**ANSWER TO REVIEWER COMMENTS**

The authors would first of all like to thank the reviewers for the positive and constructive feedback on our original manuscript. We believe that your comments have enabled us to more clearly state our scope, results and conclusions and we hope we have reflected this to your satisfaction in our revised manuscript. The tables below address the specific comments. Correspondingly, some changes to the text of the original submission have been made.

**REVIEWER #1**

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| **#** | **Comment** | **Answer** |
| **1** | The biggest issue with this traffic conflict technique is how to explore the relationship between traffic conflict or near miss with the actual crashes. The authors may want to discuss more about this to highlight the validity of this approach in maritime transportation. | Thank you for pointing out this issue. In general, there exist a certain relationship between traffic conflict or near miss and actual crashes. However, even we know the relationship should exist, it’s still difficult to define such a relationship analytically.  The purpose of this paper is to provide a method to rank ship encounter severity. The judgement of collision risk still need be decided by expert knowledge combined with contextual data like external environmental factors.  The authors add sentences in the 2nd paragraphs of section 2.3 to clarify this:  That doesn’t means VCRO can indicate risk of ship collision directly. The output of VCRO can be used to rank encounter severity that is correlative to collision risk. The further judgement of collision risk still need be drawn by expert knowledge combined with contextual data such as external environmental factors. |
| **2** | VCRO is very interesting. It seems to be superior as the expert judgement is less involved. The authors may want to highlight this difference in their discussion section. | Thank you for the comment. Since the expert knowledge is contained when MDTC is used to fit relationship between conflict severity and intercourse angle, the model of VCRO doesn’t involve expert judgement. However, the effect of VCRO is used to filter encounter scenarios with high or potential risk. In another stage, expert knowledge is still useful to judge collision risk, but the judgement workload is decreased obviously after only few severe encounters are discriminated.  The authors add sentences in the 1st paragraph of discussion section:  In addition, the model can be used to rank ship encounter conflict without experts involved. But the risk judgement still need be drawn by expert knowledge combined with contextual factors after considering the conflict ranked by the proposed model. |
| **3** | A separate paragraph highlighting the contributions of this research may be helpful. | Thank you to advice this improvement. A separate paragraph is added in the end of conclusion to highlight the contributions of this research. |

**REVIEWER #2**

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| **#** | **Comment** | **Answer** |
| **1** | How would any missed AIS data be considered in the proposed model? It is understood that there is always missed data in any AIS data record. | It’s true that there is always missed data in AIS data record. Therefore, a step of data quality control before the proposed model is necessary to be executed to correct wrong or missed data. Since the ship movement have to be follow physical rules as under a certain speed limitation, maneuvering in a continuously trajectory, the missed data can be estimated from other data before and after in adjacent track in spatial and temporality. |
| **2** | When near misses are considered, external environments (e.g. current, winds and waves) always play an important role. The proposed model does not take account such variables. How confident are the authors about ignorance of such important variables in their model? A discussion on such external environment was given in the manuscript. However, it seems less convincing. | Thank you for pointing out this. It’s true that external environment generate important effects to ship collision risk. As indicated in Figure 1, the scope of this study focus on how to rank vessel conflict severity. It’s not the final judgement of collision risk. In next step, contextual data including external conditions, and expert judgments are taken into consideration together with ranked vessel conflicts from ship movement parameters to produce insight of risk assessment for specific ship encounter. |
| **3** | The term "Conflict severity" is used in the manuscript. Would it be better to explain the significance of it? | “Conflict severity” is a term to describe severe degree of potential collision risk. This term is used to show an encounter situation related to collision risk. The conflict severity can be thought linked to degree of collision risk, but it’s not risk itself. The risk can be judged by considering this conflict severity and contextual factors according to expert knowledge. |
| **4** | Would it be useful to consider the dependencies of the parameters used in the proposed model? How would such dependencies play a role in the modelling process? | In this model, ship relative speed, the difference between the ship heading, and safety distance between the two ships are considered s parameters. In general, speed, heading and distance should be independent each other. However, the relative speed and the heading difference has a certain dependency. The safety distance may has dependency with relative speed that is determined by the ship domain model adopted. In this study, the ship domain model doesn’t account relative speed, then the safety distance is independent from relative speed and heading difference. The independency of adopted parameters definitely should be helpful to the model, but it’s not mandatory which can be inferred from the result of studied cases. In some degree, it’s difficult to keep dependency when a complex ship domain model is adopted that involves too many factors. |

**REVIEWER #3**

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| **#** | **Comment** | **Answer** |
| **1** | In line 44-48 of page 4, the authors mentioned "In other words, the model will result in rather many ship-ship encounters needing to be further manually investigated by re-contextualizing the traffic context (other maritime traffic, environmental conditions, etc.). Such expert judgments can be rather time-consuming, which may impede the practical usefulness of the model." However, it is not clear how the author overcome such difficulties in your proposed model. In the proposed model, expert knowledge is also used and I assume that the judgment on complex traffic context is also necessary. It is better to explain it more clear. | Compared to previous methods, the proposed method has a greater specificity, leaving fewer possible near miss cases to be assessed by navigational experts in a contextualized traffic setting. This is achieved by including the effect of ship size through a ship domain, and by better accounting for the criticality of the encounter direction through the Minimum Distance To Collision concept compared to earlier proposed models. Since ranking performance and accuracy is enhanced in the current model that bring decrement of severe conflict scenarios, the judgement workload is also decreased. The conclusion is validated in Table 5. That’s why the authors claim the new model achieve improvement of time-consuming expert judgements. |
| **2** | In line 32 of page 5, "Goerlandt et al. (2012) apply the …" should be "Goerlandt et al. (2012) applied the …" | Thank you for pointing out this issue. It’s corrected. |
| **3** | In line 44 of page 6, "The former issue is addressed in Section 3.2, the latter in Section 2.3." It is not clear for me what do the former and latter issues mean. It is better to explain more clear. | Thank you for indicating this issue. This is a wrong sentence, and the content is changed already, then it’s removed. |
| **4** | In Eq. 6, what does the parameter n mean? This parameter appears in the paper for the first time. So it is better to specify its meaning here. Moreover, in Eq. 26, is the parameter n the same with that in Eq. 6? Shall it be N? | Thank you for raising this the issues.  The n in Eq.6 means the number of Fourier series. The explanation is added under Eq.6.  Eq. 26 has an issue, and it’s corrected. The 1st n should be the number of sampling data, then it’s changed to *M*. And the 2nd n in Eq 26 is same as Eq.6, means the number of Fourier series. The explanation is added under Eq. 26. |
| **5** | In line 56 of page 22, "n observations into k clusters", the meaning of n is not the same with that in Eq. 6. It is better to use another letter to express it in order not confusing readers. | Thank you for pointing out this issue. ‘n’ is replaced with ‘m’ to represent the number of partition. |
| **6** | The references are not well organized. Some references are listed with last name beforehand and others are listed with first name beforehand. | Thank you for raining this issue. The authors reorganized the references. |
| **7** | Figures 5 and 6 are not clear. | Thank you for pointing out this issue. Figures 5 and 6 are redrawn and replaced. |