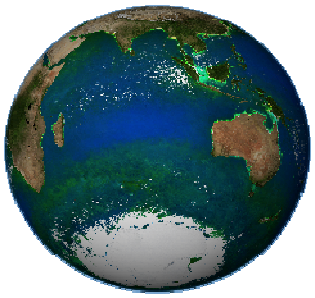

SIBER

Sustained Indian Ocean Biogeochemistry and Ecosystem Research

Report of the 5th Meeting of the SIBER Scientific Steering Committee

29 October – 01 November, 2014

Phuket, Thailand

Integrated Marine Biogeochemistry and Ecosystem Research

IMBER Report # XX

IOGOOS:PR:07:SIBER/06

SIBER Report # 06

The SIBER program reflects the importance placed on these issues by the International Geosphere-Biosphere Program (IGBP), the Scientific Committee on Oceanic Research (SCOR) and the Global Earth Observing System of Systems (GEOSS). SIBER has been developed with the approval of the Integrated Marine Biogeochemistry and Ecosystem Research Program (IMBER) and the Indian Ocean Global Ocean Observing System (IOGOOS), providing strong relevancies to the High Level Objectives of UNESCO's Intergovernmental Oceanographic Commission, which span across the generic themes of marine hazards, climate change, ecosystem protection and associated marine natural resource management.

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Introduction:

The fifth annual meeting of SIBER Science Steering Committee (SSC) meeting was held at Reference Collection Building, Phuket Marine Biological Centre (PMBC), Phuket, Thailand during October 29 - 2014 to November 1, 2014. The meeting was held in conjunction with its allied projects Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER)-5 and Indian Ocean Observing System (IndOOS) Resources Forum (IRF)-5 meetings. The Thailand-China Joint Laboratory for Marine Ecosystem and Climate Change hosted the meeting with the local support from Phuket Marine Biological Centre (PMBC), Phuket, Thailand.

The objective of having this consortium of combined meeting is to promote interaction among scientists across the groups to plan and develop scientific and observations plan to answer outstanding scientific questions pertaining to Indian Ocean. One such example is the planning of IIOE-2 expeditions and scientific plans for coming years. SIBER has played a pivotal role in initiation of plans to celebrate the 50th anniversary of the International Indian Ocean Expedition (IIOE). SIBER has also been instrumental in motivating international community to envision IIOE-2 as a 5 years expedition beginning in approximately 2015 and continuing through to 2020.

SIBER-SSC was held on 29 October 2014 and was attended by Raleigh Hood (Chair), Mike Roberts (Co-Chair), Jerry Wiggert, Dwi Susanto**,** Somkiat Khokiattiwong, Mike Landry, Birgit Gaye, Jenniger Hugget, Makio Honda, Gregg Cowie, along with SIBER IPO staff Satya Prakash and Nick D'Adamo from IOC Perth office. Invited experts attending included Weidong Yu, Ashley Johnson, Daroonwan, Mike McPhaden, and T.Srinivasa Kumar. Lynnath beckley, David Vousden, M. Ravichandran and Xabier Irigoien could not attend the meeting and expressed their regrets for the same.

Dr. Andreas Schiller, Chair, IOGOOS welcomed all the delegates of IOGOOS, SIBER IOC Perth and IOC WESTPAC members for this conuction of meetings. Dr. Andreas has expressed his gratitude to Dr. Somkiat Khokiattiwong and Dr. Weidong Yu for their generous support to IOGOOS by hosting its eleventh meeting at Phuket, Thailand.

Mini-Science Symposium

The mini-science symposium provided a forum to discuss recent scientific developments and planned future activities in the Indian Ocean. The highlights of each presentation are given below:

1. **Sampling Strategies for an Indian Ocean Bio-Argo Programme by Ms. Louise Wicks on behalf of Dr. Nick Hardman-Mountfor, CSIRO**

   Ms. Louise Wicks has briefed about the Australia-India Joint Indian Ocean Bio-Argo Project which is a collaboration between CSIRO in Australia, India's National Institute

of Oceanography (CSIR-NIO) and the Indian National Centre for Ocean Information Services (INCOIS) and with the IOC Perth Program Office and associated scientific alliance constituency. The project funding was through the Australia-India Strategic Research Fund (AISRF). The main objective of the project is to characterize the changing Indian Ocean's biogeochemistry and ecology using revolutionary new robotic tools such as Argo floats. Ms. Louise provided brief overview of the Bio-Argo float which is an Argo float attached with bio-sensors to measure parameters such as chlorophyll, coloured dissolved organic matter (CDOM), particle size distribution, dissolved oxygen and nitrate. She also briefed about its technical specifications, their functionalities and the sampling strategies. She also briefed about the simulation of float dispersal through particle tracking in near-global, 10 km eddy-resolving BGC Model Ocean Forecast Assimilation Model (OFAM) - World Ocean Model with Biogeochemistry and Trophic dynamics (WOMBAT). Ms. Louise stated the deployment strategies adopted for the current floats and the planned deployments. Ms. Louise concluded the presentation by briefing the outreach opportunities.

The project is seeking the support of IOGOOS through considering (i) conduct of a special Bio-Argo session in IOGOOS / SIBER / IRF / IOP meetings to be held in 2016 and (ii) consideration for an Indian ocean regional Bio-Argo arrays. Dr. Man-wai Rabenevanana enquired about the procedure to get the Argo profiling floats and their deployments in their region and it is clarified. Dr. Tim Moltmann explained about the International Argo Project and the Indian Ocean Science Team which takes care of the Argo project in the region. Dr. Wenxi Zhu also recalled about the International Argo project and suggested to contact them regarding the deployment in the EEZ of countries. Dr. R. R. Rao enquired about the availability of any demonstration in the utility of Bio-Argo floats in improvement of PFZ advisory services being provided by INCOIS. Dr. Srinivasa Kumar clarified that INCOIS is presently not using the data in PFZ Advisory services and mentioned that we are trying to use the data in comparing the satellite retrieved chlorophyll for in-situ validation.

2. Numerical modelling of water circulation and wind wave in northern Indian Ocean by Dr. Vahid Chegini

Dr. Vahid Chegini briefed about the wave forecasting project being carried out at Iranian National Centre for Oceanography and Atmospheric Sciences (INIOAS), Iran. Dr. Vahid detailed the main aim of the project by using the WAVEWATCH III model. Dr. Vahid mentioned that the Operational Wave Forecasting has three regional models viz. Nortwestern Indian Ocean Model with a resolution of 0.167° x 0.167°; Persian Gulf-Gulf of Oman Model with resolution of 0.05° x 0.05° and Caspian Sea Model with resolution of 0.05° x 0.05°. The models were prepared using the ETOPO1 data with resolution of 1 minute arc obtained from the National Geophysical Data Centre (NGDC). Dr. Vahid also briefed about the project on Numerical modelling of currents in the Persian Gulf and the Gulf of Oman being carried out using a 3D numerical model General Estuarine Transport Model (GETM). Dr. Vahid concluded his presentation with the details of other activities like Numerical modeling of current and physical parameters

in the North West part of Indian Ocean using 3D finite volume coastal ocean modeling (FVCOM).

Dr. Wenxi Zhu has enquired whether the models are at operational stage or operational stage and it was clarified by Dr. Vahid that Wave Watch III Model is in operational stage. Dr. Wenxi also enquired about the availability of any users experience with regard to wave forecast. Dr. Vahid mentioned that INIOAS had some marine organisations and had committees for gathering the users experience and also the committees compare the model results with DHI Denmark model results. Dr. Andreas Schiller enquired about the boundaries conditions used for southern seas for the Persian Gulf North Arabian Sea Model. It is clarified that the results of the model run by other research institutes like NOAA. Dr. Andreas also enquired about the users for the Gulf of Persian Model. Dr. Vahid mentioned the shipping industry, meteorology, navy, oil companies, ports and other private companies. They will also need both hind-cast and forecasts on currents, environmental and fisheries data.

3. Chemical oceanography of the Persian Gulf and the Gulf of Oman by dr. Alizadeh Lahijani

Dr. Hamid A.K. Lahijani briefed the INIOAS current and prospects researches in Indian Ocean including chemical oceanography. Dr. Hamid provided detailed about the INIOAS research stations its laboratories and various oceanography equipments available in the laboratories to measure physical, chemical, geology and biology parameters. He also briefed about the INIOAS plans and programs for Ocean observation such as building the first Iranian ocean going research vessel and other research activities being carried out in the Marginal Seas (Persian Gulf & Gulf of Oman) like Paleoclimate studies, Sea water and bottom sediment chemistry and ocean acidification studies.

4. Marine Biological studies in the Persian Gulf & Gulf of Oman by Dr. Hamid Rezai

Dr. Hamid Rezahi, INIOAS has briefed about the marine biological studies being carried out by INIOAS in Persian Gulf & Gulf of Oman. He mentioned about the parameters being collected under the studies using various onboard instruments at the research stations of INIOAS. Dr. Hamid provided an oversight on the distribution of benthos and the Zooplankton along the NE part of the Persian Gulf.

Dr. Faiza Yamini enquired whether the data on all the groups of marine biodiversity are available with INIOAS or only zooplankton and plankton data. Dr. Hamid responded that INIOAS could share the details on the phytoplankton groups that they study. Dr. Faiza also enquired about the possibility of the comparison of the species availability from both the regions especially the number of species and their distribution.

In response to a query on the models being used, Dr. Vahid responded that INIOAS is using local models for studying the rip currents and other models to study the currents. He also mentioned that they are trying to setup forecasting systems for rip currents in the

region. Dr.Nick expressed that all the talks from the Persian Gulf talks how we can develop the engagement in forthcoming International Indian OCean Expedition (IIOE)-2. These talks are helpful for planning in terms of IOC. Dr. Srinivasa Kumar enquired whether INIOAS has any Remote Sensing programme where they can use the remote sensing data. Dr. Vahid responded that they have a remote sensing group and have a National Centre for Ocean Data with relation to IOC and also have Ocean Forecasting Centre. INIOAS uses satellite oceanography tools especially for corals. INIOAS utilizes low resolution data from international platforms and high resolution images are obtained from remotely controlled devices for coral monitoring. Dr. Wenxi enquired about the activities on ocean acidification and it was clarified that INIOAS has different instruments to measure physical and chemical parameters to know the alkaline, carbon system and also sample corals and understanding their impact and for comparing the growth rate in natural and controlled environment.

5. Ocean Observations - India Perspective by Mr. R. Ramasundaram

Mr. Ramasundaram made a presentation on the genesis of Indian Data Buoy Programme, its objectives, activities being carried out under the Ocean Observing System (OOS), development of OMNI buoys, utilization of the data and various other innovations and collaborative activities of National Institute of Ocean Technology (NIOT). Under the OOS activities, he briefed about the network of Buoys (OMNI, Tsunami and Coastal Buoy systems), CALVAL sites, technology demonstration of new observation tools, calibration facilities, etc. Mr. Ramasundaram also recollected the experience of Phailin and Hudhud cyclones wherein the buoy system has helped to the great extent in providing accurate and in advance predictions. He also informed about the capturing of the tsunami events in the Indian Ocean by Tsunami Buoys. Briefed about various data avenues and research insights of the buoy data. He also briefed about various applications that used the buoy data. Mr. Ramasundaram provided details about the Indian Arctic Observatory (IndARC) at Kongsfjorde, successful deployment of IndARC Mooring at Arctic, Southern Ocean Carbon Process SOCarp Study, etc. Mr. Ramasundaram provided the glimpses of the in-house innovation carried out under the Ocean Observing System (OOS) like Wind Powered Green Buoy System, Indigenous Data Acquisition System (IDAS), Aquabot, Variable Buoyancy of Aquatic Glider, Dual Communication for Tsunami Buoys, R-Darash, Indigenised OMNI Buoy-Prakruti, New Generation Buoy - Sagar Bhoomi and ADvanced Data REception & analysis System (ADDRESS). A brief introduction was provided on the Indo-Japan, Indo-Norwegian, Indo-US Collaborations.

Dr. Faiza Yamini mentioned that it was very impressive to know the innovations and enquired about how NIOT dealt with the buoy fouling under the water. Mr. Ramasundaram clarified that the buoys in coastal regions were services more frequently in a year and the deep ocean buoys were not faced major fouling. He also mentioned that they use certain sensors which has a chemical to remove these bio-fouling. Dr. Rezah Badal mentioned whether NIOT has any programme to test the technology in other waters in the Indian Ocean. If so, there is a scope for mutual collaborations. Dr. Weidong has enquired about the buoys in Andaman and the availability of the data. It

was mentioned that the data is already available on INCOIS Website. Dr. S S C Shenoi mentioned that the data goes on GTS as well as on INCOIS website which you can also see the same. Dr. Hamid Rezai enquired about the cost of R-Darsh and it was clarified by Mr. Ramasundaram that the camera and other accessories will cost around USD 200. Dr. Rezah Badal enquired about the possibility of the integration of the system on the buoys. Dr. Man-Wai Rabenavanana enquired about the usefulness of the system in surveying the fishing activities as well as the status of bad weather conditions at the location.

IIOE-2 Planning and Implementation

The consortium discussed IIOE-2 expedition and science planning in great detail. There were several talks highlighting importance of IIOE-2 and science plan being developed in many countries to make IIOE-2 a grand success. Here are some highlights of talks on national plan on IIOE-2 and other IIOE-2 related activities.

1. Progress on IIOE-2 Planning – IOC Perspective by Dr. Nick D'Adamo, IOC PRPO

Dr. Nick D'Adamo briefed on the progress of the IIOE-2 planning by IOC. He talked about the aspirations and motivation to take up the decadal celebrations of IIOE. Dr. Nick presented the history of IIOE highlighting the legacy of the expedition is in terms of collection of volumes of data, publishing of science, measurements and study results in the fields of geography, chemical, physical oceanography, marine biology, meteorology, geophysics, etc. An important outcome of the expedition was the emergence of National Institute of Oceanography (NIO) in India. The Indian Ocean Bubble newsletter was an informal way to discuss the science issues during the IIOE era and is being re-brought by India. Dr. Nick mentioned that the summary of the expedition are available in terms of the websites, bloggers, archives of data, papers, and scientific information, etc. which might help in planning and executing the new expedition. Though our understanding of the Indian Ocean has considerably improved in post-IIOE era owing to expeditions such as JGOFS and WOCE in 80's and 90's, there is still much left to be done and accomplished in terms of our understanding on monsoon and the human impact on biogeochemical processes. An integrated approach, by connecting individual research programmes is the need to the hour to develop an integrated science plan for the Indian Ocean.

The Ocean science community in the region is coming together along with the global community not only with the scientific interest but also for the societal benefit interest. There are very strong societal and science drivers underpinning the motivation for another expedition in the Indian Ocean. There are science drivers from the nations presented at the IOC Assembly executive council few months ago. The understanding that comes from the science programmes to support the sustainability views in the Indian Ocean and human well-being, the contemporary techniques, infrastructure and technology will help achieve the goals.

Dr. Sidney Thurston enquired whether any entity is available to govern and coordinate the IIOE-2 plans now. It was clarified that though there is no formal governing body, it is mostly organic process and voluntary grouping of interested people coming together largely from their own / institutional funding. The IOC Executive Council at its 47th session (July 2014) adopted the International Indian Ocean Expedition-2 (IIOE-2) as a major initiative of the IOC, to be undertaken jointly with the Scientific Committee for Oceanic Research (SCOR) and the Indian Ocean GOOS (IOGOOS), through Resolution EC-XLVII.1

Dr. Raleigh Hood requested to mention about the separate roles of SCOR-IOC in the planning. At the moment, SCOR is developing the Science plan and the IOC established an Interim Planning Committee (Group of Experts) jointly with SCOR and IOGOOS to undertake initial planning work for IIOE-2. In accordance with this Resolution, the IOC invited national coordinating bodies, IOGOOS (3 members) and SCOR (2 members) to nominate potential expert members to the Interim Planning Committee (IPC).

Dr. Wenxi Zhu recalled about the discussions during the IIOE-2 Reference Group meeting in China, especially on the idea of establishment of several working groups including the working groups on Capacity building and outreach. Dr. Nick clarified that IPC is soon going to be established in next few weeks and the science plan committee being established by SCOR would come as part of IPC. Probably IPC may adopt the Science plan. There is already energy to ensure the capacity building as the sub-section of the science plan for the IPC. Dr. Raleigh Hood mentioned that the Science Plan specifically mentions about the recommendations on capacity building.

2. Status of development of IIOE-2 Science Plan by Dr. Raleigh Hood, USA

Dr. Raleigh Hood made a detailed presentation on the history of IIOE-2 development, draft Science Plan and some accomplishments and action items from the Bremen SCOR Science Plan Development Committee (SPDC) Meeting. He mentioned that the discussions were initiated by Dr. Ed Urban at the IMBER SSC meeting in Marseiles in April 2011 on the idea of 50th Anniversary Symposium and the discussion continued at the SIBER/IOP/IRF meeting in Chennai, India in July 2011. Discussions to repeat few IIOE lines were initiated by the Dr. Lynnath Beckley, Australia at IOP/SIBER/IRF meeting in Chennai in July 2011 followed by the discussions on motivating an upwelling research initiate as a part of IIOE-2. The idea of forming a Reference Group to convene meetings to explore the IIOE-2 idea emerged at the SIBER/IOP/IOGOOS/IRF meetings held at Cape Town, South Africa in October 2012. He also informed members about possibility of organising a 50th Anniversary Symposium at NIO, Goa. India, taking a lead in making IIOE-2 a reality, formed and convened a national IIOE 50th Anniversary Planning Committee meeting in April 2013 and offered to host the first IIOE-2 Reference Group meeting at Hyderabad, India in May 2013. The first reference group meeting on IIOE-2 discussed on organisation of symposium, summer schools, completion of repeat lines, science questions to be addressed and research initiatives to be taken up. A decision on the IIOE-2 was adopted by the IOC 27th General Assembly meeting in Paris during June 2013. The Science and societal drivers were emerged

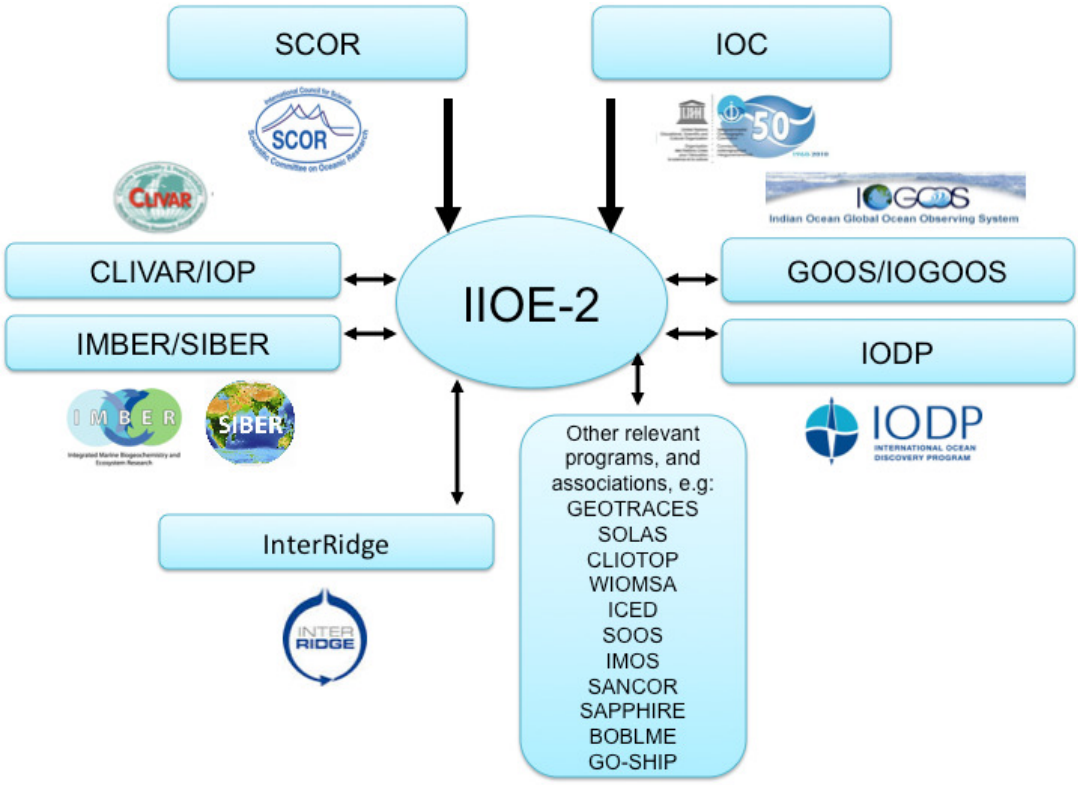
during the Second IIOE-2 Reference Group meeting held at Qingdao, China in November 2013 where the need for a Western Indian Ocean research initiative was also discussed. IIOE-2 planning workshops and meetings were convened in Germany, UK and US since January 2014 to October 2014. The third IIOE-2 Reference group meeting was held in Mauritius in March 2014 where the planning for Western Indian Ocean Upwelling Research Initiative (WIOURI) was initiated. During April / May 2014, SCOR formed an IIOE-2 Science Plan development committee and a resolution supporting the IIOE-2 concept was adopted at the 47th IOC Executive Council meeting where a plan to establish IIOE-2 Interim Planning Committee (IPC) evolved. A draft IIOE-2 Science plan was presented at the SCOR SPDC meeting in Bremen, Germany during September 12-17, 2014 with a target to complete the science plan by January 2015.

Dr. Raleigh Hood then continued to present various aspects of the draft Science plan such as the general motivation and historic background. He also briefed on scientific background and motivation based on the science and societal drivers identified during IIOE-2 reference group meetings. He then briefed about the proposed 6 science themes of IIOE-2. The Themes and the proposed core questions to be addressed are as follows:

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? ➢ How, in turn, are these impacts affecting human populations in Indian Ocean rim nations?
Theme 2: Boundary current dynamics, upwelling variability and ecosystem impacts	➢ 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 3: Monsoon variability and ecosystem response	➢ 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	➢ 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	➢ How do extreme events in the Indian Ocean impact coastal and open ocean ecosystems? ➢ How will climate change impact the frequency and/or severity of extreme weather events, tropical cyclones and tsunamis in the Indian Ocean? ➢ 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	➢ 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?

Dr. Hood stressed on few existing long-term monitoring programs that will be incorporated into and strengthened during IIOE-2. The importance of the data standardization and inter-calibration were also highlighted. It was also mentioned that the integration of multi-disciplinary research in the Indian Ocean is the core of IIOE-2 in order to address the overarching goal of IIOE-2 where in it is important to establish links between scientist's involved geological, ocean and atmospheric research, especially during the initial development stages of IIOE-2. As part of the linkages, IIOE-2 will be build upon the research experience of past projects such as the JGOFS Arabian Sea Process Study, European and Indian Expeditions and WOCE and leverage ongoing projects such as IndOOS/RAMA, GEOTRACES, GO-SHIP, IODP and InterRidge. The schematic structure of IIOE-2 is shown in figure below



Regarding the data and information management, a plan will be developed by the IOC IIOE-2 Interim Planning Committee based primarily on existing IOC Capacity with the guidance of IOC and SCOR. IOC's International Oceanographic Data and Information Exchange (IODE) provide a logical framework and infrastructure that can support IIOE-2 data and information management. The IOC Data policy (2003) was recollected to state that the generic commitment of Member states is to provide timely, free and unrestricted access to all data, associated metadata and products generated under the IIOE-2. With regard to the Capacity Building in the region, IIOE-2 Interim Planning Committee (IPC), based on existing IOC, SCOR and other organization's capacity will develop a plan. IIOE-2 will be designed to stimulate research capacity in the international community and especially among developing Indian Ocean rim nations by promoting training courses to develop multidisciplinary science skills, workshops, summer schools and a program of personnel exchange. IIOE-2 Science plan recommends IIOE-2 IPC to consider forming a capacity builign subcommittee, whose members would be from countries planning IIOE-2 activities (from the Indian Ocean region and beyond) and international organizations with activities in capacity building for ocean science. The IIOE-2 Subcommittee on Capacity Building should initiate its capacity building activities by convening a meeting of the major international and regional organizations that conduct capacity building, including IOC, SCOR, POGO, WIOMSA, etc. The purpose of this meeting will be to determine what each organization will contribute, and to develop a detailed capacity building plan for IIOE-2, including how funding will be developed for the plan. Dr. Hood also briefed about the IIOE-2 Outputs and Legacy. It was mentioned here that 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 as rich as the original expedition. Dr. Hood concluded his presentation on the draft science plan of IIOE-2 by briefing few accomplishments and the action items identified from the SCOR Science Plan Development Committee (SPDC) Meeting at Bermen, Germany.

Dr. Vahid Chegini recalled that the science plan provides the 06 scientific themes in which group of scientists are involved. It was also mentioned that some scientist especially from the Indian Ocean region are getting involved in the project of IIOE and its studies. In the 06 groups dealing with the scientific themes, the names of the scientists from the region are not seen. But it is mentioned that involvement of the next generation is one of the progress of the plan.

Dr. David enquired whether there are any representations from the Large Marine Ecosystem (LME) in the IIOE. Dr. Hood replied that the representation of LME's is not there in the Science plan development committee but we did have the representation of LME's in the reference group process of IIOE which can be seen by the next couple of presentations. There are involvement of BOBLME and former ASCLME which is now known as SAPHIRE and other regional associations such as WIOMSA.

Dr. Andreas to look at what can models could contribute towards the design of the observing system. He suggested that the science plan should focus on process modelling studies, observing system studies and the ability and opportunity to purse small data synthesis, etc. Dr. Hood responded that the research objectives can also be achievable through models. The introduction already mentions about the key process studies and how the oceanography studies changed in terms of the remote sensing, modelling and communication. The plan focuses on the science objectives and does not discuss the methods to achieve this. But it does callout for the observing systems.

Dr. Nick, responded to the Dr. Chegini and Dr. David comments, and clarified that there is nothing in the science plan on who should and should not do. What SCOR has done is to look at results of the reference group meeting which indeed multi- represented by the stakeholders. Dr. Raleigh mentioned that if it is felt that the plan doesn't provide a space for you, please let us know, we could create the space. Dr. Raleigh and Dr. Nick then briefed about the review process of the Science Plan.

Mr. Rezah enquired about the mechanism of implementation plan. Dr. Hood clarified that IOC will be responsible for the development of the implementation plan.

Dr. Srinivasa Kumar mentioned that when it was talked about the hazards and its associated impact and increased frequency of hazards in the science plan, it reminded him about the Indian Ocean Tsunami Warning and Mitigation System (IOTWS), which is working on tsunami with 23 Indian Ocean rim countries. They are generating lot of data on sea level data, seismic data, geophysical data, etc and using them effectively in

collaboration. We should look into that efforts and find ways how we could put in a similar coordinated efforts.

Dr. Wenxi mentioned that further strengthening of the science and socio economics, the involvement of scientists in the planning is very important and this need to related to the government that leads to support to funding the activities.

3. Update on Eastern Indian Ocean Upwelling Research Initiative (EIOURI) by Dr. Weidong Yu, FIO, China

Dr. Weidong Yu presented the preliminary results and planning progress of the project on Eastern Indian Ocean Upwelling Research Initiative (EIOURI). Dr. Weidong briefed about the Eastern Boundary Upwelling System, Ocean acidification scenario in 2100 and the upwelling regions in the Eastern Indian Ocean. The planning process and the sequence of planning workshops held at Yokohama, Japan (April 2013), Qingdao, China (Nov 2013) and Bergen, Norway (Jun 2014) were briefed. EIOURI Science Plan and Implementation Strategy was prepared during April 2014 at Phuket, Thailand. The core questions were identified as (i) How are marine biogeochemical cycles, ecosystem processes and fisheries in the Indian Ocean influenced by boundary currents, eddies and upwelling? (ii) How does the interaction between local and remote forcing influence these currents and upwelling variability in the Indian Ocean? and (iii) How have these processes and their influence on local weather and climate changed in the past and how will they change in the future? Provided the tract and station details on the pilot cruise conducted south of Java during September 22 – October 2, 2013 and the eddy activities observed during the cruise. The preliminary results in terms of the observed temperature, Chlorophyll, Salinity and DO variations during the cruise period and the eddy genesis in the Indian Ocean were presented. Dr. Weidong concluded the presentation with the future planning activities of the project.

Dr. Wenxi enquired about the science plan of this project for which Dr. Weidong informed that the document would be circulated soon.

4. Update on IIOE-2 activities in South-West Indian Ocean by Dr. Mike Roberts, South Africa

Dr. Mike Roberts presented the upwelling regions and seasons in the Western Indian Ocean and the subtropical Indian Ocean counter current. Dr. Mike detailed about the proposal on Western Indian Ocean Upwelling Research Initiative (WIOURI). The WIOURI facilitates regional (neighbouring country) collaboration, brings together Arabian Sea (north) and SWIO (south) science teams together and pulls in big resources like ships, funding and skills for the poorest region of the Indian Ocean. Dr. Mike expressed how the proposed 6 themes and upwelling research initiatives detailed in the IIOE-2 draft Science Plan will be integrated. In terms of capacity building, Dr. Mike referred to the potential legacy projects such as regional School of Technology Oceanography (SOTO), Cape Town and the new institute of Marine Sciences, Zanzibar, Tanzania. He concluded with a brief on the need to have a north-south WIOURI

workshop that need to be held soon and with a question of how it can be done and any mandate to go for funding for WIOURI?

Dr. Man-wai mentioned that they are interested in knowing the Southern upwelling off Madagascar and its impact, both positive and negative. One of the problem is to strengthen the capacity building of young researchers and any effort towards this is very good and encouraging. He also mentioned that the eastern side like Australia is pretty developed where as South Africa is bit okay.

Dr. Shenoi mentioned that the IIOE-2 is an inclusive programme and not an exclusive one. Each country can express their interest and where they can contribute. We see a lot of areas with common interest. The resource sharing depends on the country. The controlling office should coordinate so that everyone should get the best.

5. IIOE-2 activities and planning in India by Dr. S. S. C. Shenoi, INCOIS, India

Dr. S. S. C. Shenoi provided an update on the Science Plan of India for IIOE-2 (2016-2020). Dr. Shenoi recalled the outstanding questions of early 60's, early 80's and further developments made in terms of sustained observations, ocean modeling and theory and process studies. He also mentioned that these developments improved in better prediction of monsoons and operational oceanographic services in the region. Dr. Shenoi briefed about the major ongoing Indian programmes like Continental Tropical Convergence Zone (CTCZ), Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER), SIBER-India, GEOTRACES-India and other Paleo-oceanographic studies of the Eastern Indian Ocean and major collaborations like Bay of Bengal Boundary Layer Experiment project, Ocean Mixing and Monsoon Project and RAMA. Dr. Shenoi, in detail, explained 06 current issues on (i) Understanding of the details of air-sea interactions, (ii) understanding the deep ocean circulation (iii) understanding the biogeochemical processes (iv) understanding of the benthic ecology of Oxygen Minimum Zones (OMZ) (v) hydrodynamics and biogeochemistry of the southern subtropical Indian ocean and (vi) South West Tropical Indian Ocean (SWTIO) and the largest Geoid low on the Earth. Dr. Shenoi also provided a glimpse of the observing systems available for IIIOE-2 in the Indian Ocean. He also mentioned about the capacity building opportunities that could be available under International Training Centre for Operational Oceanography (ITCOocean) which is established at INCOIS, Hyderabad, India with the recognition of IOC. Dr. Shenoi also briefed the resources that India might contribute for IIOE-2 in terms of Ocean Research Vessels, existing satellite missions and future satellite missions with improved resolutions with capabilities for measuring more parameters. The data policy of India was also summarized. Dr. Shenoi highlighted on the IIOE-2 India website (http://www.incois.gov.in/portal/iioe/index.jsp) and the Indian Ocean Bubble-2 newsletter being released by India. Dr. Shenoi concluded the Indian activities to IIOE-2 with a request for submission of abstracts to the forthcoming workshop on "IIOE to IIOE-2 – Five decades of Indian Ocean Oceanography: Challenges in Physics and Biogeochemistry of Indian Ocean" scheduled to be held at Prague during June 22 – July 2, 2015.

6. Mobilizing Research Platforms and Instrumentation in the Indian Ocean: An Adaptive, Collaborative Approach by Mr. Jim Costopulos, Global Oceans, USA

Mr. Jim Costopulos made a brief presentation on Global Oceans / GO-CEPT Model and implications for IIOE-2 and future IO research. Made a brief situation analysis with reference to IIOE 1 vs IIOE 2 with regard to the resource availability and considering the drivers of operational complexity. He discussed about the proposed organisational frameworks to enable an adaptive, collaborative expedition approach & that can scale as needed. He also mentioned about the contribution of Global Oceans that can be made in terms of Education, Outreach & Promotion strategy for IIOE-2. Mr. Jim also briefed about the use of modular laboratory systems for research vessels, mobilizing the private sector resources for research, etc. He mentioned that the principal elements of the Global Oceans model includes vessels deployment regionally, independent & open source platforms, cost sharing model, adaptive to project research, globally scalable, etc. He mentioned that the model that they proposed to adopt is mobilizing fully functional research vessels in partnership with industry and not a ship-of-opportunity model. They mobilize the existing resources in the market and combine them with the resources available through partnerships and industry. He also mentioned about the collaborations and Partnerships that Global Ocean has in various fields such as mapping tools, data visualization, use of autonomous surface vehicles, deployment of ROPOS ROV System on Global Oceans expeditions, etc. It was mentioned that ~1380 OSVs operated in the IO basin. The IIOE-2 Logistical framework proposed by Global Oceans organizes and aggregate the broad research plan into geospatial scenarios that can correlate with expedition planning; and that supports the broadest opportunity for collaboration and resource-sharing. He briefed about the GO-CEPT: Planning & collaboration platform under which an web-based, GIS enabled expedition and research planning environment can be built on SeaSketch platform. This will be integrated with the planning of cruise tracks, activities and resource sharing with user-defined graphics tools and forums, algorithm based tools to model cost impact of various track and activity scenarios, etc. This will be hosted by Global Oceans at no cost to IIOE-2 community. Dr. Jim detailed about the proposed operational frameworks for expedition planning and IIOE-2: Education, Outreach and Promotion activities.

7. IIOE-2 Planning in Indonesia by Dr. Dwi Susanto, Indonesia

Dr. Dwi Susanto provided an update on the efforts of Indonesia in IIOE-2 planning activities. He recalled the participation of Indonesian scientists in the International Indian Ocean Expedition (1959-1965), process of coordination mechanisms and the Strategic direction adopted during IIOE. He re-iterated that 24 countries have participated in 46 research ships of 14 different flags during IIOE-1. He mentioned that the Indian Ocean Standard Net was adopted for sampling of zooplankton. The Indian Ocean Biological Centre was established during 1963 at Cochin, India as sorting centre for zooplankton. He also recalled the intercalibration of marine primary productivity measurement in preparation for the IIOE in 1962 carried out onboard HMAS GASCOYNE (Australia) and RV VITYAZ (USSR). He summarized the details on the early Indonesian Research Ships KM SAMUDERA and RI JALANIDHI. Dr. Susanto

recollected the role of Panitia Nasional Panelitian Laut (PNPL) in the Indonesian participation in IIOE and the stations occupied by Indonesia ship RJ Jalanidhi during IIOE in 1964-65. He also mentioned about various other ships took part in IIOE where Indonesian scientists have participated. He briefed about the outcomes of the expeditions such as publish of Oceanographic atlas of the International Indian Ocean Expedition and Meteorological Atlas of the International Indian Ocean Expedition and results on upwelling in the region between Java and Australia during the Southeast monsoon, flow of Banda Intermediate Water in the Indian Ocean at depth 900-1100 m. It was also recollected that the large scale phenomena's of WYRTKI Jet (Equatorial jet in the Indian Ocean), Madden-Julian Oscillation (MJO) were found in the Indian Ocean after the International Indian Ocean Expedition. Dr. Susanto mentioned that since 50 years IIOE, lot of fundamental changes have taken place in Ocean Science in terms of emergence of new components of ocean observing system, emergence of ocean modelling in all of its facets from short term forecasting to seasonal prediction to climate projections.

SIBER 5 SSC

SIBER Update: Review of Accomplishments and Activities since SIBER-4

Raleigh Hood

SIBER progress since the last SSC and scientific talks from invited local experts have already been reported in earlier sections. The meeting report of SSC-4 has already been completed and published on SIBER website. SIBER has played an important role in motivating international community for IIOE-2 and is also playing an important role in preparing the Science plan of IIOE-2. The formation of reference group on planning IIOE-2 activities that was discussed and plan during the SIBER -4 SSC meetings has made significant progress in shaping up IIOE-2 related activities and science plan.

Dr. Hood also expressed his concern on members who have not attended any of the SIBER SSC meetings such as Dr. David Vousden. It was proposed that such non-active members should be dropped from the SSC. It was also suggested to replace Dr. Zainal Arifin with other active researcher from Indonesia. It was also stresses that biogeochemical studies of Indonesian waters are limited in time and space but are important and critical to understand their impact, through Indonesian throughflow, on the Indian Ocean. It is, therefore, imperative to have linkages and collaborations with researchers in Indonesia and their representation in SIBER.

Rotation of SIBER SSC

The rotation of SSC members was discussed in great detail during SIBER 4th SSC meeting and taking it forward, and since Dr. Raleigh Hood is going to complete his second consecutive term as Chair SSC, SIBER, the issue was again discussed in the present SSC meeting. Dr. Hood offered to step down as chair. The decision was kept on hold as all SSC members felt that his contribution and effort towards success of SIBER is impeccable and he needs to continue as chair in view of upcoming IIOE-2 events. He is also contributing immensely towards finalizing IIOE-2 science plan. It was also felt that the rules on rotation of SSC members need to be looked into before taking a final call. It was therefore decided that the final decision on change of SIBER leadership will taken during SIBER executive committee meeting.

Dr. Hood also informed SSC that he is likely to rotate off from Indian Ocean panel and Dr. Jerry Wiggert will represent SIBER on Indian Ocean Panel.

Discussion on SIBER IPO in India in harmony with Australia and Africa Regional project Office

SSC reviewed the progress made towards establishing regional project offices at Australia and South Africa, in harmony with SIBER international programme office at INCOIS, Hyderabad. Members were briefed that Ms Louis Wicks of IOC Perth Program Office has been identified as a resource person to carry out SIBER related activities at Australia. Ms Wicks in fact took the charge and is attending the SIBER 5 SSC meeting. Steering committee members welcomed her and look forward towards her contribution in expanding SIBER base at Australia. She also helped in conducting the integrated meetings along with SIBER and IOGOOS secretariats. Committee suggested starting developing a website to highlight achievements of SIBER in Australia and establish linkages with active and interested researchers from this region, especially those who have keen interest in pursuing research in the Indian Ocean.

Committee also noted that we could not make a noticeable progress in establishing a parallel regional program office at South Africa. The setting up of RPO at South Africa is critical for expansion of SIBER related activities in South African continent. SIBER not only aims to promote and encourage research in those continents but also aims to train manpower/ carry out capacity building activities in the continent through sustained means. Biogeochemical studies in the South African waters are critical to develop a comprehensive understanding of the Indian Ocean and its role in global climate change/responses. Co-Chair of SIBER Prof. Mike Roberts was requested by the committee members to expedite the process towards establishing SIBER Regional programme office at South Africa. SIBER SSC will also contribute, by organizing workshops and summer schools, for capacity building in Africa. SIBER will also interact with scientists in Africa involved in biogeochemistry and ecosystem research and help broaden their scope of research to meet goals of SIBER.

Flyers on highlighting SIBER acheivements

During the SIBER SSC-4 it was decided to showcase achievements of SIBER to international community by means of flyers and leaflets. Committee discussed the possibility of coming up with flyers and leaflets on SIBER theme and tapping up Ms Lisa Maddison, Executive Secretary, IMBER for designing one page flyer. The SIBER science plan and implementation strategy (SPIS) may provide content for the flyer. It was also decided to include/highlight role of SIBER in planning and execution of IIOE-2.

SSC also reviewed progress made on special issue in Journal "Biogeosciences". Dr. Cowie updated committee members on the progress. Several papers have received for this special issue and their review in sin progress.

SIBER Webpage:

SSC reviewed the progress on SIBER website hosted at INCOIS portal in great details and made some constructive suggestion to make it more active and informative. SSC members suggested incorporating following suggestion for improving SIBER website:

1. Provide link on SIBER website on IIOE-2 Science planning committee, in synergy with SCOR website.
2. Provide the link of IIOE-2 page on SIBER home page and write a paragraph on role of SIBER in shaping IIOE-2.
3. To provide details on SIBER SSC meetings, list of participants and meeting reports.
4. It was suggested to move list of past SIBER SSC members as a separate section on SIBER web-page
5. It was also proposed to create a separate sub class of "Emeritus Members" under members subsections and move Names of Dr. Wajih Naqvi and Dr. Hiroshi Kitazato in the new sub-class of Emeritus Members. Through these members have officially rotated off from the SSC list, they continue to support and motivate SIBER community. We look forward to their continued guidance and support.

SIBER Attendees

1. Member Participants (13):

1.	Raleigh Hood	USA
2.	Jerry Wiggert	USA
3.	Dwi Susanto	USA
4.	Michael Landry	USA
5.	Birgit Gaye	German
6.	Somkiat Khokiattiwong	Phuket
7.	Michael Roberts	South Africa
8.	Jennifer Huggett	South Africa
9.	Gregg Cowie	United Kingdom
10.	Makio Honda	Japan
11.	Satya Prakash	India
12.	Nick D'Adamo	Australia
13.	Louis Wicks	Australia

Invited Experts (5)

1.	Weidong Yu	China
2.	Ashley Jhonson	IOC
3.	Daroonwan Sakuna-Schwartz	Phuket
4.	Mike McPhaden	USA
5.	T. Srinivasa Kumar	India

2. Member apology for absence (4):

1.	Lynnath Beckley	Australia
2.	David Vosuden	ASCLME, South Africa
3.	Xabier Irigoien	
4.	M. Ravichandran	India

SIBER

Sustained Indian Ocean Biogeochemistry and Ecosystem Research

5th Scientific Steering Committee Meeting, October 29-30, 2014, Phuket, Thailand

Agenda

Planned Attendees:

SIBER SSC Members: Raleigh Hood (Chair), Mike Roberts, (co-Chair), Jerry Wiggert, Dwi Susanto, Somkiat Khokiattiwong, Mike Landry, Birgit Gaye, Jennifer Huggett, Greg Cowie, Makio Honda

Invited Experts: Weidong Yu, Ashley Johnson, Daroonwan Sakuna-Schwartz, Mike McPhaden

SIBER IPO Staff: Satya Prakash

IOC Perth Office: Nick D'Adamo, Louis Wicks

SIBER-5 will be held in conjunction with the 11th Indian Ocean GOOS (IOGOOS) meeting, and the 5th IndOOS Resource Forum (IRF) meeting. The SIBER SSC meeting will be convened all day on October 29th and it will continue with a mini-science symposium on the morning of the 30th. IOGOOS will meet in parallel with the SIBER SSC in the morning on the 30th. We will have a joint session with IOGOOS in the afternoon on October 30th (see separate agenda). Also note that there is a planned joint IOGOOS-SIBER group dinner on the 30th (IOP and SIBER delegates and guests).

Wednesday Morning 29 October

0900-0915
SIBER SSC WELCOME: ***Overview of agenda and SSC meeting goals, news from the Executive Committee, Steering Committee rotations, etc.*** **(Raleigh Hood and Mike Roberts)**

0915-0945
SIBER UPDATE: ***Overview of SIBER-4 meeting report*** **(Satya Prakash and all SSC)**

0945-1000
THE SIBER IPO: ***Update on the IPO and progress on the website, blog, etc.*** **(Satya Prakash)**

1000-1015
THE SIBER IPO: ***Outcome of efforts to approach the IMBER IPO to help with advertising materials (e.g., a 1-page flyer) for SIBER in an effort to bring SIBER science to policy makers.*** **(Raleigh Hood and Satya Prakash)**

1015-1030
SIBER UPDATE: ***Review of IMBER and IOC Perth Office budgetary situations and ramifications for SIBER*** **(Raleigh Hood and Nick D'Adamo)**

1030-1045
MORNING BREAK

1045-1100
THE SIBER AUSTRALIA RPO: ***Update on progress toward establishing a Regional Program Office in Australia.*** **(Raleigh Hood and Nick D'Adamo)**

1100-1115
THE SIBER SWIO RPO: ***Update on progress toward establishing a Regional Program Office in the southwestern Indian Ocean region. Can this be done without support from David Vousden?*** **(Mike Roberts and Raleigh Hood)**

1115-1130
NATIONAL PERSPECTIVE: ***Update on SIBER India.*** **(Raleigh Hood for Wajih Naqvi)**

1130-1200
DISCUSSION: ***SIBER progress to date. Have we made significant progress on our objectives from SIBER-4? What additional work needs to be done on our website? How can additional resources for the IPO and the SSC be secured? What are the next steps that we need to take toward establishing an RPO in Australia? What are the prospects for establishing an RPO in South Africa? What can we do to better advertise SIBER in Indian Ocean rim nations and elsewhere?*** **(Leaders: Raleigh Hood, Nick D'Adamo and Mike Roberts)**

1200-1330
LUNCH

Wednesday afternoon 29 October

1330-1345
SIBER UPDATE: ***Status of SIBER research initiatives in the Indian Ocean including the Eq, 80^{o}E biogeochemical sensor data analysis, efforts to calculate ITF nutrient fluxes and the new biogeochemical sensor deployment on the RAMA mooring at 26^{o}S, 97^{o}E.*** **(Raleigh Hood)**

1345-1415
DISCUSSION: ***Developing SIBER research initiatives and products related to the science plan research themes, including on-going research, planned papers and special issues. Lets also have an update on the Biogeosciences Special Issue on the Northern Indian Ocean. What are the next steps?*** **(Leaders: Raleigh Hood, Mike Roberts and Greg Cowie)**

1415-1430
DISCUSSION: ***How can we motivate meaningful capacity building in SIBER?*** **(Raleigh Hood and Nick D'Adamo)**

1430-1500
IIOE-2 PLANNING DISCUSSION: ***Progress in planning the 2nd International Indian Ocean Expedition and overview of the various initiatives that are moving forward. What is the status of the SCOR IIOE-2 Science Plan development effort? What is the status of the IOC IIOE-2 Implementation Plan development effort? What is the status of the 50th Anniversary Symposium planning effort? How do we integrate IIOE-2 planning into SIBER? What is the status of the EIOURI planning efforts? What is the status of efforts to develop a WIOURI? Will the Reference Group meet again to try to engage northwestern Indian Ocean rim nations?*** **(Leaders: Raleigh Hood, Greg Cowie, Mike Landry, Weidong Yu and Nick D'Adamo)**

1500-1515 AFTERNOON BREAK

1500-1700
NATIONAL PERSPECTIVES: ***Brief presentations and/or discussions (10 min. max.) by SIBER SSC members and guests on national activities and/or plans related to SIBER and/or IIOE-2:***

-NATIONAL PERSPECTIVE: UK (G. Cowie)
-NATIONAL PERSPECTIVE: Germany (B. Gaye)
-NATIONAL PERSPECTIVE: Indonesia (D. Susanto)
-NATIONAL PERSPECTIVE: USA (M. Landry, J. Wiggert, R. Hood, M. McPhaden)
-NATIONAL PERSPECTIVE: Japan (M. Honda)
-NATIONAL PERSPECTIVE: Indian (S. Prakash)
-NATIONAL PERSPECTIVE: Australia (N. D'Adamo)
-NATIONAL PERSPECTIVE: South Africa (M. Roberts , J. Huggett, A. Johnson)
-NATIONAL PERSPECTIVE: China (Weidong Yu)
-NATIONAL PERSPECTIVE: Thailand (Somkiat Khokiattiwong)

1700-1730
DISCUSSION: ***Action items and plans for the coming year. Are we going to pursue the development of any new SIBER "products", e.g., related to the SIBER SPIS Themes as discussed previously? Should we consider doing another special issue? We also need to discuss plans for out next SIBER SSC meeting with the IIOE 50th Anniversary Symposium in Goa.*** **(Leaders: R. Hood and M. Roberts)**

1900-2200 SIBER Group Dinner (TBA)

Thursday morning 30 October

SIBER Mini-Symposium (Convener: Raleigh Hood)

0830-0845
Sedimentary structures of modern events preserved on the Andaman Sea continental shelf, Thailand **(Daroonwan Sakuna-Schwartz)**

0845-0900
Ocean acidification study in Thailand and regional cooperation **(Somkiat Khokiattiwong)**

0900-0915
On the quest to estimate biogeochemical fluxes associate with the Indonesian throughflow **(Dwi Susanto)**

0915-0930
On the quest to estimate biogeochemical fluxes associate with the Indonesian throughflow **(Raleigh Hood)**

0930-0945
Eastern Indian Ocean upwelling research results and plans **(Weidong Yu)**

0945-1000
Science plan in the Bay of Bengal: the effect of eolian dust on ocean biogeochemistry **(Makio Honda)**

1000-1015
Issues and potential for applying compound-specific isotope analyses in EIOURI **(Mike Landry)**

1015-1030
Interdisciplinary research in the Southwestern Indian Ocean region **(Mike Roberts)**

1030-1045 MORNING TEA

1045-1100
Application of novel techniques to explore zooplankton community structure in mesoscale eddies in the south-western Indian Ocean **(Jennifer Huggett)**

1100-1115
Benthic biogeochemical research in the northern Indian Ocean **(Greg Cowie)**

1130-1145
Biogeochemical research in the northern Indian Ocean **(Birgit Gaye)**

1115-1130
Update on RAMA and/or new research results from the equatorial Indian Ocean **(M. McPhaden)**

1145-1200
Large-scale remote sensing of biogeochemical variability in the Indian Ocean **(Jerry Wiggert)**

1200-1330
LUNCH

Thursday afternoon 30 October

Joint SIBER and IOGOOS meeting…

1900-2200 SIBER and IOGOOS Group Dinner (TBA)