

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

N. Boontanon et al.

ennbt@mahidol.ac.th

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We thank the referee #2 for his/her very critical and valuable comments. Almost all of the suggestions done by him/her have been accepted as described in the following PTP response:

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

General

AC- We do agree with the referee, and we will be stated more clearly in the N₂O production/reduction and its isotope values. And we will manage the reference values

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that we refer to be more easily to follow. We will rewrite more clearly.

RC- p.8, 1st paragraph, discussion of alpha inv/ev. Please wrap up this discussion by relating it to the actual data. What value of alpha is estimated from the Southern Ocean data?

AC- We will rewrite and mentions on the actual data.

RC- Abstract: Please mention the latitude range as well as the longitude of the measurements.

AC-We will mention the study areas in the abstract.

RC- Methods: Please give uncertainty in nM of the N₂O concentration measurements (keeping in mind that the surface undersaturation of ~6% corresponds to slightly less than 1nM at these temperatures). Is 2-decimal point precision (e.g., p 7) warranted?

AC- The analytical precision of N₂O concentration measurements is less than 2%. And the 2-decimal point precision is warranted.

RC-Figure 2. Please cite in the text when this figure is first presented. It would also be good to show DO or AOU in the same figure as DN₂O. It is hard to see the DO minimum or to match it up to the DN₂O maximum in the current set of figures.

AC- We will modified the figure follow the referee suggestion.

RC-Section 4.1, line 4. Please replace “another ocean” with the name of the appropriate ocean (Indian?).

AC- We will follow to the referee advice.

RC- p.6, line4, the statement that excess N₂O increased significantly toward continental margins seems inconsistent with smaller undersaturation of 1nM at 66S vs. 2nM at 61S.

AC- This part refer to the surface N₂O, the data shows that excess N₂O increased

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from sta.1 to sta.8.

RC- Section 4.1, lines 8-9. Please define or give a reference for Feb-Mar temperature stability. A change of 1.5 deg C could give rise to a 1nM change in N₂O_{sat}.

AC-We will refer to the data which would be available from the NOAA/CMDL flask network

RC- section 4.3, the discussion is problematic for a number of reasons. First, it is unclear what the northern extent of the Southern Ocean is, as defined in this manuscript. Please give the latitude bounds of the estimated Southern Ocean area of $37 \times 10^{12} \text{ m}^2$.

AC- The area bounds will be mention and refer to the reference.

RC- Second, the discussion implies that the escape of subsurface N₂O, which is supersaturated by 8nM (about 50% at 0 deg. C), is diffusion limited. This may be true in the summer or perhaps in the continental margin due to ice sheet dynamics, but this is not true year-round in the Antarctic Circumpolar Current. When the mixed layer breaks down in fall and winter, it is reasonable to expect to excess N₂O to escape to the atmosphere. Diffusion across a stratified subsurface layer will not be the limiting factor.

AC- We are agreeing with the referee. And we will rewrite in the context.

RC- Third, the Southern Ocean N₂O flux estimate in Mg N/day is an ambiguous measurement unit. Readers may be tempted to multiply by 365 to estimate the annual flux, but the Southern Ocean N₂O source is probably highly seasonal, with the largest net flux to the atmosphere occurring during winter when the mixed layer breaks down and enriched deepwater is ventilated. During seasons when the ocean is stratified, e.g., February, the flux is probably governed by changes in windspeed, as discussed in Section 4.1, or by solubility effects, such as warming or cooling of surface waters or freshening due to ice melt. Extrapolating fluxes resulting from temporary dis-equilibrium due to wind or solubility effects over the entire year is unlikely to give an accurate estimate

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of the annual source.

AC- We are agreeing with the referee. Our flux estimation base on only our data (summer) and we are also believe that N₂O production are highly seasonal variation. However, we do not obtain the other data that will give more accurate estimate. We will rephrase the text, merely indicating this possibility along with the caveat mentioned by the referee.

Interactive comment on Biogeosciences Discuss., 7, 7821, 2010.

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