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3.1 Integrated Marine Biosphere Research (IMBeR) project (joint with Future Earth)

Burkill

Terms of Reference

- To develop the IMBER Science Plan and Implementation Strategy, in accordance with guidance from the sponsoring organisations.
- To oversee the development of IMBER in accordance with its Science Plan and Implementation Strategy.
- To collaborate, as appropriate, with related projects of the sponsors IGBP and SCOR, and other related programmes and organisations (e.g., IHDP, DIVERSITAS, IOC and the Global Ocean Observing System (GOOS), etc.)
- To establish appropriate data management policies to ensure access to, sharing of, and preservation of IMBER data, taking into account the policies of the sponsors.
- To report regularly to SCOR and IGBP on the state of planning and the accomplishments of IMBER.

The IMBER SSC, its subsidiary groups and International Project Office shall operate in accordance with the operating procedures for IGBP Projects and the requirements of the other co-sponsors.

Chair: Carol Robinson (UK)

Vice-Chairs: Alida Bundy (Canada), Eugene Murphy (UK), Cisco Werner (USA)

Other Members: Laurent Bopp (France), Ratana Chuenpagdee (Canada), Dan Costa (USA), Mark Dickey-Collas (Denmark), Rubén Escribano (Chile), Marion Glaser (Germany), Gerhard Herndl (Austria), Alistair Hobday (Australia), Masao Ishii (Japan), Tatiana Rynearson (USA), Svein Sundby (Norway), Ingrid van Putten (Australia), and Ying Wu (China-Beijing).

Executive Committee Reporter: Peter Burkill

Executive Officer: Lisa Maddison (acting)



Annual Report to SCOR 2016-2017

A. Introduction

The Integrated Marine Biosphere Research project (IMBeR, formerly the Integrated Marine Biogeochemistry and Ecosystem Research project, IMBER) is a global environmental change research initiative co-sponsored by the Scientific Committee on Oceanic Research (SCOR) and until December 2015, by the International Geosphere-Biosphere Programme (IGBP). In 2016, IMBeR signed a Memorandum of Understanding to become a co-sponsored global research project with Future Earth.

Since its start in 2005, IMBeR has aimed to develop a comprehensive understanding and accurate predictive capacity of the ocean's response to accelerating global change and the consequent effects on the Earth system and human society. In 2016, IMBeR produced a science and implementation strategy for the next decade, underpinned by the vision,

“Ocean sustainability under global change for the benefit of society”.

This vision recognises that the evolution of marine ecosystems (including biogeochemical cycles and human systems) is linked to natural and anthropogenic drivers and stressors, as articulated in the new IMBeR research goal to

“Understand, quantify and compare historic and present structure and functioning of linked ocean and human systems to predict and project changes including developing scenarios and options for securing or transitioning towards ocean sustainability”.

To implement its new vision and goal, IMBeR's mission is to

“Promote integrated marine research and enable capabilities for developing and implementing ocean sustainability options within and across the natural and social sciences, and communicate relevant information and knowledge needed by society to secure sustainable, productive and healthy oceans”.

IMBeR science aims to foster collaborative, interdisciplinary and integrated research that addresses important ocean and social science issues and provides the understanding needed to

propose innovative societal responses to changing marine systems. The implementation of the new IMBeR Science Plan is underpinned by the International Project Office (IPO) in Bergen, Norway, sponsored by the Institute of Marine Research (IMR) and the Norwegian Research Council, and the Regional Project Office (RPO) in Shanghai, China supported by the State Key Laboratory of Estuarine and Coastal Research (SKLEC) at the East China Normal University (ECNU). The IMBeR research goal is progressed through the activities of four regional programmes, five working groups and numerous endorsed projects, and is facilitated through focussed IMBIZO workshops, conferences and symposia and the training of early career researchers at biennial ClimEco summer schools (Figure 1).

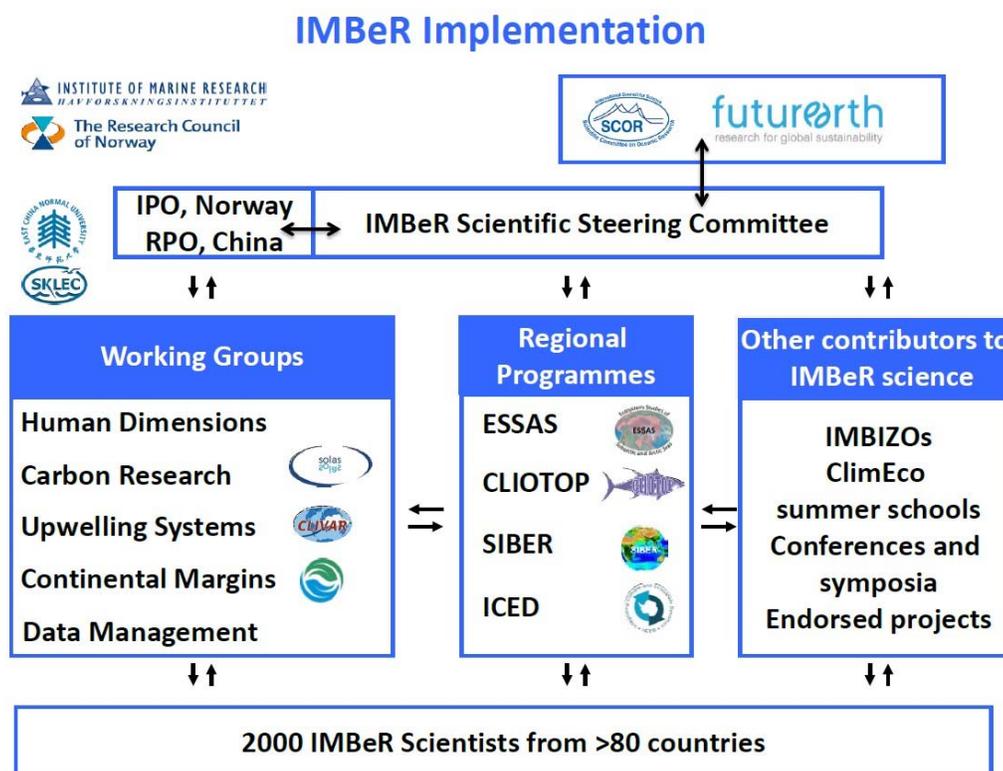


Figure 1. Implementation of IMBeR's research goal.

B. Science Plan (2016-2025)

The Science Plan and Implementation Strategy (SPIS; 2016-2025) is developed around three Grand Challenges (GC), focussing on climate variability, global change and drivers and stressors. The qualitative and quantitative understanding of historic and present ocean variability and change (Grand Challenge I) are the basis for scenarios, projections and predictions of the future (Grand Challenge II). These are linked in Grand Challenge III to understand how humans are causing the variability and changes, and how they (in turn) are impacted by these changes, including feedbacks between the human and ocean systems. Priority research areas with overarching and specific research questions are identified for each Grand Challenge. The Grand Challenges are supplemented with four Innovation Challenges (IC) that focus on new topics for IMBeR where research is needed and where it is believed that major achievements can be made within three to five years. The Innovation Challenges also provide a

means for IMBeR to adjust its focus as major science discoveries are made and new priorities arise (Figure 2).

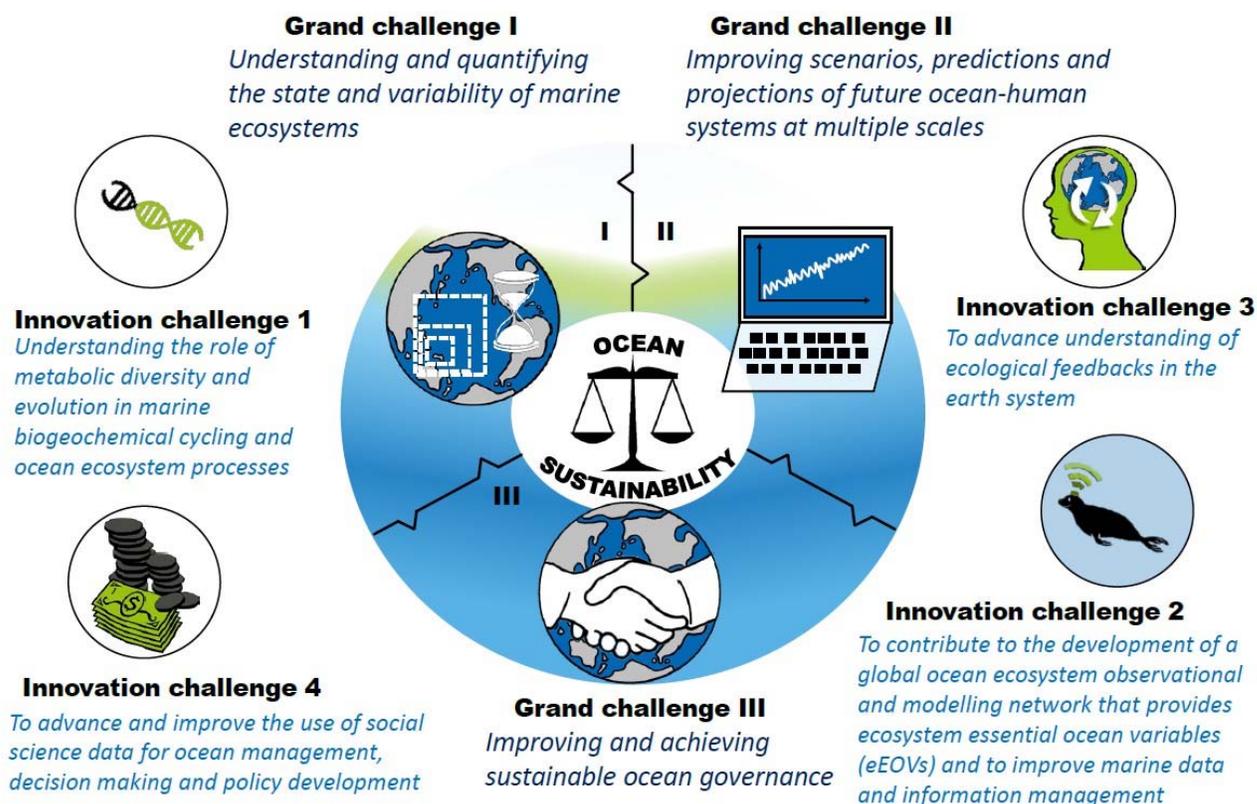


Figure 2. The Grand and Innovation Challenges

C. Selected science highlights in 2016

A list of publications is given in section K, and activities which have specifically progressed the objectives of the Science Plan are given in section G. Here we identify a selection of studies where IMBeR has contributed to the progression of fundamental knowledge in marine ecology and biogeochemistry.

- Members of the IMBeR regional programmes ESSAS (Ecosystem Studies of the Subarctic and Arctic Seas) and ICED (Integrating Climate and Ecosystem Dynamics) led a comparative study of the ecological impacts of atmospheric and oceanic circulation on polar and sub-polar marine ecosystems. The study highlights the effect of the strikingly different polar circulation patterns on the amount, thickness and duration of sea ice and the ecology of zooplankton, fish, seabirds and marine mammals (Hunt et al. 2016; <http://dx.doi.org/10.1016/j.pocean.2016.10.004>).

2. A session on the ecology of the polar cod *Boreogadus saida*, held at the ESSAS 2014 Annual Science meeting, led to the publication of a special issue of *Polar Biology* (Mueter et al. 2016; doi:10.1007/s00300-016-1965-3). The combined publications represent the largest single step yet towards understanding the ecology, life history and distribution of Arctic gadids in a changing Arctic.
3. A combined ESSAS and ICED study (Murphy et al., 2016; <http://dx.doi.org/10.1098/rspb.2016.1646>) proposes a conceptual framework that links the life histories of pelagic species and the structure of polar foodwebs, and highlights the low functional redundancy at key trophic levels, which makes these ecosystems particularly sensitive to change.
4. Members of ICED used the Framework on Ocean Observing (FOO) to begin developing ecosystem Essential Ocean Variables (eEOVs) for the Southern Ocean Observing System (SOOS). The authors outline the rationale, including establishing a set of criteria, for selecting eEOVs for the SOOS, develop a list of candidate eEOVs for further evaluation and discuss the importance of simulation modelling in helping with the design of the observing system in the long term (Constable et al. 2016; <http://dx.doi.org/10.1016/j.jmarsys.2016.05.003>).
5. An ICED study explored the views of representatives from the scientific, conservation and fishing industry sectors on the sustainability of the Antarctic krill fishery. The analysis identified key differences in viewpoints such as the priority given to different management approaches, and to continuing commercial fishing. However, the results also revealed considerable overlap between viewpoints. The study suggests that identifying shared management objectives based on stakeholder aspirations provides a strong basis for developing practical management solutions (Cavanagh et al. 2016; <http://dx.doi.org/10.1016/j.marpol.2016.03.006>).
6. As part of the IMBeR regional programme SIBER (Sustained Indian Ocean Biogeochemistry and Ecosystem Research), CO₂ and pH sensors were deployed on a mooring in the Bay of Bengal in November 2013 to provide the first continuous set of surface water and air CO₂ and pH measurements in the northern Indian Ocean. Data from the time series reveal strong seasonal variations in pCO₂ in the surface water relative to the air, which are associated with the monsoon seasonal cycle, with a slight predominance of ingassing over the annual cycle. Pronounced increases in pCO₂ during the early intermonsoon are driven by increasing temperatures and reduced CO₂ solubility, and decreases in pCO₂ during late intermonsoon and monsoon time periods are driven by decreasing temperatures and elevated CO₂ solubility.
7. SIBER has also motivated BGC-Argo deployments in the Indian Ocean through a joint Indian-Australian project in the northern and southeastern Indian Ocean. The targets of these deployments have been biogeochemical hotspots in oxygen minimum zones, island wakes, enhanced-productivity eddies and subtropical convergence zones. About 40 biogeochemical Argo floats have been deployed in the Indian Ocean to date, providing insights into productivity and carbon cycling, oxygen distributions, phytoplankton

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community composition and eddy nutrient dynamics. The radiometric and chlorophyll data from these floats have been further applied to satellite ocean colour validation.

8. A special issue of *Deep-Sea Research II* outlines research arising from the CLIOTOP (Climate Impacts on Oceanic Top Predators) regional programme 2015 symposium, spanning topics such as conservation biology, trophic ecology, fisheries science, climate change and adaptive management (Hobday et al., 2017; doi:10.1016/j.dsr2.2017.03.008).
9. The CLIOTOP Task Team 2016-02 aims to build policy-relevant scenarios for the sustainability of global oceanic ecosystems and fisheries. Maury et al., (2017; <http://dx.doi.org/10.1016/j.gloenvcha.2017.06.007>) developed five contrasting Oceanic System Pathways (OSPs) based on the shared socioeconomic pathways used in climate change research. These OSPs have been chosen to form the official scenario basis of the FishMIP (Fisheries Model Inter-Comparison initiative), the marine component of the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP), used to inform model studies in the context of IPCC and IPBES.
10. The SOLAS-IMBeR Ocean Acidification Working Group working through the IAEA Ocean Acidification International Coordination Centre (OA-ICC) co-sponsored the 4th International symposium on the Ocean in a High-CO₂ World, hosted by the University of Tasmania's Institute for Marine and Antarctic Studies, New Zealand and the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Hobart, Australia. The event, held every four years, discussed the latest developments in ocean acidification science, identified future research needs and trends, and offered prime networking opportunities to hundreds of international scientists working on ocean acidification.
11. The OA-ICC contributed to the 3rd GOA-ON Science Workshop that followed the Symposium on the Ocean in a High-CO₂ World. The workshop brought together more than 100 scientists from 40 countries, and discussions tackled issues including GOA-ON national and regional status, linkages to other global programmes, data management, developing regional hubs to facilitate national programmes and capacity building.
12. The IMBeR Human Dimensions Working Group has submitted a collation of 20 marine case studies which use the I-ADApT (Assessment based on Description and responses, and Appraisal for a Typology) framework to identify the natural, social and governance aspects of approaches used to deal with global change to the *Routledge Studies in Environment, Culture and Societies* book series.
13. Guillotreau et al. (2017), analysed six commercial bivalve industries affected by mass mortalities using I-ADApT, to assess the impacts and consequences of these perturbations on the natural, social, and governing systems, and the consequent responses of stakeholders to these events. <https://doi.org/10.5751/ES-09084-220146>

D. Regional Programmes

Ecosystem Studies of Subarctic and Arctic Seas (ESSAS)

ESSAS objectives are to understand how climate variability and climate change affect the marine ecosystems of Subarctic and Arctic seas and their sustainability and, in turn, how changes in the marine ecosystems affect humans.

The Resilience and Adaptive Capacity of Marine Ecosystems in the Arctic (RACArctic) is an ESSAS initiative between Japan, the USA and Norway, funded by the Belmont Forum. It is a 3-year project, now in its second year. Its objective is to synthesize information from completed and ongoing regional studies in order to examine how variability and changes in advection, temperature, pH and ice dynamics in the Subarctic to Arctic transition zone may affect future marine ecosystems of the Pacific and Atlantic Arctic. Of particular interest is how fish populations and their prey respond to, and may adapt to, natural and anthropogenic changes in the Arctic and how these responses are expected to affect existing and future fisheries, subsistence harvests, and the socio-economic systems that depend on them. The first meeting was held in February 2016, in Hakodate, Japan. The first day was dedicated to a stakeholder forum with representations from the fishing industry, food processing, grocers, fisheries management, transportation industry, and a weather services company. It was conducted mostly in Japanese, with translation into English. The stakeholders provided information on the kinds of information they need in order to meet the challenges of climate change. They stressed the desire for more such meetings. Days 2 and 3 of the meeting were devoted to scientific presentations and discussions from representatives of each of the countries on topics of climate and meteorology, biogeochemistry, phytoplankton productivity, zooplankton, fish and higher trophic levels.

ESSAS co-chaired a session at the **Ocean Sciences** meeting in New Orleans in February 2016 on ‘Biophysical processes at the Arctic-Sub-Arctic Interface’ which explored patterns and processes at the interface between Subarctic and Arctic waters of the Pacific Arctic, the gradients in physical characteristics and biological communities that shape this region, and the role of climate change in modifying biophysical processes in the region.

ESSAS co-chaired several sessions at the **Annual PICES meeting** in San Diego in November 2016. The session on ‘Resilience, transitions and adaptation in marine ecosystems under a changing climate’ explored the concept of resilience in both physical ocean systems and in the associated ecological systems from plankton to fish. Presentations on theoretical studies and applied case studies examined resilience in a marine ecosystem context, provided practical approaches to measuring resilience, defined the “essential structure and function” of marine ecosystems, identified thresholds beyond which essential structure and function may be lost, examined ways in which resilience of marine ecological systems can be enhanced, and explored the phenotypic and evolutionary adaptive capacity of marine organisms to deal with gradual changes and transitions.

The **2016 ESSAS Annual Science Meeting** was held in Yokohama, Japan. Fifty attendees participated in sessions on Challenges to the climate, ecological, biogeochemical and socio-

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economic sciences in a changing Arctic and Subarctic. The **2017 ESSAS Open Science Meeting** will be held in Tromso, Norway.

Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)

The ICED regional programme aims to better understand the climate interactions in the Southern Ocean, the implications for ecosystem dynamics, the impacts on biogeochemical cycles, and the development of sustainable management procedures. See www.iced.ac.uk/index.htm.

ICED scientists contributed various oral presentations and posters at the **Scientific Committee on Antarctic Research (SCAR) Open Science Conference**, in August 2016, in Kuala Lumpur, Malaysia. ICED co-coordinated a mini-symposium on Linking Antarctic science with environmental protection, which aimed to highlight the relevance of the research carried out by the international community of Antarctic scientists, under SCAR, to the Antarctic Treaty System.

ICED scientists attended the **4th International Symposium on the Ocean in a High-CO₂ World**, in May 2016, in Hobart, Australia to present work on the effects of ocean acidification on Antarctic pteropod and phytoplankton species, as well as the development and delivery of scientific knowledge and policy guidance on high-latitude ocean acidification.

ICED has continued to provide input to the Antarctic Treaty System (via SCAR; CCAMLR; Commission for the Conservation of Antarctic Marine Living Resources and CEP; the Antarctic Treaty's Committee for Environmental Protection), the Convention on Biological Diversity (CBD) and Marine Protected Areas. There is now an established recognition by these bodies of ICED's role as the provider of valuable, external input on climate change impacts on Southern Ocean ecosystems to their work.

ICED was represented at the second Joint Workshop of the CCAMLR Scientific Committee (SC-CCAMLR) and CEP, in May 2016 in Punta Arenas, Chile. The workshop aimed to identify the drivers and effects of climate change that are considered most likely to impact the conservation and management of Antarctica and its resources, and to identify existing and potential sources of research and monitoring data relevant to the work of the CEP and SC-CCAMLR on this topic. This led to ICED representation at the CCAMLR Working Group on Ecosystem Monitoring and Management meeting in Trieste, Italy, July 2016.

ICED scientists have been involved in key International Whaling Commission (IWC) work following a Southern Hemisphere humpback whale assessment (Jackson et al. 2016). Funding has been secured to support two inter-disciplinary voyages to study the sub-Antarctic right whale feeding population off South Georgia. Investigations will include identifying habitat use with satellite tracking, connecting these grounds to low-latitude calving grounds using photo identification and genetic matching, investigating the main prey sources through skin isotope analysis, and determining the health of the whales from photographs of body condition and analyses of whale hormones and microbiomes. Two years of surveys will allow whale abundance estimations at this site and contribute towards an assessment of right whale recovery in the southwest Atlantic.

ICED scientists have been involved in the agreement to establish the world's largest Marine Protected Area (MPA), in Antarctica's Ross Sea, via CCAMLR. This new MPA will come into force in December 2017 and will limit, or entirely prohibit, certain activities in order to meet specific conservation, habitat protection, ecosystem monitoring and fisheries management objectives. Seventy-two percent of the MPA will be a 'no-take' zone, which forbids all fishing, while other sections will permit some harvesting of fish and krill for scientific research. This is a significant achievement and has been several years in the making. A number of publications have been submitted by ICED scientists to CCAMLR in support of the development of future MPAs.

ICED scientists participated in delivering a chapter updating knowledge on the effects of climate change on Antarctic marine ecosystems to an International Union for the Conservation of Nature (IUCN) publication on the effects of climate change on the oceans.

The EUROMARINE science network represents the merger of three former Networks of Excellence (EUR-OCEANS, MarBEF and Marine Genomics Europe) that involved ICED scientists. ICED scientists attended this year's EUROMARINE General Assembly, to maintain links between ICED and the network.

CLimate Impacts on Oceanic TOP Predators (CLIOTOP)

The CLIOTOP regional programme organises large-scale comparative studies to elucidate key processes involved in the interaction between climate variability and change and human use of the ocean on the structure of pelagic ecosystems and large marine species.

CLIOTOP scientists contributed to a number of workshops and working groups in 2016 including the **Commission for the South Pacific Regional Fisheries Management Organisation**, Adelaide Australia in January 2017, the IOC-UNESCO (GOOS)/OceanObs Research Coordination Network co-ordinated workshop on the **Implementation of Multi-Disciplinary Sustained Ocean Observations (IMSOO)**, Miami, USA 8-10 February 2017, and the United Nations Group of Experts for the second cycle of the Regular Process for **Global Reporting and Assessment of the State of the Marine Environment**, including Socioeconomic Aspects, New York, USA March 2017.

The major activity of CLIOTOP in 2017 will be the development and organization of the Fourth CLIOTOP Symposium in late 2018. Members of CLIOTOP submitted a proposal for a SCOR working group 'Expanding Regional Application of Dynamic Ocean Management (ERADOM)'.

Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER)

The SIBER regional programme is co-sponsored by the Indian Ocean GOOS (IOGOOS) Programme with close ties to CLIVAR's Indian Ocean Panel (IOP). It focuses on understanding climate change and anthropogenic forcing on biogeochemical cycles and ecosystems in the Indian Ocean, to predict the impacts of climate change, eutrophication and harvesting.

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The 2nd International Indian Ocean Expedition (IIOE-2) was motivated by SCOR, SIBER, IOGOOS and IOP and has become the main scientific focus of SIBER. The first cruise was launched in December 2015. SIBER contributed to an IIOE-2 Town Hall meeting at the Ocean Sciences meeting, February 2016, New Orleans, USA, to the organisation and plenary presentations of the IIOE-2 symposium in February 2017 in Perth, Australia, and to the Bio-Argo workshop also held in February 2017 in Perth Australia.

A new SIBER website was launched in 2016, serviced from the Indian National Centre for Ocean Information Services (INCOIS) and linked to the IMBeR website, and a SIBER International Project Office has been set up at INCOIS, Hyderabad, India.

Together with IOP, SIBER is organising a winter school in 2018 at the National Institute of Oceanography, Goa, India.

E. *Working Groups*

IMBeR-Future Earth Coasts Continental Margins Working Group (CMWG)

The CMWG aims to compare a sparsely populated northern Arctic shelf region with a shelf in a heavily populated Southeast Asian region. IMBeR received funds from IGBP and the European Space Agency (ESA) to support a workshop to identify the relevant issues and knowledge needs for the Arctic margins case study. A special session was organized at the XMAS-III conference in Xiamen, China in early 2017 to discuss similar issues relating to the East China Sea case study. The IMBeR and Future Earth Coasts CMWG co-chairs are establishing a core group to take these case studies forward.

Human Dimensions Working Group (HDWG)

The HDWG continued development of the I-ADApT management tool. In March 2017, the manuscript of a book titled *Societal and Governing Responses to Global Change in Marine Systems* was submitted to Routledge. Objectives of the book are to explore and illustrate how the responses of the governance system have addressed the issue under consideration in 20 marine case studies from around the world.

HDWG members convened a session ‘How to integrate natural and social science into advice for policy makers’ with PICES, ICES and CLIOTOP at the World Fisheries Congress in Korea in May 2016, and contributed to the MSEAS Understanding Marine Socio-ecological Systems: Including the Human Dimension in Integrated Ecosystem Assessments conference in Brest, France in June 2016.

The 6th HDWG meeting was held at the Tokyo University of Marine Science and Technology, Japan in May 2016 and the 7th meeting will be held in France in 2017.

IMBeR-CLIVAR Eastern Boundary Upwelling Systems Working Group (EBUS)

EBUS contributed to the CLIVAR Open Science Conference “Charting the course for climate and ocean research” in Qingdao, China in September 2016, and held a workshop to refine the tasks of the working group in the context of the CLIVAR Science Plan. EBUS submitted a

proposal for a SCOR working group in 2016 which unfortunately was not successful. They will revise the application and submit it again in April 2017.

SOLAS-IMBeR-IOCCP Carbon working group (SIC)

During 2016, it was decided to close the surface water and mid-water SOLAS-IMBeR carbon working groups, as many of the original tasks were completed, and to create a new carbon working group with new objectives and incorporating the SCOR and IOC-UNESCO International Ocean Carbon Coordination project (IOCCP). The production (and review by IMBeR) of a new CLIVAR Science Plan also afforded an opportunity to align this group with CLIVAR. A small group of scientists representing IMBeR, SOLAS, CLIVAR and IOCCP will meet at the International Carbon Dioxide Conference (ICDC10) in Switzerland in August 2017 under the chairmanship of Nikki Gruber to propose new objectives for a new carbon working group.

SOLAS-IMBeR Ocean Acidification (SIOA)

The SOLAS-IMBeR Ocean Acidification Working Group continues to make advances, through the Ocean Acidification International Coordination Centre (OA-ICC), to its core activities of setting up a Global Observing Network, organising joint experiments and intercomparison exercises, maintaining advice on best practises and contributing to capacity building and outreach.

Selected highlights can be found in the quarterly releases from the OA-ICC available on their web page at <https://www.iaea.org/ocean-acidification>.

F. Endorsed projects

Atlantic Meridional Transect (AMT)

AMT is a multidisciplinary programme which undertakes biological, chemical and physical oceanographic research during an annual voyage between the UK and destinations in the South Atlantic. The AMT provides a platform for scientists to capture and analyse data related to a range of oceanographic science areas. Over 256 scientists have participated in AMT cruises and many more have worked with the data, which are accessible through the British Oceanographic Data Centre (BODC). The data have been the basis for more than 300 scientific papers, and the long-term nature of the data collected is useful in analysing trends and forecasting future outcomes.

Gulf of Trieste Time series (GoTTs)

The Department of Biological Oceanography of the Italian National Institute of Oceanography and Experimental Geophysics is responsible for the Gulf of Trieste site as part of the Long Term Ecological Research network in the North Adriatic. The research activities, which have continued since 1970, range from marine biogeochemistry to ecology and are aimed at understanding the dynamics governing marine ecosystems and to evaluate the role of the ocean in the global energy balance.

Living-resource & Ecosystem Dynamics on the Slope of the South China Sea (LEDS)

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The northern slope region of the South China Sea is the breeding and nursing ground for commercially valuable fish species such as octopus and tuna. Their vertical migration behaviour potentially forms a key link between lower and higher trophic levels as they act as predators on zooplankton and as prey for bottom and pelagic fishes, and feed in the surface layer during the night while resting and excreting in the deep layer (400-1000 m) during the day. This project aims to progress understanding of the role of mesopelagic fish in marine ecosystems, resource protection and utilization, and carbon sequestration in the ocean.

Mechanisms of Marine Carbon Storage and Coupled Carbon, Nitrogen and Sulphur cycles in response to global change (MCS-CNS)

The sensitivity of marine biogeochemical cycles to climate change remains unclear, especially for key processes that influence the long-term health of marine ecosystems. By understanding the interactions between the microbial carbon pump and the biological carbon pump, this project aims to decipher the mechanisms of marine carbon storage, and the response of biogeochemical processes to climate change and anthropogenic activities.

Processes and Approaches of Coastal Ecosystem Carbon Sequestration (PACECS)

This project aims to investigate the key processes and mechanisms of carbon sequestration in coastal ecosystems in order to propose ways in which to increase the ocean carbon sink. Most of this 'Blue Carbon Sink' resides in the biomass of phytoplankton, bacteria, archaea, and protozoa, and so maximising the efficiency of this sink requires fundamental knowledge of the dynamics of marine microbes.

Study of Kuroshio Ecosystem Dynamics for Sustainable Fisheries (SKED)

This interdisciplinary study aims to investigate the paradox of high fisheries production in the low-nutrient Kuroshio western boundary current of the North Pacific Ocean, in order to ensure sustainable use of this ecosystem.

Variability of Ocean Ecosystems around South America (VOCES)

The goal of this project is to assess the impact of climate variability - both natural and anthropogenic - on the Humboldt, Patagonia and South Brazil Large Marine Ecosystems (LMEs), which are amongst the most productive in the southern hemisphere.

Integrated Arctic Observation System (INTAROS)

INTAROS will develop an integrated Arctic Observation System (iAOS) by extending, improving and unifying existing systems in the different regions of the Arctic. An integrated Arctic Observation System will enable better-informed decisions and better-documented processes within key sectors (e.g., local communities, shipping, tourism, fishing), in order to strengthen the societal and economic role of the Arctic region.

Ocean Foodweb Patrol – Climate Effects: Reducing Targeted Uncertainties with an Interactive Network (OCEAN CERTAIN)

The goals of OCEAN CERTAIN are to

1. Determine qualitative and quantitative changes in the functionalities of the foodweb and the efficiency of the biological pump to export carbon as a response to multi-stressors,

2. Identify the interactions (impacts and feedbacks) between climate-related oceanic processes and global climate dynamics,
3. Integrate marine ecosystem scenarios with probable socio-economic scenarios to help estimate/quantify human feedbacks to the coupled socio-ecological system, relevant to mitigation and adaptation pathways,
4. Develop scenario-based impact prediction capacity, and
5. Produce and test decision support tools and systems and assess their ability to support the sustainable exploitation of marine resources.

G. Implementation of the Science Plan in 2016

The IMBeR regional programmes and working groups are working towards the research goal outlined in the SPIS (2016-2025). In order to ensure efficient progress towards this goal, a number of task teams led by members of the Scientific Steering Committee (SSC) were initiated at the 2016 SSC meeting in New Orleans. At the 2017 SSC meeting in Shanghai, a more comprehensive gap analysis was undertaken, and specific SSC members were tasked to scope out relevant activities already being undertaken in the international community and to propose a plan of action for IMBeR to achieve the SPIS Grand and Innovation Challenges. Progress towards achieving the IMBeR research goal during 2016 is outlined below:

Grand Challenge I: Understanding and quantifying the state and variability of marine ecosystems

The Challenge: To develop whole system level understanding of ecosystems, including complex biogeochemical cycles and human interactions, together with understanding of the scales of spatial and temporal variability of their structure and functioning.

ESSAS contributes to this challenge through The Resilience and Adaptive Capacity of Marine Ecosystems in the Arctic (RACArctic) initiative, which examines how variability and changes in advection, temperature, ocean acidity and ice dynamics in the Subarctic to Arctic transition zone may affect future marine ecosystems of the Pacific and Atlantic Arctic.

ICED has continued to develop whole ecosystem level understanding of the structure and functioning of Southern Ocean ecosystems, and their variability and response to change across a range of spatial and temporal scales. They have focussed on key species from Antarctic krill to whales (e.g., Jackson et al. 2016; Silk et al. 2016), and the structure of food webs (e.g., Horswill et al. 2016), as well as furthering work on comparative studies with the Arctic, focussing on the role of biodiversity in ecosystem structure and function (Murphy et al. 2016b). ICED has also examined physical, chemical and biological interactions (e.g., Hunt et al. 2016) and the effects of past and recent variability and change, such as ocean acidification (e.g., Manno et al. 2016).

The long-term overarching goal of SIBER is to improve understanding of the role of the Indian Ocean in global biogeochemical cycles and the interaction between these cycles and marine ecosystem dynamics. In order to quantify the state and variability of Indian Ocean ecosystems, and importantly, the physical forcing that drives this variability, SIBER was instrumental in

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fostering the development of the 2nd International Indian Ocean Expedition (IIOE-2) and the Eastern Indian Ocean Upwelling research Initiative (EIOURI).

CLIOTOP Task Team 2016-01 has been working to improve understanding of the trophic pathways that underlie the production of tunas and other pelagic predators in the open ocean, the movements of these predators, and the natural variability forced by the environment. Improved understanding resulting from the outputs of this task team will directly assist IMBeR-CLIOTOP in progressing understanding of marine ecology, food web dynamics, movements of top predators in a changing climate, and ocean biogeochemistry.

CLIOTOP Task Team 2016-05 is focussed on developing a standard set of metrics for describing the movements of marine animals that could be used across multiple platforms and multiple species, thereby allowing for multi-species, multi-platform comparisons in investigating the environmental and physiological drivers of movement in marine animals.

The Human Dimension Working Group (HDWG) continues to develop I-ADApT - an integrated assessment framework and learning platform for global change response. I-ADApT is developed from case studies that cover a wide range of natural and social systems around the world that have been challenged by critical global change issues, allowing cross-case comparisons within specific social and ecological contexts.

Grand Challenge II: Improving scenarios, predictions and projections of future ocean-human systems at multiple scales.

The Challenge: To incorporate understanding of the drivers and consequences of global change on marine ecosystems and human societies at multiple scales into models to project and predict future states.

Progress towards this challenge is led by IMBeR SSC member Laurent Bopp and will be the focus of one of the workshops at the IMBIZO5 conference in October 2017.

An initiative to produce policy-relevant future scenarios of ecosystem services in the oceanic realm was recently published (Maury et al., 2017), and the five contrasted Ocean System Pathways (OSPs) developed have been chosen to form the official scenario basis of FishMIP (the Fisheries Model Inter-comparison initiative).

A dataviz tool is under development to provide easy access to the recent CMIP5 climate model projections for ocean ecosystem stressors (warming, pH, oxygen, primary productivity). This tool will enable selection of any ocean region, and show visualization of projections for surface temperature, surface pH, sub-surface oxygen, and integrated primary production.

ICED has continued its model development in support of creating a suite of models of physical dynamics (ocean circulation and climate), biogeochemical cycles, and biological dynamics (life histories, population dynamics, food web structure) within a hierarchical framework of models of different spatial, temporal and trophic resolution. The ultimate aim of these activities will be

to advance end-to-end ecosystem modelling approaches that integrate physical, chemical and biological processes.

CLIOTOP Task Team 2016-03 is developing dynamic seasonal forecasting models relevant to fisheries and conservation management. This has included submission of a book chapter on 'Predicting the distribution of bluefin tunas in a changing ocean', presenting at the U.S. CLIVAR workshop on 'Dynamical and statistical modeling for ecosystem forecasts', and attending the ICES conference on 'Seasonal to decadal prediction of marine ecosystems: opportunities, approaches and applications'.

CLIOTOP Task Team 2016-06 is developing process-based animal movement models that are biologically reasonable and capable of i) modelling behavioural response in relation to environmental covariates, and therefore ii) predicting animal movements in response to climatic changes.

Grand Challenge III: Improving and achieving sustainable ocean governance

The Challenge: To improve communication and understanding between IMBeR science, policy and society to achieve better governance, adaptation to and mitigation of global change, and transition towards ocean sustainability.

A scoping exercise for this Challenge is being led by SSC member Mark Dickey-Collas.

One of the objectives of ICED is to determine how Southern Ocean ecosystem structure, functioning and projections should be incorporated into adaptation, mitigation and sustainable management procedures by improving communication and understanding between science, policy and society. ICED is continuing its work with the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Antarctic Treaty's Committee for Environmental Protection (CEP) and the International Whaling Commission (IWC) to ensure that ICED science is relevant and that scientific results are translated appropriately into messages that resonate with policy makers.

The SIBER activities that are most relevant to this IMBeR Challenge are related to IIOE-2 and the governance structure that has been created to guide it. The IIOE-2 is overseen by an international steering committee that aims to leave a lasting legacy of the expedition throughout the Indian Ocean region. This will be accomplished by establishing the basis for improved scientific knowledge transfer to wider segments of society and regional governments, and through the creation of educational and capacity development opportunities that target regional and early-career scientists.

I-ADApT is an integrated assessment framework that builds on knowledge and lessons learned from past experience of responses to global change and is designed to enable decision makers, researchers, managers and local stakeholders to: (1) make decisions efficiently; (2) triage and improve their responses; and (3) evaluate where to most effectively allocate resources to reduce vulnerability and enhance resilience of affected people.

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Innovation Challenge 1: To enhance understanding of the role of metabolic diversity and evolution in marine biogeochemical cycling and ocean ecosystem processes.

Progress towards completion of this challenge will be led by SSC members Gerhard Herndl and Tatiana Rynearson. The first activity will be a workshop at the IMBIZO5 meeting in October 2017, leading to publication of a synthesis of current understanding of metabolic diversity in the light of environmental change and identification of approaches needed to include metabolism and evolution in marine ecosystem models at multiple scales, from individual organisms to systems.

Innovation Challenge 2: To contribute to the development of a global ecosystem observational and modelling network that observes essential ocean variables (EOVs) and to improve marine data and information management.

A scoping exercise for this challenge is being undertaken by SSC member Dan Costa. Dan contributed to the organisation of the **Autonomous and Lagrangian Platforms and Sensors Scientific and Technical Review** (ALPS-II) held at the Scripps Institution of Oceanography in February 2017. The aim of the workshop was (1) to survey progress in autonomous platforms and sensors for ocean research since the original ALPS meeting 13 years ago, and (2) to assess future prospects and challenges.

Dan and CLIOTOP Co-Chair Kevin Weng participated in the Global Ocean Observing System of the IOC-UNESCO (GOOS) and the OceanObs Research Coordination Network workshop on **Implementation of Multi-Disciplinary Sustained Ocean Observations** in Miami, Florida, USA in February 2017. This workshop was tasked with identifying priorities for improving the coordinated planning and implementation of multi-disciplinary observing activities and demonstrations, by bringing together experts in physical, biogeochemical and biological/ecosystems ocean observations and modelling, users of established observing networks, and communities of practice.

The ICED community has made strong links with the SCAR-SCOR Southern Ocean Observing System and the CCAMLR Ecosystem Monitoring Program to progress integrated ecosystem observing to (i) support assessments of current status and trends of Southern Ocean ecosystems and (ii) provide foundation data for assessing the likelihood of future states of the system. Substantial progress has been made in identifying ecosystem Essential Ocean Variables as well as co-ordinating a year of field activities, proposed for 2022, to benchmark Southern Ocean ecosystems as a natural extension of the Census of Antarctic Marine Life undertaken a decade ago.

Several CLIOTOP members provided feedback on a draft paper on essential ocean variables for fish abundance and distribution circulated by the GOOS Panel on Biology and Ecosystems.

Innovation Challenge 3: To advance understanding of ecological feedbacks in the Earth System.

Implementation of this challenge will be discussed at the 2017 SSC meeting in Shanghai. ICED scientists have undertaken a review of marine biogeochemical feedbacks resulting from plankton community stoichiometry changes to ocean acidification and climate change as part of the SCAR Ocean Acidification review.

Innovation Challenge 4: To advance and improve the use of social science data for ocean management, decision making and policy development

Implementation of this challenge will be discussed at the 2017 SSC meeting in Shanghai.

ICED scientists have been actively developing studies to expand analyses of ecosystems to consider human social and economic system interactions. Following IMBIZO IV, Stuart Corney and Eugene Murphy have been working on an opinion piece “Integrating human dimensions into marine ecosystem models will improve management” that is under review with *Fish and Fisheries*.

H. Other IMBeR activities

IMBeR ClimEco 5 Summer School

The ClimEco 5 Summer School was held in Natal, Brazil in August 2016 with the theme ‘Towards more resilient oceans: Predicting and projecting future changes in the ocean and their impacts on human societies’. Sixty-four participants were chosen from more than 200 applicants based in 26 different countries. Topics that were covered included delineating the issues of climate change and impacts on marine ecosystems, modelling approaches for natural and social science data, and using science in management.

Early Career Researcher Network

An IMBeR Early-Career Researcher (ECR) network is being established to create a forum for interdisciplinary ECRs focussed on building capacity in developing nations, providing leadership roles for ECRs, and to promote gender equality throughout the marine sciences. An organizing committee has been established, and proposals are underway to attract funding for the first ECR meeting.

Gordon Research Conference on Ocean Biogeochemistry

The conference was held at the Chinese University of Hong Kong in June 2016 and co-convened by past IMBeR SSC Chair Eileen Hofmann. One of the keynote presentations was given by the current IMBeR SSC Chair Carol Robinson, and several of the ICED community participated. The meeting emphasis was on the biologically driven ocean carbon pumps, and included sessions on variations through geological time, microbial oxidation of organic matter within the water column, and the linkage of the carbon pump with silicon, nitrogen, phosphorous and iron cycles.

IMBeR-Future Earth Norway workshop

In September 2016, IMBeR and Future Earth Norway collaborated to convene a workshop to explore priorities for Norwegian research on ocean sustainability, oral presentations are

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available at www.futureearth.org/norway/results-IMBeR-fen-wshop-2016, and the meeting report at http://www.imber.info/resources/images/prosjekter/imber/IMBER_Future-Earth_Norway_Worshop_Report-Final-1-Dec.pdf.

Future Earth – Ocean Knowledge-Action Network (KAN)

IMBeR continues to contribute to the development of the Future Earth Ocean KAN. As part of a Future Earth core research project meeting in Bern, Switzerland in June 2016, Peter Liss chaired a brainstorming session to produce a draft proposal to be presented to the Belmont Forum for consideration for funding as a Collaborative Research Action (CRA). At its annual Plenary Meeting in Doha in October 2016, the Belmont Forum agreed to progress with the full scoping process of a Future Earth–Belmont Forum co-branded CRA on "Transdisciplinary Research for Ocean Sustainability". This process will be coordinated by the Swedish Research Council FORMAS, and the first scoping workshop will be held in May 2017.

As part of this activity, Future Earth, the International Council of Science (ICSU), WCRP-CLIVAR, IOC-UNESCO and ICSU-SCOR organized a scoping workshop on the development of an integrative Ocean Knowledge-Action Network (Ocean KAN) hosted by the Kiel Cluster of Excellence "The Future Ocean" on 4-5 December 2016. The workshop was overseen by a scientific committee (including the IMBeR SSC Chair) and assembled nearly 100 representatives from 27 countries. As part of this meeting, the scientific committee and executive committees met to discuss the formation of an Ocean KAN development team. The Terms of Reference and call for applications for the Development Team were discussed extensively and the call will be released in 2017. Once established, the Ocean KAN Development Team will develop a Research and Engagement Plan and a Funding Strategy based on the scoping activities held during the workshop. The aim is to formally launch the Ocean KAN at the UN Ocean Conference in June 2017.

IMBIZO 5

The fifth IMBIZO conference 'Marine biosphere research for a sustainable ocean: Linking ecosystems, future states and resource management' will be held from 2 to 5 October 2017 at the Woods Hole Oceanographic Institution, USA. Three concurrent and interacting workshops aim to progress specific aspects of the IMBeR Science Plan. These are 1) Critical Constraints on Projections of Marine Systems (led by Laurent Bopp and Eric Galbraith), 2) Metabolic Diversity and Evolution in Marine Biogeochemical Cycling and Ocean Ecosystem Processes (led by Gerhard Herndl and Tatiana Rynearson) and 3) Managing Strategy Evaluation: Achieving Transparency in Natural Resource Management by Quantitatively Bridging Social and Natural Science Uncertainties (led by Ingrid van Putten and Cisco Werner).

A capacity-building workshop will be held the day before the start of the IMBIZO on how to create infographics to communicate science.

IMBeR China/Japan/Korea (CJK) Symposium 2018

Planning is underway for the next CJK symposium, to be held in Shanghai in October 2018.

IMBeR Open Science Conference 2019

IMBeR received seven international applications to its open call to host its next open science conference. Brest, France was chosen to be the host and planning is underway.

International Project Office (IPO, Norway)

Einar Svendsen, Lisa Maddison and Svein Sundby successfully applied for and were awarded funding for the IPO from March 2017 to March 2020 from the Norwegian Research Council and the Institute for Marine Research. IMR has confirmed that a renewal of funding after 2020 is unlikely, so IMBeR has begun to investigate other possible hosts for the IPO from 2020.

Einar Svendsen retired from the Executive Officer post at the end of June 2016. Gro I. van der Meeren was Executive Officer between 1 August 2016 and the end of June 2017. The post is currently being advertised, with applications due in September 2017.

During 2016, the IPO revised the IMBeR communication strategy. An e-newsletter is distributed weekly, the front page of the upgraded www.IMBeR.info website gives regular news highlights and the @imber_ipo twitter account is frequently used to relay information to its 500 followers.

Regional Project Office (RPO, China)

Yi Xu and Fang Zuo successfully applied for a further three years of funding (2017-2020) for the RPO from the East China Normal University (ECNU). Carol Robinson and Gro I. van der Meeren visited Shanghai in October 2016 to sign the Memorandum of Understanding with the Director of the State Key Laboratory for Estuarine and Coastal research (SKLEC) and the Vice-president of ECNU.

SKLEC hosted the 2017 SSC meeting and will host the 2018 China/Japan/Korea IMBeR conference.

Yi Xu represented IMBeR at the 3rd Xiamen Symposium on Marine Environmental Sciences (XMAS III), the SCOR China meeting in Qingdao and the annual Future Earth Asia Workshop in Tokyo, Japan.

I. Scientific Steering Committee

The 2016 IMBeR Scientific Steering Committee consisted of a chair, Carol Robinson, *ex officio* Past Chair Eileen Hofmann and 14 members (8 male and 6 female). Edward Allison (M, USA), Alida Bundy (F, Canada) and Katrin Rehdanz (F, Germany) rotate off the SSC at the end of 2016. Eugene Murphy (M, UK) agreed to continue as an *ex officio* member of the SSC and Vice Chair of the Executive Committee.

An open call for nominations for three new SSC members was advertised in April 2016, requesting expertise in marine sustainability science, marine policy and governance science,

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integrated modelling of social and marine ecological systems, biodiversity and climate adaptation science and ocean literacy. From more than 30 applications, three new members were proposed and accepted by SCOR and Future Earth: Mark Dickey-Collas (M, Denmark), Marion Glaser (F, Germany) and Alistair Hobday (M, Australia).

J. Collaborative partners

IMBeR science is strengthened and its impacts extended through on-going and new partnerships and collaborations with international and national organisations, including the International Council for Science (ICSU), the Scientific Committee on Oceanic Research (SCOR), Future Earth, the World Climate Research Programme (WCRP), and the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) which sponsors the Global Ocean Observing System (GOOS) and the International Ocean Carbon Coordination Project (IOCCP).

IMBeR continues to have long standing collaborations with the SCOR and Future Earth global research projects SOLAS, Future Earth Coasts and PAGES. Further collaboration with the Earth System Governance, bioDiscovery and bioGENESIS projects are envisaged through implementation of the IMBeR Science Plan and development of a Future Earth Ocean Knowledge-Action Network.

a. Too Big To Ignore (TBTI)

IMBeR is a partner of the TBTI project, which includes 15 partners and 62 scientists from 27 countries. TBTI is conducting a global analysis, based on information systems, to better understand small-scale fisheries and to develop research and governance capacity to address global fisheries challenges.

b. Ocean Carbon and Biogeochemistry (OCB) Programme

The U.S. OCB programme continues to actively support IMBeR by advertising its activities and events, and by providing financial support for activities. OCB is hosting and co-sponsoring IMBIZO 5 at Woods Hole in October 2017.

c. World Climate Research Project (WCRP)

CLIVAR, a core project of WCRP, and its Indian Ocean panel work closely with SIBER. The IMBeR Eastern Boundary Upwelling working group is co-sponsored by CLIVAR. A representative from the China CLIVAR office attended the IMBeR SSC meeting in Shanghai in April 2017, and discussions are ongoing for a CLIVAR contribution to a newly formulated SOLAS IMBeR IOCCP carbon working group.

d. Global Ocean Observing System (GOOS)

SIBER has strong connections with the Global Ocean Observing System in the Indian Ocean – IOGOOS. Eric Lindstrom, GOOS co-Chair attended the 2016 IMBeR SSC meeting in New Orleans.

e. International Council for Exploration of the Sea (ICES)

Collaboration with ICES will be developed through the appointment of Mark Dickey-Collas (ICES) to the IMBeR scientific steering committee.

f. North Pacific Marine Science Organization (PICES)

IMBeR and PICES continue to collaborate, with representatives from both communities attending and funding each other's summer schools and science meetings. Gro van der Meeren, Cisco Werner, Ken Drinkwater and Masao Ishii attended the PICES 25th Annual Meeting in the USA in November 2016.

K. Selected IMBeR Publications

IMBeR has produced more than 1000 refereed research papers since 2005, with around 150 papers published in 2016-2017.

ICED

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Cavanagh, R.D., Broszeit, S., Pilling, G.M., Grant, S.M., Murphy, E.J., Austen, M.C. 2016b. Valuing biodiversity and ecosystem services: a useful way to manage and conserve marine resources? *Proceedings of the Royal Society of London, B*, 283 (1844), 20161635.10.1098/rspb.2016.1635

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L. Support from SCOR

IMBeR greatly appreciates the ongoing support received from SCOR, and the additional support for specific IMBeR activities provided or managed by SCOR from other funding sources. IMBeR is especially grateful for the advice and assistance received from the SCOR Executive Director, Ed Urban, and Financial Officer, Liz Gross.

We are requesting funding to support students and researchers from developing countries to attend the ClimEco 6 Summer School that will be held in Accra, Ghana in August 2018.
Amount requested: 7,500 USD

3.2 GEOTRACES

Devey

Terms of Reference:

- Organize national and international planning workshops as well as special sessions at international conferences to obtain community input on the design and implementation of GEOTRACES.
- Establish priorities for research on the sources, sinks, internal cycling, transport, speciation and fate of TEIs, and develop this information into an International Science Plan.
- Promote intercalibration of analytical methods, and the development of standard reference materials.
- Identify new instrumentation and related infrastructure that will help achieve GEOTRACES objectives.
- Define a policy for data management and sample archival.
- Forge scientific linkages with other research programs holding overlapping interests to create synergies where possible and avoid duplication of efforts. To the extent practical, this will involve cross-membership between the GEOTRACES Planning Group and the Planning Groups and Science Steering Committees of other programs.
- Interact with SCOR Working Groups that share common interests including, but not limited to, SCOR/IMAGES WG 123 on Reconstruction of Past Ocean Circulation (PACE) and SCOR/IMAGES WG 124 on Analyzing the Links Between Present Oceanic Processes and Paleo-Records (LINKS).

Co-Chairs: Ed Boyle (USA) and Reiner Schlitzer (Germany)

Other Members: Eric Achterberg (Germany), Adrian Burd (USA), Zanna Chase (Australia), Jay Cullen (Canada), Vanessa Hatje (Brazil), Tung-Yuan Ho (China-Taipei), Marina Kravchishina (Russia), Phoebe Lam (USA), Rob Middag (USA), Hajime Obata (Japan), Katherina Pahnke (Germany), Alakendra Roychoudhury (South Africa), Géraldine Sarthou (France), Yeala Shaked (Israel), Antonio Tovar-Sanchez (Spain), Tina van der Flierdt, and Liping Zhou (China-Beijing)

Executive Committee Reporter: Colin Devey

**GEOTRACES SCIENTIFIC STEERING
COMMITTEE ANNUAL REPORT TO SCOR
2016/2017**

1 May 2016 to 30 April 2017

1. SCOR Scientific Steering Committee (SSC) for GEOTRACES

Co-Chairs

Ed Boyle, USA

Reiner Schlitzer, Germany

Members

Eric Achterberg, Germany

Adrian Burd, USA

Zanna Chase, Australia

Jay T. Cullen, Canada

Tina van de Flierdt, UK

Vanessa Hatje, Brazil

Tung-Yuan Ho, China-Taipei

Marina Kravishina, Russia

Phoebe Lam, USA

Rob Middag, Netherlands

Hajime Obata, Japan

Katharina Pahnke, Germany

Alakendra Roychoudhury, South Africa

Yeala Shaked, Israel

Géraldine Sarthou, France

Antonio Tovar-Sanchez, Spain

Liping Zhou, China-Beijing

The SSC membership (listed above) contains representatives of 16 different countries with diverse expertise, including marine biogeochemistry of carbon and nutrients; trace elements and isotopes as proxies for past climate conditions; land-sea fluxes of trace elements/sediment-water interactions; trace element effects on organisms; internal cycles of the elements in the oceans; hydrothermal fluxes of trace elements; tracers of ocean circulation; tracers of contaminant transport; controls on distribution and speciation of trace elements; and ocean modelling.

2. Progress on implementation of the project

GEOTRACES continues to progress very successfully. GEOTRACES has now more than 1,000 section stations completed (1,024) from 95 GEOTRACES cruises (including 11 International Polar Year cruises). The next Intermediate Data Product will be released in summer 2017 including data from the first 5 years of the programme. So far, 818 peer-reviewed publications have been published, including 20 publications in *Nature* journals and 12 in the *Proceedings of the National Academy of Sciences* (PNAS).

2.1 Status of GEOTRACES field programme

With the completion of the German expedition in the Fram Strait in summer 2016, GEOTRACES successfully completed the international Arctic GEOTRACES Programme (with 4 cruises from USA, Canada and Germany already completed in 2015). In addition, during this reporting period, the Indian GEOTRACES programme completed 2 cruises in the Arabian Sea, Bay of Bengal and Indian Ocean.

In complement to the GEOTRACES Ocean sections cruises, one process study cruise from Netherlands was completed in the Atlantic Ocean.

The GEOTRACES cruise programme for 2017 includes 2 more section cruises, from UK and Japan, in the Atlantic and Pacific Oceans respectively, and 2 process studies: one from France in the Mediterranean Sea and another one from UK in the Atlantic Ocean.

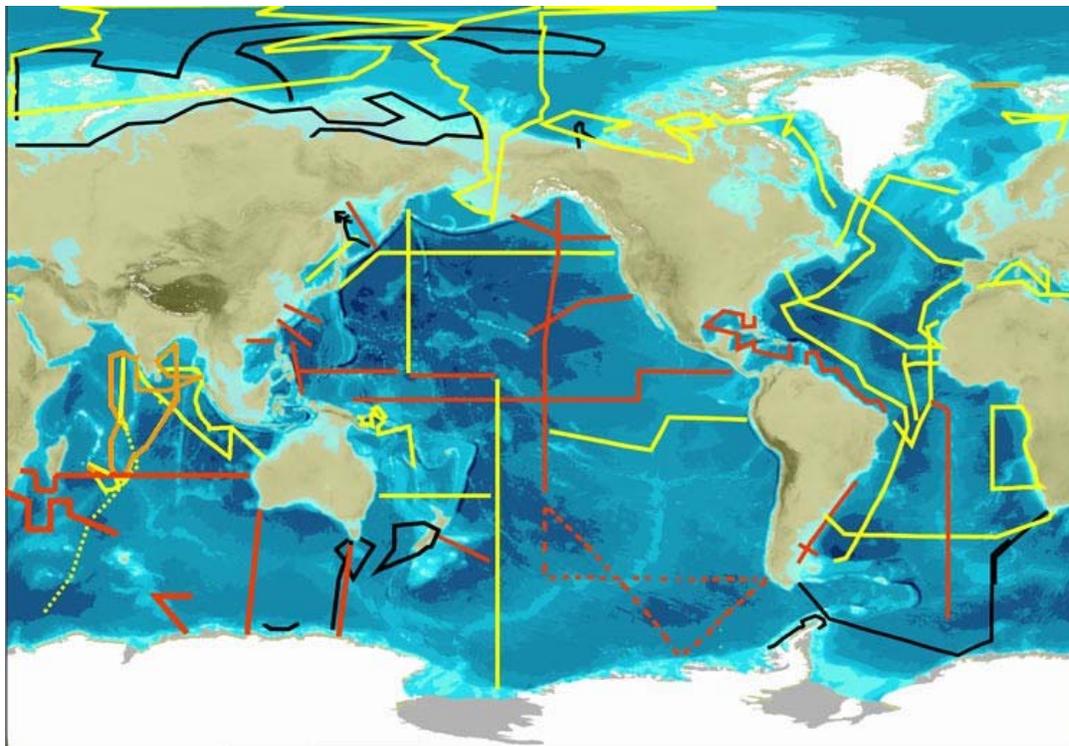


Figure 1. Status of GEOTRACES global survey of trace elements and their isotopes. In black: Sections completed as the GEOTRACES contribution to the International Polar Year. In yellow: Sections completed as part of the primary GEOTRACES global survey. In orange: Sections completed during the past year. In red: Planned Sections. An updated version of this map can be found on the GEOTRACES home page <<http://www.geotraces.org>>.

2.2 GEOTRACES Intermediate Data Products

Release of the new Intermediate Data Product in summer 2017!

Building on the success of the first Intermediate Data Product (IDP), released in 2014, the next intermediate data product will be delivered at the 2017 Goldschmidt Meeting in Paris, France. A town hall meeting is scheduled on **Wednesday, 16 August 2017** at the main venue of the Goldschmidt conference.

The Intermediate Data Product 2017 (IDP2017) will present a remarkable synthesis of data from the Atlantic Ocean and a more complete coverage of data from the Arctic, Indian, Pacific and Southern Oceans and include a larger range of biogeochemical parameters than was included in the IDP2014.

Coming soon!



Intermediate Data Product 2014

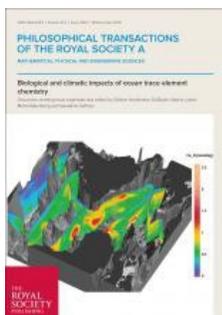
A new version of the Intermediate Data Product 2014 (IDP2014) was made available on June 2016. This version is available to download from the following web page: <http://www.bodc.ac.uk/geotraces/data/idp2014/>. A document describing the changes from previous version is available on the web page indicated above.

So far, the IDP2014 has been downloaded more than 900 times. In the past year, several events to publicise and promote use of the IDP data with the broader ocean research community were held. Please see section “3.4 GEOTRACES Workshops” below.

2.3 *GEOTRACES Publications*

During the reporting period, 140 new peer-reviewed papers have been published, including the most prestigious journals such as Nature (with 5 papers published) and PNAS (with 2 papers published). In total, the GEOTRACES peer-reviewed papers database includes 818 papers.

It is important to highlight that the special issue from the GEOTRACES-Royal Society coupled meeting and workshop to discuss and synthesis findings from the GEOTRACES programme (7–10 December 2015, UK) was published in November 2016.



The volume includes four synthesis papers, which summarise current knowledge and identify areas for future work relating to chemical fluxes at the four ocean boundaries – with the [atmosphere](#), the [continents](#), [sediments](#), and [mid-ocean ridges](#). These papers and some other papers are available open access.

[Philosophical Transactions of the Royal Society A \(28 November 2016; volume 374, issue 2081\)](#)

Biological and climatic impacts of ocean trace element chemistry

Edited by Gideon Henderson, Ed Boyle, Maeve Lohan, Micha Rijkenberg and Géraldine Sarthou

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Publicity articles to promote GEOTRACES continue to be published nationally and internationally. The complete list of promotional articles is available here:

<http://www.geotraces.org/outreach/publicity-documents>

For complete information about GEOTRACES publications please check the following web pages:

- GEOTRACES peer-reviewed papers database: <http://www.geotraces.org/library-88/scientific-publications/peer-reviewed-papers>
- GEOTRACES special issues: <http://www.geotraces.org/library-88/scientific-publications/geotraces-special-issues>

2.4 *GEOTRACES Science highlights*

The GEOTRACES International Project Office regularly edits highlights of published articles, which are posted in the website (<http://www.geotraces.org/science/science-highlight>) and in the electronic newsletter (<http://www.geotraces.org/outreach/geotraces-enewsletter>). Among the numerous highlights published since last year's report, we selected the following five:

Changing the paradigm on the oceanic iron cycle

Tagliabue and co-workers (2017, see reference below) discuss an extensive review on the recent findings on iron (Fe) cycle in the ocean. They figure out clearly that:

- Fe is a nutrient as essential as nitrogen (N) or phosphorus (P) for the phytoplankton. In other words, the full understanding of any marine ecosystem cannot neglect the analysis of micronutrients anymore.
- Fe oceanic sources are multiple, and supply from continental margins extends far beyond the coastal zone, while striking Fe inputs from hydrothermal activity along mid-ocean ridges were observed in all the oceans. This revolutionizes the preceding view of the dust inputs, although those are essential drivers of N₂ fixation at low latitude.
- The cycling of organic iron-complexing ligands has also emerged as a crucial component of the ocean iron cycle, ligand concentrations being not as uniform as considered earlier.
- It is also recognized that phytoplankton can exhibit substantial variations in their iron stoichiometry in different environments.

Synthesizing these new insights provides a more refined picture of the ocean iron cycle, challenging the global ocean modelling for testing hypotheses and projections of change. The authors also draw exciting new frontiers for the oceanic Fe cycle.

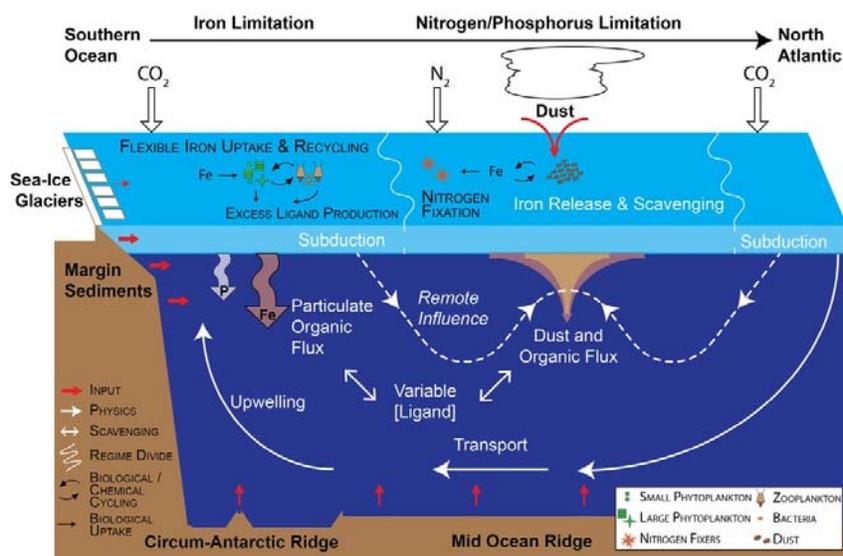


Figure 2. Revised model of the major processes in the ocean iron cycle, with focus on the Atlantic Ocean. Note that there is a broad meridional contrast between the iron-limited Southern Ocean and the major nutrient-limited low-latitude regimes. Dust remains a dominant source in the low latitudes, but continental margin and upwelled hydrothermal sources are more important in the Southern Ocean. Flexible iron uptake and biological cycling, together with the production of excess iron-binding ligands, dominate the Southern Ocean. Nitrogen fixation occurs in the low latitudes (although this process can also be restricted by lack of iron outside the North Atlantic subtropical gyre). The particulate organic iron flux is decoupled from that of phosphorus at high latitudes and the flux of lithogenic material is important at low latitudes influenced by dust. Subduction of excess organic iron-binding ligands from Southern Ocean has a remote influence on the interior ocean at low latitudes.

Reference:

Tagliabue, A., Bowie, A.R., Boyd, P.W., Buck, K.N., Johnson, K.S., & Saito, M.A. (2017). The integral role of iron in ocean biogeochemistry. *Nature*, 543(7643), 51–59. DOI: <http://dx.doi.org/10.1038/nature21058>

[Contrasting lithogenic inputs from North Atlantic to North Pacific Oceans traced by thorium isotopes](#)

Dissolved thorium (Th) isotopes and iron (Fe) are used to document the transfer of lithogenic material to the ocean. Two contrasting areas are compared: the Atlantic Ocean around Barbados Islands, under the influence of the Amazon plume and dust of Saharan origin, and the remote North East Pacific Ocean, far from dust inputs. The Amazon is a substantial source of dissolved ^{232}Th and iron (Fe) to the low-latitude Atlantic Ocean, even as far away as 1,900 km from the river's mouth. This complicates the use of ^{232}Th as a dust proxy in river-influenced ocean regions. A striking feature is the similarity in Fe concentrations from the North Pacific to the North Atlantic Oceans, while ^{232}Th reveals a dust flux six-fold higher in the later. This supports the idea that dissolved Fe distribution is highly buffered in the ocean.

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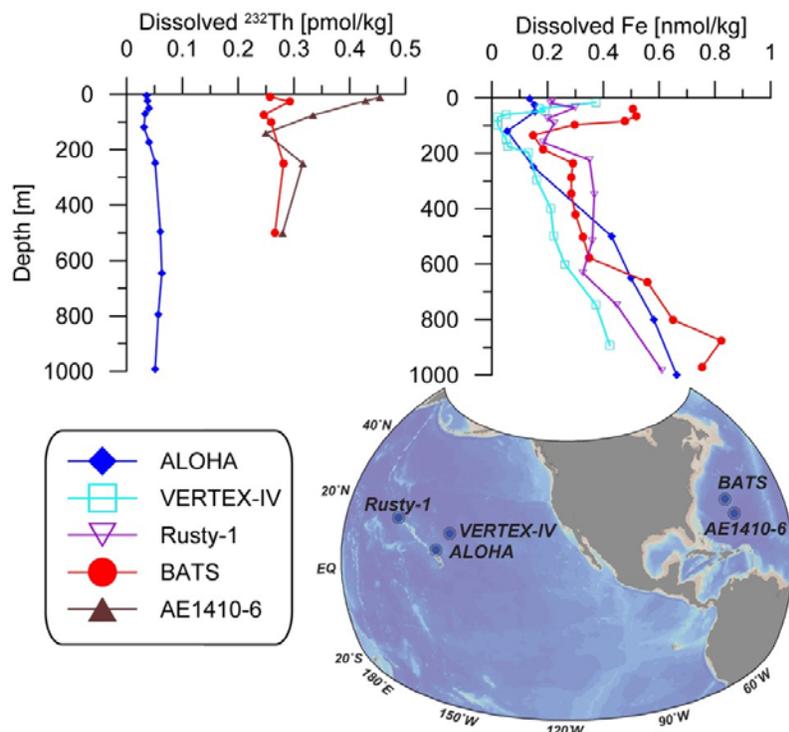


Figure 3. The North Atlantic Ocean receives a much larger input of mineral dust blown from the continents than does the remote North Pacific. This contrast is seen clearly in the seawater concentrations of dissolved Thorium-232, the isotope of thorium that is enriched in the continental crust (left panel). The distribution of Fe, however, is much more homogeneous between these two ocean basins (right panel), despite that fact that continental dust is the major source of Fe in these areas. We think this is because Fe is highly buffered in the ocean by a combination of biological uptake, adsorption onto particles, and complexation by organic molecules, or ligands.

Reference:

Hayes, C. T., Rosen, J., McGee, D., & Boyle, E. A. (2017). Thorium distributions in high- and low- dust regions and the significance for iron supply. *Global Biogeochemical Cycles*, 31, 1–20. DOI: <http://dx.doi.org/10.1002/2016GB005511>

[The coupled zinc-silicon cycle paradox illuminated](#)

The strong similarities between zinc (Zn) and silicon (Si) vertical profiles have led many studies to suggest the uptake of Zn in diatom frustules, followed by simultaneous remineralisation at depth. However, recent lab experiments have demonstrated that Zn, although essential for diatoms, is located in the organic part of the cell. These cells are characterized by particularly high Zn/P ratios in the Southern Ocean (up to 8 times greater than at low latitudes). Such contrasting observations have raised the question as to what processes could lead to such consistent Si-Zn relationship, given that Zn and Si uptake are obviously not controlled by the same biological process. Vance and co-workers (2017, see reference below) infer that the oceanic zinc distribution is the result of the interaction between

the specific uptake stoichiometry in Southern Ocean surface waters and the physical circulation through the Southern Ocean hub.

Their approach couples in situ data collected in the different oceanic basins, experimental results from the literature and physical-biogeochemical coupled modelling on a global scale. This work emphasizes how the consideration of 1-D cycling only can bias the understanding of (macro and micro) nutrient behaviours, and therefore their paleo-applications, although 1-D cycling may also play an important role in Zn cycling.

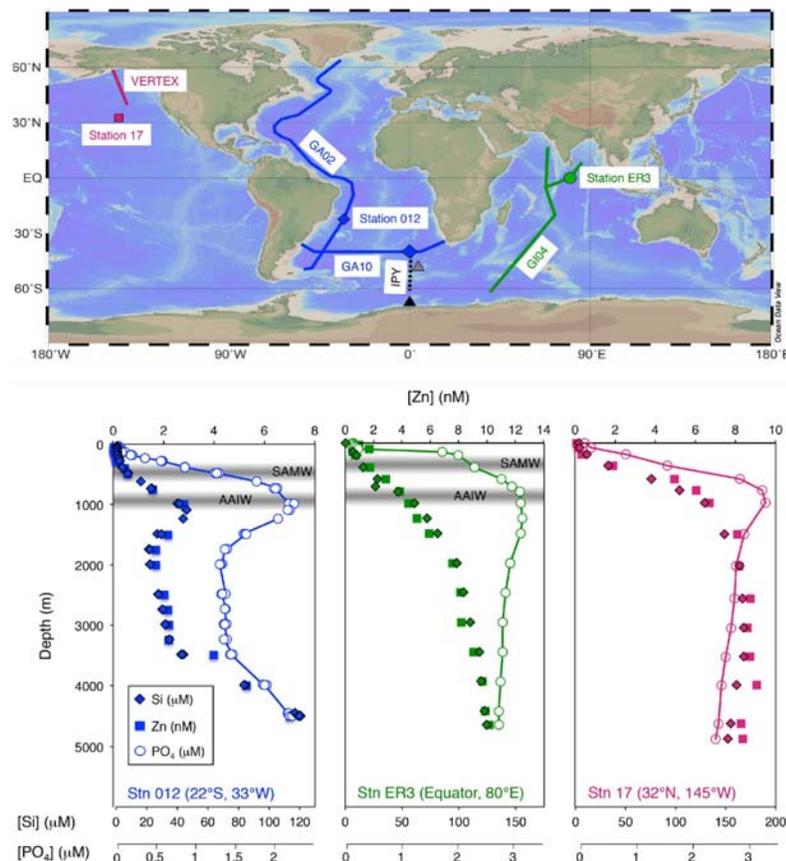


Figure 4. Depth profiles of dissolved zinc, silica and phosphate in three different ocean basins (bottom), with the locations of each profile shown on the map (top). Both zinc and silicate show deep maxima whereas phosphate has a much shallower maximum, despite the fact that the oceanic biogeochemical cycle of Zn is dominated by uptake into the organic parts of diatom cells with phosphate. Vance *et al.* explain these features in terms of biological and physical processes in the Southern Ocean.

Reference:

Vance, D., Little, S. H., de Souza, G. F., Khatiwala, S., Lohan, M. C., & Middag, R. (2017). Silicon and zinc biogeochemical cycles coupled through the Southern Ocean. *Nature Geoscience*. DOI: <http://dx.doi.org/10.1038/ngeo2890>

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Testament of the efficiency of environmental policies

Human activities, such as the combustion of leaded petrol, emissions from non-ferrous metal smelting, coal combustion and waste incineration constitute major environmental lead (Pb) sources during the past century. This resulted in a considerable increase of anthropogenic Pb in the surface and deep waters of the North Atlantic, large enough to mask the natural lead signal.

Increased usage and then phasing-out of leaded-petrol since the mid-1970s yielded a decrease of this contamination. By measuring lead concentrations and isotopes (excellent tracers of the different sources of lead) along the GEOTRACES sections GA02 and GA06, Bridgestock and his co-workers (2016, see reference below) reveal for the first time that natural lead can be detected again in the surface water of the North Atlantic. Indeed, significant proportions of up to 30–50% of natural Pb, derived from mineral dust, are observed in Atlantic surface waters off the Sahara. This clearly reflects the success of the global effort to reduce anthropogenic Pb emissions.

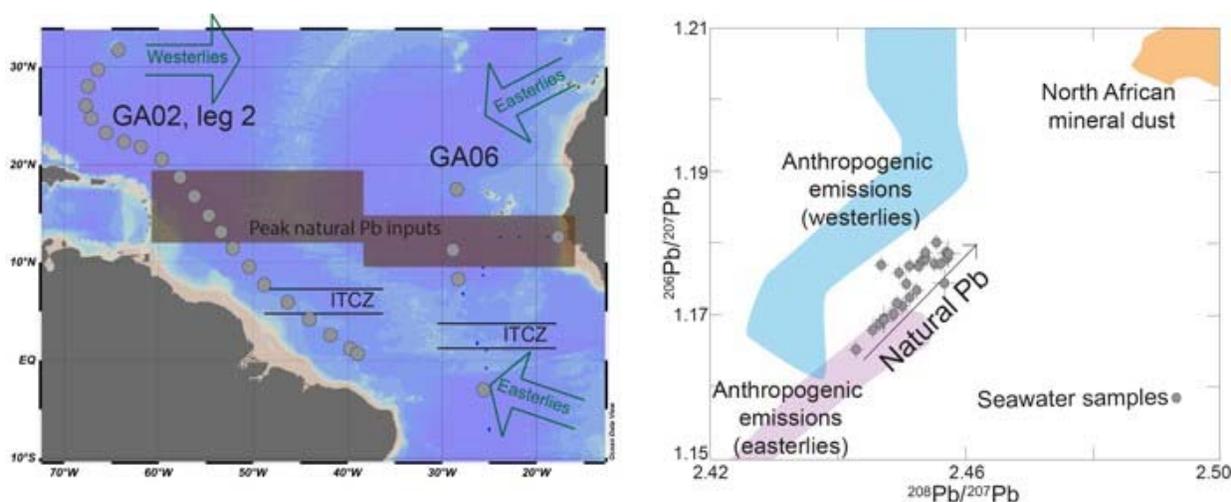


Figure 5. Locations of the surface seawater samples analyzed in this study (left). The brown shaded box shows the area found to contain the highest amounts of naturally sourced lead (Pb) resulting from the deposition of North African mineral dust. Significant inputs of natural Pb can be identified by higher Pb isotope ratio values ($^{206}\text{Pb}/^{207}\text{Pb}$ and $^{208}\text{Pb}/^{207}\text{Pb}$; right).

Reference:

Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M.C., Baker, A.R., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., Rijkenberg, M.J.A., Gerringa, L. J.A., de Baar, H. J. W. (2016). Return of naturally sourced Pb to Atlantic surface waters. *Nature Communications*, 7, 12921. DOI: <http://dx.doi.org/10.1038/ncomms12921>

Oxygen biogeochemistry exerts a strong influence on cobalt cycling

This is an important result of the U.S. GEOTRACES East Pacific Zonal Transect (EPZT) cruise (GP16) discussed by Hawco and his co-workers (2016, see reference below). The distribution of dissolved cobalt and labile cobalt along this section is closely tied to the oxygen minimum zone. This work also shows that (1) elevated concentrations of labile cobalt are generated by input from coastal sources and reduced scavenging at low oxygen; (2) atmospheric deposition and hydrothermal vents along the East Pacific Rise are contrastingly minor sources of cobalt; (3) high cobalt waters are further upwelled and advected offshore and; (4) phytoplankton export returns cobalt to low-oxygen water masses underneath. These processes result in covariation of dissolved cobalt with oxygen and phosphates, schematically represented in the Figure below.

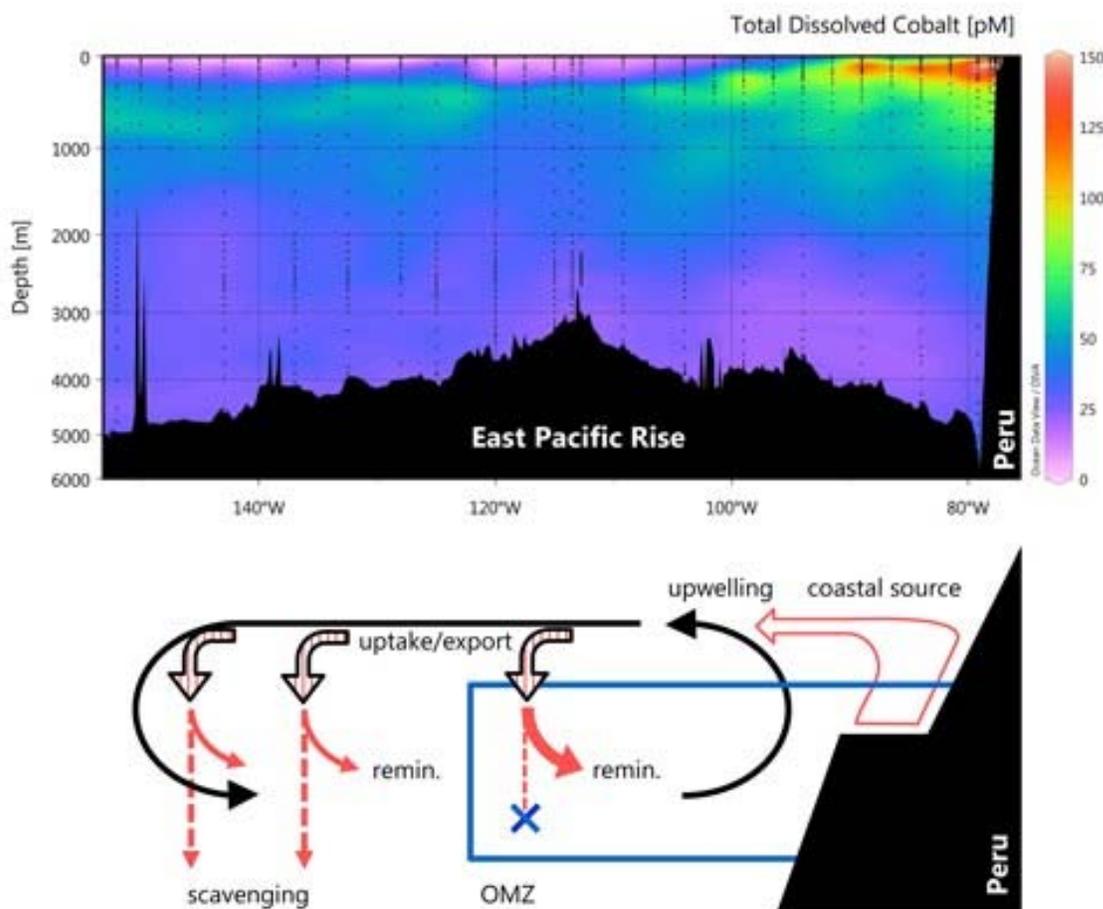


Figure 6. In the South Pacific Ocean, high levels of cobalt are harbored in waters that are devoid of dissolved oxygen (upper panel, warm colors). This plume of cobalt stems from the Peru coast and is enhanced by degradation of cobalt-bearing phytoplankton in these waters, and by the absence of removal processes (scavenging) when oxygen is low (lower panel).

Reference:

Hawco, N. J., Ohnemus, D. C., Resing, J. A., Twining, B. S., & Saito, M. A. (2016). A dissolved cobalt plume in the oxygen minimum zone of the eastern tropical South Pacific. *Biogeosciences*, 13(20), 5697–5717. DOI: <http://dx.doi.org/10.5194/bg-13-5697-2016>

3. Activities

3.1 GEOTRACES intercalibration activities

The Standards and Intercalibration (S&I) Committee is currently composed of Karen Casciotti, Peter Croot, Tina van de Flierdt, Walter Geibert, Lars-Eric Heimbürger, Maeve Lohan, and Hélène Planquette. Greg Cutter, who stepped down from the committee last year, is still completing some tasks associated with aerosol intercalibrations. Maeve Lohan and Walter Geibert serve as co-chairs. Since the S&I meeting at Stanford University on 27-29 April 2016, the S&I committee held several meetings.

- In person:
23-26 January 2017 (London Imperial College)
- Virtual meetings
(GoToMeeting):
28 November 2016
20 March 2017
24 April 2017
- Virtual S&I-Data Management Committee (DMC) co-chair meetings:
 - 7 February 2017
 - 26 April 2017

In addition, the committee is in constant communication via email and through a shared online resource, and the co-chairs are in regular personal exchange with members of the DMC and BODC at the respective locations.

The main task of the committee in the past year was continued preparation for IDP2017, which also included the intercalibration of data that were included in IDP2014, but had not been intercalibrated yet. The aim was to have all datasets in IDP2017 seen and evaluated by the S&I committee, according to defined intercalibration criteria. This aim was achieved for all but one dataset on 30 April 2017, and the committee is still working to have all data in IDP2017 assessed.

The submission procedure has been improved by providing a dedicated e-mail address for the S&I committee (sic@geotraces.org) and by reorganizing and updating the content on the GEOTRACES web page, strongly supported by the IPO in Toulouse. The improvements of

the submission procedure are working well and we are pleased with the response from the community. The committee has provided details on requirements for different types of cruises and parameters, which made the intercalibration process more transparent for data submitters. In addition, a new flowchart of the intercalibration procedure was designed and put on the website (<http://www.geotraces.org/sic/about-s-i/flow-chart-s-i-data-quality-assessment>). This is part of the continuous improvements in defining and communicating the procedures that are in place to ensure consistent quality of the GEOTRACES data products. A better description of the process, combined with regular reminders, individual letters, and written instructions for specific parameters, all contributed to receiving a large number of S&I reports from the analysts from the Atlantic and Pacific oceans. All deadlines for data submission for IDP2017 have now passed.

This year we have also produced with the community intercalibration procedures for BioGEOTRACES, which includes the following parameters:

1. HPLC Pigments
2. Single cell trace metals
3. Targeted Metaproteomics

A new committee member responsible for BIOEGOTRACES will join the S&I committee next year.

The S&I Committee received approximately 750 parameters from the Atlantic, 250 parameters from the Pacific, nothing submitted from the Indian Ocean, 32 parameters from past IPY cruises, 44 parameters from process studies and 32 parameters from GEOTRACES-compliant datasets for the final IDP2017 deadline. During the meetings of the S&I Committee, all datasets were introduced by the assigned committee members, and discussed by the full committee. In nearly all cases, questions of the committee about data quality could be easily resolved and only a small and limited number of parameters did not pass intercalibration, mostly due to issues with sampling methods. It is important in this context to refer newly joining contributors to the existence of the GEOTRACES cookbook, for which an updated version (3.0) is in preparation for release in summer 2017. A number of intercalibration reports were of outstanding quality, providing excellent detail on intercalibration procedures. Continuous exchange with submitters and the community clearly results in a better understanding of the requirements for the intercalibration process and benefits data quality and comparability in GEOTRACES.

Coverage in the Atlantic and especially the Pacific is now strongly improved from IDP2014. The first datasets on biochemical parameters (BioGEOTRACES) have been submitted and will be intercalibrated for IDP2017. For some important sections, no data or very little data were submitted for IDP2017, in spite of many attempts to raise awareness of the submission procedure. Progress has been made with including hydrography, DIC, SF₆, CFC's and some sensor datasets, where a defined intercalibration procedure developed by these communities is used, e.g., CLIVAR.

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Other Activities

Prof. Jim Moffett is now responsible for GEOTRACES consensus material. In the past year, more data has been submitted for this, extending the number of elements that can have consensus material. We hope that next year this will be published on the website. Prof. Eric Atherberg has also collected consensus material from GA08. These samples have now been distributed to laboratories around the world to generate consensus data. We hope in the next year these materials will be available for use by the community.

A small intercalibration exercise for labile particulate materials was undertaken this year so that labile particulate data could be included in IDP2017. This consisted of groups using a specific leach to apply this to 3 different CRMs. Four different laboratories who routinely carry out this work took part in this exercise resulting in labile particulate material being intercalibrated for IDP2017.

3.2 *Data management for GEOTRACES*

The GEOTRACES Data Assembly Centre (GDAC) is hosted by the British Oceanographic Data Centre (BODC), with the head office located in Liverpool; the GEOTRACES Data Manager (Chris Daniels) is based at the BODC office in Southampton, UK. Regular communication is maintained between the two sites so that support and assistance can be offered to the GEOTRACES Data Manager when required.

GDAC is responsible for the entirety of the GEOTRACES data activities from inception to completion. This takes into account the following components:

- interaction between PIs and national data centres in order to encourage regular and timely data/metadata submissions
- maintaining and modifying GDAC web pages to include updated ocean basin maps (http://www.bodc.ac.uk/geotraces/cruises/section_maps/) and upcoming cruises on the programme page (<http://www.bodc.ac.uk/geotraces/cruises/programme/>)
- liaising with the Data Management Committee and Standards and Intercalibration Committee to ensure issues/questions relating to GEOTRACES and its progress can be discussed, and deadlines can be met accordingly.
- Input of metadata and data into the BODC database and compilation of documentation to include analysis methodologies
- Collation of data/metadata for the IDP2017

Chris Daniels is the GEOTRACES Data Manager since January 2017. He took the position of Abigail Bull who left to take a different role. Since Chris started on his role he has focused entirely on processing data to be included in the IDP2017.

Data overview

The data management of the GEOTRACES Project is a large undertaking, with a total of 95 cruises (including all cruise legs) associated with the project (this takes into account all section

cruises, process studies and compliant data). More than 800 scientists have taken part in GEOTRACES cruises, with 15 different nations having run a major GEOTRACES IPY/ section/ process study cruises.

Summary of completed GEOTRACES cruises to date:

Section cruises	IPY cruises	Process studies	Compliant data
35 cruises (including all legs) with 27 sections	11	28 (including all legs) with 24 sections	9

In addition, 2 intercalibration cruises have been completed.

3.3 *GEOTRACES International Project Office*

The GEOTRACES International Project Office (IPO) is based at the Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS) in Toulouse, France. The IPO is staffed by a single person, the IPO Executive Officer, Elena Masferrer Dodas. She works under the scientific supervision of Catherine Jeandel (CNRS, LEGOS, France).

The IPO is responsible for:

- assisting the Scientific Steering Committee (SSC) in implementing the GEOTRACES Science Plan and implementation plans of the programme;
- organising and staffing meetings of the SSC, working groups and task teams;
- liaising with the sponsors and other relevant organisations;
- seeking and managing programme finances;
- representing the project at international meetings;
- maintaining the project website and Facebook and Twitter pages;
- maintaining the project mailing lists;
- preparing GEOTRACES science highlights and the bimonthly GEOTRACES eNewsletter;
- maintaining the GEOTRACES publications database and the GEOTRACES Scientists Analytical Expertise Database;
- assisting the GDAC in securing information about upcoming cruises; and
- interacting with GEOTRACES national committees and groups, as well as other international projects.

From October to December 2016, the IPO hosted Bob Anderson, U.S. GEOTRACES project office director and past co-chair of the GEOTRACES SSC. The main purpose of his visit was working on the development of the Intermediate Data Product 2017 parameter list.

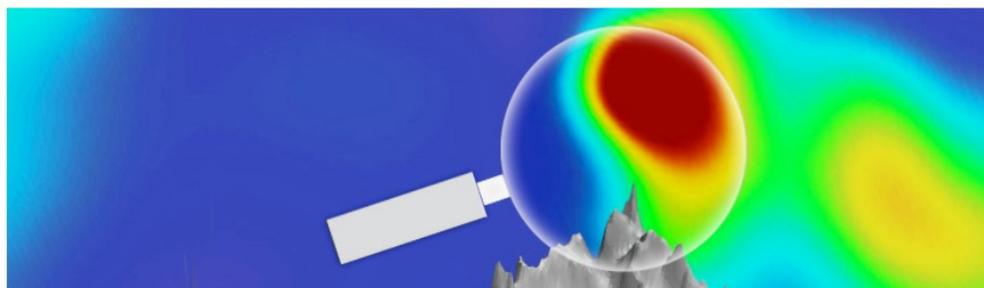
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This year, we want to highlight the following new products:

- GEOTRACES eNewsletter Special Issue – Discovery Digest

The GEOTRACES IPO has introduced a new type of newsletter, a sort of “discovery digest”, which is designed to highlight the progress in a given GEOTRACES-relevant topic. The first one was published in March 2017 and was devoted to recent discoveries in the oceanic cycle of iron. This issue is available here: <http://www.geotraces.org/outreach/geotraces-eNewsletter/listid-12/mailid-768-geotraces-discovery-digest>

Following the publication of this special issue, the GEOTRACES IPO has received several spontaneous congratulation and thank-you messages from the GEOTRACES community. At the time of writing this report, the issue has received more than 1,300 hits.



- New query capability for the GEOTRACES Publications database

A dynamic querying capability for the GEOTRACES publications database is currently being developed with the help of the Data Service of the Observatoire Midi-Pyrenees (SEDOO) in Toulouse, France. Once available, it will be possible to make advanced searches within the GEOTRACES publication database. This system will also improve the Intermediate Data Product system to link the original publications associated with the given tracer and cruise.

- Video presenting the GEOTRACES Programme

Short video interviews of SSC members were held during last SSC meeting, which was hosted by the GEOTRACES IPO in Toulouse. The IPO is currently working with Jean-Hugues Babary from Centre for the Development of the Pedagogy at the Université Paul Sabatier and the journalist Jean François Hait editing the videos.

- GEOTRACES website (<<http://www.geotraces.org>>)

A new menu devoted to Standards and Intercalibration activities has been added on the GEOTRACES site. Facebook and Twitter feeds will be added on the GEOTRACES homepage in order to give more visibility to all the activity in these two media.

- Publicity articles

An article introducing GEOTRACES has been published on the Journal of the Atlantic Society of Oceanographers, OKEANOS (Spain) with the aim of promoting GEOTRACES research in Spain. The volume (in Spanish) is available here:

<http://es.calameo.com/read/0050684378fc854b0db53>

From the regular tasks we want to highlight the following:

- Meeting and Workshop organisation

The IPO hosted the 2016 DMC and SSC meetings in Toulouse (12-16 September 2016) and organised the Workshop “Exploring GEOTRACES Data with ODV” and the GEOTRACES Indian Ocean Planning Workshop which were held in Japan (June 2016). Minor assistance was also provided to the organisation of the joint GEOTRACES/OCB Workshop: “Biogeochemical cycling of trace elements within the ocean: A synthesis workshop”, the “Arctic-GEOTRACES Early Career Researcher Networking Event (ASLO 2017)” and the “IDP2017 Parameter Committee meetings.” Please read the section “GEOTRACES Workshops” for further information about the workshops.

- Policy advice

The IPO is actively involved in the G7 Oceans Initiative. It has coordinated the topic “Ocean Chemistry”. The development of a coordinated action plan for research vessels and the need for coordinated programmes coupling physics, chemistry and biology have been the top priorities the IPO has advocated for. SCOR is included as external expert in this process. The IPO also assisted Roger François (University British Columbia, Canada) and Peter Croot (NUI-Galway, Ireland) in their initiative of approaching the Arctic Monitoring and Assessment Programme (AMAP) with the objective of establishing a joint Arctic workshop. Unfortunately, AMAP had no funding available to dedicate to this joint workshop.

- Capacity Building

During Bob Anderson’s visit to the GEOTRACES IPO, support was provided to colleagues in Korea who want to initiate a Korean GEOTRACES programme. Korea has a new ship (*RV ISABU*) and has purchased the most-up-to-date clean sampling system, so there is high expectation that Korea could successfully carry out GEOTRACES missions. A proposal for funding a Korean GEOTRACES programme has been submitted to the Korea Institute of Marine Science and Technology Promotion (KIMST).

- Some statistics

30 new highlights published (135 in total)

5 eNewsletter published, including one special issue (bimonthly 25 in total)

140 new peer-reviewed papers included in the GEOTRACES Publication Database (818 in total)

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135 new articles published on the GEOTRACES website
122 announcements sent through the GEOTRACES mailing list
112 new posts on Facebook and 371 likes (top post reach 1,6K)
240 tweets and 431 followers (top tweet reach 3.1K)
94 new subscribers on the GEOTRACES website

The IPO thanks Olivier Boebion (IT system administrator at Observatoire Océanologique de Villefranche sur Mer, France) for all his assistance with the GEOTRACES web site.

3.4 *GEOTRACES Workshops*

Six GEOTRACES workshops were held in the past reporting year including:

Exploring GEOTRACES data with Ocean Data View (Goldschmidt 2016 Workshop), 26 June 2016, Yokohama, Japan.

46 participants from 13 different nations participated in this hands-on workshop, whose goal was to teach standard and advanced ODV methods for the exploration and scientific analysis of environmental data. The GEOTRACES Intermediate Data Product 2014 (IDP2014) was used as an example dataset. Participants learned how to create publication-ready maps, property-property plots and sections, and how to apply simple or advanced station and sample filters. In addition, an overview of the wide range of derived variables available in ODV was given and a number of variables often needed in geochemical research were described and applied.

The workshop started with presentations of general software concepts and capabilities, followed by hands-on sessions for the creation of specific plot types and scientific discussion rounds explaining the findings.

For further information: <http://www.geotraces.org/meetings/geotraces-events/eventdetail/263/-/exploring-geotraces-data-with-ocean-data-view>



Figure 7. Participants of the Workshop "Exploring GEOTRACES with Ocean Data View".

GEOTRACES Indian Ocean Planning Workshop, 29 June 2016, Yokohama, Japan

35 GEOTRACES scientists met in Yokohama (Japan) to discuss the GEOTRACES Indian Ocean implementation plan. This was an opportunistic workshop held during the Goldschmidt conference in Japan.

As a result of the Workshop, the following upcoming GEOTRACES cruises in the Indian Ocean were identified: India (2 cruises completed in autumn 2016 and winter 2017), Germany (cruise in 2018) and Australia (cruise in 2018). Other nations (France and South Africa) are currently planning cruises in the Indian Ocean.

Joint GEOTRACES/OCB Workshop: "Biogeochemical cycling of trace elements within the ocean: A synthesis workshop", 1–4 August 2016, Lamont-Doherty Earth Observatory, Palisades, New York, USA

More than 100 investigators from 12 nations participated in this workshop focused on setting priorities for exploiting GEOTRACES data to advance scientific objectives at the interface between marine geochemistry and marine ecology. This workshop was the second foundational workshop of the GEOTRACES synthesis of results strategy. It was jointly sponsored by the GEOTRACES programme and the Ocean Carbon and Biochemistry activity of the U.S. Carbon Cycle Science Program.

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Workshop activities were organised around three scientific themes:

- 1) Biological uptake and trace element bioavailability,
- 2) Abiotic cycling and scavenging, including particulate and dissolved speciation, and
- 3) Export, recycling and regeneration

Following a series of plenary talks designed to stimulate discussion on these topics, workshop participants spent most of the workshop in smaller groups that identified critical knowledge gaps in each of these areas, as well as strategies to meet those needs. Participants defined six topics to be pursued in greater detail in synthesis papers that combine GEOTRACES data with results from other programmes, such as those involving molecular biology. These activities will inform and improve models used to predict how marine ecosystems are going to respond to future environmental changes, including pollution and global warming.

The plenary presentations (PDF files) from the Workshop can be opened and downloaded directly from the agenda available on the workshop web site: <http://web.who.edu/geotraces-synthesis/agenda/>

Main recommendations and anticipated products from the meeting are listed below:

- Explore Redfieldian concepts of elemental stoichiometry using GEOTRACES TEI data
- Estimate bioavailability of Fe with oceanographic data using “bioavailability envelope” concept of Lis et al., ISME Journal, 2015
- New hypothesis for light and Fe co-limitation in deep chlorophyll maxima
- A Synthesis Paper on “Paradigms of ligand composition and cycling and the degree of confidence in them” will be produced.
- Compare radionuclide-based methods ($^{234}\text{Th}/^{238}\text{U}$; $^{228}\text{Th}/^{228}\text{Ra}$; $^{230}\text{Th}/^{234}\text{U}$; $^{210}\text{Po}/^{210}\text{Pb}$; Pu/Np) to estimate the downward flux of particulate C, N, P, biogenic Si, ^{232}Th , Al, Cd, Fe, Co, Cu, and Mn
- Combine measured TEI distributions with calculated AOU and preformed TEI concentrations to discriminate among effects of abiotic scavenging, biotic uptake and regeneration, and physical transport

A complete list of products is available in the Appendix II to the National Reports to SCOR. For further information: <http://web.who.edu/geotraces-synthesis/>

First GEOTRACES-TARA meeting, 5 December 2016, video-conference.

This meeting is one of the first products of the joint GEOTRACES/OCB Workshop described above. [TARA](#) is a French non-profit organisation that manages voyages to study and understand the impact of climate change and the ecological crisis facing the world's oceans.

The meeting explored collaborations between GEOTRACES and TARA programmes and started mining the existing “omic” data from TARA cruises, in order to link metrics from sequences with the GEOTRACES data.



East Asia GEOTRACES Workshop, Trace Element and Isotope study in the Northwestern Pacific and its marginal seas, 16-18 January 2017, Sapporo, Hokkaido, Japan

The East Asia GEOTRACES Workshop was held on 16-18 January 2017 in Sapporo, Japan. The main goals were to evaluate the current status of trace elements and their isotopes (TEI) studies in the Northwestern Pacific Ocean and its marginal seas, and to identify important scientific questions and directions for future regional collaborative studies. For three days, a total of 56 registered scientists from China, Germany, Korea, Russia, Taiwan, United States and Japan took part in the workshop. The workshop consisted of 5 plenary talks, 17 keynote talks and 25 short topics talks related to GEOTRACES and BioGEOTRACES. Early-career researchers were especially encouraged to give a talk, which was very successful. During the workshop, regional scientific results, future cruise plans and possible collaborations were discussed. A follow-in workshop is planned for 2018 in China.

For further information: <http://geotraces.jp/EAGW2017/>



Figure 8. Participants of the East Asia GEOTRACES Workshop.

Arctic-GEOTRACES Early Career Researcher Networking Event (ASLO 2017), 26 February 2017, Honolulu, Hawaii

The U.S., European and Canadian [Arctic GEOTRACES cruises](#) in 2015 offered a unique and quasi-synoptic view of the Arctic Ocean. Twenty-seven early career scientists came together to kick off the ASLO Aquatic Sciences meeting in Honolulu, Hawai'i on 27 February 2017 to discuss emerging areas of international scientific collaboration within the Arctic GEOTRACES programme. The workshop was a special chance for early career scientists to meet their international counterparts and engage initial discussions of interdisciplinary research topics between programmes.



Figure 9. Participants of the Arctic-GEOTRACES Early Career Researcher Networking Event at ASLO 2017.

3.5 *GEOTRACES Summer School*

The first GEOTRACES summer school will be held in Brest, France, from 20 to 26 August 2017. It will bring together over 60 students and 20 world-leading international scientists.

The summer school aims at teaching the skills and knowledge necessary for a good understanding of the biogeochemical cycles of trace metals. It will allow PhD students and early career researchers to see how their work fits within the international community of GEOTRACES.

General lectures will be given by international experts in the field of the GEOTRACES programme and practical workshops in the laboratory will be run throughout the week.

This summer school is supported by LabexMER (<https://www.labexmer.eu/fr>) and SCOR. At the time this report is written 110 applications to participate in the summer school have been received.

GEOTRACES gratefully acknowledges support from SCOR.
For further information: <https://geotraceschool.sciencesconf.org/>



3.6 *Special sessions at international conferences featuring GEOTRACES findings*

Several GEOTRACES special sessions were held in major international conferences including:

2016 Goldschmidt Meeting, 26 June–1 July, 2016, Yokohama, Japan. For further information: <http://goldschmidt.info/2016/>

GEOTRACES-sessions:

***12d: Oceanic Cycling of Trace Elements Using Elemental, Isotopic, and Modeling Approaches: Geotracers and Beyond...**

Convenors: Tim Conway, Tristan Horner, Jessica Fitzsimmons, Hajime Obata, Catherine Jeandel, Andrew Bowie, Phoebe Lam

***12f: Elemental and Isotopic Marine Biogeochemistry at a Range of Scales: The Global Ocean, Marginal Seas, and Polar Atmosphere-Sea Ice-ocean Systems**

Convenors: Susan Little, Daiki Nomura, Gregory de Souza, Markus Frey, Delphine Lannuzel, Jun Nishioka, Patrick Rafter, Martin Vancoppenolle

***16d: Models of Life and Geochemistry: Integrating Large-Scale Datasets into Global Climate Models**

Convenors: Seth John, Tatiana Ilyina, Andy Ridgwell

Challenger Society 2016 Conference - Oceans and Climate, 5–8 September 2016, Liverpool, UK. For further information: <https://www.liverpool.ac.uk/challenger-conference-2016/>

GEOTRACES-session:

***Trace element and isotope exchange at ocean boundaries**

Convenors: Will Homoky (Oxford), Torben Stichel (Southampton) & Susan Little (Imperial)

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VII Congresso Brasileiro de Oceanografia (CBO 2016), 5 - 9 November 2016, Salvador - Bahia, Brazil. For further information: <http://www.cbo2016.org/>

GEOTRACES-session:

*MS5 – GEOTRACES – Brasil
Coordination: Vanessa Hatje (UFBA)

GEOTRACES-training course:

*MC11 – Ocean Data View para iniciantes (Training Workshop)
Speaker: Leticia C. da Cunha (UERJ)

Third Xiamen Symposium on Marine Environmental Sciences (XMAS), 9-11 January 2017, Xiamen, China. For further information: <http://mel.xmu.edu.cn/conference/3xmas>

GEOTRACES-session:

*Biogeochemical Cycling of Trace Elements in the Ocean: GEOTRACES and Beyond
Convenors: Martin Frank, Jing Zhang, Zhimian Cao

ASLO 2017, Aquatic Sciences Meeting, 26 February - 3 March 2017, Honolulu, Hawaii, USA. For further information: <http://www.sgmeet.com/aslo/honolulu2017/default.asp>

GEOTRACES-sessions:

*004 - Biogeochemical Cycling of Trace Elements and Isotopes in the Arctic Ocean
Convenors: Greg Cutter, Roger Francois, David Kadko, William Landing, Michiel Rutgers Van der Loeff

*025 - Linking atmospheric deposition to the biogeochemistry of aquatic and marine systems
Convenors: Clifton Buck and Rachel Shelley

029 - REE marine geochemistry in the 21st century: A tribute to the pioneering research of Henry Elderfield (1943-2016)
Convenors: Karen H. Johannesson and Johan Schijf

PAGES Open Science Meeting, 9-13 May 2017, Zaragoza, Spain. For further information:
<http://www.pages-osm.org>

GEOTRACES-session:

***12. Trace elements and their isotopes as geochemical proxies of past ocean conditions**
Convenors: Catherine Jeandel, Robert Anderson, Susan Little, Thomas Marchitto and Daniel Sigman.

Forthcoming:

IUPAC 2017 - World Chemistry Congress, 9-14 July 2017, Sao Paulo, Brazil. For further information: <http://www.iupac2017.org/>

GEOTRACES-session:

***5.8 Trace elements cycling, processes and fluxes across interfaces**
Energy, Water and Environmental Sciences (EE)
Symposium Organizers: Roberto M. Torresi and Daniel Belanger.
Co-organizer: Vanessa Hatje

Goldschmidt 2017, 13- 18 August 2017, Paris, France. For further information:
<http://goldschmidt.info/2017/>

GEOTRACES- sessions:

***10i: Cycles of Trace Elements and Isotopes in the Ocean: GEOTRACES and Beyond**
Convenors: Tim Conway, Geraldine Sarthou, Tianyu Chen, Gregory de Souza, Aridane G. González, Kristen Buck, Tina van de Flierdt, Walter Geibert, Zhimian Cao, Catherine Jeandel

***10o: The Role of Scavenging in the Ocean: Chemical Processes, Environmental Controls and Modeling**
Convenors: Yves Plancherel, Phoebe Lam

***10g: Submarine Groundwater Discharge: Forms, Delivery, Timing, Processes, Pathways and Scaling of Biogeochemical Fluxes**
Convenors: Hans Dürr, Nils Moosdorf, Michael Böttcher, Hannelore Waska, Jing Zhang, Walter Geibert

***10h: Non-Conventional Stable Isotopes in the Ocean: Novel Applications, Technological Advances and Future Applications**
Convenors: Horner Tristan, Pearce Christopher, Philip Pogge von Strandmann, Kathleen Scheiderich, Juan Carlos Silva-Tamayo

***10k: Atmosphere-Ocean Interactions and Impacts on Ocean Chemistry and Biology**
Convenors: Adi Torfstein, Sophie Bonnet, Eyal Rahav, William Landing

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*10m: Insights into Ocean Processes Through the Application of Radioactive Tracers

Convenors: Paul Morris, Guizhi Wang, Virginie Sanial

*17g: Paleoceanographic and Paleoclimate proxies: Their standing on Elderfield's proxy development Curve

Convenors: Marie-Laure Bagard, Marie Boye, Oscar Branson, Sambuddha Misra, Guillaume Paris, Kauzyo Tachikawa

3.7 Capacity building

At-Sea Training GEOTRACES gratefully acknowledges support from SCOR to enable one scientist per year from a developing nation to participate in a GEOTRACES cruise.

Sampling Systems It is a goal of GEOTRACES that every nation carrying out oceanographic research should have access to a trace metal-clean sampling system. GEOTRACES offers guidance based on past experience in the design and construction of sampling systems, as well as advice in operating these systems as shared facilities.

An updated status of trace metal-clean sampling systems to support GEOTRACES research is provided in the table below. Scientists interested in developing one of these systems for their own use are encouraged to contact the GEOTRACES IPO or any member of the SSC, who will arrange for contact with an appropriate person to provide technical information about the design, construction and cost of a system.

Nation	Status	System/ Carousel	Bottles	Depth
Australia	Complete	Powder coated aluminium, autonomous 1018 intelligent rosette system	12 x 10-L Teflon-lined Niskin-1010X	6000 m; 6 mm Dynex rope
Australia	2nd system (complete)	Polyurethane powder-coated aluminium autonomous Seabird rosette with CTD and other sensors, auto-fire module, and all titanium housings and fittings	12 x 12-L Teflon-lined OTE external-spring Niskin-style bottles	1750 m 9mm Dyneema rope or 200 m 6 mm Dyneema rope wth coupling to 6000 m CTD wire
Brazil	Complete	GEOTRACES WATER SAMPLER - 24-bottle sampler for use with modem equipped 911plus CTD	24 X 12-L GO-Flo	3000 m; Kevlar cable
Canada	Complete	Powder coated aluminium with titanium CTD housing, Seabird Rosette	24 X 12-L GO-Flo	5000 m conducting Vectran
China - Beijing	Complete	Towed fish	NA	Surface
China - Taipei	Complete	Teflon coated rosette	Multi- size GO-Flo	3000 m; Kevlar line
France	Complete	Powder coated aluminium with titanium pressure housing for CTD	24 X 12-L GO-Flo	8000 m; conducting Kevlar
Germany	CTD and bottles purchased, winch planned	Powder coated aluminium with titanium pressure housings and fittings	27 x 12-L OTE GO-Flo	8000 m; conducting Kevlar
India	Complete	Powder coated aluminum with titanium pressure housings and fittings	24 X 12-L Niskin-X	8000 m; conducting Kevlar
Israel	Complete	Powder coated aluminium, SeaBird Rosette	12 X 12-L Niskin; 8 X 12-L GO-Flo (Teflon coated)	2000 m, steel conducting cable

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Italy	Complete	Go-Flo bottles on Kevlar line	5 x 20-L Go-Flos	Kevlar
Japan	Complete	Powder coated aluminium	12-L Niskin-X	7000 m; Vectran conducting cable
Netherlands	Complete	Titanium frame	24 X 12-liter GO-Flo	10000 m; conducting Kevlar
Netherlands	Complete	Titanium frame	24 X 27-liter ultraclean PVDF	10000 m; conducting Kevlar
New Zealand	Complete	Powder coated aluminium	13 X 5-L Teflon-lined Niskin-X; 13 X 5GO-Flo	4000 m; 8 mm Kevlar line
Norway	In development	Standard 12 positions CTD Rosette GO	5-L Niskin-X	
Poland	Complete* (although the steel cable)	Powder coated aluminium, SeaBird Rosette	8x 10L GoFlo	3000m, steel conducting cable
Poland	Complete	Single bottle	10l G-FLO X Teflon coated	300m Kevlar
Poland	Complete	Teflon pump on-line	Surface water pump	1.5m fixed
Poland	In development	Pump CTD	Teflon hose 10mm	Up to 200m
South Africa	Complete	Powder coated aluminium, titanium housing/fittings	24 X 12-liter GO-Flo	6500 m; Kevlar cable
UK	Complete	2 x Titanium frame, Ti pressure housings	24 10-L OTE 24 10-L OTE	2 x 8000m conducting Kevlar
USA - CLIVAR	Complete	Powder coated aluminium	12 X 12-L GO-Flo	1500 m; conducting Kevlar
USA - GEOTRACES	Complete	Powder coated aluminium with titanium pressure housings and fittings	24 X 12-L GO-Flo	8000 m; conducting Kevlar
USA-University of Alaska Fairbanks	Complete	Seabird Rosette. Powder coated aluminium with Ti parts and pressure housing. Fires at pre-programmable depths	12 X 5-L Teflon-lined Niskin-X	No Kevlar line available yet.

USA- Old Dominion University	Complete	Seabird Rosette. SBE-19plusV2 CTD unit. Powder coated aluminium with Ti parts and pressure housing. Fires at pre-programmable depths	12 X 5-L Teflon-lined Niskin-X	2000 m 0.5-inch Kevlar wire
USA – Polar Programs	Complete	Powder coated aluminium with titanium pressure housings and fittings	12 X12-L Niskin-X	3000 m; conducting Kevlar

4. Plans for coming year

The release of the **Intermediate Data Product 2017 (IDP2017)** at the Goldschmidt Meeting 2017 (13-18 August 2017, Paris, France) will continue to be the top priority for the first trimester of the next reporting period. After the release of the IDP2017, GEOTRACES will focus on seeking feedback from and promoting the use of the IDP2017 data by the broad oceanographic community.

In addition, GEOTRACES will continue to **implement the field programme** and its **GEOTRACES synthesis of results strategy** with the third foundational workshop, to be held in 2018 in partnership with Past Global Changes project (PAGES). This workshop will be centred on geochemical tracers used as paleoceanographic proxies.

Acknowledgements

Once more, we wish to express our gratitude to SCOR and Ed Urban for the continuous support and valuable advice to the implementation of the GEOTRACES programme.

Written and compiled by:

Ed Boyle and Reiner Schlitzer (Co-Chairs GEOTRACES SSC)
 Maeve Lohan and Walter Geibert (Co-Chairs of the GEOTRACES S&I
 Committee) Chris Daniels (GEOTRACES Data Manager)
 Catherine Jeandel (GEOTRACES IPO Science Director)
 Elena Masferrer Dodas (GEOTRACES IPO Executive
 Officer) May 2017

3.3 Surface Ocean–Lower Atmosphere Study (SOLAS) (joint with Future Earth, WCRP, and CACGP)

Turner

Terms of Reference:

- To develop the Surface Ocean - Lower Atmosphere Study (SOLAS) Science Plan and an Implementation Strategy, in accordance with guidance of the sponsoring organisations.
- To oversee the development of SOLAS in accordance with its Science Plan/Implementation Strategy.
- To collaborate, as appropriate, with other related projects of IGBP, WCRP, SCOR and CACGP and related projects and programmes (e.g., IHDP, DIVERSITAS, IOC and the Global Ocean Observing System (GOOS), etc.)
- To establish appropriate data management policies to ensure access to, sharing of, and preservation of SOLAS data, taking into account policies of the sponsors.
- To report regularly to SCOR, IGBP, WCRP and CACGP on the state of planning and accomplishments of SOLAS.
- The SOLAS SSC, its subsidiary groups and International Project Office shall operate in accordance with the operating procedures for IGBP Projects and as required by other co-sponsors.

Chair: Véronique Garçon (France)

Other Members: Emmanuel Boss (USA), Philip Boyd (New Zealand), Anja Engel (Germany), Cristina Facchini (Italy), Hui-wang Gao (China-Beijing), Michele Graco (Peru), Ilan Koren (Israel), Maurice Lévassieur (Canada), Peter Minnett (USA), Jun Nishioka (Japan), Anna Rutgersson (Sweden), Alfonso Saiz-Lopez (Spain), VVSS Sarma (India), Parvatha Suntharalingam (UK), Erik van Doorn (Germany), and Guiling Zhang (China-Beijing)

Executive Committee Reporter: John Turner

Executive Officer: Emily Brévière

SOLAS Annual Report to SCOR

Reporting period: June 2016- May 2017
Version of 31 May 2016 by Emilie Brévière

I. Progress on implementation of project science and implementation plans, and schedule for major project activities, including open science meetings, major data releases, synthesis activities, and project completion

I.a. SOLAS 2015-2025: Science Plan and Organisation

In October 2016, SOLAS received some more comments on the 2nd draft from the four SOLAS sponsors (SCOR, iCACGP, WCRP and Future Earth), which we addressed and returned in January 2017. The sponsors' official approval of the science plan was received in February 2017. The SOLAS 2015-2025: Science Plan and Organisation (SPO) is available to download from the SOLAS website (<http://www.solas-int.org/about/solas.html>) and hardcopies are available upon request to the IPO.

The SOLAS science mission is organised around five core themes:

- Core Theme 1: Greenhouse gases and the oceans
- Core Theme 2: Air-sea interface and fluxes of mass and energy
- Core Theme 3: Atmospheric deposition and ocean biogeochemistry
- Core Theme 4: Interconnections between aerosols, clouds, and marine ecosystems
- Core Theme 5: Ocean biogeochemical control on atmospheric chemistry

In addition, the study of these themes will be integrated in efforts to understand key environments, e.g. upwelling systems, polar oceans, and coastal waters, as well as to evaluate the environmental efficacy and impacts of geoengineering proposals, policy decisions, and societal developments.

I.b. SOLAS 2015-2025. Implementation Strategy 2016-2018

With regard to the Implementation Strategy, SOLAS chose to use a pragmatic approach and proposes a strategy over a period of 2 years at a time. The document is structured around three major sections: 1) events; 2) established working groups and their activities; and 3) working groups under development. The nature of the exercise obviously makes the document a moving target that needs constant update, which is what SOLAS intends to do by having a live Web-based document only. The Implementation Strategy will be updated and revised annually. The document is available to download on the SOLAS website at <http://www.solas-int.org/activities/implementation.html>.

Version 2 is already being discussed and a major revision will take place in summer 2017.

I.c. SOLAS- IMBER Carbon Group

Much of the science of SOLAS Focus 3 of the original SOLAS Science Plan (2004-2014) overlapped with IMBER and thus a joint SOLAS/IMBER Carbon Group (SIC) was formed during a meeting held in Colorado in Oct 2005. This group worked in close collaboration with

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the International Ocean Carbon Coordination Project (IOCCP). The SIC group was subdivided into three working groups:

***WG1-Surface Ocean Systems.** Chair: Andrew Lenton (Australia)

***WG2-Interior Ocean.** Chair: Nicolas Gruber (Switzerland)

***WG3-Ocean Acidification.** Chair: Jim Orr (France)

Since SOLAS and IMBeR have new science plans that include work on carbon, and because of CLIVAR interests, the SIC has been revisited. The WGs 1 and 2 were dismantled in April 2017 and a side event is being organised at the 10th International Carbon Dioxide Conference, Interlaken, Switzerland, 21-25 August 2017 with key scientists to discuss a future structure of joint work on ocean carbon (SOLAS is co-sponsor of the ICDC10).

However, SOLAS and IMBeR will keep supporting the Surface Ocean CO₂ Atlas (SOCAT) and other products from the SIC WG 1 and 2, as well as the Ocean Acidification group.

I.d. SOLAS metadata portal

The SOLAS metadata portal was set up by the SOLAS project integration initiative (2007-2013), with the intention to help SOLAS scientists identify what data exist, the data originators and where data are stored. The portal is hosted by NASA and the metadata files are stored on the international standard Global Change Master Directory (GCMD). The resource is freely available to the entire community.

The SOLAS metadata portal is an ongoing effort. Scientists can help expand the SOLAS Metadata base by completing a simple template available at <http://tinyurl.com/328zjr5> and email it to solas@geomar.de

Access the SOLAS metadata portal at <http://www.solas-int.org/solas-metadata-portal.html>.

I.e. Task teams

Halogens in the Troposphere (HitT)

This SOLAS/IGAC-sponsored task team was established in 2003 with the primary objective to determine and quantify the importance of reactive halogen compounds in tropospheric chemistry and climate forcing. The goal of HitT was to facilitate international collaboration between laboratory, field, and model activities regarding tropospheric halogen chemistry especially in the following domains: polar regions, salt lakes, marine boundary layer (both remote and coastal), volcanoes, free troposphere, and urban areas.

In late 2015, IGAC decided to end its sponsorship of HitT. SOLAS continues to support HitT with the hope that the task team will be revisited by SOLAS SSC member Alfonso Saiz-Lopez and Lucy Carpenter. Both worked on a proposal for a new activity built upon HitT, which in the meantime has been named CATCH, on cryosphere and atmospheric chemistry (see below). Alfonso and Lucy are currently looking into the development of CATCH in parallel with reshaping HitT in order to avoid overlaps and/or cover gaps.

There was a PICO session at the EGU 2017 on Halogens in the Troposphere, well attended with approximately 100 people and it is planned to have another one in 2018 too.

Task Team: Asian Dust and Ocean EcoSystems (ADOES)

The goal of ADOES is to quantitatively understand the deposition flux and bioavailability of Asian dust, and its impact on biogeochemical processes and ocean ecosystem in order to provide scientific bases for the mechanism of eolian dust-ocean ecosystem-radiative gases-climate change.

The co-chairs are Huiwang Gao (Ocean University of China, China), Guangyu Shi (Chinese Academy of Sciences, China) and Mitsuo Uematsu (University of Tokyo, Japan).

As one of the ADOES activities, aerosol sampling was conducted during the Training Ship *Kagoshima Maru* (belonging to Kagoshima University) cruise in the south of Kyushu Island crossing the Kuroshio with China and Japan collaboration from 12 to 20 November 2016.

SOLAS Task Team: Air-Ice Chemical Interactions (AICI)

The Air-Ice Chemical Interactions Task Team (AICI) was created in 2003 and endorsed by SOLAS and IGAC. The goal of AICI is to assess the significance of the processes observed in the polar regions at the air-ice interface at local, regional, and global scales by bringing together the laboratory, field, and modelling communities. The co-chairs are V. Faye McNeill (USA) and Thorsten Bartels-Rausch (Switzerland). Since late 2015, IGAC is no longer sponsoring AICI. In parallel, the Ocean–Atmosphere–Sea Ice–Snowpack (OASIS) program was created in 2002 to bring together an international group of multidisciplinary field researchers, laboratory scientists, and modellers to study chemical and physical interactions and exchange processes between the reservoirs mentioned in the title of the group, with a primary focus on the impact on tropospheric chemistry and climate feedbacks.

SOLAS did not follow IGAC and still endorses AICI/OASIS. However the group was asked to revisit their goals and to re-structure themselves. From this regrouping emerged CATCH, Cryosphere Atmospheric Chemistry activity, supported by IGAC. A first shaping community workshop took place on 19-21 April 2017 in Paris, France. SOLAS supported this workshop and will discuss at its SSC meeting in June a possible endorsement of the activity.

The CATCH mission is to facilitate atmospheric chemistry research within the international community, with a focus on natural processes specific to cold regions of the Earth. Cold regions include areas that are seasonally or permanently covered by snow and ice, from the high mountains to the polar ice sheets and sea ice zones as well as regions where ice clouds are found. CATCH scientists will aim to understand and predict:

- How aerosols are formed and processed in cold regions;
- How cold region aerosols act and impact cloud properties;
- Feedbacks between climate change and atmospheric chemistry that are determined by changes in the cryosphere;
- How the ice core record can be used to understand global environmental change;
- How physical, chemical, biological, and ecological changes in sea ice and snow impact atmospheric chemistry;
- How microbiology adapts and impacts biogeochemical cycling of elements in ecosystems of cold environments; and

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- Background composition (trace gases and aerosols) in cold regions that are undergoing industrialization as well as impacted by climate change.

More information available at <http://igacproject.org/CATCH>.

I.f. SOLAS Open Science Conference 2019

A call to bid for hosting the next SOLAS Open Science Conference in 2019 was issued in March 2017. As of today, no proposal has been received. The call mentioned that SOLAS would welcome a proposal from a country of the Southern Hemisphere.

I.g. Ocean Knowledge-Action Network (KAN)

SOLAS took part in the scoping workshop on the development of an integrated ocean research network, in Kiel, Germany, on 4-5 December 2016 (report available on line) and is involved in the establishment of teams to lead the O-KAN. The O-KAN is coordinated by Anke Schneider based in Kiel, Germany. The O-KAN will be officially pre-launched at the UN Ocean Conference in early June 2017 in New York, USA.

SOLAS is also taking part in a scoping Belmont Forum CRA meeting on 30-31 May in Brussels, Belgium. See <http://www.futureearth.org/future-earth-ocean>.

II. Activities (including capacity building) and publications that resulted from the project's work since the previous year's report

II.a. SOLAS Summer School 2018

The SOLAS Summer School 2018 (SSS) is scheduled to take place from 23 July to 3 August 2018 in Cargese, Corsica, France.

The programme of the school has been worked on. The request for the French vessel has been made. Funding of 10kUSD has been committed from the U.S. Ocean Carbon and Biogeochemistry (OC) program. No other proposals have been submitted yet. Crowd sourcing has been investigated, but not yet set up. A webpage is open at the University of Galway, along with a mailing list for potentially interested participants. See <http://solassummerschool.nuigalway.ie/>.

II.b. Collaboration with ESA

After completion of the OceanFlux projects, ESA mentioned its very high interest in continuing the collaboration with SOLAS, though additional funding.

The final workshop of the OceanFlux Greenhouse Gases Evolution project took place on 6-9 September 2016 in Brest, France, entitled 'Air-Sea Gas Flux: Progress and Future Prospects'. Posters and presentations are available at <http://www.oceanflux-ghg.org/Workshop>. The report is available at <https://tinyurl.com/ybcwfyow>.

A SOLAS/ESA workshop on "Harnessing Remote Sensing to Address Critical Science Questions in the Ocean-Atmosphere Interface" took place on June 13-15, 2016 in Frascati, Italy. Workshop conveners were SOLAS SSC members Ilan Koren and Emmanuel Boss.

The challenges in surface ocean-lower atmosphere exchange research are highly interdisciplinary, blending ocean and atmosphere chemistry and physics, with the cryosphere and clouds thrown into the mix. Moreover, the spatial and temporal scales of SOLAS challenges cover many orders of magnitude, and remote sensing is the only practical mean to monitor large-scale properties and trends. On the other hand, classical radiation transfer sciences focus on the interactions of electromagnetic radiation with matter, how to measure it and how to invert the measured electromagnetic signals into information on the underlying matter. Climate problems are challenging, and future progress is now dependent on extending radiation transfer and remote sensing science beyond the relatively well-defined domains of the oceanic ecosystem and atmospheric aerosols.

To build connections between SOLAS science and remote sensing, we held a meeting dedicated to highlighting the key challenges in the SOLAS sciences, and how remote sensing measurements and approaches can help address them. We brought remote sensing, SOLAS, and related science experts together to brainstorm on the issue, and to produce examples of key SOLAS problems that could be approached by new or improved remote sensing methodologies. To set the stage, the first part of the workshop was dedicated to perspective talks on both SOLAS subjects and remote sensing. We then moved to group discussions on key topics. Veronique Garcon opened with an overview of the SOLAS project, its importance, and key scientific challenges. Lisa Miller talked about SOLAS at high latitudes and how interactions with ice and land affect the dynamics of near-interface processes, and Paulo Artaxo described how multidiscipline and multiscale climate questions are studied over the Amazon. The next cluster of talks was dedicated to the state of the art in ocean and atmosphere remote sensing. Chris Hostetler talked about current and future developments in active remote sensing of ocean and atmosphere. Jacek Chowdhary described recent developments in polarimeter data inversion to study the atmosphere and oceans, and Oleg Dubovik described GRASP (Generalized Retrieval of Aerosol and Surface Properties) as a unified framework for characterizing atmospheric (and potentially oceanic) properties.

The subsequent discussions were organised around three groups tasked with identifying SOLAS themes with particular potential to benefit from new approaches to remote sensing measurements and data. Those discussions generated three questions for further development:

1. How can turbulence be quantified in the global ocean? (led by Griet Neukermans);
2. To what extent does the ocean ecosystem affect the composition and radiative properties of the lower atmosphere? (led by Brian Ward); and
3. How do the characteristics of surface ocean organic matter impact properties of primary aerosols? (led by Yoav Lehahn).

A commentary manuscript is now being prepared for the journal *Elementa: Science of the Anthropocene* and will present to the Earth system science community the new ideas generated at this workshop, including how existing and possibly future remote sensing tools could be used to answer these questions.

In October 2016, Ilan Koren and Brian Ward replied to an ESA/Future Earth call for funding for a follow up workshop. The proposal was successful and SOLAS will have 12k Euros to organise

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the event. This workshop is planned to take place in late October 2017 in United States, in the vicinity of Washington, D.C. in order to encourage participation from NASA scientists.

II.c. Collaboration with PICES

The North Pacific Marine Science Organization (PICES; <http://www.pices.int>) is an intergovernmental scientific organization with the mandate to promote and coordinate marine research in the northern North Pacific and adjacent seas. The present members are Canada, Japan, the People's Republic of China, the Republic of Korea, the Russian Federation, and the United States of America.

SOLAS representatives did not attend PICES Annual Meeting in recent years, but SOLAS has participated in the scientific planning of the 4th International Symposium on 'The Effects of Climate Change on the World's Oceans', in Washington DC, USA, 4-8 June 2018. SOLAS is a co-sponsor. This is a PICES, ICES, IOC, and FAO event.

II.d. SOLAS Science and Society workshop

At the SOLAS Open Science Conference in Sept. 2015, a discussion session on SOLAS Science and Society took place and attracted a lot of interest. One of the outcomes was to have a follow-up workshop dedicated to the topic. Christa Marandino and Erik van Doorn co-organised it in Brussels, Belgium on 26-27 October 2016. The workshop brought together researchers in the field of ocean-atmosphere interactions and social scientists. The two-day workshop focussed on three separate topics:

- Valuing carbon and the ocean's role,
- (In)Forming policy across the air-sea interface, and
- The shipping industry and air-sea interactions.

A paper for the journal *Ambio* is being finalised and will be submitted shortly. Following the success of this workshop, three more papers are underway.

1. A follow-up meeting on 'how to evaluate Blue Carbon?' took place on 30 March-1 April 2017 in Monaco at the occasion of the Monaco Ocean Week. It was co-organised by Nathalie Hilmi, Martin Johnson, Christa Marandino and Erik van Doorn. A special issue in *Frontiers* is under preparation.
2. A small workshop on air-sea interactions in policy and international stewardship of the open ocean will take place in Roma, Italy on 14-15 June 2017, co-organised by Emilio Cocco, Christa Marandino and Erik van Doorn.
3. A one-day workshop will be held on 26 October 2017, with the aim to develop plans for SOLAS research focusing on shipping, and to bring together groups of researchers keen to contribute to this research. This workshop is organised back-to-back with a conference co-sponsored by SOLAS on 'Shipping and the Environment- From Regional to Global Perspectives', 24-25 October 2017 in Gothenburg, Sweden. This conference is focussing on the environmental impact of shipping and its importance within policy, marine spatial planning and the maritime transport sectors.

II.e. Biogeochemical Exchange Processes at Sea Ice Interfaces: BEPSII

Because of the strong linkage between BEPSII activities and SOLAS, and the conclusion of SCOR support to this group in 2016, BEPSII is now co-sponsored by SOLAS and CliC. BEPSII will act as a link between both projects. <https://sites.google.com/site/bepsiiwg140/home>
The BEPSII annual meeting took place early in April in La Jolla, USA. A ‘SOLAS event report’ is being prepared. In the meantime, one may read an article on BEPSII published in January 2017 in the PICES Newsletter, available at <https://tinyurl.com/yacchxcx>.

II.f. Workshop on 'Frontiers in ocean-atmosphere exchange: Air-sea interface and fluxes of mass and energy'

This workshop took place on 15-19 May 2017 in Cargese, France. Its goal was to target SOLAS Theme 2, which deals with the ocean-atmosphere exchange of heat, greenhouse gases, momentum, freshwater, and aerosols. The uncertainty in the air-sea exchanges of these constituents constrains our ability to understand and model our changing climate. Accurate quantification of air-sea fluxes is required for forcing ocean models, understanding ocean dynamics, investigating the forcing of variability by the atmosphere and ocean, understanding the ocean’s role in climate variability and change, and assessing the realism of models used for predictions from weather to climate time scales.

More information available is at <http://airsea.nuigalway.ie/cargese/workshop>.

A ‘SOLAS event report’ is being prepared.

II.g. Ocean Acidification Training and Community Networking in Africa: Pathways to Success, 13-16 Feb. 2017, Dakar, Senegal

Training and networking events on ocean acidification took place for the first time in West Africa at Dakar (Senegal). The events were organised by Future Earth Coasts with the support of KOSMOS Energy, SOLAS, MaREI, OA-ICC, IRD, to name a few, represented by participants of the events.

The training workshop assembled 15 participants from Senegal, Benin, Togo, Cameroon, Nigeria, Benin, and Cote d’Ivoire, and 6 trainers coming from France, Sweden, USA, Spain and South Africa. Lectures and discussions covered an introduction to oceanic conditions off West Africa, the goal and urgency to study ocean acidification, as well as the chemistry involved in the acidification of the ocean and its impacts on marine biodiversity. Theory presented included information on ocean acidification, measurement techniques, design of relevant acidification experiments, and manipulations in the field and in the laboratory. A one-day field trip was organised for practical training, where aquarium experiments of ocean acidification were conducted in real time. The trainees received certificates of completion.

In conjunction with the training, a networking event also took place, with interactions with the training participants in plenary sessions. About 17 networking participants were from Nigeria, Ghana, Morocco, Tunisia, Kenya, Cameroon, Cote d’Ivoire, Tanzania, Algeria, Togo, Benin, Egypt, Madagascar, Senegal, and South Africa. Presentations and discussions took place for developing the OA-Africa network and knowledge exchange on operational outcomes and identification of current needs (resources and capacity), identification of collaboration opportunity including funding, and of outputs and avenues for dissemination in Africa. Plans for white papers were presented to define current knowledge of OA-Africa and next steps forward.

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A steering committee involving researchers from Africa was then designed to provide guidance and direction of the network.

A dinner event was hosted where a range of NGOs, practitioners and government officials from Senegal were invited, along with the scientists. This event recognised the importance of involving organisations and stakeholders based in Senegal who can provide important in-country context, expertise, and experience. This dinner event provided an opportunity to connect to researchers, NGOs, and government officials in Senegal who are working tirelessly to manage environmental and ocean resources with scientists and students working on ocean acidification across Africa.

A 'SOLAS event report' is being prepared.

II.h. SOLAS in Asia: A Future SOLAS Symposium

Asian countries have made considerable contributions to SOLAS in the broad context of international collaborations, especially in the fields of ocean carbon cycle, air-sea exchange and atmospheric deposition to the oceans. Considering Asian countries acting as world economic engines, SOLAS studies therein should strengthen internal collaborations and pioneer some international collaboration programs to encourage future social-economic activities.

An Asia Symposium was organised in Qingdao, China on 26-28 October 2016, following the 16th SOLAS Scientific Steering Committee meeting. This Future SOLAS Symposium aimed to foster the exchange of ideas and knowledge between Asian scientists as well as the communication with the international community and to promote collaborations within Asian countries for SOLAS research and activities over the next decade.

Organizer: Ocean University of China

Sponsors:

National Nature Science Foundation of China (NSFC)

Qingdao National Laboratory for Marine Science and Technology, China

Key laboratory of Marine Environment and Ecology, Ministry of Education, Ocean University of China

State Key Laboratory of Marine Environmental Sciences, Xiamen University, China

II.i. Contribution to 2017 Joint IAPSO-IAMAS-IAGA Assembly

The 2017 Joint IAPSO-IAMAS-IAGA Assembly will take place in Cape Town, South Africa from 27 August to 1 September 2017.

There are two sessions of particular interest for the SOLAS community.

M01: Atmospheric Chemistry and Physics for the 21st Century

Convenors: James Drummond, Melita Keywood, John P. Burrows

With sub-sessions on Multi-scale transport processes or Tracer transport processes over complex terrain; Advances of science in delivering atmospheric services for science and society; Air quality, health and ecosystem impacts; Air-snow-ice interactions; Atmosphere ocean interactions

and exchange of trace gases; Biomass burning; Global stratospheric ozone; Polar ozone; Climate chemistry interactions and feedback; and Laboratory studies

In this session, SOLAS invited and supported Maria Kanakidou and Rainer Volkamer to present their work and to pay a tribute to Roland von Glasow's contribution to SOLAS science.

M06: Oceans as a source and sink for aerosols and related feedbacks

Convenor: Zev Levin

Co-convenors: Ilan Koren, Paul DeMott

Production of CCN and IN from the ocean and the role of aerosols like dust and pollution in affecting ocean acidity.

This session is a perfect opportunity to collaborate with the SOLAS community. It can link research related to marine ecosystems and aerosol fluxes in both directions (i.e., how ecosystems affect aerosol fluxes and properties and how aerosols affect the ecosystem) and on the complex interactions with clouds (i.e., marine aerosols affect clouds and clouds affect the ecosystem).

II.j. SOLAS IPO welcomed a school pupil

In February, the SOLAS IPO welcomed a school pupil for a week and showed her what an Ocean Research Institute has to offer and what a project like SOLAS is. Read more at <http://www.solas-int.org/events-archive.html>.

II.k. SOLAS communication

SOLAS website <http://www.solas-int.org/>

SOLASNews newsletter (NL); emailed to ~2400 scientists and airmailed to ~100 scientists (mainly from developing countries). Copies are held by the SOLAS IPO for distribution at SOLAS-relevant conferences and meetings. The NL is also available from the website. The *SOLAS News* is printed and airmailed from China courtesy of State Key Laboratory of Marine Environment Science, Xiamen University. Since issue 11, SOLAS also implemented an on-screen reader pdf version.

Due to lack of staffing in the IPO, the last issue was published in summer 2015; there were no issues produced since then and there are no plans underway to produce the next issue yet.

SOLAS Event Report; since the IPO could not deliver the traditional newsletter and had a series of workshops that took place in 2016/17, the IPO started to produce a series of short reports in the month following an event. Issue 1 was about two GESAMP WG38 workshops in parallel on 'Changing Atmospheric Acidity and its Impacts on the Oceanic Solubility of Nutrients' and on 'The Impact of Ocean Acidification on Fluxes of Non-CO₂ Climate Active Species', 27 Feb-2 March 2017, Norwich, UK. These events were endorsed by SOLAS. The report is available on the SOLAS website.

Issues 2 and 3 are about to be finalised and issues 4 and 5 are being planned.

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E-news (former E-bulletins); are sent to over 2,400 SOLAS scientists during the first week of every month since February 2017. Only 2 e-bulletins were sent out in 2016. All issues are archived on the website at <http://www.solas-int.org/archive.html>. The e-news contain news from SOLAS, opportunities for meetings, abstract submission deadlines, recent publications, vacancies and news from relevant partner project and collaborators.

Flyers; The IPO has created an A5 flyer that presents the outline of the new SOLAS science plan. This flyer is printed and copies are available for free.

Poster; A poster presenting SOLAS and its new science plan is available to download on the SOLAS website. Anyone is welcome to freely use it for conferences/meetings/workshops or just to have a brief overview of SOLAS.

Twitter account; The IPO created a SOLAS Twitter account in late 2016. Regular posts have been sent out since Jan. 2017 and the number of followers is steadily increasing since (currently 178).

III. SOLAS national networks

Thirty nations are part of the SOLAS network. Each has a representative:

Australia: Sarah Lawson and Andrew Bowie

Belgium: Nathalie Gypens

Brazil: Leticia Cotrim Da Cunha

Canada: Jon Abbatt (NEW)

Chile: Laura Farias

China (Beijing): Minhan Dai

China (Taipei): Gwo-Ching Gong

Denmark: Lise Lotte Soerensen and Mikael

Sejr

France: Remi Losno

Germany: Christa Marandino and Hartmut

Herrmann

India: VVSS Sarma

Israel: Yoav Lehahn

Ireland: Brian Ward

Italy: Chiara Santinelli

Finland: Lauri Laakso (NEW)

Japan: Mitsuo Uematsu

Korea: Kitack Lee

Mexico: Jose Martin Hernandez Ayon

Netherlands: Jacqueline Stefels

New Zealand: Cliff Law

Norway: Siv Lauvset

Peru: Michelle Graco

Poland: Timo Zielinski

Russia: Sergej Gulev

Spain: Alfonso Saiz-Lopez

Southern Africa: Sarah Fawcett (NEW)

Sweden: Katarina Abrahamsson

Turkey: Baris Saglihoglu, Mustafa

Koçak, Nazli Olgun

UK: Tom Bell

USA: Rachel Stanley

Implemented in Jan 2009, the national representatives of the SOLAS nations are asked to report annually about SOLAS activities in their country. To facilitate the reporting effort, a template form is provided. In April 2017, 20 reports were received and posted on the SOLAS website. The information contained in the reports has been/are a great source of information for the IPO to report to sponsors but also to facilitate the coordination job and to redistribute the results and progress from some nations to the rest of the SOLAS community. Information provided through the reports is also used to update the implementation strategy of the new SOLAS science plan.

(All the reports received during the reporting period are available in an Addendum to this report: see http://scor-int.org/Annual%20Meetings/2017EC/2017_SOLAS_NationalReports.pdf)

II.m. Endorsed projects

Over the reporting period, SOLAS endorsed the project Great Barrier Reef and the Tudor Hill Marine-Atmospheric Observatory.

Information about support letter and endorsement are accessible on the website, along with the endorsement submission form.

III. Income and expenses for the past year and budget for the coming year, including funding from all sources (not only SCOR funding)

- EO salary, office space and in-kind are provided by GEOMAR until December 2020
- US-NSF via SCOR annual grant of 25kUSD until 2018; one-third is used to cover the annual SOLAS/IMBER working group on Ocean Acidification and the other two-thirds to cover the cost of the SSC meeting
- US-NSF via SCOR extra 40kUSD to hire a contractor to work in the IPO
- Future Earth annual block grant of 15kEUR contributing to the cost of the SSC meeting
- French CNRS 8kEUR in 2016 and in 2017 for SOLAS activities

IV. Update on the Scientific Steering Committee and International Project Office status since the last report

IV.a. SOLAS Scientific Steering Committee

Since January 2015, Véronique Garçon from France has served as Scientific Steering Committee (SSC) chair, with her term ending in December 2017. At the last SSC meeting in October 2016, a committee was set up to start the process to search for the next SOLAS SSC Chair. The committee was composed of Maurice Levasseur, Ilan Koren and Emilie Brévière. A consultation procedure was followed, and in April 2017, Lisa Miller was nominated by SOLAS to the four SOLAS sponsors, which approved the nomination and appointed her. Lisa Miller will be the 5th SOLAS SSC Chair, serving from January 2018 for 3 years.

SOLAS has an Executive Committee composed of the chair, Ilan Koren, Maurice Levasseur and Cristina Facchini.

Since the last report the following SSC members rotated off, in December 2016:

- Lisa Miller
- Christoph Garbe
- Brian Ward

Ending his first term and being selected for a second term in the SSC was Alfonso Saiz Lopez. In January 2017, four new SSC members were appointed:

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- Jun Nishioka (M, Japan)
- Erik Van Doorn (M, Germany)
- Guiling Zhang (F, China)
- Anna Rutgersson (F, Sweden)

The SOLAS SSC met in Qingdao, China, 24-26 October 2016 for its 16th SSC meeting. The next SSC meeting is currently scheduled to take place on 19-21 June 2017 in Bologna, Italy. Unfortunately, this year there will be no SOLAS symposium organised due to time constraints. The current membership of the SOLAS SSC is listed below (17 members including the chair):

Last name	First name	Country of employment	Gender	Scientific expertise	SOLAS expertise	Term	End
Suntharalingam	Parvatha	UK	F	Numerical modelling / C, N, S bgc cycles	Theme 1, cross themes	1	18
Zhang	Guiling	China	F	Bgc of trace gases	Theme 1	1	19
Sarma	VVSS	India	M	Bgc cycling of C, N in the ocean and estuaries, stable isotopic geochem/ OA	Theme 1	1	17
Minnett	Peter	USA	M	Remote sensing, physical air-sea exchange	Theme 2	1	18
Rutgersson	Anna	Sweden	F	Air-sea physical interaction	Theme 2 WCRP rep	1	19
Boyd	Phil	Aus	M	Marine bgc	Theme 3, geoeng	1	18
Gao	Huiwang	China	M	Atm. deposition and ecological effect	Theme 3	2	17
Koren	Ilan	Israel	M	Cloud physics	Theme 4	2	18
Levasseur	Maurice	Canada	M	Ocean bgc, dimethylsulfide, Arctic, ice algae	Theme 4	1	17
Facchini	Cristina	Italy	F	Physical and chemical processes in	Themes 4 and 5	1	17

				multiphase atm. systems			
Saiz-Lopez	Alfonso	Spain	M	Atm. halogens/modelling	Theme 5, IGAC connection	2	19
Garçon	Veronique	France	F	Marine bgc and ecosystems dynamics	Integrated topics	2	17
Graco	Michelle	Peru	F	Bgc cycles in upwelling systems, OMZ	Integrated topics	2	17
Nishioka	Jun	Japan	M	Oc. trace metal bgc cycle, Polar oceanography and sea-ice bgc	Integrated topics	1	19
Van Doorn	Erik	Germany	M	Law of the Sea	SOLAS Science and society	1	19
Boss	Emmanuel	USA	M	Ocean optics and bgc	Remote sensing, cross themes	1	17
Engel	Anja	Germany	F	Microbial bgc, sea surface microlayer	Microlayer, cross themes	2	17

The current gender and country balance of the SSC is as follows; for a total of 17 members including the chair:

- 7 female members and 10 male members
- 4 members from developing countries and 13 from developed countries

IV.b. SOLAS International Project Office, Kiel

The SOLAS IPO is hosted at the GEOMAR Helmholtz-Centre for Ocean Research Kiel in Kiel, Germany. The office was staffed from June to September 2016 with Stefan Konradowitz, interim Executive Director. In October 2016, Emilie Brévière returned from maternity leave and Stefan Konradowitz left the IPO for a permanent position within GEOMAR. From Oct. to Dec. 2016, the IPO was staffed with one person, the Executive Director. From Jan. to March 2017, Juergen Weichselgartner, ex LOICZ Senior Science Officer, seconded Emilie and in mid-April Jessica Gier started as project officer (75% time) for a year. Minhan Dai, with the support from Huiwang Gao, secured some funding in China to hire a second project officer for the IPO to be based at Xiamen University. The deadline to apply for the position is 31 May 2017. This position is for 3 years full time. The SSC members should discuss at the next SSC meeting in June 2017 the possibility to have an official SOLAS regional hub in Xiamen.

The salary of the EO is supported by GEOMAR until 2020, the salary of the PO supported by funding left over by IGBP when it shut down and extra funding from US-NSF via SCOR. Another request to NSF will be made to maintain the PO position after April 2018. GEOMAR provides office space for the IPO since 1 February 2011 until December 2020.

2017 Annual Report
International Quiet Ocean Experiment

Since the 2016 SCOR annual meeting, IQOE has continued to ramp-up its activities and fill out the memberships of its working groups. A summary of accomplishments follows.

IQOE Science Committee Meeting

The IQOE

Science



Committee has the major responsibility to direct the science of the project and implement the *IQOE Science Plan*. The inaugural committee has two co-chairs, one an acoustician and the other a bioacoustician.

The members include the following:

Co-chairs: George Frisk (USA) and Peter Tyack (UK)

Other Members: Olaf Boebel (Germany), Bishwajit Chakraborty (India), Christ de Jong (The Netherlands), Jennifer Miksis-Olds (USA), Hanne Sagen (Norway), Steve Simpson (UK), Jakob Tougaard (Denmark), and Alexander Vedenev (Russia).

Other scientists will be involved in IQOE through working groups (see below) and through endorsement of national scientific activities.

The IQOE Science Committee (SC) met for the second time on 27-28 January 2017 in London, UK. As with the first meeting, several stakeholders attended the meeting to help the IQOE SC work on project implementation. The meeting included updates of ongoing IQOE activities, reports on national IQOE-related activities, and a special session on global soundscape modeling.

The 2018 IQOE Science Committee meeting will be held on 13-14 March 2018. The location is not yet decided. In case the IPO bid is approved (see below), it could be important to meet at the new IPO location.

Meeting of IQOE Strategy Group

The IQOE Strategy Group (primarily co-chairs, sponsors and staff of IQOE) met in Woods Hole, Massachusetts, USA on 11-12 July 2017. The meeting reviewed the status of IQOE implementation and discussed fund-raising for the project. The meeting also featured an afternoon session with high-level U.S. agency representatives to discuss U.S. IQOE activities, and presentations from U.S. Department of Transportation staff working on the issue of sound in air from human activities and another individual who creates videos explaining scientific activities. The developer of the new IQOE Website met with the Strategy Group by phone to explain the structure of the new Website and to get input on some design decisions.

IQOE Working Groups

1. **Standardization:** Any project that involves more than one investigator, laboratory, or observing system must agree to standard techniques and/or perform intercalibrations among techniques or observations to make it possible to later compare their results. IQOE formed a working group responsible to recommend best practices for experimentation and observation or, where this is considered undesirable, will determine other means to ensure that results are comparable. The IQOE Working Group on Standardization is well underway and has a Web page at http://www.scor-int.org/IQOE_WGs_Standardization.htm. The group has already met twice by phone and had begun work on its terms of reference. The group will create an inventory of existing standards relevant to IQOE. The group will recommend best practices for IQOE to adopt, not develop IQOE-specific standards. The group will generate a first overview of existing procedures and facilities for calibrating acoustic receivers. A list of worldwide calibration facilities is being prepared. The group will work with the POGO working group (see below) to construct a global database and Web site of past and current passive acoustic monitoring systems.
2. **Data Management and Data Access:** One of the goals of the IQOE will be to create time series of acoustic data in key locations of the global ocean, to provide to policymakers documentation of how sound in the ocean has changed over time. The IQOE will seek to make as many acoustic observations and experimental results as openly available as possible, and will develop a data management and data access policy for scientists and data centers involved in the project. This working group is in the process of being formed.
3. **Arctic Science:** The Arctic Ocean is still relatively pristine acoustically. However, with the continuing decrease in ice cover of this basin, oil and gas exploration, shipping, tourism, and other noise-producing activities are increasing. The IQOE will seek to produce an acoustic baseline against which future sound increases can be compared. This

group is in the process of being formed and the co-chairs are planning the first meeting of the group.

4. **Acoustic Measurement of Ocean Biodiversity Hotspots:** Coral reefs are some of the most biodiverse areas of the global ocean, are important to human society, and are in danger from global, regional and local changes. The biodiversity of reef habitats can be difficult to assess because it requires observations by human divers. However, many reef organisms make sounds that can be measured continuously. This working group will explore the potential to monitor sound on coral reefs continuously to characterize one measure of reef biodiversity. The group has been approved by the IQOE SC, will begin its work through a questionnaire to members of the group and conference calls, and is planning an in-person meeting for later this year. Its Web page is at http://www.scor-int.org/IQOE_WGs_Coral_Reefs.htm. The IQOE Strategy Group noted that there are other ocean biodiversity hotspots (e.g., kelp forests, mangrove areas) and requested that the title and purview of the group be generalized to ocean biodiversity hotspots. The name of the group was changed to the title above.

In addition, the Partnership for Observation of the Global Oceans (POGO) set up a Working Group to Implement IQOE Science Recommendations on Noise Exposure and Broad-Scale Acoustic Monitoring to contribute to IQOE goals. This working group will implement specific elements of the *IQOE Science Plan* related to (1) approaches to assess the impact of noise exposure and acoustic monitoring methods, (2) means to implement and improve these approaches, and (3) better understanding broad-scale issues related to ocean noise and human influences. The group is also working on an acoustic Essential Ocean Variable (EOV) and updating the list of acoustic observing systems in Appendix 2 of the *IQOE Science Plan*. The POGO working group met in conjunction with the Acoustical Society of America meeting in Boston, Massachusetts, USA in June 2017. The POGO IQOE WG has written an acoustic EOV for submission to the GOOS Biology and Ecosystems expert panel; a WG consensus draft of the acoustic EOV is currently under review by the panel, with submission of a final draft to the GOOS Steering Committee intended in time for consideration at its September 2017 meeting. While the time series of acoustic pressure measurements is a physical variable, it is used to estimate many critical biological and ecological parameters. In part because of its physical basis, ocean acoustic measurements are at a more mature readiness level than most biological EOVs and we hope that an acoustic EOV will help the integration of ocean acoustics into observing systems commensurate with its importance to many oceanographic disciplines. The POGO WG is also working with the Web designer to implement a searchable database of passive acoustic observing systems on the IQOE Website. This database will update Appendix 2 from the *IQOE Science Plan* and will allow input of new information by system operators.

IQOE Web Site

An IQOE Web site has been developed with basic information about the project (see www.iqoe.org). The site includes information about the development of the project, products that have resulted, people who have been involved, and resources for the community, such as links to relevant programs, scientific meetings, and publications. Information about IQOE working groups is being added when available. Renewal of the IQOE Web site is in progress.

Funding

SCOR budgeted US\$10,000 for IQOE implementation activities in 2017 and an additional \$10,000 was provided by the Monmouth University-Rockefeller University (MURU) consortium. These funds were used to support the January 2017 meeting of the IQOE Science Committee. \$50,000 in additional funds will be provided for the nine-month period of 1 August 2017 to 31 March 2018 by the MURU Consortium for IQOE Working Group meetings and the 2018 meeting of the IQOE Science Committee.

International Project Office (IPO)

We have had a serious offer for hosting of an International Project Office (IPO) for IQOE in Europe and the potential host is in the process of seeking national funding for the IPO.

Submitted by Ed Urban, SCOR Executive Director and Sophie Seeyave, POGO Executive Director

Second International Indian Ocean Expedition (IIOE-2)Peter Burkill¹

Summary

IIOE-2 is a large, complex, multi-disciplinary and multi-dimensional project that is sponsored by UNESCO-IOC, IOGOOS as well as SCOR. Each of these sponsors has its own characteristics and one of the many challenges is to harness the strengths and resources of each to deliver IIOE-2 optimally. This report covers the main activities and successes of IIOE-2 over the period late 2015 to mid-2017. The main focus of IIOE-2 in this early period has been on setting up the programme and getting it operational. After the lead taken by SCOR in producing the *Science Plan*, the emphasis in IIOE-2 has recently been on the infrastructure as well as scientific data gathering. International project offices have been set up in Australia and in India. The latter is based at INCOIS, Hyderabad, India where a project database is now functional. INCOIS also hosts the IIOE-2 website and produces an informal periodic publication, *Ocean Bubble*, that allows scientists to try out ideas and seek collaboration. An SSC led by co-chairs from each of the sponsors is operational; it meets in person once per year and electronically every quarter. Data collection is underway, with a total of 22 projects from 10 countries as well as 10 cruise expeditions endorsed as part of IIOE-2. One of the main focuses of IIOE-2 lies with the societal relevance, as well as the fundamental understanding gained by the projects and cruises. SCOR is requested to provide \$25k for SC meetings in 2017-2018.

Introduction

IIOE-2 is the youngest of SCOR's large-scale projects and, politically, is its most complex. It was launched in 4th December 2015 in Goa, India at the end of an international conference on the Indian Ocean attended by some 450 scientists. It has a unique claim that its first cruise, aboard ORV *Sagar Nidhi* of MoES India, sailed the very same day the project began! In fact, the *Sagar Nidhi* cruise remains an ideal model for IIOE-2 with the Indian hosts offering half the scientific berths to scientists outside India. These were readily taken up and will undoubtedly create an international cohort of collaboration for the future.

IIOE-2's complexity arises because it, like IIOE, is not 'overseen' by a single organisation. SCOR partners with two other organisations, UNESCO-IOC and IOGOOS, to deliver IIOE-2. SCOR has led the partnership in developing the research aspects of IIOE-2 and has also paid for the workshops and also publication of the *Science Plan*. UNESCO-IOC can uniquely reach out to a larger audience than SCOR could achieve, and harness the capabilities of all the governments in the region. IOGOOS has unique skills in observational oceanography together with longer-term funding opportunities that underpin the moorings and satellites in the region. So IIOE-2 is a hybrid project that is harnessing the skills and characteristics of all three sponsors to deliver IIOE-2. The challenge is, of course, to maximize use of the strengths of each

¹ This report is a personal reflection of IIOE-2 by one of its co-chairs and is not an official IIOE-2 document!

organisation while minimizing conflicts that could arise because of their different ways of operating.

Mission

The Mission of IIOE -2 is ‘to advance our understanding of the Indian Ocean and its role in the Earth System in order to enable informed decisions in support of sustainable development and the well-being of humankind’. At its core, IIOE-2 is an international project with formal participation by six countries with national IIOE-2 committees (Australia, France, Germany, India, UK , USA) and a number of other countries (Bangladesh, China, Indonesia, Japan, Kenya, Korea, Madagascar, Norway, Russia & South Africa), that have IIOE-2 activities without a national committee. This international community collaborates in research from coastal environments to the deep sea over the period 2015-2020, to generate new scientific understanding on the Indian Ocean. This will be used for future sustainable development and expansion of the Indian Ocean’s blue economy.

Guidance and Governance

Delivery of IIOE-2’s mission is guided by its *Science Plan* (Hood et al. 2015) and achieved using the criteria outlined in its *Implementation Strategy* (IPC 2015). The *Science Plan* identified six Science Themes, each of which provide a broad platform for addressing research questions at the cutting edge of current knowledge. Seven Working Groups were defined in the *Implementation Strategy* and these function orthogonally across the Science Themes. During the past year, chairs of Science Themes and Working Groups were appointed as shown in Table 1.

Table 1: The delivery of IIOE-2 is developed and co-ordinated by six Science Themes and seven Working Groups shown here together with their chairs or co-chairs.

A) Science Theme	Chair/ Co-Chairs	B) Working Groups	Chair/ Co-Chairs
<i>1: Human Benefits and Impacts</i>	Dr Ben Milligan (Australia/UK)	<i>1: Science & Research</i>	Prof Hermann Bange (Germany)
<i>2: Boundary Currents</i>	Prof P Vinayachandran (India) & Prof Yukio Masumoto (Japan)	<i>2: Data and Information Management</i>	Ms Cyndy Chandler (USA) & Dr Harrison Ong’Anda (Kenya)
<i>3: Monsoon Variability</i>	Prof Adrian Matthews (UK) & Prof Joaquim Goes (USA)	<i>3: Capacity Development</i>	Dr Nasser Zaker (Iran) & Dr Zainal Arifin (Indonesia)
<i>4: Circulation, climate variability</i>	Dr Jerme Vialard (France) & Dr Amit Tandon (USA)	<i>4: Operational Co-ordination</i>	Dr Shailesh Nayak (India)
<i>5: Extreme Events & their impacts</i>	Prof Chari Pattiaratchi (Australia/Sri Lanka)	<i>5: Outreach and Communication</i>	Dr Faiza Al-Yamani (Kuwait)
<i>6: Unique features of the Indian Ocean</i>	Dr Jerome Dymont (France)	<i>6: Translating Science for Society</i>	Dr Rezah Badal (Mauritius)

		<i>7: Sponsorship and Resources</i>	Dr Nick D'Adamo (JPO) & Dr Rajan Sivaramakrishnan (JPO)
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The Governance of IIOE-2 is overseen by the SC (Figure 1). This body has co-chairs from each of the three sponsors (UNESCO-IOC (Vladimir Ryabinin), IOGOOS (Satheesh Shenoi) as well as SCOR (Peter Burkill).

Table 2. This shows the full Steering Committee structure of IIOE-2.

Steering Committee	Core Group	CO-CHAIRS			Heads of the two JPOs - Nick D'Adamo & Rajan Sivaramakrishnan, as ex-officio members
		Dr. Vladimir Ryabinin v.ryabinin@unesco.org	Dr. Peter Burkill peter.burkill@plymouth.ac.uk	Dr. Satheesh Shenoi shenoi@incois.gov.in	
	STRATEGIC EXECUTIVE LEVEL				
	Ben Milligan (Chair ST1), P N Vinayachandran/Yukio Masumoto (Co-Chairs ST2), Adrian Matthews/Joaquim Goes (Co-Chairs ST3), Jerome Vialard/Amit Tandon (Co-Chairs ST4), Chari Pattiaratchi (Chair ST5), Jerome Dyment (Chair ST6), Hermann Bange (Chair WG01), Cynthia Chandler/Harrison O. Ong'Anda (Co-Chairs WG02), Nasser H. Zaker/Zainal Arifin (Co-Chairs WG03), Shailesh Nayak (Chair WG04), Faiza Al-Yamani (Chair, WG5), Rezah M. Badal (Chair WG6) and Nick D'Adamo/Rajan Sivaramakrishnan (Co-Chairs WG07) plus Johnson Kazungu (Chair, IOC Africa), M. A. Atmanand (Chair, IOCINDIO), Somkiat Khokiattiwong/Kentaro Ando (Co-Chairs IOC WESTPAC)				
Stakeholder Group	REGIONAL COORDINATION LEVEL				
	One representative per each IIOE-2 'National committee'				
	SCIENCE DELIVERY LEVEL				
One representative (i.e. PI) per each 'major' IIOE-2 scientific research initiative, including a representative of the Early Career Scientists Network from the Capacity Development Working Group					

The co-chairs work closely with the chairs of the Science Themes and Working Groups identified in Table 1 and the regional bodies of UNESCO IOC. The full SC also includes representatives of the National Committees and each major science research initiative. The full SC meets once per year while the core group meets electronically every quarter. The SC met for the first time face-to-face in Perth from 2nd to 4th February 2107. The minutes of that meeting are available at http://www.iioe-2.incois.gov.in/IIOE-2/SC_Meeting1.jsp

Joint Project Offices

The two project offices in Perth and Hyderabad have had a full year of activities, advocating IIOE-2 and providing support to the project. The latter includes maintaining the website (<http://www.iioe-2.incois.gov.in/IIOE-2/index.jsp>) and printing Ocean Bubble (<http://www.iioe-2.incois.gov.in/IIOE-2/index.jsp>)

2.incois.gov.in/IIOE-2/Bubble.jsp). Both offices are funded by their national governments and by IOC. Ed Urban also gives support on SCOR's behalf.

Research Activities

Early research activities of IIOE-2 centre on fieldwork, principally cruises, and these are shown in Figure 1.

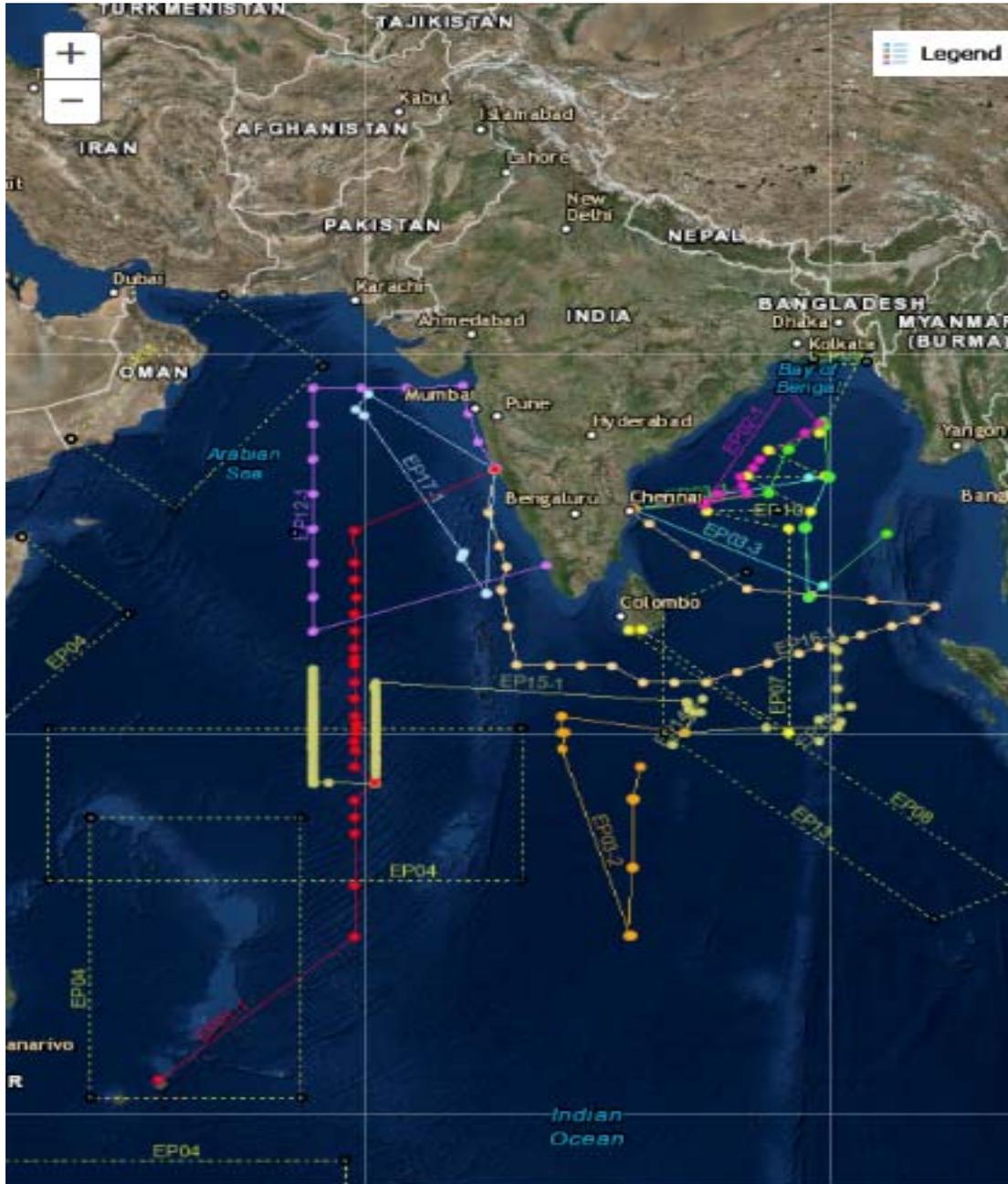


Figure 1: IIOE-2 Research Cruises that either have or will take place in the near future. Many of these research cruises are associated with projects and these are displayed in Table 3.

Table 3. Projects endorsed as contributing to IIOE-2. Those struckthrough have yet to secure funding.

Month & Year of Endorsement	Endorsement Number	Projects	Principal Investigator (PI)	Country
July, 2017	IIOE2-EP22	NEKTON INDIAN OCEAN MISSION 2018-2021	Oliver Steeds, UK	UK
July, 2017	IIOE2-EP21	PHYSICAL STUDY OF THE NORTH WESTERN INDIAN OCEAN AND OF THE ADJACENT SEAS: PHYSINDIEN	Xavier Carton, France	France
July, 2017	IIOE2-EP20	KIOST INDIAN OCEAN STUDY	TaeKeun Rho, Republic of Korea	Republic of Korea
May 2017	IIOE2-EP19	GO-SHIP OBSERVATION OF SECTIONS I8N AND I7S BY R/V MIRAI	Katsuro Katsumata, Japan	Japan
May, 2017	IIOE2-EP18	IMPACT OF CLIMATE VARIABILITY ON THE INDIAN OCEAN: ROLE OF GELATINOUS ZOOPLANKTON STRUCTURING FOOD WEB STRUCTURE AND COMMUNITY ASSEMBLAGES	Bijoy Nandan Sivasankaran, India	India
May, 2017	IIOE2-EP17	REAL-TIME METEOROLOGICAL AND OCEANOGRAPHIC DATA COLLECTION USING MOORED BUOY NETWORK IN INDIAN SEAS (OON-INDIA)	R. Venkatesan, India	India
March, 2017	IIOE2-EP16	BIOGEOCHEMISTRY OF TRACE ELEMENTS AND ISOTOPES IN THE INDIAN OCEAN (GEOTRACES-INDIA)	Sunil K. Singh, India	India
March, 2017	IIOE2-EP15	EQUATORIAL CURRENTS AND UNDERCURRENT IN THE INDIAN OCEAN	Victor Neiman, Russia	Russia
March, 2017	IIOE2-EP14	GEOLOGY AND GEOPHYSICS OF THE EASTERN INDIAN OCEAN (GEODYNAMICS, TECTONICS AND EVOLUTION OF UNIQUE INTRAPLATE FEATURES)	Oleg Levchenko, Russia	Russia
February, 2017	IIOE2-EP13	EASTERN INDIAN OCEAN UPWELLING RESEARCH INITIATIVE (EIOURI)	Weidong Yu, China	Multinational
February, 2017	IIOE2-EP12	DUST STIMULATED NITROGEN FIXATION IN THE ARABIAN SEA- AN ASSESSMENT OF HNLC REGION HYPOTHESIS (DUSTNIF)	Arvind Singh, India	India
January, 2017	IIOE2-EP11	INTERNATIONAL BUOY PROGRAMME FOR THE INDIAN OCEAN (IBPIO)	Shaun Dolk, USA	Multinational
December, 2016	IIOE2-EP10	UNDERSTANDING THE UPWELLING SYSTEM AND OXYGEN MINIMUM ZONE PROCESSES IN THE NORTHERN INDIAN OCEAN: PAST, PRESENT AND FUTURE	Hermann Bange, Germany	Germany
November, 2016	IIOE2-EP09	BIOGEOCHEMICAL CYCLING AND HYPOXIA IN THE BAY OF BENGAL COASTAL ZONE; THE ROLE OF SEDIMENT DISCHARGE (HYBOB)	Greg Cowie, UK	UK-USA
October, 2016	IIOE2-EP08	THE CHALLENGER OCEAN GLIDER MISSION: INDIAN OCEAN	Charitha Pattiaratchi, Australia	Australia-USA
October, 2016	IIOE2-EP07	BIOGEOCHEMISTRY-ATMOSPHERE PROCESSES IN THE BAY OF BENGAL: A CONTRIBUTION TO IIOE-2 (BIOCAT-IIOE2)	Hermann Bange, Germany	Germany
September, 2016	IIOE2-EP06	A COUPLED BIO-PHYSICAL, ECOSYSTEM-SCALE, EXAMINATION OF AUSTRALIA'S INTERNATIONAL INDIAN OCEAN EXPEDITION 110°E LINE	Lynnath Beckley, Australia	Australia-USA
September, 2016	IIOE2-EP05	PELAGIC ECOSYSTEM PROCESSES, NITROGEN SOURCES AND SOUTHERN BLUEFIN TUNA LARVAL ECOLOGY IN THE INDO-AUSTRALIAN BASIN	Lynnath Beckley, Australia	Australia-USA
August, 2016	IIOE2-EP04	WESTERN INDIAN OCEAN UPWELLING RESEARCH INITIATIVE (WIOURI)	Michael Roberts, UK-South Africa	Multinational
February, 2016	IIOE2-EP03	RESEARCH MOORED ARRAY FOR AFRICAN-ASIAN-AUSTRALIAN MONSOON ANALYSIS AND PREDICTION (RAMA)	Ravichandran, India	India-USA
January, 2016	IIOE2-EP02	AIR-SEA INTERACTIONS IN THE NORTHERN INDIAN OCEAN: REGIONAL INITIATIVE (ASIRI)	Ravichandran, India	India-USA
December, 2015	IIOE2-EP01	FIRST SCIENTIFIC CRUISE UNDER IIOE-2	Vinayachandran, India	Multinational

In addition to the above, the UK government announced in the last few weeks that it is to fund a major initiative in the Indian Ocean (Figure 2). This is led by Mike Roberts (UK/ South Africa) and the early stages will focus on the WIOURI component of IIOE-2 and involve Kenya, South Africa and Tanzania. This initiative is likely to take place over a period that will stretch beyond the current period (2015-2020) of IIOE-2.

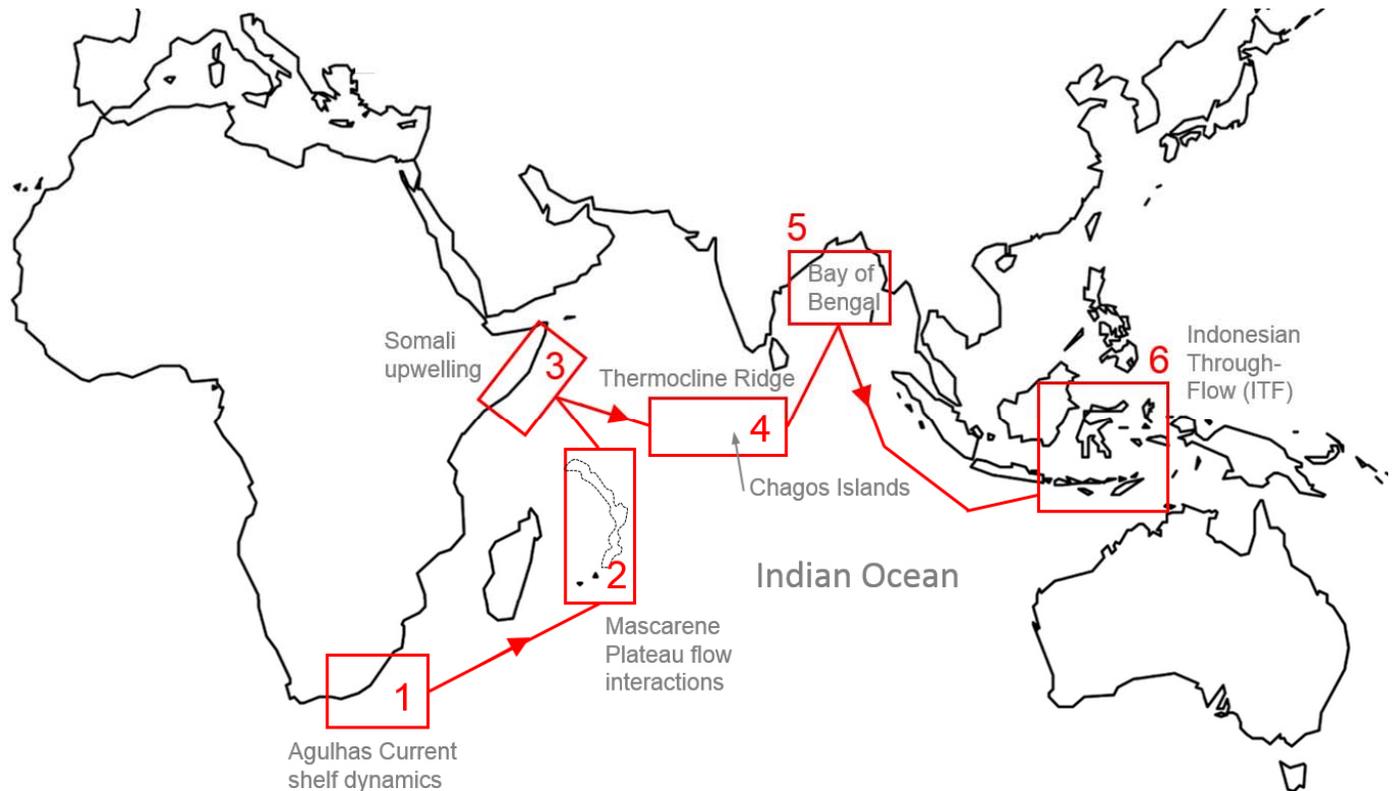


Figure 2: Proposed track of RRS DISCOVERY for a funded UK IIOE-2 initiative led by Mike Roberts.

Early Career Scientists (ECS)

This is an important strand of IIOE-2. This group met in Perth on 4th February 2017, led by Danielle Su of Australia. The SSC agreed that each chair of WG or ST should encourage participation by a member of the ECS.

Meetings

The larger meetings involving IIOE-2 are shown in Table 4. In addition smaller electronic meetings involving the SC are held quarterly.

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Table 4: Past and future meetings involving IIOE-2.

Date	Location	Organisation	Function
2-4 Feb 2017	Perth Australia	IIOE-2 SC	First face to face meeting of SC to plan IIOE-2. SC Chairs were funded by SCOR.
30 May – 2 June 2017	Busan, Korea	ECS Conference	Build international cohort of ECS. Self funded.
27 Aug 2017	Cape Town, South Africa	IAPSO-IAMAS-IAGA Symposium	Includes IIOE-2 session
4 – 6 Sep 2017	Cape Town, South Africa	SCOR AGM	Receive IIOE-2 report
11 Sep 2017	La Jolla, USA	Indian Ocean Community	Workshop for US scientists and others
19-23 March 2018	Lombok, Indonesia	IIOE-2 SC	Second face-to-face meeting to continue SC planning. SC Chairs to be funded by SCOR.

Communication

IIOE-2 website is now fully operational (<http://www.iioe-2.incois.gov.in/IIOE-2/index.jsp>) and is a great resource as well as being a communications platform for IIOE-2. Ocean Bubble (<http://www.iioe-2.incois.gov.in/IIOE-2/Bubble.jsp>), an informal periodical devoted to IIOE-2, has just released Issue 7.

Requests to SCOR

I request that SCOR funds US\$25,000 to underpin meetings of the SC in 2018 meeting. The main meeting will be in Indonesia from 19 to 23 March. The dates and location of this meeting have been confirmed by our Indonesian hosts. The funds are to allow SC Chairs to attend the meeting and also for WG 1 (Science & Research chair Hermann Bange) that coordinates IIOE-2's Research Themes to meet.

Acknowledgements

IIOE-2 involves a very large number of participants all of whom contribute to its success. It is a particular pleasure to acknowledge all the scientists of the SSC including particularly the JPO scientists, Nick D'Adamo and Rajan Sivaramakrishnanan who take responsibility for the day-to-day running of this large complex project.

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