中国科学院学部“科学与技术前沿论坛”
——中-欧海洋科学与技术进展
会议手册

主办单位：中国科学院学部

承办单位：中国科学院

欧洲科学院

协办单位：华东师范大学

中国·上海

2020 年 10 月 20~21 日

目　录

论 坛 简 介

为将中国科学院学部建设成为创新思想活跃、学术作风严谨的我国科学技术方面的最高学术机构，切实发挥学部的学术引领作用，并为决策咨询工作提供科学技术支撑，2011年3月25日，中国科学院学部主席团六届十次会议决定开展“科学与技术前沿论坛”（简称：“论坛”） 活动。

论坛活动是中国科学院学部主席团统一领导下、各学部常委会和学部学术与出版工作委员会等共同承办的高层次学术活动，着眼于科学技术前沿探索、系统评述和前瞻预测。

论坛旨在推动前沿科学理论和技术探索，促进学科发展战略研究系统深入开展，促进学科交叉融合及国际学术交流，发现和培养优秀人才，倡导科学民主，鼓励学术争鸣，充分发挥学部对我国科学技术前沿和未来创新发展的引领作用。

论坛特邀若干报告人做主题报告，鼓励与会院士、专家围绕主题进行自由讨论，一般向社会开放。特邀的报告人一般为科研一线的优秀科学家，重视邀请国外专家和优秀青年学者。报告人应提交符合《中国科学》、《科学通报》（简称“两刊”）出版要求的论文，论坛论文和综述稿以“两刊”专栏或专辑、年度论坛报告集等方式公开出版。

科学探索无止境，百家争鸣创新篇。中国科学院学部愿为中青年科技专家提供展示才华的“舞台”，共同促进学术繁荣，为促进我国科技发展和服务国家发展战略做出应有的贡献。

会 议 须 知

为比较系统地分析和总结中-欧之间近期在海洋科学与技术领域的主要进展情况，聚焦制约学科发展的关键瓶颈，寻求双方在海洋科学与技术方面进行深入合作的优先领域，经中国科学院地学部同意，拟召开以“**中-欧海洋科学与技术进展**”为主题的科学与技术前沿论坛。

我们希望，通过此次组织的题为“中-欧海洋科学与技术进展”的科学与技术前沿论坛能够帮助提升我国海洋科学和技术的发展的国际影响，对于目前执行的国家“十三五”规划中走向“蓝色的海洋”的战略实施具有促进作用。在本次论坛中，也将围绕我国海洋科学与技术的重要发展领域，结合欧洲国家的经验和教训进行不同层次的研讨和学术交流。论坛建议的议题包括：全球变化背景下海洋的作用、海洋科学与技术的前沿问题与发展战略，以及海洋科学与技术领域的合作等三个方面。通过本次论坛上的学术交流，将有助于进一步明确我国在海洋科学与技术方面的发展前景，就我国海洋科学与技术的前期工作进行总结，推动相关领域的研究和教育工作的健康发展。

本次“论坛”旨在推动地球科学中跨学科与交叉领域前沿科学理论和技术方面的探索，促进海洋与相关学科交叉融合及国际学术交流，倡导科学民主，鼓励学术争鸣，充分发挥学部对我国海洋与气候变化科学技术前沿和未来创新发展的引领作用，以及再现公关国际合作中的推动作用。根据商定并上报中国科学院地学部批准，本次论坛议题包括：全球变化背景下海洋的作用（专题一）、海洋科学与技术的前沿问题与发展战略（专题二），以及海洋科学与技术领域的合作（专题三）等几个不同的方面。

依照中国科学院的相关规定，本次“论坛”实行执行主席负责制。在“论坛”的日程中，按照规定中心议题评述报告时间限制在 30 分钟，专题报告时间为 20 分钟。“论坛”中的报告时间与自由讨论时间应达到 1：1-1：1.2。本次“论坛”的报告人数不超过 10 人。

本次“论坛”依照相关的要求，将严格控制报告时间与自由讨论时间。会议期间，执行主席负责引导会议深入讨论，及时提出敏感或关键的问题，以引起讨论与争论，使会议富有创造性。自由发言时间每人每次不超过 10 分钟，但可多次发言。

会议结束前的最后半天内，执行主席引导对会议进行总体讨论，最后对会议进行小结，并提出会议的小结要点。

考虑到中国和欧洲国家所在时区的差异，会议将在北京时间下午的 14：00 至 21 点钟举行，以便协调和兼顾中、欧双方的作息时间。

热烈欢迎各位嘉宾参加中科院学部“中-欧海洋科学与技术进展”科学与技术前沿论坛，为保证论坛期间您工作生活顺利，请注意如下事项：

一、代表报到与用餐

报到时间：2020 年 10 月 19 日 12:00-23:00，10 月 20 日 7:30-13:00

报到地点：上海苏宁环球万怡酒店（地址：上海市丹巴路 99 号）

会议期间用餐将集体安排，请妥善保管有关证件。

就餐地点：上海苏宁环球万怡酒店二层餐厅

二、会议时间

2020 年 10 月 20 日-10 月 21 日

三、注意事项

会议期间，参会代表凭会务组制发的证件参加会议活动及用餐，请妥善保管有关证件，遵守会议时间安排。根据上海市政府规定，室内公共场所禁止吸烟。

四、联系方式

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五、交通情况

- **上海火车站**
  1号线至汉中路换乘13号线至真北路下
  At Shanghai Railway Station, Please take Metro Line 1 to Hanzhong Road Station. Then Please transfer by Metro Line 13 to Zhenbei Road Station.
- **虹桥枢纽**
  2号线至威宁路站下
  At Hongqiao Airport or Hongqiao Railway Station, Please take Metro Line 2 to Weining Road Station.
- **浦东机场**
  2号线至威宁路站下
  At Pudong Airport, Please take Metro Line 2 to Weining Road Station.

注：鉴于本次论坛的内容将全部公开，所以在会议上需要注意保密的问题。根据学部办公室的建议，会上的报告内容需事先经过作者所在单位的保密审查并获得许可。

注：鉴于本次论坛的内容将全部公开，所以在会议上需要注意保密的问题。根据学部办公室的建议，会上的报告内容需事先经过作者所在单位的保密审查并获得许可。

论 坛 日 程

此次论坛的时间为期两天。在论坛中，时间划分为三个专题的报告与讨论时间。最后半天，用于会议的总结和后续工作的讨论。会议的日程如下表所示。

2020 年 10 月 20 日，星期二		
14:00-14:30	**开幕式&合照 主持人：张经, Paul Tréguer, Louis Legendre**	
议题 1: 全球变化背景下海洋的作用 主持人: 陈大可, Paul Tréguer		
14:30-14:50	*Global Warming: the Need to Keep in Line with the Paris Agreement*	Jean Jouzel
14:50-15:10	*Upper Ocean Biogeochemistry in the Oligotrophic Ocean*	戴民汉
15:10-15:30	*Predicting the Global Coastal Ocean: Toward a More Resilient Society*	Nadia Pinardi
15:30-15:50	*The Comparative Study on Marginal Seas and Discussion of Future Collaboration*	王 颖
15:50-16:00	茶 歇	
16:00-16:40	讨 论	
议题 2: 海洋科学与技术的前沿问题 主持人: 吴立新, Jean-Pierre		
16:40-17:00	*Ocean Alkalinity, Buffering and Biogeochemical Provinces*	Jack Middelburg
17:00-17:20	*Marine Sciences and Technologies in the European Framework programs: Science for Better Policies*	Pierre Karleskind
17:20-17:40	*Big Earth Data for Sustainable Development Goal 14 : Life below water*	郭华东
17:40-18:00	*Perspectives on China's Polar Ocean and Climate Research*	陈大可
18:00-19:00	晚 餐	
19:00-21:00	讨 论	

2020 年 10 月 21 日，星期三		
议题 3: 海洋可持续发展 主持人: 戴民汉, Louis Legendre		
14:00-14:20	*From Ocean Turbulence to Climate: New Challenges in Changing Ocean and Earth System*	吴立新
14:20-14:40	*Future Ocean Sustainability - From Ocean Observation towards Sustainable Development*	Marin Visbeck
14:40-15:00	*Ocean Negative Carbon Emission (ONCE) – A Proposal for International Program on Mitigation of Climate Change*	焦念志
15:00-15:20	*Ocean-based Measures to Reduce Climate Change and its Impacts, and Rebuild Marine Life*	Jean-Pierre Gattuso
15:20-15:30	茶 歇	
15:30-15:50	*The Ocean and Cryosphere in a Changing Climate, IPCC Special Report 2019*	Han-Otto Poertner
15:50-18:00	讨 论	
18:00-19:00	晚 餐	
议题 4:中欧海洋科学与技术领域的合作 主持人: 张经, Paul Tréguer		
19:00-21:00	讨论和会议总结	

与 会 名 单

本次论坛邀请了来自欧洲科学院、中国科学院、中国工程院、国内高校和研究机构中从事海洋科学研究的专家和学者，以及国家自然科学基金委员会的管理专家等，共计近 40 人。与会的专家名单如下表所示。

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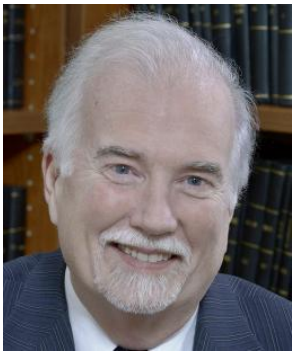
专家简介

Paul J. Tréguer

Paul J. Tréguer is emeritus professor at the University of Brest (France). He his 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 He 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, 7 full books, and 12 other book chapters. His new book entitled "Earth, Our Living Planet" will be published soon.

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.

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.

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 worldocean: she started with the contribution to the very first real time ocean forecast in the California Current systemto 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 Instituteof Geophysicsand 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.

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.

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.

Pierre Karleskind

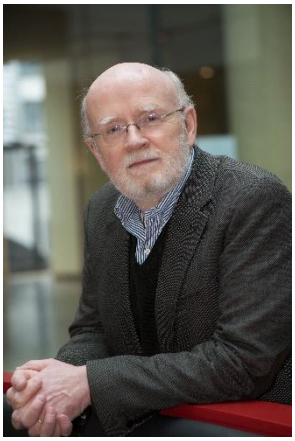
Pierre Karleskind is a Member of the European Parliament since the 2019 election and Chair of its Committee on Fisheries (PECH). Pierre Karleskind carried out its military service in the deep-sea tug of the French Navy and graduated at the Ecole Polytechnique as an engineer. Pierre Karleskind carried 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 Europ éen 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 Technop ôle 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.

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.

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.



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.

报 告 摘 要

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

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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.

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. 5 overarching objectives drive this missions : (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.

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

Future Ocean Sustainability - From Ocean Observation towards Sustainable Development

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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 CO2 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-based measures to reduce climate change and its impacts, and rebuild marine life

Jean-Pierre Gattuso

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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.

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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.

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