

Preface

Global warming and extreme weather events reported in the past years have attracted a lot of attention in academia, industry, and media. The ongoing debate around the observed climate change has focused on three important questions: will occurrence of extreme weather events increase in the future, which geographical locations will be most affected, and to what degree will climate change have impact on future ship traffic and design of ships and offshore structures?

The present study shortly reviews the findings of the Intergovernmental Panel on Climate Change Fourth Assessment Report, AR4, (IPCC 2007), the IPCC SREX “Summary for Policymakers” report (IPCC 2012) and other relevant publications regarding projections of meteorological and oceanographic conditions in the twenty-first century and beyond with design needs in focus. Emphasis is on wave climate and its potential implications on safe design and operations of ship structures.

The reviewed studies agree that there has been an increase in significant wave height (SWH) from the middle of the twentieth century to the early twenty-first century in the northern hemisphere winter in high latitudes in the north Atlantic and the north Pacific, with a decrease in more southerly latitudes of the northern hemisphere. The increase of the 99-percentile SWH has been observed to be 0.5–1.0 % per year (Young et al. 2011). However, if the record is extended back to late nineteenth century the picture changes, as studies show that storminess and wave heights in late nineteenth/early twentieth century were about the same as near the end of the twentieth century (Gulev and Grigorieva 2004). Thus, it is unclear if the increase observed during the past 4–5 decades is caused by anthropogenic climate change or just manifestation of long-term natural variability.

It is uncertain how future climate change will impact the extreme sea states that will be encountered by ocean going vessels. The reviewed studies show that there will be regional increases in the wind speeds and wave heights, more pronounced for the extremes than for the means. The increases of the 20-year return period of SWH or the highest storms in 20–30 years intervals are generally in the range 0.5–1.0 m in the North and Norwegian Seas, immediately west of the British Isles, off the northwest of Africa, around 30°N from the east coast of the United states to 50°W and in the Pacific between 25 and 40°N and from the west coast of the

United States to 170°W. However, increases up 18 % for the 99th percentile SWH have been reported for the southern North Sea by one paper of Grabemann and Weisse (2008). Thus, the increase may reach more than 10 % above present day extremes in some areas. The projections are influenced by choice of climate model, emission scenario, and downscaling method for waves. The uncertainty of the estimated increases is of the same order as the estimates.

To account for climate change of met-ocean conditions and uncertainty connected to the estimates of future extreme wave heights and other met-ocean parameters a risk-based approach for ship and offshore structure design is proposed. The impact of expected wave climate change on ship design is demonstrated for five differently sized oil tankers, ranging from Product Tanker of length 175 m to VLCC with length 320 m. The presented examples show consequences of climate change for the hull girder failure probability. They demonstrate that in order to maintain the safety level the steel weight of the deck in the midship region should be increased by 5–8 % if the extreme SWH increases by 1 m. However, it should also be noted that weather forecasts are improving, and ships ability to avoid extreme met-ocean conditions by using weather routing systems may imply that the current practice of designing ships to 20-years' North Atlantic extreme conditions may be relaxed in the future.

Recommendations for future research activities allowing the marine industry to adapt to climate change are given.

References

- Grabemann I, Weisse R (2008) Climate change impact on extreme wave conditions in the North Sea: an ensemble study. *Ocean Dyn* 58:199–212
- Gulev SK, Grigorjeva V (2004) Last century changes in ocean wind wave height from global visual wave data. *Geogr Res Lett* 31:L24302. doi:[10.1029/2004GL021040](https://doi.org/10.1029/2004GL021040)
- IPCC (2007) Climate change. The physical science basis. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds) Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, p 996
- IPCC (2012) Managing the risks of extreme events and disasters to advance climate change adaptation. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, Tignor M, Midgley PM (eds) A special report of working groups I and II of the Intergovernmental Panel on climate change. Cambridge University Press, Cambridge, p 582
- Young RI, Zieger S, Babanin AV (2011) Global trends in wind speed and wave height. *Science* 332(22):451–455



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Perspective

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