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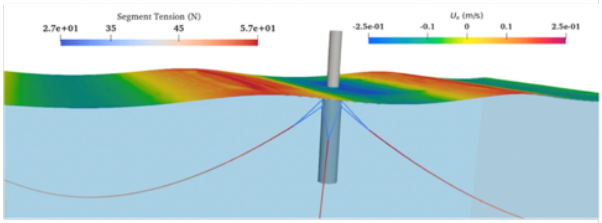


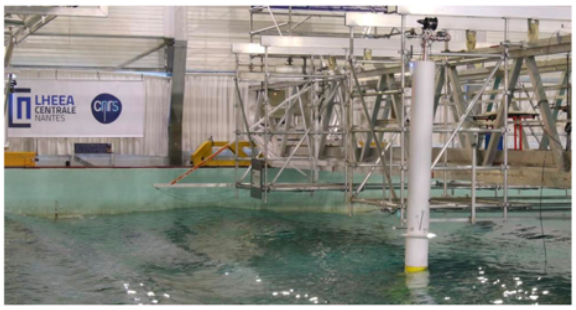


# Prédiction de houle déterministe court terme : sélection de la donnée, validation sur des données synthétiques et application à des données réelles

## *Short-term phase-resolved ocean wave prediction: data selection, validation with synthetical data and application to real data*

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**Summary**

Phase-resolved wave prediction is an active research topic in both marine renewable energy and naval fields. For the latter, accurate knowledge of the wave motion at ship position is of major importance for predictive stabilization or quiescent periods predictions.

Two main approaches are currently employed to describe a sea state : the first one is the stochastic (or phase-averaged) approach. The second one is the deterministic (or phase-resolved) approach. Phase-averaged ocean wave models (i.e. like WW3), widely used in the metocean community, described the ocean waves in terms of averaged quantities. This feature makes them bad candidates for predictive stabilization or quiescent periods predictions as they do not capture phase information (by definition). Phase-resolved ocean wave models are more adequate as they can described the instantaneous wave motion.

Due to shadowing effect inherent to the wave field observation from a ship, spatio-temporal data is needed [4]. Thus, a careful treatment of the data measured far away from the ship and very close to the ship need to be performed. The current paper aims at developing a formulation to extract only the wave data of interest for an accurate prediction.

Various authors [4] [1] [9] have developed numerical algorithms to predict the wave motion based on wave elevation measurements. These algorithms need wave elevations data sets as inputs. Wave elevation data can come from various wave elevations measurements, but the most common is to use X-band radars, which allow to measure all day long with a quite long range and a reasonable resolution.

Validation campaigns in laboratory [8] [5] [7] and at sea with X-band radars [3] [1] [9] have been performed to validate these algorithms. A validation campaign at sea led by SIREHNA and Naval Group has also been performed and will be used for validation in the paper.

For long-term prediction (needed for QPP applications for instance), a non-linear wave model is required to accurately capture the wave phase and wave steepness. Nevertheless, for short-term prediction purpose (less than 15s), a linear wave model is sufficient [6], [1] [2] to capture the main features of the wave field. Moreover, it allows to reduce the associated computational cost due to the fact that system inversion becomes linear [4].

In the present study, the approach of [4] [7] is used to predict multi-directional wave fields from both synthetic and real data with a linear wave model. The method will be briefly summarized. The concept of minimal observation zone needed to predict the wave field at future ship position will be introduced and validated with numerical data. Finally, prediction with real data will be presented.

## Références


[1] *Validation of a Deterministic Wave and Ship Motion Prediction System*, volume Volume 7B : Ocean Engineering of *International Conference on Offshore Mechanics and Arctic Engineering*, 06 2018.

[2] M. Al-Ani, J. Christmas, M. R. Belmont, J. M. Duncan, J. Duncan, and B. Ferrier. Deterministic sea waves prediction using mixed space–time wave radar data. *Journal of Atmospheric and Oceanic Technology*, 36(5) :833 – 842, 2019.

[3] B. Connell, J. Rudzinsky, C. Brundick, W. Milewski, J. Kusters, and G. Farquharson. Development of an environmental and ship motion forecasting system. page V011T12A058, 05 2015.

[4] N. Desmars. *Real-time reconstruction and prediction of ocean wave fields from remote optical measurements*. Theses, École centrale de Nantes, Dec. 2020.

[5] N. Desmars, F. Bonnefoy, S. Grilli, G. Ducrozet, Y. Perignon, C.-A. Guérin, and P. Ferrant. Experimental and numerical assessment of deterministic nonlinear ocean waves prediction algorithms using non-uniformly sampled wave gauges. *Ocean Engineering*, 212 :107659, 2020.

[6] T. Hilmer and E. Thornhill. Observations of predictive skill for real-time deterministic sea waves from the wamos ii. In *OCEANS 2015 - MTS/IEEE Washington*, pages 1–7, 2015.

[7] I.-C. Kim, G. Ducrozet, F. Bonnefoy, V. Leroy, and Y. Perignon. Real-time phase-resolved ocean wave prediction in directional wave fields : Enhanced algorithm and experimental validation. *Ocean Engineering*, 276 :114212, 2023.

[8] F. Nouguier, S. T. Grilli, and C.-A. Guérin. Nonlinear ocean wave reconstruction algorithms based on simulated spatiotemporal data acquired by a flash lidar camera. *IEEE Transactions on Geoscience and Remote Sensing*, 52(3) :1761–1771, 2013.

[9] V. Zinchenko, L. Vasilyev, S. O. Halstensen, and Y. Liu. Short-time deterministic prediction of individual waves based on space-time x-band marine radar measurements. *Proceedings of the Institution of Mechanical Engineers, Part M : Journal of Engineering for the Maritime Environment*, 235(2) :356–371, 2021.