

Review of manuscript: The Alkalinity Blue Carbon Pump: Tidal pumping drives long-term CO₂ sequestration as alkalinity in salt marshes

Summary

This well presented manuscript describes how marshes generate alkalinity that is exported to the ocean and how this contributes to carbon sequestration. Alkalinity, DIC, DOC, dissolved greenhouse gas export and a range of additional solutes are constrained using a salinity mixing model in combination with water discharge and discreet sampling over one year. Additional sampling at the site includes benthic TA and DIC fluxes and sediment cores. This research is similar to other DIC export works, but is very comprehensive and important given the global paucity of alkalinity exports from salt marsh. Overall, the study is well designed, the manuscript is well written and with minor revisions would make a valuable contribution to the literature.

Major comments

The mixing model is the most important aspect of this work and uncertainties are inherent in these studies.

Can the authors clarify why they only sampled on outgoing tides and didn't sample over complete tidal cycles. Would this not improve understanding of biogeochemical cycling in the marsh and help with uncertainties around the selection of endmembers?

The endmember selection process is well described. The export calculation uses high tide water and canal water as endmembers, with salinity acting conservatively. The "marine" high-tide sample was sometimes collected 1.5 km from the creek, while the local initial-ebb sample is later adopted as the preferred marine reference. This choice affects calculated excesses but is not presented with any sensitivity analysis. Errors around the individual endmember samples could significantly affect the export estimates and it would be good to discuss this. E.g. the canal has salinity ranging 0–4.4, and Arcachon Bay receives other freshwater inputs, e.g. the Leyre River. The actual water feeding the creek could therefore be a variable, multi-source mixture rather than a consistent endmember. Authors could show net TA, DIC, and DOC fluxes using each plausible high-tide endmember and quantify how conclusions change with endmember selection and include propagated errors.

Minor comments

L20 – The statement "all measured carbon flux" is slightly misleading, results include a range of measurements, models, lab incubations etc.

Abstract wording of: "...can remains stable..." and "...can contributes...". This also appears in the conclusions.

L66 – Rephrase the text: '...is permanently removed by through burial...'.

L76 – Rephrase the text: '...in order to better characterising these ecosystem functioning...'.

L106 mentions the 30 hectare catchment area passes through different areas of vegetation. Clarify these here.

L105 – L135: First you state 12 time series but later mention 6 out of 18 sampling dates. Please clarify.

L157 – Rephrase sentence

L285, clarify salinity unit throughout.

Reference-water terminology is inconsistent throughout: I can see high tide water, high-tide sample, marine water, inlet high tide station, outer high-tide water, inner high tide point, and the first early-ebb sample. Section 4.2 says the early-ebb sample was ultimately used as the local marine reference, then Table 2 says fluxes were calculated using the saltmarsh high tide point.

Figure 2. The meaning of the vertical dashed lines is hidden in the caption. Can you add this to the figure? Perhaps at the top

L493 – This section could also compare to the Eulerian approach, which uses a tidal mass balance rather than a radon mass balance, and is much more comparable to the approach used in your manuscript. E.g. Sippo et al. 2016 (GBC) and/or Call et al. 2019 (ECSC).

Figure 8. The units are confusing in this. Can you present results per m² or per ha, not per catchment area.

L660 – Interesting that the source of DIC is a mix of marine, terrestrial and marsh derived C. From a C abatement perspective, sites that link outwelling to an area of ecosystem are essential. Do the authors think that attributing this marsh outwelling to a mix of carbon sources complicate that finding?

L763 – I think the sentence is missing a 'not', and is currently saying the opposite of what it should be.

End of reviews