Impacts of Topography on CO_2 Flux

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Introduction

The carbon cycle is essential to the health of every ecosystem on Earth. Tropical forests play an important role in the global carbon cycle as one of Earth's most efficient carbon sinks. Almost half of the carbon in these forests is stored in their soil. However, these forests are quickly disappearing, and much is still unknown about how soil organisms respond to natural disturbances and differences in environment. Our goal with this research was to ascertain whether a relationship exists between soil respiration and topography within the context of a major drought. Previous research indicates that topography plays important roles in plant structure, soil biomes, and soil organic matter. We plan to further this research by investigating the relationship between CO_2 flux and topography during the severe 2015 Caribbean drought. We predict that CO_2 flux will vary depending on topographic location.

Methods

To understand this relationship, we analyzed data collected from 2015-2016 by Dr. Whendee Silver from UC Berkeley. Silver et al. placed 9 gas flux sensors along a hillside at the El Verde Research Station in Puerto Rico:

- 3 on the ridge
- 3 on the slope
- 3 in the valley

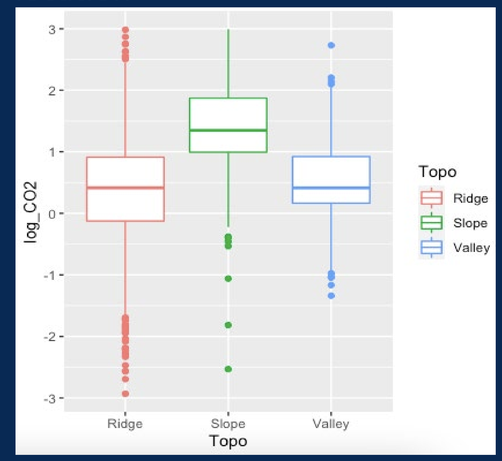
The specific elevations of these sites are unknown. Twelve measurements were taken from each sensor each day for a year. With this data, we performed multiple regression to analyze the overall trends of CO_2 flux ($\mu molm^2s^{-1}$) during time of day in each location. We adjusted our models to log(CO_2_flux) in order to normalize the distribution (Figure 2).

Results

The results from our multiple regression test indicated:

- CO_2 flux rates are significantly higher on the slope locations than those on the ridge.
- Both results from the ridge and the slope are statistically significant ($p = <0.0001$)
- Results from the valley are marginally insignificant ($p = 0.15$)
- Time of day had no significant impact on CO_2 flux.

Figure 2 – Adjusted distribution of CO_2 flux over topographic location



CO_2 flux is significantly higher on the slope than the other locations

Figure 1 – Left: Photo of El Yunque National Forest, Puerto Rico. Right: Example of a soil gas flux chamber

El Yunque National Forest is home to the El Verde Research Station, where this data was collected.

Conclusions

Based on our results, we can see that topography impacts the rates of soil respiration. Regarding the lack of correlation in the valley location, we infer that moisture likely played a role in CO_2 flux. Soil respiration increases with moisture until it becomes too waterlogged. Our guess is that the well drained slope sites received optimal moisture for respiration while the valley became too waterlogged for consistent respiration. However, this would not explain the lower flux readings on the ridge. Another likely possibility is the variation in vegetation across the different elevations producing different levels of respiration. Further investigation is required in order to understand the impacts of these variables.

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