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Editorial: Changing biogeochemical and ecological dynamics in the South China Sea in times of global change

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Editorial on the Research Topic
Changing biogeochemical and ecological dynamics in the South China Sea in times of global change

1 Introduction

In general, ocean physical processes affect marine biogeochemical cycles and ecology. The South China Sea (SCS), the largest semi-enclosed tropical sea in the Pacific Ocean, has a variety of processes that are influenced by global change and human activities. The biogeochemistry and ecology of the SCS are controlled by a complex interplay of processes, many of which need to be better understood. Under the pressure of global change, interdisciplinary research efforts on the interaction of physical, biological, biogeochemical and sedimentological processes are required. Therefore, this Research Topic aims to facilitate discussions on the use of observational, experimental, and modeling approaches to clarify how physical dynamics at multiple temporal and spatial scales affect the biogeochemistry and ecology of the SCS in the context of global change. It is a collection of 14 original and novel articles in the following four areas of research.

2 The impact of multi-scale physical dynamics on the biogeochemistry and biology

The three papers in this section use observational data to better understand the coupled physical-biogeochemical processes in the SCS. Sun et al. investigated the important role of bacterial degradation of dimethylsulfoniopropionate (DMSP) on ecosystem productivity and global climate using the northern SCS as an example. This study showed that temperature and depth were the most important factors determining the taxonomic distribution of DMSP degradation genes in the Roseobacter group, as well as their abundance. It highlights the important role of the Roseobacter group in DMSP

degradation in tropical oceans. Wu et al. correlated the vertical distribution of chl-a being regulated by mesoscale eddies with mesoscale eddies in the SCS by observing the phytoplankton under a weak cold eddy and two warm eddies along the 18°N transect in the SCS. It is shown that the presence of phytoplankton and nutrients in cold eddies is accomplished by the motion associated with eddy-induced divergence. Li et al. investigated the different tolerance and resistance to upwelling among three species of mangroves through laboratory experiments. The study provides new insights into mangroves' response to upwelling.

3 The response of biogeochemical cycles and biology to increasing human activities

This section includes four papers, which come up with interesting implications for carbon research in the SCS, especially regarding China's "carbon neutral" policy. Ding et al. conducted laboratory incubation bioassay experiments and seagoing measurement campaigns in the spring and summer of 2015-2016 and 2019 to determine the primary production, terrestrial inputs from the Pearl River and the intrusion of the Kuroshio Current influencing the distribution and microbial degradation of dissolved organic carbon in the northern SCS. The dissolution of particles supplied by rivers around the SCS and the continental margin plays an important role in supplying additional Nd to the open SCS as deduced from surface water distribution and water column profiles by Wu et al. River discharge and anthropogenic inputs are also important external sources of dissolved organic matter (DOM) in low-salinity nearshore waters, i.e. estuaries and coasts in the Beibu Gulf as demonstrated by Zhu et al. In contrast, DOM in offshore waters is mainly generated by *in situ* biological activities. Chou et al. calculated the metabolic rate and carbon sink capacity of seagrass meadows from the dynamics of O2 and pCO2 in seagrass meadows in the Southeast Asian archipelago region, and found that seagrass meadows with high total primary production (GPP) do not necessarily have a high carbon sequestration potential.

4 The cycling of gases, nutrients and trace metals

Yu et al. used the distribution of dissolved silicate (DSi) and other environmental parameters to explore the role of marginal seas in deep-sea DSi regeneration in the western Pacific Ocean. They found that in oligotrophic marginal seas (such as the SCS), the DSi content in deep water was similar to that of the adjacent Pacific waters. However, in the nutrient-rich marginal seas (e.g., Bering Sea), the DSi content in the deep sea is significantly higher than in the adjacent deep Pacific. This is mainly due to deep-sea DSi regeneration in marginal sea basins, which is driven by high biogenic particle flux from highly productive surface waters. Liu et al. studied the active chlorophyll fluorescence at a high spatial and temporal resolution using fast repetition rate fluorometry (FRRf) throughout the outer continental shelf of the northern SCS, the basin of the northern SCS, the cyclonic eddy-influenced domain in the western SCS, and the southeastern SCS. They demonstrated that FRRf has become a powerful tool for assessing the physiological status of phytoplankton in the sea and can be linked to ocean dynamics at fine scales.

5 Reconstruction of the paleoenvironment by using sedimentary archives

The five papers in this section focus on the paleoenvironment in sedimentary archives, providing some new insights into the reconstruction of paleoceanography and paleoenvironment in the SCS. Liu et al. documented a Middle Miocene shallow-water contourite depositional system in the southwest SCS by interpreting seismic reflection data and calibrating results with the previous chronological framework. Showed by radiocarbon and optically stimulated luminescence (OSL) dating of cores from the Chaoshan delta along the SCS by Zhong et al., the Quaternary sedimentation of the Rongjiang Plain dates to at least the marine isotope stage (MIS)6 of the low sea level period during which fluvial processes mainly influenced the plain. Lin et al. were interested in establishing high-resolution chronologies on two cores from Zhuhai using quartz (OSL) and radiocarbon (14C) dating, and further reconstructing the Holocene sedimentary history of the Pearl River Delta. Yu et al. were able to reconstruct the low sea levels during the Last Glacial Maximum by examining and analyses of the deepest speleothems (-116 m) collected from the deepest known blue hole on a global scale, the Sansha Yongle Blue Hole, Xisha Islands in SCS, Li et al. investigated fossil assemblages and sedimentary microfacies on high-resolution samples from two adjacent sections of the South China Block on land using the divergent patterns of Permian–Triassic mass extinction (PTME) in different paleoenvironment water depths. They found that anoxic conditions were the likely major cause of the PTME in deep-sea environments.

6 Prospects and challenges

This Research Topic provides perspectives for current research on ocean dynamic processes closely related to the environmental and ecological characteristics of the SCS. However, there still needs to be more relevant research data. As a typical marginal sea system, the South China Sea receives a large number of materials of human origin through atmospheric deposition and riverine input, which faces an environmental and ecological challenge. On the other hand, the Dynamics of SCS are complex as it is connected to the Northwest Pacific Ocean through the Luzon Strait. The water exchange between the two basins greatly impacts the distribution, transportation, and circulation of materials within the South China Sea. The relevant studies on the coupling of biogeochemistry, i.e., the interdisciplinary study between multi-scale dynamical processes in the ocean, explaining the biogeochemical processes with more

detailed physical mechanisms, are still weak. Moreover, the related systemic studies about the ocean and the atmosphere in the SCS still need to be improved. For example, some dynamical processes in the ocean, although driven by the atmosphere, affect bioecology and finally affect the processes in marine geology, which still need further study. Future studies should continue to collect long-term observation data and establish a more detailed data support and research legacy for a more comprehensive and in-depth understanding of the ocean dynamics and related biological, chemical, and geological processes in the SCS region.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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