SCOR Working Group Proposal Template

(max. 6250 words, excluding Appendix)

Title:

Quantification and Optimization of Ocean Observing System under Future Uncertainties to Improve Climate Forecasts

Acronym:

QOOSFUN

Summary/Abstract (max. 250 words)

The global ocean observing system (GOOS) was disrupted by the unexpected pandemic and is still facing increasing challenges due to factors such as budget cuts and fuel price increase. The Indian Ocean Observing System (IndOOS) has been particularly affected, and the data loss has potentially had a critical impact on the prediction of major climate processes over the pan-tropics with subsequent social and economic consequences. This situation highlights the ocean observing system (OOS) vulnerability, underscores the need to quantify its effectiveness and to enhance its optimization while recovering.

This proposal aims to integrate advanced optimization methods into the deployment and design configuration of next generation ocean observing platforms, using IndOOS as a pilot. The working group (WG) will synthesize current understandings in the effectiveness of OOS, quantify the impact of IndOOS data loss on climate simulations and predictions, evaluate the optimization of IndOOS through Observing System Simulation Experiments (OSSEs), and ultimately produce a general OOS optimization guide. The results of the WG are expected to contribute to the Second International Indian Ocean Expedition (IIOE-2), of which SCOR is a core sponsor, especially in Science Themes 4 and 5 on climate variability and extreme events in the Indian Ocean.

Expected deliverables seek to improve the efficiency and resiliency of the GOOS and include synthesis papers, a best practices manual, a website archiving IndOOS effectiveness, and training courses. The WG will also focus on capacity building, especially in developing countries and for next-generation oceanographers and promoting science-policy integration.

Scientific Background and Rationale (max. 1250 words)

The pandemic had dramatic consequences on the GOOS (Boyer et al. 2023; Sprintall et al. 2024). While most of the GOOS is now progressively recovering post-pandemic, recent challenges include rising fuel prices, inflation and budget cuts due to policy changes in the US and many other countries, reduced ship time, and maritime piracy and global conflicts that instill regional instability. Collectively these challenges provide a unique and timely opportunity to re-examine the observing system design in terms of components and locations, with the goal of adopting a more efficient observing system. A better design will "ensure a sustainable OOS across all ocean basins that delivers accessible, timely and actionable data and information to all users", as advocated in the Ocean Decade Vision 2030 White Papers (IOC 2024). Our WG proposes to integrate various optimization methodologies into the deployment and configuration including backbone and next-generation ocean observing platforms, with a focus on the enhancement of the IndOOS as a pilot case.

1 Degradation of Indian OOS

The purpose of IndOOS is to monitor the marine and atmospheric conditions in the Indian Ocean (Beal et al. 2020; McPhaden et al. 2024). Through real-time data acquisition, IndOOS facilitates improvement in dynamical understanding and model development, and contributes to early warning and disaster mitigation systems. IndOOS is aligned with the IIOE-2 goal to build an Indian Ocean observational network and applying its data to inform socio-economic decision-making. Furthermore, the importance of the IndOOS for both scientific understanding and policymaking is not limited to the Indian Ocean, but also extends to the global oceans via atmospheric and oceanic bridges (Cai et al. 2019; Foltz et al. 2025).

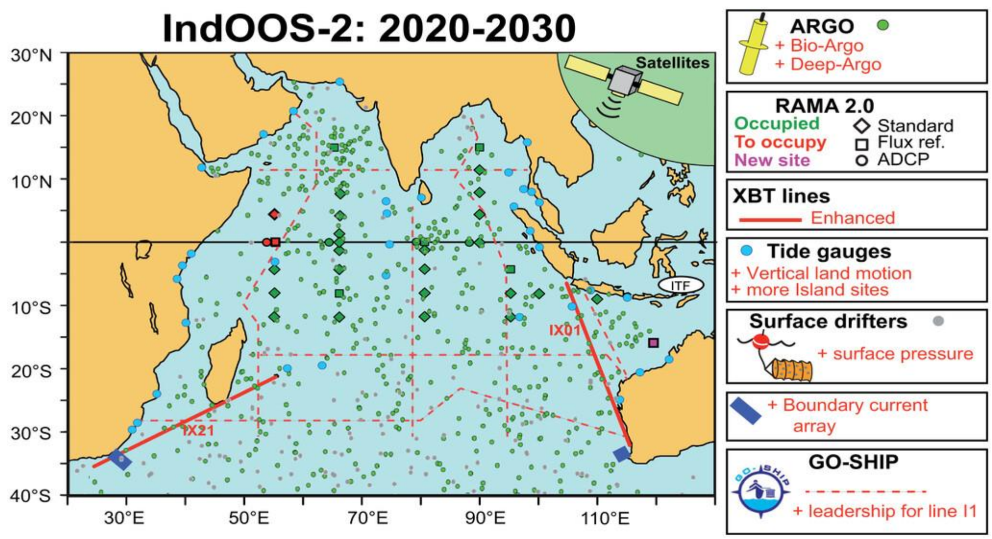

Figure 1 *Schematic of the IndOOS (after Beal et al. 2020).*

Current IndOOS platforms include the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA), the OMNI (Ocean Moored buoy network for the northern Indian Ocean) array*,* Argo floats, surface drifters, GO-SHIP and the eXpendable BathyThermograph (XBT) network, as well as other diverse platforms such as satellites and tide gauges (Fig. 1). The state of IndOOS is worrisome, in particular, due to the pandemic (Sprintall et al. 2024) but also with recent losses in the RAMA array (see https://www.pmel.noaa.gov/tao /global/status/buoystat-rama.html). Data loss in the Indian Ocean may be more severe than in the Atlantic and Pacific Oceans (Boyer et al. 2023). Prior to the pandemic in December 2019, 21 out of 22 RAMA moorings were transmitting good data and the overall data return was 87% (Fig. 2). In contrast, post pandemic, by December 2022, almost all RAMA buoys had been deployed for more than 3 years (well beyond the typical 1-year deployment schedule) and the average data return for the entire array dropped to 2% (Fig. 2). The Argo program in the Indian Ocean also suffered a decline in array size and spatial coverage. In 2022, only 85% of core Argo floats were operational. Typically, 170 floats are targeted for annual deployment in the Indian Ocean, but due to limited opportunities, 250 were needed to be deployed in 2022 to maintain the Argo coverage. Other components of IndOOS (such as the BGC Argo, surface drifter, GO-SHIP and XBT transects) were similarly impacted.

2 Quantification of the effect of data loss on weather and climate forecast

Degradation in IndOOS has critical implications for forecasts of whole pan-tropical regions (Li et al. 2025). For example, data loss may degrade model initial conditions, affecting forecasts from synoptic to interannual timescales. Accurate initial conditions are typically obtained by assimilating observations, which relies heavily on the availability of high-quality *in-situ* observations. Pradhan et al. (2021) reported that the absence of moored buoys can result in a cold SST bias and subsurface temperature errors in initial conditions that adversely affect the Indian summer monsoon rainfall (ISMR) forecast. The prediction error in the ISMR forecast caused by the exclusion of moored buoy observations is as high as 39%.

Nonetheless, the specific data loss suffered during the pandemic also provides an unprecedented opportunity to quantitatively assess the effectiveness of the IndOOS in climate simulations and forecasts. Many assessments use Observing System Experiments (OSE) and Observing System Simulation Experiments (OSSE), which rely on data assimilation systems to evaluate ocean observations and determine their effectiveness, accuracy, and impact on scientific research, operational oceanography, and climate monitoring. While OSEs assimilate real observations, OSSEs use the simulated "observations" of a coupled model (Halliwell et al. 2017; Li et al. 2023; Pradhan et al. 2021; Rao et al. 2023). The OSSE is therefore an ideal tool to quantify the consequences of these data gaps on our ability to predict tropical weather and climate. The Synergistic Observing Network for Ocean Prediction (SynObs), which is a project of UN Ocean Decade, is leading global efforts in the use of OSEs and OSSEs to assess OOS effectiveness (Fujii et al. 2024). SynObs will collaborate with this WG. Dr. Peter Oke, a SynObs Steering Committee member, is an associate member of our WG. The SynObs outputs will be a major data source for our WG to assess OOS.

In fact, the impacts of OOS are wide-ranging. They extend beyond weather and climate to include biogeochemical and environmental observations. However, given the limited time and scope of a SCOR WG and our membership expertise, our focus will be on evaluating the effectiveness of OOS in climate simulation and forecasting. The insights and guidelines developed through this WG may also be applicable to related fields.

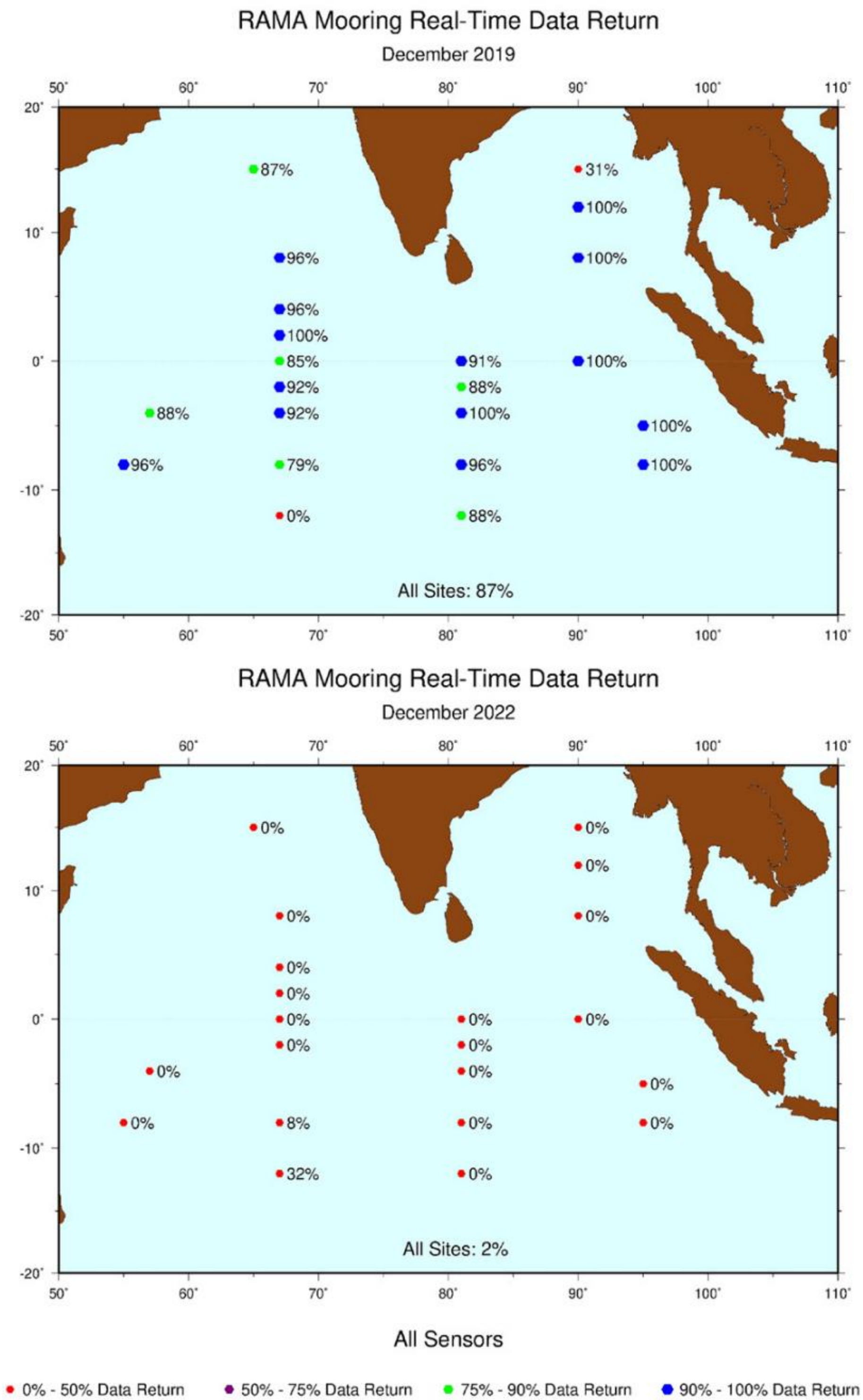

Figure 2 *The status of RAMA moorings in (top) December 2019 and (bottom) December 2022 showing real-time data return from each buoy. Data return for each site, expressed as a percentage, is based on the number of days of data acquired divided by the number of days of data expected in a given time period, summed over all sensors on a particular mooring. (after Sprintall et al. 2024)*

3 Optimization of the OOS

The optimization of OOS requires synthesized efforts, including novel concepts, cutting-edge techniques, etc. The OSSEs have been demonstrated to be an efficient approach for optimizing OOS. To support the development of efficient and adaptive observing systems, a significant opportunity lies in the rapid advancement of nonlinear optimization methods and artificial intelligence (AI) techniques. These use data assimilation, predictive modeling, and reinforcement learning to support adaptive sampling, optimize sensor placement, and adjust missions in real time. Advanced AI further facilitates improving observational efficiency, cutting costs, and aiding decarbonization of observational infrastructure — while maintaining or enhancing data quality and resolution.

There are various optimization methods, which can lead to uncertainties of OSSE approach as shown with the SynObs early results in Fujii et al. (2024). Different methods are based on different philosophies, have different focuses, and also differ in their applicability, characteristics, and advantages. For example, the optimal perturbation analysis and the sequential data assimilation framework are two methods, which have been widely applied to targeted observational analysis (e.g., Li et al. 2023). Optimal perturbation analysis is related to the growth of the initial errors, i.e., identifying the locations with the largest error growth, such as singular vectors, breeding vectors, and conditional nonlinear optimal perturbations (CNOP). Among these, CNOP overcomes the linear approximation limitation of the singular vector method and has been broadly applied to various prediction targets (Mu and Duan 2025). The sequential data assimilation framework quantifies the contribution of each observation independently by performing data assimilation analyses individually, significantly reducing computational costs. The sequential assimilation-based methods have been used for targeted observation design, including ensemble transform Kalman filter (Bishop et al. 2001; Khare and Anderson 2006) and ensemble sensitivity analysis (Anderson 2001; Hamill and Snyder 2000). One of the WG objectives is to compare the optimization methods, in terms of their effectiveness for identifying the optimal location of targeted observations with a goal to improve prediction skill of high-impact weather and climate events over the Indo-Pacific region. In this way, IndOOS can better serve its scientific purpose and optimize cost-effectiveness. Ultimately, the experience and practices accumulated for the IndOOS can help to optimize the observing system in other oceans.

The performance of targeted observation analysis has proven promising. The optimal observational array for sea level anomaly prediction in the Indian Ocean was found to theoretically reduce the initial uncertainty by up to 60% (Wu et al. 2020). A targeted observational analysis showed that the optimal observing sites in the tropical western Pacific reduced 70% of the initial SST uncertainties in the Niño 3.4 region (Rao et al. 2023). The OSSEs using a fully coupled model showed that the assimilation of the observations from the identified optimal sites in the Indian Ocean reduced up to 38% of the errors in SST simulations over the key regions of Indian Ocean Dipole (Li et al. 2023).

Thus, there is dual motivation for the proposed SCOR WG: first, to synthesize the outputs of

OOS optimization (such as SynObs results) and to leverage this transitional phase to optimize IndOOS through advanced methodologies; and second, to establish a framework from this exercise for translating regional innovations from the IndOOS into broader strategies for GOOS.

The proposed SCOR WG aligns strongly with the objectives of the GOOS Co-Design Programme and offers an opportunity to contribute to its Exemplar Projects. The WG focuses on innovative tools for optimizing OOS directly supports the Co-Design Programme aim of creating integrated, responsive, and user-informed observing networks. In particular, the WG's emphasis on improving climate forecasts through enhanced data coverage complements Exemplar Projects such as those for boundary currents, tropical cyclones, and marine heatwaves, which all rely on accurate, high-resolution ocean data for prediction and impact mitigation. By engaging operational modelers, observation designers, and end-users, the WG can contribute to both methodological innovations and regional test cases to develop best practices and co-design frameworks under GOOS, enhancing the societal value and cost-effectiveness of global ocean observing efforts.

Terms of Reference (max. 250 words)

The degradation of ocean observing systems, although immediately concerning, offers an opportunity to quantitatively assess their contribution to climate simulations and predictions.

T1: To synthesize current outputs using the OSE and OSSE approaches. OSEs and OSSEs have been conducted using various ocean-atmosphere coupled systems. The results (e.g., from SynObs) will be synthesized and analyzed, and the implications to climate simulation and forecast will be clarified.

T2: To summarize and compare optimization methods. Different optimization methods have different characteristics and different feasibility. They will be analyzed and summarized in a white paper for the reference of potential practical applications. Young oceanographers and scientists from developing countries will be trained to use these methods.

T3: To quantify the impact of IndOOS data loss on simulations and forecast in pan-tropics. The impacts on simulation and forecast of major climate processes in the pan-tropics (such as ENSO) will be tested. In addition, data losses may affect models differently, hence model intercomparisons will be conducted.

T4: To synthesize a general guide to optimize the global ocean observing system. The effectiveness of each individual platform in IndOOS (such as RAMA and Argo arrays) will be quantified and used as an example. The knowledge and experience through IndOOS will be synthesized under a broader perspective to make it applicable to GOOS.

T5: To build capacity and to transfer technical skills, particularly to scientists in developing nations. Comprehensive and actionable materials for training courses, which will facilitate the spread of practical approaches and technical skill, especially in developing countries.

Deliverables (state clearly what products the Working Group will generate. Should relate to the terms of reference. Max 250 words). A workshop is not a deliverable. Please note that SCOR prefers that publications be in open-access journals.

The WG will produce a series of deliverables that synthesize current understanding of the effectiveness of the OOS, advancing knowledge of the impacts of IndOOS data loss and support the optimization of the OOS. By focusing on critical climate processes in the pan-tropics (such as ENSO), the WG will provide the technical foundations, training, and the applied knowledge needed to enhance the effectiveness of the GOOS. Each deliverable specifically maps onto the Terms of Reference indicated above.

D1: A white paper summarizing and comparing current OSSE efforts and optimization methods. The characteristics and suitability of different methods will be highlighted. The progress and challenges to OSSE will be reviewed. Perspectives of AI applications will also be provided. (T1 and T2)

D2: A research paper presenting the quantification of the impacts of IndOOS data loss on simulations and forecast of climate processes in the Indo-Pacific region. ENSO will be the first choice of the target processes to be assessed (T1 and T3)

D3: A best practice manual on how to perform the optimal analysis of OOS will be published on IndOOS and CLIVAR websites. It will also be used as teaching materials for training courses. This is part of the capacity building of this WG. (T4 and T5)

D4: A website archiving the effectiveness of IndOOS components measured by their contributions to improving forecasts as determined from the OSSE analysis. This will become a routine display on the IndOOS website. It is expected that the website size will be relatively compact so it can be posted in multiple places, such as the webpage for the WG, the Indian Ocean Region Panel (IORP) and Global Synthesis and Observations Panel (GSOP) under CLIVAR, as well as under the IIOE-2. Since the effectiveness of various components assessed by the OSSEs may change over time, the archive will be updated regularly according to the strategy. (T3 and T5)

D5: Training courses based on the products of the WG (D1 to D3). One training course will teach the OSSE method and optimization methods to next-generation oceanographers. Another training course will focus on optimal analysis using the teaching materials written by this WG. The training materials are part of the capacity building of this WG, and they will be accessible via the WCRP Academy and/or Lighthouse Activities. (T2, T4 and T5)

Working plan (logical sequence of steps to fulfil terms of reference, with timeline. Max. 1000 words)

Year 1 - 2027

An initial workshop will be held in early 2027, possibly in conjunction with the AOGS meeting in Singapore or the IIOE-2 meeting. The activities planned for the entire WG will be discussed.

Subgroups will be formed to address each of the **ToRs from T1 to T5**.

Subgroup 1, led by Hasibur Rahaman and Youmin Tang, will focus on synthesis of OSE and OSSE results and optimization methods (**T1** and **T2**).

Subgroup 2, led by Lei Zhou and Xiaojing Li, will evaluate the impact of IndOOS data loss on the pan-tropical simulations (**T3**), such as ENSO.

Subgroup 3, led by Shikha Singh and Marie-Alexandrine Sicre, will synthesize the general guide for the optimization of OOS (**T4** and **T5**), based on the products of the first two subgroups.

Subgroup 4, led by Iskhaq Iskandar and Mu Mu, will organize the training courses for the developing countries and for young oceanographers.

Subgroups 1 & 2 will start working in the first year, while the other two subgroups will start working in following years. Starting from the first year, virtual meetings will be held every 2-3 months to ensure the timely progress of the subgroups and the WG as a whole.

Year 2 – 2028

In Year 2, we will continue to focus on summarizing and analyzing existing OSSE outputs (from SynObs for example) and optimization methods **(T1**, **T2** and **D1)**.

In Year 2, we will also assess the optimization of the IndOOS using OSSEs, which addresses **T3**. First, we will quantify the impacts of IndOOS data loss on simulations and forecasts across the Indo-Pacific region, with a focus on ENSO. Second, using OSSEs, we will assess the effectiveness of each RAMA buoy under its current deployment configuration. Third, we will optimize the RAMA buoy deployment strategy to maximize their contribution to improving ENSO simulations and predictive skill. (**T3, D2** and **D3**).

Year 3 – 2029

The effectiveness of targeted observations, which are measured by their contributions to improving forecasts, will be verified. Based on the results and the white paper (produced as **D1**), we will write the best practices manual on how to perform the optimal analysis of ocean observing systems (**T4** and **D3**) and will initiate the website archiving the effectiveness of IndOOS components (**D4**).

In Year 3, we expect to launch the first training course on optimal analysis using the training materials produced by this WG (in Year 2), especially for the developing countries and young oceanographers in the rim-countries of the Indian Ocean (**T5** and **D5**). The training course will be designed in collaboration with China–Sri Lanka Joint Center for Education and Research (CSL-CER) (**T4** and **D5**). The CSL-CER agrees to host the training course and to provide necessary financial and logistical supports for the training course in Sri Lanka. In addition, CSL-CER has Research Vessels and observation stations, and they are keen to apply the optimization methods recommended by this WG to their observations. The training course and practical application by CSL-CER will be a demonstration of the effectiveness of this WG and will be used to improve the teaching materials produced in Year 2.

Year 4 - 2030

The main task of final year is to comprehensively summarize and review the achievements of the WG. The best practice manual on the optimal analysis of ocean observing systems will be published (**T4** and **D3**); the IndOOS component effectiveness website will be regularly updated (**D4**). As a legacy of this WG, it is envisaged that the website will be a regular component on the websites of SCOR, IIOE-2, and related CLIVAR IORP.

Capacity Building (How will this Working Group build long-lasting capacity for practicing and understanding this area of marine science globally. Max 1500 words)

Most of the countries around the Indian Ocean that will benefit from this WG are emerging economies. The Indian Ocean is an under-researched and under-observed ocean, in contrast to the Pacific and Atlantic Oceans. In the context of climate change, natural hazards such as extreme droughts and floods, tsunamis, marine heat waves, and coastal ecosystem degradation are increasingly affecting populations in low-income countries. Therefore, the capacity building of this WG will focus on training young local oceanographers and knowledge transfer to the community and policy makers. The products of this WG will help increase efficiency and reduce the cost of ocean observations in developing countries.

1. A website synthesizing the effectiveness of IndOOS components, to be regularly updated.
2. Training materials developed by the WG on optimal analysis.
3. A training course on deploying an effective and optimal ocean observing system, mainly for developing countries.
4. A webpage on SCOR and CLIVAR websites to advertise the concepts, activities and achievements of this WG.
5. Establish a peer-learning and mentorship platform for early-career oceanographers, technicians, and data scientists from different countries, so that the optimization approaches can be applied as much as possible in following ocean observation designs. To sustain the peer-learning and mentorship platform beyond the SCOR WG's four-year term, it can be run as a pilot initiative. This pilot would test and refine the mentorship model, build partnerships with existing networks (e.g., WCRP lighthouse, OceanTeacher), and create a scalable framework. By documenting outcomes and leveraging participants as future mentors, the platform could demonstrate long-term value and attract ongoing support through integration into global ocean capacity development programmes.

Working Group composition (as table). Divide by Full Members (10 people) and Associate Members (max. 10 people), taking note of scientific discipline spread, geographical spread, gender balance, and participation by early-career scientists. Proponents may also include a short rationale for the composition and balance. (max. 500 words)

Full Members (no more than 10, please identify chair(s))

Name	Gender	Years since degree*	Country and institution of affiliation(s)	Expertise relevant to proposal
1 Lei Zhou (co-chair)	M		Shanghai Jiao Tong University, China	Ocean dynamics and simulation (IORP member)
2 Shikha Singh (co-chair)	F	3 ECS	Indian Institute of Tropical Meteorology, India	Indian Ocean observation and simulation, upper ocean dynamics and model parameterizations (IORP co-chair)
3 Youmin Tang	M		University of North British Columbia, Canada	Targeted observation, data assimilation, climate forecast
4 Mu Mu	M		Fudan University, China	Targeted observations and nonlinear analyses
5 Juliet Hermes	F		University of Cape Town, South Africa	Ocean observation and dynamics (IORP member; GOOS co-chair)
6 Marie-Alexandrine Sicre	F		Centre National de la Recherche Scientifique, France	Paleo-climate, organization and operation of international programs (IORP member)
7 Iskhaq Iskandar	M		University of Sriwijaya, Indonesia	Ocean dynamics in the Indo-Pacific region (IORP member)
8 Janet Sprintall	F		Scripps Institution of Oceanography, UCSD, USA	Ocean observations and dynamics (IORP co-chair)
9 Hasibur Rahaman	M		INCOIS, India	Ocean simulations. Lead for the SynObs Indian Ocean experiments
10 Shoichiro Kido	M	6 ECS	JAMSTEC, Japan	Ocean simulation and prediction with high resolution models (IORP member and SynObs member)

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Associate Member (no more than 10)

Name	Gender	Years since degree*	Country and institution of affiliation(s)	Expertise relevant to proposal
1 Xiaojing Li	F	8 ECS	Second Institute of Oceanography, MNR, China	Targeted observation, data assimilation, climate simulations (ECS)
2 Rong Feng	F	9 ECS	Institute of Atmospheric Physics, CAS, China	Targeted observation, data assimilation, climate simulations
3 Michael Mayer	M		University of Vienna, Austria; ECMWF, Bonn, Germany	Reanalysis, ocean diagnostics, seasonal forecasting
4 Zouhair Lachkar	M		New York University, United Arab Emirates	Climate change and ocean environment (SOLAS)
5 Peter Oke	M		CSIRO, Australia	Data assimilation and ocean forecast (CLIVAR GSOP; SynObs Steering Committee member)
6 P. B. Terney Pradeep Kumara	M		Ministry of Environment, Sri Lanka	In-situ observations and training course
7 E. Pattabhi Rama Rao	M		INCOIS, India	Conceptualization and implementation of diversified Ocean Observing System across the Indian Ocean (IORP member)
8 Michael McPhaden	M		NOAA/PMEL, USA	Ocean dynamics, design of ocean observing system (IORP member)

* Field only required for members identified as early career: 10 years or less post-degree, not counting time off for family leave.

Working Group contributions (max. 750 words)

Detail for each Full Member (max. 2 sentences per member) why she/he is being proposed as a Full Member of the Working Group, what is her/his unique contribution?

1 Contributions of Full Members

Lei Zhou's research focuses on a better dynamical understanding of the tropical ocean-atmosphere interactions. He aims to improve the simulations and forecasts from synoptic weather to short-term climate over the Indo-Pacific region.

Shikha Singh's research focuses on small scale processes in the upper ocean which contribute to mixing, leading to developing mixing parameterization. She developed an Ocean Dynamic Thermodynamic model to study regional dynamics of the Indian Ocean. She is currently the Co-Chair of Indian Ocean Regional Panel.

Youmin Tang has expertise in climate forecast, targeted observation, oceanic data assimilation, and AI applications. He developed the world's first dynamical-neural network coupled model for ENSO and led his team to develop targeted observation methods and oceanic data assimilation systems.

Mu Mu is a top scientist in targeted observations and nonlinear analyses. He established the CNOP method and applied it systematically to climate processes, such as tropical cyclone, extreme rainfall, ENSO, and IOD.

Juliet Hermes is a current CLIVAR SSG membe. Her research interests are observing systems, coastal observations, ocean circulation and climate. She is an active member of the CLIVAR Marine Heatwaves Research Foci group.

Marie-Alexandrine Sicre was SCOR President and was Vice-chair of UNESCO-IOC. Her proactive involvement guarantees effective communication with the oceanography community, IOC and GOOS, at the science/policy interface. She is also involved in WG of the G7 Ocean.

Iskhaq Iskandar's research focuses on the dynamics of Indian Ocean circulation and its interaction with Indo-Pacific climate modes, such as ENSO and IOD. His work also evaluated how large-scale climate phenomena influence marine ecosystems in Indonesia, affecting biodiversity, fisheries, and coastal communities.

Janet Sprintall is an oceanographer interested in process understanding of global climate systems using the global observing network. She is current co-chair of the CLIVAR IORP and chairs the IORP IndOOS-2 Tracking Task Team with a goal to track the implementation of the CLIVAR/GOOS recommendations to sustain observations for the Indian Ocean.

Hasibur Rahaman works on ocean modelling and data assimilation, with key research interests in ocean model development, data assimilation techniques, and the generation of ocean reanalysis products. He previously led a CLIVAR project that evaluated Indian Ocean simulations using 16 global models forced with the CORE-II protocol, involving collaboration with 12 leading institutes and universities worldwide. He is presently a panel member of the CLIVAR Ocean Model Development Panel (OMDP), where he contributes to advancing global ocean modelling efforts. In addition, he leads diagnostic studies for Observing System Experiments (OSEs) in the Indian Ocean as part of the Synergistic Observing Network for Ocean Prediction (SynObs) project. This initiative is endorsed by the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) under the OceanPredict program.

Shoichiro Kido is an early career researcher. He works on ocean simulation and prediction with high resolution models. He is a core member of SynObs, supporting the management of SynObs. He is also a member of CLIVAR Indian Ocean panel.

2 Contributions of Associate Members

In addition to Full Members, Associate Members are also essential to the success of this WG.

First, Associate Members Dr. Xiaojing Li and Dr. Rong Feng will carry out many OSEs/OSSEs activities. They will work closely with Dr. Hasibur Rahaman and Dr. Shoichiro Kido, both SynObs members and Full Members of this WG.

Second, Associate Members will bridge this WG with other interdisciplinary international networks. Dr. Michael Mayer is affiliated with ECMWF, a leading centre for numerical modelling, simulation, and data assimilation. Dr. Peter Oke will ensure alignment between this WG and the mission and progress of CLIVAR GSOP and SynObs. Dr. Zouhair Lachkar will provide connections to the Surface Ocean–Lower Atmosphere Study (SOLAS) and help to assess the impacts of the current IndOOS on surface heat fluxes.

Third, Associate Members will offer scientific guidance and support to this WG. Mr. P. B. Terney Pradeep Kumara will assist in organizing the WG's training courses. Dr. E. Pattabhi Rama Rao and Dr. Michael McPhaden are among the designers of the IndOOS. Their involvement will facilitate the application of this WG's outputs to practical improvement of IndOOS and GOOS.

Relationship to other international programs and SCOR Working Groups (max. 500 words)

Efficient observations are fundamental to achieving the goals of various international programs and organizations. The idea for this WG stems from an ongoing task team on Quantitative evaluation of the Indian Ocean Observing System to improve climate forecasts (QIndOOS) under the CLIVAR/IOC-GOOS Indian Ocean Region Panel (IORP). Nine IORP members are listed in this proposal as full members or associated members.

The goals of this WG are aligned with IIOE-2, which is to build an observational network around the Indian Ocean to understand key oceanic and related atmospheric processes at a wide spectrum of spatial and temporal scales, to improve modelling and predictability. The training courses of this WG will collaborate with the UNESCO Category 2 Training Centre - International Training Centre for Operational Oceanography (ITCOocean) based at INCOIS, India. This center aims at promoting the development and optimization of scientific base, technology and information system for operational oceanography at national, regional and global scales.

Targets of this WG are highly aligned with those of SynObs and we will closely collaborate with SynObs. The SynObs is a project endorsed by the United Nations Decade of Ocean Science for Sustainable Development (2021–2030). Officially launched in November 2022, the project is a collaborative effort between major international research organizations like OceanPredict, the GOOS, and the World Meteorological Organization (WMO). SynObs aims to optimize global ocean observing systems by extracting maximum benefits from combining various data sources—such as satellite and in situ (on-site) sensors—to improve ocean and coastal predictions. SynObs leads a major international effort involving over 10 ocean prediction systems to conduct two main types of experiments, i.e., the OSEs and the OSSEs, which will be examined and summarized in this WG. Dr. Hasibur Rahaman, a full member of this WG, is leading for the diagnostics of OSE experiments in the Indian Ocean in SynObs.

The objectives of this WG addresses the core themes of the SOLAS, especially air-sea interface and fluxes of mass and energy (Core Theme 2) and Greenhouse gases and the oceans (Core Theme 1). Zouhair Lachkar is a member of the SOLAS Implementation Teams on upwelling systems and the Indian Ocean.

This WG will make timely contributions to UN Ocean Decade for sustainably expanding the GOOS (Juliet Hermes is the GOOS co-chair) (Challenge 7), developing a sustainable, resilient and equitable ocean economy (Challenge 4), unlocking ocean-based solutions to climate change (Challenge 5), increasing community resilience to ocean and coastal risks (Challenge 6), and skills, knowledge, technology and participation for all (Challenge 9). Therefore, we will seek endorsement from Intergovernmental Oceanographic Commission (IOC) of UNESCO. We also plan to be in touch with Ocean Teaching Global Academy (OTGA) for training young oceanographers. The training courses and materials can be uploaded to OTGA.

This WG will also benefit from the experience of other SCOR WGs, Analyzing Ocean Turbulence Observations to quantify mixing (ATOMIX; WG 160) and Coordinating the Development of Gridded Four-Dimensional Data Products from Biogeochemical-Argo Observations (4D-BGC; WG 168).

Key References (max. 500 words, abbreviated formatting can be used)

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Appendix

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