Interactive comment on "The dynamics of İzmir Bay under the effects of wind and thermohaline forces" by Erdem Sayın and Canan Eronat
Anonymous Referee #2

The manuscript "The dynamics of Izmir Bay under the effects of wind and thermohaline forces" studies the circulation of Izmir bay using a 3-D general circulation numerical model. A z-level free surface version of the Princeton model is used as the ocean model. The model is initialized using selected winter and summer hydrological cruise CTD data. The main aim of the paper is to study the effect of two forcing, i. e. wind and thermohaline, on the circulation of Izmir bay. Therefore, two sets of numerical experiments are carried out. In the first set of runs, the model is initialized using the CTD data and run without any other external forcing, including wind and heat fluxes. The second set of runs is similar to the first set, except that wind forcing is included. The wind forcing includes artificial constant wind from four main directions. The model is run until a steady current is achieved, i.e. when the kinetic energy level reaches a plateau. The circulation patterns are then studied under different forcing. Considering the availability of long-term observational data in the Izmir bay and the scarcity of studies using numerical modeling for this region, this research has the potential to enhance the understanding of circulation of Izmir bay. However, I think that the paper needs major revisions as suggested:

1. In general some parts of the paper are difficult to follow and could be more coherent (e.g. the introduction). In my opinion, if some sentences (as suggested in the last section of this review) are rephrased, it be beneficial for a better understanding of the research. Considering that the previous papers by the same authors (e.g. Sayin 2003 & Sayin et al 2006) have a good structure and coherence, I think it is possible and worthwhile to revise this manuscript to have a more seamless structure.
E.1. The introduction section is rewritten.

2. Could you please present the reason for using an artificial wind forcing? Is it not possible to run the model with realistic data from synoptic stations or re-forecast atmospheric models? The application of using non-realistic forcing has a major drawback that the model cannot be validated against observational data. My understanding is that model validation is an important part of numerical modeling. Therefore, I would suggest that, if possible, the model be run with realistic forcing and after validation, be used for studies under different forcing such as artificial winds.
E.2. The model has been using for a long time in the Institute of Marine Science and Technology. The validation with observations has been carried out and first results have been obtained by Sayın (2003) and Sayin et al 2006. The comparison with the other models in institute (a primitive equation model of the Harvard Ocean Model and FVCOM (the Unstructured Grid Finite Volume Community Ocean Model)) are done and achieved good agreement. The model was previously applied to the Baltic Sea and the straits between Baltic and North Sea (Sayin and Krauss, 1996) justifying that this model can be used also for small seas as well as for straits and channels. Sayin et al 2006 has run the model with realistic forcing. In the present study, our motivation is to understand the behavior of the current field under blowing strong wind from four main directions. If the wind blows long time from the same direction continuously, approximately more than 12 hours, the current fields in the Bay will go under the influence of wind and form wind-driven circulation. It will help to the biologist, chemist and other researchers and they will have detailed pattern about the current field, if they know from which direction the wind blows.

3. In my opinion, the result section can benefit from more explanation on the physical reason behind the occurrence of predicted patterns. The use of artificial wind in this research could be compensated by describing the physical reason behind the formation of different patterns. Although some explanation is given in this section, a more indepth study is constructive.
Persistent wind changes thermohaline circulation and the water is immediately under the influence of wind force in shallow coastal area. Coastal jets are produced along both coasts in the wind direction and a slow return flow compensates this transport in the central area of the basin as explained by Krauss and

Brügge (1991). For example, in case of southerly wind it could be seen the establishing coastal jets and developing cyclonic gyre in the middle of the İzmir Bay is the place for the formation of the dense water.

Regarding each section I have these suggestions:
Abstract:
A.1 I think it is beneficial to mention that artificial wind is used to force the model so that the reader does not expect a realistic model setup.
Usage of artificial wind is added to the abstract.

Introduction:
I.1. Although the introduction points out the importance of Izmir bay, in my opinion this section can benefit from a more coherent structure. Also, this section provides some extra information which I think is better to omit to increase focus on the main aim of the paper. For example, the reason for extra-shallow regions in the inner bay is not directly relevant to the study and I suggest removing these lines (28-32).
The lines are removed and the introduction section is rewritten.

I.2. I would also suggest that more details on findings of previous research be given and the merit of the present research compared to previous studies be discussed. For example, in line 71 it is mentioned that Sayin (2003) has investigated the physical features based on modeling studies but no further explanation is given on the findings of his research. Similarly in line 66 the findings of Saner is not given.
The introduction section is rewritten taking consideration of the reviewer comment. We appreciate the priori modelling efforts. Any further explanation about Saner (1994) and Saner (2005) model studies are added, because his model results are relevant for the engineering point of view. He has compared his two model approaches mathematically.

1.3. In line 31 it is mentioned that elevation gradient maintained in the sea level affects the circulation. First, it is beneficial to include the source of this statement. Second, does this statement not contradict the statement given in lines 116-119?
Although surface elevation gradient generally is an important driving mechanism for the forming barotropic currents. Because of not having appropriate sea level data, the model experiments are conducted without adding sea level in the model. This issue can be a future research effort for the İzmir Bay modelling studies.

Materials and methods:
M.1. How are the vertical profiles of temperature and salinity in Izmir bay? Since a set of experiments focus on the effect of thermohaline forcing on the circulation, it would be helpful to add an explanation on how the profiles change in each season.
The figures are added.

M.2. It is mentioned that at the open boundary observed temperature and salinity is applied. What is the frequency of these data? Are these data constant in time?
Observed temperature and salinity values are prescribed at the boundary and relaxed during rest model integration time. This information is added to the text.

M.3. It is mentioned that the model is run until an equilibrium is reached. How long does it take for this steady current to occur? I think adding this explanation to the paper helps in understanding the nature of these forcing.
It is variable for every run. But it takes approximately three days. The background stratification remains not changed from its original prescribed form because of the equilibrium is succeeded in a short time. This is the importance of wind-driven scenarios with constant wind intensity. Model will not be in a steady state if we use actual wind field to run the model.

M.4. According to the supplementary explanations given as an answer to the first reviewer's comments, the wind is increased from 0 to 5 m/s in the experiments. Is that right? If so, in order to avoid confusion, I suggest to correct line 102 to include this explanation.

The suggested information is added to the text.

M.5. It is mentioned that the wind intensity is chosen to be 5 m/s but there is no reason as to why this speed is used. Is this speed chosen according to observed wind in Izmir bay? How does the wind change seasonally? This may be important in analyzing the effect of wind and stratification on the results. I think these questions can be answered by including the wind-rose in the paper and adding some explanation about the dominant wind and its intensity, if possible for summer and winter.

The dominant wind and its intensity for İzmir Bay environment is demonstrated using a wind-arrow graphic in the materials and methods section. Wind direction and average wind intensity from 2000 up to now monthly and yearly for İzmir Bay environment shows that the wind from north is predominant direction and the average wind speed is 5 m/s. Therefore 5 m/s wind intensity is chosen to simulate persistent wind condition.

Results:
R1. As mentioned before, I think it is beneficial that a more in-depth explanation be given to why the described patterns occur rather than adhering to describing the patterns. For example, in line 140, it is mentioned that the M pattern changes sign from winter to summer. Is it possible to give an explanation to why this happens?

The patterns, that are seen as a result of density-driven model experiments, can vary in time and space depending on the background distribution of temperature and salinity in the İzmir Bay model domain. So it is not correct to conclude that the pattern change sign from winter to summer. We reorganized the abstract section and removed the statement related the patterns for density-driven case. But result section is changed slightly by including information about the general distribution of density field in the Bay.

R2. Are the current fields depicted in the figures depth-averaged fields? If so this should be indicated in the figures captions.

The figure captions are rearranged indicating the current fields depicted in the figures are depth-averaged fields.

Conclusion:
C.1. Regarding the conclusion, I also have the opinion that this part is only a repetition of the results section.

The importance of pattern **M** is added to the conclusion section:

The cyclonic middle gyre M is important for İzmir Bay environment from two points. First is related to the dense water formation. The densest water (IBW) forms in the Middle Bay as a result of winter convection enhanced with cyclonic circulation in winter season. It causes a dense water cascading from İzmir Bay to Aegean Sea. Second is important from the biological point of view, forming upwelling brings nutrients rich water to the surface.

Regarding the change in sentences I suggest to rephrase these lines:
Line 10: although I understand the meaning of this sentence by looking at the answer to the first reviewer comments, I think this sentence is still not clear for the reader and should be rephrased.

The sentence is changed to "Instead two-layer stratification during summer, a homogeneous water column exists in winter".

Line 14: The lasting strong wind from certain direction: be more specific, what is meant by certain directions.

The sentence is rephrased.

Line 18: Outer and Inner Bay have also certain wind driven recirculation patterns: Again what is meant by certain? I think vague statements should be avoided in the abstract.

"and Inner Bay have also certain wind driven recirculation patterns" is replaced by "and Inner Bay have also expected wind driven recirculation patterns"

Line 63: One can increase the number of examples: rephrase

The sentence "One can increase the number of examples in which the currents and background-forming horizontal and vertical stratification are crucial for marine environments" is removed and the paragraph is rephrased.

Line 131: turns to the direction to: rephrase
The paragraph is rewritten and rephrased replacing "turns to the direction to" with "turns towards".

Line 133and other branch complete the cyclonic circulation in basin wide: rephrase
The paragraph is rewritten and rephrased replacing "and other branch complete the cyclonic circulation in basin wide" with "and other branch combines with the strong current at the east coast making a big cyclonic circulation in the middle area".

Line 135: Instead of being vertically homogeneous, it is almost horizontally homogeneous; but vertically stratified water column changes the behaviour of the current during summer: rephrase
The paragraph is reorganized taking attention reviewer suggestion.

Line 138 – 140 : rephrase
It is rephrased.

Line 161 : the certain layers : what does certain mean here?
It is rephrased writing "vertical" instead of "certain"

Line 163 : It is preferred to explain the current system : rephrase
It is rephrased as "The current system is explained giving emphasis only to the recirculation patterns forming in the Bay"

I also suggest to change these sentences as follows:
Line 3: wind is the most important driving-force (instead of driven-force)
It is replaced with "driving-force"

Line 14: Change "Lasting strong wind" to "Strong consistent wind"
"Lasting strong wind" is replaced with "Strong consistent wind"

Line 33: The water input through Gediz River is relatively low (instead of small)
"small" is replaced by "low"

Line 77: In (the) present study (add article)
(the) is added

Line 80: omit "the information"
"the information" is omitted.

Line 94: reaches a plateau (omit to)
"to" is omitted.

Line 110: omit "which were done"
"which were done" is omitted

Line 110: "deals with": change to "focuses on"
"deals with" is changed to "focuses on"

Line 135: "comparison to": change to "compared to"
"comparison to" is changed to "compared to"