Geophysical Research Abstracts
Vol. 13, EGU2011-4602, 2011
EGU General Assembly 2011
© Author(s) 2011

Combining continuous soil respiration and eddy covariance measurements to assess environmental controls on soil respiration and gross primary production

Leonardo Montagnani (1), Damiano Zanotelli (1), Christian Ceccon (1), Giovanni Manca (2), and Massimo Tagliavini (1)

(1) Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy (leonardo.montagnani@unibz.it), (2) Rende Division, Institute for Atmospheric Pollution, Consiglio Nazionale delle Ricerche, Rende, Italy (g.manca@iia.cnr.it)

In terrestrial ecosystems, respiration is primarily driven by assimilation, although relevant differences in the ratio between respiratory and photosynthetic or net flux have been found in previous studies. Information retrieved from eddy covariance measurements on the ratio between total ecosystem respiration (TER) and gross primary production (GPP) is elusive both on spatial and temporal scales. In fact, there are inherent difficulties in properly assessing the night-based TER, due to the frequent low turbulence conditions, while GPP estimates, partly relying on daytime measurements, are more robust, although possibly self-correlated with TER.

To explore the environmental controls on respiration and photosynthesis variability, we used two independent systems that continuously measured the largest component of TER (soil respiration, SR) and the net ecosystem exchange (NEE). SR was measured at half-hour time steps by an array of 8 multiplexed soil chambers (Li 8100-104, Lincoln, NE, USA), placed at 20 different locations rotated over time, combined with extensive measurements performed with a survey chamber. NEE was measured by a standard eddy covariance system, and GPP was modeled through a flux partitioning method, using data that were quality tested for turbulence and stationarity. The research was carried out in an agricultural field, an apple orchard located in South Tyrol, Italy, where nitrogen and water availability varied across time and space.

We observed that GPP explained much of the day-to-day variability in SR during the growing season. The correlation coefficient between GPP and SR peaked with a time lag of one day, with a correlation coefficient r=0.66. Contrary to what is observed in most forest sites, we found that high soil water content (SWC), when exceeding 30% Vol Vol^{-1}, was a strong limiting factor for soil respiration (50% reduction in SR with a soil water content increase from 30% to 36%), and to a lesser extent for GPP. Similarly, the positive temperature control on SR was higher than on GPP. As a result, from May to October, the daily SR/GPP ratio decreased by 39% in the upper 25^{th} percentile of the SWC range with respect to the average, favoring carbon sequestration, and increased by 23% in the upper 25^{th} percentile of the soil thermal range.

Results obtained from this research are site specific, and cannot be extrapolated to other sites which have different climate or management systems. To establish to which extent, and in which locations, SWC is a driver for the SR/GPP relation, similar studies should be replicated in water limited environments, possibly with a standardized measurement protocol. This will allow global modeled estimates of GPP to be linked to estimates of sequestered carbon in soils, which are suggested to be controlled by temperature and water availability on the global scale.