Chapter 1
Introduction

Safety at sea is one of the main concerns of shipping and offshore industry in general and Classification Societies as well as oil companies in particular. The importance of including the state-of-the-art knowledge about meteorological (temperature, pressure, wind) and oceanographic (waves, current) conditions in ship standards have been discussed increasingly by industry and academia in the last decades in several international forums. There are potential safety, economic, and environmental advantages in utilizing the most recent knowledge about meteorological and oceanographic (met-ocean) conditions and investigating its implication for design and operation of ship and offshore structures.

The ongoing debate around the observed and projected climate change has confronted the shipping and offshore industry with two important questions: Is it likely that ship and offshore structures will experience higher environmental loads; and Will Classification Societies' Rules and Offshore Standards need to be updated? The present study makes an attempt to answer these questions based on the state-of the-art knowledge about climate change and structural reliability analysis.

In this monograph emphasis is on wave climate, which is expected to have the largest impact on ship and offshore structure design in comparison to other environmental phenomena. Changes in wind climate may affect also loads and responses of ship and offshore structures, depending on how significant they will be, while projected changes in sea level combined with potential increases in storm surge activity have little potential to influence ship design directly but are expected to have impact on harbours, fixed offshore structures and coastal installations, e.g. on harbour depths and offloading and deck heights. Secondary effects, such as a possible increase in marine growth due to warmer oceans may increase loads on ship and offshore structures in some ocean regions, e.g. the Baltic Sea. However, this effect may also be compensated by improved antifouling coating.

We start with a short review of the findings of the Intergovernmental Panel on Climate Change Fourth Assessment Report, AR4, (2007), the IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) (IPCC 2011, 2012) and other publications regarding

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projections of met-ocean conditions in the twenty-first century and beyond. We also illustrate the impact relevant uncertainties may have on climate change projections with design needs in focus.

It is emphasized that this review of expected impacts of anthropogenic climate change on the wind and wave conditions in the twenty-first century is limited to look for evidence in the scientific literature. It is not a critical scientific review of the publications with respect to methods, use of data or similar, neither is it discussing whether anthropogenic climate changes are happening or likely to happen in the future, but just asking: if it happens, what changes in wind and wave conditions can be expected according to recent published information and what are the possible impacts for ship transport and offshore structures? It is not an exhaustive review of all possible publications that deal with the topic, just a selection of key references.

Although the presented review is not covering all studies regarding climate change the authors believe that the reader will gain a fair and balanced view of the state-of-the-art in the field of climate change and would be able to understand the importance of the existing findings for design and operations of ships and also offshore structures in general.

Another limitation of this monograph is that it has not covered all combinations of extreme weather types and structures, as illustrated in the matrix below. Our focus has been on ships and extra-tropical cyclones.

Weather type	Structure	
	Ship	Offshore platforms
Extra-tropical cyclones ("Regular storm")	Increase in wave height by region, examples of impact	Increase in wave height by region
Tropical cyclones (hurricanes and typhoons)	General statements on potential changes in intensity and frequency, no regional information. Tropical cyclones may generally be avoided by ships, and offshore operations may be closed down	

We show how the latest scientific results on climate change can be in-cooperated in design practice of ship and offshore structures. A risk based approach that continuously allows combining new information about climate change and relevant uncertainties in ship and offshore structure design is proposed being an extension of a systematic approach built up over many years. Further, the potential impact of wave climate change on ship structure design is demonstrated for five oil tankers, ranging from Product Tanker to Very Large Crude Oil Carrier (VLCC). Consequences of climate change for the hull girder failure probability and hence the steel weights (reflecting potential increased of costs) needed to compensate for the increase of the failure probability in the midship deck region are shown. Recommendations for future research activities which will allow adaptation of the shipping and offshore industry to climate change are given.

References

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