Ocean Dynamics and Modeling Program

香港科技大学 Hong Kong University of Science and Technology

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Introduction to the ODMP

The Ocean Dynamics and Modeling Program (ODMP) aim to develop multi-scale coupled physical-biogeochemical model on South China Sea (SCS), Northern South China Sea (NSCS), and Pearl River Estuary (PRE); to establish an integrated database that includes the historic data, field measurement, model output and the results from other research programs; to conduct kinematic and dynamic investigations of the physical, and associated bio-geochemical processes in carbon cycle based on synthesized model and observed data and to intensify our understanding of the role of ocean in climate change, environmental pollution, and sustainable development.

The ODMP will emphasis on the environment and ecosystem of PRE and its adjacent region, providing scientific support and assistance for the marine environmental management and administration in the Pearl River Delta region.

The task of ODMP includes:

- Marine environmental information——To study and provide the necessary information of ocean circulation, mass transport and ecosystem characteristics over the SCS basin, continental shelf off Guangdong, and PR.
- Ocean circulation modeling system——To develop a multi-scale coupled ocean circulation modeling system and to provide an advanced tool for marine environmental management and study.
- Marine ecosystem analysis and prediction——To develop a coupled physical-biogeochemical modeling system for PRE and continental shelf off Guangdong to make analysis and prediction on the marine resource, ecosystem, pollution, and their controlling mechanisms.
- Tidal current and wave information——To provide the tidal current and tidal wave information of PRE and continental shelf off Guangdong.
- Personnel training——To educate and train personnel on ocean modeling for research and management.

The ODMP will focus on the research excellence of the multi-scale modeling study of SCS and China seas; enhance our understanding of the physical, biological, and chemical processes and mechanisms of the study area.

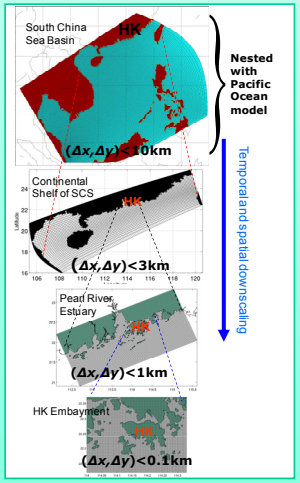
Research strategy

Numerical simulation:

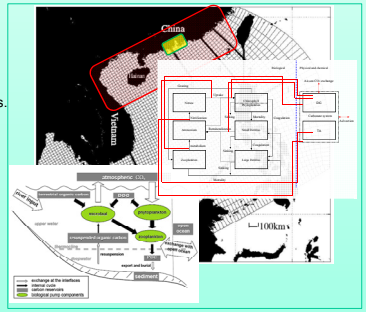
The model development and modeling study are important component in investigating ocean circulation and its associated biogeochemical responses. They will be utilized to interpolate and/or extrapolate the spatially and temporally limited field measurements in understanding the processes and dynamics that govern the ocean circulation and biogeochemical cycle in the China Sea. The model and modeling study are also the necessary and effective tools for diagnostic and prognostic studies of physical-biogeochemical processes in the China Sea. The main objective of this study is to develop a coupled physical-biogeochemical model that is physically/biologically suitable for continental shelves and marginal seas in China Sea.

With ocean models, we can:

- Develop and enhance understanding;
- Quantify descriptions of processes;
- Synthesize and consolidate our knowledge;
- Establish interaction of theory and observation;
- Develop predictive potential;
- Simulate scenarios of past and future developments.



The first South China Sea (SCS) multi-scale modeling system that is capable to resolve the oceanic processes with different temporal and spatial scales that dynamically links the coastal embayment (Hong Kong waters), Pearl River Estuary, continental shelf of northern SCS, SCS basin and Pacific Ocean together. The modeling system has been applied to the regional ocean dynamics and ecosystem studies.



The marginal sea connects with open ocean through strait and channel, while the continental shelf links with land through estuary and with the basin of the marginal sea through continental margin. The transport and the associated material exchanges in this land-estuary-shelf-marginal sea-open ocean involve interactions of different processes and forcing regimes with different temporal and spatial scales. The underlying carbon budget in the China Sea is largely controlled by the dynamic linkages in the system.

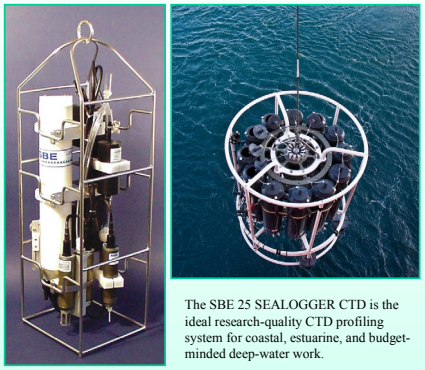
Intrinsic dynamics distinctly exists in the different portion of the China Sea and determines the transport of biogeochemical substances, the distributions of nutrient and primary productivity, and the magnitude and distribution of pCO_2. In marginal sea, the material exchange with open ocean is dominated by the ageostrophic currents that cross isobaths and is tightly controlled by the variability of western boundary current (Kuroshio) and the associated eddies, mixing and flow instability. In the shallower continental shelf, the flow field is strongly governed by the amplified coupled surface and bottom frictional forcing. The circulation, particularly the cross-isobath circulation over the shelf is tightly controlled by the characteristics of shelf topography as well as the terrestrial flux (buoyancy) from estuary and intrusive forcing from the marginal sea. Estuarine circulation, on the other hand, mixes the ocean and fresh waters in the tidally amplified environment and defines the physical-biogeochemical fluxes between the land-sea boundary.

Field observation:

The combined observational and modeling study is scientifically important and necessary to understanding the extremely complicated nature of the time-dependent three-dimensional variability of oceanic circulation and the associated biological and chemical responses. Based on Guangzhou HKUST Fok Ying Tung Graduate School, field observations in the adjacent Pearl River Estuary and the continental shelf of the Northern South China Sea is another main task of ODMP. Parameters will be measured including salinity, temperature, current velocity, nutrients concentration etc.

The instruments including:

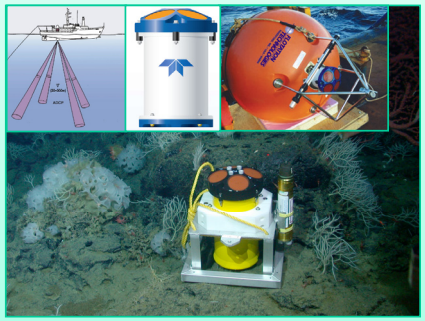
- SBE 25 SEALOGGER CTD (SBE 55 ECO Water Sampler);
- WHS-300 Workhorse SENTINEL self-contained ADCP standard system;
- T-S Chain;
- Nutrient analyzer;
- Others…



The SBE 25 SEALOGGER CTD is the ideal research-quality CTD profiling system for coastal, estuarine, and budget-minded deep-water work.

For multi-layer salinity and temperature observation.

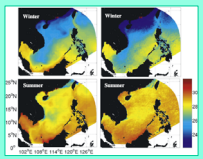
For coastal and estuary nutrient in situ observation.



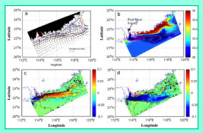
By providing profiling ranges from 1 to 165m, the high-frequency Sentinel ADCP is ideally suited for a wide variety of applications. The lightweight and adaptable Sentinel is easily deployed on buoys, boats, or mounted on the seafloor.

Research highlight

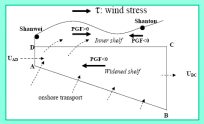
- **Gan, J**., H. Li, E. N. Curchitser and D. B. Haidvogel, 2006, Modeling South China Sea circulation. Response to seasonal forcing regimes. J. Geophysical Research (Ocean), 111, C06034, doi:10.1029/2005JC003298.
- **Gan, J**., and T. Qu, 2007, Coastal jet separation and associated flow variability in the southwest South China Sea. Deep-Sea Res. I, doi:10.1016/j.dsr. 2007.09.008.
- Zu, T., **Gan J**., S.Y. Erofeeva, 2008, Numerical study of the tide and tidal dynamics in the South China Sea, *Deep-Sea Res. I*, 10.1016/j.dsr.2007.10.007
- **Gan, J**.., Cheung, Y.Y., Guo, X.G., Li, L., 2009a. Intensified upwelling over a widened shelf in the northeastern South China Sea. Journal of Geophysical Research (Ocean), doi:10.1029/2007JC004660 .
- **Gan, J**.., Li, L., Wang, D.X., Guo, X.G., 2009b. Interaction of a river plume with coastal upwelling in the northeastern South China Sea. Continental Shelf Research. 29 (4), 728-740.
- **Gan, J**.., Lu, Z.M., Dai, M.H., Cheung, Y., Harrison, P., Liu, H.B., 2009c. Biological response to an intensified upwelling over a widened shelf and a river plume in the northeastern South China Sea: a modeling study Journal of Geophysical Research, (submitted).
- Lu, Z.M., **Gan, J**., Dai, M., Cheung, Y., 2009. Influence of coastal upwelling and river plume on the formation and sustenance of subsurface chlorophyll maximum over the shelf of northeastern South China Sea. Journal of Marine Systems, (submitted).



Mean winter and summer sea surface temperatures (oC) from the (left) model and (right) MODIS data, for the winter and summer.



(a) Surface velocity vectors (m s^{-1}); (b) surface salinity (psu); (c) the differences of surface alongshore velocities (Δ u, m s^{-1}); and (d) cross-shore velocities (Δ u, m s^{-1}) for the cases with and without the river discharge on day30.



Schematic showing the wind-driven upwelling processes and forcing mechanism over a widened shelf.