

The authors provide an interesting study on predicting Arctic sea ice condition and the associated shipping navigability. Overall I think the work is of importance under the trend of ongoing climate change, and it can provide valuable insights for relevant stakeholders such as shipbuilders and operators. Therefore, I am in favour of publishing this manuscript.

However, I did find a list of issues existing in the current form, as follows:

1. It is rare to use the term “Northeast Passage (NEP)”. The common term is “Northern Sea Route (NSR)”.
2. Line 47-51, the authors say “Northeast Passage” is an alternative to Panama Canal and Suez Canal - this is an incorrect expression, because the Northwest Passage (NWP) is the alternative of Panama canal and the Northern Sea Route (NSR) is the alternative of Suez Canal. They should be stated separately and clearly.
3. Line 51-52, “It is navigable for approximately a month and half per year for ice-strengthened ships at the end of summer (Khon et al., 2010)”. Is this information outdated as reference is from more than ten years ago? Please check there is some recent reference for this, because the navigable season is probably already longer than 1.5 months nowadays.
4. Line 52-53, “The day at which open water (OW) ships can cross the NEP has reached 297 ± 4 (October 24th) since 2010.” It is not clear in English, please rewrite.
5. Line 54-55, “However, navigability is still affected by the ice regime around the Severnaya Zemlya Islands, the Novosibirsk Islands, and the East Siberian Sea (Chen et al., 2019)” It is unclear what does the ice regime mean? And how does the ice regime influence shipping navigability?
6. Introduction, Page 3: I suggest the authors provide a review of the geographical and political factors on the NWP and NSR. This is because the practicality for employing the NSR is currently greater than for the NWP. As introduced by Ryan et al. [Ref], The NWP is made up of straits through the Canadian Arctic Archipelago that are both narrow and shallow. These straits are easily clogged by free floating ice, and are still insufficiently surveyed, presenting the very real risks of grounding or becoming stuck in ice; By contrast, the NSR presents a less complex situation, yet has several choke points where ships must pass through shallow straits between islands and the Russian mainland. Apart from the geographical factor, politics has also been providing increasing impetuses for adopting the NSR; for example, China has indicated its plans to establish a Polar Silk Road as part of the Belt and Road Initiative, which aims to build infrastructure and perform voyages through the NSR.
[Ref] C. Ryan, G. Thomas, D. Stagonas, Arctic Shipping Trends 2050, University College London, 2021.
7. Introduction Page 4: I suggest the authors provide a table of Ice Class versus Operating Ice Thickness for ships. In the current manuscript, I feel the authors suddenly bring out the concept of Polar Class (PC) from Line 68 – this does not fit for a general audience if no background information is given.
8. End of Introduction: the authors should clearly state the novelty and contribution of this work, in comparison with previous studies, e.g. V. Khon, I. Mokhov, M. Latif, V. Semenov, and W. Park, “Perspectives of northern sea route and northwest passage in the twenty-first century,” Climatic Change, vol. 100, no. 3-4, pp. 757–768, 2010.
9. Line 223-224: “The number of vessels passing through the Arctic is increasing year by year, but OW ships usually need the guidance of icebreakers, which increases

transportation costs.” I believe this is not a correct statement, because open water vessels only need icebreakers when encountering unnavigable consolidated ice.

10. Line 225: “The opening of Arctic passages for OW ships is profitable for ocean shipping companies” Some references to support this statement?
11. Line 230-232: “Fortunately, the crucial straits, such as the Shokalskiy Strait, Vilkitsky Strait, Sannikov Strait, and Dmitrii Laptev Strait, will be accessible for OW ships.” I suggest the authors remove the word “fortunately”, because it is not academic writing and many readers may feel uncomfortable if you say the global-warming effect is fortunate.
12. Section 3.3. The authors need to provide a more comprehensive description of ice conditions, such as level ice, pack ice, pancake ice, ice channels. These ice conditions are very different for different types of ships’ navigabilities and should be clarified. Some brief discussion of ship interactions with different ice types is required here, for which, I suggest the authors check more references. If different ice conditions are all assumed the same in your model, you should say more about the assumption and the associated limitation.
13. Results: seems only PC6 ships are studied in this work? What is the authors’ opinion about other polar ships?