Observation of flow and turbulent mixing around Oitsukami Island in the Bungo Channel for prediction of sudden coastal intrusion of Kuroshio water (*Kyucho*)

*Eisuke Tsutsumi[1], Naoki Yoshie[2], Xinyu Guo[2], Takahiro Endoh[3], Yasumasa Miyazawa[4], Toru Miyama[4]

1. Faculty of Fisheries, Kagoshima University, 2. Center for Marine Environmental Studies, Ehime University, 3. Research Institute for Applied Mechanics, Kyushu University, 4. Japan Agency for Marine-Earth Science and Technology

In the Bungo Channel, the occurrence of *Kyucho*, a sudden coastal intrusion of warm water from the offshore Kuroshio region, during summertime is known to affect coastal ecosystems and fisheries. It has been shown that the occurrence of rapid tides in the Bungo Channel is related to local vertical mixing in addition to the frontal disturbances of the Kuroshio flowing to the south. Highly accurate prediction of *Kyucho* is needed to prevent the damage to fisheries, and to achieve this, both the disturbance of the Kuroshio on the offshore side and the turbulent mixing on the coastal side need to be adequately reproduced by numerical ocean circulation models. With the support of Grant-in-Aid for Scientific Research project “Prediction and Understanding of Sudden Kuroshio Coastal Intrusion Processes by Integrating New Generation Satellites and Responsive Field Observations” (JP21H01444, PI: Toru Miyama), and Leading Academia in Marine and Environment Pullution Research (LaMer) of the Center for Marine Environmental Studies (CMES), Ehime University, we investigate the vertical mixing of the Bungo Channel based on field surveys of flow and microstructure turbulence, and to contribute to the prediction of the *Kyucho*.

The Oitsukamijima Island area off Uwajima, Ehime Prefecture, is considered to be an area where vertical mixing plays an important role in controlling the northward flow of warm water associated with the *Kyucho*. Flow and turbulence measurements were carried out by *TR/V* Isana of CMES, during the flood and ebb tide from 17 to 23 July 2022. Microstructure turbulence and hydrographic data were obtained with a free-falling turbulence profiler, and current velocity data with shipboard Acoustic Doppler Current Profilers.

During the field campaign, the Kuroshio was positioned further south than normal in the Shikoku Basin, so the frontal disturbance did not extend into the Bungo Channel, resulting in no *Kyucho* occurrence. Satellite-derived sea surface temperature showed the formation of a cold water pool in the Oitsukamijima Island area throughout the study period, indicating that the area was vertically mixed compared to the surrounding areas. The surveys revealed that topographic wakes were generated around Oitsukamijima Island with semi-diurnal tides, and that horizontal and vertical sheared currents dominated the flow fields. An average vertical diffusivity of 10^{-3} m^2 s^{-1} was obtained in the surface to sub-surface layer and 10^{-2} m^2 s^{-1} in the mid-column to bottom layers. Highly elevated vertical diffusivity up to 10^{-1} m^2 s^{-1} was observed during the ebb tide around the spring tide with a notable surface water cooling event. However, the observed vertical diffusion and vertical advection could not explain this decrease in water temperature, indicating a central role of the horizontal advection. To elucidate the vertical mixing processes in this area, it is necessary to understand the mixing and advection processes not only around Oitsukamijima Island, but also in the straits such as that between Hiburijima and Tojima Islands in the same area.

Keywords: turbulent mixing, island wake, tidal currents, sudden coastal intrusion of Kuroshio water (Kyucho), vertical eddy diffusion

