General comments:

This study investigated the formation and main drivers of the Qingdao cold water mass by using numerical simulations from a series of ensemble experiments. The study pointed out that the geostrophic balance is no longer applicable in the Qingdao cold water mass region due to the considerable friction terms. A seasonal anticyclonic circulation system was detected around the cold water mass. Wind and tides were found to be the main factors to this circulation. As for the method, the authors introduced an ensemble methodology, which is seldom applied and discussed in many numerical studies. I think, it is an advantage that can help this study to stand out. However, some major points still remain unclear and need to be resolved before the publication. Therefore, I recommend the publication of the manuscript after major revision.

Major comments:

1. The logic of the manuscript is unclear. I spent a lot of time trying to figure out how the authors organize the manuscript. My understanding is (1) that there is a seasonal anticyclonic circulation system observed around the Qingdao cold water mass; (2) that the geostrophic balance is no-longer applicable in coastal Qingdao and cannot be used for explanation of the formation of this anticyclonic circulation system; (3) that this anticyclonic circulation system mostly results from the balance of pressure gradient force, the Coriolis force, and the friction force with an emphasize of the non-negligible friction in the shallow water and (4) that the wind and tidal forcings contribute significantly to the evolution of this anticyclonic circulation system through the adjustments to the friction term. The authors, for example, put a part of discussion of wind and tidal impacts at the beginning (section 2.2), which, I think, is a scattered way of thinking and makes the readers hard to capture the main points of this study. Similar problems were found in the abstract and conclusion sections (see detailed comments below). Another example of this erratic or scattered way of thinking is reflected in the orders of figures shown. Figure 2,3, and 5b, 5c should go to the discussion section, while figure 5 should be merged with figure 15.

2. The manuscript is lack of in-depth discussion although a “Discussion” section is performed. Each subsection in section 4 seems like other result section without detailed quantification and comparison (against previous studies). Please see the detailed comments below.

3. There are some findings or points listed in the manuscript that are contradicted to each other weakening statements. I have listed them below.

4. The manuscript is lack of quantitative analysis and comparisons no matter in the results but also the discussion sections. This can largely weaken the convincibility of the findings.

Detailed comments:

1. The title is not specific enough. Saying “the seasonal anticyclonic circulation” may be too general. Per my understanding, the authors are investigating the mechanisms of the evolutions of this circulation. So, it could be better to point out the main purpose of the study in the title.

2. Lines 14-30. The abstract is not concise enough and is lack of a “main clue” to guide the reader to rapidly capture the findings (please see the above comments).

3. Lines 19-20. The authors should point out directly what results in the anticyclonic circulation rather than saying the cool poor is not the main cause.

4. Lines 22-24. Too verbose. Try to concise it.

5. Line 105. 11 year? The simulation period of the climatological run is from Nov 2008 to Dec 2019.

6. Lines 127-134. This part should belong to the discussion section and same for figures 2–3.

7. Line 159. “Northeast” or “southeast”? Please double check. If “northeast”, the corresponding temperature and salinity distribution should be shown, i.e., enlarge the coverage in Fig. 4.

8. Lines 163 and 167. The location of the cold water mass center was mentioned twice but with different longitudes.

9. Lines 163–165. My understanding of the formation of cold water body is somehow slightly different from the explanation here. Firstly, during winter, water column is homogenized forming cold water from surface to bottom. Secondly, as in early summer, fast heating on the ocean surface induces strong and rapid stratification sealing the cold water below the thermoclines. Thirdly, vertical mixing due to wind disturb or upwellings is not strong enough to homogenized the water column, which results in the maintenance of near-bottom cold water mass.

So, it may not be appropriate to emphasize only the role of thermocline to the cold water mass formation. In addition, citations are needed here as there is no clue shown in Fig. 4 that thermocline leads to the formation of the cold water mass.

10. Figure 5 should be merged with Figure 15, as they contain largely overlapping information. Arrows in figure 5 are not clear enough.

11. Lines 183–185. Is the southeasterly wind strong enough to induce vertically-homogenized the northward currents?

12. Line 188. Could you also show the June pattern to support this statement?

13. Lines 190–192. This is an incomplete sentence. “As the water depth is shallow in the western portion of the anticyclonic circulation and the dominant southeasterly monsoon…” This part is incomplete. This is a conclusion-like statement. Model evidence are needed to support this causality.

14. Lines 200–201. I cannot see velocity increases with depth. Perhaps the authors need to replot the Figure 7 showing 5 separate 2D panels rather than using a 3D plot. The Figure 7 shown makes current arrows hard to compare. Also, the panels do not align with the corresponding depth, e.g., the first panel does not align with depth 25 m and so on.

15. Equation (1)–(2). Please also show the momentum equation in the vertical direction. Also please decompose the force terms in (1) and (2) into the term shown in Figure 8 and put all force terms to the right-hand side. It is important to provide the readers with the detailed mathematic expressions of the force terms shown in Figure 8 and others.

16. Lines 215–216. Although horizontal friction is usually negligible in open ocean, in the coastal region this friction may not be negligible. The Qingdao cold water mass occurs quite nearshore. So, please provide quantitative comparisons of all friction terms before removing any of them out of the analysis and discussion.

17. Lines 216–218. Lack of evidence. At least, the difference of barotropic gradient force and the sum of baroclinic gradient force, Coriolis force, and vertical friction force are needed before addressing the balance of these terms.

18. Line 219. The “southwesterly wind stress” contradict against the “southeasterly monsoon” in Line 183. In the northern hemisphere, the southeasterly wind most

likely induces southerly wind stress rather than southwesterly ones. Please overlap the wind patterns in Fig. A2.

19. Lines 220–222. It is more like a hypothesis or an inference without necessary evidence. Also I doubt that the horizontal friction also considerably affects the Qingdao cold water mass which locates quite nearshore.

20. Figure 8. Please also show the mathematic expression of each term in each subplot because the signs of these shown force terms are also important to readers.

21. Line 226. Format is wrong.

22. Figure 9. Same suggestion as for Figure 8.

23. Lines 235. The difference of pressure gradient force and the sum of Coriolis force and friction force is needed to support this statement.

24. Lines 239–243. Lack of horizontal friction. See above comment.

25. Lines 244–253. I think this part is a very important finding of this study and also the reason why the author wanted to dig deeper in the wind and tidal impacts in the discussion section. I suggest the authors provide more explanations and details here.

26. Line 244–246. It is not surprised that the geostrophic balance is not satisfied as it is a state of large-scale ocean flows in open ocean. In the coastal region, the authors may want to focus more on the theories of boundary layer. So then the friction is very important and may need more analysis and discussion.

27. Lines 270–271. But along the anticyclonic circulation, friction is lower in the no-tide experiment.

28. Liens 274–275. "…and Coriolis terms change direction…"? The force direction seems not change. For example, the changes in Coriolis force in the no-tide experiment is at an order of magnitude of 10E-6, while the Coriolis force in the control experiment is at an order of magnitude of 10E-5.

29. Figure 11b. Why control-no_tide? It different from other difference terms. Please make the calculation consistent.

30. Lines 310–312. I did not understand this sentence.

31. Lines 312–314. The causality is misleading. It is not the decreases in water temperature that cause an increase in baroclinic pressure gradient force but the weaker mixing processes when wind is eliminated.

32. Lines 321–323. I did not observe a downwelling system from figure 5a.

33. Line 325. “For the western portion (122.625–123^{o}E)” or “For the eastern portion (122.625–123^{o}E)”?

34. Line 326. The tidal mixing font is a new term here (not mentioned in previous sections). So, where is this tidal mixing font? Seems like it is a part of the decomposition of mixing. I am not sure. Please convince me.

35. Lines 330–331. Below 20m, all flows seem eastward.

36. Lines 332–341. The part is not convincible to me. I would suggest the authors compare the difference of current velocity between control and no-tide runs and the difference between control and no-wind runs.

37. Lines 349–351. There is still temperature font found in Figure 5b, which means that when tides are excluded, the cold water mass maintains at the similar location. So, how can the tidal impacts be important to the cold water mass? As I observed, the impacts of winds outperform tidal impacts, as in Figure 5c, the location of the cold water mass shift westward to 121.5^{o}E.