

Reviewer #1 comments

General comments

This manuscript presents a new data set which contains in particular, an estimation of ocean wave power density in various coastal sites, at high spatial resolution. It is based on satellite radar altimeter measurements functioning in the “Synthetic Aperture Radar” (SAR) mode. The wave power density estimation relies on two variables classically provided by the satellite altimeter measurements (the normalized radar cross-section and the significant wave height H_s), which are estimated here using a processing specifically designed for SAR-altimeters and coastal regions (SAMOSA+ , see Dinardo et al, 2018), combined with an empirical function which relates these two variables to the zero-crossing wave period T_z . This empirical function to estimate the zero-crossing period was already proposed and assessed by Gommenginger et al (2003), but the authors present here a new estimation of the relationship and a validation based on their satellite data set and buoy measurements.

The data set presented by Ponce de Leon et al. was obtained from two satellite data sets (Sentinel-3 A/B and Cryosat-2) and covers the Atlantic coasts of Europe, Madeira, the French Polynesian archipelagos, the Azores, the Canary Islands, the Mediterranean and Baltic Seas, and the coastal zone of French Guiana, over a period of 13 years (2011-2023).

This data set is new, and should interest users involved in the development of energy production from the waves. It is potentially an interesting downstream product from satellite observations. However, at the moment it lacks information on the possible biases in wave power density induced by the method developed by the authors.

As the data set also contains significant wave height and zero-crossing period with a high spatial resolution and in various coastal zones, it may also serve the validation of wave models specifically designed for these coastal zones and other oceanic and coastal applications.

The manuscript suffers however from a lack of details regarding i) the method to estimate the zero-crossing period and its validation, ii) sources of errors and error estimates concerning the wave power density , iii) the practical usefulness of the data set for wave energy applications, taking into account the time sampling at each site, which seems not very high.

After revision, I think that the manuscript could be published.

Specific comments

Section 2.2

- In Gommenginger, the empirical relationship between T_z and X is proposed based on dimensional arguments, which implicitly assume that the wave dispersion relationship is the one valid for deep water. Here, you apply it in coastal environment with various depths. So, justify why this approach may still be used even if applied in shallow water.

Reply:

We thank the reviewer for this insightful comment. We agree that the empirical relationship proposed by Gommenginger et al. (2003) is derived from dimensional arguments that implicitly assume deep-water wave dispersion conditions.

In the revised version of the manuscript, we added this paragraph in section 2.2,

after this sentence: The samples with a 'misfit' greater than 4 counts are eliminated.

- Concerning the evaluation of the a and b coefficients of the T_z equation: please be clearer on how it was done: (a, b) values estimated for each buoy location? Or mixing all locations? According to line 92, it seems to be done for each location, but improve the clarity of the earlier text. And explain in the manuscript why this has to be done for each location.

I guess that by doing so, the result of the fit (coefficients a, b) is adapted for each encountered condition of sea-state and bathymetry.

But please, comment in the text. Also, do you mix all satellites data when you perform the regression or do you separate the data sets between Cryosat, S3-A, S3-B?

Please also comment in the manuscript and justify (if you mix all the satellites, did you check for potential H_s or s_0 biases between the three satellites?)

Reply:

1. We thank the reviewer for pointing out the need for clarification.

The regression coefficients a and b in the formulation proposed by Gommenginger et al. (2003) were estimated independently for each wave buoy location, using only the collocated altimeter-buoy pairs for that site.

We acknowledge that this was not sufficiently clear in the original manuscript and have now revised the text to explicitly state this point.

We estimated the regression coefficients a and b for each wave buoy separately. Yes, we separate the datasets for both missions.

In the revised version of the manuscript, we added more information in response to your suggestions. Please, see below:

“The regression coefficients a and b were estimated independently for each buoy location using collocated altimeter and in situ observations. This site-specific calibration accounts for regional differences in wave climate, spectral characteristics, and coastal effects, which can influence the relationship between the altimeter-derived parameter X and the mean zero-crossing period T_z .”

Once the regression coefficients (a and b) are derived from the relationship between X (computed from altimeter measurements) and the zero-crossing wave period (T_z) from buoy observations, the two datasets must be collocated to form paired (X , T_z) samples.

For each buoy, the collocation procedure is performed independently for each satellite mission. For a given buoy record, all altimeter measurements within a 40 km radius are averaged to obtain representative values of significant wave height (H_s) and normalized radar cross section (σ_0). This approach produces mission-specific time series of satellite-derived parameters that are consistently matched to in situ observations at each buoy location. The temporal spacing between collocated pairs depends on buoy position, in situ sampling frequency, and each satellite mission's revisit characteristics.

The temporal spacing between collocated pairs varies with the buoy's geographic location and the dataset's sampling frequency.

The main advantage of this approach is that, once the wave energy period (T_e) is estimated, the wave power density can be readily computed from satellite altimetry data. This enables large-scale assessments of wave energy resources in regions where in situ observations are not available.”

The estimation of the linear regression coefficients (a, b) is performed separately for each location, motivated by the fact that the relationship between the altimeter-derived parameter X and the mean zero-crossing

period T_z is not strictly universal but depends on local sea state characteristics and environmental conditions, including:

- Variations in wave climate (wind-sea vs. swell dominance)*
- Differences in spectral shape and bandwidth*
- Bathymetric effects influencing wave transformation in coastal regions*
- Potential regional biases in altimeter measurements, especially in the nearshore zone*

As a result, a single global calibration may introduce systematic biases when applied across heterogeneous environments. Performing the regression at each buoy location allows the empirical relationship to better adapt to local conditions and improves the accuracy of the retrieved T_z .”

2. Regarding the joint use of three satellites, we did not combine data from all three when estimating the regression coefficients, nor did we assess potential inter-satellite biases in H_s or σ_0 . However, for both CryoSat-2 and Sentinel-3 (with Sentinel-3A and Sentinel-3B processed jointly), we estimated bias, scatter index, and correlation coefficient relative to buoy measurements. The results for buoys around the British Isles show good agreement for both missions. Although this is not a direct inter-mission comparison, it suggests that the measurements from the two missions are broadly consistent; however, a dedicated cross-comparison would be required to quantify any systematic differences between them.

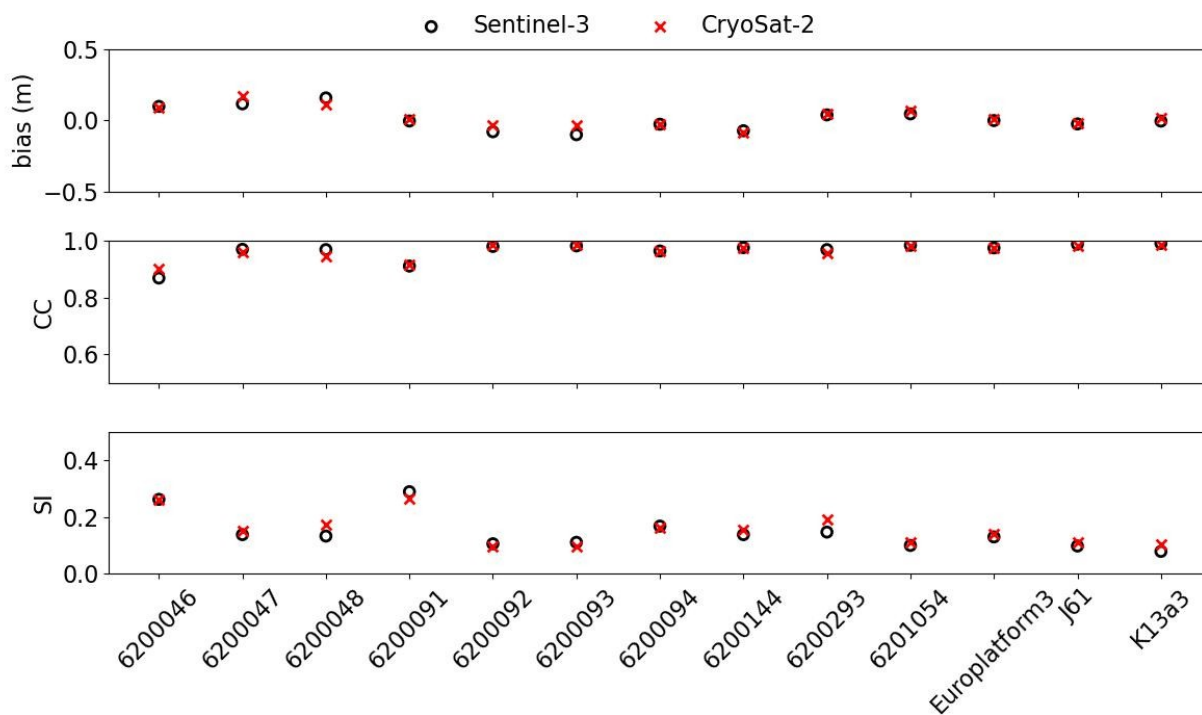


Fig. 1 Comparison of statistical metrics for Hs. Red crosses - Cryosat-2, circles - Sentinel-3A/B.

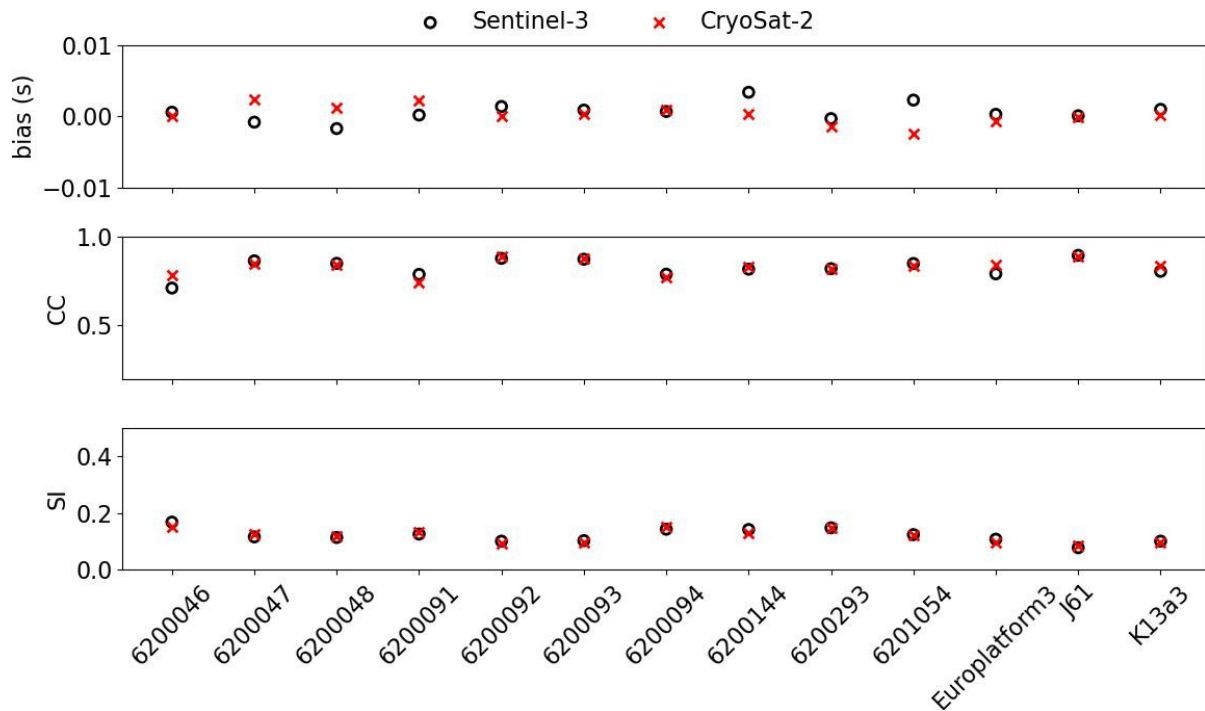


Fig. 2 Comparison of statistical metrics for Tz. Red crosses - Cryosat-2, circles - Sentinel-3A/B.

- training and validation sets: please give more details about how data sets have been separated: all buoys used in both steps? Different time periods for training and validation? Random selection?

Reply:

The dataset was randomly partitioned into two equal subsets: a training set and a validation set. The training set was used to estimate the regression coefficients, while the validation set was employed to evaluate model performance in terms of bias, scatter index, and correlation coefficient. This procedure was repeated 1000 times, and the resulting ensemble was used to compute averaged estimates of both the regression coefficients and the statistical metrics.

We have included this information to the text.

- about results of the regression: can you comment on the range of values obtained for (a,b) from the different sites? And also, is the quality of the regression the same for all sites? More generally what is the quality of the fit when estimating (a,b)?

Reply:

The quality of the fit when estimated (a,b) was validated for 82 wave buoys locations across the 11 different regions of the WAPOSAL project database.

The regression coefficients vary across regions where the WAPOSAL project applied the Gommenginger et al. 2003 method. This variation is directly related to the basin, the number of wave buoys (which varies widely from place to place), the quality and length of the records, and the sea state.

For the Mediterranean Sea (21 wave buoys), the regression coefficients were derived from CryoSat-2 data, with “a” ranging from 0.8801 to 1.6321 and “b” from 0.5204 to 1.7894. For Sentinel-3 A/B, the linear regression coefficients for “a” ranged from 1.1788 to 2.9321, and for “b” from 0.45892 to 1.5063.

In general, for the Mediterranean Sea, the statistical fits between wave data derived from satellite observations and those measured in situ by buoys are good. This indicates that the satellite data represent the field measurements quite well. As in the other study areas, the buoys with the best statistical fits are those farthest from the coast, which have a larger fetch.

In the North Atlantic, for example, for the French Façade, the CryoSat-2-derived linear regression coefficients ranged from 1.4446 to 2.116 for “a” and from 0.71117 to 2.6025 for “b.” Using Sentinel-3 A/B, the linear regression coefficients for “a” ranged from 1.3648 to 2.2453 and from 1.0178 to 3.0135 for “b”.

The quality of the regression varies across sites depending on the quality and length of the records. The correlation coefficient is high for the H_s and wave-period comparisons, indicating a strong linear relationship between the satellite series and the buoy data, with greater variability in the period data.

For the French Façade in general, the statistical fits between the periods and wave heights determined by satellite and in situ measurements are good. The best statistical fits generally occur at those buoys that are relatively far from the coast and are not surrounded by islands.

- Comparison of H_s and T_z between satellite and buoy measurements (Fig.2): The results seem really good, but it would be useful to know whether all sites give equivalent quality or, regarding T_z , whether some of them (in particular those more exposed to swell) give results of lower quality. This is an important information to provide to the future users of the data set.

Reply: Thank you for the comment. We performed a careful assessment using 82 wave buoys distributed across the 11 regions of the WAPOSAL

project. The results are very interesting. We agree with the Reviewer that quality varies. Now provide a buoy-by-buoy assessment highlighting that not always swell-exposed sites perform worse for Tz.

We agree that the overall comparison shown in Fig. 2 may mask performance differences among buoy locations, and that this information is important for future users of the dataset.

Indeed, the correlation for Hs is usually higher than for Tz. In areas where swell is dominant, the correlation for Tz is lower at sheltered sites, such as wave buoy 6200046, than in areas dominated by local wind sea states, such as the Mediterranean. However, our results showed that there are also swell-dominated areas, such as the French Façade, where the fit for Tz shows high correlation.

The quality of the estimated wave power density is almost always high for the wave buoys in the Mediterranean and the North Atlantic because it depends primarily on Hs.

In the new version of the manuscript, we added section 2.3.1, containing Fig. 4 showing the cases of 2 buoys from North Atlantic and Mediterranean and Table 1 and the description for them:

“ Two locations were selected in the North Atlantic (wave buoys 6200048 and 6200046) and one in the Mediterranean Sea (wave buoy 6100196). The position of the buoys is shown in the Figure 3. Table 1 shows the statistical metrics for Tz, Hs, and the wave power density and the regression coefficients for the selected locations.

In addition, our results show that in some swell-dominated places, the correlation is also good for the Tz. As shown in Table 1, for the North Atlantic locations, the correlation is good for the French Facade wave buoy (0.8 for Tz, 0.99 for Hs, and 0.98 for WPD). For the wave buoy selected in the North of the UK (6200048), the correlation (using Sentinel-3) is also high for the Tz (0.85), Hs (0.96), and the wave power density (0.94). For the location shown for the Mediterranean (61000196) in deep waters of the Gulf of Leon, using Sentinel-3 A/B, the correlation for Tz is high (0.89), as are those for Tz (0.97) and WPD (0.95).

In Figure 4 the example showing the comparison between buoy and altimeter wave period is presented for the buoys located in Atlantic and

Mediterranean sea. The root mean square error (RMSE) for T_z for buoy 61000196 located in Mediterranean sea is 0.4 seconds, while for the buoy 6200048 located in North Atlantic RMSE is higher and reaches 0.79 seconds.

A site-by-site analysis shows that the agreement between satellite and buoy measurements varies with the local wave climate. Mediterranean locations, dominated by fetch-limited wind seas, generally show higher skill, particularly for T_z . In contrast, North Atlantic sites, more exposed to long-period swell and bimodal spectra, show slightly reduced performance in T_z , reflecting the empirical formulation's sensitivity to spectral shape. This spatial variability should be considered when using the dataset, especially in swell-dominated environments. This result highlights that the accuracy of satellite-derived wave period is not uniform and depends on sea-state conditions, with better performance in wind-sea-dominated environments than in swell-dominated regimes.

This behavior is consistent with the known limitation that the empirical relationship used to estimate T_z (Gommenginger et. al. 2003) depends on the underlying spectral shape. In swell-dominated or multi-peaked conditions, the relationship between the altimeter-derived parameter X and T_z becomes less robust.

Table 1. Statistics from the collocation for Sentinel-3AB and CMENS wave buoys. CC - correlation coefficient; S.I.- Scatter index.

Wave Buoy	Regression Coefficients	T_z wave buoy vs. satellite	H_s wave buoy vs. satellite	WPD wave buoy vs. satellite
6100196 Mediterranean Sea	a=1.4662 b=1.2492 $CC_{XT_z} = 0.9$	S.I. =0.092 Bias=-0.0003 s CC=0.89	S.I. =0.195 Bias=-0.02 m CC=0.966	S.I. = 1.843 Bias=0.1266 kW/m CC = 0.95
6200048 North Atlantic (UK)	a = 1.833 b = 1.325 $CC_{XT_z} = 0.849$	S.I. =0.11 Bias=-0.0017 s CC = 0.85	S.I. = 0.133 Bias= 0.15 m CC= 0.96	S.I.= 1.05 Bias=7.14 kW/m CC = 0.94
6200001 French Façade	a = 1.852 b = 1.797 $CC_{XT_z} = 0.78$	S.I. =0.14 Bias=-0.0044 s CC = 0.8	S.I. = 0.091 Bias= -0.1291 m CC= 0.99	S.I.= 1.4908 Bias=-3.71 kW/m CC = 0.98

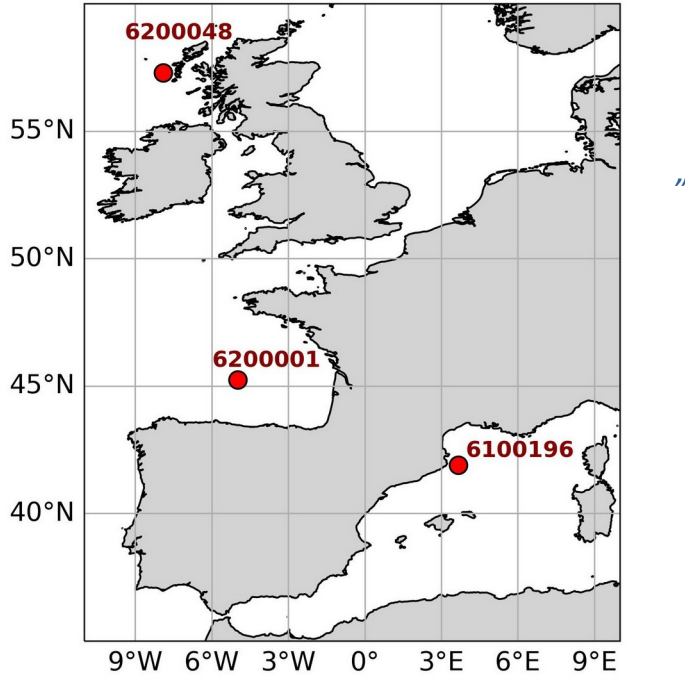


Figure 3. Locations of wave buoys with data presented in Table 1.

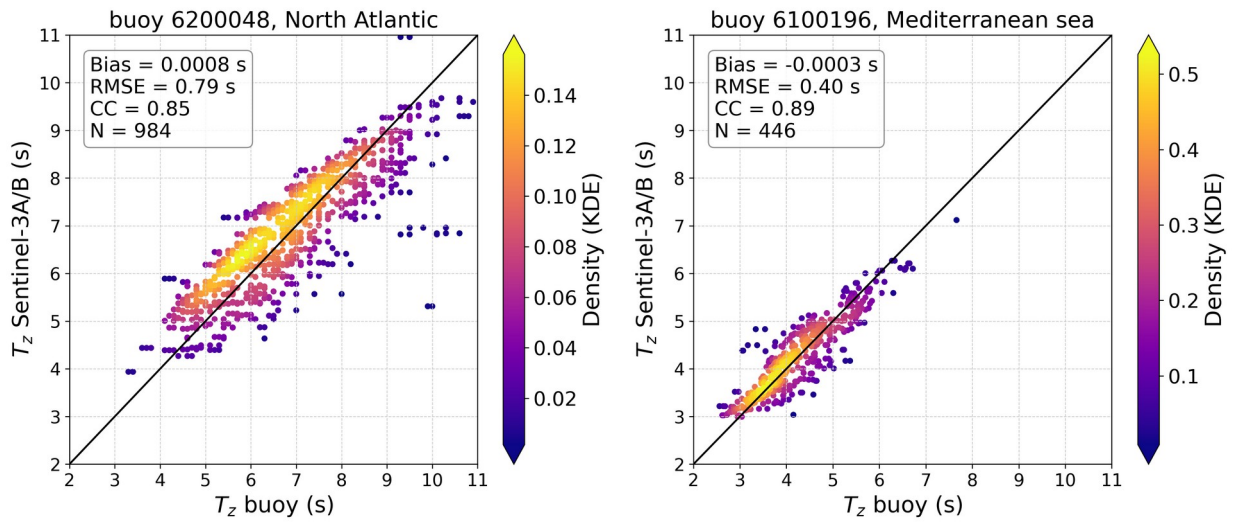


Figure 4. Scatter plots for the wave period wave buoy and Sentinel-3 A/B in an Atlantic location (left) and in a Mediterranean location (right) for the CMENS wave buoys 6200048 and 6100196, respectively.

- estimation of wave power density P : you provide an expression which relates the “energy period” T_e to the mean zero-crossing period T_z . However, it is known that the relation between T_e and T_z depends on the wave spectrum shape (see Cahill and Lewis, 2014 – same paper as in your reference list). So, you must model the underlying assumption on the wave spectrum shape associated with this relationship and estimate the possible bias on the wave power density due to other sea state conditions (or shape of wave spectrum). At least give a range of error in the estimate on P . Also, a statistical comparison of P from buoy and satellites using, for the buoys, T_e directly estimated from the buoy spectral measurements would give more confidence in the data wave power density set.

Reply:

We thank the reviewer for this important comment. Please see the statistics for the wave period and wave power density in the new Table above. We fully agree that the relationship between the energy period T_e and the mean zero-crossing period T_z is not universal, but depends on the shape of the wave spectrum, as discussed in Cahill and Lewis (2014).

1) Assumption on spectral shape

In this study, the conversion from T_z to T_e implicitly assumes a unimodal wave spectrum representative of wind-sea-dominated or moderately mixed sea states (e.g., JONSWAP-type spectra). Under such conditions, previous studies (including Cahill and Lewis, 2014) indicate that the ratio T_e/T_z typically falls within a relatively narrow range.

2) Expected uncertainty and impact on wave power density

Based on the range of spectral shapes reported in the literature, the ratio T_e/T_z can vary typically between ~ 1.05 and ~ 1.20 depending on sea state conditions (e.g., narrowband wind sea vs. broader or bimodal spectra). Since wave power density scales linearly with T_e , this translates directly into an uncertainty in PP of approximately ± 10 – 15% under typical conditions, and up to $\sim 20\%$ in more complex (e.g., swell-dominated or bimodal) sea states.

3) Implications for coastal applications

We note that in the study region, wave conditions are predominantly characterized by short- to intermediate-period wind seas, which tend to exhibit relatively stable spectral shapes. Therefore, the variability in the T_e/T_z ratio—and thus in P —is expected to remain within the lower end of the uncertainty range for most cases.

4) Validation with buoy-derived energy period

To the best of our knowledge, the wave buoys that measure wave spectrum belong to NDBC network and they are located near the coast of North America. In the areas of WAPOSAL project unfortunately we have not found buoy data on the wave spectrum or T_e directly.

In the revised manuscript we added this information:

“The estimation of wave power density relies on the conversion between the mean zero-crossing period T_z and the energy period T_e , which depends on the spectral shape (Cahill and Lewis, 2014). In this study, we implicitly assume a unimodal spectrum typical of wind-sea or mixed conditions. Under such assumptions, T_e/T_z typically ranges between 1.05 and 1.20, leading to an uncertainty in wave power density on the order of 10–15%, and up to ~20% for more complex spectral conditions (e.g., bimodal sea states). This limitation is inherent to the use of bulk parameters and should be considered when interpreting the results.”

Section 4 (example of data application)

Line 158-160 and Figure 3: please mention what is the time period of averaging (annual mean or over all the data set period ?)

Reply:

The figure caption was replaced as follows: Figure 4. Along-track mean wave power density for 11 regions, derived from Sentinel-3A/B altimeter measurements and averaged over the period 2016–2023.

In the revised paper, we updated the information in line 160 as follows:

“The along-track mean wave power density derived from Sentinel-3A/B data is presented in Figure 4 for the 11 study regions. While these data can be further processed through interpolation, binning, or smoothing, the original along-track product preserves the intrinsic high spatial resolution of the measurements. This high-resolution information is particularly valuable in coastal zones, where wave conditions exhibit strong spatial variability and may not be adequately captured by gridded products.”

Lines 162-163 and figure 4: please mention what is the sampling time for this estimation of wave power density. Are the values plotted in Fig.4 averaged over a given time period? Or is it the minimum sampling time that

is shown in Fig.4 ? If the sampling period is more than 1 or 2 days, discuss the usefulness for wave energy applications with such long gaps.

Reply: The time series presents collocated altimeter and buoy data. The time series has gaps, because the revisit time of the altimeter is limited. For Cryosat-2 revisit time is approximately 10 days for the area around the buoy with the radius of 50 km. We have also added the time series for Sentinel-3A/B. For the data from the two missions the revisit time is less: around 3 days.

The time series indicates seasonal variations of wave power density. However, due to limitations of sampling, some intense events are captured by Cryosat-2 and Sentinel-3A/B at different moments.

In Fig.4- bottom panel, I suggest that you overlay the results from S-3 1/B and discuss their agreement with the estimations from Cryosat.

Reply: We do apologize because the time series from S3 A/B is missed. In the revised version this is fixed. We decided to show the plots for two sensors on separate panels.

“The time series for this location, derived from 11 years of CryoSat-2 data and 7 years of Sentinel-3A/B data, are shown in Figure 5.

For comparison, the time series for the same location is also presented using ERA5 data. Seasonal variability in CryoSat-2 and Sentinel-3A/B is similar; however, due to differences in temporal sampling between the two missions, some intense wave events may be captured by one mission while missed by the other. For the 2016-2022 period, data from the two satellites complement each other and provide a more complete time series.”

Suggested technical corrections

- Everywhere: please number the equations

Reply: Fixed.

- Lines 74-76 = Suggestion to make the sentence and reference to Gommenginger more clear: “ In (Gommenginger et al., 2003), it was **suggested, based on dimensional arguments**, that T_z is linearly related to **a variable named X, which is** a combination of significant wave height H_s and of the normalized radar cross section σ_0 , with $X = (H_s^2 \sigma_0)^{0.25}$, and σ_0 expressed in natural units (non-dB).”

Reply: Thanks for the suggestion.

- Suggestion for Line 77: Therefore, following Gommenginger et al, 2003, using collocated Tz in situ wave buoy data and altimeter Hs and σ_0 data, we have re-evaluated for each collocated data set the coefficients (a and b) of the following equation:

$$T_z = aX + b$$

Reply: Thanks for the suggestion.

- Before line 80: add a sentence to explain that the method was validated by Gommenginger et al. 2003, using Topex altimeter measurements and a set of NDBC buoys, and why it is necessary to establish this relationship in your analysis again.

Reply:

The empirical method was originally validated by Gommenginger et al. (2003) using TOPEX altimeter measurements and a set of NDBC buoys. However, it is necessary to re-establish the relationship in the present study, since the calibration can depend on several factors that differ from the original work, including the use of coastal-retracked altimetry (SAMOSA+), the nearshore application (down to ~5 km from the coast), and the regional wave climate (Mediterranean vs. North Atlantic for example). These differences may affect both the altimeter-derived parameter X and its relationship with Tz, thus justifying a new, dataset-specific calibration.

We find that:

- The agreement on significant wave height (Hs) remains consistently high across all locations.*
- The variability in performance is mainly observed in Tz, as expected from its stronger sensitivity to spectral characteristics.*

We have now included buoy-specific statistical metrics and added a discussion highlighting these regional differences. This provides a clearer indication of where the dataset performs best and where additional caution is required (See Table 1).

Text added to the manuscript:

“Although the relationship proposed by Gommenginger et al. (2003) was originally calibrated using TOPEX altimeter data and NDBC buoys, a recalibration is required here due to differences in the altimeter processing (use of SAMOSA+ retracker), the proximity to the coast, and the regional wave climate. These factors can influence the altimeter-derived parameter and its relationship with Tz, justifying a site-specific calibration.”

- Line 93: suggestion; **Using the triplets** (σ_0 , H_s from altimeters T_z from buoy), the regression coefficients a and b were determined **for each buoy location**

Reply: Fixed.

- Line 109: inconsistency between the reference given here and the reference in the list at the end of the manuscript. I think that the reference here is Cahill and Lewis, 2014, not Cahill, 2012.

Reply: Fixed.

- in the reference list: the doi and doi link for “Kasiulis et al, 2015” is not correct.

Reply: Fixed. Thank you for the comment.

Data description and data availability

Following the link given in the manuscript, I checked that I could access to the ncdf files (sorted per country, satellite, date, and satellite tracks). But I did not find the .zarr files mentioned in section 3 and in appendix A.

Reply: Thanks for the comment. Yes, .zarr files are available to download only directly using the python environment or gdal command line. We have tested this option: when the python script is run, the content of .zarr file is directly attributed to the variable ds as described in the Appendix.

There is a small Inconsistency between the content of the manuscript and the general description found when following the link indicated in the abstract and at line 147 or 204 (<https://doi.org/10.57780/ESA-1AB8CF3>). Indeed, in the landing page of <https://doi.org/10.57780/ESA-1AB8CF3>, the products that are mentioned are H_s and T_z but not the wave power. However, the product handbook is consistent with the current manuscript. (see screen copy below).

Reply: We have notified the team responsible for hosting the dataset to correct the description

Reviewer #2 comments

This manuscript presents the satellite altimeter dataset. The authors develop a high-resolution wave dataset derived from Sentinel-3A/B and CryoSat-2 SAR altimetry, providing significant wave height (H_s), estimated zero-crossing wave period (T_z), and wave power density (WPD) across 11 coastal and oceanic regions. The dataset addresses the gap between sparse buoy observations and numerical model limitations, particularly in coastal environments.

The manuscript is clearly written, however methodology requires clarification. Below are my comments and questions:

1. I suggest the authors to discuss potential limitations in regions where validation relies solely on ERA5 rather than in situ measurements, and the implications for confidence in those areas.

We thank the reviewer for this valuable comment. We agree that validation against in situ wave buoy measurements is preferable, while ERA5 data serve as a practical substitute due to their global coverage and availability. We have added a statement to this effect in the manuscript, together with references reporting comprehensive validations of ERA5 wave parameters against buoy observations.

Validation studies of ERA5 significant wave height have demonstrated good agreement with buoy measurements (V. Bessonova et al., 2025, <https://doi.org/10.1016/j.apor.2025.104490>; A. Anusree and V. Sanil Kumar, 2024, <https://doi.org/10.1016/j.dynatmoce.2024.101478>). These studies show that ERA5 generally underestimates significant wave height under extreme wave conditions. They also indicate that the accuracy of ERA5 improves with increasing distance from the coast, while changes in water depth have only a minor influence on its performance.

The consistency of ERA5 wave period estimates with buoy observations has also been evaluated by V. Fanti et al. (2023, <https://doi.org/10.1038/s43247-023-00819-0>), who compared ERA5 peak and mean wave periods with buoy measurements and demonstrated good agreement, confirming the reliability of ERA5 wave period data for wave climate studies.

Accordingly, although direct validation using buoy observations would be preferable, the published literature provides strong evidence that ERA5 wave parameters are sufficiently accurate for the purposes of the present study.

2. The methodology is based on the deep water approximation (eq. 2 in the manuscript). The limitations of this approach should be discussed, how this limitations may influence the result.

We thank the reviewer for this insightful comment on the applicability of the deep-water formulation for wave power density in a study focused on coastal regions. We fully agree with the Reviewer's comment. The deep-water formulation is strictly valid only when the water depth exceeds half the wavelength. In the revised manuscript, we have clarified this assumption and explicitly discussed its implications.

We acknowledge that for longer-period swell waves, the deep-water assumption may not be strictly valid in parts of the shelf, where intermediate-depth conditions can occur. This may lead to a moderate overestimation of wave power density when the deep-water formulation is used. We have therefore revised the manuscript to explicitly state the assumption of deep-water conditions, discuss the potential bias introduced by neglecting finite-depth effects. Future work will address this limitation by implementing finite-depth formulations of wave power density alongside high-resolution bathymetry and numerical wave models, enabling a more accurate assessment near the coastline.

3. There are several approaches to estimate wave period using altimeter data, for instance (Mackay et. al. 2008, 10.1029/2007JC004438), (Badulin et.al. 2014 10.1002/2013JC009336). Please, justify why the method (Gommenginger et al. 2003 10.1029/2003GL017743) was chosen.

We thank the reviewer for this valuable suggestion. We have added a review of the existing methods for estimating wave period to the manuscript. The method proposed by Gommenginger et al. (2003, <https://doi.org/10.1029/2003GL017743>) was selected because of its simplicity and practicality. In particular, it allows regression coefficients to be derived individually for each wave buoy and subsequently interpolated to regions where buoy observations are unavailable. We have added a discussion of the rationale for this choice and its advantages in the revised manuscript.

4. Please, clarify if for obtaining the equation for wave period and for validation the same buoys are used, or a group of buoys in each region is used to develop the model and another one to validate it.

We thank the reviewer for this comment. We used data from all available wave buoys both to derive the regression coefficients and to evaluate the proposed method. Since the number of available buoys is limited, all buoy locations were included in the analysis to maximize the amount of training data. The complete dataset was subsequently divided into separate training and validation subsets to ensure an independent assessment of the model performance. We have clarified this procedure in the revised manuscript.

5. The energy wave period is calculated as $T_e=1.18T_z$, however in fact wave period ratio is not constant (Cahill, 2014.). Please discuss the limitations of this approach and possible ways to solve this problem.

We thank the reviewer for this important comment. We investigated the regional and seasonal variability of the wave period ratio, T_e/T_z along the European Atlantic coast using data from the SWIM radar onboard the CFOSAT satellite. Our analysis showed that for the North Sea, where wind waves are predominant, a value of $T_e/T_z=1.18$ is appropriate. In contrast, in regions exposed to Atlantic swell, where mixed sea states dominate, the ratio reaches higher values, up to 1.32 during winter. These results indicate that using a constant value of $T_e/T_z=1.18$ may lead to an underestimation of wave power density in swell-dominated regions. Therefore, SWIM radar observations have the potential to improve wave power density estimates derived from satellite altimeter measurements by providing regionally and seasonally varying T_e/T_z values. This represents a promising direction for future research.

Reviewer #3

General comments

This manuscript presents a new dataset created using Synthetic Aperture Radar (SAR) altimetry data from Sentinel-3A/B and CryoSat-2. Thirteen years of the SAR data are analyzed to retrieve measurements of the significant wave height (Hs), zero crossing wave period (Tz) and wave power density (WPD) around eleven oceanic and coastal regions.

The high resolution data is retrieved using the SAMOSA+ retracker and empirical functions. The new dataset contains crucial information for the assessment of the wave parameters, needed for marine spatial planning, offshore renewable energy development and maritime safety.

Although the manuscript presents a new dataset with products of SAR observation, it lacks details on the methodology of data retrieval and details on limitations and error estimates regarding the two different satellites used.

Below the comments and questions on the manuscript.

Suggested technical corrections

1. Line 14-17: Suggest rewriting the sentence to make it easier to follow and more clear: “ Marine renewable energy is a promising source for countries with extensive maritime zones. This is due to a growing interest in renewable energy sources for electricity generation to fight climate change, rising global energy consumption, competition for land use (agriculture, urban planning, and protected areas), and high population density.”

Fixed

2. Line 46-47: Suggest rewriting the sentence to make it easier to follow and more clear: “This article describes the method used to determine the wave period, the validation of the Hs and Tz obtained from satellite altimetry, the structure of the final dataset and finally the applications of the wave power density dataset.”

Fixed

3. Line 98: Suggest rewriting the sentence to make it more coherent and clear: “ with a Root Mean Square Error (RMSE) of 0.22 m and a correlation coefficient (CC)”.

Fixed

Line 124-129: Suggest rewriting this list of the satellite’s data availability or create a table for better visualization of the information.

The table was added:

Variable name and description	Units
Geodetic Latitude at 20 Hz	degree north
Geocentric Longitude at 20 Hz	degree east
Time of Surface Reflection Point at 20 Hz, seconds since 01-Jan-2000 00:00:00 UTC	seconds
Significant Wave Height at 20 Hz	meters
Sigma Nought at 20 Hz (corrected for atmospheric attenuation)	dB
Quality flag: 1 – labeled as an outlier, 0 – labeled as non-outliers	-
Zero-crossing wave period calculated based on SWH and Sigma0	seconds
Wave Power Density per Unit Crest at 20 Hz	W/meter
Distance to Coastline at 20 Hz	meters
Misfit between Power Waveform Model and Power Waveform Data at 20 Hz	count

Table 2. The variables provided in the WAPOSAL dataset.

5. Line 65: Clarify and explain with more detail what is the “misfit”.

In the revised version of the paper, we added the explanation below:

In the retracking procedure, the measured reflected radar waveform is fitted to a theoretical model, and several parameters, including the significant wave height and σ^0 , are estimated. The 'misfit' quantifies the discrepancy between the measured waveform and the fitted model waveform. Therefore, a larger 'misfit' indicates poorer agreement between the observations and the model used in the retracking procedure. The dataset contains information on the 'misfit' between the model and the measured altimeter waveform, which was later used for quality control.

6. Line 109: The reference "(Cahill 2012)" is not present in the list of references. Another article is present in the references as (Cahill 2014)

Fixed

Specific comments

1. Line 43: Mentions that “the data is validated against in-situ wave buoys and/or ERA5 data.” suggestion to explain what type of validation technique *is*

applied to the data, and highlight how the data is divided between validation with ERA5 and validation with buoys.

For each buoy and each ERA5 node, the collocated dataset was randomly partitioned into two equal subsets: a training set and a validation set. The training set was used to estimate the regression coefficients a and b , while the validation set was employed to evaluate model performance in terms of bias, scatter index, and correlation coefficient. This procedure was repeated 1000 times to obtain a stable estimate, and the resulting ensemble was used to compute averaged estimates of both the regression coefficients and the statistical metrics. We followed the methodology outlined in Mackay (2008, <https://doi.org/10.1029/2007JC004438>).

We have added this information to the text.

2. Line 53: Mentions that the “data in high resolution Synthetic Aperture Radar (SAR) mode were considered and reprocessed.” Suggestion to describe how much data has been used for each location, if there is a minimum threshold of number of images from SAR that are needed for the location to be able to determine the wave height, wave period and wave energy density.

We are thankful for an important comment. Indeed, for several locations, the number of collocated samples was insufficient. Thus, we used only those locations with more than 100 points for further processing. This information has been added to the text. For several locations, the number of collocated samples is >2500 points. We have performed linear regression for each buoy separately.

3. Line 74-77: The method presented by Gommenginger et al. in 2003 calculates the zero crossing wave period for deep water, suggestion to consider and explain limitation on how that applies to the selected buoys and ERA5 points’ data since the area of interest is a coastal area. Or state whether the selected buoys and ERA5 points are located in deep water.

We are grateful for this important comment on the applicability of the deep-water formulation for wave power density in a study focused on coastal regions. We fully agree with the Reviewer's comment. The deep-water formulation is strictly valid only when the water depth exceeds half the wavelength. In the revised manuscript, we have clarified this assumption and explicitly discussed its implications. We acknowledge that for longer-period swell waves, the deep-water assumption may not be strictly valid in parts of the shelf, where intermediate-depth conditions can occur. This may

lead to a moderate overestimation of wave power density when the deep-water formulation is used. We have therefore revised the manuscript to explicitly state the deep-water assumption and discuss the potential bias introduced by neglecting finite-depth effects. Future work will address this limitation by implementing finite-depth formulations of wave power density alongside high-resolution bathymetry and numerical wave models, enabling a more accurate assessment near the coastline.

Moreover, suggestion to describe more thoroughly how the coefficients a and b are calculated.

The coefficients were calculated using linear regression for X and T_z , we have added this phrase to the text:

Therefore, following Gommenginger et al. (2003), we have re-evaluated, for each collocated data set, the coefficients (a and b) of the following equation using linear regression, with collocated T_z in situ wave buoy data and altimeter H_s and σ_0 data.

$$T_z = aX + b \quad (1)$$

4. Line 87: Mentions "the selected ERA5 grid nodes" without assessing how and how many grid nodes are selected. Did you select the closest node to the location? Did you consider all the nodes in the radius of 40 km from the location? Or did you interpolate the values of the closest nodes? In addition, how many nodes for location did you use? And does this number change depending on the locations?

ERA5 data were used as a substitute for buoy observations. For each area of interest, several ERA5 grid points within the coastal zone were selected for analysis. An example for the Madeira region is shown in Figure 1, where 12 grid points were selected. The number of selected grid points varied by region (6–12 points for the French Guiana, Madeira, and Canary Islands regions), depending on the size and spatial extent of the study area. The grid points were selected to provide representative coverage of the coastal zone. No spatial interpolation was applied; instead, ERA5 data from each selected grid point were used directly. Time series of significant wave height and wave period were extracted from the ERA5 dataset and then processed in the same manner as the wave buoy observations.

The information is added to the text.

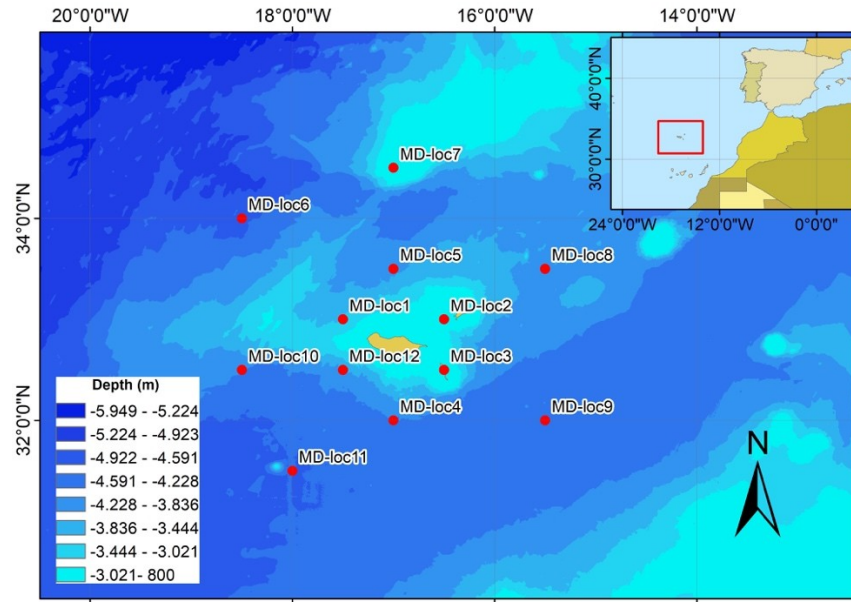


Figure1. The locations of the twelve ERA5 grid points in the region surrounding the Madeira Archipelago, whose data were used to obtain the linear regression coefficients.

5. Line 89/90: Mentions that "the time interval was 45 minutes, and the spatial distance was 40 km", how were these spatial and temporal conditions for the data collocation selected? Did you follow any previous study done or is there any reference in literature? Did you consider the possibility of the results changing if you selected different spatial and temporal conditions?

In Gommenginger (2003, <https://doi.org/10.1029/2003GL017743>), the collocation criteria are 100 km in space and 1 hour in time. In Mackay (2008, <https://doi.org/10.1029/2007JC004438>), the spatial collocation criterion was 100 km and the temporal criterion was 30 minutes. However, the authors used NDBC buoy data, and these buoys are located farther from the coast. The buoys from the network around Europe that we used are located mostly in the coastal zone; therefore, we have limited the spatial distance to 40 km to ensure higher homogeneity of the data around the buoy, and the collocation time was set to less than 1 hour, on the one hand, to capture the variability of wave parameters, and on the other hand, to accumulate sufficient statistics.

We acknowledge that different spatial and temporal thresholds could lead to somewhat different validation statistics. However, a sensitivity analysis of the collocation criteria was beyond the scope of the present study. Therefore, while we recognize that the results may vary depending on the selected criteria and local conditions, we have limited our analysis to the

adopted collocation scheme and have clarified this limitation in the revised manuscript.

6. Line 93: Assesses "training and validation" which was never mentioned before therefore it is suggested to discuss this part of the method in more detail, specifically describing how the datasets were divided, if they had the same or different sizes, and if there are any constraints on the selection of the data. It would be extremely useful to have more quantitative data on this part of the methodology.

The training and validation datasets are similar in size: we use one half of the dataset for training and the other for validation. The dataset is randomly split, and this procedure was repeated 1000 times to obtain a stable estimate, and the resulting ensemble was used to compute averaged estimates of both the regression coefficients and the statistical metrics as discussed in (Mackay, 2008, <https://doi.org/10.1029/2007JC004438>).

The information is added to the revised manuscript.

7. Line 97: States that " for CryoSat-2, similar results are obtained", without giving any type of numerical value of the error metrics like RMSE or CC. It is suggested to add the graph of the CryoSat-2 results, or at least report the numerical qualitative data as done for Sentinel-3A/B data. It is also suggested to integrate information about differences between the Sentinel-3A/B and CryoSat-2, and where such differences may come from, biases or differences in the satellite sensors swath.

We have added the information on the error metrics for Cryosat-2: For Hs, bias=0.02 m, RMSE=0.24 m, CC=0.98; for Tz, bias = -0.0003 s, RMSE=0.57 s, CC = 0.9.

8. Line 116/117: mentions "observation time in seconds since 01-01-2000 for each antenna footprint", without specifying the time zone taken as reference for the observation time data.

The time is indicated in the UTC time zone, and the information is added to the text.

9. Line 169: States " The satellite-derived WPD closely follows the ERA5 observations.", without discussing any numerical value nor quantitative data. What is the bias and RMSE between the satellite derived WPD and the ERA5 observation?

Wave power density derived from CryoSat-2 was compared with ERA5 observations, yielding a bias of 3.5 kW/m and RMSE of RMSE=9.9 kW/m. For Sentinel-3A/B, the corresponding bias was also 3.5 kW/m, while the RMSE was slightly lower at 9.7 RMSE=9.7 kW/m. These results indicate good agreement between the satellite-derived and ERA5 wave power density estimates.

This information is added to the text.