Overall Statements

The manuscript "Sedimentary alkalinity generation and long-term alkalinity development in the Baltic Sea" by Erik Gustafsson and colleagues presents the simulated development of alkalinity generation in the Baltic Sea over the last decades and, additionally, projections until 2100. The modelling tools include a reactive-transport model (RTM) for sedimentary processes which is able to resolve Fe-S cycling and burial of corresponding components, which in turn generates TA. Such irreversible processes are necessary to describe the missing (unresolved) contributors to the overall TA sources in the Baltic Sea.

Instead of a coupled physical – biogeochemical 3D model which couples benthic and pelagic processes, the authors use the less expensive model BALTSEM for the different Baltic Sea basins and the RTM which is weakly coupled to BALTSEM. For the reader it is unclear which information (fluxes) are provided for RTM by BALTSEM and vice versa. A full bidirectional coupling of both models, which is claimed as not feasible (I doubt) will definitively produce results differing from the weak applied coupling. It is necessary to estimate the error induced by this weak coupling. I suggest to test this with an application of BALTSEM for one water column and the underlying RTM sediment core. Within one scenario the weak coupling should be applied and within another scenario a full coupling should run. With these two results the authors can compare the TA generation of both scenarios and hopefully are able to demonstrate that the result of the weak coupling shows the main TA-related features as the full coupled run.

One of the main conclusions of the manuscript is that Fe-S dynamics impact the TA generation only on longer time scales. This is derived from one sentence on page 15 line 23. For this conclusion I expect a deeper analysis.

Detailed remarks

P2 L3: Sarmiento and Gruber, 2006: Ref missing

P2 L8: Rabalais et al., 2015: Ref says 2014

P2 L17 and L25 Reference List shows only Hu and Cai, 2011

P3 L1: Table 1 in Gustafsson et al 2014b gives 453 Gmol yr^{-1} as riverine TA load.

P4 L21: The expression ΣH_2S must be introduced.

P5 L2: How large was the increase of TA loads when the new Swedish and Finnish data were included?

P5 L17: Lukawska-Matuszewska and Kielczewska, 2016

P6 L18: The use of these unresolved fluxes is very unsatisfying. They might also represent sinks that are assumed too high. Using such a "joker", it's relatively easy to match observed TA concentrations.

P7 L3ff: How do you handle the lateral Fe input? How do you treat S burial and the consecutive TA flux into the pelagic? The normal way across pore water diffusion in connection with overlying water cannot work with this model setup.

P7 L10 Describe the upscaling process in more detail.

P7 L19 I do not see the problem to handle 1400 sediment “boxes”.

P7 L22 You should say that the current model setup is only an intermediate step towards full coupling.

P10 L14-20 The text is non-transparent. Enumerate all shortcuts and discuss their implications. Specify the processes and species, which cannot be linked. Here, the above mentioned sensitivity study should be discussed.

P12 L24 Dijkstra et al,. 2018: Ref says 2017

P15 L23: “Striking ..” Discuss this item in more detail. Why would you have assumed a stronger impact? Which mechanism hampers it?

P19 L6: “2014a”

P19 L9: “2014b”

P36 L3: Ruppin (1909): Ref missing