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Biogeosciences Discussions

Interactive comment on "Production and consumption mechanisms of N_2O in the Southern Ocean revealed from its isotopomer ratios" *by* N. Boontanon et al.

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The authors present a very unique data set on the isotopologue composition of N2O in the southern ocean and have a unique opportunity to make a substantial contribution to this research area. Nonetheless, important research papers that establish a strong foundation for the interpretation of site preference, in particular, are not referenced nor included in their interpretations. Many of these papers are published in the soils literature (but not all) and I can understand how they would be overlooked. Nonetheless, I cannot support publication of this manuscript until a more thorough consideration of prior studies is provided. I don't expect that this will be difficult nor do I expect that

it will change significantly the conclusions of the paper but there is an opportunity to strengthen the impact of this work if it builds upon the foundations provided. I include a list of criticisms below as well as a short list of published manuscripts that the authors may wish to incorporate.

Page 7823, line 2: Perhaps indicate that the contribution of N2O to overall warming is small but still significant; particularly as emissions of N2O are expected to increase in the near future.

Line 12: Please describe specifically what "seasonal variation at the surface" refers to... I assume this is in reference to the velocity and nature of the surface currents.

Page 7824, line 24: It would be good to reference papers describing the methodology here. I recall that Karen Casciotti has a recent paper out and Rockmann and Brenninkmeijer similarly published one in 2003 or 2004.

Page 7825, line 4: Indicate that the PreCon Unit is provided by Thermo-Finnigan. You may wish to reference Brand (1995: Isotopes and Envir. Health, 31: 277-) with regard to the PreCon.

Page 7826, line 6: Define delta-N2O as the concentration in excess of that expected from atmospheric equilibration.

Line 14: What depth does "subsurface" refer to?

Line 17: Rather than referring to the "literature" compare to results in "other ocean environments".

Page 7827, line 1: Please state the actual site preference value referred to.

Line 12: Rather than stating "another ocean" specify which ocean.

Lines 20-25: Are the authors suggesting that gas injection and bubble collapse lower the concentration of N2O below saturation values? Please be very clear on this point.

Page 7828, line 20: Rewrite as ". . . is consistent with the values expected to result from isotopic equilibration with the atmosphere".

Line 13: I don't believe that "equilibrium fractionation" is the correct term in this context. We don't know what the isotopomer values or fractionation factors are for the alpha and beta N atoms in N2O during air-water equilibration as this has never been determined. The surface values presented in this paper may be one of the few data sets providing this information.

Line 17: Why would the beta site be more active than the alpha site?

Page 7830, line 1-4: Confusing wording; rewriting needed.

Line 10: Please be more clear. Decomposition will yield ammonium, not N2O. Decomposition followed by nitrification will yield N2O.

Page 7831, lines 3-8: The authors have neglected many recent studies addressing SP values associated with production of N2O in pure culture as well as isotope effects during N2O reduction. This is a major oversight and limitation to the manuscript. Yamagishi et al. (2005) would be appropriate here.

Page 7832, lines 5-10: This is another area where there has been much discussion in the recent literature that is not referenced here. Schmidt et al. (2004) is a fairly good recent reference but several others have touched on production mechanisms.

Lines 12-15: The authors need to reference pure culture studies that define the SP values expected during different production pathways. See Sutka et al. (2006; 2008) and Toyoda and Yoshida (2005).

Lines 21-24: The authors need to refer to a series of articles that define the SP isotopomer effects associated with N2O reduction (Ostrom et al., 2007; Jinuntuya et al., 2008; Yamagishi et al., 2006).

Page 7835, lines 3-14: The writing here is confusing in that it suggests that there is

production of N2O and flux to the atmosphere. But the authors indicate that fluxes are from the atmosphere into the ocean. I believe that they are indicating a production rate at depth; but overall the fluxes are from the atmosphere into the ocean. Please revise the writing to avoid this confusion. This point is also confusing in the Abstract.

Page 7835, line 24: This sentence is not clear. I am not certain what "marine movement" refers to and why there is reference to "glacial region". Please revise.

References: Frame, C., and Casciotti, K. 2010. Biogeochemical controls and isotopic signatures of nitrous oxide production by a marine ammonia-oxidizing bacterium. Biogeosciences Discussions 7: 3019–3059.

Jinuntuya-Nortman, M., Sutka, R.L., Ostrom, P.H., Gandhi, H., and Ostrom, N.E. 2008. Isotopologue fractionation during microbial reduction of N2O within soil mesocosms as a function of water-filled pore space. Soil Biol. Biochem. 40: 2273-2280.

Ostrom, N.E., Pitt, A., Sutka, R., Ostrom, P.H., Grandy, A.S., Huizinga, K.M., and Robertson, G.P. 2007. Isotopologue effects during N2O reduction in soils and in pure cultures of denitrifiers. J. Geophys. Res.-Biogeosci. 112: 12.

Röckmann, T., Kaiser, J., Brenninkmeijer, C.A., and Brand, W.A. 2003. Gas chromatography/isotope-ratio mass spectrometry method for high-precision position-dependent 15N and 18O measurements of atmospheric nitrous oxide. Rapid Communications in Mass Spectrometry 17: 1897–1908.

Schmidt, H.L., Werner, R.A., Yoshida, N., and Well, R. 2004. Is the isotopic composition of nitrous oxide an indicator for its origin from nitrification or denitrification? A theoretical approach from referred data and microbiological and enzyme kinetic aspects. Rapid Commun. Mass Spectrom. 18: 2036-2040.

Sutka, R.L., Ostrom, N.E., Ostrom, P.H., Breznak, J.A., Gandhi, H., Pitt, A.J., and Li, F. 2006. Distinguishing nitrous oxide production from nitrification and denitrification on the basis of isotopomer abundances. Appl. Environ. Microbiol. 72: 638-644.

Toyoda, S., Mutobe, H., Yamagishi, H., Yoshida, N., and Tanji, Y. 2005. Fractionation of N2O isotopomers during production by denitrifier. Soil Biology and Biochemistry 37: 1535–1545. Yamagishi, H., Yoshida, N., Toyoda, S., Popp, B.N., Westley, M.B., and Watanabe, S. 2005. Contributions of denitrification and mixing on the distribution of nitrous oxide in the North Pacific. Geophys. Res. Lett 32: L04603, doi:10.1029/2004GL021458

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