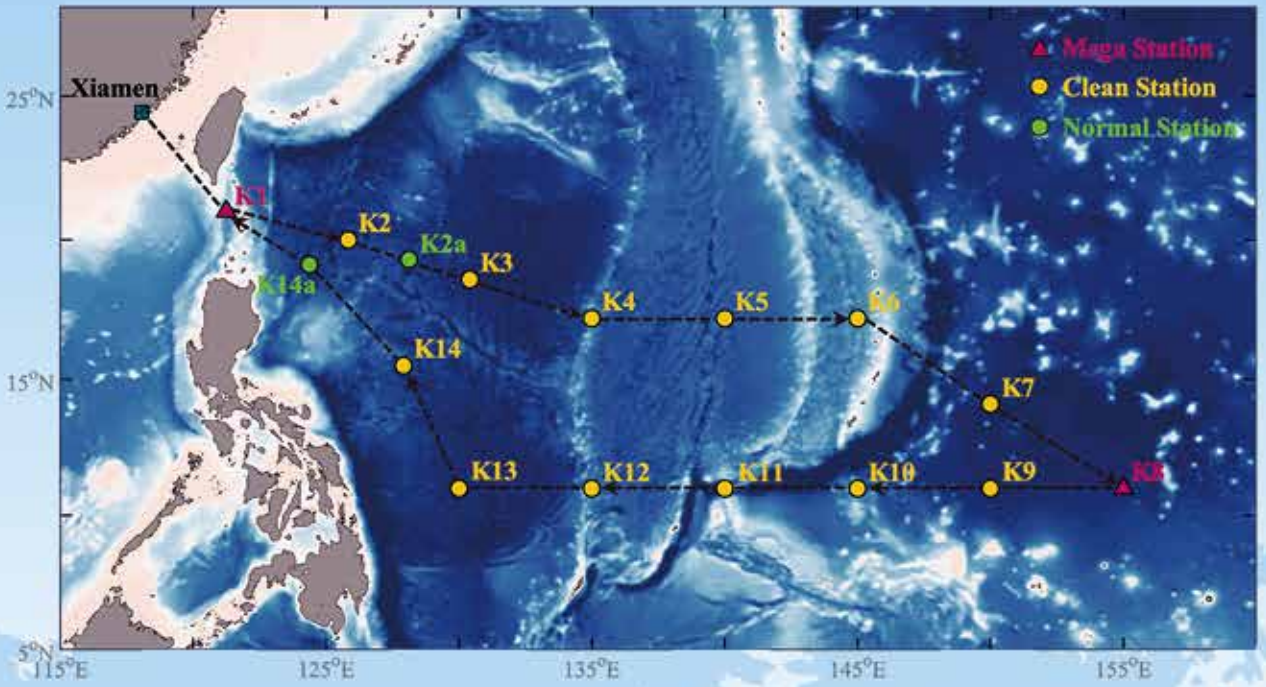

2019 年度报告

ANNUAL REPORT

近海海洋环境科学国家重点实验室（厦门大学）

State Key Laboratory of Marine Environmental Science
(Xiamen University)

MEL INTRODUCTION

近海海洋环境科学国家重点实验室（厦门大学）(英文缩写MEL）启动建设于2005年3月，2007年6 月通过科技部验收，2010、2015年连续获评优秀国家重点实验室。实验室瞄准与全球变化有关的重大科学问题，直面国家对海洋环境保护和生态安全的重大需求，立足基础研究，以多学科交叉为基础、以技术创新为动力、主攻海洋生物地球化学过程及其与海洋生态系统相互作用，关注在自然变化和人类活动影响下的海洋生态系统对环境变化的响应和反馈。实验室坚持走国际化发展道路，科学研究力求具备国际视野，管理体系参比国际标准，文化建设崇尚自由宽松，努力建设成为具有重要国际影响力的海洋环境科学研究和创新性人才聚集的基地。

Founded in 1995, the Laboratory of Marine Environmental Science (MEL) was formally promoted to a state key laboratory in March, 2005. MEL consists of 64 scientists and 96 technicians. It is dedicated to cutting-edge and interdisciplinary research related to global and regional environmental changes. MEL's focus is on marine biogeochemistry and its interactions with the marine ecosystem.

实验室学术委员会

名誉主任：胡敦欣
主　　任：吴立新
副 主 任：刘丛强、焦念志
委　　员：柴　扉、傅伯杰、郭正堂、翦知湣、林群声、宋微波、唐启升
　　王　凡、王　辉、魏庆琳、张　偲、赵美训、朱　彤、朱永官

MEL Academic Committee

Honorary Director: Dunxin Hu
Director: Lixin Wu
Associate Directors: Congqiang Liu, Nianzhi Jiao
Members: Fei Chai, Bojie Fu, Zhengtang Guo, Zhimin Jian, Paul K.S. Lam, Weibo Song, Qisheng Tang, Fan Wang, Hui Wang, Ching-Ling Wei, Si Zhang, Meixun Zhao, Tong Zhu, Yongguan Zhu

实验室领导班子

名誉主任：洪华生
主　　任：戴民汉
副 主 任：焦念志、王海黎

MEL Leadership Team

Honorary Director: Huasheng Hong
Director: Minhan Dai
Associate Directors: Nianzhi Jiao, Haili Wang

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序言

三周前，藉赴美参加 AGU 秋季年会之机，我与一众同事访问了硅谷、圣地亚哥、洛杉矶 *，收获颇丰。尤令我感触弥深的是那里只争朝夕的创新文化与生态，不由地想谈谈“登月计划（Moonshot Project）”以及未来的大势问题，权作对 2020 年代的畅想，以此为年报之序。

1969 年 7 月 16 日，宇航员尼尔·阿姆斯特朗、巴兹·奥尔德林、迈克尔·柯林斯驾驶阿波罗 11 号飞船从地球出发，穿越 38 万公里的太空飞抵月球表面。随后，阿姆斯特朗迈出了人类在外太空“个人小小的第一步”时，也成就了“整个人类文明的伟大一步”。这一切皆源于肯尼迪总统在 1962 年宣布启动的阿波罗载人登月计划（Apollo Program）。在成功登月 50 年后的今天，没有人会质疑阿波罗载人登月计划给人类社会带来的政治、科学、技术、经济、生活，甚至精神等方面的巨大影响和促进作用。但在当时，鲜有志士相信该计划是可以实现的。

受此启发，“登月”项目有了新时代里的新内涵，意指“极其大胆的想法或者很难实现的项目，唯有非常规解决方案和突破性技术方有可能予以解决”。一个“登月”项目的成功可能耗时耗资巨甚，亦可能永远都不会有任何成果，但其所激发的创新活力及深远影响正是我们现处的科技创新时代所亟需的那股力量。

很多年前，当我还在就读本科二年级之时，曾经幼稚地热衷过未来学研究，并撰文徜徉思绪：“面对着唯一的地球，人类该怎样采取对策呢？如果人类的活动空间还一味局限在超饱和的大陆上，地球的超负荷现象将成为事实。怎么办？于是人们的视线自然地转向那深邃的大洋底部，……”。

如今，海洋已成为联合国继气候变化、生物多样性后热切关注的第三大全球性议题，各国政府、企业家、民众亦都极度关注海洋问题。人们日益深刻地认识到海洋是人类及所有生命的摇篮，是地球可持续发展的命脉所在。据联合国预测，世界人口在 2050 年将增长至 100 亿。那么问题来了，地球届时将该如何承载这 100 亿人口？在水资源和土地资源日益紧缺的情况下，海洋或许将是最后一个能够为全人类持续提供食物之所？诸如此类的大哉问，以及与海洋相关的零碳工业、人海融合等问题，正是我们当今时代所亟需解决的“登月项目”。

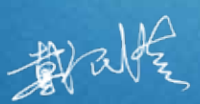
欲解决“登月”级的世界性难题，必须塑造“登月文化（Moonshot Culture）”。谷歌前任总裁 Eric Schmidt 以及奥巴马总统的科技政策办公室副主任 Tom Kalil 在纪念登月成功 50 年的文章中写道：“通过造就登月文化，我们期望吸引大批有志之士以及社会组织，致力于识别、解决那些宏大的却又可能实现的世界级难题，诚如比尔·盖茨期盼着在地球上根除小儿麻痹症、埃隆·马斯克期待‘在火星上终老’那样”。

我更深深地坚信，构架明日之大势为该文化的核心所在。

1946 年，唐世凤先生在厦门大学创立了中国第一个海洋学系，这在七十余年前的中国不可谓不是一个大格局，因为她为中国海洋科技发展注入了持续性的源动力。十五年前，MEL 的成立开启了厦门大学海洋学科发展的新篇章。而今，MEL 已成为厦门大学的海洋科技龙头，自然应在构建厦大的未来海洋科技人才、科技平台和创建文明等方面扮演“弄潮儿”的角色。众所周知，科学观测与认知是解决海洋问题的基石。鉴于此，我们自十五年前即起步策划强化海洋观测能力。如今，若干海上及岸基、空基观测设施均已基本建成并投入使用，我们完全可以期许，“嘉庚”号和东山站等基础设施的完善必将让厦大的海洋科学研究走得更远、更高。2018 年，MEL 邀请了以 Peter Liss 领衔的国际评估委员会为 MEL 的发展献计献策。2019 年，由林森杰、史大林、蔡平河、刘志宇、张锐等老师组成的实验室战略规划工作组在此基础上密集研讨，勾画未来发展蓝图，定位 MEL 在中国乃至世界大势之格局。

在喜见 MEL 已小有所成的当下，也是站在新十年的起点上，我们或许更应该思考未来、布局明天？纷繁的世界瞬息万变，诸多如火的考验挑战着人类，是熔于烈焰之中？还是正在淬炼真金？中国的科技共同体应该、也是时候探讨明日我们身处的这个世界将会发生何种变化？我们做了哪些准备？科技革命方向在哪里？大学既是为未来培养人才的象牙塔，亦是构架未来文明之所；那我们又如何通过大学的体系构架未来之势呢？

谨以此，诚祝关心 MEL 成长的各位海内外同仁及朋友新年快乐，期待共同携手，开启 MEL 的“海洋科技创新十年”。



主任：戴民汉

于 2019 年 12 月 31 日

* 此行得到 *Nishan Degnarain, Greg Mitchell, Yi Zhao* 的精心安排与协助，在此特致谢忱！

Message from the Director

Three weeks ago, while I was attending the 2019 AGU Fall Meeting in San Francisco, USA, I also visited Silicon Valley in Palo Alto, San Diego, and Los Angeles with some of my colleagues*. It was an eye opening trip. Among others, what impressed me the most was the culture of innovations and bold ideas. Thus, I cannot help but talk about the impressive "Moonshot Project" and the general trend of the future. I see this reflection as my vision for the new decade and make it core of my message.

On July 16, 1969, astronauts Neil Armstrong, Buzz Aldrin, and Michael Collins took off for the Moon, flying the Apollo 11 spacecraft through 380,000 kilometers of space. When Armstrong first stepped onto the Moon, it indeed was "one small step for man, one giant leap for mankind." This was the culmination of the Apollo Project, launched by President John F. Kennedy back in 1962. Today, 50 years after the first moon landing, no one even questions President Kennedy's declaration of "landing a man on the moon and returning him safely to the Earth," as well as the profound implications that the Apollo Project has brought to humanity and the society. But at the time, few people believed it would actually happen.

Inspired by the lunar landing, "Moonshot Project" has new meaning in the new era. Today we can take it to represent some extremely bold ideas or projects that are very difficult to achieve, which require radical solutions and breakthrough technologies to solve. The success of such projects may be time-consuming and costly, or may never yield any results, but the moonshot-project-induced innovative vitality and far-reaching implications are exactly what we need for scientific and technological innovation at the present time.

Many years ago, when I was still a sophomore at university, I was naively enthusiastic about futurology and thought "In the face of our one and only Earth, what will human beings do? If human activities are always limited to the continents which have become supersaturated, the Earth will become overloaded. So, what's the solution? People started to turn their attention to the deep, deep seas…."

Today, the ocean is the third major global issue that the United Nations is paying close attention to after climate change and biodiversity. Governments, entrepreneurs, and publics are also paying close attention to ocean issues. People now increasingly understand that the ocean is the cradle of humankind and all life, and the lifeblood of sustainable development on the planet. The UN predicts that the world population will grow to 10 billion by 2050. The immediate question is, how can we feed 10 billion people? Given increasingly scarce water and land resources, is the ocean the last place to provide food for all mankind? Questions such as these, as well as ocean-issues such as the zero-carbon industry, and the integration of people and the sea, are exactly such "moonshot projects" that need urgent resolutions in our time.

In order to solve these complex global problems, a "moonshot culture" must be created. Former President of Google, Inc. Eric Schmidt and Tom Kalil, Deputy Director for Office of Science and Technology Policy during the Obama Administration, wrote in an article commemorating 50 years since the successful moon landing: "By moonshot culture, we mean a future in which many more individuals and organizations are involved in the identification and pursuit of ambitious but achievable goals, in the same way that Bill Gates wants to eradicate polio, Elon Musk wants to "die on Mars, but not on impact".

In view of this, I deeply believe that forward thinking is at the core of this "moonshot culture".

In 1946, Prof. Shifeng Tang founded the first Department of Oceanography in China at Xiamen University (XMU). This was highly insightful in China over 70 years ago, because the department provided continuous support and momentum to the development of marine science and technology in China. Fifteen years ago, the creation of MEL opened up a new chapter of marine science at XMU. Nowadays, MEL is a leader of marine science and technology at XMU. As such, it should naturally play a leading role within XMU not only in training professional talents but also in building up research platforms and promoting ocean literacy across society. As we all know, scientific observation is the cornerstone of addressing ocean problems. Given this, we have been planning to strengthen marine observation capabilities in the last 15 years. Nowadays, a number of offshore, shore-based and space-based observation facilities have been completed and put into use. We can expect, with confidence, that such infrastructure improvement including the R/V Tan Kah Kee and Dongshan Swire Marine Station will definitely propel XMU's ocean research further and higher. In 2018, MEL invited an international review committee headed by Peter Liss to contribute to the future development of MEL. In 2019, the MEL Strategic Planning Working Group, composed of Senjie Lin, Dalin Shi, Pinghe Cai, Zhiyu Liu, and Rui Zhang, organized intensive discussions, drawing up a blueprint for future development, and positioning MEL in the context of developing China and the changing world.

Seeing all that MEL has achieved while standing at the starting point of a new decade, we should perhaps think more about the future and plan for tomorrow. The complex world is changing rapidly. Human beings are facing many severe challenges. Will we be defeated by the challenges or become tougher? It is also time for China's science and technology community to explore what will happen to the world we live in. What solutions have we already created? What is the direction of the technological revolution in upcoming decades? The university is not only an ivory tower for cultivating talents but also a place to structure future civilizations. So how can we frame future trends?

With this in mind, I sincerely wish all colleagues and MEL friends at home and abroad a very Happy New Year. I very much look forward to working together with you all to open a new chapter of "MEL's Decade of Marine Science and Technological Innovation".

Minhan Dai
December 31, 2019

*Special thanks to *Nishan Degnarain, Greg Mitchell, and Yi Chao* for their thoughtful arrangements and helpful assistance for this visit to California, USA.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一月 / January

第四届厦门海洋环境开放科学大会召开，来自24个国家和地区、189个科研单位，共890位学者参会，成为亚洲最大的海洋环境科学国际会议之一。

The 4th Xiamen Symposium on Marine Environmental Sciences took place in Xiamen, attracting 890 participants from 24 countries and 189 institutions making it one of the largest international conferences on marine environmental science in Asia.

厦门大学–特拉华大学联合研讨会召开，回顾两校“近海海洋研究与管理联合研究所”成立十周年合作成果，双方将继续探索新的合作契机，携手开启新十年。

A joint workshop between Xiamen University and University of Delaware took place in Xiamen to celebrate the 10th anniversary of the Joint Institute for Coastal Research and Management (Joint-CRM). Participants had profound discussions and explored new partnership opportunities for the next decade.

根据科睿唯安基本科学指标数据库（ESI）统计，厦门大学地学学科进入2008年1月-2018年11月该领域全球研究机构排名前1%。

According to Essential Science Indicators (ESI) based on the Web of Science, Xiamen University ranked among the top 1% highly cited institutions in the field of Geoscience from January 2008 to November 2018.

三月 / March

“海洋生物地球化学创新引智基地”获教育部及科技部“高等学校学科创新引智计划（111计划）” 2.0项目的持续支持。

The international collaboration project “Marine Biogeochemistry and Ecotoxicology” was renewed for a third funding term (2019-2023) through the Program of Introducing Talents of Discipline to Universities (known as the “111” Program).

刘海鹏、史大林、张锐入选科技部“万人计划”科技创新领军人才。

Haipeng Liu, Dalin Shi and Rui Zhang received support from the “National High-Level Talents Special Support Plan” for Science and Technology Innovation Leaders.

陈曦、戴民汉、党宏月、高坤山、焦念志等五名学者入选爱思唯尔“2018年中国高被引学者”。

Xi Chen, Minhan Dai, Hongyue Dang, Kunshan Gao and Nianzhi Jiao listed among the “Most Cited Chinese Researchers in 2018” as published by Elsevier.

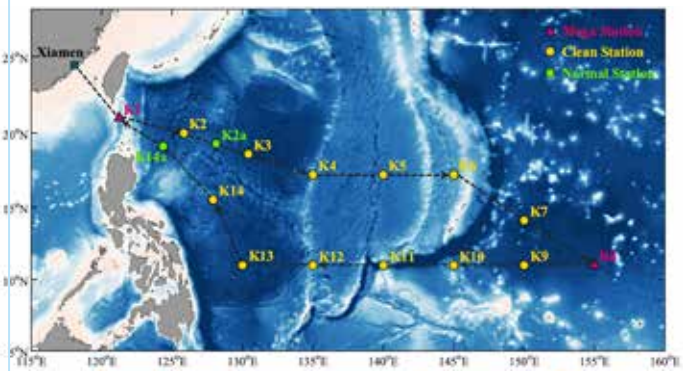
四月 / April

史大林与罗亚威团队在《自然·通讯》期刊发表论文，揭示固氮酶效率下降主导海洋酸化对优势固氮束毛藻的抑制效应。

Dalin Shi and Ya-wei Luo published in *Nature Communications*. Their work reveals a reduced nitrogenase efficiency dominates the response of the globally important nitrogen fixer *Trichodesmium* to ocean acidification.

4-6月，牵头组织的“痕量元素和同位素海洋生物地球化学循环计划”首个中国断面航次GEOTRACES-CHINA GP09圆满完成，预期产出首批完整的西太平洋海水和颗粒物痕量元素和同位素含量与组成的数据。

The first Chinese GEOTRACES section cruise, GEOTRACES-CHINA GP09 expedition, completed its 45 days voyage to the West Pacific Ocean, which will reveal the distributions of dissolved and particulate trace elements and their isotopes in this oligotrophic ocean.



七月 / July

实验室在东山召开战略规划研讨会，为迎接实验室五年一次的评估和下一轮的发展制订规划。
MEL's Strategic and Planning Workshop held in Dongshan, planning for the next round of lab development and evaluation.


© Lun Cai

八月 / August

第二届“海丝学堂”本科生教学实习航次首次前往马来西亚，并首次停靠国外港口（马来西亚巴生港）举办公众开放日。
The second training cruise for undergraduate students - "XMU at Sea" sailed to Malaysia for the first time and held its R/V open days in Port Klang, Malaysia.

九月 / September

主办首届全球海洋氧气网络国际研究生暑期学校。
The first Global Ocean Oxygen Network (GO2NE) Summer School was hosted by MEL.

十月 / October

主办第六届国际硝化及相关微生物过程大会。
The 6th International Conference on Nitrification and Related Processes was held in Xiamen.


© Qunrui Chen

联合承办“亚洲沉积体系时空连续性之全球视角”国际研讨会。
MEL co-sponsored the International Conference on Asian Sedimentary Continuum: Toward a Global Perspective.


© Shengyao Sun

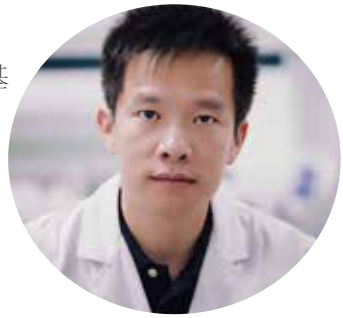
以厦门大学东山太古海洋观测与实验站为主要组成的台湾海峡海洋生态系统野外科学观测研究站（台海站）于10月获批为教育部首批野外科学观测研究站。
The Taiwan Strait Marine Ecosystem Research and Observation Field Station, of which Dongshan Swire Marine Station (D-SMART) is a major part, was endorsed as one of the first field observation and research stations by the Ministry of Education of China.

承办第三届国家重点实验室公共管理与公共服务联合论坛，吸引逾半数国家重点实验室的300多人参加会议，该论坛已成为我国高校、科研院所间管理交流的重要平台。
MEL hosted the 3rd Joint Workshop on National State Key Lab Public Management and Service, attracting 300 participants. The workshop has become an important platform for communication among universities and institutes in China.

十一月 / November

MEL助推厦门大学地球科学与技术学部与新浪厦门共建的“70.8海洋媒体实验室”成立。这是全国首个顶尖科研机构与权威媒体联合创建的海洋媒体实验室，将致力于创新海洋科学传播模式。
The 70.8 Media Lab was jointly established by XMU's Faculty of Earth Science and Technology (for which MEL provides the major manpower) and Sina Xiamen, and strives towards partnering science and communication. It is the first marine science media lab co-sponsored by a top institution and mainstream media outlet.

第八届海洋科学开放日顺利举办，吸引6500公众参与。
The 8th Xiamen University Ocean Sciences Day welcomed 6500 visitors.



史大林获批国家自然科学基金杰出青年科学基金项目。
Dalin Shi received the NSFC Science Fund for Distinguished Young Scholars Award.

实验室推动厦门大学与德国亥姆霍兹基尔海洋研究中心签署校际合作备忘录。
A Memorandum of Understanding between Xiamen University and GEOMAR Helmholtz Centre for Ocean Research Kiel was signed.

人员情况
PERSONNEL

陈能汪博士 Dr. Nengwang Chen

A researcher dedicated to watershed-coastal environmental science and sustainable development

教授 Professor
nwchen@xmu.edu.cn

陈能汪博士于 1998 年获南京农业大学环境科学专业学士学位，2006 年获厦门大学环境科学博士学位；2006-2008 年浙江大学博士后，2011-2012 年美国马里兰大学访问学者，2016-2017 荷兰乌特勒支大学访问学者。他于 2009 年入职厦门大学，2019 年 10 月正式加入 MEL，在当前海岸带地区面临人为营养盐增加引起富营养化、有害藻华、低氧和酸化问题，社会经济的可持续发展面临资源、环境、生态等诸多挑战的背景下，陈能汪博士主要研究营养盐生物地球化学、环境过程与效应、环境规划与管理、环境大数据，并致力于为陆海统筹生态环境综合治理提供科技支撑。

Dr. Nengwang Chen became a member of MEL in October 2019. He is a professor of environmental biogeochemistry. He received his PhD in Environmental Science from Xiamen University in 2006, then moved to Zhejiang University as a post-doc before he was employed by Xiamen University as an associate professor in 2009. He was promoted to professor in 2014. He has been a visiting scholar at University of Maryland, USA (2011-2012) and Utrecht University, the Netherlands (2016-2017).

Dr. Chen seeks to understand how anthropogenic stressors impact the coastal system. He has broad research interests in nutrient biogeochemistry, environmental processes and effects, environmental planning and management, and environmental big data. By looking at the flow of nutrients, carbon, and oxygen at key points through the system and by analyzing their role in major ecosystem processes and controls, he is able to paint a much clearer picture of just how our activities are threatening our coastal environment.

高光博士 Dr. Guang Gao

Focusing on the interaction of global ocean changes and macroalgae

副教授 Associate Professor
guang.gao@xmu.edu.cn

高光博士于 2019 年 8 月加入 MEL，他于 2012 年在英国纽卡斯尔大学攻读博士期间，开始全球气候变化与大型海藻相互作用的研究工作。

大型海藻是近岸初级生产力的主要贡献者，也是海洋生态系统生态过程的重要驱动者之一，由大型海藻所形成的海藻场在支撑海洋生物摄食、生长和繁殖等生命活动中扮演着极为重要的角色。同时，大型海藻作为“功能性食品”，受到越来越多人的青睐。高光博士的研究聚焦全球气候变化（酸化、暖化）与近岸环境污染（富营养化、微塑化）对大型海藻光合固碳、生长、繁殖及生化组成等的耦合影响，以及大型海藻在碳捕获、富营养化修复、生物能源生产、微塑料吸附及转运等方面对海洋环境变化的调节反馈机制。

Dr. Guang Gao first became interested in how changes in the ocean impact macroalgae while working on his doctorate program at Newcastle University, UK in 2012. Since then, he has published over 30 papers in many peer-reviewed journals and has been sited over 600 times. His investigation of how the combined stressors of ocean acidification, increasing sea temperatures, and eutrophication affect the development of algae associated with green tides was published in *Marine Pollution Bulletin* (2017) and was the first examination of this question. This has attracted attention both at home and abroad to his work.

杨进宇博士 Dr. Jinyu Yang

A new MELer in marine particle dynamics and nitrogen cycle

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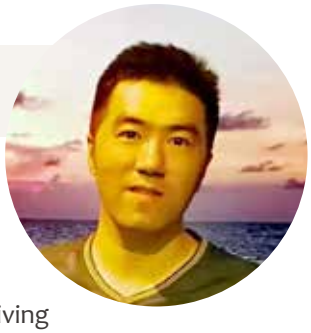

杨进宇博士于 2019 年 5 月加盟 MEL，为海洋化学方向的助理教授。他于 2015 年获厦门大学环境科学博士学位。研究生期间，曾作为交换学生赴台湾“中央”研究院访学两年。2015-2016 年，他受聘 MEL 助理研究员；2016 年初，获得韩方全额资助，前往韩国浦项工科大学进行博士后研究。

杨进宇博士研究兴趣是利用稳定同位素手段示踪人为活动和气候变化胁迫下海洋颗粒物动力学和海洋氮循环过程的响应和变化。他的主要研究聚焦于大气和海洋中不同氮组分中元素的迁移转化过程，以及不同种类颗粒物中生源要素的耦合关系及其控制机理。

Dr. Jinyu Yang joined in Xiamen University since May 2019. Dr. Yang earned his PhD in Environmental Science at Xiamen University in 2015. During his graduate studies, he stayed at the Academia Sinica (Taipei) for two years as a visiting student. Afterwards, he was an assistant research scientist at MEL and after receiving a postdoc fellowship from Korea in early 2016, he moved to Pohang University of Science and Technology (POSTECH) .

Dr. Jinyu Yang's research interests are the responses and variations in marine particle dynamics and the marine nitrogen cycle under anthropogenic and climate change forcing using stable isotope tools. His research focuses specifically on elemental transfer and transformation among difference nitrogen species in the atmosphere and ocean, as well as coupling of biogenic elements in particles and their controlling mechanisms.

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研究方向：
海洋硅循环，稳定同位素地球化学
Research Interests:
Ocean silicon cycle; Stable isotope geochemistry

我在 MEL 学习近八年、入职工作大半年，深刻感受到 MEL 是一个自由、开放、鼓励创新、追求突破的科研平台。

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研究方向：
海洋数值模拟，大中尺度海洋动力学，及气候变化
Research Interests:
Ocean modeling, large to mesoscale ocean dynamics, and climate change

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研究方向：
利用氮同位素手段研究湿地—河口—近岸海洋生态系统沉积物中氮的迁移转化
Research Interests:
Nitrogen cycle in sediments; application of N isotopes in understanding the sedimentary nitrogen transformation in wetland-estuary-coastal ocean ecosystems

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研究方向：
海洋颗粒态痕量金属的生物地球化学循环
Research Interests:
Biogeochemistry of marine particulate trace metals

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研究方向：
古海洋生物地球化学循环及其环境背景变化
Research Interests:
Changes in biogeochemical cycles and redox conditions of the ancient ocean

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研究方向：
海洋病毒生态，深部生物圈微生物生态
Research Interests:
Marine viral ecology, microbial ecology in deep biosphere

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研究方向：
海洋光学，辐射传输模型
Research Interests:
Ocean optics and radiative transfer model

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蔡伦 Lun Cai
学术及宣传秘书
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成为 MEL 的一员，是既幸运又有挑战性的。在这里的每一天，我享受海洋科学的魅力和在这蓝色摇篮里成长的快乐。

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在人生中的又一个转折点我进入了 OCG 课题组，三个月的科研助理工作，我认识到科研工作的严谨认真、体会到组会的头脑风暴、感受到领导同事的热情帮助，在这里，我找到了细笔勾勒人生蓝图的舞台。

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Secretary
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在 MEL 的每一天都充满激情与挑战，最大的感触是，一个向上的环境激励着我不断地进步，希望自己永葆一颗年轻、进取的心，乐观，坚持！

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人才计划、晋升及奖项／ Recognition, Promotion and Awards

- 洪华生、焦念志、张瑶获“庆祝中华人民共和国成立 70 周年”纪念章
- Huasheng Hong, Nianzhi Jiao and Yao Zhang were awarded the medals in commemoration of the 70th anniversary of the PRC

- 史大林获国家杰出青年科学基金项目资助
- Dalin Shi received the National Science Fund for Distinguished Young Scholars Award

- 刘海鹏入选 “万人计划”科技创新领军人才
- Haipeng Liu received the Science and Technology Innovation Leader Award via “National High-Level Talents Special Support Plan”

- 史大林入选 “万人计划”科技创新领军人才
- Dalin Shi received the Science and Technology Innovation Leader Award via “National High-Level Talents Special Support Plan”

- 张锐入选 “万人计划”科技创新领军人才
- Rui Zhang received the Science and Technology Innovation Leader Award via “National High-Level Talents Special Support Plan”

- 马剑、王桂芝晋升为厦门大学教授
- Jian Ma and Guizhi Wang were promoted to full Professors

研究亮点
RESEARCH HIGHLIGHTS

01

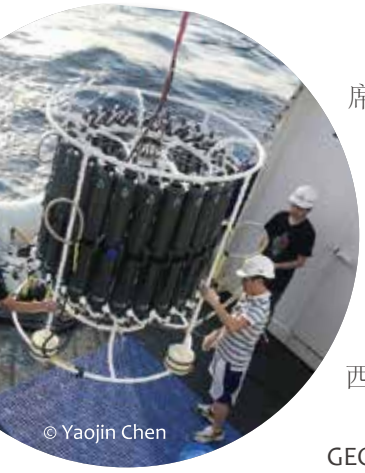
中国痕量元素和同位素海洋生物地球化学循环计划首个断面科考航次

The first GEOTRACES-CHINA sectional cruise: GP09 expedition


© Na Qian

西太平洋在全球气候和海洋变化研究中具有特殊地位。西太平洋表层水中通常缺乏生命所需的营养盐及痕量元素铁，生产力水平低下，从而被认为是海洋“荒漠”地带。然而目前对于这一海区中的痕量元素含量和同位素组成知之甚少，阻碍了科学家对海洋“荒漠”中的生物地球化学过程及其与全球气候变化的紧密联系的深入认识。

2019 年 4-6 月，中国 GEOTRACES（痕量元素和同位素海洋生物地球化学循环）计划首个西太平洋断面调查科考航次完成。航次为期 45 天，共完成 16 个站位的科考作业任务，包括 12 个洁净站，2 个重点站及 2 个常规站，运用了多学科、多平台、多仪器的观测和采样技术，体现了现代海洋调查研究的特色，主要作业内容包括常规 CTD 采水、痕量元素洁净 CTD 采水、大体积海水过滤系统采样、大体积现场生物培养、浮游生物拖网、气溶胶和大气采样、湍流观测等。其中，痕量元素洁净 CTD 采水在中国属于首次正式开展的大洋海上作业项目。本航次将提供大量关于西太平洋海水和颗粒物痕量元素和同位素含量与组成的数据，为该海域生物生产力、碳循环及 CO_2 增汇潜力的研究提供独特视角。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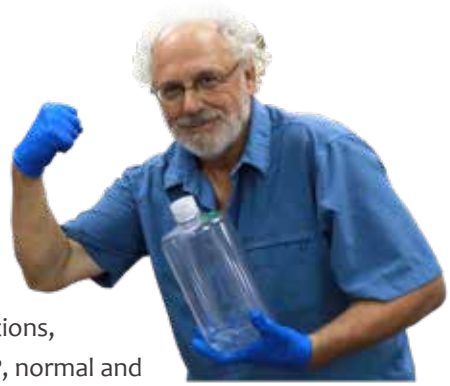
蔡毅华和周宽波担任航次联合首席科学家，船上 36 名科考队员来自国内外 10 所高校和科研单位，分别是厦门大学、中国海洋大学、自然资源部第二海洋研究所、北京大学、上海交通大学、天津科技大学和德国 GEOMAR、日本富山大学、美国缅因大学及加拿大西安大略大学。

GEOTRACES 是 21 世纪最新的、正在持续推进的国际计划，旨在研究全球海洋痕量元素及其同位素生物地球化学循环。她是继上世纪 70 年代 GEOSECS（地球化学海洋剖面研究计划）和 90 年代 WOCE（世界大洋环流实验）等大型海洋调查计划之后，国际上衍生的又一重大计划，不仅为海洋化学和古海洋学研究提供重要科学数据和视角，也有助于评估人类活动对地球环境与全球气候的影响。这一国际性海洋生物地球化学循环研究计划的成功实施也将为地球化学其他新兴领域的研究提供参考模板。

GEOTRACES 是国际海洋研究委员会（SCOR）近年最大的国际合作项目。戴民汉参与了 GEOTRACES 计划的规划，也是第一位在该计划科学指导委员会担任委员的中国科学家，之后蔡平河担任委员，在过去六年里，北京大学周力平教授继任委员。多年来，他们在推动 GEOTRACES 在中国的执行起到至关重要的作用。“嘉庚”号是国内首个完全具备痕量海水洁净海水大体积采集能力的科学考察调查船，在未来海洋痕量元素及其同位素生物地球化学研究中将担负起举足轻重的支撑作用。中国将有越来越多的科学家投身其中，对此做出贡献。

The western North Pacific Ocean is known for its critical role in ocean variability and global climate. However, it remains extremely under-sampled for the distribution of trace elements and their isotopes (TEIs). This region is also considered one of the so-called "marine deserts", due to its lack of essential nutrient elements for life, such as Fe and N.

To have a clearer understanding of the area, the first GEOTRACES-China cruise investigated the western North Pacific along the GP09 Section from April to June, 2019, onboard R/V Tan Kah Kee. Thirty-six scientists from China (Xiamen University, Second Institute of Oceanography, Ocean University of China, Peking University, Shanghai Jiao Tong University), Germany (GEOMAR), Japan (Toyama University), USA (University of Maine) and Canada (University of Western Ontario) participated in this cruise. Two chief scientists, Yihua Cai and Kuanbo Zhou, were both from MEL. During the 45 days at sea, 16 stations were have been investigated with multi-disciplinary, platform, and instrumental observations, including LADCP, MVP, normal and clean CTD rosettes, *in situ* pumps, large volume incubation experiments, plankton trawling, and aerosol sampling. This cruise obtained valuable TEIs data and will provide key clues to the paleo-proxies used in paleoceanographic research, micronutrients elements essential for life in the ocean, and anthropogenic imprints of contaminants. This cruise will also reveal the distributions of dissolved and particulate trace elements and their isotopes of in this oligotrophic ocean, including Fe, Cu, Ni, Al, Mn, Cd, in the full water column, which helps further the understanding of the carbon fixation there and its relationships to the global climate changes.



GEOTRACES is an international program initiated that was formally proposed in early 2000's to study the global marine biogeochemical cycles of TEIs. Following the GEOSECS and WOCE programs of the early 1970's and 1990's, GEOTRACES has operated for more than a decade, striving to investigate the marine biogeochemical cycle of TEIs. For the development of GEOTRACES in China, Minhan Dai, participated in the planning of GEOTRACES and was the first Chinese scientist in the Scientific Steering Committee (SSC), followed by Pinghe Cai of MEL. Over the past six years, Liping Zhou from Peking University has been a member of the SSC. These scientists have contributed much to the promotion and implementation of GEOTRACES in China. The R/V Tan Kah Kee and scientists in China plan to do more work with GEOTRACES and accelerate progresses in the future.

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02

边缘海CO_2源汇新解析

Diagnosis of CO_2 dynamics and fluxes in global coastal oceans

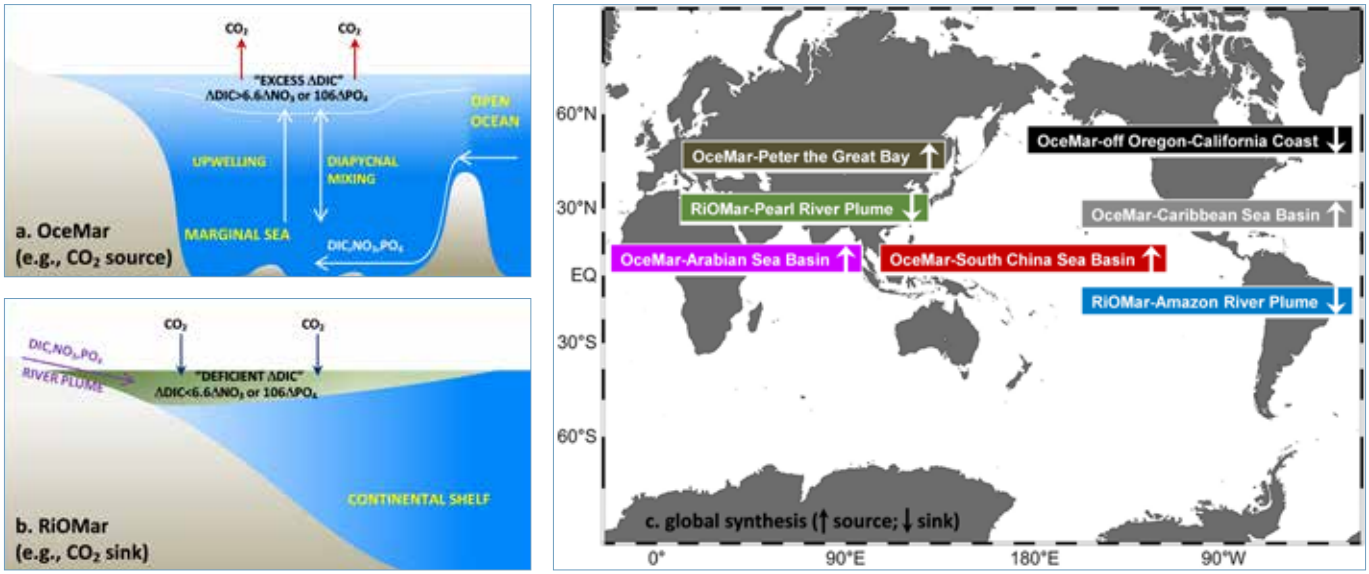
陆架边缘海既受河流输入影响，又与大洋发生交换，是全球碳循环中最复杂和最薄弱的环节之一。时至今日，“为什么一些边缘海是大气 CO_2 的源（向大气释放 CO_2），而另一些则是汇（从大气吸收 CO_2）”这一基本问题仍然悬而未决，调控边缘海 CO_2 源汇格局的主要过程和关键机理也有诸多不明之处。基于与大洋交换和陆源输入两个过程，戴民汉、曹知勉等人聚焦两大边缘海特征系统：大洋主控型边缘海（Ocean-dominated Margins, OceMar）和河流主控型陆架海（River-dominated Ocean Margins, RiOMar），解析 CO_2 源汇格局及其关键物理 – 生物地球化学调控过程与机理，揭示边缘海碳循环的全球意义。

研究首先分析了全球陆架边缘海表层海水 CO_2 分压（pCO_2）的时空分布。发现 pCO_2 受温度效应影响较小，由纬度差异和季节变换导致的海表温度差异均不能主导 pCO_2 变化；而非温度效应，如水团混合和生物消耗，在控制全球陆架边缘海 CO_2 分布和 CO_2 源汇格局中发挥着更为重要的作用。那么，这些非温度效应又该如何定量解析？

基于“边缘海 – 大洋”和“陆地 – 边缘海”两个界面的物质交换，该研究构架了 OceMar 和 RiOMar 碳循环概念框架。两类系统分别接受大洋和河流输入的外源无机碳和营养盐，经由一系列动力过程进入边缘海真光层后同时被生物消耗，无机碳和营养盐之间的“竞争”最终决定边缘海 CO_2 源汇格局。若无机碳过剩，则以 CO_2 形式向大气释放，即为源；若无机碳不足，则需从大气补充 CO_2，即为汇。根据上述框架，该研究建立了物理 – 生物地球化学耦合诊断新方法，成功解析了两大 OceMar（南海海盆区、阿拉伯海海盆区）和典型 RiOMar（南海北部陆架珠江冲淡水影响区）的 CO_2 源汇格局，预测结果与实测数据相符。此外，这种定量解析方法还具有其他用途，如甄别除通过界面输入的额外营养盐、检验无机碳与营养盐的生物消耗是否遵循 Redfield 比值等。

OceMar 和 RiOMar 碳循环概念框架同时将物理与生物地球化学耦合、无机碳与营养盐耦合融于一体，溯源追终（外源输入、内部变化和最后归宿），全面解析边缘海 CO_2 源汇格局及其控制过程，首次真正由局限于表层海水 pCO_2 的现场观测提升至三维一体的理论总结，从而有助于边缘海碳循环的机制性理解和全球碳模型的准确模拟。

以上工作于 2019 年 8 月发表于 *National Science Review* 期刊，曹知勉为第一作者，戴民汉为通讯作者。



大洋主控型边缘海和河流主控型陆架海 CO_2 源汇解析。
Diagnosis of CO_2 source/sink nature in OceMars and RiOMars.

Global coastal oceans as a whole represent an important carbon sink but, due to high spatial-temporal variability, a mechanistic conceptualization of the coastal carbon cycle is still under development, hindering the modelling and inclusion of coastal carbon in Earth System Models. Although temperature is considered an important control of sea surface pCO_2, we show that the latitudinal distribution of global coastal surface pCO_2 does not match that of temperature, and its inter-seasonal changes are substantially regulated by non-thermal factors such as water mass mixing and net primary production. These processes operate in both Ocean-dominated Margins (OceMar) and River-dominated Ocean Margins (RiOMar), with carbon and nutrients sourced from the open ocean and land, respectively. These can be conceptualized by a semi-analytical framework that assesses the consumption of dissolved inorganic carbon relative to nutrients, to determine how a coastal system is a CO_2 source or sink. The framework also finds utility in accounting for additional nutrients in organic forms and testing hypotheses such as using Redfield stoichiometry, and is therefore an essential step toward comprehensively understanding and modelling the role of the coastal ocean in the global carbon cycle.

Reference:
Cao, Zhimian; Yang, Wei; Zhao, Yangyang; Guo, Xianghui; Yin, Zhiqiang; Du, Chuanjun; Zhao, Huade; Dai, Minhan*. Diagnosis of CO_2 dynamics and fluxes in global coastal oceans. *NATIONAL SCIENCE REVIEW*, nwz105, DOI: org/10.1093/nsr/nwz105.

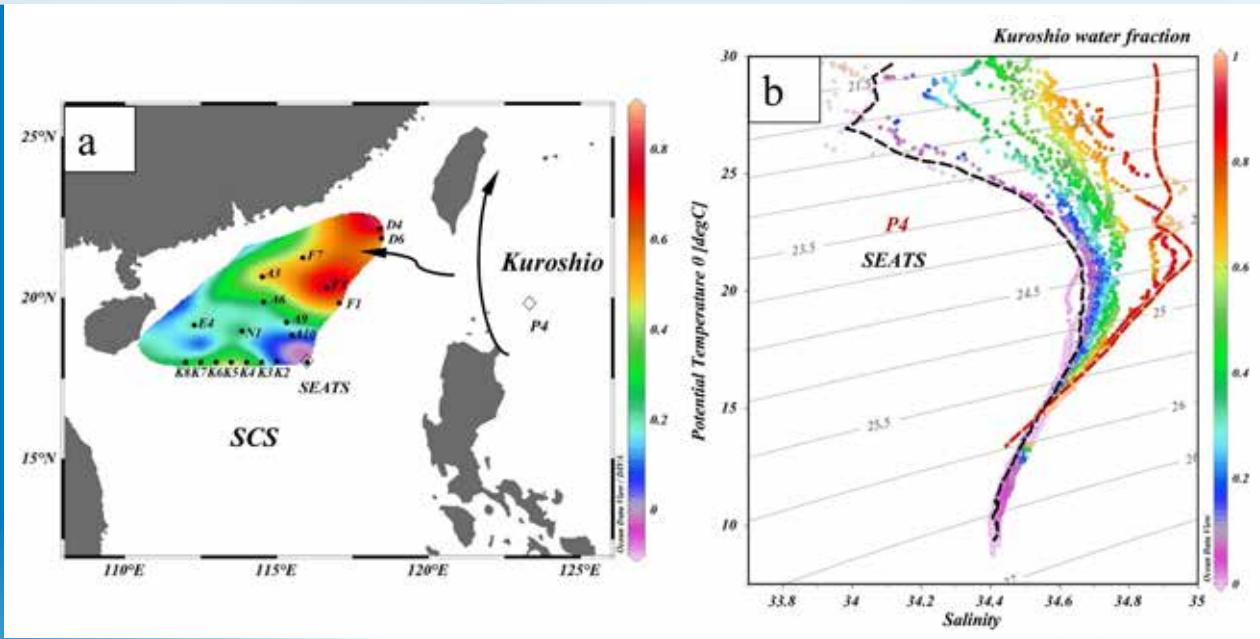
03 西边界流入侵影响下中国南海的固氮生物地理特征

西边界流入侵边缘海是全球大洋环流系统中的一个重要特征，已有研究发现，西边界流入侵对于边缘海的水团结构、环流特征和物质组成均具有重要的影响，从而可能也会对生物地球化学过程产生深刻影响。

黑潮入侵南海是全球范围内一个典型的西边界流入侵现象，高树基与合作者在研究黑潮入侵南海的路径上，通过在不同黑潮入侵强度的站位开展真光层水柱的固氮生物、固氮速率以及初级生产力的调查，发现黑潮入侵对于南海北部的固氮生物分布、固氮速率和初级生产过程均具有重要影响。数据表明黑潮入侵为南海北部输送了以束毛藻为主的固氮生物，显著提升了南海的固氮速率，而且固氮速率与初级生产力显著正相关，暗示了固氮速率的提升促进了初级生产力。有趣的是，出现最高固氮速率的站位并非纯粹的南海端元或者黑潮端元，而是二者以接近 60% 黑潮份额混合的站位，这进一步暗示了西边界流与边缘海的水体混合过程中，可能诱发了二次的生物地球化学过程，从而为氮动力过程例如固氮过程提供一个独特的生境，产生了不同于混合端元的独特生物地球化学行为。

总的来说，该研究在黑潮入侵南海背景下，结合现场水文观测与培养实验，首次提出西边界流长途输运造成了南海北部固氮的生物地理学分布，而西边界流入侵边缘海过程中产生的水团混合行为创造了更优的生境刺激了远域来源的固氮生物勃发，继而改变南海的新生产力与后续生物地球化学循环。该研究有助于大洋环流与边缘海水动力交互作用对于区域生物地球化学循环的机制性理解。

以上研究作为封面文章，于 2019 年 9 月发表于 *Journal of Geophysical Research-Oceans* 期刊，博士生卢阳阳和温作柱为共同第一作者，高树基为通讯作者。

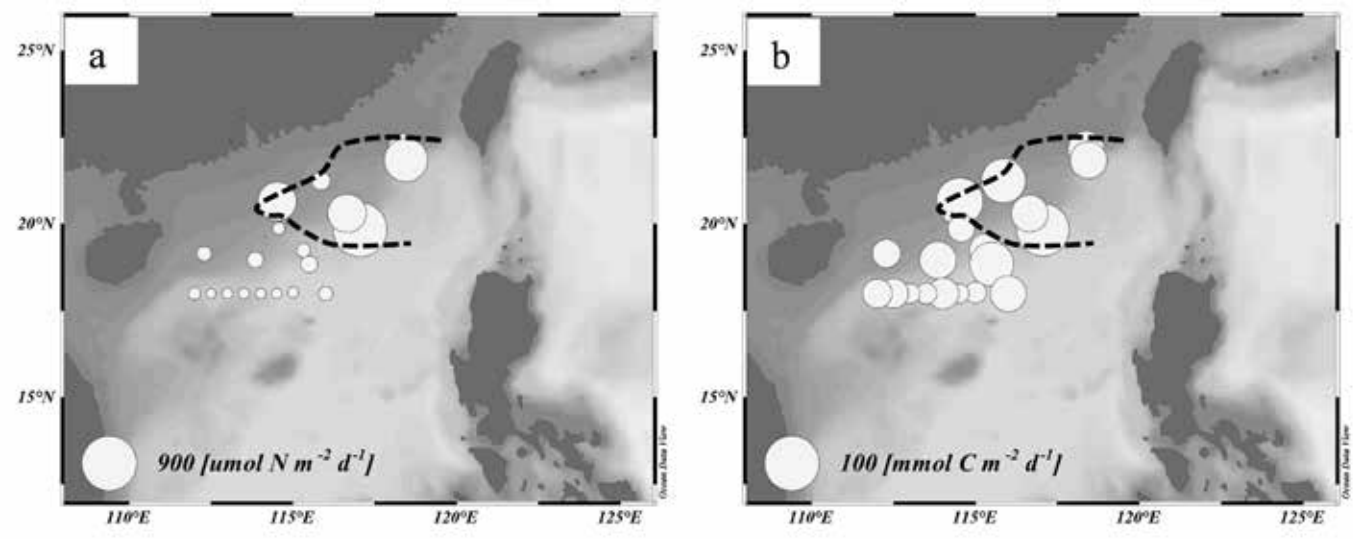


(a) The spatial pattern of the KI index. The color bar represents the value of $R_{kave\text{-}100}$. Black solid dots represent the sampling stations. The two open diamonds are the two end member stations (SEATS for the SCS and P4 for the Kuroshio) chosen for the isopycnal mixing model. (b) θ-S diagram of the upper 400 m for all the investigated stations. The red dashed curve denotes typical Kuroshio water, and the black dashed curve denotes typical SCS water. KI = Kuroshio intrusion; SCS = South China Sea.

Biogeography of N_2 fixation influenced by the western boundary current intrusion in the South China Sea

The N_2 fixation and primary production rates were measured simultaneously using $^{15}N_2$ and ^{13}C incubation assays in the northern South China Sea influenced by the Kuroshio intrusion (KI) seasonally. The degree of KI (KI index, range from 0 to 1) was assessed by applying an isopycnal mixing model. The water column integrated N_2 fixation and primary production for stations with KI index larger than 0.5 were 463 ± 260 μmol $N \cdot m^{-2} \cdot day^{-1}$ and 62 ± 19 mmol $C \cdot m^{-2} \cdot day^{-1}$, respectively, significantly higher than those for stations with KI index lower than 0.5 (50 ± 10 μmol $N \cdot m^{-2} \cdot day^{-1}$ and 28 ± 10 mmol $C \cdot m^{-2} \cdot day^{-1}$, respectively). *Trichodesmium* was the dominant diazotroph at stations with KI index larger than 0.5, with 2 orders of magnitude higher *nifH* gene abundance than that at stations with KI index lower than 0.5. However, the highest N2 fixation rates were found in waters with moderate KI index around 0.6, suggesting that frontal zone mixing might stimulate N_2 fixation. Our results demonstrated that diazotrophs (mainly *Trichodesmium*) were tightly associated with the KI, which modulated the biogeographic distribution of N_2 fixers. In summary, we found the transportation of Trichodesmium by KI, then, we quantified the fraction of KI and N_2 fixation rates in the northern South China Sea. The results suggested that KI generated a new biogeographic regime which could significantly influence the carbon and nitrogen cycles far away from the main stream.

Reference:
Lu, Yangyang[#]; Wen, Zuozhu[#]; Shi, Dalin; Lin, Wenfang; Bonnet, Sophie; Dai, Minhan; Kao, Shuh-Ji[*]. Biogeography of N_2 fixation influenced by the western boundary current intrusion in the South China Sea. *JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS*, 2019. DOI: 10.1029/2018JC014781. (Feature article)



Spatial distributions of (a) the depth-integrated N_2 fixation rate (μmol $N \cdot m^{-2} \cdot day^{-1}$) and (b) depth-integrated primary production (mmol $C \cdot m^{-2} \cdot day^{-1}$). The dashed curves represent the isopleth of Kuroshio intrusion index of 0.5.

04 从多学科视角分析红树林无机氮的源汇功能及其主控过程

红树林作为陆海界面重要的湿地生态系统，可提供包括水质净化、碳的埋藏与储存（蓝碳）等多种生态系统服务。受人类活动与气候变化影响，红树林湿地生态功能退化问题突出。到目前为止，红树林与河口湾之间营养盐交换的界面过程与宏微观机制仍不清楚。本研究以漳江河口－湿地生态系统为整体研究对象，重点关注营养盐形态、分布、输运、转化及其调控机制，探讨红树林－河口系统的地学与环境学意义。

研究以红树林潮沟和漳江河口之间营养盐浓度的对比为切入点。经不同季节多个航次的调查，发现在河口中无机氮形态（氨氮 NH_4-N、硝氮 NO_3-N、亚硝氮 NO_2-N）的浓度表观上呈现保守混合行为，而红树林潮沟中的浓度偏离保守线，其中 NH_4-N 浓度高于河口（正偏离），NO_3-N 浓度低于河口（负偏离）。汇总归纳不同季节航次数据，发现偏离量与潮差显著正相关，意味着红树林－河口之间无机氮的交换受控于潮汐泵。但是，是什么过程控制着红树林－河口氮的源－汇格局呢？

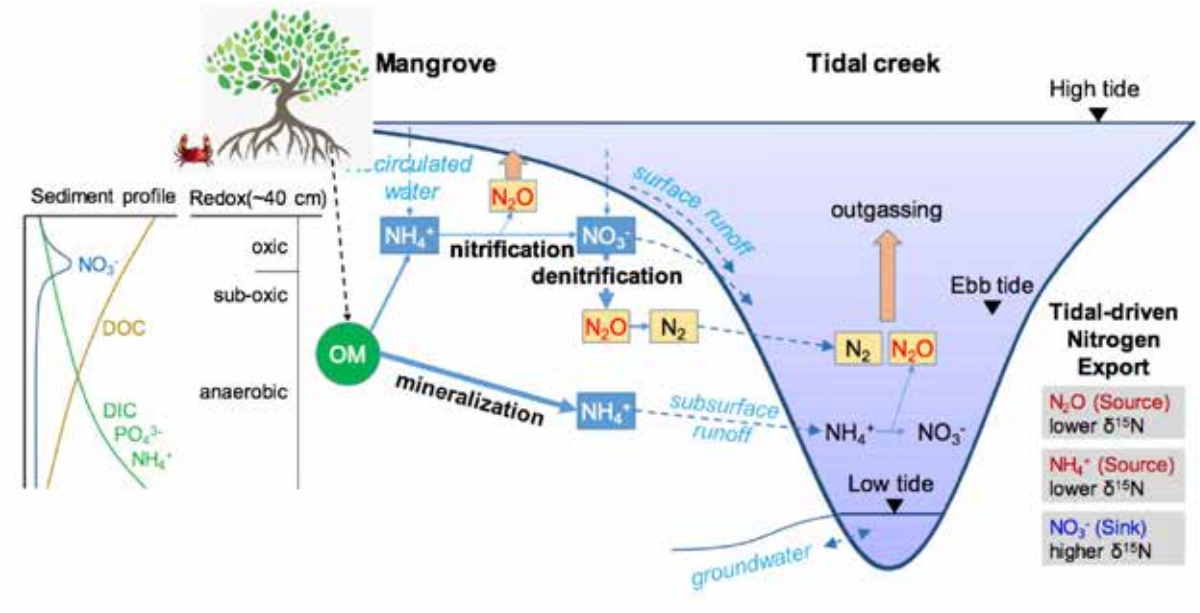
研究关注到红树林沉积物－水界面。沉积物作为地球表层圈层的中心，与水圈、大气圈和生物圈有强烈的相互作用与反馈。在红树林潮沟出口中开展全潮时间序列观测和验证性实验，识别沉积物氮循环的主要过程。在退潮期间发现潮沟中的 NH_4-N 浓度逐渐升高，硝氮浓度无明显变化（略微降低），$\delta^{15}NH_4$-N 和 $\delta^{15}N$-N_2O 逐渐下降，而 $\delta^{15}NO_3$-N 和 $\delta^{18}O$-N_2O 逐渐升高；同时发现水中溶解 N_2 和 N_2O 含量有增加趋势。根据氮形态的这些时序变化规律，可以推测在红树林沉积物中有较强的矿化和反硝化过程，才导致孔隙水中氨氮累积和硝氮去除，退潮时这些高氨氮和低硝氮的孔隙水进入潮沟往河口输出。进一步对潮沟边坡上的柱状沉积物（30-40 cm）进行剖面精细测量，发现中下部沉积物孔隙水中有很高的 NH_4-N 和无机碳（DIC）含量，而硝氮和亚硝氮含量相对河口水低很多。同时发现沉积物的反硝化菌基因丰度也相当高。进一步通过泥浆法培养实验，发现随时间延长 NH_4−N 显著增加，硝氮和有机碳（TOC）减少，气体组分（CO_2,N_2 和 N_2O）增加。这些数据进一步证实红树林沉积物的矿化和反硝化是主要过程。

该项研究通过野外综合观测和室内培养实验，应用精细观测技术、同位素示踪技术和分子生物学技术，从多学科视角初步揭示了红树林中不同形态无机氮（氨氮和硝氮）相对河口的源汇关系和主控过程方面的差异，建立了红树林－河口系统氮循环的概念模型，为后续逐步提升陆海环境系统的科学认知、支撑陆海统筹和红树林湿地保护修复工作提供基础。

以上工作于 2019 年 4 月发表于 *Journal of Geophysical Research: Biogeosciences* 期刊，2016 级硕士生王芬芳为第一作者，陈能汪为通讯作者。

Major processes shaping mangroves as inorganic nitrogen sources or sinks: Insights from a multidisciplinary study

Mangrove wetlands support numerous ecosystem services including nutrient cycling and carbon sequestration and storage (blue carbon). Mangrove sediments may serve as a nitrogen source or sink to the hydrosphere and atmosphere at both regional and global scales. However, major mechanisms controlling the connection between the mangrove and the adjacent tidal creek (nitrogen cycling in sediments and outfluxing) remain unclear. A multidisciplinary study based on intensive investigation, incorporating detailed sediment profiling, multi-isotopes analysis, sediment incubation and microbiological identification was conducted in the Yunxiao mangrove reserve and Zhangjiang Estuary in southeast China. Here we show that mineralization and denitrification are major processes shaping mangroves as an ammonium source and nitrate sink. Enrichment of ammonium in pore water (10-40 cm in depth) likely resulted from strong ammonification with limited nitrification in the anaerobic sediments. Denitrification played a key role in nitrate removal from pore waters while producing N_2O and N_2. Overall, there was a net export of dissolved inorganic nitrogen (DIN) from mangroves toward the estuary in winter and spring but a net import to mangroves in summer and fall, mainly driven by tidal pumping with seasonal variation of bio-uptake. These findings highlight the role of mangrove wetlands in regulating nutrient status and carbon budget in coastal areas, providing theoretical values for wetland protection and management.



水文 - 生地化过程驱动的红树林沉积物 - 潮沟界面营养盐循环与横向交换概念图。
A conceptual schematic of hydrobiogeochemical controls on nitrogen cycling, lateral transport, and greenhouse gases outgassing in the mangrove-creek interfaces.

Reference:
Wang, Fenfang; Chen, Nengwang*; Yan, Jing; Lin, Jingjie; Guo, Weidong; Cheng, Peng; Liu, Qian; Huang, Bangqin; Tian, Yun. Major processes shaping mangroves as inorganic nitrogen sources or sinks: Insights from a multidisciplinary study. *JOURNAL OF GEOPHYSICAL RESEARCH: BIOGEOSCIENCES*. 2019, 124: 1194-1208.

05

近岸海域硅循环对人为干扰的响应

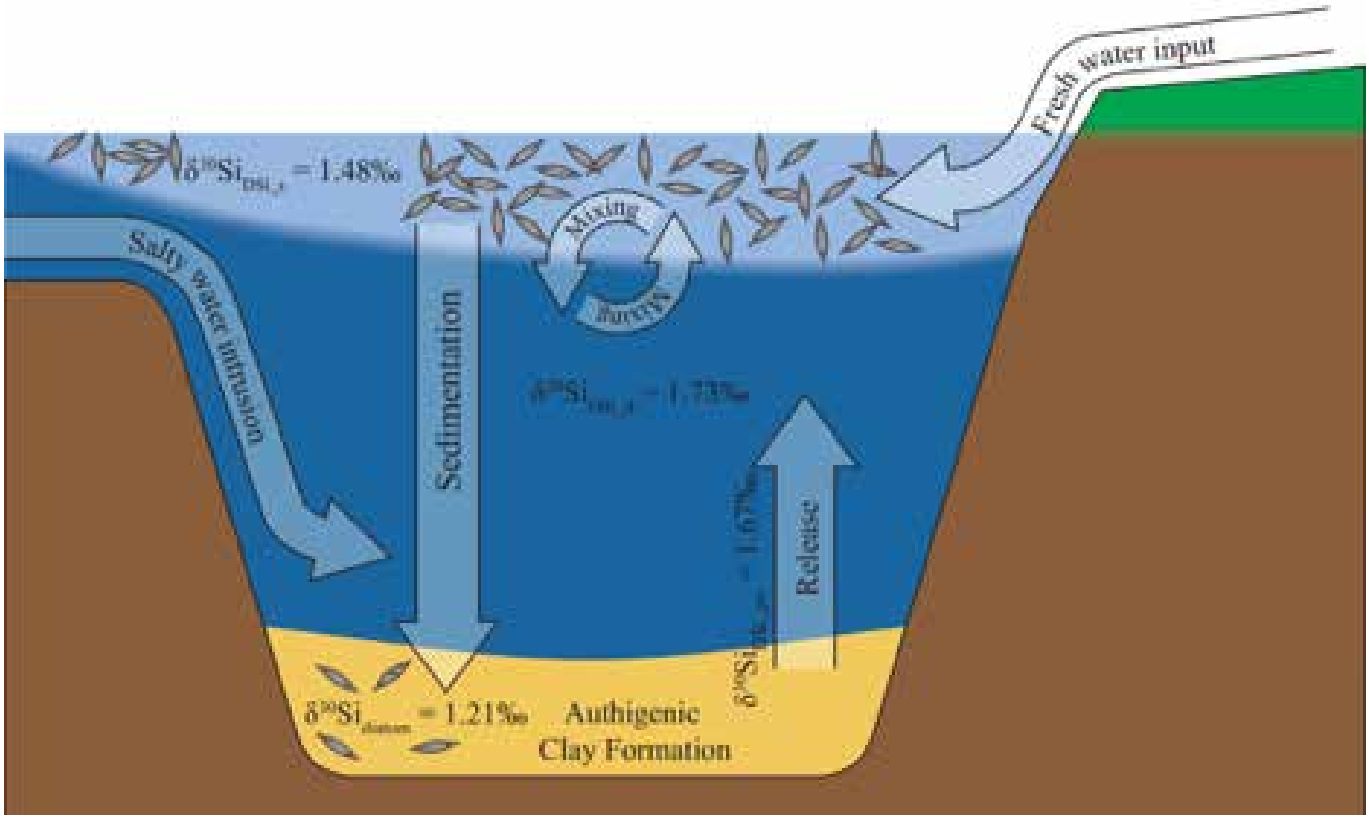
Impact of human disturbance on the biogeochemical silicon cycle in a coastal sea revealed by silicon isotopes

近几十年来，由于气候变化和人为干扰的影响（如富营养化、土地利用变化导致的河流输入的变化），近岸海域硅循环发生了显著变化。自 20 世纪 80 年代以来，在全球近岸海域均观测到硅酸盐（DSi）浓度的大幅降低，研究认为未来在筑坝的持续增加及全球变暖背景下，硅循环将会发生进一步变化，导致近岸海域初级生产和生态系统发生剧烈变化。为强化对未来近岸海域硅循环变化的预测基础，戴民汉课题组与隆德大学 Daniel Conley 课题组以及斯德哥尔摩大学孙晓乐研究员开展合作，张周凌等人以波罗的海为研究案例，通过硅同位素分析手段，结合海区观测与箱式模型，揭示了近岸水体硅循环对人为干扰和环境变化的响应。

研究首先调查波罗的海 DSi 及其硅同位素（$\delta^{30}Si_{DSi}$）的分布特征，观测到中央海盆的 $\delta^{30}Si_{DSi}$ 呈现罕见的垂直分布，即深层水较表层水更重，这一分布违背海水 $\delta^{30}Si_{DSi}$ 表层较重（硅藻生长利用较轻的 DSi）而深层变轻（硅藻溶解释放出较轻的 DSi）的一般分布原则。为探讨这一罕见垂直分布背后的调控机制，研究采用双箱模型对波罗的海 DSi 浓度和 $\delta^{30}Si_{DSi}$ 值的变化进行模拟，模型结果表明工业化前中央海盆的 $\delta^{30}Si_{DSi}$ 呈现正常的垂直分布特征，而工业化时期不同人为干扰和环境变化（包括筑坝、富营养化和层化加强）对硅动态产生较大影响，其中富营养化驱动下强烈的硅的内部循环导致了 $\delta^{30}Si_{DSi}$ 的罕见垂直分布。大量的硅藻生产及输出从表层水向深水输送大量高度分馏的硅，随后沉降的硅藻在沉积物水界面的循环使硅不断溶解在间隙水中并重新释放回深水，而自生粘土矿物形成使间隙水中 DSi 产生分馏携带较重的 $\delta^{30}Si_{DSi}$ 信号，进而最终使深层水的 $\delta^{30}Si_{DSi}$ 重于表层水。

这项研究揭示了人为扰动对波罗的海硅动态的显著影响，暗示在全球变化的背景下，水体 – 沉积物耦合对于海洋生态系统功能的重要性，为预测未来人为干扰及全球变暖下近岸海域硅循环和向开阔大洋输送营养盐的变化提供重要依据。该工作于 2019 年 9 月发表于国际期刊 *Limnology and Oceanography*。2019 届博士生、助理研究员张周凌为第一作者和通讯作者。

Biogeochemical silicon (Si) cycling in coastal systems is highly influenced by anthropogenic perturbations in recent decades. Here, we present a systematic study on the distribution of stable Si isotopes of dissolved silicate ($\delta^{30}Si_{DSi}$) in a highly eutrophic coastal system, the Baltic Sea. Besides the well-known processes, diatom production and dissolution regulating $\delta^{30}Si_{DSi}$ values in the water column, we combined field data with a box model to examine the role of human disturbances on Si cycling in the Baltic Sea. Results reveal that 1) damming led to increased $\delta^{30}Si_{DSi}$ values in water but had little impacts on their vertical distribution; 2) decrease in saltwater inflow due to enhanced thermal stratification had negligible impacts on the $\delta^{30}Si_{DSi}$ distribution. An atypical vertical distribution of $\delta^{30}Si_{DSi}$ with higher values in deep water (+1.57 to +1.95 ‰) relative to those in surface water (+1.24 to +1.68 ‰) was observed in the central basin. Model results suggest the role of enhanced biogenic silica deposition and subsequently regenerated DSi flux from sediments. Specifically, eutrophication enhances diatom production, resulting in elevated exports of highly fractionated biogenic silica to deep water and sediments. In situ sedimentary geochemical processes, such as authigenic clay formation further fractionate Si isotopes and increase porewater $\delta^{30}Si_{DSi}$ values, which then leads to porewater DSi flux carrying higher $\delta^{30}Si_{DSi}$ compositions into deep water. Our findings provide new quantitative information on how the isotope-based Si cycle responds to human perturbations in coastal seas and shed lights on shifts of Si export to open ocean.



富营养化驱动下强烈的硅的内部循环。
Strong internal recycling of Si driven by eutrophication.

Reference:
Zhang, Zhouling*; Sun, Xiaole; Dai, Minhan; Cao, Zhimian; Fontorbe, Guillaume; Conley, Daniel. Impact of human disturbance on the biogeochemical silicon cycle in a coastal sea revealed by silicon isotopes. *LIMNOLOGY AND OCEANOGRAPHY*. 2019. DOI:10.1002/lno.11320.

06

海洋中被低估的铁来源——近海沉积物

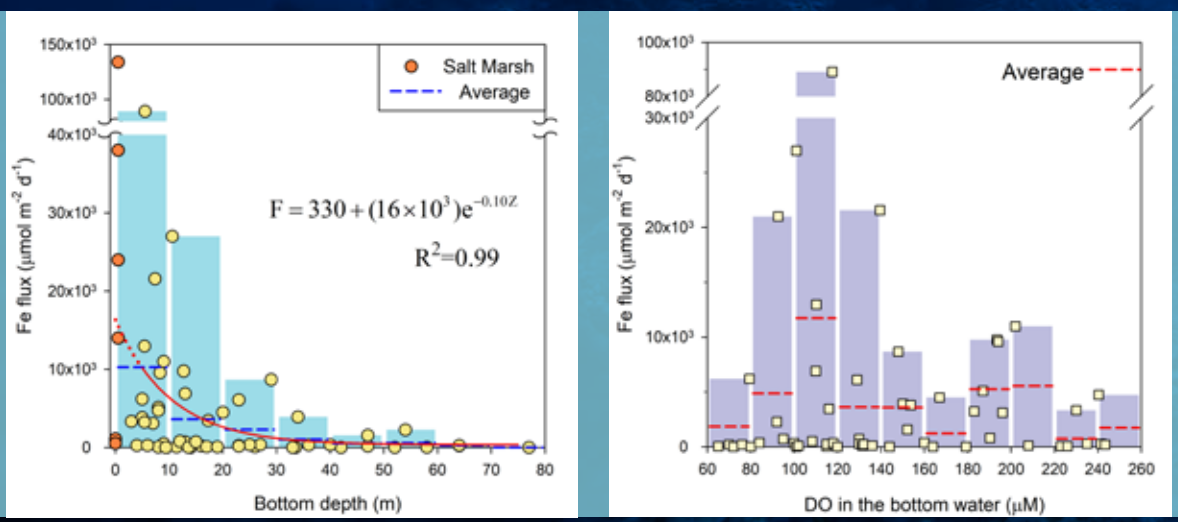
铁（Fe）是海洋中维持初级生产力不可缺少的痕量元素，“铁假说”更将其视作调节地球冰期–间冰期更替的控制因子，因此厘清海洋中 Fe 的源汇格局对认识 Fe 在海洋固碳，甚至全球气候变化中的调节机制至关重要。尽管越来越多的研究认识到海洋沉积物可能是 Fe 的重要来源之一，但囿于传统定量方法，目前已有的全球海洋 Fe 模型中，所使用的沉积物 – 水界面 Fe 的交换通量相差 1-2 个量级，直接影响海洋中 Fe 停留时间的估算。

本研究首先利用课题组自主发展的 $^{224}Ra/^{228}Th$ 不平衡法，对沉积物 – 水界面溶解态 Fe 的交换进行定量估算。早期研究已证实该方法可在不干扰原位环境的条件下，准确定量氧化还原敏感物质在沉积物 – 水界面间的交换。研究汇总了中国主要河口及浅海陆架沉积物 – 水界面的 Fe 交换通量，并与水深、底部溶解氧含量（DO）等环境因子对比分析，发现：1）沉积物 Fe 通量和界面水交换速率均随着水深的增加呈指数下降的趋势，与沉积物有机质的耗氧速率的变化趋势一致，表明沉积物中有机质的降解可能增加了沉积物中溶解态 Fe 的来源，而沉积物所在的水动力环境是影响界面 Fe 释放效率的关键因素；2）沉积物 – 水界面铁通量的高值多出现在 DO 为 100-150 μmol/L 的范围内，表明沉积物中溶解态 Fe 的释放是界面动力作用和氧化屏障相互制约的结果。

本研究还归纳比较了全球不同近岸海域（底部深度 <100 m）采用其他方法得到的沉积物 Fe 通量，发现 $^{224}Ra/^{228}Th$ 不平衡法较过去基于原位培养法得到的 Fe 通量高 30 倍，揭示出原位培养方法在定量 Fe 交换时存在的固有偏差，表明原有海洋中 Fe 的收支平衡需要重新评估。

本研究准确定量近海沉积物对海水 Fe 的贡献，并揭示了沉积物释放 Fe 的过程机理，不仅为全球近海 Fe 的来源研究提供了可靠方法和理论基础，同时定量阐释了近海沉积物对开阔大洋 Fe 的重要贡献。

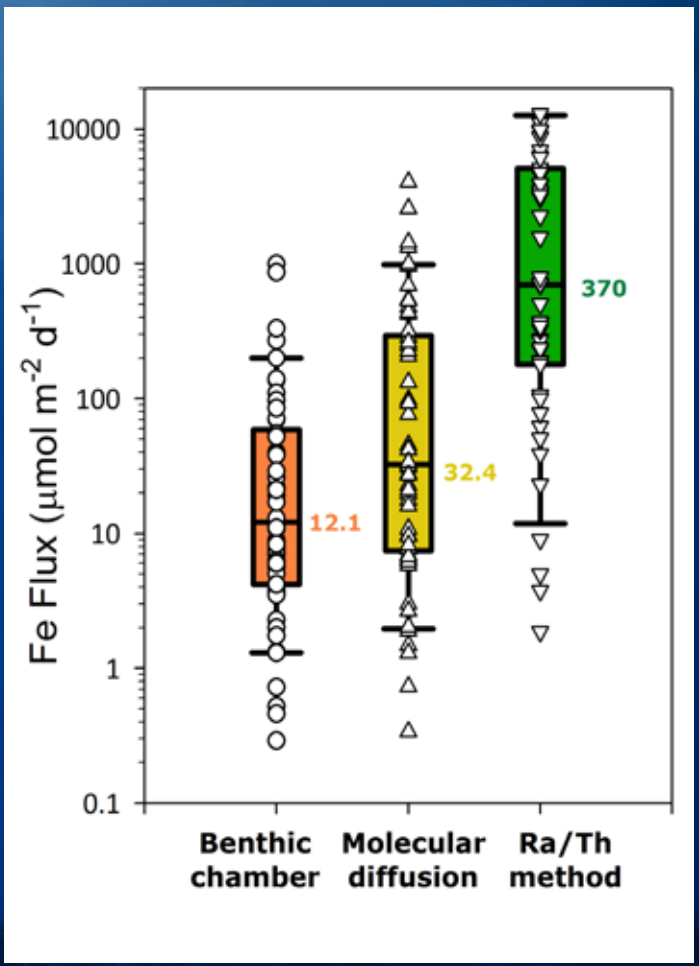
以上工作于 2019 年 9 月发表于 *Geochimica et Cosmochimica Acta* 期刊，2019 届博士生史向明（现为 University of Connecticut 博士后）为第一作者，蔡平河为通讯作者。



Fe 通量与环境因子的关系。
Relationship between benthic Fe fluxes and environmental factors.

The underrated source of global Fe budget — Coastal sediments

We report benthic flux estimates of Fe from China coastal seas based on a recently developed $^{224}Ra/^{228}Th$ disequilibrium approach. There were considerable temporal and spatial variabilities in benthic Fe fluxes, which spanned over 4-5 orders of magnitude, from <10 μmol m^{-2} d^{-1} up to ~100 mmol m^{-2} d^{-1}. Nonetheless, we have identified a prominent trend in China coastal seas showing that benthic Fe fluxes tended to decline exponentially with bottom depth. This trend is probably a result of kinetic energy and chemically bound energy gradients that culminate in the coastal seas. In the meantime, large benthic Fe fluxes were more frequently observed within a narrow redox window of 100-150 μM dissolved oxygen (DO) in the bottom water. This observation contradicts an early assumption that iron release from continental margin sediments increases with decreasing DO concentration in the bottom water. It possibly reflects a compromise of oxygen-demanded irrigation that acts to enhance Fe release from bottom sediments, and re-oxidation of dissolved Fe(II) that results in more efficient Fe retention near the sediment-water interface. Notably, benthic fluxes of Fe based on 224Ra/228Th disequilibria were an order of magnitude larger than those derived from the porewater concentration gradient method. Moreover, the isotopic estimates were >30 times higher than the historical measurements based on the traditional incubation method (i.e., the benthic chamber method) in other coastal seas. However, our estimates of benthic Fe flux were in general agreement with the reported flux value based on a new two-dimensional imaging technique.



不同方法间的比较。
Comparison between different methods.

Reference:
Shi, Xiangming; Wei, Lin; Hong, Qingquan; Liu, Lingfeng; Wang, Yuning; Shi, Xueying; Ye, Ying; Cai, Pinghe*. Large benthic fluxes of dissolved iron in China coastal seas revealed by $^{224}Ra/^{228}Th$ disequilibria. *GEOCHIMICA ET COSMOCHIMICA ACTA*, 2019(260): 49-61.

07 微型生物碳泵理论和相关内容纳入IPCC海洋与冰冻圈特别报告

2019 年 9 月 25 日，联合国政府间气候变化专门委员会（IPCC）发布了《气候变化中的海洋和冰冻圈特别报告》（以下称《报告》）。报告指出，海洋覆盖了地球表面的 71%，包含地球近 97% 的水。地球上同时还有约 10% 的土地覆盖着冰川或冰盖，海洋和冰冻圈支持独特的生境，并通过水和碳与气候系统的其他组成部分相互联系。《报告》强调了海洋和冰冻圈对人类文明和可持续发展的重要性，评估了温室气体排放等人类活动对海洋生态系统、冰冻圈和气候变化影响的现状，并在总结全球研究成果的基础上提出了减缓和适应的对策，包括焦念志院士提出的“微型生物碳泵（Microbial Carbon Pump, MCP）”原创理论和应用方案。

在应对气候变化、减少风险对策方面，《报告》指出：MCP 储碳机制将碳转化为可在海洋中长期储存的难降解溶解有机物质，维持了海洋中高达 7000 亿吨的巨大有机碳库，对气候变化产生缓冲和调节作用。MCP 理论揭示：减少陆源营养盐向海洋输送，将有利于富营养化河口和近海增加碳汇，并缓解赤潮、缺氧、酸化等环境问题。该陆海统筹生态工程为保障近海生态系统可持续发展指明了研发方向。

《报告》列举了基于 MCP 理论引导的应用案例。气候变暖将加剧海水成层效应，导致上层水体营养盐不足和下层营养盐过剩，这不仅不利于储碳，且当台风扰动时，大量营养盐的突然释放就像“炸弹”一样引发赤潮、并发一系列生态环境问题。通过采用绿色能源（太阳能、风能、波浪能等）驱动的人工上升流调节水柱营养盐余缺，不仅为上层海藻光固碳提供营养，同时缓释底层富营养。该生态工程尤其适合中国国情：养殖业是我国海洋经济的重要组成部分，对于供给食品、增加就业、保障民生有重要意义，但养殖活动常引发富营养化、缺氧、酸化、导致底栖动物消亡，相关环境问题被长期诟病。基于 MCP 原理的生态工程提供了缓解上述环境问题和增加碳汇的一揽子方案，并为我国在碳交易和气候谈判等方面的国际话语权提供了科技支撑。

鉴于 MCP 的重要性，《报告》还在 “名词解释”中对 MCP 作了概念阐释。

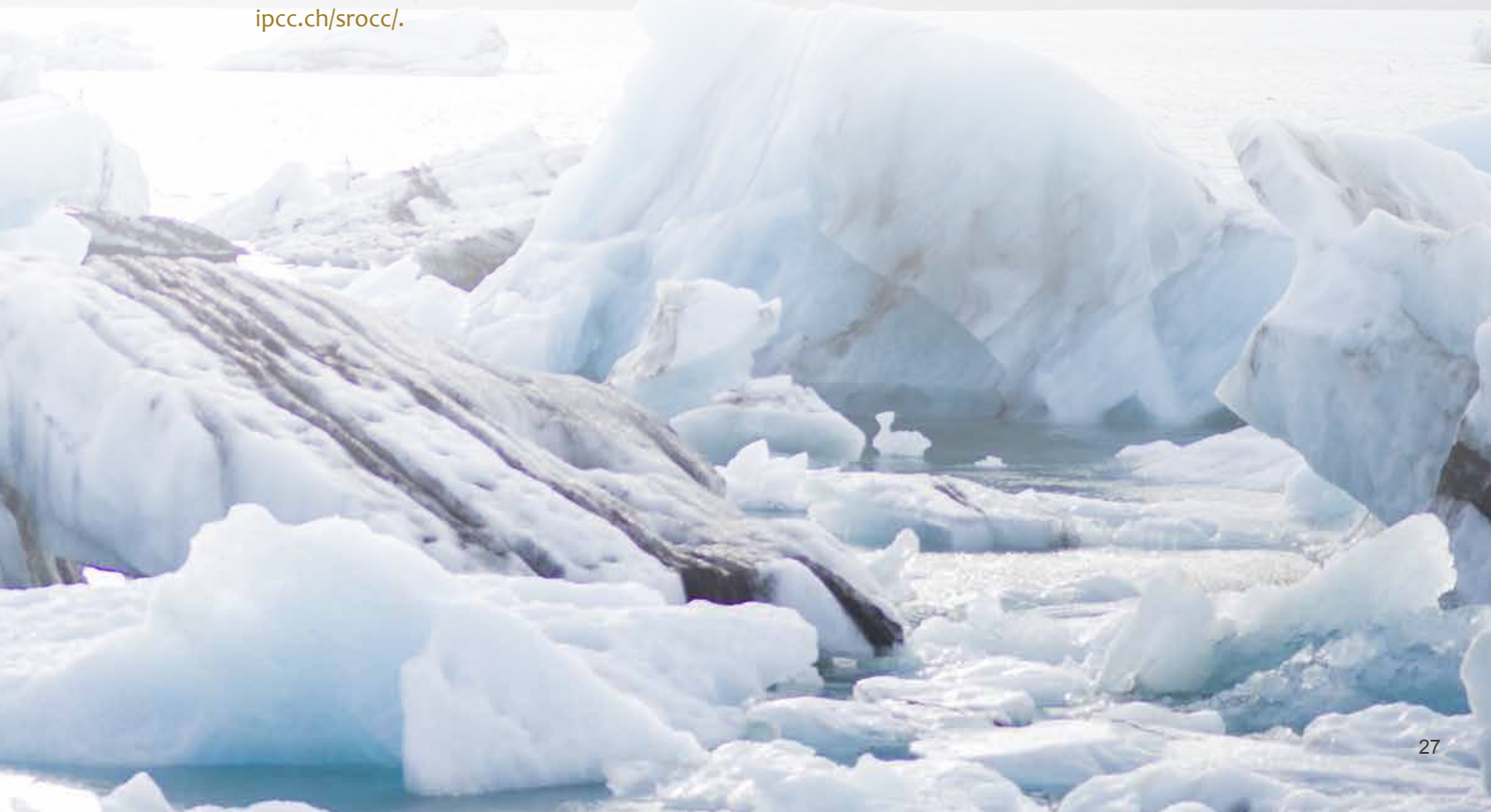
报告原文：https://www.ipcc.ch/srocc/

The Microbial Carbon Pump Concept and relative adaptions included in the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate

On September 25 2019, the Intergovernmental Panel on Climate Change (IPCC) published its Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), which is the first Special Report about the ocean. The SROCC highlights the importance of ocean and cryosphere for climate change and proposes countermeasures for mitigation and adaptation based on the current knowledge and recent research progresses, including the concept of microbial carbon pump (MCP) proposed by Nianzhi Jiao. The MCP produces refractory dissolved organic carbon with long residence time in the ocean, maintaining a huge carbon reservoir that is equivalent in amount to the total inventory of atmospheric CO_2, and thus of significance in regulation of climate changes.

Based on the MCP principle, a land-sea integrated eco-engineering scheme is proposed, i.e., increasing carbon sequestration in the coastal waters by reducing fertilization on the land, which also has multiple co-benefits of mitigation of eutrophication, algal blooms, hypoxia and ocean acidification. The SROCC also gives an example of MCP based eco-engineering adaptation solution for seaweed aquaculture, i.e., artificial upwelling powered by green energy (solar, wind, wave or tidal energy) which can moderate the amount of deep water upwelled to the euphotic zone to just meet the demands of nutrients by the seaweed for photosynthesis, while avoiding the acidification and hypoxia that often occur in natural environments. The artificial upwelling based eco-engineering also gradually release the 'bomb' of rich nutrients and hypoxia in the bottom water, which could otherwise breakout following storms.

The MCP concept has also been illustrated in the Glossary. Further details can be found at: https://www.ipcc.ch/srocc/.

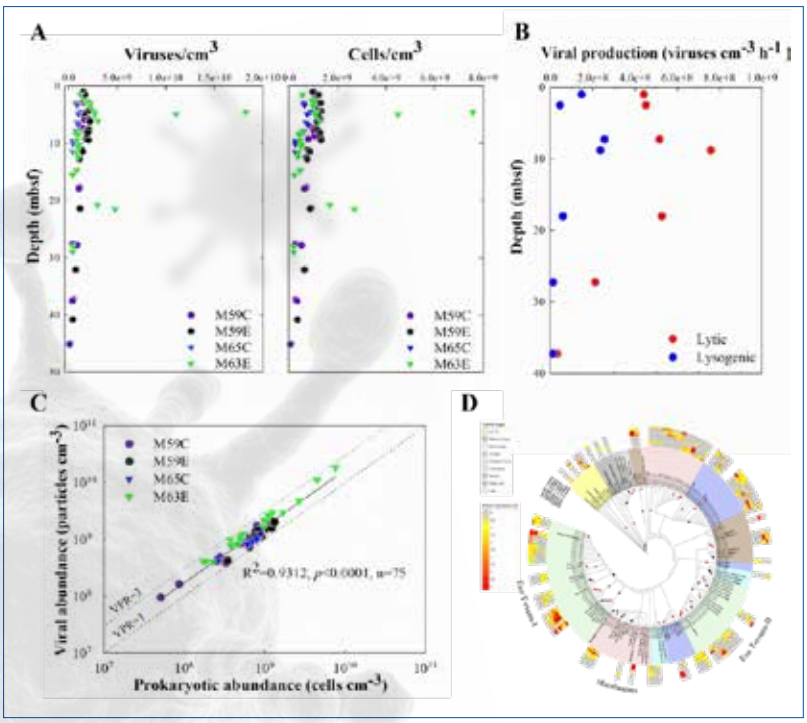


08

深部生物圈病毒的活性和多样性

Active and diverse viruses persist in the deep sub-seafloor sediments over thousands of years

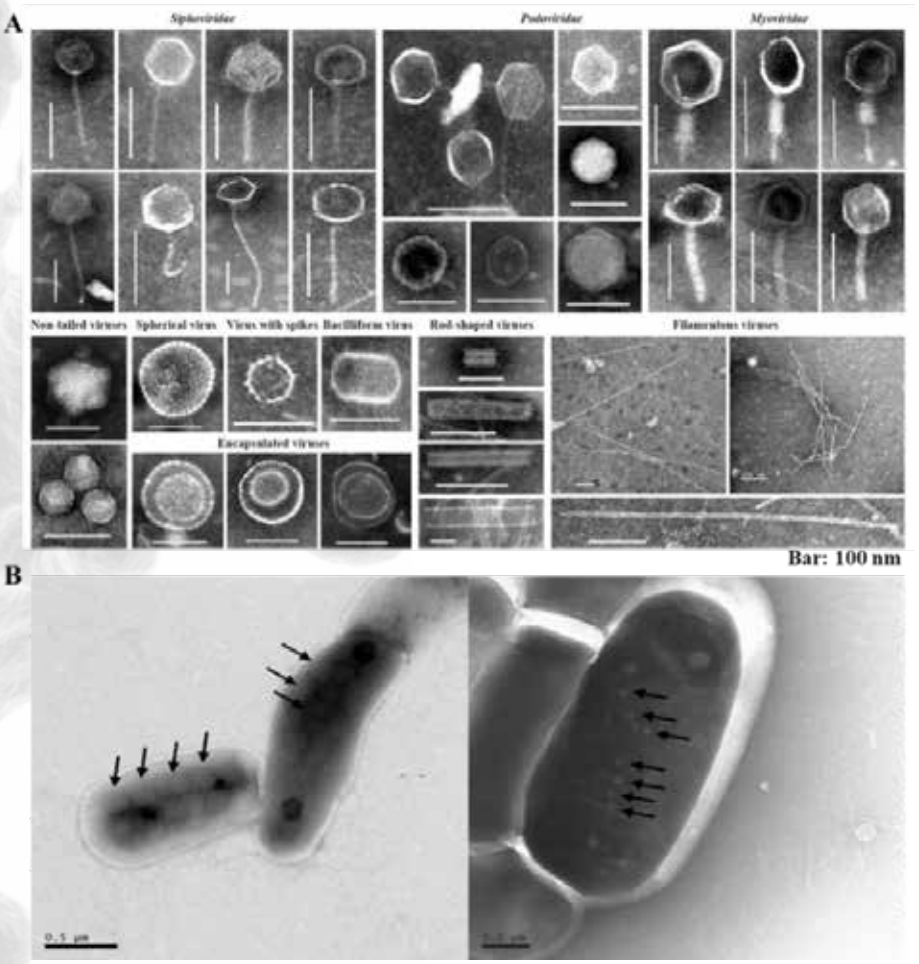
作为海洋生态系统中数量最多的生物类群，海洋病毒在调控海洋水体和表层沉积物微生物群落结构、影响宿主多样性和驱动海洋生物地球化学循环等方面发挥着巨大的作用。然而迄今为止，关于病毒在深部生物圈这一地球上最大的生态系统中的研究还十分有限，为数不多的研究主要局限在病毒的丰度调查上，甚至连其活性都缺乏直接的实验证据，极大地限制了人们对海洋深部生物圈生态系统的认识。该研究借助国际大洋钻探计划 IODP 347 航次，通过考察不同沉积条件下波罗的海沉积物垂直剖面上病毒的丰度、形态、裂解性和溶源性生产力以及 T4 类噬菌体的多样性，系统研究了深部生物圈中病毒的分布、活性、生存策略、多样性等生态特性及其与环境因子的相互关系，并成功捕捉到深部生物圈原位状态下微生物细胞内的完整病毒颗粒，首次提供了深部生物圈病毒原位侵染、复制、组装的直接证据，为解决学术界长期以来关于深部病毒生态功能的争议奠定了基础；首次定量了深部生物圈病毒的活性，发现溶源性生产力只占总病毒生产力的 5.83 - 33.20%，对传统的认识（深部极端环境中病毒倾向于溶源性生存策略）提出了挑战。在沉积物中，除了观察到多种水体环境中典型的有尾噬菌体形态结构外，还检测到丝状、杆状、纺锤状等不常见的病毒类群颗粒。同时，通过分子手段发现，沉积物中 T4 类噬菌体主要分为海洋类群、土壤类群、淡水类群和未知类群，且在数千年的沉积物中发现了大量蓝细菌病毒序列，验证了深部生物圈的病毒群落来源于上层水体的外来沉降和深部环境的原位产生。研究表明，深部生物圈中病毒丰富多样且具有较高的活性，病毒裂解作用对维持深部生物圈中微生物活动和种群大小以及深部生物圈的生物地球化学循环具有重要贡献。



以上研究于 2019 年 7 月发表于 *ISME Journal* 上，第一作者为博士后蔡兰兰，焦念志与张锐为共同通讯作者。

深部生物圈病毒的分布、活性和多样性。其垂直分布与宿主和营养条件密切相关（A、C），其高活性主要表现为裂解性生产（B），其多样性来自原位产生和上层水体沉降（D）。

Depth profiles of microbial abundance (A) and viral production (B), and viral diversity based on g23 gene (D).



深部生物圈病毒形态多样性（A）及微生物细胞内的病毒颗粒（B）。
Transmission electron micrographs showing the morphologies of virus-like particles (A) and infected cells (B) in the deep sediments of the Baltic Sea.

Viruses are ubiquitous and cause significant mortality in marine bacterial and archaeal communities. Little is known about the role of viruses in the sub-seafloor biosphere, which hosts a large fraction of all microbes on Earth. We quantified and characterized viruses in sediments from the Baltic Sea. The results show that the Baltic Sea sub-seafloor biosphere harbors highly abundant viruses with densities up to 1.8 x 10^{10} viruses cm^{-3}. High potential viral production down to 37 meters below seafloor in ca. 6000-years-old sediments and infected prokaryotic cells visible by transmission electron microscopy demonstrate active viral infection. Morphological and molecular data indicate that the highly diverse community of viruses includes both allochthonous input from the overlying seawater and autochthonous production. The detection of cyanophagelike sequences showed that viruses of phototrophic hosts may persist in marine sediments for thousands of years. Our results imply that viruses influence sub-seafloor microbial community dynamics and thereby affect biogeochemical processes in the sub-seafloor biosphere.

Reference:
Cai, Lanlan; Jorgensen, Bo B.; Suttle, Curtis A.; He, Maoqiu; Cragg, Barry A.; Jiao, Nianzhi[#*]; Zhang, Rui[#*]. Active and diverse viruses persist in the deep sub-seafloor sediments over thousands of years. *ISME JOURNAL*, 2019, 13, 7:1857-1864.

09

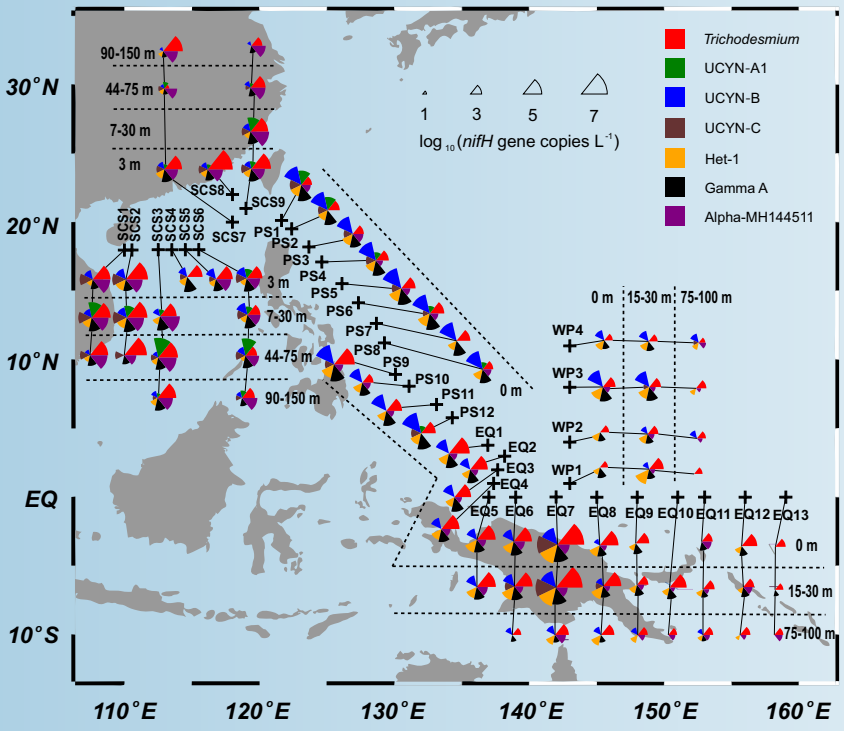
西太大尺度跨系统固氮菌群的生物地理学分布格局及其控制机理

Biogeographic drivers of diazotrophs in the western Pacific Ocean

氮是海洋水体中最关键的营养要素之一，是海洋初级生产力的重要控制因子。但目前的估计显示海洋的氮收支过程并不平衡，具体表现为通过反硝化和厌氧氨氧化过程释放的氮远大于固氮作用固定的氮。产生这个不平衡的重要原因可能是我们目前对海洋固氮类群的多样性、地理学分布格局及各类群对固氮速率的贡献仍然知之甚少。

研究选取了南海北部、吕宋海峡、菲律宾海及西热带太平洋的大尺度多系统海域作为研究区域，对比研究了迄今发现的七种主要固氮类群的生物地理学分布格局及其控制机理，同时结合固氮速率测定，探讨它们对区域固氮过程的贡献。结果显示：

（1）这些固氮类群表现出了不同的空间及时间分布模式：束毛藻（*Trichodesmium*）是南海和西赤道太平洋区域最主要的固氮类群，而单细胞蓝藻 UCYN-B 则是菲律宾海最优势的固氮种群，分别贡献了区域较高的固氮速率。同时，*Trichodesmium* 和 UCYN-B 展现出了相反的固氮基因（*nifH*）转录表达模式，*Trichodesmium* 在白天表达 *nifH* 基因，而 UCYN-B 在夜间表达 *nifH* 基因；除蓝藻之外，异养固氮类群 Gamma A 也广泛分布于西太平洋，它与 UCYN-B 有着相似的生态位，而且在某些区域，Gamma A（或者其他异养固氮类群）可能贡献了较高的固氮速率；

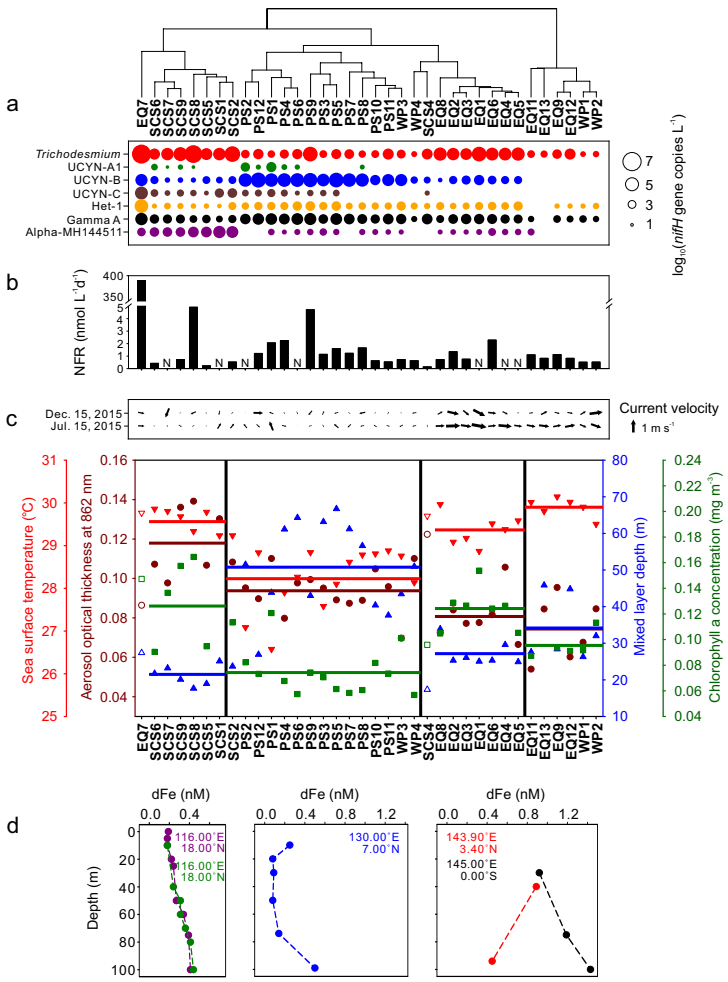


西太海域七种主要固氮种群的分布模式。
nifH gene abundance distribution of the seven targeted major diazotrophic groups in the western Pacific Ocean obtained by quantitative PCR.

（2）结合大尺度环境因子的分析表明，温度、气溶胶光学厚度、叶绿素浓度、洋流流速及混合层深度都能够影响固氮类群的生物地理学分布格局，这些环境因子本质上反映了铁（Fe）元素的输入程度及其生物可利用性。因此，Fe 是控制区域大尺度固氮种群生物地理学分布格局的决定因素。

该研究阐明了热带 – 亚热带西太平洋海域固氮种群的生物地理学分布格局及其控制机理，证实了 Fe 元素对固氮种群分布的重要影响，为进一步了解固氮各种群在全球海洋氮循环中的贡献提供了参考。

以上工作于 2019 年 1 月发表于 *Limnology and Oceanography* 期刊。陈明明为第一作者，张瑶为通讯作者。



a. 根据七种固氮种群的表层丰度进行的层次聚类；b. 各站位表层的固氮速率；c. 各站位对应的表层洋流流速、海表温度、气溶胶厚度、叶绿素浓度以及混合层深度数据；d. 各海域溶解铁浓度。

(a) Hierarchical clustering dendrogram of the surface N_2-fixing communities based on the *nifH* gene abundance (log transformed) of seven diazotrophic groups; (b) the corresponding NFRs of these communities; (c) the biogeochemical conditions including the absolute geostrophic velocity (current velocity), sea surface temperature, aerosol optical thickness at 862 nm, mixed layer depth, and *Chl* a concentration of these stations; and (d) the dissolved Fe concentrations obtained from previous studies (Wen et al. 2006; Kondo et al. 2007; Slemons et al. 2010; Labatut et al. 2014).

The global budget of marine nitrogen (N) is not balanced, with N removal largely exceeding N fixation. One of the major causes of this imbalance is our inadequate understanding of the diversity and distribution of marine N_2 fixers (diazotrophs) as well as their contribution to N_2 fixation. Here, we performed a large-scale cross-system study spanning the South China Sea, Luzon Strait, Philippine Sea, and western tropical Pacific Ocean to compare the biogeography of seven major diazotrophic groups and N_2 fixation rates in these ecosystems. Distinct spatial niche differentiation was observed. *Trichodesmium* was dominant in the South China Sea and western equatorial Pacific, whereas the unicellular cyanobacterium UCYN-B dominated in the Philippine Sea. Furthermore, contrasting diel patterns of *Trichodesmium nifH* genes and UCYN-B *nifH* gene transcript activity were observed. The heterotrophic diazotroph Gamma A phylotype was widespread throughout the western Pacific Ocean and occupied an ecological niche that overlapped with that of UCYN-B. Moreover, Gamma A (or other possible unknown/undetected diazotrophs) rather than *Trichodesmium* and UCYN-B may have been responsible for the high N_2 fixation rates in some samples. Regional biogeochemistry analyses revealed crosssystem variations in N_2-fixing community composition and activity constrained by sea surface temperature, aerosol optical thickness, current velocity, mixed-layer depth, and chlorophyll a concentration. These factors except for temperature essentially control/reflected iron supply/bioavailability and thus drive diazotroph biogeography. This study highlights biogeographical controls on marine N_2 fixers and increases our understanding of global diazotroph biogeography.

Reference:
Chen, Mingming; Lu, Yangyang; Jiao, Nianzhi; Tian, Jiwei; Kao, Shuh-Ji; Zhang Yao*. Biogeographic drivers of diazotrophs in the western Pacific Ocean. *LIMNOLOGY AND OCEANOGRAPHY*. 2019 (64): 1403-1421.

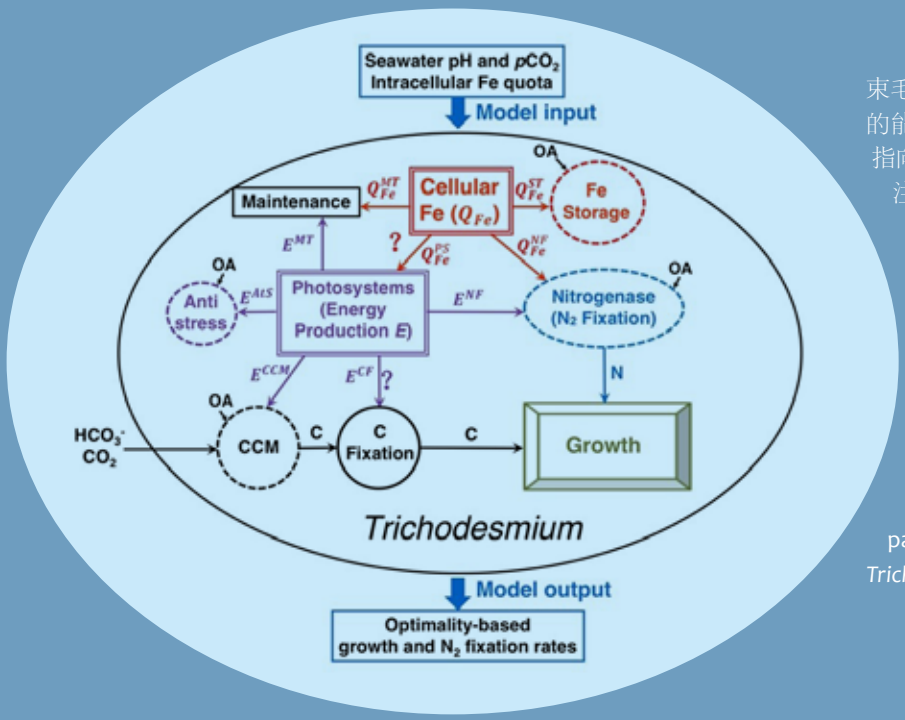
10 固氮酶效率下降主导了全球重要的固氮蓝藻——束毛藻——对海洋酸化的响应

工业革命以来，海洋吸收了约三分之一人为排放的 CO_2，以迄今 3 亿年来最快的速度酸化（CO_2 升高、pH 下降），这势必影响海洋生态系统的关键过程和功能。全球面积一半以上海洋的初级生产力受氮营养盐缺乏的限制，而优势固氮蓝藻束毛藻是寡营养海区中氮的重要来源，可贡献高达 50% 的海洋总固氮量。因此，束毛藻对海洋酸化的响应将可能显著影响海洋的初级生产力和气候调节功能。然而，国际上就酸化对束毛藻的影响存在截然相反的研究发现，且原因不明，这将影响对未来海洋碳、氮生物地球化学循环的准确认识和预测。

针对这一备受关注却悬而未决的科学问题，史大林在前期的研究中发现酸化会抑制束毛藻的固氮作用，并且铁限制条件将加剧该负效应；而先前报道的酸化对束毛藻固氮的促进作用，很可能是因人工海水培养基受金属和氨的污染所导致的假象。

在上述研究工作的基础上，史大林团队与罗亚威紧密合作，进一步系统地测定了固氮和光合系统蛋白的表达量及其含铁量，建立了一个束毛藻的“资源最优化分配”细胞模型。该模型模拟束毛藻胞内铁和能量如何在无机碳吸收、光合作用、固氮作用、生命维持、对抗酸化协迫、铁储藏等各主要生理过程之间的最优化分配，以最大化其生长速率；并且模拟了海洋酸化对几个主要生理过程的调控，包括 CO_2 浓缩机制（CCM）耗能的减少、固氮酶效率的下降、抗酸化胁迫耗能的上升、以及铁储藏的减少。以胞内铁水平以及海水 pH 和 CO_2 浓度为输入变量，该模型即可求解胞内铁和能量的最优化分配以及对应的最大化生长和固氮速率。

以上成果于 2019 年 4 月发表于 *Nature Communications* 期刊上，罗亚威与史大林为共同第一作者和共同通讯作者。

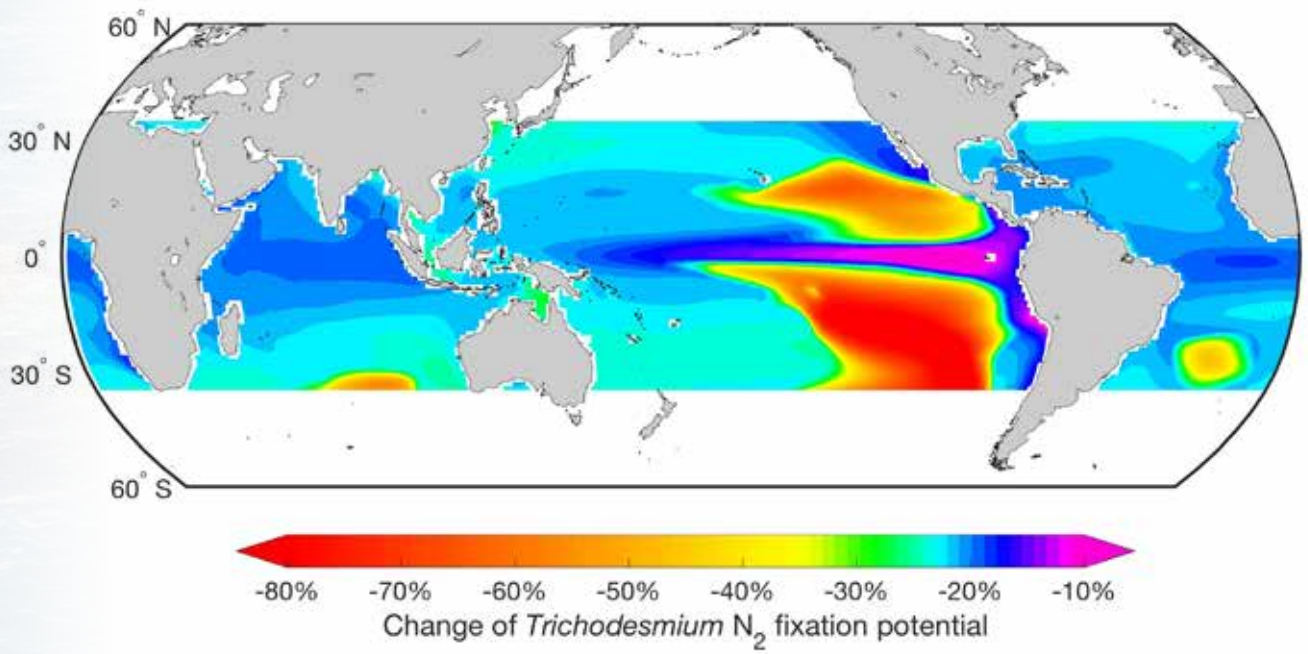


束毛藻细胞模型结构。胞内的铁（红色）和生成的能量（紫色）被分配到不同的细胞过程。OA 指向的虚线圈代表被海洋酸化所影响的过程。标注问号的两个箭头代表模型需要优化以最大化束毛藻生长速率的两个参数。

Trichodesmium cellular model structure. The intracellular Fe (red) and produced energy (purple) are allocated to different cellular processes. The dashed circles and ellipses pointed by OA indicate processes that are influenced by ocean acidification. The two flows with question mark represent unknown parameters to be optimized to maximize *Trichodesmium* growth.

Reduced nitrogenase efficiency dominates response of the globally important nitrogen fixer *Trichodesmium* to ocean acidification

The response of the prominent marine dinitrogen (N_2)-fixing cyanobacteria *Trichodesmium* to ocean acidification (OA) is critical to understanding future oceanic biogeochemical cycles. Recent studies have reported conflicting findings on the effect of OA on growth and N_2 fixation of *Trichodesmium*. Here, we quantitatively analyzed experimental data on how *Trichodesmium* reallocated intracellular iron and energy among key cellular processes in response to OA, and integrated the findings to construct an optimality-based cellular model. The model results indicate that *Trichodesmium* growth rate decreases under OA primarily due to reduced nitrogenase efficiency. The saved cellular energy from downregulation of the carbon dioxide (CO_2)-concentrating mechanism under OA has very little enhancement on *Trichodesmium*. The energy demand of anti-stress responses to OA has a moderate negative effect. The cellular-level model runs in global OA environment projected by an Earth System Model under RCP 8.5, a scenario if anthropogenic CO_2 emissions continue to rise. The results show that OA could reduce global N_2 fixation potential of *Trichodesmium* by 27% in this century, with the largest decrease in iron-limiting regions particularly the Southeast Subtropical Pacific.



预测的 1990 年代到 2090 年代束毛藻固氮潜力的相对变化。
The projected relative change of *Trichodesmium* N_2 fixation potential from 1990's to 2090's.

Reference:
Luo, Ya-Wei[*#]; Shi, Dalin[*#]; Kranz, Sven A.; Hopkinson, Brian M.; Hong, Haizheng; Shen, Rong; Zhang, Futing. Reduced nitrogenase efficiency dominates response of the globally important nitrogen fixer *Trichodesmium* to ocean acidification. *NATURE COMMUNICATIONS*, 2019.10,1521.

11

Frontiers专刊：海洋微生物、群落及其生态功能对环境梯度变化的响应

从河口到边缘海和开阔大洋，从热带暖池到亚热带环流和极地冰冻圈，从阳光充足的真光层到昏暗的中层水和漆黑的深海深渊区，从水体到沉积物和深部生物圈，海洋生态系统经历着不同的环境梯度。除这些大尺度梯度外，海洋中（特别是河口、近岸浅海和边缘海），各种理化因子的小尺度和微尺度梯度也很常见。物理化学参数、营养物质和作为电子供体和电子受体的化学物质的不同梯度有助于生境异质性的形成，沿着梯度的不同环境可能为微生物创造了独特的生态位。

地球及其微生物群落的共进化决定了单个微生物及其所组成的群落对环境变化的响应能力。尽管微生物用于响应环境变化的机制和过程是高度多样化和复杂的，但遵循已建立的生物学和生态学等原理，因此是可以进行分析和解密的。实验技术和研究策略的不断进步，例如高频率采样、足够多的实验重复、长期连续调查、深度测序、系统分析和建模等，将有助于最终揭示海洋生态系统中微生物世界的奥秘。该研究策略和前景分析，将有助于海洋微生物及其功能分析项目的深入开展和持续进行。

2019 年 2 月，党宏月联合三名同行学者，在 Frontiers 组织论文专辑《海洋微生物、群落及其生态功能对环境梯度变化的响应》。该论文集旨在突出一些在该研究方向的近期主要发现，研究涵盖了从微生物代谢动力学到微尺度、小尺度和宏观地理大尺度海洋梯度中碳、氮、硫和铁的生物地球化学循环的广泛主题，包括：（1）微生物对能量代谢物质及其动态变化的生态能学响应；（2）微生物群落对自然梯度和人为梯度的响应及其对海洋碳、氮、硫、铁循环的影响；（3）微生物对环境梯度和变化的响应的调节过程和机制。

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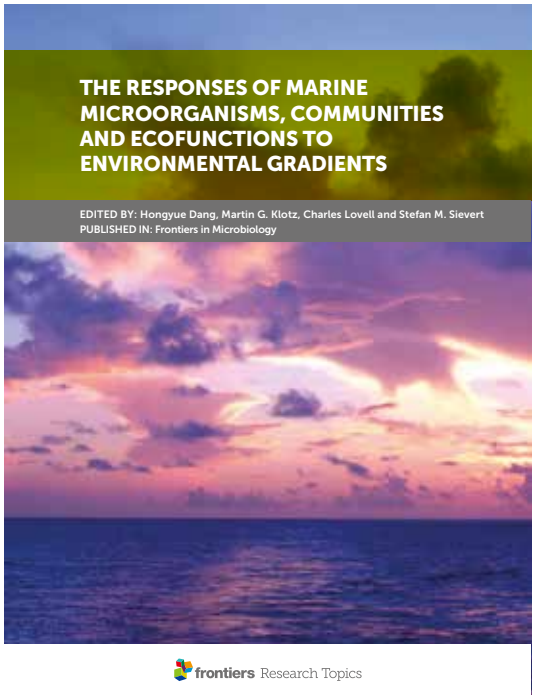
Special topic in Frontiers: The responses of marine microorganisms, communities and ecofunctions to environmental gradients



From estuaries to marginal seas and open oceans, from tropical warm pools to subtropical gyres and polar cryospheres, from sunlit surface water to twilight zone and pitch-black abyssopelagic water, from water columns to sediments and deep subseafloor biospheres, marine ecosystems experience diverse environmental gradients. In addition to these large-scale gradients, small-scale, and micro-scale gradients of various physicochemical factors are common in the ocean; in particular, in marginal seas and coastal environments. The diverse gradients of physicochemical parameters, nutrients, and chemicals serving as electron donors and acceptors contribute to the creation of habitat heterogeneity and novel locales along a gradient may create unique niches for any given microorganism. The characterization of how the abundance and spatial distribution of marine microorganisms, the structure of microbial communities and their provided ecosystem functions respond to the diverse environmental gradients is of fundamental importance to our understanding of the microbial ecology and biogeochemistry of the oceans. With the progress of marine molecular microbial ecology and "omics" techniques, certain environmental keystone microorganisms have been discovered at some of these interfaces. Continuing advancement of experimental techniques and protocols, such as those with high sampling frequency and sufficient replicates, long-term surveys, deep sequencing, systematic analyses and modeling will eventually help to reveal the mysteries of the microbial world in aquatic systems.

Aiming to highlight some of the main findings, Hongyue Dang, together with Martin G. Klotz, Charles R. Lovell and Stefan M. Sievert, organized a special session in the Frontiers Microbiology in February 2019, contributed by a total of 21 publications covering a wide variety of subjects spanning from microbial metabolic dynamics to biogeochemical cycling of C, N, S, and Fe in micro-, small-, and geographic-scale marine gradients, including 1) Microbial ecoenergetic responses to energy sources and dynamics, 2) Microbial community responses to natural and anthropogenic gradients and their impacts on marine C, N, S and Fe cycling; 3) Regulation of microbial responses to environmental gradients and variations.

Reference:
Dang, Hongyue*; Klotz, Martin G.; Lovell, Charles R.; Sievert, Stefan M. The responses of marine microorganisms, communities and ecofunctions to environmental gradients. *FRONTIERS MEDIA*. DOI: 10.3389/978-2-88945-807-3.

12

建立生态位周期表解析和预测浮游植物群落对多重环境变化的响应

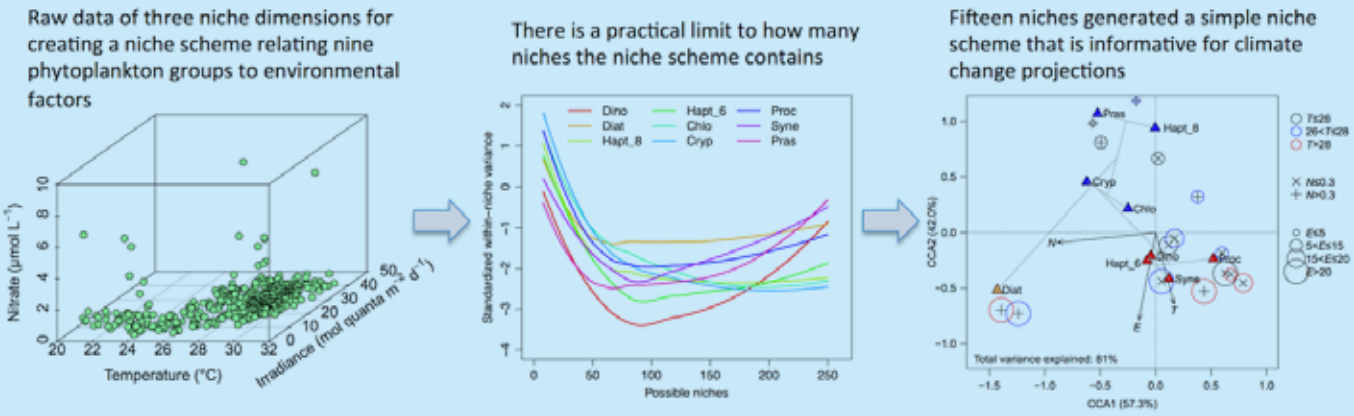
Using periodic table of niches to explain and predict the responses of phytoplankton communities to multiple environmental changes

随着全球变暖，海洋上混合层温度和光强增高，营养盐减少，定鞭藻 8 型、青绿藻、隐藻和绿藻这几类冷型浮游植物的相对丰度会降低。硅藻的变化取决于营养条件，在高营养水体中，如近岸、强混合的陆架以及富营养的羽流（亦称冲淡水），硅藻会受益于光强的升高，而在中营养和寡营养水体中，如层化的陆架和寡营养的外海水，其相对丰度都会随营养盐的进一步下降而降低。原绿球藻、聚球藻、甲藻和定鞭藻 6 型这几类暖型浮游植物的相对丰度会升高。其中原绿球藻和聚球藻可能受益最明显，这两大类群的相对竞争力也取决于环境条件。在中营养水体中，如层化的陆架、强混合的外海水以及中营养的羽流，聚球藻的优势大于原绿球藻，而在层化的寡营养水体中，原绿球藻的优势大于聚球藻。

预测浮游植物群落对全球变暖的响应是生态预测的挑战之一，其中一个制约因素是缺乏适用于群落生态学的一般原则。黄邦钦课题组基于南海十年尺度的浮游植物群体生态学数据集，通过多种机器学习手段及实际生态位性状分析，阐明了南海浮游植物群落结构的变化是各类群在温度、光照和营养盐浓度之间权衡的结果。

同时，通过开发选择最佳生态位数量和生态位边界的生态位划分方案，结合数据简化、排序和分类等多变量方法，建立了一个由温度、光强和营养盐组成的图示化三维生态位周期表，将浮游植物群落组成与 15 个三维生态位相关联。该生态位周期表将浮游植物群落划分为三种类型：高光高营养盐、冷型和暖型，其中冷型浮游植物类群的生态位主要通过光强区分，而暖型类群的生态位主要通过营养盐进一步分离。该生态位周期表符合一般生态学理论的假设，并证明以往的个体生态学（autecology）研究结论存在偏差，可有效解析和预测浮游植物群落对多重环境变化的响应。

以上成果分别于 2018 年 3 月及 2019 年 8 月发表于 *Progress in Oceanography* 及 *Water Research* 期刊上，博士后肖武鹏为第一作者，黄邦钦为通讯作者，柳欣为后者共同通讯作者。



浮游植物生态位划分方案及生态位周期表示意图。

Schematic diagram of phytoplankton niche classification scheme and periodic table of niches.

Predicting changes of phytoplankton communities in response to global warming is one of the challenges of ecological forecasting. One of the constraints is the paucity of general principles applicable to community ecology. Based on a synecological analysis of a decadal-scale database in the South China Sea, we showed that variations of major phytoplankton groups in this system can be explained by different adaptive trade-offs to constraints imposed by realized niche-based traits of temperature, irradiance, and nutrient concentrations. We also created a periodic table of niches relating nine phytoplankton groups to fifteen statistically refined realized niches comprised of these three niche dimensions based on a systematic niche classification scheme, which was useful to explain and predict the responses of phytoplankton communities to multiple environmental changes.

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Xiao, Wupeng; Wang, Lei; Laws, Edward; Xie, Yuyuan; Chen, Jixin; Liu, Xin; Chen, Bingzhang; Huang, Bangqin*. Realized niches explain spatial gradients in seasonal abundance of phytoplankton groups in the South China Sea. *PROGRESS IN OCEANOGRAPHY*. 2018. DOI: 10.1016/j.pocean.2018.03.008.

Xiao, Wupeng; Laws, Edward A.; Xie, Yuyuan; Wang, Lei; Liu, Xin#*; Chen, Jixin; Chen, Bingzhang; Huang, Bangqin#*. Responses of marine phytoplankton communities to environmental changes: New insights from a niche classification scheme. *WATER RESEARCH*. 2019, 166. DOI: 10.1016/j.watres.2019.115070

13

定量蛋白质组学揭示现场甲藻藻华期间不同细胞周期时相发生的重要分子事件

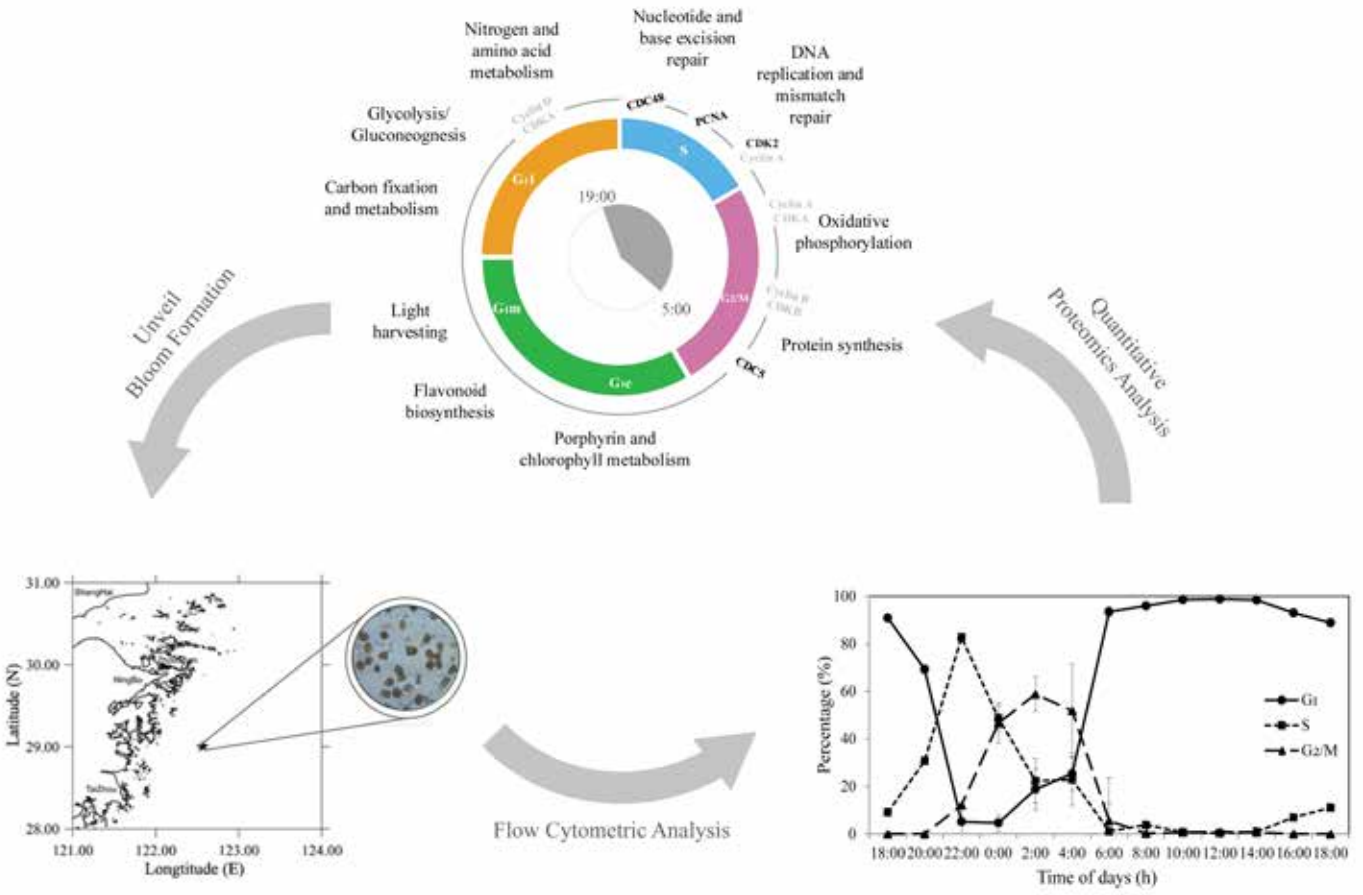
Quantitative proteomics reveals the key molecular events occurring at different cell cycle phases of the *in situ* blooming dinoflagellate cells

甲藻是海洋生态系统最重要的初级生产者之一，也是引发有害藻华的最主要类群。研究表明，全球变化背景下海洋甲藻藻华的发生频率、扩散范围和持续时间都显著提高，有毒有害甲藻藻华研究已成为一个全球性热点。有关甲藻藻华发生机制已开展多方面研究并提出了多种假设。但由于海洋环境的复杂性和藻华物种的遗传差异性，对海洋甲藻藻华发生的深层次机制的了解仍非常有限。基于甲藻藻华的发生是细胞快速增殖的结果，而细胞增殖又受到细胞周期的调控，张浩、王大志等人聚焦海区现场甲藻藻华，采集藻华期间典型细胞周期时相甲藻细胞，运用定量蛋白质组学方法，解析了甲藻细胞周期推进过程中的蛋白质表达模式和关键生物学过程，探讨甲藻藻华发生的分子机制。

通过对藻华高发区长达半个月的现场追踪调查，在东海原甲藻藻华爆发站位进行 24 小时的定点采样。显微观察和色素谱系分析结果表明，24 小时光暗周期内东海原甲藻细胞生物量一直占据绝对优势，超过 73.4%，而白天正午时分其细胞密度最高，体现了甲藻的趋光性和垂直昼夜迁移特性。细胞流式检测结果表明，东海原甲藻细胞 24 小时内完成一个完整的 G_1-S-G_2/M 的细胞周期，与其他真核生物的细胞时相分布类似，且细胞同步率达到 82% 以上。现场环境条件下细胞时相分布和各时相时长与实验室内最佳培养条件下的一致，且受到光暗周期调控。这些结果表明海区现场东海原甲藻细胞并未发生变异，细胞维持正常的细胞周期时相分布，并未发生爆发性增殖。

基于流式细胞分析结果，分别采集 G_1、S 和 G_2/M 典型时期的样品进行定量蛋白质组学研究，解析了各时相的重要生物学过程，发现 G_1 期早期细胞光合作用、色素和叶绿素合成高表达，主要进行光能捕获和能量储备以满足后续过程能量需求；G_1 期后期碳氮代谢和氨基酸代谢等过程高表达，主要合成重要物质为细胞分裂做储备；S 期 DNA 复制和失配修复等过程高表达，以保证基因的精准遗传；G_2/M 期蛋白质合成和氧化磷酸化等过程高表达，且鉴定到最高丰度的组蛋白。此外，鉴定到东海原甲藻在 S 期显著高表达 PCNA 和 CDK2 蛋白以保证 S-G_2/M 时期的平稳过渡。本研究加深了我们对现场海区甲藻藻华爆发期间细胞周期和细胞生长的认识，为揭示甲藻藻华发生机制和藻华的预警防治等提供了理论支持。

以上工作于 2019 年 4 月发表于 *Science of the Total Environment* 期刊，张浩和刘九玲为共同第一作者，王大志为通讯作者。



东海原甲藻藻华期间细胞周期进程中的重要生物学过程及细胞周期调控蛋白。
The major biological processes and key cell cycle regulation proteins during the cell cycle progression of *in situ* blooming cells of the dinoflagellate *P. donghaiense.*

Dinoflagellate blooms are the results of rapid cell proliferation governed by cell cycle, a highly-ordered series of events that culminates in cell division. However, little is known about cell cycle progression of the *in situ* blooming cells. Here, we compared proteomes of the *in situ* blooming cells of a dinoflagellate *Prorocentrum donghaiense* collected at different cell cycle phases. The blooming P. *donghaiense* cells completed a cell cycle within 24 hrs with a high synchronization rate of 82.7%. Proteins associated with photosynthesis, porphyrin and chlorophyll synthesis, carbon, nitrogen and amino acid metabolisms exhibited high expressions at the G_1 phase; DNA replication and mismatch repair related proteins were more abundant at the S phase; while protein synthesis and oxidative phosphorylation were highly enriched at the G_2/M phase. Cell cycle proteins presented similar periodic diel patterns to other eukaryotic cells, and higher expressions of proliferating cell nuclear antigen and cyclin dependent kinase 2 at the S phase ensured the smooth S-G_2/M transition. Strikingly, four histones were first identified in P. donghaiense and highly expressed at the G_2/M phase, indicating their potential roles in regulating cell cycle. This study presents the first quantitative survey, to our knowledge, of proteome changes at different cell cycle phases of the *in situ* blooming cells in natural environment and provides insights into cell cycle regulation of the blooming dinoflagellate cells.

Reference:
Zhang, Hao[#]; Liu, Jiuling[#]; He, Yanbin, Xie, Zhangxian; Zhang, Shufei; Zhang, Yong; Lin, Lin; Liu, Siqi; Wang, Dazhi[*]. Quantitative proteomics reveals the key molecular events occurring at different cell cycle phases of the *in situ* blooming dinoflagellate cells. *SCIENCE OF THE TOTAL ENVIRONMENT*, 2019, 676: 62-71.

14

环境污染物苯并(a)芘BaP对海洋鱼类的分子免疫毒性机制

The molecular immunotoxic mechanism on marine fish upon exposure to BaP

海洋环境中富含多种不同类型的污染物，许多研究已报道污染物对海洋动物有免疫毒性效应。污染物对海洋动物免疫反应的影响是否与免疫因子一样通过类似的信号通路调控？诱导或抑制免疫基因的表达调控机制是什么？是值得阐明的毒理学相关的科学问题。基于前期研究，以海洋模式生物海水青鳉（*Oryzias melastigma*）为实验动物，以海洋鱼类中普遍存在的一种重要先天性免疫因子—抗菌肽 hepcidin 为代表，通过研究典型污染物多环芳烃 BaP 致毒性效应的信号调控通路，发现 BaP 通过 JAK-STAT 通路调控 OM-hep1 的表达，而 BaP 暴露产生的持续性低浓度 ROS 抑制了 NF-κB 通路激活。该系列研究在分子水平上揭示了 BaP 对海洋鱼类的分子免疫毒性机制，对于深入理解污染胁迫与海洋鱼类健康生存的关系具有重要意义。

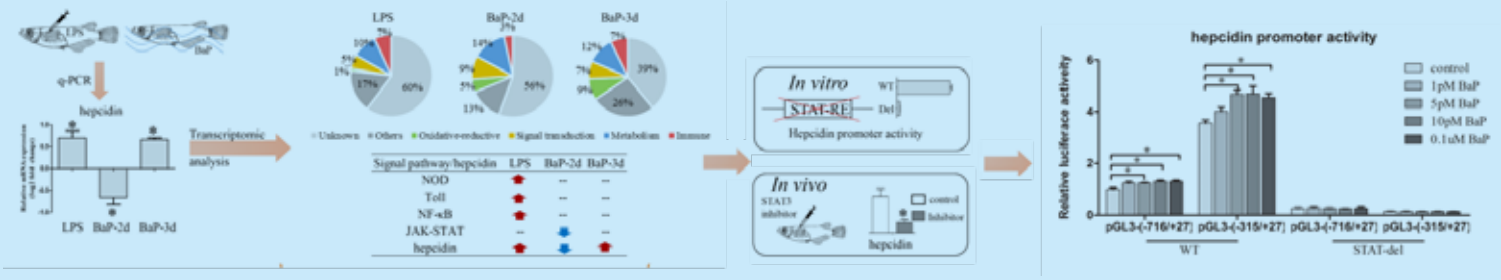
转录组学揭示青鳉暴露 BaP 后 hepcidin 基因的表达是通过信号通路 JAK-STAT 介导的

本实验室前期报道真鲷抗菌肽 hepcidin 在 LPS 刺激或 BaP 暴露下都能显著被诱导，但两者诱导的 hepcidin 转录表达是否由同一条信号通路介导一直未知。为了阐明其分子机制，以模式生物青鳉为实验动物，以 BaP 暴露及 LPS 刺激的样本进行转录组测序。转录组数据分析发现，与 LPS 不同，BaP 暴露下半数以上的免疫相关基因下调表达；LPS 刺激可诱导 NOD，TOLL 和 NF-κB 等信号通路上调表达，而 BaP 暴露 2 d 后信号通路 JAK-STAT 被抑制。进一步通过细胞转染 hepcidin1 启动子质粒，并以 BaP 暴露，检测了 BaP 对 hepcidin 的调控通路，发现 BaP 暴露能够有效诱导野生型 hepcidin1 启动子的表达，但对删除 STAT3 调控元件的 hepcidin1 启动子无诱导能力。研究表明，与 LPS 不同，BaP 对 hepcidin 的调控与 JAK-STAT 通路相关。

BaP 暴露产生的持续性低浓度活性氧（ROS）抑制海水青鳉的免疫信号通路 NF-κB

NF-κB 是生物体内重要的信号通路之一，参与多种免疫反应。BaP 暴露通常产生活性氧（ROS），但 ROS 是否影响 NF-κB 的调节作用迄今尚未明确。为揭示 BaP 的毒性效应与免疫信号通路 NF-κB 的关系，开展了海水青鳉体内试验和青鳉肝细胞的体外试验。青鳉体内试验表明 BaP 暴露导致 NF-κB 下调表达，而 ROS 水平升高；相反，用惯用的 H_2O_2 方法（ROS 检测）在青鳉肝细胞 DIT-29 上的体外试验发现 NF-κB 上调表达；据此是否认为 BaP 暴露产生的 ROS 与 NF-κB 的调节无关？但抑制试验发现，ROS 抑制剂可抑制 BaP 引起的 NF-κB 下调表达，表明 ROS 参与了 NF-κB 的调节。体内和体外试验对 NF-κB 的影响显著差异的原因，推测可能与 ROS 产生的浓度和持续时间有关；这种推测通过 a modified luminol detection system 进行 BaP 暴露得到验证，发现 BaP 暴露可持续产生生理学浓度的 ROS，维持 24 h，而添加 H_2O_2 虽会迅速产生高浓度 ROS，但仅维持 30 min。基于这些试验与前人的研究，改良了 ROS 的检测系统与表达系统（H_2O_2ss），在 H_2O_2ss 系统上 H_2O_2 可以维持 24 h。比较试验发现，H_2O_2ss 处理和 BaP 暴露产生的 ROS 结果一致，都能抑制 NF-κB 的表达，而传统的直接 H_2O_2 暴露结果相反，该结果通过 western-blot 和 EMSA 检测验证。本项研究首次揭示了 BaP 暴露后产生的持续性低浓度 ROS 抑制了免疫信号通路 NF-κB 的活性。

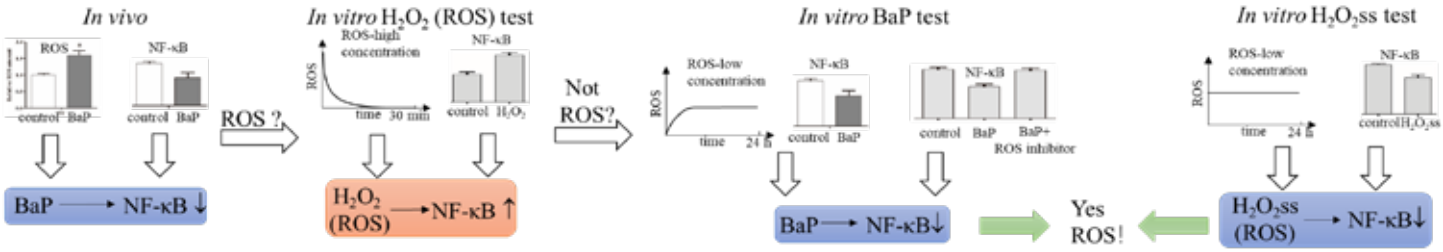
以上工作于 2019 年分别发表于 *Aquatic Toxicology* 和 *Environmental Pollution* 期刊，博士生崔倩为第一作者，王克坚为通讯作者。



(*Aquat Toxicol*, 2019.)

Our previous study revealed that an antimicrobial peptide hepcidin, can be significantly up-regulated either with LPS challenge or upon exposure to Benzo[a]pyrene (BaP) in red sea bream, but the molecular mechanism involved in whether the transcriptional expression of hepcidin induced by LPS or BaP is regulated through a similar signaling pathway is not yet known. To elucidate the underlying molecular mechanism, the marine model fish *Oryzias melastigma* was exposed to 1 μg/L BaP as well as challenged with 5 μg of LPS per fish. Samples at 3 h post-LPS challenge, and 2 d and 3 d post-BaP exposure were separately collected for transcriptome analysis. Specific comparative analyses of the immune-associated signal pathways NOD, TOLL, NF-κB and JAK-STAT with LPS challenge or upon exposure to BaP, indicated that most of the modulated genes in association with the NOD, TOLL and NF-κB pathways were induced with LPS challenge but only a few after exposure to BaP, suggesting that BaP exposure was generally not associated with any of the three signal pathways. Interestingly, further transcriptomic analysis revealed that 5 of the 8 modulated genes associated with the JAK-STAT pathway were down-regulated, while 2 inhibiting genes were up-regulated after BaP exposure for 2 days whereas LPS challenge resulted in only less than half modulated, suggesting the possibility of down-regulation caused by BaP exposure through JAK-STAT pathway. Further testing using an EPC cell culture demonstrated that expression of the hepcidin1 gene was less involved in the known signal pathways, such as c/EBP, BMP, and NF-κB, but instead mostly in association with the JAK-STAT pathway upon BaP exposure.

Benzo[a]pyrene (BaP), a common environmental pollutant, can modulate the immune-associated signal pathway NF-kB, which is one of the critical signal pathways involved in various immune responses. BaP exposure usually generates reactive oxygen species (ROS), but whether ROS are predominantly involved in the modulation mechanism of the NF-kB pathway has not been clearly understood. In this study, an in vivo examination of *Oryzias melastigma* demonstrated that BaP exposure led to a down-regulation of the NF-kB pathway and increased levels of ROS. Conversely, in vitro results using the medaka liver cell line DIT-29 and a widely applied H_2O_2 method showed the opposite: up-regulation of the NF-kB pathway. However, the down-regulation of NF-kB upon BaP exposure in vitro was inhibited by the addition of a ROS inhibitor, indicating ROS are involved in the modulation of NF-kB. The discrepancy between in vivo and in vitro results of ROS impacts on NF-kB activation might be related to the concentration and persistence of ROS. Using a modified luminol detection system, BaP was found to generate sustained physiological concentrations of ROS for 24 h, while an H_2O_2 bolus generated ROS for less than 30 min. Furthermore, a steady-state sub-micromolar H_2O_2 system (H_2O_2ss) was developed in parallel as a positive control of ROS, by which H_2O_2 could be maintained for 24 h. Comparative evaluation using H_2O_2, H_2O_2ss and BaP exposures on the medaka cell line with pGL4.32 demonstrated that the persistent physiological concentrations of ROS generated upon BaP exposure or treatment with H_2O_2ss inhibited the NF-kB pathway, but direct H_2O_2 exposure had the opposite effect. Moreover, a western-blot assay and EMSA detection further confirmed the modulation of the NF-kB pathway in DIT-29. Taken together, this study shows that BaP exposure inhibits the NF-kB pathway by generating sustained physiological concentrations of ROS.



(*Environ Pollut*, 2019.)

Cui, Qian; Chen, Fang-Yi; Zhang, Min; Peng, Hui; Wang, Ke-Jian* . Transcriptomic analysis revealing hepcidin expression in *Oryzias melastigma* regulated through the *JAK-STAT* signaling pathway upon exposure to BaP, *AQUATIC TOXICOLOGY*, 2019, 206: 134-141.

Cui, Qian; Chen, Fang-Yi; Chen, Hui-Yun; Peng, Hui; Wang, Ke-Jian* . Benzo[a]pyrene (BaP) exposure generates persistent reactive oxygen species (ROS) to inhibit the NF-κB pathway in medaka (*Oryzias melastigma*), *ENVIRONMENTAL POLLUTION*, 2019, 251: 502-509.

15

应用高时空分辨遥感平台助力沿岸防灾减灾

Application of high spatial and temporal resolution remote sensing platform to help coastal disaster prevention and mitigation

藻华是一种常见的自然灾害现象，当在沿岸爆发时，常常危害生态环境和人类社会的生产生活，造成巨大经济损失。如何对其进行有效的监测与预测，成为全球性的关注热点。卫星观测是监测大空间尺度藻华的唯一有效手段。然而，目前在轨运行的卫星往往时空分辨率低，不能满足及时有效监测藻华发生发展的需求。

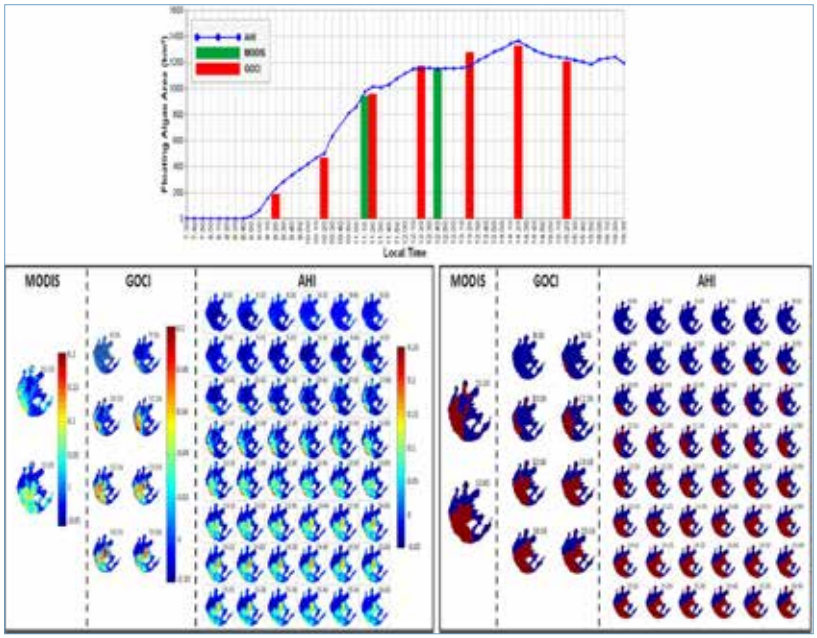
光学海洋学研究组及时注意到日本新近发射的气象卫星 Himawari-8/AHI。Himawari-8 卫星作为静止气象卫星，其优势是获取地球全圆盘图的频率为每 10 分钟一次。Himawari-8 上搭载有先进的葵花成像仪 AHI，它有 8 个可见光、1 个近红外和 2 个短波红外通道，具备对海洋水色进行高时效性的连续观测潜力。团队新近成功实现了其大气校正，计算获得漂浮藻类指数 (FAI)，确定太湖水域探测阈值为 -0.008，漂浮蓝藻探测结果与水色界常用的 MODIS 和 GOCI 卫星的结果高度一致；同时 AHI 超高频率的监测结果表明，其在太湖（例如梅梁湖）的一部分水域中监测到了比 GOCI 所获取结果更频繁的漂浮藻类暴发情况（60% vs. 40%）。该方法不仅可以对漂浮藻类藻华现象进行定性识别与定量分析，更可以依据超高的观测频率对藻华的日变化进行一个近连续性的观测，以捕捉到其他卫星如韩国水色静止卫星 GOCI，在监测藻华过程中可能遗漏的变化细节。

因此，AHI 提供了更大的可能性和更好的机会来观察生态系统中的动态事件和偶然事件，这不仅对于生态环境监测富有重要意义，且对于科学上更好地理解藻类动态变化也极为重要。同时，Himawari-8/AHI 的空间覆盖范围超出现有的静止水色卫星，预期 Himawari-8/AHI 将在更多内陆水域、沿海生态系统以及大洋开阔海域的环境监测与科学研究中发挥巨大作用。最关键的是，马尾藻、团扇藻等漂浮藻类威胁核电取水，实验室提供的超高频率的 Himawari-8 卫星观测已经在 2018 年 4 月博鳌论坛期间监测海南昌江核电遭遇的大型藻类侵袭发挥作用。未来融合多传感器拓展该技术的应用，对于及时预警、使得核电厂得以及时采取措施应对，减轻损失，具有重大意义。

以上成果于 2019 年 6 月发表于 *Remote Sensing of Environment*，2019 届硕士生陈新荣是第一作者，商少凌为通讯作者。

Reference:

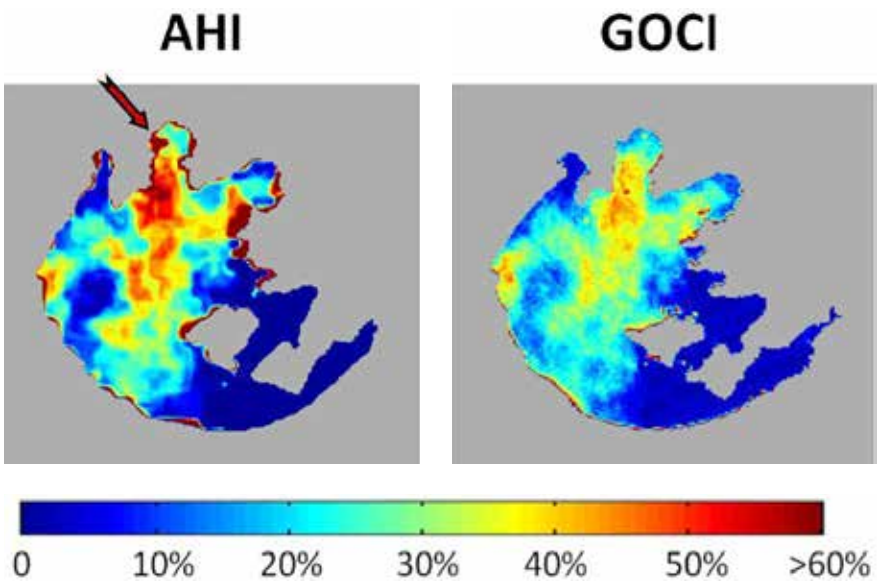
Chen, Xinrong; Shang, Shaoling*; Lee, Zhongping; Qi, Lin; Yan, Jing; Li, Yonghong. High-frequency observation of floating algae from AHI on Himawari-8. *REMOTE SENSING OF ENVIRONMENT*. 2019, 227:151-161.



2017年11月23日太湖漂浮藻类面积的日变化，蓝点与蓝色曲线表示Himawari-8/AHI FAI的观测结果；绿色红色分别表示GOCI AFAI和MODIS FAI的观测结果。下图为2017年11月23日太湖漂浮藻类分布，左图为FAI/AFAI图像，右图为二值图。

(Top) Diurnal change of the area of floating algal patches in Lake Taihu on November 23, 2017. Blue dot and curve: area derived from AHI FAI; red bar: area derived from GOCI AFAI; green bar: area derived from MODIS. (Bottom) Distribution of floating algae in Lake Taihu on November 23, 2017, with the FAI/AFAI images (left) and the binary images (right). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Himawari-8 (H8) is a geostationary meteorological satellite launched by JAXA (Japan Aerospace Exploration Agency) and is now operated by JMA (Japan Meteorological Agency). It takes measurements at a temporal resolution of 10 min for full disk view. Although designed as a meteorological satellite, the Advanced Himawari Imager (AHI) onboard H8 has three visible (460, 510 and 640 nm), one near infrared (860 nm) and two shortwave infrared bands (1610 and 2257 nm) to observe the Earth system. In this study, the Floating Algae Index (FAI) developed for ocean color satellites (Hu, 2009) is adapted to process AHI data for the first time and applied for waters of Lake Taihu, China. For a total of 18 near-cloud-free images, a correlation coefficient (r) of 0.92 was obtained between the algae area derived from AHI FAI and that from the Moderate Resolution Imaging Spectroradiometer (MODIS) FAI, and the mean percentage difference is similar to 5% in algae coverage. More concurrent images (n = 80) were collected for a comparison between AHI and Geostationary Ocean Color Imager (GOCI), as GOCI is also a geostationary satellite, resulting in a correlation coefficient of 0.91 and percentage deviation of similar to 8% in observed algae coverage. These results indicate that H8/AHI can obtain reliable observations of floating algae at ultrahigh temporal resolutions (10 min). Especially, such ultrahigh-frequency measurements show that part of Lake Taihu (e.g., Meiliang Bay) experienced more frequent events of floating algae (mostly > 60%) than that observed by GOCI (generally < 40%). These results indicate that ultrahigh-frequency measurements are important not only for efficient environmental monitoring but also for the scientific understanding of algae dynamics.



Himawari-8/AHI和GOCI分别监测到2017年10月份太湖水面被漂浮藻华覆盖的频率。

The frequency of water surface covered by floating algae in October 2017, detected from AHI and GOCI, respectively. It was calculated by counting the times a pixel was covered by floating algae in that month, and then divided this number by the total times of cloud-free observations at that pixel in that month. The red arrow points to Meiliang Bay, where AHI shows a higher frequency of floating algae than GOCI. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

16

基于透明度盘深度数据模拟上层海水中可见光的传输

Estimating the transmittance of visible solar radiation in the upper ocean using Secchi disk observations

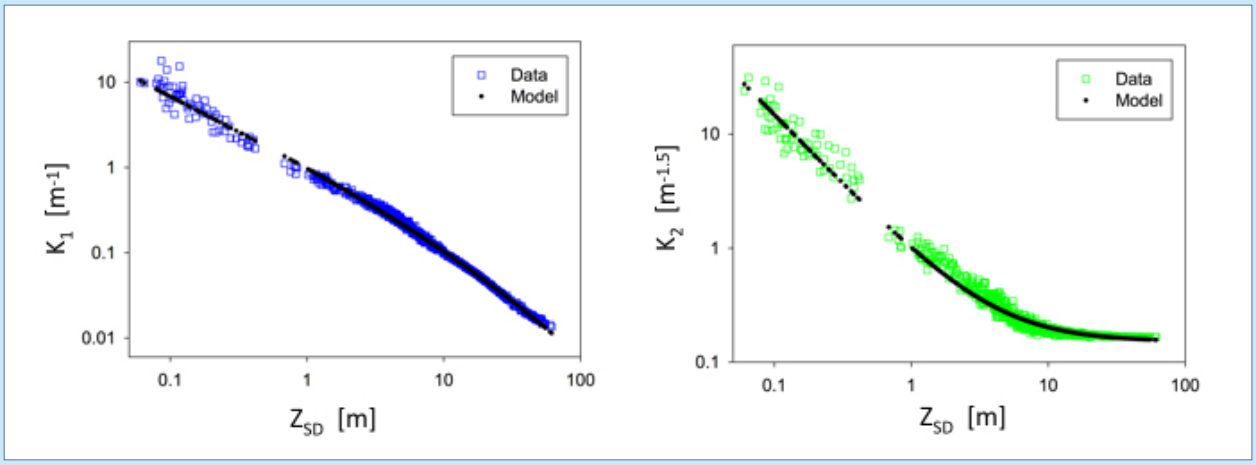
太阳辐射是地球的主要能量来源，不仅决定着作为“生物泵”的浮游植物的光合作用，对海洋热收支也至关重要。太阳辐射在水体中的辐射传输取决于水的光学性质。要精确描述水中太阳辐射的分布，全波段、高光谱的海洋辐射传输模型需要极高的计算能力，这对于大规模的海洋环流模型是不实际的。因此，海洋模型中太阳辐射的传输系数（T_{vsR}）通常基于水体类型。这个模型虽然比较简单，但是水体类型的确定很粗略，难以体现同一水体类型中海水的光学特性的变化。另外，要想更可靠地模拟和理解气候变化下的海洋系统的变化，就需要进行长年代尺度的观测和评估。尽管现在我们可以从多个观测系统和卫星获得越来越多的数据，这些数据对于研究未来几十年的变化至关重要，但模拟和了解过去的海洋将大大提升我们对海洋的认知。

Secchi 盘深度（Z_{sD}），作为海水透明度的量度，是十分实用的判断 T_{vsR} 的途径。因为 Z_{sD} 的测量操作和记录比较简单，在现代海洋光学研究之前，它是海洋光学特性的唯一测量方式。在过去的 150 年里，研究人员及大众收集了全球大量 Z_{sD} 数据，显示了海洋透明度的详细空间变化。

为了利用这个海洋透明度数据库，该研究基于 Secchi 盘深度的最新理论，建立了 Z_{sD} 与漫衰减系数（K_{vsR}）之间的关系，从而开发了一种用 Z_{sD} 作为输入的计算 T_{vsR} 的模型，并使用模拟数据和现场测量数据对模型结果进行评估。结果表明，此模型对近岸海域到非常清澈的大洋都能准确模拟海洋 T_{vsR}，并可以被用于海洋环流模型。其简单的数学形式使计算成本与过去使用的水体类型模型相同。

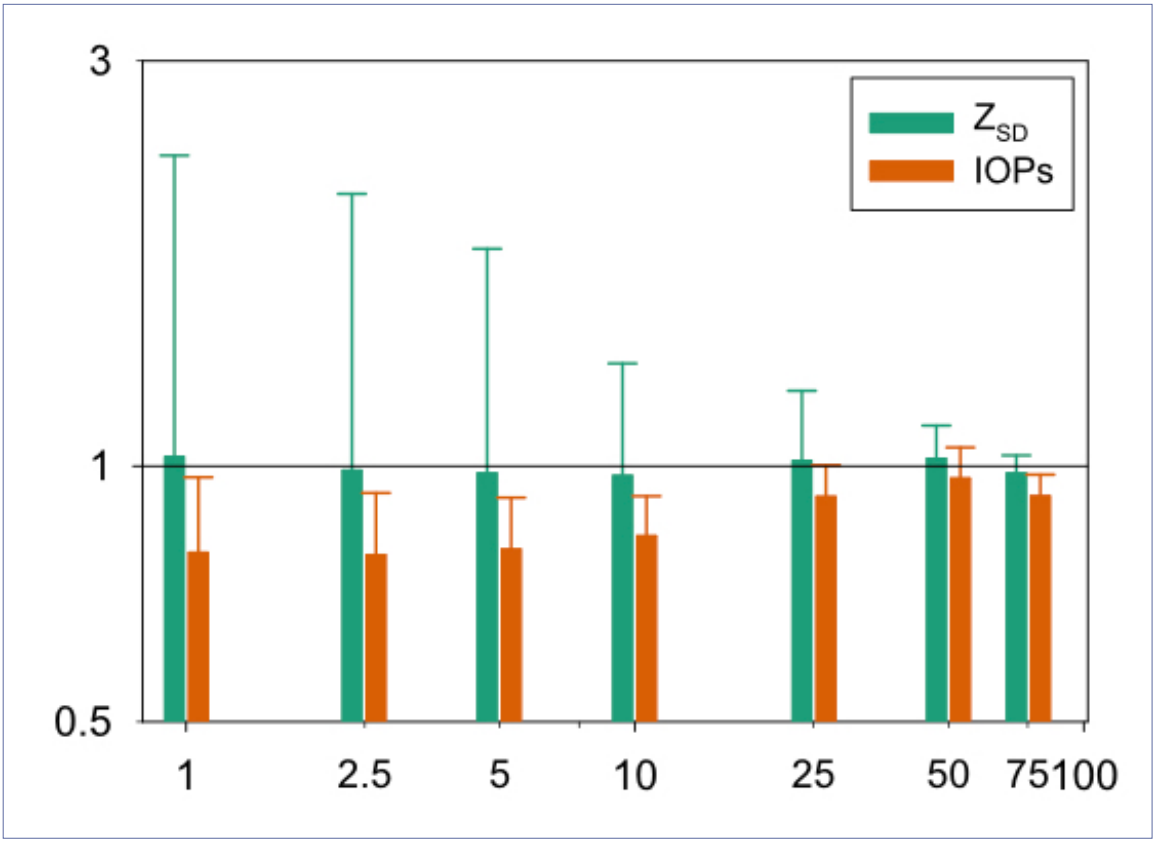
这一研究不仅在保证低计算成本的情况下大大提高了太阳辐射传输模拟的准确度，同时使得过去 150 年积累的大量透明度数据有了发挥作用的可能，在未来可以大幅度扩展我们对太阳辐射海洋系统影响的知识和理解。

以上工作于 2019 年 4 月发表于 *Journal of Geophysical Research: Oceans* 期刊，李忠平为第一作者，李忠平和商少凌为共同通讯作者。



Z_{sD} 和 K_{vsR} 模型参数 K_1 和 K_2 的关系。
Relationships between Z_{sD} and model parameters K_1 and K_2 for K_{vsR}.

Penetration of visible solar radiation (VSR) drives heating and phytoplankton photosynthesis in the upper water column; thus, it is always important to accurately describe the vertical distribution of VSR in the oceans. Before the invention and application of modern optical-electronic instruments to measure the vertical profiles of VSR, the transmittance of VSR from surface to deeper ocean (T_{vsR}) was commonly estimated based on water types and subsequently incorporated in dynamic ocean circulation models. However, the measurement of Secchi disk depth (Z_{sD}) has been carried out since the 1860s and there are about a million of Z_{sD} data available for the global oceans. In this study, based on radiative transfer and using numerically simulated data, the T_{vsR} is modeled as a function of Z_{sD}. This scheme was further evaluated using data from numerical simulations and from field measurements where Z_{sD} spans a range of ~1–75 m. For waters from coastal to super blue oceanic gyres, the modeled T_{vsR} agree with measured T_{vsR} very well for T_{vsR} greater than 1%. Better modeled T_{vsR} can improve general ocean circulation models, which opens a door to better study the ocean–atmosphere systems in the past decades to a century with the large volume of Z_{sD} data.



现场观测数据模拟 T_{VSR} 在七个 T_{VSR} 范围的 rt 值（评估模型 T_{VSR} 与观测 T_{VSR} 的差异，rt=1 表示完全一致）中值和标准差：模型与高精度全波段模拟软件（HydroLight，IOPs）的对比。
Median and standard deviation of rt (quantifier of the agreement between in-situ data and modeled value; *rt* = 1.0 means perfect agreement) values for the seven scales of T_{VSR} for data from Hydrolight simulations.

Reference:
Lee, Zhongping[#*]; Shang, Shaoling[#*]; Du, Keping; Lin, Gong; Liu, Tongtong; Zoffoli, Laura. Estimating the transmittance of visible solar radiation in the upper ocean using Secchi disk observations. *JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS*. 2019, 124: 1434-1444.

17

与ENSO事件相关的全球海洋热含量变动

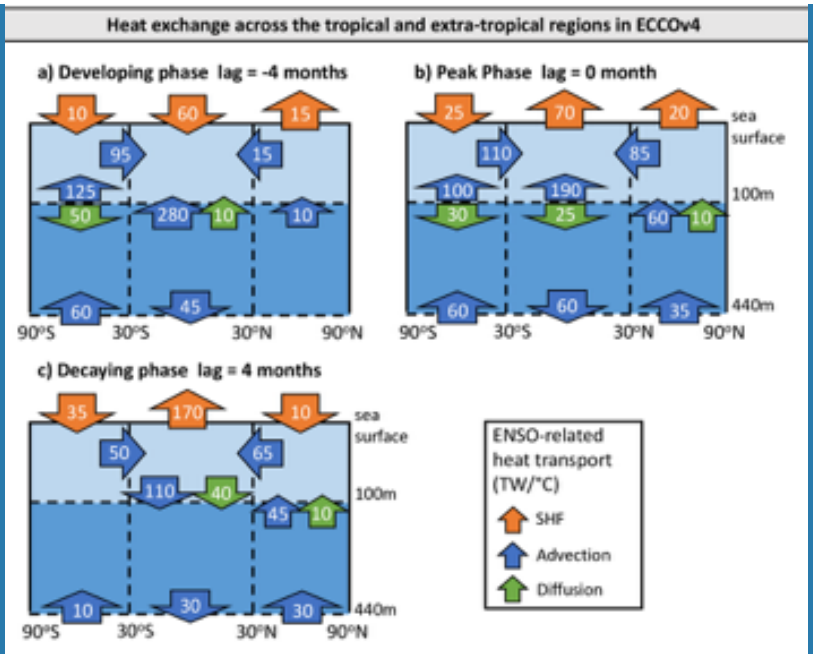
ENSO-related global ocean heat content variations

海洋在气候系统的能量平衡中扮演着重要的角色。在温室气体排放增加导致的大气层顶净热辐射异常中，超过 90% 以热含量的形式储存在海洋中，造成海洋增暖、海平面上升。海洋热含量的全球积分值也因此成为监测气候变化的重要指标。全球海洋热含量存在年际尺度的变动，部分研究提出这些变动可在统计上与气候系统的自然模态建立联系，例如厄尔尼诺 – 南方涛动（ENSO）事件。最显著的例子为全球海洋在 1997/1998 厄尔尼诺事件后的异常失热。近期研究还发现在 ENSO 事件期间，海洋热含量的分布在全球尺度上存在垂向和经向的异常变动。现有的 ENSO 研究主要关注于浅层热带海洋，目前尚不清楚这些与 ENSO 相关的全球海洋热含量变动的形成机制。

本研究通过新一代的海洋再分析数据，定量分析了热带和高纬度海洋在 0-100 m 和 100-400 m 层的热量收支，揭示了 ENSO 事件影响全球尺度海洋热含量的机制。研究发现全球海洋在厄尔尼诺的峰值期和衰退期异常失热。该失热主要由热带海表热通量负异常导致，并部分被中高纬度的海表热通量正异常抵消。在海洋内部，热量在厄尔尼诺的发展期和峰值期由 100-400 m 和中高纬度向浅层和低纬度移动，导致热带 0-100 m 层异常增暖。该过程与前述热带海表热通量异常存在显著的滞后相关，表明后者可能是对前者的滞后反馈。此外，研究还进一步揭示了海洋内部不同的环流结构对热传输过程的贡献。在 ENSO 事件期间，热带和中高纬度的垂向热交换分别受纬向和经向翻转环流主导，而热带和中高纬度之间的热交换主要受风生 Ekman 输运主导。

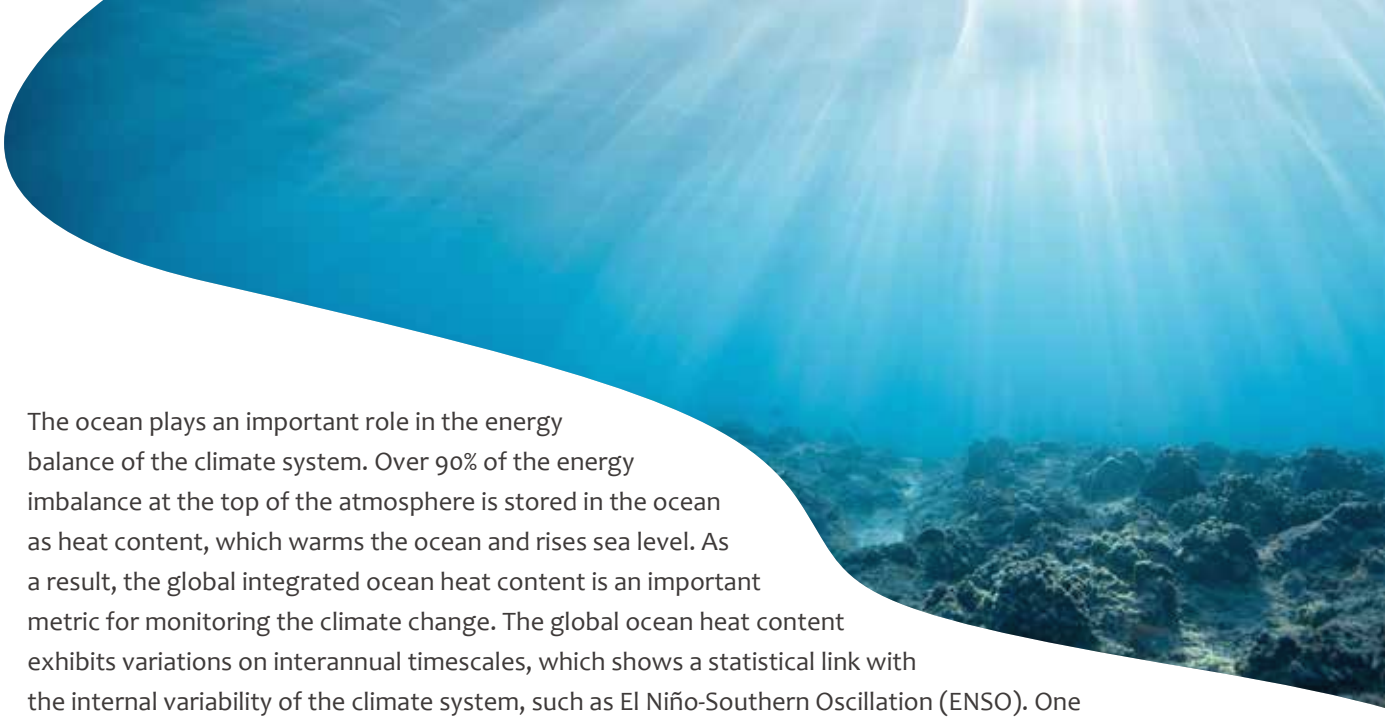
本研究的全球尺度热收支分析展示了海洋内部与 ENSO 相关的热量重分布过程对全球海洋热含量年际变动的影响，建立了研究 ENSO 事件全球影响的分析框架以及定量基准，对理解气候系统在年际尺度的能量平衡有重要意义。

以上研究成果于 2019 年 4 月发表于 *Deep-sea Research Part II-Topical Studies In Oceanography* 期刊，2016 届博士生林培根为第一作者及通讯作者。



与 ENSO 事件相关的异常热传输过程在 0-440 m 层跨深度和纬度的分布。箭头和符号对应厄尔尼诺事件，在拉尼娜事件时将反向。图中忽略了幅值小于 10TW/°C 的项。

Schematic of anomalous heat transports associated with ENSO in the upper 440 m shown as a function of latitude and depth. The arrows and signs are shown for El Niño events, but they would be reversed for La Niña events. Values less than 10 TW/°C are neglected.



The ocean plays an important role in the energy balance of the climate system. Over 90% of the energy imbalance at the top of the atmosphere is stored in the ocean as heat content, which warms the ocean and rises sea level. As a result, the global integrated ocean heat content is an important metric for monitoring the climate change. The global ocean heat content exhibits variations on interannual timescales, which shows a statistical link with the internal variability of the climate system, such as El Niño-Southern Oscillation (ENSO). One well documented example this the heat loss of the global ocean after the 1997/1998 El Niño event. Moreover, recent studies have shown that the ocean heat content is redistributed vertically and meridionally at a global scale during ENSO events. Most existing ENSO studies focus on the upper tropical ocean, whereas the mechanisms that control the ENSO-related ocean heat content variations on the global scale remain unclear.

The mechanisms underlying the ENSO-related global ocean heat content variations are investigated here using an ocean reanalysis. Specifically, we examine the heat budget of the global ocean for the 0-100 m and 100-400 m layers and the tropical and extra-tropical bands. We find that the global ocean heat content exhibits a cooling tendency during the peak and decaying phases of El Niño, which is caused by the negative surface heat flux anomaly in the tropics and partially compensated by that in higher latitudes. In the ocean interior, heat is redistributed from 100-400 m and extra-tropics towards lower latitudes and depths during the developing and peak phases of El Niño, leading to an anomalous heat content build-up in the 0-100 m of the tropics. This process exhibits a significant lagged correlation with the surface heat flux anomaly in the tropics, implying that the latter is a lagged feedback to the former. Contributions from different types of the ocean circulation to the ENSO-related heat transport anomalies are further quantified. The vertical heat transport in the tropics and extra-tropics are dominated by the zonal and meridional overturning circulations, respectively, while the meridional heat exchange between the tropics and extra-tropics is mainly controlled by the wind-driven Ekman transport.

Importantly, this work demonstrates the impact of the internal heat redistribution on the global ocean heat content during ENSO events. The analysis framework and quantitative results presented here could serve as a benchmark for evaluating the global impact of ENSO in different models. The implication for the energy balance of the climate system on interannual timescales is discussed.

Reference:
Lin, Peigen*; Pickart, Robert S.; Moore, G. W. K.; Spall, Michael A.; Hu, Jianyu. Characteristics and dynamics of wind-driven upwelling in the Alaskan Beaufort Sea based on six years of mooring data. *DEEP-SEA RESEARCH PART II-TOPICAL STUDIES IN OCEANOGRAPHY*. 2019, 162: 79-92.

18

基于渗透泵和固相萃取技术的水体有机污染物新型原位主动式采样器

A novel active sampler coupling osmotic pump and solid phase extraction for *in situ* sampling of organic pollutants in surface water

为了获得水质监测数据，你经常派出采样人员携带采样工具乘坐车船前往现场进行采样，对于缺人、缺钱的你这种方法真的好吗？你也可以花上几万块甚至更多的钱买一台传统的自动采样器放在现场采样，可是你想过供电的问题怎么解决吗？你还可使用不需要供电的被动采样器，然而你能确定监测结果是靠谱的吗？如果你恰好无法回答上述“灵魂拷问”，那么李权龙团队的研究成果也许可以帮帮你！

你一定知道泵是需要供电的，可恰好就有泵不需要供电，利用中学学过的渗透原理就可以搞定。用一片反渗透（Reverse Osmosis, RO）膜隔开两个用有机玻璃制作的腔体，一个腔体中装纯水，另一个腔体中装饱和氯化钠溶液和足量的氯化钠固体，纯水就会透过 RO 膜往氯化钠溶液中扩散，一个由渗透压驱动的无需供电的渗透泵（Osmotic Pump, OP）就做好了。这很简单，大家都想得到！由于 RO 膜的性质使然，一侧的氯离子和钠离子会通过 RO 膜扩散到另一侧的纯水中，导致 RO 膜两侧的离子浓度差减小，OP 的流速会随时间快速下降而无法使用。解决的办法是在纯水中加入足量的离子交换树脂，将氯离子和钠离子分别交换成氢离子和氢氧根离子，最后生成水。这样就得到结构简单、流速稳定、成本低廉的 OP 了。

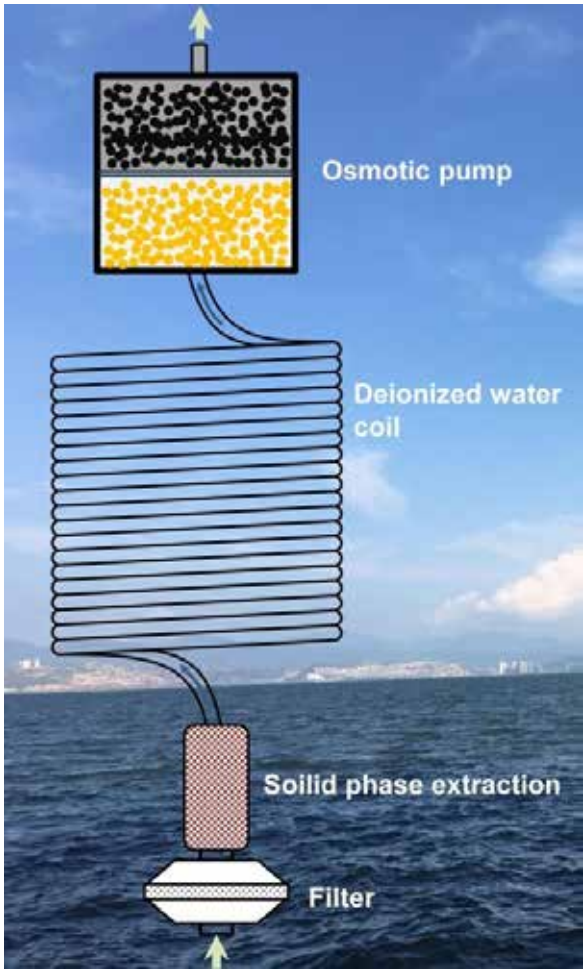
团队首次将 OP 与固相萃取（solid phase extraction，SPE）结合，研制无需供电的 OP-SPE 时间平均浓度（time-weighted average，TWA）采样器。在 OP 的作用下，水样以恒定的流速通过 SPE 小柱，根据被富集在小柱上的目标物的量和流过水样的体积可以获得采样期间目标物的 TWA。水体中凡是可以用 SPE 小柱富集的物质都可用此采样器采集。如果你用过被动采样器，你肯定会觉得这个采样器好用，因为其监测结果准确且无需校正采样速率。

团队将 OP 与气泡间隔技术结合，研制了时间序列浓度采样器。在 OP 的作用下，水样连续不断地被吸入一根绕成盘状、长达百米的细管中，同时用一个气泡添加装置定时向管中打入一个气泡，该气泡将管中的样品分隔成段并可作为采样时间标记。采样结束后，按气泡间隔将管中的水样段放出，得到不同时间段内采集的水样，上机分析后得到水体中目标物（重金属、营养盐）的时间序列浓度。你只需去一次现场，固定好采样器，便可在长达 20-30 天的时间里每天获得 1 个监测数据。如此省时省力，采样还是个问题吗！

以上研究成果于 2019 年 3 月发表于 *Environmental Science & Technology* 期刊，林坤德是第一作者，李权龙为通讯作者。

OP-SPE sampler

OP-SPE采样器



Active samplers for monitoring of trace contaminants in surface water are highly desirable, but their use is often constrained by power supply. Here we proposed a novel solution by coupling an improved osmotic pump (OP) with a solid-phase extraction (SPE) cartridge to construct a power-free active sampler for collecting organic contaminants in water. We for the first time added ion-exchange resins into the OP using reverse osmosis membrane and successfully constructed OPs with a smooth and constant flow. In the OP-SPE sampler, water was continuously drawn through the SPE cartridge at a constant flow, and time-weighted average concentration over the sampling course may be easily calculated from the amount of target analytes retained on the SPE cartridge and water collected in the sampler. The OP-SPE samplers were deployed in a river to detect herbicides, and the measured concentrations were largely in agreement with the average of 11 daily spot samples. Given that a wide range of SPE cartridges are available for different classes of organic contaminants, this approach is versatile and may find widespread applications for in situ sampling of surface water under different conditions, including poorly accessible locations. Due to the accurate time-weighted average concentrations and unnecessity for calibration of sampling rate, OP-SPE samplers can be an excellent replacement for passive samplers. The constructed OPs can be used in the development of other samplers and in situ analyzers of low power consumption.

Reference:

Lin, Kunde; Zhang, Ling; Li, Quanlong*; Lu, Bingyan; Yu, Yue; Pei, Junxian; Yuan, Dongxing; Gan, Jay. *ENVIRONMENTAL SCIENCE & TECHNOLOGY*, 2019. 53(5):2579-2585.

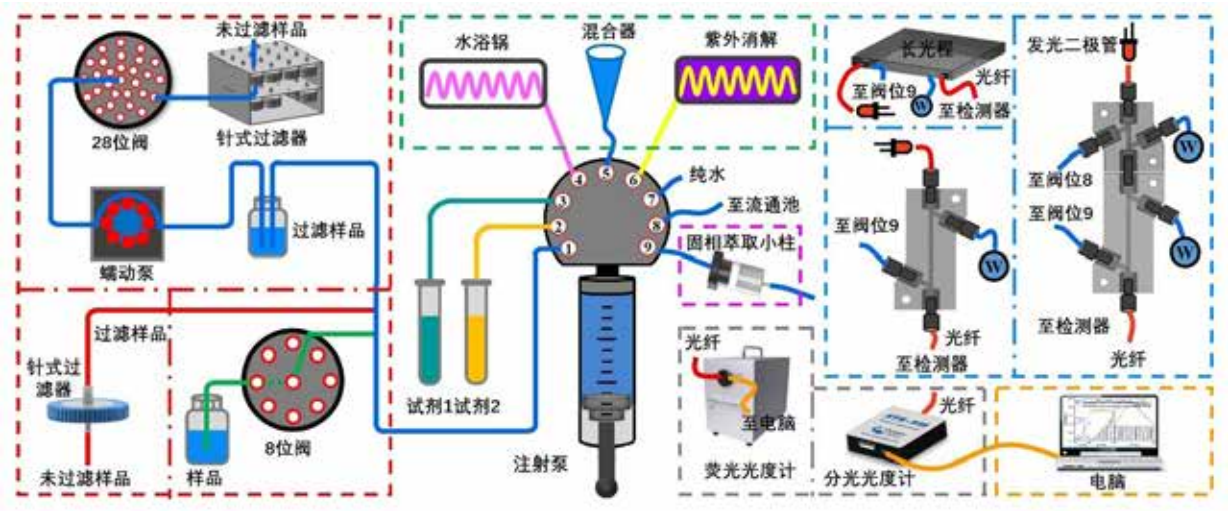
19

基于注射泵的集成式水环境分析仪的研制及在海洋环境监测中的应用研究

Development and application of an *i*ntegrated Syringe-pump-based Environmental-water Analyzer (iSEA) for marine environmental monitoring

河口和近海连接陆地与海洋两大系统，是人类活动影响海洋和气候系统的重要渠道。受人类活动和全球变化影响，河口－近海区域富营养化、缺氧、酸化等生态环境问题突出，且多重效应耦合，机制复杂。为应对全球环境变化给各区域、国家和社会带来的挑战，提升生物地球化学过程与生态系统过程等基础科学研究，亟需对海洋环境参数进行现场多参数、高精度、高时空分辨率的自动测定。通用型海水化学参数现场分析方法与仪器的缺乏，使得一些科学研究发展受到制约，很多重要机制的深入探究缺少综合数据的支持。基于此背景，马剑课题组研发了基于注射泵的集成式水环境分析仪（*i*ntegrated Syringe-pump-based Environmental-water Analyzer, *i*SEA），由注射泵、选择阀和 LabVIEW 编写的软件组成。采用分光光度法对各化学参数进行测定。该系统具有体积小巧、易于操作、试剂消耗量少、稳定性好、通用性强等优点。目前已成功运用于以下的现场分析：1）在共计 420 km 的 7 次走航分析中，共自动测定了 716 个铵氮样品，仪器工作状况良好；2）与在线过滤系统相结合，用于河口和近海水样中硝酸盐和亚硝酸盐的走航分析；3）用于观测珊瑚饲养缸内人工海水碳酸盐体系的变化（连续 5 天）和 13 天走航测试中碳酸根浓度的测定。这些成功的应用证明了 *i*SEA 系统的可靠性，可以为后续河口－近海区域的海洋生物地球化学研究提供技术支持。

以上工作分别发表于 *Talanta*、*Analytica Chimica Acta* 及 *Marine Chemistry*，马剑为通讯作者，第一作者分别为研究生李佩聪、方腾越和上官琪佩。



基于注射泵的集成式水环境分析仪的流路图。
Schematic diagram of *i*SEA.

The estuarine-coastal areas are facing the ecological problems such as eutrophication, hypoxia, acidification, etc. The comprehensive studies on these complicated processes are significantly important. However, because of the limit of the current methods and techniques, there are insufficient field data based on traditional routine analysis. In order to establish methods and automatic instruments for field determination of several typical parameters in estuarine-coastal areas, we developed a new automated system named as *i*SEA (*i*ntegrated Syringe-pump-based Environmental-water Analyzer). The compact and portable system consists a mini-syringe pump equipped with a selection valve and laboratory-programmed software written by LabVIEW. Based on spectrophotometric detection, the *i*SEA has been successfully applied in several occasions. 1) The analyzer worked well in the transect of 420 km during 7 cruises for determination of ammonium. A total of 716 analyses were performed automatically on board, demonstrating the capability of *i*SEA in automated real-time mapping of ammonium distribution in a shipboard laboratory; 2) The analyzer was combined with an on-line filtration system for underway analysis of nitrate and nitrite in saline samples; 3) The analyzer was used to continuously monitor carbonate ion concentration variations in a 2500 L coral reef tank for five days, and used for shipboard underway and vertical profile analysis during a 13-day cruise. The successful applications in real samples demonstrated the robustness and reliability of *i*SEA for autonomous environmental monitoring under harsh conditions.

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Li, Peicong; Deng, Yao; Shu, Huilin; Lin, Kunning; Chen, Nengwang; Jiang, Yiong; Chen, Jixin; Yuan, Dongxing; Ma, Jian*. High-frequency underway analysis of ammonium in coastal waters using an integrated syringe-pump-based environmental-water analyzer (*i*SEA), *TALANTA*, 2019, 195: 638-646.

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Shangguan, Qipei; Shu, Huilin; Li, Peicong; Lin, Kunning; Byrne, Robert H.; Li, Quanlong; Yuan, Dongxing; Ma, Jian*. Automated spectrophotometric determination of carbonate ion concentration in seawater using a portable syringe pump based analyzer, *MARINE CHEMISTRY*. 2019, 209: 120-127.

科研课题与航次
RESEARCH PROJECTS AND CRUISES

34 科考航次

259 人次

407 天

2019年，实验室组织和参与34个科考航次，259人次在西北太平洋、南海、东海、黄海、台湾海峡等海域及河口开展了共计407天的海上调查。

In 2019, MEL organized and participated in 34 cruises. A total of 259 scientists, technicians and students spent 407 days at sea. The investigation areas ranged from the West Northeast Pacific, South China Sea, East China Sea, the Taiwan Strait and several estuaries.

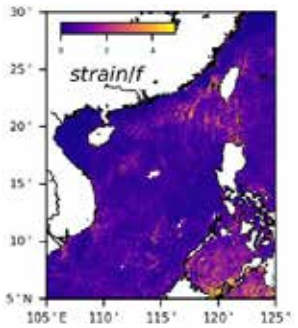
吕宋海峡复杂地形调控下南海北部—西太平洋环流格局与水体交换研究

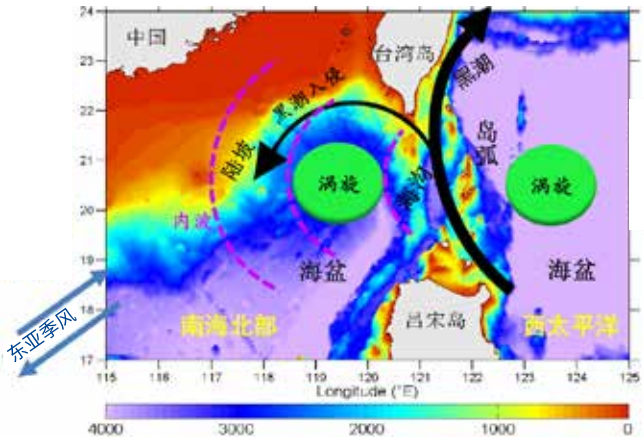
Circulation pattern and volume transport in the northern South China Sea and western Pacific Ocean under the modulation of complex topography near the Luzon Strait

国家自然科学基金重大研究计划重点支持项目，胡建宇
NSFC Major Program, Jianyu Hu

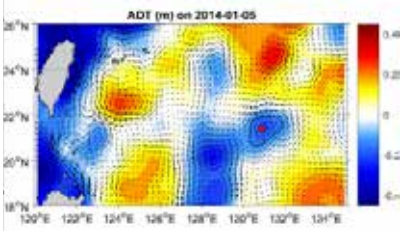
作为西太平洋“沟—弧—盆”体系的典型代表性海区，吕宋海峡附近海域伴随着西边界流、中尺度涡、亚中尺度过程、内波等多尺度海洋动力过程，其在复杂地形约束下共同构成了吕宋海峡附近的环流格局，并深刻影响着南海北部—西太平洋的水体和能量交换。本项目拟结合现场观测、遥感观测与数值模拟，较为系统地阐释吕宋海峡附近海区西太平洋中尺度涡 /Rossby 波与黑潮的相互作用机理；探讨涡旋与地形对吕宋海峡水体交换时空特征的调制作用；分析南海北部陆坡处海流、中尺度涡和内波对跨陆坡输运的贡献与作用机制。这些研究可望显著提升对吕宋海峡复杂地形调控下南海北部—西太平洋环流格局与水体交换的科学认识。本项目还将创新观测技术，自主研发带温盐链的漂流浮标，为研究吕宋海峡水交换和南海跨陆坡输运等提供有用的数据。

吕宋海峡地形诱发内波的传播





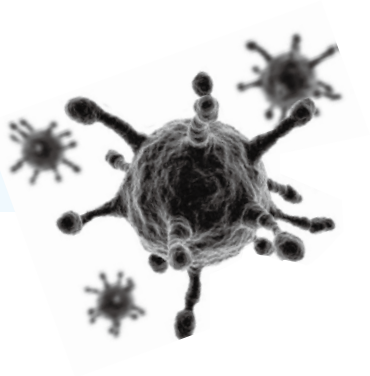
中尺度涡与黑潮相互作用



As a representative area in the context of “trench-island arc-basin” system in the western Pacific, the Luzon Strait and its adjacent area is rich of multi-scale dynamical processes including the western boundary current, mesoscale eddies, submesoscale processes, internal waves, etc. Such processes, under the constraint of the above topographic features, form the local circulation patterns and exert a significant impact on the exchanges of water mass and energy between the northern South China Sea (SCS) and western Pacific. Based on in situ and satellite observations and numerical simulations, this project aims to systematically investigate (i) the interactions between mesoscale eddies/Rossby waves and the Kuroshio in the vicinity of the Luzon Strait, (ii) influence of mesoscale eddies and topography on modulating the spatiotemporal characteristics of water exchange near the Luzon Strait, and (iii) the respective contributions of currents, mesoscale eddies and internal waves to the cross-slope transport in the northern SCS. Better knowledge of the above aspects will significantly improve our understanding of the circulation patterns and water exchange in the topographically regulated Luzon Strait area. In addition, this project will innovate in the marine observational technology by developing satellite-tracked drifters towed with chains that collect temperature and salinity data. Such type of drifters would undoubtedly provide invaluable in situ measurements for studies of water exchange in the Luzon Strait and cross-slope transport in the northern SCS.

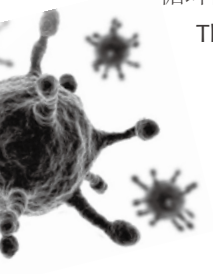
病毒驱动的深部生物圈碳循环机制与过程

Virus-driven organic carbon cycle in the deep biosphere



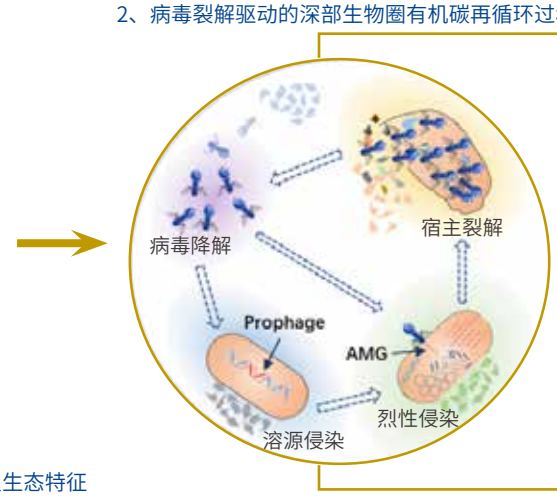
国家自然科学基金重大研究计划重点支持项目，张锐
NSFC Major Program, Rui Zhang

深部生物圈是地球上重要的生态系统和有机碳库，影响全球生物地球化学循环。病毒是深部生物圈丰度最高的生命形式，但人们对深部生物圈病毒及其生态学和生物地球化学地位的认识十分有限。本项目拟聚焦这一空白领域，遵循“水圈微生物”重大研究计划的总体设计，借助“国际大洋发现计划”（IODP）样品，针对若干典型深部生物圈环境，通过现场调查、模拟培养以及实验室研究相结合，对深部生物圈病毒的生态特性、生态过程、与宿主相互作用及其环境调控因素进行系统的研究；解析病毒裂解宿主对深部生物圈微生物多样性、群落结构及有机碳利用的影响；阐明病毒侵染宿主过程中辅助代谢基因（AMGs）和前噬菌体（Prophage）对宿主碳代谢途径的调控机制；建立模型评估病毒对深部生物圈元素循环（尤其是有机碳循环）的贡献。本研究将探明病毒驱动的深部生物圈有机碳循环的机制与过程，有助于完善和加深人们对深部生物圈生态系统和生物地球化学循环的理解。



The deep biosphere is one of the most important ecosystems and reservoirs of organic carbon on Earth, playing an important role in global biogeochemical cycles. Viruses are the most abundant biological entities and may be a major top-down factor for unicellular microorganism in the deep biosphere. However, most studies of viral ecology and biogeochemistry were limited in water column and surface sediment and few touched the deep biosphere. This proposed project will conduct field and laboratory studies to investigate viruses in deep biosphere including their ecological characteristics and interactions with microbial hosts, through cruises organized by the International Ocean Discovery Program (IODP) in typical deep biosphere environments. We will investigate the effects of viral lysis on prokaryotes (abundance, production, respiration, growth efficiency, diversity and community structure, etc.) and therefore, ecological significance of viruses in deep biosphere. Environmental factors impacting host-virus interaction will be analyzed on population and molecular levels. Regulation of host metabolism by auxiliary metabolic genes (AMGs) and prophages during viral infection will be studied as well. The study will elucidate the role of viruses in the ecology and organic carbon cycle of the deep biosphere, and improve our understandings of microbial ecology and biogeochemistry of the deep biosphere.

1、典型深部生物圈病毒分子多样性及生态特征



2、病毒裂解驱动的深部生物圈有机碳再循环过程

3、病毒侵染介导的宿主碳代谢重构机制

4、评估病毒对深部生物圈碳循环的贡献

铁限制区浮游植物对酸化的响应及其生物地球化学效应

The response and its biogeochemical impact of marine phytoplankton to acidification in iron-limited oceanic regions

国家杰出青年科学基金项目，史大林
The National Science Fund for Distinguished Young Scholars, Dalin Shi

本项目聚焦海洋酸化和铁限制的耦合对浮游植物的影响及其机理与效应，拟采取室内受控实验－现场观测与培养－综合集成与预测等研究手段，开展由类群到群落、从微观分子机制到宏观生物地球化学过程的系统研究，旨在阐释不同关键浮游植物类群受铁限制和酸化协同作用的影响及其机制，揭示铁限制海区浮游植物群落结构及其碳、氮生物地球化学过程对酸化的响应及其效应，从而提升对全球变化下海洋生物地球化学循环关键过程及其调控机制和效应的认识。

This project focuses on the coupled effect of ocean acidification and iron limitation on marine phytoplankton. Using multiple approaches including laboratory manipulation experiments, field observation and incubation, and data integration and prediction, the combined impact of acidification and iron deficiency will be studied systematically, to elucidate the response and its underlying mechanisms of key phytoplankton groups and to understand the change in phytoplankton community structure and related biogeochemical processes of carbon and nitrogen. The study will improve our understanding of key marine biogeochemical processes and their regulation mechanisms and potential impacts under ocean global change.

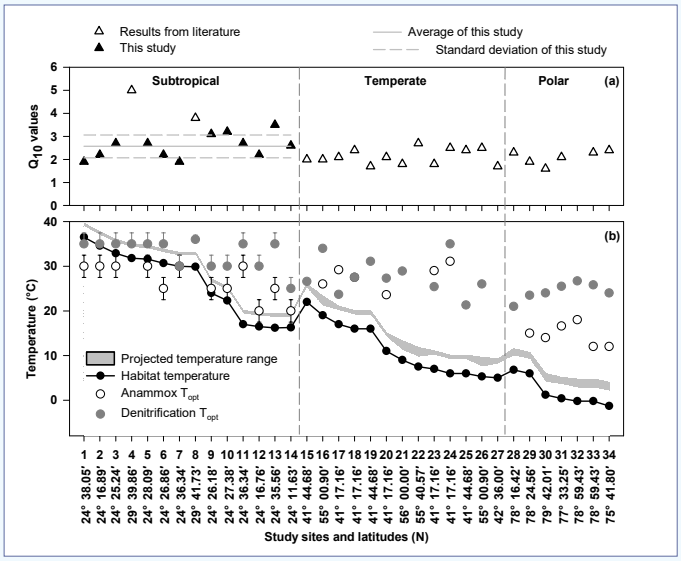
海洋氮循环与全球变化

Marine nitrogen cycle and global change

国家自然科学基金创新研究群体，2018-2023，高树基、史大林、张瑶、陈敏、高坤山、刘志宇
NSFC Innovative Research Group, 2018-2023, Shuh-Ji Kao, Dalin Shi, Yao Zhang, Min Chen, Kunshan Gao and Zhiyu Liu

2019 年，创新群体项目以先进碳氮稳定同位素为核心技术手段，结合现场观测、室内实验和中尺度生态系统实验展开研究，在脱氮及固氮过程及其调控机制方面取得了突破性进展，相关研究在 *Nature Climate Change*, *Nature Communications*, *Limnology and Oceanography* 等顶尖期刊上发表。一方面，加深了对海洋水体及沉积物脱氮过程的控制因子及其气候效应的认识：沉积物的温控操控实验表明气候变暖将以牺牲厌氧氨氧化为代价促进沉积物的反硝化过程进而形成气候正反馈；我们发现脱氮细菌优先利用新鲜且含有易降解组分的生源颗粒有机质，证明有机物及其组成对沿岸海湾水体反硝化过程具有重要的调控作用；硝化是珠江口 N_2O 产生释放的主要过程，其中氨氧化细菌在 N_2O 产生和释放中扮演关键角色。另一方面，研究结果增强了对固氮生物的分布、固氮速率影响因子和调控机制的认识。我们发现铁是控制区域大尺度固氮类群生物地理学分布的决定性因素；另外，研究表明人类活动导致的溶解有机质的生物可利用性变化对富营养化区域固氮作用的发生具有重要调控作用；同时，通过建立海洋固氮束毛藻细胞内铁和能量分配的数值模型，来探讨酸化和铁条件的耦合对其固氮和生长的影响机制，模型结果预示海洋荒漠区的固氮可能对未来全球变化更为敏感。

By using isotopic techniques and combining field observations and laboratory experiments with mesoscale ecosystem experiments, we made a breakthrough in 2019 on key nitrogen cycle processes including denitrification and nitrogen fixation, and their environmental control mechanisms. The discoveries were published in *Nature Climate Change*, *Nature Communications*, and *Limnology and Oceanography*. On one hand, the results broadened our understanding of control factors and climatic effects of denitrification in marine environments. Temperature manipulation experiments in sediments indicated that future warming will stimulate sediment denitrification at the expense of anammox, and result in positive climate feedback. Denitrifiers may preferentially utilize fresher and labile autochthonous POC, emphasizing the importance of both suspended particles and POC components in regulating denitrification in turbid and productive coastal environments. Nitrification is a main N_2O producer in the Pearl River Estuary, in which ammonia-oxidizing bacteria play a key role in the production of N_2O. On the other hand, our results enhanced the understanding of the distribution of nitrogen fixing organisms and their environmental factors and mechanisms. Iron is the decisive factor controlling the biogeographic distribution of nitrogen fixers at a large scale. Additionally, our results showed that the bioavailability of DOC plays an important role in regulating the occurrence of nitrogen fixation in eutrophic regions. Meanwhile, we established a numerical model of intracellular iron and energy distribution to study the control mechanism on the effect of acidification and iron on the growth of *Trichodesmium*. The results indicated that the nitrogen fixation marine desert may be more sensitive to global change in the future.



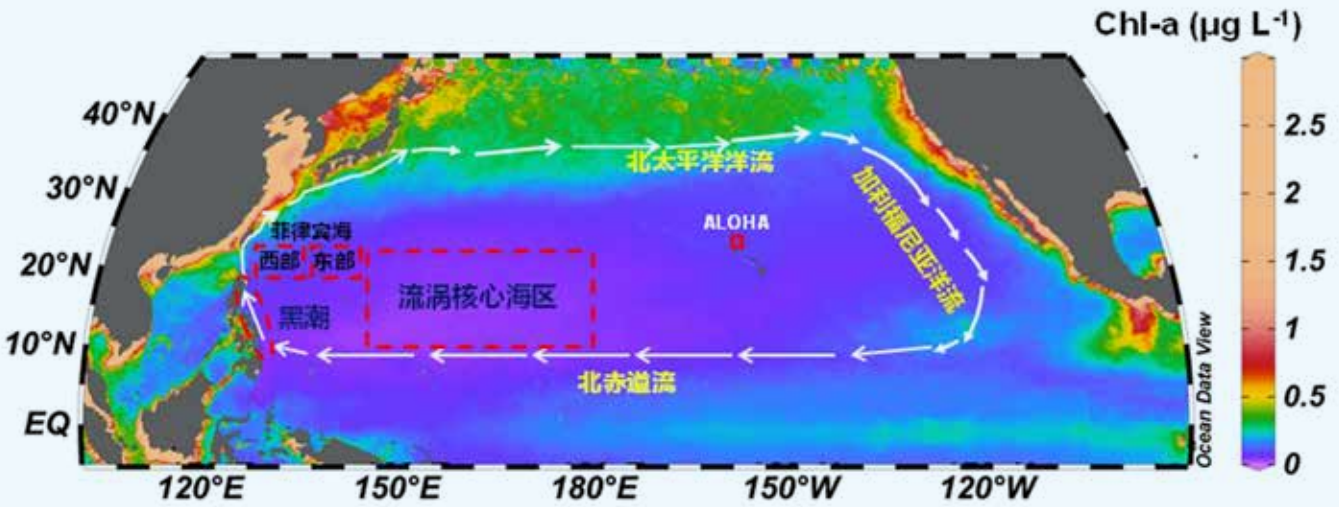
全球不同纬度下反硝化过程 Q10 值，反硝化和厌氧氨氧化最适温度以及环境温度的分布规律。
The compilation of Q10 for denitrification, habitat temperatures and Topt values for denitrification and anammox in subtropical, temperate and polar sediments globally.

海洋荒漠生物泵固碳机理及增汇潜力

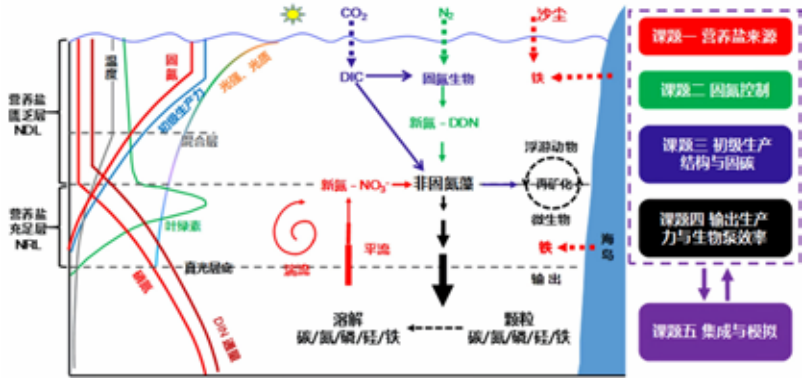
Carbon fixation and export in oligotrophic ocean

国家自然科学基金重大项目研究计划，2019-2023，戴民汉、张劲、史大林、商少凌、修鹏等
National Natural Science Foundation of China, 2019-2023, Minhan Dai, Jing Zhang, Dalin Shi, Shaoling Shang, Peng Xiu et al.

全球表层海洋面积约 30% 为低生物量的寡营养海域，通常称为“海洋荒漠”。尽管单位面积的生产力很低，然而海洋荒漠面积巨大，故而对全球海洋碳汇具有潜在`的重要贡献，可能具有增汇潜力，显然是全球海洋碳循环的重要环节，但却是研究最为匮乏的海域，也缺乏理论框架。项目聚焦最大的海洋荒漠区之一，北太平洋副热带流涡区，拟系统探究海洋荒漠区真光层的生物泵结构、过程和机理，评估其在全球变化背景下的发展趋势，进而构架寡营养系统生物泵新理论框架，并为海洋荒漠的增汇途径及其有效性提供科学论证。



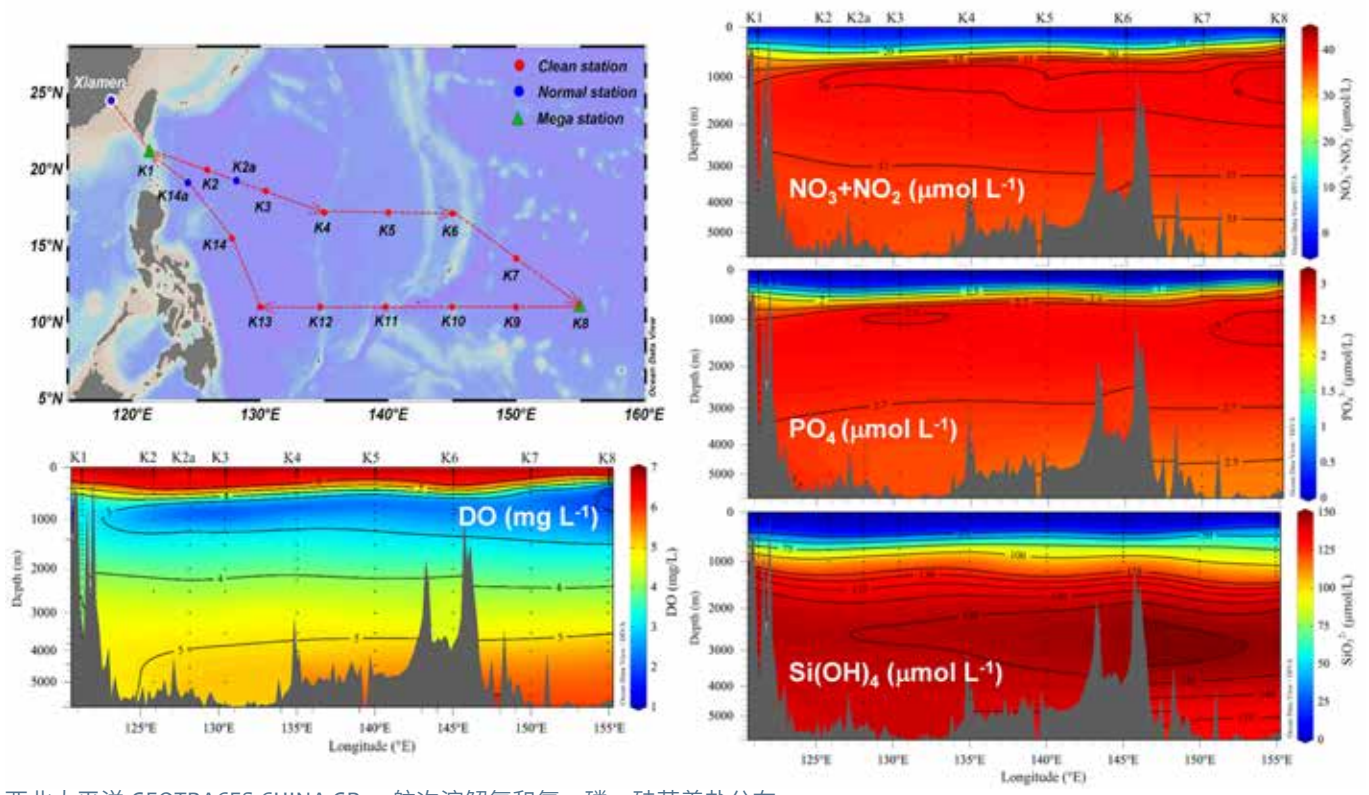
北太平洋副热带流涡区图示。NPSG 西接黑潮、东邻加利福尼亚洋流，南北界分别为北赤道流和北太平洋洋流；颜色表示 1997-2010 年平均的表层叶绿素浓度（NASA/GSFC OBPG）；ALOHA 代表夏威夷时间序列站。
Schematic of the North Pacific Subtropical Gyre (NPSG). NPSG is formed by four prevailing ocean currents: the North Pacific Current to the north, the California Current to the east, the North Equatorial Current to the south, and the Kuroshio Current to the west. The background color indicates the long-term (1997-2010) climatology surface chlorophyll (NASA/GSFC OBPG). ALOHA represents the Hawaii Ocean Time-series station in the eastern NPSG.



寡营养海域真光层内的生物地球化学过程与机制示意图与本项目课题设置

围绕核心科学问题，项目设置常量和微量营养盐的来源与通量、固氮作用的时空格局及调控因子、初级生产固碳及浮游生物群落结构、碳输出及其与氮、硅等生源要素的耦合、海洋荒漠区生物泵的模拟 5 个课题。

2019 年，项目进展良好，于 4 月 25 日至 6 月 13 日实施项目预航次，已初步获得西北太平洋温盐、溶解氧、营养盐和溶解态铁的空间分布特征。其中，连续走航观测显示，西北太平洋表层水中溶解态铁的浓度范围为 0.17-0.54 nmol L^{-1}，总体呈现出西北高、东南低的分布特征。湍流观测显示，湍动能耗散速率主要分布在 1.0×10^{-10}-1.0×10^{-5} W kg^{-1} 之间，扩散通量的高值多出现在 100 m 以深，而在调查区域的南部其高值显著变浅。营养盐添加实验表明，氮是西北太平洋浮游植物生长最主要的限制性营养盐。沉积物捕获器的初步结果显示，输出营养盐匮乏层的颗粒物具有较轻的稳定氮同位素组成，说明固氮作用对于该层输出生产力具有较大的贡献，而输出营养盐充足层的颗粒物主要源于由真光层以下的营养盐输入所支持的浮游植物生产。



西北太平洋 GEOTRACES-CHINA GP09 航次溶解氧和氮、磷、硅营养盐分布。
Distributions of DO and N, P, and Si nutrients during cruise GEOTRACES-CHINA GP09 to the western North Pacific.

此外，本项目初步构建了覆盖太平洋的三维物理 – 生态耦合模型，并在 ALOHA 站进行了验证，能够较合理地模拟该海区上层水体的固氮过程和速率，以及总浮游植物受光驱动的垂向分布结构。在遥感反演研究方面，优化了浮游植物吸收系数的反演，使用 $Z_{1\%}^{USR}$ 重新定义真光层深度，从而提高了海洋荒漠区初级生产力估算的精度。

CARBON Fixation and Export in oligotrophic ocean (Carbon-FE, pronounced as "Carbon Fei")

The oligotrophic ocean occupies about 30% of the ocean surface and has been conventionally regarded as ocean deserts. It is characterized by nutrient depletion in the surface waters and extremely low net biological production and hence, per unit area, contributes little to carbon export from surface to deep waters. Emerging evidence, most notably based on ocean time-series studies such as those at the Hawaiian Ocean Time-series station, has shown a wider than previously assumed dynamic range of nutrient inputs and biological responses in this oceanic system. This project selects the North Pacific Subtropical Gyre (NPSG), one of the world's largest oligotrophic regimes, as the study site to examine carbon fixation and export, or the biological pump in general, regulated by differently sourced nutrients including macronutrients (i.e., N, P, Si) and micronutrients (e.g., Fe).

The major objectives of this project are (1) to determine the distribution of macro- and micro-nutrients, fingerprint their sources and estimate their fluxes into the NPSG, (2) to constrain the spatial-temporal variability of biological N_2 fixation and its limiting factors in the NDL, (3) to quantify the carbon fixation and associated planktonic community structure, (4) to constrain the export production from both the NDL and NRL, and (5) to simulate the biological pump and carbon sinks in the NPSG. This project can substantially improve our understandings to fundamental biogeochemistry in these climatically and ecologically important oligotrophic ocean systems.

In 2019, a pilot cruise of Carbon-FE was conducted from April 25 to June 13 in the western North Pacific (wNP). We have obtained the spatial distributions of temperature, salinity, dissolved oxygen, nutrients and dissolved iron (DFe) in the wNP. Underway measurements of DFe, ranging between 0.17 and 0.54 nmol L^{-1}, showed a decreasing trend from northwest to southeast of the wNP. Turbulent microstructure observations showed that the turbulent kinetic energy dissipation rate varied within a range of 1.0×10^{-10} to 1.0×10^{-5} W kg^{-1}, which will be used to calculate the nutrient diffusive fluxes. Nutrient addition experiments suggested that nitrogen (N) was the major limiting factor of phytoplankton growth in the wNP. Preliminary results from sediment traps showed that sinking particles in the nutrient depleted layer (NDL) had lighter N isotopic compositions, suggesting that N_2 fixation is the major source of N nutrient in the NDL. In contrast, the subsurface supply should be the primary nutrient source to the nutrient replete layer, support the export production therein.

In addition, a three-dimensional physical-ecological coupling model has been developed to simulate N_2 fixation and phytoplankton composition in the Pacific Ocean. In terms of remote sensing, the euphotic zone was redefined using a $Z_{1\%}^{USR}$, which helps improve the accuracy of primary productivity estimation in the oligotrophic ocean.

南海碳循环过程、机理及其全球意义

CHOICE-C II: Carbon cycle in South China Sea: budget, controls & global implications

国家重大科学研究计划，2015-2019，戴民汉等
National Key Scientific Research Project, MOST, 2015-2019, Minhan Dai et al.

边缘海碳循环受海 – 陆 – 气相互作用的影响，是全球碳循环不可或缺但又最复杂的环节之一，属全球变化科学热点和前沿领域。但时至今日，对边缘海碳循环过程与机理的认识依然有限，“为什么一些边缘海是大气 CO_2 的源而另一些却是汇”这一基本问题仍然悬而未决，调控边缘海 CO_2 源汇格局的主要过程和关键机理也有诸多不明之处。

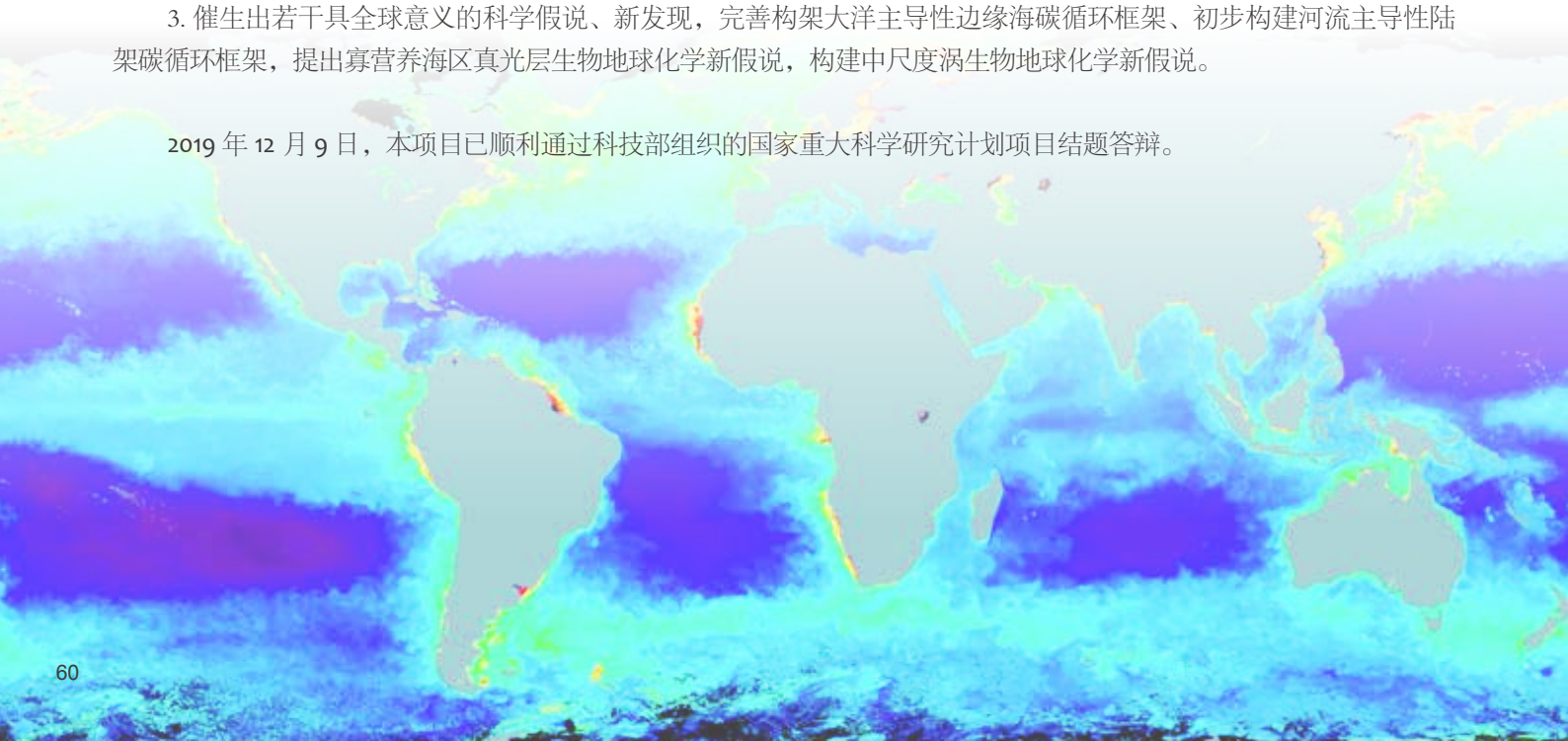
本项目是 973 计划项目“中国近海碳收支、调控机理及生态效应研究”（CHOICE-C I）的延续与深入。本项目（CHOICE-C II）在 CHOICE-CI 构建的大洋主控型边缘海（Ocean-dominated Margin, OceMar）碳循环的概念框架基础上深入集成资料分析、拓展观测手段、强化过程研究，在南海碳的源汇格局及其调控过程、生物泵结构、碳循环的动力调控等方面取得了若干重要进展，通过解剖南海碳循环这一“麻雀”，构架边缘海碳循环的理论框架及解析方法，将我国碳循环研究的着眼点拓展至全球：

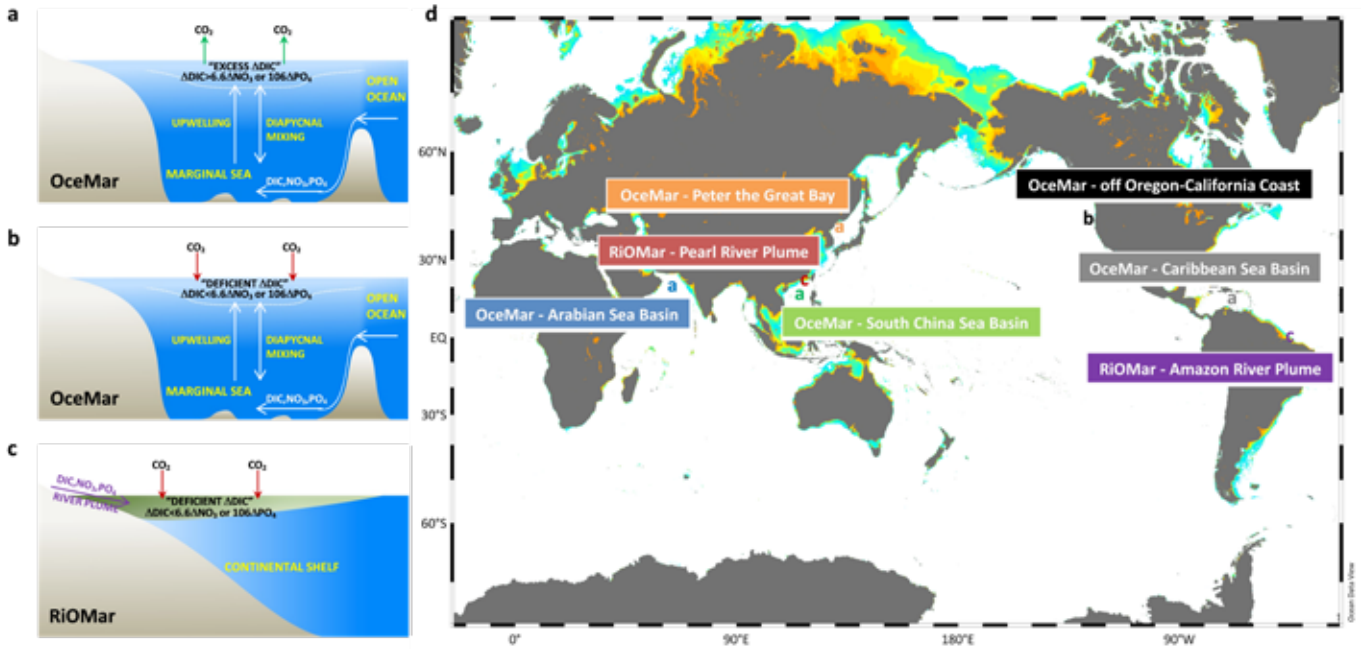
1. 提供最详尽丰富的 CO_2 收支数据产品，为我国在国际气候变化及减排义务谈判中的国家立场提供关键数据和科学支撑，并为国家海洋局编制“CO_2 海 – 气交换通量评估方法”，提供碳酸盐系统产品，为评估南海酸化、缺氧趋势奠定基础，南海也由此成为碳通量研究最为系统的边缘海之一。

2. 提供营养盐的数据产品，为提高数值模式的能力提供初始场，提供大量数值模式、遥感反演产品，构建南海动力循环新框架，使得南海成为生物地球化学及其物理的融合观测和模拟研究最为深入的边缘海之一。

3. 催生出若干具全球意义的科学假说、新发现，完善构架大洋主导性边缘海碳循环框架、初步构建河流主导性陆架碳循环框架，提出寡营养海区真光层生物地球化学新假说，构建中尺度涡生物地球化学新假说。

2019 年 12 月 9 日，本项目已顺利通过科技部组织的国家重大科学研究计划项目结题答辩。





大洋主控型边缘海（OceMar）（a 为 CO_2 源；b 为 CO_2 汇）和河流主控型陆架海（RiOMar）碳循环概念框架（c 为 CO_2 汇），以及全球各大陆架边缘海的 CO_2 源汇解析（d）。（d）中字母 a、b、c 分别对应左图（a）、（b）、（c）所示 CO_2 源汇格局。
Diagnosis of CO_2 source/sink nature in OceMars and RiOMars.

Influenced by land-ocean-atmosphere interactions, coastal ocean carbon cycling is an important component of the Earth's climate system. However, mechanistic understanding to the coastal ocean carbon cycle remains limited, leading to the unanswered question of why some coastal systems are sources while others are sinks of atmospheric CO_2.

Built upon the success of the five-year multiple-PI "973" project, entitled CHOICE-C I on "Carbon cycling in China Seas budget, controls and ocean acidification", CHOICE-C II focuses on the northern South China Sea (SCS) shelf and the SCS basin. Through in-depth data synthesis, multiple observation measures and process study, CHOICE-C II made significant progress in improving estimates of the air-sea CO_2 flux and its physico-biogeochemical controls and in better characterizing the biological pump in the SCS and in other ocean margins.

1. CHOICE-C II produced a comprehensive CO_2 dataset with highest temporal-spatial coverage, which is an important foundation for regional climate science. We set a national standard of "Protocol of air-sea CO_2 flux monitoring and assessment ". In addition, our comprehensive dataset of SCS carbonate system helps provide a baseline of ocean acidification in the SCS. The South China Sea is increasingly becoming one of the most well-studied marginal seas in terms of coastal ocean carbon cycle.

2. CHOICE-C II revealed a new framework of physical dynamics in the SCS, featuring a three-layered circulation structure. A multi-scale carbonate system, nutrients and related biogeochemical cycles have been simulated using a well-validated three-dimensional circulation-biogeochemistry coupled model.

3. Through CHOICE-II, we have extended our diagnostic framework of coastal ocean carbon cycle from Ocean-Dominated Margin (OceMar) to River-Dominated Margin (RiOMar). Based on CHOICE-C II, we have also generated new hypotheses, which include two-layered structure of the euphotic zone in the oligotrophic ocean and a new concept model of eddy biogeochemistry showing transient export fluxes in responding to the eddy evolution.

On December 9, 2019, the project successfully passed the final review organized by the Ministry of Science and Technology.

海洋生态系统储碳过程的多尺度调控及其对全球变化的响应

Marine carbon sequestration: Multiscale regulation and response to global change

国家重点研发计划“全球变化及应对”专项，2016-2021，黄邦钦等
National Key Research and Development Program, 2016-2021, Bangqin Huang et al.

海洋是地表系统中最大的碳库，在全球碳循环中起着举足轻重的作用，显著影响地球气候系统。生物泵和微型生物碳泵是海洋储碳的两个重要途径，其储碳效率在很大程度上决定了海洋和大气中的碳库变动，是碳增汇的关键过程。

项目围绕科学问题“全球变化影响下的海洋储碳机制和碳库变动”，从现代生物地球化学过程入手，以生物群落结构和碳库变动存在显著差异的南海北部陆架、海盆和珊瑚礁三个典型生态系统为研究对象，在不同层级（基因－蛋白－个体－种群－群落－生态系统）水平上研究海洋生态系统的固碳过程、储碳机制及其对海洋酸化的响应；并结合不同沉积系统近 2000 年来的碳库变动，以及工业革命以来高分辨率的海水温度、pH 和碳库记录，探讨海洋碳库变动对自然变化和人类活动的响应机制，阐明生物泵和微型生物碳泵储碳的调控机理。

项目开展 3 年来，取得若干显著成果：1）较系统地阐明了西太平洋中低纬度边缘海浮游植物群落的时空格局、多样性特征与演变机制；2）深入揭示了海洋酸化抑制固氮束毛藻固氮和生长及其机理，构建束毛藻细胞能量模型、预测酸化对全球固氮的影响；3）阐明南海北部陆架和海盆区 2000 年来沉积碳埋藏演变进程及其对气候变化和人类活动的响应机制，为进一步深入阐明海洋生态系统储碳的调控机制及其对全球变化的响应这一科学问题奠定了良好的基础。截止至 2019 年 12 月，项目已独立组织 / 联合组织 7 个航次，在 *Science*、*Nature Communications* 等高水平学术期刊发表论文 98 篇，科技人才和团队建设显著提升。

The ocean is the largest carbon stock on Earth. It plays an important role in the global carbon cycle and has significant impact on the Earth's climate system. The Biological Pump (BP) and Microbial Carbon Pump (MCP) are two of the most important pathways for carbon sequestrations, the efficiency of which determines carbon stock changes in the ocean and atmosphere.

This project focuses on "ocean carbon sequestration mechanisms and pool changes under the influences of global change". Three typical ecosystems (continental shelf, basin and coral reef) in the northern South China Sea, with significant differences in biological community structure and carbon pool changes, were used as study sites. The project will be initiated from the modern biogeochemical process, to demonstrate marine ecosystem processes and mechanisms of carbon storage and its response to ocean acidification at different levels (gene - protein - individual - species - community - ecosystem). Combined with the sedimentary carbon records of the past 2000 years and high-resolution sea water temperature, pH and carbon records available since the Industrial Revolution, we explore ocean carbon pool changes in response to natural variability and human activities, to clarify the regulatory mechanisms of the biological pump and microbial carbon pump.

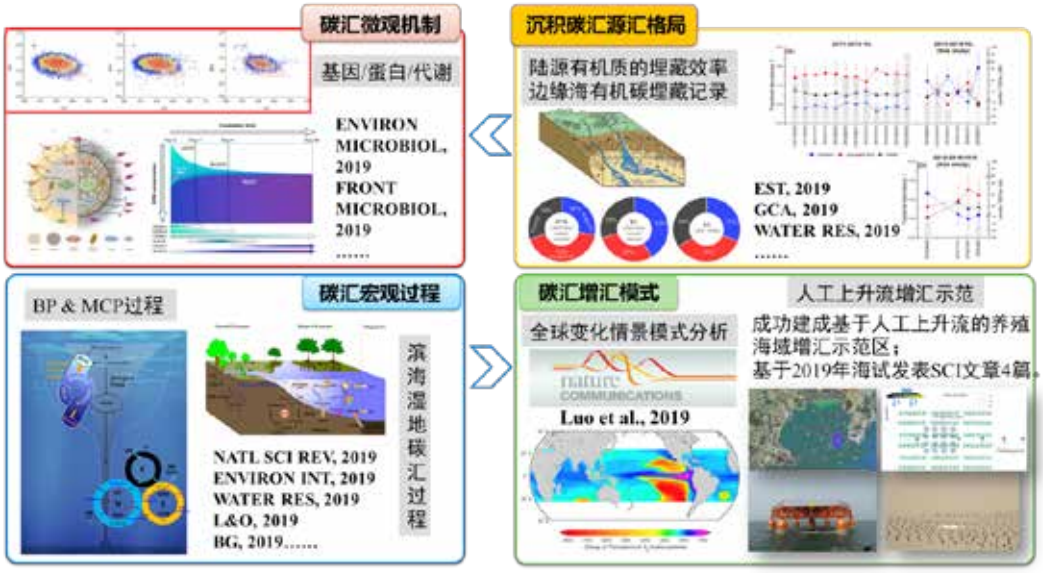
During the past three years, the spatial-temporal pattern and variation mechanism of the phytoplankton community has been revealed. How inhibition of nitrogen fixation and growth in *Trichodesmium* by ocean acidification has been delineated in depth, the variation process of sedimentary carbon burial and its response mechanisms to climate change and human activities in the northern shelf and basin of the South China Sea in the past 2000 years have been preliminarily described; the mechanism of carbon storage regulation in the marine ecosystem and its response to global change has been further elucidated. As of December 2019, this project has organized 7 cruises, published 98 papers in *Science*, *Nature Communications* and other high-level academic journals, and significantly improved talent cultivation and team building, both indiviually and jointly with other institutions and groups.

近海生态系统碳汇过程、调控机制及增汇模式

Process and approaches of coastal ecosystem carbon sequestration (PACES)

国家重点研发计划“全球变化及应对”专项，2016-2021，张瑶等
National Key Research and Development Program, 2016-2021, Yao Zhang et al.

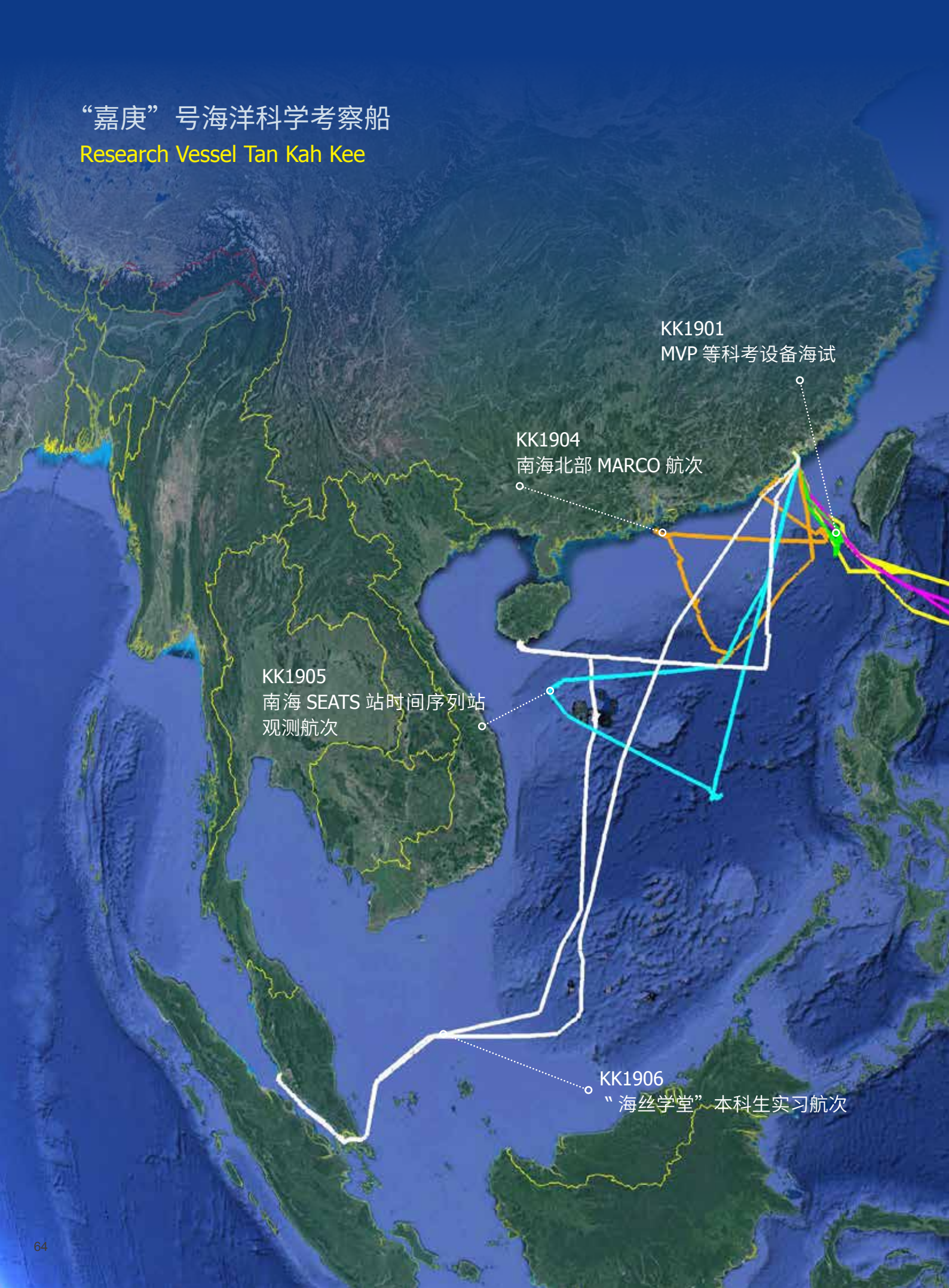
海洋是地球上最大的碳库，发挥着全球气候变化“缓冲器”的作用。蓝碳，即由海洋生态系统捕获的碳（主要是有机碳），是海洋储碳的重要机制之一。蓝碳最初认识的形式是可见的海岸带植物固碳。但之前没有得到足够重视的、看不见的微型生物（浮游植物、细菌、古菌、原生动物）占海洋生物量 90% 以上，是蓝碳的主要组分。我国近海占国土总面积的 1/3，碳汇潜力巨大，亟待研发。针对“近海碳汇对缓解气候变化的贡献和意义”这一具有重要战略意义的目标，“近海碳汇增汇要增到哪里？其过程机制及对全球变化的响应如何？是否可能实现可实施的减排增汇生态工程？”成为摆在我们面前的核心科学问题。该项目共设置四个课题，通过多学科交叉、微观与宏观结合、古今链接研究近海碳库变动与全球变化的关系，评估自然过程和人类活动对碳汇的影响；阐明近海碳循环过程与碳源汇变化过程及蓝碳增汇机制，建立海洋碳汇的指标体系和陆海统筹的近海增汇模式。项目执行至今已在碳汇生物学微观机制和生态学宏观过程、沉积有机碳埋藏机理及千年尺度碳汇演变、全球变化情景模拟碳汇分析，以及人工上升流增汇示范等方面取得突出进展和显著成果。



The ocean is the largest carbon pool on Earth. It serves as a buffer to global climate change, absorbing about 1/3 of the CO_2 produced by human activities. The carbon sink captured by the marine ecosystem is called the "Blue Carbon Sink" (hereinafter referred to as "blue carbon"), which is one of the most important mechanisms for the sea to store carbon. The initial form of blue carbon is visible as plant carbon sequestration in the coastal zone. As a matter of fact, invisible microorganisms (phytoplankton, bacteria, archaea, and protozoa), which have always been ignored, account for 90% of the marine biomass and constitute the main components of blue carbon. The marginal sea covers one third of the total territory of China, and it is urgent that we explore the immense potential of these carbon sinks. This project is comprised of four subprojects, aimed at the key processes and mechanisms of carbon sequestration in coastal ecosystems and ways to increase the carbon sink. To date, the project has made outstanding progress and achievements describing community structure and ecosystem function in the carbon cycle, physiological and molecular mechanisms of refractory dissolved organic carbon production, the re-establishment of the evolutionay process of ocean carbon sequestration in geological history by sedimentary records, carbon sink dynamics under global warming scenarios, and theoretical and technical foundations for engineering ocean carbon sequestration.

“嘉庚”号海洋科学考察船

Research Vessel Tan Kah Kee



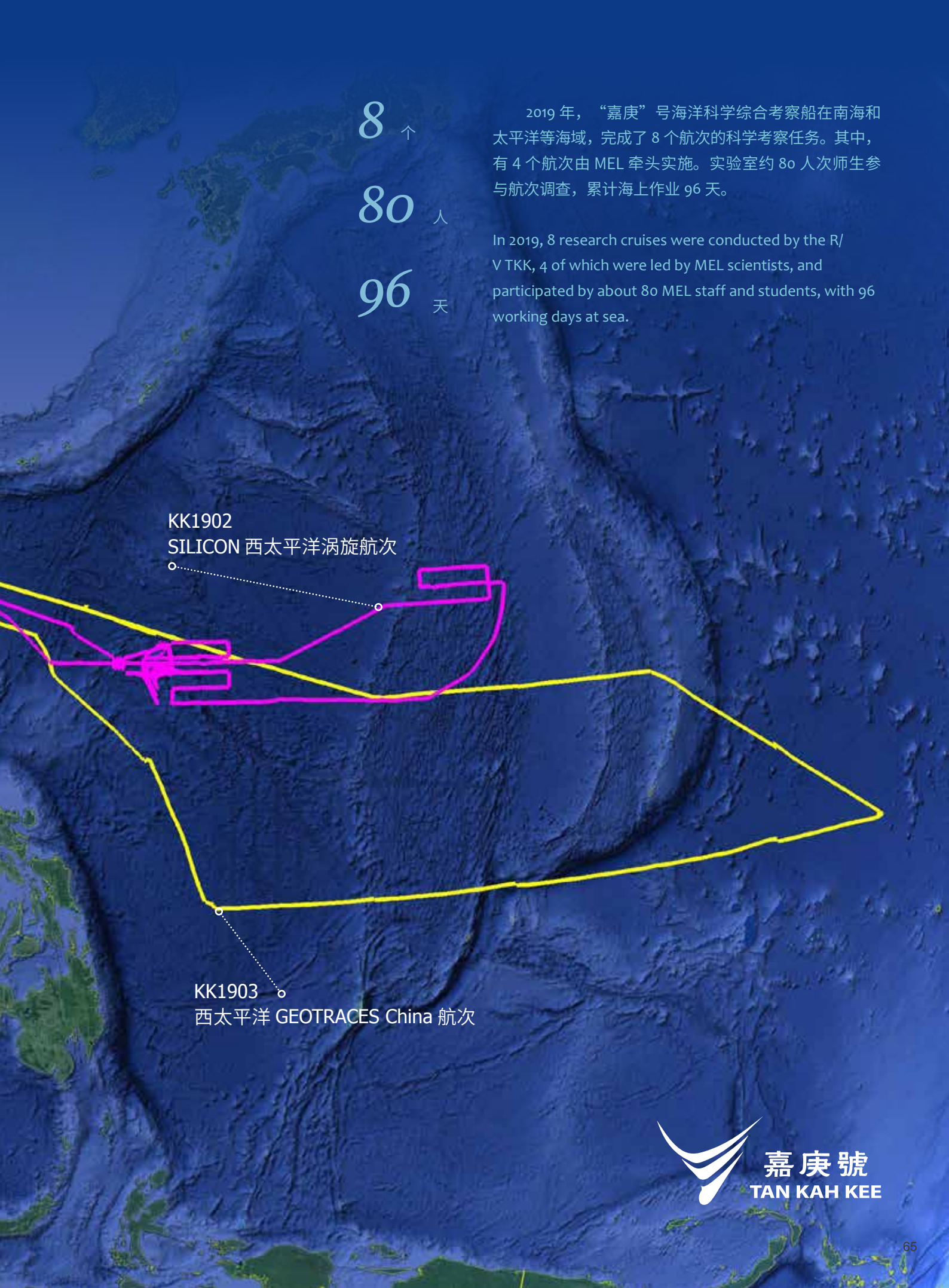
8 个

80 人

96 天

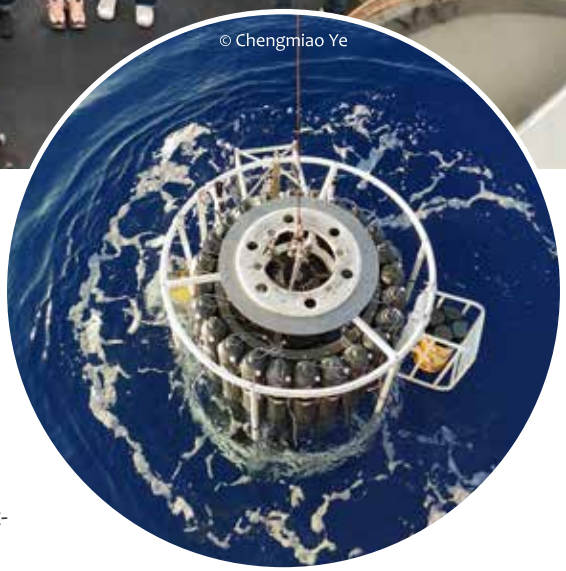
2019 年，“嘉庚”号海洋科学综合考察船在南海和太平洋等海域，完成了 8 个航次的科学考察任务。其中，有 4 个航次由 MEL 牵头实施。实验室约 80 人次师生参与航次调查，累计海上作业 96 天。

In 2019, 8 research cruises were conducted by the R/V TKK, 4 of which were led by MEL scientists, and participated by about 80 MEL staff and students, with 96 working days at sea.



嘉庚號
TAN KAH KEE

© Zongpei Jiang



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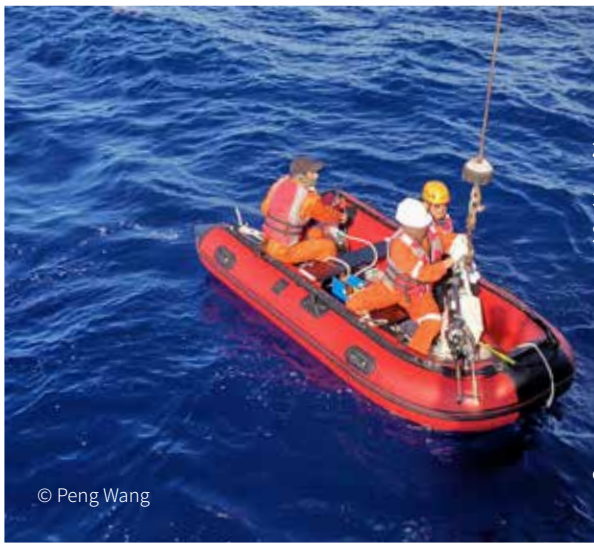
4 月 20 日，协同戴民汉、黄邦钦及张瑶的三个国家级科研项目野外观测研究的 SILICON 西太平洋涡旋航次（KK1902）由“嘉庚”号执行并顺利完成。航次实现多平台、多学科同步观测与实验，累计完成站位 65 站，现场作业 331 项。

On April 20, the SILICON Eddy cruise in the West Pacific Ocean (KK1902) was completed. During the cruise, multi-platform and multi-disciplinary observations and experiments were conducted, with 65 stations and 331 at-sea-operations completed.



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自 2005 年起，厦门大学已参与实施了十余次南海时间序列研究站（SEATS）站现场观测，聚焦生物地球化学和生态系统尤其是碳氮循环相关研究。7 月 10-22 日，“嘉庚”号顺利完成 2019 年 SEATS 观测。

MEL joined the South East Asia Time-series Study (SEATS) investigation and has conducted several cruises since 2005, focusing on biogeochemistry, with a special interest in carbon cycle related studies. The 2019 SEATS Cruise (KK1905) was conducted by RV/TKK on July 10-22.

7 月 25 日 –8 月 28 日，第二届“海丝学堂”本科生教学实习航次首次前往马来西亚。来自厦门大学、马来亚大学、沙巴大学、雅博特拉大学、美国特拉华大学的 92 名师生参加了厦门 – 三亚 – 马来西亚 – 厦门的 3 个航段，执行多学科综合考察暨教学实习，并停靠马来西亚巴生港举办首次海外公众开放日。该航次极大增强了学生海上科考实践能力、动手能力和科研思维能力。

The 2nd “XMU at Sea” Training Cruise for Xiamen University undergraduate students sailed to Malaysia for the first time. The investigation areas range from offshore to deep sea from Xiamen, Sanya to Malaysia. It aims to strengthen students’ practical abilities in marine science. During the cruise, 93 undergraduate students and staffs from XMU, XMU Malaysia, University of Malaya, Malaysian University of Sabah, Universiti Putra Malaysia and University of Delaware, conducted hands-on research. A 2-day R/V open house were held at Port Klang. The cruise provided a valuable platform for students to apply what they have learned in the classroom.


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交流与合作
EXCHANGES AND COOPERATION

组织或承办的会议
CONFERENCES ORGANIZED & CO-SPONSORED BY MEL

2019全球海洋观测大会
Ocean Obs'19

全球海洋观测大会自1999年起，每十年举办一届，是引领全球海洋观测领域发展的高水平大会，具有广泛的国际影响力。2019年9月16-20日，全球海洋观测大会在美国夏威夷檀香山召开，以“充满机遇的海洋”为主题，汇聚了来自全球74个国家从事海洋观测的科研院所及企业的1368名参会者，收到128篇白皮书。

会议发布了大会宣言，指出海洋观测离不开政府、国际组织、社会团体、企业的共同参与，“全面并可持续地观测有助于提高对海洋系统的认知、增强海洋安全、减少海洋灾害、保护海洋资源等”，提出引领未来十年全球海洋观测发展的方向和战略，并将其列为联合国海洋科学促进可持续发展十年（2021-2030年）的重要补充内容，用具体的行动计划指导海洋观测领域的发展。

会议由美国宇航局、大气与海洋局、中国自然科学基金委员会等众多机构和组织支持，MEL也是会议的支持单位之一，戴民汉是大会议程委员会四位共同主席之一。这是中国海洋科学界首次全面参与全球海洋观测大会的发起、筹建和交流研讨。下一届全球海洋观测大会将于2029年在中国青岛举办。

The OceanObs Conference is a community-driven conference that has brought people from all over the planet together to communicate the decadal progress of ocean observing networks since 1999. Themed "An ocean of opportunity", OceanObs'19 was held in Honolulu, Hawaii from September 16 to 20, 2019, gathering 1368 participants from 74 governments, institutions, organizations and stakeholders, and received 128 community white papers.

The participants adopted the conference statement, stating the importance of more complete and sustained observations in the ocean globally: "Information about the ocean is needed to advance the understanding of the ocean system, strengthen security and safety at sea, mitigate the risk of disasters……", and invited all governments, international organizations, industries, scientists, engineers, youth and all people to engage in a collective effort to evolve ocean observing to generate the data and information we need for the ocean we want. A plan of action has been assembled outlining a variety of actionable tasks for the next decade to contribute to the UN Decade of Ocean Science for Sustainable Development (2021-2030).

The conference was sponsored by NASA, NOAA and NSFC along many other cosponsors such as MEL. Minhan Dai was one of the four Program Committee Co-chairs. This is also the first time for Chinese ocean observing community to be fully involved in the OceanObs conference series. Next conference, OceanObs'29 will take place in Qingdao, China.

戴民汉代表中国2029年全球海洋观测大会组委会发言
Minhan Dai, giving a speech on behalf of the Ocean Obs'29 China organizing committee

第四届厦门海洋环境开放科学大会

The 4th Xiamen Symposium on Marine Environmental Sciences (XMAS-IV)

厦门海洋环境开放科学系列会议是由 MEL 发起和组织的系列国际会议，主题为“多学科交叉研究海洋环境”。第四届大会于2019年1月6-9日在厦门大学科学艺术中心召开，戴民汉担任学术顾问委员主席，刘志宇担任大会组委会主席。大会设 33 个专题分会和 4 个特别专场及研讨会，来自海内外 189 个学术机构的 890 余名学者参加了大会。

法国巴黎高等师范学校教授、法国科学院院士 Chris Bowler、澳大利亚新南威尔士大学教授、澳大利亚科学院院士 John Church、美国老多米尼大学教授、美国地球物理学会会士 Eileen Hofmann、美国蒙特利尔湾海洋研究所高级研究员、美国地球物理学会会士 Kenneth Johnson 和荷兰乌得勒支大学教授、荷兰皇家科学院院士 Jack Middelburg 等 5 名海洋科学领域的著名学者受邀分别在海洋生态系统、海洋生物地球化学、气候变化影响、海洋观测等领域做大会主题报告。大会共安排口头报告 278 个及展板报告 352 个，内容涉及海洋与气候、海洋与环境、海洋与可持续发展、海洋与科普等。此外，大会还组织了《自然·地球科学》杂志编辑分享会、女性科学家沙龙、师生交流会等一系列交流与研讨活动。

第五届大会将于 2021 年 1 月 11-14 日在厦门举办，欢迎关注更多资讯：http://melmeeting.xmu.edu.cn/xmas5。

戴民汉开幕式报告
Dr. Minhan Dai giving an opening remark

法国巴黎高等师范学校教授、法国科学院院士 Chris Bowler作主旨报告
Dr. Chris Bowler from École Normale Supérieure (ENS) giving a keynote speech

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The Xiamen Symposium on Marine Environmental Sciences (XMAS) is a serial international conference convened and organized by MEL, with the overarching theme "The Changing Ocean Environment: From a Multidisciplinary Perspective". The fourth XMAS was held in Xiamen from January 6 to 9, 2019. The Scientific Advisory Committee was chaired by Minhan Dai and the Local Organizing Committee was chaired by Dr. Zhiyu Liu. The symposium consisted of 33 general sessions, 4 special sessions, and 2 workshops, attracting 890 participants from 24 countries and 189 institutions, among them 190 from 24 overseas countries and regions, such as Canada, USA, UK, Germany, Italy, Japan, France, Australia, Malaysia, and India.

Five renowned scientists were invited to deliver keynote speeches. They were Dr. Chris Bowler from École Normale Supérieure, Dr. Eileen Hofmann from Old Dominion University, Dr. Jack Middelburg from Utrecht University, Dr. John Church from University of New South Wales, and Dr. Ken Johnson from Monterey Bay Aquarium Research Institute. The topics covered marine ecosystems, marine biogeochemistry, climate change, and ocean observation.

The symposium included 278 oral and 352 poster presentations, covering ocean and climate, marine environmental sciences, marine ecosystems, sustainable development, and science communication. In addition, the conference organized several special sessions, including Meeting with the Editor, Women in Science Salon, and Mentoring Workshop.

The next XMAS-V (http://melmeeting.xmu.edu.cn/xmas5) will be held in January, 2021. We are looking forward to meeting you in Xiamen.

Dr. Rebecca Neely, associate editor of *Nature Geoscience*

"Many many thanks for the excellent XMAS-IV conference. It was a wonderful three days filled with great talks, presentations, and opportunities for informal conversations. The organization of the whole event was outstanding. For a conference of this scale and quality to be organized by an in-house team is a truly remarkable achievement."

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第六届国际硝化及相关微生物过程大会
The 6th International Conference on Nitrification and Related Processes (ICoN6)

国际硝化及相关微生物过程大会（ICoN）自 2009 年开始，每两年一届，已先后在美国、荷兰、日本、加拿大和奥地利成功举办了 5 届。2019 年 10 月 8-12 日，由 MEL 承办的第六届大会在厦门举行，党宏月担任大会主席。会议围绕 6 个主题展开讨论，包括新生理、新生物、新型相互作用，生物化学和生物标志物，工程系统，可持续发展与氮循环，进化和生态等。来自 17 个国家和 80 个科研单位的 173 名学者参加了会议。

The ICoN meetings are the premier biennial opportunity for sharing scientific research related to nitrification. The first five ICoN conferences have been held in the United States, the Netherlands, Japan, Canada and Austria since 2009. ICoN6 was hosted by MEL in Xiamen from October 8 to 12, 2019 and chaired by Hongyue Dang. The conference consisted of 6 sessions, attracting 173 participants from 17 countries and 80 institutions. The thematic topics included new physiologies, new organisms, new interactions, biochemistry and biomarkers, engineered systems, sustainability and the N-cycle, and evolution and ecology.

More on: http://melmeeting.xmu.edu.cn/icon6/

Dr. Bess Ward, Professor, Princeton University
"The conference was wonderful, extremely well organized and very stimulating. I thoroughly enjoyed my visit to both beautiful campuses of Xiamen University. I was thrilled to be able to visit the research vessel Tan Kah Kee. It is absolutely magnificent! I would love to have the opportunity to sail on her. You have a very impressive operation here."

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第三届国家重点实验室公共管理与公共服务联合论坛

The 3rd Joint Workshop on National State Key Laboratory Public Management and Service

2019 年 10 月 15-16 日，第三届国家重点实验室公共管理与公共服务联合论坛在厦门大学召开，旨在探讨国家重点实验室管理服务中的共性问题，分享实验室运行管理的成功经验，促进各国家重点实验室的共同进步。该论坛自 2017 年始，每年一届，已先后在昆明和广州举办了两届。本届由厦门大学主办，固体表面物理化学国家重点实验室、近海海洋环境科学国家重点实验室、细胞应激生物学国家重点实验室联合承办，吸引逾半数国家重点实验室或依托单位主管部门的约 300 名代表参加了本次会议，已成为我国高校、科研院所间科研管理交流的重要平台。

In order to share the experience and explore challenges and solutions in the management and service of state key laboratories nationwide, the third Joint Workshop on National State Key Lab Public Management and Service was held in Xiamen from October 15 to 16, 2019. The workshop has been held in Kunming and Guangzhou once a year since 2017. The 3rd one was hosted by Xiamen University and jointly organized by the State Key Lab of Solid Surface Physics and Chemistry, the State Key Lab of Cell Stress Biology and MEL. About 300 administrators from 140 state key labs or supporting departments attended the workshop. The workshop has become an important platform for communication among universities and institutes in China.

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BioGeoSCAPES国际研究计划中国策划研讨会
BioGeoSCAPES China planning workshop

2019 年 10 月 21 日，由史大林召集的“全球变化下的海洋新陈代谢与营养盐循环（BioGeoSCAPES)”国际研究计划中国策划研讨会在翔安校区召开。30 余位与会者就 BioGeoSCAPES 国际计划的研究构架、内容、挑战等议题展开研讨，并就中国在该国际计划中可扮演的角色、可做出的贡献以及如何在国内推动该计划等进行了探讨。

BioGeoSCAPES 计划由来自 9 个国家的 28 名科学家于 2018 年 11 月在美国伍兹霍尔共同策划发起，旨在通过系统整合、标准化运用观测、实验及数值模型等的新工具和新方法，在生物地球化学的多时空尺度上，揭示海洋新陈代谢的作用和功能，以及其对海洋环境变化的适应力。

The BioGeoSCAPES China planning workshop was held at Xiamen University's Xiang'an Campus on October 21, 2019, convened by Dalin Shi. Thirty participants had a discussion on the research framework, content, challenges and other topics of the BioGeoSCAPES international program. They also had a discussion on China's role, its contribution and how to promote the program at home.

BioGeoSCAPES was put forward by 28 scientists from 9 nations in Woods Hole in November 2018. It aims to reveal the functioning and regulation of the ocean metabolism, along its resilience to changes in the ocean environment, at multiple biogeochemical time and space scales, by linking new tools across observations, experiments and models within a coherent framework.

协办的会议 / CONFERENCES CO-SPONSORED BY MEL

◇ 联合国教科文组织国际地球科学计划 639 项目第四次年会
UNESCO IGCP Project 639, Sea Level Change from Minutes to Millennia, 4th Annual meeting. October 13-19, Xiamen, China

◇ 基于生态系统海洋综合管理与治理国际研讨会
International Workshop on Integrated and Ecosystem-Based Ocean Management and Governance. January 30-31, Xiamen, China

◇ 海洋放射化学国际讲习班
Training Workshop on Marine Radioactivity. February 20-22. San Juan, Puerto Rico

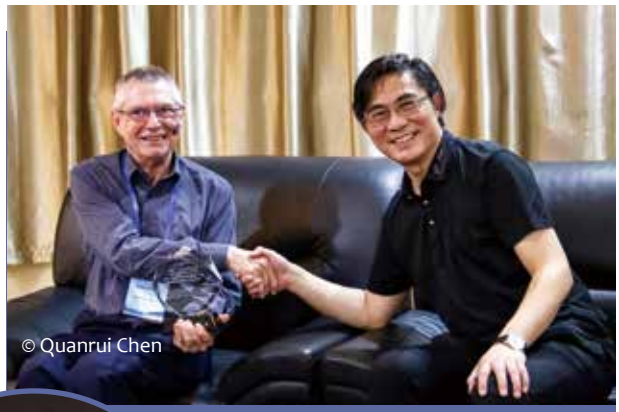
◇ 第四届全球海洋酸化观测网络国际研讨会
The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop. April 14-17, Hangzhou, China

◇ 亚洲沉积体系时空连续性之全球视角国际研讨会
The Asian Sedimentary Continuum: Toward a global Perspective. October 11-12, Xiamen, China

访问学者与开放课题基金 / Visiting Fellowship Program

实验室访问学者基金（分为“郑重”杰出 / 杰出、高级和青年 3 类）支持国内外知名专家及青年学者到实验室开展 1-6 个月的学术交流与合作。2019 年，英国阿伯丁大学 James Prosser 教授、奥地利维也纳大学 Michael Wagner 教授、美国路易斯安那州立大学 Edward Law 教授、西安交通大学程海教授等 30 名国内外学者获批该项基金，其中，杰出 7 名（包括“郑重”杰出学者 2 名）、高级 10 名、青年 13 名。

The MEL Visiting Fellowship Program was launched in 2009. The program has supported visiting fellows to conduct collaborative studies with MEL scientists for durations of 1 to 6 months, providing research funds, travel and living expenses. Thirty fellows were sponsored in 2019, including Prof. James Prosser from University of Aberdeen, Prof. Michael Wagner from University of Vienna, Prof. Edward Allen Laws from Louisiana State University, Prof. Hai Cheng from Xi'an Jiaotong University.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James Prosser from the University of Aberdeen, UK having a discussion with Minhan Dai

William D. Smyth from Oregon State University

其它交流与合作 / Other Exchange Highlights

实验室通过访问学者与开放课题、“111”引智计划、“凌峰论坛”、“周一午餐交流会”（34 讲）等形式为实验室成员提供与海内外学者交流的平台。2019 年度，共有 130 余名国内外学者通过学术报告、讲授课程、合作研究等多种形式来实验室开展合作交流。此外，科研、技术人员和研究生共计 320 余人次出访，参加国内外学术研讨会、合作研究、联合航次或技术培训等。

International exchanges and collaborations are supported by several programs, for example, the MEL Visiting Fellowship Program, Lingfeng Forum, Luncheon Seminar and the “111” Collaborative Program. In 2019, more than 130 visitors came to MEL and more than 320 MEL members and students went overseas for conferences, academic exchanges, joint research and cruise surveys.

Daniel Conley-Luncheon, Seminar #138 The Baltic Sea from Understanding to Management

34 午餐交流会

130 来访人次

320 出访人次

Shufen Pan-Luncheon, Seminar #150 Global Net Primary Productivity and Water Use Efficiency Induced by Climate Change and Increasing Atmospheric CO_2 in the 20th and 21st Centuries

可持续海洋经济高级别小组专家组“蓝皮书”：海洋综合管理
Leading the blue paper on Integrated Ocean Management under the high level panel for a sustainable ocean economy

可持续海洋经济高级别成立于 2018 年 9 月，由 14 位政府首脑和联合国秘书长海洋特使倡议，致力于推动大胆、务实的海洋健康和财富解决方案。支持可持续发展目标，为人类和地球建设更美好的未来。通过与世界各国政府、专家和利益相关方合作，高级别小组的目标是制定一个实现可持续海洋经济的路线图，并在世界范围内启动、扩大和加速应对行动。

高级别小组由澳大利亚、加拿大、智利、斐济、加纳、印度尼西亚、牙买加、日本、肯尼亚、墨西哥、纳米比亚、挪威、帕劳和葡萄牙的总统或总理组成，并由一个专家小组、顾问组和设在世界资源研究所的秘书处支持，开展情势分析、加强沟通和推动利益相关者的参与。

为探讨海洋与经济之间的紧迫挑战，高级别小组委托全球专家撰写一系列“蓝皮书”，总结在技术、政策、治理和金融等领域的解决方案和最新科学进展，加快建立更可持续发展的海洋。其中，以“海洋综合管理”为主题的蓝皮书由 Jan-Gunnar Winther 和戴民汉领衔编写，作为 16 篇系列蓝皮书之一，将于 2019 年 11 月至 2020 年 6 月期间出版。该蓝皮书提出了价值创造与生态系统健康保障相结合、以生态系统为基础的综合管理模式。通过借鉴以往的成功经验和失败教训，总结当前施行的政策和实践过程中存在的问题，提出一套实现海洋综合管理的步骤和指导原则，并评估加快发展进程的契机及其对就业和公平的影响。

Established in September 2018, the High Level Panel for a Sustainable Ocean Economy (HLP) is a unique initiative of 14 serving heads of government committed to catalysing bold, pragmatic solutions for ocean health and wealth that support the UN Sustainable Development Goals and build a better future for people and the planet. By working with governments, experts, and stakeholders from around the world, the HLP aims to develop a road map for rapidly transitioning to a sustainable ocean economy, and to trigger, amplify and accelerate responsive action worldwide. The HLP consists of the presidents or prime ministers of Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, and Portugal, and is supported by an Expert Group, Advisory Network and Secretariat that assist with analytical work, communications and stakeholder engagement. The Secretariat is based at the World Resources Institute, Washington, US.

The HLP has commissioned a series of ‘Blue Papers’ to explore pressing challenges at the nexus of the ocean and the economy. These Blue Papers summarise the latest science and state-of-the-art thinking about innovative ocean solutions in the technological, policy, governance and finance realms that can help accelerate a move into a more sustainable and prosperous relationship with the ocean. Lead by Jan-Gunnar Winther and Minhan Dai, Blue Paper #14 on Integrated Ocean Management, is part of a series of 16 papers that are being published between November 2019 and June 2020. This paper makes the case for integrated ecosystem-based management, which combines value creation and the safeguarding of ecosystem health. By drawing on learning from previous successes and failures, the paper identifies existing impediments in policy and practice and lays out a set of steps and guiding principles toward successfully integrated ocean management. Finally, it assesses current opportunities to accelerate progress and the impact of these opportunities on jobs and equity.

参与规划未来十年全球海洋碳循环综合研究
Planning the integrated ocean carbon research for next decades

戴民汉、焦念志应邀参加 2019 年 10 月 28-30 日在法国巴黎联合国教科文组织总部召开的海洋碳综合研究专家研讨会。该会议由政府间海洋组织（IOC）、国际海洋碳循环协调计划（IOCCP）、上层海洋与低层大气计划（SOLAS）、国际海洋生物地球化学与生态系统综合研究计划（IMBeR）、气候变化与预测计划（CLIVAR）、全球碳循环计划（GCP）联合召集，通过对生物地球化学、时空尺度、方法与模型、及海洋碳研究的社会应用等主题的探讨，填补关键知识空白，解决政府决策对碳循环（尤其是其对海洋的影响）信息日益增长的需求，规划未来十年全球海洋碳循环综合研究。我们提出的微型生物碳泵 (MCP) 理论、以及海洋负排放（ONCE) 建议被纳入 IOC 报告。

Minhan Dai and Nianzhi Jiao were invited to participate the International Workshop on Integrated Ocean Carbon Research, held at IOC-UNESCO headquarters in Paris (France) on October 28–30, 2019. The Workshop was co-convened by the Intergovernmental Oceanographic Commission of UNESCO (IOC), the International Ocean Carbon Coordinating Project (IOCCP), the Surface Ocean-Lower Atmosphere Study (SOLAS), the Integrated Marine Biosphere Research Project (IMBeR), the Climate and Ocean Variability, Predictability and Change core project of the World Climate Research Programme (CLIVAR), and the Global Carbon Project (GCP).

The goal of this workshop was to bring together the decades of collective experiences of the above mentioned expert groups to inform the next generation of integrated ocean carbon research. Specifically, by discussing the themes on biological and geochemical aspects, temporal and spatial scales, methodologies and models, and societal applications of ocean carbon research, the workshop aimed to identify the research needed to fill critical knowledge gaps, better integrate our science so as to address the growing policy needs for information on how global change impacts on the carbon cycle and how, in turn, changes in the carbon cycle impact on our planet – with a focus on the ocean component.

The concept of microbial carbon pump (MCP) and the proposal of ocean carbon negative emission (ONCE) are included in the IOC report.

Newly Appointed: Service in Journals and Associations

Minhan Dai, Member, Executive Committee of AGU Ocean Sciences section

Minhan Dai, Member, High Level Panel for a Sustainable Ocean Economy Expert Group

Xianghui Guo, Review Editor, Frontiers in Marine Science

Haipeng Liu, Member of Editorial Board, Developmental and Comparative Immunology

Zhiyu Liu, Special Issue Guest Editor, Ocean Dynamics

Jian Ma, Associate Editor, Frontiers in Marine Science

Bingbing Wang, Member of Editorial Board, Journal of Applied Oceanography (in Chinese)

Dazhi Wang, Editor, Marine Life Science and Technology

Yao Zhang, Editorial Board, Scientific Reports

Yao Zhang, Special Issue Guest Editor, Sustainability

Selected invited talks in national / international conferences

Xi Chen, Highly stable luminescent lead halide perovskite materials: syntheses and applications in analytical sensing. 2019 China-Japan-Korea Symposium on Analytical Chemistry, October 11-14, 2019, Yongin, Korea. (Keynote speech)

Minhan Dai, Biological carbon pump in the oligotrophic ocean: perspectives on the North Pacific Subtropical Gyre, International Symposium on Environmental Geochemistry (ISEG) Conference, August 8-10, 2019, Beijing, China. (Keynote speech)

Dazhi Wang, A draft map of the marine diatom proteome. The International Conference on Genomics-Ocean (ICG-Ocean 2019), September 21-22, 2019, Qingdao, China. (Invited talk)

袁东星 , 海水化学参数高通量检测方法及仪器的研发 . 南方科技大学 2019 水质安全与环境传感研讨会 . 2019 年 11 月 25-26 日 , 深圳 . (主题报告)

Dalin Shi, The complex effect of ocean acidification on primary producers in a multi-stressors marine environment. The 4th Global Ocean Acidification Observing Network (GOA-ON) International Workshop, April 14-17, 2019, Hangzhou, China. (Plenary Keynote)

与特拉华大学开启合作新十年

A new decade of Join-CRM with University of Delaware

厦门大学与美国特拉华大学“海洋研究与管理联合研究所”于2008年6月成立，至今已运行十年。 2019年1月5日，厦门大学 – 特拉华大学联合研讨会在翔安校区召开，特拉华大学地球、海洋与环境学院 Estella Atekwana 院长率团参加，与厦大师生共同回顾双方十年来的合作成果。

十年间，联合研究所取得了丰硕的成果，双方互派师生交流访问、联合举办学术研讨会、联合发表论文，开展设施与数据共享，在海洋遥感、物理海洋学、化学海洋学等方面开展了深层次合作。值得一提的是，12名博士生入选两校的“海洋学双博士学位”项目，获得联合培养。站在新十年的开端，双方将继续拓展合作，在数据共享为两校师生提供全球化平台，携手开启新征程，共同探索全球近海与大洋。

Minhan Dai and Dean Estella Atekwana at the joint workshop

Guizhi Wang guiding a lab tour to UD faculty to explore new partnership opportunities.

院际交流 / Institutional Collaboration

It's been 10 years for the Joint Institute for Coastal Ocean Research and Management (Joint-CRM) since its establishment in June 2008 by Xiamen University and University of Delaware (UD).

On January 5, 2019, the Workshop on Joint-CRM 10th Anniversary took place on Xiang'an Campus, attended by XMU faculty and students, and the UD delegation led by Dean Estella Atekwana of College of Earth, Ocean, and Environment. The workshop summarized the success Joint-CRM has achieved during the last decade, among which, the most notable one would be the 12 students being enrolled in the Dual Oceanography PhD Program and the workshops that have been convened together. Besides, many research accomplishments have been achieved over the past decade, including the papers published by faculty and students working together as co-authors in remote sensing, physical oceanography, and chemical oceanography, etc, as well as shared infrastructure and data that has highly promoted the research work between both institutions.

During the workshop, participants had profound discussions to explore new partnership opportunities. The Joint-CRM will spare no effort for the next decade to continue building the best global platforms for scientists, staff, and students from both UD and XMU to explore the roles of coastal and global oceans in climate change.

UD students Rucha Wani (front row, far right) and Paul Ernst (back row, far left) were the first UD students to take part in XMU's student practical cruise to the South China Sea and XMU Malaysia campus aboard R/V Tan Kah Kee in summer 2019.

与机器人学国家重点实验室开展战略合作

New collaboration with the State Key Laboratory of Robotics

2019 年 2 月，实验室与中国科学院沈阳自动化研究所机器人学国家重点实验室签署合作协议。4 月，机器人学国家重点实验室为西北太平洋春季涡旋调查航次提供了 11 台“海翼”水下滑翔机，装载了温盐深、叶绿素、浊度、溶解氧等传感器，对该航次重点关注的 E2 中尺度冷涡进行了为期 20 天的连续组网观测，启动了双方在海洋观测领域的首次合作。

接下来，双方将围绕海洋环境科学与智能海洋观测技术发展趋势，推进智能海洋观测技术与前沿海洋科学研究交叉融合；利用现有与正在研发的实用海洋观测装备，合作开展海洋观测示范应用，并优势互补，开展人才培养与访问交流，提升我国海洋环境保护与生态安全保障的整体水平。

An agreement was signed between MEL and the State Key Laboratory of Robotics (SKLR) of Shenyang Institute of Automation, CAS, in February 2019. In April, 11 “Sea Wing” gliders developed by SKLR were deployed during the MEL SILICON (SprIng time cycLonIc eddy in the northwest paCific Ocean off taiwaN) cruise. Loaded with CTD, chlorophyll, turbidity and dissolved oxygen sensors, the gliders conducted 20-day-time-series observations at the focal E2 mesoscale cold eddy station, signaling the first cooperation between the two institutions.

In the future, MEL and SKLR will conduct joint research in marine environmental science and intelligent technology on ocean observation. Interdisciplinary research on cutting-edge science collaboration, student training, and staff exchanges are encouraged to promote environmental protection and ecological security study in China.

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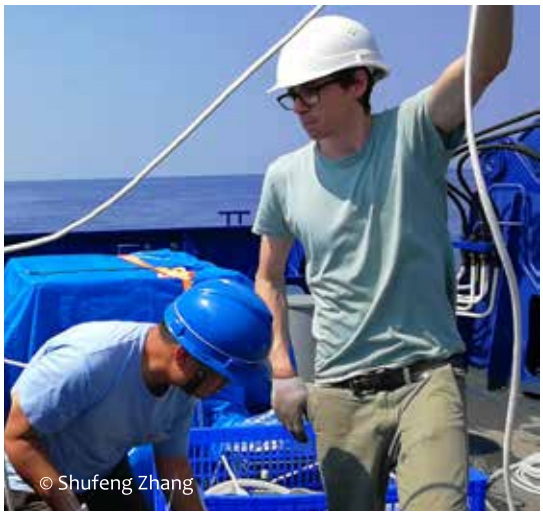
与亥姆霍兹基尔海洋中心开启合作
MOU with GEOMAR

GEOMAR
Helmholtz-Zentrum für Ozeanforschung Kiel

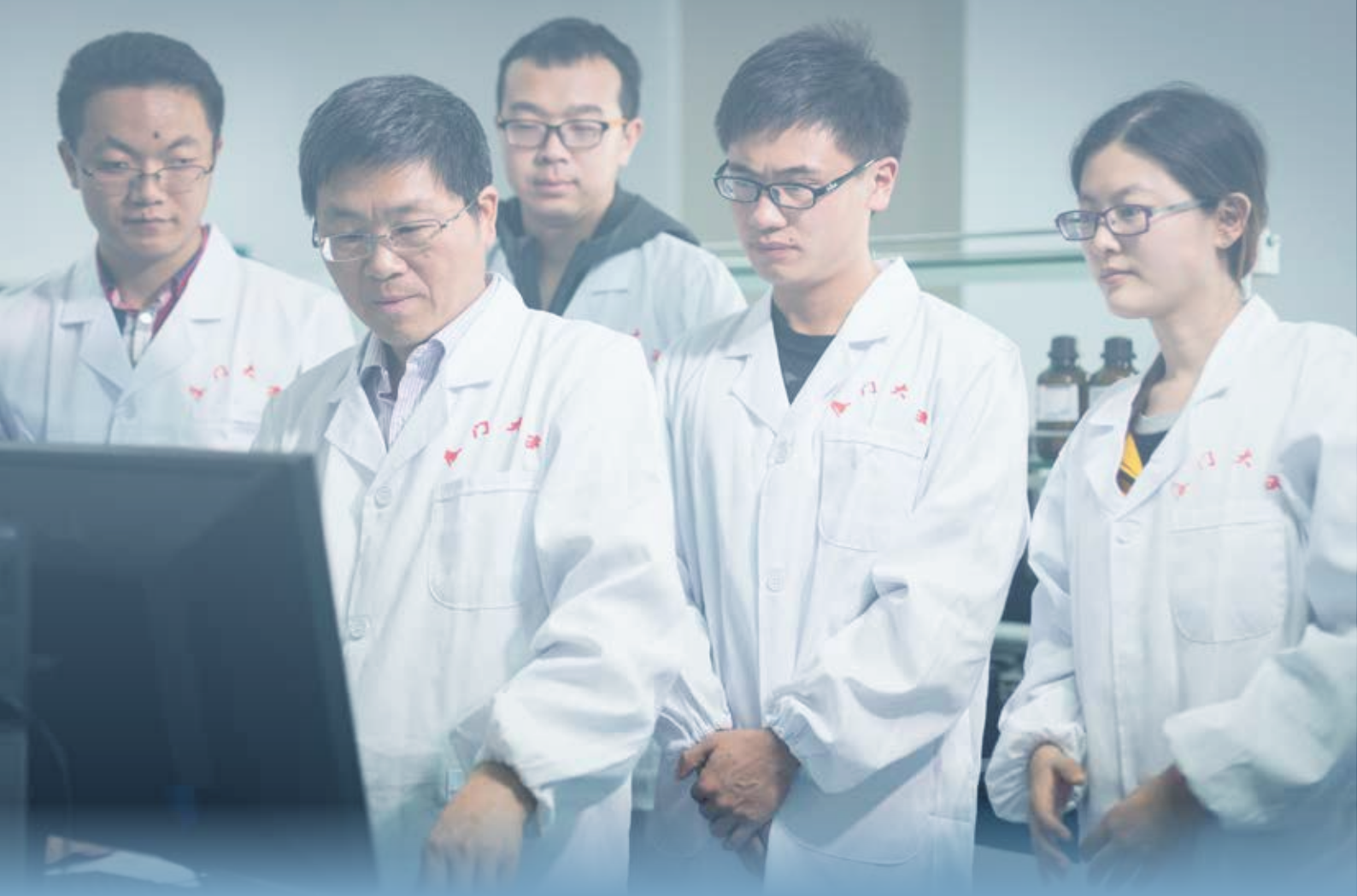
2019 年 11 月 19 日，在实验室的推动下，厦门大学与德国亥姆霍兹基尔海洋研究中心签署校际合作备忘录，旨在促进合作研究，推动海洋科学的发展。合作研究方向包括：海洋生物和生态学（如海洋生物学观测，海洋生产力和生物固氮作用的驱动因子），海洋生物地球化学（如海洋微量元素观测），物理海洋学（如耗散尺度到全球尺度的海洋动力过程观测、数值模拟和理论研究），洋盆演变、海洋灾害和海底资源等（如海底测绘、陆坡稳定性分析和天然气水合物）以及地质海洋学（如古环境变化、古海洋学、古气候学等）。

The Memorandum of Understanding between Xiamen University and Helmholtz Centre for Ocean Research Kiel (GEOMAR) was signed on November 19. This MOU aims to promote research cooperation with a view to contributing to the advancement of scientific research in marine science. The scope of this joint research cooperation includes ocean biology, ecology (observations of ocean biology and studies of forcing factors determining ocean productivity and diazotrophy, etc.), ocean biogeochemistry (observations of ocean trace element, etc.), physical oceanography (observational, numerical and theoretical studies of oceanic dynamical processes from dissipation scale to the global scale), ocean basin evolution, marine hazards and seafloor resources (seafloor and subsurface mapping, slope stability analysis and gas hydrates) and geological oceanography (palaeoenvironmental change, palaeoceanography, palaeoclimatology, etc.).



Dr. Thomas Browning, Postdoc, GEOMAR marine biogeochemistry division, participating in the GEOTRACES-China GP09 cruise onboard R/V TKK.

Jing Liu (3rd from left) will head to GEOMAR in 2020-2022 to start her joint PhD examining ammonium sources and pathways in the South Indian Ocean. Supervision will be provided by both GEOMAR and MEL researchers.



人才培养
EDUCATION

“弹指一挥间，与MEL结缘已近十年；十年来我以MEL为荣，愿十年后MEL以我为荣。”

—肖武鹏

2019年3月参加KK1902西北太平洋Eddy航次
Dr. Chuanjun Du on the KK1902 Northwest Pacific Ocean Eddy Cruise in March, 2019

—杜川军

参加日本筑波大学下田海洋观测站的调查航次
Dr. Xikun Song attending the coastal cruise of the Shimoda Marine Station, University of Tsukuba

—宋希坤

在海南三亚参加第十九届中国水色遥感大会并做口头报告
Dr. Xiaolong Yu, giving a presentation at the 19th China Water Color Remote Sensing Conference in Sanya, November, 2019

—余小龙

在GEOTRACES-CHINA GP09 航次期间进行原位大体积泵作业前的准备工作
Dr. Kan Zhang, preparing for the operation during the GEOTRACES-CHINA GP09 Cruise

—张衍

MEL杰出博士后基金
MEL Outstanding Postdoctoral Fellowship

实验室于 2014 年设立“杰出博士后基金”，吸引国内外优秀的博士毕业生开展博士后研究，以此促进学科交叉，提高人才培养能力。

2019 年共有 5 人入选，分别是中国地质大学（武汉）刘犇嗣博士、荷兰特文特大学余小龙博士、厦门大学肖武鹏博士、中国海洋大学王龙博士、印度 Mohanlal Sukhadia 大学 Venkatesh Chinni 博士。

张衍、肖武鹏入选 2019 年度“博士后创新人才支持计划”；高霄龙、肖武鹏分别获得中国博士后科学基金面上项目一等资助；余小龙、张衍、刘犇嗣获二等资助。此外，宋希坤于 2019 年出版专著《中国与两极海域桧叶螅科刺胞动物多样性》。

Aiming to foster interdisciplinary research, MEL initiated the Outstanding Postdoctoral Fellowship Program in 2014. The Fellowship funds innovative, ground-breaking projects that have the potential to advance knowledge in marine environmental sciences and other interdisciplinary research that fits into MEL’s research scopes.

Five applicants were funded in 2019. They are Dr. Jiangsi Liu from China University of Geosciences (Wuhan), Dr. Xiaolong Yu from Universiteit Twente, Dr. Wupeng Xiao from Xiamen University, Dr. Long Wang from Ocean University of China, and Dr. Venkatesh Chinni from Mohanlal Sukhadia University.

Among the fellows, Kan Zhang and Wupeng Xiao were listed (granted) under the Postdoctoral Innovative Talent Support Program; Xiaolong Gao, Wupeng Xiao, Xiaolong Yu, Kan Zhang, and Jiangsi Liu were listed (granted) under the China Postdoctoral Science Foundation for General Projects. Furthermore, Xikun Song has published a book entitled *Biodiversity of Sertulariidae Lamouroux, 1812 (Cnidaria: Hydrozoa) in Chinese Seas, with Records from Chinese National Arctic and Antarctic Research Expeditions.*

博士生奖学金
MEL PhD Fellowship

为吸引国内外优秀生源，培养杰出的博士研究生，实验室于 2016 年设立“MEL 优秀博士生奖学金”，面向国内外高校所有读博申请者，资助海洋环境科学及与实验室主攻方向相关的其他学科领域。2019 年共有 5 名学生入选，并已于 2019 年 9 月入学。

Aiming to attract and encourage academically outstanding PhD students, MEL initiated the MEL PhD Fellowship since 2016. The Fellowship is offered in marine environmental sciences and other interdisciplinary research that fits into MEL's research scopes. Applicants must be seeking admission as new full time PhD students. 5 awardees joined MEL in September 2019.

“MEL有很多优秀的老师，他们对待科研的认真态度深深地影响着我；有很多很棒的讲座与论坛，拓宽了我的视野，增加对其他方向的了解；有很棒的科研仪器与平台，给予我们科研上的技术支持与保障。”

—陈丽英（Liying Chen）

郭嘉宇（Jiayu Guo）

“在MEL学习能获得很多工作指导和科研经验，了解科学前沿工作，接触众多国内外海洋科学的前辈们，极大拓展了我的视野、扩充了我的知识储备。同时MEL能让我更好地和相关方向的科研人员交流，让我少走弯路，减少碰壁，掌握更好的学习方法。”

— 黄汝辉 (Ruhui Huang)

姜若桐 （Ruotong Jiang）

“在本科四年的学习生涯中，我感受到了MEL浓厚的学术氛围以及老师们认真严谨的科研态度，更重要的是海洋学科的魅力深深吸引着我，让我想要不断地探索下去。在MEL有良师也有益友，给我提供了很多的帮助，还有丰富的科研讲座让我受益匪浅。”

—陈若男（Ruonan Chen）

6 名厦大学生于 3 月 25-29 日前往台湾高雄参加了第十一届 高校水环境科学研究生研讨会
Six MEL students attended the 11th UCAS Postgraduate Symposium on March 25-29 in Kaoshiung

第四届MEL研究生学术论坛
The 4th MEL Graduate Forum

6 月 28 日 –7 月 1 日，第四届研究生学术论坛在东山太古海洋观测与实验站召开。论坛以“More Talking, More Thinking”为主题，围绕“海洋生态与资源”、“海洋与海岸带管理”、“气候变化”、“生物地球化学循环”四个专题，来自不同专业的近 40 名研究生展开了学术报告和研讨。论坛特设现场调研活动和团队汇报环节，评选出一个最佳团队汇报奖，获奖团队赴东山二中进行科普巡讲。论坛以“海洋环境科学研究生委员会”为主体进行组织，秉持开放包容的精神，不断提升举办水平和影响力，吸引越来越多各学科优秀研究生参与交流。

The Fourth MEL Graduate Forum took place in Dongshan Swire Marine Station from June 28 to July 1, attended by 40 graduate students from different majors. With the overarching theme “More Talking, More Thinking”, the forum discussed marine ecosystems and resources, ocean and coastal management, climate change and biogeochemistry cycling. Three best oral presentations and one best presentation team were awarded. The best team also delivered an outreach speech in the local Dongshan No.2 Middle School the following day. Field research is another highlight of this forum. Organized by the Marine Environmental Science Student Association (MESSA), this forum has become a platform for fostering young generation scientists and leadership building.

"在MEL的第四年，也是陪伴MEL研究生论坛的第四年。尤记得16年夏天第一次参加时的好奇和激动，真的爱上了站在台上和不同专业的同行分享的感觉。它就像有魔力一样，让我接下来的三年能有机会留在组委会，并有幸见证自己和论坛共同成长。专业交流、团队合作、分享学习、科普巡讲是我心目中理想的论坛的样子。“大概永远保持热情的原因，是有着永远都热情洋溢的伙伴”。

—刘婧 2017级博士研究生， MESSA主席
Jing Liu, 3rd year PhD student, Chair of MESSA

“研究生论坛从筹备初期到圆满结束可以看到工作人员的辛勤付出，从论坛报告到沙滩素拓以及中学科普，整个过程内容丰富而充实，学术和生活上都受益良多。”

—袁忠伟 2018级博士研究生
Zhongwei Yuan, 2nd year PhD student

海洋环境科学本科生暑期科研奖学金项目
MEL Summer Undergraduate Research Fellowship

为鼓励本科生尽早开展科研训练，更好地培养本科生的创新能力和学术精神，激发优秀学生的科学兴趣，并为其提供继续深造的平台和机会，实验室自 2014 年起启动“MEL 海洋环境科学本科生暑期科研奖学金”。2019 年录取了来自美国加州大学圣塔芭芭拉分校、厦门大学马来西亚校区、浙江大学、南京大学等 11 所高校的 17 名本科学生。项目以科研课题为导向，本科生在导师的指导下进行学习，开展实验研究。组委会还为本科生组织了系列学术讲座、技术安全讲座和野外调查，并定期开展学术沙龙，以期全方位培养学生的学术能力、科学表达与交流能力，助其拓展国际化的视野。

Initiated in 2014, the MEL Summer Undergraduate Research Fellowship in Marine Environmental Science (URF) encourages undergraduates to pursue science and technology careers by providing research experiences at MEL. Seventeen undergraduate students from 11 universities joined the program in 2019, working on mini research projects with individual supervisors. They also received training on lab safety and facility operations. Several interactive seminars and field studies were also organized for the participants.

我最感兴趣的是关于海洋藻类的相关知识。教授的讲解让我了解到通过海洋藻类来判别一些全球气候变化，我真正意识到海洋微藻对全球气候变化的重要性。此次项目活动让我掌握了多种实验方法和实验仪器的基本操作。我深刻了解到科研的不容易，也更加坚定了我以后从事科学研究的决心。

天津科技大学 唐一昌
Yichang Tang from Tianjin University of Science and Technology

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第二届海洋动力学春季讲习班
The Second Xiamen Spring School on Ocean Dynamics (Xmod-II)

以“上层海洋动力学”为主题的第二届厦门海洋动力学春季讲习班于 2019 年 5 月 6-10 日在厦门举办。该系列习班由刘志宇联合美国伍兹霍尔海洋研究所黄瑞新教授等于 2017 年发起，旨在通过邀请国际知名物理海洋学家讲授海洋动力学前沿基础理论课程，提升物理海洋学相关专业研究生与青年学者的海洋动力学理论水平与科学素养。讲习班以英文授课，以贯穿基础理论与研究前沿为特色，免费向广大研究生与青年学者开放。

本次主讲专家美国布朗大学 Baylor Fox-Kemper 教授与俄勒冈州立大学 William D. Smyth 教授围绕上层海洋小尺度物理过程、上层海洋准地转湍流与不稳定过程等开展系列课程，黄瑞新、夏威夷大学裘波、中国海洋大学张志伟及自然资源部第一海洋研究所宋振亚等担任客座讲师。

The 2nd Xiamen Spring School on Ocean Dynamics (Xmod-II) was held in Xiamen from May 6 to 10, 2019. Convened by Zhiyu Liu and Ruixin Huang (Woods Hole Oceanographic Institution) since 2017, The Xmod series aims at introducing fundamental ocean dynamics, from the basics to research frontiers, to graduate students and early-career scientists. The topics cover a wide range of oceanic phenomena and processes. It has a specific theme for every course. With the theme of "Upper Ocean Dynamics" in 2019, Baylor Fox-Kemper (Brown University) and William D. Smyth (Oregon State University) were invited to deliver principal lectures, while Ruixin Huang, Bo Qiu (from University of Hawaii Manoa), Zhiwei Zhang (from Ocean University of China), and Zhenya Song (from the First Institute of Oceanology, MNR), were guest lecturers.

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首届海洋氧气网络国际研究生暑期学校

The First Global Ocean Oxygen Network Summer School


© Lun Cai

由联合国教科文组织政府间海洋学委员会组织，MEL 承办的首届全球海洋氧气网络暑期学校于 2019 年 9 月 2-8 日在翔安校区举办，学员由来自 19 个国家和地区的 37 名研究生及青年科研人员组成。本次暑期学校邀请 14 名学者，展开系列理论讲授和前沿学术讲座，主题包括：近海和封闭海域缺氧、大洋缺氧、生态系统模型、与缺氧有关的海洋观测系统设计、海洋观测数据管理及分析、缺氧对生物的影响等；指导学生动手实验、学习生物地球化学模型，进行海报交流，并赴东山开展实地调查及公众交流；此外，还搭乘“嘉庚”号科考船前往厦门湾及九龙江口进行海上调查实习。

Organized by IOC-UNESCO and hosted by MEL, the First Global Ocean Oxygen Network Summer School (2019 GO2NE SS) was held at Xiamen University from September 2-8, 2019. Fourteen world-leading international scientists and 37 early career scientists participated. It connected young researchers with world leading scientists from the academic and small medium enterprises working on oxygen not only in a theoretical framework, but also through practical sessions on laboratory experiments, field work aboard the R/V TKK in the Xiamen Bay, modelling, science communications, ethics and engagement with stakeholders in Dongshan.


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GO$_2$NE SS 2019

GO$_2$NE Summer School


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Visiting the abalone farm in Dongshan
© Lun Cai

Yosra KHAMMERI from National Institute for Marine Sciences and Technologies, Tunisia

"Overall, the summer school was very successful. Lectures and practical sessions were well presented and well received. This experience was not only rich from scientific side, it makes me understand that there is no limits and barriers in science, no matter traditions or habits, we are all connected in the name of science and we have the same goals."

Genevieve L. Fernandes from CSIR- National Institute of Oceanography, Goa, India

"It lived up to my expectations! The communication session gave me a chance to present my research ideas and in turn discuss with my peers and experts that share common interest. The hands-on learning experience of the one-day cruise trip on RV Tan Kah Kee was an exciting and learning experience. Working in a group and writing a work report was the best part and I got to learn and teach during this activity which is one of the most vital phases in scientific research."

公众教育
OUTREACH

“海洋对于人类社会生存和发展具有重要意义，人类被海洋连结成了命运共同体，我们要像对待生命一样对待海洋。” 科学普及与公众开放是高校及科研单位应承担的社会责任，因此，实验室以中国海洋科学卓越教育伙伴计划（COSEE-China）为依托，继续开展公众教育与科学普及。

“The ocean is of great significance for the survival and development of human society. Human beings are connected by the ocean into a community of destiny. We must treat the ocean as we treat life.” It is the social responsibility of universities and research institutes to popularize science and open themselves to the public. To that end, COSEE China has continued to serve in this capacity, as providers of marine environmental education and awareness programs for the greater Xiamen community.

COSEE China -
Creating the Scientists and Science Communicators of Tomorrow

实验室依托 COSEE China 已连续八年举办深受公众喜爱的“水生科学暑期生态营”和“厦门大学海洋科学开放日”。2019 年的开放日，近 6500 名公众来参观实验室，参与我们举办的互动实验、趣味教学、科普讲座等活动，从而了解海洋和我们的地球。COSEE China 还加入亚洲海洋教育工作者协会，继续参与国际海洋教育项目。同时，我们也与厦门当地的中小学校和社会团体开展更多合作，了解公众诉求，努力让海洋科学更深入人心。

多年的海洋科普工作，受益的不仅是社会公众，还有众多志愿者。一批优秀的志愿者在 COSEE 的活动中成长起来，“教学相长，培养未来的教育工作者”，也是 COSEE 的核心目标之一。

Now in its eighth year COSEE China continues to run the much loved Aquatic Sciences Eco-Learning Programme (summer camp) and Ocean Science Day, which again saw thousands of visitors coming to see the labs and learn a bit more about our watery planet. The platform also continues to expand its involvement with international marine education programs by participating in the Asian Marine Educators Association, a regional network modeled after NMEA and EMSEA in the West. It is also looking to expand its outreach capabilities by looking at new ways to get involved with local schools and groups, to see what their needs are and how we can work together to get ocean science more into the public mindset.

But at its heart, COSEE China is about the people. Not just visitors and public it engages with through events and programs but its student volunteers also. Not only are they the heart of COSEE China, what makes it work, but they are the future as well.

I really enjoy working with and talking with the middle school students. I especially enjoy teaching them new things and seeing them learn. It makes me feel really fulfilled.

Haoyang He, Project Assistant, PhD Student, Marine Biology

During this time we collaborate, experiment, and test things out which allows me to better understand why we are doing a particular activity and the overall reason for it. You real get a sense of the significance of what we are doing.

Yixuan Chen, Project Assistant, Senior, Marine Biotechnology

70.8 海洋媒体实验室
70.8 Media Lab

2019 年 11 月 1 日，70.8 海洋媒体实验室举行揭牌仪式，宣布正式成立。该媒体实验室以 MEL 为主力，携手厦门大学地球科学与技术学部师生，与新浪厦门共建，是全国首个顶尖科研机构与权威媒体联合创建的海洋媒体实验室。实验室将以厦门大学为基地，充分融合社会化媒体的传播特性，连接全球海洋科研力量，致力于推动海洋科学大众化传播实践与理论的创新，提升公民的海洋意识。

Launched on November 1, 2019, the 70.8 Media Lab was jointly established by the XMU Faculty of Earth Science and Technology and Sina Xiamen. The Media Lab will fully integrate social media and the global forces marine research to promote the development of channels between the public and marine science, and enhance the marine awareness of citizens.

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海洋科学开放日
Ocean Science Day——“Voyage to Discovery”

Students surveying the rocky shore,
© COSEE China

水生科学暑期生态营
Aquatic Sciences Eco-Learning Programme

Students surveying the rocky shore
© COSEE China

平台设施
FACILITIES

大型仪器与技术服务中心
Center of Major Equipment and Technology (COMET)

“大型仪器与技术服务中心”（简称 COMET）于 2008 年成立，以“推动大型科研仪器的资源共享、提高仪器使用效率”为宗旨，为培养高层次人才，开展高水平科研项目提供高效率、高水准服务。COMET 致力于全面规范化管理实验室安全、仪器设备，以及技术人员培训和考核，成功建立了大型仪器网上预约共享系统，真正实行仪器公开透明化管理。

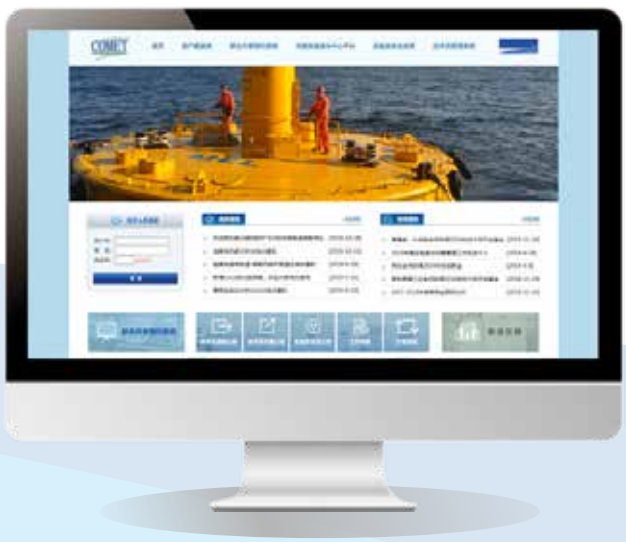
The Center of Major Equipment and Technology (COMET) was established in 2008 to better maintain MEL's scientific instruments with higher efficiency and lower operating costs. COMET continues to strive for excellence as an infrastructure for research and teaching and to inspire innovative research discoveries.

216
大型预约共享设备
Major facilities

2300
注册会员
Registered users

18000
年均预约次数
Reservation per year

700
年均用户
Users per year



2018-2019 年度，COMET 网站进行了改版：包含资产数据库、联合共享预约系统、功能实验室与中心平台介绍、实验室安全系统、技术员管理系统、野外监测平台六大模块。新升级的共享设备预约系统正式运行，预约方式更加便捷、灵活，数据统计更准确、全面。系统涵盖仪器预约、仪器使用、费用计算、绩效分析等一系列业务流程，采用智能化的设备监控保护仪，并加装门禁及监控，实现了仪器全过程监管。同时实现了与厦门大学校级实验室资源管理信息系统的交互对接，报送学校测试费单，通过本网站后台无缝对接，采用线上电子化制作，更加便利、精准。

In 2019, the COMET website was updated. It includes six modules: asset database, functional laboratories and platforms, facility booking system, safety management system, technician management system and field observation facility. The new booking system is more flexible and convenient for technicians and users. Technicians can monitor and manage the instruments remotely from the internet or mobile phone and keep the system open to users for 24 hours. Real-time data updates and analysis will also be realized.

2017-2019 年，实验室获批了国家财政部仪器专项 1.018 亿元，主要用于购置海洋现场观测和实验室公共平台设备，目前大部分已完成试运行，包括超速流式细胞分析分选平台、温湿度可控纳米级化学成像平台、超高分辨率液相色谱—三合一质谱联用仪、高分辨电感耦合等离子质谱仪等。

In 2017-2019, MEL received a special fund of 1.018 billion RMB from the Ministry of Finance for equipment and infrastructure construction. Most of the facilities are in place and commissioned, including a BD Influx™ high-speed cell sorter, a chemical imaging system with temperature and humidity control, and an ultra high resolution liquid chromatography - tribrid mass spectrometer (Thermo Fisher UltiMate™ 3000 RSLCnano – Orbitrap Fusion™ Lumos™).

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技术人员开放基金
MEL Technology and Innovation Fund

为继续鼓励技术人员的技术创新，实验室 2019 年资助两项技术开放基金，分别为船载大气采样多单元自动控制系统的研制（叶成淼工程师）、大水量海水走航培养系统的研制（蔡建南工程师）。

Two projects were supported by Technology and Innovation Funds in 2019 for 2 years for technical staff. They were: 1) Automatic control system for multiple shipborne atmospheric sampling units (Chengmiao Ye); 2) Development of an in-situ incubation system (Jiannan Cai).

仪器研制与改造
Instrumentation

在线式浮标-潜标联用同步观测平台
The integrated shelf sea online buoy and submarine observation system

在线式浮标 - 潜标联用观测系统首次在东海陆架海域作示范性应用，获取与海气界面浮标 CO_2 观测数据获取同步的词表层 / 底层水参数，为揭示海洋碳循环的主要调控机制提供高分辨率的数据基础。

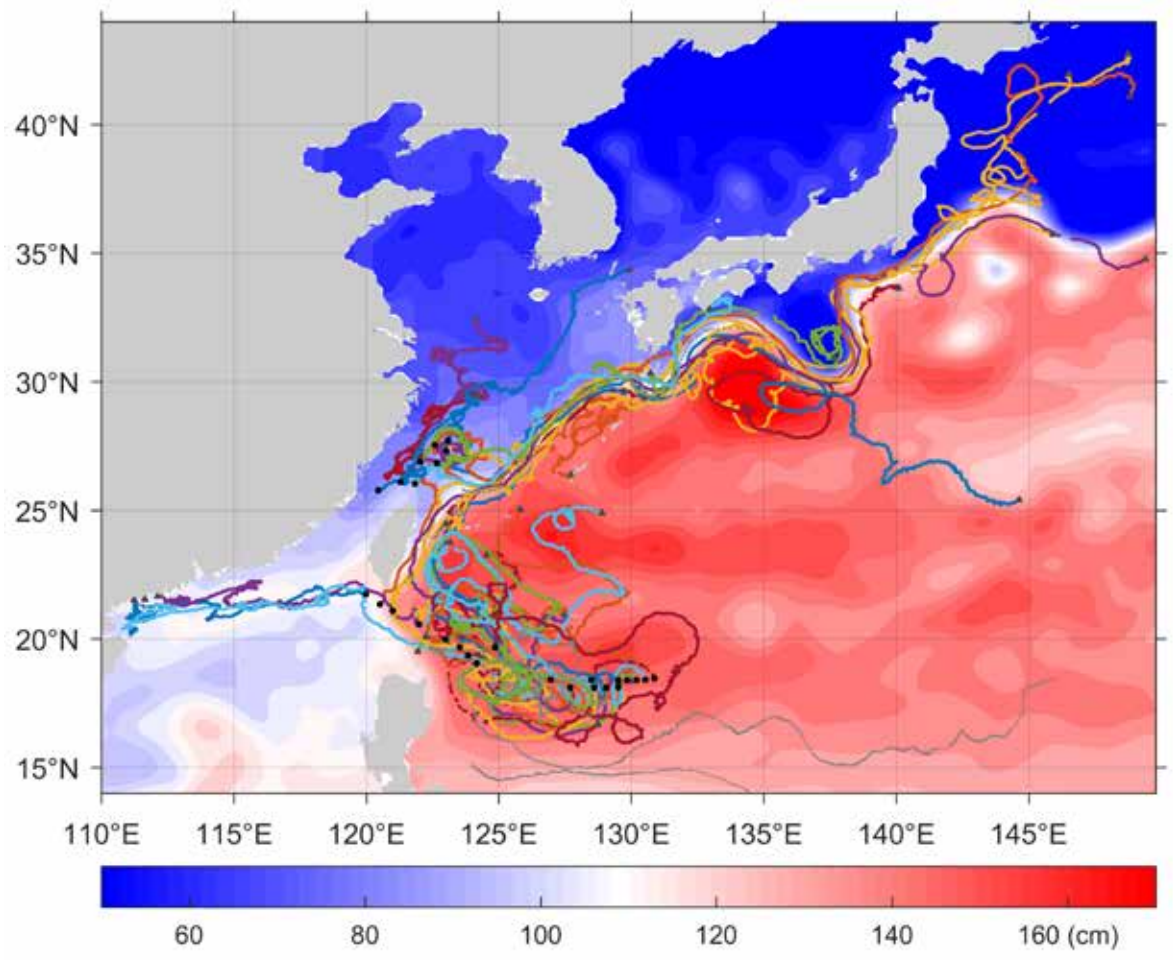
The integrated online buoy and submarine observation system was deployed to the East China Sea shelf sea and monitoring the CO_2 partial pressure of the air-sea interface. The observations in the bottom water, together with the synchronously obtained sea-air interface CO_2 data provides high resolution quantitative analysis for revealing the influencing factors of the carbon cycle on the East China Sea shelf.

漂流浮标

Surface current experiment drifter, SUCE

近岸表层漂流浮标是专门为近岸海域设计研发的一款高续航能力，高采样频率，具备自容补发功能的一种新型漂流浮标，可用于近岸海区表层海流的观测和追踪。北斗表层漂流浮标是基于北斗通讯的表层漂流浮标，在北斗卫星通讯系统覆盖下的海域都能够实时数据传输。这是一款完全国产自主研发的产品，数据保密性强，可用于开阔大洋表层海流的观测和追踪。

The coastal surface drifter is specially designed for coasts, and has a high battery life, and high sampling frequency. Its data can be stored when no mobile network is available and be sent again when it is. It can be used for the observation and tracking of the near shore surface current. The Beidou satellite surface drifter is a surface drifter based on Beidou communication, which can transmit real-time data in the sea area covered by the Beidou satellite communication system. This is a completely home made product with strong data confidentiality. It can be used for the observation and tracking of surface currents in the open ocean.



北斗表层漂流浮标在大洋的应用

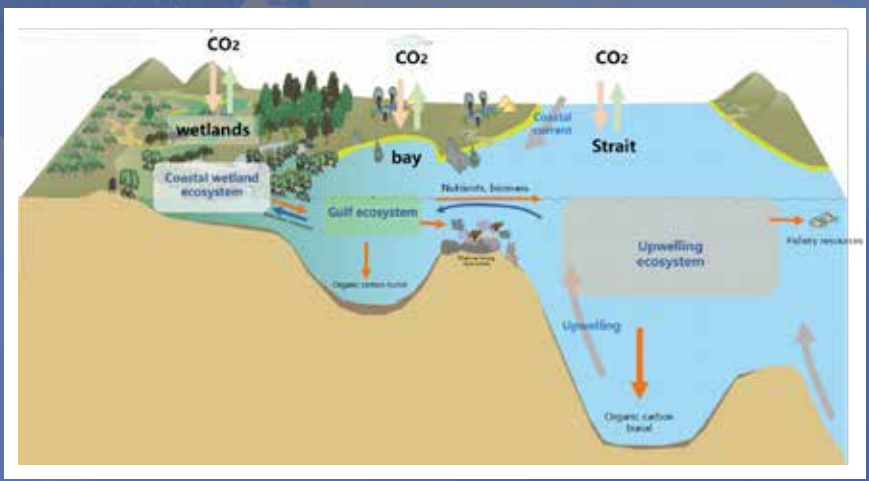
The application of Beidou satellite surface drifter

台湾海峡海洋生态系统野外科学观测研究站

The Taiwan Strait marine ecosystem research and observation field station

“台湾海峡海洋生态系统野外科学观测研究站”(简称台海站)于 2019 年 9 月获批为教育部首批野外科学观测研究站。依托厦门大学地球科学与技术部开展建设，致力于保障台湾海峡生态环境安全，服务国家海洋强国战略，支持区域生态文明建设和经济可持续发展。

台海站整合了厦门大学在台湾海峡上升流生态系统、红树林等滨海湿地生态系统近 30 年的综合观测和定位研究，依托于海洋科学、生态学等国家“双一流”学科和环境科学、水生生物学等国家重点学科，以长期观测台湾海峡典型生态系统的连通性、阐明生态系统的长期演变及其驱动机制为主要科学目标，系统观测台湾海峡生态系统中上升流、亚热带海湾、滨海湿地生态系统结构与功能，解析全球变化影响下海峡生态系统的演变过程与响应机制，为保障海洋生态环境健康和促进经济可持续发展提供重要科技支撑。



The Taiwan Strait Marine Ecosystem Research and Observation Field Station (TWS Marine Station) has been approved as a field station by the Ministry of Education of the People’s Republic of China in September 2019.

Relying on the XMU Faculty of Earth Science and Technology, TWS Marine Station is committed to guaranteeing the security of the ecological environment in the Taiwan Strait, serving the national strategy of maritime power development, and supporting regional ecological civilization construction and sustainable economic development.

It integrates multi-disciplinary observation and research of coastal wetland ecosystems such as upwelling ecosystem and mangroves in the Taiwan Strait over the past 30 years. It is based on the national “Double First-class” disciplines of marine science and ecology, and national key disciplines such as environmental science and aquatic biology.

The main scientific objective is the long-term observation of the connectivity of typical ecosystems in the Taiwan Strait, and clarifying the long-term evolution of ecosystems and their driving mechanisms. TWS marine station aims to systematically observe the structure and function of upwelling and subtropical gulf and coastal wetland ecosystems in the Taiwan Strait, revealing the evolutionary process and response mechanism of the strait ecosystem under the influence of global changes, and provide important scientific and technological support for ensuring the health of the marine ecological environment and promoting sustainable economic development.

东山太古海洋观测与实验站
Dongshan Swire Marine Station

东山太古海洋观测与实验站（简称“东山站”）坐落于东山县西埔镇冬古村苏峰山，地处东海和南海交界的关键区，占地 87.59 亩，距离厦门约 140 公里，于 2017 年启用。

2019 年，东山站各项基础设施日趋完善，防护护岸工程于 10 月顺利完工，海水供应系统取得关键进展，预计 2020 年春季投入使用。科研工作全面开展，已开展夏、秋两次东山站长时间序列共享航次；水动力剖面观测系统、海底有缆珊瑚生态在线观测系统、地下河口观测系统已顺利布放并开始产出观测数据。学术交流氛围日渐浓厚，多次举办学术研讨会、学生实习、研究生论坛、科普教育等活动，初步建成了独具特色的集海洋观测、实验与教育为一体的开放式、国际化科研基地。2019 年 10 月，以东山站为主要组成之一的台湾海峡海洋生态系统野外科学观测研究站（台海站）经国家教育部批准为教育部野外台站。

D-SMART

Launched in 2017, the Dongshan Swire Marine Station (D-SMART) is located in Donggu Village, Xipu Town, Dongshan Island, 140 km from Xiamen, and covers approximately 14.43 acres.
（http://mel.xmu.edu.cn/dsmart）

During 2019, with the infrastructure improved, D-SMART is taking the shape of an open center for ocean observation, research, and education. Two time-series cruises were conducted in June and November and the hydrological observation system, coral ecosystem cabled observatory and subterranean estuary monitoring system were launched and started to produce data. Several academic workshops, student field practical courses, graduate student forums and outreach programs took place throughout the year as well.

论文专著
LIST OF PEER-REVIEWED PUBLICATIONS

300 篇学术论文
papers in SCI journals

44% 发表于中科院界定的顶级期刊
papers published in JCR top journals

海洋生物地球化学
Marine Biogeochemistry

Bao Hongyan*; Niggemann Jutta; Huang Dekun; Dittmar Thorsten; Kao Shuh-Ji. Different responses of dissolved black carbon and dissolved lignin to seasonal hydrological changes and an extreme rain event. ***JOURNAL OF GEOPHYSICAL RESEARCH-BIOGEOSCIENCES***, 2019. 124: 479-493.

Brodeur Jean R.; Chen Baoshan; Su Jianzhong; Xu Yuan-Yuan; Hussain Najid; Scaboo K. Michael; Zhang Yafeng; Testa Jeremy M.; Cai Wei-Jun*. Chesapeake bay inorganic carbon: Spatial distribution and seasonal variability. ***FRONTIERS IN MARINE SCIENCE***, 2019. 6, UNSP 99.

Cao Zhimian; Yang Wei; Zhao Yangyang; Guo Xianghui; Yin Zhiqiang; Du Chuanjun; Zhao Huade; Dai Minhan*. Diagnosis of CO_2 dynamics and fluxes in global coastal oceans. ***NATIONAL SCIENCE REVIEW***, 2019. nwz105.

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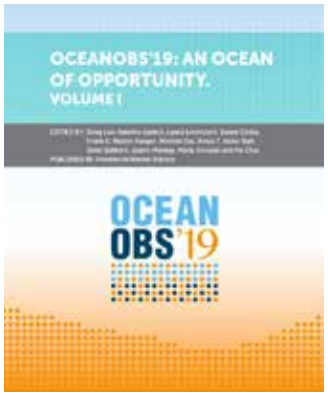

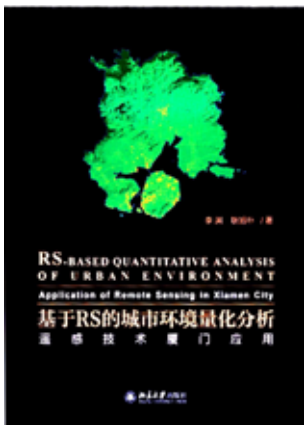

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封面图像：“痕量元素和同位素海洋生物地球化学循环计划”首个中国断面航次站位图（赵秧秧绘）和航次全体人员合影 (叶利萍摄)。特别感谢蔡毅华、周宽波及曹知勉对封面设计的协助，航次详细内容请见年报第 14 页。

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