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EDITORIAL

Introduction to the Special Issue: Coastal and Marginal Sea Studies

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1 Introduction

As an important part of the ocean system, the coastal and marginal sea (CMS) is a junction between land and the open ocean where the ocean-land interaction occurs, and also it is the area with substantial marine-economic activities for many countries. The development of marine economics greatly affects the CMS environment and causes deteriorating environmental problems. The study on the CMS helps to understand how the land and ocean interact, and how the marine environment responses to the land system change resulting from economic developments in coastal regions. Therefore, deeply understanding physical properties of the CMS is of great importance not only in the earth science study, but for marine environmental protection.

For past decades, a number of major interdisciplinary research projects have been conducted that were related to the CMS studies and monitoring. The Shelf Edge Exchange Processes (SEEP) experiments took place in the Middle Atlantic Bight (MAB) of the eastern U.S. continental shelf and slope. The experiments included multi-instrumented moorings and oceanographic cruises to address the problem of the fate of continental shelf particulate matter (Walsh et al., 1988; Biscaye et al., 1994). The project of the river influence on shelf ecosystem (RISE) focused on the coastal dynamics and interaction between river and coastal ambient waters supporting primary production in the Columbia River (CR) plume area. The concepts generated by the project improved understanding of the impacts of river plumes worldwide, productivity on eastern boundary systems, and the global carbon cycle (Hickey et al., 2010). The project studies suggested that river-supplied nitrate can help maintain the ecosystem during periods of delayed upwelling (Hickey et al., 2010).

In addition to major researches, the observation network is an important issue in CMS studies. The U.S. Integrated Ocean Observing System (IOOS) is a vital system for integrating *in-situ* data and modeling simulations to provide data sources to support different kinds of applications in the CMS (http://www.ioos.noaa.gov). The system helps coastal hazard mitigation, sustainability of coastal ecosystem, fishery, and water quality, marine operation, etc. (Willis et al., 2008). Satellite imagery provides a new data source to study and monitor coastal marine environments. In the National Oceanic & Atmospheric Administration (NOAA) coastal watch program (CoastWatch, http://coastwatch.noaa.gov), multi-satellite data of ocean color, sea surface temperature, and sea surface winds are made available to different users to enhance the coastal data accessibility (Hughes et al., 2013). Products available through CoastWatch have expanded beyond the original infrared and visible images to include synthetic aperture radar (SAR) data (Pichel and Clemente-Colón, 2000). Significant progresses in data collection technology and numerical modeling provide abundant data sources, which constitute a major driving force to advance our knowledge in the CMS and promote coastal marine environment management.

2 Topics of this issue

This special issue assembles coastal and marginal sea studies in broad ranges including numerical modeling system, real-time coastal observation infrastructure, marine remote sensing applications, etc. to reflect cutting-edge progresses in the field. Although some of the study areas are not limited in the CMS region, all the topics are closely related to the processes occurred in

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the CMS, which may bring broader views to some regional issues.

For modeling of ice-covered ocean water, brine drainage from sea ice formation is an important factor affecting ocean mixing and seasonal variations of halocline. Because the horizontal scale of the brine drainage and its induced convection is much smaller than a climate model grid, the simulation may generate false turbulences when the brine drainage is averaged over a grid. A scheme of two-column ocean grid (TCOG) for the coupled sea ice-ocean model with and without brine rejection could be adopted, and the modeling results show consistent improvement of modeled salinity and mixed-layer depth, indicating improved simulation of the ocean mixing for the sea ice-covered ocean area (Jin et al., 2015, this issue). Numerical modeling is a key measure for ocean forecast systems that can be used to track marine pollutants. The U.S. Naval Oceanographic Office developed a nowcast-forecast system covering the Gulf of Mexico and adjacent Caribbean Sea. The validation and evaluation of the system are necessary to make the forecast system applicable. Therefore, initial evaluations of the nowcast-forecast system are implemented in context of the Deepwater Horizon disaster in the Gulf of Mexico. Validation is presented for water temperature and salinity profiles, sea surface wind, sea surface temperature, sea surface height, and volume transport, for different forecast time scales. Although there are certain geographic and time biases/errors, systematic improvements relative to earlier regional and global modeling efforts are characteristic of the nowcast-forecast system, and therefore, the transport of an oil spill resulting from the Deepwater Horizon disaster is captured with the model system results (Zaron et al., 2015, this issue).

Oil spill is one of the most common pollutions for the coastal waters, and the mitigation measures really rely on the precise prediction of oil spill movements over the sea. In tracking oil spills from two separate accidents of platforms B and C of the Penglai occurred on June 4 and 17, 2011, respectively, a numerical experiment is conducted with the General NOAA Operational Modeling Environment (GNOME) model. The modeling shows that ocean currents are likely to carry the oil spills along the Bohai coast toward the northeast and the results are consistent with *in-situ* observations (Xu et al., 2015, this issue). In the Bohai Sea and Yellow Sea, a new numerical model is developed to accurately simulate the current and sea level. The model is a terrain-following vertical coordinate with a horizontally orthogonal curvilinear coordinate system to fit the complex bottom topography and coastlines near estuaries, continental shelves and harbors. The model is capable of predicting tidal patterns in the Bohai Sea and Yellow Sea, and helps to reveal the dynamics of tidal wave and its interaction with the geomorphology (Lu et al., 2015, this issue).

Estuarine study has drawn more and more attentions for recent years, and modern estuarine science needs to be interdisciplinary and collaborative and be responsive to issues facing both regionally and globally in data-rich environments. For the Columbia River estuary, an infrastructure of observation network and operational modeling system is established with openly accessible data from observation sensors and model results within convenient timeframes, entitled as the science and technology university research network (SATURN). SATURN observation network includes tidal freshwater stations, ocean gliders, autonomous underwater vehicles (AUVs), and estuarine and plume stations-measured many parameters from salinity and temperature to biogeochemistry and bacterial diversity on a 24/7 basis, while the modeling system is designed to create a progressively more comprehensive and skilled multi-scale description of the estuary and associated tidal freshwater and continental shelf plume as a Virtue Columbia River (Baptista et al., 2015, this issue).

In the Gulf of Mexico, the Loop current (LC) has been regarded as a vital dynamic phenomenon. A good understanding of the LC system is important for studies of coastal ecosystems. By using the atmospheric reanalysis data and the satellite altimeter sea surface heights (SSH), it is found that the LC migration and ring shedding are affected by the zonal wind stress in the eastern Gulf of Mexico (Lindo-Atichati and Sangrà, 2015, this issue). For the mass and heat transports, in addition to the mean current-carried, the tidal and eddy fluxes may contribute a significant part. Based on the mooring data at 100 m away from an active hydrothermal vent over the Southwest Indian Ridge (SWIR), multiple-scale variations are extracted in terms of temporal scales: time-mean, seasonal, tidal, super-tidal, and eddy. Eddy heat flux was stronger than tidal heat flux in the cross-isobath direction, while eddy heat flux was weaker in the along-isobath direction; for the momentum flux, the eddy momentum flux was weaker than tidal momentum flux in both directions (Chen et al., 2015, this issue).

With advent of the satellite technology, the remote sensing has been an effective way for the ocean studies. Satellite synthetic aperture radar (SAR) images could be used to analyze ocean internal waves. Based on a SAR image near the Dongsha Island in the South China Sea, internal wave parameters such as phase speed and wave amplitude, as well as the surface wind speed and the ocean pycnocline depth are extracted (Fan et al., 2015, this issue). The study may provide a way to extend the satellite observation into the internal structure of the ocean. With satellite altimetry data, the ocean cyclonic eddies (CEs) and anticyclonic eddies (AEs) can be detected. Along the Kuroshio Current, it is found that CEs are most likely generated on its west side and AEs on its east side (Qin et al., 2015, this issue).

For the satellite remote sensing, the data fusion technology is used to temporally and spatially enhance satellite datasets from different satellite platforms. With a Bayesian maximum entropy method, daily sea surface temperature (SST) data from multiple satellites are merged to generate a SST product with high spatial resolution and coverage (Tang et al., 2015, this issue). Satellite optical remote sensing provides a measure to estimate the coastal water quality by retrieving concentrations of chlorophyll a (*Chl a*) and suspended particulate matters (SPM) and absorbance of Colored Dissolved Organic Matters (aCDOM). However, in estuarine water, water contents are really complicated and vary significantly, and the common-used algorithms for *Chl a*, SPM, and aCDOM exhibit significant deterioration. For the Pearl River estuary, the modified optical remote sensing algorithms are developed with the data collected in a cruise survey (Chim et al., 2015; this issue). In the Indian Ocean sector of the Southern Ocean (SO), concentrations of total surface *Chl a*, diatoms, and chlorophytes during the austral summer of 1998–2014 are derived by using satellite data and the National Aeronautics Space Agency (NASA) Ocean Biological Model (NOBM). The data analysis results show effects of light and temperature on diatoms and chlorophytes phytoplankton in the surface water (Mishra et al., 2015, this issue).

The CMS is broad regions on the global scale. The study in the CMS is an important part of the oceanographic research. The publication of the papers in this issue may provide with some first-hand materials to the oceanographic community, revealing achievements with the support of advanced technology in *in-situ* observation, modeling, and remote sensing.

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