April 2016

Challenger Wave

Monthly newsletter of the Challenger Society for Marine Science (CSMS)

NEWS

Their Royal Highnesses visit the Central Caribbean Marine Institute

Their Royal Highnesses The Prince and Princess Edward, Earl and Countess of Wessex were in Little Cayman 6 – 7 March 2016 to commemorate the outstanding achievements of the Central Caribbean Marine Institute (CCMI) in its drive to achieve its mission of "protecting the future of coral reefs through research, conservation and education" over its 13-year history.

Prince Edward is the Royal Patron of the CCMI and was present at the groundbreaking of the Little Cayman Research Centre in 2003. At that time, he heralded a dedication that remains today: *to sustain the biodiversity of coral reefs so that children of the world may forever discover the treasures of the sea.*

A video of his tour is now available on the CCMI website at http://reefresearch.org/a-message-from-our-royal-patron/ .

He has previously visited the facility three times to check in on progress and the development of the various CCMI programmes, including the Ocean Literacy programme that he launched during his 2007 visit. The Ocean Literacy programme's mandate is to ensure that "every child in the Cayman Islands is ocean literate by the time they are 12 years old." To date over 1,000 children in the Cayman Islands have participated in the CCMI's residential programme, 368 last year alone and the organisation has recently launched an in-school workshop, reaching school children in their classrooms.

His Royal Highness spoke to the reasons why he was so interested in CCMI and their work: "Declining coral reefs pose urgent threats to society and indeed, to the economy of entire island nations. The Central Caribbean Marine Institute is one of the premier research institutes that is working to reduce this disastrous decline and to save coral reefs around the globe," he said.

President of the CCMI Dr. Carrie Manfrino was grateful for the support and emphasised the importance of their work: "One of our greatest discoveries is that coral reefs in Little Cayman are capable of rebounding from global stressors. Our next mission is to uncover what is driving this and hopefully we can reverse the decline of coral reefs around the world – but first we need to expand our research capacity," she added.

The success of the CCMI's science and research arm alongside its educational mission means that the facilities have been outgrown and accommodating both of these diverse groups is increasingly difficult. To overcome this challenge, Dr. Manfrino announced during the Royal visit the CCMI's intention to launch the Caribbean Ocean Science Academy (COSA).

The Royal couple toured the Little Cayman Research Centre, meeting school children who were in residence at the time, as well as a research team of students from Dartmouth College. They also attended a special dinner for the CCMI's many sponsors and donors.

For more information on how to donate to CCMI please visit http://www.reefresearch.org.

Undergraduate Tripartite Societies' Undergraduate award 2016

The prize of £500 is awarded jointly by the Challenger Society, Institute of Marine Science, Engineering and Technology and the Society for Underwater Technology, for the best undergraduate dissertation submitted for examination by a panel of scientists and engineers from the three Institutes. The award is made to students studying at a UK college or university and the field of study a clear marine science, engineering or technology subject.

Full details of the award can be found at www.challenger-society.org/Undergraduate_Prize.

Application is by submission of an abstract of the work by the closing date of 30th April 2016. Six of the projects will be shortlisted and the winner judged from the full project report submitted by the end of June. **- John Bacon, Honorary Secretary**

Challenger Conference abstract submission is open !!!

The 17th Biennial Conference of the Challenger Society for Marine Science takes place in Liverpool on the 5th to 8th September 2016. On behalf of the conference organising committee, you are invited to submit an abstract for inclusion in the conference programme. Please follow the link below for a full list of available sessions and links to further conference information:
https://www.liverpool.ac.uk/challenger-conference-2016/abstract-submission

The deadline for abstract submission is May 12th 2016. We look forward to seeing you in Liverpool in September. ***- Dr Matthew Palmer, Challenger Conference 2016: Organising committee chair***

Presidents' Photographic Prize

At every Challenger Conference we invite attendees to submit entries to the Presidents Photographic Prize. For the Liverpool conference we are looking for beautiful and entertaining pictures under the theme of "what the oceans mean to me".

This title is deliberately designed to be broad ranging and allow you all to bring your creativity to bear to impress your friends and colleagues. There will be fabulous prizes for the best pictures (judged by the President and President Elect) and

we anticipate using them in future publications of the society, with the artist's permission of course. So please start planning to bring your best photographs to Liverpool. Details of how to submit pictures will be posted on the conference website nearer the time. ***- Tim Jickells and Rachel Mills, President and President Elect***

VIEWS

Diving into oceanography: a world beneath the waves

Over the weekend of 5-6 March 2016, a keen group of divers and marine enthusiasts from around the UK (including as far away as Plymouth !) converged on Norwich for the second 'Introduction to Oceanography for Divers Course' at the University of East Anglia. After the success of the inaugural course in 2015, there was a lot to live up to, and thanks to Carol's flawless organisation and expert contributions from UEA, Cefas, BAS and SAHFOS, this year didn't disappoint !

After a timely arrival by all (apparently divers are notoriously good timekeepers - missing a tide means missing a dive !) the morning got off to a historical start with a jaunt through the development of oceanography. Carol took us all the way back to the 4th century BC when Aristotle, the 'father of oceanography' made the first known observations of marine life, and we were brought up to date with Rob teaching us how innovations in the most modern marine technology, such as gliders, are used to gather physical oceanography data that may otherwise be difficult (or impossible) to obtain. Continuing in the scientific vein, other lectures introduced students to the importance of the oceans and their biology in regulating climate, the complex chemistry going on beneath the waves, and the delicate interplay between a changing ocean and the diverse ecosystems that live within.

Students weren't confined to the classroom all weekend, however, and over the two days, eight laboratory demonstrations allowed participants to get their hands dirty and put theory into practice. Dave Pearce illustrated how Cefas uses a network of buoys to collect tidal data used in forecasting, whilst Dave Sivyer demonstrated the collection of chemical oceanography data using CTDs, to help monitor the health of the UK's seas. Other practicals involved seeing how Rob controls gliders, often as far away as the Southern Ocean, from the comfort of his office; Ollie used colourful chemistry, a tank and a miniature polar bear to demonstrate ocean circulation and acidification; and Cansu, Clare, Katrin and Cecilia untangled the trophic web, taking students from bacteria, to phytoplankton, all the way up to Antarctic krill. Julian completed the picture, with a hands-on demo of the types of tagging equipment Cefas uses to monitor fish to consistently improve our understanding of their ecology and how to manage fish resources for the future.

Of particular interest to the group were lectures on scientific diving (including in the world's coldest, most inhospitable waters around Antarctica); waves, tides and currents; and the range of 'citizen science' that individuals, amateurs and enthusiasts can get involved in, with little training (or sometimes none); see, for example, Kieron Hyder's 'Dive into Science' programme. Simon Jennings' reflections on human impact, policies and motivations for conservation gave us all pause for thought, prompting us to consider the many and varied ways we interact with the seas. We were also truly globally interconnected this year, with Simon Morley from BAS videoing in before flying home from his season at the Antarctic base of Rothera, hosting a dynamic lecture and Q&A session on polar biology and oceanography.

As the weekend drew to a close, it became clear that not only had the students come away with new knowledge, motivations, and enthusiasm for the oceans, so had the lecturers. Bonds had been formed and new friends made, and already there is talk of organising next year's course. Thank you to everyone that helped organise and run the

course, but most importantly, thanks to the students, whose enthusiasm and insightful questions made teaching it so much fun and inspiring. ***- Cecilia Liszka, PhD student BAS and UEA***

Coastal communities threatened by rising sea levels – CCMI

A scientific study, "Rising Sea Levels in the Indian Ocean: Evaluating Nature-Based Solutions for Reducing Vulnerabilities of Sri Lanka's Coastal Villages", is currently being undertaken by Carrie Manfrino, President of the Central Caribbean Marine Institute (CCMI), who was awarded the prestigious Fulbright Scholarship to conduct the research.

Because of her extensive work in the Cayman Islands, which began in the mid-1990s, including the development of the Central Caribbean Marine Institute in 2004, she is already able to draw immediate comparisons between her findings in Sri Lanka and what she has seen in the Cayman Islands. "Coastal communities, including those here in the Cayman Islands are increasingly threatened by rising sea levels", she stated. "The work in Sri Lanka will examine the potential for local nature-based solutions to reduce the impact of rising sea levels. As the sea level rises, coral reefs, mangroves, and beaches can aggrade and either catch up or keep up with rising sea levels. These natural ecosystems, therefore, offer a significant line of defence for coastal communities. Alternatively, the rates of sea level rise may outpace the relative capacity for coastal ecosystems to keep up to the rising sea level, making them especially vulnerable. We need to be aware of and monitor this carefully".

In Sri Lanka, a range of coastal and shallow marine habitats will be surveyed to develop an understanding of current and future risks of rising sea levels. Results will inform efforts to improve protection of mangroves, reefs, and other coastal habitats as natural defences to climate change in Sri Lanka with many applications to the Cayman Islands.

Manfrino is now a Fulbright Scholar because of her extensive and impressive history as an oceanography professor and researcher. She grew up in South Florida where she developed a fascination with the sea and the record of the earth's history from limestone remnants of coral reefs. She received a PhD from the University of Miami's Rosenstiel School of Marine and Atmospheric Sciences in Marine Geology and Geophysics (1996) under the direction of Dr. Robert N. Ginsburg; a MSc degree in geology from the Colorado School of Mines; and a BA from the University of Colorado, Boulder. Her deep-rooted curiosity to understand the mechanisms that drive the evolution of coral reefs continues to inspire her work as an oceanography professor and researcher. As a graduate student she mapped and established a timing of the final departure of the Western Interior Seaway out of North America (Durango Colorado) during the Late Cretaceous

geologic period. She then focused on deciphering the signals of sea level oscillations from coral reef sequences deep in the Great Bahama Bank. After the massive 1998 El Nino event killed corals globally and threatened the survival of reefs, she was inspired to establish the Central Caribbean Marine Institute, a Cayman Islands, US and UK non-profit marine research and education institute. In 2005 she designed and developed the Little Cayman Research Centre and launched a campaign designed to ensure that every child in Cayman is ocean literate by the age of 12. She has received several awards and was recently recognised for her work in the Cayman Islands as the first Sea Keeper of the World. She also received a Sea Hero Award from SCUBA Diving Magazine and Oris and the National Department of Defence Science and Engineering Fellowship. She is a Fellow of the Explorers Club.

For more information on the Central Caribbean Marine Institute and its work visit www.reefresearch.org.

Sonardyne deep water pressure testing facility available to hire

Subsea technology company Sonardyne International Ltd., has announced that it is making available to hire its new deep water hydrostatic pressure testing chamber, one of the largest in the UK. Located at its headquarters in Yateley, 40 miles south-west of London, the facility is now open to third party companies and organisations to test the integrity of their underwater components and instruments by simulating water depths up to 6,300 metre (20,670 feet).

Sonardyne's deep water pressure chamber

Hydrostatic testing is the most reliable and cost-effective way to validate the integrity of subsea equipment before it is deployed in the field. With an internal diameter of 0.76 m and internal length of 2 m, Sonardyne's chamber is able to accommodate large single instruments or multiples of smaller instruments and components at the same time. It can be programmed to meet the requirements of specific industry standards including pressure cycling, ramping and holding.

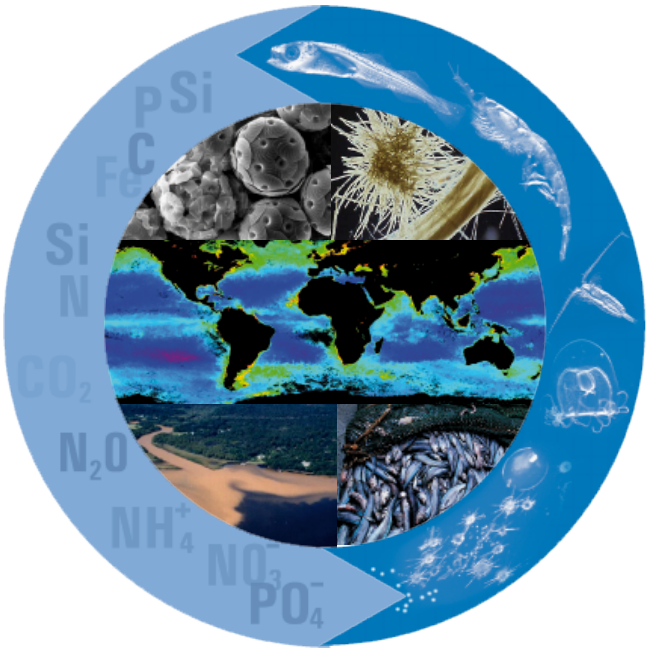
A dedicated Test Engineer supervises all testing activities, providing clients with full reports which include applied pressure graphs, test certificates and photographic records. Full technical and custom engineering support is also available on-site. For more information, including pricing and availability, please email: support@sonardyne.com

IMBER – Synthesis and the Way Forward

The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) project grew from a desire by the international marine science community to address the challenges of understanding the interactions and relationships between biogeochemical cycles and food webs across multiple space-time scales, and to quantify and predict marine system responses to natural and anthropogenic forcing. IMBER was initiated in 2005 as a joint project of the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR) with the central goal to provide *a comprehensive understanding of, and accurate predictive capacity for, ocean responses to accelerating global change and the consequent effects on the Earth system and human society*. IMBER has its origins in previous IGBP-SCOR projects, the Joint Global Ocean Flux Study (JGOFS) and the Global Ocean Ecosystem Dynamics (GLOBEC) project, which highlighted knowledge gaps and limitations in the global research capacity for integrated approaches across multiple scales and key processes that were needed to understand global change effects on marine ecosystems.

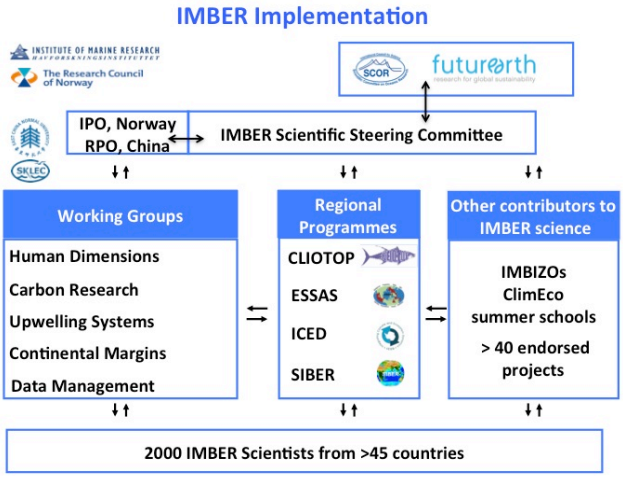
During the past ten years (2005-2015), the IMBER goal has been pursued through science activities under four overarching and interlinked themes that consider key interactions in marine ecosystems, sensitivity to global change, feedbacks to the Earth system, and responses of society. IMBER has addressed these themes through international coordination, networking and capacity building activities, regional programs, working groups, national contributions, endorsed projects, and integrative, project-wide activities. In-depth regional and topical analyses

and comprehensive comparisons of diverse marine ecosystems have provided new understanding about the potential effects of global environmental change on biogeochemical cycling, food web dynamics, and impacts and linkages to human systems at multiple scales. The focus of a global community of natural and social scientists on a specific research agenda facilitated these important advances.



Schematic of interacting science themes that guided the first decade of IMBER research (2005-2015) illustrating the linkages between food webs and biogeochemical cycles (Theme 1 key interactions, outer circle), marine organisms (such as calcifying and N_2 fixing phytoplankton) that respond to global change (Theme 2 sensitivity to global change, upper panel), a global chlorophyll distribution (Theme 3 feedbacks to the Earth system, middle panel), and human-marine interactions including fisheries (Theme 4 responses of societies, bottom panel).

The IMBER project is now undergoing a transition in parallel with changes and transitions in the global environmental research community. The IGBP ended operations in late 2015, following the ending of other international science coordination bodies, the International Human Dimension Programme, DIVERSITAS and the Earth System Science Partnership. These multiple organizations were replaced with a single overarching program, Future Earth, a 10-year international research initiative focused on providing the knowledge and support to accelerate transformations to a sustainable world. The science plan and implementation strategy (SPIS) that guided IMBER for the past 10 years is ending, which provides the opportunity to reconsider IMBER's vision and goal in light of its accomplishments and research needs and directions for the future.

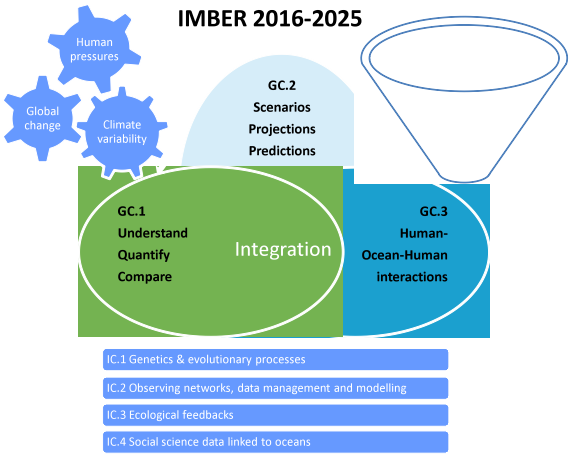


IMBER Project organization and implementation. Coordination of IMBER activities is through the International Project Office (IPO), the Regional Project Office (RPO) and the Scientific Steering Committee. IMBER science is implemented through working groups, regional programs, project-wide activities (IMBIZOs, ClimEco summer schools), and endorsed projects; all supported by an international community of scientists. The Carbon, Upwelling and Continental Margins working groups are jointly sponsored with the Surface Ocean-Lower Atmosphere (SOLAS) project, the Climate and Ocean: Variability, Predictability and Change (CLIVAR) project, and the Future Earth Coasts project, respectively. The regional programs are: CLimate Impacts on Oceanic Top Predators (CLIOTOP), Ecosystem Studies of Subarctic and Arctic Seas (ESSAS), Integrating Climate and Ecosystem Dynamics (ICED) in the Southern Ocean, and Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER).

IMBER began the process of developing a new SPIS with its 2014 Open Science Conference (OSC). The OSC provided an opportunity for the marine science community to present key findings of IMBER-relevant research and promote integrated syntheses of IMBER research. It also gave a planned opportunity to solicit and discuss approaches for updating the IMBER research agenda to guide future research into marine biogeochemistry, ecosystem structure and functioning, the human dimensions of global marine change, and interactions between each of these. The outputs from the OSC, subsequent community-wide consultations, and inputs from partner organizations and national programs resulted in the development of a new IMBER SPIS to guide the next decade of research, and to provide the basis for IMBER to transition to becoming a core project

of Future Earth and to continue as a research focus for SCOR.

The new IMBER SPIS recognizes that the evolution of marine ecosystems (including biogeochemical cycles and human systems) is linked to natural and anthropogenic drivers and stressors. This broadened the IMBER vision to focus on *ocean sustainability under global change for the benefit of society.* This vision is supported by a research goal for the next decade to: *Understand, quantify and compare historic and present structure and functioning of linked ocean and human systems to predict their future structure and functioning and develop options for securing or transitioning towards ocean sustainability*.



Integrative structure of IMBER Grand Challenges (GC) and Innovative Challenges (IC). Marine ecosystems are responding to major pressures (upper left) that operate at a range of scales. Understanding, quantifying and predicting responses of marine ecosystems to these pressures requires integrated observational, experimental and modelling programs (upper right).

The integrated research agenda for the next decade supports this new vision and goal, and is based on three grand challenges that focus on climate variability, global change and human drivers and stressors, and innovation challenges that focus on new areas for IMBER where research is needed and where it is believed that major achievements can be made within 3-5 years. The first grand challenge considers the state and variability of marine ecosystems, the impacts of natural variability and anthropogenic global change, and interactions across time and space scales. This grand challenge is further developed in the second that focuses on predictions and projections of ocean-human systems at multiple scales, which includes improving ecosystem models for scenario testing and evaluation, and includes considerations of maintenance of biodiversity and direct anthropogenic drivers such as fishing. The final grand challenge focuses on improving and achieving sustainable governance and recognizes the need to improve the science-policy-society interface and develop new linkages between marine and human systems, and includes "communicating relevant information and knowledge needed by society to secure sustainable, productive and healthy oceans". Implementation of the grand challenges in a 3-5 year time horizon is provided by the innovation challenges that consider metabolic diversity and evolution, global ocean observational and modelling networks, ecological feedbacks in the Earth system, and social science data for ocean management, decision-making and policy development.

With its new SPIS, IMBER will maintain its strong commitment to basic, curiosity-driven science and expand into new areas of problem-driven, policy-relevant interdisciplinary research. The IMBER project is now evaluating its working group and regional program structure with a view towards better alignment with the new SPIS. As IMBER moves forward into a new decade of research, the project will maintain the legacy of IGBP, continue to contribute to the objectives of SCOR which focus on promoting international cooperation in planning and conducting oceanographic research, and solving methodological and conceptual problems that hinder research, and transition to a core project of Future Earth to contribute to their vision of supporting research which enables transformation to global sustainability and equitability. The IMBER SPIS is undergoing final review by SCOR and Future Earth and will be jointly published by both organizations in 2016. **- Eileen E. Hofmann, IMBER Past-Chair, and Carol Robinson, IMBER Chair**

IMBIZO IV, Marine and Human Systems: Addressing Multiple Scales and Multiple Stressors

The Integrated Marine Biogeochemistry and Ecosystem Research Project (IMBER) is developed around four research themes, which focus on: key interactions in marine ecosystems; sensitivity to global change; feedbacks to the Earth system; and responses of society. When IMBER was initiated in 2005, the responses of society theme represented a new direction for global environmental change programs because it explicitly acknowledged the role of humans as both drivers

and recipients of change in marine ecosystems. IMBER project-wide activities, regional programs and working groups have advanced the science associated with each research theme. However, the strength of these activities has been in the identification of theoretical and methodological overlap among the themes, facilitating integration of ideas and synthesis of research outcomes, and highlighting new research directions.

The biennial IMBIZO (Zulu word for a gathering) is an important IMBER-wide activity for assessing current understanding of theoretical and empirical research at the local, regional and global scale, and pointing to future research needs. IMBIZO IV, held in October 2015 in Trieste, Italy, addressed linkages between marine ecosystems and human systems. In particular, emphasis was on current systems understanding and approaches to predict the effects of multiple stressors, at multiple scales, on marine ecosystems and dependent human populations. A novel aspect of this IMBIZO was the focus on exposing the need for human systems to respond to changes and for governance systems to adequately guide these responses.

Schematic of human-ocean interactions and the four workshop topics that were the focus of IMBIZO IV.

IMBIZO IV was developed around four workshops that addressed i) marine ecosystem-based governance, ii) upwelling systems as models for interdisciplinary global change studies, iii) integrated modelling to support marine socio-ecological systems under global change, and iv) regime shifts and their socio-ecological implications. Although each workshop had distinct objectives, all addressed aspects of climate, ecosystems and societies with a view towards integrating and synthesizing current understanding and highlighting approaches for developing innovative societal responses to changing marine ecosystems. The workshops were supplemented with plenary presentations that provided overviews of the state of understanding and research needs and joint sessions and debates that allowed cross-workshop interactions.

Within the context of each workshop, questions were addressed that considered the challenges of multiple stressors, pressures, and drivers, existing knowledge gaps, and the type of expertise needed to move forward. Some workshops also evaluated the need for paradigm shifts to adequately address particular research questions. The overall goal of each workshop was to determine how integration of the diverse array of knowledge and different research outcomes for marine systems could be done to provide useful advice for policy and management.

The results of the individual workshops are being summarized in a variety of ways including white papers, synthesis papers, short communications, and special issues. However, the workshop results have common components with perhaps the clearest message being the need for continued conversations and exchange of information between scientists from different disciplinary backgrounds. To enable this dialogue to take place collaboratively and ultimately to develop workable solutions will mean that a common understanding of language will need to be developed and that jargon be avoided. Facilitating cross-disciplinary communication by domain experts will also help crucially important communication to management authorities and decision makers.

Aside from the need for good communication between scientists that straddle the physical, ecological and human domains, the different workshops considered the linkages and interactions

between the driving forces (pressures-state-impacts-responses, DPSIR) and how these are understood and represented. For most marine systems, the system state, how much of what is present and where, can be described with differing degrees of certainty depending on location and factors such as monitoring intensity and accessibility. The connectivity and linkages between marine system components and driving forces are known from a theoretical perspective and for many systems these have been described quantitatively using different modeling approaches. However, there is considerable empirical uncertainty about how marine systems might respond to continued and cumulative anthropogenic stresses and how in turn, this may feedback to the human domain and affect, for instance, future food security.

Marine systems may not be generalizable, sometimes cannot be simply scaled up, or may not respond linearly to anthropogenic stressors. Regime shifts may occur that are not easily – or not at all reversible thus requiring adaptation by resource users. The governance system is crucially important in this context as it provides links to management, policy and regulatory systems that influence use of, and access to, marine resources. Governance institutions are ultimately responsible for the sustainable management of marine resources and any necessary reduction in the pressure exerted on the resources. These governance systems in essence close the loop between the natural and human systems. Natural, socio-economic, and governance systems need to be central to continued research efforts and inform all levels of decision making to ensure informed steps are taken.

Global environmental change is happening and will continue to affect ecosystems and alter the ecosystem services provided to humanity. The need for timely detection and attribution of these changes remains, especially where change is irreversible. Human systems and society at large are at the same time the creators of the many stressors as well as the drivers of change to our marine ecosystems. Human systems can drive positive changes through good governance aimed at reducing vulnerability, and enhancing adaptive capacity and resilience. It is clear that many knowledge gaps remain, in particular the way in which multiple drivers and stressors interact. Much work also remains to be done in further detailing and modelling the crucial dependencies between human and ocean systems. All these uncertainties place limitations on the predictability of governance outcomes and risk unintended consequences and maladaptation if not addressed adequately. Outcomes from IMBIZO IV will provide guidance for these important research efforts for the next decade of IMBER research.

IMBER gratefully acknowledges the support provided by the OCB Program for IMBIZO IV and its ongoing support of IMBER activities. **- Eileen Hofmann, Lisa Maddison, Ingrid van Putten and Javier Arístegui**

SALTS

No news from sea this month I'm afraid

I know that this is a favourite section for many readers, where we get the inside information about life at sea, its thrills and spills. So please the next time you are at sea or carrying out any fieldwork, please remember that a simple paragraph or two will get you published here. – ***Ed***

CALENDAR

13th-15th April 2016: Workshop on "High-resolution ocean modelling for coupled seamless predictions"

Exeter, UK

The scope of this workshop, to be held at the UK Meteorological Office, is to look at the scientific development of ocean models and global coupled prediction systems at resolutions of order 1/12° for seasonal to decadal prediction and short-range weather forecasting and to:

- Identify expected improvements to processes and performance
- Clarify the key choices for ocean model configurations and parameterisations
- Discuss the development of coherent designs and collaborations for experiments and diagnostics

This is an International workshop supported by GOV and the GOV CP-TT (Coupled Prediction Task Team). For more detailed information about the workshop, agenda, sessions and local infor-

mation please visit the workshop website: https://www.godae-oceanview.org/outreach/meetings-workshops/external-meetings-supported-by-gov/international-coupled-seamless-prediction-meeting/local-information/.

5th-6th May 2016: Marine Technology and Data Symposium
Glasgow, UK

23rd-27th May 2016: 48th Liège Colloquium "Submesoscale Processes: Mechanisms, Implications And New Frontiers"
Liège, Belgium
A rich tapestry of oceanic processes is manifest at scales O(0.1-10 km), small enough for the constraints of the earth's rotation and oceanic stratification to be overcome, but larger than that of three-dimensional turbulence. Rossby and Richardson numbers of O(1) lead to a range of dynamical instabilities that respond to surface forcing and boundary stresses, and interact with the mesoscale flow field, upper ocean turbulence, and near-inertial waves. These dynamics result in enhanced vertical velocities and mixing, as well as stratification, on time scales that range from a few days to the inertial period and intersect with the time scales of internal waves and tides. Their diagnoses is facilitated through advances in high-resolution autonomous, in-situ and remotely sensed observations, modeling, and theoretical advances. Their implications are wide-ranging and include the transfer of energy across scales, lateral mixing and transport, restructuring of the upper ocean's density and stratification, modulation of air-sea, ice-ocean, ocean-bathymetric interactions, the exchange of biogeochemical properties across the mixed layer base, vertical supply of nutrients for primary production, modulation of light exposure and growth rates for phytoplankton, subduction of surface water, and export of particulate organic carbon and oxygen from the surface mixed layer.

The similarity of physical and biological time scales of phytoplankton growth heightens the relevance of submesoscale processes for the production and export of phytoplankton, and the structuring and diversity of oceanic ecosystems.

This colloquium aims to advance our collective understanding of submesoscale processes, their mechanistic functioning, relevance, and implications across a range of oceanic disciplines. Discussions will include observational, modeling and theoretical approaches for elucidating submesoscale phenomena.

From this colloquium, its oral/poster presentations and scientific interactions, will emerge new cross-cutting themes for future research. For more information, please visit: http://modb.oce.ulg.ac.be/colloquium/

12th-17th June 2016: Gordon Research Conference on Ocean Biogeochemistry
Hong Kong, China
The 1st Gordon Research Conference (GRC) on Ocean Biogeochemistry will be held at the Chinese University of Hong Kong. The topic of this first conference will be *The Biologically-Driven Ocean Carbon Pumps*.

Interested researchers, postdoctoral fellows and graduate students are invited to apply for participation as soon as possible on the GRC website (Online Application):
http://www.grc.org/programs.aspx?id=17297

Nianzhi Jiao and Eileen E. Hofmann (Chairs)
Louis Legendre and Sylvia Sander (Vice Chairs)

5th-7th July 2016: UK Antarctic Science Conference
UEA, Norwich, UK
We welcome everyone working on Antarctic or Southern Ocean science, including techniques such as in situ measurements, numerical models, laboratory experiments or remote sensing. The conference welcomes all science disciplines, including cryosphere, earth, atmosphere, marine, climate and life sciences.

There are rooms booked for associated meetings Monday - Tuesday and Thursday - Friday, so if you would like to organise a side meeting (e.g. UK Polar Network, Sea Ice group) then please contact us. We also look forward to hearing from you if you are interested in sponsoring the conference or having a stand or display at the conference. We look forward to welcoming you to Norwich: http://www.challenger-society.org.uk/News/UKASC2016

5th-8th September 2016: 17th Biennial Challenger Society Conference: Oceans and Climate
Liverpool, UK
We are pleased to announce the next biennial Challenger Society for Marine Science conference will be held in Liverpool in September 2016: http://www.liv.ac.uk/challenger-conference-2016/

Space and funding is available to support special interest groups (SIGs), large project meetings and education/outreach events, with free facilities offered on Monday 5th and Friday 9th September. Please submit proposed events of this type using the same format as for scientific sessions with the subject prefix "SIG:".

Further enquiries can be made via csms_enquiry@noc.ac.uk. We look forward to seeing you in Liverpool next September, ***- Dr Matthew R. Palmer***
On behalf of the conference local organising committee.

12th-16th September 2016: CIESM Congress
Christian Albrechts University, Kiel
To All CIESM Friends, this will be the first time that our Congress takes place in Germany, which has been a Member of our Commission since 1969.

The 41st CIESM Congress will take place in mid-September in Kiel, on the Baltic shore, at the kind invitation of the German Government. Our Meeting, one of the largest multi-disciplinary forums in marine science, will present a major opportunity not only for researchers working on the Mediterranean and Black Seas, but also to any investigator from the Red Sea all the way to the Kara Sea, including the Atlantic shores, to come and share / compare / discuss their scientific approaches and latest findings in some 90 distinct sessions that will cover key issues. The sectors will range from marine geo-sciences, ocean climate, marine food-webs, invasive species, to marine plastics, biotechnology, geo-chemistry and marine policy. Note that each session will include a 30 minute-debate with the audience.

The link, www.ciesm.org/marine/congresses/Kiel.htm, will lead you to our Congress web pages, with details on the many Congress themes. We look forward to see many of you in Kiel in September. With my best regards, Frederic Briand,Director General, The Mediterranean Science Commission, CIESM

15th-17th November 2016: SUT 2016 Technical Conference, The Future of Underwater Technology
London, UK
Abstracts are now invited for submission of papers for the SUT Future of Underwater Technology Conference 2016. The conference will be held in London (UK) to celebrate the 50th anniversary year of the Society. It aims to attract the best authors in their field from across the world to showcase new technologies, products, best practices and in particular foresight the next generation of subsea engineering, marine science, and all aspects of underwater technology.

It will be a flagship event for the Society and it is the intent for it to become a regular occurrence and be held in future at SUT global centres around the world.

The SUT Technical Conference 2016 will offer:

- First class sessions and networking
- Opportunity to connect with underwater engineering, science, and business professionals from around the world and progress your knowledge
- A showcase for the latest technologies in subsea engineering, marine science, and allaspects of underwater technology
- An opportunity to see and meet the talent of students and young professionals that are emerging as the next generation in our industry
- The conference will have an intimate exhibition area which will provide excellentopportunities for networking and knowledge exchange.

Academics, Consultants, Engineers and Scientists, Business Executives and Managers, Lawyers, Insurers and Underwriters, Researchers, Technicians, Young Professionals and Students are some of the people we expect to see at the conference. There are also opportunities for sponsorship and to take up exhibition space. The venue will allow provision for vessel access alongside.

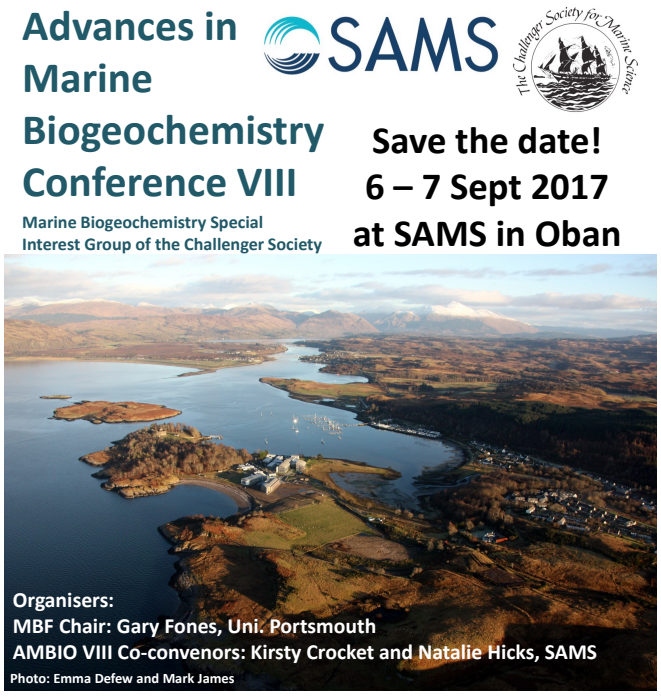
The programme will consist of plenary sessions, technical sessions, and student poster displays. Substantial effort will be made to ensure the highest quality programme with emphasis on the theme of the event. The final programme will be developed by the Technical Steering Committee which will be made up of representatives from the whole SUT organisation including Branch Committees, Special Interest Groups, and Council. Provision has been made for approximately 200 papers to be presented in plenary and parallel sessions throughout the 3 day event.

The deadline for abstract submissions is 9 May 2016. Please use the abstract submission form, which can be downloaded from www.sut.org/event/sut2016. Abstracts should be submitted in English and in Microsoft Word format; please do not send PDF format abstracts. Abstract forms should be submitted by the deadline by email to sut2016@sut.org. A notice of receipt will be emailed by return. Student poster submissions should use this call process and mark submissions as "Poster"; no paper will be required. If you have any queries about your submission please contact either· David Liddle, Business Development Executive david.liddle@sut.org , or· Kirsty Webster, Events Manager: kirsty.webster@sut.org

6th-7th September 2017: Advances in Marine Biogeochemistry Conference VIII

Oban, UK

Save the date for AMBIO VIII, more information nearer the time, www.challenger-society.org.uk/Marine_Biogeochemistry_Forum



AMBIO meetings set the stage for Marine Biogeochemistry in the UK, connecting disciplines within the field and establishing networks for the integration of early career scientists. The AMBIO VIII meeting in September 2017 is to be hosted at the Scottish Association for Marine Science in Oban. Save the date! Registration will open in early 2017.

Info: www.challenger-society.org.uk/Marine_Biogeochemistry_Forum
Contact: kirsty.crocket@sams.ac.uk, natalie.hicks@sams.ac.uk

CSMS email addresses are president, admin, membership, secretary and treasurer@challenger-society.org. Contributions for next month's edition of Challenger Wave should be sent to: john@vectisenvironmental.com by the 29th April.

We continue to send printed copies of Challenger Wave to members of the CSMS without email addresses. However it is in everybody's interest to send your email address to Jennifer Jones jxj@noc.ac.uk as soon as possible

---

JOBS

Marine Earth Observation Applications Scientist: Senior Appointment

Plymouth Marine Laboratory, Plymouth, UK

Closing Date: 20 April 2016 at 17:00 BST
Salary Range: from £45,625, negotiable for the right candidate
Fulltime – Open-Ended Appointment Online application at:
https://advanced.advorto.com/pml/VacancyInformation.aspx?VId=19127

Job Purpose: The EO group at PML has an excellent international reputation for marine EO research, application of research results and operation of services derived from the research, primarily in the area of Ocean Colour. PML is seeking to appoint a senior scientist to develop and grow marine EO applications in an area complementary to existing PML strengths. The postholder will undertake research into, and develop, EO applications which would be commercialised through PML Applications Ltd. The area of EO research should be relevant to PML priority research topics.

Key Deliverables

1. Develop and grow marine EO applications in an area complementary to existing PML EO strengths through writing successful commissioned research proposals.
2. Develop EO applications with a view to commercialisation via PML Applications Ltd.
3. Publish high-quality, high-impact science in the peer-reviewed literature.
4. Manage commissioned research projects and associated resources including staff.

Experience & Eligibility Requirements

- A track record in winning and managing significant commissioned research projects in marine Earth Observation
- An existing network of collaborators
- An extensive track record in publishing high-quality, high-impact science
- Experience in commercial development of science
- A PhD or equivalent experience in a relevant discipline
- A background in managing people and resources
- Excellent IT and communication skills.

For additional information please contact Mrs E Hamilton-Matthews, Human Resources Group, Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH. Tel: +44 (0)1752 633100 or Email: careers@pml.ac.uk