

Interactive comment on “Production and consumption mechanisms of N₂O in the Southern Ocean revealed from its isotopomer ratios” by N. Boontanon et al.

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We thank Prof. N.E. Ostrom for his very critical and valuable comments. Almost all of the suggestions done by him have been accepted as described in the following PTP response:

RC = Referee’s Comments; AR = Authors’ Response

RC-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.

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AC- We will follow referee suggestion.

RC-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.

AC- Yes, this refers to the velocity and surface currents, and we will describe more detail in the manuscript.

RC- 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 Bren-ninkmeijer similarly published one in 2003 or 2004.

AC- We will refer to the reference that use the similar methodology.

RC- 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.

AC- We will follow to the referee advice and also include those reference.

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

AC- We will describe for the delta-N₂O.

RC- Line 14: What depth does “subsurface” refer to?

AC- Subsurface refers to the depth 150-300 m.

RC- Line 17: Rather than referring to the “literature” compare to results in “other ocean environments”.

AC- We will follow to the referee advice.

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

AC- The value of site preference will be show in the text.

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RC- Line 12: Rather than stating “another ocean” specify which ocean.

AC- We will follow to the referee advice.

RC- 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.

AC- We believe that this process is a possible way to make N₂O undersaturation. However, we will make it clearer.

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

AC- We will rewrite as the referee suggestion.

RC- 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.

AC- Yes, until now we have no data of N₂O isotopomer during air-water equilibrium. However, we will use the other term which more

RC-Page 7829, Line 17: Why would the beta site be more active than the alpha site?

AC- We do believe that side N would easier to react than center N due to its position in the molecule.

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

AC-Line 1-4 will be rewrite to be clearer.

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

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AC- We will rewrite as the referee suggestion.

RC- 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.

AC- We will refer and add more recent data about site preference.

RC- 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.

AC- We will refer and add more recent information in the production mechanisms.

RC- 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).

AC- We will refer to the references that the referee suggestion.

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

AC- We will refer to the references that the referee suggestion.

RC- 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.

AC- We will rewrite in this part.

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RC- Page 7835, line 24: This sentence is not clear. I am not certain what “marine move- ment” refers to and why there is reference to “glacial region”. Please revise.

AC- We will rewrite as the referee suggestion.

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