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Interactive comment on "The importance of nitrogen fixation to a temperate, intertidal embayment determined using a stable isotope mass balance approach" *by* Douglas G. Russell et al.

Anonymous Referee #1

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Russel and co-workers have attempted to understand the respective roles of nitrogen fixation and denitrification in an intertidal embayment using the stable isotopes of nitrogen. They estimated that the Western Port receives 36% of the bioavailable nitrogen through nitrogen fixation. Although their findings are interesting, their model requires robustness and better description. As nitrogen cycle is not as simple as presented, authors need to take into account several other end members (such as dissolved organic nitrogen) in their mass balance model. Use of fractionation factor has been completed ignored in their model. My detailed review is as below:

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Major comments:

1. This model (equations presented on page 5-6) is very trivial. Nitrogen cycle is very dynamic, many components of the cycle are missing in the model, such as anaerobic ammonium oxidation that occurs in sediments (Thamdrup & Dalsgaard, 2002) and flux of the dissolved organic nitrogen (Jickells et al., 2017) to name a few. Moreover, isotopic fractionation factors (ε) for these processes are different – not much is known about their precise values. None of the equations presented here have considered fractionation factors barring equation (3), and that too has inappropriately incorporated fractional factors. In addition, each term (expression) used in equations must be defined clearly, for example, what does mSources in equation (1) stand for? In a nutshell, equations need elaboration and model requires robustness.

2. These (model) equations are equations are time independent. We understand that biogeochemical processes are time dependent – for example N2 fixation is more in some season, while denitrification would dominate in some other season. So how good these isotope mass balance equation can represent such processes?

3. It is stated that equations (2) and (3) provide equation (4) (Page 5, line 30) but I guess equations (1) and (3) provide (4).

4. Section 2.2.1 on atmospheric deposition. Dissolved organic nitrogen in an important source of nitrogen that has been ignored.

5. In the same section, how was atmospheric flux estimated from the concentration. Is it dry deposition or wet deposition or sum of the both? What was the deposition velocity and scavenging ratio? How much area was considered to estimate concentration into areal fluxes? All factors must be elaborated.

6. Are the measurements of atmospheric deposition, river inputs, N2 fixation, denitrification done simultaneously? If not, then how can one do mass balancing?

7. Models (mathematics) are useful to understand processes but one cannot ignore ex-

perimental results just because there are methodological issues. Because of methodological issues, experimentalists provide errors associated with estimates. Models also need to be verified with observations. Therefore, the criticism of experiments presented on page number 14 (first paragraph) is a bit overdone.

Minor comments:

Page 1, line 6-7: It is not just the nitrogen fixation and denitrification, riverine inputs and atmospheric deposition are equally important source of bioavailable nitrogen in coastal ecosystems.

Page 1, line 16 and wherever standard deviation is reported: standard deviation (error) should have only one significant digit and the mean value should be adjusted accordingly. See (Bevington & Robinson, 2003) for more details.

Page 1, line 19-20: Is 36% comparable with literature estimates based on direct measurements.

Page 2, line 5-8: "As these. . .. .eutrophic". This is intuitively correct but factually incorrect. We know that most of eutrophic oceans (for example the Arabian Sea and the eastern South Pacific) have the most intense denitrified zones, while the oligotrophic oceans (such as the North Atlantic) witness nitrogen fixation process.

Page 2, line 9-19: (Jickells et al., 2017) is an updated reference on this topic.

Page 2, line 21-24:, "This is particularly. . .. .". Recent modelling and experimental studies, both have shown that the bioavailable nitrogen does not inhibit nitrogen fixation (Landolfi et al., 2015; Meyer et al., 2016)

Page 2, line 29: (Montoya et al., 1996) is an appropriate and original reference.

Page 3, line 1-6: Since the authors are listing issues with the N2 fixation estimation technique, they must also mention the bubble problem (Großkopf et al., 2012; White, 2012) and contamination problem (Dabundo et al., 2014).

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Page 3, line 22: “is” should be replaced by “are”

Page 3, line 29: “However, such a model represents a simplified version. . . . . .”. Authors may refer to (Ramesh & Singh, 2010) for a complex isotope model based on Rayleigh isotope fractionation.

Page 4, line 19: sediment has appeared for the first time after its appearance in the abstract. Authors should make it clear in the first lines on the introduction that this study is based on the sediments.

Page 5, line 4: was should be replaced by were.

Page 6, line 11: Does t stand for ton in t N yr-1. State it accordingly.

Page 7, equation (6), Rivers also transport DON. This term must be included.

Page 9, line 8: How was the error estimated?

Page 11, line 4: Is 36% significantly different from 35%?

Table 1, column 3. Is it fractionation factor or just the delta value?

Table 2, How many data were used in this regression?

Fig. 3: What statistical analysis was done to test the difference (to obtain p value) between estimated and actual value?

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Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-418/bg-2017-418-RC1-supplement.pdf

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