Australian Government
Department of Industry, Science and Resources

Australian Academy of Technological Sciences & Engineering

Australian Academy of Science

16TH AUSTRALIA–CHINA SYMPOSIUM

MARINE SCIENCES FOR SUSTAINABLE DEVELOPMENT

20–21 NOVEMBER 2023 SYDNEY, NSW

ACKNOWLEDGEMENT OF COUNTRY

The Australian academies acknowledge and pay their respects to the Eora Nation, the Traditional Owners of the lands on which the symposium is taking place. We also acknowledge and pay respects to the Traditional Owners and the Elders past and present of all the lands on which Our academies operate, and Fellows live and work. We recognise the continuous living culture of Aboriginal and Torres Strait Islander peoples—their diverse languages, customs and traditions, knowledges and systems—and the deep relationship and responsibility to Country as integral to their identity and culture. We thank Traditional Owners for their enduring stewardship and protection of the marine estate for thousands of generations—and for their ongoing guidance and partnership in the shared efforts to protect it.

CONTENTS

WELCOME MESSAGE

Since 2004 the Australian Academy of Science (AAS), the Australian Academy of Technological Sciences and Engineering (ATSE) and the Chinese Academy of Sciences (CAS) have held annual symposia on topics of strategic importance to both countries. These meetings provide an opportunity to build strong bilateral networks and increase research collaborations between Australia and China.

The Australian academies are pleased to host this year's symposium on the topic of marine sciences for sustainable development in Sydney, from 20 to 21 November, with subsequent site visits and cultural excursions in Sydney for the Chinese delegation on 22 and 23 November. This is the first time we have held a symposium since 2019, due to the COVID-19 pandemic, and we are delighted to be gathering in-person again for this important meeting. We welcome the Chinese and Australian researchers, including a cohort of early- and mid-career researchers from both countries, and thank them for their participation.

The symposium will showcase both countries' world leading marine science capabilities. For Australia, this includes the importance and value of Indigenous stewardship of the marine estate. We are pleased that for the first time in this symposia series, we will listen to and learn from Traditional Owners and Indigenous Scientists through a yarning circle. A yarning circle is a practice used by Aboriginal and Torres Strait Islander Peoples to sit together to talk and listen from the heart and share ideas and stories. It is a way for Aboriginal and Torres Strait Islander Peoples to learn, build respectful relationships, and to preserve and pass on cultural knowledge and wisdom. We look forward to sharing this practice with our Chinese colleagues.

Finally, this event has been made possible with funding and support from the Australian Government Department of Industry, Science and Resources, through the Australia–China Science and Research Fund, as well as the Chinese Academy of Sciences. We thank them for their continued support of this activity that will enhance collaborations between Australia and China in marine sciences.

Welcome once again, and all the best for a successful symposium.

Professor Chennupati Jagadish AC PresAA FREng FTSE
President
Australian Academy of Science

Dr Katherine Woodthorpe AO FTSE
President
Australian Academy of Technological Sciences and Engineering

PROGRAM

Sunday 19 November 2023

Various times	**Australian and Chinese delegates arrive** Accommodation at Hyatt Regency Sydney
1900 – 2030	**Infomal dinner - The Royal Palace Seafood Restaurant**

Monday 20 November 2023

Wharf 1&2, Hyatt Regency Sydney

830	**Welcome to Country** **Opening remarks and welcome** **Professor Chennupati Jagadish** President, Australian Academy of Science **Professor Yaping Zhang** VP, Chinese Academy of Science **Dr Katherine Woodthorpe** President, Australian Academy of Technology and Engineering **Dr Rebecca Doolan** Australian Government Department of Science Industry and Resources
900	**Keynote presentations** Professor Fan Wang, IOCAS Scientia Prof. Matthew England, UNSW
1000	**Morning tea** Presidents' meeting, King Room 4
1020 – 1230	**Session 1: Ocean observing systems, ocean data and information**
1020	Introduction by session chair, Professor Xiaofeng LI
1030	Dr Michelle Heupel, Integrated Marine Observing System
1050	Professor Xiaofeng Li, IOCAS
1110	Associate Professor Shane Keating, UNSW
1130	Professor Jianing Wang, IOCAS
1150	**Discussion**
1220 – 1320	**Lunch**
1320 – 1530	**Session 2: Climate change, physics and biogeochemistry**
1320	Introduction by session chair, John Gunn
1330	Professor Weidong Sun, IOCAS
1350	Professor Nathan Bindoff, Australian Antarctic Program Partnership
1410	Professor Yan Du, SCSIO
1430	Dr Elizabeth Shadwick, CSIRO
1450	**Dscussion**
1520	**Afternoon tea**
1540 – 1730	**Session 3: Blue economy**
1540	Introduction by session chair, Professor Rob Lewis
1550	Professor Song Sun, IOCAS
1610	Professor Wei Zhang, Flinders University
1630	Professor Song Qin, YICCAS
1650	Professor Chris Carter, Seafood & Marine Products Research Program
1710	**Discussion**
1740 – 1745	**Day one wrap-up** Professor Frances Separovic, Australian Academy of Science Foreign Secretary
1900 – 2100	**Official symposium dinner** Wharf room, Hyatt Regency Sydney

Tuesday 21 November 2023

Upper Deck, Hyatt Regency Sydney

830	**Welcome to day two – John Gunn**
840	Yarning circle with Traditional Owners/ Knowledge Holders, Professor Roxanne Bainbridge and Bianca McNeair, facilitated by Future Earth Australia Manager, Kate Nairn
930	**Morning tea**
950 – 1150	**Session 4: Ocean ecosystem health**
950	Introduction by session chair, Professor Jenny Stauber
1000	Professor Rencheng Yu, IOCAS
1020	Professor Gretta Pecl, Centre for Marine Socioecology UTAS
1040	Professor Xiaoke Hu, YICCAS
1100	Professor Adriana Vergés, UNSW
1120	**Discussion**
1150	**Lunch**
1250 – 1600	**Topic 5: Deep ocean**
1250	Introduction by session chair Professor Chaolun Li, SCSIO
1300	Dr Bernadette Sloyan, CSIRO
1320	Professor Kuidong Xu, IOCAS
1340	Dr Skip Wooley, CSIRO
1400	Professor Chaolun Li, SCSIO
1420	**Discussion**
1450 – 1500	**Symposium wrap-up** Professor Frances Separovic, Australian Academy of Science Foreign Secretary
1800 – 1930	**CAS delegation informal dinner - Casa Ristorante**

Wednesday 22 November 2023

845	Depart hotel
930	Site visit 1- University of Technology Sydney (UTS) Climate Change Cluster and Deep Green Biotech Hub
1145	**Lunch (at UTS)**
1300	Depart for next site visit
1400	Site visit 2- Sydney Institute of Marine Sciences
1800 – 1930	**CAS delegation informal dinner - Ripples, Chowder Bay**

Thursday 23 November 2023

915	Catch ferry from Darling Harbour for excursion
945	Taronga Zoo
1200	**Lunch**
1330	Ferry back to Darling Harbour
1400	Program ends

ACADEMY REPRESENTATIVES

Professor Chennupati Jagadish AC PresAA FREng FTSE

(Formal: Professor Jagadish, Informal: Jagadish)

Australian Academy of Science

president@science.org.au

Professor Chennupati Jagadish is a Distinguished Professor and Head of Semiconductor Optoelectronics and Nanotechnology Group in the Research School of Physics, at The Australian National University. He has published widely in semiconductor physics, materials science, optoelectronics and nanotechnology. Professor Jagadish is the Editor-in-Chief of Applied Physics Reviews, editor of 2 book series and serves on editorial boards of 19 other journals. He is a fellow of 11 science and engineering academies in Australia, the US, Europe and India, and 14 professional societies. He has received many Australian and international awards, including a UNESCO medal for his contributions to the development of nanoscience and nanotechnologies, and has been an Australian Research Council (ARC) Federation Fellow and an ARC Laureate Fellow. He became President of the Academy in May 2022.

Professor Yaping Zhang

Chinese Academy of Sciences

Professor Yaping Zhang graduated from Fudan University with a bachelor's degree in 1986 and received a Ph.D. from the Kunming Institute of Zoology (KIZ) of CAS in 1991. After receiving his doctorate, he worked as a postdoctoral fellow for three years at the Center for Reproduction of Endangered Species, Zoological Society of San Diego, USA. He then returned to China and became a professor at KIZ. He also served as director of the Laboratory of Cellular and Molecular Evolution at KIZ. In 2002, Prof. ZHANG was appointed professor and head of the Laboratory of Genetics at Yunnan University. In 2012, he became director of KIZ and director of the State Key Laboratory of Genetic Resources and Evolution, KIZ. He was named Vice President of CAS in 2012.

As a research professor at KIZ, he has focused his work on molecular evolution and genome biodiversity. His investigations involve five correlated areas: molecular phylogenetics; molecular ecology and conservation genetics; human genetics and evolution; origin of domestic animals and artificial selection; and genome diversity and evolution.

Professor Zhang has published more than 300 articles in SCI journals and is the author or co-author of five books. He was elected Member of the American Society of Human Genetics in 1996, the Society for Molecular Biology and Evolution in 1997, and the American Genetic Association in 1998. He was also elected Vice President of the Genetics Society of China in 2004, Vice President of the Chinese Zoological Society in 2005, and President of the Yunnan Association for Science and Technology in 2008.

Professor Zhang sits on the editorial boards of several international periodicals including *Human Molecular Genetics* and *Frontiers in Genetics*. He has won dozens of natural science prizes in China, including the Ho Leung Ho Lee Prize for Science and Technology awarded by the Ho Leung Ho Lee Foundation in 2004. He was elected Fellow of the Third World Academy of Sciences (TWAS) in 2007.

Dr Katherine Woodthorpe AO FTSE
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Dr Katherine Woodthorpe AO FTSE is one of Australia's most influential people in innovation. She is also a Fellow of the Australian Institute of Company Directors and has been a Fellow of ATSE since 2015. In 2017, she received an Order of Australia for her ongoing service to research and technology innovation in Australia.

She has been a professional director for over 20 years including as Chair of the Great Barrier Reef Foundation, Natural Hazards Research Australia, the Antarctic Science Foundation and the HEARing Cooperative Research Centre. She has been a Director of the Olivia Newton-John Cancer Research Institute, Bioplatforms Australia (NCRIS), the Australian Renewable Energy Agency, Vast Solar, and listed companies Sirtex and Anteotech. She previously chaired the National Climate Science Advisory Committee and currently chairs the Government's "Vision 2040" committee reviewing the strategy for investment in medical research for the next two decades.

SPEAKERS

Keynote speakers

Professor Fan Wang
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Professor Fan Wang is Director of the Institute of Oceanology, CAS (IOCAS) and Dean of the Marine Science College, University of Chinese Academy of Sciences (UCAS). His work focuses on ocean circulation dynamics, including the western boundary currents in the low-latitude Pacific, tropical ocean circulation, shelf circulations in the China Seas and mesoscale processes. He has undertaken more than 30 projects funded by the National Basic Research Program, National High Technology Research and Development and National Natural Science Foundation of China.

He has published over 140 papers and three Academic Monographs. He has been awarded several awards for his remarkable work including the National Advanced Science and Technology Workers and National Science and Technology Innovation Talents awards. His current positions include Chair of the Scientific Steering Committee, Northwestern Pacific Ocean Circulation and Climate Experiment (NPOCE), Chair of Chinese Society of Oceanology and Limnology, Member of Partnership for Observation of the Global Oceans (POGO), and Member of CLIVAR/PRP.

The seas around China in a warming climate

Anthropogenic forcings have led to multifaceted changes in the seas around China, which include the Bohai, Yellow, East China and South China Seas, affecting the functions and services they provide. This review synthesizes physical, biogeochemical and biological findings to understand how the seas around China have changed and are projected to change under a warming climate. The average surface temperature of these seas increased by 0.10-0.14 °C dec-1 between 1950- 2021. Meanwhile, the annual frequency and average intensity of marine heatwaves increased by 1-2 dec-1 and 0.1-0.3 °C dec-1 since the 1980s, respectively. Terrestrial input has increased nutrient concentrations and composition changes in coastal waters. These warming and nutrient changes have increased the severity of hypoxia and acidification, leading to complex changes in primary productivity. Changes to marine organisms such as plankton, benthos and fish are also apparent, including the northward invasion of warm-water species and miniaturization. These observed changes are projected to persist into the future. These coupled physical-ecological changes highlight the need for strengthened multidisciplinary oceanographic research in the seas around China.

Scientia Professor Matthew England FAA
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Matthew England is Scientia Professor of Ocean & Climate Dynamics at the UNSW Centre for Marine Science and Innovation, Deputy Director of the Australian Centre for Excellence in Antarctic Science, and the Academic Lead of the International Universities Climate Alliance (IUCA). Professor England's research explores large-scale ocean circulation and its influence on regional and global climate, from the tropics to Antarctica, spanning timescales from seasons to multi-century. Professor England's research combines numerical model simulations with theory as well as observa¬tions to explore the physics of ocean and climate phenomena, publishing >250 journal papers. Professor England completed a PhD at the University of Sydney in 1992 and held a Fulbright Scholarship at Princeton University in 1990. He has previously worked at the Centre National de la Recherche Scientifiqué (CNRS), France and at CSIRO's Climate Change Research Program. He has been at the University of New South Wales since 1995, where he held an ARC Federation Fellowship from 2006-2010 and an ARC Laureate Fellowship during 2011-2016. He is a Fellow of the Australian Academy of Science and a Fellow of the American Geophysical Union.

The critical role of the Earth's oceans in moderating climate

Earth's oceans play a critical role in moderating climate whilst also mitigating the worst effects of climate change. By absorbing vast quantities of heat and carbon, the oceans slow atmospheric warming and moderate extremes of climate. But these benefits do not come without cost. As the oceans warm, acidify and expand, they also disrupt ecosystems, bleach coral reefs, melt ice caps, reshape coastlines and generate more severe hurricanes. In this talk I will outline the ways in which the ocean is currently absorbing vast quantities of heat, and how this acts to moderate extremes of climate and climate change. I will also show how melting ice around Antarctica is slowing the ocean's abyssal overturning circulation, and what this means for global climate and sea-level rise.

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Session 1: Ocean observing systems, ocean data and information

Dr Michelle Heupel
Integrated Marine Observing System (IMOS)
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Dr Michelle Heupel is Director of Australia's Integrated Marine Observing system (IMOS). She is a research scientist with over 25 years' experience working on ecology, conservation and management of marine predators, predominantly sharks and fish. Her career has spanned a range of sectors in marine science (university, public funded research agency, private non-profit research laboratory, joint ventures). Dr Heupel was the recipient of a prestigious Australian Research Council Future Fellowship in 2011 and in 2019 assumed leadership of IMOS.

Dr Heupel has produced over 200 peer reviewed scientific publications, held various editorial positions with scientific journals and previously or currently sits on several national and international committees. She is a former member of the Commonwealth Threatened Species Scientific

Committee and was a member of the Australian Delegation to the Convention on Migratory Species Sharks MOU meetings in 2016 and 2018. In 2022 she was invited to address the twenty-second meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea, at United Nations Headquarters in New York and is Vice-Chair of the Global Regional Alliance of the Global Ocean Observing System. She is considered a national and international leader in the application of ocean data to support policy and decision-making.

Enhancing integration: the role of Australia's Integrated Marine Observing System in understanding our future oceans

The Integrated Marine Observing System (IMOS) is a national research infrastructure funded under the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS). Since 2006, IMOS has routinely operated a wide range of observing equipment throughout Australia's coastal and open oceans, making all its data accessible to the marine and climate science community, other stakeholders and users, and international collaborators. Ocean observations collected by IMOS are made freely available via the Australian Ocean Data Network. These data holdings include long time series of essential ocean variables including physical, biological, biochemical and atmospheric variables. The existence of a sustained observing system provides a unique opportunity to integrate data streams to better understand key ecosystems and processes. The data IMOS collects are integral to coastal and ocean modelling which are crucial to understanding oceanographic patterns that can influence local conditions and drive the abundance and behaviour of a range of species. This presentation will highlight the applicability of IMOS infrastructure and opportunities for data integration to improve our understanding of our marine estate. This understanding is critical to defining and measuring change in our ocean ecosystems now and into the future.

Professor Xiaofeng Li

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Professor Li is a fellow of the IEEE, the Electromagnetics Academy, and the Asia-Pacific Artificial Intelligence Association, and a researcher at the Institute of Oceanology, Chinese Academy of Sciences. He completed his undergraduate and doctoral studies at Zhejiang University in China and North Carolina State University in the United States.

Professor Li's primary research focus is artificial intelligence applications in oceanography and big data. He has published over 200 peer-reviewed publications and edited over ten books. Professor Li currently serves as the Associate Editor for IEEE Transactions on Geoscience and Remote Sensing (TGRS), the International Journal of Remote Sensing, and the Deputy Editor-in-Chief of the journal, Oceanologia et Limnologia Sinica. He also holds the position of Executive Editor for the journal, Journal Remote Sensing, a joint publication of the Chinese Academy of Sciences and Science, and serves as an editorial board member for the International Journal of Digital Earth, Big Earth Data and other publications.

Presentation Title: The latest progress in the utilisation of AI in the field of oceanography

Artificial intelligence (AI) plays a crucial role in the ongoing technological revolution and industrial transformation. Its close integration with big data offers significant technological advantages in compressing massive observational data, accelerating model development, and enabling nonlinear feature learning and modeling. Unlike traditional knowledge-driven modeling in oceanography, data-driven approaches provide reliable and efficient modeling from data to information.

This presentation will provide a detailed overview of the latest research achievements in using AI technology to extract information from oceanographic phenomena and processes, as well as forecasting and modeling oceanic and

atmospheric phenomena. Information extraction topics will include mesoscale eddies, internal waves in the ocean, oil spills, and flooding caused by typhoons. Lightweight forecasting will cover small-scale internal waves, mesoscale sea level changes, large-scale equatorial instability waves and ENSO.

Associate Professor Shane Keating

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A/ Prof. Keating is an Associate Professor at the School of Mathematics and Statistics, UNSW Sydney. His research explores novel mathematical and data science tools to better understand our oceans. He leads the Space and Defence research theme of the UNSW Data Science Hub (uDASH), the Australian Surface Water and Ocean Topography working group (AUSWOT) and is a member of the NASA Science Team for the US-French SWOT satellite mission. Shane has extensive experience collaborating with government, industry, and defence partners, including the Bureau of Meteorology, the Royal Australian Navy, Spire Global (UK) and Naval Group (France).

Opportunities and challenges for the next generation of satellite altimeters

By 2030, a new generation of satellites equipped with pioneering wide-swath radar will measure the dynamic ocean environment with unprecedented resolution and accuracy. The first path-finding mission, the NASA-CNES Surface Water and Ocean Topography (SWOT) satellite, which launched in Dec 2022, will map sea-surface elevation at 10 times the resolution of current satellites. The step-change in resolution, accuracy, and coverage provided by these satellites will be a game-changer for capability in ocean forecasting as well as coastal and maritime industries. A/ Prof. Keating will present a primer on the principles of wide-swath altimetry, the SWOT mission, and its possibilities and limitations compared to existing altimetry products. He will give a summary of Australia's contributions to the SWOT mission through calibration/validation and synergistic in situ measurements of fine-scale ocean dynamics in the Indo-Pacific region. The presentation will conclude with a discussion of the challenges and opportunities offered by SWOT as well as follow-on missions planned in the next decade by the US, European, and Chinese space agencies.

Professor Jianing Wang

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Jianing Wang, Ph.D., Professor, Head of the Key Laboratory of Ocean Circulation and Waves CAS; winner of the National Science Fund for Excellent Young Scholars; member of the Youth Commission for the Chinese Scientific Committee on Oceanic Research and Youth Planning Committee of OceanObs'29. Professor Wang mainly works on the multi-scale dynamical processes in the intermediate and deep ocean. He has published more than 50 peer-reviewed scientific papers, including 20 first- or corresponding-author SCI-indexed papers. He has led the Major Program of the National Natural Science Foundation of China (NSFC) the sub-project of the National Key Research and Development Program. He has been the chief scientist on several cruises in the western Pacific funded by the Strategic Priority Research Program of the Chinese Academy of Sciences and the NSFC. Based on the observation data, he has illustrated the "overpass" structure of the intermediate-deep circulations in the western Pacific and revealed the "high-speed way" connecting the deep ocean to the upper ocean and climate change signals. He was awarded the first prize of "The Chinese Oceanographic Engineering Science and Technology Award".

Long-term observation of the deep ocean circulations in the Western Tropical Pacific Ocean

After ten years of construction, the Scientific Observing Network of the Chinese Academy of Sciences (CASSON) in the Western Pacific Ocean now has more than 30 sets of deep-sea subsurface moorings and has successfully acquired temperature, salinity, and currents data for 10 consecutive years. These measurements constitute the first time long-term simultaneous observations of the intermediate-deep ocean circulations in the Western Pacific.

The CASSON has strongly supported many innovative research results. First, the data revealed the three-dimensional circulation structure of the western Pacific Ocean. Long-term continuous data from the CASSON were used to directly confirm the existence and structure characteristics of the equatorial intermediate currents system, as well as determine the pathway, volume transport, and structure of deep meridional overturning circulations into the Western Pacific Ocean at depths deeper than 2000 meters. Second, the multi-time scale variabilities of the intermediate-deep ocean circulations were revealed, and new mechanisms have been proposed for the propagation of climate change signals into the deep ocean at different timescales through the atmospheric intraseasonal variability, planetary and topographic Rossby waves, and eddies.

Session 2: Climate change, physics and biogeochemistry

Professor Weidong Sun
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Professor Sun obtained his BSc and MSc at the University of Science and Technology of China, Hefei, China and his PhD at the Australian National University, Canberra, in geochemistry. He joined the Max-Planck Institute of Chemistry in Mainz as a Humboldt Fellow in 2003 and became a full professor at Guangzhou Institute of Geochemistry, the Chinese Academy of Sciences through the 100-Talent Program, receiving the Outstanding Young Scientist of China grant in 2005. He served on the Integrated Ocean Drilling Program (IODP, 2011-2013), the International Ocean Discovery Program (IODP, 2013-2015), the Goldschmidt Medal Evaluation Panel (2013-2015), and as a Board Director of the Geochemical Society (2015-2018). He is currently an Associate Editor of Geochimica et Cosmochimica Acta, Chinese Journal of Geochemistry, Journal of Oceanology and Limnology. He works in the field of marine geology, with a speciality and research interests that include: the subduction factory and mineralization, plate geodynamics and climate change. He has published more than 400 peer reviewed papers with a citation of 18,000, and was named a Highly Cited Researcher by Thomson Reuters - Clarivate Analytics between 2014-2023.

Reconstruction of the Pacific plate: constraints from the ocean floor and eastern China

Magnetic anomalies show that the Pacific plate rotated counterclockwise by ~50°, induced by the eruption of the Ontong Java Plateau at ~125 Ma. Meanwhile, the drifting direction of the Pacific plate also changed from southwestward (~265°) to northwestward (~300°). The rotation promoted the destruction of the North China Craton (NCC) and induced slab rollback, which was responsible for the Cretaceous large-scale magmatism and mineralisation in eastern China. The spreading ridge between the Pacific and Izanagi plates changed orientation from southwest (~265°) to northwest (~290°). Such a configuration is consistent with Late Mesozoic geologic events in eastern China. The spatiotemporal distribution of magmatic rocks and ore deposits suggests that the Pacific plate began to subduct southwestward underneath southeastern China in the Early Jurassic (⩾175 Ma), and reached the Nanling Mountains. In contrast, the Izanagi Plate was still connected to the NCC before ~170 Ma. Its northwestward drift before/during subduction initiation resulted in compression that wedged the NCC into the East Asian continent and resulted in fold belts in three directions in weak zones surrounding the NCC and strike-slip faults along the south and the north margins (known as the Event A of the Yanshanian Movement [165-170 Ma]). This is followed by extension during slab rollback. The Izanagi plate spun clockwise by ~50° between 149.35 Ma and 140.42 Ma, which was coincident with commencement of Event B of the Yanshanian Movement, both of which resulted from the collision between a micro-continent on the Izanagi plate and eastern China.

Professor Nathan Bindoff
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Professor Bindoff is a physical oceanographer, specialising in ocean climate and the earth's climate system, with a focus on understanding the causes of change in the oceans. He was the coordinating lead author for the Inter-Governmental Panel on Climate Change three times. Professor Bindoff and colleagues found early evidence for changes in the oceans in the global oceans and the fingerprint of human influence in the Southern Ocean and changes in the Earths hydrological cycle from ocean salinity. He has published more than 163 peer reviewed papers and more than 44 reports. He led seven ocean voyages to Antarctica, including the first and only mid-winter voyage to Antarctica (Commonwealth Bay) and the infamous fire voyage in 1998.

The changing state of our global oceans

The oceans provide key services like climate regulation, particular through the energy budget, and water cycle. The observing system shows clear climate-related trends from human activities that are causing ocean warming, acceleration of the water cycle and oxygen loss. The ocean has warmed unabated since 2005, continuing the clear multi-decadal ocean warming trends documented in the IPCC Fifth and Sixth Assessment Reports. It is likely the ocean warming has continued in the abyssal and deep ocean below 2000 m (southern hemisphere and Southern Ocean) and that the rate of ocean warming has increased since 1993 with at least a two-fold increase in heat uptake. The upper ocean is very likely to have been stratifying since 1970 and the ocean water cycle is accelerating. Observed warming and high-latitude freshening are making the surface ocean less dense over time relative to the deeper ocean and inhibiting the exchange between surface and deep waters. Oxygen loss due to warming is reinforced by other processes associated with ocean physics and biogeochemistry, which cause the majority of the observed oxygen decline. The oxygen minimum zones (OMZs) are expanding and the Southern Ocean has the largest oxygen loss when integrated over the entire water column.

Dr Yan Du
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Dr Yan Du is a senior scientist of the South China Sea Institute of Oceanology, Chinese Academy of Sciences and a Professor of the University of Chinese Academy of Sciences. He obtained his Ph.D. degree in physical oceanography from the Ocean University of China in 2002. He was a postdoctoral fellow at the University of Hawaii from 2004 to 2008 and has been a senior scientist at the South China Sea Institute of Oceanology, CAS since 2008. His scientific interests include multi-scale dynamics of the ocean and climate, air-sea interaction, ocean circulation and extreme weather/climate events. He has published more than 170 SCI papers with more than more than 8,000 citations, four of which are Highly Cited Papers ranked in the top 1% of ESI global geosciences field. He was listed in Elsevier's Highly Cited Chinese Researchers and The Reuters TOP 1,000 most influential climatologists in the world. He is serving as Co-Editor-in-Chief of DAO and Associate Editor-in-Chief of JTO (in Chinese), Editorial Board member of Meteorol., SR, AOS, STI. He was awarded the Special Government Allowance of the China State Council, Young Science and Technology Innovation Leaders in the Innovative Talent Promotion Plan from MOST, the China National Science Foundation for Distinguished Young Scholars and the Science and Technology Award for Chinese Youth.

Characteristics and drivers of marine heatwaves

A marine heatwave (MHW) is typically defined as an anomalous warm event in the surface ocean, with wide-ranging impacts on marine and socio-economic systems. The surface warming associated with MHWs can penetrate into the deep ocean;

however, the vertical structure of MHWs is poorly known in the global ocean. Here, we identify four main types of MHW vertical structures using Argo profiles: shallow, subsurface-reversed, subsurface-intensified, and deep MHWs. These MHW types are characterised by different spatial distributions with hotspots of subsurface-reversed and subsurface-intensified MHWs at low latitudes, and shallow and deep MHWs at middle-high latitudes. These vertical structures are influenced by ocean dynamical processes, including oceanic planetary waves, boundary currents, eddies, and mixing. The area and depth of all types of MHWs exhibit significant increasing trends over the past two decades. As the MHWs extend warming to the depths, the impacts on marine organisms and ecosystems are not limited to the surface ocean. This study provides a better understanding of the physical processes and climate drivers of MHWs, contributes to improved predictions of MHWs in a warmer ocean, and provides managers of fisheries, aquaculture, and conservation with forecasts to support mitigation strategies.

Dr Elizabeth Shadwick
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Dr Shadwick's scientific expertise lies broadly in observational marine biogeochemistry, and specifically in detection and attribution of natural and anthropogenic changes in the ocean carbon cycle, with a focus on the Southern Ocean. Dr Shadwick leads the CSIRO Ocean Carbon Observations Team and the IMOS Southern Ocean Time Series and co-Leads the Biogeochemistry Project in the Australian Antarctic Program Partnership. She is currently acting as Co-Chair of the Southern Ocean Observing System (SOOS) Indian Ocean Sector Regional Working Group and sits on the Executive Committee of the global OceanSITES network. Her recent work includes new research focused on ocean-based carbon dioxide removal as part of the CSIRO CarbonLock Future Science Platform.

The ocean carbon cycle as a climate solution

Atmospheric carbon dioxide (CO2) concentrations are nearly 50% higher than in the pre-industrial era and are predicted to increase at similar or accelerating rates over the next century. The ocean has absorbed roughly a quarter of the total anthropogenic CO2 emissions, resulting in changes in the carbonate system including decreases in pH (i.e., ocean acidification) and the saturation states of carbonate minerals. These changes come with a range of impacts on marine organisms and ecosystems.

The ocean covers more than 70% of the earth's surface, and is the largest long-term sink for anthropogenic CO2, storing more carbon than both the atmosphere and terrestrial biosphere. Ocean-based Carbon Dioxide Removal (CDR) has great potential due to its durability and capacity and may be achieved through a range of approaches (e.g., enhancement of the oceans biotic and/or abiotic carbon cycles). To utilise the oceans for long-term carbon storage, however, requires the development of novel approaches to increase ocean storage with minimal adverse impacts. Ocean Alkalinity Enhancement (OAE) is one approach to CDR that may have the co-benefit of relieving ocean acidification.

Session 3: Blue economy – utilising ocean resources

Professor Song Sun
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Professor Sun is a former director of the Institute of Oceanology, Chinese Academy of Sciences, Dean of the College of Ocean Sciences, University of Chinese Academy of Sciences, President of the Chinese Society of Oceanology and Limnology, and Vice President of the Scientific Committee on Oceanic Research (SCOR). He has long been committed to research and technological innovation in the field of ecology in bays, coastal seas, polar seas, and the deep sea. He has played leading roles in the development of theories and methods related to

marine ecosystem evolution, studies of both the mechanism and the comprehensive prevention and control of marine ecological disaster occurrence, and deep-sea exploration and research system construction. He has published more than 280 peer-reviewed scientific papers, of which 147 have been published with him as the lead author and corresponding author. He has published seven monographs, and he has won four awards (ranked 1st), including the "Chinese Academy of Sciences Outstanding Achievement in Science and Technology Award" and "Marine Engineering Science and Technology Award". He has supervised 44 graduate students, including 30 doctoral students.

Ocean health and sustainable development-actions in China

Healthy and sustainable marine ecosystems are needed for human survival and development, but under the combined influence of human activities and global climate change, marine ecosystems, especially offshore ecosystems, have undergone great changes and are in turmoil. Some marine organisms grow abnormally, resulting in marine ecological disasters such as the decline in marine biodiversity and decline in marine fishery resources and seawater acidification. The decline in dissolved oxygen levels in seawater has led to the emergence of large "submarine deserts" in many areas, and the deteriorating health of the oceans has serious implications for coastal industries, tourism, marine fisheries, and human health. In 2021, the United Nations released the second Global Marine Assessment Report, and compared with the first report, the state of marine ecosystems has not improved, and problems such as ecological disasters and marine pollution remain the same. We develop ocean management policies and continue to exploit the ocean without understanding it. In China, we are focusing on the following activities: establishing an efficient marine ecosystem assessment; simplifying the process and indicators; and finding the key causes of ecosystem disasters.

Matthew Flinders Distinguished Professor Wei Zhang

Flinders University/ Marine Bioproducts Cooperative Research Centre
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Professor Zhang is an inspiring leader in marine biorefinery and bioproduct development technologies, and he has passionately pursued an overarching career driving translational research with industry impacts.

He obtained his PhD from Dalian Institute of Chemical Physics, CAS in 1994, and did his Postdocs at the University of Tokyo, Adelaide University and Cambridge University. He won several important awards including "South Australia Young Tall Poppy Science Award" in 2008, "South Australia Science Excellence and Innovation Award", and "Finalist of Australian Eureka Prizes for Leadership in Science and Innovation" in 2022. He is the Inaugural President of Australia-New Zealand Marine Biotechnology Society, Chair of Marine Biotechnology Subcommittee, Australia National Marine Science Committee, and the inaugural Research Director of Marine Bioproducts Cooperative Research Centre (MB-CRC). Currently, he is Chief Science Advisor of MBCRC, President of the Asia-Pacific Marine Biotechnology Society, and Matthew Flinders Distinguished Professor at Flinders University.

An entrepreneurial academic champion, Wei's vision to connect formerly disparate marine bioproducts research and commercial sectors led to growing Australia's industry R&D capability and market impact into a new 3rd-Gen marine bioproducts industry, sustainably utilising Australian untapped marine bioresources.

He was the driving force behind ground-breaking work in functional foods, nutraceuticals, cosmetics and biomaterials, leading to the successful $270m Marine Bioproducts CRC. Wei's advanced bio-refinery technologies allow Australia to use untapped unique marine bioresources sustainably, creating new sectors for Australia's research ecosystem and economy.

Australian blue economy and partnership opportunities with China

Australia is the world's biggest island and third largest EEZ. Australia's vast marine territory and unique marine resources present an ocean of opportunities for Australia to make great fundamental discoveries and develop an ocean-based economy – the blue economy.

The 2023 AIMS Index of Marine Industry has reported the blue economy has contributed $105.3 billion to Australian GDP and supported 462,000 FTE jobs in 2021. The blue economy contributed 5.2% to the Australian GDP in 2021. In contrast, the Chinese blue economy is about $1978 billion, contributing to about 8% of Chinese GDP in 2021.

While Australia has been one of the leading countries in marine science capabilities embedded in our innovation systems, our ability and success to translate our unique marine resources and great science discoveries are limited due to the lack of market and industry drivers locally. This presentation will present an overview of the Australian blue economy, the Australian National Marine Science Plan, and Australia's marine innovation ecosystem. Australia's opportunities and challenges will be discussed in realising its ambitious ocean sustainable development goals and building international partnerships to benefit Australia and the global blue economy. Case studies of Marine Bioproducts CRC will be used to demonstrate the partnership model and collaborations among government, academia, industry and investors.

Professor Song Qin

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Professor Qin initiated the study of molecular phycology in China. He found the evidence for light-adaptive evolution of phycobiliproteins, revealed the regulation mechanism of antioxidant system specialized in algae, and established the genetic transformation system of kelp. His work was reported by Science magazine. He has published >216 SCI-indexed international papers and gained 43 patents (including three PCT patents) and published 11 books as editor-in-chief. He was former chairman of the Asia-Pacific Marine Biotechnology Association and chairman of International Marine Biotechnology Association. He was an IAP (Inter Academy Panel) Young Scientist in 2009, and member of the Ten Thousand Plan.

Marine biotechnology R&D and industrialisation innovation networking in China

Modern marine biotechnology relating to the production and utilisation of marine bioresources from molecules to communities on the basis of protecting marine biodiversity and the marine ecosystem started in the 1990s and since then has been known as the Five Blue Waves: seaweed cultivation, shrimp cultivation, scallop cultivation, fish and rare animal cultivation and blue medicines.

This presentation illustrates the R&D of marine biotechnology throughout the past three decades and showcases innovations in industrialisation and commercialisation of high value blue products.

It will share experiences and lessons learnt in how to build a practical blue value chain based on networking institutions and enterprises, setting up QC standard systems, and the training new generations of entrepreneurs.

Professor Chris Carter

Blue Economy Cooperative Research Centre & University of Tasmania

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Professor Carter leads Seafood and Marine Products in the Blue Economy CRC and is Professor of Aquaculture Nutrition at the University of Tasmania. He contributed to the formation of the Institute for Marine and Antarctic Studies (IMAS) and recently stepped down after five years as its Deputy Executive Director and Academic Director. Over

the last 30 years he has contributed to building sustainable aquaculture through research, education and stakeholder collaboration. His research broadly concerns animal performance and nutritional physiology with the aims of understanding production biology, how aquatic animals use and waste nutrients in different aquaculture systems. Current projects focus on offshore aquaculture systems, nutrition under sub-optimum conditions, rock lobster feeds and nutrition, building pathways to achieve next generation sustainable aquafeeds.

Building and integrating offshore renewable energy and seafood production

Two expanding and critical parts of the blue economy are the use of marine based renewable energy sources and seafood production from marine aquaculture. Established in July 2019, Australia's Blue Economy Cooperative Research Centre (Blue Economy CRC) is aimed at unlocking the potential of the nation's ocean resources through sustainable development. The Blue Economy CRC brings together 44 partners from 10 countries to generate opportunity by using established and new practices to move renewable energy and seafood production offshore safely, economically and sustainably. To facilitate this, the Blue Economy CRC contributes to building effective pathways for offshore development by investing in international and regionally relevant R&D. This activity explores potential synergistic benefits that include shared resources, efficient use of ocean space, less competition amongst other user groups of marine space, reduced operational and maintenance costs from possible shared activities. Key impacts are to increase sustainability and build community trust in blue economy industries. The aim here is to provide a brief overview of national offshore prospects and detail some R&D building blocks, current and required, that address barriers to realising the opportunities for offshore co-location and/or integration of both renewable energy and aquaculture production systems.

Session 4: Ocean ecosystem health

Professor Rencheng Yu
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Professor Lu is a professor of the Key Laboratory of Marine Ecology and Environmental Sciences and chief scientist of IOCAS and is an adjunct professor of the University of the Chinese Academy of Sciences. He received his Bachelor degree from Nankai University in 1993 and PhD degree from IOCAS in 1998. His research interests include phycotoxin and pigment analysis, molecular identification of microalgae, and dynamics and ecological consequences of harmful algal blooms. He has been working on different types of harmful algal blooms in the coastal waters of China including red tides, brown tides, green tides and golden tides formed by different species of microalgae and seaweeds. Supported by many state level projects from the China National Natural Science Foundation (NSFC) and Ministry of Science and Technology (MoST) of China, he has published 190 peer-reviewed papers.

Harmful algal blooms in China: status and research perspectives

Harmful algal bloom (HAB) is a typical marine ecological disaster in the coastal waters of China. Different types of HABs, such as red tides of dinoflagellates and haptophytes, brown tides of pelagophytes, and the macroalgal blooms of Ulva spp. and Sargassum horneri, have been recorded in different regions along the coast of China. The scale, frequency, and negative impacts of HABs exhibited remarkable increases over the last three decades, together with the marked shifts in HAB-causative species. Research on HABs has been supported continuously by the Natural Science Foundation of China, Ministry of Science and Technology of China, and Chinese Academy of Sciences. Great achievements have been made to understand the biological, ecological and oceanographic processes of major HABs in China. However, the emerging HABs in a changing marine environment driven by climate change and eutrophication bring new

challenges to HAB studies and management. A comprehensive system on risk assessment, monitoring and mitigation of HABs needs to be established, besides the basic research on the mechanisms of HAB formation and evolution, to reduce their disastrous impacts.

Professor Gretta Pecl
Centre for Marine Sociology/ Institute for Marine Antarctic Studies, The University of Tasmania
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Gretta Pecl is a professor of marine ecology at

the Institute for Marine and Antarctic Studies (IMAS), and the Director of the Centre for Marine Socioecology (CMS) at UTAS. She has a diverse research background but currently spends most of her time exploring the impact of climate change on natural systems, and helping develop adaptation options for conservation, fisheries and aquaculture. Ms Pecl has a specific interest in how climate change is resulting in a redistribution of life on earth, and she leads several national and international efforts to better understand climate-driven changes to species distributions, including the citizen science initiative, Redmap Australia and the international Species on the Move collaboration. She is a Lead Author for the IPCC AR6 report, a recent Australian Research Council 'Future Fellow', and an associate editor for several leading international journals. Ms Pecl has been prominent in UN Decade of Ocean Science programmes, actions and working groups, including co-leading Future Seas 2030 and other major international initiatives. She has a strong passion for science communication and engagement with the public and is ranked in the top 200 most influential climate scientists in the world and the top 20 women.

Climate-driven species redistribution in marine systems and the challenges for ocean health

Ocean health is inextricably linked to the structure and function of marine ecosystems, and the biodiversity within them. Yet climate change is driving a pervasive global redistribution of biodiversity, with manifest implications that we are just starting to understand. Species redistribution defies conservation paradigms that focus on restoring systems to a baseline, and adds to management complexities for natural resources, particularly when species cross jurisdictional boundaries and where historical catch rates and assessment processes may no longer be appropriate. Moreover, we are still a long way from understanding the suite of mechanisms and processes underlying the high variation in rate and magnitude of shifts.

Building on that uncertainty, we lack understanding of how species redistribution will drive changes in ecological communities and further complicate aspirations of ecosystem-based management. Climate-driven species redistribution therefore presents intriguing ecological challenges to unravel, as well as fundamental philosophical questions and urgent issues related to conservation, food security, Indigenous and local livelihoods, and many other aspects of human well-being.

Understanding from ecological, physiological, genetic and biogeographical perspectives is essential for informing and designing conservation and natural resource management strategies for a changing future. Further, to support development of relevant adaptive strategies and policy decisions adequately, studies need to take an interdisciplinary approach and must recognise and value diverse stakeholders.

Professor Xiaoke Hu
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Professor Hu currently serves as the Associate Dean of the Laboratory of Coastal Biology and Biological Resources Utilization, member of the Chinese Society of Microbiology, Marine Biological Resources Committee, editor of Frontiers in Microbiology, and senior editor of ISME Journal Communication. She has undertaken more than 30 research projects including the NSFC, "973" project, the National Key

Research and Development Program, and the Key Priority Research Program of the Chinese Academy of Sciences, which equates to a total of more than 50 million RMB. She has published more than 120 research papers, one book in Chinese with five chapters in English. She has been granted 25 patents, and received six major awards in China, including the "Zeng Chengkui" Marine Science and Technology Award, Industry-University-Research Cooperation Innovation Award, Marine Science and Technology Award, Ocean Engineering Science and Technology Award, Shandong Science and Technology Award, and National Ocean Innovation Achievement Award. She is also an expert for the Division for Ocean Affairs and the Law of the Sea in the United Nations. Professor Hu has played a leading role on the research of Marine Ecology, Marine Microbiology, and Seaweeds for decades.

Development of marine biological products based on the enzymolysis-fermentation coupling technology

Marine aquaculture production in China leads the world. The massive cultivation of kelp, white shrimp, bay scallop, sea cucumber etc. makes them widely available for consumers. In the meantime, the sustainable use of the aquaculture bio-resources becomes an inevitable problem.

The enzymolysis-fermentation coupling technology (EFCT) was developed to explore the functional ingredients from the sea cucumbers. EFCT mainly takes low-value resources as the research object and combines biological enzyme conversion with high-throughput fermentation to establish the coupling relationship between target products, cell growth, energy consumption and enzyme secretion, to achieve efficient and energy-saving large-scale preparation of active substances. Accordingly, commercial products such as functional foods, skin care products, biological feed have been developed.

The development of marketable products and processes is necessary for the contribution toward the growth of the blue bio-economy. To develop the value chain of the blue bio-economy, both the scientists and industrial partners need to be involved throughout the entire process. Scientists are responsible for the exploration of bioactive resources. The industrial partners oversee the marketing and selling of the new products, with different organisations being involved in specific phases; in this way, there is an increased likelihood for success for the blue bio-economy.

Professor Adriana Vergés

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Professor Vergés's research focuses on the ecology and conservation of coastal marine habitats. In particular, her team investigates the ecological impacts of climate change in our oceans and develops hands-on restoration solutions to protect and conserve marine ecosystems including seagrass meadows, kelp forests and coral reefs. She is a passionate science communicator and has authored over 100 peer-reviewed scientific publications. Professor Vergés is a Director of the Kelp Forest Alliance and a co-founder of Operation Crayweed and Operation Posidonia, two projects that have been restoring missing seaweed forests and seagrass meadows over the last ten years. Operation Crayweed was awarded the NSW Green Globe Award in 2017. Adriana received the UNSW Emerging Thought Leader Prize in 2019. She holds a PhD from the University of Barcelona, an MSc in Science Communication from Dublin City University and is a Professor at UNSW Sydney and the Sydney Institute of Marine Science.

The rise of coastal ecosystem restoration in Australia

Australia's coastlines are dominated by critically important habitats that include seagrass meadows, saltmarshes, mangroves, seaweed forests, oyster reefs and coral reefs. These habitats drive coastal productivity, protect shorelines from erosion, underpin biodiversity, and support many of Australia's most valuable fisheries and tourism industries. Multiple human stressors including

coastal development, pollution and climate change have led to extensive losses of many coastal habitats in recent decades. In response to these declines, coastal restoration is emerging as an increasingly important management tool aiming to recover and secure the ecosystem functions and services provided by these habitats. In this talk I will first provide a brief overview of the trajectory of coastal restoration in Australia. Further, I will focus on seaweed and seagrass restoration to show how coastal restoration can result in substantial quadruple bottom-line benefits that reach a wide section of the Australian population including First Nations Peoples.

Session 5: Deep ocean

Dr Bernadette Sloyan

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

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Dr Bernadette Sloyan is a CSIRO Senior Principal Research Scientist. She is a science leader in documenting and understanding the role of the ocean circulation and variability in the global climate and on the marine ecosystem. She applies sophisticated analysis methods to ocean observations to produce data products for use by the research community. Her work has elucidated key ocean climate processes including mixing and air-sea interactions in the Southern, Pacific and Indian Oceans. She provides leadership to many national and international science planning and advocacy committees. As co-chair of the Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP, 2009-2019) she revitalised the coordination and communication between participating nations and was a strong supporter of the addition of biological samples to the GO-SHIP observation suite. Her leadership led to the reaffirmation of the decadal ocean survey as a vital component of the sustained ocean observing system. As chair of Ocean Observations Physics and Climate (OOPC, 2015-2020) panel, she led the OOPC response and input to the 2016 Global Climate Observing System (GCOS) implementation plan that guides national investment in the ocean observing system. She is co-chief-editor of EGU Ocean Science, national representative for SCOR and GO-SHIP.

The Deep Pacific Ocean physical, biogeochemical and biological environmental diversity

The oceans have absorbed 25% of the anthropogenic CO2 and 93% of the excess heat in the climate system. The ocean circulation preferentially determines regions of ocean heat and carbon uptake and how these quantities are redistributed throughout the ocean basins. This talk will explore knowledge gained and questions raised of the deep ocean by the Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP) observations of the Southern and Pacific Oceans.

The Pacific Ocean is the largest and deepest ocean basin on Earth. In the Southern Hemisphere, the 170°W meridian traverses, from south to north, the Southern Ocean's Ross Sea, the eastward flowing Antarctic Circumpolar Current system, the southern branch of the South Pacific gyre, and the northward Deep Western Boundary Current that transports deep ocean water masses into the North Pacific Ocean. Over this latitudinal range distinct physical, biogeochemical and biological environmental regions are found, all of which are experiencing unprecedented warming and property variability. The heat and carbon uptake has impacted the marine environment and ecosystems. Yet the highly intertwined relationships amongst the physical, biogeochemical and biological in the deep ocean remain poorly understood.

Professor Dr Kuidong Xu

Institute of Oceanology, Chinese Academy of Sciences (IOCAS)

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Professor Dr Xu is Principal Investigator in the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) and director of Laboratory of Marine Organism Taxonomy and Phylogeny, IOCAS. He is also a professor at the University of Chinese Academy

of Sciences. He received his PhD from the Ocean University of China in 1999. Then he worked as a postdoctoral researcher at Inha University, Korea during 1999-2002 and in Salzburg University, Austria during 2002-2005. His main research interests include the taxonomy, biodiversity and phylogeny of marine animals. Recently, his focus is mainly on the biodiversity and distribution of megabenthos as well as microbial eukaryotes from seamounts in the Western Pacific Ocean, a key program supported by the Natural Science Foundation of China. He has published approximately 200 peer-reviewed papers including 101 articles in SCI-indexed journals, and four monographs.

Diversity and distribution of megabenthos in the Northwestern Central Pacific

Seamounts, as characteristic deep-sea habitats, have been known to support high diversity of marine life, particularly corals. So far, our knowledge of seamount animals particularly corals remain very limited, resulting in controversial explanations on their biodiversty and distribution. The northwestern central Pacific (NWCP) contains a high number of seamounts, but it is also a region where seamount diversity is poorly explored. We conducted six seamount cruises using remotely operated vehicle (ROV) and investigated the diversity and distribution of megabenthos as well as cold-water corals in the NWCP. Our analysis indicates that the seamount megabenthic communities in the NWCP are distinctly isolated, and depth-related parameters, substrate types and currents are the main factors structuring the diversity and distribution of seamount megabenthos. We found high diversity and specificity of seamount corals and suggested the NWCP a center of deep-sea diversity. Very low community similarity and species overlap occurred between adjacent seamounts in the NWCP. Higher species diversity and specificity occurred in the South China Sea than in the NWCP. The high diversity and specificity of deep-sea corals in this region argue for higher priorities for biodiversity conservation.

Dr Skip Wooley

CSIRO

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Dr Woolley is a Research Scientist within the environment business unit at CSIRO. His research focuses on understanding how marine biodiversity interacts with human activities and pressures, to better protect and reduce the risk of biodiversity loss and manage ecosystems into the future. He works across several marine environments, including the deep-sea, where his work aims to improve outcomes for nature and improve management for proponents. His work at CSIRO has largely concentrated on the development, application and interpretation of statistical and mathematical models to facilitate environmental risk assessments. He is currently working on several project relevant to deep-sea environments, including, bioregionalisation of benthic and pelagic species in Areas Beyond National Jurisdiction (ABNJ), modelling benthic ecosystems to inform management of Australia's Commonwealth Marine Reserves and understanding the risk of deep-sea mining in the Clairon-Clipperton Zone (CCZ).

Biodiversity management for deep-sea ecosystems

Deep-sea environments are one of the largest ecosystems on earth. They harbor huge diversity, yet much work is needed to effectively manage species and ecosystems within this immense realm. At CSIRO we have been working on integrated ecosystem management for deep-sea environments using a broad range of approaches. We have been undertaking broad-scale marine spatial planning, such as the development of bioregions for benthic ecosystems to inform spatial management of Areas Beyond National Jurisdiction (ABNJ) in the Indian Ocean. We have also looked at how bioregions could be used to inform spatial selection of area-based management regions (e.g. protected areas) in the context of deep-sea biodiversity and human use. Finally, the presentation will look at some of the integrated ecosystem assessment and management work being done in response to proposals for deep-sea mining, where we are working with mining proponents to understand the risks of deep-sea mining exploration and extraction on deep-sea biodiversity.

Professor Chaolun Li
South China Sea Institute of Oceanology, Chinese Academy of Sciences
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Professor Li obtained his PhD degree from the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) in 2002, after which he worked the marine ecology team of IOCAS. He moved to the South China Sea Institute of Oceanology, Chinese Academy of Sciences (SCSIO) as a director in 2022. As a visiting scientist, he worked at the University of Tromsø, Norway in 2004-2005, and at the University of Connecticut, USA in 2007. His research interests include zooplankton population dynamics, ecological disasters (jellyfish bloom) in China coastal waters, extreme environment and ecosystem exploration in the deep sea and polar sea. Professor Li's group has developed some toolkits for the in-situ detection of deep-sea extreme environment and in-situ experiment of deep-sea organisms. Based on this equipment and platforms, Professor Li and his colleagues carry out comprehensive studies in the chemotrophic strategy of megafauna and their role in the biotransformation of methane/HS- in cold seeps and hydrothermal vents.

Deep ocean exploration technology and scientific progress of CAS in the last decade

The deep ocean is a dynamic, yet poorly explored system that provides critical climate regulation, hosts a wealth of hydrocarbon, mineral, and genetic resources, and represents a vast repository for biodiversity. Deepening scientific understanding of deep-sea ecosystems is important for sustainable development. In the past decade, the Chinese Academy of Sciences (CAS) has vigorously developed deep-sea survey platforms and exploration technologies, which have promoted scientific understanding of deep-sea ecosystems. This talk will introduce the deep-sea exploration research platforms that have been built by CAS and describe the scientific discoveries and mechanism understandings of some deep ocean chemosynthetic ecosystems in the NW Pacific under the support of these platforms.

Yarning Circle

In this session, Future Earth Manager, Kate Nairn, will guide a discussion with Traditional Owners/ Knowledge Holders, Professor Roxanne Bainbridge and Bianca McNeair.

A yarning circle is a practice used by Aboriginal and Torres Strait Islander Peoples of Australia for sitting together to talk and listen from the heart and share ideas and stories. It is used to learn from a collective group, build respectful relationships, and to preserve and pass on cultural knowledge and wisdom.

Professor Roxanne Bainbridge
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Professor Bainbridge is a Gunggari/Kunja medical anthropologist from South-West Queensland. Currently, she is Professor/ Deputy-Director at the Poche Centre for Indigenous Health at the University of Queensland (UQ) and inaugural Senior Atlantic Fellow for Social Equity at the University of Melbourne/Oxford. Prof. Bainbridge focuses on medical anthropology as a culturally constructive critique of the biomedical sciences and policy to provide new understandings of human health, wellness and illness for Indigenous Australians. She is firmly committed to value-based health care and the role of culture, policy, governance, funding and measurement to deliver positive health and life outcomes that matter to Indigenous Australians. Prof. Bainbridge is an engaged researcher/evaluator with extensive experience leading, collaborating and coordinating projects with international, national and local teams. Leading and collaborating in the development and application of co-designed intervention research that is rigorous, pragmatic and embedded into the routine delivery of services and government policy. Her methodological expertise is in high-impact applied research conducted in participatory, action-oriented whole of system approaches. Specific proficiencies include research impact assessment and evaluation, improvement

sciences, systems sciences, mixed methods, phronetic grounded theory, ethnographic techniques and tool adaptation.

Bianca McNeair

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Bianca McNeair is a Malgana Woman from Gathaagudu, Shark Bay, WA. Bianca is a Steering Committee member of the 4th Biennial National First Peoples Gathering on Climate Change and works with Marine Scientists bringing them together with Traditional Owners to address growing climate issues.

Working with the University of Western Australia, the Seagrass restoration project in Gathaagudu produced significant outcomes for climate research with respect to the cultural values of her people.

Bianca also coordinates an annual loggerhead turtle monitoring program for Malgana women on Dirk Hartog Island. which monitors the endangered species amongst other species and fosters opportunities for Malgana women to share cultural knowledge, as a part of the oldest continual culture in the world.

Symposium steering committee

We extend our deep gratitude to the symposium steering committee for their guidance on the program and selection of speakers.

Professor John Church AO FAA FTSE

Dr John Church is an Emeritus Professor in the Climate Change Research Centre, University of New South Wales. His area of expertise is the role of the ocean in climate, particularly anthropogenic climate change, and the oceanic storage of increased heat in the World's oceans. He was co-convening lead author for the Chapter on Sea Level in the IPCC Third and Fifth Assessment Reports. His expertise has been recognised nationally and internationally with a number of highly significant awards. He is an Officer of the Order of Australia, a Fellow of the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering, of the American Geophysical Union, the American Meteorological Society and the Australian Meteorological and Oceanographic Society.

Dr Beth Fulton FAA FTSE

Dr Beth Fulton is CSIRO's research domain leader for integrated oceans stewardship and the blue economy. In shaping the strategic direction for CSIRO's research in this area, she is building off more than 20 years of work developing various system modelling tools for looking at marine ecosystems, sustainability and climate adaptation. Dr Fulton is also an Adjunct Professor and Deputy Director at the Centre of Marine Socioecology, a centre focuses on working collaboratively to find transdisciplinary, equitable and sustainable solutions to the problems facing coasts and oceans.

John Gunn FTSE

Mr Gunn has an over 40-year career as an applied scientist, organisational leader and most recently in governance positions. Mr Gunn has been committed to ensuring the best scientific advice is available, communicated, trusted and used to tackle sustainable development challenges at local, national and international scales.

As Chief Executive Officer of the Australian Institute of Marine Science (2011-2017), Chief Scientist of the Australian Antarctic Program/ Senior Executive in the Australian Government (2008-2011), and Deputy Chief of CSIRO's Marine and Atmospheric Research Division (2003-3008), John led the development of national and global science strategies, major research programs, science capability (people, research infrastructure and partnerships), and stakeholder engagement across research portfolios encompassing coral reef systems, aquaculture, marine ecology, fisheries, coastal systems, physical and chemical oceanography, atmospheric chemistry and climate science.

Mr Gunn has advised Commonwealth and State Ministers and governments and worked at the interface between R&D and industry throughout his career. This included Board and Advisory Committee roles on the national science and research policy (including the National Science, Research and Technology Committee), Great Barrier Reef policy and regulation, national and global fisheries management, and Antarctic research. As Chair of the National Marine Science Committee (2011-2016) he led development of the National Marine Science Plan 2015-25: Driving the development of Australia's blue economy.

Dr Jennifer Stauber GAICD, FTSE, FAA, SETAC Fellow

Dr Stauber is a Chief Research Scientist at CSIRO Environment, Sydney and Adjunct Professor at La Trobe University. She was formerly a Visiting Professor at the Environmental Research Institute, South China Normal University, Guangzhou, and at the Department of Biology and Chemistry, City University, Hong Kong.

Dr Stauber is an aquatic ecotoxicologist with expertise in the bioavailability and toxicity of contaminants in marine and freshwater systems under climate change, environmental risk assessment including deep sea mining and deep-sea tailings placement, and the derivation of toxicant water and sediment quality guidelines. She chairs and serves as expert ecotoxicologist on many national and international advisory committees including the Ecotoxicity Technical Advisory Panel for the International Metals Associations, Independent Expert Committee on Coal Seam Gas and Large Coal Mining Development, Reef Water Quality Independent Science Panel, and recent external review panels for the Australian Antarctic Division and Australian Institute of Marine Science. She was a previous recipient of Australia's Land and Water Eureka Prize and has authored over 400 journal papers, book chapters and reports.

Matthew Flinders Distinguished Professor Wei Zhang

Professor Zhang is an inspiring leader in marine biorefinery and bioproduct development technologies, and he has passionately pursued an overarching career driving translational research with industry impacts.

He obtained his PhD from Dalian Institute of Chemical Physics, CAS in 1994, and did his Postdocs at the University of Tokyo, Adelaide University and Cambridge University. He won several important awards including "South Australia Young Tall Poppy Science Award" in 2008, "South Australia Science Excellence and Innovation Award", and "Finalist of Australian Eureka Prizes for Leadership in Science and Innovation" in 2022. He is the Inaugural President of Australia-New Zealand Marine Biotechnology Society, Chair of Marine Biotechnology Subcommittee, Australia National Marine Science Committee, and the inaugural Research Director of Marine Bioproducts Cooperative Research Centre (MB-CRC). Currently, he is Chief Science Advisor of MBCRC, President of the Asia-Pacific Marine Biotechnology Society, and Matthew Flinders Distinguished Professor at Flinders University.

An entrepreneurial academic champion, Wei's vision to connect formerly disparate marine bioproducts research and commercial sectors led to growing Australia's industry R&D capability and market impact into a new 3rd-Gen marine bioproducts industry, sustainably utilising Australian untapped marine bioresources.

He was the driving force behind ground-breaking work in functional foods, nutraceuticals, cosmetics and biomaterials, leading to the successful $270m Marine Bioproducts CRC. Wei's advanced bio-refinery technologies allow Australia to use untapped unique marine bioresources sustainably, creating new sectors for Australia's research ecosystem and economy.