

CLIVAR REPORT

Climate and Ocean: Variability, Predictability, and Change



Meeting Report

The 19th Session of CLIVAR/GOOS Indian Ocean Region Panel

8th February, 2023, Perth Australia and online

March 2023

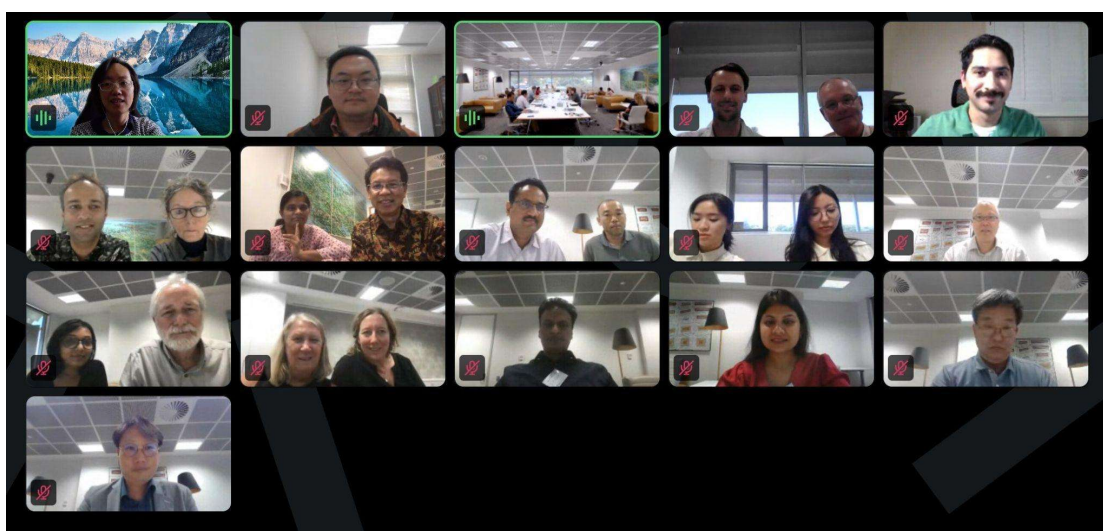
CLIVAR Report No. 03/2023

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Executive Summary



The [19th Session of CLIVAR/IOC-GOOS Indian Ocean Region Panel](#) (IORP) was successfully organised on 8th February 2023 in Perth Australia and online, alongside the annual meetings of IIOE-2 Steering Committee (SC), IOGOOS, IndOOS Resource Forum (IRF) and SIBER. The meeting consisted of three parts, all of which were open to participants at the IIOE-2 SC meeting. Thus, a wide range of participants contributed to the meeting, including additional ECRs and ex IORP members. This was found to be stimulating and helped expose current IORP activities to a wider audience and the panel would encourage this again in future.

Part I of the meeting was an open plenary session co-organized by CLIVAR and [SIBER](#). Two talks each from the two projects were given during this session. Dr. Ming Feng, former member of IORP, presented his recent research on [machine learning modelling effort to make ocean predictions](#). Dr. Roxy Mathew Koll, former co-chair of IORP and a member of CLIVAR Scientific Steering Group (SSG), made an overview of IORP activities in the past year. The two talks from SIBER scientists were: Remote Sensing of Harmful Algal Bloom in north Indian Ocean with special emphasis on Noctiluca (Aneesh Lotiker); and Dynamic change in an ocean desert: Microbial diversity and trophic transfer along the 110 °E meridional in the Indian Ocean (Eric Raes).

Part II was the IORP panel business meeting, during which, three scientific talks were given by new members of IORP ([Shikha Singh](#), [SungHyun Nam](#) and [Fahad Al Senafi](#)). Then the updates on [IndOOS-2](#) ([IRF](#), RAMA, [TRIUMPH](#), and [TIOON](#)) and the key activities of IORP

were presented and discussed among the panel members. Potential linkage with [SCOR](#) was also explored. In addition, the IORP co-chairs communicated the SSG feedback to [IORP 2022 annual report](#) to the panel, and led the review of accomplishment of action items from last IORP meeting. The IORP activities that are also relevant to SIBER were presented in Part III.

Part III of the meeting was a joint discussion session participated by members of IORP and SIBER. The updates of IORP/SIBER joint activities were presented, including: [CoLaB](#), [Western Indian Ocean Workshop](#), and [ICTP/CLIVAR Marine Heatwave Summers School](#) and application of SDA² Framework. Members of the IORP and SIBER also discussed the plan for collaboration between IORP and SIBER in the future and beyond 2025. The IndOOS-2 recommendation tracking and a paper on COVID impact on IndOOS-2, as well as the GOOS Co-Design exemplar on boundary current were covered the next day in the IRF and IGOOS meetings respectively, as they are also relevant to those groups.

In addition, there will be a wrap-up and feedback session to be organized online in the coming weeks.

Part 1: CLIVAR and SIBER Joint Plenary Science Talks

1.1 Marine extremes in the Indian Ocean and machine learning model predictions of sea surface temperature (Ming Feng, former IORP member)

In this talk, Dr Ming Feng reviewed spatial and temporal distribution and drivers of marine heatwaves in the Indian Ocean and the influences on the tropical cyclone genesis. Then, he introduced the application of two machine learning-based SST prediction models, i.e., the Convolutional Neural Network (**CNN**) model trained by only using the CMIP model to predict the Eastern Indian Ocean Dipole (EIOD) SST variability, and the **Unet** (encoder-decoder) model trained by using monthly analysis of global surface temperature to predict 2-dimensional global SST variability at various lead times.

Discussion:

- SST, SL and OHC anomaly are independent. The models can pick up independent information, no matter whether the anomaly is heat content driven or SST driven.
- May need to consider other factors: SST, winds, sea level pressure in the future models.
- Special evaluation on the extreme events will be further studies via a [PostDoc Project](#) at CSIRO Perth.

1.2 Indian Ocean Region Panel and Indian Ocean Observing System (Roxy Mathew Koll)

Dr. Roxy Mathew Koll, former co-chair of IORP presented the updated activities of IORP during the past year, including its membership updates and featured activities. IORP has expanded its membership by recruiting new members from the WIO region, as well as involving ECS through the IO Young Ambassadors initiative. The panel in particular focused on: 1) western Indian Ocean (new members from WIO countries,

WIO workshop), 2) Early Career Researchers (ECR) capacity building (IO Ambassador, SDA² Framework), and 3) marine heatwave and cyclones in the Indian Ocean ([new CLIVAR Research Foci on MHW](#); [ICTP/CLIVAR MHW Summer School in 2023](#); [MHW poster session at 2023 WCRP Open Science Conference](#)). He also shared recommendations from modeling groups on Indian Ocean research, updates on IndOOS tracking and implementation and regional partnership. Roxy stepped down from IORP since 1 January 2023, but is now a member of CLIVAR SSG.

1.3 Remote Sensing of HABs with special emphasis on Noctiluca (Aneesh Lotliker)

Dr. Aneesh Lotliker briefly introduced the biological features of *Noctiluca scintillans*, a dinoflagellate species that can cause algae bloom and oxygen minimum zone (OMZ) and with an extended trend. Aneesh introduced the *Noctiluca scintillans* bloom in the North Arabian Sea and the biogeochemical processes underpinning the bloom, e.g., the relationship with hypoxia; the silicon (diatom) & *Noctiluca Scintillans* balance; the light and phytoplankton impact on *Noctiluca Scintillans*; the response of phytoplankton size structure, inter parameter linkage, and etc. He finally introduced the operational application of satellite products in algal bloom monitoring, as well as [Algal Bloom Information Service \(ABIS\)](#).

Discussion:

- The study has not looked at the role of the Gulf water (e.g., Gulf deep water) yet. It only looks at the satellite data so far, as it could provide time-series data. There is no BGC mooring in this region.

1.4 Dynamic change in the ocean desert: Microbial diversity and trophic transfer along the 110°E meridional in the Indian Ocean (Eric J. Raes)

The eastern Indian Ocean is among the most oligotrophic regions in the world and is described as an 'ocean desert'. The spatial extent of the ultra-oligotrophic region in the IO has expanded between 1998 and 2013, correlated with the significant downward trend in chlorophyll-a (Chl-a) concentration. Dr Eric J. Raes from SIBER introduced their study aiming to develop a deeper understanding of how community and trophic structures respond to physicochemical variability in the oligotrophic conditions along 110°E. The trophic links and energy transfer across the food web was investigated by synthesizing multiple datasets. The different niches of marine life, from bacteria to eukaryotic phytoplankton and zooplankton, including early life stage of fisheries were distinguished, and the need to better understand the impact of climate change on the eukaryotic autotrophs, whose composition and abundance might affect the standing stock of zooplankton, was also highlighted. The [OceanOmics](#) project funded by the Mindereroo Foundation was introduced, which consists of research using eDNA, marine genomics and Artificial Intelligence (AI).

Part 2: IORP Panel Business Meeting

2.1 Introduction

2.1.1 Quick introduction to IORP and welcome new members and new co-chair (Juliet)

The CLIVAR/IOC-GOOS Indian Ocean Region Panel (IORP) provides scientific and technical oversight for implementation of the sustained ocean observing system for the Indian Ocean and coordinates research on the role of the Indian Ocean on the climate system. The terms of references of IORP and major activities and publications of IORP are available on [IORP webpage](#). Dr. Juliet Hermes, co-chair of IORP, welcomed four new members (Tamaryn Morris, South Africa; SungHyun Nam, Republic of Korea; Lei Zhou, China and Fahad Al Senafi, Kuwait) and the new co-chair (Janet Sprintall, USA) of the panel.

2.1.2 A tribute to Dr. Wil de Ruijter.



Tribute to Wil de Ruijter: Royal decoration in the Order of the Dutch Lion (2011) and member of the Royal Society of South Africa (RSSA). Wil de Ruijter provided a focus for Dutch efforts on the Agulhas current. He is an international scientific leader on many Agulhas related works. He stimulated the cohesive efforts of a large group of creative colleagues to work on central problems at the forefront of ocean science. The most important papers on the Agulhas have come from Wil's mind. He was a great original thinker on ocean mesoscale dynamics and mesoscale processes, and has bridged the gap between models and observations. Wil was an inspirational mentor and friend.

2.2 Scientific talks and IORP science priorities

2.2.1 A modified upper ocean mixing scheme for the Bay of Bengal (Shikha Singh)

Dr. Shikha Singh, an ECS member who joined IORP in 2022, presented her research on upper ocean mixing in the Bay of Bengal that may possibly address the model biases. Shikha reviewed the generalized model for ocean mixing, in which the diffusivities are calculated as functions of Richardson number (R_f). As models do not take the reversible mixing into account, the vertical mixing is overestimated. Shikha did the experiment-control runs by using the forcing data from [OMNI buoys](#) and from IMDAA reanalysis dataset respectively, to examine the sensitivity of simulation with conventional and modified $k-\epsilon$ Model. She also highlighted the need for high resolution spatial and temporal observation data for such sensitivity experiments.

2.2.2 KUDOS (Korea-US Indian Ocean Scientific Research Program) & KIOS (Korea Indian Ocean Study) (by SungHyun Nam)

Dr. SungHyun Nam, a new member of IORP, presented the research efforts of KUDOS and KIOS that he is involved in and proposed the potential engagement with IORP in the future. SungHyun highlighted the further engagement with IORP on Seychelles-Chagos Thermocline Ridge (SCTR) studies, through KUDOS and the existing effort on observations, e.g., KIOS cruises targeting WIO; station K mooring and PIES in the SCTR; and RAMA moorings and ADCP moorings in the southeast IO, that will contribute to RAMA/IndOOS/IOGOOS/OceanSITES. He also pointed out the possible collaboration on investigating the year-to-year changes in isopycnals and water properties through new observations, joint publications, as well as capacity development activities, e.g., on ship training opportunities for students and ECS to join KIOS R/V Isabu. Finally, he indicated the potential for cornerstone of international collaboration for WIO and WIO-EIO connections through future multilateral cooperation system contributing to IORP/IIOE-2/UNDOS 2021-2030.

Discussion:

- Ship training opportunities on KUDOS/KIOS ships can be applied for by the students/ECSs from all over the world. Application will be conducted through mutual communication. May chief scientist help advertise the opportunity via IORP network.
- Top of sub-surface moorings at Station K is usually in 400-500m (to avoid damage from fishing activities), and we deployed bottom mounts (PIES) at 3,000m to fill in the gap at the upper 300m of water column.
- SungHyun suggested to establish a new time series stations in the EIO subtropics, e.g., southern part in 110°E. Mike pointed out that there was a RAMA mooring there and they got two years of data in 2020-2022. But it cannot be continued due to lack of ship time. PMEL was trying to use IMOS but failed. Ship time in the EIO is very difficult. Piracy has declined in the WIO but people are still worrying about it.
- Upwelling measurement. Cannot use standard ADCP for measuring vertical velocity mainly because of mooring heave that contaminates the small signal.

2.2.3 The Marine Desert (Fahad Al Senafi)

Dr. Fahad Al Senafi, a new member of IORP, chose 'marine desert' as his presentation title, to highlight the challenges faced by Kuwait on marine and environmental science, e.g., the lack of marine scientists, data and data sharing. He briefly introduced his research highlights and potential engagement with IORP. He has been involved in several research projects in the recent years, e.g., Observational study of the Climate and extreme weather events in Arabian/Persian Gulf (2012-2015), Internal Wave Climate and Turbulence Mixing of the Gulf (2016-2020), Kuwait CubeSat Project (2018-present) and Dynamical Processes Induced by Atmospheric Forcing in the Gulf (2022-present). He also identified the potential engagement with IORP, mainly through observation network, data diplomacy and sharing (scientist leading the way) (Al-Mudaffar et al, 2022) and capacity building. He specifically introduced the societal impacts and capacity development activities, which aim to create the large-scale learning and training environment that encompasses multidisciplinary, theoretical, and hands-on opportunities with state-of-the-art technology for scientists at different career stages.

Discussion:

- **Observation:** Kuwait CubeSat has not provided wind data yet, just pure high-res images. Need bigger satellite for wind measurements. According to Srinivas, the OceanSat launched in Dec 2022 that can provide wind data.
- **Capacity building:** Janet indicated the potential cooperation with IORP WG for ECR, led by Shikha Singh, and encouraged Fahad to join the ECS WG. According to Fahad, the trainings in Kuwait are open to institutions that cooperate with Kuwait University with MoU attached. Juliet suggested Fahad to look at hosting a SCOR visiting fellow in Kuwait or POGO.

Action 1: Fahad to share the link of his paper on data sharing with IORP members.

[Fahad: <https://www.science.org/doi/10.1126/science.add1555>]

Action 2: To link the IORP ECS activities led by Shikha with the capacity building activities of Fahad's project.

[Fahad: Kindly find the project capacity building plan in [pdf](#)]

Action 3: Fahad to look at POGO/SCOR fellowship programme.

[Fahad: Unfortunately, citizens of Kuwait are not eligible to apply]

2.3 Updates on IndOOS-2 and key activities

2.3.1 IndOOS Resource Forum (IRF) updates (Juliet Hermes/Nick D'Adamo)

The following bulletin points were presented by Juliet, referring to the notes prepared by Dr. Nick D'Adamo.

- IORP will be at IRF-15 on 9 Feb 2023 – e.g., Co-Chairs IORP in Perth during the meeting;
- See IRF-14 minutes for current membership and details of IRF progress leading up to IRF-15. The IRF-15 agenda and IRF-14 minutes were sent by email to all members last week, in prep for IRF-15;

- Dr Sidney Thurston retired from NOAA approximately one month ago, hence is stepping down as Chair IRF after IRF-15;
- IOGOOS as patron of IRF is going to coordinate the process for replacement of Chair. Agenda item IRF-15;
- Nick D'Adamo has been Convener pro bono;
- IRF met a few times since last in person IIOSC of 2019 (Port Elizabeth);
- IRF constituency strengthened, engagement of members and substance of meetings improved under Sid Thurston's Chairing;
- IRF encourages IORP (and SIBER) leaderships to take advantage of their standing agenda item inputs in ref to submitting concise summaries of key resource gaps/needs and submit those as in the past to the IRF-15, and following IRF meetings.

Discussion:

- It is essential that IRF garner resources needed for IndOOS. Need to bring a resource person in.
- Wait for direction from IRF as to how IORP can contribute - at the IRF meeting the following day, an important decision from the IRF meeting was that IOGOOS will facilitate the process of finding a replacement to Sid who stepped down from the Chair and this will be done within 2 months.
- IRF members will contribute to *BAMS* article.

2.3.2 RAMA update (Mike McPhaden)

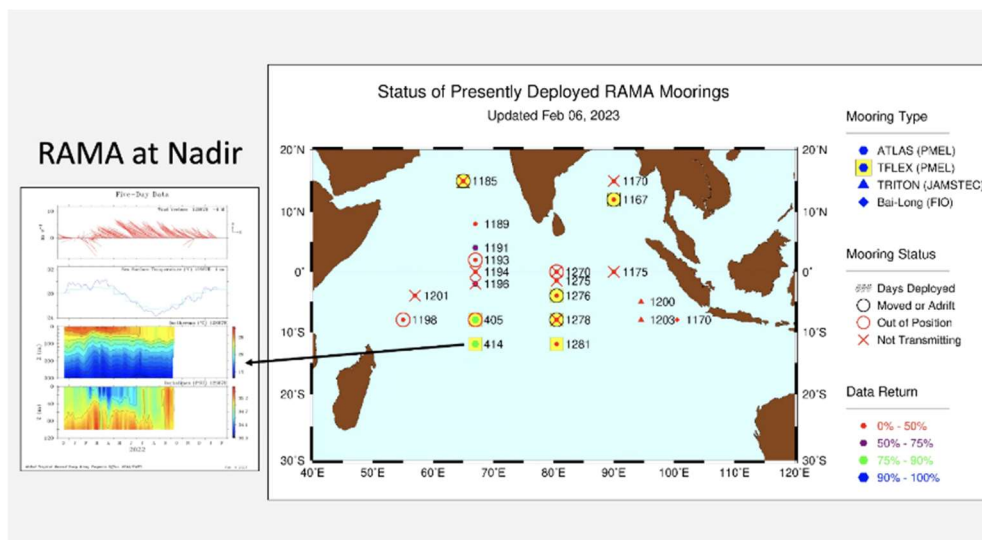


Figure 1: Current status of RAMA. Numbers alongside the mooring show the number of days since its last time being serviced.

Dr. Michael McPhaden, from NOAA/PMEL introduced the current status of RAMA. 91% of the RAMA array was complete by Sep 2019. The mooring buoys are designed for one year lifetime, and thus needs to be maintained on annual basis. However, due to COVID, only one cruise (R/V Isabu) was carried out in the past three years. Currently,

only one mooring is providing real time data of surface meteorology, and most moorings are already over 1,000 days (see figure 1) and thus stopped transmitting data. The good news is that there are four cruises being planned for 2023, aiming for 70% renewal of RAMA by the year end: R/V Sagar Nidhi (India), R/V Isabu (RoK), R/V Sagar Kanya (India), and R/V Brauna Jaya (Indonesia). In addition, the Infrastructure Investment and Jobs Act was implemented by the US in 2021 (Aka Bilateral infrastructure law), and \$2.5 million was allocated to RAMA/PIRATA mooring recapitalization. PIRATA is maintained in a better stage as cruises are still going on in Europe, so the funds will be mainly used for RAMA. Meanwhile, strong bilateral partnership has been built in the past years, e.g., in 2021, MoES/NOAA partnership agreement was renewed for five years, to coordinate in field and serving data (but only those OMNI moorings outside EEZ), and the new joint RAMA/OMNI oceanographic data portal was launched; the MoES/NOAA/ONR US EKAMSAT Programme (2022-2026), a 3-year program in Southeast Arabian Sea on the effect of warming pool on monsoon onset; BMKG/NOAA Partnership renewed for five years; no formal MoU with KIOST/Korea yet, but have a joint research programme, e.g., KUDOS. 52 publications in last 14 months used RAMA data. A paper on COVID impacts on IndOOS is being prepared by IORP members for publication in BAMS.

Discussion:

- Mike was inquired about his succession plan, and he is thinking about it and will endeavor to have a successor come on board to overlap with him.

2.3.3 TRIUMPH overview (Dwi Susanto)

Dr. Dwi Susanto, briefly introduced his research on the Indonesia Throughflow (ITF) and the TRIUMPH project (**T**hroughflow Indonesian Seas, **U**pwelling & **M**ixing **P**hysics), jointly implemented by Indonesia (LIPI & BRIN), China (FIO-MNR) and the US (University of Maryland), and is multidisciplinary. The 1st cruise of TRIUMPH was implemented in 2019, with the deployment of all surface and subsurface moorings, TRBMs and with CTD/water sample, pCO₂, plankton and biogeochemical measurement carrying out, while the 2nd TRIUMPH cruise conducted in 2021, with subsurface moorings recovered and/or redeployed. The 3rd cruise, which was originally scheduled for Dec 2021 – Jan 2022, has been postponed to July 2023, to recover the TRBM and moorings, and deploy a new mooring south of Java. The 4th cruise is now being scheduled for 2023, under the new MoU signed with BRIN/Indonesia-FIO/China-Uni. Maryland/USA. Dwi called for long term observation of ITF, as the ITF, stratifications and mixing variability are critical to understand the Indian Ocean variability.

2.3.4 Potential interactions with SCOR (Marie Alexandrine Sicre)

Dr Marie-Alexandrine Sicre introduced different SCOR programmes (GEOTRACE, IIOE-2, IMBeR, IQOE, SOLAS, etc.) and [working groups](#) (WG-156, 161, 162, 166, 167, etc.) that are relevant to CLIVAR and IORP. GEOTRACE makes transects across the ocean big basins, and conducted field experiments to measure trace elements. All the datasets for SOLAS are located in France, and they are making effort on data sharing. IMBeR is working on the modeling of ecosystem, including the impacts of climate

change on marine ecosystem. SOLAS may be quite relevant to CLIVAR, as they work on gas exchange in air-sea interface, including oxygen, CO₂, NO₂, aerosol, etc. There used to be a programme on Paleo climate (IMAGES), but no longer existed. The linkage with paleo community (e.g., new/improved proxies for reconstruction) can be built through the collaboration between WCRP and PAGES. The SCOR working groups that may be relevant to IORP are: WG167 (RUSTED) and 166 (DMS-PRO) linking with SOLAS; WG162 (OASIS), WG161 (ReMO) on ocean mixing quantification; WG156 on global marine primary productivity measurement, WG153 on physical transport of marine litters. SCOR will be happy to see more interaction with IORP, through new working groups ([Call for new SCOR working groups](#) is now open until 12 May 2023) and [POGO-SCOR Fellowship Programme](#) (The next call is expected to open in March 2023).

2.3.5 Ongoing observation and circulation Dynamics in the tropical eastern Indian ocean (Dongxiao Wang)

Dr. Dongxiao Wang, from Sun Yat-sen University, introduced China's effort in the tropical eastern Indian Ocean observations through the Eastern Tropical Indian Ocean Observation Network (TIOON) during the past decade, and the research findings based on these observation data. The China-Sri Lanka Joint Center for Education & Research (CSL-CER) was established between South China Sea Institute of Oceanology (SCSIO) of China Academy of Sciences (CAS) in China and University of Ruhuna in Sri Lanka. Shore-based marine meteorological observation in Sri Lanka and off-shore facilities (coastal cruise, wave tide observation, offshore buoys, wind profile radar, AWS and air boundary layer tower) for air-sea observation network were implemented. Annual cruises sponsored by Natural Science Foundation of China (NSFC) have been implemented since 2010 in repeated transects. The observation data was used by Sri Lanka government agencies to forecast the marine pollution spread. The Indian Ocean glider observation platform is under construction in the South China Sea. A [review paper](#) was published in *BAMS* in 2021 to overview the progress on TIOON and the equatorial Indian Ocean dynamics and ITF variability. Some advanced understanding of the marine environmental changes in the Tropical Indian Ocean were developed, such as the mechanism and dynamic relationship of circulation changes in equatorial Eastern Indian Ocean (Chen et al., 2020a; Chen et al., 2020b; Huang et al., 2020), the ITF slowdown under global warming (Pen & Wang et al., 2022), the Southern Indian Ocean Dipole mode (STIOD). The future plans include to maintain and build new facilities (boundary layer observation tower, AWS and long-range underwater glider) for Indian Ocean observation.

Discussions:

- Dongxiao requested Mike to consider sharing the mooring data from TIOON through the PMEL website or IRF/IOGOOS. Mike suggested to talk offline via email as he needs to know more details about the data and how they can be integrated with the existing RAMA mooring array data. Mike would like to know first if the real time data are all connected to GTS. Dongxiao suggested to start from delayed mode data.

Action 4: Mike will communicate with Dongxiao offline via email for sharing the data from TIOON, starting from the delayed mode data.

2.4 Updates from IORP co-chairs (20 mins)

2.4.1 IORP Annual Report to SSG and SSG feedback (Juliet/Janet)

Dr. Janet Sprintall, co-chair of IORP, presented on behalf of IORP at the CLIVAR Scientific Steering Group online meeting on 3 February 2023. The presentation covered the IORP membership; WIO workshop and CLIVAR-GOOS workshop on ocean observation in Trieste; SDA² Framework; IndOOS-2 Implementation Tracking and ICTP/CLIVAR MHW Summer School in 2023.

The initial feedback from SSG to IORP are:

- Sonya: The WIO workshop is an excellent capacity building activity, intense to focus on the problems faced by IO observing system. The pan-CLIVAR-GOOS workshop is also a big success. IORP is an exemplar of ECR activities
- CLIVAR-GOOS workshop – follow up on whether the report is being written up and published. Response that an official report + an article to highlight what we have done and the next steps are being prepared, with ECR participants involved.
- Make sure to follow through on WCRP Academy LHA plans for summer school and capacity building activities (e.g., WIO workshop).
- Specific science question from Francois: Increased tropical cyclones and impacts on rainfall, how about the research on the variability of landfalling cyclones. Juliet – covered in WIO workshop and it is the focus of various members like Roxy.
- IORP participation in the 2023 WCRP Open Science Conference (OSC) in Kigali, Rwanda on 23-27 October 2023. Roxy will co-convey a poster cluster on MHWs. Check the links for WCRP OSC [poster clusters](#) and [oral sessions](#). Abstract submission deadline: **28 February 2023 (now extended to 15 March 2023)**. CLIVAR will follow up externally with all and encourage participation.
- IORP is suggested to link more closely with the [Monsoons Panel and its regional WGs](#).

Discussion:

- We could either put an abstract from IORP or individually submit abstracts to WCRP OSC. We could prepare an abstract regarding the COVID impacts on IndOOS by including some interesting implications to the science as well.
- The establishment of IORP in CLIVAR is not easy, but we demonstrate our capacity in many aspects, e.g., the engagement with ECS, and the interdisciplinary cooperation with the biogeochemical community (SIBER).
- The CO₂ emission only reduced in 2020 due to COVID, and then bounced back, but with a relatively slower trend.
- Being a new member of CLIVAR SSG, Roxy may help IORP link more closely with WCRP LHAs, and bring feedback/suggestions from IORP to SSG.

Action 5: To follow up on the CLIVAR-GOOS workshop report/paper.

Action 6: To submit an abstract on impacts of COVID on IndOOS to WCRP OSC, by referring to the review paper to be submitted to BAMS and the article written by Mike in the [CLIVAR Exchanges special issue for IndOOS-2](#).

Action 7: To follow up with Antonietta for the connection to WCRP Academy LHA for the MHW Summer School.

2.4.2 Update on IORP-18 Tasks (Juliet)

Dr. Juliet Hermes, co-chair of IORP led to review the accomplishment of IORP-18 action items:

- **Done.** Shikha to finalize the ECS framework she has put forward and perhaps prioritize. This can then be sent to Jose and CLIVAR SSG for further discussion with WCRP Lighthouse Activity and with other CLIVAR panels. - *Thanks to Shikha for developing the SDA² framework and application to the MHW summer school.*
- **Done.** Incorporate some of suggestions into cross-panel workshop proposal. – *The workshop has been successfully organized.*
- **To follow up.** Support ECS to write papers after workshops - Juliet to reach out to Lisa for someone (Franck) to do this as part of the CLIVAR/GOOS Trieste workshop.
- **To follow up.** Marie-Alexandrine to follow up with IIOE-2 ECR to discuss ECR published papers and see how we can promote them e.g., within *CLIVAR Exchanges*.
- **Ongoing.** Article on COVID (*BAMS*). Jing/Janet/Motoki/Juliet/Roxy - set up a doodle poll and invite to a meeting in a few weeks to discuss all of these ideas. Invite Sid Thurston, Mathieu Belbeoch and Michael McPhaden.
- **Done.** ECS network – Jing to organise a doodle poll for a meeting with 5 members to help take framework forwards. – *2nd ECS network telecon was organized. We need to continue this effort, and involve new IORP members in the ECS WG.*
- **Done.** Need to promote active members Jing/Roxy/Juliet to draft a letter to all current members asking them to circulate the call for memberships and also asking them to confirm they would like to stay on the panel and how they will contribute to the IORP. – *All members are supposed to be active in the panel.*

2.4.3 Discussion (10 mins)

(1) Ideas from modeling teams

Discussion on the way forward of IORP was conducted by including the suggestions from Roxy's presentation in [section 1.2](#):

- Data access - IndOOS website for observations datasets, pointing out where data is.
- State of the Indian Ocean, e.g., SOOS
 - Interactions between observation and modelling
 - Access to EEZ data
 - More BGC data
 - High frequency data for cyclone research
 - moisture and heat transport in the IO
 - Technology exists capacity building required
 - Emerging techs: sail drones, organic Argos

- Citizen science
- IndOOS Resource Forum (IRF)
- Regional partnership

Meanwhile, the progress, challenges and future plans of IORP task teams were also discussed. The new IORP members were encouraged to join the IORP Task Teams (TTs) or formulate new TT if they are interested in any of the topics.

(2) Boundary Current

Tamaryn (Tammy) Morris, a new member of IORP, is currently involved in pushing on boundary current through the OOPC/GOOS Boundary System Task Team (BSTT). The western boundary current (WBC) is in particular to be concentrating the marine heatwave and transporting the heat down, as well as intensifying tropical storms. They are looking at the Agulhas Current in the western Indian Ocean now. Also, Tammy is involved in the Argo Steering Team, which is trying to deploy more Argo floats in the western Indian Ocean. A more detailed presentation on the [Boundary Current Exemplar of GOOS Co-Design Project](#) was given by Tammy during the IOGOOS-19 on Feb. 9 and was summarized in section 2.5.1 in this report.

Discussions:

- The boundary current may be further explored as a new task team of IORP.
- How can IORP develop better links with OOPC and GOOS? The first step is having Dr Morris on both panels.

(3) Expansion of the IO Ambassador (ECS Task Team)

We may consider expanding the Indian Ocean Ambassador Task Team with a larger community, e.g., through more collaboration with IIOE-2. Collaboration with IO partners may also be explored with the above-mentioned ideas from the modeling team, See 2.4.3 (1).

- Make the IO Ambassador a cross activity with the broader community by connecting the existing effort.
- More interaction with IIOE-2, e.g., publication on *Indian Ocean Bubble*.
- Continuity of membership for the IO Ambassador Task Team.
- Development of SDA² (Skill Development, Awareness, Application) framework and implementation in MHW summer school in July 2023.
- Call for a 3rd meeting of the ECR network.
- Slack channel is not very active. May need some resources for this. Shikha will look into it.
- Ocean CD-Hub: Gateway to Ocean related Capacity Development opportunities around the world (<https://oceancd.org/>)

Action 8: Shikha to look into some platforms and resources needed for promoting ECS interactions.

Action 9: To call for the 3rd Meeting of IO Ambassador (ECS TT).

(4) Science to Policy Task Team:

- Policy report: Juliet, and Janet, want to bring Nick HM in.
- ECR could help transfer science results to public via social media.
- Nick: Make policy makers informed and understood the science we are doing, and we also try to understand what they need, and tailor our science to fit their needs. Need to start the conversation.
- Ask SSG how they can help us do this and make it a cross-panel thing.
- Srivinas: To address the needs of **operational users** as well - one end of the value chain, a lot of buy-in for this comes from the **funders**, this is one of the ways we sell the observations. GOOS is coming up with **case studies/best practices** on how these observing systems are being used. So good to touch base on what is happening in this space.
- How RAMA lobby to policy makers?
 - Mike: It did not happen overnight. Chance and timing are important. A two-page perspective was prepared to highlight the services that RAMA data could help generate the support from the government. Monsoons and Indian Ocean influence could trigger ENSO, so better observation will improve our understanding and prediction of weather from hurricane to subseasonal time scales. A mooring group was built up at NOAA/PMEL that had been sustaining the TAO array. This was then taken out of PMEL and given to the weather service, leaving a tremendous resource that was at risk of dissipating.
- Both the US and India have done economic impacts assessments of their services. These assessments have been put into the [IORP google drive](#). Economic assessment will be mentioned in the *BAMS* article.

Action 10: To bring the science-to-policy idea to CLIVAR SSG and promote it as a cross-panel activity.

2.5 Future plans

2.5.1 Potential new Task Teams

There were no volunteers for new TT, it was felt best to focus on the ones we have, as well as the MHW summer school and research foci.

2.5.2 UWA policy report (Juliet/Janet/Roxy)

During the IIOSC meeting in Perth, Juliet, Roxy and Janet met with Prof. Shamit Sagar, Director, UWA Public Policy Institute, and discussed what is required in the article. JJR are currently writing up the policy report. It is hoped that when finished the new TT will be able to leverage it further.

2.6 Wrap-up Consolidate action items (5 mins)

2.6.1 Next meeting

To be determined. Quarterly telecons and in-person every 18 months. Potential to meet with either IO programmes and IIOE-2 in 2024 (TBD tomorrow 9 Feb 2023), or to meet alongside a big science conference (e.g., AGU or OSM).

Part 3: IORP and SIBER Joint Discussion

3.1 Updates of joint activities

3.1.1 CoLaB (Greg Cowie)

Dr. Greg Cowie, chair of SIBER Steering Committee, introduced the 'CoLaB: Coastal Observation Lab in a Box' a joint initiative of SIBER and IORP about a portable and affordable package of instruments and methods for physical, biological and biogeochemical observations. It also falls into the ocean best practice task team on coastal observations in the under-resourced countries. The CoLaB is intended to offer a portable and affordable, easy-to-teach, low maintenance, minimal infrastructure required, and proven modular of instruments and methods, and has diverse applications (wetland to shelf edge), and complementary to moored systems and remote sensing. It includes a whole suite of protocols, including the data management and modeling tools packages, and regional hubs for instrument/sensor cross-calibration. A training camp with follow-up online support are offered.

Greg has been working on the basic hydrographic instrumentation (basic CTD, homemade drifters, acoustic current meter) without the needs of laboratory or research vessels and biogeochemical analyses in the past 20 years. He then shared two examples of using basic instruments for coastal observations, as well as some innovative tools and methods. There are also modeling package integrated into the CoLaB concept, which is optimized for key coastal regions and with limited-domain operational ocean forecast system (Oofs), as well as CoLaB data management package on the integration of ERDDAP services.

The future activities of CoLaB include an in-person workshop being planned for June 2023 and the long-term efforts to seek funds for broader roll out, regional calibration hubs, training camps, etc. The CoLaB concept has also been included in the CoastPredict project endorsed by the UN Ocean Decade. More recent updates: originated from one of the CoLaB training camps, now there is a project on the sources and impacts of mercury contamination in rivers of Ghana from illegal gold mines, for which the CoLaB will provide key data.

3.1.2 WIO workshop and a ReMoTURB sub-project (Bernadino and Greg)

Dr. Bernardino Malawene, a member of IORP, briefly presented the [Regional Training Workshop on Observing the Coastal and Marginal Seas in the Western Indian Ocean](#), which was held from 7 to 9 June 2022, in a hybrid format, with physical venue in Maputo, Mozambique. 22 trainers (12 in-person), and over 120 participants (26 in-person, and over 100 online) attended the workshop. Day 1 was dedicated to the discussion on the existing WIO observing systems, coastal instruments and platforms, and data best practices; Day 2 was on marine robotics and site visit, Argo floats (Bio-Argo), satellite observation and moorings; and Day 3 was on data analysis and management, ocean observation for societal needs and panel discussion. More detailed information of the workshop can be found in the [workshop report](#).

In addition, Bernardino introduced the project on 'Strengthening fishery and food security in Mozambique: Planning for climate change resilience with an MPA network', which is a sub-project of ReMoTURB and may have potential linkage with SIBER. The main objective of the programme is to safeguard healthy ecosystems and vital recruitment for sustainable fisheries resources resilient to climate change through the role of marine protected areas (MPAs). Other objectives include: 1) to determine the latitudinal gradient of ocean warming across the MPAs; 2) to investigate key habitats and species change; 3) to identify climate change hotspots; and 4) to support a climate change resilient MPA network. The project is structured in three elements: **Oceanography element** (climate change latitudinal gradient, upwelling mechanism, MHW), **Coral element** (monitoring coral & coral habitat; fish assemblages) and **Seagrass element** (seagrass and seagrass habitats, associated invertebrates). UTR network, CTD, weather station and moored array are used in this project. The project brings together partners from government agencies, MPAs, research institutes and NGOs.

3.2 Updates from IORP of interest to SIBER

3.2.1 Marine heat wave summer school and research foci and ECR (Shikha)

Dr. Shikha Singh, an ECS member of IORP, introduced the SDA² (Skill Development, Awareness, Application) Framework she has developed, which is a methodological roadmap for framing ECRs. The framework is to provide training on basic knowledge and skills, opportunities for ECS to interact with senior scientists, and apply the knowledge and skills they have learned in their future research. Shikha and Janet are co-leading the organization of ICTP/CLIVAR Summer School on Marine Heatwaves: Global Phenomena with Regional Impacts, which will be organized from 24 to 29 July 2023 at ICTP, Trieste, Italy and online. Four main topics will be covered in the School: **Technical aspects:** Methodologies used to estimate extremes; **Drivers** of MHW: Atmospheric and Oceanic mechanism; **Impacts** of MHW: Cyclones, ecosystems, societal costs; and **Future projections, attribution and forecast:** trends VS internal dynamics. Registration to the summer school is now [open](#) until 1 April 2023. The SDA² Framework will be applied in the summer school.

3.2.2 IndOOS-2 and COVID impacts update (Motoki and Janet)

Not presented at IORP/SIBER joint session - Motoki presented at the IndOOS meeting. Presentation is available [here](#).

3.2.3 GOOS co-design boundary currents (Tammy)

Not presented at IORP/SIBER joint session - presented at the IRF or IndOOS meeting. Presentation is available [here](#).

3.3 Future of IMBeR SIBER and plan beyond 2025

All present were keen on continuing SIBER until 2025 and then it could evolve into more regional focus or at least refocus to identify the remaining gaps, IORP will endeavor to continue supporting SIBER.

Annex 1: Agenda

Agenda

Part 1: Joint IORP/SIBER Plenary Session

Virtual access: <https://meet.goto.com/425581733>

Time	Agenda Item
9:00-10:30 Shikha Singh (chair)	Plenary session (15 mins talk each + 30 mins discussion) <ul style="list-style-type: none">• Talk 1: Machine learning modelling effort to make ocean predictions (Ming Feng)• Talk 2: Overview of IORP activities (Roxy Koll)• Talk 3: Remote Sensing of Harmful Algal Bloom in north Indian Ocean with special emphasis on Noctiluca (Aneesh Lotiker)• Talk 4: Dynamic change in an ocean desert: Microbial diversity and trophic transfer along the 110 °E meridional in the Indian Ocean (Eric Raes) Discussion

Part 2: IORP Panel Business

11:00 - 12:30, 13:30 - 15:00, 8 Feb 2023, Perth, Australia and hybrid

Virtual access: <https://meet.goto.com/425581733>

Time	Agenda Item
11:00 - 11:05	Quick introduction to IORP (Roxy's talk!) Welcome new members and new co-chair. (Juliet)
OPEN SESSION 11:05-11:45 Marie-Alexandrine (chair)	Session 1: Scientific talks (template) and IORP science priorities (10 mins * 3 talks + 10 mins discussion, ~40 mins) <ul style="list-style-type: none">• Talk 1: Shikha Singh (in person)• Talk 2: SungHyun Nam, KUDOS (in person)• Talk 3: Fahad Al Senafi (Kuwait) Discussion (new direction for scientific research).
11:45 - 12:30 Sunghyun (chair)	Session 2a: Updates on IndOOS-2 and key activities (10 mins each + 5 min discussion) <ul style="list-style-type: none">• IRF update (<i>Sidney</i>)• RAMA update (<i>Mike McPhaden</i>)• TRIUMPH overview Dwi• TT on IndOOS-2 recommendation tracking and COVID impacts paper, (<i>Motoki and Janet</i>)
12:30-13:30	Lunch

Time	Agenda Item
13:30-14:00 INVITE SIBER Dwi (chair)	Session 2b: Updates on IndOOS-2 and key activities (10 mins each and 5 min discussion) <ul style="list-style-type: none"> Potential interactions with SCOR (Marie Alexandrine) Ongoing Observation and Circulation Dynamics in the Tropical Eastern Indian Ocean (<i>Dongxiao Wang</i>)
14:00-14:30 Motoki (chair)	Session 3: Updates from IORP co-chairs (20 mins) <ul style="list-style-type: none"> IORP Annual Report to SSG and SSG feedback (<i>Juliet/Janet</i>) Update on IORP-18 Tasks, (<i>Juliet</i>) Discussion (10 mins)
14:30-14:55 Pattabhi (chair)	Session 4: Updates on IndOOS-2 and key activities continued (<i>NB some items such as ECR and MHW will be presented in the joint SIBER session</i>) <ul style="list-style-type: none"> Discussion around potential new TT eg Science to policy TT UWA policy report (<i>Juliet/Janet/Roxy</i>)
14:55-15:00	Wrap up. Consolidate action items (5 mins) <ul style="list-style-type: none"> Next meeting

*A tribute to Wil de Ruijter.

Part 3: IORP and SIBER Joint Discussion

15:30-17:00 8 February 2023, Perth, Australia and hybrid

Virtual access: <https://meet.goto.com/425581733>

Time	Agenda Item
15:30-15:40	Brief round table (Raleigh and Greg and Juliet and Janet and Roxy)
15:40-16:00	Agenda 1: Updates of joint activities <ul style="list-style-type: none"> COLaB (<i>Greg and Juliet</i>) Coastal observing summer school (<i>Bernadino and Greg</i>) AOB
16:00-16:20	Agenda 2: Updates from IORP of interest to SIBER <ul style="list-style-type: none"> Marine heat wave summer school and research foci and ECR (<i>Shikha</i>) IndOOS-2 and COVID impacts update (<i>Janet and Motoki, Roxy</i>) GOOS co-design boundary currents (Tammy) Anything additional from SIBER
1620:1650	Agenda 3: Future of IMBeR SIBER and plan beyond 2025
16:50:17:00	Wrap up

Annex 2: List of Participants

Name	Affiliation	Country	Role	Participation
Juliet Hermes	SAEON	South Africa	Co-chair	In-person
Janet Sprintall	Scripps Institution of Oceanography	USA	Co-chair	In-person
Marie-Alexandrine Sicre	CNRS, LOCEAN	France	Member	In-person
Shikha Singh	IITM	India	Member	In-person
Eluri Pattabhi Rama Rao	INCOIS	India	Member	In-person
Motoki Nagura	JAMSTEC	Japan	Member	In-person
Dwi Susanto	University of Maryland	USA/Indonesia	Member	In-person
SungHyun Nam	Seoul National University	Rep. Korea	Member	In-person
Srinivasa Kumar	INCOIS IOGOOS	India	Ex officio	In-person
Michael McPhaden	PMEL/NOAA	USA	Ex officio	In-person
Roxy Mathew Koll	IITM	India	Former co-chair/ SSG member	In-person
Ming Feng	CSIRO	Australia	Former member	In-person
Nick D'Adamo	UWA Oceans Institute	Australia	Invited Participant	In-person
Matt Carr	UCT	South Africa	Invited Participant	In-person
Chris Reason	UCT	South Africa	Invited Participant	In-person
Fahad Al Senafi	Kuwait University	Kuwait	Member	Online
Lei Zhou	Shanghai Jiao Tong University	China	Member	Online
Tamaryn Morris	SAEON	South Africa	Member	Online
Lisan Yu	WHOI	USA	Member	Online

Nick Hardman-Mountford	Commonwealth Secretariat	UK	Member	Online
Bernardino Sérgio Malauene	Instituto Nacional de Investigação Pesqueira	Mozambique	Member	Online
Dongxiao Wang	Sun Yat-sen University	China	Former member	Online
Jing Li	ICPO	China	Staff Scientist	Online