

Sea-water spray observation and analysis along JARE59 Shirase cruise

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Ship icing often affects the ship's navigation such as a decrease in operation efficiency, a malfunction of deck equipment, increasing the risk of falling water, declining in restoring power, and so on. It is generally said that the main cause of ship icing is seawater spray generated by collision of ship and wave.

In Japanese Antarctic Research Expedition (JARE59), we conducted sea-water spray observation, which is an important factor of ship icing. In the observation, we installed two kinds of equipment, a spray particle counter (SPC) and marine rain gauge type spray gauge (MRS), on the Japanese icebreaker Shirase. SPC is a sensor that counts classified spray particles of 50 to 1000 μm into 32 classes according to their particle diameters. It was attached at the compass deck (06 deck). MRS is a sensor designed to measure the amount of spray by attaching a cylindrical spray cap to a normal marine rain gauge meter. It is installed at the starboard side and the port side on the upper deck (01 deck), and the 06 deck. As a result of this observation, we succeeded in acquiring continuous data on spray.

We attempted to predict spray flux using neural network (NN) model since it is difficult to calculate the droplets theoretically. There are two hidden layers and each hidden layer has 64 neurons in NN. ReLU, RMSprop and mean square error is used as activation function, optimization function, loss function. Currently, we succeeded in highly accurate prediction (Fig. 1).

Also, we are trying to analyze the behavior of droplets considering the behavior of the wind around the Shirase using OpenFOAM that is open source software. As a trial calculation, we calculated wind behavior around miniature Shirase (Fig. 2). We used SST $k-\omega$ model as turbulence model and SIMPLE algorithm as numerical procedure. Sea surface has no wave and free-slip condition. 25m/s wind blows from the front of the ship. Reynolds number is about 3.791×10^5 (ship beam base) in this simulation. Currently, we are developing model which calculates how droplets behave. The data acquired in JARE59 will be used for the accuracy verification of this analysis.

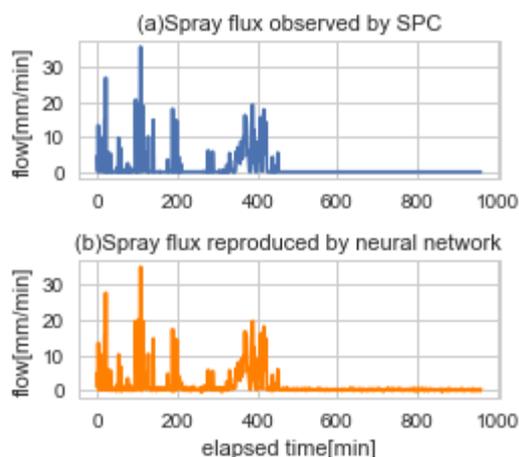


Figure 1 Spray flux predicted from pitch fluctuation and relative wind speed and direction

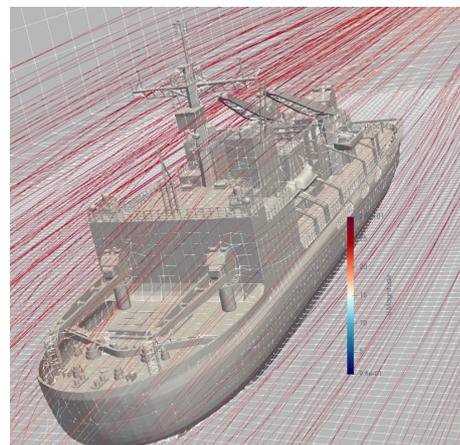


Figure 2 Wind streamlines around the ship

References

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