

東京大学 大学院工学系研究科 システム創成学専攻

講師 宝谷研究室 (海事流体力学研究室)

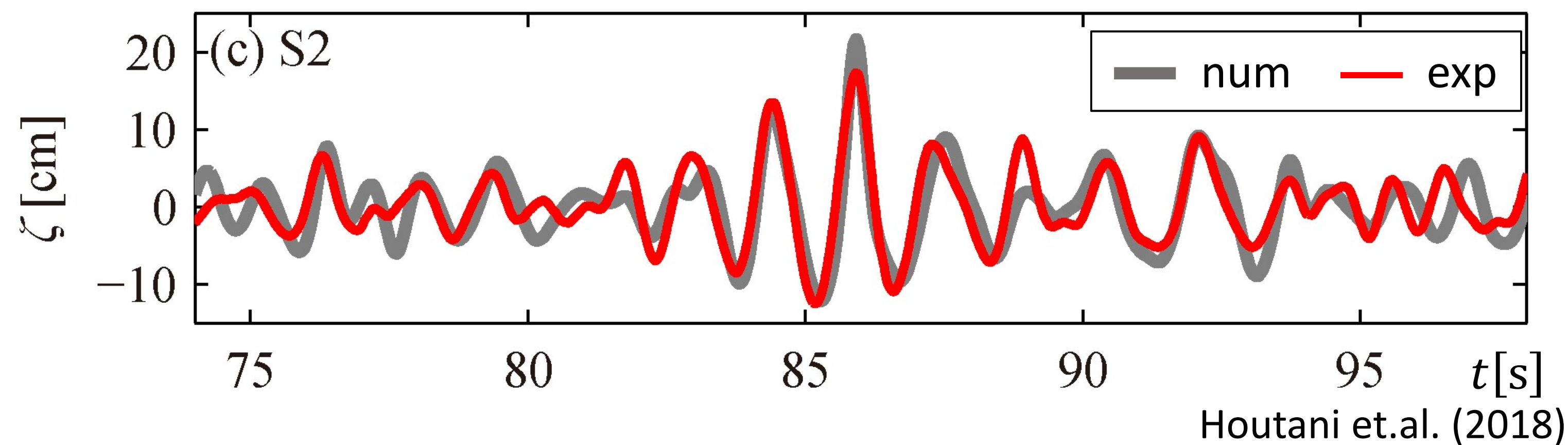
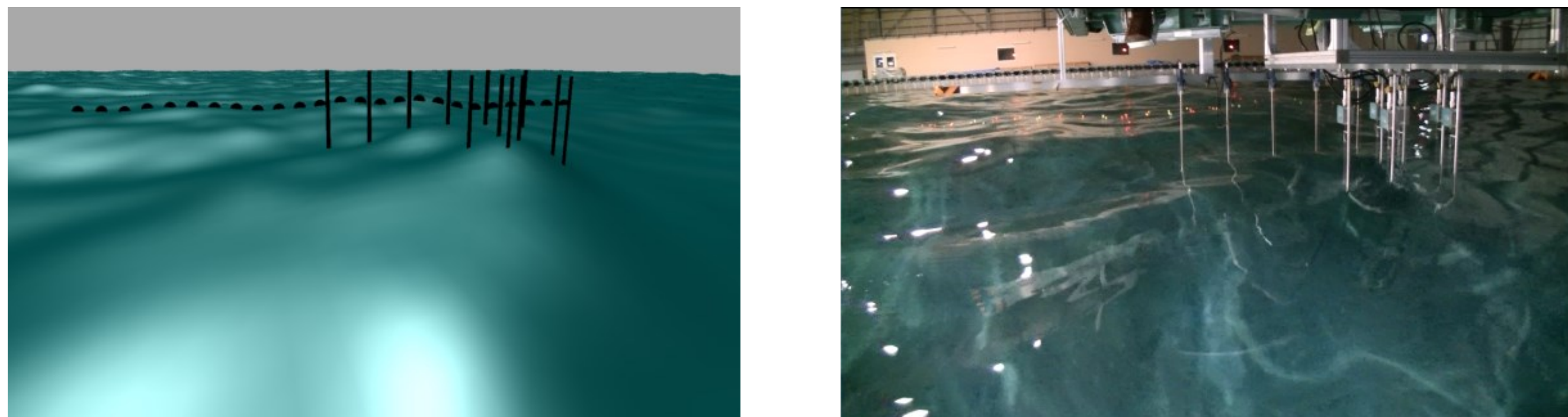
Keywords: 海洋波, 非線形波浪, 海洋工学, 船舶耐航性能, 水槽実験, 流力弾性応答

当研究室では、波浪に関連する海洋工学問題を中心に、理論、数値シミュレーション、大型水槽施設での模型実験等による研究に取り組んでいます。特に、海洋の安全な利活用に向け、巨大波の形成に至る非線形な物理過程や、巨大波中の浮体(船舶や海洋構造物)挙動といった極めて複雑で非線形な現象を理解することを目指しています。

海洋波の非線形なふるまい

船舶や海洋構造物の安全性を脅かす存在と考えられている、外洋で突発的に現れる巨大波“フリーク波”の形成過程の解明や、その水槽への実験再現に取り組んでいます。

波の非線形発達シミュレーションによるフリーク波の検出と水槽への再現



波の非線形発達の記述 (Zakharov方程式、非線形シュレディンガー方程式)

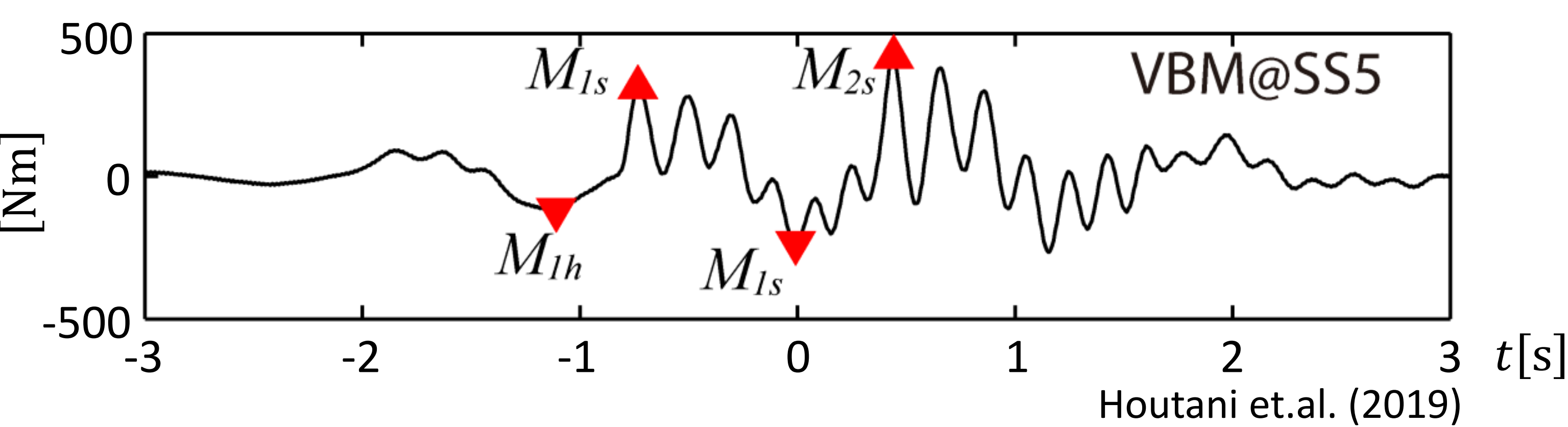
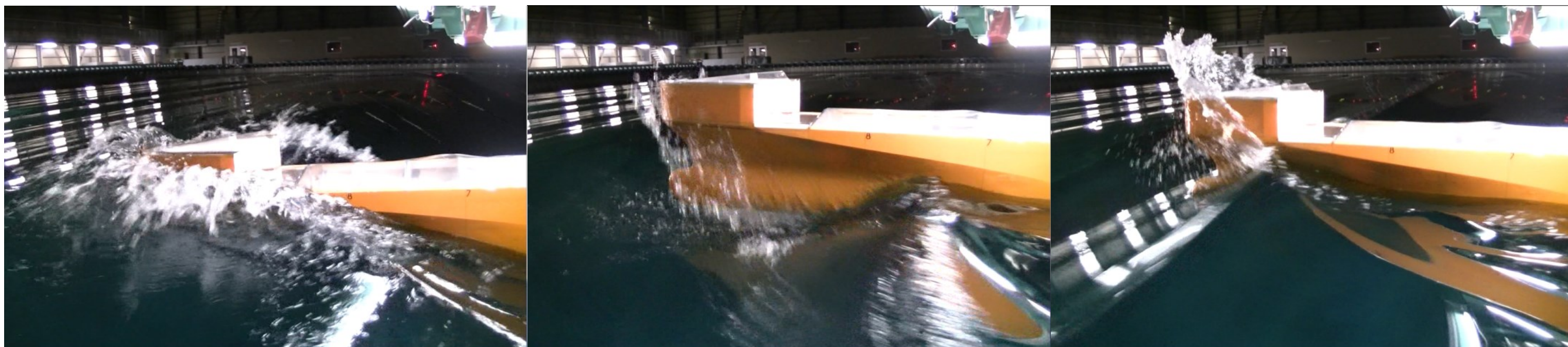
$$i \frac{\partial a_1}{\partial t} = \omega_1 a_1 + \int \tilde{V}_{1,2,3,4}^{(2)} a_2^* a_3 a_4 \delta_{1+2-3-4} dk_{234} + H.O.T.$$

$$\left(\frac{\partial A}{\partial t} + c_{gc} \frac{\partial A}{\partial x} \right) + i \frac{\omega_c}{8k_c^2} \frac{\partial^2 A}{\partial x^2} + i \frac{\omega_c k_c^2}{2} |A|^2 A = 0$$

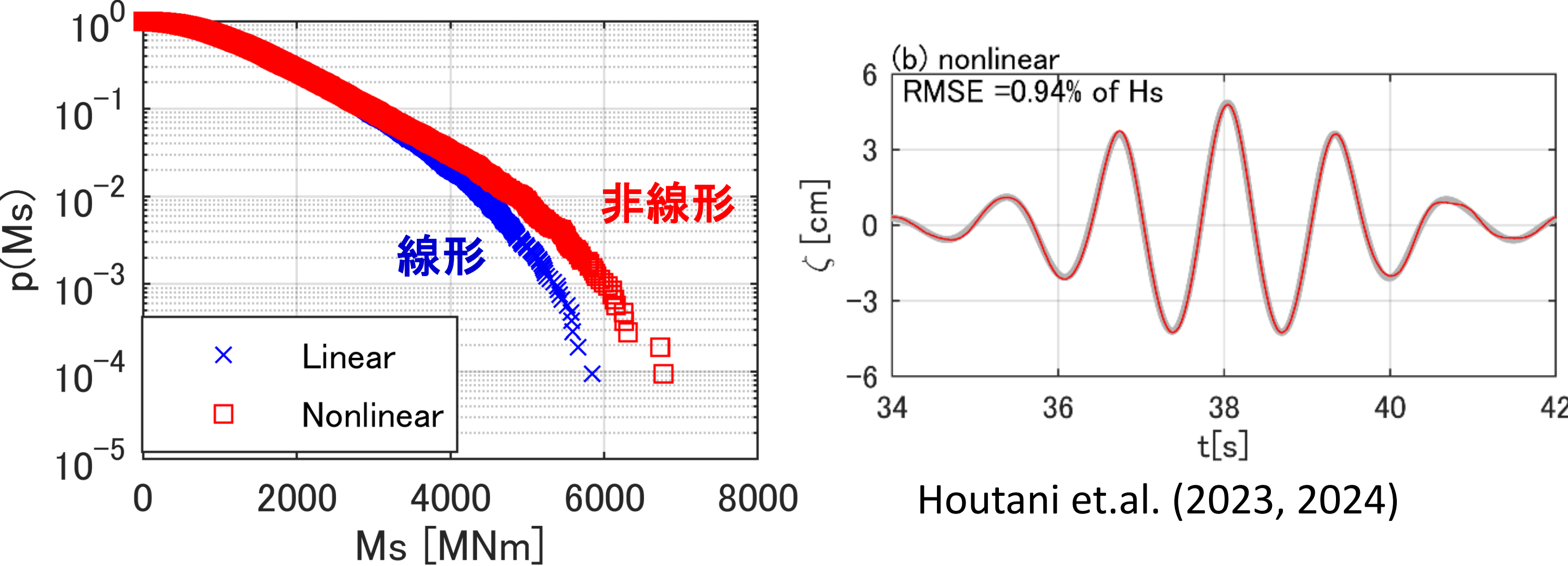
巨大波中の船体応答

巨大波に遭遇した際に船体に作用する衝撃荷重とそれに伴う船体弾性振動現象といった極めて複雑で非線形な現象の解明や、波浪中船体応答極値の確率的推定手法の開発に取り組んでいます。

フリーク波中のコンテナ船弾性模型の曳航実験/船体弾性振動の計測



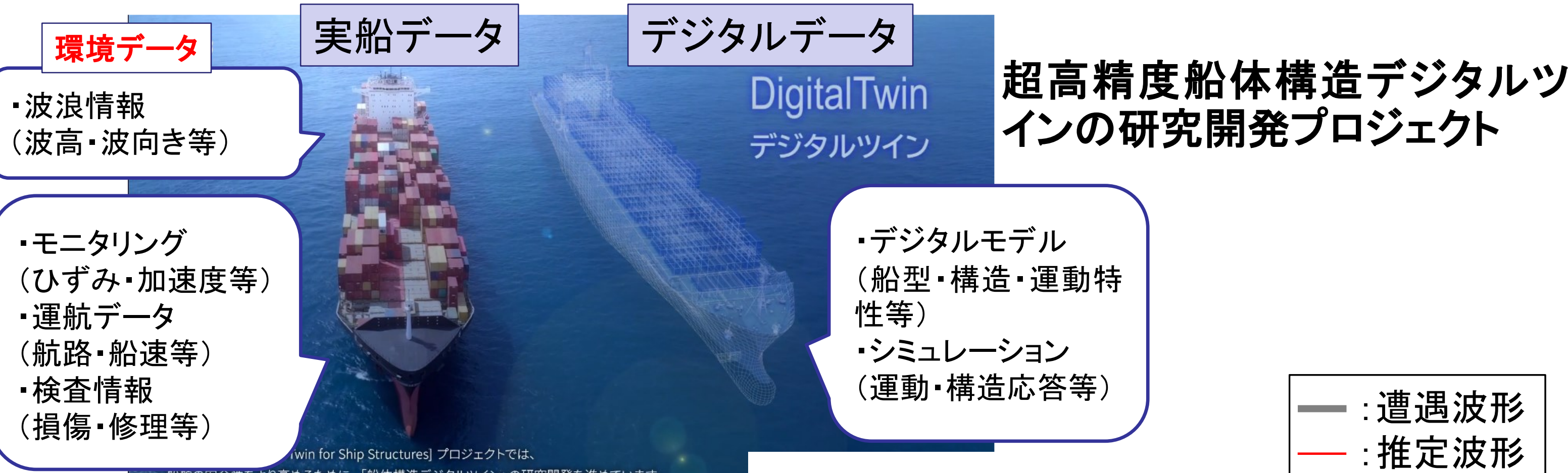
非線形波浪中の船体縦曲げ荷重の極値分布とそれを実現する尤もらしい波形



宝谷研究室は2024年に立ち上がった新しい研究室です。一部の研究は鈴木英之研究室と共同で実施しています。興味のある方は、是非お気軽にご連絡ください。研究室見学にも是非お越しいただければと思います。

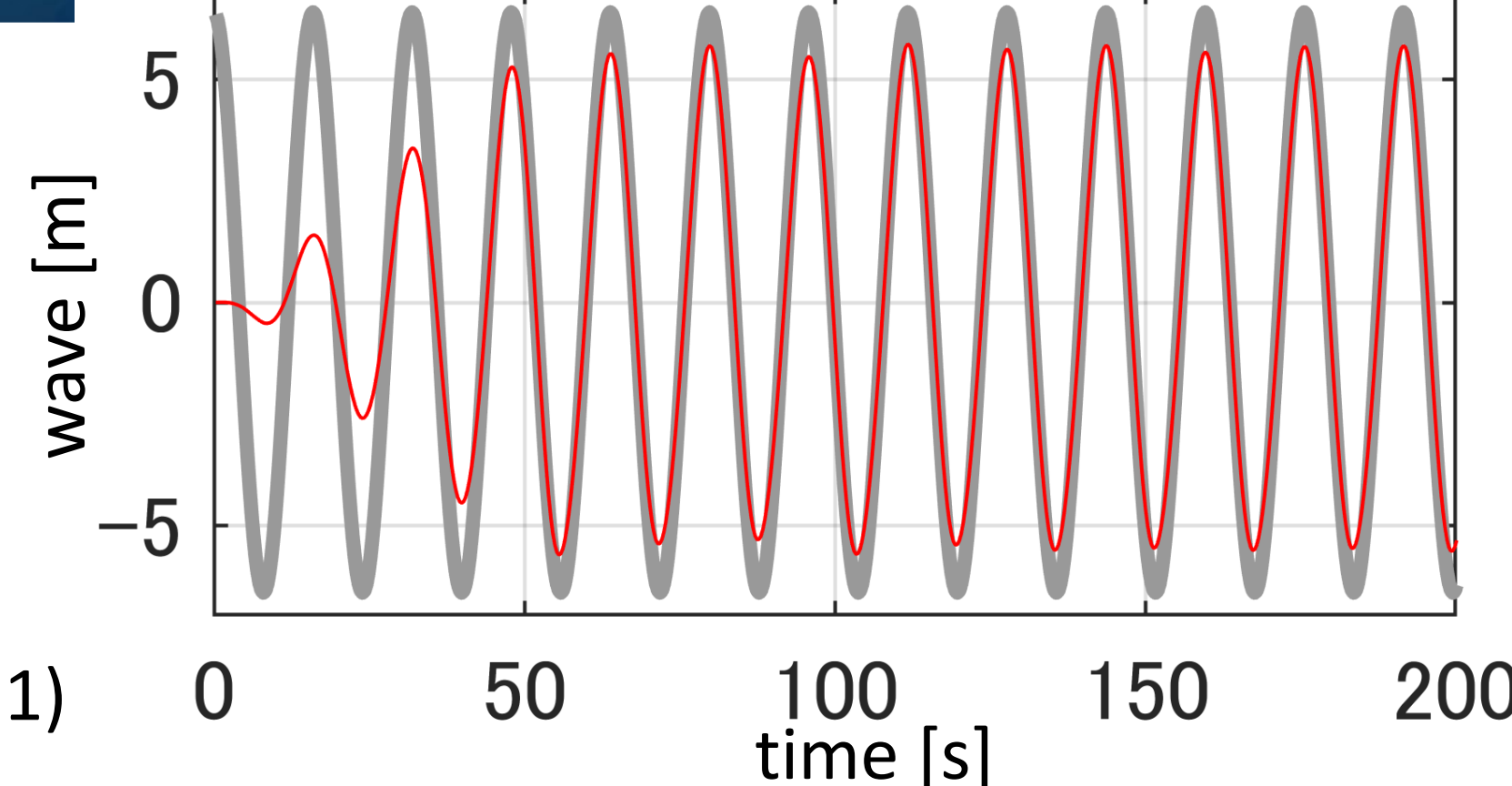
波・船体応答の予測

波浪中船体応答の計測データから、データ同化により波や非計測応答を推定する手法の開発に取り組んでいます。



<https://www.youtube.com/watch?v=Z7JhtkxIOAY>

船体応答データを用いたカルマンフィルタによる遭遇波浪推定 (双子実験)



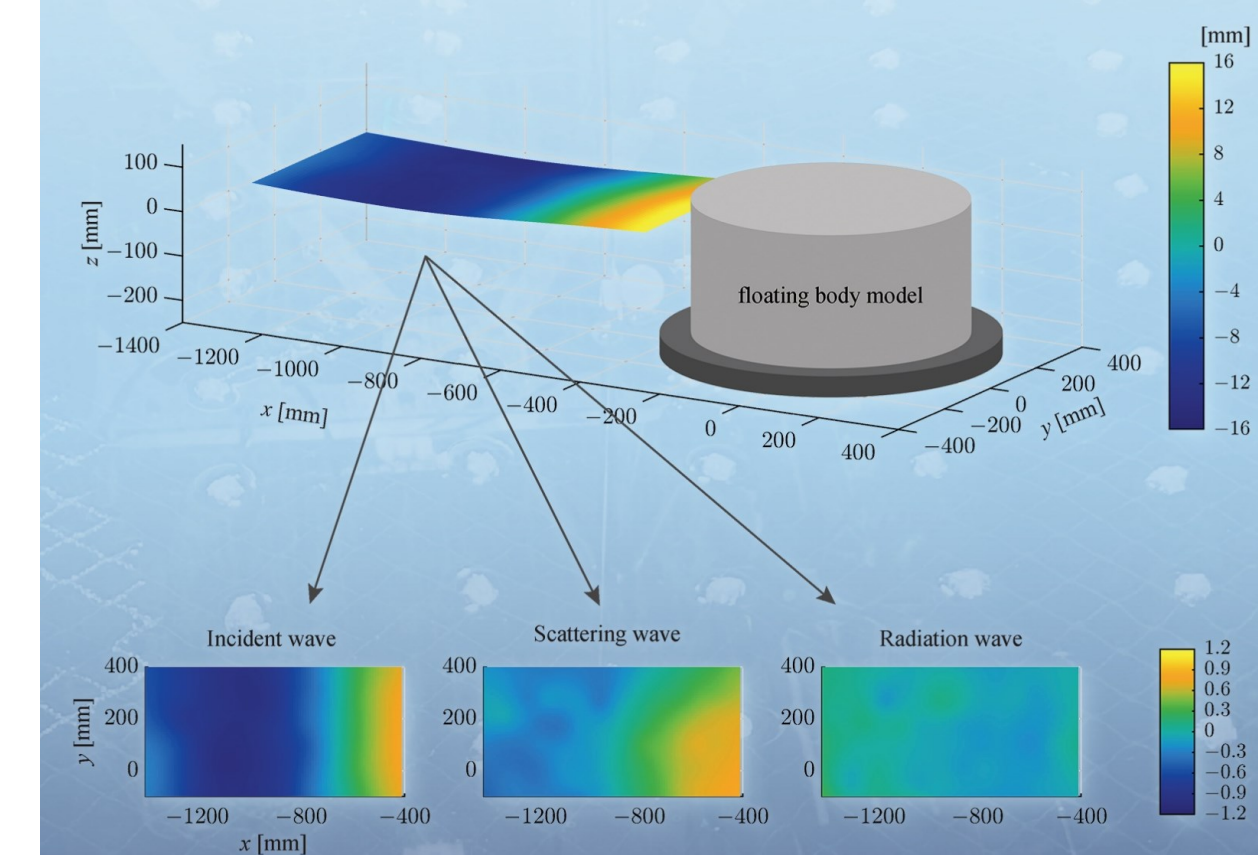
水槽模型実験技術の高度化

新しいコンセプトの弾性模型船の製作、ステレオカメラによる浮体模型周囲の波浪場の可視化、様々な造波技術の開発を行ってきました。工学部船型試験水槽の実験・計測の自動化に取り組んでいます。

製作した弾性模型船



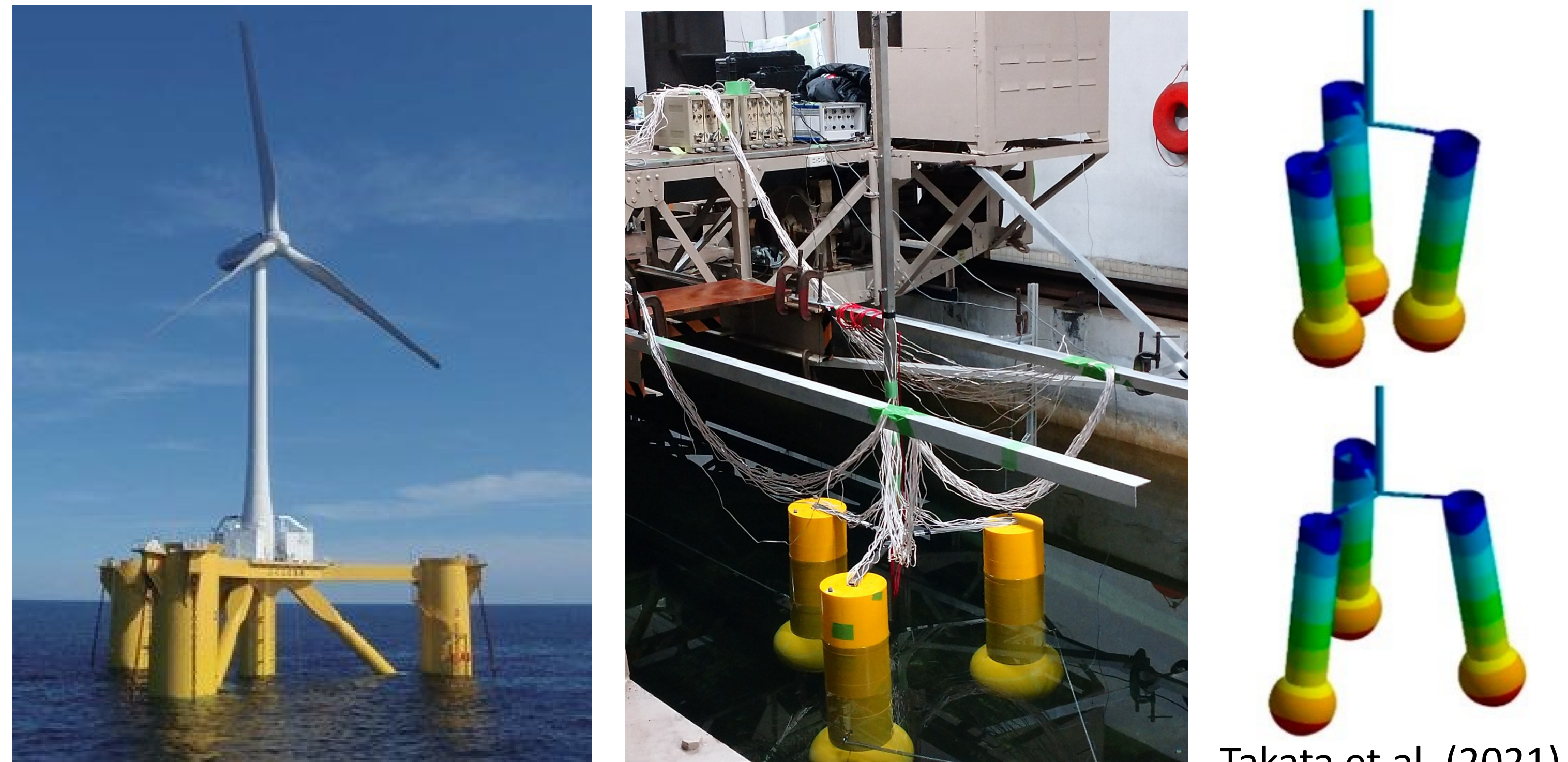
ステレオカメラによる浮体周囲の波浪場の可視化



浮体式洋上風力発電

浮体式洋上風車の波浪中動的応答解析や、新形式小型軽量浮体の開発を行っています。(鈴木英之教授と共同で実施)

マルチカラム型浮体式洋上風車の運動・弾性変形に関する研究



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Lecturer Houtani Lab. (Marine Hydrodynamics Lab.)

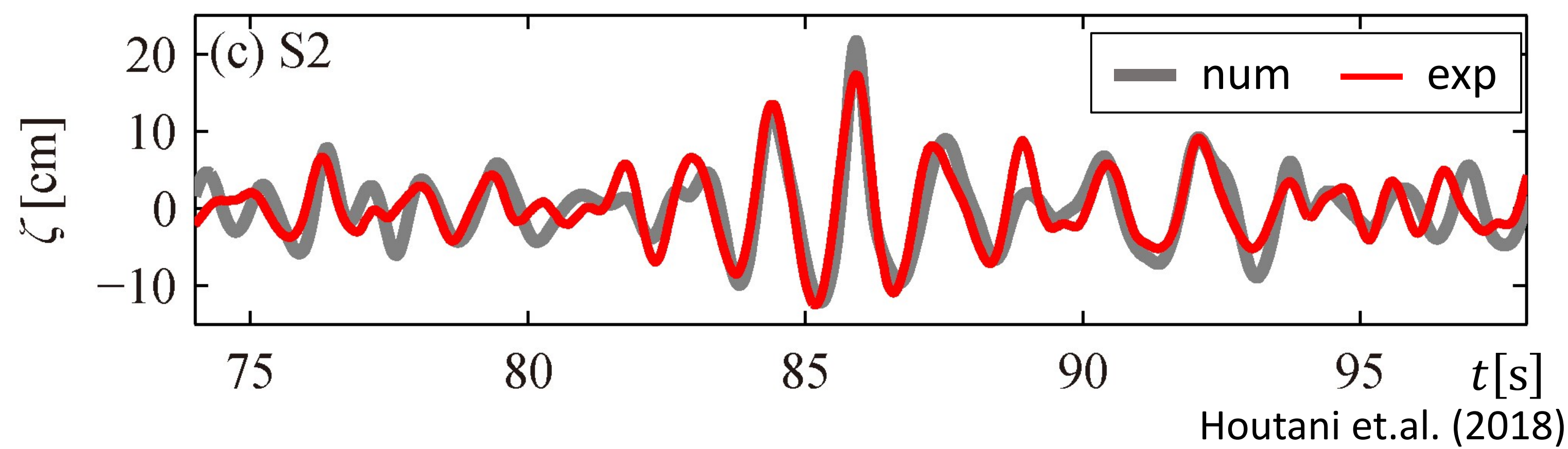
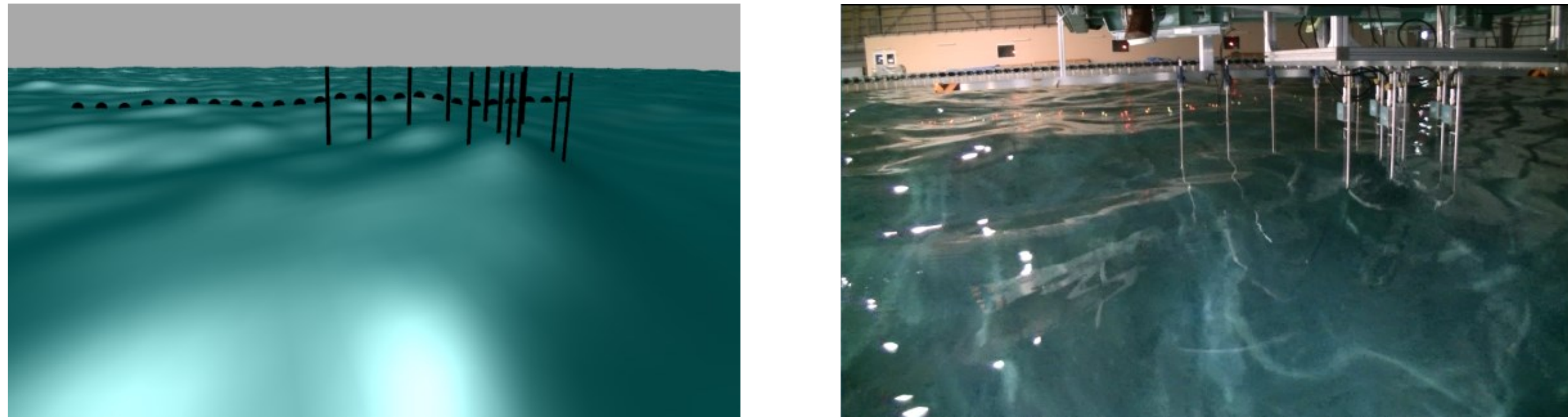
Keywords: Ocean Waves, Nonlinear Waves, Ocean Engineering, Seakeeping Performance, Tank Experiments, Hydroelasticity, Ships and Offshore Structures

In our quest to ensure the safe use of the ocean, we conduct research focusing on the ocean engineering problem associated with waves, using theoretical, numerical, and experimental approaches. Our goal is to elucidate the nonlinear physical processes underlying the formation of freak/rogue waves and to understand the complex nonlinear behavior of ships and offshore structures in such waves.

Nonlinear Ocean Waves

We are working on elucidating the nonlinear physical processes underlying the formation of freak/rogue waves - exceptionally large waves that suddenly appear in the ocean - and the experimental reproduction of such waves in wave basins.

Numerical simulation of freak waves and their reproduction in a wave basin



Description of nonlinear wave evolution

(Zakharov Equation, Nonlinear Schrödinger Equation)

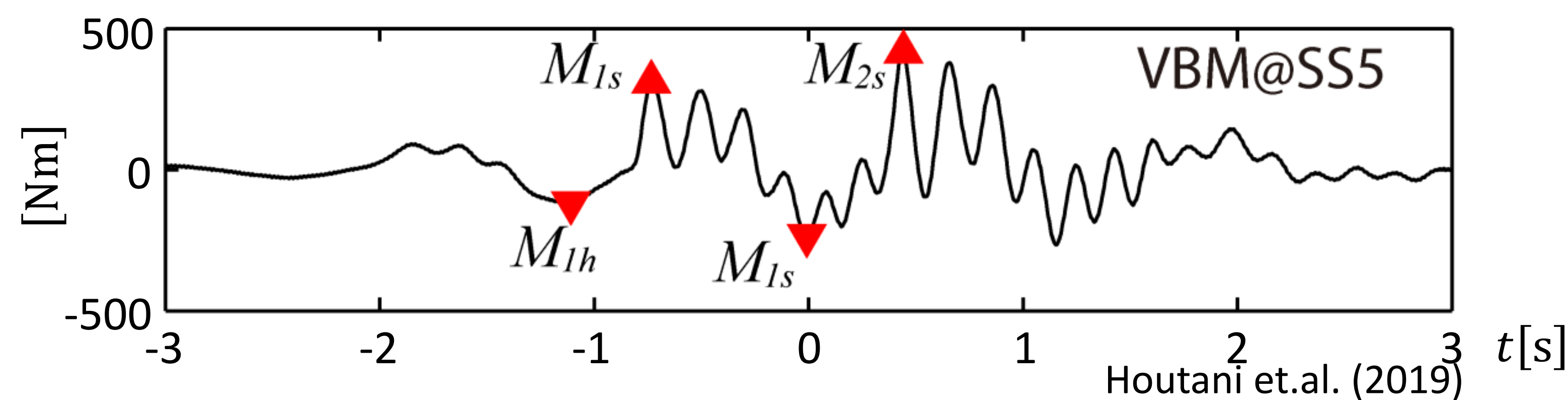
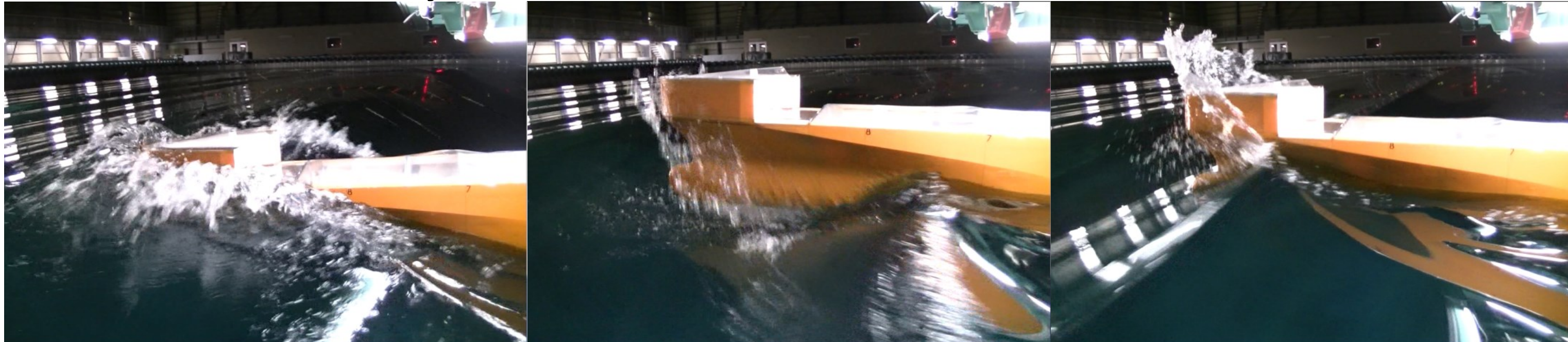
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$$\left(\frac{\partial A}{\partial t} + c_{gc} \frac{\partial A}{\partial x} \right) + i \frac{\omega_c}{8k_c^2} \frac{\partial^2 A}{\partial x^2} + i \frac{\omega_c k_c^2}{2} |A|^2 A = 0$$

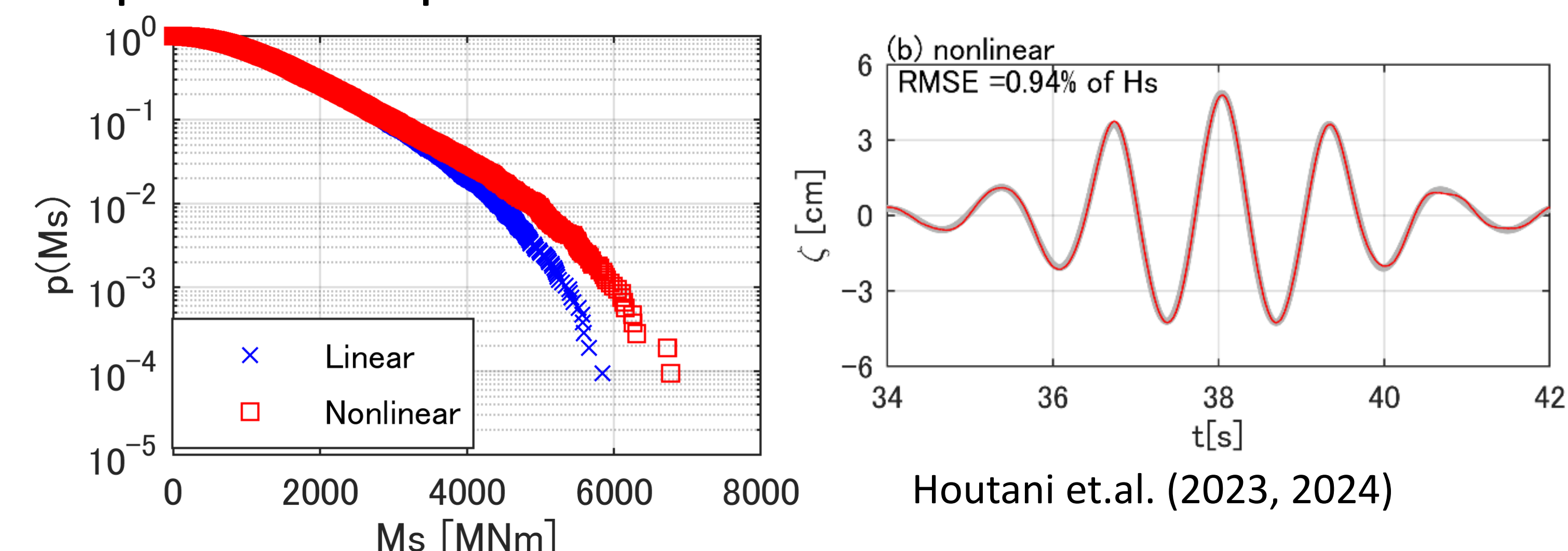
Ship Responses in Extreme Waves

We conduct research on unraveling highly nonlinear phenomena of ships and offshore structures against extreme waves, such as impact loads from slamming and the resulting elastic vibrations of structures.

Towing experiment of a flexible container ship model in freak waves and measurement of the hydroelastic vibration of the model

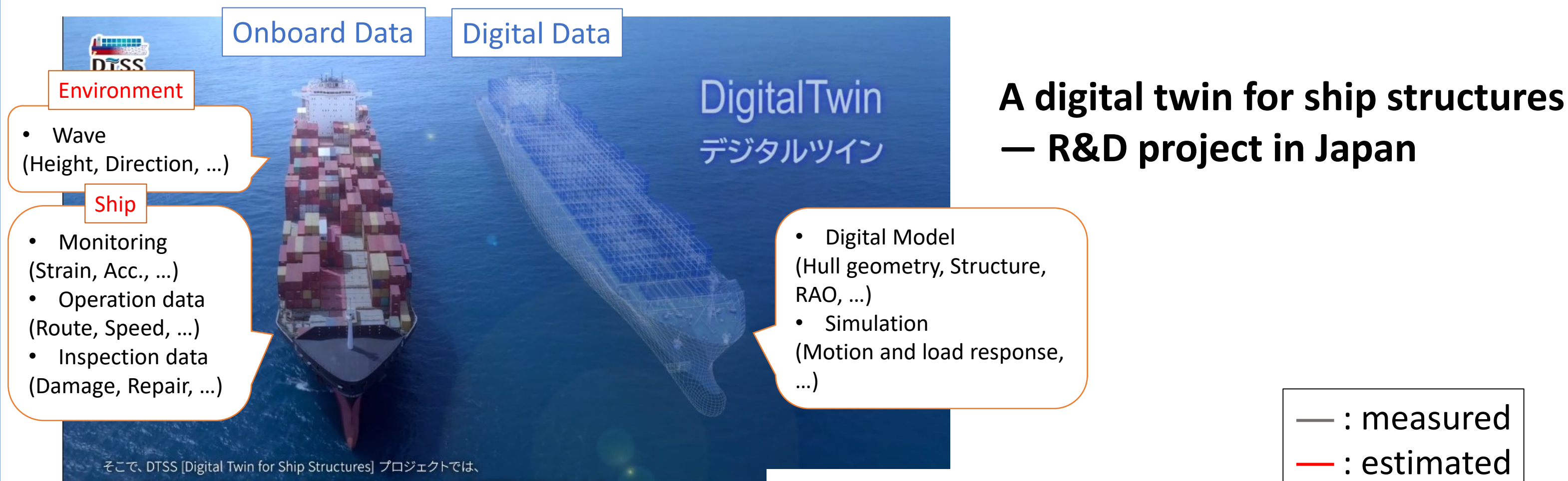


Stochastic prediction of wave loads on ships in nonlinear waves and corresponding most probable wave episode



Predicting Wave and Floating Body Response

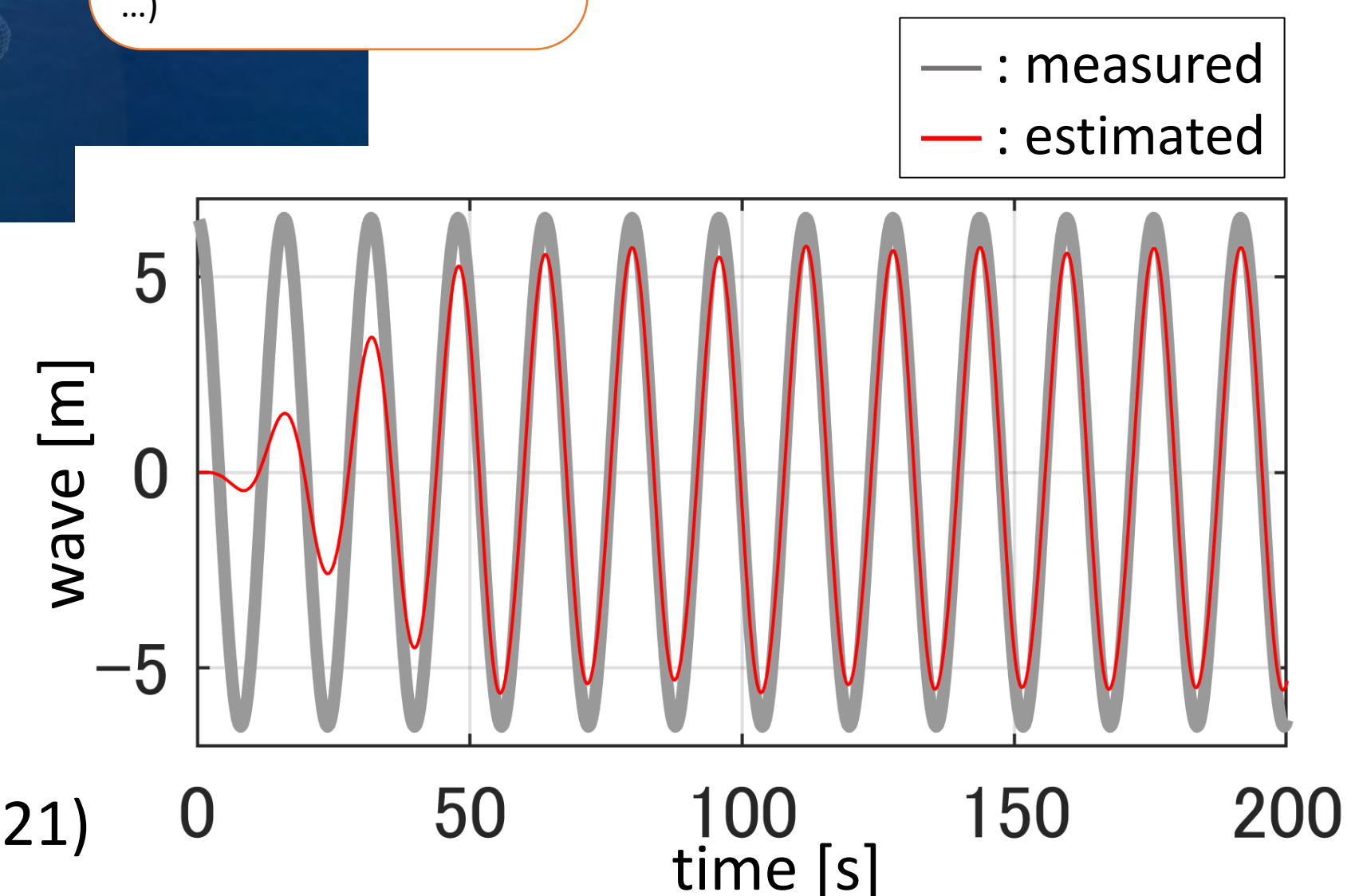
We are developing methods to predict unmeasured waves and ship responses using measured ship responses with data assimilation schemes.



<https://www.youtube.com/watch?v=Z7JhtkxIOAY>

Encounter wave prediction using measured ship response data with Kalman filter (twin experiment)

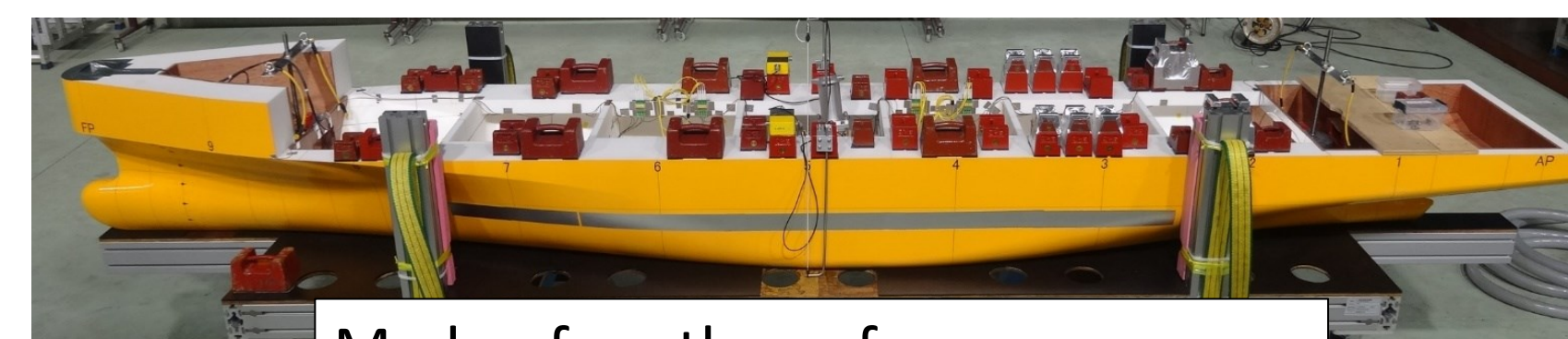
Sugino, graduation thesis (2021)



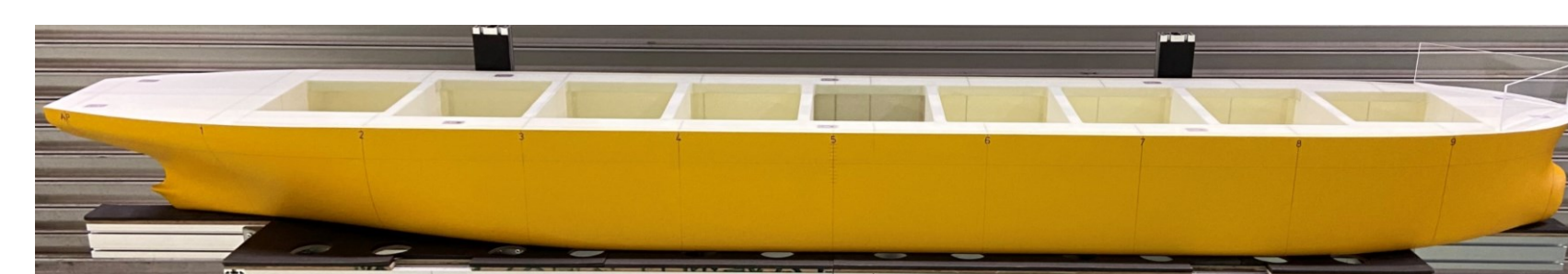
Novel Tank Experiment Techniques

We have developed novel experimental techniques, such as new concept flexible ship model designs, wave generation methods in wave tanks, etc.

Novel flexible ship models

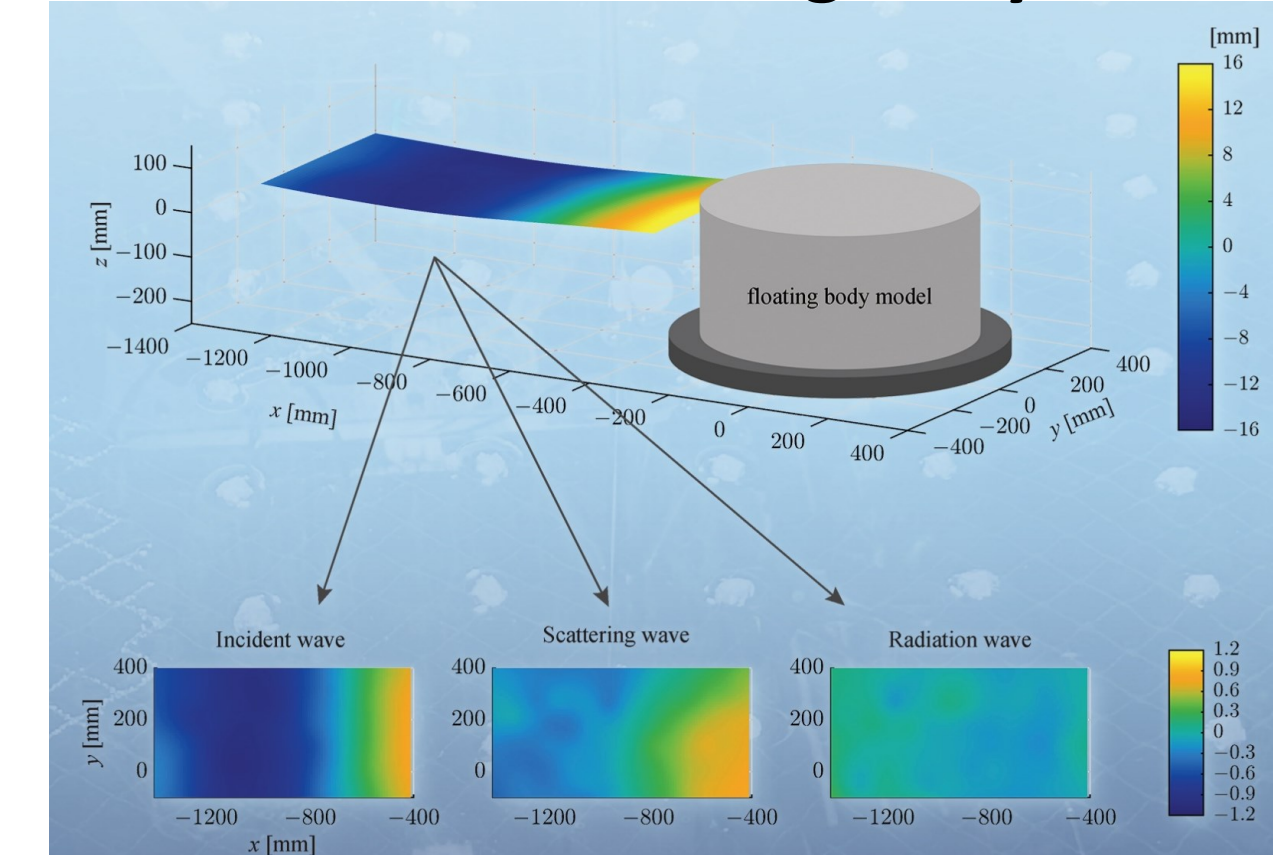


Made of urethane foam: to measure torsional vibration



Made of GFRP sandwich panels: to measure ship hull response and local deformation of the bottom hull

Stereo reconstruction of 3D wave fields around a floating body model

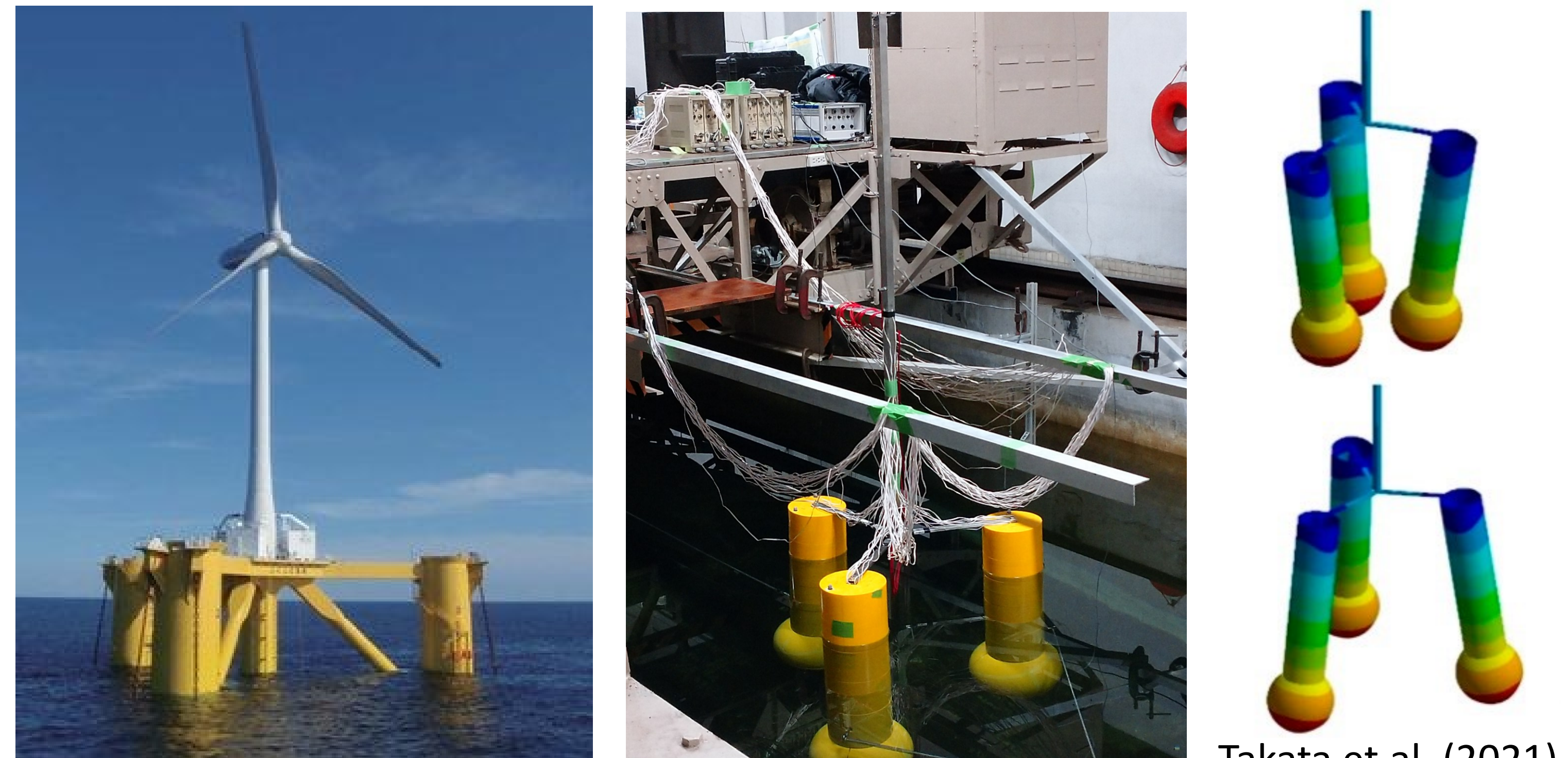


Higuchi et.al. (2023)

Floating Offshore Wind Turbine

We are working on the analysis of the dynamic response of floating offshore wind turbines (FOWT) and the development of very lightweight FOWT designs. (with Prof. Hideyuki SUZUKI.)

Research on the motion and elastic deformation of multi-column FOWT



Takata et.al. (2021)

Houtani Lab. is a new lab established in 2024. Some studies have been conducted in collaboration with Hideyuki Suzuki Lab. Don't hesitate to contact us if you are interested in our lab. We welcome you to visit our lab.



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