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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 #2

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This manuscript estimated the N supply by nitrogen fixation under an assumption of balanced nitrogen influx (source) and outflux (sink) in the intertidal embayment, and addressed its validity by comparing 15N of sediments between the model derived and measured values. It's interesting approach, but I have serious concerns about the steady state in the study area, and the fluxes and isotopes used in the model (see the following comments). While I appreciate the effort of the work presented, I cannot recommend this manuscript for publication unless these concerns are solved clearly.

Major comments: 1. I doubt the steady state within the small and complicated bay

that authors assumed. This requires no change of nitrogen budget (pool size) in the system. Authors should discuss about major nitrogen pools, their sizes and temporal change of them.

2. Authors also assumed the pseudo closed system in which all nitrogen supplied is consumed by the sink processes (sediment burial, denitrification, algal assimilation) within the study area. This implied that any riverine nitrate is not transported out of the bay. Although authors pointed extremely low concentration of dissolved inorganic nitrogen in the bay, Russell et al. (2016) reported the range of 0.2-5 uM of nitrate. The spatial distribution of nitrate should be presented along the rivers-the inside bay-out of the bay, then mixing of freshwater and seawater to be discussed. Authors also suggested no flux between inside and out of the bay for the particulate nitrogen because of similar concentration and its isotope between them. However, many scientists (e.g. Sukigara & Saino, 2006, Geophysical Research Letters, 33, L09607) have stressed a significant transport of resuspended sediments as nitrogen flux from the bay to open ocean. This possibility should be examined in this study. If any riverine materials including nitrogen is not transported, dissolved inorganic nitrogen out of the bay should originate from open ocean. Is it true?

3. Authors assumed that almost riverine nitrate are assimilated by phytoplankton and seagrass. Ultimately, I think, these organic nitrogen is decomposed into inorganic nitrogen (ammonium and nitrate). A part of them can be buried into the bottom. The nitrate regenerated from algal organic nitrogen can be consumed by denitrification. These processes links each other complicatedly. It's impossible to estimate their independent fluxes, especially in annual scale.

4. Authors seem to confound the 15N of removed nitrogen with the isotopic fractionation associated with the removal (sink) processes. The isotopic fractionation (ε) is expressed as 15N difference between substrate and product of the process. Therefore, equation (3) was inadequate. Furthermore, I have some concerns about 15N of removed nitrogen used in the model. As for denitrification, 15N of 3.5 ‰ is used by

referring Brandes & Devol (2002) in which they assumed 15N of typical oceanic nitrate with 5 ‰ and ε with 1.5 ‰Meanwhile, authors suggested that riverine nitrate 15N was 12.6 ‰ (P7_L24), which looks to conflict with nitrate 15N of 5 ‰Authors should explain the origin of nitrate in the bay. As for algal assimilation, it's okay with ε of 4 ‰The 15N of assimilated nitrogen, however, to be calculated from nitrate 15N minus ε. If assuming riverine nitrate with 12.6 ‰ as a major substrate, it corresponds with 8.6 ‰ (= 12.6 - 4.0). This would lower the sediment 15N estimated from your model.

5. I'm afraid I can't understand the model calculation in this study. The sediment 15N derived from this model were shown in Fig. 3 and S1, which are the output of 10,000 iterations (P10_L16). I suspect that these outputs are same with the result of sensitivity analysis, illustrated in Fig. S2 and S3. If so, I cannot find any significance of the average and the standard deviation of this result because, I think, they do not support the validity of model output.

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