Review on the manuscript

“ Mesoscale Eddies in the Algerian Basin: do they differs as a function of their formation site ?”

by F. Pessini, A. Olita, Y. Cotroneo and A. Perilli

submitted to Ocean Science

This work presents a statistical analysis of the dynamics of meso scale anticyclones in the western mediterranean sea, and especially in the Algerian Basin, performed with an automatic eddy detection and tracking algorithm applied to 22 years sea level anomaly of the AVISO/DUACS data set. This analysis emphasis on the dynamical properties of two distinct types of anticylones, the AEs and the FAEs, formed in distinct area. However, due to some a priori choices which exclude the cyclones from the analysis or limit the area of investigation, some important dynamical features are missed in the present analysis. I listed below a numbers of important issues that should be satisfactorily addressed in order to consider a (major) revised paper for publication in Ocean Science.

Major comments:

1. *Sensitivity of the eddy contour to the Okubo-Weiss threshold W.*

Several studies (Sadarjoen and Post 2000; Chaigneau et al. 2008; LeVu et al. 2017) mentionned a high sensitivity of the size and the shape of the detected eddies to the threshold value W and a general tendency for false positive eddy detection. Isern-Fontanet *et al.* (2003, 2005) suggests to use the threshold $W = -0.2\sigma$ to identify the vortex cores, where σ is the standard deviation of the W distribution among the domain. Another study (Chaigneau et al. 2008) suggests that the best compromise is a value of W in the range $-0.3\sigma \leq W \leq -0.2\sigma$ while Chelton et al. (2007), propose to use a fixed value $W = 2.10^{-12}s^{-2}$ for the eddy detection. In the present study, the authors fixed the threshold value $W = 0$. However, it is never explained why ? The authors, shoud at least investigate how the typical eddy size and the EKE is affected if this threshold value is changed ? The method limitations are brought up in the manuscript but never quantified, for instance what is the sensitivity of their eddy detection to the Okubo-Weiss threshold W ?

2. *The statistical analysis of cyclonic eddies is missing.*

The authors restrict their statistical analysis to anticyclonic eddies, assuming that most of the cyclonic eddies are short-lived. First, they should confirm that, according to their eddy detection and tracking algorithm, this is indeed the case ! Besides, a significant part of their analysis focus on short-lived anticyclones (shorter than 90 days). I would be very surprize if they do not find a large fraction of cyclonic eddies for this range of lifetime. Mkhinini *et al.* (2014) have shown, in the eastern mediterranean basin, that it is only when the lifetime exceeds 6 months that the anticyclones become dominant. Hence, even if their lifetime are shorter, cyclonic eddies could be more numerous than anticyclones and contribute significantly to the eddy kinetic energy. The recent work of Escudier et al. (2016) investigate AE’s of both sign and found that their propagation speed differs. Therefore, a significant fraction of mesoscale eddies (the cyclonic ones) are missing in this study and should be investigated to assess correctly the EKE distribution in the Algerian basin. The terms “eddies” or “eddy” used throughout the manuscript is really misleading because it always correspond to anticyclones (i.e. A.E.).

3. *The western part of the Algerian basin (<2°E) is not studied.*

The authors restrict their analysis into an area that does not extend below 2°E. However, the previous study of Escudier et al. (2016) have shown that Algerian eddies are , on average, advected along two large cyclonic loops. The first one is located between 0°-4°E and the second one between 5°E-8°E. Besides, according to the Figure 11 of Escudier et al. (2016), three main formation areas are located along the Algerian coast: 1°W-0°E, 1°E-3°E and 5°E-8°E. Hence, the limit of 2°E used in the present study exclude two main formation areas of AE and cut the first cyclonic loop which characterize the trajectories of long-lived eddies. The statistical analysis of the eddy formation and termination in the box D will be strongly impacted by the westearn part of the basin (1°W-2°E) which is unfortunately not studied in the paper. Therefore, a larger domain should be investigated to describe accurately the spatial and temporal distribution of long-lived eddies in the Algerian Basin.

4. *Interactions and transport between FAEs and AEs.*

One conclusion of this paper is to emphasis that the Algerain basin can be separated in two parts, the Algerian coast and the Balearic Front, with (almost) no connections between these two area. However, there is a striking correlation in the time series (Figure 6) of the anticyclonic EKE between the southern Algerian basin and the northern basin. The three peaks that occur in the northern part seems to be correlated (6 months shift) to the three peaks of the southern part. Besides, according to the eddy trajectories shown in the figures 12 and 14 some long-lived anticyclones formed along the Algerian coast crosses the 39°N latitude and may therefore interacts with the North Balearic Front or the FAEs. These two types of eddies could merge together in the central part of the basin. Therefore, the statement of "no-connection" or "no-interarctions" between AEs and FAEs seems doubtfull. I encourage the authors to investigate more carfully the possible interactions between the AEs and the FAEs rather than emphasis on a virtual "separation" between the north and the south.

Other comments:

5. page 2 line 13: The following references are mainly related to the western Mediterranean Sea (WMED), therefore the authors should be more explicit here and mention "Mesoscale eddies in the **western** Mediterranean sea have been widely investigated in the past...". Otherwise, many other papers related to the eastern meditteranenan eddies should also be mentionned.

6. page 2 line 15. Some recents papers related to in-situ measurements of meso scale eddies in the Western mediterranean sea, especially from glider survey, should be mentionned here:

- Amores, et al. (2013), J. Geophys. Res. Oceans, doi:10.1002/jgrc.20150.

- Cotroneo, *et al.* Journal of marine systems. (2016).

- G.Aulicino *et al.* Journal of marine systems (2018). (https://doi.org/10.1016/j.jmarsys.2017.11.006).

The following reference, related to the intercomparisons between satellite altimetry and numerical model, is also missing:

- Escudier, et al. (2016), J. Geophys. Res. Oceans, 121, doi:10.1002/ 2015JC011371.

7. page 2 line 16: "Most data on the motion of the eddies are provided by infrared and colour satellite imagery" I am a bit suprized by such statement, because the visible images do not provides any quantitative informations on the intensity (velocity or vorticity) of the detected eddies. Besides, as far as I know, there is no automatic methods or algorithm able to track the eddies on visible images. The number of eddy trajectories deduced from infrared or colour satellite images remain limited and subject to qualitative interpretation. It is therefore very difficult to get any statistical analysis on the dynamics or even the drifting speed of meso scale eddies only from visible images.

8. page 5 line1-2: The automatic eddy detection algorithms based on geometrical methods or hybrid ones are not fully explained and some appropriate references are missing here. Sadarjoen and Post (2000) and Nencioli et al. (2010) used only the geometrical properties of closed streamlines to identify coherent vortices regardless of their intensity. As far as hybrid methods are concerned, some studies (Viikmäe and Torsvik 2013; Halo et al. 2014; Yi et al. 2014) used the OW parameter to detect the possible eddy centers, while Mkhinini et al. (2014) and LeVu et al. (2017) used the local normalized angular momentum (LNAM).

9. page 12 line 21-27: The figure 4 of this paper should be compared to the figure 9(a) of Escudier et al. (doi:10.1002/ 2015JC011371.) which shows similar patterns of the eddy density in the Algerian Basin.

10. The authors often give very precise numbers “A total of 125,256 anticyclonic eddies and 127,761 cyclonic eddies were detected” or values with two digits “The mean radius of anticyclonic (cyclonic) eddies was 97.78 (96.53) km”. I am not sure that the eddy detection algorithm is so precise and accurate !! a rough order of magnitude will be sufficient, such as “ 125,000 anticyclonic eddies were detected ” and “a mean radius around 98 km”...

11. Page 20, the trajectory of the AE depicted in Figure 14(a) should be compared in more details with the one deduced from the analysis of SST images in Puillat et al. (2002). In the latter, this long-lived anticyclone was detected up to December 1998 and not November 1997. Besides, the termination point is located at 1.5°E and not around 8°W. The differences between these distinct trajectories of the same eddy should be discussed.

References:

- Amores, A., S. Monserrat, and M. Marcos (2013), Vertical structure and temporal evolution of an anti-cyclonic eddy in the Balearic Sea (western Mediterranean), J. Geophys. Res. Oceans, 118, 2097–2106, doi:10.1002/jgrc.20150.

- Le Vu, B., Stegner, A., & Arsouze, T. (2017). Angular Momentum Eddy Detection and tracking Algorithm (AMEDA) and its application to coastal eddy formation. DOI: 10.1175/JTECH-D-17-0010.1

- Mkhinini, N., A. L. S. Coimbra, A. Stegner, T. Arsouze, I. Taupier- Letage, and K. Béranger, (2014): Long-lived mesoscale eddies in the eastern Mediterranean Sea: Analysis of 20 years of AVISO geostrophic velocities. J. Geophys. Res. Oceans, 119, 8603–8626, https://doi.org/10.1002/2014JC010176.

- Nencioli, F., C. Dong, T. Dickey, L. Washburn, and J. C. McWilliams, 2010: A vector geometry–based eddy detection algorithm and its application to a high-resolution numerical model product and high-frequency radar surface velocities in the Southern California Bight. J. Atmos. Oceanic Technol., 27, 564–579, https://doi.org/10.1175/2009JTECHO725.1.

- Sadarjoen, I. A., and F. H. Post, 2000: Detection, quantification, and tracking of vortices using stream-line geometry. Comput. Graphics, 24, 333–341, https://doi.org/10.1016/S0097- 8493(00)00029-7.

- Viikmäe, B., and T. Torsvik, 2013: Quantification and character- ization of mesoscale eddies with different automatic identifi- cation algorithms. J. Coastal Res., 65, 2077–2082, https://doi.org/10.2112/SI65-351.1.