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Interactive comment on "Sedimentary alkalinity generation and long-term alkalinity development in the Baltic Sea" *by* Erik Gustafsson et al.

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This manuscript reports alkalinity development in the Baltic Sea since 1970 based on two models. I am, however, not convinced about the results as there is a lot of extrapolation, and the calculations are done without an error analysis. For instance, it is said that 260 Gmol/y of the additional TA source can not be explained but there is no error bar. In fact, most of the numbers given have no error bars.

Response: The standard deviation of all terms in the TA budget has now been added in Table 5 and also in the text (Section 3.2).

My other major concerns are: 1. Sulfur in umol/g is converted to umol/cm3 using measured porosity but this can not be done using porosity alone.

Response: Besides porosity, a sediment density of 2.65 g cm-3 is used for this conversion, which is typical for marine sediments. This is now added in the manuscript (Section 2.1.1).

2. The results are integrated to 25cm and extrapolated to basin scale. But, how reliable is the age model and how homogeneous is the sediments in the Baltic Sea? I would expect a lot of variability in both but the uncertainty is not evaluated.

Response: The age model for site F80 is extensively discussed by Lenz et al. (2015b). Briefly, it was constructed using high-resolution Mo and Mn data obtained by laser ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS) line scanning. By comparing fluctuations in Mo/Al and Mn/Al with instrumental records of bottom water oxygen conditions, ages were assigned to features in these profiles. It is the best age model available for this site, and as already shown by Reed et al. (2016), matches well with likely scenarios regarding bottom-water oxygenation and organic matter input. Assuming that the upper 25 cm of the sediment represents the period 1970-2009, is thus validated, in our opinion. As also responded to Reviewer 3, we would like to stress that we extrapolate our results not over the entire Baltic Sea, but only over the Baltic Proper (or central Baltic Sea) which is where F80 is located. However, there are indeed spatial differences in the sediment geochemistry of muddy Baltic Proper sediments. To clarify the uncertainties and limitations with our approach, the following paragraph has been added to Section 4.1: "The RTM fluxes are upscaled under the assumption that the fluxes computed for the F80 site are representative for the muddy sediment area of the Baltic Proper. This assumption is associated with uncertainties because of spatial differences in the sediment geochemistry of muddy Baltic Proper sediments as illustrated by the porewater and Fe-S chemistry for 4 other sites as published by Lenz et al. (2015). The solid phase profiles for these sites show similar temporal trends over the past decades as F80. Furthermore, the porewater profiles show that site F80 has a relatively high rate of organic matter deposition and alkalinity regeneration when compared most of the other sites. This implies that, with our extrapolation, the role of the sediment could be slightly overestimated. Thus, the large-scale fluxes we obtain by extrapolating fluxes from one specific site are to be regarded as a high-end estimate of e.g. the possible contribution of Fe-S burial to the overall TA budget".

3. It is said that borate is ignored because it is expected to have a low contribution to TA. I am surprised. What is the basis for such a statement?

Response: Borate is included in BALTSEM as indicated in the new Equation 4 as well as in the supplementary material; the contribution in most areas is small because of the low salinity, although one exception is the entrance area with more oceanic conditions. In the RTM on the other hand, borate is not included as its contribution to TA is even smaller. With S=12 (i.e. total boron = 142.5 umol/kg according to Uppström, 1974) and prevailing conditions, bottom-water borate alkalinity (BA) is ~9e-3 mM, while measured TA equals 2.2 mM. Thus, BA contributes only 0.4% to TA in the bottom-water. With no significant source or sink term for boron in the sediments, its contribution to TA sharply declines with sediment depth. It is thus acceptable to ignore this term in the RTM.

My minor concern is the statement that the Baltic Sea today forms the largest anthropogenic dead zone is the world. It is not true. There are many dead zones in the Baltic Sea so the authors must have summed them up. If one sums up separate dead zones in other seas, such as the East China Sea, the total area is much larger. In fact, the dead zone off the Changjiang river mouth alone is now larger.

Response: We now write "one of the largest" instead of "the largest" (Section 1).

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