CAS-EurASc
FRONTIER FORUM ON MARINE SCIENCES AND TECHNOLOGIES

Shanghai | Online via Zoom
2020.10.20-21

Sponsors
European Academy of Sciences **Chinese Academy of Sciences**

Forum on Frontiers of Science & Technology

CAS-EurASc Frontier Forum on Marine Sciences and Technologies

Dates and place

20-21 October 2020

Forum held in Shanghai and online via Zoom.

Forum link (for audience):

https://zoom.com.cn/j/68071273480?pwd=WHRiOFhwaUR3N09jalQxaUh3aVRwUT09

Meeting ID: 680 712 73480

Password: 523291

Chairs

Prof. Paul Tréguer, University of Western Brittany, France

Prof. Louis Legendre, Sorbonne University, France

Prof. Jing Zhang, East China Normal University/Shanghai Jiao Tong University, China

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Description

The CAS-EurASc Frontier Forum on Marine Sciences and Technologies co-sponsored by the Earth Sciences Divisions of the Chinese Academy of Sciences (CAS) and the European Academy of Sciences (EurASc) aims to provide a platform for marine scientists and engineers in China and Europe to share their knowledge and experience of frontier research methods and results, and to foster international and interdisciplinary collaboration.

The Forum dedicates special focus of a dialogue between scientists from China and Europe, which will be also delivered online and open to the general public. The keynote speakers are all scientists who are actively engaged in state-of-the-art research in various aspects of this field.

In order to synthesize an understanding of progress in marine science and technology, and determine priority areas for cooperation that will provide a basis for a future research agenda, the Forum consists of interactive sessions that include different aspects of oceanography, in particular multidisciplinary topics, as well as presentations that reflect new and emerging research on the ocean and society.

The themes of the four sessions are:

- **Session One:** The Earth System and the future ocean in a changing climate
- **Session Two:** Perspectives of ocean sciences in a changing climate
- **Session Three:** Ocean sustainable development
- **Session Four:** Cooperation between China and Europe on ocean sciences and technologies

The Forum will be held online from 8:00 to 15:00 (CEST, UTC +2) to accommodate the time difference between China and Europe.

Program (Central European Summer Time, CEST)

Day One (Tuesday, 20 October 2020)

08:00-08:30 Opening ceremony & Group photo

Session One: The Earth System and the future ocean in a changing climate,

Conveners: Dake Chen, Paul Tréguer

08:30-08:50 *Global Warming: The Need to Keep in Line with the Paris Agreement*, Jean Jouzel

08:50-09:10 *Upper Ocean Biogeochemistry in the Oligotrophic Ocean*, Minhan Dai

09:10-09:30 *Predicting the Global Coastal Ocean: Toward a More Resilient Society*, Nadia Pinardi

09:30-09:50 *Estuary and Delta — Example of Land-Sea Interactive Process & Sedimentation*, Ying Wang

09:50-10:00 Coffee break

10:00-10:40 Discussion session 1

Session Two: Perspectives of ocean sciences in a changing climate,
Conveners: Lixin Wu, Jean-Pierre Gattuso

10:40-11:00 *Ocean Alkalinity, Buffering and Biogeochemical Provinces*, Jack Middelburg

11:00-11:20 *Marine Sciences and Technologies in the European Framework Programs: Science for Better Policies*, Pierre Karleskind

11:20-11:40 *Big Earth Data for Sustainable Development Goal 14: Life Below Water*, Huadong Guo

11:40-12:00 *Perspectives on China's Polar Ocean and Climate Research*, Dake Chen

12:00-13:00 Lunch

13:00-15:00 Discussion session 1 (continued) and discussion session 2

Day Two (Wednesday, 21 October 2020)

Session Three: Ocean sustainable development, Conveners: Minhan Dai, Louis Legendre

08:00-08:20 *Multiscale Air-sea Interaction and High-resolution Earth System Modeling,* Lixin Wu

08:20-08:40 *Future Ocean Sustainability - From Ocean Observation towards Sustainable Development*, Martin Visbeck

08:40-09:00 *Ocean Negative Carbon Emission (ONCE) – A Proposal for International Program on Mitigation of Climate Change,* Nianzhi Jiao

09:00-09:20 *Ocean-based Measures to Reduce Climate Change and its Impacts, and Rebuild Marine Life*, Jean-Pierre Gattuso

09:20-09:30 Coffee break

09:30-09:50 *The Ocean and Cryosphere in a Changing Climate, IPCC Special Report 2019*, Hans-Otto Pörtner

09:50-12:00 Discussion session 3

12:00-13:00 Lunch

Session Four: Cooperation between China and Europe on ocean sciences and technologies, Conveners: Jing Zhang, Paul Tréguer

13:00-15:00 Synthesis

END

List of Invited Participants

Participants in the CAS-EurASc Frontier Forum includes nearly 60 marine scientists and experts from the European Academy of Sciences (EurASc), the Chinese Academy of Sciences (CAS), the Chinese Academy of Engineering (CAE), and other Chinese universities and research institutions, management experts from the National Natural Science Foundation of China, as well as delegates from international projects and academic journals.

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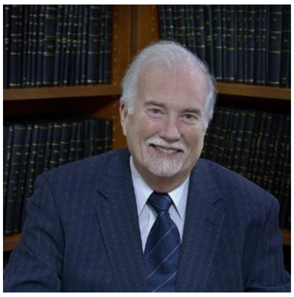
Chairs

Paul J. Tréguer

Paul J. Tréguer is emeritus professor at the University of Brest (France). He is a marine biogeochemist who has expertise in nutrient cycles in coastal and open oceans, and in polar ecosystems. He is at the initiative of the SILICA International School (open in October 2020) and of the SILICAMICS network (third conference, Hangzhou, October 2021). From 2000 to 2008, he chaired/co-chaired/directed different international programs, including: the Southern Ocean – Joint Global Flux Study (SO-JGOFS) appointed by the International Geosphere Biosphere Programme (IGBP), and the Scientific Committee on Oceanic Research (SCOR), and the EUR-OCEANS Network of Excellence (NoE) on the impacts of global change on marine ecosystems. From 1991 to 2012, he founded and directed the "European Institute for Marine Studies" (IUEM), and the consortium Europôle Mer. Since 2000, he has been developing cooperative actions with Chinese universities or marine institutes, including: the Ocean University of China (Qingdao) and the Second Institute of Oceanography (Hangzhou). Paul J. Tréguer has received numerous prizes and honours, including: fellow of the American Geophysical Union AGU (2016), fellow of the Association for the Sciences of Limnology and Oceanography ASLO (2016), fellow of the European Academy of Sciences EurASc (2015), Honorary Doctorate from the University of Québec-Canada (2014), Georges Millot medal of the French Academy of Sciences (2013). Paul J. Tréguer is officer of the Legion of Honour (2017). He has published more than 150 refereed papers and several books. His new book entitled "Oceans – evolving concepts" is in press.



Louis Legendre

Louis Legendre is Professor emeritus at Sorbonne University, France, and Laval University, Canada. He is an elected fellow of the European Academy of Sciences, the Royal Society of Canada - Academy of Sciences, and the Chinese Academy of Sciences (foreign member). He was director of the Villefranche Oceanography Laboratory, France, from 2001 to 2010. His fields and topics of research are marine biogeochemistry, biological oceanography, numerical ecology, and philosophy of science. His work is a blend of theoretical studies, laboratory research, and fieldwork. He has received numerous prizes and honours, including: Sustaining Fellow of the Association for the Sciences of Limnology and Oceanography (ASLO), Knight in the Order of Saint Charles (Principality of Monaco), the International Ecology Institute Prize, the G. Evelyn Hutchinson Award (American Society of Limnology and Oceanography), Honorary Doctorate from the University of Liège (Belgium), the Québec Prize in Pure and Applied Sciences. He has published more than 260 refereed papers, seven full books, and 12 other book chapters. His new book entitled "Earth, Our Living Planet" will be published soon.

Jing Zhang

Jing Zhang, professor at Shanghai Jiao Tong University and East China Normal University, teaching chemical oceanography and biogeochemistry. His research work focuses on the behavior and the circulation of trace elements and biogenic elements in the ocean. His early work has concentrated on biogeochemical processes in estuaries and coastal waters, including the behavior and destination of chemical elements. Recently, he has attended many cruises in the tropical Western Pacific and equatorial Eastern Indian Ocean, focusing on the research about the distribution pattern, migration and transformation of trace elements and nutrients at different depth and in different sea areas, and understanding the intersection problems with different disciplines such as physics, biology.

Speakers

Dake Chen

Dake Chen is a fellow of Chinese Academy of Sciences, and is currently working at the Second Institute of Oceanography in Hangzhou, China. He received his Ph.D. degree in physical oceanography from the State University of New York at Stony Brook in 1989, and has worked in the fields of ocean and climate sciences ever since. His research interest includes ocean-atmosphere interaction, ocean general circulation, coastal ocean dynamics, tropical climate variability, as well as polar climate and its global connections. He is now serving at many international and national scientific committees, and is playing an instrumental role in promoting and organizing several large-scale national campaigns in ocean and climate research.

Minhan Dai

Minhan Dai is a Chair Professor of Marine Biogeochemistry at Xiamen University, China (http://mel2.xmu.edu.cn/faculty/MinhanDai/) where he serves as Director of Faculty of Earth Science and Technology, and Director of State Key Laboratory of Marine Environmental Science. His primary research interests are ocean biogeochemistry of carbon and nutrients, and geochemistry of radioactive elements in surface and ground waters. Recently, his research interests have been expanded in linking ocean science and sustainability.

Minhan Dai earned his B.S. degree from Xiamen University, China in 1987 and his Ph.D. from Université Pierre & Marie Curie, France in 1995. After a Doherty Foundation Postdoctoral Fellowship at Woods Hole Oceanographic Institution (WHOI), he took a faculty position at Xiamen University in 1998. He is an adjunct scientist at Woods Hole Oceanographic Institution (WHOI) since 2002. He was selected as an Academician of the Chinese Academy of Sciences in 2017.

He has published over 190 papers in leading international journals (http://www.researcherid.com/rid/G-3343-2010). He is a leading PI of a "973" project funded through the National Basic Research Program of China on "Carbon cycling in China Seas - budget, controls and ocean acidification" (CHOICE-C) which was renewed by the Ministry of Science and Technology (MOST) of China (2015-2019). He is also a leading PI of a newly funded NSFC major project "CARBON Fixation and Export in the oligotrophic ocean" (Carbon-FE) (2019-2023). He has served on many national and international committees. He was Secretary General of the Asia Oceania Geosciences Society (AOGS) during 2010-2012, the President of AOGS's Ocean Section from 2009-2010, and Founding President of AOGS's Biogeosciences Section from 2012-2014. He has been an at-large member of the AGU Ocean Sciences Section Executive Committee since 2013. He was a co-chair of the Programme Committee of OceanObs'19 Conference. He is a member of Expert Group for the High Level Panel for a Sustainable Ocean Economy.

Jean-Pierre Gattuso

Jean-Pierre Gattuso is CNRS Research Professor at the Laboratoire d'Océanographie de Villefranche (Sorbonne University). He is also Associate Scientist at the Institute for Sustainable Development and International Relations (IDDRI-SciencesPo, Paris). His current research relates to the effects of ocean acidification and warming on marine ecosystems and the services that they provide to society. He also investigates ocean-based solutions to mitigate and adapt to climate change. Jean-Pierre Gattuso led the launch of the Ocean Acidification International Coordination Centre at the International Atomic Energy Agency. He coedited the first book on ocean acidification (Oxford University Press) and contributed to several IPCC products (AR5, Special Report on 1.5 ℃ of Warming, and the Special Report on the Ocean and Cryosphere). He received the Vladimir Vernadsky medal of the European Geosciences Union, the Blaise Pascal medal of the European Academy of Sciences (of which he is an elected member), and the Ruth Patrick Award of the Association for the Sciences of Limnology and Oceanography. Jean-Pierre Gattuso is an elected member of Academia Europaea. More information: http://bit.ly/1OQDYeh.

Huadong Guo

Huadong Guo is a Professor of the Chinese Academy of Sciences (CAS) Aerospace Information Research Institute, an Academician of CAS, a Foreign Member of Russian Academy of Sciences, a Foreign Member of the Finnish Society of Sciences and Letters, and a Fellow of TWAS. He presently serves as Honorary President of International Society for Digital Earth (ISDE), Member of UN 10-Member Group to support the Technology Facilitation Mechanism for SDGs, Director of the International Center on Space Technologies for Natural and Cultural Heritage under the Auspices of UNESCO, Science Committee Member of the Integrated Research on Disaster Risk (IRDR) of ISC/UNDRR , Chair of Digital Belt and Road Program, and Editor-in-Chief of the International Journal of Digital Earth and Big Earth Data. He served as Chairman of the International Committee of Remote Sensing of Environment (2017-2020), President of ISDE (2015-2019) and ICSU Committee on Data for Science and Technology (2010-2014). Prof. Guo specializes in remote sensing, radar for Earth observation, and Digital Earth science. Currently he is the chief scientist of the Big Earth Data Science Engineering Program of CAS and PI of Moon-based Earth Observation Project of National Natural Science Foundation of China. He has published more than 500 papers and 17 books, and is the awardee of 17 domestic and international prizes.

Jean Jouzel

Research director (emeritus) at the CEA, Jean Jouzel is an expert in climate and glaciology. He has mainly worked on the reconstruction of past climate derived from the study of the Antarctic and Greenland ice. He has been a vice-chair of the Scientific Working Group of the IPCC (co-recipient of the Nobel Peace Prize 2007) from 2002 to 2015. From 2001 to 2008, he headed the Institute Pierre Simon Laplace. His work has been recognized with awards such as Milankovitch and Revelle medals. Together with Claude Lorius, he was awarded the gold medal by the CNRS in 2002. In 2012, with Susan Solomon, he was awarded the Vetlesen Prize, which is referred to as the “Nobel Prize for Earth sciences”. Member of EURASC since 2015, he has in 2016, been elected as a foreign member of NAS (US National Academy of Sciences) and in 2017 as a member of the French Academy of Sciences.

Nianzhi Jiao

Nianzhi Jiao, Distinguished professor of "Changjiang Scholars" at Xiamen University. Deputy Director of the Earth Science Division of the Chinese Academy of Sciences. Member of the Discipline Group of Academic Degrees Committee of the State Council. Vice President of the Chinese Society for Oceanology and Limnology, and the Chinese Society of Microbiology. Deputy Chief-editor of SCIENCE CHINA Earth Sciences. Editorial board member of some international journals, such as Embio, AEM. Adjunct Professor at University of Maryland, USA, and Dalhousie University, Canada. Co-chair of the Joint Working Group on Ocean Carbon Sink of the International Council for the Exploration of the Sea (ICES) and the North Pacific Marine Science Organization (PICES). His research interests lie in Marine ecological processes and their environmental effects. He proposed a new conceptual framework of ocean carbon sequestration, the “micro-biological carbon pump (MCP)”, which was commented in Science as “An invisible hand behind the vast carbon reservoir”. Scientific Committee on Oceanic Research (SCOR) established a scientific Working Group on the MCP, and the MCP-based theory and applications to mitigation of climate change were incorporated into the special report on climate change by the Intergovernmental Panel on Climate Change (IPCC). He has published more than 300 papers in international journals including Science, Nature sub-issues, PNAS, etc., and has been rated as highly cited Chinese scholar by Elsevier for many years. He was awarded the Second Prize of National Natural Science Award twice (2006, 2015). and “He Liang He Li Award for progress in science and technology” in 2013, the first National Innovation Prize (2017) and the Commemorative medal for the 70th anniversary of the People's Republic of China (2019). He is elected member of Chinese Academy of Sciences (2011), the World Academy of Sciences (TWAS) (2014), the American Academy of Microbiology (AAM) (2018).

Pierre Karleskind

Pierre Karleskind is a Member of the European Parliament since the 2019 election and Chair of its Committee on Fisheries (PECH). Pierre Karleskind carried out its military service in the deep-sea tug of the French Navy and graduated at the Ecole Polytechnique as an engineer. Pierre Karleskind carried out its military service in the deep-sea tug of the French Navy. He then prepared his PhD thesis in marine sciences at the Institut Universitaire Européen de la Mer, which he defended in 2008. He was a consultant in marine sciences and techniques at Altran from 2008 to 2014, president of Technopôle Brest Iroise from 2014 to 2017 and Vice-President of the Brittany Region in charge of the sea from 2012 to 2019.

Pierre is committed to support research and programmes involving maritime topics such as renewable energy, transportation, port facilities or marine biology. In the European Parliament, he fights for the consideration of maritime themes in their entirety, whether these be transport, aquaculture and fishing or even marine energies.

Jack Middelburg

Jack Middelburg was trained as a biogeologist/geochemist and worked from 1992-2009 at the Netherlands Institute of Ecology. Since 2009 he holds the geochemistry chair at Utrecht University and an excellent chair at MARUM, University of Bremen (since 2019). He has a very wide scientific interest, from inorganic geochemistry via biogeochemistry to ecology, from elemental-cycles oriented to organisms-oriented studies, from weathering of rocks to deep-sea pore-waters, from laboratory studies and field observations to numerical modelling, from global scale down to nanometer scale, and through the use of reductionistic as well as holistic and explorative approaches. He has been elected member of the Royal Netherlands Academy of Arts and Sciences, Academia Europaea and European Academy of Sciences, is Fellow of the EAG/Geochemical Society and is recipient of various awards, including ASLO's Hutchinsons award in 2016 and the EGU's Vernadsky award in 2017. He has authored an open access text book Ocean Carbon Biogeochemistry and is scientific director of the Netherlands Earth System Science Centre.

Nadia Pinardi

Nadia Pinardi holds a Ph.D. in Applied Physics from Harvard University, and she is full professor of Oceanography at Bologna University, Italy. Her interests range from ocean numerical modelling and predictions to data assimilation, numerical modelling of the marine physical-biological interactions and pollutants at sea. She has written more than hundred and sixty papers in peer reviewed journals on a wide range of subjects. The last topic of her research is the understanding of uncertainties in ensemble forecasting, oil spill numerical modelling coupled to operational oceanographic forecasts and the analysis of climate indices in the Mediterranean

Sea, such the Mediterranean Sea Overturning Circulation index. Her major achievement is the conceptual design and practical implementation of ocean forecasting systems across the world ocean: she started with the contribution to the very first real time ocean forecast in the California Current system to the complete development of monitoring, modelling and data assimilation components for the Mediterranean, Marmara and Black Sea. Furthermore, she used the products of the forecasting system to understand new ocean dynamics in the Mediterranean Sea (Pinardi et al., 2014, Pinardi et al., 2019) and to develop several new societal benefit applications. She has been the director of the National Group of Operational Oceanography of the National Institute of Geophysics and Volcanology from 2004 to 2012. She has been Member of the European Space Agency Space Advisory Group, of the European Environment Agency Scientific Advisory Committee and of the European Research Council for Earth Sciences. From 2012 to2019 she was co-president of the Joint Committee for oceanography and Marine Meteorology(JCOMM)of Unesco-IOC and WMOand she is, since 2019, co-chair of the Commission for Observation, Infrastructure and Information Systems (Infrastructure Commission) of WMO and Member of the Joint Collaborative Board of Unesco-IOC and WMO.


Photo from AWI Rolfes

Hans-Otto Pörtner

Dr. Hans-Otto Pörtner received his PhD and habilitated in Animal Physiology at Münster and Düsseldorf Universities. As a Research and then Heisenberg Fellow of the German Research Council he worked at Dalhousie and Acadia Universities, Nova Scotia, Canada and at the Lovelace Medical Foundation, Albuquerque, New Mexico, USA, before he became Professor and Head of Integrative Ecophysiology at the Alfred Wegener Institute, Bremerhaven, Germany. He has established theory and evidence on effects of climate warming, ocean acidification, and hypoxia on marine animals and ecosystems. His efforts focus on linking biogeography and ecosystem functioning to molecular, biochemical and physiological mechanisms shaping organism tolerance and performance. In October 2015 he was elected Co-Chair of IPCC Working Group II for AR6. He is a Clarivate Analytics highly cited researcher 2018 and 2019.

Martin Visbeck

Martin Visbeck is head of research unit Physical Oceanography at GEOMAR Helmholtz Centre for Ocean Research Kiel and professor at Kiel University, Germany. His research interests revolve around ocean dynamic and the ocean's role in the climate system, integrated global ocean observation and ocean sustainable development. He advanced the 'Future Ocean' Network in Kiel to advance integrated marine sciences by bringing together different disciplines to work on marine issues. He has led the EU AtlantOS Project on sustained ocean observing in the Atlantic. He serves on a number of national and international advisory committees including the Governing Board of the International Science Council

(ISC), Joint Scientific Committee of the World Climate Research Programme (WCRP), leadership council of the Sustainable Development Solutions Network (SDSN), Executive Planning Group for the UN Decade of Ocean Science Decade for Sustainable Development 2021-2030 and the Assembly supporting the development of the EU Horizon Europe Ocean Mission. He chairs the Advisory Committee for Earth Observations at ESA. He is President of The Oceanography Society (TOS), and was elected fellow of the AGU, AMS, TOS and the European Academy of Sciences. Martin Visbeck is involved in strategic planning and decision-making processes about the ocean and sustainable development at a national, European and global level.

Ying Wang

Prof. Dr. WANG Ying, Academician of the Chinese Academy of Sciences, Professor of Nanjing University. Female, native of Kangping country, Liaoning Province. She was born on 24 Feb.1935, in Huangchuan, Henan Province China. She had completed undergraduate studies during Sep. 1952 to Aug. 1956 in Nanjing University, and completed postgraduate studies in the Department of Geology and Geography in Peking University during Feb. 1957 to Feb. 1961. She has obtained an honorary doctorate degree of environmental science from Waterloo University in Canada in Jun. 2001. Her speciality is in the area of coastal ocean geomorphology and sedimentology studies. From 1979-1982, she was the research fellow of Marine Geology at the Department of Geology of Dalhousie University, and a visiting scientist of Atlantic Geosciences in Bedford Institute of Oceanography Canada. She has close collaborated with Canadian geoscientists, supported by IDRC, CIDA and Ministry of Education China, to carry out 3 items of Sino-Canadian projects in the South China Sea area successfully, towards to set up the foundations of Coast & Island Development Laboratory in Nanjing University successfully.

Her scientific contribution predominates over the coastal ocean science includes the research on the evolution of muddy flat coasts, the drumlin coast, the river-sea system and the sedimentation of continental shelf, and has also expanded research on deep sea turbidity sedimentation of Atlantic abyssal plain. She has summarized tidal dynamic environment, sedimentary processes and ecological coast patterns, and then applied the result to the analyses of ancient tidal environment of muddy-silty strata of the Mesozoic and Cenozoic period. Her research on tidal flat sedimentation has reached the leading edge of the world coastal science. The study on major river inputs to the continental shelf of China seas, especially the case study on evolution of radiative sandy ridge field of the South Yellow Sea, has developed further to the river-sea system, sediment transport and terrigenous fluxes to the world coastal ocean. As a result, it has improved a multi-disciplinary land-sea interactive science of the Asia-Pacific Marginal Seas, and applies the results to coastal ocean development in China. Recently, she concentrates the research on river-sea interaction with sea level changes to trace the evolution of huge paleo delta complex of Changjiang-Yellow River system. She wish to continue the collaboration of multi-disciplinary research with International Scientists on the topic of Asia-Pacific Marginal Seas; and comparing the study with Arctic and Atlantic Ocean. As a chief editor, she has published 25 books and as the major author published more than 270 papers.

She has applied her coastal research to about 30 harbour sites selection successfully, and had owned the 1st National Scientific Congress Award of China with other 2 collaborators in 1978. She was awarded China's outstanding experts in 1984, present she services as the Director of Collaborative Innovation Center of South China Sea Studies, Nanjing University.

In 2001, Wang was elected as an academician at the Chinese Academy of Sciences. Based on her contribution to international Earth Science, she has owned the Honorary Fellowship from the Geographical Society of France in 2010, Honorary Fellowship from International Association of Geomorphologists (IAG) in Aug. 2013, and also the Honorary Life Fellowship from International Union for Quaternary Research (IAQUA).

Lixin Wu

Prof. Dr. WU Lixin, Fellow of Chinese Academy of Sciences, Fellow of The World Academy of Sciences, AGU Fellow, heads the only national marine laboratory in China, Qingdao National Laboratory for Marine Science and Technology (QNLM), and serves as vice president of the Ocean University of China (OUC). WU is one of the early pioneers in scientific committee of the NPOCE, first big international marine program initiated by China. As an internationally-recognized physical oceanographer, WU's research explores ocean circulation and climate change. He is committed to shape the success of Chinese marine community and China's ability to find solutions toocean and climate challenges through collaboration and innovation in marine science and technology. WU leads the efforts of Transparentizing Global Oceans, endorsed by the UN "Decade of Ocean Science for Sustainable Development" (2021-2030), which has continuously expanded China's excellence and impact on establishing comprehensive observation network to deepen our understanding to the ocean and better marine prediction. In 2018, WU was awarded the Second Prize of the National Natural Science Award of China. And in the next year, he received the Ambassador Award of the American Geophysical Union, AGU.

Abstracts

Global warming: the need to keep in line with the Paris agreement

Jean Jouzel

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The main objective of the Paris agreement consists in “holding the increase in the global average temperature to well below 2 ℃ above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 ℃ above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change”. Still, if nothing is done to manage the increase of the greenhouse effect tied to human activity, we should see, at the end of this century, a minimum average 4 ℃ global warming which will increase well beyond 2100. The impacts of such a “business as usual” scenario would be difficult if not impossible to handle. And, even if easier to manage, these difficulties will hold true for a +3 ℃ climate change a level which could be reached in the current context of the Paris agreement. We will conclude on the absolute need to keep global warming well below 2 ℃ - if possible around 1.5 ℃ - if we want today young generations be able to adapt to future climate change in the second part of this century and beyond. Only a few decades are thus left to reach carbon neutrality - around 2050 for 1.5 ℃ and between 2070 and 2080 for 2 ℃ – and in this context the role of Europe and China which aim carbon neutrality in 2050 and 2060, respectively will be extremely important.

Upper ocean biogeochemistry in the oligotrophic ocean

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The oligotrophic ocean, mostly located in subtropical regions occupies ~30% of the Earth surface and has been conventionally regarded as an ocean desert. It is characterized by permanent stratification, nutrient depletion and extremely low net biological production, and hence, contributes little to carbon export from surface to deep waters at per unit area. Emerging evidence has shown that this oceanic system has a much larger dynamic range of nutrient inputs from different sources in addition to those from depth. These differently sourced nutrients with differing stoichiometry may stimulate biological productions in different community structures and drive the carbon export at various depth horizons within the sunlit euphotic zone (EZ). Hence, the EZ is better characterized by a two-layered structure with a nutrient nutrient-depleted layer (NDL) above the nutricline and a nutrient replete layer (NRL) across the nutricline to the base of the EZ. Based on simultaneous turbulence microstructure and high-resolution chemical measurements, we quantified diapycnal fluxes of nitrogen, phosphorus, silicon, and carbon in the oligotrophic South China Sea showing a negligibly low diapycnal dissolved inorganic nitrogen (DIN) flux in the NDL where other nutrient supplies sustain the new production. Here, higher phosphate and silicate fluxes relative to DIN than Redfield stoichiometry further indicate N-limited biological productivity and additional removal of DIN by diatoms. In the NRL, the DIN flux is sufficiently large in supporting the export production therein. Here, higher dissolved inorganic carbon (DIC) flux relative to DIN than Redfield stoichiometry further infers DIC excess in the upper ocean of oligotrophic nature. Considering the new understanding of the biogeochemistry of the oligotrophic ocean, we attempt to propose an improved framework of nutrient-determined and biologically mediated carbon export in the ocean desert.

Predicting the global coastal ocean: Toward a more resilient society

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Climate change impacts and growing human activities at sea, at the coasts and in the oceans require an international system of monitoring and forecasting that supports a science-based approach to management. In Europe, the Copernicus program has been developed in the past ten years to implement the backbone of operational oceanography from the global to the regional European sea basins, serving the ocean community at large, especially the academic one. Predictions and long-term reanalysis of the past state of the oceans allow to explore the ocean circulation dynamics and the connected pelagic biochemical cycles with unprecedented accuracy and completeness. It is a new era of abundant data to explore the earth system dynamics.

On the other hand, such operational oceanographic systems are the backbone of the implementation and assessment of United Nation Sustainable Development Goal targets. To reach this final goal, a further step is required which is to bring operational oceanography at the level of the global coastal regions and develop standards and methodologies to face the coastal complexity. A UN Ocean Decade program is being developed (https://www.coastspredict.org/) that partly addresses the next ten years developments in observing, numerical modelling and applications of societal impact.

Estuary and delta

——Example of land-sea interactive process & sedimentation

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When rivers enter seas, the flow field and velocity change result from the variation of terrain slope and bidirectional flows. At the river mouth, sediment-laden fluvial currents suddenly expand, the sediment is dispersed and deposited, gradually diffuses from the river “pivot point” to a triangular or inverted folded fan-shaped accumulation “Delta”. With the fluvial discharge, sediment accumulation gradually form the delta plain on land, the delta shoals, sandy islands in the estuary, the underwater delta body platform, slope and submarine fan may be combined successively.

Delta is an active estuary area, distributed in the river-sea interaction zone. The main factors affecting the development and morphological characteristics of the delta are as follows:

- River discharge and the nature of sea water, especially the relative density of river fresh water and salty sea water;
- Quantity, grain size and velocity of sediment discharges;
- Wave, tide, current characteristics, strength and variation;
- Geological and geomorphic structure of River mouth area;
- Human act effects.

Take the major Rivers of China as example: the Yangtze, Yellow, and Pearl Rivers originated from the west-southwest mountain area, run out eastward into the marginal seas of the Asia and Pacific Ocean. Deltas accumulated on the river end seabed where the slope is slowing down. The Asia-Pacific marginal sea delta forms a ring of series rivers out of the mountains, alluvial fans are accumulated and developed alluvial plains. Plains extend to the sea dispersing currents as continental shelf accumulation.

Other types of rivers that are directly connected to the sea from the mountains have steep slopes, such as: the Indus River flowing from the southern foothills of the Himalayas; the rivers flowing into the Pacific Ocean from the eastern part of Taiwan; and the rivers flowing into the Pacific Ocean from the western part of the American continent. After flowing out of the mountains, the slopes are very steep. The accumulation of deltas is not only in the area where the sea and land intersect, but extends farther on the seabed, and accumulates at the foot of the continental slope to form a submarine fan.

Delta deposits have the basic composition from coarse to fine sequence. With the difference of flood season and dry season, the fine-grained sediments in the outer edge can also be overlapped on coarse particles. The sedimentary structure of overlapping coarse-fine rhythmic layers reflects the seasonal or annual variation of river discharge. This is the basic structure of the delta. However, when the delta continues to accumulate, heighten and enlarger, there will be superimposed sequence on the basic sedimentary sequence. Moreover, the sequence of extended channel is not completely from coarse to fine in accordance with the law of gravity deposition. There has never been an absolutely same structure.

When mountain or mountain ranges directly adjacent to the sea, the mountain water flows rapidly, a delta can’t be formed at the estuary. Fluvial sediment discharge eroded from the land can be transported to the deep water, and then deposit on the sea bottom where the slope suddenly slows down. It develops into a deep-water submarine fan, which is a gravity accumulation and has a sequence from coarse to fine.

In addition, in the high latitude area of the Northern hemisphere, there is few fine-grained sediment cover on the bedrock hilly area or polished rock ground with the coverage of large ice sheet and erosion of ice flow. The ice eroded gravels are mostly accumulated along the coastal zone, and melted-ice current directly erode the wide valley and flow into the sea, where delta accumulation occurs rarely. The St. Lawrence River in Canada is an example.

What is the sedimentary structure model of the Delta? We can't generalize.

The delta structure of China marginal seas cannot be compared with the submarine fan outside of the eastern coast of the Pacific Ocean where the mountain river flows directly into the deep ocean, although there is a genetic connection in the sediment source.

Is there any difference between the deltas formed in the Mediterranean Sea and those in the marginal sea? Yes. The wind wave and current system in the Mediterranean delta are smaller than those in the marginal seas. However, its delta structure is introduced as a classic delta model. In fact, it can’t be generalized comprehensively. It is very interesting that the runoff of the Mississippi River directly extends into the deep water of the Mexico Gulf, sediment is transported only along the main and branch channels, and developed as a bird-foot-like delta. The sedimentary structure is unique.

The case studies of various types of deltas show that to trace back their environmental characteristics while study their sedimentary structures. Deltas in marginal seas are either different from those in open oceans, or deltas extending from land of fault sunks. Can not to treat different deltas as the same model.

The research focus on should be kept up with the times.

Ocean alkalinity, buffering and biogeochemical processes

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Uptake and storage of anthropogenic carbon dioxide in the ocean is related to the reaction of dissolved carbon dioxide with water to form bicarbonate (and minor quantities of carbonic acid and carbonate). Alkalinity, the excess of bases in solution, governs the efficiency at which this occurs and provides buffering capacity towards acidification. Here I present the biogeochemical processes impacting the ocean carbonate system over multiple timescales. Over geological time scales alkalinity input to the ocean from weathering should be in balance with removal via carbonate mineral burial in the sea. However, a re-evaluation of the modern oceanic alkalinity balance revealed that the so far neglected riverine delivery of particulate inorganic carbon should be included to balance inputs and outputs. Next I present a retrodiction of ocean alkalinity, dissolved inorganic carbon and pH over the last 50 million years. At intermediate time scales (decades to thousands of years), the marine carbon system is governed by carbonate compensation mechanisms, i.e. changes in calcium carbonate production and dissolution, and I argue that we need to distinguish between biological and chemical carbonate compensation. At the shortest time scale, ocean chemistry is buffered by proton transfer among various dissolved species. These processes are well understood and can be used to quantify the impact of individual biogeochemical processes on the pH of seawater.

Marine sciences and technologies in the European framework programs: Science for better policies

Pierre Karleskind

European Parliament

Green deal, biodiversity strategy, Farm to fork strategy… the ambitions that the European Union address in 2020 have connections with the ocean. In a world in which interactions are more and more complex, decision-makers need to rely more and more and robust, shared and evolutive science expertise. Relying on the Horizon Europe framework program, the "Starfish 2030" mission proposes to adopt a research strategy in order to fulfill theses ambitions and to give politicians keys for acting in the next 10 years in the field of ocean. Five overarching objectives drive this mission: (i) Filling the knowledge and emotional gap, (ii) regenerating marine and freshwater ecosystems, (iii) zero pollution, (iv) decarbonising our ocean, and waters (v) revamping governance.

Big earth data for Sustainable Development Goal 14: Life Below Water

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The ocean covers 71% of Earth's surface and is one of our planet's three ecosystems. A balanced marine ecosystem is vital to the survival and sustainable development of humankind. In recent decades, human activity and global climate change have adversely affected the stability of marine ecosystems, especially the coastal-ocean ecosystem. Environmental problems like acidification, hypoxia, and eutrophication have increased considerably, while ecological disasters such as harmful algal blooms (HABs) and jellyfish blooms have occurred more frequently. Coastal fishery resources are currently being exhausted, and marine biodiversity is also under stress from ocean acidification and terrigenous pollutants. Therefore, the need to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development (SDG 14)" was written into the 2030 Agenda for Sustainable Development published by the United Nations in 2015. This issue has become one of the top priorities on the international agenda.

The vast marine ecological environment is in a perpetual state of flux. Currently, the assessment of SDG targets related to oceans and seas and science-informed policymaking is hampered by the lack of monitoring data. Big Earth Data is a technological innovation that plays an important role in macroscale dynamic monitoring and provides a means for evaluating sustainable development. The Chinese Academy of Sciences (CAS) initiated the “Big Earth Data Science Engineering Program” (CASEarth) in 2018 to shape science-based policies and data-driven decision mechanisms in service of SDGs. CASEarth has conducted 14 practice cases to monitor the progress of SDG 14 indicators.

This presentation focuses on two SDG 14 targets, namely, marine pollution (SDG 14.1) and marine ecosystem health management (SDG 14.2). An integrated eutrophication assessment model and an experimental evaluation model were developed for marine ecosystems to aid in preventing and significantly reducing pollution. These models are based on field data describing nutrient composition, chlorophyll-a concentration, and phytoplankton biomass. The models also rely on chemical indexes such as dissolved oxygen observed in China’s coastal waters, and information obtained from bulletins produced by national marine monitoring departments. An integrated eutrophication assessment model was developed based on the “Pressure-State-Response” framework. This model was implemented at different scales for estuaries and bays along China’s coastline to assess their eutrophication level. The results provide scientific support and decision making for the management of discharged offshore nutrient pollutants and coastal eutrophication. Additionally, this study also aims to map the current state of pollution by marine debris and microplastics in China's coastal waters and their regional distribution by consolidating available mapping data. The study also includes an analysis of the variation of these pollutants in comparison with historical data. The data is sourced from marine bulletins and academic literature that describe the distribution of marine debris and microplastics in these areas. The results show that the abundance of floating debris has decreased in China's coastal waters since 2015. Moreover, there was a continuous reduction in microplastic pollution between 2016 and 2019.

The study has several objectives that can assist in building resilience against disasters and protecting marine and coastal ecosystems. First, this study aims to refine the assessment methodology to consider bay ecosystem characteristics, analyze the current state and variation of different ecosystem elements, and adjust and select parameters for comparison with SDG indicators. Second, the study uses machine learning-enabled data mining to introduce additional threshold criteria, which may improve existing assessment criteria. Last, the study develops a report card assessment model that supports policymaking and coastal ecosystem management. Sishili Bay, Jiaozhou Bay, and Daya Bay were chosen as study areas that represent different ecological environments and human activities. The results show that the ecosystems in these areas are currently in relatively good health. The overall health of the Jiaozhou Bay ecosystem was stable from 2007 to 2019 with some improvement, while Sishili Bay and Daya Bay remained stable. The health of Daya Bay has shown a slight improvement since 2016.

These practice cases prove that Big Earth Data can assist with fulfilling SDG 14. Additionally, new methodologies are proposed for utilizing Big Earth Data technologies and models to improve SDG 14 indicator systems. Big Earth Data is a new approach to sustainability science that can bring great value and potential and can provide data and information support for identifying critical issues related to the sustainable development of China's oceans and seas.

Perspectives on China's polar ocean and climate research

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The polar oceans and ice-sheets play vital roles in the Earth's climate system, and have been the focus of many international research initiatives, such as the Southern Ocean Observing System (SOOS) and the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC). The implementation of these initiatives calls for a strong international collaboration to provide scientific, technic and logistic supports. Here we first briefly describe the scientific drivers of polar ocean and climate research from a global perspective, and then discuss China's potential contributions to the ongoing and future international polar programs, in accordance with our national polar research activities supported by various agencies. In particular, starting with a description of our existing capabilities in both Antarctic and Arctic exploration, we outline our research priorities and ongoing projects in polar ocean and climate research, as well as our plans for future enhancement in technology and infrastructure, including a multi-platform, multi-disciplinary circumpolar "Big Ring" to serve as a sustained backbone for SOOS. China is surely in the process of largely enhancing its polar research activities, which will provide support and lead to new opportunities for international collaboration in this important research area, especially with our European colleagues.

Keywords: Polar ocean and climate, Observing network design, Research priorities

Multiscale air-sea interaction and high-resolution earth system modeling

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In the ocean, dynamic processes involve the turbulent mixing, meso-submeso scale motions and gyre-scale circulation, spanning lateral scales from a few meters to thousands of kilometers. They interact with atmospheric multiscale processes such as fronts, cyclones and planetary waves, thereby regulating regional transfer of momentum, heat and carbon and eventually affecting global climate. The extreme complexity of cross-scale ocean-atmosphere interactions emerges as a key challenge in improving seamless climate forecast capabilities and narrowing down climate projection uncertainties. In this talk, recent progresses regarding multiscale air-sea interaction will be highlighted.

High-resolution coupled modeling studies reveal that ocean mesoscale eddy-atmosphere (OMEA) interaction is of great importance to the dynamics of western boundary currents and modulation on sea surface temperature (SST). Suppressing OMEA interaction in the Kuroshio and its extension results in a 20%–40% weakening in the jet velocity. The energy budget for the ocean mesoscale eddy potential energy (EPE) shows that OMEA interaction dissipates ~30% of the EPE. The absence of such interaction reduces the EPE production to balance the energy budget, which results in a weakened mean current. The OMEA interaction also weakens the oceanic eddy vertical heat transport, which leads to the weaker ocean stratification and the lower SST.

It is also found that the vertical heat transport by ocean mesoscale eddies acts as an important heat supplier to the surface ocean in frontal regions. Strong surface cooling associated with intense winds in winter promotes turbulent mixing in the mixed layer, destructing the vertical shear of mesoscale eddies. The restoring of vertical shear induces an ageostrophic secondary circulation transporting heat from the subsurface to surface ocean. This vertical heat transport could rapidly transfer the heat convergence by the western boundary current in the subsurface to the surface ocean, which is crucial for maintaining the oceanic front and sustaining the atmospheric heat uptake.

Regarding climatic effects of the western boundary currents, the Kuroshio interannual variability is found to significantly modulate the summertime precipitation over the East China Sea and adjacent area. A persistent offshore displacement of the Kuroshio in spring drives the cold SST anomalies over the continental shelf until late fall. On one hand, the cold SST anomalies are conducive to an earlier arrival of the meiyu-baiu front and its subsequent slower northward migration, which prolongs local rainy days thereby leading to the increased rain belt extending from the Yangtze River delta to Kyushu in summer. On the other hand, the cold SST anomalies intensify atmospheric fronts embedded in the extratropical cyclones and thus the frontal precipitation in early fall.

Future ocean sustainability - From ocean observation towards sustainable development

Martin Visbeck

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The ocean is essential to our society – it regulates the global climate, provides us with natural resources such as food, materials, important substances, and energy. It is essential for international trade and recreational and cultural activities. Ocean observations touch our lives every day from the food we eat, to the clothes we wear, to how we spend our leisure time. The ocean is estimated to be the seventh largest economy in the world. Goods and services from coastal and marine environments have been estimated at US$2.5 trillion each year worldwide. Together with human development and economic growth, increased use and overuse of ocean resources and services have exerted strong pressure on the marine environment, ranging from overfishing, unsustainable resource extraction, and alteration of coastal zones to various types of thoughtless pollution including CO_2 emissions causing climate change - the ocean is warming, acidifying, deoxygenating and sea level is rising.

International cooperation in science and effective local, regional and global governance are required to protect the marine environment and promote the sustainable use of marine resources to preserve an 'healthy' and productive ocean to keep delivering fundamental ocean services to meet the needs of future generations. Some of the global challenges such as food security, marine community health, and material and energy supply require more science from discovery and sustained ocean observations to understanding and the development of scenarios and predictions. We need an integrated basin-scale ocean observing system to support ocean management. Coordinated basin-scale activities will lead to better modeling, monitoring, and forecasting products (e.g. through alignment of observing network activities as well as supporting data management and integration). This information needs to be assessed and recommendations for development pathways given. We need both a better understanding of ocean change and its challenges as well as more knowledge about new opportunities in order to develop towards a more sustainable relationship between humans and the ocean.

How do we move from an unsustainable human-ocean interaction towards a world where sustainability is key and ocean-ecosystem-services are valued and preserved? A profitable approach is to fully implement an ocean value chain from observations via understanding to information, from information to scenarios to knowledge and from ocean knowledge to societal action.

Martin will introduce two elements of the value chain more specifically: First as a regional example the All-Atlantic Ocean Observing System (AtlantOS), a community-based program to support the implementation of an integrated basin-scale observing system "that benefits all of us living, working and relying on the ocean" as a contribution to the Global Ocean Observing System (GOOS) and similar programs and promotes the GEO Blue Planet activity with the OCEANOBS19 conference series. How can we transform current ocean observing from a niche action to the societal norm. Martin will also introduce the concept of a Digital Twin of the Ocean as the next step in the value chain, filling the need to integrate a wide range of data and information sources (from physics to ecology through biology, chemistry and geology, as well as from social or economic sciences and business operators), to transform data into knowledge and to connect, engage, and empower citizens, governments and industries by providing them with the capacity to inform their decisions with the goal to arrive at a more sustainable ocean governing system. Neither GOOS nor the Digital Twin Ocean can succeed without full engagement of the ocean community including the Global North and Global South, actors from academia, business, civil society, indigenous and communities of practice. The upcoming UN Decade of Ocean Sciences for Sustainable Development provides a once in a lifetime opportunity to advance such agendas in partnership including China and the EU.

Ocean Negative Carbon Emission (ONCE) – A proposal for international program on mitigation of climate change

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Negative emissions is an approach to the goal by Paris Agreement to limit the global warming to 2.0 or even 1.5 ℃ by the end of this century. The ocean has a large capacity for carbon sequestration, and Ocean Negative Carbon Emission (ONCE) is of great potential to manipulate if the mechanisms and processes involved are better understood. To this end, cross-disciplinary efforts are required. The ONCE international program to promote comprehensive efforts on: 1）Ocean carbon sequestration mechanisms and processes, such as, the solubility pump, carbonate pump, biological carbon pump, and microbial carbon pump etc.; 2）The multi-effects of biotic and abiotic processes, interactions between organic and inorganic carbon and other relevant elements; 3）The biogeochemical mechanisms to maintain a surface-to-deep ocean gradient and to reshape costal-to-open ocean gradient of dissolved inorganic carbon; 4) Systematic observations in the field, and simulated/scenario studies such as mesocosm experiments; 5) Modeling based on observed biogeochemical parameters; 6) Eco-engineering demonstration towards sustainable development and mitigation of climate change.

Ocean-based measures to reduce climate change and its impacts, and rebuild marine life

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Current emission reduction pledges under the 2015 Paris Agreement are insufficient to keep global temperature "well below +2°C" in 2100 relative to pre-industrial levels and to reach targets of the United Nations Sustainable Development Goals. Even a full and timely implementation of the Paris Agreement will heavily impact the ocean. Increased political ambition is therefore required, as well as enhanced efforts of both mitigation and ecosystem and human adaptation. There is growing evidence highlighting the role the ocean plays in mitigating anthropogenic climate change (i.e., uptake and storage of heat and anthropogenic carbon), and the cascading consequences on its chemistry and physics (ocean warming, acidification, deoxygenation, and sea-level rise), ecosystems and ecosystem services. In this context, a critical question arises: what are the ocean-based opportunities for climate action? In other words, what is the potential of the ocean and its ecosystems to reduce the causes of climate change and its impacts?

A comprehensive and systematic assessment of 13 global- and local-scale, ocean-based measures, including negative emissions, was performed to help steer the development and implementation of technologies and actions toward a sustainable outcome. We show that (1) all measures have tradeoffs and multiple criteria must be used for a comprehensive assessment of their potential, (2) greatest benefit is derived by combining global and local solutions, some of which could be implemented or scaled-up immediately, (3) some measures are too uncertain to be recommended yet, (4) political consistency must be achieved through effective cross-scale governance mechanisms, (5) scientific effort must focus on effectiveness, co-benefits, disbenefits, and costs of poorly tested as well as new and emerging measures.

Sustainable Development Goal 14 of the United Nations aims to "conserve and sustainably use the oceans, seas and marine resources for sustainable development". Achieving this goal will require rebuilding the marine life-support systems that deliver the many benefits that society receives from a healthy ocean. We have documented the recovery of marine populations, habitats and ecosystems following past conservation interventions. Recovery rates across studies suggest that substantial recovery of the abundance, structure and function of marine life could be achieved by 2050, if major pressures are mitigated. These actions are: protecting vulnerable habitats and species, adopting cautionary harvesting strategies, restoring habitats, reducing pollution, mitigating climate change. Rebuilding marine life represents a doable Grand Challenge for humanity, an ethical obligation and a smart economic objective to achieve a sustainable future.

Key messages:

The ocean is a key element of our life support system and provides many services. Ocean-based actions can maintain or increase those services despite climate change.

1. Ocean-related measures cover both mitigation and adaptation, and range across four clusters (Decisive, Low Regret, Unproven, Risky) that offer a policy-relevant framing for decision and action.

2. The next iteration towards more ambitious NDCs should scale up ocean-based climate action by prioritising Decisive (e.g. Marine renewable energy) and Low Regret (e.g. Conservation and Restoration and enhancement of coastal vegetation) measures, improving knowledge on the Unproven measures, and very cautiously weighing the Risky ones
3. Decisive and Low Regret measures are both key priorities for action because (1) the full implementation of Decisive measures will not completely eliminate coastal risks and (2) the effectiveness of Low Regret measures, especially nature-based solutions, depends on the global warming level.

More information on The Ocean Solutions Initiative: http://bit.ly/2xJ3EV6.

References:
Abram N., Gattuso J.-P., et al. 2019. Framing and context of the report. In: Pörtner H.-O.,et al. (Eds.), Special Report on Ocean and Cryosphere in a Changing Climate, pp. 73-129. Geneva: IPCC.
Bindoff N. L. et al. 2019. Changing ocean, marine ecosystems, and dependent communities. In: Pörtner H.-O.et al.(Eds.), Special Report on Ocean and Cryosphere in a Changing Climate, pp. 447-587. Geneva: IPCC.
Duarte C. M…. Gattuso J.-P. et al., 2020. Rebuilding marine life. Nature 580:39-51.
Gattuso J.-P. et al., 2019. Opportunities for increasing ocean action in climate strategies. Iddri Policy Brief 02/19:1-4.
Magnan A. K., … Gattuso J.-P., 2018. Ocean-based measures for climate action. Iddri Policy Brief 6:1-4.
Gattuso J.-P.et al. 2018. Ocean solutions to address climate change and its effects on marine ecosystems. Frontiers in Marine Science 5:337.
Magnan A. K., … Gattuso J.-P., 2015. Intertwined ocean and climate: implications for international climate negotiations. Iddri Policy Brief 04/15:1-4. Chinese version: http://bit.ly/1MnIYR1.
Gattuso J.-P. et al. 2015. Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science 349:aac4722.

The Ocean and cryosphere in a changing climate: An IPCC Special Report 2019

Hans-O. Pörtner
IPCC Co-Chair Working Group II

In 2019 the Intergovernmental Panel on Climate Change (IPCC) approved the Special Report on The Ocean and Cryosphere in a Changing Climate (SROCC) as the third special report of the 6th Assessment Cycle, following the Special Report on Global Warming of 1.5 ℃ (SR1.5) and the Special Report on Climate Change and Land (SRCCL). The SROCC addresses climate change phenomena for about 80% of the Earth's surface as covered by the ocean and the cryosphere, and develops a picture how even these remote areas of the planet are affected by climate change. It also deals with how these changes feedback on human societies, through ice melt and associated sea level rise, or through ocean warming, oxygen loss and acidification impacting marine life and fisheries results. Terrestrial aspects cover the potential exacerbation of climate change and associated impacts through permafrost thaw. The ocean and the cryosphere hold risks for the future passing of warming induced tipping points such as the one already passed for warm water coral reefs, as well as associated irreversible changes. While all SRs assess impacts and risks, SR1.5 also discusses ambitious mitigation options. The SROCC focuses on opportunities to adapt to e.g. sea level rise and to support mitigation efforts through nature-based solutions. Through the Special Reports and the Main Assessment Report, which is currently in the making, the IPCC provides policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. Hundreds of scientists from all over the world contribute to the work of the IPCC on a voluntary basis as authors, contributors, reviewers and IPCC bureau members. For governments at all levels the assessment reports provide a scientific basis for developing climate-related policies, and they form the basis of negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). While traditionally, analyses of climate scenarios and associated impacts have been at the fore of climate assessments, the sixth assessment cycle also explores the so-called solutions space and investigates options for adaptation and mitigation, their effectiveness, potential synergies and trade-offs as well as their contributions to achieving the Sustainable Development Goals of the United Nations. Together with the other SRs, the SROCC's findings emphasize the urgency to take immediate and ambitious action as needed for a sustainable future in a climate stabilized according to the Paris agreement. This would be enabled by ambitious mitigation and an unprecedented transformation of virtually all aspects of society.