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Speed of Carbon Cycling in Grassland Ecosystems by Destructive and Non-destructive Techniques

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The allocation of recently assimilated C to below- vs. aboveground plant components and the time this C remains inside the ecosystem are the key uncertainties in global terrestrial C models. Recent studies reported the time lag between the photosynthetic C uptake and its following respiration through the rooting systems in the magnitude from minutes to days. Studies *in situ* are still not numerous, covering few plant functional types and ecosystems. The methodology is not unique, destructive and non-destructive techniques with different shortcomings are involved and it is not clear if obtained results are comparable.

In situ pulse labeling of plants in $^{13}CO_2$atmosphere was performed in a Mediterranean grassland site (Amplero, Italy), aiming to advance the understanding of allocation patterns and speed of cycling of recently assimilated C in such types of ecosystem. Raw isotopic values of respired $^{13}CO_2$, mean residence time and mean age of this C in aboveground and belowground compartments were estimated. Time lag between photosynthesis and root-derived respiration was obtained also by destructive mesh exclusion technique, performing bimonthly measurements of soil respiration and its components and relating this data to the changes in gross primary production (GPP) from eddy covariance station installed in the study site.

Two distinct pools of C were recognized: a fast turning over pool, which integrates the assimilates of the current day and fuels mainly aboveground respiration, and slower turning over pool which integrates C with higher mean residence time and fuels mainly belowground respiration. The peak in aboveground respiration happened between 2 and 4 hours after the pulse labeling. Root-derived respiration of recently assimilated $^{13}CO_2$ peaked between 16-24 hours after the label introduction. The last value goes in accord with the time lag of 20 hours obtained by destructive mesh exclusion method. The fact that such type of partitioning technique is widely used in environmental studies, and is often coupled with eddy covariance measurements makes it promising for the estimation of the speed of C cycling within and between ecosystems, however up to now it was rarely used for this purposes.