

Including multi-modal seas in design wave climate



Layla Loffredo, Jaak Monbaliu
Hydraulics Laboratory, KU Leuven (Belgium)
layla.loffredo@bwk.kuleuven.be

KATHOLIEKE UNIVERSITEIT
LEUVEN



INTRODUCTION

What is the added value of separating spectral information in wave systems?

Tromsøflaket
Lat 71° Lon 18.75°

Design practice has shown that reliable directional data allow cost optimization in offshore facilities (Jonathan *et al.*, 2008) by reducing the inconsistencies in design criteria due to omni-directional approaches. Multi-modal sea states can have a significant impact on design and operability of fixed and floating offshore platform (Ewans *et al.*, 2006).

Norwegian Sea

For certain marine operations and design practices, there is a need for statistical information about the co-existence of different wave systems. One of the questions to be answered is: **Have wind sea and swell spectral components an influence on design criteria?**

METHODOLOGY

Data consists of WAM model simulated 2D wave spectra and integrated wave parameters for the location of Tromsøflaket on the Norwegian Sea retrieved from the ECMWF operational archive. Collected data cover the period from January 2003 till December 2007.

A **spectral partitioning scheme** was applied to 2D spectra for a period of 5 years in order distinguish between wind sea and swell systems originated from different meteorological events.

In first instance wave systems are sorted by energy criteria only. The second option follows the **assignment** criteria leading to the identification of wind sea and swell component on the base of local wind direction.

An **exploratory statistical analysis** consists of directional distribution plots to visualize spectral partitioning results and of a comparison between different assignment schemes. Matrix scatter plots investigate the level of correlation between parameter.

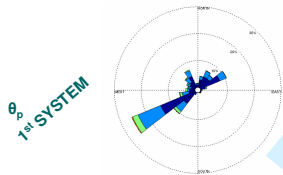
RESULTS

1. Wave climates derived from partitioning show a **consistent difference in the directional distribution** with respect the omni-directional case, which has a more spread distribution.

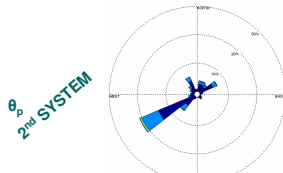
2. The systems assigned to **wind sea prove a very good correlation with ECMWF criteria**, whereas a **different behavior is observed for total swell**.

3. Assignment of wind sea and swell results in more clear patterns in relationships between different parameters (e.g. relation between Hm0 and Tp for wind sea).

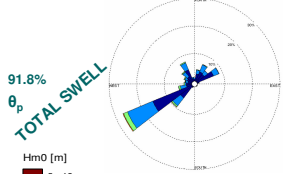
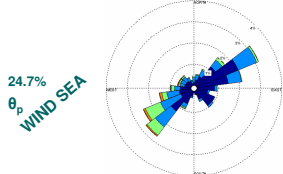
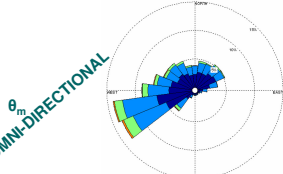
Hm0 DIRECTIONAL DISTRIBUTION



1



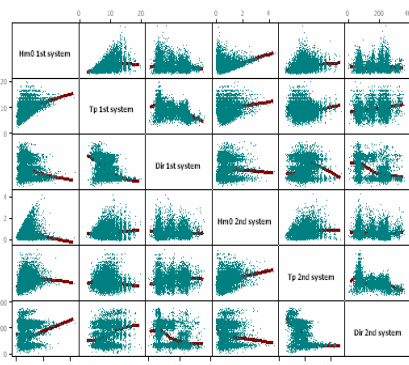
2



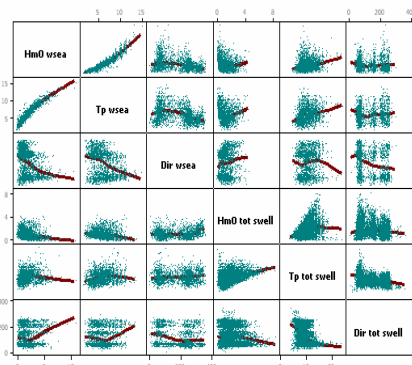
3

Hm0 [m]
8 - 10
6 - 8
4 - 6
2 - 4
0 - 2

SCATTER PLOTS FOR 1ST AND 2ND SYSTEM

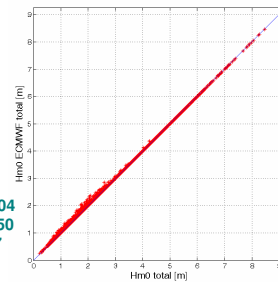


SCATTER PLOTS FOR WIND SEA AND SWELL

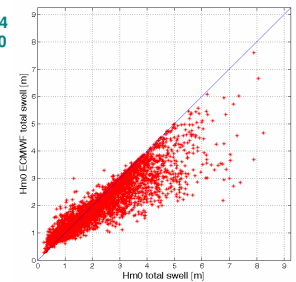


N = 6708
N_{ECMWF} = 7304
RMSE = 0.50
Bias = 0.17
SI = 0.25

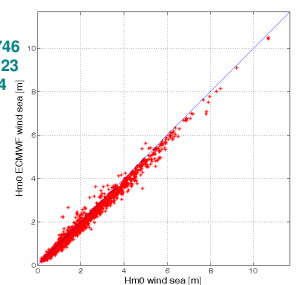
SCATTER PLOTS FOR ASSIGNMENT CRITERIA



N = 7304
N_{ECMWF} = 7304
RMSE = 0.50
Bias = 0.17
SI = 0.25



N = 1804
N_{ECMWF} = 6746
RMSE = 0.23
Bias = 0.14
SI = 0.11



References

Ewans K., Bitner-Gregersen E.M., Guedes Soares C. (2006) *Estimation of wind-sea and swell components in a bimodal sea state*. Journal of Offshore Mechanics and Arctic Engineering Vol.128 (265-270).
Jonathan P., Ewans K., Forristall G. (2008) *Statistical estimation of extreme ocean environments: the requirement for modelling directionality and other covariate effects*. Ocean Engineering Vol.35 (1211-1225).

Acknowledgements

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