/m³]	1500

➢ Soil sampling and subsample preparation:



2 auger samples (6cm Ø , 14cm height) were taken from each of the 4 bare areas delimited in the field.

The samples were sieved at 5 and 2mm, and homogenized.

9 new samples (100 g fresh soil) were prepared from the whole quantity of soil, put into 210 mL jars and slightly compacted.

3 jars were placed into each incubator.

Incubator temperatures were set at 5, 15 and 25°C.

➢ Experimental protocol and measurements:

- Pre-incubation period: 4 days ½.
- Cycle 1: Temperature modified sequentially by 10°C-steps between 5 and 35°C, starting from the incubation temperature (see the example in *Fig. 4*). This temperature cycle lasted about 22h.

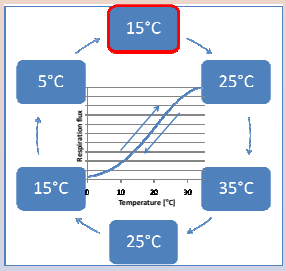


Fig. 4: The temperature cycle of incubator B.

- Cycle 2: same as cycle 1, repeated two days later.
- Respiration flux measurements:
  - o At each temperature step with a dynamic closed chamber system (infrared gas analyzer Gascard II, *Edinburgh Instruments Ltd*, UK). Three measurements sequentially on each jar.
  - o Between each measurement, ventilation of jars with outside air to prevent CO_2 from accumulating inside the jars.

EXPERIMENTAL SET-UP:

- 3 incubators keeping the temperature constant between 5 and 35°C.
- A water-bath to warm up or cool down the jars inside the incubators.
- Sample ventilation with water-saturated air in each incubator.
- Checking of the temperature evolution in the samples with thermocouples.

Fig.1: View of the 3 incubators.

Fig.2: Zoom on 1 incubator.

Fig.3: Inner part of an incubator : detail of the ventilation system.

4. Results:

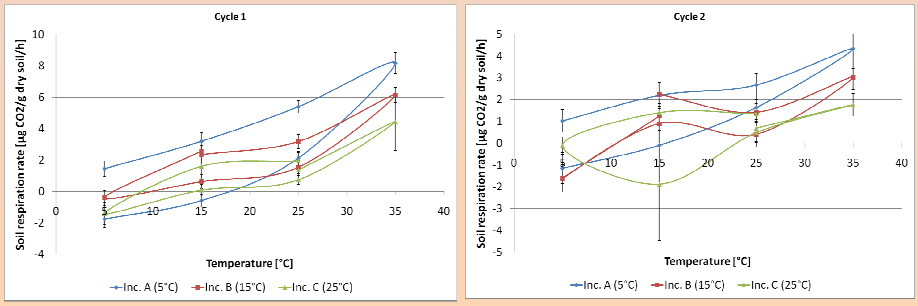


Fig. 5: Soil respiration flux vs. Temperature relationships in each incubator for cycle 1 (left) and cycle 2 (right). Error bars take account of the slope uncertainty and of the jar to jar variability in each incubator.

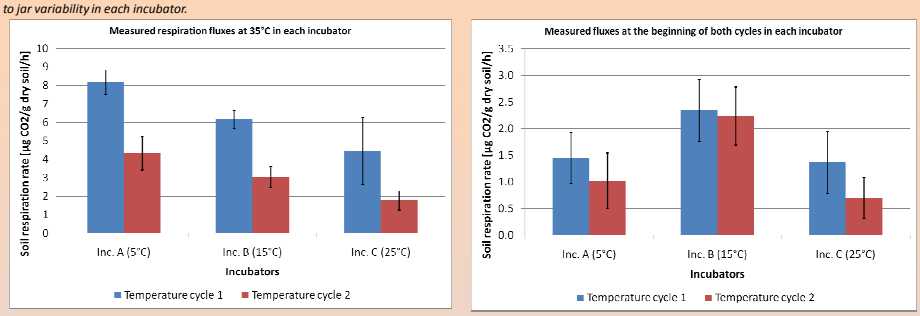


Fig.6: Measured soil respiration fluxes at 35°C (left) and at the beginning of both cycles (right) in each incubator. Cycle 1 is in blue and cycle 2 is in red. Error bars take account of the slope uncertainty and of the jar to jar variability in each incubator.

5. Main observations

- Short term impact of temperature was very clear (*Fig.5* and *Fig. 6 (left)*): in the three incubators and during both cycles, soil respiration increased with temperature.
- Unexpectedly, the pre-incubation temperature had only a small impact on initial respiration fluxes to (*Fig. 6 (right)*).
- On the opposite the pre-incubation temperature impacted on the respiration temperature sensitivity. The sensitivity was larger in the coolest incubator (*Fig.5*).
- Large hysteresis effects were observed during both cycles in each incubator, higher fluxes being systematically measured during the heating phase (*Fig.5*).
- In all incubators, the fluxes decreased with time. (*Fig.5* and *Fig.6*).
- Negative fluxes were measured during the cooling phase in all incubators (*Fig.5*).

6. Conclusions

- These results suggest that:
  - The impact of temperature is not the same at a daily and a hourly scale.
  - Soil respiration temperature sensitivity increases with pre-incubation temperature.
  - Soil respiration temperature sensitivity is larger during cooling phases compared to heating phases.
- Microbial biomass and soil labile carbon content analyses are ongoing. They will allow a deeper interpretation of the preceding results.

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