Biogeosciences Discuss., 11, C8517–C8519, 2015
www.biogeosciences-discuss.net/11/C8517/2015/

Biogeosciences Discussions
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Interactive comment on "Seasonal methane accumulation and release from a gas emission site in the central North Sea" *by* S. Mau et al.

Anonymous Referee #3

Received and published: 5 February 2015

The manuscript of Mau and co-authors describes the distribution of methane at a methane seep in the North Sea, together with the microbiological methane consuming process, its oxidation. The authors provide data from classical water sampling and additional in situ measurements of the methane concentration. Methane oxidation rates were measured with 3H-tracer, as an appropriate method. Thus, altogether a valuable data set. However, I have difficulties with the modelling part and the kinetics of the Mox rates of the manuscript. I therefore suggest "major revision". Modelling 1) Based on the in situ data of methane, the authors have a 3-dimensional data set at hand. Thus it is not clear, why they restrict these data to simple box plots and further restricts the modelling to a 2-dimensional model. At the study site a 3-dimensional model with transport processes in all (or at least 4) directions would be more appropriate. 2) The transport processes used for the modelling are not clear to me. The authors neglect

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the advective process, as " currents only transport the water from the methane seep away“. However, by doing so, at the study site the methane concentrations will decrease as methane rich water from the seep will be displaced / mixed with methane poor water. Thus, I think that dilution / mixing of water bodies through currents is an important factor, which should not be neglected. 3) The description of the turbulent diffusion seems to me not correct. Fick law of diffusion handles molecular diffusion with only the concentration gradient as driving force. In the case of methane in the North Sea I think that eddy covariance calculations would be more appropriate. The cited literature of Largier 2003, seems to be not appropriate as it is dealing with the distribution of particles and not dissolved molecules by advection!! and diffusion. There are some studies modelling the methane distribution in shallow sea, however they are using numeric modelling. Grunwald, M., Dellwig, O., Beck, M., Dippner, J. W., Freund, J. A., Kohlmeier, C., . . . Brumsack, H.-J. (2009). Methane in the southern North Sea: Sources, spatial distribution and budgets. Estuarine, Coastal and Shelf Science, 81(4), 445-456. Wahlström, I., & Meier, H. E. M. (2014). A model sensitivity study for the sea–air exchange of methane in the Laptev Sea, Arctic Ocean. Tellus B, 66, 24174,.

Kinetics of MOx I cannot follow the conclusion that MOx rates are low. The MOs rates from this study lay well within the range of other marine areas, as the authors state. And even a comparison of the turnover times, which is independent from the M.conc. show that data from this study (100 d) are comparable with 80 - 1000 d from Gentz et al 2013, or 127 - 455 d from the Baltic Sea (Jacobs et al 2013). There are two ways of calculation k’ the first order constant. It can be obtained via arithmetic, i.e. calculation the average or median of the single measurements or – as suggested by the authors – graphically i.e. the slope of the linear regression. However, if using the latter one has to prove / test the linearity of the relation and give as well the confidence interval of the regression line. But no matter how k’ was calculated, it still will be only k’ in the end. The authors also use data from literature of the Km and a range of marine Mox rates to interpolate a Michaelis Menten kinetics. However, the methane concentrations of

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this study are in very low range and not even near the half-saturation concentration (1 – 12 μM = 1.000 -12.000 nM). For a kinetic study to obtain vmax or Km much more data with a broader range of Mconc are needed. See also Lofton et al 2014. Thus I do not follow the interpolated values of vmax and Km given in the text and in figure 7.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/11/C8517/2015/bgd-11-C8517-2015-supplement.pdf

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Interactive comment on Biogeosciences Discuss., 11, 18003, 2014.