### Goal8 Realization of a society safe from the threat of extreme winds and rains by controlling and modifying the weather by 2050.

Typhoon Control Research Aiming for a Safe and Prosperous Society

### **R&D** item

# 2. Engineering Approach

## Progress until FY2023

### 1. Outline of the project

Effective typhoon intervention methods for control utilizing meteorological models have been studied. However, to determine whether these methods are realistically feasible, studies on specific intervention devices need to be conducted simultaneously. In addition, while the impact assessment team can calculate the amount of damage that can be reduced by typshoon control, the cost of implementing these typhoon intervention methods must be calculated to determine whether we should conduct the typhoon control action or not.

The engineering approach team studies to address the above issues; in FY2023, our team mainly studied how to intervene in typhoons using ships and offshore structures.

### 2. Outcome so far

Currently, the method of weakening typhoon intensity using the large-scale deployment of ships with large sails is studied as one of the candidates for typhoon intervention methods. To evaluate the feasibility of this intervention method, a tank test was conducted in an experimental tank at Yokohama National University using a scaled model of a large sailing ship to check whether the operation of the sailing ship could be conducted under the typhoon environment (Figure 1). As a result, it was confirmed that the assumed large-size sailing ship could be operated stably in strong winds and rough waves.

Our team also estimated the degree to which the assumed largesize sailing vessels could intervene in typhoons using past typhoon track histories. A simplified system model of a typhoon power generation ship, in which the propulsive force obtained from typhoon winds by large rigid sails moves the ship and rotates an underwater turbine to generate and store electricity, was created to quantitatively evaluate how well the typhoon power generation ship could follow typhoons and how much electricity it could generate against past typhoon track histories. Our team also conducted a comprehensive cost evaluation of a large rigid sail ship as a typhoon intervention device, as shown in Figure 2.



Figure 1. Tank test in the YNU experimental tank.



Figure 2. Relationship between the deployed area of sails and the required cost. The number D in the legend indicates the number of days of electricity generation to be conducted per year.

As an example of a more advanced typhoon intervention device study, our team has studied to develop a control method that can more efficiently influence the force and path of a typhoon by controlling wind volume and temperature with arranged wind turbines and exploring the capacity, number, installation location, and cooling capacity of the wind turbines required. In addition, our team has studied the types of state variables required for windmill control based on typhoon conditions and their estimation methods. Figure 3 shows an example configuration of a power generation unit of a heat pump ship as a typhoon intervention device. In this study, heat pump heat cycle simulations were conducted on this configuration example to estimate the required energy for the amount of cooling/heating.



Figure 3. Example configuration of a power generation unit of a heat pump ship.

#### 3. Future plans

Our team will conduct research to realize the methods examined in FY2023 and examine various other intervention methods proposed by the meteorological approach team. In particular, in FY2024, our team plans to develop a new chemical intervention method to control sea surface evaporation through surfactants and others.





