Temperature dependency of anaerobic microbial activities in a tropical vs. temperate soil

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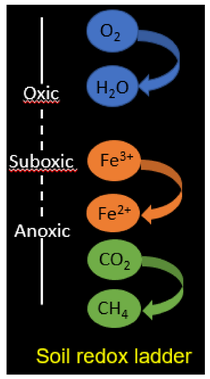
Introduction

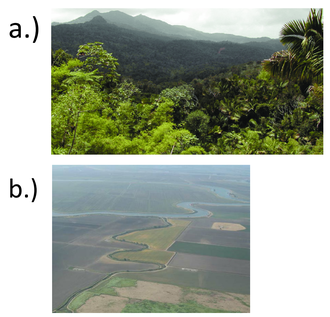
- Increased temperature and rainfall are predicted in regions associated with human-induced climate change, especially in the tropics.
- Wetter soils are more likely to experience periodic low redox events.
- Anaerobic processes like methane (CH_4) production and iron (Fe) reduction are more favorable in lower redox environments.
- Though CO_2 respiration rate is known to be positively correlated with temperature, temperature sensitivity of anaerobic soil processes is poorly quantified.

Research question: How can simultaneous variations in redox and temperature affect soil biogeochemical processes including:

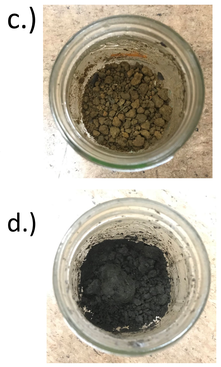
- **Carbon dioxide (CO_2) respiration**
- **Methane (CH_4) production**
- **Iron (Fe) reduction**



Methods

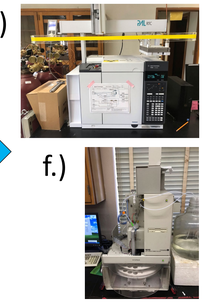


Soil was sampled from a.) Luquillo Experimental Forest in Puerto Rico and b.) Sacramento-San Joaquin River Delta in California.



c.) PR and d.) CA soils were incubated at 8, 26, and 35 C in oxic and anoxic environments for 4 weeks.

Microcosms were gas sampled every day for week 1, every third day for weeks 2-4. Sampled for Fe(II) and total Fe at the end of each week, and microbial biomass at the end of first and fourth weeks.



Gas samples analyzed for CO_2, CH_4, N_2O on e.) Agilent GC. Fe measured using ferrozine spectrophotometry. DOC measured on f.) O-I Analytical TICTOC analyzer

Results

CO_2 Respiration

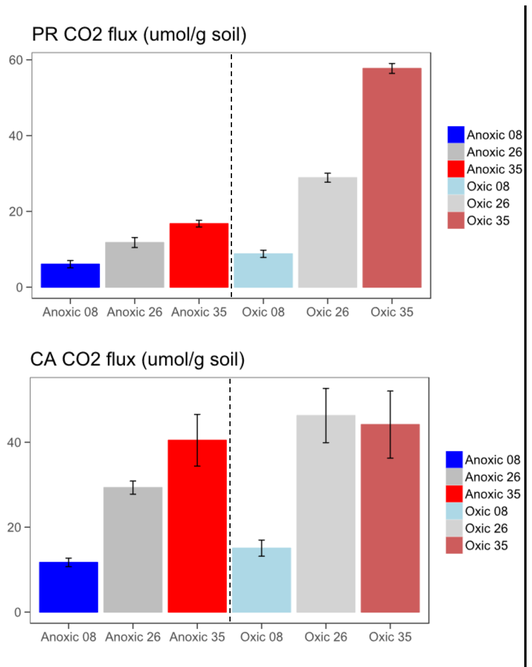


Fig. 1. Sum of 3-hour period CO_2 fluxes measured over course of experiment in PR and CA soils.

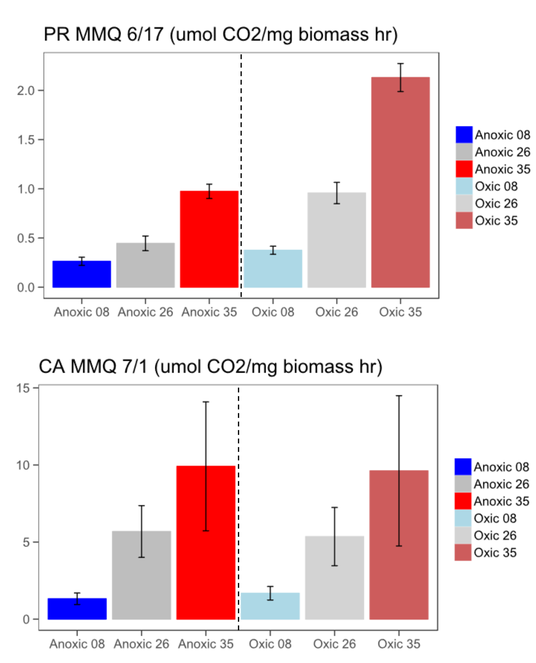


Fig. 2. Microbial metabolic quotient (MMQ) for PR and CA soils: CO_2 flux per unit of microbial biomass.

Anaerobic Processes

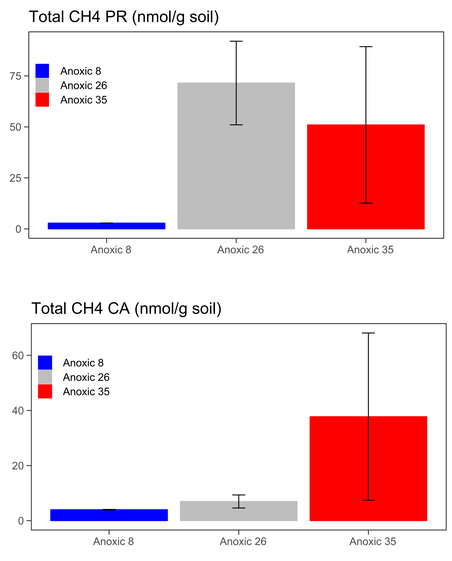


Fig. 3. Sum of 3-hour period CH_4 fluxes measured over course of experiment in anoxic PR and CA soils.

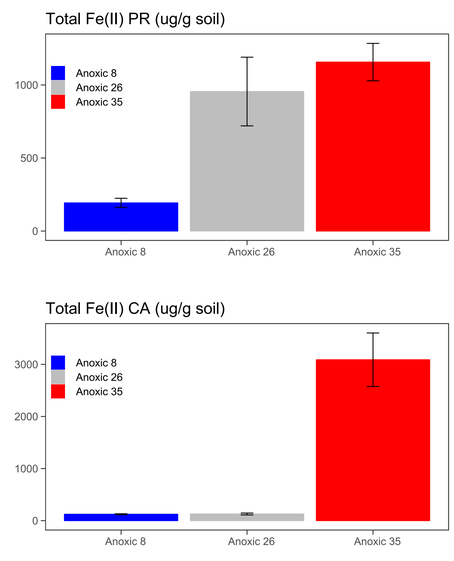


Fig. 4. Total reduced Fe(II) measured after 4 weeks of incubation.

Conclusions

- Anaerobic processes (CH_4 production, Fe reduction) do not follow temperature sensitivity responses exhibited by CO_2 respiration
- Standardization of CO_2 respiration by microbial biomass increases Q_{10} values, suggesting temperature sensitivity of soil biogeochemical processes is influenced by both biomass size and rate
- Variability in temperature sensitivity of CH_4 production and Fe reduction may be attributable to C availability, or a temperature threshold for anaerobic microbial activity
- If PR pattern holds true in other tropical soils, anaerobic conditions may be able to limit loss of SOM and soil GHG production in warmer, wetter climate

Future Research

Repeat experimentation with altered venting procedure, may correct for fluxing variability.
Expand sample size to include tropical forest soils from other field sites.
Introduce artificial C inputs to PR mesocosms to determine if temperature sensitivity of methanogenesis may be function of C availability.

References

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