

Review SC1

We thank the reviewer for helpful comments and corrections. In the following we address each of the points raised:

1. *In line 13, 'The Bohai Sea' seems to be appeared first time, It is suggested to use 'The Bohai Sea(BHS)' instead here.*

Authors' reply: We will correct this.

2. *The author is suggested to check several sentences which is difficult to read such as In line 15, 'It is therefore crucial to quantify the reactive nitrogen input to the BHS and to understand the processes and determine the quantities of nitrogen eliminated in and exported from the BHS' is suggested to revise as 'Therefore, it is crucial to quantify the reactive nitrogen input to the BHS and understand the processes and determine the quantities of nitrogen eliminated in and exported from the BHS.'*

Authors' reply: We will correct it.

3. *The author is suggested to check the whole manuscript about some small mistakes, such as in line 44-45 Chen, 2009 should be Chen et al., 2009, Su, 2001 could not find in the reference list.*

Authors' reply: We checked the “Chen, 2009” reference again and the sole author of this paper is Chen-Tung Arthur Chen (please see the link here:

<https://www.sciencedirect.com/science/article/abs/pii/S0924796309000748>).

The reference “Su, 2001” is called up in line 642 and the citation was indeed omitted - will be added. Also, the paper will be thoroughly checked for small mistakes.

4. *In line 24-25, In here, Ground water should be groundwater, it is suggested that “submarine discharge of nitrate with fresh ground water’ changed to ‘submarine fresh groundwater discharge of nitrate’.*

Authors' reply: We will correct this as proposed.

5. *In line 23-26, 'The main nitrogen sources are rivers contributing 17.5%-20.6% and the combined terrestrial runoff (including submarine discharge of nitrate with fresh ground water) accounting for 22.6%-26.5% of the nitrate input to the BHS while atmospheric input contributes only 6.3%-7.4% to total nitrate.' In here, firstly you discussed about nitrogen sources, then mentioned about nitrate percentage. It seems a little confuse, please use nitrate or nitrogen (DTN?) instead.*

Authors' reply: In the revision, we will correct “The main nitrogen sources” in line 23 to “The main nitrate sources” to be more explicit.

6. *In line 29-30, the sentence 'A further eutrophication of the BHS could, however, induce water column hypoxia and denitrification as already observed – often seasonally off river mouths - in other marginal seas.' is hard to read, please revise it as more simple way.*

Authors' reply: The restructured sentence could be: “However, a further eutrophication of the BHS could induce water column hypoxia and denitrification, as is increasingly observed in other marginal seas and seasonally off river mouths”.

7. In line 43 (Smith et al., 2003;Liu et al., 2009). Please make sure if a space is needed between two citations.

Authors' reply: Spaces will be inserted between multiple citations in the revised version of the manuscript.

8. In line 70, a comma is needed after study. For this study, we analyzed.

Authors' reply: We will correct this.

9. In line 73, Aim of the study - The aim of the study.

Authors' reply: We will correct it.

10. In line 75, . . .et al., 2011), Please remove the comma here.

Authors' reply: We will correct it.

11. In line 92, The author described as 'Samples were taken monthly in May, July to November from Yellow River, and in November from Daliao River, Hai River, Luan River and Xiaoqing River (Fig. 1).', Why the water sample is only taken monthly from summer to winter in Yellow river(Also why it is not taken in June?), the other river is only a winter sample, Because it contains dry and wet season in the research region, is it enough to calibrate/validate the mass balance model using one month data?

Authors' reply: The sampling for Yellow River (YR) was fit into the time schedule of the lead author, who participated in a ship sampling expedition to the Yellow Sea in June.

In our view, the data still are representative for the following reasons: The flood season of the YR is July to October (MWR, 2019), so that we have 4 months representative of the flood season (July, August, September and October) and 2 months for dry season (May and November). This means that our data set covers flood and dry seasons, although admittedly not in an ideal way. YR emptied 333.8×10^9 m³ water and 8.0×10^9 mol nitrate to the Bohai Sea in 2018 and accounted for 85% and 84% of water and nitrate discharge among the largest rivers discharging to the Bohai Sea, respectively. The nitrate $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of YR changed little during the sampling period. Because the average values of nitrate $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ for rivers are mass weighted instead of arithmetic mean values, the change of nitrate $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ for rivers with low nitrate discharges would induce little change of the average values.

For instance, the nitrate $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of Daliao River in the flood season was reported as 20.1‰ and 9.4‰, respectively (Yue et al., 2013). Assuming that the flood season in Daliao River basin is also 4 months like in the YR basin, the flood and dry season mass weighted averaged nitrate $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ is 13.4‰ and 3.5‰, respectively. Combing these values with the rest of the rivers, the Daliao discharge resulted in quite small relative deviations (0.7% for $\delta^{15}\text{N}$ and 0.8% for $\delta^{18}\text{O}$) to our data used in the manuscript ($\delta^{15}\text{N}_r=10.0\%$ and $\delta^{18}\text{O}_r=1.3\%$). We fully agree with the referee that the more completed monthly sampling for rivers will improve the results, but also consider the data at hand to be quite reliable.

12. In line 135-140, the author described the model by using HAMSOM, and calculate the model in year 2018. How about the warm up periods of the model? And how about the calibration/validation process, the author is suggest to describe the model more detailly.

Authors' reply: The spin-up period of this model is 1 year. The HAMSOM model has been applied to investigate the Bohai Sea physical circulation for several decades now and has been extensively validated in the Bohai Sea (Jia and Chen, 2021; Hainbucher et al., 2004; Huang et al., 1999). This information will be added to the manuscript.

13. *In line 165-176, Please uniform the nutrient name in this part, Such as there are NH₄⁺ in the text but NH₄⁺ -N in the figure.*

Authors' reply: The text in the figures will be corrected.

14. *In line 247, 'nitrate- rich' please remove the space before rich.*

Authors' reply: We will correct it.

15. *In line 250, '(= halo- and nutricline)' I did not understand the expression here, Could the author explain it more clearly?*

Authors' reply: The original text in the manuscript is “the water is stratified with the thermocline (= halo- and nutricline) at about 8 m water depth”, we intended to tell the readers that the thermocline, halocline and nutricline were all observed at 8 m water depth. This will be rephrased.

16. *In line 245, the author described as 'the YR is one of the major sources of these nutrients in the BHS' but not discussed the nutrient contents from other rivers, The author is suggested to described more detailly here.*

Authors' reply: As we described above, Yellow River discharged 333.8×10^9 m³ water and 8.0×10^9 mol nitrate to the Bohai Sea in 2018, accounting for 85% and 84% of water and nitrate discharge of all large rivers in the Bohai Sea, respectively. We will add this information to the revised version.

17. *In line 249, '(see the discussion of chapter 4.2.5).' I am not sure if it is ok to refer as this way. Because it makes the reader more confused about the discussion part.*

Authors' reply: The parentheses and the text included will be deleted.

18. *In line 314, 'sea water.' In manuscript, there are two descriptions as 'sea water' and 'seawater', please uniform the callings.*

Authors' reply: We will use “seawater” in the revised version of the manuscript.

19. *In line 317, 'north China Plain' should be 'North China Plain'.*

Authors' reply: We will correct it.

20. *In line 327, 'The difference of the' of – between.*

Authors' reply: We will correct it.

21. *In line 340, 'from sediment' to 'from the sediment.*

Authors' reply: We will correct it.

22. *In line 345, 'Sinking particles in the BHS have a $\delta^{15}N$ of 5.2‰ ($\delta^{15}N_{\text{sink}}$), ' I am confused about this part, is this data measured from this curies? This suspended particulate matter value is not*

shown in the manuscript (in Line 200-206, it shows the average $\delta^{15}\text{N}$ of SPM in spring was $4.8\pm 0.9\text{‰}$), The author is suggested to add reference or method of this data.

Authors' reply: The $\delta^{15}\text{N}$ of particles in spring and summer was $4.8\pm 0.9\text{‰}$ (line 205) and $5.6\pm 0.8\text{‰}$ (line 207), respectively. The annually averaged value $\delta^{15}\text{N}_{\text{sink}}$ were calculated as the mean value of spring and summer. This will be described in the revised version.

23. In line 363-365, 'ground water' should be 'groundwater' 'Most important sinks' should be 'The most important sinks' 'steady state' should be 'steady-state'.

Authors' reply: We will correct it.

24. In line 371, 'deposited nitrate,,' please remove a comma.

Authors' reply: We will correct it.

25. In line 440, 'in the eastern Hainan Island' remove 'the'.

Authors' reply: We will correct it.

References:

- Hainbucher, D., Hao, W., Pohlmann, T., Sündermann, J., and Feng, S.: Variability of the Bohai Sea circulation based on model calculations, *J. Mar. Syst.*, 44, 153-174, <https://doi.org/10.1016/j.jmarsys.2003.09.008>, 2004.
- Huang, D., Su, J., and Backhaus, J. O.: Modelling the seasonal thermal stratification and baroclinic circulation in the Bohai Sea, *Cont. Shelf Res.*, 19, 1485-1505, [https://doi.org/10.1016/S0278-4343\(99\)00026-6](https://doi.org/10.1016/S0278-4343(99)00026-6), 1999.
- Jia, B., and Chen, X. e.: Application of an ice-ocean coupled model to Bohai Sea ice simulation, *Journal of Oceanology and Limnology*, 39, 1-13, 10.1007/s00343-020-9168-8, 2021.
- MWR, C.: *China River Sediment Bulletin 2018* (in Chinese), Beijing, 81, 2019.
- Yue, F.-J., Li, S.-L., Liu, C.-Q., Zhao, Z.-Q., and Hu, J.: Using dual isotopes to evaluate sources and transformation of nitrogen in the Liao River, northeast China, *Appl. Geochem.*, 36, 1-9, <https://doi.org/10.1016/j.apgeochem.2013.06.009>, 2013.