【Grant-in-Aid for Transformative Research Areas（A）】

Macro coastal oceanography: integrated simulation for the material dynamics from the land through the open ocean

Head Investigator	The University of Tokyo, Atmosphere and Ocean Research Institute, Professor HASUMI Hiroyasu　　Researcher Number:40311641
Research Area Information	Number of Research Area : 22A402　Project Period (FY) : 2022-2026 Keywords : coastal zone, nutrient, land water, massive discharge, simulation

Purpose and Background of the Research

●Outline of the Research

The coastal zone environment is changing due to human activities. Global scale changes in the ocean associated with global warming affect the coastal zone, while the supply of various anthropogenic substances is increasing from the land. Rivers, which transport material from the land to the coastal zone, are also affected by global warming. For example, the intensity and frequency of massive discharge are increasing in Japan. There is an increasing need for prediction and impact assessment for the coastal zone. Still, the current simulations cannot meet such a need because the influences from the land and the open ocean are not sufficiently considered. This Research Area aims to transform the coastal oceanography into a macroscale framework to properly include the influences from the land and the open ocean. Thereby, we intend to realize such a simulation that can properly predict the ongoing changes in the coastal zone and assess their impact. This Research Area focuses specifically on the dynamics of nutrients in the coastal zone around Japan. Nutrients are supplied to the coastal zone from the land and the deep open ocean, and both are rapidly changing under human influences.

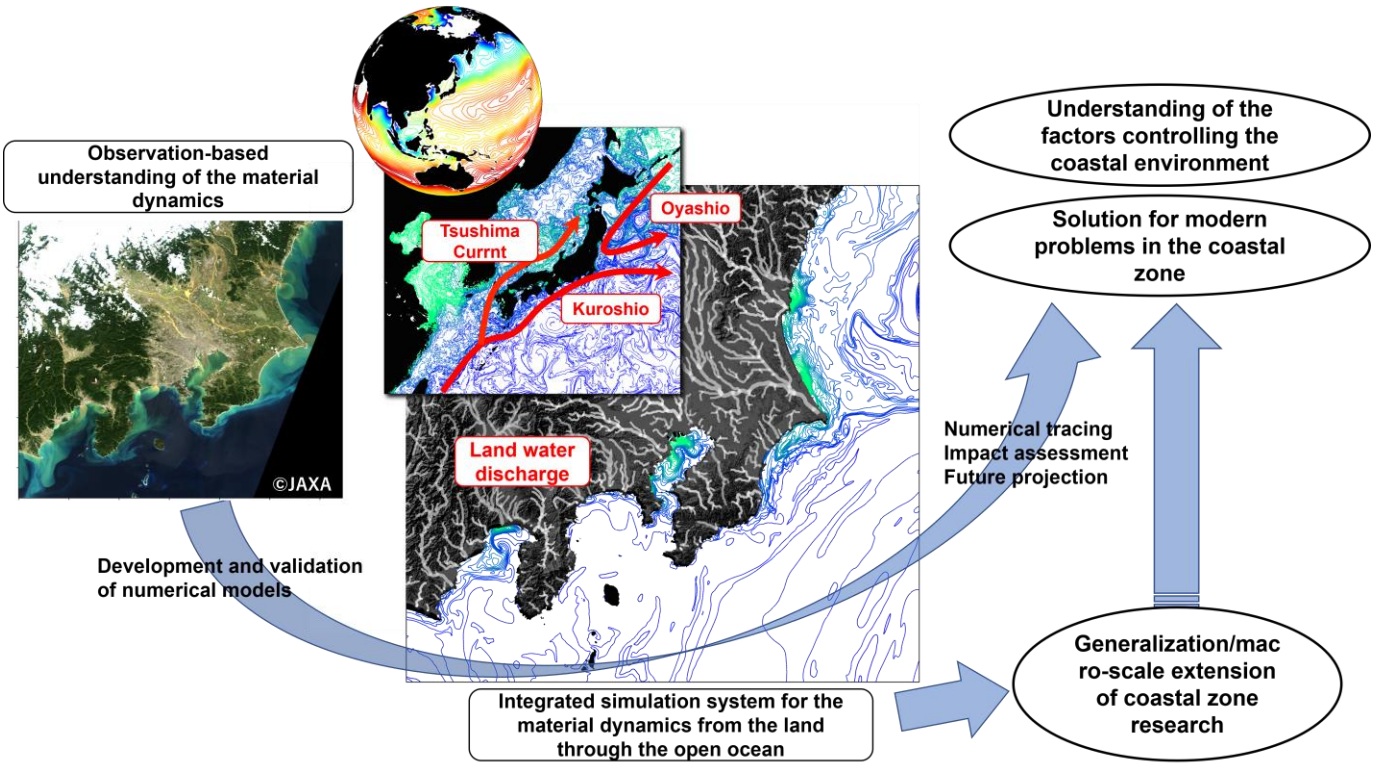

Figure 1. Schematic for “Macro coastal oceanography”. An integrated simulation system, validated by observation-based understanding, is to be established for the material dynamics from the land through the open ocean. By extending the coastal oceanography into a macro-scale framework, we intend to accumulate scientific knowledge and develop the methods which lead to solutions for problems in the coastal zone under the influence of human activities.

●Integrated simulation system

It is the final product of this Research Area, composed of models for 1) the supply of water and material from the land, 2) the water exchange between the coastal zone and the open ocean, and 3) tracing the history of the material.

We currently have prototype models for each component (Figure 2). We refine them regarding the modeled processes and spatial resolution and integrate them into a single system.

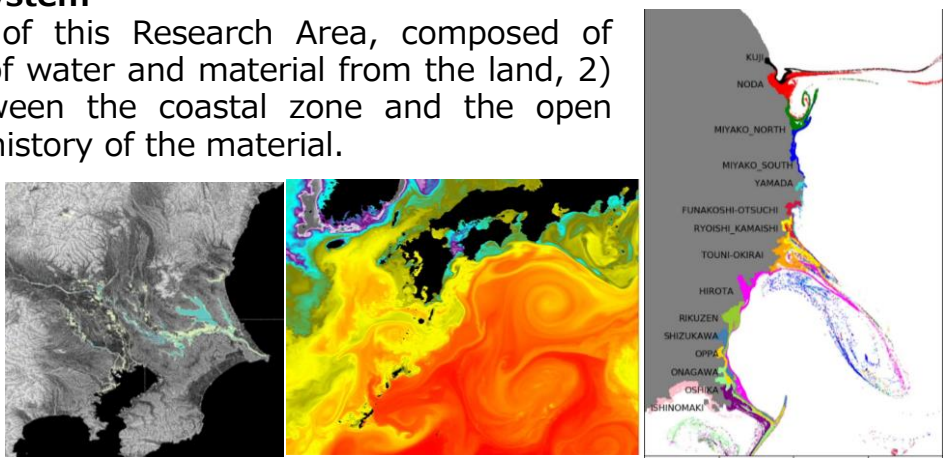

Figure 2. Prototype models of the integrated simulation system. Left: rivers after heavy rainfall in the Kanto region. Center: eddy-dominated exchange of water (colors represent the sea surface temperature). Right: movement of particles released from the coast.

Expected Research Achievements

●"Milestone" of this Research Area

We set a symbolic question to be answered that truly needs a macro-scale view of the coastal zone:

> Which of the land and the open ocean is dominant in the supply of nutrients that sustains the biological production in the coastal zone?

This is a classical and fundamental question in the coastal zone environment, but it has not been fully answered yet. We need to properly consider the influences from the land and the open ocean, including their ongoing changes due to human activities, on the coastal zone.

●Impact of massive discharge of rivers

It has been considered that the supply from the open ocean is dominant even for relatively closed coastal regions around Japan. However, some of the factors controlling the above question have not been sufficiently estimated, and we consider that the importance of the supply from the land has been underestimated. Our recent observation around a river mouth suggests that sedimentation of discharged material and its resuspension is a crucial factor in the nutrient supply in the coastal zone (Figure 3), and such a process has been overlooked so far. Furthermore, the discharge of material is not proportional to the discharge of water. For mountain rivers which are typical in Japan, it is pointed out that the amount of material discharged by a single flooding event can easily exceed the annual discharge of material by normal flows. The assessment of the impact of massive river discharge is a key point in achieving our milestone.

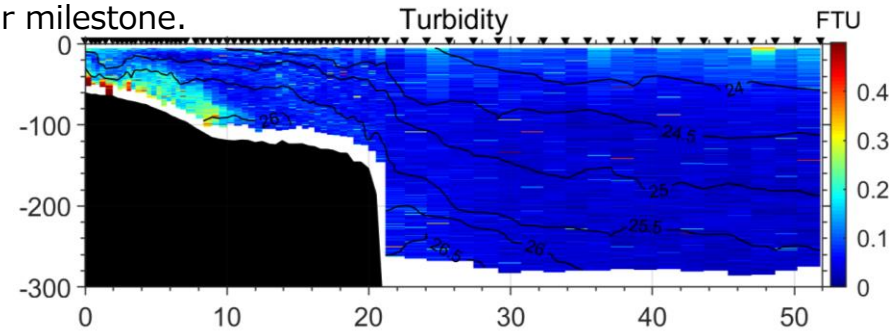

Figure 3. Observed seawater turbidity (amount of suspended material) from the Tone River mouth (left) to the offshore (right). High turbidity exists on the coastal seafloor and extends upward.

Homepage Address, etc.	https://macrocoast.jp info@macrocoast.jp