CLIMATE CHANGE AND MARINE ECOSYSTEM

J. Ishizaka[a, *]

[a] Hydrsosperic Atmospheric Research Center, Nagoya University, Furo-Cho, Chikusa, Nagoya, Aichi, 464-8601, Japan - jishizak@hyarc.nagoya-u.ac.jp

Commission VIII, JAXA Special Session

KEY WORDS: Ocean, Coast, Ecosystem, Colour, Primary Production, SGLI

ABSTRACT:

Climate change is influencing both open ocean and coastal marine ecosystems. In the open ocean, change of stratification and other forcing may alter phytoplankton biomass and composition and resulting change of primary production and carbon export to deep ocean. In the coastal ocean, change of river discharge may also change primary production. Furthermore, extreme events, such as typhoon, affect to both ocean and coastal marine ecosystems. Those may influences global carbon cycle and make positive or negative feed back to the global climate. High resolution global observation of ocean colour by SGLI/GCOM-C is expected to play an important role of the study of interaction between climate change and marine ecosystem.

1. INTRODUCTION

Climate change is expected to be changing the ocean environment through accumulation of heat at surface as well as changes of frequency and magnitude of precipitation, river discharge, storm and other forcing. It is concerned that those impacts also influence to structure and dynamics of marine ecosystem. Ocean colour remote sensing can measure phytoplankton abundance and estimate primary production of the ocean environment which is an important parameter for carbon cycle as well as fish production on the earth.

2. OPEN OCEAN

It is known that phytoplankton abundance is related to sea surface temperature because stratification of water often controls nutrient flux to surface from deeper layer. Chlorophyll-a distribution measured by ocean colour remote sensing clearly showed the areas of higher nutrient flux. Climate change seems to be accumulated more heat at the surface of the ocean, and this may increase the stronger stratification and cause less nutrient flux to the surface. There are some studies indicating that abundance of phytoplankton decreasing. However, it is not certain that the change is caused by global warming and/or by other climate variation. Abundance of phytoplankton is not only the change but also phytoplankton group may also changing and smaller phytoplankton may dominate under warm and less nutrient environment (Ishida et al., 2009). Both less abundance as well as dominance of smaller phytoplankton may reduce the vertical transport of organic carbon to deep ocean, namely biological pump, and reduce the capability of carbon storage in the ocean.

Ocean colour remote sensing is great tool to monitor the phytoplankton abundance, and there are already more than 10 years of data accumulation since Ocean Color and Temperature Sensor (OCTS) on Advanced Earth Observation Satellite (ADEOS) launched on 1996 and Sea-viewing Wide Filed-of-view Sensor (SeaWiFS) on 1997. Primary production can be estimated from the phytoplankton abundance (chlorophyll-a) measured by ocean colour data, sea surface temperature (SST) and photosynthetically active radiation (PAR). Kameda and Ishizaka (2005) method was applied to data of Global Image (GLI) on ADEOS-II launched on 2002. The method applied assuming the phytoplankton was composed by large and small groups. Presently, more sophisticated algorithms to distinguish different phytoplankton group by ocean colour data is under development. It is expected that those algorithms will be used for Second-generation GLI (SGLI) on Global Change Observation Mission-Climate (GCOM-C).

3. COSATAL ENVIRONMENT

Coastal environment is an important area because large population was living near the area and using the environment in many ways. The area is also expected to be influenced by climate change. One of the large forcing to coastal environment is river discharge. For example, the East China Sea is surrounded by Japan, China and Korea, and Changjiang River in China is discharging large amount of freshwater to the area. Ocean colour remote sensing data clearly showed high phytoplankton plume extended from the mouth of the Changjiang River to near Tsushima Strait during summer when the discharge is maximum. Ten years of ocean colour remote sensing data indicate that the area of high chlorophyll-a region was well correlated with Changjiang River discharge amount. It was also noticed that the concentrations of chlorophyll-a in areas between the mouth of the Changjiang River to Tsushima Strait were also correlated with Changjigang River Discharge amount (Kim et al., 2009). This indicates that the freshwater input from river, which is controlled by both climate change and direct human activity strongly affect to the primary production in the East China Sea and possibly other similar regions. It is also important that direct human activity also change the amount of nutrient in the river water and possibly make eutrophication of the estuarine region (cf. Siswanto et al., 2008). Our analysis of ocean colour in the Yellow Sea showed the increase of chlorophyll-a and may indicate the eutrophication.

Similar influence of climate change and human activity in the coastal and estuarine environment is also persistent in the smaller embayment around Japan and other countries. It is quite important to use ocean colour remote sensing to detect those changes including red tide events which are often harmful for human activities. High resolution ocean colour capability of SGLI/GCOM-C is also useful for monitoring those areas.

4. EXTREAM EVENTS

It may be possible that typhoon number increase and/or magnitude increase with climate change. It is very difficult to do study influence of typhoon to marine environment by ship. We analysed past satellite data and found significant decrease of sea surface temperature and increase of chlorophyll-a just after the pass of typhoon in the East China Sea (Siswanto et al., 2007). The analysis allowed us to estimate primary production from the magnitude and speed of typhoon and water depth of the path. Our analysis further indicated that increase of magnitude for El Nino years and of number in the area after 1990 made increase of primary production in the East China Sea.

5. CONCLUSION

Presently, ocean colour remote sensing is the only way to monitor change of marine ecosystem globally. Time series data from 1998 makes the influence of climate change to the marine ecosystem. High resolution SGLI/GCOM-C data is expected to show advantage for monitoring of coastal environment.

References:

Ishida, H., Y.W. Watanabe, J. Ishizaka, T. Nakano, N. Nagai, Y. Watanabe, A. Shimamoto, N. Maeda and M. Magi, 2009. Possibility of recent changes in vertical distribution and size composition of chlorophyll-a in the western North Pacific region. *J. Oceanogr.* 65, pp. 179-186.

Kameda, T. and J. Ishizaka, 2005. Size-fractionated primary production estimated by a two-phytoplankton community model applicable to ocean color remote sensing. *J. Oceanogr.* 61, 663-672.

Kim, H.-C., H. Yamaguchi, S. Yoo, J. Zhu, K. Okamura, Y. Kiyomoto, K. Tanaka, S.-W. Kim, T. Park, I. S. Oh, and J. Ishizaka, 2009. Distribution of Changjiang Diluted Water detected by satellite chlorophyll-a and its interannual variation during 1998-2007. *J. Oceanogr.* 65, pp. 129-135.

Siswanto, E., J. Ishizaka, K. Yokouchi, K. Tanaka, C.K. Tan, 2007. Estimation of Interannual and Interdecadal Variations of Typhoon-Induced Primary Production: A Case Study for the Outer Shelf of the East China Sea. *Geophysic. Res. Lett.* 34, L03604, doi:10.1029/2006GL028368.

Siswanto, E., H. Nakata, Y. Matsuoka, K. Tanaka, Y. Kiyomoto, K. Okamura, and J. Ishizaka, 2008. The long-term freshening and nutrient increases in summer surface water in the northern East China Sea. *J. Geophysic. Res.* 113, C10030, doi:10.1029/2008JC004812.