Response to editor

Comments to the author:
Thank you for addressing my comments.

I cannot see your response to referees #1 and #3. They also made minor comments you should consider and respond.

When preparing the next version also note the comment from Polina Shvedko (21 March).

Additionnaly, please consider using cmocean's "thermal" colormap for the temperature fields of Fig 2 and 3, and a blue-white-red (0 centered at white) for Figure 5 (correlation coefficients).
Thank you,

Ilker

Thanks for your kind reminder and suggestion. We have made responses to referees #1 and #3 in the new revised manuscript. Following your suggestion, we have changed the colormap to cmocean's "thermal" for the temperature fields of Fig. 2 and Fig.3 and a blue-white-red for Fig. 5.
According to the comment from Polina Shvedko, we have renamed the figures and tables in supplement file, such as "Fig. 1" to "Figure S1" and "Table 1" to "Table S1", and modified the representation in the new text when it comes to the corresponding diagrams and tables. Besides, we are the originator of the images (Figure 1, Figure 3 and Figure 8), we have confirmed this issue explicitly by email.
We express our thanks for editor and reviewers in the new revised manuscript.

Response to review #1:

Regarding comment #1 in my first review:
As the authors emphasize, the ideal model experiment shows that surface heating from May to July has a significant effect on the bottom cold water. On the other hand, the observation result (Fig. 4) shows that the surface temperature during this period does not correlate with the temperature of the bottom cold water. Considering that surface heating first changes the surface temperature, there seems to be a contradiction between the model and observation results. The authors should discuss possible causes of this contradiction, or note that it should be resolved in the future.

Caption of supplementary Fig. 4: Correct "July" to "August".

Thanks for your careful reading and comments.
The water temperature of bottom cold water mass is influenced by vertical heat transfer from upper layer water and horizontal heat transport from lateral water. In summer, vertical heat transfer from sea surface is impeded by the strong thermocline. The vertical distribution of temperature difference between Case 2 and Control (Case 2 - Control) from May to July is shown (Fig. R1). When local sea surface heating increases by 10% in Case 2, the temperature difference at surface ranges from 0.2 ℃ to 0.5 ℃, while the temperature difference inside the INCWM is around 0.05 ℃ - 0.1 ℃. The 0.1 ℃ isotherm of temperature difference always appears at around the depth of 10-20 m where the thermocline develops from May to July (Fig. 2e-g). Apparently, more heat stays above the thermocline while the INCWM has the same variation of water temperature with the waters around the depth of 10-20 m. The increase of INCWM temperature is obviously slower than that at sea surface when increasing local heat flux. Besides, the lateral heat transport due to the presence of density-driven circulation is an important process for temperature variation of INCWM according to sensitivity numerical experiment and observation.
In the ideal model experiment, we show that the temperature change in a BCWM caused by the interannual variation of air-sea heat flux is proportional to sea surface heat flux change under the assumption of constant vertical and horizontal heat transport velocity. In this case, the change of BCWM temperature should be consistent with that of surface temperature although the thermocline reduces the vertical heat transport. However, we do not consider the changes in density-driven current which is mainly influenced by river discharge and the water temperature in Hayasui Strait. The lateral heat transport could readjust the temperature change of the cold water mass, weakening the consistency between changes of BCWM temperature and sea surface temperature. Correlation analysis from observation (Fig. 5f-h) shows that the water temperature of INCWM in July is closely related to the water temperature around the depth of 10-20 m, but is not correlated with sea surface temperature. This is the result of above two heat transfer processes, which also illustrates the importance of lateral heat transport for temperature variation of BCWM in Iyo-Nada.
Therefore, the results of ideal model and observation is not contradiction. In Fig. 9, we only evaluate the importance of vertical heat transport caused by change of air-sea heat flux based on ideal model. According to your comment, we added the discussion about the limitations of the ideal model in Section 4.2 and related discussion of sensitivity numerical experiment in Section 4.1 to address this issue in the new revised manuscript.

Also, we have changed the "July" to "August" in the caption of supplementary Fig. S4.

We added the description below in Section 4.1:
“Compared the vertical temperature distribution from May to July between Case 2 and Control (Fig. S5), when local sea surface heating increased by 10% in Case 2, the temperature difference at surface ranged from 0.2 ℃ to 0.5 ℃, while the temperature difference inside the INCWM was 0.05 ℃ - 0.1 ℃. Meanwhile, the 0.1 ℃ isotherm of temperature difference (Case 2 - Control) always appeared at around the depth of 10-

20 m where the thermocline develops from May to July (Fig. 2e-g). Apparently, more heat stayed above thermocline while the INCWM mainly obtained heat from waters around 10-20 m."

We added the description below in Section 4.2:
"In the evaluation, local air-sea heat flux is key factor for interannual variation of INCWM. However, correlation analysis from observation (Fig. 5f-h) shows that the water temperature of INCWM in July is closely related to the water temperature around the depth of 10-20 m, but is not correlated with sea surface temperature which responses to air-sea heat flux first. On the one hand, due to the presence of a strong thermocline in summer, the response of INCWM temperature is obviously slower than that at sea surface when local air-sea heat flux changes (Fig. S5). On the other hand, we do not consider the changes in horizontal density-driven current in the above evaluation (Fig. 9b) which is mainly influenced by river discharge and the water temperature in Hayasui Strait. The lateral heat transport could readjust the temperature change of the INCWM, weakening the consistency between changes of INCWM temperature and sea surface temperature."

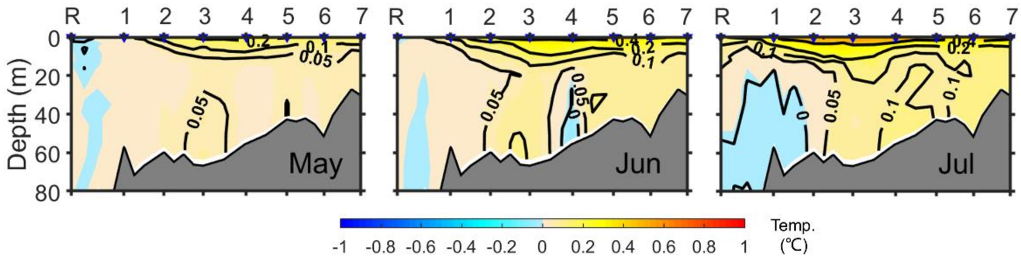

Figure R1 Vertical distribution of temperature difference between Case 2 and Control (Case 2 - Control) from May to July.

Response to review #3:

The manuscript has been improved, and I am satisfied with the way how the authors address the reviewers' comments. I only have these following questions/comments:
Thanks for your affirmation and suggestions. Following your comments, we have finished a comprehensive revision on the original manuscript. Below is a point-to-point response.

1. Sensitivity experiments: when comparing Case 2 and Case 3, actually it is unfair to compare their impacts; Case 2 increases surface heat gain locally by 10% from May to July, which lasts for 3-months; while Case 3 increases surface heat gain in Hayasui Strait by the same percent, but only for one month - July. And the two cases' impacts are measured and compared for July. It is reasonable to think, the less temperature change in July for Case 3 than that for Case 2 is because the heat-flux-increase's lasting

time period is shorter. To avoid this problem, Case 3 or a new case should be modified or added: increase surface heat gain in Hayasui Strait by 10% from May to July.
Thanks for your suggestion. According to the results of observation (Section 3.3 and Section 3.4), we found that the temperature change of INCWM in July on an interannual scale is controlled by three processes, i.e., the local retention of bottom low water temperature from early spring, local vertical heat diffusion from May to July and horizontal heat advection originating from Hayasui Strait in July. Therefore, we designed three sensitivity numerical experiments to analyze the influence of air-sea heat flux during the corresponding time period.
Actually, we have did a sensitivity numerical experiment with the case that sea surface heat gain in Hayasui Strait from May to July increased by 10% (Case 4 in the new manuscript). Results show that the sensitivity coefficients have little difference with those in Case 3 which suggests the lateral heat transfer induced by air-sea heat flux change in July is the most important than those in May and June. Comparison between Case 3 and Case 4 also confirms the correlation analysis from observation (Fig. 5h) in Section 3.3. Therefore, we mainly discussed the result of Case 3 in Section 4.1.
According to your suggestion, we added a new sensitivity numerical experiment named as Case 4 and related description (in Table 1, Table 2, and Section 4.1) in the new revised manuscript.
"In Case 4, the sensitivity coefficients had little difference with those in Case 3 which suggested that the effect of remote air-sea heat flux change in July is much larger than those in May and June. Comparison between Case 3 and Case 4 confirmed the importance of lateral heat transfer from Hayasui Stratit to Iyo-Nada in July which was also displayed from observation (Fig. 5h)."

2. Lines 470-471. "This is an inverse pathway to the heat transport and is expected to be large in some BCWMs. " What does this sentence mean?Why nutrient transport is an inverse pathway to heat transport?
Thanks for your comments. Beneath the thermocline, nutrient is abundant inside the bottom cold water mass in summer. Vertical nutrient transport from bottom cold water mass to waters in the upper layer is the key factor to subsurface chlorophyll-a maximum above the bottom cold water mass. This phenomenon has been observed in several coastal seas with bottom cold water mass (Takeoka, 1993; Williams et al., 2013; Fu et al., 2018). Besides, in our study, density-driven circulation in summer from Hayasui Strait to Iyo-Nada below surface layer can carry nutrient from Hayasui Strait to Iyo-Nada and then diffuse into the upper water. The nutrient transport in was proposed by Takeoka (2002) who given a diagram (Fig. R2) for nutrient transport in the Seto Inland Sea. As shown by Fig. R2, nutrient transport is an inverse pathway to the heat transport as the bottom cold water mass is a nutrient-rich pool in summer.
To be clear, we changed the sentence to "Another issue is the biogeochemical aspects around the BCWMs. As BCWM is a nutrient-rich pool in summer, the transport of nutrient across the BCWMs has considerable effects on the phytoplankton growth around the BCWMs (Takeoka, 2002). This is an inverse pathway to the heat transport and is expected to be large in some BCWMs".

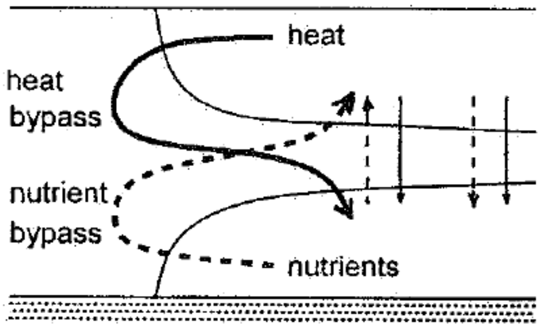

Figure R2 Transport routes of heat (solid line) and nutrients (broken line). (Takeoka, 2002)

References:

Takeoka H. Progress in Seto Inland sea research[J]. Journal of Oceanography, 2002, 58(1): 93-107.

Williams C, Sharples J, Green M, et al. The maintenance of the subsurface chlorophyll maximum in the stratified western Irish Sea[J]. Limnology and Oceanography: Fluids and Environments, 2013, 3(1): 61-73.

Fu M, Sun P, Wang Z, et al. Structure, characteristics and possible formation mechanisms of the subsurface chlorophyll maximum in the Yellow Sea Cold Water Mass[J]. Continental Shelf Research, 2018, 165: 93-105.

Minor:

1. Line 58: "… a schematic diagram in Fig. 5" - > Fig. 6 ?
   We have changed it.
2. Lines 90-91: "However, water temperature at Hayasui Strait is almost **vertically** homogeneous throughout a year"
   Thanks and changed as your suggestion.
3. Line 105: "The red line of the 18 °C isotherm in (a)" -> (g)
   We have changed it.
4. Line 106: "The red and black bars in (b) " -> (m)
   We have changed it.
5. Line 129: analysis -> analyze
   Thanks and changed as your suggestion.
6. Lines 173 and 299: "Fig. 2c" -> Fig. 2g
   We have changed it.
7. Line 178: "Supplementary Table 1" -> 2
   We have changed it.
8. Supplemental Figure 4 caption: July -> August
   Thank you and we have changed it.
9. Figure 5 caption: significant difference level? -> significant confidence level; as well as in Line 249
   Thank you and we have changed it.
10. Line 233: Fig. 5a -> Fig. 5e; Figs. 5b-d -> Figs. 5f-h

We have changed it.

11. Line 236: Fig. 5d -> Fig. 5h

    We have changed it.

    Thanks for your careful reading. We have changed the sentences you mentioned above and examined the article carefully.