Influence of climate, soil and vegetation on rain pulses responses in seasonal drought ecosystems (or across different ecosystems): a synthesis based on Fluxnet data

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Outline

1/ Everyone observed respiration rain pulses, from temperate to arid ecosystems, and even in boreal climate. The first step is to realize a typology of these pulses: 1/ describe patterns and magnitude in different ecosystems and climates, 2/ look at enhancement and persistence, and effect on Q_{10}, 3/ try to isolate the main controlling factors in these different ecosystems: seasonality, antecedent soil moisture and temperature, previous respiration rate, previous pulses, role of labile vs more protected or recalcitrant C pools...

2/ The second question is: does it really matter for long-term ecosystem carbon balance? If only very soil labile carbon pools are decomposed, then it would not matter too much since this pool would be eventually decomposed during early fall or winter rainfalls. Two main questions are 1/ do these pulses affect more recalcitrant organic matter? 2/ do these pulses affect protection processes by which labile carbon are transformed into recalcitrant? These are difficult questions to address only based on field data, but we might be able to have further insight using combining several database: 1/ comparing flux data from ecosystems with different C pools, 2/ using data from manipulations experiment (trench vs control, control vs irrigation,…), 3/ using data from lab incubations.

3/ The third point is that current standardized eddy-covariance data measurement and treatment techniques failed to reproduce these respiration pulses satisfactorily. Some current measurement techniques, as the use of open-path CO_2 sensor (e.g. LI-7500) may lead to selective systematic error due to under-sampling of higher respiratory fluxes associated to these pulses because of the removal of data during rain events. Some of the respiration pulses might be underestimated, and thus annual NEE estimates from eddy covariance data could be significantly biased in some ecosystems because of underestimation of respiration. In addition, the strong discontinuities induced by these respiration pulses in NEE series are not correctly reproduced by current gap-filling methods (MDS, NN,...). In case of moderate rain pulses, significant respiration pulses are observed in some ecosystems, whereas none of the soil water content sensors "see" the rain event, because water does not penetrate the soil deep enough. For such reasons, there is a need to develop semi-empirical model(s) to reproduce correctly both the magnitude and the dynamic of these pulses which can be very important.

4/ Considering all of the above, the last question is: what will be the influence of future climate change? Most RGCM predicts warmer and dryer conditions for Mediterranean ecosystems, and more convection storms in late summer. This will eventually affect the respiration pulses “climatology” in these ecosystems. Based on the knowledge developed above, we could modify current model such as Century, to take into account the effect of

summer respiration rain pulses correctly across ecosystem. Then we could realize some run for future climate and look at the effect on a more global scale onto C balance of dry and more vulnerable ecosystems.

Proposing group

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Sites involved

First, we would like to look at data from seasonally drought ecosystems, e.g. ecosystems that systematically experience a drought season. We did a pre-selection of 25 sites at the workshop in La Thuille. These sites are in United States, Europe and Mediterranean Basin, Africa (for example: France-Puechabon, Italy-Tolfa, Spain-Majadas, Portugal-Mitra, California-Tonzi-Vaira-Blodgett-Jasper Ridge, Oregon-Metolius, South Africa, Israel-Yatir,…). Then we would like to extend to temperate ecosystems to see if rain pulses have similar effects.

Data

We need to look at eddy-covariance fluxes and ecosystem NEE to have an idea at ecosystem level. If available, we should also look at CO_2 profile in the canopy, which can give us a good idea at CO_2 production in the lower part of the canopy when eddy-fluxes are not reliable during rain. We also need soil CO_2 efflux data, and ideally soil CO_2 concentration profile (e.g. from Vaisala sensors). We will try to gather data on manipulative experiment (e.g. MIND project): rain exclusion (or throughfall displacement), irrigation, trenching… (for example: California-Blodgett, Arizona-Santa Rita Experimental Range, France-Puechabon, Italie-Tolfa, Spain-Majadas,…). Ideally it would be great to get some data from laboratory incubation.

Rules for co-authorship

We would involve at least 1 co-author for each site. We would consider involving more co-author per site based on intellectual input.