Commemoration of the 60th Anniversary of the Japanese-French Oceanographic Society of Japan
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Oceanography for the future we want:
transformation of our society or sustainable development under the changing sea

Toward Prediction of Interaction Between Coastal Circulation and the Kuroshio

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1. Objectives

We are currently conducting a research project designed to investigate interaction between coastal circulation and the Kuroshio current. The goal of our project is to present a clear vision for future ocean science in bays and estuaries adjacent to the Kuroshio, meeting the expected outcome of the UN Decade of Ocean Science, especially for "A Predicted Ocean". To achieve this goal, we have three objectives: development of numerical simulation, establishment of sustainable in situ observation, and collaboration with stakeholders. Background and progress of the project is introduced in this paper.

2. Background

Coastal circulation off the south coast of Japan interacts strongly with the Kuroshio current. For example, after being detached from the Kuroshio current, meso- and submesoscale disturbances with momentum are often captured into small bays, where they drive local peculiar coastal circulation (Fig.1). This example indicates that understanding and prediction of the interaction between coastal circulation and the Kuroshio current are necessary to achieve a healthy, safe, and resilient ocean for sustainable development including improved forecasts of regional weather and climate and better management of regional fisheries and aquaculture.

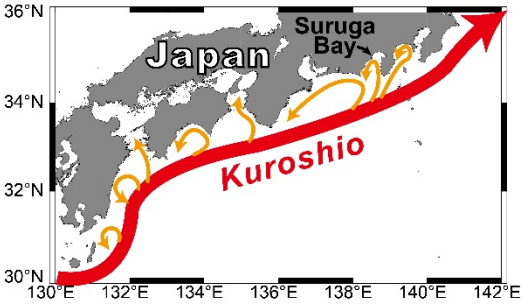

Fig. 1. Schematic of the Kuroshio current and coastal circulation off the south of coast of Japan.

We are in an age when high-resolution ocean circulation models have started simulating the meso- and submesoscale disturbances directly. Moreover, in situ observation has recently become easier to perform using ordinary fishing boats or commercial ships, because observational instruments have been downsized. It should be noted that in coastal seas, there are usually few research boats or ships equipped with advanced observational instruments. Therefore, we have developed a project that performs numerical simulation using state-of-the-art ocean circulation models and in situ observation using ordinary fishing boats and a commercial ship to study the interaction between coastal circulation and the Kuroshio current around Suruga Bay off the south coast of Japan (Fig. 1). A key point is that the numerical simulation is validated by the in situ observations.

3. Results

Two types of numerical models with variational data assimilation are used: JCOPE model with a terrain following (σ-) coordinate system has been developed by JAMSTEC (Japan Agency for Marine-Earth Science and Technology). MRI.COM model with a geopotential (z-) coordinate system has been developed by JMA (Japan Meteorological Agency). Both the models successfully reproduce complex circulation systems between the south coast of Japan and the Kuroshio, including daily variations of winds, river discharge, and tides (Figs. 2 and 3).

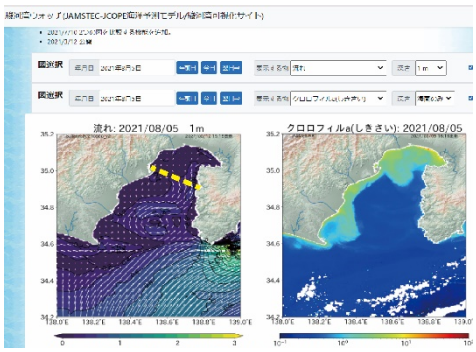

Fig. 2. Open website of JCOPE model. Left: forecasted surface currents. Right: forecasted surface chlorophyll.

Two types of in situ observation are ongoing. An ADCP (acoustic Doppler current profiler) mounted on the bottom of a commercial ferry (Fig. 4) is measuring velocity profiles on a transect across Suruga Bay every day (dashed line in Fig. 2). Moreover, mooring observation (Fig. 5) has been performed to record time series of temperature, salinity, and velocity with shorter time intervals at a few fixed positions in the bay.

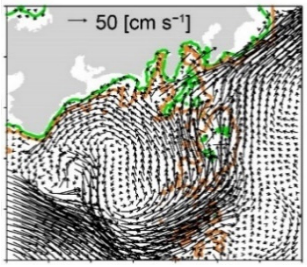

Fig. 3. Surface currents in MRI.COM model.

4. Discussion

To achieve our project goal, synergistic collaboration with stakeholders such as local fishers and shipping agencies is essential. This is because frequent observations with high spatial and temporal resolution cannot be made without their support. In other words, there are usually few research boats or ships in most of the coastal seas. At the same time, there are many fishery problems that cannot be solved without state-of-the-art ocean science, because seawater circulation has a crucial influence on fishing grounds. In these points our project meets the goal of the UN Decade of Ocean, developing a sustainable ocean science.

Fig. 4. The ferry “Fuji”, on the bottom of which an ADCP is mounted.

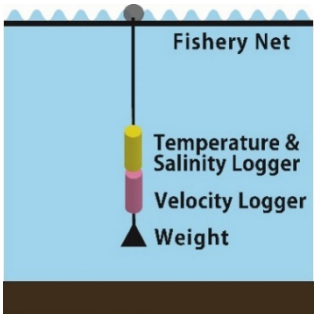

Fig. 5. Schematic of mooring system equipped with a fishery net.

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Reference

Toyoda, T. et al. (2021): Surface-layer circulations in Suruga Bay induced by intrusions of Kuroshio branch water, *Frontiers in Marine Science*. DOI: 10.3389/fmars.2021.721500