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Discussions

Interactive comment on "The Impact of Upwelling on the Intensification of Anticyclonic Ocean Eddies in the Caribbean Sea" *by* Carine G. van der Boog et al.

Anonymous Referee #2

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In this manuscript the authors use a numerical simulation to study the effect of upwelling filament advected by anticyclonic eddies in the eastern Caribbean basin. They showed that upwelling filaments, mostly from the upwelling centers are entrained on the western side of the eddies and contribute to their westward intensification. The intensification gets stronger when the upwelling is stronger and vice and versa but it can be influenced by the low salinity of the Amazon and Orinoco plume, which is also influenced by the wind. I think that this study in a good contribution to the understanding of the dynamics of the circulation in the Caribbean Sea and the authors have made an excellent job at describing the mechanics of the intensification process within the case studies that they analyzed. But it would have been good to show in a simulation

with realistic forcing that reproduce the seasonal cycle, that ACs intensifies as they propagate westward.

Most of my comments are technical and there are a few sentences that I wasn't able to understand that need to be properly edited. And it starts with the abstract.

Abstract edits - Should read "These dense filaments are advected by the 5 anticyclones, leading to an increase of the horizontal density gradients on the western side of the anticyclones". - Should read "Following the thermal wind balance, the increased density gradients result in an increase of the vertical shear of the anticyclones and of their westward intensification." - "As expected, stronger (weaker) upwelling is associated with more stronger (weaker) offshore cooling and a more (less) westward". Remove "more". - Last sentence is difficult to understand. Should be rephrased. Especially without the context of the study. Think of someone who'd just reading the abstract, it would be unable to follow.

Manuscript edits Page 2: " and propagate along the wind-driven upwelling regions along the South-American coast". Remove the "along" repetition.

Page 3, lines 10-20: what topography was used and how the passages between the island were accounted for in the 1/12-degree resolution grid? Was the transport between the island estimated and compared to observations? How did the model perform in the other passages?

Page 3, line 20-25: It is difficult to understand how the forcing were applied. It is said that stationary conditions were applied, but it is not clear exactly which ones. For instance the SST relaxation was not stationary? Was it released to monthly averaged SST? What about heat and freshwater fluxes?

Page 3, last paragraph: Did all simulations used stationary boundary conditions? Not only Ekman 100, right?

Page 3, line 30: I don't understand the sentence: "the upwelling regions corresponds

to of the year-averaged northward Ekman transport (100%),". How is the year averaged calculated? Is it over the 20-year simulation? But which simulation since in your case studies the simulations cannot be realistic because of the stationary boundary conditions?

Page 4, Line 5: "with a constant proportional to the wind stress at the upwelling regions". Not sure the sentence expresses what the authors are trying to say. The authors mean to talk about the wind stress magnitude that was reduced by the same amount between simulations. Please revise.

Page 4, line 14: please indicate the figure that shows the upwelling centers location.

Page 5, first line: "We will use this set of simulations with the different to study aspects of the seasonal and". Please revise.

Page 5: "the swirl velocity as the average of the maximum northward and maximum southward velocity of the eddy". Is the location estimated from the center of the SSH anomaly or the point of maximum SHH? Also, why using the meridional velocity only? Why not the location of the maximum of the radial velocity instead?

Page 6, line 3: the thermal wind balance is not a force or a driver, but rather another way to express the geostrophic balance. So, it is meaningless to say how it affected the westward intensification. It is simply the horizontal density gradient as you express it. It can be related to the vertical shear through the thermal wind balance equations.

Pages 6, line 9: Can you show how sigma_T and sigma_S contribute to sigma? What equation of state was used?

Page 6, line 18: should read "Further west, . . . at 17N.." maybe the longitude can be given here as well because the sentence starts with "Further west . . .".

Page 7, line 11: I think the authors meant Fig. 3c.

Page 7, lines 12-15: over what depth this density gradient can be observed. I would

imagine that it strongly depends on the thickness of the fresh water plume? All the dynamics discussed in this study is limited to the first 50 meters, which is the vertical extension of most eddies. What happens below? Do the surface eddies have a deep signature and are they also intensified at depth?

Page 8, lines 10: "corresponds" could be replaced by "matches".

Figure 5, caption: "Near-surface properties of the Caribbean Sea, averaged over 5 days in Ekman100 in year 20"

Page 9, line 17: Not sure the first sentence is correct here. None of what it says has been proven yet. Page 10, line 6: Do the authors mean "To assess the contribution of the anticyclones with the long tracks to the total EKE variability. . ."?

Page 11 line: which component of the velocity is used? Only v or the magnitude?

Page 11, line 9: "At 64oW and 71oW, the vertical shear of the anticyclones increases zonally more rapidly. " I have a problem with these statement. It is based on visual assessment, which is difficult to prove. Figure 8 could show that, but it only starts at 65W, so one can't see the strong increase. Also, the strong increase at 71W is not visible. Then it becomes harder to see the link with the upwelling centers, although I think the link between the sharp shear increase and the upwelling filament average position is a viable argument. Maybe Figure 8 can be expanded to show that?

Page 11, line 10: "A comparison to the average shear of the total velocity field indicates that these longitudes are located close to two regions with strong background vertical shear (black contour in Fig. 7a)." I don't understand what is done here.

Page 11, lines 15-16: what else than temperature and salinity the density gradient could be due to?

Page 11, line 21: to make such statement, which is not obvious in Figure 8, the slopes along the curve could be shown on Figure 8

Page 11, line 26-27: it means that AC are not fully geostrophic.

Page 11, line 31: cite Figure 7(c&d) after ". . .differences."

Figure 8: the average AC density anomaly could also be shown and the figure should start at 64W.

Page 13, line 9: why is the location of the sudden increase keep changing?

Page 14, line 3: " that increases their western horizontal . . ."

Page 14, line 11: growth and intensification are two different things. So which one is it? Follows the thermal wind balance means that they are in geostrophic equilibrium, for most part based on Figure 8? But they seem to become more ageostrophic as they intensify, probably due to the effect of ageostrophic filaments.

Figure 10: maybe adding more isotherms would help relating the text to the figure.

Page 15, line 5: 50% of what. Maybe the sentence should be rephrased. Page 15, line 7: "Sea-surface salinity decreased in both .."

Page 15, line 8: "this freshening is related to the presence of a subsurface salinity maximum in the Caribbean Sea, causing upwelled waters to be more saline than surface waters." How does that make sense? Please rephrase. What is the name of the water mass that constitutes the salinity maximum?

Page 16, line 14: what is "mesoscale variability"? It doesn't mean anything in the context of this sentence. Are the authors talking about a meridional average, of the maximum along each meridian line?

Page 16, line 17:" the EKE increased by 123%..."

Page 16, line 18:" and Ekman75 resulted in ..."

Page 16, line 32: "even though they are only due to 30-40% of the total number of anticyclones in this region", meaning they constitute only 30-40% of the total number

of ACs?

Page 18, line 7: based on what numbers of figures do you make this statement? The standard deviation in Table 1?

Page 18, line 8: "Similar observations by (Centurioni and Niiler, 2003), we . . ."

Page 18, line 11: Is this something observed in real data? How much cyclones contribute to EKE? And why less cyclones with stronger upwelling?

Page 18, line 17: "These simulations have relatively lower vertical shear at 65oW than ???. "

Page 21, line 19: cite Table 1 at the end of the sentence.

Page 22, line 7: "Furthermore, we showed how the westward intensification of Caribbean anticyclones could be driven by baroclinic instabilities". This was not shown is this study. Please remove statement.

Page 22, line 17: the authors previously stated that both salinity fluxes and wind have to be accounted for to explain the variability. So how reliable is the relationship with the wind only?

Page 22, line 18-19: the authors are saying that the variance is higher, but it was previously shown that there was less eddies. So what causes the higher variance?

Page 22, last line: "processes explain some of the mesoscale variability in the Caribbean Sea"

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