Alteration of Biogenic Gas Dynamics in the Everglades Due to Temperature Variations

Mario Job, Mitchell Collins, and Xavier Comas

Florida Atlantic University, Department of Geosciences

How increasing temperatures in the Everglades may alter biogenic gas dynamics (gas accumulation and releases) within the peat soil?

1. Abstract / Introduction

- Average temperatures in subtropical peatlands such as the Everglades are expected to increase by two degrees Celsius over the next fifty years, with some models indicating even a greater increase. For that reason it is important to understand how the accumulation and release of biogenic gases in peat soils (mainly in the form of methane and carbon dioxide, two powerful greenhouse gases) are affected by such increase. Studies conducted on northern peatlands indicate a direct correlation between increased temperature and increased efficiency in methanogen productivity. It is expected that in the subtropical Everglades (very active producers of biogenic gases throughout the year) a similar correlation should occur, however few studies have described such response, and to our knowledge no study has utilized methods to infer internal changes in gas dynamics within the peat matrix as temperature increases in the Everglades. The goal of this work is to measure the impact of temperature variations in the accumulation and release of biogenic gases in the peat column in several peat soils from the Everglades. Ground penetrating radar (GPR) will be used in conjunction with time-lapse photography, gas chromatography, and soil moisture probes to estimate changes in gas accumulation and release within the peat matrix, and to infer changes in gas production and flux release. This work has potential implications for current models related to climate change and their effects on carbon dynamics in the Everglades.

2. Methods

- Ground penetrating radar (GPR) measurements taken with Mala 1.2 GHz antenna
- Gas traps collected gas that was analyzed with a Shimadzu gas chromatograph GC-8A
- Temperature and moisture content measured and collected with Decagon moisture probe and Em50 data logger
- Complex refractive index model (CRIM) used to calculate gas content

$$\varepsilon_{r(b)}{}^{\alpha} = \theta\varepsilon_{r(w)}{}^{\alpha} + (1-n)\varepsilon_{r(s)}{}^{\alpha} + (n-\theta)\varepsilon_{r(a)}{}^{\alpha}$$

Assuming

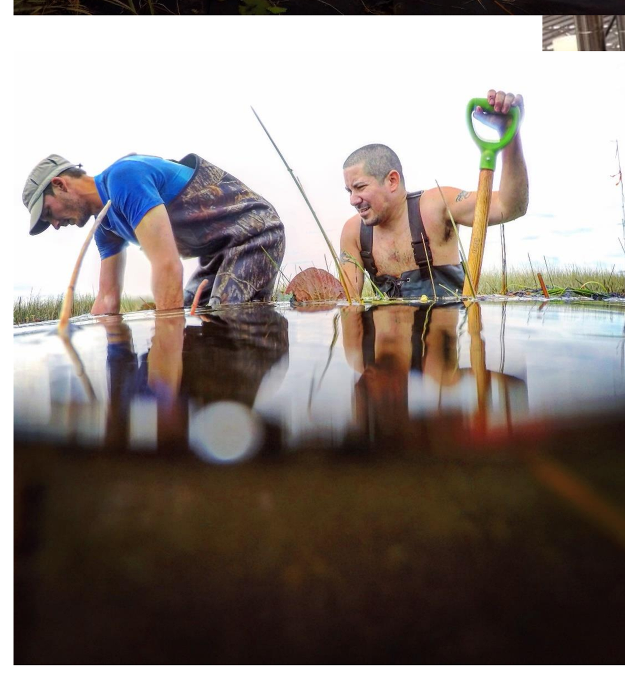
n = 96%

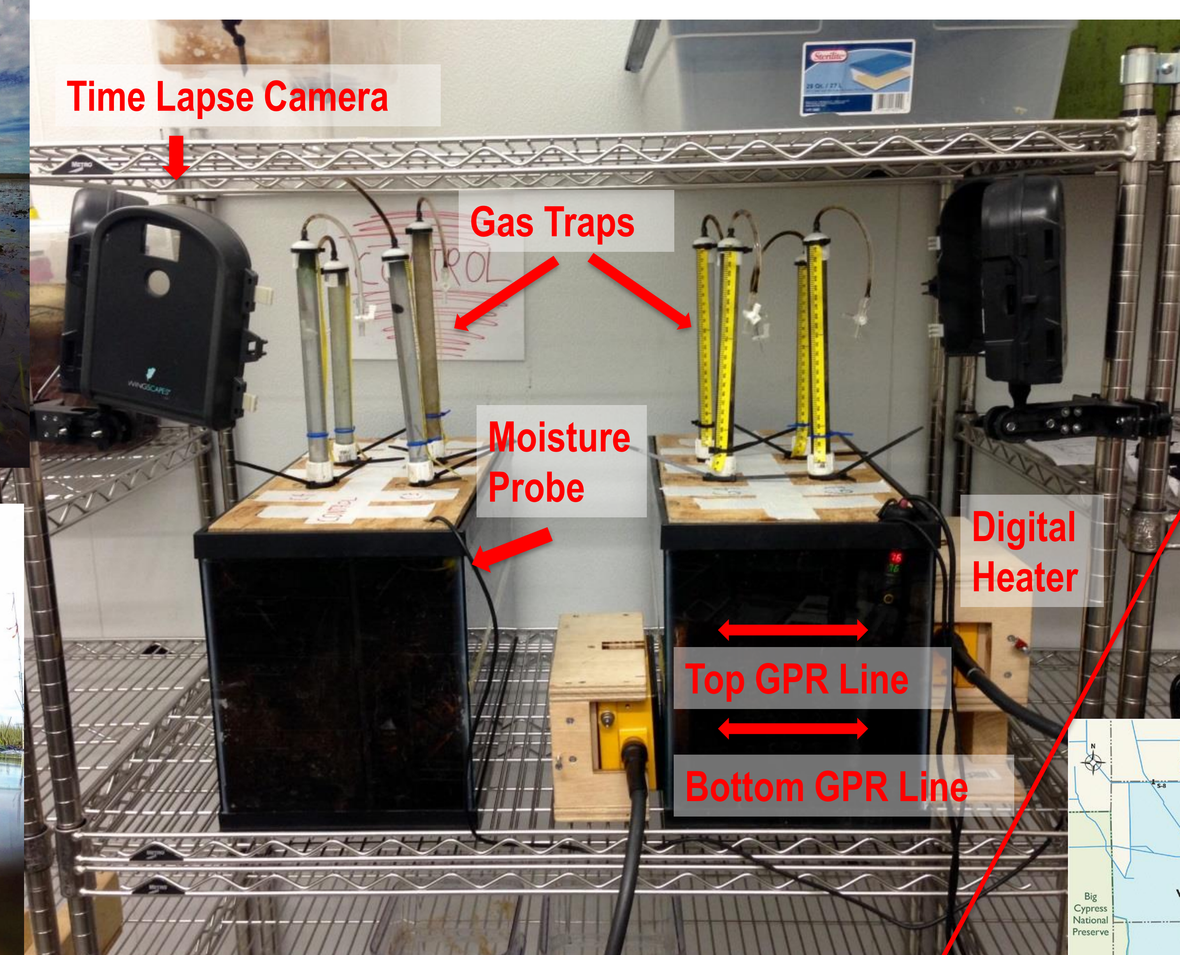
$\varepsilon_{r(s)}$ = 2

α = .35

$$v = \frac{c_0}{\sqrt{\varepsilon_{r(b)}}}$$

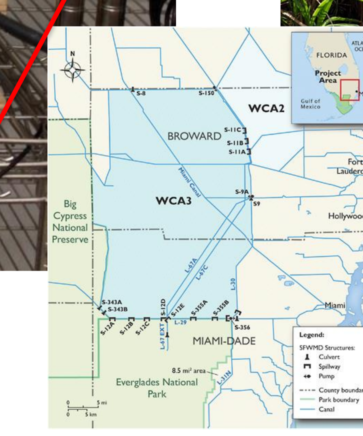
3. Experimental Setup

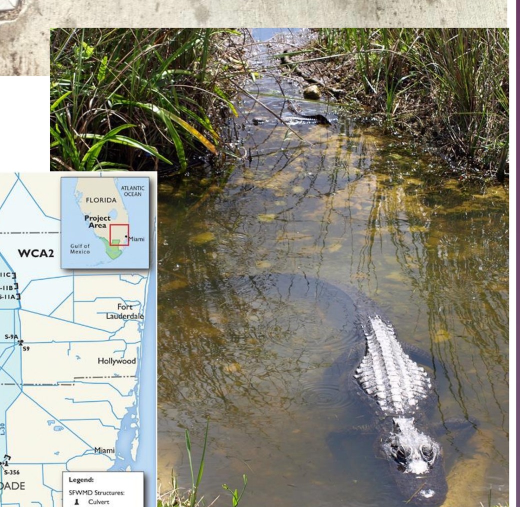




Sample 2 (Control)

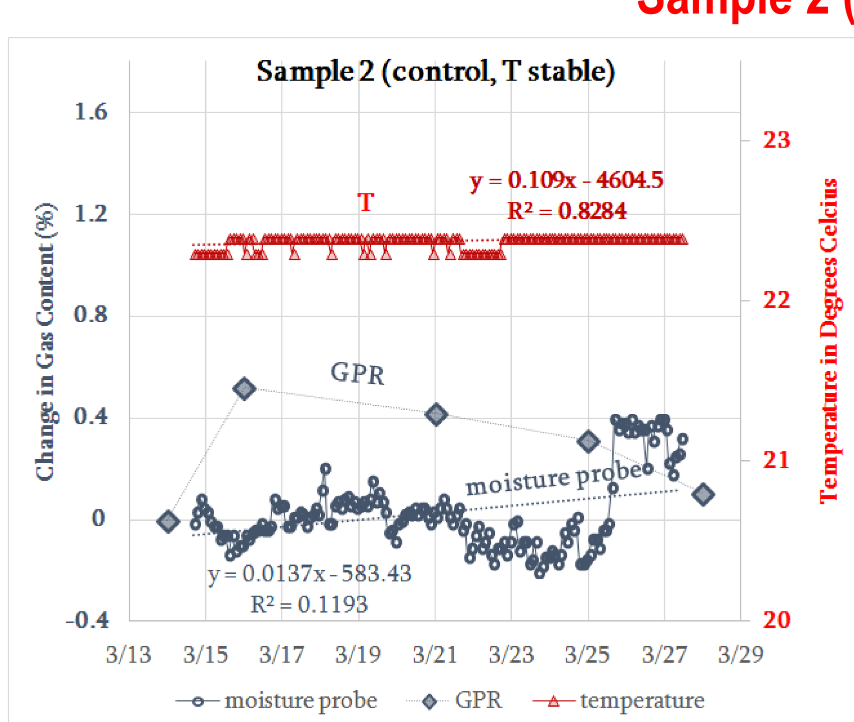
Sample 1 (T increase)

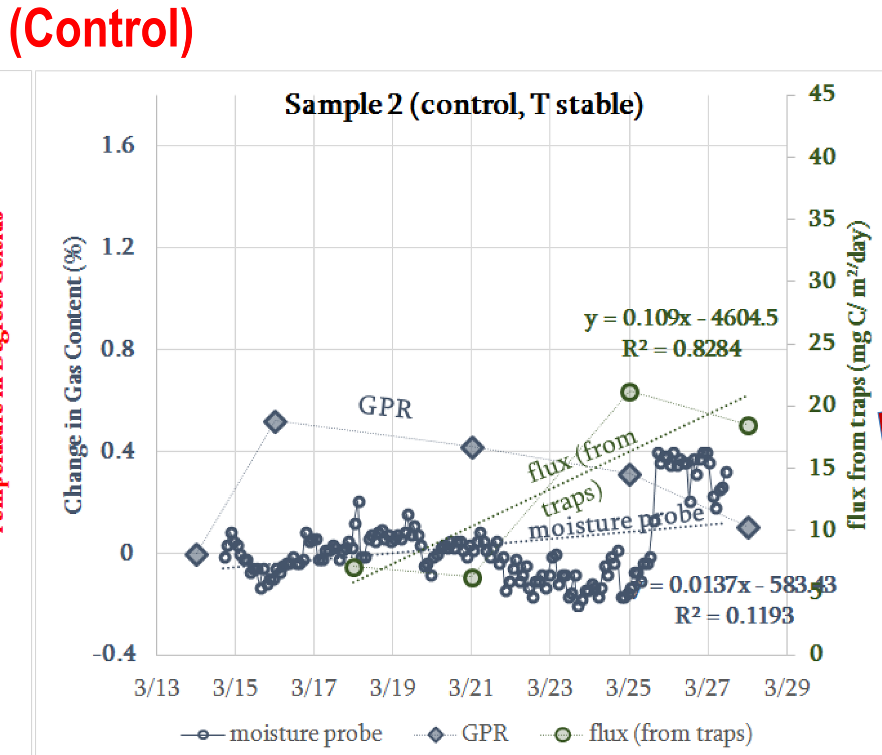




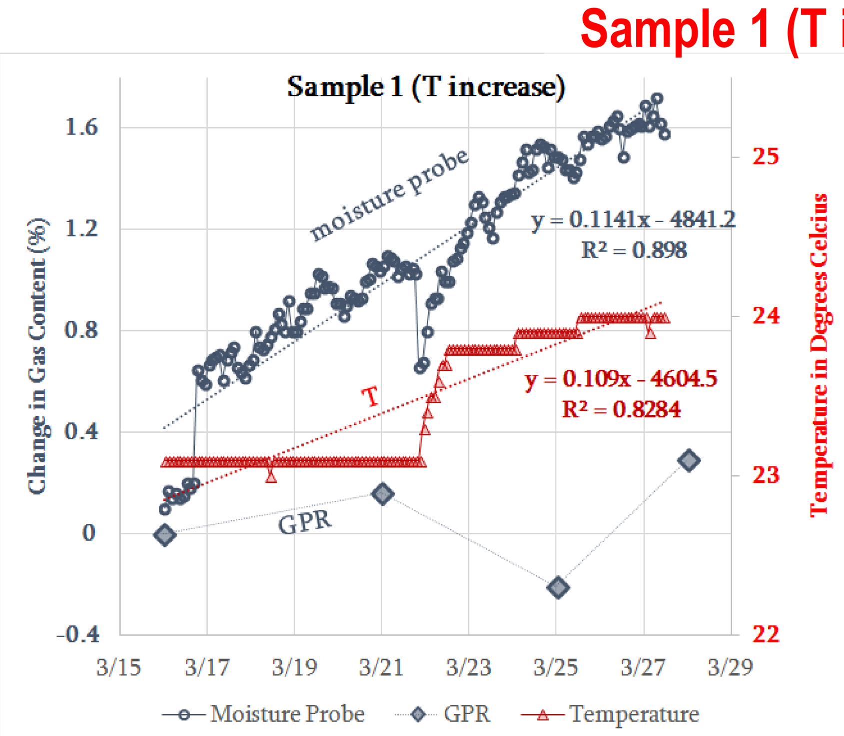
4. Results

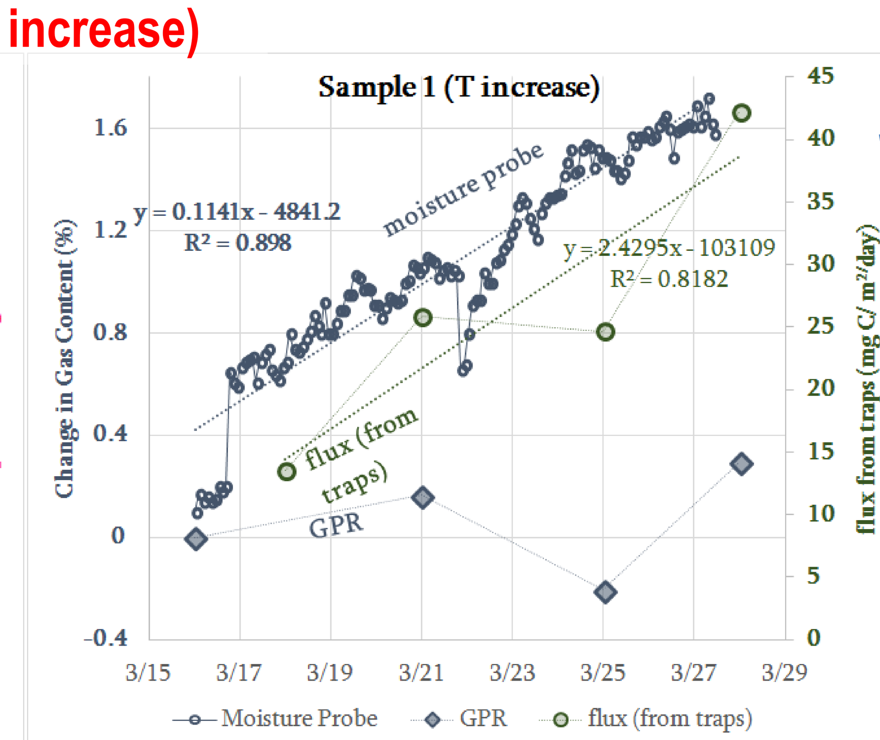
Sample 2 (Control)



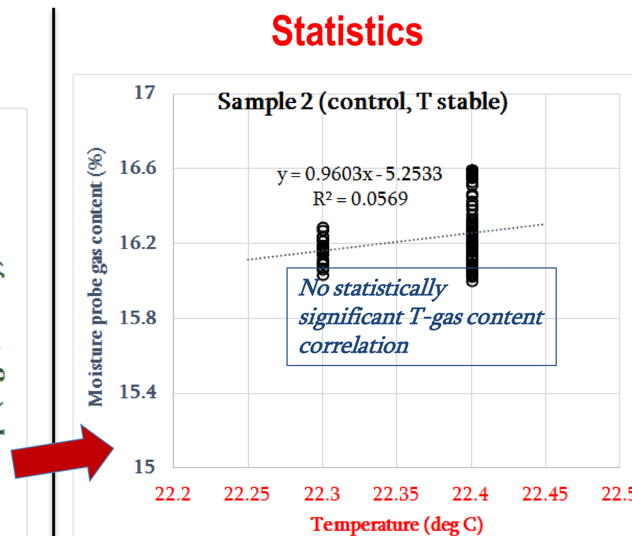


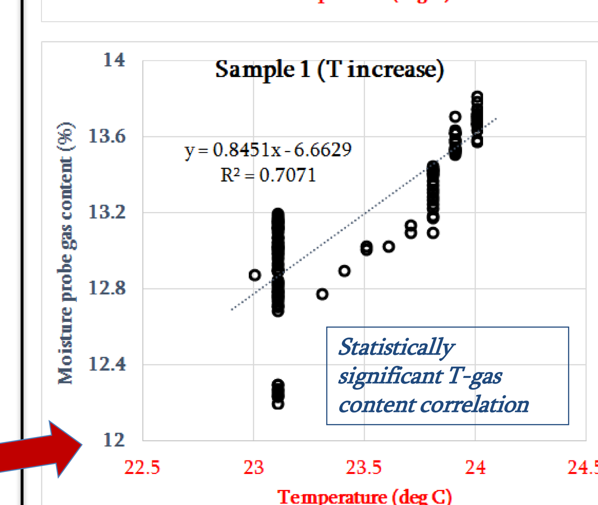
Sample 1 (T increase)

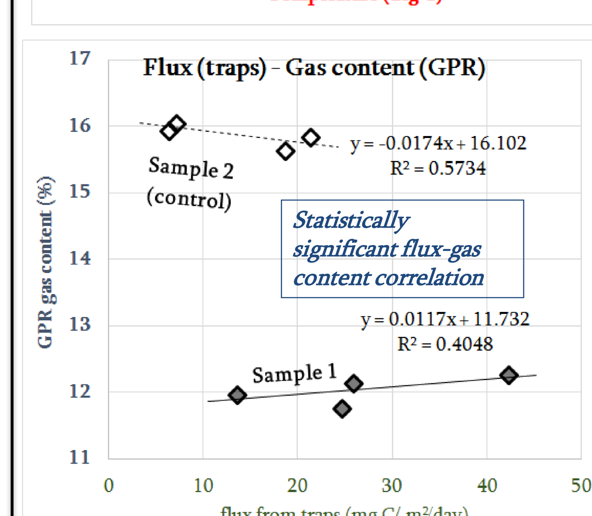




Statistics







5. Discussion / Conclusions

- Although only in the preliminary stages, this work shows a *positive correlation between increased gas content and T*:
  - An increase in T of only 1 deg C results in gas contents within the peat matrix that triplicate the control sample (with constant T) as measured from moisture probes.
  - This is consistent with the fluxes as measured from gas traps, with values *increasing from 14 to 42 mg C/m²/day after 1 deg C increase in T*.
  - Gas content inferred from GPR also shows an overall increase for Sample 1 (T increase) while an initial increase followed by a decrease for Sample 2 (control, T stable).
- Preliminary data also suggests a *statistically significant positive correlation between flux and GPR gas content for Sample 1* (T increase) while that relation is negative for Sample 2 (control, T stable).
- As expected, these results suggest that *increases in T translate in dramatic increases in gas content within the peat matrix and subsequent increases in gas release*.
- Datasets will be continued to test whether these patterns in gas dynamics are consistent as T is increased further. Once reached a T maximum, decreases in T will also be tested to investigate whether gas content returns to initial values within the samples.

6. Acknowledgments

- This work was partially supported by National Oceanic and Atmospheric Administration grant #GC11-337, the United States Geological Survey, and the Florida Atlantic University Department of Geosciences. A huge thanks goes to everyone who helped collect and process data: Matthew Mcclellan, Matthew Sirianni, William Wright, Cali Munzenrieder. We would also like to thank MALA Geosciences and Shimadzu for help with equipment support.

7. References

- Hydrologic and Environmental Systems Modeling South Florida Water Management District, (2011) *PAST AND PROJECTED TRENDS IN CLIMATE AND SEA LEVEL FOR SOUTH FLORIDA*
- Comas, X., Wright W., 2012. *Heterogeneity of biogenic gas ebullition in subtropical peat soils is revealed using time-lapse cameras.* Water Resources Research.