

The 5th China-Japan-Korea IMBER Symposium and Training Course
Jing Zhang, Hiroaki Saito, Se-Jong Ju, Sumei Liu, Sinjae Yoo and Liuming Hu

The 5th China-Japan-Korea (CJK) IMBER Symposium and Training was held from 22-25 November 2011 at the East China Normal University (ECNU) in Shanghai, China. The purpose of this symposium was to provide a platform for marine scientists from the three countries to share and discuss the latest scientific achievements in the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) and Global Ocean Ecosystem Dynamics (GLOBEC) areas. Over 80 scientists from the three countries participated in the symposium (Figs. 1 and 2). In addition to nearly 40 oral presentations, over 30 posters with IMBER scientific achievements were displayed during the symposium. Twenty-one early career scientists and students attended the CJK IMBER training course on 25 November.



Figure 1. The 5th China-Japan-Korea (CJK) IMBER Symposium participants.



Figure 2. Symposium venue (left) and poster presentations (right).

Marine scientists from China, Japan, and Korea have been working actively in

the areas of GLOBEC and IMBER science since the early 1990s. Various scientific workshops and training activities have been held periodically by these three countries. Since 2002, the China-Japan-Korea GLOBEC/IMBER symposia provided GLOBEC, and more recently IMBER, scientists from these countries with the opportunity to collaborate, exchange, and compare the results of their research. Although GLOBEC ended in 2010, IMBER decided to continue with this symposium series. The 5th CJK IMBER Symposium focused on the impact of climate change and anthropogenic forcings on physical processes and biogeochemical cycles, ecosystem structure and functions, fisheries in the northern Pacific region, and how these complex interactions, in turn, influence marine ecosystems and human society.

The meeting was opened by Xiuzhen Li, the vice-chair of the State Key Laboratory of Estuarine and Coastal Research (SKLEC), ECNU, who gave the welcome address and an introduction to the SKLEC. Sumei Liu, IMBER Science Steering Committee member, introduced the science themes of IMBER and its organizational structure. She explained the objectives of IMBER's five working groups and four regional programmes and emphasized the upcoming IMBER events: ClimECO₃ summer school (23-28 July 2012, Ankara, Turkey) and IMBIZO III (28-31 January 2013, Goa, India).

IMBER-related research and activities from the three countries were reviewed (Fig. 3). Chinese IMBER-related research was reviewed by Jing Zhang. The new national IMBER project "Sustainability of marine ecosystem production under multi-stressors and adaptive management (2011-2015)" is being undertaken by five Chinese organizations including the East China Normal University, Institute of Oceanology, Ocean University of China, Second Institute of Oceanography and Yellow Sea Fishery Research Institute. The aim is to investigate the sustainability of ecosystems and adaptive management. The project focuses on four aspects: 1) biogeochemical dynamics, 2) nutrient cycles, 3) physical processes and their effect on nutrient supplies, and 4) coupling of the microbial loop and biogeochemistry. Jing also reviewed the aspects of the project that had been implemented in 2011.



Figure 3. Jing Zhang (China), Hiroaki Saito (Japan), Se-Jong Ju (Korea) reported on the IMBER-related research and activities in their respective countries.

Hiroaki Saito mentioned that IMBER-Japan mainly targets the North Pacific Ocean and its marginal seas. The major research projects include Amur-Okhotsk, Population Outbreak of Marine Life (POMAL), Studies on Prediction and Application of Fish Species Alternation (SUPRFISH), and Studies on Prediction and Control of Jellyfish Outbreaks (STOPJELLY). IMBER-Japan in collaboration with SOLAS-Japan plan to conduct nine cruises from 2004-2012. More IMBER cruises have been proposed from 2013-2015.

Se-Jong Ju reported on the ongoing IMBER-related research projects in Korea, including “KOREA EAST-1 (East Asian Seas Time-series)”, “Understanding the mechanism of the East Sea ecosystem changes”, “Assessment of the climate impact on the South Sea ecosystem”, “The study on the physical dynamics of the Yellow Sea bottom cold water and its impact on the ecosystem”, “Long-term change of structure and function in marine ecosystems of Korea”, and “POSEIDON (Northwestern Pacific Ocean Study on Environment and Interactions between Deep Ocean and marginal seas)”. He introduced the objectives, geographic scope, strategy, and components of each project and how they fit into the IMBER research themes.

The oral presentations were grouped into four session themes:

- Impact of climate change on physicochemical and biological properties of marginal seas (Chair: Se-Jong Ju)
- The impact of anthropogenic activities on marine biogeochemistry and ecosystem dynamics (Chair: Hiroaki Saito)
- Development of biological indicators to detect and evaluate changes in marine ecosystem structure and function (Chair: Sumei Liu)
- The application of end-to-end food web models: predicting the impact of environmental change on marine ecosystems (Chair: Jing Zhang)

1. Impact of climate change on physicochemical and biological properties of

marginal seas

In this session, presentations considered studies on elemental cycles (nutrients, sulfur, iron, etc.) and biological properties (algae and zooplankton) of the Northwest Pacific ranging from open ocean to coastal regions (i.e. South and East China Seas, Yellow Sea).

The presentations given by Hiroaki Saito, Daji Huang, Xinyu Guo and Jun Hu showed the importance of the role of the Kuroshio Current to fish production (success or failure of sardine recruitment in the Kuroshio Extension Regions) and marine ecosystems (from the Taiwan Strait to the East China Sea). Xiping Lian and Jun Hu indicated that spatial and temporal heterogeneity of local planktonic communities and biomass are strongly coupled with the physicochemical properties and local circulation patterns (i.e. episodic river plume and upwelling events) changes due to natural and anthropogenic forcings. Liang Xue showed the strong correlation between temperature (increase) and pH (decrease) of Yellow Sea Cold Water, which is a remnant of the winter water mass, based on long-term historic data. However, no correlation has been found between pH and DO.

2. The impact of anthropogenic activity on marine biogeochemistry and ecosystem dynamics.

Anthropogenic impacts on marine ecosystems are very apparent in eastern Asian coastal regions. In this session, recent investigations into changes in biogeochemical cycles in coastal waters, especially focusing on the impact of anthropogenic forcing, were presented. Major science achievements presented in this session included: 1) Understanding the temporal change in the ecosystem and biogeochemical cycles of Chinese coastal waters responding to the recent increase in anthropogenic forcings, 2) Valuation of ecosystem services in coastal Chinese waters, 3) Understanding the impact of aquaculture on coastal water carbonate system, and 4) The use of four Ra radioisotopes to investigate biogeochemical cycles.

Detailed observations of nutrient (Sumei Liu et al) and oxygen (Zhuo Zhu et al) distribution in the East China Sea clarified the seasonal patterns and recent increasing (decreasing) trend of P, N and organic matter (Si and O₂) due to anthropogenic activities. The longer-term (10-1000 years) trend in the ecological structure and biogeochemical cycles were revealed by radium tracer analysis (Jinzhou Du et al.) and diatom species composition (Baoping Di et al.) from core samples.

Zhenke Zhang et al. examined the role of tidal flats on biogeochemical cycles, ecosystem services and species diversity and found that rapid storm-induced accumulation of sediments significantly impact them. Zengjie Jiang and Jianguang Fang found that intense aquaculture in coastal Chinese waters

influence the carbonate system and proposed an equitable proportion of shellfish and seaweed aquaculture to eliminate CO₂ efflux due to shellfish aquaculture. One of the highlights presented was the valuation of coastal marine ecosystem services (ES) in 11 provincial regions of China by Shang Chen et al. They estimated the annual marine ES provided 1034 billion CNY in 2008, and found the region used for mariculture + recreation provided high ES value per area.

3. Development of the biological indicators to detect and evaluate changes in marine ecosystem structure and function

In this session, the presentations focused on the interactions between the biological processes and ecological environments in China, Japan, and Korea, including the Yellow Sea, East China Sea, South China Sea and north Pacific Ocean. Biological indicators include bacteria, archaeae, viruses, phytoplankton and zooplankton. Environmental changes include hypoxia, radioactive materials released from the Fukushima nuclear accident in Japan, upwelling, eddies, freshwater discharge and cold water masses.

Se-Jong Ju reported that *Euphausia pacifica* does not only utilize the Yellow Sea bottom cold water mass as an over-summering site but also switches its diet to survive the hot summer. Jung-Hoon Kang indicated that the existence of the Yellow Sea Bottom Cold Water affected the vertical distribution of all developmental stages of *E. pacifica*, and changed the food-rich depths preferred by the earlier developmental stages before and after formation of the cold waters in the Yellow Sea.

Jun Sun described the development of the spring phytoplankton bloom in the central Yellow Sea. These blooms can occur in the surface and the thin subsurface layers. The surface layer bloom comprises large-celled chains of diatoms such as *Thalassiosira rotula* and *T. pacifica*. However, annihilation of these species by *Noctiluca* and copepod grazing resulted in the development of a small-celled chain-form diatom bloom comprised of *Skeletonema dorhnii*. The subsurface layer bloom is formed by shade blooming diatom species, such as *Denticula* and the dinoflagellate *Heterocapsa*.

Ganning Zeng stressed that the upwelling system not only brings physical but also chemical effects on the HABs event off Zhejiang. In addition, the variation of the physical environmental elements may play different roles in HABs.

The genus *Chattonella* is a representative red tide-causing raphidophyte in coastal waters worldwide. Toshiya Katano reported that in the Ariake Sea, located in western part of Japan, severe *Chattonella* blooms frequently occur in summer. *Chattonella* does not always utilize the deeper nutrient pool as the sole source for their development, but also use surface nutrients supplied after

the heavy rain.

Min Liu reported that bacterial communities in the Changjiang Estuary hypoxia area were different from those in non-hypoxia area. The predominant bacteria are Flavobacteria in the hypoxia area. While there is no significant difference on archaeal community structure between hypoxia area and non-hypoxia area with Euryarchaeota and Crenarchaeota as the dominant communities.

Meiping Feng reported on the relationship between the distribution of ciliate abundance and different water masses on the East China Sea shelf. Ciliate abundance increased close to frontal areas. Most tintinnids identified as neritic species did not show discrimination of distribution in the Changjiang Estuary. However, there were pronounced distribution zones of tintinnid species and some occasional oceanic species might indicate the intrusion of Kuroshio Water on the shelf.

Linbin Zhou explored zooplankton response to the influence of the Pearl River plume and coastal upwelling. He indicated that copepods accounted for most of the difference in abundance between the plume-affected and upwelling-affected areas, which may account for the high fishery yield in the upwelling area, as copepods are a good food source for the fish.

Xingyu Song examined the patterns and drivers of the spatial variability of phytoplankton biomass and primary production in the northwest South China Sea in summer. The coastal waters off the eastern Leizhou Peninsular (ELP) have higher phytoplankton biomass than that off the eastern Hainan Island, probably due to the topography and eddy-driven enhancement of nutrient supply and light availability along the ELP. The Yuexi Coastal Current tends to inhibit phytoplankton growth and thus depresses the surface phytoplankton biomass in the near-shore waters of the ELP, mainly through the stratification-induced nutrient limitation.

Yanhui Yang indicated that in the Southern Ocean and the central Pacific, the most outstanding feature was the presence of the viral abundance gradient along the path of meridional overturning circulation. This pattern was remarkably consistent with that of dissolved organic carbon. Long-distance transport of viruses along the meridional overturning circulation may provide a means for viruses to spread across oceanic basins and depth layers, and explains locally high, but globally limited viral diversity in the oceans.

Mitsuo Uematsu indicated that the Fukushima Nuclear Power Plant accident created ^{137}Cs levels in the surface ocean near the accident site that were several orders of magnitude higher than those prior to the accident. He stressed that it is essential to develop comprehensive figures for radionuclide

release based on both comprehensive field and modelling studies for land and the ocean.

4. The marine end-to-end food web: the impact of environmental change on marine ecosystems

Sinjae Yoo and Joo-Hyung Ryu from KORDI (Korea) introduced a new algorithm with applications for the satellite data extraction of eight bands in 400-900 nm from GOCI (i.e. Geostationary Ocean Color Imager from Korea). The data are compared with other commercial satellite information, showing the advantage in spatial (i.e. 500m vs. ca. 1000m) and temporal (e.g. daily vs. one week) resolutions. Data extracted from GOCI have been successfully applied in extracting the sea ice cover from Bohai in North China, dispersal of Changjiang effluent plumes in the East China Sea, as well as the Chl-a distribution and eddies in the East Sea or Sea of Japan.

Jihong Zhang from YSFRI (China) reported on the culture of kelp in the Sanggou Bay of North China, where changes in temperature and nutrient levels were examined. It was realized that low temperatures in winter can considerably reduce the kelp production (by 10-30%), while the kelp culture can reduce eutrophication in the coastal environment and uptake CO₂ from the atmosphere through the accumulation of organic matter biomass. Based on their experiments from Sanggou Bay, a biogeochemical model and nutrient budgets were established for kelp culture process.

Keun-Hyung Choi from KORDI examined the time series and observational data for zooplankton (e.g. copepods) in the northern part of the East China Sea over the last 30 years and found a remarkable decrease in abundance of copepods. Information suggests that this phenomena was related to a bottom-up driven effect. Besides the systematic change in hydrographic parameters (e.g. temperature), it was suggested that such a situation could be related to the function of TGD in the Chaignjiang Watersheds (e.g. reduction of fresh water influx and hence increase in salinity).

Xiaodong Bian from YSFRI (China) presented the results of the life history study of the Pacific cod *Gadus macrocephalus*. Cod is one of key species to maintain the food web of North Pacific Ocean and it has been found that the early stages (i.e. eggs and yolk sac larvae) can be dramatically affected by the hydrographic conditions (e.g. temperature and salinity) in terms of success in fertilization, hatching, as well as the survival in hatch through yolk sac absorption. It has been found that the hatching and hence the survival of larvae can be inhibited by low-temperature-low-salinity and high-temperature-low-salinity situations. The 50% hatching survival time is 1-4 weeks for the temperature range of 0-15 °C.

Yang Yang from SIO (China) reported on progress in numerical techniques in simulating the ecosystem parameters (e.g. nutrients, TSM and Chl-a) of the Changjiang Estuary and adjacent coastal environment. The model was adopted from production models (PMs) with refined grades and modules for TSM and nutrients. The results show that model outputs can snapshot the patterns of distribution for TSM and nutrients offshore of the Changjiang Estuary, including the plumes of high turbidity and eutrophic coastal waters and blooms.

Hui Wu from ECNU (China) reported on the recently published work on the tidal effect on the extension of Changjiang effluent plumes in summer. The numerical simulation was based on the ECO-si model with structureless grades with a spatial resolution of 0.2-2 km from coast to the open boundary. It was found that the incorporation of tidal modules can improve the results of numerical simulation of plume dispersal off the Changjiang and in the East China Sea, with fine structure of bifurcation and eastward extension of plumes in summer.

Discussion Session

During the open discussion, topics focused on the outreach of this 5th CJK Symposium and regional IMBER-related activities.

Regionally coordinated joint research activities using a data sharing mechanism of the sediment cores from the marginal seas (e.g. Yellow Sea and East China Sea) were proposed. This would provide the opportunity to understand the climate change through history. It was acknowledged that differences in sample analysis methods might differ from one laboratory to another, and standardization and/or inter-comparison of methods may also present a challenge.

The variability of the Kuroshio Current and its influence on the marginal seas is an important issue in IMBER research activities in the region, and studies need the collaboration of research in China, Japan and Korea. It was proposed that the CJK Symposium seek collaboration with PICES to form joint activities in the near future (e.g. topic session in PICES Annual Meetings).

PICES has agreed to provide financial support the next IMBER Summer School (ClimECO₃) and will encourage early career scientists and PhD students from the three countries to attend.

It was proposed that a special issue of the CJK Symposium be published in an international peer-reviewed journal. The IMBER RPO will contact all the participants to invite them to contribute papers for the special issue.

The date and venue of next CJK IMBER Symposium (i.e. 6th meeting) were

also discussed. Colleagues from Japan will contact the relevant authorities in Japan and inform the IMBER RPO about the possibility of hosting the next meeting.

The China-Japan-Korea IMBER training course

In conjunction with the CJK symposium, a training course was held at the East China Normal University on 25 November. Jing Zhang welcomed the 21 early career scientists and students.- Sinjae Yoo, Hiroaki Saito, Xinyu Guo and Jing Zhang (Fig. 4), presented information about IMBER, the North Pacific Marine Sciences Organization (PICES) and Forecasting and Understanding Trends, Uncertainty and Responses of North Pacific Marine Ecosystems (FUTURE) programmes, as well as systemic knowledge about physical, chemical, and multi-disciplinary ocean science approaches.

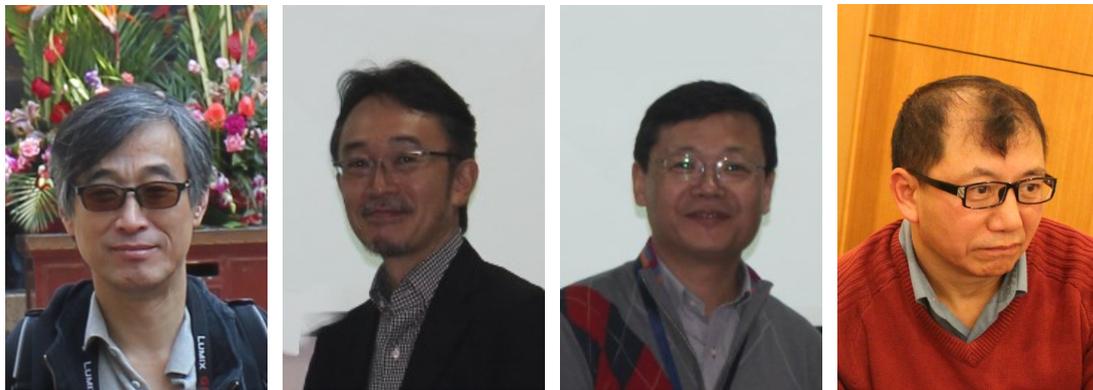


Figure 4. Training course instructors: Sinjae Yoo (Korea), Hiroaki Saito and Xinyu Guo (Japan), and Jing Zhang (China)



Figure 5. Training course participants concentrating on a lecture.

Topics presented:

1. Introduction to IMBER (Sinjae Yoo)
2. Progress in PICES/FUTURE programme (Sinjae Yoo)
3. A multidisciplinary ocean science programme SUPRFISH (Study on Prediction and Application of Fish Species Alternation): Implementation strategy and results (Hiroaki Saito)
4. Volume and nutrient transport across shelf break: A physical approach (Xinyu Guo)
5. Aspects of the biogeochemical dynamics of marginal seas (Jing Zhang)



Figure 6. Participants of the China-Japan-Korea IMBER training course.