CLVAR/IOC GOOS Indian Ocean Region Panel

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Panel overview

One of the initial big achievements of the IORP was to produce in 2006 an implementation plan for what would then become IndOOS, the sustainable Indian Ocean Observing System. Eleven years down the line, it was timely to review the successes and failures of IndOOS, in light of the new science developments and observing technologies. This review of IndOOS (to be finalized in 2018) has been the main IORP activity in 2017, with a dedicated workshop (together with the IORP annual meeting) in Perth. The outcome of this workshop was a list of chapters and lead authors. A first draft of these chapters has since been written, commented by all IORP members. The final draft (due in November) will be reviewed by a specially-designated review panel, during the next IORP meeting, in Lombok (Indonesia), in March 2018. This time-consuming task has put some other IORP action items on hold for now (details below).

1. IndOOS Review

The IndOOS review is a major IORP task in 2017. It is led and coordinated by the IORP on behalf of the international community, with the assistance of SIBER. This review is sponsored by CLIVAR and IO-GOOS (through IORP participation), IMBER (through SIBER participation), IOC (through its Perth office) and OOPC.

From January 30th to February 1st, 2017, the CLIVAR/IO-GOOS Indian Ocean Region Panel (IORP) met for its 13th session in Perth, Australia. The main agenda item of the meeting was the Indian Ocean Observing System (IndOOS) Review Workshop, jointly organized with SIBER. The workshop consisted of 24 review presentations along three themes: past and present of IndOOS; new scientific drivers in the Indian Ocean; and new technologies for future IndOOS, as well as two discussion sessions charged with identifying the scientific drivers of IndOOS and their observing requirements. Important outcomes of the workshop were: a mission statement for IndOOS, terms of reference for the IndOOS Review and, most importantly, a list of scientific drivers and observational requirements for IndOOS.

Following the workshop, the IndOOS review writing team has been established, and 25 draft chapters have been prepared including the current state of the system, operational and science drivers, and now are being circulated for comments by chapter lead authors and IORP members until October 1st 2017. Then, all chapter leaders need to revise their chapters before 31 October 2017, paying special attention to (1) societal motivation; (2) specific recommendations in the context of essential ocean variables (EOVs); and (3) reviewer comments. Then IORP Co-chairs (J. Vialard & L. Beal) will draw on the motivations and recommendations provided by each chapter for the Executive Summary, which is aimed at policymakers and funders. The final draft, together with the executive summary, will be opened for comments from the broader community in November 2017.

Meanwhile, a six-members IndOOS Review Board has also been established including representatives nominated by CLIVAR, OOPC, IOC, IOGOOS, and IMBeR. The Review Board is expected to provide detailed written comments on the draft implementation plan, and meet the writing team during the face-to-face (or teleconference) meeting in Lombok from 22 to 23 March 2018, in conjunction with next IORP meeting. Each of the chapter of the review will be presented orally to the Review Board, and the overall recommendations will be agreed on. An updated IndOOS Implementation Plan will be produced by December 2018. More information for the IndOOS Review can be found at http://www.clivar.org/indoos-review-2006-2016.

2. The Research Moored Array for African-Asian-Australian Monsoon Analysis (RAMA)

RAMA principal investigators in the U.S., China, India, and Japan have proposed a revised array design referred to as RAMA-2.0 in the context of the 2017-18 Indian Ocean Observing System (IndOOS) review. This design is intended to make the array more robust, cost-effective and less dependent on ship time, which is the most limiting resource for sustaining the array. RAMA-2.0 has slightly fewer moorings (40) than the original design (42) and eliminates moorings in regions prone to heavy fishing vandalism or where it has not been possible to find ship support. RAMA-2.0 also calls for deployment of more proven moored biogeochemical instrumentation in support of the Sustained Indian Ocean Biogeochemical and Ecosystem Research Program (SIBER) so that the array can address a broader range of multi-disciplinary problems. Plans are outlined for completing RAMA with occupation of mooring sites in the Arabian Sea during the Second International Indian Ocean Expedition (IIOE-2), which is scheduled for 2015-2020. It is understood that the RAMA-2.0 proposal needs full vetting as part of the IndOOS review process, but it provides starting point for discussion.

RAMA-2.0 will be fully implemented in 2018. New sites in the Arabian Sea will be established in 2018 using the NOAA ship Ronald H. Brown; and FIO/SOA will continue to maintain the RAMA buoy (Bailong) at 100E 8S station.

However, U.S. funding for RAMA has been flat for many years. Thus, additional funding is needed to complete the array during IIOE-2. Ship time will be needed in 2019 and beyond to sustain newly established RAMA sites in the Arabian Sea.

3. Years of the Maritime Continent (YMC)

The Years of the Maritime Continent (YMC) is a CLIVAR endorsed project. We hence briefly report on its status below (inputs from Kunio Yoneyama & Chidong Zhang).

The YMC field campaign phase has started since July 2017, for two years. Prior to that, the 3rd international science and planning workshop was held at the National University of Malaysia, March 14-16, 2017. Over 80 people participated, coordinating for intensive observations and model intercomparison. In conjunction with this workshop, special lectures have been arranged as a part of YMC's outreach and capacity building activities, and over 60 local university students and agency's staff participated. Another outcome of the workshop is the YMC Implementation Plan (http://www.bmkg.go.id/ymc/ and http://www.jamstec.go.jp/ymc/). YMC observations consist of two parts: long-term routine-based atmospheric and oceanic measurements

done by the local meteorological agencies and several intensive observation periods (IOPs). The YMC data archive centers (BMKG and JAMSTEC) have started to collect those routine data from the MC countries. Its first IOP will start since mid-November 2017 for two months, involving research institutes and universities from Indonesia, Japan, and US. Observations will target the west coast of Sumatra Island focusing on the study of diurnal convection, the Madden-Julian oscillation, and their interaction. Currently, IOPs for studying air-sea interaction in the Indonesian inland seas, boreal summer monsoon and intraseasonal oscillation around the Philippines and South China Sea, and equatorial waves along the equator from Indian Ocean to the Pacific, are planned for 2018.

While new scientific results have not been produced yet as the campaign has just been started, several papers that used pre-YMC campaign data over the MC and Indian Ocean (e.g. Wu et al. 2017, Yokoi et al. 2017) as well as relevant modeling studies have been published. Those can be found from JAMSTEC YMC web site publications page. In addition, pre-YMC campaign data and the MC-relevant model products are available from YMC web site data page.

4. Eastern Indian Ocean Upwelling Research Initiative (EIOURI)

EIOURI is a sub-component of the International Indian Ocean Expedition, 2 (IIOE-2) that has been endorsed by the IORP. We hence briefly report on its status below (inputs from Yukio Masumoto).

EIOURI is now officially endorsed by IIOE-2. EIOURI is trying to coordinate research cruises in the eastern IO organized by Indonesia, India, China, and Japan. R/V Hakuho-maru will visit eastern Indian Ocean in late 2018 to observe physical, geochemical, and biological parameters in the Bay of Bengal along 88E, the eastern Indian Ocean upwelling region off the coast of Java, and the ITF region. Detailed cruise plans are being discussed among related scientists and negotiations on the EEZ issue with the Indonesian side are in progress. Additional cruises by Indonesian scientists using R/V Baruna Jaya are planned in 2019.

Research highlights from EIOURI: (**a)** The BoBBLE (Bay of Bengal Boundary Layer Experiment) was conducted in the southern Bay of Bengal during the summer monsoon of 2016. This expedition has mapped the features of the southern Bay of Bengal during the peak of summer monsoon. The observations have been able to capture the Sri Lanka Dome and the Summer Monsoon Current in their different stages of seasonal evolution and two events of upper layer freshening and barrier layer formation. **(b)** Eddy-resolving OGCMs with realistic forcing indicate strong mean upwelling in the tropical Indian Ocean with its maximum on the equator in subsurface layer below the thermocline. It turns out that this mean upwelling is excited by rectified contribution of intraseasonal Mixed Rossby-Gravity waves forced by wind variability over the equatorial Indian Ocean. (Ogata et al., 2017, J.Phys.Oceanogr., 47, 1347, https://doi.org/10.1175/JPO-D-16-0257.1)

5. Western Indian Ocean Upwelling Research Initiative (WIOURI)

There have been no workshops or planning meetings for a Western Indian Ocean Upwelling Research Initiative (WIOURI), and there is no science or implementation plan. These necessary steps were expressed by the IIOE-2 Steering Committee through its initial endorsement of WIOURI in 2016 and the community remains willing

to assist. A collection of cruises and projects in the western Indian Ocean led and co-led by South African PIs, including ACEP, ASCA, and SOLSTICE, as well as a dedicated DEA cruise aboard Agulhas II, are contributing to IIOE-2.

Achievements for 2016-17

1. **Workshops/conference sessions:**
   - 1st IndOOS Review Workshop, January 31 to February 1, 2017 at Perth, Australia.
   - Multi-scale ocean-atmosphere interaction in the tropical Indo-Pacific region" session at the JpGU-AGU Joint Meeting 2017 (T. Tozuka)
   - "The Indian Ocean's past, present, and future – A session in Honour of Gary Meyers" at the 2017 EGU Meeting in Vienna (Austria) (Convenors: C. Ummenhofer and J. Vialard, keynote talk by M. Feng). This session will also be proposed in 2018.
   - Variability and change in the Indo-Pacific and Australian regional seas – A session in Honour of Gary Meyers, Joint 25th AMOS National Conference and 12th International Conference for Southern Hemisphere Meteorology and Oceanography, AMOS-ICSHMO 2018, Sydney, Australia, February 2018 (Convenors: H. Philips and C. Ummenhofer)
   - US IIOE-2 Workshop, La Jolla, CA, September 2017 (M. McPhaden, L. Beal, J. Wiggert: members of the organizing committee)

2. **Scientific results from activities:**
   - **IndOOS Review**
     - All 25 chapters of the **IndOOS review** have been written in first draft, most led by IORP members together with expert co-authors from across the international community. These chapters provide the state-of-the-art in terms of scientific understanding and observing technologies for the Indian Ocean basin. Currently IORP members are reviewing these chapters and will be revising and finalising over the next two months. This has been an enormous body of work for the panel.
   - **Review paper on Indo-Pacific interactions**
     - This paper is led by M. Lengaigne (PRP co-chair) and J. Vialard (IORP co-chair). A writing team and essential science themes have been identified. The initial goal was to provide a first draft by the end of 2017. This activity is however on hold due to the time-consuming IndOOS review.
   - **Review Paper on Monsoon-Indian Ocean Interactions**
     - Joint discussion between the monsoon panel and IORP have identified the need to write a review on the effects of the Indian ocean on rainfall in the surrounding regions, and in particular the Indian and Australian monsoon. A writing team has been identified and the literature review started. This activity is however on hold due to the time-consuming IndOOS review.

3. **Scientific capacity building and career support**
   - **IIOE-2 Summer school**

- J. Vialard and IORP offered their help for setting up an IIOE-2 summer school dedicated on the Indian Ocean climate variability and resulting bio-physical interactions, on the model of a winter school organized by M. Lengaigne / J. Vialard in Goa in 2016. INCOIS offered to host this summer school. The scientific program & school committee have been drafted.
- The school logistics are however too much to manage for IORP alone and J. Vialard has requested IIOE-2 co-chairs to provide support for pushing the logistics further and taking case of the funding support, in liaison with INCOIS. There has been no further progress since.

4. **Articles published in 2016/17 as part of panel activities:** No article has been published as part of IORP panel activity, but many individual contributions from IORP members (See Annex 4).

Plans for 2018 and beyond

1. The main activity of the IORP and 2018 will be to finalize the decadal review of IndOOS, and recommendations for its evolution over the next decade.
2. The two review papers discussed above (influence of Indian Ocean on monsoons and Indo-Pacific interactions) will be revived in 2018.
3. Further plans for future activities will be discussed at the next meeting in Lombok (e.g. some coordinated work on CMIP climate change projections in the Indian Ocean could for instance be initiated).

Budget and other needs for 2018

The main need of IORP for 2018 will be financial support for the upcoming IORP-14 including the 2nd IndOOS review workshop as part of it in Lombok in March 2018. The workshop does not only include IORP members who won't be able to support their travel/local costs (an estimated number of 16, including 7 which will have opportunity to be supported by US-CLIVAR) but the two CLIVAR-nominated review board members (J. McCreary and Susan Wijfels), and some chapter leaders from the IndOOS review who are not IORP members. While we will solicit help from other sponsors of the review (IMBER, OOPC, IOC & IO-GOOS), we hope that CLIVAR will be able to fund travel for the two review board members (both travelling from the US) and for two IORP members (priority given to developing and emergent countries).

Estimated budget:

$6.5K: anticipated from **WCRP** to support the travel of IORP members and review board members.

Additional Funding supports (around **$25K**) are anticipated from **US CLIVAR, IAPSO, OOPC, SIBER, IOGOOS, IOC Perth Project Office,** etc.

Proforma for CLIVAR Panel requests

for SSG approval for meetings

1. **Panel or Working Group:** Indian Ocean Region Panel (IORP)

2. **Title of meeting or workshop:** The 14th Session of CLIVAR/IOC-GOOS Indian Ocean Region Panel Meeting and the 2nd Indian Ocean Observing System (IndOOS) Review Workshop

3. **Proposed venue:** Lombok, Indonesia

4. **Proposed dates:** 21-23 March 2018 (back to back with IOGOOS-14/SIBER-8/IRF-8/IIOE-2 Steering Committee meeting)

5. **Proposed attendees, including likely number:** ~15 for IORP panel business meeting, and ~40 participants from the Review Committee of IndOOS Review; leading authors of each chapter and IORP panel members

6. **Rationale, motivation and justification, including: relevance to CLIVAR science and WCRP Grand Challenges, and any cross-panel/research foci links and interactions involved**

The CLIVAR/IOC GOOS Indian Ocean Region Panel plans to have its 14th Session in Lombok, Indonesia from March 21 to 23, 2018, back to back with the IOGOOS-14, IRF-8, SIBER-8 and 2nd Steering Committee meeting of IIOE-2. The meeting consists of two parts, in the afternoon of March 21, 2018, the IORP panel business will be discussed by covering the following topics: 1) update of the IndOOS Review; 2) update from other IORP activities; 3) plans in 2018-2019. Then on March 22 and 23, 2018, the 2nd IndOOS Review Workshop will be organised as an important part of the IORP-14.

IndOOS is the sustainable ocean observation system for the Indian Ocean. The goal of IndOOS is to provide sustained high-quality oceanographic and marine meteorological measurements to support knowledge based decision making through improved scientific understanding, weather and climate forecasts, and environmental assessments. The current IndOOS design was established on the basis of the Implementation Plan drafted by the IORP in 2006. Both Indian Ocean science priorities and measurement technologies have evolved since the original design was established. Also, we have learned some practical lessons in the implementation phase of IndOOS that can be usefully incorporated into recommendations for how to improve cost-effectiveness, operational efficiency and interdisciplinary synergies. Finally, the Second International Indian Ocean Expeditions (IIOE-2, 2015-2020) was just kicked off, provide a unique opportunity for providing enhanced resources to IndOOS.

The CLIVAR IORP co-chairs are leading the writing of a revised IndOOS implementation plan, with the help of a writing team comprised of selected IORP, SIBER, IO-GOOS members as well as invited experts (see Annex 1). The IndOOS decadal review process was endorsed by the Ocean Observations Panel for Climate

(OOPC) in July 2016. During the review process, the current status of IndOOS and its past successes and failures has been critically assessed, so as to the scientific and operational drivers of IndOOS and their societal impacts. The Essential Ocean Variables (EOVs) that address these drivers, their spatial coverage and temporal/spatial resolution have also been identified. The IndOOS Review is expected to make actionable recommendations for priority observing system components going forward, including pilot studies with new technologies. The review is planned to be one year, including the preparing for and holding review workshops and producing a white paper and implementation plan.

Now, the draft chapters of the IndOOS Review are now available at https://drive.google.com/drive/folders/0B_M8OA1I21BSTzduTW9HR3M1bjQ and being commented by lead authors and IORP members. The first draft and executive summary will be available in November and be open to scientific colleagues for comments and feedbacks, and will be formally reviewed by an ad hoc review board (see Annex 2), independently nominated by the review sponsors, back to back with the next IORP face-to-face meeting in early 2018. This review of IndOOS is sponsored by CLIVAR (through IORP) , OOPC, IMBER (through its SIBER Indian Ocean project) and IO-GOOS, IOC Perth Project Office.

IndOOS Review will provide to GOOS, GCOS and the Unifying Theme of WCRP on 'Observations and Analysis', the valuable scientific assessment and actionable recommendation on future development and implementation of the Indian Ocean Observing System. The review will definitely contribute to ensure that the components of Indian Ocean Observing System are meeting the physical/climate requirements and the societal needs.

7. **Specific objectives and key agenda items:**

See Annex 3 for draft agenda of IORP panel business meeting and the 2nd IndOOS Review Workshop. The 2nd IndOOS Review workshop will provide an opportunity for each of the 25 chapter of the IndOOS Review to be presented by lead authors to an independent Review Board, in talks of about 15 minutes each on the first day (Mar. 22), plus a half day feedback from the Independent Review Board of IndOOS, plus a half day discussion on how to move forward and finalise the white paper on the second day (Mar. 23).

8. **Anticipated outcomes (deliverables):**

Overall recommendations to the first draft of the report are expected to be agreed on during the workshop. Then, the draft of IndOOS Review White Paper and the revised implementation plan for IndOOS are expected to be produced by September 2018, and the final white paper and the revised implementation plan will be completed by December 2018.

9. **Format:** half day panel business meeting followed by a two-day workshop (each of the review chapters will be presented orally to the review board)

10. **Science Organizing Committee (if relevant):** N/A

11. **Local Organizing Committee (if relevant):** N/A

12. Proposed funding sources and anticipated funding requested from WCRP

$6.5K: anticipated from **WCRP** to support the travel of IORP members and review board members.

Additional Funding supports (around **$25K**) are anticipated from **US CLIVAR, IAPSO, OOPC, SIBER, IOGOOS, IOC Perth Project Office,** etc.

Annex 1: IndOOS Review Lead Authors

Chapter	First Name	Last Name	Affiliations	Email	Country
1. Science Drivers					
SD 01: Effect of Indian Ocean on monsoon and monsoon onset	H.	Annamalai	University of Hawaii	hanna@hawaii.edu	USA
SD 02: Oxygen variability and change, oxygen minimum zones	Jerry	Wiggert	University of Southern Mississippi	jerry.wiggert@usm.edu	USA
SD 03: Upwellings and coastal/open ocean interactions	Y.	Masumoto	University of Tokyo	masumoto@eps.s.u-tokyo.ac.jp	Japan
SD 04: Extreme events (cyclones, marine heat waves)	Matthieu	Lengaigne	Institute of Research for Development (IRD)	Matthieu.Lengaigne@locean-ipsl.upmc.fr	France
SD 05: Intra-seasonal air-sea coupling (MJO, monsoon ISO, eddies)	Toshiaki	Shinoda	Texas A&M University-Corpus Christi (TAMU)	Toshiaki.Shinoda@tamucc.edu	USA
SD 06: Interannual variability and its predictability: IOD, IOBM, subtropical IOD, Ningaloo Nino	Tomoki	Tozuka	University of Tokyo	tozuka@eps.s.u-tokyo.ac.jp	Japan
SD 07: Basin-scale heat and freshwater flux variability	Lisa	Beal	University of Miami	lbeal@rsmas.miami.edu	USA
SD 08: Carbon cycle, acidification, and eco/biological impacts	Raleigh	Hood	University of Maryland, Cambridge	rhood@umces.edu	USA
SD 09: Oceanic fluxes: Boundary currents and Indonesia Throughflow	Ming	Feng	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Ming.Feng@csiro.au	Australia
SD 10: Decadal variability and predictability	Jerome	Vialard	Laboratory of Oceanography & Climate (IRD)	jerome.vialard@ird.fr	France
SD 11: Anthropogenic climate change	Roxy	Matthew Koll	Indian Institute of Tropical Meteorology (IITM)	roxy@tropmet.res.in	India
SD 12: Ocean productivity variability, predictability & change	Peter	Strutton	University of Tasmania	Pete.Strutton@utas.edu.au	Australia

Chapter	First Name	Last Name	Affiliations	Email	Country
SD 13: Hydrological cycle	Caroline	Ummenhofer	Woods Hole Oceanographic Institution (WHOI)	cummenhofer@whoi.edu	USA
SD 14: Regional sea-level variability and change	Weiqing	Han	University of Colorado	whan@colorado.edu	USA
2. Operational Drivers					
OD 01: Improvement of Seasonal prediction	Aneesh	Subramanian	Scripps Institution of Oceanography	aneeshcs@gmail.com	USA
OD 02: Improvement of surface fluxes	Lisan	Yu	Woods Hole Oceanographic Institution (WHOI)	lyu@whoi.edu	USA
OD 03: Improvement of ocean reanalyses	Tony	Lee	NASA	tlee@jpl.nasa.gov	USA
3. IndOOS Component Review					
IR 01: Past, present & future satellites in support of IndOOS	Tony	Lee	NASA	tlee@jpl.nasa.gov	USA
IR 02: Argo, including Deep & Bio Argo outlook	M.	Ravichandran	Indian National Centre for Ocean Information Services (INCOIS)	ravi@incois.gov.in	India
IR 03: RAMA	Mike	McPhaden	NOAA, PMEL/Tropical Moored Buoy Implementation Panel	Michael.J.Mcphaden@noaa.gov	USA
IR 04: Surface Drifter	Rick	Lumpkin	NOAA	rick.lumpkin@noaa.gov	USA
IR 05: XBTs	Ming	Feng	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Ming.Feng@csiro.au	Australia
IR 06: Tide Gauges	Unnikrishnan	Alakkat	National Institute of Oceanography (NIO)	unni@nio.org	India
IR 07: New technologies	Craig	Lee	University of Washington	craig@apl.washington.edu	USA
IR 07: New technologies	Magdalena	Andres	Woods Hole Oceanographic Institution (WHOI)	mandres@whoi.edu	USA
IR 08: GoSHIP	Bernadette	Sloyan	Commonwealth Scientific and Industrial Research Organisation (CSIRO)	bernadette.sloyan@csiro.au	Australia

Annex 2: Review Board Members

First Name	Last Name	Organisation	Email	Country	Recommended by
Jay	McCreary	University of Hawaii	jay@hawaii.edu	USA	CLIVAR
Susan	Wijffels	CSIRO	Susan.Wijffels@csiro.au swijffels@whoi.edu	Australia	CLIVAR
Coleen	Moloney	University of Cape Town	coleen.moloney@gmail.com	South Africa	IMBeR
Marjolaine	Krug	CSIR	mkrug@csir.co.za	South Africa	OOPC
Richard	Matear	CSIRO	Richard.Matear@csiro.au	Australia	IOGOOS
Peter	Dexter	Bureau of Meteorology, Australia	plsinoz@gmail.com	Australia	IOC PPO

Annex 3: Draft Agenda for IORP-14 and 2nd IndOOS Review Workshop

Time	Agenda item	Speaker
Mar. 21	**IORP Panel Business meeting (14:00 – 18:00)**	
Mar. 22	**Day 1: Presentations of the IndOOS Review Chapters (Chaired by Jerome and Lisa)**	
09:00	***Session 1: Operational Drivers***	
09:00	OD 01: Indian Ocean impacts on the South-Asian monsoon	H. Annamalai
09:15	OD 02: Improvement of surface fluxes	Lisan Yu
09:30	OD 03: Improving ocean data assimilation	Tony Lee (remote)
09:45	***Session 2: IndOOS Components and New Technologies***	
09:45	IR 01: Past, present & future satellites in support of IndOOS	Tony Lee (remote)
10:00	IR 02: Argo Profiling floats in the Indian Ocean	M. Ravichandran
10:15	IR 03: RAMA-2.0	Mike MacPhaden
10:30	***Coffee break***	
11:00	IR 04: Surface Drifter Observations in the Indian Ocean	TBC
11:15	IR 05: XBT network	Ming Feng
11:30	IR 06: Tide gauges in the Indian Ocean	A.S. Unnikrishnan
11:45	IR 07: New Technologies for In Situ IndOOS Measurements	TBC
12:00	IR 08: GO-SHIP	Bernadette Sloyan
12:15	***Lunch***	
14:00	***Session 3: Science Drivers***	
14:00	SD 01: Indian Ocean observations for operational subseasonal and seasonal forecasts	Aneesh Subramanian
14:15	SD 02: Oxygen variability and change, oxygen minimum zones	Jerry Wiggert
14:30	SD 03: Upwelling, coastal-open ocean interactions, and ecosystems	Yukio Masumoto
14:45	SD 04: Extreme events	Matthieu Lengaigne
15:00	SD 05: Intra-seasonal air-sea coupling: Madden-Julian Oscillation and Monsoon Intra-seasonal Oscillation	Toshiaki Shinoda
15:15	SD 06: Interannual variability and predictability	Tomoki Tozuka
15:30	***Coffee break***	
16:00	SD 07: Indian Ocean heat content and heat flux variability	Lisa Beal
16:15	SD 08: Carbon cycle, acidification, and ecological impacts	Raleigh Hood
16:30	SD 09: Oceanic fluxes: Boundary currents and Indonesian Throughflow	Ming Feng
16:45	SD 10: Decadal variability and predictability	Jerome Vialard
17:00	SD 11: Anthropogenic climate change in the Indian Ocean	Roxy Mathew Koll
17:15	SD 12: Ocean primary productivity - variability, predictability and change	Peter Strutton
17:30	SD 13: The Indian Ocean's Influence on Regional Hydroclimate	Caroline Ummenhofer
17:45	SD 14: Regional sea-level variability and change	TBC
18:00	**End of the day**	
Mar. 23	**Session 4: Review Board Response to the IndOOS Review draft chapters**	
09:00	1. Review Board Response to Science Drivers	
10:30	***Coffee break***	
11:00	2. Review Board Response to Operational Drivers	
11:45	3. Review Board Response to ***IndOOS Components and New Technologies***	
12:30	***Lunch***	
14:30	**Session 5: Discussion and next steps**	**Jerome and Lisa**
18:00	**End of the day**	

Annex 4: Publications related to IndOOS by IORP members.

Chen G., **W. Han**, Y. Li, **M.J. McPhaden**, J. Chen, WQ Wang, **DX Wang,** 2017: Strong Intraseasonal Variability of Meridional Currents near 5N in the Eastern Indian Ocean: Characteristics and Causes. J. Phys. Oceanogr., 47, 979-998, DOI: http://dx.doi.org/10.1175/JPO-D-16-0250.1.

Cuypers, Y., P. Bouruet-Aubertot, **J. Vialard,** and **M.J. McPhaden,** 2017: Focusing of internal tides by near-inertial waves, Geophys. Res. Lett., 44, doi:10.1002/2017GL072625.

Dong, L. and **M.J. McPhaden,** 2017: The effects of external forcing and internal variability on the formation of interhemispheric sea surface temperature gradient trends in the Indian Ocean. J. Climate, in press.

Dong, L. and **M.J. McPhaden,** 2017: Why has the relationship between Indian and Pacific Ocean decadal variability changed in recent decades? J. Climate, 30, 1971-1983.

Dong, L. and **M.J. McPhaden**, 2017: The role of external forcing and internal variability in regulating global mean surface temperatures on decadal timescales. Environ. Res. Lett., 12, 034011. https://doi.org/10.1088/1748-9326/aa5dd8.

Fu, J.X., W. Wang, **T. Shinoda,** H.-Li. Ren, X. Jia (2017) Towards understanding the diverse impacts of air-sea interactions on MJO simulations. *JGR-Oceans* (revised).

Fuan Xiao, Lili Zeng, Qinyan Liu, Wen Zhou, **Dongxiao Wang,** 2017. Extreme subsurface warm events in the South China Sea during 1998/99 and 2006/07: observations and mechanisms. Clim. Dyn., DOI: 10.1007/s00382-017-3588-y

Guo, Y., **Shinoda, T.,** Lin, J.-L., Chang, E.K.M. (2017). Variations of the Mid-latitude Storm Track Activity associated with the Madden-Julian Oscillation. *J. Climate*. 13, 4799-4813, dx.doi.org/10.1175/JCLI-D-16-0513.1.

Han W., G.A. Meehl, A. Hu, J. Zheng, J. Kenigson, **J. Vialard,** B. Rajagopalan, and Yanto, 2017: Decadal variability of Indian and Pacific Walker Cells: Do they co-vary on decadal timescales? J. Climate, DOI: 10.1175/JCLI-D-16-0783.1.

Han, W., G. Meehl, D. Stammer, A. Hu, B. Hamlington, J. Kenigson, H. Palanisamy, and P. Thompson, 2017: Spatial Patterns of Sea Level Variability Associated With Natural Internal Climate Modes. Surveys in Geophysics, 38(1), 217-250, DOI:10.1007/s10712-016-9386-y.

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