



Overview of the Science Plan for the “Second International Indian Ocean Expedition (IIOE-2)”

This overview was sourced from the report: R. Hood et al. (Eds.) (2015). The Second International Indian Ocean Expedition (IIOE-2) Science Plan. (Version 1, 13 May 2015). Scientific Committee on Oceanic Research IIOE-2 Science Plan Development Committee (SPDC).

The Indian Ocean was a largely unexplored frontier up to mid-19th century. Since 1873, less than two dozen vessels had carried out oceanographic investigations in Indian Ocean, applying state of the art techniques of the day in limited areas. To make a significant step jump in the exploration and understanding of the Indian Ocean, the International Indian Ocean Expedition (IIOE) was carried out during 1959-65 and included research cruises through the participation of 13 countries engaging 46 research vessels for a total of some 320 months of ship time.

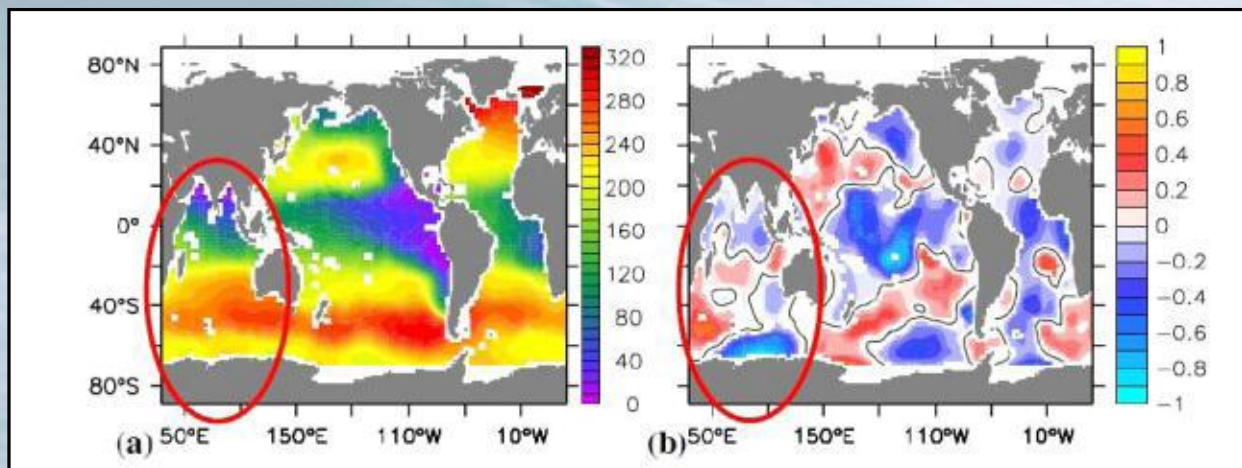
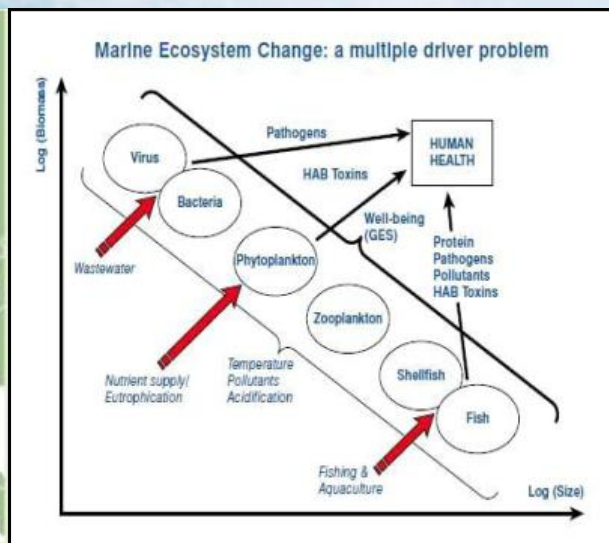
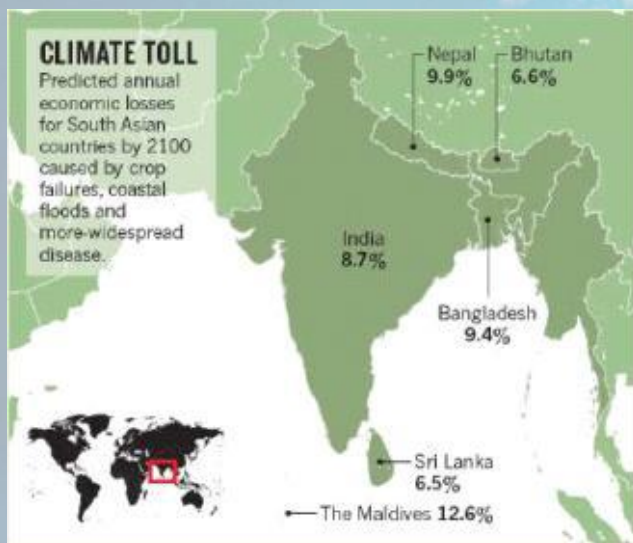
Compared to the IIOE, we now have a much improved capacity to obtain a much more integrated picture of the Indian Ocean, using new technologies that can be combined with targeted and well-coordinated in-situ measurements. The Indian Ocean remains as an under-sampled regime, particularly in terms of biogeochemical and ecological observations, and hence this is as an area that would benefit from sustained ocean observations. Motivated by this opportunity and challenge, and to celebrate the completion of 50 years of IIOE, the international community connected to the Indian Ocean has initiated the IIOE-2. IOC/UNESCO at its 48th Assembly Session adopted the IIOE-2 as a major new initiative of the IOC, to be undertaken jointly with SCOR and IOGOOS. The overarching goal of IIOE-2 is to advance our understanding of interactions between geologic, oceanic and atmospheric processes that give rise to the complex physical dynamics of the Indian Ocean region, and to determine how those dynamics affect climate, extreme events, marine biogeochemical cycles, ecosystems and human populations. IOC entrusted the development of a research plan for the IIOE-2 to SCOR in collaboration with IOC and IOGOOS. The IIOE-2 Science Plan addresses this goal.

The IIOE-2 Science plan is structured around six scientific themes (below). Each theme comprises a set of core questions fundamental to our need to understand the forcing, processes, and resultant variability of the Indian Ocean and to develop the capacity to predict how this variability will influence human populations in future.

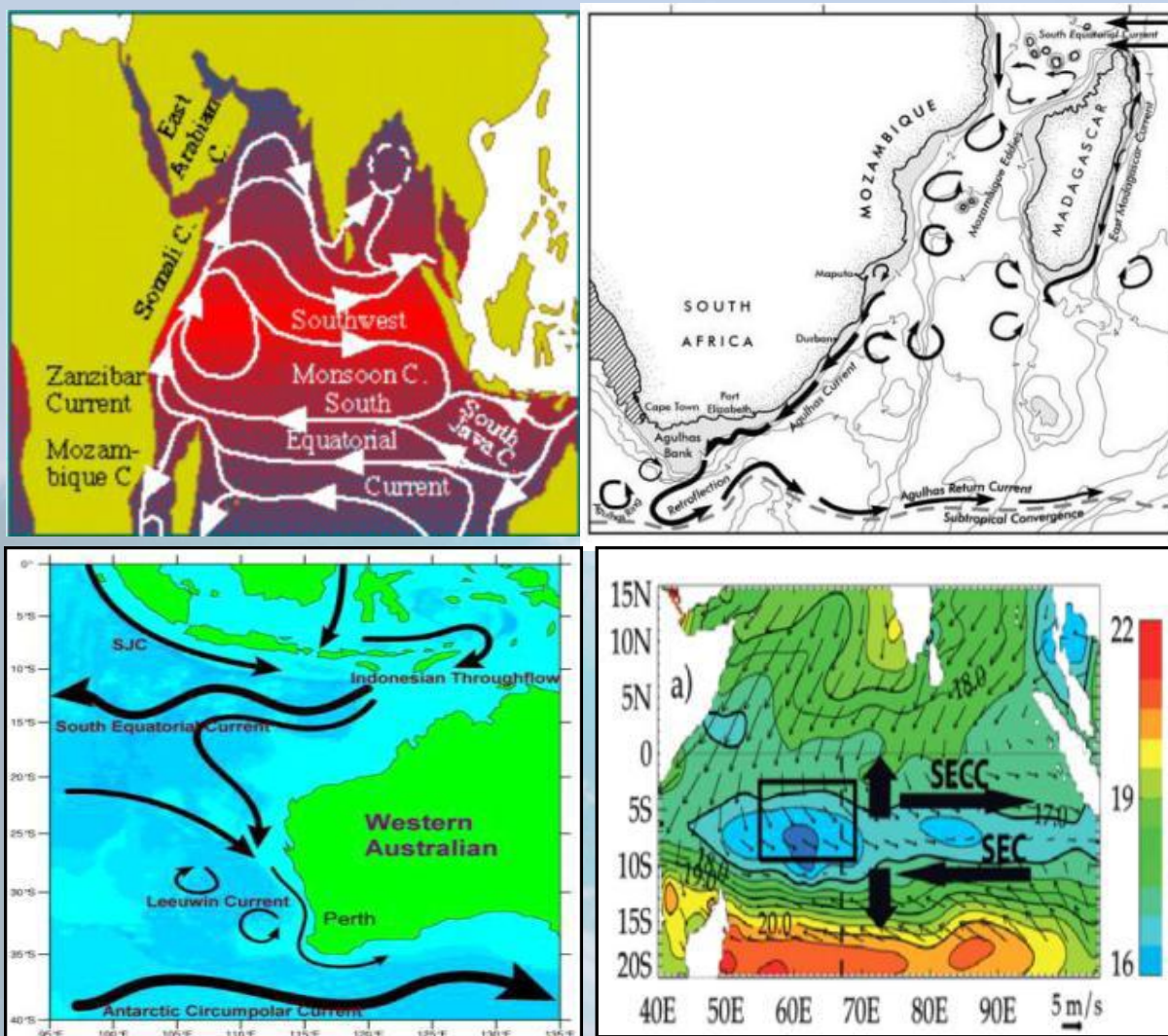
Theme 1: Anthropogenic Impacts

➤ How are human-induced ocean stressors (for example, warming, sea-level rise, deoxygenation, acidification, eutrophication, atmospheric and plastic pollution, coastal erosion and overfishing) impacting the biogeochemistry and ecology of the Indian Ocean?

	<ul style="list-style-type: none"> ➤ How, in turn, are these impacts affecting human populations in Indian Ocean rim nations?
Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts	<ul style="list-style-type: none"> ➤ How are marine biogeochemical cycles, ecosystem processes and fisheries in the Indian Ocean influenced by boundary currents, eddies and upwelling? ➤ How does the interaction between local and remote forcing influence these currents and upwelling variability in the Indian Ocean? ➤ How have these processes and (their influence on local weather and climate) changed in the past and how will they change in the future?



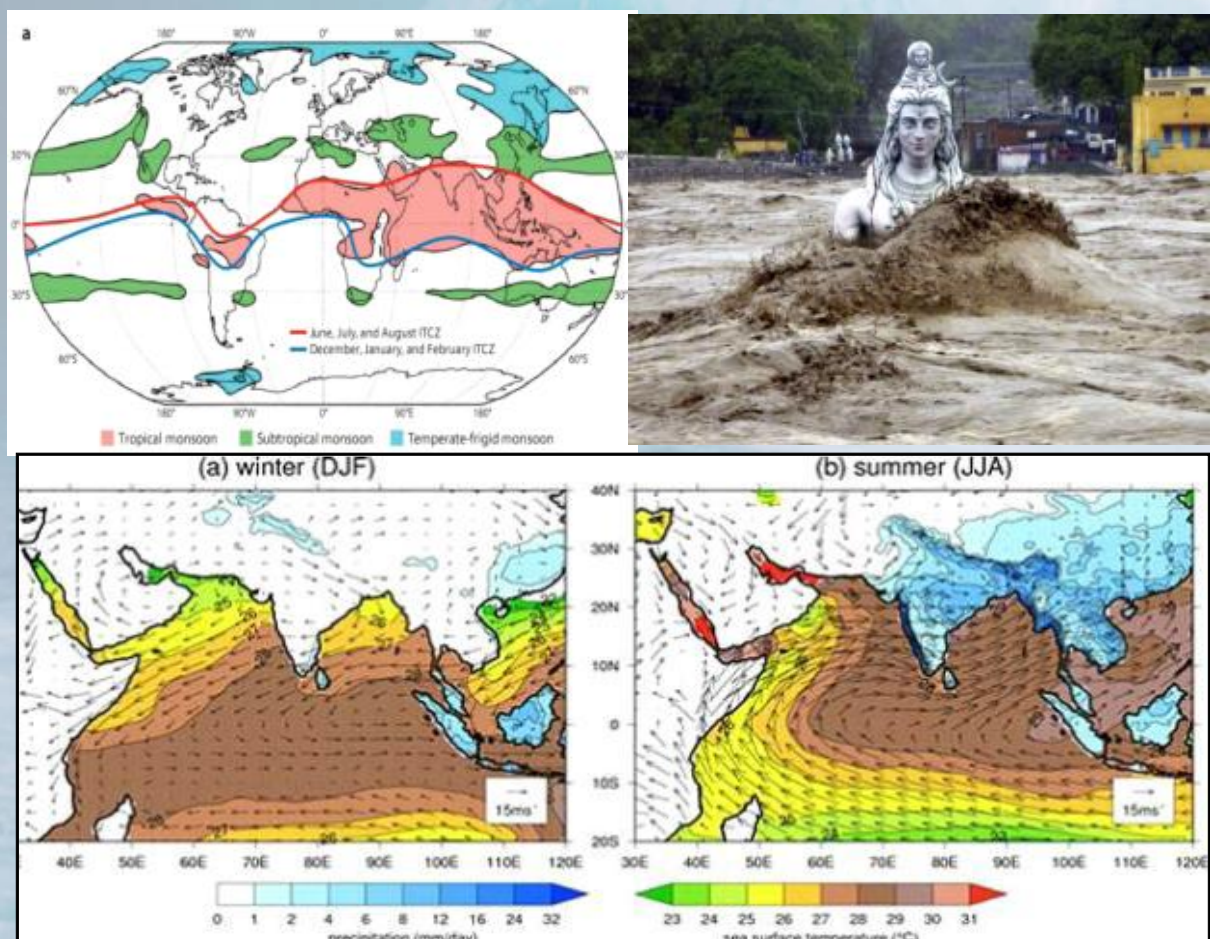
Theme 1: Anthropogenic Impacts: Predicted annual economic losses for South Asian countries by 2100 caused by crop failures, coastal floods and more widespread disease, schematic diagram illustrating the multiple drivers underlying the various processes contributing to the interactions between marine ecosystems and human health; Global mean dissolved oxygen distribution.



Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts Figure: Surface currents in the tropical Indian Ocean during the Southwest Monsoon; Source waters, eddies and coastal flow of the Agulhas Current and the Leeuwin Current; Climatological surface winds.

Theme 3: Monsoon variability and ecosystem response	<ul style="list-style-type: none"> ➤ What factors control present, past and future monsoon variability? ➤ How does this variability impact ocean physics, chemistry and biogeochemistry in the Indian Ocean? ➤ What is the effect on ecosystem response, fisheries and human populations?
Theme 4: Circulation, climate variability and change	<ul style="list-style-type: none"> ➤ How has the atmospheric and ocean circulation of the Indian Ocean changed in the past and how will it change in the future? ➤ How do these changes relate to topography and connectivity with the Pacific, Atlantic and Southern Oceans? ➤ What impact does this have on biological productivity and fisheries?
Theme 5: Extreme events and their impacts on ecosystems and human populations	<ul style="list-style-type: none"> ➤ How do extreme events in the Indian Ocean impact coastal and open ocean ecosystems? ➤ How will climate change impact the frequency and/or

	<p>severity of extreme weather events, tropical cyclones and tsunamis in the Indian Ocean?</p> <ul style="list-style-type: none"> ➤ What are the threats of extreme weather events, volcanic eruptions, tsunamis, combined with sea level rise, to human populations in low-lying coastal zones and small island nations of the Indian Ocean region?
Theme 6: Unique geological, physical, biogeochemical and ecological features of the Indian Ocean	<ul style="list-style-type: none"> ➤ What processes control the present, past, and future oxygen dynamics of the Indian Ocean and how do they impact biogeochemical cycles and ecosystem dynamics? ➤ How do the physical characteristics of the southern Indian Ocean gyre system influence the biogeochemistry and ecology of the Indian Ocean? ➤ How do the complex tectonic and geologic processes, and topography of the Indian Ocean influence circulation, mixing and chemistry and therefore also biogeochemical and ecological processes?



Theme 3: Monsoon variability and ecosystem response: The global monsoon distribution, where the Indian Ocean and its rim are under the regime of African-Asian-Australian monsoon; flooded River Ganges in Rishikesh in the northern Indian state of Uttarakhand; Schematic diagram of boreal winter and summer daily mean precipitation, SST and winds over the Indian Ocean and adjacent continents

The science plan benefited significantly from regional inputs derived from the results of the IIOE-2 Reference Group meetings held during 2013-15 (including Hyderabad, Qingdao, Mauritius, Bangkok). The IIOE-2 will coordinate with international research efforts such as the Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) program, the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) program, the Surface Ocean – Lower Atmosphere Study (SOLAS), the Indian Ocean Global Ocean Observing System (IOGOOS), GEOTRACES (a global survey of trace elements and isotopes in the ocean), the Global Ocean Ship-Based Hydrographic Investigations Program (GO-SHIP), the International Ocean Discovery Program (IODP), InterRidge (an international project that promotes interdisciplinary, international studies of oceanic spreading centers), and others.

The IIOE-2 Science Plan also makes important reference to the need to ensure there is a legacy from the science that is pursued in the programme. IIOE-2 motivation, coordination and integration of Indian Ocean geological, oceanographic and atmospheric research will advance our knowledge of this under-sampled basin and provide a major contribution to the understanding of how regional and global change may impact biogeochemical cycles, ecosystems and human populations, not only in the Indian Ocean, but in the Earth System, creating a lasting legacy on which future research can build. The success of IIOE-2 will be gauged not just by how much it advances our understanding of the complex and dynamic Indian Ocean system, but also by how it contributes to sustainable development of marine resources, environmental stewardship, ocean and climate forecasting, and training of the next generation of ocean scientists from the region. If this vision of success is realized, IIOE-2 will leave a legacy at least as rich as the original expedition.

International Indian Ocean Expedition (IIOE-2) adopted by the IOC at its 28th Session in June 2015

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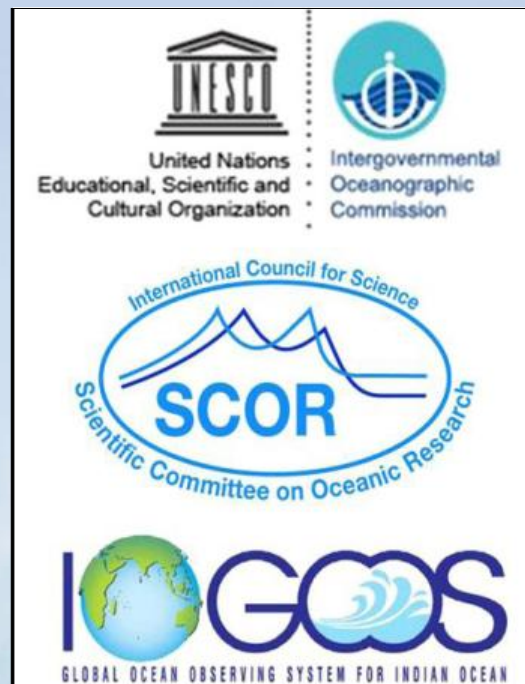
At the 28th Session of the IOC Assembly, the Second International Indian Ocean Expedition (IIOE) was adopted formally by the IOC as a new project under its auspices, to be co-led with SCOR and IOGOOS.

The IOC/UNESCO Executive Council through resolution EC-XLVII.1 established the IOC IIOE-2 Interim Planning Committee (Group of Experts) [IPC] jointly with SCOR and IOGOOS to undertake the initial planning work for IIOE-2. The IPC has a number of tasks including: establishing relevant









programme coordinating bodies; coordinating the development of implementation plans based upon the research plan developed by the SCOR IIOE-2 Science Plan Development Committee (SPDC) and identifying and securing resources for the management and implementation of IIOE-2.

The IPC comprises members jointly appointed by the Executive Secretary of the IOC, the President of SCOR and the Chair of IOGOOS (10 nominated by IOC, 3 nominated by IOGOOS, and 2 nominated by SCOR). To select IOC's nominated 10 representatives, the IOC Executive Secretary invited Member States to nominate individuals with the necessary range of scientific and technological skills, and aiming for geographical and gender balance, to facilitate the full engagement of all IOC Members States and relevant scientific and technological organizations.











Key outcomes at the 28th IOC Assembly Session

The IOC/UNESCO at its 28th Assembly held in Paris, France during June 17 – 25, 2015, through Resolution XXVIII-I, discussed the science plan, governance and implementation mechanisms of the Second International Indian Ocean Expedition (IIOE-2). The following were the key outcomes:

-  Appreciated the IPC Report entitled “Strategic Framework for Implementation of the Second International Indian Ocean Expedition”
-  Adopted the “The Second International Indian Ocean Expedition (IIOE-2) Science Plan” developed by SPDC and recommended by IPC.
-  Approved the governance structure of IIOE-2 and other recommendations of the IPC report.
-  Urged Member States to commit adequate resources as cash using available IOC Funding mechanisms or in-kind, to support International Project Office Framework (IPO) functions, the work of the Steering Committee and implementation of the IIOE-2 Science Plan
-  Encouraged IOC Member States, IOC Regional Subsidiary Bodies, including Member States of IOCINDIO, and other relevant organizations to propose, coordinate and promote research projects to implement IIOE-2 science priorities, noting the ongoing EIOURI and WIOURI
-  Urged the IPO to build synergies among existing regional initiatives and programmes, including those already planned or underway.

The Sessional Finance Committee at the 28th Assembly Session also considered the financial implications and needs of the IOC's IIOE-2 function and recommended (subsequently agreed by the Assembly in Plenary) that IIOE-2 within the IOC Secretariat budget framework be allocated a specified dedicated budget line item for the 2016-17 calendar year biennium, and further recommended a \$25K USD per year budget to facilitate the IOC IIOE-2 Coordinator's function.

Key points and action items for IPC from the IOC Resolution

-  **IIOE-2 Launch:** IOC accepted IPC's recommendation for IIOE-2 to be launched in Goa on December 4, 2015 for an initial period of 5 years
-  **IPC Mandate:** To continue functioning until the launch of IIOE-2 in Goa.
-  **IIOE-2 Steering Committee:** IOC Executive Secretary to work with SCOR, IOGOOS and partners to establish the IIOE-2 Steering Committee (SC), including chairing and noting the recommendations of the IPC's report on the SC, and to report back to the 49th IOC Executive Council in 2016.
-  **International Project Office (IPO) Framework:** Authorizes the IOC Executive Secretary to (i) continue efforts in extending the list of partners in planning and implementation of IIOE-2; (ii) formalize the offer of India to establish an IIOE-2 Project Office in India to support the IIOE-2 related activities; and (iii) designate an IOC staff member to coordinate the IIOE-2 activities in close coordination with the IIOE-2 Steering Committee, Member States and the IIOE-2 IPO by taking advantage of the generous action of Australia in hosting and supporting the IOC Perth Programme Office in Perth, Western Australia.
-  **IIOE-2 Governance:** The co-sponsors (IOC, SCOR and IOGOOS) therefore need to, as a priority, develop and establish the IIOE-2 governance framework (Chairing, Steering Committee, etc.) and, in turn, enable the IPC to oversee the development of an Implementation Plan for IIOE-2
-  Seven working groups will be constituted and tasked to develop the IIOE-2 Implementation Plan with major involvement of the IPC members and experts from stakeholder groups willing to assist in the process, focusing on the WG themes of:
 - Science and Research
 - Data and Information Management
 - Capacity Building
 - Operational Coordination
 - Outreach and Communication
 - Translating Science for Society
 - Resources and Sponsorship
-  The IOC IIOE-2 Coordinator and Indian based IIOE-2 Programme Office will work together to develop collaborative Terms of Reference, Roles and Responsibilities in support of the running of IIOE-2.
-  IOC IIOE-2 Coordinator will work with IIOE-2 International Programme Office (IPO) in India and co-sponsor representatives to facilitate the above.

IOGOOS Workshop and 11th Annual Meeting (IOGOOS-XI)

IOGOOS Eleventh Annual Meeting was successfully held at the Phuket Marine Biological Centre (PMBC), Phuket, Thailand during October 29, 2014 to November 1, 2014. The meeting was held in conjunction with the respective 5th annual meetings of its allied projects Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) and Indian Ocean Observing System (IndOOS) Resources Forum (IRF). About 35 delegates from 16 countries and IOC Perth Regional Programme Office participated in the meetings.

During the IOGOOS meeting discussions were held on the Second International Indian Ocean Expedition (IIOE)-2 planning and implementation. The status of the



development of IIOE-2 Science Plan, the IIOE- planning efforts from IOC and from India, Indonesia and South-west Indian Ocean regions were discussed. The status of the piracy in the Indian Ocean, the availability of ship time by the prospective countries and current capacity building activities were reviewed in detail and emphasis was placed on the need for additional ship time in order to complete the targeted deployment of various observing systems in the Indian Ocean (eg RAMA).

The 11th annual general body meeting of IOGOOS reviewed and accepted the IOGOOS Strategic Plan for 2015-2020. Elections were held for IOGOOS Officer positions and for hosting of the IOGOOS Secretariat for a term of six years. Dr. Andreas Schiller, Dr. T. Srinivasa Kumar and Dr. Rezah Badal, Dr. Somkiat Khokiattiwong and Dr. Michael McPhaden are the newly elected officers of IOGOOS. The generous offer from the Indian National Centre for Ocean Information Services (INCOIS) for hosting of IOGOOS for the third term of 6 years was accepted and Mr. M. Nagaraja Kumar continues to act as Secretary of IOGOOS. The annual meeting also selected Dr. Andreas Schiller, Dr. S. S. C. Shenoi and Dr. Vahid Chegini (later replaced by Dr. Nasser Hajizadeh Zaker) as IOGOOS's nominees to the IIOE-2 Interim Planning Committee (Group of Experts) [IPC] constituted by IOC/UNESCO.

Seventh Session of the GOOS Regional Alliances Forum- *by Andreas Schiller*




The biennial forum of the Global Ocean Observing System (GOOS) Regional Alliances will be held at Heraklion, Crete, Greece, on 22-24 September 2015 (<http://ioc-goos.org/GRF-VII>). This meeting will bring together the chairs of the GOOS Regional Alliances (GRAs), leaders of the GOOS science panels, members of the UNESCO-IOC office and the GOOS Steering Committee (GOOS SC). The overarching foci of this year's Forum will be on strengthening the engagement across the GRAs to foster partnerships and the GRA evolution in support of the regional implementation of GOOS. One of the foci areas for discussion will be closer cooperation among GRAs and capacity building. The associated expected outcomes are for participants to come up with:

- 2-3 recommendation on how the GRAs define their role in implementing GOOS; and
- recommendations on how the GRAs think the GOOS SC can best support the development of capacity and the GOOS in each region.

If you (the readers) have any suggestions or comments about these topics in the context of the Indian Ocean please send them to the chair of IOGOOS (Andreas.Schiller@csiro.au).

Other topics to be covered at the Forum will be sharing GRA success stories, ideas and knowledge plus specialist talks about HF radar and modelling partnerships.

Meetings / Workshops

-  The International Symposium on the Indian Ocean to celebrate the Golden Jubilee of National Institute of Oceanography (NIO), Goa, the 50th Anniversary of the International Indian Ocean Expedition (IIOE) and the launch of the Second International Indian Ocean Expedition (IIOE-2) is scheduled to be held at Goa, India during November 30 – December 4, 2015. It will provide a forum for marine and related scientists from all over the world to present the results of their latest research in the Indian Ocean, review the progress made in understanding the unique characteristics of the region and plan future research to address outstanding issues. The Symposium will consist of keynote addresses along with invited and contributed talks on all aspects of Indian Ocean oceanography and related climate science. A complete description of sessions and the schedule will be made available on the symposium website.
-  The first expedition of IIOE-2 is to be flagged off from the port of Goa, India on December 4, 2015 on board ORV Sagar Nidhi at the concluding session of the above International Symposium. The primary objective of this expedition is to revisit a hydrographic section along 70 E which was sampled in 1962, during the IIOE. This expedition will conclude at Port Louis, Mauritius on December 24, 2015.
-  The 2015 integrated meetings of IOGOOS, IOP, SIBER and IRF are also scheduled to be held at Goa, India during December 5-9.

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