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Interactive comment on "Global trends in marine nitrate N isotopes from observations and a neural network-based climatology" *by* Patrick A. Rafter et al.

Anonymous Referee #1

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Overview: The paper targets a useful goal – providing a map of 15N-NO3 estimates for the global ocean for use in biogeochemical studies. To do this, it uses a neural network to obtain a relationship between sparse observed 15N-NO3 and World Ocean Atlas (WOA) values of temperature, salinity, oxygen, phosphate and nitrate, and then maps the derived 15N-NO3 estimates. The utility of the approach is assessed via correlation statistics between the estimates and the observations. There are areas where the estimates and observations agree well and others where they agree poorly. The latter are ascribed to temporal offsets between the WOA data collection and the 15N-NO3 observations. As far as it goes, the paper is sound, but it doesn't go very far (as an aside it does provide clear and well-constructed descriptions of possible mechanistic

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Discussion paper

causes of the spatial variations in the 15N-NO3 observations, although these do not really derive from or depend on the mapping exercise). It could be improved by addressing the following issues: 1. Is the neural network (NN) approach demonstrably better than a multiple linear regression (MLR) to the same input variables? Assessing this would be useful for two reasons: a. The MLR has the advantage that is provides a simple equation that all can use with their local and future input variable observations [(notably MLR approaches are becoming widely used for nitrate in the context of BGC-Argo observations; Carter et al. 2017, https://doi.org/10.1002/lom3.10232] b. Determining whether and in which parts of the ocean the non-linear NN approach outperforms the linear MLR approach is likely to shed light on the processes that drive 15N-NO3 variations. 2. Are there other metrics that could assess possible causes of the quality of the matches and mismatches between estimates and observations, to go beyond simply ascribing them to temporal offsets? For example since some of the 15N-NO3 estimates were probably collected synchronously with the WOA data, do these points show closer agreement? Can agreement with mechanistic understanding be assessed – for example in regions where single processes largely dominate 15N-NO3 variations (e.g. nitrate assimilation in Southern Ocean surface waters) does the NN approach produce sensible correlations between [nitrate] and 15N-NO3 ?

Details: Line 63: ammonia assimilation is also a significant determinant of the 15N of organic matter. Line 370: meaning of sentence beginning “Equivalent processes... was opaque to me. Lines 384-395: This discussion of separating nitrification from denitrification influences on deep water 15N-NO3 values would benefit from recognition that relationships with O2 and nitrate have opposite signs. Line 403: The estimate low sinking organic matter 5N estimate of +1.5 should be compared to published results in Lourey et al., 2003, GBC, which show good agreement: https://doi.org/10.1029/2002GB001973

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