Using Vegetation Cover Type To Predict And Scale Methanogenesis In Peatlands

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Background

- Study site: Stordalen Mire, Abisko, Sweden. (68.352, 19.014)
- Stordalen is located along the discontinuous permafrost boundary.
- Permafrost regions contain about 50% of the global soil carbon.
- Methane emissions are increasing as permafrost thaws.
- Measuring $\delta^{13}CH_4$ values can indicate pathways of methane production:
  - Acetoclastic vs. Hydrogenotrophic

Importance

- No study has examined pathways of methogenesis across a landscape using a random sampling design.
- Atmospheric inversion models currently use a $\delta^{13}C$= -60‰ to -65‰ for peatlands, and therefore assume a mostly acetoclastic pathway.
- Better understanding of pathways will help to improve the accuracy of atmospheric inversion studies.
- By linking field based measurements with a remote sensing effort, the spatial implication of methogenesis pathways, can be ascertained.

Methods

- Pulled porewater samples from a depth of 20 cm at each site and measured $\delta^{13}CH_4$, methane concentration, and pH values.
- Compared $\delta^{13}CH_4$ values to vegetation cover type.
- UAV imagery and field based plot locations of cover type were used in a neural network to determine covertype across our study area

Cover Type Prediction Map

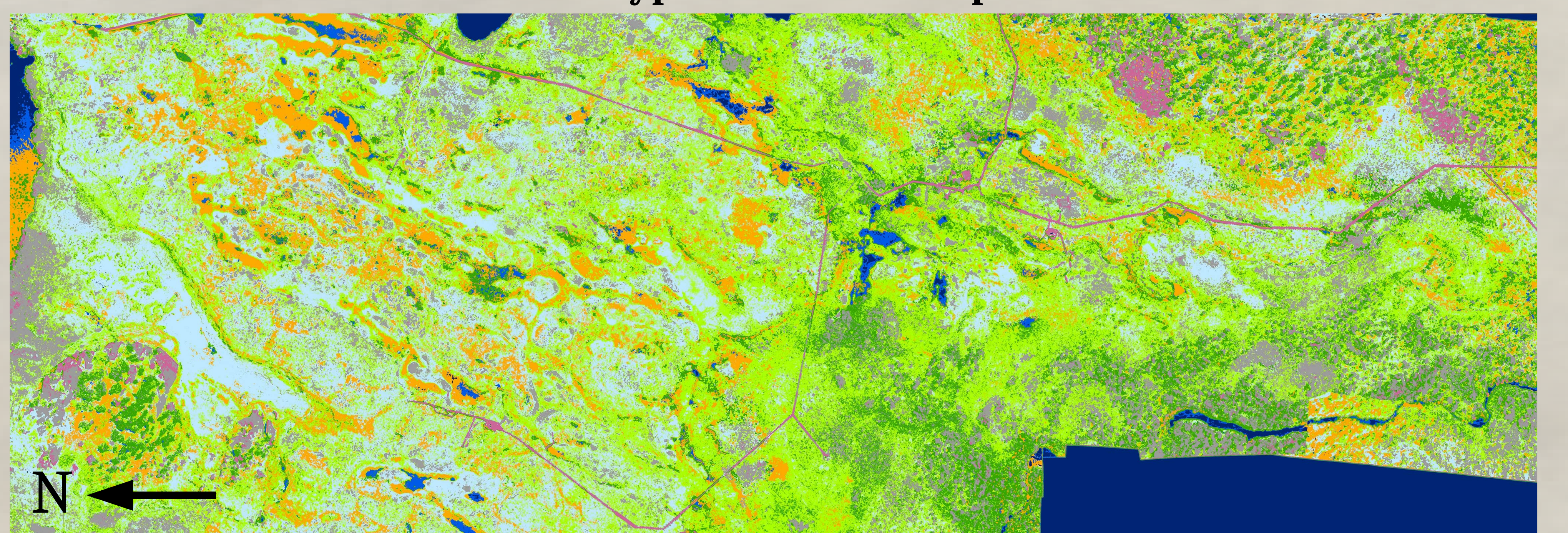


Image credit: M. Palace, C. Herrick, c.herrick@unh.edu

Cover Type Legend

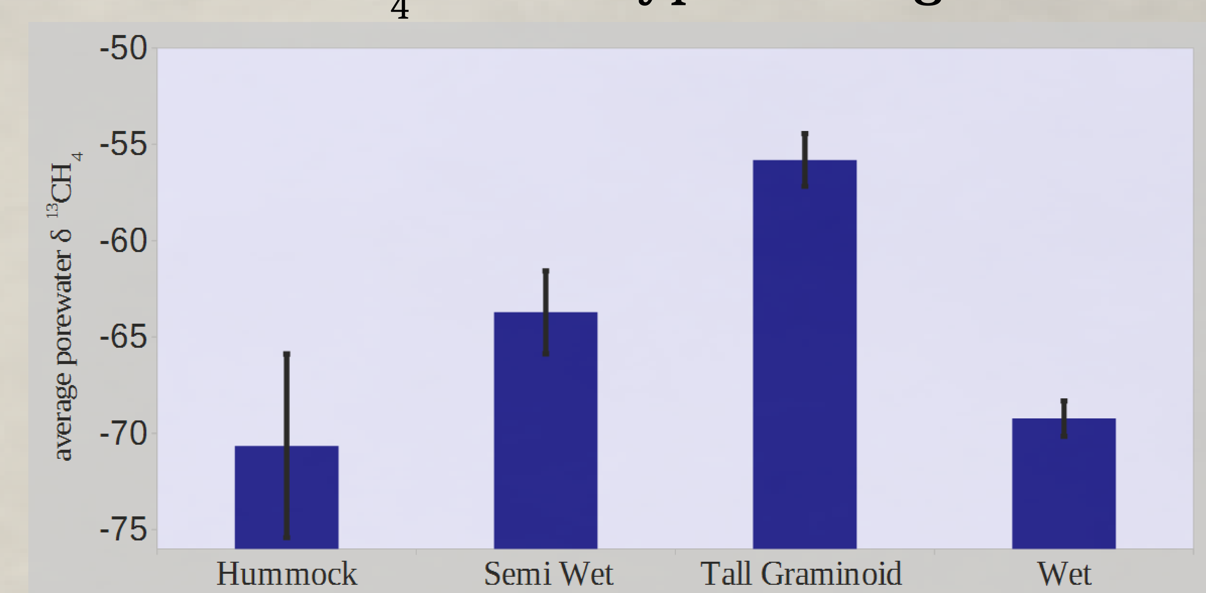
- Hummock
- Semi Wet
- Tall Graminoid
- Rock
- Tall Shrub
- Wet
- Open Water
- Other

UAV Image

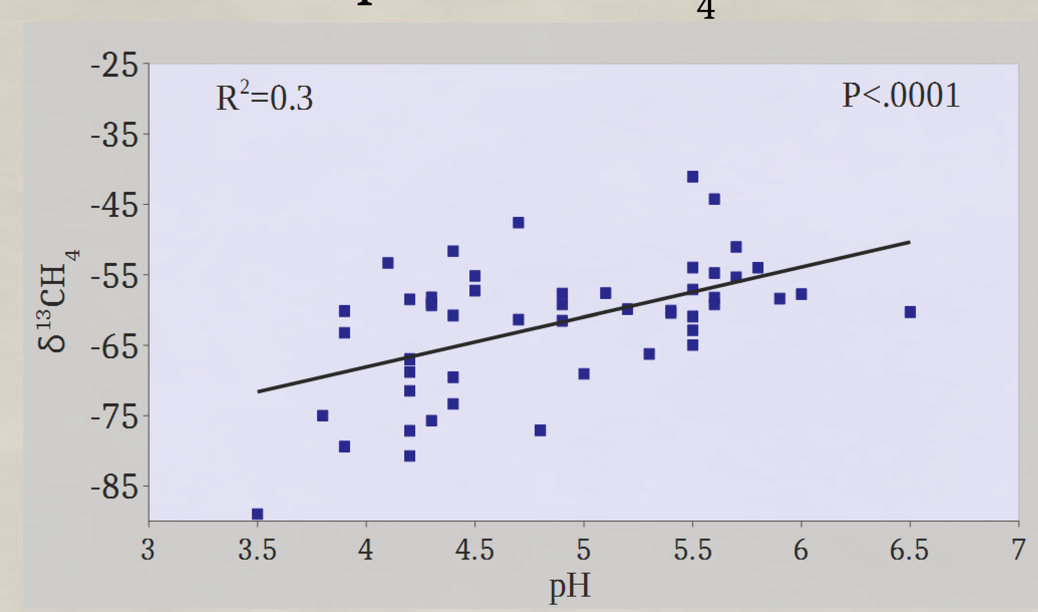
Image credit: M. Palace, C. Herrick, c.herrick@unh.edu

Color infrared photo with hydrological mapping. Classified by Palsa-A , Bog-B, and Fen-C. Arrows show surface water flow direction. (Olefeldt, 2012). Fens have continuous surface water flow, which correlates with the presence of tall graminoid.

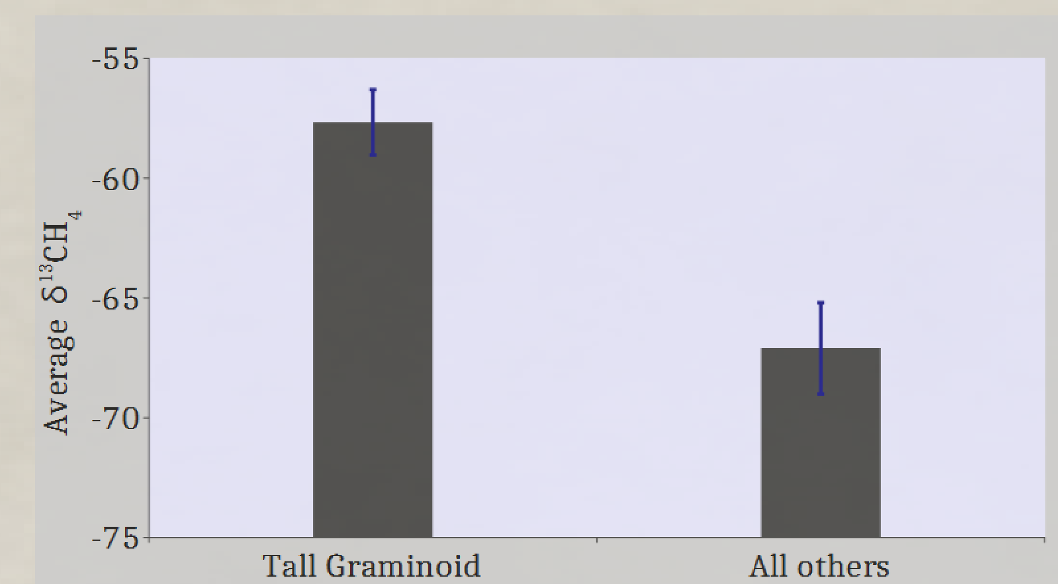
$\delta^{13}CH_4$ Cover Type Averages



pH vs. $\delta^{13}CH_4$



Tall Graminoid vs. All Others



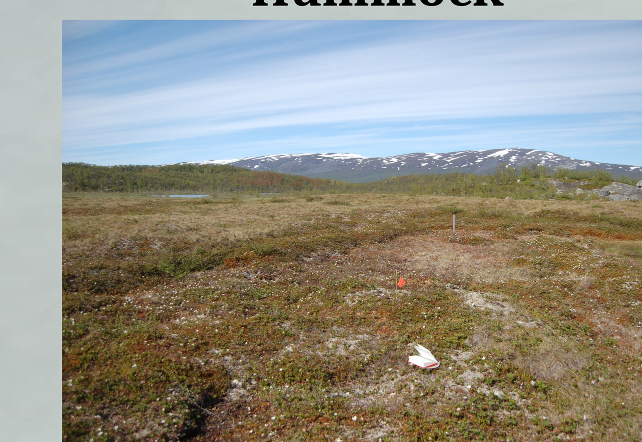
Results

- **As permafrost thaws, the presence of surface water flow will create tall graminoid sites, while hyrdological isolation will create wet sites.**
- **Tall graminoid sites shift methane production to a more acetoclastic pathway.**
- **Wet sites shift methane production to a more hydrogenotrophic pathway.**
- **Graminoids are believed to pump acetate back into the system, which may explain this pathway difference.**
- **Our observed $\Delta^{13}CH_4$ values range from -44‰ to -79‰, inversion models use-60‰ to -65‰**
- **The UAV cover type map is important in interpreting biogeochemical processes on the landscape level**
- **The neural network currently has difficulty distinguishing between tall graminoid and wet sites.**
- **Some of the variability in $\delta^{13}CH_4$ may be explained by pH levels.**

Olefeldt, David, and Nigel T. Roulet. "Effects of permafrost and hydrology on the composition and transport of dissolved organic carbon in a subarctic peatland complex." Journal of Geophysical Research: Biogeosciences (2005–2012) 117.G1 (2012).
McCalley, C. K., Woodcroft, B. J., Hodgkins, S. B., Wehr, R. A., Kim, E. H., Mondav, R., ... & Saleska, S. R. (2014). Methane dynamics regulated by microbial community response to permafrost thaw. Nature, 514(7523), 478-481.

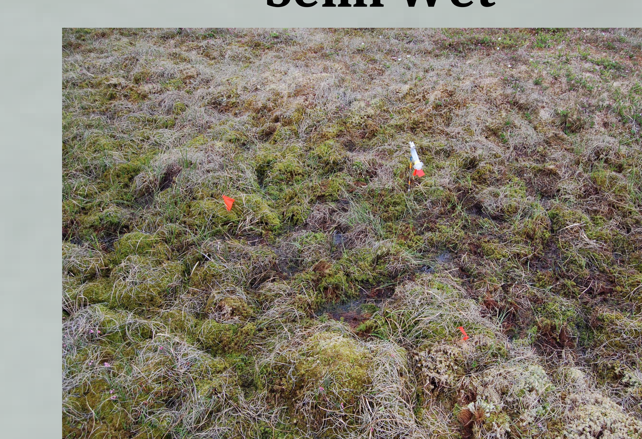
Thaw Transition

Hummock



Thaw

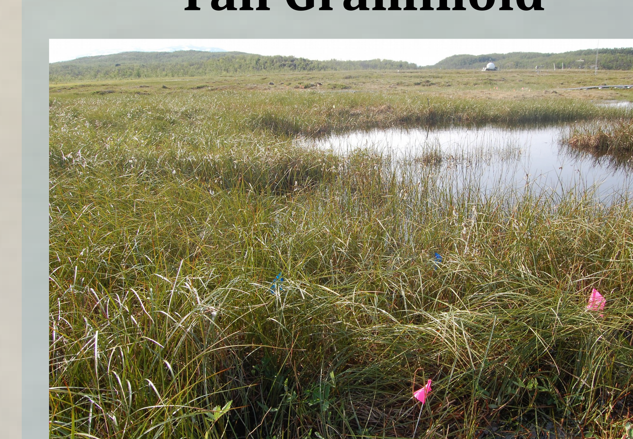
Semi Wet



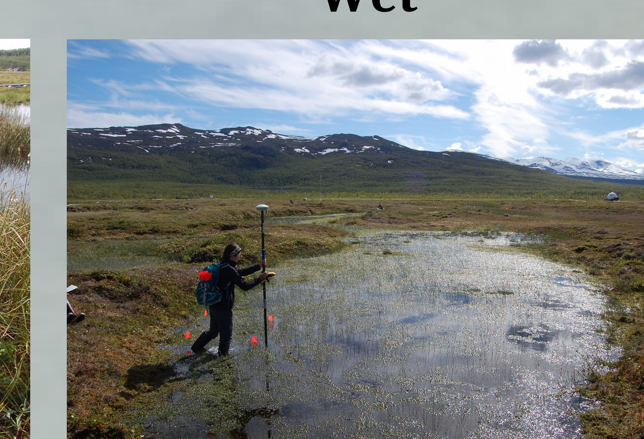
Surface water flow

Hydrological isolation

Tall Graminoid



Wet



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