Ocean-Ecosystem Change Systematics: The Science Aimed at by WPI-AIMEC

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Since the Industrial Revolution, human activities have expanded to the extent that they significantly impact every subsystem that constitutes the Earth system, which manifestations include global warming, ocean acidification, biodiversity loss, and ecosystem collapse. In the face of this crisis, understanding and projecting the mechanisms of change in the Eart system is the most crucial challenge for the sustainability of human society. Marine ecosystems account for approximately half of global primary production and support about 80% of Earth’s total animal mass. Indeed, marine ecosystems provide humans with various material and functional benefits known as “ecosystem services,” including food supply, atmospheric and marine chemical component regulation, nutrient cycling, wastewater treatment, recreation and culture, and shoreline protection. Despite this, we lack a fundamental understanding of how marine ecosystems respond and adapt to anthropogenic environmental changes compared to terrestrial ecosystems. Against this background, the Advanced Institute for Marine Ecosystem Change (WPI-AIMEC) proposed by Tohoku University and Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has been selected as a World Premier International Research Center Initiative (WPI) project plan in FY2023 and formally established on January 1, 2024. WPI-AIMEC has designated the Northwest Pacific Ocean, including the waters around Japan, as a priority research area, and is taking a combined approach of ocean physics, ecology, mathematics, and data science to 1) elucidate the interactions between climate, ocean, and ecosystems, 2) elucidate the mechanisms of response and adaptation of marine ecosystems to the environment, and 3) predict changes in marine ecosystems. Specifically, while focusing on the phenomenon called “regime shift,” in which the marine ecosystem undergoes rapid structural changes over a wide area, we will conduct wide-area geophysical observations including biogeochemical (BGC) Argo data, environmental DNA analysis, and laboratory experiments to understand better the linkage, stability, and adaptability that are important for the maintenance of the marine ecosystem. Furthermore, by fully utilizing AI and machine learning, we will promote integrated analysis of ocean physics-ecosystem big data and build a model of ocean ecosystem change that can be applied to the entire global ocean. Through these efforts, we aim to create “Ocean-Ecosystem Change Systematics” as a new academic field.

Keywords: Marine Ecosystem, Argo, eDNA, Earth System Model

