Reviews for "Sea surface height anomaly and geostrophic current velocity from altimetry measurements over the Arctic Ocean (2011-2020)" by Francesca Doglioni et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-111-RC1, 2022

Referee#1

The authors created a new gridded, altimetry-based, monthly sea surface height and geostrophic velocity dataset in the Arctic Ocean over both sea-ice covered and sea-ice free regions. Compared with the existing gridded dataset of sea surface height and geostrophic velocity (Armitage et al., 2016, 2017), this dataset covers more recent period 2011-2020 from 2003-2014, and is processed with the newer tidal model FES2014 and different interpolation method to have better spatial resolution for boundary currents.

The manuscript is well written. The methods involved have been described in detail, and the validation is extensive. The dataset would be useful for many scientific communities studying the changes happening in the Arctic Ocean, especially the extension in time from 2003-2014 to 2011-2020. I recommend the paper accepted subject to minor revisions (review by editor)

Major comments:

Swapping Section 4.3.3 and Section 4.3.2 makes more sense to me. The 1-week decorrelation time scale (L438-439) presented in Section 4.3.3 provides a basis for how to estimate monthly error maps from weekly error maps. Therefore moving Section 4.3.3 before Section 4.3.2 makes more sense.
We agree and swapped the two sections. Thank you for your suggestion.

The manuscript does not mention ocean reanalysis products (e.g., ASTE by Nguyen, et al., 2021, doi:10.1029/2020MS002398) or recent modelling studies (e.g., Bacon et al., 2015, doi:10.1098/rsta.2014.0169). In particular, this new data product can be used for constraining new ocean reanalysis products. Comparing the new data product with some ocean reanalysis products in this manuscript may not be practically possible because of the space limit, but adding a few sentences about ocean reanalysis effort for the Arctic Ocean (e.g., in Introduction) and potential usefulness of the new altimetry data for the ocean reanalysis community (e.g., in Discussion) would be helpful.
This is a very good point that we missed somehow to emphasise, thank you for suggesting reference literature. We included few sentences in this regard in the Introduction and Conclusions (as the Discussion was focused on the results from the dataset assessment).

L302-308: Regarding the dynamic ocean response to air pressure forcing, a recently-published paper by Piecuch et al. (2022, JPO, https://doi.org/10.1175/JPO-D-22-0090.1) should be cited here and probably also in Appendix B. The East Siberian Sea where the improvement is large by using the DAC correction (Fig. B1) is also found by Piecuch et al. (2022).
Thank you for pointing to this relevant literature. We included a citation to this paper both in this section and in appendix B.

L385/L421: Monthly fields were calculated by averaging four weekly data (such as L385, L421). Did the authors do something extra (such as interpolation) to take care of possible misalignment of the average time of four weekly data and the center time of a calendar month?

The weeks were defined based on the days of the month rather than the actual calendar week. Each month was divided in four parts as follows: day#1-day#8, day#9-day#15, day#16-day#23, day#24-LASTday. We believe that this has a negligible influence on our final results.

L421-422: The sentence, especially "quadratic sum of four weekly error maps", needs to be reworded. The monthly error maps are probably square root of some averaging of the weekly error maps. It would also be nice to explicitly say something about the assumption made about how the weekly error maps are correlated. Are they independent, fully correlated, or something in between?

Thank you for pointing that out the wrong wording, we meant to refer to the sum in quadrature, which is the square root of the sum of the squares. We modified this part of the sentence to "[…] the associated interpolation error was computed by adding in quadrature of four weekly error maps".

Before this sentence we also clarified that, as it results from the section about the error on the monthly fields, the weekly SLA fields are statistically independent, which allow us to treat the errors as independent and add them in quadrature. This will be in the worst case an estimate of the maximum error.

Figure 1: Some of the texts in the figure are hard to read. Might better to change color/font to make them easy to read.

We improved the readability of the above figure by changing colors and re-arranging text.

Figure 6: Can the authors explain why there are ring-like patterns that are aligned with latitudinal circles?

If we understand well, the reviewer refers to the pattern in Fig. 6b. This pattern emerges because the gaps left by the satellite orbit geometry in the weekly data distribution are larger in some latitude bands (visible in Fig. 3g, e.g., around 80° N or 67° N). Over the month these large gaps only shift in longitude but not in latitude. This makes so in those latitude bands one gets the largest error.

Minor comments:

L44-45: Replace "methodological developments" with "methodologies" to avoid redundant "develop"(ments) in this sentence.

Done.

L73: Add (Sect. 4) after "section"

Done.

L80: Replace "to understand" with "to understanding"

Done.

L120: Remove "Remko"
Done.

L121: Replace "section" with "Sect."
Done.

L125: Replace "section" with "Sect." to be consistent throughout the manuscript
Done.

L136: GOCO3s should be GOCO03s
Done.

L138: Why not starting from January 2010?
CryoSat-2 observations are available only starting November 2010, with the quality of the first few months being significantly lower that the rest of the mission. Therefore, our gridded product starts from January 2011.

L155: Since L146-147 just talked about how steric height would be calculated, either remove "Steric height was computed following equation 7 (Sect. 4.2.1)" or change it to "Again, steric height was computed following Eq. 7 (Sect. 4.2.1)".
Done.

L161: AWI was defined above. so there is no need to define AWI again here. Just use AWI instead of Alfred Wegener Institute.
Done.

L169: Remove the comma after "the Arctic Data Center"
Done.

L172-173: Missing words in "monthly averages of the of the hydrographic profiles"
Corrected.

L186: Maybe "close", not "closer"?
Changed to "closest".

L196: moorings locations, instead of "moorings positions"
Done.

L213: Add what is rho' (e.g., density anomaly w.r.t. 1000 g/m3)
In the introduction to this section, we specified that all prime variables in Eq. (5) and (6) refer to time anomalies. We removed the rho' in the sentence following Eq. (6) to avoid confusion, as this is already defined above.

L216: Vertical density profiles
Added.

L223: avoided propagating
Changed.

L224-225: Not clear why linear interpolation of TS between discrete measurement levels might introduce "time-mean biases", especially why "time-mean biases"
We agree that in general the bias introduced can be also a time-variable one. We rephrased this paragraph to clarify that we are only concerned with the accuracy in the temporal variability, reason why we tested the interpolation used as described in the text below this sentence (now at lines 225-229).

L259: change (Fig. ??b) to (Fig. 1)
Corrected.

L346: Replace "interpolation of" with "interpolating"
Done.

L347: Replace "section 4.3.1" with "Sect. 4.3.1"
Done.

L347-349: Need to rewrite/reword the sentence "In Sect. 4.3.2 ... to obtain monthly fields", which is hard to read and understand.
We rephrased the sentence, thank you.

L352: Replace "Along track" with "Along-track"
Done.

L391: Replace "sections" with "Sects."
Done.

L392: Replace "Fig" with "Fig."
Done.

L402: Replace "sections" with "Sects."
Done.

L461-462: The two sentences are redundant. Remove one.
Done.

L530: Replace "section 4.2.1" with "Sect. 4.2.1"
Done.

L588: Take "into" account
Corrected.

L589-591: How is the weight defined, if averaging data sets over only two moorings? I believe the subscripts i & j-1 or i & j+1 means moorings i & j-1 or i & j+1. So either d (i,j-1) or d(j, j+1) is missing in the equation for the weight if there are only two moorings.

Thanks for pointing this out, I slightly modified the text to make this point clearer. The "outermost" moorings in the average are weighted only based on the distance to the one nearby mooring (without dividing by 2). In this way, if only two moorings are used, they will have equal weight.

L593: Use ";" instead of "," for "... was highest, compare ..."
Changed.

L598: Replace "4 an 5" with "4 and 5"
Corrected.

L608: Replace "Fig." with "Figs."
Changed.

L662: should "allow to assess" be "allow us to assess"?
Changed.

L683: Change "multi year ice" to "multi-year ice"
Done.

L606: Add a space before the left parenthesis "used(FES2004".
Corrected.

L765: Remove one "the"
Corrected.

L769: Make "non significant" one word "nonsignificant".
Corrected.

L776: Same as L769 to use "nonsignificant"
Corrected.

L777: Replace "cental" with "central"
Done.

L782: Maybe replace "the single moorings" with "at a single mooring"
Corrected.

L787: Maybe remove the second "which"?
Done.

L828: "currents there are weaker" sounds better than "currents are there weaker"
Changed.

L830: Replace "sArctic" with "Arctic"
Done.

L860: "2011-2018" or "2011-2020"?
Thank you for pointing that out, I missed to correct it to "2011-2020". I changed it now.

Appendix:

L908: Replace "larger then" with "larger than"
Corrected.

L925: Add a dot after "Fig" in " Fig C1" to make it "Fig. C1"
Done.

Reference:

L1006-1007: The second URL (https://www.sciencedirect.com/science/article/pii/S0273117718300309#f0005) is not needed.
Corrected.

Tables and Figures:

Table 1 Replace "position" with "locations"
Changed.

Table 2 Replace "position" in " Name, location, monthly ..." with "location". Same replace "positions" in "Variable positions indicate ..." with "locations".
Changed.

Figure 1: Probably need to rephrase "the bottom pressure data are taken from the empty star" to something like: the empty star is where the bottom pressure data are taken.
Corrected.

Figure 2: Rearrange panels b-d by moving panel b to top right and panels c & d to bottom right and change the caption " The two upper panels ..." accordingly. Also, change "prior correcting the offset" in the caption to "prior to correcting the offset".
Changed.

Figure 3: It seems "(per 100 km2)" only for number of observations, not for standard deviation. Probably moving "(per 100 km2)" (also add "per month") after "number of observations" in the second sentence makes more sense.
Corrected.

Figure A1: It appears some panels are incorrectly referenced. Replace "... correction FES2004 (a, d) and FES2014 (b, c). In panels (e) and (f)" with "... correction FES2004 (a, d) and FES2014 (b, e). In panels (c) and (f)"
Corrected.

Referee#2

The paper describes a new satellite-based Arctic-wide gridded dataset for monthly sea surface height anomaly and geostrophic velocity. The paper is in general well written. The methodology for generating the dataset is clear and robust. The new dataset is evaluated using both independent gridded satellite data and in-situ observations in different locations. The paper and the dataset are very relevant to the Arctic research community.

I am reviewing the revised manuscript. The major criticism of the early version, which I didn't review, was the limited validation (only at two locations) of the Arctic-wide gridded dataset. In response to the criticism, the authors substantially expanded the assessment to include all eastern and western Arctic circulation regimes, the central Arctic Ocean, Arctic shelf seas and the main exchange gateways of the Arctic. In other words, all major aspects of Arctic Ocean circulations are now included in the validation. The authors also included thorough discussion on the quality of the data source and the advantages of their methodology to previous approaches. I feel the work is now acceptable for publication after some very minor revisions, mostly editorial.

The figures are generally in good quality. But some of the inserts could benefit from enlargement. For example, it is rather difficult to distinguish the different colors of the dots in the insert of Figure 4. There is plenty of space to make the insert larger.
The velocity vectors in Figure 6 are too small. The authors may want to enlarge the vectors and perhaps only plot out every other vectors.
We improved the readability of the above figures by enlarging the inset panel and enlarging the vector fields.

<u>Figures:</u>

Figure 7, Caption: " in the small area in the Baffin Bay encircled by a thick black line" There are three areas encircled by thick black line. In the small areas instead of area?
The area shaded in gray north of 82 N The region shaded
Corrected.

Figure 5, Label (b) is not properly positioned. In the caption, 4 weeks average 4-week average
Changed.

Figure 10, Caption, Red and green circles …. I notice red and black circles, no green circles.
Changed.

Figure 13, Missing horizontal axis labels
Changed, the horizontal time axis is now present in all speed and bearing time series.

Figure 14, horizontal axis c , month number month
Changed.

Main text:

The paper was, overall, well written. There are, however, some typos that should be fixed and sentences that could be improved before publication. Below are a few examples:

L16, basin wide seasonal basin-wide seasonal …
Changed.

L21-22, trends …has largely been found trends…have largely been found
Left as is, as "has" refers to "Evidence … has been found".

L23-26, "observational studies of ocean currents give a more fragmentary picture of changes and intensification of surface ocean currents: analysis of regional in situ data (e.g., McPhee, 2012), indirect 25 calculation from wind and ice drift observation (Ma et al., 2017) or, only recently, satellite altimetry data (Armitage et al., 2017; Morison et al., 2021)"
Consider rephrase the sentence to:
observational studies of ocean currents, including analysis of regional in situ data (e.g., McPhee, 2012), indirect calculation from wind and ice drift observation (Ma et al., 2017) or, only recently, satellite altimetry data (Armitage et al., 2017; Morison et al., 2021), give a more fragmentary picture of changes and intensification of surface ocean currents.
Changed.

L37, altimetry derived altimetry-derived
Changed.

L38, velocity which is velocity that is
Changed.

L44, Further data Future data?
We rephrased the sentence to highlight that the amount of data collected over the Arctic Ocean is going to quickly increase thanks to recently launched altimetry missions.

L45, "methodological developments for the processing of the signal coming from the ocean in ice covered regions have taken much longer to develop"
Development and to develop are redundant. Consider change to methodologies for … have taken much longer to develop Or methodological developments for … have taken much longer
Changed.

L50, 'few' should be 'a few'
Changed.

L53, differences between them 'them' refers to what here?
It refers to gridded datasets independently derived. We rephrased the sentence to clarify this point.

L124, Anderson et al. (2015)) (2015)
Corrected.

L151, compared there zonal cross-section Compared zonal cross-section?
We rephrased the sentence.

L155, equation 7 Eq. 7 is mentioned above. Be consistent
Corrected.

Table 1, Names, position, monthly data… Names, positions … or Name, position, …
Changed to "Names, locations …".

Table 2, Caption: first 17 rows, following 4 rows, etc. Add a column to indicate the location or add a horizontal line between two locations
Changed the table by adding rows with the names of locations before the first mooring at each location.

L293, The DAC is today conventionally used over The DAC is conventionally used today over
Changed.

L322, state of the art ocean tidal state-of-the-art ocean tidal
Corrected.

L421, Monthly η maps were obtained as the average of four weekly maps. What happened to the average when a week spans two months?
The weeks were defined based on the days of the month rather than the actual calendar week. Each month was divided in four parts as follows: day#1-day#8, day#9-day#15, day#16-day#23, day#24-LASTday. We believe that this has a negligible influence on our final results.

L461, Repeat of the sentence: In the η 0 monthly fields we generally find that there are extended regions of either positive or negative values. In the η 0 monthly fields we generally find that there are extended regions of either positive or negative values.
Removed one of the repetitions.