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Biogeosciences Discussions

Interactive comment on "Methane production in aerobic oligotrophic surface water in the central Arctic Ocean" *by* E. Damm et al.

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Reply to Reviewers Comments:

We thank the editor and the two reviewers for taking time to read our paper and for their many constructive comments on our manuscript that helped us to improve it. We have considered the suggestions and made several changes in the manuscript. In the following, our responses to each of the referee's specific comments are listed:

Response to the comments of M. Scranton:

The transport pathways of water in the study area are discussed now (P4-5 L97-108) The point 4.1 (Excess methane in Pacific derived surface water) is partly rewritten to show that during the travel time of both water masses methane is consumed. Con-

sumption is visible in both water masses in water depth >100 m by extremely enriched ˆ13C values of methane (more than 7‰ in comparison to the atmospheric delta_13C methane value. These values reflect that the methane inventory results from the ongoing methane consumption during the long transport to the study area.

P10367 L20: In both studies methane production is demonstrated in an aerobic and nitrate depleted environment. Differences between the two studies exist with respect to the phosphor (Karl et al. use methanephosphonate in a phosphate depleted surrounding while our studies run in phosphate sufficient habitats) and carbon sources (methanephosphonate and DMSP). However, these differences appear to be unimportant as far as the microorganisms are supplied by sufficient phosphor and a carbon source that has a methyl group which may act as the direct precursor for methane production. Thus, in our opinion the two studies exhibit more similarities than discrepancies and support in combination a final understanding of the mechanisms that create the methane paradox.

P10368: The objective of the journal (BG) is to cut across the boundaries of established sciences and achieve an interdisciplinary view of the interactions between the biological, chemical and physical processes in terrestrial or extraterrestrial life with the geosphere, hydrosphere and atmosphere. Because of the interdisciplinary character (and hence of the general audience) of the journal we provided a lot of detail in how to calculate Delta_G. This might be helpful to scientists from the different fields who have not done such calculations before, or to others who like to compare our result for Delta_G with own data.

According to the proposed methane formation reaction (equation 1) both methane and HS- are products of the reaction. While the neutral CH4 can easily escape the cell via diffusion, the charged HS- will accumulate within the cell during methane production. We simulate the HS- enrichment by assuming a very high [HS-], whereas the [CH4] within the cell is assumed to be only slightly elevated compared to the concentration in the environment. The Delta_G calculated for [HS-] = 1 mM (a typical concentration

for sediments) and [CH4] = 10 nM represents a conservative estimate for the gain of energy during methane formation via equation 1. This means that the methane production via equation 1 becomes more favorable for the actual concentrations of [HS-] (< 1 mM) and [CH4] (around 5 or 6 nM).

P10372: The conclusions are partly rewritten reflecting more the state of the art now.

Technical comments:

All comments are considered and the mistakes are corrected

Response to the comments of Anonymous Reviewer #2:

P10358 L 22-24: The advection of Pdw is discussed in more detail now. Unfortunately, we have not found further literature concerning the methane concentration in the central Arctic Ocean. But we have improved the manuscript by the discussion about water transport.

P10360-10361: The microcosm experiments were designed additionally to establish that DMSP can serve as a precursor for methane production under aerobic incubation conditions. Further we wanted to learn more about the bacteria types involved in methane formation. Indeed we run batch cultures and did not keep nutrient and oxygen conditions constant, however, the low concentration of amended DMSP has not allowed the development of anaerobic conditions during the experiment. The structure of the microbial community in the experiments without carbon source addition was not followed up because considerable changes were unlikely during the incubation period due to the limitations in nutrients and carbon.

P10363: Our oceanographic data show that ice and melting water influences are restricted to the uppermost 10 m in both water masses.

P10358: We described the calculation of Delta_G at full length. This might be useful to scientists from other fields who have not done such thermodynamic calculations before.

In figure 1 the characteristics of the two water bodies are shown. An additional table including all these data would be redundant information.

Technical corrections:

P10357 L23-24: “Tallant and Kryzcki (1997)” is written here and in the references

P10360 L8-9: the calibration is specified (P6 L145)

P10360 L9-10: Gas extraction was done by a vacuum-ultrasonic treatment (P6 L145)

P10360 L21-25: is added (P7 L168-171)

P10361 L09-10: The DGGE analyses were performed with the original water sample as well as with the DMSP amended water after different incubation times. In the case of the CARD-FISH analyses the specifically prepared filter of the original water sample was missing.

P10363 L14-22: values are included (P11 L255)

Figure 1 map: the black points are stations

Figure 1c: is changed

Interactive comment on Biogeosciences Discuss., 6, 10355, 2009.