

Test operation under stormy environment in the tropical northwestern Pacific Ocean

Progress until FY2022

1. Outline of the project

We conduct open-ocean tests of virtual mooring (VM) drone prototypes in the tropical Northwest Pacific Ocean, a region where many typhoons are generated and develop, during R/V *Mirai* tropical ocean cruises in 2023 and 2024 to validate hull control, navigation, communication, and accuracy of atmosphere-ocean sensors in stormy condition with strong wind and high waves around the center of typhoons.

In the first year (FY2022), we established specific procedures and safety measures as preparation for the short-term open-ocean test (approx. one week) of the prototype #2 outfitted with modified sensors developed by R&D Themes 1 and 2 during R/V *Mirai* cruise in 2023 in the east coast of Philippines.



Fig. 1 R/V *Mirai* used for open-ocean tests of prototypes. A-frame crane on the aft deck (blue dashed circle) and other equipment used for deployment and retrieval of the VM drone prototypes. C-band radar (yellow dashed circle) and various atmosphere-ocean sensors equipped with the vessel are used to validate data obtained by the prototypes.

2. Outcome so far

The activities and results in 2022 are as follows.

1. We submitted a marine scientific research (MSR) application, which is required to prepare about one year prior to a cruise to obtain consent from coastal states if we plan activities in waters under the jurisdiction of a foreign state, to the MEXT (and then, MOFA) for the short-term open-ocean test after international coordination with relevant countries concerning the test in advance,
2. We made a specific test plan of the prototype #2 to obtain sufficient ship time based on discussion among PIs of various projects, such as the Wave Glider and drifting buoys, which are planned during the same cruise.
3. We established safety procedures on the deck of R/V *Mirai* and ocean, including deployment and retrieval the prototype during the test, and coordinated with research safety committee of the representative institution in advance.

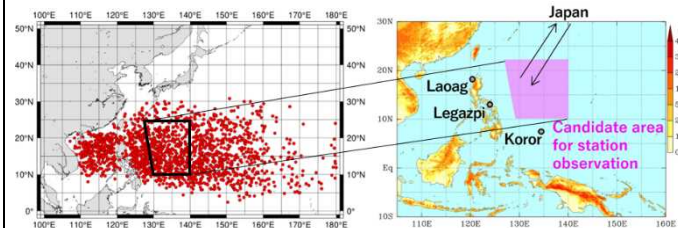


Fig. 2 Climatological of typhoon occurrence locations (red dots), 1951-2021, based on Digital Typhoon*1 (left). Planned route of R/V *Mirai* cruises in 2023/2024 and stationary points for open-ocean tests of VM drone prototypes in the east of Philippines (right).

*1 <http://agora.ex.nii.ac.jp/digital-typhoon/reference/birthplace.html>

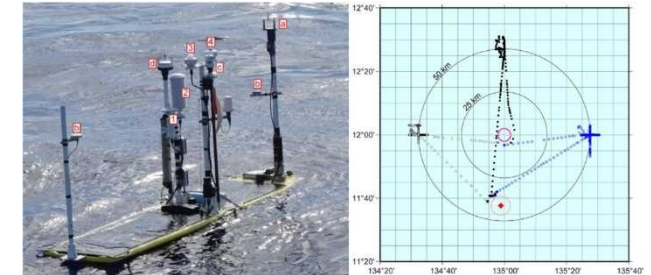


Fig. 3 Atmospheric sensors on the deck of a Wave Glider used for the 2020 R/V *Mirai* tropical ocean cruise (left) and arrangement of three Wave Gliders for their intercomparison (right). They were deployed at 50 km each to the east, west and north of the station point of R/V *Mirai* (red circle at the center) (R/V *Mirai* Cruise Report MR20-E01*2). Open-ocean tests of VM drone prototypes in 2023 and 2024 are planned in a similar configuration which can be intercompared among prototypes, Wave Gliders, and R/V *Mirai* atmosphere-ocean sensors.

*2 https://www.godac.jamstec.go.jp/cr_catalog/external/metadata/MR20-E01_all/file/MR20-E01_all.pdf

3. Future plans

In the next year (2023), we conduct the short-term (approx. one week) open-ocean test of the VM drone prototype #2 in the east of the Philippines during R/V *Mirai* tropical ocean cruise in collaboration with R&D Themes 1 and 2. For this purpose, we prepare for a safety assessment from the research safety committee of the representative institution about the test procedure on the deck and ocean including coordination with vessel crews. In addition, we submit the MSR application for a long-term open-ocean test in 2024 (approx. one month) over the same waters by R/V *Mirai* tropical ocean cruise.