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EVALUATING AUTOTROPHIC AND HETEROTROPHIC RESPIRATION IN AN OAK GRASS SAVANNA USING FLUX-GRADIENT MEASUREMENTS OF SOIL RESPIRATION WITH NEW INFRA-RED CO_2 SENSORS

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1. INTRODUCTION

In order to assess gross photosynthesis from measurements of net ecosystem carbon exchange, we must first evaluate ecosystem respiration and partition it into its autotrophic and heterotrophic components. It is preferable to develop a method that is non-destructive, has minimal intrusion and can be operated in a continuous mode.

In this study we measured soil CO_2 efflux under an oak tree and in the open grassland between trees using profiles of new CO_2 sensors, buried in the soil, to assess the separate contributions of autotrophs and heterotrophs to soil respiration.

2. MATERIALS AND METHODS

The field study was conducted at an oak-grass savanna (38.4311°N, 120.9660°W and 177 m), near Ione, California, USA. The climate is Mediterranean — hot and dry with almost no rain during the summer and relatively cool and wet during the winter. The overstory of the savanna consists of scattered blue oak trees (*Quercus douglasii*). The ratio of crown area over the whole ground area, or crown closure, was 42.4%. The understory grass and herbs are annual species.

CO_2 efflux was computed based on Fick's first law of diffusion. CO_2 concentration gradients in the soil were measured with 3 solid-state infrared gas analyzers (GMT 222, Vaisala, Finland) (Tang et al., 2003). Each profile consisted of sensors buried at 0.02, 0.08 and 0.16 m. One set of sensors was under a tree, one meter from the bole. The other set of instruments was in an open area, 18 m from the nearest tree and away from the influence of tree roots (Tang and Baldocchi, 2004). CO_2 diffusivity in soils was computed as a function of soil volumetric water content, soil texture (Moldrup et al., 1999), and was corrected for temperature and pressure.

These two flux-gradient measurement systems were located along a transect where we measured the spatial variation of soil respiration, and corresponding soil temperature and moisture. The period chamber measurement of soil respiration along the transect was made by a portable photosynthesis system (LI-6400-09, Licor Inc, Nebraska, USA).

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3. RESULTS AND DISCUSSION

The magnitude of soil CO_2 efflux and the processes controlling it were a function of position. During the summer period, when the grass was dead, CO_2 efflux from the open area was relatively low (below 0.45 μmol m^{-2} s^{-1}) and a strong function of soil temperature (Figure1).

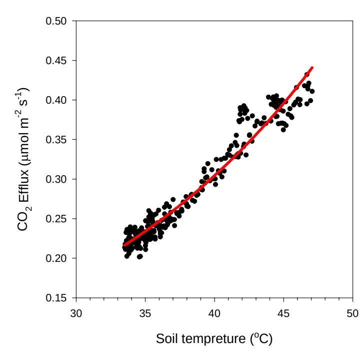

Figure 1. Response of soil CO_2 efflux to temperature. Respiration was measured

from a patch of dead grass during the summer.

The magnitude of CO_2 evolution remained very low due to the excessively dry nature of the soil; sol moisture was less than 7%. Conversely, CO_2 effluxes under the tree were nearly ten times greater than effluxes from the open, at similar temperatures (Figure 2), even though the soil was excessively dry there, too. Furthermore, CO_2 effluxes exhibited considerable hysteresis with respect to the daily course in soil temperature. Comparing these rates with canopy photosynthesis measurements suggests that soil respiration is feed by carbon produced by recent photosynthesis. Consequently, the hysteresis is eliminated when we compare soil respiration with photosynthesis that has been lagged by 7 to 12 hours (depending on the season).

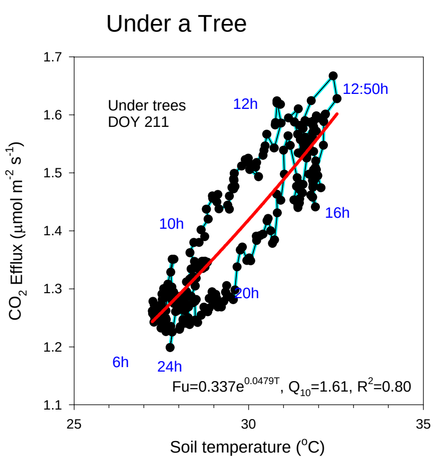

Figure 2. Response of soil CO_2 efflux to temperature. Respiration was measured under an oak tree during the summer.

4. REFERENCES

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