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# Updating soil $CO_2$ emission experiments to assess climate change effects and extracellular soil respiration

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Experimental work is an essential component in training future soil scientists. Soil $CO_2$ emission is a key issue because of the potential impacts of this process on the greenhouse effect. The amount of organic carbon stored in soils worldwide is about 1600 gigatons (Gt) compared to 750 Gt in the atmosphere mostly in the form of $CO_2$. Thus, if soil respiration increased slightly so that just 10% of the soil carbon pool was converted to $CO_2$, atmospheric $CO_2$ concentrations in the atmosphere could increase by one-fifth. General circulation model predictions indicate atmosphere warming between 2 and 5°C (IPCC 2007) and precipitation changes ranging from about -15 to +30%. Traditionally, release of $CO_2$ was thought to occur only in an intracellular environment; however, recently $CO_2$ emissions have been in irradiated soil, in the absence of microorganisms (Maire et al., 2013). Moreover, soil plays a role in the stabilization of respiration enzymes promoting $CO_2$ release after microorganism death. Here, we propose to improve $CO_2$ emission experiments commonly used in soil biology to investigate: 1) effects of climatic factors on soil $CO_2$ emissions, and 2) rates of extracellular respiration in soils and how these rates are affected by environmental factors. Experiment designed to assess the effect of climate change can be conducted either in field conditions under different ecosystems (forest, grassland, cropland) or in a greenhouse using simple soil chambers. The interactions of climate change in $CO_2$ emissions are investigated using climate-manipulation experiment that can be adapted to field or greenhouse conditions (e.g. Mc Daniel et al., 2013). The experimental design includes a control plot (without soil temperature and rain manipulation) a warming treatment as well as wetting and/or drying treatments. Plots are warmed to the target temperature by procedures such as infrared heaters (field) or radiant cable (greenhouse). To analyze extracellular respiration, rates of $CO_2$ emissions from sterilized soils and their unsterilized counterparts are compared. Moreover, different pH treatments are compared to analyze how soil pH affects extracellular $CO_2$ release. Students benefit from experimental learning. Practical courses, being either in the field or indoors are of vital importance to bring soil processes to life and to evaluate implications for environment and climate change.

IPCC, 2007: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom, 996 pp.

Maire, V., G. Alvarez, J. Colombet, A. Comby, R. Despinasse, E. Dubreucq, M. Joly, A.-C. Lehours, V. Perrier, T. Shahzad, and S. Fontaine. 2013. An unknown oxidative metabolism substantially contributes to soil $CO_2$ emissions. Biogeochemistry, 10, 1155–1167, 2013