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# *Interactive comment on* "Modelling Seasonal Circulation and Thermohaline Structure of the Caspian Sea" *by* M. Gunduz E. Özsoy

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Reviewer's original comments are in *italics*,
Our responses are as follows.

*The paper devoted to investigations of the wind and buoyancy driven seasonal circulation of the Caspian Sea (CS) with a use of HyCOM which was forced with ERA-40 winds and heat fluxes, as well as major rivers' discharge. As was shown, the applied model successfully reproduces the basic elements of the circulation as the southward flowing current systems along the eastern and western coasts, the upwelling along the eastern coast and some elements of mesoscale circulation known from previous observations and modeling. I endorse publishing this paper since it demonstrates effectiveness of HyCOM for regional issues.*



We would like to thank Dr. Korotenko for reviewing the manuscript.

*Along with this, I want to point out some drawbacks of this work: 1. For the CS, period when it is covered by ice in very important for basin-scale circulation. In strong winters, ice usually covers a significant part of the NCS. So, patterns of the circulation in shallow part of the NCS presented in figures for December seems to be misleading. Need discussion.*

We confirm that the current HYCOM model we used already had an ice model incorporated in it. However, in our experiments, the quantity of ice produced by the model was much less than those reported by various observations. The following paragraph was added to the text to explain this issue.

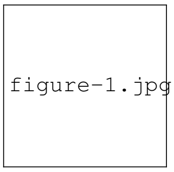
Although the current model has an ice model incorporated in it, the amount of ice predicted by the model was usually less than the observed levels (not shown). The inefficiency of ice formation in the model could possibly be attributed to insufficient heat loss from the shallow northern Caspian Sea estimated by the model bulk formulae. Firstly, the heat fluxes were obtained from a coarse resolution atmospheric model used by the ECMWF reanalysis. Secondly, careful evaluations of heat flux estimates compared with the observations (Pettenuzzo et al., 2010) have shown that the ERA-40 reanalysis data set used in our study is unable to close the surface budgets of heat in the case of the Mediterranean Sea unless some corrections are applied. Because we did not apply such corrections that should be carefully computed for the Caspian Sea, we had to accept the fluxes given by the existing module of HYCOM, although we note that the ice effects are under-represented in winter months in the NCS as in the case in December (Fig. 3)

Pettenuzzo, D., W. G. Large, and N. Pinardi, 2010. On the corrections of ERA-40 surface flux products consistent with the Mediterranean heat and water budgets and the connection between basin surface total heat flux and NAO, Journal of Geophysical

Research, 115, C06022, doi:10.1029/2009JC005631.

*2. It would be interesting to demonstrate a particular contribution of baroclinicity to the general circulation of the CS separately from wind-driven circulation, for which many modeling attempts were made.*

We already conducted a couple of sensitivity experiments to test the relative importance of various processes, but with a lack of room here, these were saved for discussion in a more comprehensive future paper. In Experiment 1 we performed the control run described in the paper. In Experiment 2, a purely wind-driven barotropic case was run with the surface buoyancy and river fluxes turned off, and constant values of temperature and salinity ($5°C$ and 12 ppt) were specified as initial conditions. Experiment 3 is the twin of the barotropic experiment with the 3-D climatological temperature and salinity specified as initial condition, in order to investigate the role of baroclinic contribution in the purely wind driven case. Experiment 4 is the twin of the control run but with river runoff turned off. Based on these tests we concluded that both the buoayancy and the wind-driven contributions were equally important in the circulation.




*3. Shown as a result of the NE winds action (Fig.9), summer upwelling is seen to occupy much narrower area than that usually observed with remote sensing (eg. NOAA-15, Aug,5, 2004, 14:55). It seems that such upwelling is governed not only by winds but, perhaps, baroclinicity too. In the work, Authors did not show the entire eastern coast in summer, along which upwelling usually occurred.*

The results of the above mentioned sensitivity experiments showed that summer up-



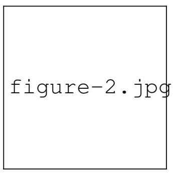
welling along the eastern coast and the associated Ekman drift currents across the basin preserved their basic structure, mainly driven by the wind, and modified little by other changes in setting. Perhaps it is not easy to identify the latitudinal extent of the upwelling region in the inclined coordinate axes of Fig. 9, but the southernmost upwelling structures start at $39.5°N$, while there is almost no upwelling observed along the eastern coast south of this latitude.

*4. As to Derbent anticyclonic eddy, it really appears periodically but I am doubt that river forcing alone could spin up the eddy throughout the entire water column in Derbent Depression (Fig. 12). Need discussion.*

We agree with Dr. Korotenko, and would like to discuss this issue, in the processing sensitivity paper. However we enclose the attached figure where comparisons are made for the sensitivity experiments mentioned above We reserve this discussion for the paper to follow.

*5. Finally, I do not like that, in the paper, Authors avoid to show area of the MCS (40N–41.6N) with Apsheron Peninsula. It is extremely important part of the CS forming water exchange between NCS and SCS. To this point, schematic of circulation, presented in Fig.12, without along-peninsula current at its northern side is misleading.*

In the Fig.12, the along-peninsula current following the northern coast of the Apsheron Peninsula are consistently sampled (blue vectors) when synthesizing the schematics. However they may have easily missed one's attention because of the poor reproduction of the figure, the new version of the figure are attached to this document.



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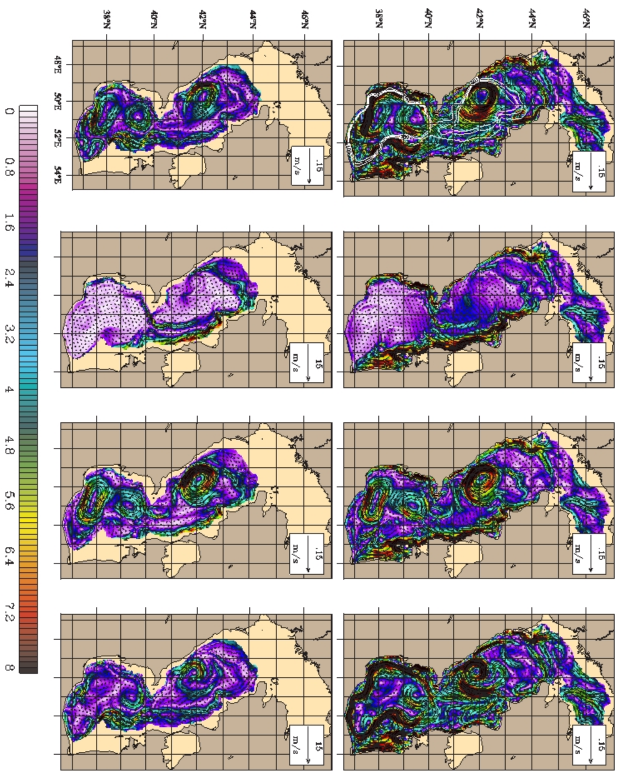


**Fig. 1.** Circulation pattern averaged over different depth intervals in August for the four experiment mentioned in the text, upper figures 0-30m lower figures 30-150m

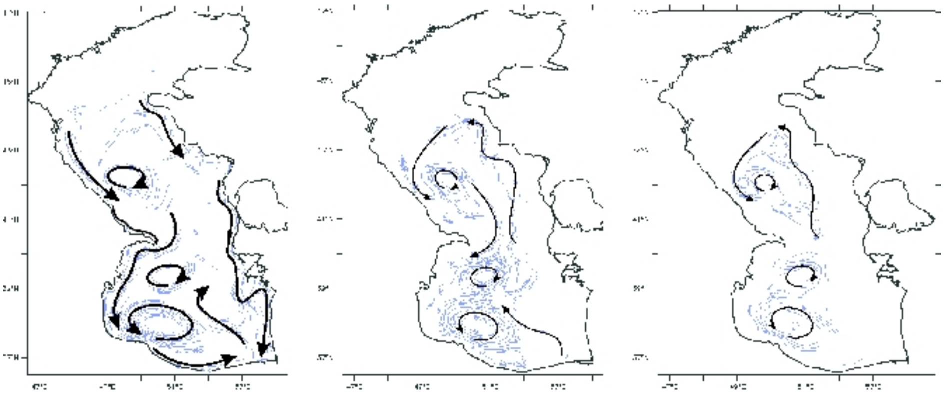

**Fig. 2.** Schematic representation of annual mean circulation of the Caspian Sea for the depth ranges (a) Surface (0-10 m), (b) Intermediate (50-100 m) (c) Deep (200-1000 m).