Tittle of the proposed research project:

Moisture and temperature sensitivity of the respiration of available C compounds depending on their origin: an annual incubation at different depths with a tracer of fresh organic matter

Applicant's name:

Luis Lopez Sangil

PhD. Student at the University of Barcelona (Spain)

Date of visit:

14/Jan/2013 - 09/Feb/2013 (4 weeks)

Host Institute:

Dr. Iain Hartley

Depart. Geography, College Life & Environmental Sciences, University of Exeter (UK)

1. Purpose of the visit

Our primary intention was to make the most of the existing analytical data-set obtained from the annual incubation experiment (PVC mesocosms with ^{14}C-labeled wheat straw incorporated into agricultural soil horizons, which were subjected to 2 different drying-rewetting frequencies). This experiment was carried out during the PhD. project of Luis Lopez Sangil at the University of Barcelona. Existing data include total (bulk SOM) and labeled (^{14}C-straw) carbon contents, microbial and K_2SO_4-extractable C fractions (Vance et al. 1987, Jones and Willet 2006), daily soil temperature and moisture contents, and daily CO_2-C effluxes from total and labelled OM. Measurements of humic substances (humic and fulvic acid contents following the IHSS standard procedure; Aiken 1985), both for total and labeled C, were similarly performed on the extractable fractions in order to characterize their chemical recalcitrance to microbial respiration (Kalbitz et al. 2003, Namour and Müller 1998).

From this starting point, this 4-week MOLTER exchange visit aimed to perform a profound assessment on i) the impact that pedoclimatic variables (horizon position with

depth, soil temperature and rewetting frequencies) have on the evolution of the bio-available OM fractions (microbial + soluble), depending on its origin (the recently-incorporated straw or the more stabilized bulk SOM); and ii) how the amounts of CO_2-C lost by soil heterotrophic respiration evolved at different temporal scales under field controlled conditions. We hypothesized that the evolution of the different bio-available C fractions (i.e. microbial biomass and K_2SO_4-extractable organic C) in soils may be influenced by both environmental and substrate quality factors, with possible interactions between them. Further, we wanted to check the hypothesis observed in previous field work (Casals et al. 2009; Casals et al. 2011) that the amount of bio-available soil C prior to rewetting would be determining the post-rewetting response from soil microbial mineralization, both at the short term ('Birch effects') and on the longer time scales. By comparing between bulk and radio carbon data, we were able to gain extra insight into the possible influences of the substrate origin on the carbon turnover.

2. Description of the work carried out during the visit

During this 4-week stage with Dr. Iain Hartley, I basically took advantage from his expertise in soil C respiration fluxes, in order to extract the most from the PhD. data-set and to be able to build up the first draft of a manuscript that will be submitted (hopefully in a short period of time) as a regular article to a soil science journal.

In particular, during the first ten days of the stage, we worked in elaborating additional graphs that were able to give more insight into some of the hypothesis previously established. For the second half of the stage (2-3 weeks), it was a time for re-elaborating the structure, hypotheses and some methodological aspects of the first draft of the manuscript, and so developing it until almost completion under the guidance of Dr. Hartley.

3. Description of the main results obtained

Herein, I present the article's title, abstract and some of the most representative figures of the manuscript elaborated during my MOLTER exchange visit under the supervision of Dr. Iain Hartley. Please, note that the manuscript is currently under

construction yet, as we are trying to implement final analyses before its submission to journal, so the results presented herein may still be subjected to slight changes.

Short- and long-term post-rewetting responses in soil OM mineralization under severe drying conditions: relation with pre-wetting levels of microbial and extractable organic C

Luis Lopez-Sangil [1,2*], Iain Hartley[3], Pere Rovira[2], Pere Casals[2]

Abstract Aiming to better define the soil organic matter (OM) sources that are mineralized after rewetting a dry soil, and the impact that the projected soil drought extensions may have on this, we used the experimental approach of Lopez-Sangil et al. (2013). to assess the effects of both depth and rewetting factors on the microbial (MBC) and soluble (K_2SO_4-extractable, EOC) organic C fractions in agricultural soil horizons incubated under differing drying and rewetting (D-RW) frequencies. The sum of these two pools (CFE) was considered as the amount of bio-available C (i.e. readily-accessible for microbes) prior to the rewetting phenomena. Further, ^{14}C-labeled wheat straw was incorporated into each agricultural horizon in order to compare the evolution of fresh organic debris against that from more-stabilized SOM. Our results evidenced a gradual increase of soluble compounds into the CFE fraction, only at surface level and derived from SOM. This replenishment was favored by the increased recurrence of irrigations and their higher abruptness at surface level. Soil microbial biomass viability was strongly compromised by the severe soil droughts. Our results suggest, however, that neither the microbial mortality nor the increased availability of organic solutes prior to rewettings determined the observed post-rewetting peaks in microbial mineralization. Moreover, the amount of CO_2-C lost from ^{14}C-straw mineralization was primarily determined by soil temperature or by the number of previous irrigations, depending on whether 3-day ('Birch effect') or monthly cumulative CO_2 effluxes were considered, which may evidence a different behavior of short- and long-term post-rewetting responses. We discuss the contrasting results obtained in our previous studies based on the same approach.

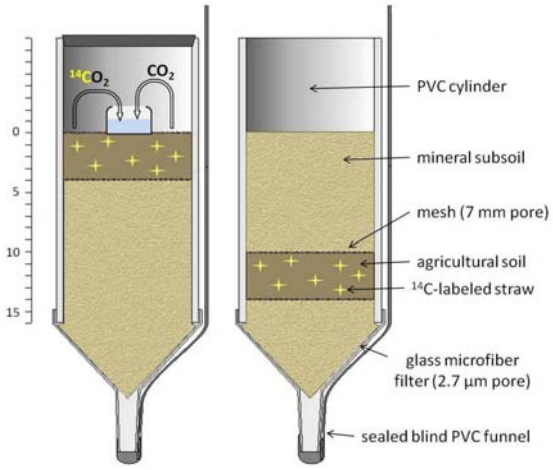

FIGURE 1 Scheme of the PVC mesocosms in which the labeled agricultural horizons were incubated: at 0 – 4 cm (left) and 10 – 14 cm depth (right). The mineral subsoil fills the rest of the soil profile. An alkali trap for measuring the daily soil CO_2-C efflux is represented.

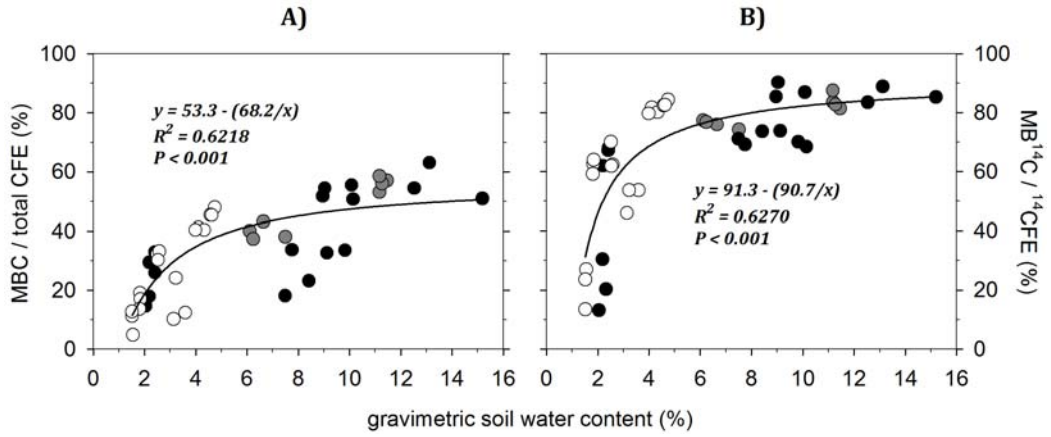

FIGURE 4 Relation between gravimetric soil water content and the microbial biomass C (MBC) from the agricultural horizons, previously standardized by the respective amount of $CHCl_3$-fumigated extractable organic C (CFE). **A)** total soil organic C; **B)** straw-derived organic ^{14}C. Black and white dots correspond to IRG and DRO treatments respectively; grey dots refer to Jan/07 sampling (no differential rewetting frequencies yet). First-order inverse polynomial equations were those that fitted better to empirical data.

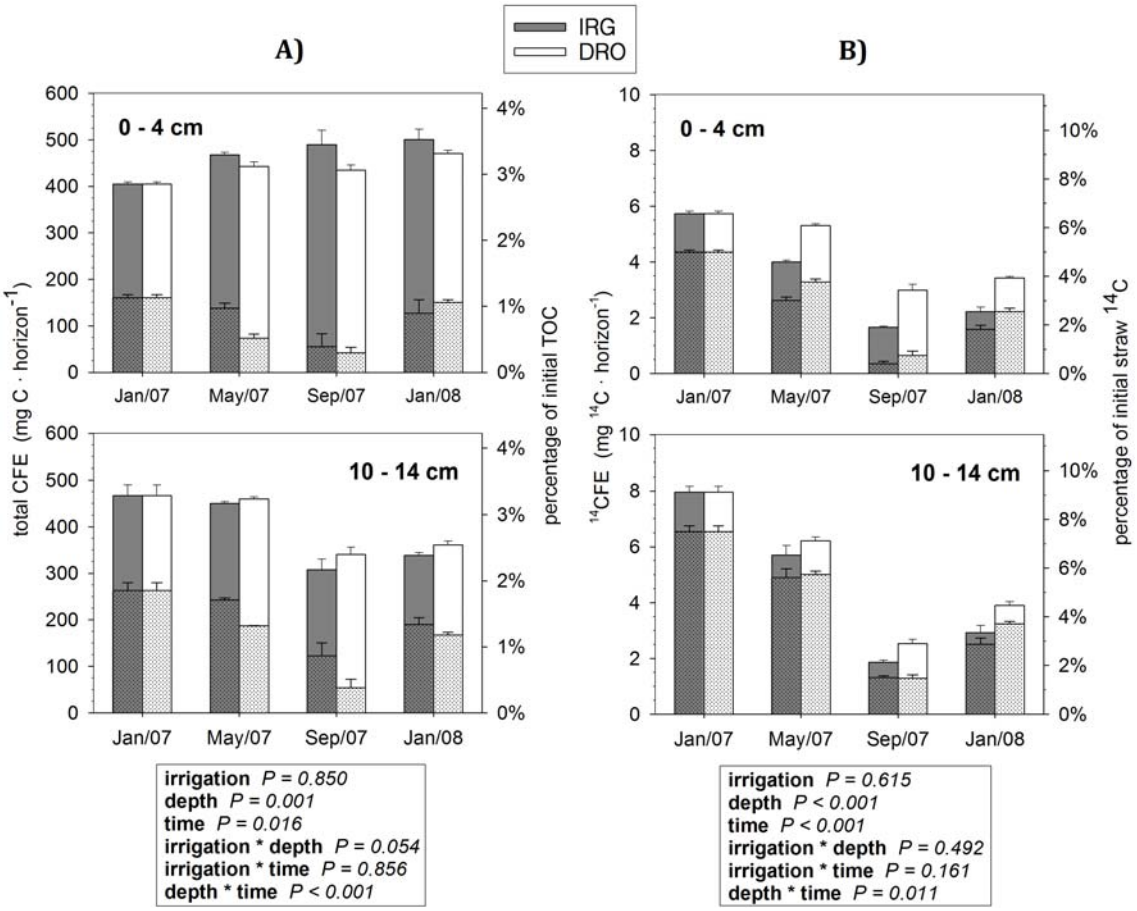

FIGURE 3 Evolution of the $CHCl_3$-fumigated extractable organic C fraction (CFE) of the agricultural soil horizons along the four destructive samplings (mean ± SE; n = 3 except for Jan/07: n = 4). **A)** bulk SOM-derived organic C (TOC); **B)** straw-derived ^{14}C. Dotted areas indicate the microbial biomass C (MBC; Vance et al. 1987). Statistics refer to CFE fractions.

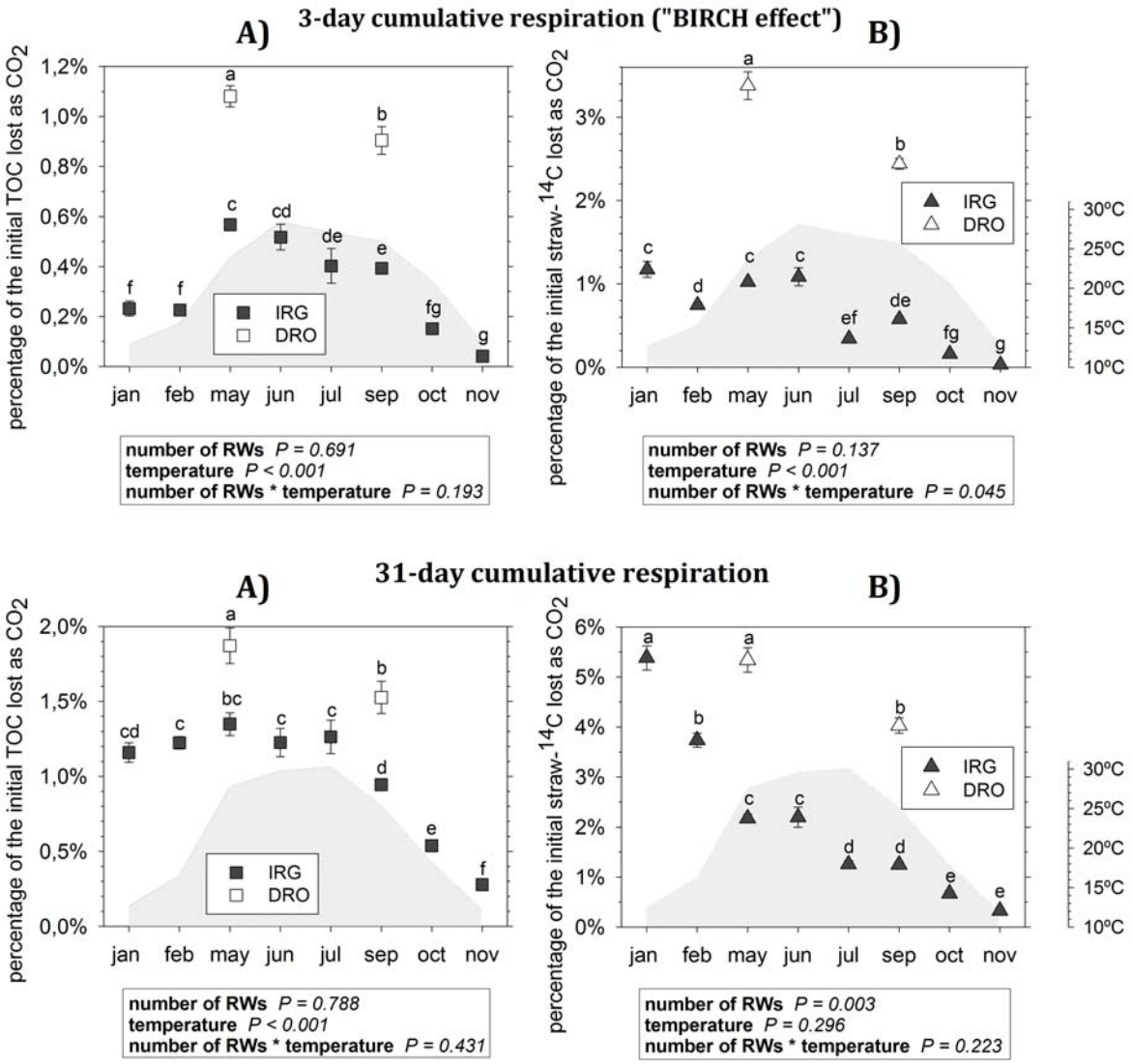

FIGURE 6 Cumulative post-rewetting CO_2–C losses (soil heterotrophic respiration) from the surface agricultural horizons during the first 3 post-rewetting days ("Birch effect"; above) and the first 31 days after the rewetting (below); mean ± SE; n = 2. **A)** CO_2 derived from bulk SOM respiration; **B)** straw-^{14}C respiration. Grey areas represent the mean soil temperature for the assessed periods. GLMs were applied for assessing the statistical significance of soil *temperature* and previous *number of rewettings* (RWs) factors. Duncan post-hoc analyses were performed for comparing the values in each graph (SPSS 15.0 for Windows).

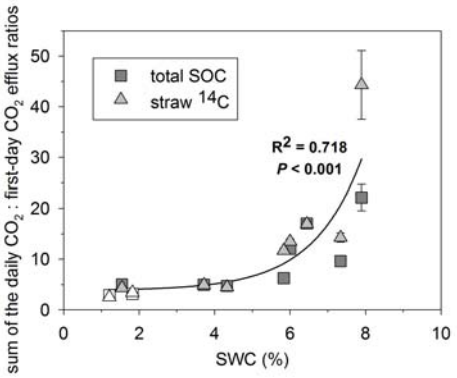

FIGURE 8 Relation between the dryness of the surface horizons before rewetting (volumetric soil water content, %) and the shape of the heterotrophic respiration response along the subsequent 31 days (grey area from CO_2 efflux standardization, see Figure 7). N = 20 (each form is mean ± SE; n = 2). White forms are DRO treatment.

4. Future collaboration with host institution

The research group of Dr. Iain Hartley (*University of Exeter*, UK) is one of proven expertise dealing with the microbial mineralization of soil organic substrates with different quality and its dependence on environmental factors.

Future collaborations to be held on the spring - summer time within this year have been already agreed, in order to additionally apply C modelling tools on the CO_2 data-set. This will enable us to enhance our comprehension of the CO_2-C effluxes from a more mechanistic point of view, comparing the obtained evolution of soil respiration of both bulk SOM and fresh straw debris throughout a year with that predicted by the most commonly-used models for soil organic C dynamics (Roth C, Century, Yasso07). These planned collaborations will extend the aim and benefits of the MOLTER fellowship into further research work and, hopefully, articles.

5. Projected publications

A manuscript regarding the work carried out during the MOLTER exchange visit is being elaborated and it is currently near completion, and almost-ready to be submitted to journal:

Short- and long-term post-rewetting responses in soil OM mineralization under severe drying conditions: relation with pre-wetting levels of microbial and extractable organic C

Authors: Luis Lopez-Sangil, Iain Hartley, Pere Rovira, Pere Casals

The valuable help given by the European Science Foundation through the conceded MOLTER exchange visit grant will be for sure recognized within the ‘acknowledge’ section of the future publication.

6. Other comments

Please, note that the MOLTER exchange visit grant was initially conceded for 8 weeks, and scheduled for starting on 1st October 2012. For personal reasons (birth of my son), I had to reformulate the starting date (14th January 2013) and the length of my visit to Exeter (4 weeks). As I was already given in advance the 80% of the grant, I will be waiting for instructions in order to return the surplus amount of money.

Thank you very much for all the comprehension.

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