Response to Dr. Alamgir Hossan (Reviewer #2)

We thank Dr. Alamgir Hossan for careful evaluation of the manuscript and valuable suggestions. Below we provide our replies in a point-by-point manner with our responses given in blue and comments of Dr. Alamgir Hossan in italic black.

AH C1: *The English language, both grammar and expression, of this manuscript is significantly flawed (some of the example recommendations are provided in the minor comment section below), it should be thoroughly revised.*

AC: According to this comment and also comments by Reviewer#1 the revised MS was entirely edited and proofread with many being fully re-written. We are very much hopeful that English of the revised version meets the ESSD standards.

AH C2: *Use of X-band marine radar for sea surface wind and wave measurements is not new in the literature (see Huang et al., 2017 for examples). More in-depth description of SeaVision, its unique features, and algorithm used to measure the wind waves should be discussed. Comparison with contemporary X-band radar - in design and performance – is recommended.*

AC: Thank you for this comment. In the revised version we provided more extensive description of the SeaVision advantaged and methodology with specifications of the technical details of the hardware and methodological details of algorithms.

Changes in manuscript: The whole Section focused on methodology for the analysis of sea clutter images was rewritten, we have also added Appendix B which gives detailed explanations of associated algorithms. Specifically, the following text elaborating the purposes of SeaVision development was added:

….."Development of the SeaVision system was based on a commonly accepted approach of the recording and analysis of the sea clutter images. Using a similar approach to commercial systems such as WaMoS II (http://www.oceanwaves.de), SeaDarQ (Greenwood et al., 2018) and WaveFinder (Park et al., 2006) were developed. These commercial systems provide customers with their original software and hardware (sometimes including the X-band radar itself). In our approach we are focused on the development of an independently operating and low cost system compatible with the existing navigation radars with which ships are already equipped"…..

AH C3: *In lines 180 - 185, and in section 2.3, you mentioned that,m"*$Hs = A + B\,SNR$ *(1) where A and B are empirical calibration coefficients for each radar. In this study calibration coefficients were calculated on the basis of the simultaneous observations with the Spotter wave buoy (see Section 2.3). Calibration coefficients are also used for calculation of the wave energy spectrum. We also use modulation transfer function (MTF, Nieto-Borge et al., 185 2004) to correct radar antenna effects of tilting and shadowing to correct the wave energy spectral density." "We further use wave parameters derived from buoy as the "ground truth" for the SeaVision calibration and estimation of the radar calibration coefficients A and B, these coefficients are further used to rescale the SeaVision wave energy spectrum to match buoy spectrum with least squares" - However, nowhere in the paper, the*

numerical values of 'empirical calibration coefficients' A and B have been given. Please, include those important numbers and describe the calibration procedure more clearly and quantitatively.

AC: We thank Dr. Alamgir Hossan for this comment. In the revised version we provide a clear explanation of the calibration procedures in section 2.2.2 which was re-written. We also provide important details of the computations in Appendix B.

Changes in manuscript: Values of the calibration coefficients A and B added in the Table 2:

Calibration coefficients A and B	A = -0.4042, B = 1.0034	A = -0.4042, B = 1.0034

AH C4: *From the standard expression of the linear dispersion relation, $\omega 2 = gk \tanh(kh)$, we know that h is the water depth (even the same is given in the reference Nieto-Borge et al., 2004), not directly significant wave height. But in line 165, you claimed that it is the significant wave height which is the key parameter of your results. Therefore, please, review the relevant theory and justify it more clearly.*

AC: Thanks for noticing this inconsistency. In the revised version we corrected the equation for the linear dispersion relation, explained all notations in the equations and also added the equation used for wave period estimation. As we pointed out above, the whole section 2.2.2 is now rewritten, we also provide new Appendix B, where we explain the details of the processing of images in detail.

Changes in manuscript: The whole section 2.2.2 was rewritten, Appendix B was added.

AH C5: *What quality filters were used? Was there any rain event during any expeditions and data acquisition? Please, discuss these in detail in the data collection section.*

AC: We thank Dr. Alamgir Hossan for this comment. We did not use any quality filters as the standard output of the meteorological station was already quality controlled, the Spotter wave buoy data do not require any quality control, as the buoy system passed calibration procedure. SeaVision and radar operation indeed can be affected by the rain events as the raindrops can scatter electomagneitc radar signal. We checked our records with respect to this and found no rain events during observation periods.

Changes in manuscript: Sentence on weather conditions was added in the lines 240-241 of the revised version of the manuscript:

…."We note that local weather conditions, specifically rain events, can potentially affect the electromagnetic radar signal as the raindrops absorb and scatter radar signal. However the analysis of current weather has shown that no rain events were observed during observations."….

AH C6: *The data could not be accessed/retrieved from the given link (https://sail.ocean.ru/tilinina2021/), consequently, the data could not be verified.*

AC: Thank you for noticing this. The temporary link at PANGAEA repository is available now for the Reviewers' attention -

https://www.pangaea.de/tok/644c8383ea60396920442184e648ad95714c8d9e

AH C7: *X-band radars are usually capable of other wave parameters including sea-swell, which is a very important related parameter. So, authors should justify why the swell measurement was not included in this study. In the open ocean, swell and surface current contributions to the wave height can be significant depending on the location and time of the year. Therefore, results should be presented on the basis of different sea states. You may use different colors in your scatter plots to indicate different sea states. How have you estimated significant wave height without swell and surface current information, or how have you separated them?*

AC: We thank Dr. Hossan for this comment. Indeed, we provide only wind wave statistics disregarding swell. At the same time, in the dataset, we provide 1D spectra from both Spotter buoy and SeaVision system. There are two reasons why we do not provide data on swell and wind waves separately in this manuscript: (i) the methodology development for accounting contributions from swell and wind waves is still under development in SeaVision and have not been tested to a full extent, and (ii) when a proper algorithm (and likely modification of SeaVision) is developed and the uncertainties of separation of wind waves and swell on the basis of sea clutter images are quantified (expected to be quite large), this will need to be addressed in separate study. We plan to include swell and wind wave separation in the future study and a new versions of SeaVision. At this stage we do calculate surface currents, however we are aware that methodologies for surface currents are successfully used in e.g. WaMoS system.

Changes in manuscript: Comment on swell separation was added to the Data availability section:

…"In this dataset we only provide wind waves statistics, disregarding separation of the swell and wind waves at this stage of the SeaVision development. We plan to include this procedure into the next studies. At the same time we provide one dimensional spectrum that allows to see first and second peaks associated with winds waves and swell"…

AH C8: *Validation with the satellite altimeter/SAR or other observational data product (for the possible range) is recommended besides the Spotter wave buoy and WaveWatch model.*

AC: We thank Dr. Alamgir Hossan for this comment. We added the results of intercomparison of our wind wave observations with all available satellite altimeter crossovers.

Changes in manuscript: Figures 8 and 9 added to the text of the MS. Section 3 significantly reworked, intercomparison with satellite altimeters crossovers added.

AH C8: *Overall description of the WaveWatch III model experiment in section 2.5 is not sufficient. Describe more about the model input, output, and also discuss model limitations. Models usually have their inherent bias/uncertainty, furthermore, the native spatial resolution of ERA5 reanalysis is 31 km. You should include its possible effects on the results.*

AC: We thank Dr. Alamgir Hossan for this comment. We added more extensive description of the WaveWatch III set up. Also in the revised version Table 3 with the details of experiments was added.

AH C9: *The focus of this manuscript is validating the SeaVision radar, not the Spotter buoy. So, I recommend presenting "Spotter minus SeaVision (Fig. 5a) and WW3 minus SeaVision (Fig, 5b)" in Figure 5, instead of "Spotter minus SeaVision (Fig. 5a) and Spotter minus WW3 (Fig, 5b)". Same recommendation applies to Figure 7. Also, plot the ground truth along the x-axis, and SeaVision measurement along the y-axis.*

AC: Thank you for this suggestion. We swapped Spotter minus WW3 to WW3 minus SeaVision in Figure 5 and the results should be more clear now. In addition, we highlighted extreme differences reaching 1 m with red on both plots.

Changes in manuscript: Updated Figure 5 now stands as follows:

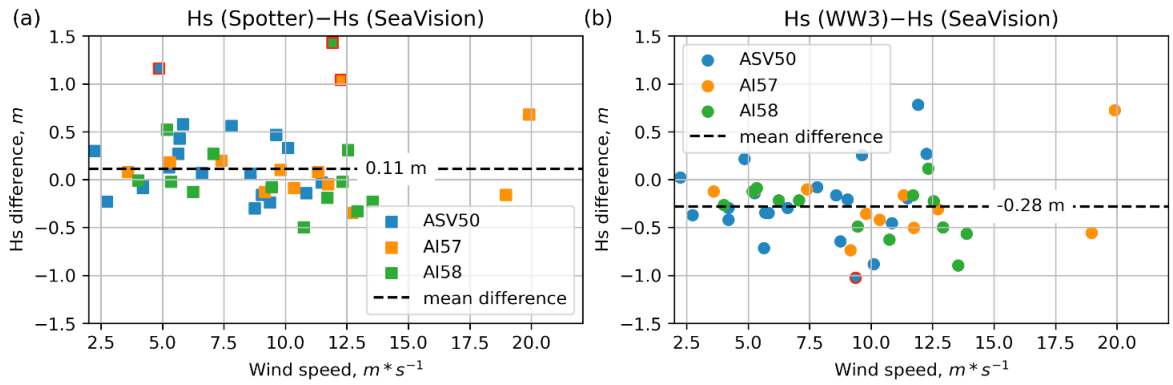

Figure 5: Difference in the significant wave height (H_s) estimates for all stations as a function of the wind speed: Spotter buoy ("ground truth") *minus* SeaVision (a), WW3 *minus* SeaVision (b). Dash lines mark the mean difference across all data points. Red squares and circles mark differences higher than 1 m.

AH C10: *Solid line must be a 45° line originating from {0,0} in all scatter plots of Figure 6. Quantitative information, i.e., Numerical values of the bias and the STD/root mean square error should be included in the scatter plots (Fig. 6).*

AC: Thank you for this comment. We included RMSE and SI statistics into the plot panels (also suggested by Reviewer#1). The fitting line now crosses [0 0] points.

Changes in manuscript: Updated Figure 6 looks as:

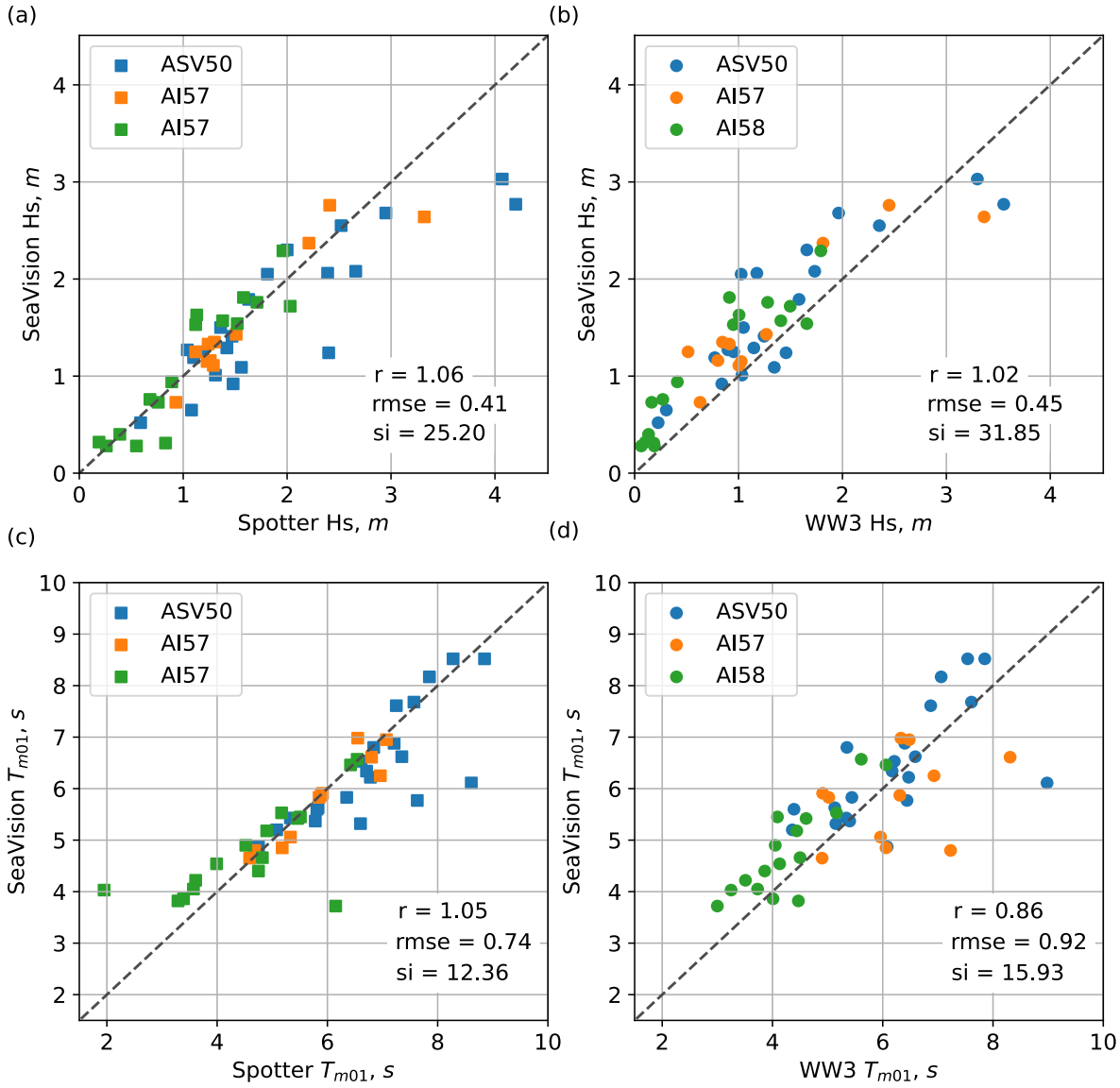

Figure 6: Scatterplots of the significant wave height (H_s) and wave period (T_{m01}) revealed by SeaVision and measured by Spotter (a,c) as well as revealed by SeaVision and simulated with WW3 (b,d) for all stations. Together with Root Mean Square Error (RMSE) and Scatter Index (SI) statistics.

AH C11: *It is recommended to include the validation results of the wave energy frequency spectrum measured by the SeaVision system in a separate plot.*

AC: Thank you for this comment. In the dataset, that supports this manuscript we provide the digital data quantifying 1D wave energy spectrum which can be easily plotted from the netcdf files (Figure R1). Example of the buoy spectra is also provided in Figure 4.

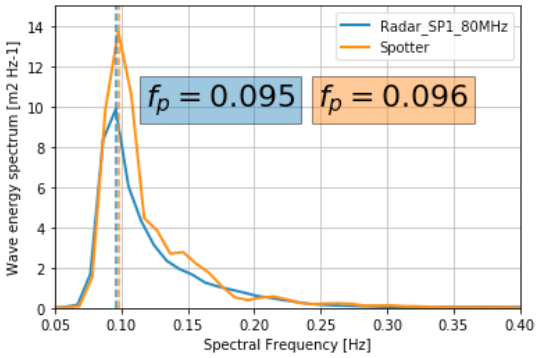

Figure R1. 1D wave energy spectra on the basis of Spotter buoy and SeaVision.

Changes in manuscript: We highlighted in the text of the MS that 1D spectra are available by adding the sentence in the Data availability section:

…"At the same time we provide one dimensional spectrum that potentially allows to see first and seconds peaks associated with winds waves and swell"…

We thank Dr. Alamgir Hossan for his efforts focused on the careful evaluation of our manuscript. As the text of the manuscript was significantly reworked and many text fragments were rewritten, we adopted all minor comments everywhere, except for text pieces which were entirely rewritten.

Minor comments

AH*: "Simultaneously with SeaVision observations of the wind waves we were collecting data in the same locations and time", use simple past tense. Same as in line 99 -- "we were using Spotter wave buoys"; line 120 "we were collecting"; line 121-122 "vessels were drifting".*
Response: Thank you. Corrected.

AH: *Please, clarify what you mean by 'wind waves' (possibly, in the introduction section) for the general audience and state specifically which wave parameters the SeaVision system measures. Although you mentioned it later in the abstract, "The dataset that supports this paper consists of significant wave height, wave period and wave energy frequency", I think it'd clearer if you mention it at the beginning when you first describe it "In this paper we present the SeaVision system for measuring wind waves' parameters in line 19.*

Response: Thank you for this comment. In the Introduction we provide a clear definition of wind waves along with references highlighting wind waves importance for different applications:…."Wind waves are wind-driven ocean surface gravity waves". We also added to the manuscript Appendix C with all definitions of the dataset parameters, thus making it easier to go through the manuscript. We mention in the beginning of the Section 2 that all definitions of all parameters in the published dataset can be found in the Appendix C.

AH: *The data link can be given in the data section, instead of providing in the abstract.*
Response: Thank you for this comment. It is a requirement of the ESSD journal to provide link to the dataset that supplies the manuscript both in the abstract and in the Data section.

AH: *In line 33: "The history of wind waves studies" - should be 'The history of wind wave studies'. Same as in line 114, "the wind waves data", should not be a plural adjective.*
Response: Thank you. Corrected.

AH: *For lines 33-40, cite proper sources.*
Response: Thank you. Citations are provided.

AH: *In line 41: use the simple present for "Remote sensing datasets of the wind waves are dating back". Same for lines, 50, 53.*
Response: Thank you. Corrected.

AH: *In line 41, "when the first satellite radar altimeters missions began measurements of the elevations of the ocean surface" -- should be the first satellite radar altimeter mission.*
Response: Thank you. Corrected.

AH: *In line 41, "when the first satellite radar altimeters missions began measurements of the elevations of the ocean surface" -- which satellite radar altimeter? Please, cite.*

Response: Thank you. Now the citations are provided as follows: …"when the first satellite radar altimeter missions (Seasat in 1978 (the first satellite to provide data) and Geosat in 1985)"...

AH: *In line 44:* "Buoys are measuring vertical and horizontal displacements of the ocean surface", -- please use simple present tense instead of progressive.
Response: Thank you. Corrected.

AH: *In line 48: "buoys cover only a few locations" -- it is true that buoy networks are sparse for global coverage, nevertheless, it is not "a few".*
Response: Thank you. Now this is rewritten as follows: …."However, buoy networks are sparse with most deployments being in the coastal regions and can only effectively serve for verification of all other dataset rather than for developing global or regional climatologies."….

AH*: In line 53: "collecting wind waves observations" -- should be 'wind wave observations'.*
Response: Thank you. Corrected.

AH: ***Line 88:*** *"2 3 Spotter wave buoy data", please use a dot to indicate a subsection. Same as in line 109 - "2 1 Expeditions"; line 125 - "2 2 SeaVision system"; "2 2 1 Radar signal preprocessing".; "2 2 2 Analysis of the sea clutter images"; "2 3 Spotter wave buoy data"; "2 4 Meteorological data"*
Response: Thank you. This was corrected throughout of the whole manuscript.

AH: *Please, use a dot (instead of a comma, which is misleading) to represent fractional numbers, such as in line 117 (59,5°N), line 289 (2,5s), table 1 (231,5) and some other places.*
Response: Thank you. This was corrected throughout of the whole manuscript.

AH: *Lines 57-58, "(i) collecting wind waves observations in the open ocean using navigational marine X-band radar and (ii) to monitor in real time wave heights, direction and period along the ship track in the open ocean." - use parallel sentences (either gerund or infinitive noth mixed)*
Response: Thank you. The sentence is rewritten as reads now as: …"We present the design and pre-processing methodology of the SeaVision system along with the dataset collected during the three research cruises (Fig. 1)"….

AH: In line 108, I prefer "2. Data collection and analysis" to "Data collection and analysis principles" as the section heading.
Response: Thank you. Corrected.

AH: *In Figure 1, indicate the start, end and direction of the expeditions. For a large portion of the track, especially for figure a and c, data were not collected, why? Please, mention this in the description.*
Response: Thank you for this comment. We added Table 1 with the description of the research cruises. We have also significantly reworked the description of the strategy of the field experiments. The locations of the measurements were chosen on the basis of predefined hydrographic stations. This is now clearly posed in the text in lines 125-133.

AH: *In section 2.2.1, and 2.2.2, indentations are used for paragraphs, and nowhere else it is used. Please, make it consistent throughout the paper.*
Response: Thank you. Corrected throughout the whole manuscript.

AH: *In line 133, you mentioned "For our purposes we used the shortest possible pulse length of 0.08 μs", please explain why.*
Response: Thank you for this comment. Indeed, the reason for setting the radar to short pulse length was not clearly explained in the previous version. In the revised version we made the changes to clarify this issue with the following: …."Radars can optionally operate at the pulse lengths of 0.08 μs, 0.25 μs, 0.5 μs, 0.8 μs, 1.0 μs. For our purposes we used the smallest possible pulse length of 0.08 μs (at the so-called "short-pulse" mode - SP1) providing the highest possible resolution of the image (thus the best resolution of the ocean surface). Our X-band radars are characterized by a 3.18 cm wave length of the emitted electromagnetic waves (Table 2). The pulse length is the emission time of the wave beam, thus the number of the emitted waves

and the area of the reflection at the ocean surface (defining spatial resolution) increase with increasing pulse length".....

AH: Please, follow the custom to abbreviate megahertz as MHz in Table 1.
Response: Thank you. Done.

AH: *Line 157-158, you mentioned, you chose "minimal distance from the ship of 300 m (to avoid potential impact of the ship to the wave field and illumination of the radar signal by the ship).", but for the Spotter wave buoy, in lines 195-196, you mentioned that it was selected to be 200 m. Please, make it consistent. However, if there is any particular reason, please, include your explanation.*
Response: Thank you for noticing this inconsistency. Numbers are corrected now.

AH: *In line 165, please, correct the unit of gravitational constant 'g' (ms-2).*
Response: Thank you. Corrected.

AH: *In line 195: "200m" vs "300 m" in line 158. Please, make the syntax (space between quantity and unit) consistent throughout the paper.*
Response: Thank you. Corrected through the whole manuscript.

AH: *Line 206, "We further use wave parameters derived from buoy" -- please, specify the parameters.*
Response: Thank you. This is specified now in the Data availability section as: …"Datasets that contains significant wave height, wave period, wave direction, wave energy frequency spectrum, meteorological data and other related parameters from both SeaVision and the Spotter buoy at the locations of every station"….

AH: *Line 228, What is ST6 parameterization? Please, explain ST6 parameterization and the discrete interaction approximation (DIA) scheme a little more about it considering the general audience.*

Response: Thank you for this comment. In the revised version of the manuscript we provide a reference to the WaveWatch III development group basic publication and few other references giving the description of source term (ST6) package for parameterizations of wind input, wave breaking, and swell dissipation and of Discrete Interaction Approximation (DIA) parametrizations.

AH: *Line 255, "worser" should be worse.*
Response: Thank you. Corrected.