Biogeosciences
Discussions

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# *Interactive comment on* "A decade of methane measurements at the Boknis Eck Time-series Station in the Eckernförde Bay (Southwestern Baltic Sea)" *by* Xiao Ma et al.

**Xiao Ma et al.**

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We thank reviewer 2 for the detailed comments. Please find our replies below.

GENERAL COMMENTS The paper by Ma et al. titled: "A decade of methane measurements at the Boknis Eck Time-series Station in the Eckernförde Bay (Southwestern Baltic Sea)" investigated the CH4 temporal variability (from 2006 to 2017) in the whole water column at the Boknis Eck Time-series Station located in the Eckernförde Bay (SW Baltic Sea). In this system the concentration of CH4 increases with depth due principally to the fluxes from the sediments. Sporadic elevated CH4 concentrations (up to 696 nM) have been observed in the upper layer coinciding with Major Baltic

Inflow events. During the period studied the Eckernförde Bay is an intense but highly variable source of atmospheric CH4. The manuscript is very interesting and as the authors state, time-series measurements of CH4 are still sparse, reason why the study can contribute to have a better knowledge of the behaviour of this greenhouse gas in coastal systems, hot spots of CH4 emissions. The data are well presented and the discussion of the dataset is comprehensive and conclusive. However, from my point of view, I have some suggestions to render the work more attractive to readers. Therefore, I suggest its publication after minor revisions. Since part of the behaviour of CH4 is attributed to contributions of more saline water from the North Sea and that it is a seasonal study with significant variations in temperature, it is convenient to include the variations of temperature and salinity in Figures 2 and 3.

Reply: Thank you for your suggestion. Seasonal and inter-annual variations of temperature and salinity will be shown in the figures.

Throughout the manuscript it have been discussing about good and bad correlations between the different variables studied, however, hardly any statistical data (p values, r2) are provided to indicate the good or bad degree of these correlations. I think it would be convenient to include a table with the annual intervals of variation and mean values and deviation of the studied variables including salinity, temperature and wind speed.

Reply: We will include a table with the variables as suggested.

SPECIFIC COMMENTS Pg. 1 Ln 27. Missing "l" in oil. Pg2 Ln 52. Include "temperature increment" in : : :.. which is one of the most rapid temperature increment in large marine ecosystems.

Reply: We will revise them as suggested.

Pg 3 Ln 74. HgCl2 was added to the sample once it was sealed with rubber stopper and aluminium caps? Was the measurement done with a gas-tight syringe? In that case,

could a small pore have been left in the rubber stopper to facilitate gas exchange?

Reply: There is a small pore left in the rubber stopper after poisoning, but the gas exchange is negligible for this standard method. We have tested that the vials are gas-tight despite of the pores.

Pg 3 Ln 83. The concentrations of CH4 standards used should be indicated, because although the average concentration is 51.2 _ 84.2nM, there were some sporadic samples with very high concentrations (more than 600 nM) and those concentrations should be within the calibration line.

Reply: The measurements last for more than a decade and the standard gases we used changed several times. We have adjusted the concentrations of standard gases for every measurement to make sure that the values of the samples fall in the range of the calibration curves. In this case, we think it is not necessary to list all the CH4 standards. We will include this information in the method section.

Pg 3Ln 89-90. The accurate in dissolved oxygen and Chla measurements should be indicated. How were temperature and salinity measured? What was the precision of these measurements?

Reply: Temperature and salinity were measured by the sensors equipped on CTD. Different methods might be adopted for individual parameter during the past decades. A more comprehensive overview of temperature, salinity, dissolved oxygen, Chla as well as other parameters at BE can be found in the paper by Lennartz et al. (Lennartz, S. T., Lehmann, A., Herrford, J., Malien, F., Hansen, H. P., Biester, H., and Bange, H. W.: Long-term trends at the Boknis Eck time-series station (Baltic Sea), 1957–2013: does climate change counteract the decline in eutrophication? Biogeosciences, 11, 6323–6339, https://doi.org/10.5194/bg-11-6323-2014, 2014). We will include this information in the method section.

Pg 4 Ln 112-113. What H2S concentrations were measured? It would be interesting

to include these values

Reply: Unfortunately we did not measure the H2S concentrations. The presence of H2S was recognized by the strong smells of the bottom water. We will add it to the text.

Pg 4 Ln 115. Indicate the value of the DO concentration that was obtained in the surface waters. This upwelling has also been appreciated in other variables such as nutrients?

Reply: We have shown the approximate O2 saturation in the surface water, which is a better proof than the actual DO concentration. The occurrence of the upwelling can be identified by nutrients, too, but not as clearly as indicated by temperature and O2. In this case, we think it is not necessary to include the variation of nutrients in the water column. We will add more detail here.

Pg 4 Ln 115-116. Since the authors write about behaviour of temperature and salinity, it would be convenient to include graphs of these variables in Figures 2 and 3.

Reply: The variations of temperature and salinity will be shown in figure 2 and 3.

Pg 5 Ln 124. What is the reason that in BE the Chla has elevated concentrations only in the upper layers in March and not occupied the whole water column as other works realised in this system? Are Chla and Secchi depth well related to the entire study? Perhaps it could be included in the figure of the Chla the Secchi depth graph. If we look at figure 2 in 2006 and 2012 the Chla occupies the entire water column. What could have happened in these years for the Chla behaviour to be different?

Reply: It remains unclear why elevated Chla concentrations were only detected in the upper layers in March. The overall correlation between Chla and Secchi depth is poor (r2=0.17, p<0.0001, n=111). High Chla concentrations all over the water column in November/December 2006 and March 2012 were coinciding with slightly enhanced nutrients and high temperatures. Nutrients and temperature might be potential environmental controls on Chla distribution. We will incorporate this additional information

in section 4.1.

Pg 5 Ln 130. To show seasonal and inter-annual variations, a table could also be presented showing the variation interval and annual mean value of each variable. Figures 2 and 3, although very illustrative, have been made with interpolations and do not show the specific data that it is interesting to know.

Reply: A table will be shown in the main text as suggested.

Pg 5 Ln 154. Is there any work in the area where CH4 benthic fluxes have been measured? If so, it would be interesting to include the value.

Reply: There are several papers reporting benthic CH4 fluxes in the Eckernförde Bay. Sedimentary CH4 release, via pockmarks or ebullition, was discussed in section 4.3.

Pg 6 Ln 166-167. Was the water more turbid? Did Secchi's disc reach less depth?

Reply: We did not see a strong decline in Secchi depth. We will add this information in the text.

Pg 6 Ln 178. What is the r2 of the relation between salinity and CH4?

Reply: r2=0.84, and this value together with p and n are now included in the text.

Pg6 Ln 184. Include variation of dissolved oxygen values to change from hypoxic to oxic condition in the bottom layer.

Reply: The values are now included as suggested.

Pg 6 Ln 189. Include the correlation coefficient (r2) of the relation between salinity and CH4 in November 2013. Pg 6 Ln 199. Include the correlation coefficient (r2) of the relation between salinity and CH4 in March 2014.

Reply: r2, p and n are now described in the text.

Pg 7 Ln 213-214. Since CH4 saturation has been obtained from the surface methane concentration and equilibrium concentrations of CH4 in seawater, it is obvious that

surface CH4 saturations are directly proportional to its concentrations in the surface water, I would omit this from the manuscript.

Reply: The calculation of CH4 saturation involves concentration, as well as temperature and salinity. The authors would like to point out that surface CH4 saturations are directly proportional to its concentrations, despite of the significant seasonality in temperature and salinity. In another paper about dissolved N2O at BE, the influence of temperature is stronger. We think this comparison might be interesting.

Figures: In the figures the letters and numbers are in Arial and not in Times New Roman like the rest of the manuscript.

Reply: BG does not require a consistency for the fonts in the figures and in the text. As long as the fonts in all of the figures are consistent, it would not be a problem.

Figure 1. The quality of the figure must be improved. Figures 2 and 3. The axis titles should appear with capital letters as: Depth, not depth and Dissolved oxygen not only oxygen. It should be convenient to include isolines in these figures for a better appreciation of the concentration variations. Figures with temperature and salinity variations should be included.

Reply: The figures will be revised as suggested, except for the isoclines. We tried to include isoclines in figure 2 and 3, but they seem crowded and messy because of the strong gradients.

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