General remarks

The article has a clear scientific objective and is written clearly and concisely. It provides new insights into East China Sea hypoxia.

Unfortunately I see two major shortcomings which need to be clarified before the article can be published. The first one is about the appropriateness of using a simplification of the nutrient tagging method for this application. The second one is about insufficient model validation. If these can be fixed and the authors show that (a) the method is applicable and (b) the model has a sufficient quality in the parameters in question, I would recommend publication of the article.

Choice of the tagging method

I see a serious issue with the applied tagging method.

Problem

Your equation (2) presented in line 101 does not describe the element tracing method described in Menesguen et al. (2006) and Radtke et al. (2012),

$$\frac{\partial C_X^i}{\partial t} = \nabla \cdot \left(\overline{\overline{D}} \nabla C_X^i\right) - \nabla \cdot \left(C_X^i \mathbf{v}\right) + R_{C_X} \cdot \frac{C_{X_{con}}^i}{C_{X_{con}}} . \tag{1}$$

but you rather use a simplification

$$\frac{\partial C_X^i}{\partial t} = \nabla \cdot \left(\overline{\overline{D}} \nabla C_X\right) \cdot \frac{C_X^i}{C_X} - \nabla \cdot \left(C_X \mathbf{v}\right) \cdot \frac{C_X^i}{C_X} + R_{C_X} \cdot \frac{C_{X_{con}}^i}{C_{X_{con}}} , \tag{2}$$

which deviates from the full equation.

In your 2017 publication ("A Novel Modeling Approach to Quantify the Influence of Nitrogen Inputs on the Oxygen Dynamics of the North Sea") you discussed this problem in a specific paragraph, but you do not state this difference here.

The effect is that in the simplified equation, mixing or advection of the tagged element is always driven by a gradient in the **total** concentration C_X. So your formulation does not allow a diffusion or advection of a tagged element C_X^i against the gradient of the total concentration C_X.

This is especially problematic in this application, where you try to investigate how much oceanic N enters the (N-richer) coastal area. Your simplification prevents this transport. In this way, the contribution of a "local" source is systematically overestimated while that of a remote source is underestimated. I cannot see why it can be ruled out that this methodological error actually determines the result of your study.

Suggested solution

I suggest a simple experiment to quantify the impact of the simplification. In a first step, you initialize three passive tracers with the concentrations of

- p_1 = riverine N,
- p_2 = non-riverine N and
- p_3 = total N

at some single time step. Then you run the model for a few years and see how these spread. I expect that your numerical scheme will be linear and p1+p2=p3 will be maintained as it should.

Then, initialize two "active elements" (whose spreading is calculated by equation (2)):

- a_1 = riverine N,
- a_2 = non-riverine N.

with the same initial concentrations, using p_3 as their "parent element". Make them practically passive by setting $R_{p_1} = R_{p_2} = 0$. If the simplification error is negligible, a_1 should behave very similar to p_1 and a_2 to p_2, and you should end up with very similar ratios of non-riverine N to total N in both methods. Then you could present this as a verification that your simplification error is small.

If my expectation is right and the results will show a significant difference, this would mean that you have to apply the full rather than the simplified method for this application.

Missing validation

You refer to an existing publication for the model validation. That is not sufficient. Your study relies on the assumption that at least the following is reproduced by the model:

1. lateral nitrogen transport,
2. oxygen consumption rates,
3. hypoxic area extent.

You should then present model validation that proves that the model is capable to do that. I am thinking of

1. DIN observations,
2. benthic chamber lander O2 fluxes or, if not existent, at least primary production rates as a proxy,
3. observational-based estimates of the hypoxic area.

Specific comments

- L38: The correct reference for the element tracing method is Menesguen et al. 2006: "A new numerical technique for tracking chemical species in a multisource, coastal ecosystem applied to nitrogen causing Ulva blooms in the Bay of Brest (France)". In the Menesguen and Hoch 1997 paper, a more general method for tracking multiplicative properties of model state variables was described which only later in the later paper was applied for element tracing.

- Figure 1: I suggest to change the color scale. Firstly, it guides the reader's focus to the location of the shelf edge only and makes it hard to distinguish topographic features in the tracing region. Secondly, a scale like that is typically used the opposite way, having the darkest shades of blue at the deepest locations, I would recommend to stick to this habit to make it more intuitive for the reader.

- L61-62: Instantaneous benthic remineralization is a good choice if (a) sediment biogeochemistry is in a dynamic steady state (carbon accumulation negligible) and (b) the area is so deep that lateral transport of resuspended organic matter does not play a role. Both assumptions seem questionable here, please discuss the possible implications on your model results.

- L75: Please specify which rivers you prescribed, maybe by adding them as dots in Figure 1 or by supplying a table with their mouths' coordinates in the online supplement.

- L86: Please state earlier than in the "Discussion" section what motivates the reduced-oxygen scenarios and why you choose a 20% reduction.

- L122: The TN concentrations are actually monthly, daily values are only obtained by interpolation, correct? Please also change the caption of Figure 2.

- Table 1: How is "anoxic area" defined?

Technical corrections

- L59: Citation style is wrong here, please use the "citep" command if the reference can be omitted without changing the meaning of the sentence.

- L138: A comma is missing after "South of 32°N".

- L278: A comma is missing after "e.g."