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Review and rebuttal of the paper

Directional Spectrum Estimation for Sea States Generated by the Single Summation Method

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Editor handling the paper: Miguel Esteban

Revision

Comments from Editor:	Author's comments
In addition to the comments by reviewers (See below for reviewer #1 and attached for reviewer #2), please "recheck equations and interpretations in Line 91-99 to see if they are correct or not (...) please ask the authors to provide more details directly (about these equations)".	Thank you for the additional comments. The equations have been revisited by the author. They are originally derived by Lin and Huang (2004) and agree with the original formulation. This reference has furthermore been added to the revised manuscript. Let us know if further elaboration is required in another revision.

Reviewer #1	Author's comments
This manuscript proposes a new single summation method, called SORS, to analyze the oblique reflection of multidirectional waves. The methodology is concisely presented through mathematical formulations. Although some equations lack full rigor, they are still comprehensible. SORS was tested with five specific sea states, and the computational results were consistent with the target data. The authors considered several potential sources of computational error, demonstrating the robustness of SORS. Please consider addressing the following points if a revision is planned:	Thank you for the detailed review and great suggestions for improving the paper. All the comments have been handled in the revised version and have contributed to a significantly stronger paper. Regarding your comment about equations lacking full rigor, we refer to the answer given above to the editor.
1. Line 46-47: "When oblique...of the direction" is a very strong statement. Please make it milder.	The reviewer is right as the error depends of course on the obliquity and the reflectivity of the structure. It is rewritten in the revised manuscript with more specific reference to the results from Draycott et al. (2016).
2. Line 60: Please replace "shortly" with "briefly."	Thanks, it is corrected in the revised manuscript.
3. Equation (2): Please clearly define the subscripts (I and R).	Description of subscripts I and R added below equation 2 in the revised manuscript.
4. Equation (3): This is the dispersion relationship for linear waves. Have the authors calculated the wave steepness and the Ursell number for the test data? In Table 1, for sea states No.4 and No.5, (if the reviewer calculated it correctly,) the wave steepness values calculated from H_{m0} and T_p are close to the limit of the linear wave theory's applicable range. This should be mentioned somewhere in the manuscript.	The following comment is added in the manuscript: The present work considers wave fields generated from linear wave theory. The significant wave heights and peak periods in Table 1 are in some of the sea states close to the limit of the applicable range of linear wave theory. If those tests are generated in a physical model then nonlinear waves will appear and these will contribute with larger errors as demonstrated for long-crested waves by Eldrup and Andersen (2019). As the present work revolves around synthetically generated waves only, it is though not of influence for the analysis, as the generated waves matches the assumptions of the mathematical model in Eq. (1)

<p>5. Figure 2 and 3: 5-(1) Please merge Figures 2 and 3 into a single figure with two subfigures: Figure 2(a) and Figure 2(b), as they show the same data. 5-(2) Please convert the 3D plots into 2D contour plots or 2D color plots. With only three variables, a (3D+1 color) graph is unnecessary.</p>	<p>Thanks for the suggestion. Figure 3 has in the revised manuscript been converted to a 2D color plot as suggested by the reviewer. Figure 2 was of little legibility in 2D as the logarithmic scale is more appropriate for the color plot.</p>
<p>6. Line 146: If the green object in Figure 5 represents the structure, is "6 m" the correct position for the structure?</p>	<p>Yes, the distance is given in the x-direction relevant to position (0,0), which is placed outside the figure. The position corresponds to an approximate position of the corner of the wave basin. This information has been included in the revised manuscript as well.</p>
<p>7. Figure 5: Is it necessary to use such a green object to represent the structure (possibly a dyke)? Also, please indicate the mean wave direction, θ_0, in the graph.</p>	<p>Figure updated to be in black and white and mean direction added as suggested by the reviewer.</p>
<p>8. Table 1: 8-(1): If θ_0, s, C_r, α_s are the same for all sea states, listing them in the table is unnecessary. Instead, please include the values of D (or R). This will help in discussing error sensitivity. Including wave steepness or the Ursell number would also be beneficial. Please make this table more informative as it is used in the major analysis. 8-(2): Please revise the significant digits of H_{m0}. 0.10 and 0.20 should be used.</p>	<p>8-(1): As suggested by the reviewer the values that are identical for all tests has been deleted from the table and added in the text instead. The peak wave length (L_p) and the diameter of arrays (D) is now specified in the table as suggested by the reviewer. Wave steepness/Ursell number is not included, as the present work only presents waves synthetically generated from linear wave theory. Potential nonlinear interactions are therefore not included in the analyzed wave fields as also stated in reply to comment 4. 8-(2): Suggestion by reviewer followed.</p>
<p>9. Figures 6 and 7: Please consider merging them into a single figure. But if this affects the legibility of the figures, please keep them separate.</p>	<p>Figure has been merged to a single Figure in the revised manuscript, where it is Figure 5.</p>
<p>10. Figure 8: 10-(1) The markers are illegible. Please use line plots where large errors are represented by spikes. 10-(2) Why were the absolute values of errors used for amplitude?</p>	<p>Thanks for the suggestion. In the revised paper the figure is Figure 6 where; 10-(1): Scatter plots are replaced with line plots as suggested. 10-(2): Amplitude no longer specified as absolute error as also suggested.</p>
<p>11. Figure 11: There is an unexpected comma in the label of the horizontal axis.</p>	<p>Thanks, comma deleted (Figure 9 in revised version)</p>
<p>12. Line 237: Please re-check if the structure is perpendicular to the "y-axis." A back wall usually means that it is perpendicular to the x-axis if the mean wave direction is parallel to the x-axis.</p>	<p>The reviewer is right. Changed to x-axis in revised manuscript.</p>

<p>13. Lines 239, 240, 243: The subscripts are incorrect.</p>	<p>Thanks, corrected in revised manuscript.</p>
<p>14. Lines 252-253, 259-260: Please rephrase these sentences for grammatical accuracy. Please specify which gauges were moved or manipulated.</p>	<p>Thanks, the text has been rewritten in the revised manuscript. The details about the movement and manipulation have been stated in bullet points for clarity.</p>
<p>15. Figure 12: Please modify the caption to "back wall reflection."</p>	<p>Thanks, this recommendation is followed. The figure has number 10 in the revised manuscript.</p>
<p>16. Figures 12-15: There are unexpected commas in the labels of the horizontal axes.</p>	<p>Commas deleted in Figures 10-13 in the revised manuscript.</p>
<p>17. Section 4.1: In the view of the reviewer, this section appears to be a discussion. Please consider moving it to the Discussion part.</p>	<p>We agree with the reviewer and has followed the recommendation. Thus, this part is moved to the discussion part in the revised manuscript.</p>
<p>18. Future Work: This should not appear in the Discussion section. Please consider merging it with the Conclusion section and renaming the chapter to "Conclusions and Future Work."</p>	<p>Thanks for the suggestion which we have followed in the revised manuscript.</p>
<p>19. References: If it is possible, please add more recent research papers to the references list. Only five articles published after 2014 are included.</p>	<p>Not much research has been performed on this specific type of analysis the past couple of years. A vast amount of the research covers analysis of two-dimensional waves with inclusion of i.e. nonlinearity, shoaling, wave-current interactions and more. Additional references has been added (Lin and Huang (2004), Pallida and Alsina (2020)) But none of these are applicable in multidirectional waves, wherefore they are of less relevance in the present work. If the reviewer has specific references in mind then please let us know so we can check their relevance.</p>

Reviewer #2	Author's comments
<p>Title: Directional Spectrum Estimation for Sea States Generated by the Single Summation Method</p> <p>Overview: The manuscript presents an interesting method of separating water surface elevations into their constituent incident and reflected components based on a Single Summation idealization. Its novelty is applying wave-separation techniques to a wide range of incident/reflection angles, allowing for easy and precise decomposition of obliquely incident wave fields. However, the presented results are based on synthetic data. The manuscript is well-structured and concisely written, and the authors did a great job of presenting their results clearly. Here are my major and minor comments.</p>	<p>Thank you for spending your time giving review and suggestions to our work. We have handled all comments and incorporated the suggestions in the revised manuscript. The authors are thankful for the contributions in improving the paper.</p>
<p>Major: 1) The conclusion undermines the sensitivity of the obtained reflected wave field in the SORS method to wave gauge positioning (Figure 14), wall reflection (Figure 12), and calibration error (Figure 15), which is obvious in the results. Understandably, the incident waves are usually of primary concern; however, the wave-current interaction during longshore transport processes could also surface as a counterargument.</p>	<p>The authors are aware that the method is only tested for a limited number of deviations from the theoretical sea state model. Presence of current is therefore not considered in the following but would be interesting to test in future work. Additional specification hereof is added in line 72-73.</p>
<p>2) In line 136, the authors start by saying they used synthetic data for the analysis. Then, in Lines 147-149, they go on to say, "The present analyses revolve around waves generated in laboratory facilities." I assume they are drawing a parallel to actual laboratory experiments here, but they could be clearer.</p>	<p>Yes, that is correctly understood. Lines 147-149 have been rewritten for clarification.</p>
<p>Minor: Out of curiosity, would it have lessened the computational workload if the angle of reflection had been obtained from Snell's law?</p>	<p>If the orientation of the structure causing the reflection is known as well as no refraction occur then the reviewer is right. Thus that is expected to work well on the investigated cases in the present paper. However, in most physical model tests it is more difficult as the structure might be curved or even floating. Also a bathymetry might be present that cause refraction between the array and the structure.</p>
<p>Line 53 – 55: This sentence is a little confusing and may be missing something, consider rewording?</p>	<p>Yes, the sentence has been rewritten to: Common for these different contributions is, that they diverge from the single summation model assumptions. Such contributions are therefore not considered in the mathematical model.</p>

<p>Lines 122 – 124: Would it be more relevant to practical applications if the error “E” was assessed for the peak frequency?</p>	<p>The error is assessed for all frequencies and show the same trend for all frequencies: that the correct directions yield a very local minimum of the squared error E. Additional text is added in line 132-133 in revised manuscript.</p>
<p>The meaning of these abbreviations should accompany their first appearance: “BDM” and “MLM” (line 16), “MEM” (Line 18), and “SPAIR” (39).</p>	<p>Yes, thank you for pointing this out. Abbreviations are now elaborated when first mentioned.</p>
<p>Line 59: “Here it will be presented by the influence on the estimated incident and reflected time series.” Please rewrite for clarity</p>	<p>Yes, the sentence has been rephrased in the revised manuscript:</p> <p>The performance will be quantified based on how well the incident and reflected time series are estimated</p>
<p>Line 174: “The performance of method can be evaluated based on different parameters depending on the desired application of the analysis.” The highlighted text might be missing a the/this. Please review.</p>	<p>Yes, thank you. ‘the’ has been added in the revised manuscript.</p>
<p>Line 235: “The same wave fields as the ones given the results in Figure 11 are tested,…” The highlighted text is missing in/by. Please review.</p>	<p>Yes, the word ‘given’ is not correct. It should be ‘The same wave fields as the ones yielding the results in Figure 11 are tested,…”.</p>
<p>Line 251-253: “For the sensitivity towards positional error of the wave gauge three different configurations have been tested; one gauge moved 0.03m in the x-direction, one gauge moved 0.03m in the y-direction, and a configuration where one gauge is moved 0.03m in the x-direction and another gauge is moved 0.03m in the y-direction.” Please rewrite for clarity.</p>	<p>Yes, the authors agree that it could be written more accurately. In the revised manuscript is has been stated in bullets instead:</p> <p>The following part of the sensitivity analysis revolves around positioning errors of wave gauges where three different configurations (errors) have been tested:</p> <ul style="list-style-type: none"> • WG3 moved 0.03m in the x-direction • WG3 moved 0.03m in the y-direction • WG2 moved 0.03m in the x-direction and WG3 moved 0.03m in the y-direction.
<p>Lines 275- 276: “The size of this gap may also be chosen frequency dependent to account for the frequency dependency of the condition number shown in Figure 10.” Please rewrite for clarity.</p>	<p>Yes, the sentence is rewritten in the revised manuscript as:</p> <p>It could be considered to choose different directional gaps depending on the different frequencies. From 9 it also appears that different frequencies will yield different condition numbers when using the same wave gauge array.</p>
<p>Table 2: Typo error “Varaince”. It should be “Variance”.</p>	<p>Thanks, the typos in this caption have been corrected in the revised manuscript.</p>