

Reviewer comments, response and actions for manuscript:

Accounting for shelf-width in selecting altimetry observations for estimating coastal sea level changes improves its agreement with tide gauges

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Reviewer 1	Response	Action
In this paper a selection method for satellite altimetry data is proposed to produce a better agreement with data from tidal gauges. I find it difficult to form an opinion on the validity of the results, because on the one hand the <i>text is filled with a large amount of details and abbreviations</i> , which severely hampers readability, while on the other hand the <i>text is short on crucial information</i> .	<p>We thank the reviewer for raising the issue of readability.</p> <p>To accommodate the exhaustive validation of Dynamic Search Radius (DSR) against 13 existing algorithms from the literature across 272 stations, we used abbreviations for the algorithms and grouped stations into 14 coastal regions.</p> <p>Although Table 1 in Section 2.2.2 defines the algorithm abbreviations, it was not cited in Section 4.1 (Results). We will add this citation and will refrain from using abbreviations for regions. Further, we will include a table summarizing median correlation coefficient (r) and normalized root mean square error (NRMSE) values across regions for all algorithms to improve readability.</p>	<p>Revise Section 4.1 to spell out region names.</p> <p>Add a citation to Table 1 in Section 4.1, which defines the algorithm abbreviations.</p> <p>Add a table to Section 4.1 summarizing median r and NRMSE values across regions for all algorithms.</p> <p>Revise the manuscript to avoid unnecessary abbreviations.</p>
For example, in the Introduction the authors phrase their central hypothesis as "that selecting altimetry points along the coast and within the shelf would represent the coastal sea level better". This is really <i>too unspecific to form a meaningful and testable hypothesis</i> .	<p>We thank the reviewer for the comment and agree that the hypothesis is too general in Section 1 (Introduction). However, we note that the hypothesis is defined and explained in detail in Section 3 with an illustration of the algorithm shown in Fig. 1.</p> <p>To make the hypothesis clearer in Section 1, we will rephrase it as "We hypothesise that selecting altimetry points along the coast and within the continental shelf yields sea level time series that agree more closely with tide gauges than those from existing selection approaches (fixed search radius, nearest observation, nearest pass)."</p> <p>To test this hypothesis, in Section 4.1, we carry out extensive comparisons with different</p>	Revise wording accordingly.

	<p>altimetry selection algorithms from literature and their adapted variants at 272 tide gauges. The algorithms are defined in Table 1 (Section 2.2.2). Evaluation results are shown in Figs. 3 and 4.</p> <p>Further, the parameters of the DSR algorithm that decide how far along the coast the search extends are shown to be robust through a sensitivity analysis spanning 396 parameter combinations (see Section 3.2, Figs. B1–B3 in Appendix B).</p>	
<p>In discussing altimetry data, the authors mention corrections that are included as “tidal correction and Dynamic Atmospheric Correction (DAC)”. This again lacks specificity, but I assume the authors refer to the long-period nodal tide and to the inverted barometer effect. However, <i>when discussing the tide-gauge data, the long-period nodal tide is no longer mentioned and apparently is not corrected for</i>. This makes the <i>comparison between altimetry data and tide gauges problematic</i>.</p>	<p>The DAC product is a combination between the TUGO HR barotropic model output (high frequencies) and the Inverted Barometer corrections (low frequencies). The TUGO simulation is forced by ERA5 meteorological reanalysis data. The purpose of DAC correction is to remove sea level response to atmospheric pressure and wind forcings, as explained in Section 2.1.3. We assumed the readership to be acquainted with it, but we agree with the reviewer that it should have been explained briefly where it is first introduced.</p> <p>Since we retain DAC correction applied on the altimetry product, we also apply it to the tide gauge observations for consistency. This is explained in Section 2.1.3, Lines 144-148.</p> <p>We retain the tidal correction applied on altimetry product, which includes 34 tidal constituents from the FES2022 ocean tide product. However, we do not apply tidal correction to tide gauge, as we use monthly means data from the Permanent Service for Mean Sea Level (PSMSL), for which monthly averaging is commonly assumed to effectively remove the tidal signal, as also noted by Reviewer 2.</p> <p>The temporal sampling of altimetry is poor compared to the hourly sampling of tide gauge.</p>	<p>Add in to Section 2.1.1 where the DAC product is first introduced to explain the product and its purpose.</p> <p>Additional analysis in which the tidal signal is added back to the XTRACK product and then to calculate monthly means, enabling comparison of results with and without explicit tidal correction.</p> <p>Additional analysis of nodal tidal correction at each tide gauge station using the equilibrium form described in Woodworth (2012).</p>

	<p>Hence, adding back the tidal signal to the XTRACK product and then taking the monthly mean may introduce tidal aliasing, with different alias periods for different tidal constituents (Smith et al., 2000). However, following Reviewer 2's suggestion, we will add back tidal signals and then take monthly means to compare results with and without explicit tidal correction.</p> <p>Since our study period of estimating coastal sea level trends (30 years) is longer than the nodal tidal cycle (18.61 years), we argue that the effect will be negligible. Moreover, we might not be able to resolve the nodal tide using harmonic analysis, as ocean variability might be larger than the nodal tidal signal at these temporal scales (Woodworth, 2012). Therefore, following Woodworth (2012), we will subtract equilibrium form at each station to correct for nodal tide before estimating coastal trends from tide gauges.</p> <p>Smith, A.J.E., Ambrosius, B.A.C. and Wakker, K.F., 2000. Ocean tides from T/P, ERS-1, and GEOSAT altimetry. <i>Journal of Geodesy</i>, 74(5), pp.399-413.</p> <p>Woodworth, P.L., 2012. A note on the nodal tide in sea level records. <i>Journal of Coastal Research</i>, 28(2), pp.316-323.</p>	
<p>Another problem is that the tide-gauge data collected by national agencies worldwide, <i>may not always have been fully corrected for land subsidence</i>. The authors seem to suggest (in Section 2.2.4) that the Revised Local Reference offers a fixed datum, but as explained on the PSMSL website it is rather a convenient and arbitrary choice: "The RLR datum at each station is defined to be approximately 7000mm below mean sea level, with this arbitrary choice made many years ago in order to avoid negative numbers in the resulting RLR monthly and annual mean values."</p>	<p>We clarify that we used the phrase "stability of the local datum is ensured" to refer to the continuity of the reference level used for sea level observations (forming the RLR dataset), rather than its geodetic stability.</p> <p>We acknowledge that RLR is a convenient local reference and does not, in itself, account for land subsidence or uplift. As described in Section 2.2.4, Line 214, we correct for vertical land motion (VLM) using GPS data before calculating sea level anomalies for comparison with altimetry. We will revise the text</p>	<p>Revise the phrase as "continuity of the local datum is ensured".</p> <p>Add in text explicitly stating that we have corrected for VLM using GPS data since the RLR dataset does not imply a geodetically stable datum.</p>

	to clarify this distinction and avoid ambiguity.	
In the same paragraph, the authors mention removing a “ <i>long-term mean</i> ”, without specifying what they mean by “ <i>long-term</i> ”.	<p>We thank the reviewer for raising this important point.</p> <p>We calculated sea level anomalies from tide gauge observations by removing the long-term mean over the respective study periods. For inter-algorithm comparison and validation (Sections 4.1 and 4.2), we calculated the mean over 2002–2020. For validation of DSR across various temporal scales and estimation of coastal sea level trends (Sections 4.3 and 4.4), we used long-term mean over 1994–2023.</p>	We will add text to clarify what we mean by “long-term mean”.
The Results section in its present form is unreadable; again, it is <i>buried under details (which would rather belong in a table) and abbreviations</i> . Just to quote one paragraph: “DSR consistently outperforms other algorithms across most regions, with median <i>r</i> value of 0.97 (Baltic), 0.75 (Eaus), 0.79 (GoM), 0.72 (IO_SCS), 0.71 (NEAt), 0.84 (NSea), 0.71 (NZ), 0.51 (SA), 0.92 (WAus) (Fig. 3). It performs comparably with XTRACK/ALES algorithms in several regions: MedSea (0.77 for DSR, compared to 0.79 and 0.78 for ales_300 and ales_200), NEA (0.75 for DSR and 0.76 for ales_300), NPO (0.74 for DSR and 0.76 for ales_300), NWA (0.84 for DSR and 0.85 for ales_300) and PI (0.86 for DSR and 0.89 for ales_300 and ales_200) (Fig. 3(a)).” There should be better ways of conveying the essence of the information to the reader.	<p>We agree.</p> <p>We will include a table summarizing median correlation coefficient (<i>r</i>) and Normalized Root Mean Square Error (NRMSE) values across regions for all algorithms to improve readability.</p> <p>Although Table 1 in Section 2.2.2 defines the algorithm abbreviations, it was not cited in Section 4.1 (Results). We will add this citation and will refrain from using abbreviations for regions.</p>	<p>Add a table to Section 4.1 summarizing median <i>r</i> and NRMSE values across regions for all algorithms.</p> <p>Add a citation to Table 1 in Section 4.1, which defines the algorithm abbreviations.</p> <p>Revise section 4.1 to spell out region names.</p>
The Conclusions section raises a couple of points that perhaps require comment. First, the authors put forward as the central novelty of the paper that they developed a selection algorithm to choose points on the continental shelf rather than in the open ocean in order to determine sea-level change at the coast. But given the large regional variability in sea-level change, why would one even consider open-ocean data to get	<p>We thank the reviewer for this comment.</p> <p>We note that, in practice, the open ocean and the coast are not intentionally separated in existing altimetry selection algorithms.</p> <p>As explained in Lines 60-75, existing literature uses algorithms such as fixed search radius, which may select altimetry points in the</p>	<p>We will add text in conclusions to clarify the contributions of the algorithm.</p> <p>We will include discussion of results from previous studies that used statistical approaches.</p>

<p>coastal trends? In other words, the author's choice makes sense but is also obvious.</p>	<p>open ocean if the shelf is narrow. Restricting data within 10 km or taking the nearest observation avoids the problem but can limit temporal sampling (see Section 4.1 for results of inter-algorithm comparison).</p> <p>Statistical approaches taken in Cazenave et al. (2022), which selects observations within a length scale determined at each station by correlating the detrended deseasonalized signal with tide gauges, and Cipollini et al. (2017), where they test for different search radii from 0 to 200 km and select the radius by minimizing the root mean square error with tide gauges, address this issue empirically but do not account for the physical significance of the shelf break.</p> <p>The DSR algorithm has two benefits: first, it has a physical basis, as acknowledged by the reviewer; and second, it improves temporal sampling while restricting observations to within the shelf by extending the search along the shelf.</p> <p>We will revise the conclusions to clarify the contributions of the algorithm and expand the discussion to include comparisons with previous studies that used statistical approaches.</p> <p>Cazenave, A., Gouzenes, Y., Birol, F., Leger, F., Passaro, M., Calafat, F.M., Shaw, A., Nino, F., Legeais, J.F., Oelsmann, J. and Restano, M., 2022. Sea level along the world's coastlines can be measured by a network of virtual altimetry stations. <i>Communications earth & environment</i>, 3(1), p.117.</p> <p>Cipollini, P., Calafat, F.M., Jevrejeva, S., Melet, A. and Prandi, P., 2017. Monitoring sea level in the coastal zone with satellite altimetry and tide gauges. <i>Integrative study of the mean sea level and its components</i>, pp.35-59.</p>	
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<p>Furthermore, they point out that coastal sea-level dynamics is very different from the open ocean - which is certainly true - but they identify as the primary cause the fact the currents have to follow the coastline (l. 514). First, it is not made clear why this would have an implication for sea-level change, but second, a much more important difference has to be the wind variability (also on inter-annual time scales) and its major effect on (annual-mean) sea level at the coast. This aspect would need to be considered in the analysis.</p>	<p>We agree that wind variability is an important forcing factor for sea level changes at the coast. Additionally, we note that responses to forcing signals propagate along the shelf and slope with characteristics dependent on the shelf and slope topography (Woodworth et al., 2019), for example, as coastally trapped waves (mentioned in Line 515).</p> <p>For example: winds associated with climate modes such as El Niño-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) generate eastward-propagating equatorial Kelvin waves, which, on reaching the eastern boundary, continue poleward as coastally trapped waves and affect sea level over long stretches of coastline in the eastern Pacific (Enfield and Allen, 1980) and eastern Indian Ocean. Along the eastern North Atlantic, the coherent decadal signal tied to the North Atlantic Oscillation (NAO) is mainly wind-driven, confined to the shelf, and consistent with poleward-propagating coastally trapped waves (Calafat et al., 2012).</p> <p>We note that this manuscript does not account for all factors impacting coastal sea level but shows that considering the effect of continental shelf improves agreement between altimetry and tide gauges.</p> <p>Woodworth, P.L., Melet, A., Marcos, M., Ray, R.D., Wöppelmann, G., Sasaki, Y.N., Cirano, M., Hibbert, A., Huthnance, J.M., Monserrat, S. and Merrifield, M.A., 2019. Forcing factors affecting sea level changes at the coast. <i>Surveys in Geophysics</i>, 40(6), pp.1351-1397.</p> <p>Enfield, D.B. and Allen, J.S., 1980. On the structure and dynamics of monthly mean sea level anomalies along the Pacific coast of North and South</p>	<p>We will add text to the conclusions clarifying that wind variability is an important driver of coastal sea level and that its effects propagate along the shelf and slope, for example, as coastally trapped waves.</p>
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