

Review of os-2021-96

"Air-sea heat flux during warming season determines the interannual variation of bottom cold water mass in a semi-enclosed bay" by Junying Zhu et al.

Recommendation:

Major revision

Summary:

The authors investigated the interannual variation of a bottom cold water mass (BCWM) formed in the summer in Iyo-Nada, the Seto Inland Sea, based on ship-based hydraulic observations and a three-dimensional hydrodynamic model. The results indicate that the heat transport during the stratification season may affect the interannual variation, in addition to water temperature before the season (so-called pre-conditioning). They also considered that control factors of interannual variations differ depending on the size of BCWMs, through comparison of BCWMs in some regions. These results are important in understanding changes in coastal seas and predicting future changes under climate change. I recommend that the paper be published in Ocean Science after some major revisions. My concerns are listed in *Major comments* below.

Major comments:

1. As a central result of this paper, Figure 5 shows that the interannual variation of the Iyo-Nada bottom cold water mass (INCWM) depends on both the local water temperature in April (the horizontal axis) and the water temperature at the strait in July (the vertical axis). This means that the INCWM are affected by both the early pre-conditioning and the horizontal heat advection during the stratification season (summer). I think this is the most important result of this paper, but is that okay? If so, it appears to be inconsistent with discussion of Sec. 4.1, which emphasizes sea surface heat flux as the main factor based on model results. I suggest to reconsider the title of the paper, too.

(a) P.9 L. 213-220

Please emphasize that important results were obtained indicating that the interannual variation depends on both.

(b) P.11 L.245 *we conclude that the vertical and horizontal heat transport processes in the warming*

season, rather than the initial condition preserved from the previous winter, are responsible for interannual variation in the INCWM in July.

First, the evaluation of the vertical heat flux seems to be inconsistent with the observational results, and so an explanation to address it is needed. Next, Fig. 5 shows that the initial temperature is also important. I do not think the expression "rather than" is grounded.

- (c) P.12 L.281 *we found that the vertical and horizontal heating processes during the warming season, rather than the initial temperature before warming, were the dominant factor for interannual variation in the INCWM.*

Reconsider this part following the above comment (b).

- (d) P.14 Table 3

As explained above, I do not think that the "Main factor" of "Iyo-Nada" is only "Air-sea heat flux during stratified seasons".

- (e) P.17 *Therefore, with respect to interannual variation in the INCWM, the heat transport process during the warming season is more important than the initial temperature after the cooling season.*

As noted above, I do not think that "more important" is well-founded.

2. Temperature distribution of the INCWM should be shown, not only for the average, but at least for a strong-INCWM year and a weak-INCWM year. In July of Fig.2a alone, the reader does not know what kind of interannual change have occurred as a whole. It is also necessary to explain that the July analysis is sufficient. (The same result can be obtained for August, right?)
3. A schematic diagram will help the reader's understanding. I want the figure to include an estuary circulation. It would also be better if the figure could be applied to the discussion of "cylinder" in Sec. 4.2.
4. Descriptions of the observation and the model specifications are insufficient. Please enrich the explanations.

- (a) P.3 Sec. 2.1

It is not enough to explain the observation data only in the first paragraph. Please supplement information on observation methods and accuracy. Are there any documents to refer to?

- (b) P.5 Sec. 2.2

Although written in Zhu et al. (2019), this paper should also outline the model. The following

explanations are necessary at least.

- i. Model specifications: horizontal resolution, vertical resolution, region, basic classification of model (hydrostatic model? depth-coordinate model?), settings of tides
 - ii. Experimental settings: initial value, integration period, lateral boundary conditions, sea-surface boundary conditions (moved from Sec. 2.3 to Sec. 2.2), rivers
 - iii. The purpose of using multi-year average (climatological normal) data, instead of actual historical data, for sea surface forcings.
5. It is necessary to improve the structure of the paper to make it easier to understand. I think it is better that explanation of the analysis method is moved from Sec. 2 to the result sections. Please consider the following modifications.
- (a) P.5 The first paragraph
Move it to Sec 3.1.
 - (b) P.6 Sec. 2.3
Move the explanation of the sensitivity coefficient q to Sec. 4.1, since it is used only there. Also, by moving it after defining INCWM, the explanation will be easier to understand. In addition, I could not follow what cr means. The authors need to brush up the explanation. I think that the explanation of the experimental cases should be moved to Sec. 2.2.

Minor Comments:

6. P.1 L.14: *The interannual variation in water temperature inside the INCWM showed a negative correlation with the area of the INCWM,*

It is difficult to understand what kind of interannual variations has been observed. Please give a brief explanation using rough numbers, such as temperature and volume in strong-INCWM years and weak-INCWM years.

7. P.5 L.100 *The mean range of change over the entire study period is denoted by the mean value of the absolute value of ΔX_i*

I think that the standard deviation is usually used, when the magnitude of variation over time is investigated. Explain why you use this definition.

8. P.7 L.156 *the average water temperature and area inside the 18 C isotherm were calculated.*

Please write the formula for calculating the area-averaged value from the observation data, in

order to show the treatment of the area.

9. P.12 L.266 *Compared with these BCWMs,*

I think the expression "In the same way as in these BCWMs" is better to indicate that the INCWM has the same characteristics as BCWMs in other regions.

10. P.12 L.285

Clarify the purpose of the analysis in the rest of this section.

11. P.15 L.335 *As R is much larger than H (at least 1000 times), the influence of Δm is supposed to be more important than that of Δn .*

Is it true? The heat flux fluctuation due to horizontal advection, Δn , can be larger by several orders of magnitude than the air-sea heat flux fluctuation, Δm . And, this sentence seems to be inconsistent with the argument that horizontal advection from the strait is more important for interannual variation than the local sea surface heat flux during the stratification season, based on the results of Fig. 4 and Fig. 5.

12. P.17 L.368 *The interannual variation of the mean water temperature inside the INCWM and that of its area show a significant negative correlation.*

Explain in detail the interannual variation. (See my comment No.6.)

13. P.17 L.383 *As an extension, we analyzed the control processes on interannual variation of water temperature in the five BCWMs reported in the literatures using a cylinder column to represent their shape.*

This sentence alone is difficult to understand. It is desirable to add a schematic diagram.

14. P.4 Fig. 2

Add a panel number for each month, such as Fig.2 (a) for January, Fig.2 (b) for April etc.

15. P.6 Table 1

Add the CONTROL experiment to the table.

16. P.7 Fig. 3

The "area" means "vertical cross-section area"? It may be misunderstood like a horizontal area.

17. P.8 Fig. 4

The example marks at the bottom right of the figure should be changed from an open circle and star to a closed circle and star.

18. P.8 Fig. 4

This figure does not plot observation points with the significant difference level of 0.95 or less, right? Since it looks as if there had been no observations, those points should be also indicated (maybe black dots?).