Reviewer #2 (Nathaniel Weston)

This study assesses the impact of altered hydrologic conditions on the decomposition of soil organic matter in brackish marshes. While the response of plants in tidal marsh environments to altered flooding has received considerable attention, much less is known about how rates of soil organic matter decay respond to alterations in flooding. The balance between organic matter production and decomposition in tidal marshes largely determines rates of carbon sequestration. As sea-levels rise, this balance will play an important role in determining whether a marsh keeps pace or converts to a sub-tidal habitat. It has often been assumed that rates of organic matter decomposition would decline following increased flooding, because of more anaerobic conditions in marsh soils. However, there is little direct evidence for changes in decomposition with sea-level rise.

The authors of this study measured rates of soil decomposition by mass loss and change in C and N content of peat in mesh bags placed in marsh mesocosms (including soil and plants) for several months. The mesocosms were placed at various elevations at three brackish marsh sites in the Chesapeake Bay, as part of a larger study on the influence of flooding on plant biomass. The decomposition bags were therefore subject to various regimes of inundation (0-100%) and soil redox potential (decreasing with increasing flooding). The authors found that, overall, rates of soil organic matter decomposition were fairly insensitive to a range of flooding conditions. There was some limited evidence that rates of soil organic matter decay increased with greater flooding duration at two of the sites, contrary to expectations. These findings have major implications for the response of tidal marshes to sea-level rise. For brackish marshes to keep pace with sea-level rise then, either 1) organic matter production must not respond negatively to increased flooding, or 2) increased mineral sediment deposition will be required.

This study addresses an important biogeochemical response to climate change. The design is fairly simple and straightforward, and benefits from the evaluation of soil organic matter decay measured as several sites. It is sometimes difficult to accurately measure decay rates based on relatively small changes in mass in soil decomposition bags, as the authors acknowledge (Figure 3 demonstrates the variability in replicate measures). Further, ingrowth of roots, gain or loss of fine particles through the mesh, and other factors can complicate measurement of decay rates. Finally, other responses to flooding, most notably from the plant community, may complicate measurement of mass loss in these soil decomposition bags.

1. The authors discuss these limitations, yet then take the analysis of soil C and N in the decomposition bags a step further than I feel is warranted. They evaluate changes in C and N mass with flooding by using the change in overall mass together with the change in C and N content (percent; Figure 4), and conclude that rates of decomposition were likely highest in the partially-flooded elevations (40-60% inundation) because of greatest decrease in C content (organic matter decomposition) and largest increase in N content (microbial immobilization) at these flooding regimes. Given the error associated with the overall mass loss measurements

(Fig. 3), and what look to me fairly weak quadratic relationship between inundation of C and N content change (Fig. 4b and 4d), this analysis feels unwarranted. I suggest that the percent C and N of the soil organic matter can be shown, but that the mass change analysis be removed.
While we agree that the relationships are not extremely tight, we do feel that examining the nutrient mass changes is warranted. Rather than propagating error by multiplying two error-laden variables, the C and N values could help correct for experimental error in the dry mass values. For instance, incursion of mineral matter would increase the mass of a decomp bag while decreasing the %C of the material therein- but it should not affect the C mass. We see the C mass calculation as a necessary correction rather than a reach for a pattern. For this reason, we set out to use change in C mass mainly, but also change in N mass, to assess decomposition because they may be more sensitive to biodegradation than any other variables we report.

2. The statistical tests used in this manuscript should be more thoroughly detailed. There are p values reported in the results that I am assuming are from non-parametric regressions, but this isn't stated. Were the statistical tests conducted on the averaged data, or on all data? This should be made explicit in the text.
We will more explicitly describe the statistical tests in the revised manuscript. Unless otherwise noted, all replicate mesocosms at a given elevation and site were averaged together before statistical analysis. Data from different sites were not averaged together. This should easily be clarified in the revised manuscript.

3. I also note: In Figure 3a and 3b there appears to be at least one measurement of a mass loss and decay coefficient for the Transquaking site at 0% inundation that is not shown on Fig. 3c. This needs explanation in the text, especially if this point was removed from the statistical analysis.
Thank you for bringing this to our attention. We included a single point in the raw data presented in Figure 3a and 3b. We did not include that point in the averaged data presented in Figure 3c because there were no replicates for it (we only recovered one unripped bag for the 0% inundation treatment at the Transquaking River site). Nevertheless, in response to Reviewer #1, we have deleted the Transquaking River data from our analysis altogether.

Overall this is a valuable contribution to our understanding of marsh response to sealevel rise. The study gains strength from its relative simplicity, which I feel should be further enhanced through removal of the mass loss analysis and a more thorough description of the statistical treatment of the data.