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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Safe-economical route and its assessment model of a ship to avoid tropical cyclones using dynamic forecast environment" *by* L. C. Wu et al.

Anonymous Referee #1

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General comments

The paper "Safe-economical route and its assessment model of a ship to avoid tropical cyclones using dynamic forecast environment" by L.C. Wu, Y.Q. Wen and D.Y. Wu presents an interesting exercise on the design of relatively safe and economically viable ship routes in the presence of a moving source of increased risk with a certain remote impact. The focus of the study is on the risk assessment and mitigation by means of optimization the fairway in a dynamic forecast environment where the basic source of risk form high waves and the measure of risk is the probability of capsizing of the ship.

The presentation is sound and mostly clear. The paper is well structured and has an adequate length. The authors use widely known wind data and wave models with an appropriate resolution and accuracy. The mathematical background (Section 3) and the RATC algorithm (Section 4) are described in a concise manner but with enough details to catch the basic ideas and assumptions.

Specific comments

There is some room for improvement of the manuscript. First of all, it is not clear for a non-expert reader which concepts, equations and fairway design methods are commonly in use, which ones taken from earlier specialized studies and which aspects are new in this manuscript. Even if the presentation (or its part) follows some classical sources, external sources should be indicated (unless the material is generic).

The readers would appreciate if the authors could view their methods and results in a somewhat wider context. Although the text contains a number of references to various fairway design methods, the authors do not mention many generic and widely used approaches. Doing so is fine for experts in the field but may create a biased perception for those who are not familiar with the ship routing problems. In particular, the pool of European and US-based research is almost not reflected (see, e.g., Christiansen M, Fagerholt K, Ronen D (2004) Ship routing and scheduling: status and perspectives. Transp Sci 38:1–18). There exist many methods which do not rely on a set of predefined waypoints. In essence, most of such methods rely on a particular quantification of the offshore (either in terms of the risk to the ship, or the risk to the environment stemming from the ship) similarly to the present manuscript, after which a variety of approaches (Monte-Carlo-type optimization, Dijkstra's algorithm, or even simply following the local maxima or minima of the resulting 'cost function', see, e.g., Andrejev O, Soomere T, Sokolov A, Myrberg K (2011) The role of spatial resolution of a three-dimensional hydrodynamic model for marine transport risk assessment. Oceanologia 53:309–334) can be used to specify the optimum route. The presented method is, in essence, a discrete version of finding an optimum fairway along the minima cor-

responding to the areas that can be crossed with minimum fuel consumption in the presence of an additional restriction of staying in safe enough areas in terms of the risk of capsizing.

The description of the results (Section 5.3) and the Conclusions section are perhaps too compact and also partially fail to fully open the importance of the results. Also, the description is to some extent deceptive. For example, it is claimed that the new method is superior to a simple typhoon avoidance method. The results in Table 3, however, show that the simple method actually is the second best (in terms of fuel consumption) among the sequence of optimized fairways. The same claim is repeated in Conclusions – a large part of which actually is dedicated to forthcoming research. The Conclusions are the weakest part of the manuscript and should be clearly improved. I suggest to considerably expand the sections in question towards more unambiguous explanation of the results of the study and towards discussion of the shortcomings (e.g. quantifying the associated increase in computational costs), benefits and applicability of the new method.

Some claims are not exact. For example, Abstract tells that both the impact of wind and waves are taken into account. In the body of the paper, however, it is explained that the wind impact is accounted for implicitly, through its role in wave generation.

The use of English is generally satisfactory. The text contains however, many obviously wrong expressions, typos and formatting issues. For example, all equations should be punctuated as parts of the text. Therefore, the entire manuscript definitely requires attention of a professional copy-editor. A small selection of such issues is listed below.

Given the large number of issues to be adjusted or corrected, I recommend that the manuscript should undergo moderate to major revision before it can be accepted for publication.

Technical issues

The title should be adjusted; in particular “model” stands in a wrong location

The two sentences of the Abstract are not exactly correct; the claim on lines 10–11 is unclear as the risk level is evaluated in terms of risk of capsizing of the ship under the impact of wind and waves; moreover “wave resistance” is normally used in a completely different context

Page 1858, line 22: reference (Chen, 2004) is missing from the reference list

Page 1859, line 1: should be "The resolution and precision ..."

Line 3: "for guiding ship routing” sounds strange, probably "for guiding of ships” or "for ship routing” is meant

Line 20: reference "Delitala showed” should be completed

Line 27: (i) probably "based on the output of the WAM model” is meant; (ii) to my knowledge, WAM stands simply for WAve Model (Komen et al. 1994)

Page 1860, line 3: should be "Soda et al. (2011)”

line 8: reference "Hopkins examined” should be completed

line 15: reference "Chu et al.” should be completed

line 24: should be “Liu et al. (2006)”

line 26: should be “Zhang et al. (2010)”

line 27: should be “Wu et al. (2010)”

Page 1861, title of Section 3: should be "Mathematical”

lines 5-6: if possible, avoid beginning of a sentence with a symbol

line 15: should be “Huang et al. (2001)”

Page 1863, Eq. (4): there is no need for double brackets

Page 1864/1865: the meaning of function "\psi" is not explained

Page 1865, line 5: (i) here time is denoted by "\tau", otherwise it is "t"; (ii) please specify whether frequency in Hz or in radians (angular frequency) is meant

Eq. (9): "\alpha_0" is not defined and "g" is explained much later (p. 1866, line 3)

line 15: Fig. 1 does not contain "\omega_e" but contains "\mu" instead of "U"

Page 1866, line 1: "ITTC" is not defined and no reference is given to the source. Equation (12) presents, in essence, a classical Pearson-Moskowitz spectrum but the sea state near a tropical cyclone generally does not match well this spectrum

Line 13: how do you know that "\varepsilon is a very small value"; and probably "is a small parameter" or "has a small value" is meant

Equation (15) contains "a" but this quantity is evidently called "\alpha" on line 3 on p. 1867

Page 1868, line 7: should be "design speed"

line 16: to my knowledge, this is the first time when "wave feature period" has been used; please reformulate in conventional terms

Page 1869, line 26: consider replacing "interval of" by "distance between"

Page 1870, line 1: "computing budget" sounds strange; consider using, e.g., "amount of calculations" or similar

Page 1871, lines 8-10: "risk probability" (used here for the first and last time) sounds strange; either is is a probability (nondimensional) or risk (a product of probability and consequences, usually dimensional). I guess that still "capsizing probability" is meant

line 10: it is not clear how to proceed if the risk is unacceptable

line 12: "broken point" is used here for the first and last time; although heuristically understandable what has been meant, still please rephrase in more common terms

Page 1872: optimization procedure of the set of waypoints is a classical routine for similar problems and needs not to be described in detail; just a description of the principles on a couple of lines and a reference to Fig. 5 would do. BTW, how do you avoid touching a cyclone when sailing along the optimised route (cf. the red short way in the upper part of the cyclone in Fig. 4); is this a part of step 2?

Page 1873, line 6: please explain what is "281 000"

line 18: not clear what is meant by "the beam wave is close"

Page 1874, line 3 and below: consider some other word to replace "experiment", e.g., "route design", "fairway design" or similar. In particular, the sentence on lines 7–8 sounds strange

line 7: the meaning of "is unchangeable" is not clear; do you mean that in the simulations the ship's speed was kept constant?

Page 1875, line 2: it is probably meant that the used model provides fairways or routes that are more safe and economical

line 6: use "avoided" or similar instead of "cancelled"

line 15. "geometric" is not exactly wrong but deceptive; use "rapid" or similar

line 16: probably "spatial resolution of alternative waypoints" is meant; "precision" is not suitable

References:

Chen (2012) is not referred to

Figure 2 is extracted from (Chu et al. 2004) and can be omitted without any loss to the content of the paper

Figure 4: (i) consider replacing "break waypoints" by some other word(s); (ii) use "alternative"

Figure 7, 12: panels and size of lettering are too small

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