

# World Climate Research Programme

## JOINT SCIENTIFIC COMMITTEE (JSC)

### 41st online session

## CLIVAR Report

### (draft 2)

#### 1. Highlights for JSC

- The [new Agreement for hosting of the International CLIVAR Project Office \(ICPO\)](#) was signed between the First Institute of Oceanography of the Ministry of Natural Resources, China (FIO, MNR) and the World Climate Research Programme (WCRP) on July 11, 2019. According to the agreement, FIO will continue to host ICPO until June 2024 in Qingdao, China.
- WCRP and the Indian Institute of Tropical Meteorology (IITM), Pune, India, have formally extended their agreement to host the International CLIVAR Monsoon Project Office (ICMPO) at IITM for one more year until February 2021 to enable consultations on future evolution of ICMPO. Consultations with the relevant stakeholders are currently underway on a proposal to evolve ICMPO to become a consolidated global Monsoon Project Office, which needs to be discussed and jointly agreed between WCRP (GEWEX and CLIVAR) and WWRP/WMO.
- The [IndOOS-2: Roadmap to Sustained Observations of the Indian Ocean for 2020-2030](#) was launched during the 2019 AGU meeting in San Francisco, USA in December 2019. The IndOOS-2 roadmap is a joint publication of CLIVAR and GOOS. It represents a four-year effort that was initiated in 2016 involving more than 60 scientific experts. A series of activities to disseminate IndOOS-2 have been organised or planned, including the [Town Hall at 2020 Ocean Science Meeting](#), Session on 2020 EGU, IIOSC2020, etc.
- [CLIVAR actively participated in OceanObs'19](#), Sep. 16-20, 2019 in Hawaii, USA. With the efforts of SSG, all panels and Research Foci, CLIVAR participated in the submission of [10 white papers](#). The [Executive Summary of IndOOS-2](#) was released during the conference, and ICPO presented a poster on 'The Contribution of CLIVAR to Sustainable Ocean Observation and Information in Support of Ocean and Climate Research'.
- CLIVAR actively participated in the Ocean Sciences Meeting 2020, which took place on Feb. 17-21 2020 at San Diego, USA. CLIVAR panels/RF organized associated sessions or town hall meetings. In particular, the WCRP town hall 'CLIVAR in WCRP: Present and Future of international collaboration in climate and ocean research', and the IndOOS-2 town hall received significant attention.
- The [Research Foci on Tropical Basin Interaction \(TBI\)](#) has been approved by the SSG. The main goal of TBI is to elucidate the complex two-way interaction between the tropical basins and to quantify the benefit to climate prediction. TBI will initiate and facilitate research activities with a focus on seasonal to multi-annual variability and predictability, thus complementing the CLIVAR DCVP RF.
- The first [ICTP-CLIVAR Summer School on Oceanic Eastern Boundary Upwelling System](#) took place from 15 to 19 July 2019 in Trieste, Italy. The research school aimed at stimulating discussion and new ideas concerning the mechanisms that influence the responses of EBUSs to climate variability and change. 37 students and 11 lecturers from 22 countries participated in the summer school.
- An [Advanced School and Workshop on American Monsoons: progress and future plans](#) was organized by the CLIVAR/GEWEX Monsoons Panel at São Paulo, Brazil, from 19-24 August, 2019, with support from ICTP, CLIVAR, GEWEX, IUGG, WCRP, FAPESP, ICTP-SAIFR, IFT-UNESP. There were 82 participants, including lecturers, scientists, graduate students, stakeholders and forecasters.
- The [2<sup>nd</sup> CLIVAR-FIO Summer School](#) is scheduled from 6-11 July 2020 in Qingdao, China on Ocean Macroturbulence and Its Role in Earth's Climate, coordinated by ARP. Leading experts in ocean

macroturbulence will address observations, dynamics and modeling of the meso/submeso- scale motions and their role in the climate system in the training courses.

- The [3<sup>rd</sup> Summer School on Theory, Mechanisms and Hierarchical Modeling of Climate Dynamics: Tropical Oceans, ENSO and their Teleconnections](#) will be organised from 3 to 14 August 2020 at ICTP, Italy. The first week of the school will focus on the phenomenology, theory, modelling and prediction of ENSO, while the second week will explore teleconnections from the tropical oceans to the extra-tropics, decadal variations of ENSO teleconnections, and inter-basin teleconnections. The summer school is co-sponsored by NOAA Climate Variability and Predictability, NOAA Modeling, Analysis, Prediction and Projection, NSF Physical Oceanography, US CLIVAR and International CLIVAR.
- The CLIVAR-ICTP joint workshop 'From Global to Local: Cultivating new solutions and partnerships for an enhanced Ocean Observing System in a decade of accelerating change', is planned for May 2021, in Trieste, Italy, with the participation of all CLIVAR region panels and GSOP. The motivation of the workshop is to discuss the similar challenges that face the ocean observation in all regions, sharing experience and lessons learnt.
- Two issues of CLIVAR Exchanges were published in 2020. [Issue #77](#) is a joint publication of CLIVAR Exchanges and US CLIVAR Variations, highlighting the recent scientific progress from the [2019 US CLIVAR/CLIVAR Sources and Sinks of Ocean Mesoscale Eddy Energy Workshop](#), and includes information on the newly formed Ocean Transport and Eddy Energy Climate Process Team. [Issue #78](#) focuses on the [decadal review](#) of the Indian Ocean Observing System (IndOOS) and its outcomes.

## 2. Primary science issues (looking ahead, 3 to 5 years)

- **Tropical Pacific Decadal Variability (TPDV)**

'A review of decadal climate variability in the tropical Pacific: characteristics, causes, predictability and prospects' has been submitted to *Science* (Power et al.) in 2019 as a result of two workshops organised by the CLIVAR Pacific Region Panel (San Pedro de Manglaralto, Ecuador; 2018 & Paris, France; 2019). This paper provides a comprehensive review of our current state-of-knowledge of TPDV, its spatial and temporal characteristics, its many proposed mechanisms, and the current ability of state-of-the-art modeling and prediction systems to simulate and predict TPDV. Several open questions have been identified by the paper, such as western Pacific off-equatorial heat content, Low-Latitude Western Boundary Currents and Pacific-Indian Oceans connections via the Throughflow in regulating the variations of equatorial Pacific heat content at decadal timescales. PRP will make further efforts to address these questions.

- **Monsoon Modelling and Prediction**

WCRP has taken a more global view of the monsoons among its core projects, under the auspices of the CLIVAR/GEWEX Monsoons Panel, to enable knowledge and best practice to be shared between the various monsoon regions and to better coordinate monsoon research between GEWEX and CLIVAR, particularly in emphasizing the role of convection and the land surface in the monsoons. It is important to extend this pan-WCRP focus on the monsoons to weather timescales through appropriate linkages with WWRP, as many of the primary science issues in representing the monsoons in models are common, with implications for monsoon prediction across time and space scales. Such a joint effort will have enormous potential for societal applications, given the large populations dependent on the monsoons. A key target in this regard is sub-seasonal to seasonal prediction (S2S), including the extremes.

- **ENSO Research**

The PRP contributed substantially to chapters of an AGU monograph titled '[El Niño Southern Oscillation in a Changing Climate](#)'. This book provides a comprehensive review of ENSO and the effect of climate change on its dynamics, predictability, and impacts. A Working group on ENSO conceptual models has been established within PRP. The ENSO metrics effort continues to make progress. A Python package has been generated to diagnose and explore ENSO characteristics in the CMIP5 and CMIP6 models and will be plugged into widely-used community diagnostic tools, including ESMValTool and the PCMDI Metrics Package.

- **Eastern Boundary Upwelling System (EBUS)**

A perspective paper on EBUS research is being prepared by the EBUS RF, and is scheduled to be submitted in 2020. This paper will highlight important research questions on the current knowledge on EBUS and on their future, on some of which group members have initiated active scientific collaboration.

- **Climate and Ecosystem Prediction**

Links between physical oceanography and biogeochemical and biological sciences have been promoted by CLIVAR panels. Two joint workshops with PICES WG-40 on Climate and Ecosystem Predictability have been organised in 2019. The [first workshop](#) was organised in FIO, Qingdao, China in June 2019, and aimed to review the current ecosystem forecasting efforts, assess the mechanisms responsible for predictability in the different areas, and discuss the steps and action required to develop a common and integrated framework for forecasting activities. The [second workshop](#) was organised on Oct. 20, 2019 in Victoria, Canada alongside the 2019 PICES annual meeting. The workshop aimed to synthesize our current knowledge on the sources of marine ecosystem predictability arising from the large-scale climate. A special issue on [‘North Pacific Climate and Ecosystem Predictability on Seasonal to Decadal Timescales’](#) in *Frontiers in Marine Science* is being coordinated.

- **Climate Services**

[A workshop on WCRP Grand Challenge and Climate Services](#) has been organised by SL GC on Nov., 2019 in Orléans, France. Six topics were covered: 1) assessments of the current status of coastal climate services (CCS); 2) identification and mapping of users; 3) identification and analysis of needs for different types of users (e.g., insurance, critical infrastructures or settlements, observation needs); 4) review of existing practices and how they can be improved; 5) translating sea-level science to operations and communicating uncertainties and 6) potential framework for coastal climate services. A special issue to assess the current status of climate services supporting adaptation to sea-level rise is being coordinated by SL GC. Meanwhile, ICMPO assisted in organising the [Sixth International Conference on Climate Services \(ICCS-6\)](#), which was organised on Feb. 11-13, 2020 in Pune India.

- **Ocean Model Development**

OMDP has been pushing forward the development of ocean circulation model through identifying the challenges and prospects in ocean circulation models (Fox-Kemper et al. 2019; Griffies et al. 2010), organizing the Co-ordinated Ocean-Ice Reference Experiments (CORE-I and CORE-II) and the newest variants, the Ocean Model Intercomparison Projects (OMIP-1 and OMIP-2). The panel was involved in the coordinated development of forcing datasets: CORE-I (Large & Yeager, 2004), CORE-II (Large & Yeager, 2009), and now JRA55-do (T sujino et al. 2018). Since last year, OMDP has built protocols for comparing ocean-sea ice models at high-resolution and low resolution (Chassignet et al., 2020), and protocols for comparing ocean model parameterizations, (Li et al., 2019). Based on these protocols and previous successes, OMDP will continue leading the ocean model community to engage in intercomparison of model resolution and parameterizations, and other aspects of ocean models.

- **Climate Dynamics**

The frontline problems and techniques described in Collins et al. (2018 NCC) will constitute the science topics of the Climate Dynamics Panel; with the overarching topic of “Developing predictive theories of climate dynamics”. Other science issues in the climate dynamics field are: i) Response to external forcing of mid-latitude jets, storms and blocking, ii) Basin-to-basin and tropical-extratropical teleconnections, and iii) Decadal variability and predictability. Techniques needed are: i) High-resolution coupled modelling, ii) Partial coupling and pacemaker experiments, iii) Decadal predictability experiments, and iv) Complex diagnostics and simplified models.

- **Update on Arctic freshwater storage**

Northern Oceans Region Panel is preparing a review paper on the update of Arctic freshwater storage, which will be finished in the first half of 2020. Progress and knowledge gaps on Arctic freshwater distribution, sources and sinks, reanalysis will be recognized.

### 3. Issues and challenges:

- **WCRP flagship projects**

In order to strengthen the interaction among WCRP core projects, three flagship projects have been jointly identified by the WCRP core projects and CORDEX, and linkage between CLIVAR panels and the flagship projects have been further explored. The [Third Pole Environment \(TPE\)](#), relevant to CLIVAR and GEWEX, may potentially be linked with the Monsoons Panel (MP) and Indian Ocean Region Panel; the [ANDEX program](#), potentially linking CLIVAR, GEWEX, CliC and SPARC, could be linked with the MP and Pacific Region Panel; and the Greenland project, relevant to CLIVAR and CORDEX, is potentially linked with CLIVAR through NORP and probably the Atlantic Region Panel. Meanwhile, the CLIVAR Ocean Modeling Development Panel (OMDP) may be relevant to all three flagship projects.

- **CLIVAR's contribution to WCRP 'big questions'**

The CLIVAR SSG has identified two main areas of contribution to the WCRP flagship objectives and associated projects to establish the scientific basis for adaptation and mitigation action for a climate resilient society. One is to improve the understanding and prediction of climate variability and its response to human activities. CLIVAR suggests the promotion of other experimental campaigns in addition to CMIP, in order to complement the existing CMIP protocol with initialized ensemble seamless predictions. Those experiments require truly Earth System Models operating at all time scales (by leveraging efforts among modelling centers), Earth System Reanalysis back in time (through data rescue and data analysis methods) and inclusion of innovative Machine Learning approaches. The second suggestion from CLIVAR is to establish a WCRP Climate University and/or Open Labs in order to enable the generation of actionable climate information on global to local scales.

- **Contribution to UN Ocean Decade**

CLIVAR has been involved in providing broad ideas for guidelines in ocean modeling and ocean data synthesis as well as the carbon component of the [UN Decade of Ocean Science for Sustainable Development](#). Meanwhile, CLIVAR is active and has considerable experience in implementation of specific activities especially for promoting ECS, disseminating knowledge and connecting to stakeholders, which may also contribute to the capacity building component of the Ocean Decade.

- **Cooperation with US CLIVAR**

The US CLIVAR and International CLIVAR have many shared interests in ocean and climate research. Many of them have been implemented through joint activities, e.g. the Joint Workshop on Sources and Sinks of Ocean Mesoscale Eddy Energy (March 2019), Joint Workshop on Atmospheric Convection and Air-Sea Interactions of the Tropical Oceans (May 2019), etc. Moreover, the US AMOC Science Team is sunsetting in 2020 and transitioning coordination to the CLIVAR Atlantic Region Panel is being explored.

- **How you work with other WCRP activities**

Some CLIVAR panels/RF are co-sponsored by other WCRP activities, such as SORP, NORP, IORP, Monsoon Panel, SL etc., and this needs detailed and sustained communication with partner core projects. These panels/RF may be the main platforms for CLIVAR to co-organize joint activities with partner core projects.

- **How you see your community evolving**

Greater emphasis on integrating modelling and observations, data science and machine learning, greater emphasis on interdisciplinarity, e.g. role of biophysical interactions in carbon uptake; greater emphasis on connecting understanding to improved predictions of impacts relevant to society]

- **How you work with partners outside of WCRP**

CLIVAR is also looking to engaged with partners outside the WCRP family, which share common scientific interests, among the partners that we have had recent communications include: SCOR, POGO and PICES.

- **How the current funding affects your community, your activities, your service**

In reference to funding for CLIVAR- constraints mean fewer in person meetings/workshops, less participation from developing world.

In reference to funding from governmental and intergovernmental agencies for science: funding limits ability to maintain observing system and facilities, ability to attract the next generation of researchers, ability to upgrade prediction capabilities].

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