Mechanisms of marine carbon storage and coupled carbon, nitrogen and sulfur cycles in response to global change

Principal investigators

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Objectives

Through focusing on the interaction of microbial carbon pump and biological pump, the coupling of carbon, nitrogen and sulphur cycles, and the integration and comparison of modern days with critical periods of Earth history, the project aims to decipher the mechanisms of marine carbon storage, biogeochemical processes in response to climate change and anthropogenic activities, and their impacts on ecosystems. This research tries to fill the critical gap between short-term processes in modern oceans and the long-term effects through ancient times. The goal of the project is to provide a comprehensive understanding of the responses of marine carbon pool to global climate change on multiple spatiotemporal scales, and to identify the naturally or anthropogenically-driven ocean acidification processes, key processes of carbon storage, and their impact on marine ecosystems.

Research themes in 2016 - 2021

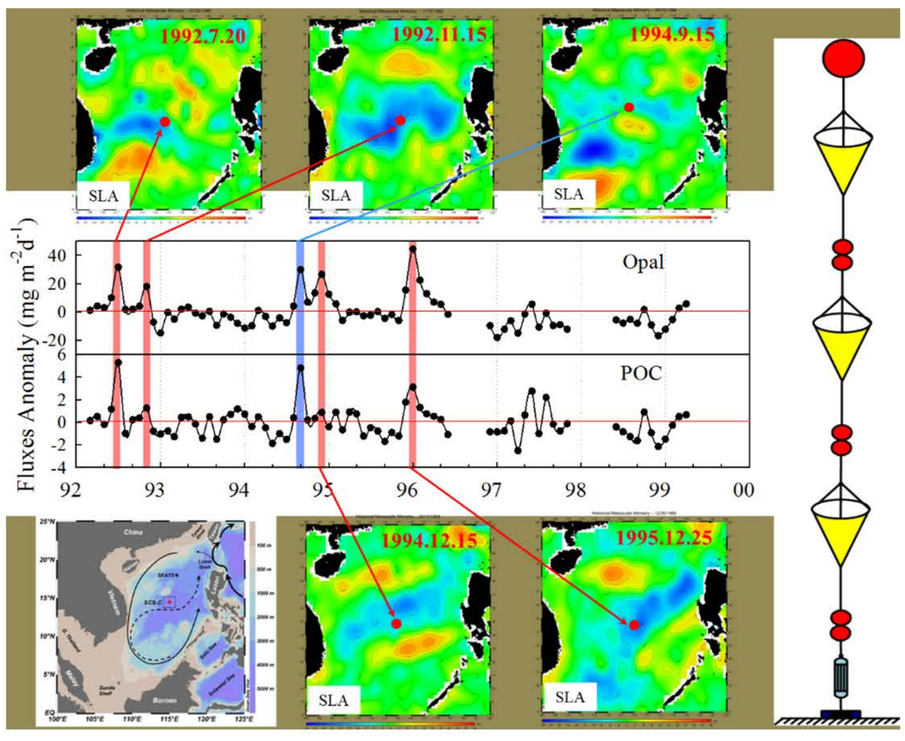
◆ The interaction between the microbial carbon pump (MCP) and biological pump (BP) and its contribution to marine carbon storage in the South China Sea.
◆ The effect of the carbon, nitrogen and sulphur cycles across the sediment-water interface and its contribution to marine carbon storage in the South China Sea.
◆ The regional carbon pool in response to recent global climate change, with a particular target on the seasonal acidification in the Bohai Sea in East China.
◆ The coupling of carbon, nitrogen and sulphur cycles in response to deep-time global change to decipher the relationship between climate, biogeochemical cycles, oceanic chemistry and ecosystems of the three time intervals including the last deglaciation, the Permian-Triassic boundary at 252 million, and the Neoproterozoic-Cambrian boundary.

Academic achievements in 2016 - 2018

Papers published: The participants of this project published over 80 papers in international journals in 2017 and 2018, including papers published in PNAS, Nature Communications, Geology, EPSL, JGR-Oceans, ISME J, Limnology & Oceanography, Geobiology, Environmental Microbiology, Earth-Science Reviews, Quaternary Science Review, National Science Review, etc.

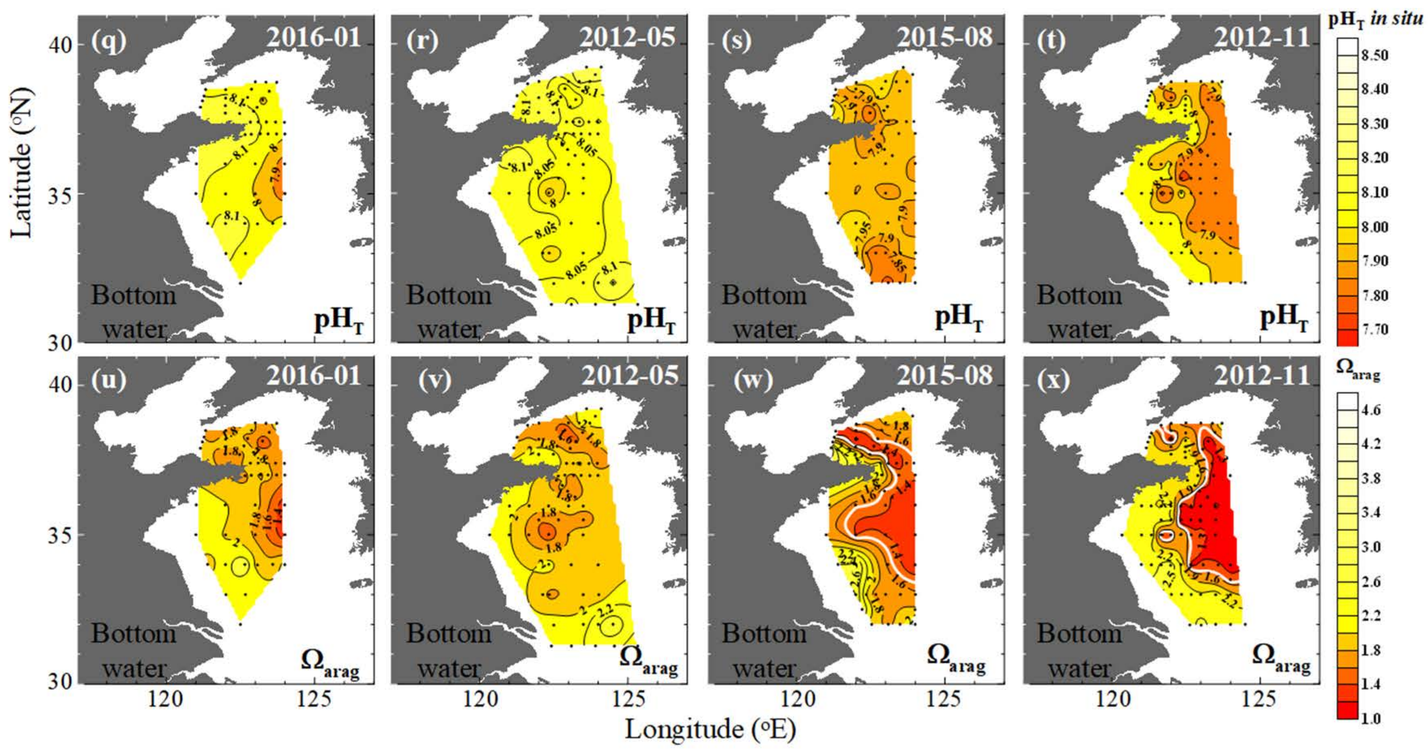
Modern oceans: Sulfide production and oxidation in sea water could be conducted by heterotrophic bacteria under aerobic conditions. Given the abundance of these bacteria on Earth, their contribution to the sulfur cycle should not be overlooked. Microbial degradation on particular organic matter will release abundant dissolved organics with a decreased ratio of C:S. The cyclonic eddies in South China Sea could lead to the biological pump more efficient at CO_2 sequestration. The seriously acidified seawaters occupied one third of the surveyed areas in summer and autumn in the Bohai Sea of East China.

Ancient oceans: The photic zone euxinia and sea water acidification in 252 million years ago were documented to be associated with the coupled carbon, nitrogen and sulfur cycles as well as the most severe marine ecosystem collapse in Earth history. Based on patterns of microbial community change during this ancient biotic crisis, the continued environmental pressures in the present-day oceans are likely to lead to more profound and disruptive changes to the Earth's biosphere.



South China Sea: The cyclonic eddies make the biological pump more efficient at CO_2 sequestration, with an increase in POC and opal by 22% and 69%, respectively

Li et al., 2017, Deep Sea Research I



Yellow Sea of East China: The seriously acidified seawaters (shown by the area in red) were found to occupy one third of the surveyed areas in summer and autumn of 2012, 2015 and 2016.

Zhai et al., 2018, Science China Earth Sciences