# Final Author Comments

**"Occurrence and characteristics of mesoscale eddies in the tropical northeast Atlantic Ocean"**

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Dear Editor, dear Reviewers,

We would like to thank you for the positive evaluation of our manuscript, the constructive criticism and the very careful corrections and suggestions, which surely helped to improve the manuscript. On the next pages we will answer point by point to the remarks of the reviewers and how we intend to address their concerns in the manuscript. Below, comments by the reviewers are marked italic and our response as normal text.

**Anonymous Referee #1**

*The paper presents an appropriate overview of eddy properties off the west African up-welling (TANWA region) and of their contribution to transports. It uses most of the data of the upper ocean available, either in situ or satellite-based, and nicely synthesizes the results. The methodology both for identifying eddies, tracking them or establishing their properties is appropriate. The introduction gives a fine state-of-the-art review, and the discussion/ conclusion sections presents a fine analysis of the relevance of the results and of possible limitations of the approach.*

Thank you very much for this evaluation.

*What folllows are some minor comments/queries:*

**Data and methods:**

*Right choice of satellite data products. Among the data, glider data collected in this region have not been used. Is it because of insufficient vertical reach of the glider CTD data? (maybe not before end 2013?).*

- Before the end of 2013 we only had two glider missions in the TANWA (2010 and 2013) that possibly could use in the present eddy study. We checked the glider data on potential eddy crossings and found only few profiles that could be used, but overall do not help to improve the eddy statistics significantly. Thus we decided not to use glider data here. However, for future studies glider data is getting interesting due to the intensification of glider deployments in the TANWA during the last years in the project AWA/Eddy-Hunt (see also special issue in Biogeosciences: http://www.biogeosciences.net/special_issue213.html).

*Among the Argo data, 40% rejection with the three criteria chosen seemed particularly high: which of the criteria used explains that in this region?*

- The Argo float data marked with quality category 1 still had several issues, which led to the rejection of the relatively large number of profiles for the present study. From original 2906 profiles in the TANWA we delete 886 profiles (31%): 52 profiles were deleted because they have no data between 0 and 10 m depth; 31 profiles were deleted because they have less than 4 data points in the upper 200 m; 139 profiles were deleted because they do not reach down to 1000 m. The remaining 664 profiles were deleted because either the temperature, salinity or pressure measurement was not existent, the pressure was not continuous or temperature or salinity measurements were obviously wrong for that region (temperature > 40°C and 30 < salinity > 40). This additional information of how many profiles are rejected due to the different criteria's is now added to the manuscript (page 3051, line 13-17):

„In the following, we give the criteria applied to the Argo float profiles and in brackets the percentage, to which the criteria were fulfilled. Selected profiles must i) include data between 0 and 10 m depth (98.2%), ii) have at least 4 data points in the upper 200 m (98.8%), iii) reach down to 1000 m depths (95%), iv) continuous and consistent temperature, salinity and pressure data (78%). This procedure reduced the number of profiles by around 30% to 2022 Argo float profiles for the TANWA."

*In CVOO mooring profiles, the reference profile is chosen before the eddy passage. Any reason for not also taking into account profiles collected afterwards?*

- We thought that the profile before the eddy passage is very likely not affected by the eddy, while the profile after the eddy passage could include contributions from the eddy core mixed with the surroundings. But we checked now diverse profiles before and after the eddy passage and could not find a systematic difference. Thus, we agree with the reviewer and conclude that it is not relevant if a reference profile is taken before or after an eddy.

*Bottom page 3053, line 17-19: not completely clear. Is it that for each profile inside an eddy, one checks whether there are reference profiles outside of the eddy filling the criteria and then estimate (or not) an anomaly. . .*

- Yes, it is exactly what we have done. For every profile inside of an eddy we searched for a reference profile outside of an eddy to compute an anomaly. This reference profile should be at maximum 120 km apart of the eddy center (not within another eddy) and ±25 days apart from the time the profile inside of the eddy were taken. If no reference profile is fulfilling these criteria, an anomaly cannot be derived. To clarify this we changed page 3052 line 15 to 20 from:

"Here we are interested in the anomalous water mass characteristic inside the eddy compared to the surrounding water. Anomaly profiles of potential temperature, $\theta$, salinity, S, and potential density, $\sigma_\theta$, were derived as the difference of the profiles inside and reference profiles outside of an eddy. Profiles outside of eddies are required to be taken within a maximum distance of 120 km from the eddy centre and at maximum ±25 days apart from the time the profile inside of the eddy were taken (Figure 4). For 176 profiles out of the 1174 profiles inside of eddies no reference profile could be found fulfilling these criteria. In total 587 anomaly profiles for anticyclones/ACMEs and 411 anomaly profiles for cyclones were derived."

**Results and Discussion**

*The average eddy-radius is 56 km, so it is rather close to the resolution in the AVISO products that are used to estimate the eddy statistics (size, velocity). What is the implication on these statistics?*

- As correctly mentioned by the reviewer the AVISO SLA products cannot resolve eddies with radii smaller than 45-50 km and, consequently, no eddies with radii smaller than 45 km were included in our database. The occurrence of eddies decreases rapidly with increasing eddy radius and eddies with radii between 45 – 60 km that are close to the resolution limit of the AVISO product dominate the eddy statistics. Thus, the given number of eddies and corresponding eddy fluxes must be seen as a lower limit and would increase if accounting for smaller eddies. We include a corresponding sentence in the manuscript at page 3056, line 11:

"Note, that the given number of eddies must be seen as lower limit due to the coarse resolution of the satellite products."

*I understand that the uncertainties in tracking due to errors in mappings (insufficient altimetric covereage) requires to check whether same eddy reemerges a while after. I did not fully understand what is the cirterium used to identify a same structure after a tracking interruption.*

- The insufficient explanation of the tracking algorithm was also noted by referee #2. We rephrased this paragraph and added additional information to improve its structure, both hopefully clarifying the description of the applied algorithms. We added the paragraph at page 3050 line 3-11:

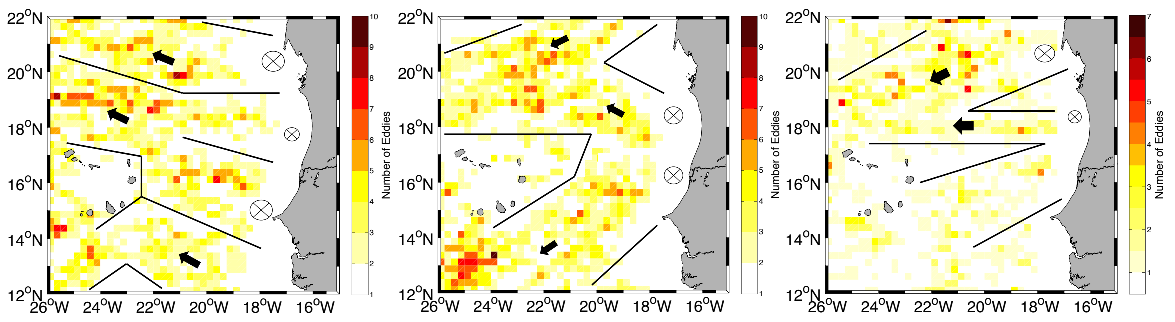
"When applying the two different eddy detection methods to the SLA data from the TANWA region, we used the same eddy detection thresholds for both methods, i.e. a feature only counts as an eddy, if its radius is larger than 45 km and it is detectable for a period of more than 7 days. Note, as the identified eddy areas are rarely circular we used the circle-equivalent of the area of the detected features to estimate the radius. For eddy tracking both eddy detection methods use the same tracking algorithm. An eddy trajectory was calculated if an eddy with the same polarity was found at least in 7 consecutive SLA maps (corresponding to one weeks) within a search radius of up to 50 km. Due to e.g. errors in SLA mappings (insufficient altimetric coverage) an eddy could vanish and reemerge after a while. Therefore we searched in 14 consecutive SLA maps (corresponding to 2 weeks) in a search radius of up to 100 km after an eddy disappearance, if eddies with the same polarity reemerges. If more than one eddy with the same polarity emerge within the search radius, we defined the following similarity parameter to discriminate between the eddies:

$$X = \sqrt{(\frac{distance}{100})^2 + (\frac{\Delta\, radius}{radius_0})^2 + (\frac{\Delta\, vorticity}{vorticity_0})^2 + (\frac{\Delta\, EKE}{EKE_0})^2}\ , \qquad (1)$$

which include four terms including the distance and the difference of the two radii, mean vorticities and mean EKE of the eddies. $Radius_0$, $vorticity_0$ and $EKE_0$ are the mean radius, vorticity and EKE of all identified eddies in TANWA. The eddy with the smallest X is selected to be the same eddy."

*3.2 formation and propagation (pages 3058-3059). Very interesting and informative sections. On the other hand, the arrows and eddy corridors delineated on figures 8 (right panels) are rather schematic. Is there a way to be more quantitative there. At least, it should be possible to add average speed (both zonal and meridional) as well as its rms for these different 'average' vectors (and each eddy type). For ACME, however, statistics might not be that relevant. Seems that they are mostly in the north?*

- Referee #2 also noted the rather schematic presentation of the eddy propagation in figure 8. We decided to add trajectories of long-lived eddies exemplarily showing the eddy propagation direction and pathways (see figure 1). The satellite statistics indicate that long-lived ACMEs occur mostly in the northern part of TANWA, but recent in-situ observations found ACME structures in surprisingly high numbers and in a wide area from about 5°N to 20°N east of 30°W in the tropical Northeast Atlantic Ocean (for more details see Schütte et al. 2016).



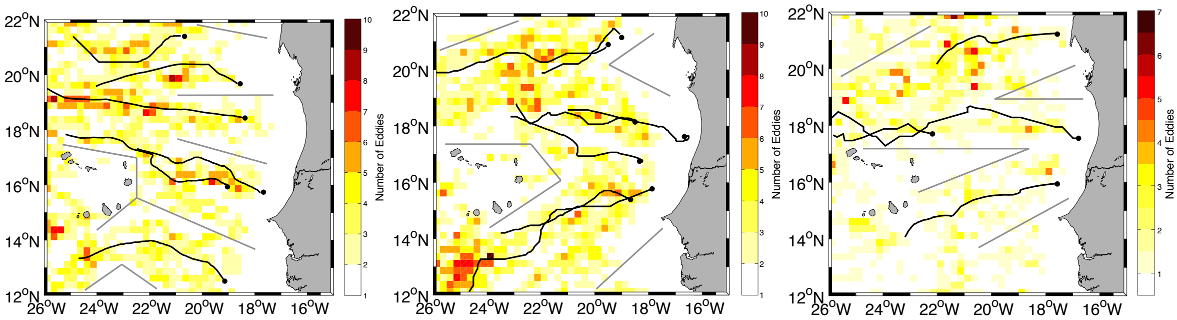



**Figure 1:** Upper row old figures: Total number of eddies detected in 1/6° x 1/6° boxes for cyclones, anticyclones and ACMEs. Only eddies are counted with a lifetime larger than 35 days. Main eddy propagation corridors are indicated by solid black lines and thick black arrows, main generation spots by circles with crosses. Lower row new figures: Total number of eddies detected in 1/6° x 1/6° boxes for cyclones, anticyclones and ACMEs. Only eddies are counted with a lifetime larger than 35 days. Main eddy propagation corridors are indicated by solid grey lines and selected trajectories of long-lived eddies. The dots mark the starting point of the eddy trajectories.

*p.3059-3060 interesting strong seasonal dependency on cyclone formation that is correctly identified and analyzed. I see it much less with anticyclones (except after removing ACME), and not so sure that the July isolated peak is so relevant (or at least, this should be further argued; as one could as well state the maximum at the end of the year...).*

- We agree with the reviewers comment and included one sentence at page 3060 line 12-13 to mention the maximum of anticyclone formation at the end of the year:

"While the maximum formation of cyclones occurs in June during the acceleration phase of the MC, the seasonality of anticyclone formation is not as distinct with weaker maxima in July and at the end of the year."

*Obviously, ACME have a formation peak in spring, during the core upwelling season. Is it the influence of the undercurrent water, which would also explain why they have such a strong SACW signature?*

- Yes, we think that the instability of the poleward undercurrent (PUC), which is strongest during the core upwelling season (spring), are involved in the formation of ACMEs (e.g. as suggested by D'Asaro 1988). The PUC with its core depth at around 100 m depth transports SACW northward, which could explain the strong SACW signature of ACMEs. Hence water mass anomalies and depth range of ACME cores coincide with the PUC. However, we have no observational evidence of the instability process. That is why we are not discussing the formation process in detail and only mentioned the context on page 3060 line 16-17, that during the time of maximum ACME formation the PUC is strongest and getting unstable at the end of the upwelling period.

*Could a cap be formed in spring time over a structure that would be cold and fresh at subsurface, with the formation related to subsurface eddying?*

- With the formation of an ACME, a subsurface water volume is established within the eddy core (at around 80-100 m depth) that is largely isolated from the surroundings and transported westwards with the eddy. The mixed layer above the eddy core is not similarly isolated because of the weaker eddy rotation near the surface. Water exchange above the eddy core with the surroundings is thus much more effective. The weaker surface anomaly of ACMEs compared to cyclones or anticyclones might be maintained by vertical mixing between the mixed layer and the eddy core resulting in weak cold and fresh mixed layer anomalies.

*3.4: eddy structure. Very nice summary statistics. However, on table 3, I am not sure of the consistency of the 5 comparisons. One difference; for 2 to 5; diff of T-anomalies in anticyclone-cyclone=1.2°C, whereas for 1 it is 2.1°C? (also larger diff for salinity in 1: 0.29, compared to 0.15 for 2 to 4). Why is there such a large difference, which seems to have mostly originated from cyclones? Could it be that at the chosen distance from cyclone core, one tends to be into an anticyclonic structure: this would be somewhat surprising, but...?*

- To explain the differences between the climatologies we included in table 1 the mean temperature and salinity values in a small box in TANWA in 100 m depth during June. The order of the climatologies from warm (saline) to colder (fresher) values is MIMOC, WOA, CSIRO, Levitus. This explains the highest (lowest) temperature anomaly for cyclones (anticyclones) using the MIMOC climatology and a decreasing (increasing) anomaly with the climatologies WOA, CSIRO and Levitus. The same is valid for salinity. In our example box the MIMOC climatology is nearly 0.5°C warmer and 0.3 more saline than the CSIRO climatology. These differences between the different climatologies are of the same order of magnitude than the water mass anomalies in the eddy cores.

| | Cyclones (CE) | | Anticyclonic eddies (AE) | | Difference (CE-AE) | |
|---|---|---|---|---|---|---|
| | Temp [°C] | Salt | Temp [°C] | Salt | Temp [°C] | Salt |
| Next Profile Out | -1.22 | -0.26 | 0.87 | 0.13 | -2.09 | -0.39 |
| MIMOC | -0.56 | -0.32 | 0.60 | -0.17 | -1.16 | -0.15 |
| WOA | -0.32 | -0.10 | 0.85 | 0.05 | -1.17 | -0.15 |
| CSIRO | -0.21 | -0.08 | 0.94 | 0.06 | -1.15 | -0.14 |
| Levitus | -0.16 | | 0.97 | | -1.13 | |

| | Mean temperature (14.5N to 15.5N / 18.5W to 19.5W) at 100m depth, during June | Mean salinity (14.5N to 15.5N / 18.5W to 19.5W) at 100m depth, during June |
|---|---|---|
| | Temp [°C] | Salt |
| MIMOC | 15.06 | 35.80 |
| WOA | 14.66 | 35.64 |
| CSIRO | 14.60 | 35.52 |
| Levitus | 14.53 | |

**Table 1:** Upper table: On the left different mean temperature and salinity anomalies of cyclones and anticyclones (anticyclones + ACMEs) of the first 350 m relative to reference profile (Next Profile Out) or different climatologies (CSIRO CARS2009a V1.1 climatology, monthly WOA09 climatology, monthly MIMOC V2.2 climatology, monthly Levitus94 climatology with salt values not included in monthly base). Right column shows the difference between mean anomalies of cyclone and anticyclone in each case. Lower Table: Mean temperature and mean salinity in a box of 14.5N to 15.5N / 18.5W to 19.5W in 100 m depth during June of the different climatologies.

The difference between the mean temperature (salinity) anomaly of anticyclones and cyclones is around 1.15°C (0.15) for all climatologies (see table 1), which one would expect, if all climatologies behave similarly. The differences derived by using the "next profile outside" are instead larger when compared to the differences derived by using the climatologies. As suggested by the reviewer, the "next profile outside" could be located in a neighboring eddy of reversed polarity. While we used only reference profiles outside of eddies (as identified by the eddy detection algorithm), we cannot exclude that eddy borders are inaccurately determined due to noise in the SLA data or the reference profile is located near a neighboring eddy of reversed polarity. Such a possible influence is discussed in an additional paragraph at page 3046 line 1:

"The differences in the mean anomalies depend on the used reference profiles. Besides the "next profile outside", we used different climatologies as reference. However, the differences between the climatologies are of similar magnitude than the derived mean anomalies of the different eddy types (Table 1). When using the "next profile outside" as reference we obtained larger mean anomalies, which could suggest that the "next profile outside" is systematically biased by nearby eddies of reversed polarity (which are not detected perfectly by the eddy detecting methods). However, in particular in regions with strong gradients/fronts (e.g., CVFZ, coastal upwelling) with strong seasonality and variability, the "next profile outside" should deliver the most realistic background condition surrounding an eddy and thus should be preferably used to calculate water mass anomalies transported by eddies."

*3.5: when estimating, volumen (mass), assumption of coherency (close streamlines) to 350m. Why this choice? (as one goes down, geostrophic velocity would diminish, thus water would be less trapped).*

- We choose 350 m depth as maximal trapping depth as the mean temperature and salinity anomaly in the eddy vanishes around that depth (see in the submitted manuscript page 9, line 33-34). The reduction of the anomaly with depth is associated with reduced trapping of the water mass inside the eddy core due to a reduction of the rotational velocity with depth below the eddy core.

*I am slightly flustered by the estimates of transport and release based on ASA and AHA, as they assume implicitly that there is horizontal compensation of mass, thus heat/salt by reference water (thus rather different when one uses reference profile or the climatologies 2 to 5). Also, clearly, one expects partial compensation between the cyclones and anticyclones, and thus the net estimate will be very dependent to how structure are identified, how the statistics are established and how they are tracked. I am not convinced that these computations bring any relevant estimate (at least order of magnitude).*

- We agree with the reviewer: the assumption behind our calculation of ASA and AHA is the compensation of mass with background (next profile outside) conditions. In this sense, our results represent a first order estimate of the heat and salt transports associated with westward migrating cyclones and anticyclones. These heat and salt transports are, when compared to surface heat and freshwater fluxes, a non-negligible effect in the heat and freshwater budget of the TANWA, which in our opinion is worth to be noted.

*After, bottom page 20 and 21, estimate of transport of SACW yields more robust results with strong differences between structures that are carefully analyzed (better transport by ACME and then cyclones. . .; but for anticyclones, is it compatible with earlier statement on U/C on good water trapping in these structures). An important role of eddies is identified to transport SACW from the coast to the west (and all the way to Cap Verde front?)*

- The main reason for the weak water mass anomalies in anticyclones seems to be the formation mechanism. During boreal summer, which is the dominant formation period, anticyclones are formed on the warm side of the southward surface boundary current. In this case, the water mass anomalies in the cores are very weak from the beginning.

To comment on the nonlinearity, i.e. the trapping of water mass anomalies, we shortly discuss the differences between the different eddy types in the following. After their generation, eddies of all three types propagate westward with a speed, c, of about 3.00 ± 2.15 km $day^{-1}$, which is in general agreement with the first baroclinic mode Rossby wave phase speed at that latitude range. The maximum surface swirl velocity, U, as obtained from the surface geostrophic velocity of in SLA detected eddies is on average 16 ± 10 km $day^{-1}$ in cyclones, 15 ± 10 km $day^{-1}$ in anticyclones and 14 ± 9 km $day^{-1}$ in ACMEs. This indicates highest nonlinearity for cyclones $\alpha = U/c = 5.2$, followed by anticyclones $\alpha = 4.9$ and ACMEs $\alpha = 4.6$. Due to this nonlinearity the exchange between eddy interior (eddy core) and surrounding water is limited and hence they are able to trap and transport water masses. However, the nonlinearity of ACMEs is much large at the subsurface eddy core and thus the trapping can be estimated to be most effective in ACMEs. During a recent research cruise of the R/V Meteor (M 105), for example, an ACME could be crossed in the TANWA. The ADCP zonal and meridional currents show a baroclinic, anticyclonic rotation flow, with a maximum swirl velocity of about 31 km $day^{-1}$ at about 100 m depth, in that depth $\alpha = 13$ (see more in Karstensen et al. 2016).

*Figures 2 and 3: the tracks on fig.2b of cruises do not always cover the red dot of cruise CTDs in Fig. 3 (for example near 15°N or 13°N).*

- Thank you very much. We corrected the figure. Unfortunately the cruise tracks in figure 2b were not complete. We create a new figure including all cruise tracks, the red dots of figure 3 should now be covered by the cruise tracks in the new figure 2b.

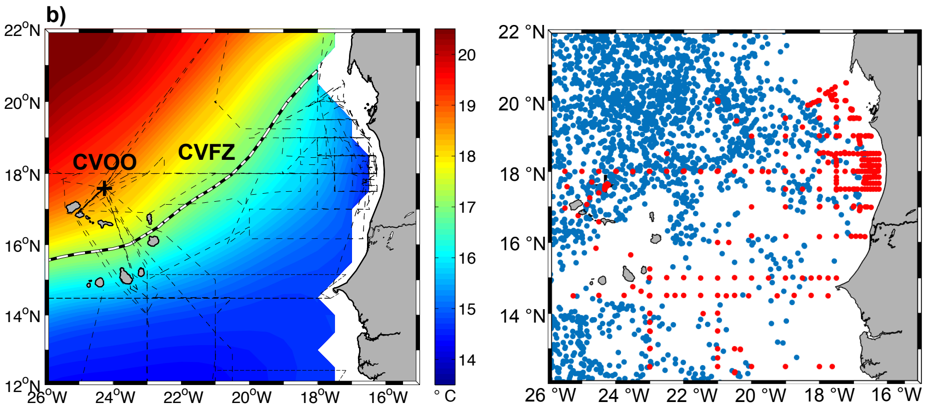



**Figure 2:** Mean potential temperature (b) at 100 m depth in the TANWA from the MIMOC Climatology (Schmidtko et al., 2013). The thick black/white line indicates the CVFZ. The thin dashed lines mark cruise tracks of 20 research cruises to the TANWA. The right panel shows a map with the locations of available profiles taken in the TANWA between 1995 and 2013. Red dots mark shipboard CTD stations and blue dots locations of Argo float profiles.

*Figure 9, I am wondering how one can separate ACME from other anticyclones for their generation in the source region? (to be more specific: at what point in eddy life is SST used to characterize whether anticyclone is an ACME or not).*

- This is an interesting point. We calculated the difference of the SST anomaly in the eddy core for ACMEs as function of longitude (Figure 3). As questioned by the reviewer, there is indeed a large variability in the SST anomaly with smaller values near the coast, an abrupt increase toward offshore at about 18°W and a continuous weakening further offshore during westward eddy propagation.

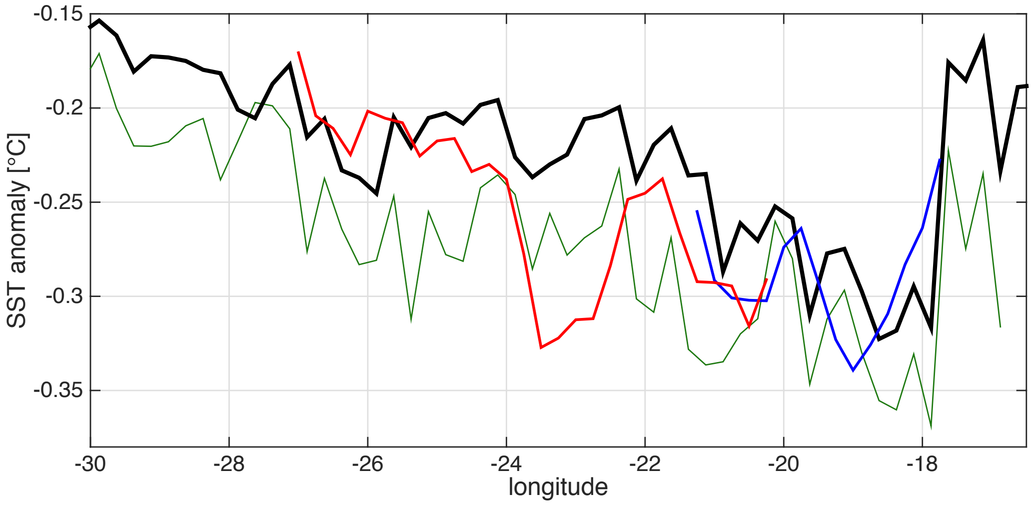



**Figure 3:** SST anomaly of the eddy core as function of longitude. Black – mean SST anomaly of all detected ACMEs from satellite data; Green, red, blue – SST anomaly of 3 different ACMEs where glider or shipboard observations during the lifetime of the eddies were conducted and clearly identified the eddy as ACME.

We do not include a threshold in eddy life to detect ACMEs and searched for anticyclones with reduced SST also in the source region. The eddy detection methods could not detect an eddy near to the coast, as it requires at least structures larger than 80 km on diameter and with a lifetime of more than a week. Hence, detection signals from the near-coastal ACME/anticyclone generation region and eddies just generated near to the coast are not included in the statistics. Therefore we think that ACMEs could not be misleading as anticyclones (or vice versa) near to the coast. Nevertheless, the development of the SST anomalies including the sudden increase (likely when the eddy leaving the upwelling area) followed by a continuous decrease (likely associated with the continuous weakening of the eddy structure) of the absolute anomaly is very interesting but beyond the scope of this work.

*Figure 12: for ACME, left sections and right average profiles are compatible for ACME, but show same anomaly sign for T and S through the vertical profile. It is worth mentioning that there S dominates over T for horizontal density gradients below the eddy core (somehow, I did not see that mentioned in the text; lines 22-23 of 3.4.2 state the opposite, but probably only refer to cyclones and anicyclones). (fully compatible with figure 15)*

- We added one sentence in the manuscript at page 3063 line 15. Now, we are also mentioned that S dominates over T for horizontal density gradients below the eddy core for ACMEs:

“Note, that beneath the eddy core (>150 m depth) horizontal density anomalies are dominated by salinity with temperature playing a minor role.”

**Anonymous Referee #2**

*This study provides a thorough analysis of the eddy characteristics in the Tropical North Atlantic Ocean, merging various satellite and in-situ datasets. The paper provides a very interesting description of the eddy properties, with a special focus on their vertical structures and associated crossshore transports from the near-coastal upwelling region to the offshore ocean. I really appreciated i) the proposed discrimination between "regular" anticyclones and anticyclonic mode water eddies, ii) the use of satellite sea- surface salinity data which are barely used in studies dealing with mesoscale activity. I really liked reading this paper which is well-written and conveniently organized. The conclusions are supported by the use of appropriate methods and data. I have only some minor comments/suggestions that could probably help to improve the quality and clarity of the paper:*

Thank you very much for this evaluation.

**Abstract:**

*As the number of eddies per year is highly dependent of the minimum lifetime used in the tracking algorithm, I strongly recommend to mention this duration.*

- We agree and added the information of the minimum lifetime (7 days) used in the tracking algorithm to the abstract (page 3044, line 13-15):

"About 146 ± 4 eddies per year with a minimum lifetime of 7 days are identified (52% cyclones, 39% anticylones, 9% ACMEs) with rather similar mean radii of about 56 ± 12 km."

**Introduction:**

*The introduction is concise and well written. p.3045, L18-21. It is mentioned that previous studies found a low eddy activity in the TANWA region (p.3045, L18-21). However, among the 4 major upwelling system, the TANWA region has been shown to be one of the most active in terms of eddy generation, both at the coast and around the Cap-Vert islands [see for instance Figure 1 in Chaigneau et al., 2009].*

- As correctly stated by the reviewer high mesoscale activity in terms of eddy generation is shown by Chaigneau et al 2009 for the TANWA region with similar hot spots for eddy generation around Cap-Vert and the Cape Verde Islands as we could identify in our manuscript.

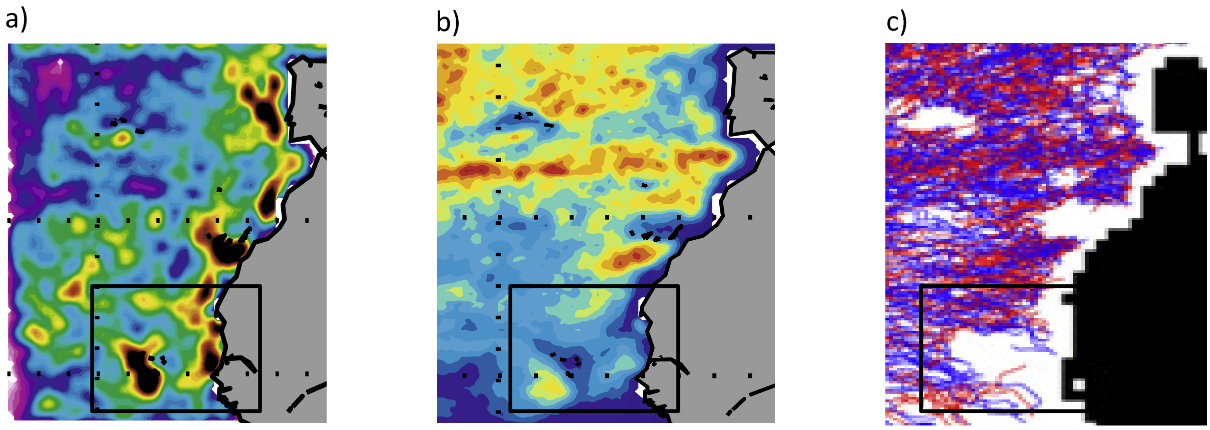



**Figure 4:** Extraction of eastern Atlantic from a) Chaigneau et al. 2009 Figure 1 showing the first detection of eddies, b) Chaigneau et al. 2009 Figure 2 showing the frequency of long-lived eddies (>35 days) and c) Chelton et al. 2011 Figure 4 showing trajectories of long-lived eddies (>16 weeks).

In the introduction we wanted to point to a difference between former studies and our studies regarding the occurrence of long-lived eddies. In the former studies (Figure 4 b,c) the number of long-lived eddies was found to be small or not existing in parts of the TANWA, while in our study long-lived eddies with coastal waters trapped in their cores could be observed as far as 800 km offshore at the CVOO mooring. However, we agree with the reviewer that the sentence was rather strict and not fully correct and rephrased the section in the introduction (page 3045 , line 18-23) from

„However, global as well as regional satellite based studies of eddy distribution and characterisation (Chelton et al. (2007), Chaigneau et al. (2009), Chelton et al. (2011)) found eddy activity in the TANWA low and with the absence of long-lived eddies (>112 days referred to Chelton et al. (2007), >35 days, referred to Chaigneau et al. (2009)).“

to

„However, global as well as regional satellite based studies of eddy distribution and characterisation (Chelton et al. (2007), Chaigneau et al. (2009), Chelton et al. (2011)) found high eddy activity in terms of eddy generation in the TANWA, but only rare occurrence of long-lived eddies (>112 days referred to Chelton et al. (2007), >35 days, referred to Chaigneau et al. (2009)).“

*p. 3047, L11. Please, mention the latitude of Cap Blanc.*

- We added the latitude of 21°N of Cap Blanc at page 3047 and line 11 of the manuscript:

“During boreal summer the MC re-establishes contemporaneously to the suppression of coastal upwelling south of Cap Blanc at 21°N (Peña-Izquierdo et al., 2012).

*p.3047, L19-20, It is mentioned that one of the topics investigated in the manuscript is the efficiency of mesoscale eddies in dissolving existing gradients. I found this sentence rather unclear and I don’t think the authors explicitly study the role of mesoscale eddies on the gradients’ distribution. Please explain, rephrase or remove.*

- We rephrase the sentence (page 3047 line 19-20) from:

„The efficiency of mesoscale eddies within the TANWA in dissolving existing gradients and transporting cold, less saline and nutrient-rich SACW from their generation regions near the coast into the open ocean is one topic investigated in this paper.“

to

“The efficiency of mesoscale eddies to transport cold and less saline SACW from their generation regions near the coast into the open ocean where NACW dominates is one topic investigated in this paper.”

*Figure 1. I recommend including in the Figure Caption, the nomenclature of the depicted currents.*

- We added the nomenclature of the depicted currents in the Figure Caption of Figure 1 (page 3082):

“Schematic of the current system of the eastern tropical North Atlantic (red arrows; North Equatorial Current (NEC), Canary Current (CC), Poleward Under Current (PUC), Mauretania Current (MC), north Equatorial Counter Current (nNECC), Guinea Current (GC), North Equatorial Under Current (NEUC)) a) in boreal spring and b) in boreal autumn. Black Arrows are mean wind vectors, green areas indicate seasonal mean SST<21°C. Blue color represents topography and the dashed box indicates the TANWA area. The mean position of the

Intertropical Convergence Zone (ITCZ) in autumn is indicated by the two black dashed lines in b).”

**Data and methods:**

*2.1.1. Please, mention which SLA product was used ("two-sat- merged"or "all-sat-merged")*

- We added the information that the SLA product “all-sat-merged” is used in the study (page 3048, line 8-10):

“The delayed-time reference dataset “all-sat-merged” of SLA (Version 2014), which is used in the study, is produced by Ssalto/Duacs and distributed by AVISO (Archiving, Validation, and Interpretation of Satellite Oceanographic), with support from CNES [http://www.aviso.altimetry.fr/duac/].“

*2.1.2. The authors used the geometrical approach (GEO) developped by Nencioli et al. (2010). However in this method, the eddy edge is not ientified by the longest closed streamline around the eddy center (such as in Chaigneau et al., 2009) but by the closed streamline associated with the strongest swirl velocity. This difference between the longest closed streamline and the Nencioli’s criterion can induce strong differences in the eddy radius distribution (e.g. see Figure 4). Furthermore the Nencioli’s method needs to specify 4 constraints for the identification of eddy centers and edges. Thus, I would recommend the authors describe in details this eddy identification method and how they adapt the constraints for the TANWA region.*

- That is correct. Unfortunately the GEO-method was only poorly described before. We rephrase paragraph 2.1.2 to improve the description of the eddy detection algorithms (page 3049-3050).

„In order to detect eddy-like structures two different methods are applied to the SLA data. The first method, the Okubo-Weiß-Method (OW-method; Okubo (1970), Weiss (1991)), has been frequently used to detect eddies using satellite data as well as the output from numerical studies (e.g. Isern-Fontanet et al. (2006), Chelton et al. (2007), Sangrà et al. (2009)). The basic assumption behind the OW-method is that regions, where the relative vorticity dominates over the strain, i.e. where rotation dominates over deformation, characterize an eddy. In order to separate strong eddies from the weak background flow field a threshold needs to be identified. For this study the threshold is set to $W_0 = -0.2 \cdot \sigma$, where σ is the spatial standard derivation of the Okubo-Weiß parameter $W = {s_n}^2 + {s_s}^2 - \omega^2$. Here, $s_n = \frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}$ is the normal strain, $s_s = \frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}$ is the shear strain and $\omega = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$ is the relative vorticity. A similar definition of the threshold was used in other eddy studies applying the OW-method (e.g. Chelton et al. (2007)). The maximum (minimum) SLA marks the eddy center.

The second method for eddy detection is based on a geometric approach (GEO-method) analyzing the streamlines of the SLA derived geostrophic flow. An eddy edge is defined as the outmost streamline with the strongest swirl velocity around a center of minimum geostrophic velocity (Nencioli et al., 2010). For the detection of an eddy the algorithm requires two parameters *a* and *b* to be defined. The first parameter, $a$, is a search radius in grid points. Inside the search radius, the velocity reversal across the eddy center is identified (*v* component on an east-west section, *u* component on a north-south section). The second parameter, $b$, is used to identify the point of minimum velocity within a region that extends up to *b* grid points (for a more detailed description of the method see Nencioli et al. (2010)). After a few sensitivity tests in comparison with the results of the OW-method and following the instructions of Nencioli et al. (2010), we set *a*=3 and *b*=2. Optimal results were obtained when we linearly interpolated the AVISO velocity fields onto a 1/6 by 1/6 degree grid before we applied the algorithm (for more information see also Liu et al. 2011). If an eddy is detected an eddy center is identified analog to the OW-method as maximum (anticyclone) or minimum (cyclone) of SLA within the identified eddy structure."

*p. 3050, L.4-11. The eddy tracking algorithm is also unclear. Please rephrase. In particular it is unclear if the authors used a threhold of 7 days (e.g. L.5) or 14 day (L.9) to identify an eddy. How the authors dicreminate between distinct eddies that could have the same polarity in the search radius ? The exact definition of the search radius (10 or 60 km ?) is also unclear. If eddy centers are defined by local extrema in SLA (p. 3050, L-1) how can the authors find another eddy center within 10 km with a grid resolution of 25 km ? Did the authors used eddy centroids instead of local extrema in SLA ?*

- The unclear explanation of the tracking algorithm is also noted by referee 1. We rephrased this paragraph and added additional information in order to improve the structure, which hopefully help to better understand the applied algorithms (at page 3050 line 3 to 11):

"When applying the two different eddy detection methods to the SLA data from the TANWA region, we used the same eddy detection thresholds for both methods, i.e. a feature only counts as an eddy, if its radius is larger than 45 km and it is detectable for a period of more than 7 days. Note, as the identified eddy areas are rarely circular we used the circle-equivalent of the area of the detected features to estimate the radius. For eddy tracking both eddy detection methods use the same tracking algorithm. An eddy trajectory was calculated if an eddy with the same polarity was found at least in 7 consecutive SLA maps (corresponding to one weeks) within a search radius of up to 50 km. Due to e.g. errors in SLA mappings (insufficient altimetric coverage) an eddy could vanish and reemerge after a while. Therefore we searched in 14 consecutive SLA maps (corresponding to 2 weeks) in a search radius of up to 100 km after an eddy disappearance, if eddies with the same polarity reemerges. If more than one eddy with the same polarity emerge within the search radius, we defined the following similarity parameter to discriminate between the eddies:

$$X = \sqrt{\left(\frac{distance}{100}\right)^2 + \left(\frac{\Delta\, radius}{radius_0}\right)^2 + \left(\frac{\Delta\, vorticity}{vorticity_0}\right)^2 + \left(\frac{\Delta\, EKE}{EKE_0}\right)^2}\ , \qquad (1)$$

which include four terms including the distance and the difference of the two radii, mean vorticities and mean EKE of the eddies. $Radius_0$, $vorticity_0$ and $EKE_0$ are the mean radius, vorticity and EKE of all identified eddies in TANWA. The eddy with the smallest X is selected to be the same eddy.”

*Finally I did not understand when the OW or GEO method is preferred in the results Section. . . please, clarify.*

- That is correct. It was not stated in the results section, which algorithm is preferred. Please note, that the whole analysis was repeated with both algorithms for comparison and all results were obtained for both algorithms separately. This is now also pointed out in the manuscript on page 3050 line 10:

„To give an idea of the uncertainty related to the detection technique both methods are applied to the data. Every step is computed separately with both methods and the results are compared.“

However, as mentioned in the manuscript both algorithms show very similar structures and results for every stated point in the manuscript (only exception is maybe the first detection of eddies near the coast, where the local maximum in the number of newly detected eddies is shifted slightly offshore for the GEO-method compared to the OW-method, the structure is still the same though). So we decided not to show nearly identical figures and only show the results of the OW-method for the main results. In the following we present in detail for which part of the results the OW or the GEO method or a mean of both is used and where we inserted additional sentences in the manuscript to clarify that issue:

3.1 Eddy statistics from SLA data:
Both algorithms are used and listed separately in table 1 of our submitted manuscript.

3.2 Formation areas and pathways and 3.3 Seasonal variability of eddy generation
The results of the OW-method are shown in Figure 7, 8, 9 and Figure 10. We included the information in the mentioned figure captions:

"**Figure 7**: Total numbers of eddies generated within 1° x 1° boxes (colors) based on the results of the OW-method. Marked are the headlands Cap Timris (Mauretania), Saint-Louis (Senegal), Cap Vert (Senegal) and the Islands Santo Antão (Cape Verde) and Fogo (Cape Verde), which can be associated with the most productive eddy generating regions. The thick solid black line along 18°W/19°W separates the coastal region from the offshore region."

"**Figure 8**: Number of eddies generated in 1° x 1° boxes (a, c, e) and total number of eddies detected in 1/6° x 1/6° boxes based on the results of the OW-method (b, d, f) for cyclones (a, b), anticyclones (c, d) and ACMEs (e, f). In b), d) and f) eddies are only counted with a lifetime larger than 35 days. In b), d), and f) main eddy propagation corridors are indicated by solid black lines and thick black arrows, main generation spots by circles with crosses. The thick solid black line along 18°W/19°W in a), c) and e) separates the coastal region from the offshore region."

"**Figure 9**: Seasonal cycle of the number of newly detected eddies per year based on the results of the OW-method in the coastal region as shown in Figures 7 and 8. In a) all eddies are marked by the black line, cyclones by the blue line and all anticyclonic eddies by the orange line. In b) anticyclonic eddies are separated into anticyclones (red line) and ACMEs (green line). The shaded areas around the lines represent the standard error."

"**Figure 10**: Phase of the annual harmonic of the number of detected eddies in 2° x 2° boxes based on the results of the OW-method for a) cyclones and b) anticyclones. Phases are only shown for boxes with an amplitude larger than 5 eddies. Phase is given in month of the year with maximum eddy number."

3.4.1 Surface anomalies related to eddies

The eddy centers obtained from the OW-method are used to build the composites of Figure 11. We added the information in the figure caption:

„**Figure 11**: Composites of SLA, SST and SSS of a cyclone, anticyclone and ACME in TANWA. Composite SLA for each eddy type and the associated geostrophic velocity (white arrows) are shown in a), b) and c); SST in d), e) and f); and SSS in g), h) and i), respectively. The solid circles mark the mean eddy radius. „

3.4.2 Vertical structure of eddies and all following sections regarding the vertical structure

We co-locate, in space and time, vertical profiles with eddy surfaces identified in the SLA data. Both algorithms are required to identify an eddy, so we are using a combination of the OW and the GEO-method for that purpose. However, this procedure is already described on page 3053 line 4-7 of the manuscript in the Data & Methods section.

*Section 2.1.3. 20% of the eddies were classified as ACMEs. How the SST and SSS anomalies were computed? An average within their cores or the value at the eddy center? An average along their trajectory? Please, explain.*

- First, fields of SST and SSS anomalies are computed by excluding large-scale variations from the datasets. The large-scale variations are computed by low-pass filtering (with cutoff wavelength of 15° longitude and 5° latitude) the original SST and SSS datasets. The filtered datasets are subtracted from the original datasets preserving the mesoscale variability (SST and SSS anomalies). Second, a box with an extent of 300 km x 300 km around the eddy center is selected. In order to know whether an eddy is cold or fresh in its core, the average value over the edge of the box is subtracted from the average over the eddy center and its closest neighboring grid points. We added one sentence to page 3051 and line 1 to give that information:

"The information whether an eddy is cold/warm or fresh/saline in the core is obtained by subtracting the average value over the edge of the box from the average value over the eddy center and its closest neighboring grid points."

*The authors decided to use cartesian coordinates to depict the composite maps of eddy properties. However they mix eddies having a wide range of eddy radii. It would probably have been more appropriate to use would a normalized distance.*

- That is correct. However, we decided to use unscaled coordinates, because in our relatively small investigation area the majority of eddies is of similar size. In addition, we only use eddies with a radius between 45 to 70 km to build the composite maps (80 % of all detected eddies). We add one sentence at page 3051 line 1-3 to the manuscript to give that information:

"The composite plots are based only on eddies with a radius between 45-70 km and an absolute SLA difference between the eddy centre and the mean along the edge of the 300 km x 300 km box used for the composites greater than 2 cm."

*A criterion on the eddy amplitude (2 cm) is also applied to construct these maps. How the composite analysis presented in Section 3 varies with the eddy amplitude?*

- In order to build distinct composites of SLA, SST and SSS, we only used eddies with an amplitude greater than 2 cm in SLA. Such eddies typically exist since a while. The criterion is particularly important for the composites of SSS. If all eddies were used, the SSS anomaly of the composit was much weaker and lost its (more or less) circular eddy shape. The SLA and SST composites are much less affected by the chosen amplitude. We add one sentence at page 3061 line 27 to the manuscript to give that information:

"Note, that the SSS composites showed only coherent eddy structures when selecting energetic eddies (i.e., with a radius between 45-70 km and an absolute SLA anomaly >2 cm). The SLA and SST composites are much less affected by the restriction with regard to the eddy amplitude."

*Section 2.2. Why the authors decided to retain only Argo float profiles having data down to 1000 m if they only study the upper part (0-350m). I guess considering profiles having data only in the firsts 500 m would have considerably increased the number of available data.*

- That is correct. As we only study the first 500 m, we could indeed soften the restriction of continuous data of Argo floats from 1000 m to 500 m. However, changing the restriction only provides 8 more profiles. We decided that the additional 8 profiles (outside of an eddy) do not help to improve the statistics significantly.

*A Table indicating, for each dataset (Argo, mooring, ship data, etc.), the number of profiles within Ces, Aes, ACMEs or outside eddies would have been appreciated. Do Argo floats in the TANWA have a preference to be trapped within a particular eddy-type or within larger and long-lived eddies as mentioned by Pegliasco et al. [2015]?*

- The randomly distributed profiles of the Argo floats surfaced preferentially in large (= high amplitude of SLA), long-live eddies. This is not observed for the shipboard and mooring data. In addition the Argo floats surfaced more often in anticyclones, which could also be seen for shipboard CTD data. Interestingly, the mooring in contrast records more cyclones passage the mooring position (11 events) than anticyclones (7 events). However, we decided not to include this table in the present manuscript as it does not represent, in our opinion, substantial additional information.

**Table 2:** Separation into all different types of data (Argo float, shipboard CTD and CVOO mooring) and the associated profiles in Cyclones, Anticyclones and ACMEs**.**

| | Cyclones | Anticyclones | ACMEs | ∑ of all profiles |
|---|---|---|---|---|
| Argos floats | 215 | 300 | 16 | 582 |
| Shipboard CTD | 79 | 112 | 23 | 163 |
| CVOO mooring | 11 eddy events (205 profiles) | 7 eddy events (168 profiles) | 4 eddy events (56 profiles) | 429 |
| ∑ of all profiles | 499 | 580 | 95 | 1174 |

*Figure 3. The mooring location is unclear.*

- We added the location of the CVOO mooring in figure 3.

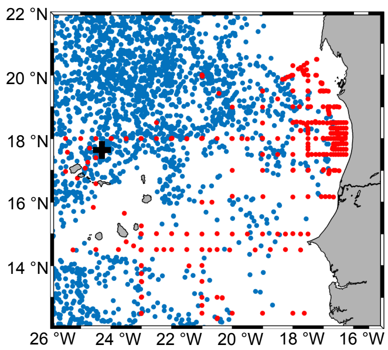


**Figure 5:** Locations of available profiles obtained in the TANWA between 1995 and 2013. Red dots mark shipboard CTD stations, blue dots locations of Argo float profiles and the black cross the location of the CVOO mooring.

*Section 2.3. p. 3053, L.10-15. Do Pegliasco et al. [2015], who also used Argo floats near the TANWA region but a distinct eddy detection algorithm, also found a similar proportion of floats within eddies ?*

- Pegliasco et al. [2015] found 62% of all profiles outside of an eddy, 20% within anticyclones and 18% within cyclones. If we do the statistics with our full dataset (Argo floats, shipboard CTD and mooring profiles) we found surprisingly similar numbers of 61% of all profiles outside of an eddy, 22% within anticyclones and 16% within cyclones. However, the mooring profiles should be excluded from the data set as we only extracted eddy events here and a random distribution is not granted. Without the mooring profiles (only using Argo float and shipboard CTD profiles) around ~29% of all profiles were taken per coincidence inside of an eddy (71 % profiles outside of an eddy, 16 % within anticyclones, 13 % within cyclones). We added that information in one sentence on page 3053 line 13-15:

„Excluding the mooring based profiles, from which we only extracted eddy events, around ~29% of all profiles (Argo float and shipboard CTD profiles) were taken coincidentally inside of an eddy. This proportion is in the range of earlier results derived by Chaigneau et al. (2011), who estimate that ~23% of the eastern upwelling regions in the Pacific Ocean are covered by eddies and Pegliasco et al. (2015), who found 38% of all profiles in the eastern upwelling areas covered by eddies."

*p. 3053, L.15-20. Several authors (Castelao, 2014 ; Pegliasco et al., 2015) have constructed their anomalies using profiles outside eddies, within +/- 30 days independently of the considered year. It is unclear if in this manuscript the authors used a similar approach. . . if not, using such an approach would probably strongly increased the number of available anomaly profiles. Furthermore the comparison with other climatologies (CARs, WOA, Levitus) presented in the Results Section would be probably more robust. Also, is there any justification to choose criteria of 120km (why not 150 or 200km ?) and +/- 25 days (why not 30 days?) for the reference profile.*

- We do not look for reference profiles independently of the considered year. The reasoning behind the chosen criteria (120 km and 25 days) is that we wanted to have the reference profile reasonably close in time and space to the profile inside the eddy to calculate robust anomalies, especially with regard to the strong fronts and seasonal changes in the TANWA and, at the same time, to obtain enough reference profiles to derive robust anomalies. Applying our restrictions we end up with 998 profiles out of the 1174 profiles in eddies with a reference profile nearby. For 176 profiles we could not find a reference profile. A further relaxation of the chosen restriction probably does not improve much the obtained anomalies, while it increase the uncertainties associated with the large spatial and temporal variability in the TANWA.

*p. 3054, L. 3-4. The authors mention that 95 profiles are within ACMES. However from Fig 5, we only see ~20 profiles within ACMEs. Please, explain such a difference.*

- This is because a large number of individual profiles are taken at the same position. Especially at the CVOO mooring 56 profiles were taken during 4 ACME events, but it is only indicated by one single dot, because it is always at the same position.

**Results and Discussion**

*Section 3.1. Is there any physical reason why the standard deviation on the eddy radius is much higher when the GEO-method is used?*

- We examined the radii identified from the GEO-method in more detail and figured out that the GEO-method seem to identify sporadic some very large eddies. For example identified the GEO-method 192 eddies (106 cyclones, 86 anticyclones) with a radius larger than 100 km, whereas the OW-method detected not one single eddy of that size. It seems that the GEO-method tends to identify a certain feature as on single eddy rather than dividing it and on the other hand, the OW-method rather divide one large eddy structure into several smaller eddies if the OW parameters in some parts of the large eddy does not match the threshold. We included an additional sentence in the text at page 3057 line 1:

"The difference in the standard deviation of the eddy radius derived from GEO and the OW-method is partly due to the identification of few very large eddies using the GEO-method, which is not the case for the OW-method."

*p.3057, L.10 : Is the maximum lifetime constrained by the longitudinal extent of the study area? (e.g. Do anticyclones disappear/dissipate after 280 days or they are no more detected due to the presence of the western boundary at 28W ?)*

- Yes, the eddy trajectories are cut off at the western boundary at 28°W (also at the northern and southern boundaries) and hence the length of the trajectories and therefore also the lifetime of eddies is restricted to the size of the domain. We applied the eddy algorithms to an area extending the TANWA region by 4° (to the west, north and south) to avoid spurious effects of the detection algorithms at the borders. However, we checked the eddy trajectories and around 12% of all detected eddies in TANWA crossed a border of the domain. The majority of the eddies leaving the domain are not old and most of them are generated near the Cap Verde Islands propagating to the west. Nevertheless, some older eddies generated in the upwelling area are also among them (see for example the longest trajectories of the eddies represented in figure 1). Therefore, we agree with the reviewer that the mean eddy lifetime is restricted/biased/underestimated in the paper. In addition to that the eddy tracking algorithms tend to underestimate the eddy lifetime in general (errors in the eddy tracking/wrong identification) and hence the significance of the mean eddy lifetime is questionable anyway. Interestingly, the mean eddy lifetime is consistent for both methods with anticyclones living longer than cyclones in both methods. We added one sentence to the manuscript on page 3058 line 8 to mention that issue:

"In addition the mean eddy lifetime of eddies in TANWA is underestimated due to restriction of eddy trajectories at the northern, southern and western boundaries."

*p.3057, L.19-20. The dominance of anticyclones is interesting and was also observed in the polarity map of Chaigneau et al. [2009]. Is there any explanation for such a dominance of long-lived anticyclones?*

- As mentioned correctly by the reviewer the dominance of observed long-lived anticyclones is also stated by e.g. Chaigneau et al. (2009) or Chelton et al. (2011). In general, the observational studies show that anticyclones exhibit larger radii, higher SLA amplitudes and live longer than cyclones. Cushman-Roisin and Tang (1989) demonstrated theoretically that anticyclonic eddies are generally more robust and merge more freely than cyclones. Following Cushman-Roisin and Tang (1989), cyclonic eddies are better capable of self-destruction. They even showed that interactions with surrounding eddies and turbulence are not necessary to account for the absence of cyclonic eddies in the statistical equilibrium.

We decided to added additional information about long-lived anticyclones to the manuscript (page 3057, line 20):

„The dominance of long-lived anticyclones is also shown in the observational studies of Chaigneau et al. (2009), Chelton et al. (2011) and theoretically proven by Cushman-Roisin and Tang (1989). The latter authors showed that in an eddying environment anticyclonic eddies are generally more robust and merge more freely than cyclones producing long-lived eddies, while cyclones show a higher tendency to self-destruction.“

*Section 3.2. A visualization of the eddy trajectories in Figure 8 would be better than a rather simple schematics of the eddy propagation patterns. Or both of them (schematics and "true" trajectories) should be presented.*

- Referee #1 also noted the rather schematic presentation of the eddy propagation in figure 8. We decided to follow the suggestion of the reviewer and add trajectories of long-lived eddies exemplarily showing the eddy propagation direction and pathways (see figure 1).

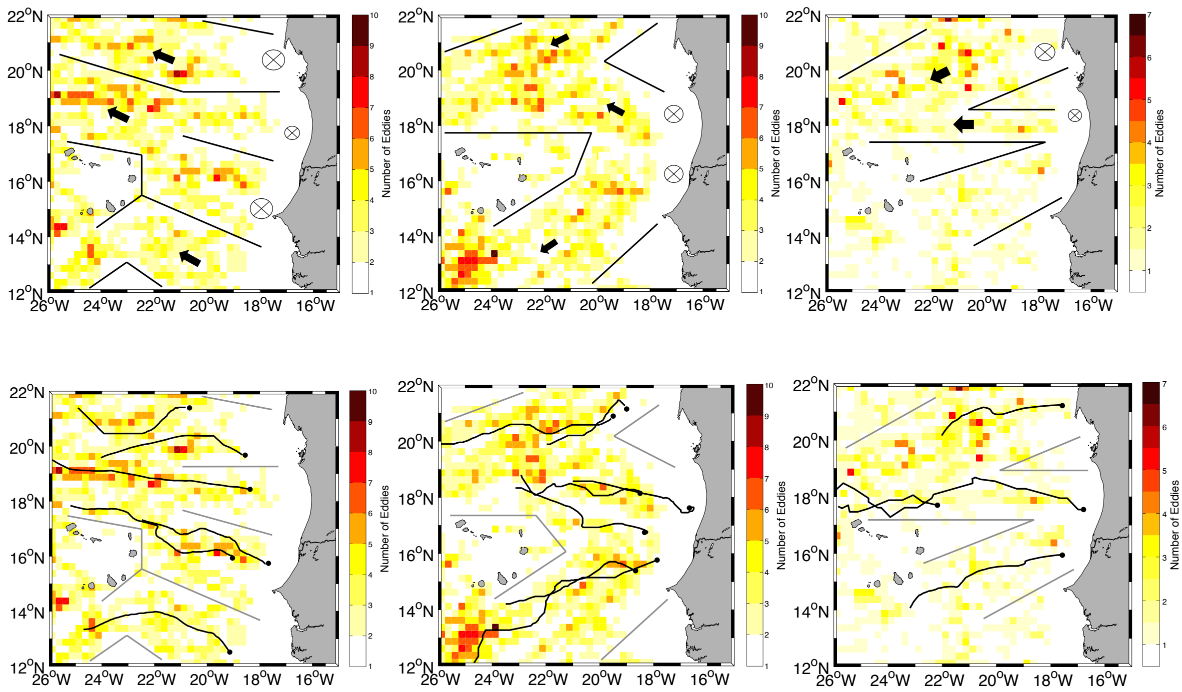



**Figure 6:** Upper row old pictures: Total number of eddies detected in 1/6° x 1/6° boxes for cyclones, anticyclones and ACMEs. Only eddies are counted with a lifetime larger than 35 days. Main eddy propagation corridors are indicated by solid black lines and thick black arrows, main generation spots by circles with crosses. Lower row new pictures: Total number of eddies detected in 1/6° x 1/6° boxes for cyclones, anticyclones and ACMEs. Only eddies

are counted with a lifetime larger than 35 days. Main eddy propagation corridors are indicated by solid grey lines and selected trajectories of long-lived eddies. The dots mark the starting point of the eddy trajectories.

*Section 3.4.2. It is unclear why a deepening of the isopycnal below ~120-150m in the ACMEs does not produce a positive temperature anomaly since it should inject warmer water in deeper levels. Please, explain.*

- This could only be explained due to the strong SACW anomaly (cold and fresh) within the eddy core. The water injected into a deeper level due to the deepening of the isopycnals is not significantly warmer than the surrounding water at that depth. We add one sentence in the manuscript to explain that issue (page 3063, line 11):

"Note, that the cold and fresh SACW in the ACME core does not produce a positive temperature anomaly when it reaches deeper levels due to the downward bending of isopycnal surfaces below the eddy core."

*Also, the mean distribution of isotherms and isohaline levels in Figure 12 a-b would have been probably more relevant than isopycnals. A description and quantification of the vertical displacement of the isopycnal layers with depth would have been appreciated.*

- We followed the suggestions of the reviewer and added isotherms and isohaline levels in Figure 12 a-b and briefly describe the vertical displacement of the isopycnal layers of cyclones and anticyclones in the manuscript on page 3062 line 25:

"This is illustrated by the elevation (deepening) of 25 m (36 m) of the density surface of 26.2 kg $m^{-3}$ in the core of the cyclone (anticyclone) compared to the surroundings."

For ACMEs at page 3063 line 1:

"The mode-water in the core of the ACME exhibits only small density gradients. This is illustrated by the elevation of 48 m of the density surface of 26.2 kg $m^{-3}$ slightly above the core and the deepening of 52 m of the density surface of 26.7 kg $m^{-3}$ beneath the core compared to the surroundings."

1

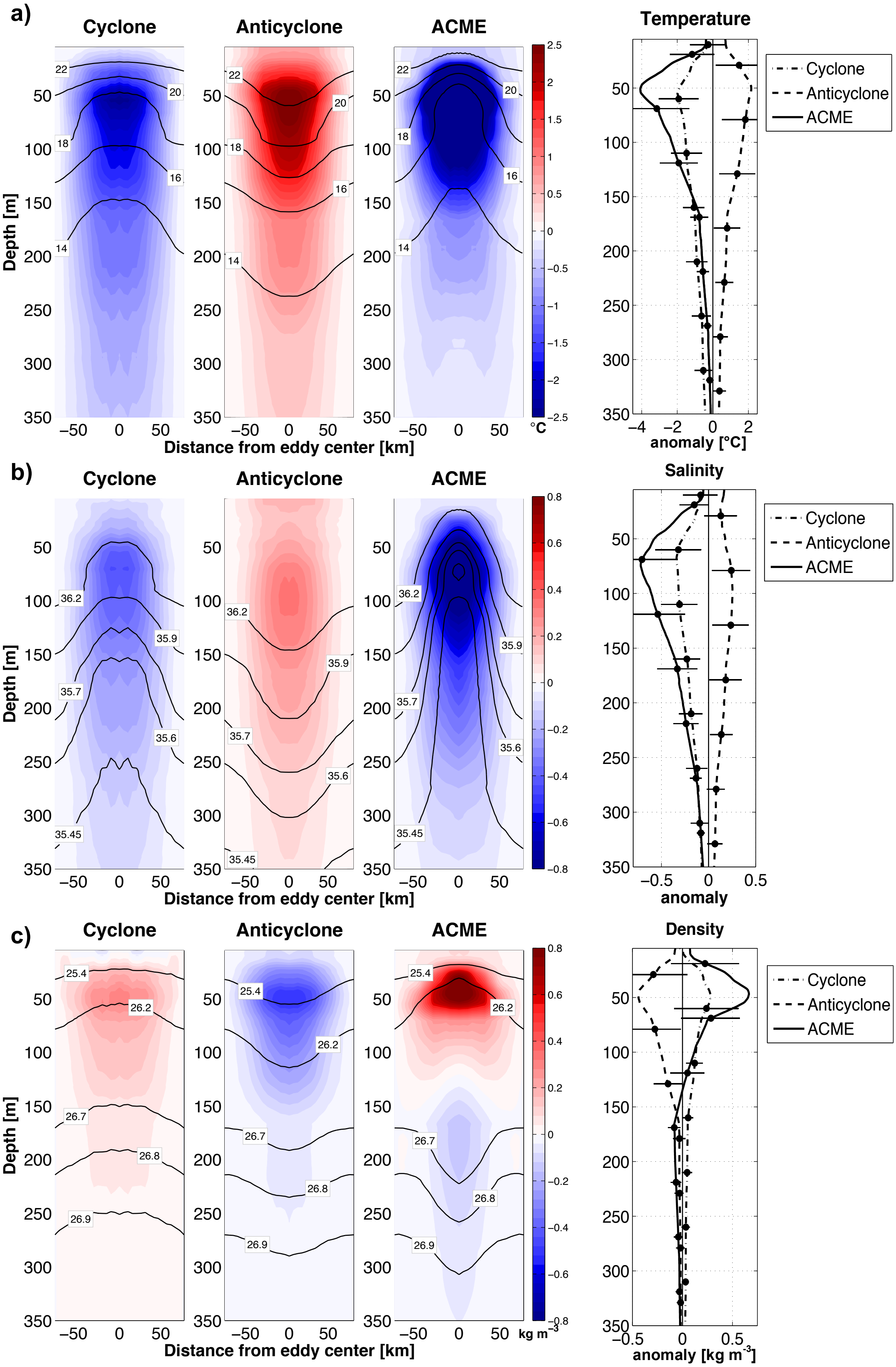

a)
Cyclone
Anticyclone
ACME
Temperature
Depth [m]
Distance from eddy center [km]
°C
anomaly [°C]
Cyclone
Anticyclone
ACME
b)
Salinity
anomaly
c)
Density
kg m$^{-3}$
anomaly [kg m$^{-3}$]

**Figure 7:** Vertical structure of the composite cyclone, anticyclone and ACME in TANWA as presented as sections across the eddies (left three columns) and mean profiles (right column). In **(a)** potential temperature, in **(b)** salinity and in **(c)** potential density anomaly relative to the nearest profile outside of the eddy is shown. Black contour lines in the left three columns mark mean isotherms, isohalines and isopycnal surfaces. In the right column, solid lines represent the composite ACME, dashed lines the anticyclone and dashed-dot lines the cyclone; the error bars at the black dots represent the standard deviation calculated from the individual anomaly profiles

*Section 3.5.1. Figure 14b. It is unclear how ESHF were computed. Please, provide more details since I could not reproduce the obtained HF values.*

- The equivalent surface heat flux (ESHF) is computed by using the heat transport of the eddies (table 4 of the submitted manuscript) times the amount of eddies dissolving during a year in Area II (see Figure 14a of the submitted manuscript) divided by the surface area of Area II resulting in a mean heat release in W $m^{-2}$. At the end the ESHF is compared to the net atmospheric heat flux in Area II derived from the NOC Surface Flux Dataset (Berry and Kent, 2011). We add that information in the manuscript at page 3055 line 24-25:

"By multiplying the heat transport of the composite eddies with the amount of eddies dissolving during a year in a given area (corresponding to an flux divergence) a mean heat release (in W $m^{-2}$) and a mean salt release (in kg $m^{-2}$) was calculated. The mean heat release can be compared to the net atmospheric heat flux in the area here derived from the NOC Surface Flux Dataset (Berry and Kent, 2011)."

*Section 3.5.2. It is considered in this Section there are only 2 Water Masses between the surface and 350m depth (SACW and NACW). However this region can also be influenced by tropical surface water (at least in the southern part of the TANWA) in the surface layer (0-50m) [e.g. Stramma et al., 2005]. Should the TSW be considered in the WM analysis?*

- Tropical surface water (TSW) might only affect the very shallow part of the eddy, the main body of the eddy is well-separated from the upper ocean with only weak vertical mixing.

*It is mentioned (p.3067, L.29) that anticyclones have the same SACW signature as the background. In this case, which Water Mass anticyclones transport and which water mass explain the strong positive T/S anomalies inside their cores?*

- If we calculated the water mass anomalies on density surfaces anticyclones transport nearly no water mass anomaly in their cores. The T/S anomalies in the core (figure 12 – calculated on depth layers) are only generated by the vertical displacement of isopycnals.

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