

## ***Interactive comment on “The Holocene Evolution of a Sedimentary Carbon Store in a Mid Latitude Fjord” by Craig Smeaton et al.***

**Anonymous Referee #2**

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Smeaton et al. tried to illuminate Fjord terrestrial OC burial over the Holocene, through measuring and analyzing inorganic geochemical proxies (e.g., metal element, grain size) and organic proxies (e.g., OC%, BIT,  $^{13}\text{C}$  of OC) on the downcore sediment in a Scottish fjord. They presented many hypotheses in this manuscript, the major one is that human disturbance affects the OC burial in the catchment. They used different approaches including models to interpret their results and propose their hypotheses. While they showed some interesting and valuable data, they fail to interpret the results. Many important parts in discussion section 4&5 are not convincing, even confusing and self-conflicting. I do not think that its present version of manuscript is ready for publishing in Biogeoscience. Some substantial revision should be conducted before resubmission.

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## Main points:

1. The discussions in Section 4 are not generally convincing. Several arguments are not self-consistent either. For example, for Lines 276-282, the cold, fresh and ice-bearing surface waters seems to have a larger influence in the subpolar region while the authors then argue that their site was more influenced by warm water from the STG during ~5-6 ka BP. Actually, this may suggest that their site was not sensitive to the subpolar gyre dynamics at all.
2. In section 5, the authors discussed the terrestrial and marine organic carbon burial over the Holocene, largely based on C/N ratios. Other proxies should be discussed in-depth in the main manuscript rather than supplementary materials. Unfortunately, there are such many speculative discussions (e.g., line 343) over the whole manuscript. I suggest reframing the structure of manuscript and refining the storyline.

3. Some necessary references and descriptions about methodology and illustration in discussion should be added and further clarified. Please check the more specific points below:

Line 118-123, please show the population in this catchment. While the figure 2 shows some important events/activities, human impact is closed related to how many people really executed these activities in this region. The supplementary Figure 6 does not show population after 1700 yr AD.

Line 143 and 146, please add unit for longitude and latitude.

Line 175, please added the reference for acidification, for instance, Bao Rui et al., (2018), The effect of different acid-treatments on the radiocarbon age spectrum of organic matter in sediments determined by Ramped PyrOx/Accelerator Mass Spectrometry, Radiocarbon.

For section 4, Further thinking is required, for instance, the sill depth (~30-40m) only allows the surface layer (i.e., shallower than the sill depth) coming from outside the fjord



to have an influence in the fjord, and yet Thornalley et al. (2009) seemed to show that it is the sub-thermocline water that underwent large changes in temperature and salinity while the near-surface water properties was relatively stable. In addition, based on modern observations (e.g., Hatun et al., 2005 Science), the surface water properties along the Scottish coast does not vary with the SPG dynamics clearly (see their Fig. 3).

Line 303, it is not convincing, only lower C/N ratios?

Line 306, why entire Holocene here? The authors are discussing the OC burial during early to middle –Holocene. In addition, I can not follow why proportion of terrestrial OC increases due to falling RSL.

Line 311, the conclusion is largely based on C/N results. Maybe need more robust evidences.

Line 308 and 313, please clarify what does climate reorganizations mean.

Figure 2 The figure looks nice, please combine the downcore “sedimentgolical ” description with the human activities Timelines.

Figure 4, please highlight your geological periods (e.g., early to middle –Holocene)

Line 308-316, the goal of paragraph is ambiguous. Do you attempt to say more local terrestrial signal documenting in the sediment archive during the period?

Line 327, there is a gap between anthropogenic forcing and removal of woodlands during the mid-late Holocene, Additionally, please specify the year for the geological time period.

Line 327-330, OC% decreases and Gallanech Beg record shown in Figure 4 can not infer to the human impact in this area. It is not convincing.

Line 333-341, it is over speculative.

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Line 343-344 "but can not prove"???

BGD

Line 346-350, I do not understand why the authors discussed the OCAR in the early Holocene.

Line 350, range? Please show the results.

Line 355, throughout the Holocene? I think that the subtitle is Mid- to Late Holocene . Please follow one topic to illustrate your discussion. However, the present version appears to discuss the OCAR results.

The sections had a problem in the framework and storyline, less logic.

Line 363-365. Please cite your figure

Line 365-366, How do the author illuminate the "concentration of marine OC has remained stable"

Line 366, it is very difficult to follow this sentences. Why constant crenarchaeol concentrations suggest an increase in OCAS, driven by changes in terrestrial input.

Line 368-369, I can not follow the meaning of this sentence, how do the author conclude?

Line 414 "It is therefore unlikely?" The authors fail to tell their story to the readers, although the authors did many works. I also think that the results and data should be presented in the main text, rather than in supplementary materials. Line 416. "Hypothesis". While I understand there is a big uncertainty to decipher the influence of the intertwined factors between humane impact and climate (natural) processes, I suggest to reframe the structure of manuscript and clarify what the authors are able to confirm based on the available data, and propose a new sub-section focusing on these hypotheses. Given the whole paper with many speculative statements, the readers would not follow your points.

Line 270 this is very important and significant sentence in this paragraph. However, it

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appears to miss some information, incomplete sentences.

BGD

Line 54 Hinjosa? Must Hinojosa

In addition, I find it difficult to follow some sentences in Section 4. For example, the sentence on Lines 269-272 seems to miss something, and as it stands now does not provide any clear information. Also, on lines 258-259, given that temperature does not change, shouldn't a 1 permil shift in d18O reflect a salinity change of ~2 PSU? Line 259 ~5.5? Based on my knowledge, it may be ~2, in addition, please provide your references for this sentences.

Figure 3. in caption, a and b descriptions do not match what you showed in the figure.

Figure 1. VM 28-14 and VM29-191 cores locations may be incorrect, according to the reference (Bond et al., 1997)

Figure 2, dished line should not link to the event vertical line.

Figure 6. incorrect X axis direction (calendar year vs. 14C ages)?

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