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Interactive comment on "NO_x reduction is the main pathway for benthic N_2O production in a eutrophic, monomictic south-alpine lake" *by* C. V. Freymond et al.

Anonymous Referee #2

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The manuscript "NOx reduction is the main pathway for benthic N2O production in a eutrophic, monomitic south-alpine lake" by Freymond et al. presents results from 15N incubation experiments in a flow-through reactor with sediment cores from an alpine lake.

There are only a few studies on N2O emissions from lakes, and I believe that this manuscript is a valuable contribution to improve the understanding of N2O emissions, although it lacks information on in-situ N2O measurements. These measurements could have given a direct estimate of N2O fluxes based on surface N2O measurements and in-situ N2O accumulation below the thermocline, which could have been an independent measure for the N2O emissions from the sediments to the water column.

The paper is concise and generally well written; and the main conclusions are clearly stated.

However, I still have some issues that need to be addressed:

One of the main conclusions the authors draw is that they found pronounced production of N2O mainly under anoxic conditions, which is in contrast to previous studies that found N2O consumption. As this is a strong new finding, I wonder if the authors also measured the oxygen concentrations during their experiments to ensure that the whole sediment core and the overlying water column were anoxic over the time of the experiment. It is known that N2O production and consumption during denitrification are extremely sensitive to oxygen concentrations (Naqvi et al., 2000;Ferguson, 1994), and very small differences in oxygen concentrations can result in massive differences between net N2O production and consumption. Even small contaminations could therefore lead to a large N2O production instead of consumption. Without any measurements of the oxygen concentrations during the experiments, the conclusion that N2O was mainly produced under anoxic conditions thus needs to be considered as speculative.

Specific comments: Page 4974, line 11: define abbreviation when used for the first time. Page 4975, line 9: what was the storage temperature during the transport to the laboratory? Page 4976, lines 20-21: I am curious why N2O standards were prepared by reduction of nitrate to N2O? The usage of gaseous N2O standards is very common, and the preparation of liquid standards from these is quite straightforward. The method presented by Sigman et al. (2001) was developed for measurements of 15N-Nitrate, not to measure N2O concentrations. I would therefore recommend that the authors provide some more information on the precision of the N2O standard concentrations, the standard error of the calibration curves and the overall precision of the N2O measurements. Page 4978, lines 8-11: I would not use the term “increased” in this context as this implies a continuous rise of the N2O fluxes, which cannot be verified from two samplings in six months. Page 4978, lines 15-16: “heterogeneity of the sediments”:

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please elaborate on this term: what differences in the sediment cores could have an influence on N2O production? Page 4982, line 15: please cite the original literature (Goreau et al., 1980, Löscher et al., 2012) instead of Bange et al. (2010). Page 4983, line 6: “Net N2O fluxes varied seasonally”: the presented data from this manuscript do not allow an assessment of a seasonal variability. To do so, a perennial study of the N2O fluxes with seasonal coverage would be necessary.

References:

Ferguson, S. J.: Denitrification and its control, Antonie Van Leeuwenhoek International Journal of General and Molecular Microbiology, 66, 89-110, 1994. Goreau, T. J., Kaplan, W. A., Wofsy, S. C., McElroy, M. B., Valois, F. W., and Watson, S. W.: Production of NO2- and N2O by nitrifying bacteria at reduced concentrations of oxygen, Appl. Environ. Microbiol., 40, 526-532, 1980. Laverman, A. M., Meile, C., Van Cappellen, P., and Wieringa, E. B. A.: Vertical distribution of denitrification in an estuarine sediment: Integrating sediment flowthrough reactor experiments and microprofiling via reactive transport modeling, Appl. Environ. Microbiol., 73, 40-47, 10.1128/aem.01442-06, 2007. Löscher, C. R., Kock, A., Könneke, M., LaRoche, J., Bange, H. W., and Schmitz, R. A.: Production of oceanic nitrous oxide by ammonia-oxidizing archaea, Biogeosciences, 9, 2419-2429, 10.5194/bg-9-2419-2012, 2012. Naqvi, S. W. A., Jayakumar, D. A., Narveka, P. V., Naik, H., Sarma, V. V. S. S., D’Souza, W., Joseph, S., and George, M. D.: Increased marine production of N2O due to intensifying anoxia on the Indian continental shelf, Nature, 408, 346-349, 2000.

Interactive comment on Biogeosciences Discuss., 10, 4969, 2013.