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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Identification of early warning criteria for rough sea ship navigation using high-resolution numerical wave simulation and shipboard measurements" *by* Chen Chen et al.

Anonymous Referee #1

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This paper addresses the risk of operating ships in severe weather conditions and aims at providing decision support for ship navigation. It studies the relationship between weather conditions and motion responses of ships by comparing numerical wave modelling with on-board measurements of ship motions from a bulk carrier. This is an important issue for maritime safety, and also influence optimal weather routing that may lead to more cost-efficient and environmentally friendly shipping. Hence, the paper addresses an important issue for the maritime industry which is, in principle, relevant for publication. However, I feel the quality of the paper is too poor to warrant publication in

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Discussion paper

a quality international journal. The language and presentation of the research is poor and at times very imprecise, and also the proposed warning criteria seems very simplistic and based on a very simple analysis of correlation between various variables. Hence, I don't find this paper to be interesting enough to recommend publication. On another note, I do not find NHESS to be the most relevant channel for presenting this research and would suggest that the authors possibly submit a revised version to a more ship-focused journal.

Some of my main concerns are given in the following:

- The "warning criteria" are based on a rather simple statistical analysis (essentially only studying correlations between sea state variables and ship motion responses). They seem to be very simplistic and I wonder if not state-of-the art numerical response calculations could be used to obtain better decision support. I guess you may easily estimate the effect of the different sea state variables on ship responses by performing a set of numerical simulations using hydrodynamic models etc (for any loading condition). How does your proposed method compare with such methods and what is the benefit of doing the simple correlation analysis to suggest warning criteria. However, I believe the collected dataset is interesting, and possibly this could be used to validate such numerical models (in addition to model tests, which are commonly used to validate ship model simulations).

- Some ships are equipped with a hull monitoring system to advise about operation in high seas. This is not mentioned in the paper, and a discussion on the effect of such systems, perhaps in combination with other methods for decision support could be relevant in the introduction or in section 2. Such systems measure stresses and accelerations in the ship hull and would provide additional information to what is collected in your case study. You could get ship structural response in addition to ship motion response that may be important in terms of safety and reliability.

- You study the correlation between sea state variables and ship response variables,

and this is a major part of the paper. The times series are obviously highly auto-correlated. It is well known that strong serial correlation may give cross-correlated time-series even for independent variables, so the correlation coefficients given in Fig 6 should be interpreted with care. A note could be included on this (perhaps with reference). Moreover, what insight do you really get from all the correlations you find for the sea-states and ship response variables in sections 5.2/5.3? On p. 13 you state that the ocean waves will have a larger influence on ship motions in ballast conditions. How can you conclude on that from higher correlation between roll and pitch?

- You study the correlation between sea states and ship responses. However, you only study one response/effect at a time. How do you account for interaction effects? That is, the effect of one parameter will be influenced by the value of another. How do you account for possible confounding effects? Could you gain insight if you try to fit a statistical regression model to these data, e.g. explaining the ship responses by the sea state variables. In such models you could include interaction terms to account for such dependencies and could perhaps give more insight than merely studying the (linear, I assume, but you do not say) correlation coefficients. Also, how statistically significant are the correlations you estimate? Particular with respect to section 5.4 and Fig 13 where you compare the correlations for loaded and ballast conditions this is a relevant question.

- When you compare ship responses and what you refer to as navigation – can you assume that different behavior is only due to weather conditions? Is it the same crew operating the ship in all four situations? It is well known that different seafarers may respond differently, for example. Do you have control of other influencing factors (human factors etc.) For example, you state that ship operators usually reduces engine RPM more, but later, in half-loaded cases than in ballast conditions. Can you say this from just two cases of ballast and two cases in loaded conditions? Many other factors than the loading condition could be at play here.

- The warning criteria in Figure 14 is the main results of this study, as I understand it,

and I wonder if the is based on a weak foundation (a crude correlation analysis for four situations). Does this really push state-of-the art in weather warning criteria?

Minor comments:

- The language is at times poor, and thorough language vetting is recommended. The following are merely a few examples from the first parts of the paper but proof-reading by a native speaker is recommended throughout the paper.

o “Due to an increase in ship size and number, shipping activities frequently lead to a higher possibility of ship accidents and increased safety risk to human beings, property losses, and the pollution of ocean environments.”. I understand what you try to say, but this is poorly formulated. …. frequently lead to a higher possibility… What is meant by frequently? And higher than what?

o “Therefore, marine weather information, including an accurate forecast of extreme ocean surface wave states.” This sentence has no verb and makes no sense.

o These are just two examples, but the language needs to be improved for this to be published in a quality international journal.

o Check throughout the use of definite/indefinite form (e.g. “the”), and singular/plural forms.

- On p. 3 you mention different failure modes and potential problems related to waves. How about fatigue? I guess operation in severe weather can lead to increased fatigue on ship hull which may ultimately lead to failure. Fatigue is a cumulative effect and perhaps somewhat different from e.g. capsize and grounding, but it seems relevant to include here (possibly, with relevant references).

- Why do you give two drafts for case 1 and 2 in Table 2?

- On p.7 you mention 6 rough sea navigation cases. However, previously you only mention four cases. Check and update.

- Your statement on p.8 should be backed up with a reference: “The most common sources of errors in wave model results are errors in the wind field”. There are several other sources of errors. Can you validate this statement by a reference? Alternatively, just say “one of the most common errors. . .”

- You state that wind input is important but use low-resolution wind input to drive the models. Will linear interpolation (in both space and time, or only in space? Do you assume six-hourly stationary conditions?) give accurate results? Could you use other downscaling methods (physical/statistical) to gain better results? Especially since you argue that the wind forcing is one of the most important sources of error of the numerical wave modelling.

- Abbreviations should be spelled out on first use. For example, what is WRF? (Weather Research and Forecast model??). MDS = Mean directional spreading? RWD = relative wave direction? (relative to wind? Relative to ship heading? OK, this is defined in Fig. 9, but not when it is first mentioned). RPM = revolutions per minute. GM = metacentric height (not obvious to all readers of this journal). Check throughout that all abbreviations are explained.

- What do you mean by “total” or “whole cases” on p. 12? I guess I understand what you mean (that you group statistics from all cases together?) but it should be better explained.

- What do the colors in Figs 6, 7, etc. represent? Time? Value of one of the variables? This should be explained.

- Caption of Figs 6, 7, . . . should be revised. You are not showing correlations per se, but scatterplots of selected wave parameters to illustrate correlations. I believe you could be more precise.

- This sentence on p. 13 does not make any sense: “As observed in the top-middle panel, as the pitch amplitude increases, the ship operators tend to further reduce the

engine RPM (a higher correlation coefficient of -0.717), but later (when the pitch motion reaches approximately 3 degree in the half-loaded cases than in the ballast ones (-0.513 and less than 2 degree)." For one, the parentheses do not match. I can understand what you want to say, but you do not say it very well. Also, you continue to say that operators prefer to maintain speed, but the figure clearly shows that speed decreases as pitch increases. What do you try to say here?

- What do the dashed rings in Fig. 8, 9, ... represent? They are not discussed and should be removed (or discussed).

- On p. 20, the following sentence is very imprecise: "Ship responses such as ... in ballast conditions are of an equal or slightly smaller amplitude than those in the half-loaded one". You are not comparing ship responses, but correlations between ship responses and sea states. Re-phrase to be more precise.

- On page 22, values of Hs 5m, 4,m and 1.5m are not the same as in Figure 14. Moreover, 3.5m, 3.8m and 1.3m is given in incorrect sequence (large, modest, small).

- The presentation of the warning criteria in Fig. 14 is counter-intuitive, with large responses corresponding to small radius in the circle, and small responses far out with large radius. A minor issue, but strange that you chose to present it this way.

- Reference list must be updated. List all authors not only et al. in the references list. Moreover, several citations in the text cannot be found in the reference list. E.g. Chen et al. 2013; 2015; 2018, ...

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