Overall Statements

The manuscript "Impact of sedimentary alkalinity release on the water column CO2 system in the North Sea" by H. Brenner, U. Braeckman, M. Le Guitton, and F.J.R. Meysman presents North Sea wide pelagic-benthic fluxes of TA, DIC and O2 in the North Sea. The revised manuscript has been improved but there are still some mistakes in which must be corrected. My hint to compare the results with other papers was followed only partly in the introduction. This should be done in more detail in the discussion part. If, for example, Winde et al 2014 would be taken into account, it would have become clear that the Wadden Sea Alkalinity Export dominated the DIC Export and thus this must be included in the budgets.

We're not sure we fully understand the comment/suggestion. The Winde et al (2014) paper shows that freshwater with high concentrations of TA and DIC enters the Jade Bay system of the Wadden Sea, and subsequently this TA and DIC is exported further into the SNS. This type of TA and DIC import into the SNS is captured in our budget by the riverine input of DIC (1.5 mmol m-2 d-1) and TA (1.5 mmol m-2 d-1).

To our knowledge, the Winde et al (2014) paper does not provide an indication or estimation of the internal generation of alkalinity within the Wadden sea system. In this discussion, the most important issue is whether the export TA and DIC is in equilibrium with the atmosphere or not. If the water is in equilibrium with the atmosphere (excess CO2 in high-DIC freshwater is already outgassed and/or net TA generation in the Wadden sea is compensated by CO2 uptake), then there will be no additional CO2 uptake in the SNS.

To clarify this, we have now rewritten the text in the section "System-wide alkalinity budget" as:

However, the important question is whether the Wadden Sea exports 'uncompensated' TA that must be compensated by CO_2 uptake in the SNS. Any net A_T generation in the Wadden Sea will generally also induce an atmospheric CO_2 uptake in that area. If the residence time of the water is sufficiently long, water masses of the Wadden Sea will be in equilibrium with respect to pCO_2 with the atmosphere. In this scenario, the net A_T generation in the Wadden Sea will be fully compensated by CO_2 uptake in the Wadden Sea, and so, this will not influence the air-sea CO_2 exchange of the SNS. In absence of reliable estimates, uncompensated A_T inputs from the Wadden Sea were ignored in the budget here, and so the F_{river} terms for DIC and TA must be interpreted as inputs from both rivers and Wadden Sea to the SNS

Several other detailed points must be clarified before I would suggest publishing the manuscript in BG:

Discuss Spearman's rank correlation. It is used when normal correlation tests fail. This becomes clear in Figure 6: The reader of such a figure will never have the impression to see a reasonable correlation.

The Pearson correlation does not strictly require normality (although it does assume finite variances and finite covariance), but when the variables are bivariate normal, the Pearson's correlation provides a complete description of the association. Though more importantly, Pearson's correlation is a measure of the linear relationship between two continuous random variables, while Spearman correlation allows non-linear correlation. More precisely, a perfect Spearman correlation results when X and Y are related by any monotonic function, while for the Pearson correlation, a perfect correlation only results when X and Y are related by a linear function.

The reason for our choice of the Spearman correlation coefficient is that the data are clearly not linearly correlated (this is illustrated in figure 6, as also pinpointed out by the reviewer). Following the suggestion of the reviewer, we have adjusted the text by adding a justification for why we are calculating the Spearman correlation (rather than the Pearson). We've added following text to the section on "Statistical analysis":

The Spearman's rank correlation coefficient (\emph{ρ}) was used as a measure of the statistical dependence between two variables X and Y. The more frequently used Pearson's correlation provides a measure of the linear relationship between two continuous random variables , while Spearman's correlation allows non-linear correlation. More precisely, a perfect Spearman correlation results when X and Y are related by any monotonic function, while for the Pearson correlation, a perfect correlation only results when X and Y are related by a linear function. As the environmental variables tested were non-linearly related (see Fig. \ref{fig:dic_ta_tou}), we used the Spearman correlation.

The notation "southern North Sea" or SNS for the region shown in Figure 1 is misleading. All other publications, even maps of the oil-industry limit the SNS at about 54 - 55 degree north.

We agree with the concern of the reviewer. We've now implemented the presence of stratification as a rigorous criterion to classify stations as either Southern North Sea (non-stratified stations) versus Northern North Sea (stratified). The revised Figure 1 shows that stations 38 and 45 are now included in the NNS rather than the SNS (which reconciles our SNS-NNS delineation with the prior literature). We went through the effort to recalculate all mean fluxes and other statistics, and adapted the budget calculation accordingly to the newly calculated mean fluxes. However, this revised station classification had only a marginal impact on the calculated mean areal fluxes for the SNS and NNS, and did not change the budget calculations. Overall, the new SNS-NNS delineation did not affect our conclusions in any way.

L205: ")" missing
Text has been adjusted.

L281: Say that the correlation TOU rate at 40 RPM vs TOU rate at 80 RPM was performed. This should be before the hint to advective transport.

Text has been adjusted. The new text reads.

Within the permeable sediments of the SNS and NNS, flux chamber incubations were performed at two different stirring speeds (40 RPM and 80 RPM). The TOU values at these two stirring speeds were linearly correlated (Figure 4a). In general, the TOU rates were about 80% higher at the higher stirring speed, indicating that the porewater transport was dominated by physical advection, as expected in permeable sediments.

L317: These numbers differ substantially from the numbers of the previous manuscript. How can that be?

This is indeed the case. The previous manuscript contained incorrect values for the OPD, which were corrected in the revision.

L439 omit "strongly"
Text has been adjusted.

L453 one mole DIC per one mole $CaCO_3$
Text has been adjusted.

L709 It is misleading to use different numbers when you mean the same value (45.45 vs 45.40 (L695)).
Text has been adjusted.

L591 and L612: It's not per carbon atom but "per mole C in POC"
Text has been adjusted.

L715 ",," -> ","
Text has been adjusted.

L720 ff: How is the pelagic nitrification included?

Pelagic mineralization is modelled as the reverse of primary production

$OM + 138O_2 \rightarrow 106CO_2 + 16NO_3^- + H_2PO_4^- + 122H_2O + 17H^+$

This reaction equation includes hence includes both ammonification and nitrification. No ammonium is assumed to escape the sediment, hence there is no nitrification of sedimentary ammonium. This way, pelagic mineralization can simply be modelled as a reduction of pelagic primary production (eq 14 in the text).

L729 using an area of 329.230 km2 the 2.33 mmol m-2 d-1 turns into 280 Gmol yr-1

Thank you. Text has been adjusted.

L738 Schwichtenberg (2013) shows that the Alkalinity export strongly dominates the DIC export from the Wadden Sea.

See comment above.

L762 "2.3" -> "2.33"
Text has been adjusted.

L775 ff: How is F(out)(DIC) determined? It seems that is the closure term. But this was already F(air).

The CO2 uptake from atmosphere - F(air) - is not a closure term, as it is calculated from the net AT generation, as discussed in the text. The DIC export to the *NNS - F(out)(DIC)* – is the only closure term.

Figure 1: station 2 and station 7 are interchanged. (See Tab. 1)
Stations 2 and 7 in this figure are correct, but in Table 1 reversed. Updated in the current manuscript.

Table 4: The month (4) is still wrong for "This Study"
Fixed.

Figure 6: I did not ask for label revising here.
We don't fully understand this comment. Labels of figure 6 were not revised

Figure 8: There was no line removed.
Text has been adjusted.

Figure 9: dashed line is missing
Text has been adjusted.