

Review

The manuscript quantifies the skill of two well-known Reanalyses to reproduce the eddy population against two altimetry gap-free datasets in the North Atlantic. The high-resolution GLORYS12 reanalysis at $1/12^\circ$ and mid-resolution GLORYS2V4 reanalysis at $1/4^\circ$ are verified against conventional altimetry maps and SWOT-enriched altimetry maps. The SWOT-enriched dataset is a recent product that merges conventional altimetry with the new SWOT data at higher spatial resolution, starting from mid 2023. The assessment cover roughly two years, and it is performed using a well-known pyEddyTracker algorithm already tested and used in literature and by the Authors themselves. Verification methodologies based on the combination of hit, miss, false-alarm statistics are used to analyze the probability of the two Reanalyses to match eddies in the observation datasets: results obtained using different “ground truths” (either conventional or SWOT-enriched maps) are discussed considering eddies with lifetime longer than 4 days and 7 days. The Authors showed that high-res Reanalysis has a probability to detect eddies that is around the 60% in total, being 30% better than mid-res Reanalysis (both using conventional or SWOT-enriched maps). High-res Reanalysis has a 20% more probability to generate false alarm, however the 90% of false alarms have a radius smaller than 50km, that is the effective resolution of altimetry maps according to literature. Looking at the statistics of small eddies, high-res Reanalysis is more consistent with SWOT-enriched maps than conventional ones. Differences in the eddy population between the two altimetry products are also discussed.

Two main novelties can be found in the manuscript: -) While SWOT-enriched products are already proven to have higher resolving power than conventional altimetry in a statistical way, the manuscript moves the topic into the physical ground by comparing the coherent turbulences resolved by the two products. -) High-resolution Reanalysis is proven to have a richer North Atlantic eddy population that is closer to observational data (not matter the observational product used).

The analysis is well-done, robust and critically discussed, I do not see the need of other analyses to prove the results, but the text is sometimes redundant and requires improvements. I can support the publication after a major revision.

Mayor Points

1) The use of two altimetry products is interesting since it shows that there is not a single truth. However, the North Atlantic has been used as a playground for several SWOT-enriched experimental products. Apart from MIOST, there are experimental maps produced with other software:

<https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products/global/experimental-multimission-gridded-l4-sea-level-heights-and-velocities-with-swot.html>

The Authors should expand the literature review.

2) The analysis is sometimes redundant, the text can be reshaped in a better way :

-) According to the Authors' idea, the use of two similar lifetimes can be seen as a sensitivity analysis. I can agree on this point, but results should be presented accordingly. Rather than discussing values that are similar, priority can be given to one lifetime and introducing the second lifetime only when it shows results significantly different. The rest of the plots can be put in the supplementary material.

-) Similar comment can be done for the analysis of bootstrap resampling that largely confirms the standard analysis and can be partially put in a supplementary.

-) About the reanalysis comparison, the Authors described the hit/misses/false alarm skills and then the POD/FAR metrics moving back and forth multiple times. The two types of metrics can be described together for one reanalysis and then for the second.

-) There are some mismatches between the text described and the corresponding figures and tables that do not facilitate the readability. I can suggest the use of acronyms to not repeat AVISO DUACS 1/8, AVISO DUAC, MIOST SWOT, SWOT MIOST etc. Some sentences tend to assess the quality of altimetry products based on the skill-scores of the Reanalyses. This mutual assessment should be avoided; the quality of observation-only data can be quantified by comparing the two datasets among themselves.

Further comments on the text will be provided in the minor comments.

Minor Points

-) Line 20: “[..] small and weak eddies”

Please add the definition of weak eddy

-) Line 24: “[..] eddies in ocean reanalyses and highlight the value of wide-swath.”

Such behaviour is proven only in energetic regions

-) Line 45: ”The detection method used [...]”

The line should be rephrased, some of the methods listed in the sentence are similar to Chelton et al 2011.

-) Line 59: “For this reason [...]”

The Authors suggest that similar problems affect also the product at 1/8 at lines 100-109. Is there a scientific/technical reference supporting the use of the product at 1/8 rather than 1/4?

-) Line 61: “The AVISO DUACS 1/8 satellite [...] ”

I do not understand the comment. The AVISO at 1/4 is also available since 1993, moreover the manuscript works on a limited period.

-) Line 68: “Second, the primary purpose of SWOT [...]”

I find hard to believe that SWOT was design and put in orbit for the data assimilation. Please add a citation or rephrase the sentence.

-) Line 84: “This comparison also provides [...] pre SWOT”.

The uncertainties, especially at the beginning of the altimetry era, depends on the heavy usage of interpolation methodologies and the error associated to that satellite retrivials.

-) Line 135: “ Finally there are [...]”.

There are different SWOT products over North Atlantic that are not based MIOST (see mayor point).

-) Line 186: “A closed contour [...]”

Equation 1 is also used at detection level, which are the values of the parameters in that case?

-) Fig. 2: “At large scales, the four [...]”

This comment should go in the text rather than in the caption.

-) Fig. 3

The description of dashed lines is missing

-) Fig. 5 “Most eddies have an amplitude of less than 10 cm. However, their mean lifetime is lower than 50 [...]”

This comment should go in the text rather than in the caption.

-) Line 252: “ The minimum radius and amplitude are 25km and 0.4cm”

The threshold of 0.4cm can be used at detection level as a technical parameter (see line 194) but the actual eddy population should not consider eddies with an amplitude that is much smaller than the error on SLA (1 or 2 cm).

-) Fig. 6 : “ [...] (satellite data: source for the comparison) [...]”

The source is missing

Line 304 :”)”

typo

-) Line 305-309, “Many small eddies...”

The Authors described the correlation between amplitude and lifetime for two populations: eddies with amplitude below and above 10 cm. I do not see particular differences in the results, why the description of the population is divided in two?

-) Line 313-316: “Following the tabulation of hits, misses, and false alarms [...]”

The sentence is not clear

-) Table 2: There is no reference in the text to Table 2. Why the number for GLORYS2V4 and GLORYS12V1 differ passing from Table 2 and 3?

-) Line 338: "An exception is observed for GLORYS2V4[...]"

This should be referred to GLORYS12, right?

-) Line 342: "In this case, we demonstrate [...]"

It seems a final statement and should go after the description of Table 4 and 5

-) Line 345-356: "GLORYS12V1 achieves a POD exceeding 50% (higher than 60% for SWOT MIOST comparison) [...]"

The description jumps from eddies longer than 4 days to 7 days, from one reanalysis to another, percentages have sometimes two decimals sometimes zero. Table 3 is described after Table 5.

-) Line 365-375: "This indicates [...]"

The word "This" is used multiple times in the next sentences

-) Line 366-371 "This confirms [...]"

It seems that GLORYS2V4 is used to assess the quality of the two altimetry datasets, but the mutual assessment is something to avoid.

-) Line 369: "[...] and that, therefore, it would be necessary to introduce an effective methodology capable of eliminating these ones."

Too long a sentence please rephrase or remove.

-) Line 373-374: "[...] such a scale lower than mesoscale [...]"

I do not understand why the trajectory prediction is affected, can the Authors clarify the reason?

-) Table 7: "days days"

Typo

-) Line 401-405: A final [...] 7 days.

If I understood well, results from 20-day block show similar values in term of POD/FAR w.r.t. 4-day and 7-day block, but at same time they are different from POD in table 4 (table 3 does not show POD). Since the Authors are discussing the 20-day block for "sake of completeness" than such values should be added. Otherwise rephrase the paragraph.

-) Line 406: "In general, it can be observed that, as the minimum lifetime threshold increases [...]"

The Authors discussed long-lived eddies, but I did not understand whether it refers to 7-day or 20-day. Whether it refers to 20-day that the corresponding values should be added. If it refers to 7-day than I would avoid calling them long-lived eddies.

-) Line 407: “This is shown [...]”

The connection between long-term eddies and small eddies is not clear, the discussion started from Figures 8 and 10 then they move to Figures 9 and 11 and then back to 8 and 10.

-) Fig 9

The plots on AVISO DUACS are placed twice (instead of SWOT ones), please check

-) Line 431: “[...] they accurately represent eddies [...]”

It seems to me it should be the opposite. Moreover, if the minimum threshold in radius is 25 km, what is the purpose to discuss the statistics at 30km?

-) Line 441 “This suggests [...]”

The assessment of the quality of conventional and SWOT altimetry cannot be based on reanalysis skill but only by comparing the two datasets among themselves. I would drop the sentence

-) Line 479 “GLORYS12V1 shows a 15–20% [...]”

The description of eddies with amplitude higher than 20cm does not seem to include more insights.

-) Line 486: “Below what radius do 90% of misses?”

The question is not clear to me, please rephrased.

-) Line 491: “[..]Fig 11 [..]”

The reference should be Figure 12

-) Line 492: “90% of false [...]”

There is only one point listed plus it seems there are too many decimals.

-) Line 499 : “[..]Fig 12[..]”

The reference should be Figure 13

-) Line 515: “This shows that SW [...]”

The sentence seems to quantify the better quality of SWOT-based data based on reanalysis skills. See mayor point

-) Table 9: the caption misses the reference to SWOT

-) Line 573: “[...] AVISO DUACS product (Table 7)”

Why is the Table 7 cited here?

-) Line 605: "It should be noted..."

Products at $\frac{1}{4}$ is not analyzed in the manuscript. What is the purpose of discussing it in the conclusion?

Line 617 " [...] the Merged Interpolation of Observations with Spatial and Temporal constraints (MIOST) [...]"

MIOST acronym is previously used in the conclusion, please put the definition the first time it is used.

Line 628: "For amplitudes above 10 cm [...]"

The values are given with too many decimals. Please discuss the limitation coming from the fact that the period analyzed covers less than two years.