Peatland methane emissions driven by interaction of soil temperature and water table

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October 30, 2018

Model Goal

We want to be able to express methane as a function of soil temperature and water table, e.g.

$$CH_4 = f(T_{soil}, WT)$$

We can further assume a different behavior based on whether soil is inundated or aerated. Namely, we could obtain the following model,

$$CH_4 = \begin{cases} f_1(T_{soil}, WT), & \text{inundated} \\ f_2(T_{soil}, WT), & \text{aerated} \end{cases}$$

where f_1, f_2 are more reasonably linear than f alone is.

Motivation comes from prior research and Eddy covariance data from Bog Lake Fen.

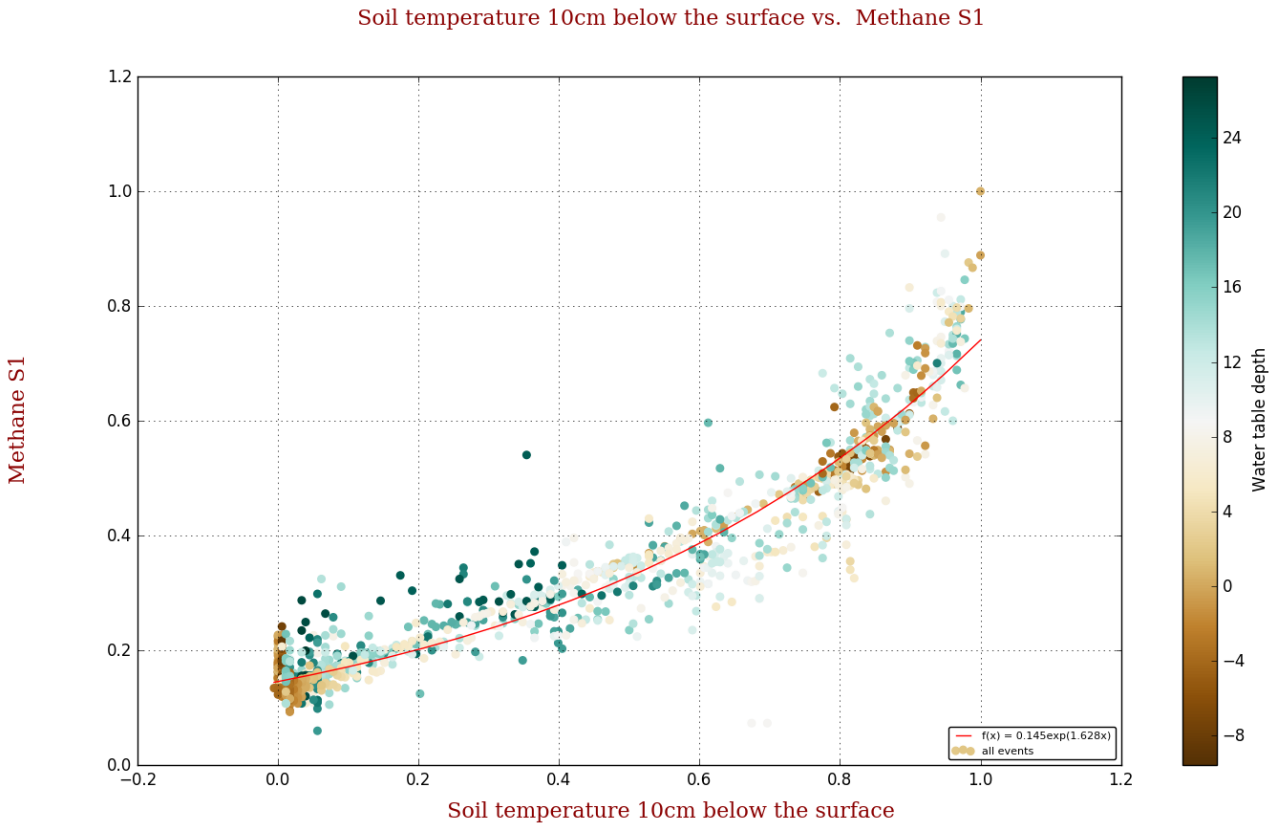
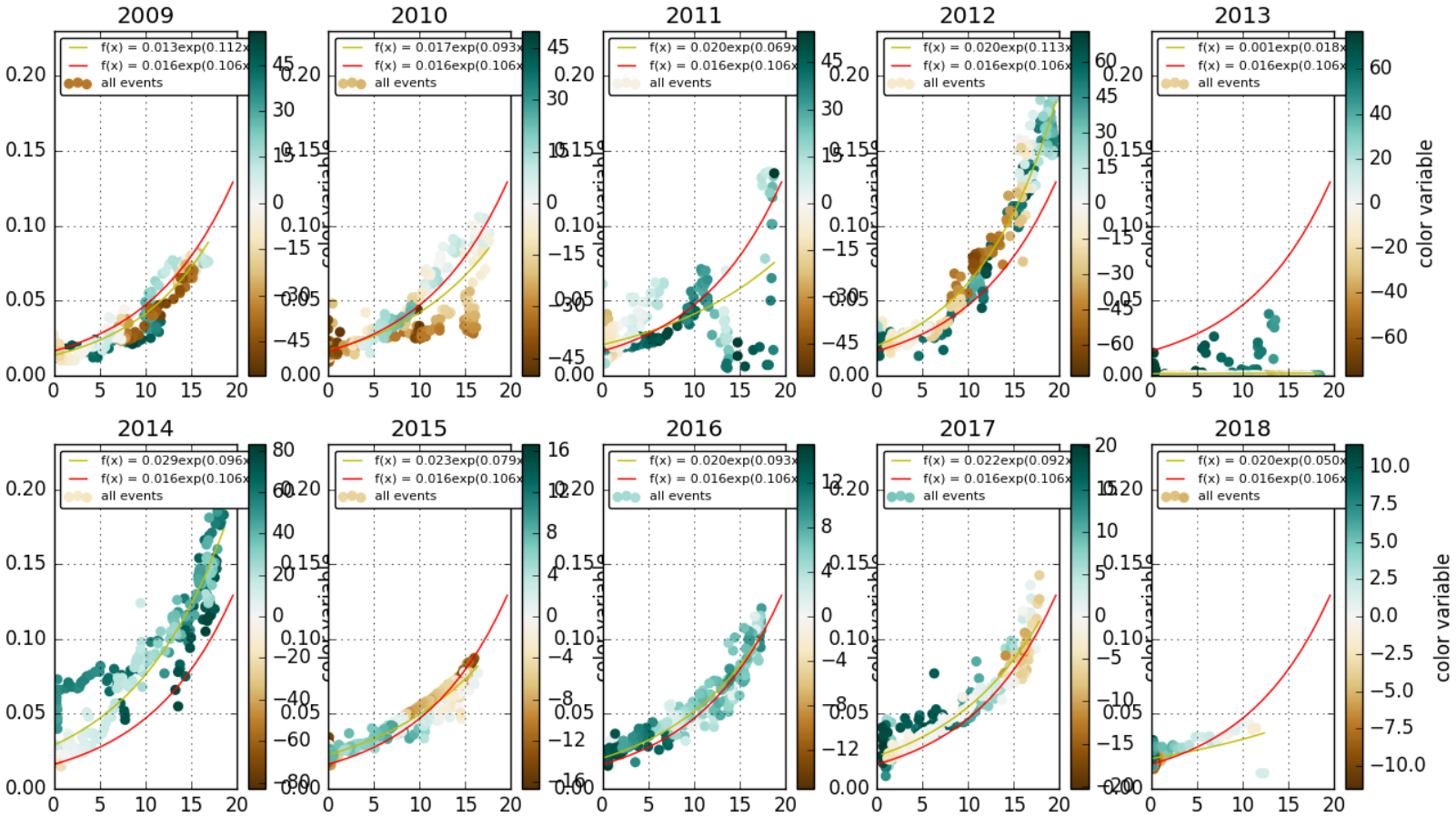


Figure: Methane can be modeled as a exponential function of soil temperature. Data here from open path measurements taken from 2015-2018.

Annual relationships deviate from the overall relationship between soil temperature and methane emissions, indicating there is something else at play.



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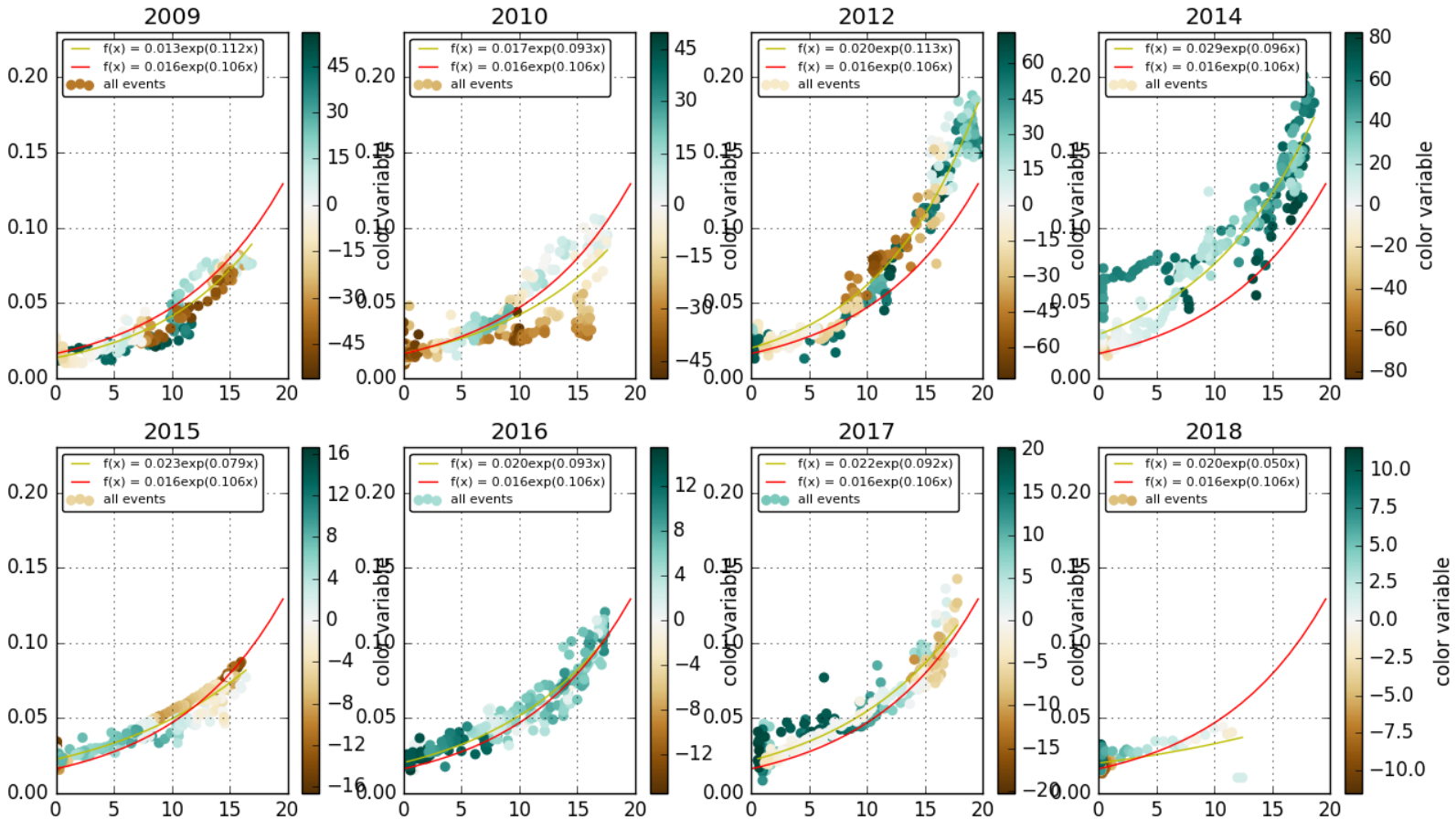

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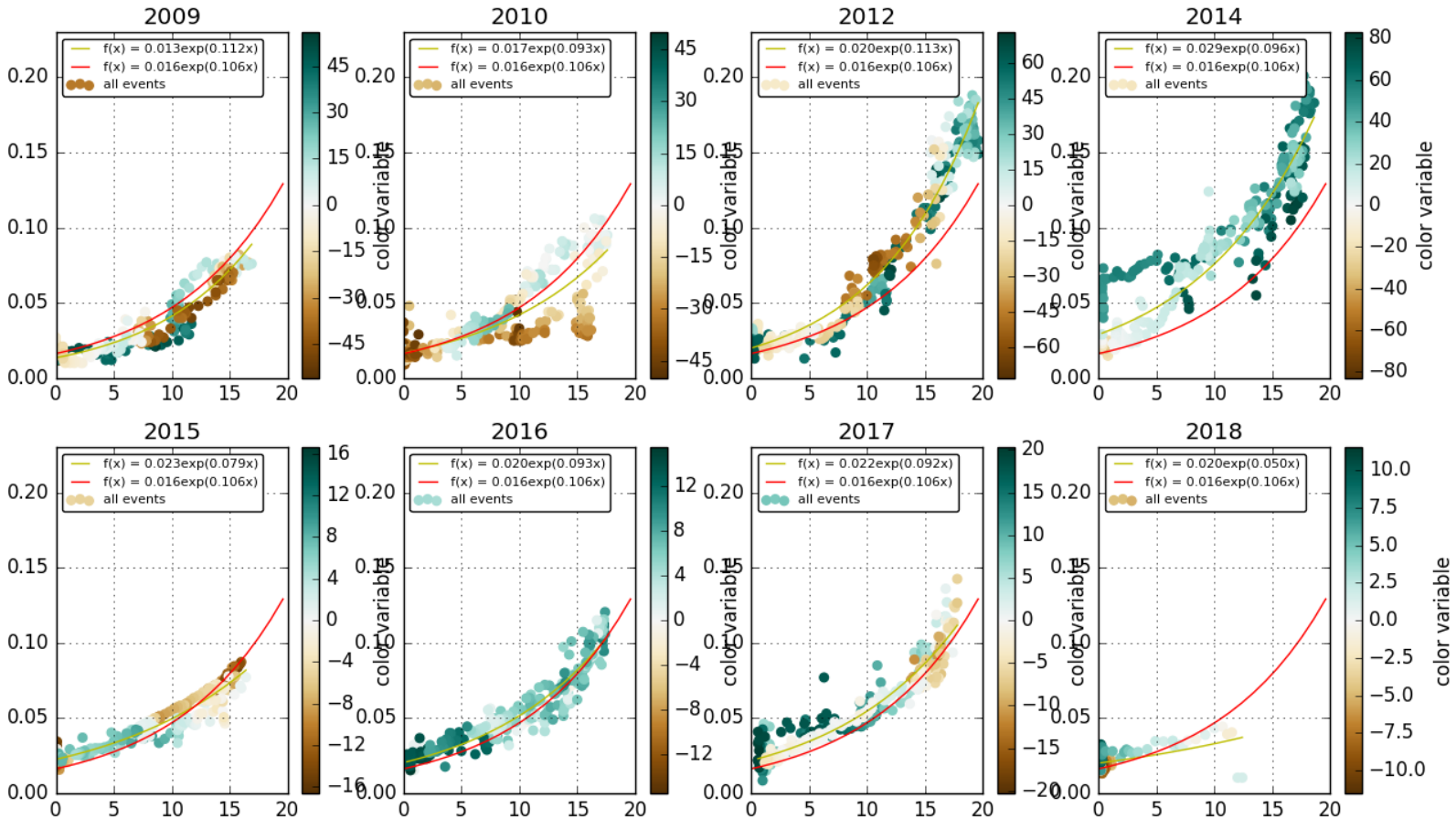
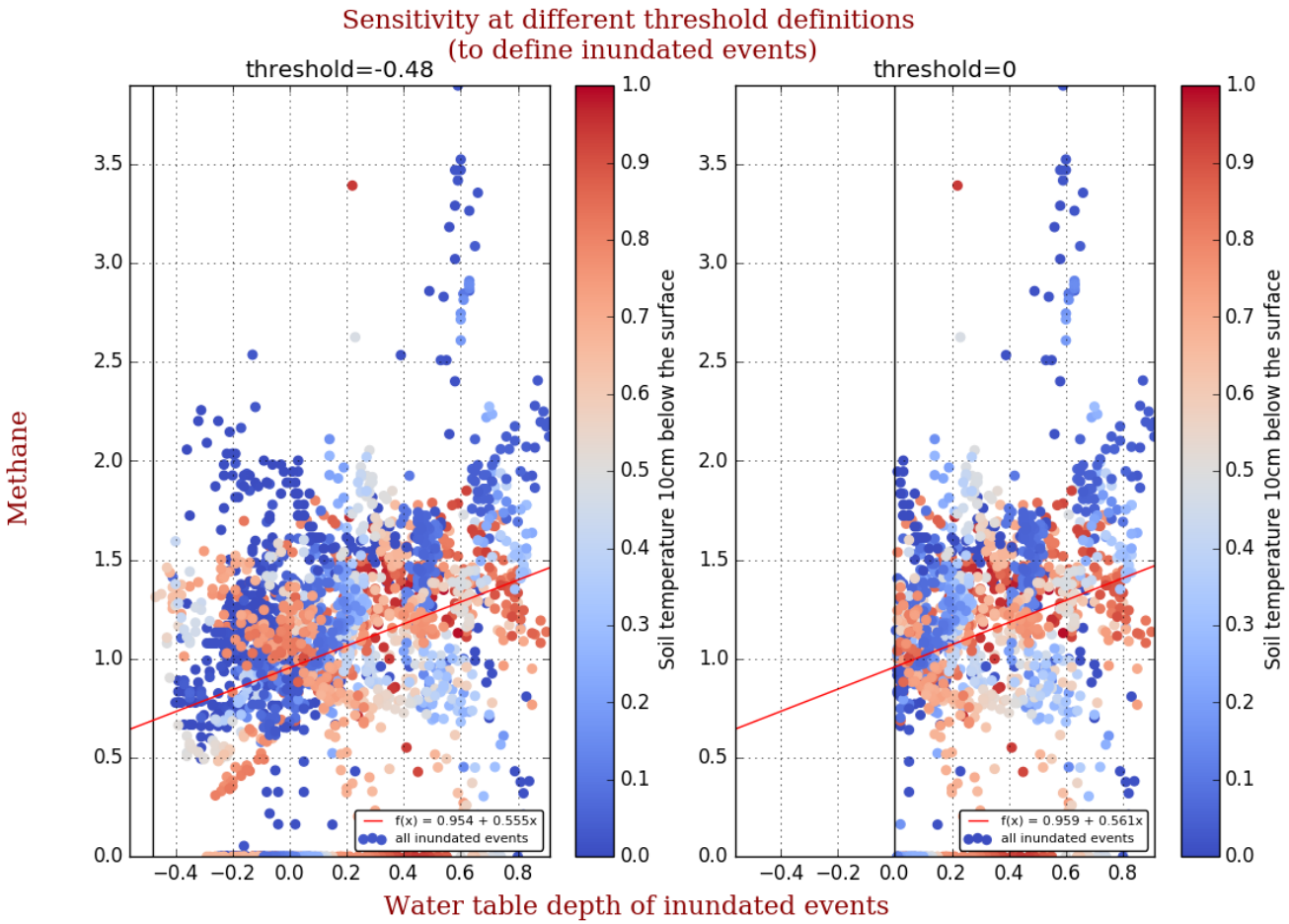
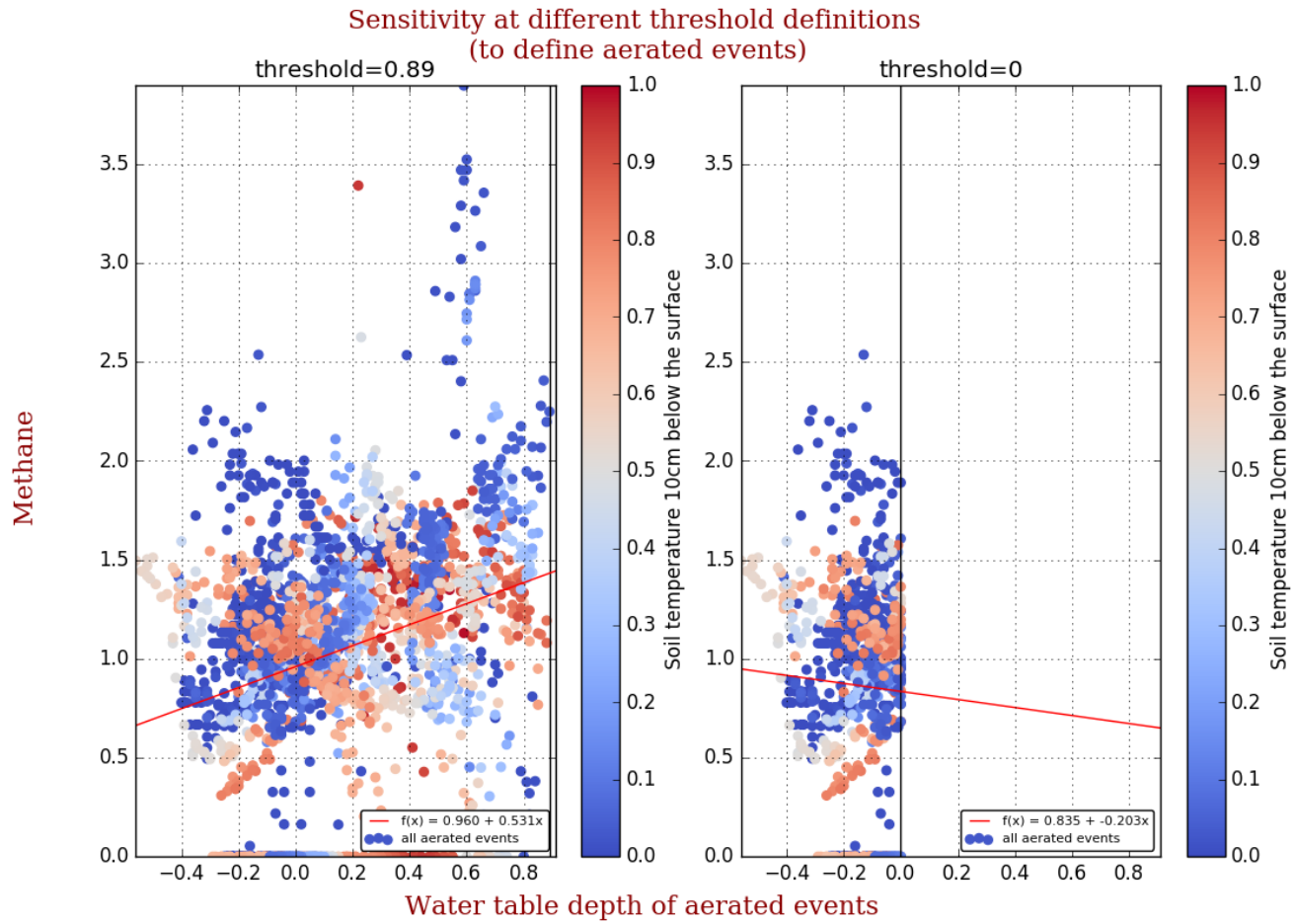


Methane deviations are positively correlated with water table, and this relationship becomes stronger when we restrict ourselves to inundated events.



Methane deviations are positively correlated with water table, but this relationship becomes *negative* when we restrict ourselves to aerated events.



Methane's sensitivity to water table is dependent on the state of the system, e.g. whether or not the peat is inundated or aerated.

Considerations:
Biological mechanism?
Transport and production of methane are separate processes that both depend on water table.

Looking forward: Dichotomous Markov process?

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