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Interactive comment on "Biogeochemical and plant trait mechanisms drive enhanced methane emissions in response to whole-ecosystem warming" *by* Genevieve L. Noyce and J. Patrick Megonigal

Anonymous Referee #1

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This manuscript focuses on exploring the mechanisms for enhanced methane emissions under warming. The authors make use of a long-term project, SMARTX, at the Smithsonian's GCReW site. They measured methane fluxes, porewater methane concentrations, and porewater sulfate concentrations in two areas with differing plant communities, one dominated by Schoenoplectus americanus, C3 grass, and the other dominated by Spartina patens and Distichilis spicata, C4 grasses. Each area contained ambient plots, and plots with temperatures elevated 1.7 °C, 3.4 °C, and 5.1 °C above ambient. The authors found that methane flux increased with soil temperature

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and that mean annual CH4 emissions were higher in the C4 community than in the C3 community with methane flux only increasing incrementally with temperature in the C4 community and only increasing at the 5.1 °C treatment in the C3 community. In the C3 community, porewater dissolved methane also increased at the 5.1 °C treatment. However in the C4 community, there was no difference in porewater methane across treatments in the surface sediment and methane concentration declined with increasing temperature in deeper sediment. Sulfate depletion also increased with increasing temperature. The authors used these data to explore the mechanisms behind methane emissions in these communities noting that these methane fluxes are likely a result of increased rates of methanogenesis, increased substrate availability, reduced competition with sulfate reducers, and indirect plant effects.

Overall this manuscript is well written and very well thought out. It is a significant contribution to the literature in that there are very few groups with enough funding to perform a long-term warming project such as this. I commend the authors on the hard work and dedication that went into this study. The introduction does a great job of setting up the rest of the paper and the discussion thoroughly explores the mechanisms responsible for these emissions. The authors provide a great comparison of their results to other studies.

My main critique is the discussion around the pattern seen in CH4 concentrations at depth in the C4 community. The decline in methane concentrations with warming indicates a shift in where methanogenesis is occurring. With a shift from below the rhizosphere at lower temperatures, to within at higher temperatures. Why do you think this is occurring? Is there less labile C at depth at high temperatures? Is there a shift in the type of methanogenesis occurring to methylotrophic methanogenesis? There should be more discussion of this potential mechanism as methylotrophic methanogenesis has been found to be important in coastal sediments (Zhuang et al., 2016; Xiao et al., 2018).

Minor comments:

Lines 111 – 112: Can you change the 10-20% of high tides to a comparison as all tides like you did for the low elevation areas? This will make the comparison between the areas easier.

Lines: 147 – 149: Using $\frac{1}{2}$ of the LOD is not a great way to deal with non-detects. Checkout Helsel (2006, Chemosphere). Here they outline why substituting value for non-detects is not a great idea and how to deal with these data. They are a pretty small percentage of your data, but it could be useful to use other methods in the future. Figure 1: Can you add a legend describing the colors on your density plot?

Lines 356 – 359: I really like your discussion of differing plant communities as net oxidizers or net reducers here.

Supplement Table S2: There is a typo in the figure legend. "2017, 2018, and 2018"

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