

Dear professor John M. Huthnance

Many thanks for the points on "Some aspects of the deep abyssal overflow between the middle and southern basins of the Caspian Sea" by Javad Babagoli Matikolaie et al. Some points are very useful for us to improve our study. We try to answer and address one by one each comments as follows:

Dear Javad Babagoli

Thank-you for sending me this revised version. I think there are still some improvements that you should make before it is reviewed again.

The main point among the details below is that I think there needs to be more explanation for the two analytic models: How are they more useful than the numerical model? What are the differences in physics between the two analytic models? How good are the assumptions enabling analytic treatment?

Yes. Based on your opinion, we add a new section in page 21, section 3.3.

Detailed comments and corrections.

Page 2.

Lines 13-14. Better ". . He pointed out such flows around world that may lead to . ."

Corrected.

Page 2, lines 13-14.

Line 30. Add "," after "tracers".

Corrected.

Page 2, line 29.

Line 31. Better ". . year by year, dominated . ."

Corrected.

Page 2, line 30.

Page 3.

Line 22. Better ". . difference for these two points . ."

Corrected.

Page 3, line 24.

Line 24. Delete "is" at start.

Corrected.

Page 3, line 26.

Page 4 line 9. Better ". . 2005 to validate the Numerical"

Corrected.

Page 4, line 9.

Page 5.

Line 10. "Compression" -> "Comparison"

Corrected.

Page 4, line 13.

Line 12. Better "spacing of CTD stations, distance is plotted in kilometres on the top . ."

Corrected.

Page 5, line 11.

Lines 13-14. "mainly due to the low resolution of observational data". But there is more detail in Figure 4(a) than in 4(b). Are these figures perhaps (a) model and (b) observational (opposite to caption statement)?

4a and 4b are the observation data and numerical simulation respectively. In the new version, at the end of each sentences, we emphasize which one is related to numerical and simulation.

Page 5, line 13-14.

Last 2 lines. "distance between two" (twice).

Corrected.

Page 5, line 17-18.

Page 6.

Line 6. Better "To achieve our goal, we ran the numerical model and used these data."

Corrected.

Page 6, line 3.

Line 13. "coastlines and bathymetry data with  $0.5^\circ \times 0.5^\circ$  resolution are acquired from GEBCO". Please check this stated resolution. Figures 6, 9, suggest finer resolution.

Corrected. Thank you so much.  $0.5'$  (30 seconds) is right rather than  $0.5^\circ$ .

Page 6, line 11.

Lines 26-27. Better ". . validation and are not related to deep flow near the Absheron Strait. For the latter, ADCP data in the Strait would be very useful . ."

Corrected.

Page 6, line 25-26.

Lines 29-30. This last sentence of the paragraph is very unclear. Maybe "This similarity relates to timing of flow increase and decrease rather velocity magnitude."?

Ok. Corrected.

Page 6, line 28.

Page 7

Line 1. Better ". . data at the location of"

Corrected.

Page 6, line 31.

Lines 23-24. Better ". . Strait is correct as is reflected . ."

Corrected.

Page 7, line 21-22.

Page 9.

Line 22. "... closed ..."

Corrected.

Page 9, line 22.

Lines 22-23. Better "... Caspian Sea. However, accurate information about the connection is not accessible for whether to include the higher-salinity source in the numerical model ..."

Corrected.

page 9, line 22-24.

Line 27. Better "... 200-300 m in the middle basin in the numerical simulations, ..."

Corrected.

Page 9, line 27-28.

Line 33. "isopycnals". "... (see 3a, b and 4a). Some other"

Corrected.

Page 9, line 33-34.

Lines 34-35. Better "... Caspian sea (e.g. Terziev et al. (1992) and Ibrayev et al. (2010))."

Corrected.

Page 9, line 35.

Page 10 line 35. Delete "but".

Corrected.

Page 11, line 1.

Page 11 lines 1-3. The sentence "One of . . . Sea." looks like an aim of the paper which should be in the Introduction.

Corrected. We moved the sentences to the introduction.

Page 3, lines 11-12.

Page 16.

Lines 20-21. Better ". . . solved analytically using sufficient assumptions related to the research aims. In comparison with this work . . ."?

Corrected.

Page 16, lines 20-21.

Line 24. "profiles" is unclear, usually referring to depth dependence but here there are 2 layers at most.

Ok. Now, we use velocity section instead of profiles. This was exactly used by Cenedese et al (reference: page 191: Figure 2)

Page 16, line 24.

Line 26. "and also sinking process are more important when the overflow moves over the Strait." is not clear. "more" implies a comparison; between what and what?

Corrected.

Page 16, lines 25-26.

Line 30. "ventilated"

Corrected.

Page 16, lines 30.

Line 31. "can sink up to 600-700 m". Is there a limit to the sinking in this model?

No, it is not a limitation for the model and the 400-500 is correct. However 400-450 m is more appropriate because the depth of sill is about 200m and the sinking is about 200-250 m. as a result the water can sink to 400-450 m in this process.

Page 16, lines 30-31.

Line 32. Better ". . Black sea which lacks such ventilation and is almost non-productive . ."

Corrected.

Page 16, lines 33.

Page 17. There still needs to be motivation for TWO analytic models.

Corrected.

Page 17, lines 5-13.

Line 4. Define PV

Corrected.

Page 17, lines 12.

Lines 11-13. How do the assumptions here compare with those in section 3.1?

Corrected.

Page 21, section 3.3.

Line 28. "mean". How are the vorticity and PV averaged (in space and time)?

The equation 5 is as the Eq.13b in Falcini and Salusti (2015). In the new version, we add some note to clarify the reasons of using averages in the Eqs. (See page 21, section 3.3). Here we try to explain more about this. Based on the Falcini and Salusti paper, they obtained the vorticity equation as follows:

$$\frac{\zeta}{f} = e^{-\int_0^{\xi} \frac{X}{u} dx} \left\{ \frac{\zeta_0}{f} - \int_0^{\xi} e^{\int_0^{x'} \frac{X}{u} dx'} \frac{1}{u} (\text{div } u) dx \right\}. \quad (\text{a})$$

To obtain this formula, they use many assumption. After that due difficulty of calculation  $h(\xi, \psi)$  and  $u(x,y)$  from data, they used some assumption and prove the following equation as cross sectional average.

$$\frac{\bar{\zeta}}{f} = e^{-\int_0^{\xi} \frac{x}{u} dx} \left\{ \frac{\bar{\zeta}_0}{f} - \int_0^{\xi} e^{\int_0^{x'} \frac{x}{u} dx'} \frac{1}{u} (\overline{\text{div}u}) dx \right\} \quad (b)$$

After some mathematical operation the Eq.5 is obtained. About how the Eq. b is obtained from Eq. a please see page 402, **Appendix A** in Falcini and Salusti(2015).

Line 32.  $\Delta h$  and  $\Delta x$  are not defined and not in (5), (6).

Corrected.

Page 18. Lines 6-7.

Lines 9-10. Better ". . although in January the vorticity is a minimum among other months . ."

Corrected.

Page 18. Lines 22-23.

Lines 11-12. "changes of  $\Pi$  over the sill (from I to III) are about . ."?

Corrected.

Page 18. Lines 24-25.

Line 15. Better ". . Fig. 15 shows an important point that the changes of"

Corrected.

Page 18. Lines 28.

Line 19. "pressure gradient" (reverse order of the two words)

Corrected.

Page 19. Line 3.

Lines 21-24. What is the basis of these statements about the width of the flow? It does not appear in the equations (5) or (6). If these statements are based on the numerical model, please say so.

In new version, we explain our method in page 17, lines 12-13. Based on your comment, we emphasize.

Page 19, lines 6-7.

Line 24. "The results" – of what?

Corrected.

Page 19, line 8-9.

Page 19.

Line 8. Not "figure 16" which is transect V not near the Cape.

Ok. Corrected.

See page 19, line 18.

Line 9. Insert "(figure 16)" after "May"? But neither figure 16 or 17 shows PV directly.

Corrected. We don't want to show the PV in these figures. In general, we discuss the behavior of the flow near the cape.

We use the potential vorticity in the upstream because Stern shows that his method is based on the upstream parameters of the flow. For this reason we calculated the vorticity and potential vorticity from I to V which is located before the cape. We explain it in page 19, lines 22-24.

Line 21. Better "separation. A more rigorous criterion is needed . ."

Corrected.

Page 19, lines 30-31.

Page 21 lines 8, 11 and page 22 lines 8, 10. I think you mean Figure 18 each time (page 23 line 23 "Fig. 18" correspondingly).

Corrected.

Page 22, lines 18,21...



Page 22.

Line 5. "with less assumptions." What is/are the extra assumption(s) in (10)?

Corrected.

Page 23, line 10.

Lines 15-16. Better ". . table 4, the numerical model value is greater than that of the analytical model. This underestimation by Eq. 10 can be due to the fact . ."

Corrected.

Page 23, lines 20-21.

Page 23. Caption for figure 18 needs to explain 18c.

Corrected.

Page 24, lines 27-29.

Page 24.

Line 12. Better ". . middle basin, like deep convection in"

Corrected.

Page 25, lines 15.

Lines 21-22. Better ". . The Rossby scale width of the flow varies for different seasons. . ."?

Corrected.

Page 25, line 25.

Line 24. Delete "that are used".

Corrected.

Page 25, line27.