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Understanding Soil Respiration: an Integrated Approach

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Introduction: Spatial and Temporal Variation in Soil Respiration

Soil respiration and carbon balance

- Soil respiration is a key factor for understanding the responses of terrestrial ecosystems to climate change, and it is crucial to understand the effects of variation in biophysical regulators of soil respiration for assessing carbon balance of forested temperate ecosystem.

Figure 1. Natural spatial gradients at the James Reserve to study soil respiration. A) closed forest understory site, B) open forest understory site.

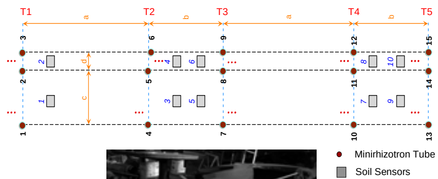
Study Site: San Jacinto Mountains, CA

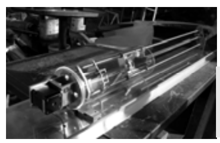
- The James San Jacinto Mountains Reserve is a networked ecological observatory and a test site for experimental embedded networked sensors (ENS).
- We used natural spatial gradients within a mountain mixed conifer forest to determined spatial and temporal variation in soil respiration rates.

Problem Description: Biotic and Abiotic Regulators of Soil Respiration

Spatio-temporal variation

- One fundamental challenge for soil research is the spatial and temporal heterogeneity of soil processes. Therefore, we deployed a dense array of soil sensor in combination with minirhizotrons to study variation in soil temperature, moisture, root production, and rhizomorph production on soil respiration within natural spatial gradients at the James Reserve.



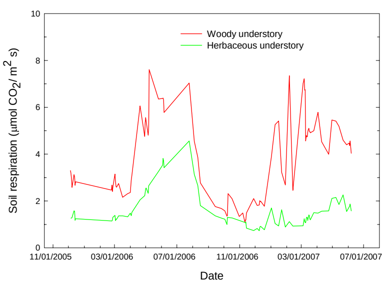


•**Figure 2.** Schematic of sensor array along the AMARRS transect (above). Automated minirhizotron to study fine root production and turnover (below).

•. ENS technology is leading to new understanding of spatio-temporal rhizosphere processes.

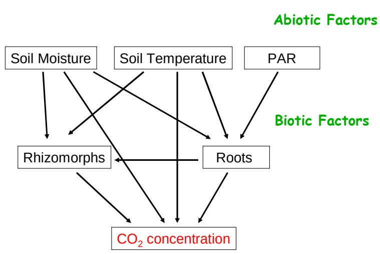
Proposed Solution: Structural Equation Modeling: an Integrated Approach

Variation in Soil Respiration



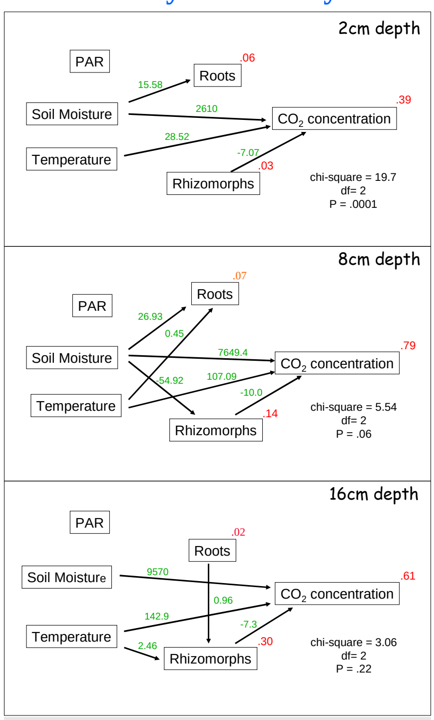
•**Figure 3.** We modeled soil respiration using continuous measurements from a network of soil CO_2 sensors buried at three depths (2, 8, 16 cm) from December 2005 to May 2007 at the James Reserve.

Conceptual Model



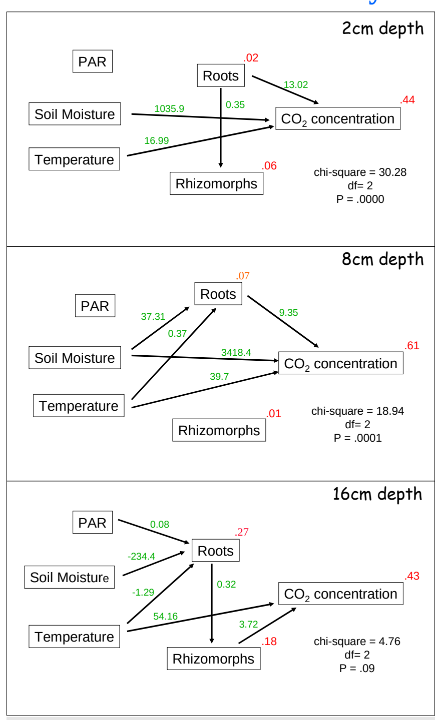
•**Figure 4.** Path diagram demonstrating the hypothesized casual relationship among soil moisture, soil temperature, photosynthetically active radiation (PAR), root growth, rhizomorph growth, and CO_2 concentration within the soil profile.

Woody Understory



•**Figure 5.** Path diagram demonstrating the casual relationship among aboitic factors, biotic factors, and soil CO_2 concentration at three different depths in the woody understory. Shown regression weight (green) are significant ($P < 0.05$). Diagrams with the goodness-of-fit statistic greater than 0.05 represents possible causal explanation for the correlation structure among variables.

Herbaceous Understory



•**Figure 6.** Path diagram demonstrating the casual relationship among aboitic factors, biotic factors, and soil CO_2 concentration in the herbaceous understory. Shown regression weight (green) are significant ($P < 0.05$). Diagrams with the goodness-of-fit statistic greater than 0.05 represents possible causal explanation for the correlation structure among variables.