Equilibrium Solutions for Marine Food-chain to Bottom-up and Top-down Controls

*Yutaka Isoda[1]

1. Hokkaido University

Using a simple four-level food-chain model (N: nutrient, P: phytoplankton, Z: zooplankton and F: fish), the equilibrium solutions are investigated under the nutrient supply (bottom-up control) and the loss-parameter of fish (top-down control). The solutions of bottom-up control suggest that Z stock is always stabilized, while those of top-down control reveal the phase relation between [N, Z] and [P, F] is out of phase.

Keywords: Bottom-up control, Top-down control, Marine food-chain, Volteraa equation

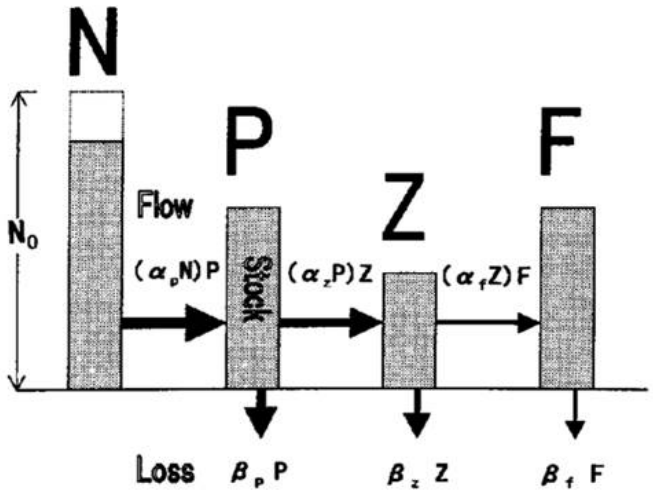

Fig. 1. Diagram of the dynamics of our food-chain model with four stock levels: N (nutrient), P (phytoplankton), Z (zooplankton), and F (fish).

Tidal changes in the Tokyo Bay during the last 10,000 years estimated from a numerical model

*Katsuto Uehara[1]

1. Kyushu University

Many major inner bays in Japan such as Tokyo Bay, Ise Bay south of Nagoya City and Osaka Bay have experienced a specific pattern of morphological changes during the Holocene: a rapid expansion of bay areas during the early Holocene due to the inundation of incised valleys in accord to the postglacial sea-level rise, which was followed by a gradual progradation of shorelines as a result of sediment depositions more apparent during mid- to late-Holocene when the sea level was stable or fallen by several meters. The current study estimated tidal changes taken place during the last 10ka in Tokyo Bay, where most of the modern bay area exposed subaerially during the earliest Holocene while the length of the bay axis extended up to about twice as large as the modern setting during the mid-Holocene. The estimation has been undertaken by compiling a series of paleobathymetry (every 1ka from 10kaBP to 4kaBP) using various sources and by conducting numerical experiments. It was found that the maximum tidal level at the head of the bay may have increased by 52%-93% compared to the present value during the maximum transgression period (7kaBP). The increase in the tidal prism during the transgressive stage have given rise to a significant increase in the tidal current strength at the mouth of the bay. During the early Holocene, strong tidal currents were also observed at around the modern head of the bay, which might be correlated to the coarse sediments observed at the base of the Holocene layer in this area. These features could be explained qualitatively by employing a simple resonance theory with two parameters, i.e., the water depth and the length of the bay.

Keywords: Holocene, paleotides, numerical simulation, Oku-tokyo Bay, Sea-level change

Possible oceanic signals of the 18.6-year period modulation of tide-induced vertical mixing

*Satoshi Osafune[1]

1. Japan Agency for Marine-Earth Science and Technology

Bi-decadal variability is one of the prominent features of the decadal to multi-decadal ocean and climate variability in the North Pacific. This has received considerable attention, because this is seen in many societally important variables such as air temperature, precipitation, and even fishery resources. However, while several possible mechanisms underlying this variability have been proposed, it has not been fully understood. The 18.6-year nodal tidal cycle related to the precession of the moon’s ascending node is a possible one. It is known that the diurnal tides induce strong vertical mixing around steep topographies like sills in the Kuril Straits and the Aleutian Passes, and this strong mixing is thought to play important roles in water-mass modification. The 18.6-year cycle largely modulates the amplitudes of the major diurnal tidal constituents by 11% and 19% for K_1 and O_1, respectively. Thus, it is hypothesized that the modulation of mixing contributes to the bi-decadal variability in water-masses in the North Pacific and its marginal seas. Using the historical ocean observation data, I found various bi-decadal variations downstream of the strong mixing regions, which can be explained qualitatively by the modulation of vertical mixing, although it is difficult to prove whether those are really the 18.6-year period signals by using only the limited observation data.

Keywords: bidecadal variability, 18.6-year nodal tidal cycle, tide-induced vertical mixing

Holocene changes of the Japan Sea Proper Water (JSPW) inferred from marine plankton (radiolarian) fossil records

*Takuya Itaki[1], Ken Ikehara[1]

1. Geological Survey of Japan, AIST

The Sea of Japan has its own deep-circulation system, with its deeper parts occupied by cold and highly oxygenated water formed by winter convection in the northwestern part of the sea. According to recent observations, such deep convection has been weakened with the global warming. How was in the past warming before the historical period? For example, it is well known the warmer climate during the Jomon period (ca. 7,300 years ago) in the mid-Holocene. Here, we will discuss about the deep-circulation changes in the Japan Sea during the past 12,000 years (Holocene) based on marine plankton (radiolarian) fossil records.

Radiolarians are planktonic Protozoans widely distributed in the world ocean, and their skeletons composed of opal are preserved in marine sediments. Many radiolarian species are restricted to discrete depth intervals and the depths at which they dwell are closely related to the vertical water structure. As a result, radiolarian fossils prove to be useful indicators not only in the reconstruction of the surface water conditions, but also for the conditions of the water masses at intermediate and deeper depths. In the Sea of Japan, investigations based on plankton tows and surface sediments revealed that *Cycladophora davisiana* occurs in a depth interval between 1,000 m and 2,000 m (deep layer of JSPW = Japan Sea Proper Water), and *Actinomma boreale* group in depths below 2,000 m (bottom layer of JSPW).

The study of six sediment cores located in water depths ranging from 300 to 3,600 m show that the radiolarian assemblages have varied during Holocene, indicating changes in water-ventilation strength in this marginal sea. Bottom-water ventilation has been dependent on high-salinity inflow through the Tsushima Strait in the south and winter cooling in the northwestern part of the Sea of Japan. Deep water was being actively formed in the early Holocene. This bottom-water formation has resulted in relatively constant water composition since 9 cal ka BP, with the overall increase in high-salinity oceanic-water inflow, although the latter decreased transiently from 7,000 to 5,000 years ago in concert with climatic warming.

Keywords: Paleoceanography, Microfissil, water structure

Collaboration study of paleoceanography and physical model in the Japan Sea

*Takuya Sagawa[1], Xinyu Guo[2]

1. Institute of Science and Engineering, Kanazawa University, 2. Center for Marine Environmental Studies, Ehime University

The Japan Sea is semi-enclosed marginal sea that is connected with adjacent seas with shallow narrow straits. During the last glacial maximum (LGM) sea level was ~130 m lower than today, which is similar to the sill depths of Tsushima and Tsugaru straits. Therefore, the Japan Sea was almost isolated from adjacent seas, and the Tsushima Warm Current (TWC) did not flow into the Japan Sea. Microfossil records suggest that the Oyashio Current flowed into Japan Sea first followed by the TWC as the sea level rose through the deglaciation. However, the deglacial reorganization of Japan Sea current system in relation to global eustatic change is not well understood in terms of physical oceanography. In this talk, we'll introduce our vision of collaboration research between paleoceanography and physical oceanography.

Keywords: Japan Sea, Paleoceanography, Physical Ocenography

Reconstruction of vertical temperature structure in the East China Sea to better understand the past Kuroshio variability

*Yoshimi Kubota[1], Katsunori Kimoto[2], Ryuji Tada[3]

1. National Museum of Nature and Science, 2. Japan Agency for Marine-Earth Science and Technology, 3. University of Tokyo

The East China Sea (ECS) is a marginal sea, located in western edge of the Pacific and the Kuroshio is one of the major current systems in the ECS and has a crucial impact on water properties in the ECS (Chen et al., 2010; Guo et al., 2012). Because the position of the Kuroshio in the ECS is relatively stable (standard deviation is ~10 km) compared with the outside ECS (Andres et al., 2008), it is suitable to investigate long-term variations in the Kuroshio without the consideration of meandering of the main axis. However, there has been ongoing debate about the variability of the Kuroshio in the past in the East China Sea. One argument is, like the Ryukyu Current today, the Kuroshio main axis migrated to be outside of the Okinawa Trough during the last glacial maximum (LGM)(e.g., Ujiié et al., 1991; Ujiié and Ujiié, 1999; Diekmann et al., 2008). Another argument is that the Kuroshio main axis remained located in the Okinawa Trough even at the lowest sea level stand (e.g., Kawahata and Ohshima, 2004; Lee et al., 2013). Based on a comparison of planktic foraminifera assemblages inside and outside the Okinawa Trough, Ujiie et al. (2003) advocated “outside Okinawa Trough”. Their comparison revealed the appearance of cold water species inside the Okinawa Trough during LGM, despite only minimal variation in assemblage-derived sea surface temperature (SST) outside the Okinawa Trough. However, a recent study based on comparison of Mg/Ca-derived SST records demonstrated that there was no significant difference in SST between inside and outside the Okinawa Trough, suggesting the entrance of the Kuroshio inside the Okinawa Trough during the LGM (Lee et al., 2013). Although there are many studies focusing on reconstruction of surface hydrology in the Okinawa Trough since the MIS 3 or LGM using planktic foraminifera assemblages (Li et al., 2001; Ujiie et al., 2003; Xu and Oda, 1999) and alkenon-derived SST (Ijiri et al., 2005; Yu et al., 2009), and Mg/Ca-based SST (Chen et al., 2010; Kubota et al., 2010; Sun et al., 2005), information concerning water properties at subsurface and intermediate depth is sparse, which is important as variations in the Kuroshio velocity and transport have a greater impact on temperature and salinities at subsurface and intermediate depths rather than those at surface (Oka and Kawabe, 1998). In this study, we reveal temperature structure in the Okinawa Trough since the late MIS 3 and discuss how we understand the Kuroshio variability in the past.

Keywords: Kuroshio , East China Sea , Last Glacial period

