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

Estimation and Control of Air-Sea Momentum and Heat Fluxes of Typhoons

R&D item

2. Air-sea momentum and heat transfer mechanism at high wind speeds

Progress until FY2023

1. Outline of the project

The accuracy of typhoon track prediction has improved in recent years, whereas that of typhoon intensities prediction has not been improved yet. One of the main reasons is the difficulty of representing momentum and heat transfer mechanisms across the sea surface in typhoons.

On the sea surface under a typhoon, friction occurs between the atmosphere and the sea surface, resulting in the transfer of the typhoon's kinetic and thermodynamic energy at the sea surface (Fig. 1). The energy transfer due to friction has a significant impact on the track and intensity of a typhoon.

In this R&D item, we aim to investigate the airwater momentum and heat transfer (flux) at high wind speeds, using the world's largest typhoon simulation tank located at Research Institute for Applied Mechanics, Kyushu University. We also aim to



Fig. 1: Momentum and heat transfer across the sea surface in a typhoon

formulate the momentum and heat fluxes across the sea surface at high wind speeds and elucidate the momentum and heat transfer mechanism.

Although the air-sea momentum and heat fluxes have been investigated in our previous studies, the simulation tank used there had a short fetch. Therefore, the results may not accurately represent the air-sea momentum and heat fluxes in the wide ocean field. Our goal is to clarify the momentum and heat transfer mechanism and develop the reliable model formulae applicable to wide ocean.

2. Outcome so far

(1) More accurate measurement of momentum flux Using the typhoon simulation tank and the momentum budget and profile method, we estimated the momentum flux and drag coefficient at a fetch distance of 20 m under conditions with wind speeds up to 40 m/s. This momentum budget method successfully achieved precise observations at medium to high wind speeds. By combining this with the profile method using vertical wind speed distribution measurements obtained by Pitot tubes (Fig. 2), we proposed a more reliable model formula.



Fig. 2: Pitot tube (left) and the measurement (right)

② Estimation of heat flux

Previously, the estimation of heat flux in the



Fig. 3: Experimental apparatus for droplet measurement

typhoon simulation tank was rough due to the nonuniform water temperature. To address this, we established new environment by introducing new water pump. With stabilized water temperatures, we successfully estimated the heat flux with the targeted precision.

2 Measurement of scattered droplets

Under high wind speeds with breaking waves, various sizes of droplets are scattered into the air. These droplets may be involved in the heat transfer, but this has not been sufficiently verified. Therefore, we introduced a system to measure droplets in the typhoon simulation tank and began observing the droplets (Fig. 3).

3. Future plans

In this R&D item, we aim to formulate more reliable models for the momentum and heat fluxes across the sea surface by considering droplet dispersion under high wind speeds.





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