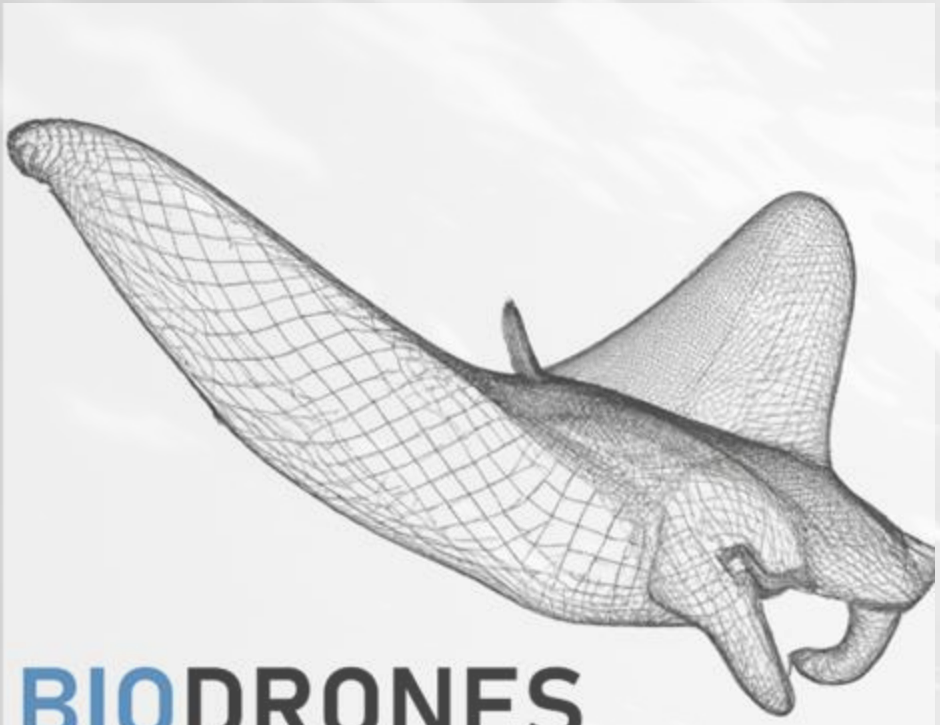

BIODRONES
PRIN 2022

A BIODRONES PROJECT WORKSHOP
TALKING WITH THE EXPERTS
Prof. Kevin J. Maki
University of Michigan

Thursday June 19, 2025
Sala Bulgarelli, CNR-INM, Via di Vallerano 139 Rome

11:00 Prof. Kevin J. Maki, Language Modeling of the Ocean to Predict Extreme Ship Responses

Abstract: Large language models (LLMs) are perhaps the most disruptive form of artificial intelligence, fundamentally changing how humans access the vast body of knowledge available on the internet. LLMs have already begun to impact engineering and science, and we are only starting to understand their potential to help address the complex challenges we face as a society. This talk focuses on how language models can prescribe dangerous ocean wave conditions that produce the largest responses, which can then be analyzed using state-of-the-art computational fluid dynamics simulations. The new language model, called GenWave, will be introduced, and examples will be provided demonstrating its capabilities for predicting extreme waves, parametric roll, and the loads experienced on a ventilatingship propeller during an emergency crashback maneuver.

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Consiglio Nazionale delle Ricerche

Prof. Kevin J. Maki
University of Michigan

Kevin Maki is Professor of Naval Architecture and Marine Engineering (NA&ME) and the **Director of the Aaron Friedman Marine Hydrodynamics Laboratory** at the University of Michigan.

His research interests include numerical and experimental naval hydrodynamics, hydroelasticity, and marine renewable energy. In 2007 and 2009, he served as a Summer Faculty Fellow at the Naval Surface Warfare Center Carderock Division, supported by the Office of Naval Research, and has also been a Visiting Professor at the Italian Ship Model Basin.

His research is funded by the **Office of Naval Research, Ford Motor Company, NAVSEA, and the American Bureau of Shipping**. He teaches courses in naval hydrodynamics as well as the design of sailing yachts and high-speed craft. Professor Maki is an Associate Member of SNAME.

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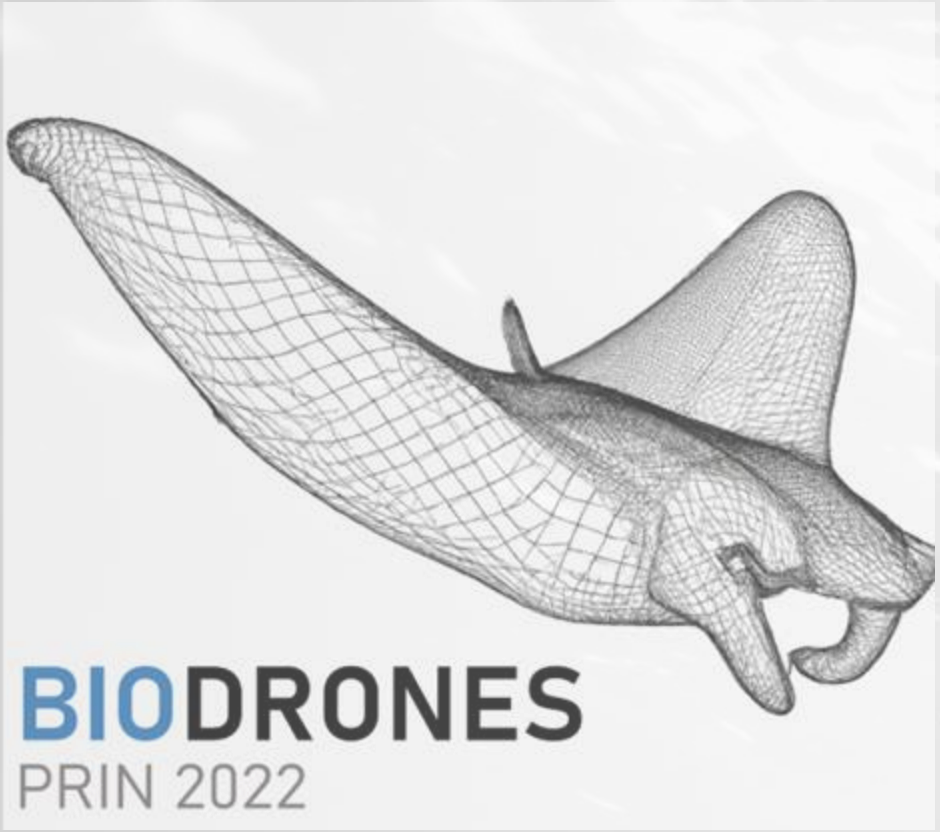

Biomimetic and Innovative Optimized hydrodynamic concepts of high-efficiency underwater gliding DRONES for ocean research

THE PROJECT

- The BIODRONES project aims to optimize hydrodynamic designs for compact autonomous underwater gliders (AUGs) tailored for ocean surveying. These designs seek maximum efficiency, range, and endurance within set constraints. The project's objectives include providing guidance for next-gen AUGs, enabling cost-effective ocean data collection, and promoting technology transfer to small and medium underwater robotics enterprises.
- AUGs offer cost-effective, long-range data collection capabilities, measuring various ocean parameters. Buoyancy control methods involve seawater flooding/evacuation or adjusting oil levels in an external bladder. Efficient hydrodynamic designs are crucial for equilibrium between lift, drag, and buoyancy force, ensuring extended missions.
- The project explores biomimetic and innovative glider concepts inspired by nature (rays, sea turtles) and other industries (aircraft design). To ensure a fair comparison, all concepts undergo high-fidelity hydrodynamic optimization using simulation-driven methodologies, including multifidelity solvers, metamodeling, active learning, dimensionality reduction, and robust multi-objective optimization techniques.

THE PARTNERS

• Consiglio Nazionale delle Ricerche – Istituto di Ingegneria del Mare	Dr. Matteo Diez
• Università Roma Tre	Prof. Umberto Iemma
• Sapienza Università di Roma	Prof. Giampaolo Liuzzi

LINKS

- http://www.inm.cnr.it/biodrones
- https://www.linkedin.com/company/biodrones

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