**ABSTRACT**

The objective of this study is to find a possible solution for estimating the effect of climate change on sea states with focus on the fatigue assessment of floating structures. In this paper, two key issues are discussed. One is involved with data mining. It’s recommended to make a seasonal and a directional analysis for both windsea and swell in order to improve the accuracy of predictions. With a database covering more than 34 years, seasonal wave height, period and direction of either wind sea or swell are all identified in this research. Another point is the methodology in evaluating the impact of climate change. Two widely-applied methods from literature are compared and a new wave-power methodology is proposed. The conclusion indicates that the best solution for a particular sea area is highly dependent on the geographic characteristics, seasons, variable (windsea or swell) and the dominant direction of waves.

**KEY WORDS:** Climate change, seastates, fatigue, floating structures

**INTRODUCTION**

In order to improve the quality of manufactures, designers tend to estimate all the possible seastates for ships and offshore structures. Data of seastates is observed, measured and selected by operators and designers, which will be used as designed data. For ultimate strength analysis, extreme seastates are the key element, which could usually result in Max. wave height and wind speed. As fatigue damage is an accumulative process and the designed lifetime of floating structures is 20 or 25 years, the main source of fatigue damage are those intermediate seastates with relatively low wave height and high frequency. However, during the operation of ships or offshore structures, it is common to find differences between on-site seastates data and designed data. That’s because climate is always changed in time. (Bitner-Gregersen and Eide, 2010).

Due to climate change, the characteristics of waves, such as significant wave height, wave period or directions of waves, are all varying. These variations make the actual fatigue damage of floating structures quite different from the designed one, which may result in an unexpected structural failure. Generally speaking, these variations are due to natural variation and man-made climate change. Because of the Earth’s system dynamics, the climate could change itself in many ways such as by influencing the global heat exchange system or moving the poles. Man-made climate change is caused by human activities such as the release of CO₂. Since human activities are somehow unpredictable and the effect of man-made climate change usually take place over centuries, this research only focused on natural variations.

Climate model is a well-known solution in the field of seastates’ estimation and prediction. These models usually consist of several components, such as an atmospheric component, an ocean component and an anthropogenic model. In fact, there is a strong coupling between the atmospheric model and the ocean model. Wind is generally considered as the main driving force of the waves. And at the same time, waves and ocean circulation will exchange heat between different regions and finally result in wind. The impact of human’s activity is another element (e.g., greenhouse gases). They all make it extremely complex to simulate the climate and make an accurate prediction. Until now, many different climate models and wave models have been presented, such as ECHAM5 (Roeckner et al., 2003), WAM (WAMDI-Group,1988) and SWAN (Booij et al., 1999). However, the predicted results are usually different from each other in either trend or rate. Even with the same climate model, the prediction of climate trend was found to be dependent on location, season, variable (mean or extreme value) and forcing scenario. (Vanem and Binner-Gregersen, 2012) Based on the wave model WAM and two global climate models (GCMs: HadAM3H and ECHAM4/OPYC3), Grahemann and Weisse (2008) simulated the sea state in the North Sea for the 30-year period 2071–2100 and found a moderate increase of the most severe wave conditions. They concluded that extreme wave heights may increase by up to 0.35 m in the southern and eastern North Sea at the end of the century. However, another different conclusion was made by using SWAM and MRI-JMA model(Mori et al., 2010). MRI-JMA GCM is the high-resolution atmospheric General Circulation Model developed by the Japanese Meteorological Research Institute and Japan Meteorological Agency (MRI-JMA). The prediction indicated that both the mean and the top-10 wave heights of North Atlantic would decrease