General comments:

I can see the improvement of the manuscript. However, I am still confused on some critical points. Therefore, I recommend the publication of the manuscript after major revision.

Many thanks for the reviewer's efforts to review and give comments. We have replied all the comments, please see the details below.

Major comments:

1. The logic of the manuscript is still unclear. In section 3.1 and 3.2, the authors showed the temperature and salinity features and circulation pattern of the cold water, trying to demonstrate the evolution of the cold water and the related mechanisms. However, there is a lack of supported evidence. I will list those points out later. In section 3.3, the authors tried to prove that geostrophic balance is not applicable for the maintains of the anticyclonic circulation in lower layer in May due to the non-negligible friction in the shallow water. Isn't it obvious in a shallow shelf? I am not quite sure why the authors spent a section to demonstrate this question. It may be better to merge this section into section 3.1 and 3.2? In section 3.4, the authors demonstrated that the anticyclonic circulation is NOT caused by the cold water mass which induces changes in baroclinic conditions. So,why not just to demonstrate which factor cause the anticyclonic circulation? As I observed from the figures shown in the manuscript, there are at least two compensate currents (secondary currents) which, I think, are important for the anticyclonic circulation development and the cold water mass evolution, i.e., the landward current at near bottom layers (westward current) and the upwelling system. Also, the background current system outside the shown region is very important. In section 3.5 and 3.6, the tidal and wind effects on the anticyclonic circulation are studied. But I am not quite satisfied with the explanation provided. I will list my concerns later. In section 4.1, the upwelling effects on the cold water mass is discussed, which I think is very important and should be move to section 3.3. More focus should be put to this part. And I found it is hard to follow the tidal effects on the upwelling and the mixed layers (lines 334–360). I will list my questions. Section 4.2 is too short to be a section alone. Instead, as supporting evidence for the tidal and wind effects, it may be better to merge this section into the sections discussing the tidal and wind effects (section 3.5 and 3.6). The same problem raises to section 4.3.

Since the mechanisms driving the evolution of the Qingdao Cold Water Mass (QCWM) have already been extensively discussed in previous studies (see Introduction), this paper does not aim to revisit that topic. Instead, our focus is on the evolution of the seasonal anticyclonic circulation around the QCWM. Please note that the QCWM is not the direct reason of its formation. A novel aspect of this paper is the evolution of the seasonal anticyclonic circulation around the Qingdao cold water mass.

To our knowledge, the momentum analysis has not used before in the seasonal anticyclonic circulation around the Qingdao cold water mass to test if the geostrophic balance is satisfied or not, so we think we need to proof it in this area. While we believe it is important to include this analysis, we have streamlined the manuscript in response to the reviewer's comment about the section being too lengthy. As a result, we have removed subsection 3.4 and retained only subsection 3.3.

The compensation current (second currents) and upwellings are described in subsection 3.5 and 4.1.

Furthermore, the application of t-test analysis to distinguish between internal variability and external forcing in regional ocean model simulations is a new addition to this study. We emphasize the importance of the t-test and introduce the concept of ensemble simulations in this context. Subsection 4.2 provides a comprehensive discussion of these points.

For clarity and thematic consistency, we prefer to keep this material as an independent section. Addtionally, we have also expanded subsection 4.2 to provide more detailed explanations.

2. I am a bit confused as to why the authors devoted so much effort to comparing all the forcing terms. Based on Figure 5, the barotropic term appears to dominate in the near-bottom layer, which I believe is likely due to water piling up on the eastern side of the domain under the influence of the southwesterly monsoon. As a result, the landward flow in the near-bottom layers along the coastal region is primarily driven by this pressure gradient force, with minimal influence from other forcing terms. This aligns with what I mentioned earlier regarding the compensating current in my previous comment. So, it seems that too much discussion on other terms (baroclinic, Coriolis, friction) is not necessary. Could you please clarify the rationale and necessity for such extensive discussion of these terms (as presented in Figures 5, 6, 7, 9, and 13)?

We have rewrote the subsection which describes the wind effects on the seasonal anticyclonic circulation around Qingdao cold water mass by explaining it from the compensating current driven by barotropic pressure gradient force aspects.

Please see lines 273-304:

Xu and Zhao (1999) demonstrated the effect of wind on the seasonal anticyclonic circulation around the Qingdao cold water mass using a two-dimensional numerical model, but a more thorough discussion is needed. Therefore, a no-wind experiment was conducted to examine the effect of wind on the seasonal anticyclonic circulation structure. The results show that wind is a dominant driving force for clockwise circulation. The general magnitude of the current weakens, particularly on the western side of the clockwise circulation (northward current); conversely, the influence of wind on the eastern side of the circulation is minor, as shown in Figs. 6b and 6d. The direction and magnitude of the eastern side are similar to those of the control run.

The effect of wind on the seasonal anticyclonic circulation structure around the Qingdao cold water mass can be understood as the seawater piling eastward, under the impact of the southwesterly monsoon. Hence, the landward current (westward) at the western side of the seasonal anticyclonic circulation structure around the Qingdao cold water mass is primarily driven by the pressure gradient force, with minimal influence from other forcing terms. To prove this phenomenon, we examine the surface elevation fields from both the control and no-wind experiments (Fig. 9). The results clearly show that under southwesterly wind forcing (control run), surface waters accumulate to the east. In contrast, the no-wind experiment shows a much flatter sea surface. This finding indicates that the wind-induced water piling on the eastern side is responsible for the enhanced barotropic pressure gradient force. Further diagnostics of the momentum balance around the seasonal anticyclonic circulation confirm that the cross-shelf barotropic pressure gradient force is the dominant term driving the bottom flow along the coast.

In Fig. 10, we compare the spatial distributions of the momentum terms in the control (top row) and no-wind (bottom row) experiments. These terms are derived from the x-direction momentum equation, which is particularly relevant since the barotropic pressure gradient force is predominantly directed in the zonal direction. In the control experiment, a strong *barotropic pressure gradient is established, corresponding to a pronounced landward current at the western side of the anticyclonic circulation structure surrounding the Qingdao cold water mass. Conversely, the no-wind experiment shows much weaker pressure gradients in the same region. The Coriolis, baroclinic pressure gradient, and vertical friction terms are relatively weak in both experiments. These results support the interpretation that the southwest monsoon induces water piling eastward, thereby establishing a stronger barotropic pressure gradient that dominates the bottom-layer momentum balance and drives the landward current in the control run on the western side of the seasonal anticyclonic circulation; these findings differ from those of the no-wind run.*

Beyond the local coastal dynamics around the Qingdao cold water mass, previous studies have demonstrated that the wind forcing plays a key role in shaping the large-scale summertime circulation in the Yellow Sea. For example, a wave–tide–circulation coupled model is used to reveal a three-dimensional structure characterized by wind-driven surface flows and compensating near-bottom currents (C. Xia et al. 2006). This basin-scale mechanism is consistent with our findings, suggesting that the landward bottom flow observed in our control experiment is not only locally forced but also part of a broad wind-driven circulation system across the Yellow Sea.

3. There are still some findings or points listed in the manuscript that are contradicted to each other.

Corrected.

Detailed comments:

1. Figure 1. Please overlap the bathymetry used in the model and also provide the coverage of the entire computation domain.

We have added a diagram in Fig. 1b with the coverage of the entire computation domain and the bathymetry in the model.

2. Section 2.2. There is a lack of description of the lateral boundary conditions and riverine forcings, which I think are very important to shelf dynamic simulations.

We have added the information about the lateral boundary conditions and river forcings.

Lines 96-97: The Huanghe, Huaihe, and Haihe are considered, and the river discharges are sourced from the "China Sediment Bulletin (2019)".

We use the tidal elevation to introduce the effect of the tides.

Lines 90-92: We use the tidal elevation to introduce the effects of the tides. The tidal elevation forcing comprises eight major tidal components (M_2, S_2, N_2 K_2, K_1, O_1, P_1, and Q_1) derived from the TPXO8 database (Egbert and Erofeeva 2002).

3. Line 103. Please use the specific years here, e.g., use November 1st, 2017 instead of November 1st of the 9th year. The latter expression may confuse the readers if they count the 2008 as the 1st year.

We have changed it according to the suggestion (lines 108-109).

4. Lines 141–142: Evidence is needed to support the claim that the merging of warm and cold water (i.e., the deformation of the cold water mass) is primarily due to increased solar *radiation and not other factors, such as mixing caused by the sustained monsoon. Additionally, doesn't surface heating contribute to maintaining the cold water mass near the bottom by reinforcing strong stratification?*

Since the evolution and mechanism of the Qingdao Cold Water Mass have been discussed in previous studies and are not the main focus of this paper, we have added a reference to support our description (lines 147–150).

5. Lines 142–145. Although the author added my understandings on the cold water mass formation, it is just the knowledge from my previous studies in physical oceanography. The authors need to provide evidence to support this statement. I see that Figure 12 is a helpful clue. And also, the author may need to add more plots in the appendix showing the evolution of this cold water mass from April to June (may be evolution of the transect as depicted in Figure 12?). So, it is better to move Figure 12 to here.

Figure 12 was initially placed in the Results section. In the last round of review, the reviewer recommended relocating it to the Discussion section. While we are open to adjusting the structure as suggested, we would appreciate further clarification.

6. Lines 141–142 contradict to Lines 142–145. The former one emphasize the importance of solar radiation, while the latter emphasize the role of mixing and upwelling.

We deleted the sentences, since it causes confusion and the mechanism of the Qingdao cold water mass is not the main topic of this paper.

7. Section 3.2. Please confirm the direction of the summer monsoon. According to the Figure A3, it is southwesterly wind, but southeasterly wind is used during the discussion, e.g., Line 166. The inconsistence is found almost all over the manuscript. Please double check.

Thank you for catching it. Corrected.

8. Lines 159–161. The southwesterly wind induces the northward current on surface, but the authors indicate that the near bottom northward current is also induced by this wind pattern. I doubt that. This is the reason why I asked, "Is the southeasterly wind strong enough to induce vertically-homogenized the northward currents?" during the last round of revision. It is better to show the current pattern from surface to near bottom. Now, I would argue that it is the compensate current that induces the northward current near bottom but not the direct effects from the surface winds.

We have rewritten the discussion regarding wind effects on the circulation around the Qingdao cold water mass area. Please see the reply to the major comment 2.

9. Lines 166–167. This sentence is an incomplete one grammatically. The "southeasterly" contradicts to the previous description and Figure A3. The causality shown confused me. Why do the shallow water and southeasterly monsoon lead to stronger current at the west part of the anticyclonic circulation? Here, the authors may miss the boundary effects but only focusing on the local wind effects. So, how does the current system like over the entire computational domain?

Ok. We had added a discussion about the other researcher's publication on the effect of wind forcing effects on the entire computational domain. The previous publication is consistent with our new statement that suggests that the landward bottom flow observed in our control experiment is not only locally forced but also part of a broader wind-driven circulation system across the Yellow Sea.

Please see lines 298-304:

Beyond the local coastal dynamics around the Qingdao cold water mass, previous studies have demonstrated that the wind forcing plays a key role in shaping the large-scale summertime circulation in the Yellow Sea. For example, a wave–tide–circulation coupled model is used to reveal a three-dimensional structure characterized by wind-driven surface flows and compensating near-bottom currents (C. Xia et al. 2006). This basin-scale mechanism is consistent with our findings, suggesting that the landward bottom flow observed in our control experiment is not only locally forced but also part of a broad wind-driven circulation system across the Yellow Sea.

10. Lines 171–174. What is the purpose to show the circulation below 25m?

We would like to show a vertical distribution below the anticyclonic. However, we are open to removing it should the reviewer consider it redundant.

11. Line 174–175. I don't think the baroclinic pressure gradient forces are contribution to the vertical structure of the current patterns near bottom. As I observed from the Figure 4, current patterns are quite similar over these near bottom layers (northwestward and northward). Isn't is due to the landward compensate currents or the current from the south boundary? A well-known Subei current system usually intrudes into the Yellow Sea in summer and merge with the cold water mass. That is, a larger picture of current systems needs to be discussed.

Sorry for this confusion, lines 174-175 has been deleted. We have rewritten the wind impacts on the horizontal circulation in section 3.5.

12. Lines 175–176. I don't understand why the anticyclonic circulation contribute to the formation of the cold water mass near bottom? Does it contradict to Lines142–145?

Sorry for the confusion, we have deleted this sentence.

13. Line 194–195. The vertical friction shown in figure 5 is the friction at depth of 25m. So, the wind stress at the surface layer does not contribute to this friction term but the current speed gradient around the 25 m depth does.

We have deleted this sentence.

14. Lines 195. I doubt that the surface wind can impact the current pattern near bottom through direct dragging. If so, the whole water column can be well mixed with not cold water exists at near bottom.

We have deleted line 195 and wind impact on the horizontal circulation has been rewritten in Subsection 3.5.

15. Lines 190–199. I see that the discussion is conducted mixing the current patterns at surface and near bottom layers, which should be discussed separately as they should not be the same as shown by Figure 3 and Figure A3.

As suggested by the reviewer, the discussion of the geostrophic balance is too long. Lines 190-199 has been deleted.

16. Line 200. The expression of the vertical friction force is wrong and same for Line 219.

Thank you for catching it. Corrected.

17. Section 3.4. I don't think discussion on geostrophic balance is useful for linking the anticyclonic circulation and the cold water mass.

As suggested, we have deleted the previous Section 3.4 in the revised manuscript.

18. Line 227. The term "significant" has statistical meaning. So, "significant" usually come along with statistical tests. Please use another term. Please check throughout the manuscript for this issue.

We have changed the "significant" to obviously or delete it.

19. Lines 227–232. The geostrophic balance should not be the theory discussed here as in this region, wind forcing cannot be ignored. Instead, it is the wind stress that causes the pressure gradient forcing (higher SSH on the east than on the west evident by the westward barotropic term) and the compensate current in lower layer but not the violation of geostrophic balance by tidal forcing. The explanation here conflicts with my knowledge. Holp the authors can convince me if I am wrong.

This part has been deleted.

20. Lines 233–236. What does the "dynamic reason" refer to? And I don't see the anticyclonic circulation contribute to the evolution of the cold water mass, rather, based on my study on the figures show, both of which (anticyclonic circulation and cold water mass) are the results of the compensate currents induced by the surface wind forcings. Again, please convince me if I am wrong.

Since the section 3.4 has been deleted, this sentence is not in the manuscript now.

21. Section 3.5. In-depth discussion is lacking. I suspect that the elimination of tidal forcings results in the changes of the background current systems which affect the anticyclonic circulation near Qingdao. The authors, however, only provide the description of how the anticyclonic circulation changes due to the absence of tides. Additionally, when removing the tidal forcing (that is in the no-tide experiment), how the boundary conditions are configured? The tidal forcing here should be the tidal signal generated within the computational domain, right? If tidal signal is not removed from the open boundary conditions, the no-tide experiment still contains tidal signal generated from outside.

We have added a discussion of the background current with and without tidal forcing. Please see lines (228-249).

Regarding the question of how tidal forcing is removed in numerical model simulations. Generally, there are two common approaches to generate tidal forcing in ocean numerical models. The first method is through internal tidal potential forcing, where the model calculates tidal motion based on astronomical tidal potential (gravity and Earth-Moon-Sun interactions). This approach is often used in global models. The second, more commonly used method in regional ocean models, is to impose tidal elevation and/or tidal velocity at the open boundaries, based on data from global tidal models such as TPXO, FES, or OTIS. These datasets provide tidal constituents derived from satellite altimetry and other observations. In the model setup used in this study, tidal forcing was applied at the open boundaries by prescribing tidal elevations based on the TPXO8 dataset.

To remove tidal forcing in the regional model, we simply excluded the tidal elevations at all open boundary grid points. This effectively eliminates the tidal component from the simulation, allowing us to isolate and evaluate the impact of tidal forcing on the regional circulation.

In the case of the Bohai and Yellow Seas, neglecting the astronomical tidal potential (i.e., internal tidal potential forcing) in numerical simulations is generally acceptable. This is because the primary tidal dynamics in this region are overwhelmingly dominated by external tidal forcing from adjacent open oceans, rather than by the local response to the astronomical tidal potential within the model domain. Specifically, the tidal waves entering the Yellow Sea mainly originate from the Pacific Ocean and propagate through the open boundary (e.g., along the East China Sea shelf). As such, the major tidal constituents can be accurately represented by prescribing tidal elevations and/or velocities at the open boundaries using data from global tidal models like TPXO or FES. These boundary conditions are sufficient to reproduce the dominant tidal features and energy in the region.

Therefore, for regional models focused on the Bohai and Yellow Seas, it is common practice to omit internal tidal potential forcing and instead rely solely on boundary-forced tidal constituents. This approach significantly simplifies the model configuration without compromising the accuracy of the simulated tidal dynamics.

Lines 228-249:

The eastern side of the anticyclonic circulation direction reverses when the tidal forcing is turned off. This effect is related to the tidal forcing impact on the general circulation of the entire Yellow Sea area (Fig. 8). When tidal forcing is considered, this area is dominated by a basin scale anticlockwise gyre in the Yellow Sea at a depth of 25 m. In the eastern part of the Yellow Sea, the main current directions are northward. In the western part of the Yellow Sea, the North Shandong coastal current (NSCC) and the Yellow Sea coastal current (YSCC) are present. Most current directions are southward, except for those located west of 122°E, which are directed westward. This phenomenon is the compensation for surface layer wind transport, which will be discussed in the next subsection. Such observations are in agreement with previous observations and numerical results (Bearsley et al. 1992, Yangagi and Takashi, 1993, Xia 2006). The northward flow in the eastern part of the southern Yellow Sea is a jet-like flow, which is different from the southward flow in the west portion of the southern Yellow Sea; this flow is much weaker and broader. However, when tidal forcing is removed, the overall circulation configuration transitions into a clockwise gyre (Fig. 8). This large-scale circulation change influences the local flow structure around the Qingdao cold water mass. Specifically, the reversal of the eastern branch of the anticyclonic circulation (122.5°-123°E 35°-35.5°N) results from the adjustment of the broad-scale Yellow Sea gyre, highlighting the significant role of background circulation in shaping the local current system.

The reason for the background anticlockwise circulation in the Yellow Sea when tidal forcing is considered has been discussed in previous research. (1) In the middle layer of the Yellow Sea (10–40 m), the flow is quasigeostrophic. During spring and summer, strong tidal mixing over the western and central parts of the shelf leads to the formation of a pronounced tidal front, which separates the well-mixed coastal waters from the stratified offshore waters. This front induces strong lateral density gradients, which in turn generate geostrophic currents around the front. This front-associated baroclinic structure promotes the formation of a basin-scale cyclonic (anticlockwise) gyre (C. Xia et al. 2006). (2) The Eulerian residual tidal currents *form a cyclonic gyre, implying that these currents strengthen the cyclonic circulation that occurs in the upper layers (C. Xia et al. 2006).*

22. Line 265. Please be consistent of the difference terms. Based on the caption, Figure 8c is flow differences of no-tide and control runs (no-tide minus control), Figure 8d is flow differences of control and no-wind runs (control minus no-wind). And what does the colored patches represent? Magnitudes? Or directions?

Sorry for this confusion, we have corrected it. Both are control runs minus no-wind/no-tide runs for the consistency. The color represents the magnitude, and a negative value indicates that the magnitude of velocity is smaller in the control run than the no-tide run. Please see the updated caption of Fig. 6.

23. Section 3.6. The authors demonstrated that the wind is the dominant driving force for the anticyclonic circulation, which I agree with. But I don't agree with the rest. Firstly, there is a westward shift of the Qingdao cold water mass when wind is removed. It should be pointed out and discussed but the authors did not. Instead, the authors mentioned that the temperature of the cold water decreases by 2oC which is due to the weaker wind mixing when wind is removed. Rather, I think, it should be related to the location changes in cold water mass.

After changes the wind effects on the horizontal circulation, this part has been deleted already.

24. Line 309. Based on Figure 12a, the upwelling does not reach the surface but stop at depth around 10m

We have checked the vertical velocity between 10m to the surface around the rectangle box area. The vertical velocity between 20m to the surface is upward as well. In the previous manuscript, there was a diagram showing the contour of the vertical velocity distribution. This diagram has been removed because the reviewer suggested Fig. 12 has overlapping information with the contour of vertical velocity. But we are open to adding that diagram again.

25. Lines 312–313. As I observed, the upwelling occurs over the entire transect but with different strength.

Ok. We have changed the description way. Please see lines 313-315.

Lines 313-315: Obvious upwelling occurs near the frontal zones of 122.375–122.5°E and 122.625–123°E on the eastern and western sides of the Qingdao cold water mass, respectively.

26. Lines 313–315. Yes, it is true. But the convergence is not pronounced. Instead, the most remarkable point is the eastward surface current and the associated secondary westward current at lower layers over the east of the 122E and the strong upwelling system.

We added a description of convergence and the barotropic and baroclinic pressure gradient comparison between the with- and without- tidal forcing runs, around the obvious upwelling area (lines 329-335).

Lines 329-335: A comparative analysis between the tidal and non-tidal experiments reveals that both the barotropic and baroclinic pressure gradient forces are significantly intensified when tides are included (Fig. 12). The magnitude of the barotropic pressure gradient force is larger than its baroclinic counterpart. This enhancement in barotropic forcing leads to increased horizontal convergence in nearshore regions, which, through the continuity equation, results in intensified upward motion. Notably, at approximately 122.5°E, surface currents from *both the west and east appear to converge (Fig. 11a), as indicated by the opposing surface flow directions. This horizontal convergence is accompanied by a strong upward motion below, supporting the interpretation that tidal forcing enhances barotropic pressure gradients, leading to horizontal convergence and subsequent upwelling in this region.*

27. Line 317–318. Based on Figure 12a–12b, the upwelling system is strengthened over studied transect but not just the east side when tides are considered, right?

We have changed the description from the “further strengthening the upwelling intensity on the east side” to “further strengthening the upwelling intensity” (line 319).

28. Lines 320–321. The westward or eastward flows in the rectangle zone are not the most remarkable point but the upwelling, instead, westward current at lower layers over the east of the 122E may be more interesting.

The westward and eastward flows are related with the convergence. We are a bit confusion about the comment “westward current at lower layers over the east of the 122°E may be more interesting”. Please give us more hints about this point. Thank you.

29. Line 325. Southeasterly monsoon? The upwelling is contributed by tidal forcings, not by wind forcing? highlight two points: the upwelling system and how it is related to wind and tide. Apparently, the authors did not provide convincible evidence of how tide affect the upwelling here.

The term "southeasterly monsoon" has been corrected to "southwesterly monsoon." Thank you for pointing this out. Sorry about the misunderstanding that the upwelling is contributed by tidal forcings, not by wind forcing. This misunderstanding likely arose from our wording. We have changed discussion on the tide and wind effects on the upwelling, please see subsection 4.1.

31. Lines 334–360. I lost here. Instead of believing the tide induce thermal fronts, I would rather believe that the background current system (like the Subei coastal current) is affected by the tides. So, when tides are removed, the background current system change a lot leading to the changes in upwelling and also anticyclonic circulation around the Qingdao cold water mass. Also, I don’t know why the authors focus on the relationship between tide and baroclinic pressure gradient force which is a very small term comparing to the barotropic pressure gradient force. Again, the tidal effects can be reflected by changing the background current pattern which, I guess, results in more pronounced changes in the barotropic term than the baroclinic term.

We have deleted the previous lines 334-360 in the old version.

Previous studies have demonstrated that baroclinic pressure gradient forces can play a critical role in modulating vertical circulation and the evolution of subsurface cold water masses in shallow and seasonally stratified marginal seas like the Yellow Sea. For instance, Xia (2006) and Zhang et al. (2016) showed that tidal mixing significantly alters stratification and induces baroclinic responses, including nearshore upwelling and downwelling circulations.

We have investigated the influence of tidal forcing on upwelling by analyzing the contributions of both barotropic and baroclinic pressure gradients. Please see subsection 4.1.

32. Figure 13. Please double check the caption.

Figure 13 has been deleted in the latest version.

33. Line 369. No. Oceanic modelers use statistic tests a lot.

We have added a more detailed description in line 379-380: "However, for the ocean regional simulation community, statistical tests are seldom applied to examine the variation between internal and external forcing".

Additionally, we are happy to add reference if the reviewer can give us hints about pervious publications about t-test application in regional seas to distinguish internal variability and external forcings.

34. Lines 370–380. Is t-test an appropriate test for this study? You only have 4 ensemble members. That is, for example, for the temperature at a given grid point, you are testing if the 4 temperature values in the control run are significantly different (assuming two-side testing) from the 4 temperature values in the no-wind (or no-tide) run. So, sample size is very small. Hope my understanding to your ttest is correct.

T-test can be used for small samples, even though it would be nice to have more ensemble member. More information about this point can be found in (von Storch & Zwiers, 1999).

35. Lines 377–380. I don't get it. Could you provide more detailed explanation?

Ok. We have added more details in lines 386-401.

Lines 386-401: When such local tests are conducted, it is expected that even if the null hypothesis is valid, at approximately 5% of grid points, the null hypothesis is rejected (multiplicity of tests, cf. von Storch, and Zwiers, 1999). Since the rejection rate is itself a random variable, the false rejection rate can be much larger, but more than 20% is very unlikely. A limitation of univariate tests, such as the t-test, is the problem of multiplicity of tests. This challenge arises when multiple tests are conducted simultaneously across different points in a field without proper adjustment. This issue is discussed in standard textbooks, such as that by von Storch and Zwiers (1999), who built upon previous work (H. V. Storch 1982; Livezey and Chen 1983).

The core argument is as follows. For example, if a test has an acceptable false rejection rate (Type I error rate) of 5% when the null hypothesis is true, then repeating the test multiple times while the null hypothesis remains valid will still yield a 5% chance of false rejection in each test. Thus, one would therefore expect false rejections in approximately 5% of the cases on average. However, since the rejection rate itself is a random variable, the actual proportion of false rejections may exceed 5%, although rates significantly higher than 20% are unlikely.

The situation becomes more complex when the tests are not independent, such as when analyzing spatially correlated data from a grid. In such cases, nearby grid points exhibit stronger dependencies, suggesting that false rejections are less likely to appear as isolated points and more likely to form spatially coherent patterns.

In our analysis, the observed rejection rate is substantially greater than 20% in both scenarios, suggesting that not all rejections can be attributed to the multiplicity effect. Instead, many of these rejections likely reflect genuine signals.

36. Lines 394–396. The anticyclonic circulation discussed in this study locate at near bottom, right? The northeastward current induced by summer southwesterly monsoon is at the surface. So, how does this surface current affect the near bottom current system?

The explanation about the wind impacts on the horizontal circulation has been modified, please see the reply above.

37. Section 4.3. This section is weak as the authors did not do a great comparison between the finding from this study and the previous studies, e.g., which points agree with the previous findings, and which do not.

We have expanded the section 4.3 with adding the comparison between previous work results and our results.

38. Figure A1. The term "evolution" is not expected as only one map is shown.

Fig. A1 is combined with Fig. 2. In total, it is the map of four month, rather than one-month distribution. We put Fig. A1 in the appendix because it is before the generation of Qingdao cold water mass, and the reviewer suggested that it would be better if we also show the temperature distribution of March.

39. Figure A3. Blue arrow is for wind while the black for the wind stress, right?

Yes, the blue arrow is for wind and the black for the wind stress. We have also added one sentence to clarify it.

Reference:

von Storch, H., & Zwiers, F. W. (1999). *Statistical analysis in climate research*. Cambridge University Press.

Xia, C., Qiao, F., Yang, Y., Ma, J., & Yuan, Y. (2006). Three-dimensional structure of the summertime circulation in the Yellow Sea from a wave-tide-circulation coupled model. *Journal of Geophysical Research*, *111*(C11), C11S03. https://doi.org/10.1029/2005JC003218

Xu, D., & Zhao, B. (1999). Existential proof and numerical study of a mesoscale anticyclonis eddy in the Qingdao-Shidao offshore. *Acta Oceanologica Sinica*, *2*, 18–26.