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Interactive comment on "Influence of mesoscale eddies on the distribution of nitrous oxide in the eastern tropical South Pacific" *by* D. L. Arévalo-Martínez et al.

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1 Summary

Dr. Arevalo-Martinez et al. present and discuss a novel set of vertical profile measurements of N2O taken from the Eastern Tropical South Pacific. They find strong vertical gradients in N2O with a two-peak structure associated with the upper and lower boundaries of the oxygen minimum layer, indicative of highest N2O yields at very low oxygen concentrations but shy of full anoxia. They combine these N2O concentration measurements with genetic information to infer the most likely organisms responsible for

the distinct N2O distribution. By comparing the profiles inside and outside of a suite of three eddies, they also discuss how mesoscale activity and transport influences the production and consumption of N2O, but also its transport.

2 Evaluation

With the Eastern Tropical South Pacific representing a "hotspot" of global oceanic N2O production (Arevalo-Martinez et al., 2015) it behooves us well to understand the processes controlling the production and consumption of N2O in this region. The data presented and discussed here represent a good step forward in elucidating these processes, adding an important additional puzzle piece in our understanding of the marine N2O cycle. The data are of excellent quality, well presented, and their discussion is thorough and generally insightful. The paper is well written and generally easy to follow. In summary, this is a good paper, whose publication I am glad to support.

There are, however, a few of major comments that I would like the authors to consider when preparing the final version of their paper.

- *Overinterpretation of the data*: While I admire the authors for their very thorough and deep discussion of the data, sometimes I had the feeling that they went too far and started to pick up simply "noise", resulting from the fact that they investigate a rather dynamic environment. For example, some of the differences in "aging" could simply be just within eddy variations, stemming from differences in formation, transport, initial nutrient levels, etc. I suggest that the authors acknowledge this alternative interpretation more strongly and adjust their wording accordingly.
- *Stronger synthetic view:* The paper would greatly benefit from the authors taking a more synthetic view of their results. As it stands, the authors emphasize

differences and much less the common aspects. Thus, the reader comes away with the impression that every eddy is different, preventing them from formulating more general principles. I thus strong encourage the authors to add a synthesis section where they develop a diagrammatic view of how N2O is formed, consumed and transported in such a dynamic environment such as the ETSP.

- *Molecular genetic methods*. I applaud the authors' combination of the (bio)geochemical measurements with those using molecular genetic methods. But in the text, the integration is not as strong as it could be, as the genetic information is used in a rather qualitative manner. In particular, one wonders whether the bacterial biomass present would suffice to produce/consume the amount of N2O needed in order to produce the environmental concentrations and gradients in N2O.

3 Recommendation

I recommend acceptance of this manuscript with minor revisions. I would like to encourage the authors to pay particular attention to my recommendation to take a more synthetic view of their data.

4 Minor comments

Introduction: I suppose the authors want to refer also to their Nature Geoscience paper.

page 9215, line 22: "This result can be explained by lower water column O2 concentrations in eddy A than in eddy B (36.4 and 42.9 molm-2)" This is an example of a possible "overinterpretation" of the results. This is a rather small mean difference, which I doubt is big enough to really explain the difference.

page 9252, line 19 "Therefore it is likely that the decaying primary production 20 of eddy C during its transit away from the shelf led to a diminished supply of organic matter which could fuel N-loss within the OMZ's core, explaining the relatively high N2O concentrations observed in comparison to eddies A and B." This speculation is reasonable, but again, the difference is not as marked as the authors portray it to be. Hence, I would be more cautious in the interpretation of these differences.

page 9254, line 13ff "[..] show that denitrifiers produce increasing N2O:N2 ratios as the O2 concentrations increase..." It would be very interesting if the authors were able to be more quantitative here. Shouldn't it be possible to estimate this ratio by combining an estimate of the N-loss with the increase in N2O?

page 9257, line 5ff "After integrating ΔN over the depth range of the OMZ, we obtained values of 8.9 and 0.02 molm-2 for eddy A during M90 and M91, respectively". I don't understand this result. A nitrogen deficit that is once created cannot be easily alleviated. One of the few options is to have N2-fixation to kick in, providing a lot of newly fixed N to compensate for the lost N2. Thus, it is puzzling to me how this change in ΔN can happen.

Nicolas Gruber, September 2015

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