Response to Reviewer #3 Comments

Bukaveckas, P presents an interesting study on the carbon transformation in river-estuarine system by the biological processes. The author has conducted an impressive amount of biogeochemical measurements that shed light on the carbon dynamics associated with the fluvial and biochemical processes. While the manuscript raises some important questions and provides viable reasonings, I have some lingering concerns that I believe should be addressed before publication.

Major concerns:

1. Throughout the text, author mentioned labile carbon forms. However, without knowing what are the residence time of these forms, it was hard to distinguish them from the recalcitrant forms. Author should provide a background information about the different types of organic carbon forms that one can expect in estuarine system. I expect in such environments, both terrestrial and aquatic sources to contribute to the total organic carbon pool. Each of these sources contain distinct carbon forms, and their residence time may differ very significantly. In absence of background information and lack of focus on this issue, it was hard to evaluate the quality of the manuscript.

2. Introduction is loosely written, with poor connectivity among the paragraphs. I strongly believe paragraph 2 (lines 60-89) should be re-written to maintain a flow.

Author's Response (Comments #1 & 2): the Introduction has been substantially revised, focusing particularly on the second and third paragraphs. Text that was deemed to be non-essential was deleted to improve flow. A new paragraph was added focusing specifically on organic matter sources to estuaries and their bioreactivity. In the revised Introduction, the first paragraph establishes the importance of inland waters in the global C cycle, the second paragraph focuses on organic matter sources to estuaries, the third paragraph explains tidal freshwater systems, the fourth paragraph describes how longer water residence time in tidal freshwaters may influence C cycling, and the last paragraph states the objectives of the research.

3. Result section can be reduced by presenting the data in tabular format. The current form is way too lengthy.

Author's Response: much of the quantitative information which added to the length of the Results was contained in Table 2 (results of GAM analysis). To shorten this section and reduce redundancy, I deleted references to specific values in the text where these could be found in the Table. As a result, I was able to reduce the length of the Results section by 15%.

4. What is the role of catchment vegetations in supplying different organic carbon forms? What type of vegetation was there? What was the vegetation density?

Author's Response: I am unaware of specific studies that have analyzed forms of carbon associated with dominant vegetation types in these basins. However, I have added a description of the dominant vegetation types to Section 2.1 Study Sites. "The river basins fall within the Temperate Deciduous Forest biome. Though highly fragmented, the area is still

predominantly rural and forested (>70%) with small contributions from agricultural lands (row crops and hay fields; 23%) and urban-suburban areas (6%; Smock et al. 2005). The predominant trees include a variety of oaks, hickories, sweetgum, tuliptree and loblolly pine. Floodplain forests along the Pamunkey and Mattaponi are dominated by bald cypress, swamp black gum and water tupelo. Soils of the region are old and highly weathered, with ultisols predominating over much of the area."

Minor comments:

1. Abstract is full of abbreviations. Please introduce the terms before using the shorter forms.

Author's Response: terms used in abstract defined at first usage (POC, DOC, and DIC).

2. Please provide suitable references in line 61, 64.

Author's Response: references were added to the corresponding lines in the revised Introduction.

3. Line 70: Be specific about the biogeochemical processes.

Author's Response: reference to biogeochemical processes replaced to provide greater specificity. "Tidal freshwaters are a common feature of river-dominated estuaries throughout the world but have received relatively little attention for their role in modifying landscape-scale fluxes of C, N and P (Hoitink and Jay 2016; Ward et al. 2017; Jones et al. 2020)."

4. Line 95: GPP!!! It is frustrating to see abbreviations without any prior introduction.

Author's Response: reference to GPP changed to "phytoplankton production". GPP (and ER) defined at fist use (Lines 191-192).

5. Line 509: Without any information/data of the residence time, such claims seem to be over tall. Sink and source at what time-scale? Annual? Decadal? Centennial?

Author's Response: text revised based on reviewer comment. "The mass balance indicates that on an annual basis the James Estuary is a sink for organic C and a source of inorganic C. This finding is consistent with the metabolism results showing that ecosystem respiration exceeds GPP."

6. Line 634: Please re-phrase the line, and try to avoid citation to previous work.

Author's Response: text moved from Summary to Introduction.