

The World Climate Research Programme (WCRP): a Short Update to SCOR-2021

The World Climate Research Programme

“The World Climate Research Programme (WCRP) coordinates and facilitates international climate research to develop, share and apply the climate knowledge that contributes to societal well-being.”

WCRP leads the way in addressing frontier scientific questions related to the coupled climate system — questions that are too large and too complex to be tackled by a single nation, agency or scientific discipline. Through international science coordination and partnerships, WCRP contributes to advancing our understanding of the multi-scale dynamic interactions between natural and social systems that affect climate. It as well engages productively through these partnerships to inform the development of policies and services and to promote science education.

Like SCOR, WCRP does not fund science directly, but provides coordination and a platform for exchange of ideas on specific high-priority research topics related to the climate system. Funds for WCRP activities come from its co-sponsors¹ as well as voluntary contributions from various countries and agencies. Since the start of the COVID-19 pandemic, all WCRP activities have been organised virtually, including meetings of the Joint Scientific Committee.

Currently, WCRP is in the process of implementing its new research strategy (WCRP Strategic Plan 2019-2028²). Major elements of the implementation plan are to strengthen support for core research, ensure engagement of the next generation of scientists and improve the diversity of WCRP leaders—across nations, regions and disciplines, deepen our interaction with partners partners at the national and international levels, and ensure that society has the climate knowledge that it needs for decision-making. The new WCRP structure was fully approved at the 42nd Session of the Joint Scientific Committee (JSC-42) held in June/July 2021, and will be fully operational by late 2022, with the first step being the development of the Implementation Plan.

Through its Strategic Plan 2019-2028, WCRP is reorienting itself to ensure that there is the science, knowledge and understanding to target frontier problems, such as disaster risk reduction, climate adaptation, mitigation, and intervention strategies, that need to be solved together with partners for which WCRP’s core research continues to be essential for developing answers. The integral role of WCRP in developing knowledge of the climate system will result in an increased understanding of the Earth system, including the complex interactions between the physical environment and human society.

WCRP has been organising the ["Climate Research Forums"](#), a series of regional informative and discussion webinars focused on the WCRP reform process, and with a view to engage communities from all regions of the world, so that the ongoing implementation of the WCRP Strategy and the way in which WCRP evolves lead to outcomes that are useful and useable across the world.

The WCRP Lighthouse Activities

As a part of its new structure, WCRP has developed five new activities called the Lighthouse Activities (LHAs) that aim to make critical near-term progress towards meeting WCRP’s Vision, Mission, and four Scientific Objectives, as outlined in the WCRP Strategic Plan 2019–2028. The WCRP LHAs are designed to be ambitious and transdisciplinary (integrating across WCRP and

¹ World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) and the International Council for Science (ISC)

² <https://www.wcrp-climate.org/wcrp-sp-overview>

collaborating with partners) so that they can rapidly advance some of the new science and technologies, and institutional frameworks, that are needed to manage climate risk and meet society's urgent need for robust and actionable climate information more effectively. WCRP's five LHAs are [Digital Earths](#), [Explaining and Predicting Earth System Change](#), [My Climate Risk](#), [Safe Landing Climates](#) and [WCRP Academy](#), and their draft Science Plans have been recently approved at JSC-42. These LHAs are now working on the implementation of their science plan and developing their first activities, aimed at building wider collaboration in the community. Though still in the early stages, at least one of the many scientific themes of a few LHAs are ocean related. For example, one of the Safe Landing Climates' themes is sea level rise which aims to quantify an "acceptable" rate of sea level rise and its irreversibility from multiple decades to millennia and study the impact of storm surges and cyclones on coastal communities to assess the potential for adaptation. My Climate Risks is also involved in Ocean Climate Risk (as part of the UN Ocean Decade) and have a special co-sponsored session planned at the American Geophysical Union (AGU) Fall Meeting 2021. This interaction aims at developing a better understanding of ocean climate risks that goes beyond the risks presented by sea-level rise, i.e., taking into consideration the risks from ocean extremes. Digital Earths' main areas of science activities is to establish a global research network with expertise in ultra-high-resolution global Earth system and its individual components including the ocean. These LHAs are also working towards partnerships external to WCRP such as with the Future Earth (Risk KAN, Ocean KAN, Coasts, Surface Ocean – Lower Atmosphere Study (SOLAS)), Global Climate Observing System (GCOS), Global Ocean Observing System (GOOS) etc.

The WCRP Grand Challenges

<http://wcrp-climate.org/grand-challenges>

The overarching WCRP Grand Science Challenges (GCs) represent major foci of scientific research, modelling, analysis, and observations. WCRP promotes these GCs through community organized workshops, conferences, and strategic planning meetings to identify high-priority and exciting research that require international partnership and coordination, and that yield "actionable information" for decision makers. The WCRP Grand Challenges will all sunset by the end of 2022.

Of the Grand Challenges, Regional Sea-Level Change and Coastal Impacts is of most relevant to SCOR, though many others (e.g., decadal climate, carbon feedbacks) have a significant ocean component. The Sea Level GC represents an integrated interdisciplinary program on sea level research reaching from the global to the regional and local scales. The 2020 meeting of the WCRP Grand Challenge on Regional Sea Level and Coastal Impacts was held virtually from 17-18 November 2020, with the focus of the science priorities for the six Working Packages and preparation of 2022 Sea Level Conference. A specific research topic on '[Climate Services for Adaptation to Sea-Level Rise](#)' in *Frontiers in Marine Science* is being coordinated by the SL GC. The 2nd Sea Level Conference will be held on 11-15 July 2022 in Singapore, with a large representation from vulnerable Asian coastal areas, and including top world stakeholders, city planners, coastal developers and managers and other relevant stakeholders to focus on the flow of knowledge from sea-level science to strengthen climate change adaptation and disaster resilience in coastal zones. An Organising Committee consisting of SL GC co-chairs and members, local organisers and ICPO staff was established, with monthly teleconferences being organised. The SL GC will sunset after the 2nd SL Conference, and it is expected that some of the activities/topics of the SLGC will be continued by other CLIVAR panels and some of the proposed WCRP LHAs.

The WCRP Core Projects

WCRP has been carrying out a major part of its activities through its four core projects, CLIVAR (oceans and climate - www.clivar.org), CliC (cryosphere and climate - www.climate-cryosphere.org), GEWEX (water and climate www.gewex.org) and SPARC (upper atmosphere and climate - <http://www.sparc-climate.org>). In WCRP's new structure, the established Core Projects, CLIVAR, GEWEX, CliC and SPARC, will continue as major WCRP brands and are now joined by two new Core Projects: Earth System Modelling and Observations (ESMO) and Regional Information for Society (RiFS). These new Core Projects are in the process of developing their science plan, their governance structure and will be working in the establishing linkages with the other core projects and with the Lighthouse Activities. Both CLIVAR and CliC are endorsers of the [SCAR/SCOR Southern Ocean Observing System \(SOOS\)](#). Of these core projects the work of CLIVAR is of particular relevance to SCOR.

The CLIVAR Core Project of WCRP

Under the new structure of WCRP, CLIVAR (Climate and Ocean: Variability, Predictability and Change) is one of the six core projects of the WCRP, which aims to understand the dynamics, the interaction, and the predictability of the climate system with emphasis on ocean-atmosphere interactions. Many scientific activities carried out by CLIVAR panels and Research Foci groups are of strong relevance to the WCRP Science Plan and the five Lighthouse Activities, particularly the [Explaining and Predicting Earth System Change](#). CLIVAR also assisted WCRP's regional consultation by supporting the organisation of WCRP Climate Research Forum in the [East Asia](#) and [South America](#) regions and being actively involved in the RiFS new core project.

With the continuity of COVID-19, all CLIVAR meetings in the past 12 months have been organised virtually, including the SSG-26 and the [WCRP-CLIVAR Workshop on Climate Interactions among the Tropical Basins](#). With the consideration of reducing carbon footprint and travel costs and promoting equal access to CLIVAR activities, CLIVAR SSG encourages all panels and RF to meet virtually in the future unless the panel/RF meetings to be held with an early career scientists (ECS) capacity building component. Meanwhile, in order to increase the presence of ECS in the CLIVAR community, the CLIVAR SSG suggested each panel to recruit at least one ECS as panel members and build strong link with ECS organizations, such as the [Young Earth System Scientists \(YESS\) community](#).

The [CLIVAR-FIO Summer School on Ocean Macroturbulence and Its Role in Earth's Climate](#) is now rescheduled for 19-25 June 2022, in Qingdao, China. Meanwhile, the 3rd Summer School on Theory, Mechanisms and Hierarchical Modelling of Climate Dynamics: Tropical Oceans, ENSO and their Teleconnections and the [CLIVAR-GOOS Workshop titled 'From global to coastal: Cultivating new solutions and partnerships for an enhanced Ocean Observing System in a decade of accelerating change'](#) are also being rescheduled for August 2022 at ICTP, Trieste, Italy. All of those upcoming in-person activities will enable virtual access, in order to facilitate the participation of people from the global south and/or with strict travel limitations.

Appendix: Relevant CLIVAR activities, by Panels and RF

Eastern Boundary Upwelling System Research Foci (EBUS RF)

The CLIVAR EBUS RF used to have close cooperation with the SCOR WG-155 on Eastern Boundary Upwelling Ecosystem (EBUE) in the past and they look forward to further cooperation and continuation of the partnership in the future (e.g., to co-organise the EBUS Summer School). The CLIVAR EBUS RF will sunset in 2022 at a session titled 'PL11 Key uncertainties challenging our understanding of the responses of Eastern Boundary Upwelling Systems to climate variability and change' to be organised during the 2022 Ocean Science Meeting as is sunsetting activity, and a EBUS Perspective paper to be published in 2022.

Indian Ocean Region Panel (IORP)

IORP is devoted to promoting the sustained Indian Ocean Observing System (IndOOS). After completing the IndOOS Decadal Review in 2019, the panel established a working group to track the implementation of IndOOS-2 recommendations with the cooperation of IndOOS Resource Forum (IRF), the 2nd International Indian Ocean Expedition (IIOE-2) and IOGOOS. It also works closely with other partner programmes to promote the interdisciplinary cooperation between physical oceanography (IORP) and biological and biogeochemistry (SIBER and SOLAS). The panel is also proposing an 'Indian Ocean ECS Ambassador' initiative to enhance the connections between ECS groups working in the Indian Ocean, e.g. [WIOMSA](#), IIOE-2 ECSN, [YESS](#). A Regional training workshop on observing the coastal and marginal seas in the western Indian Ocean including the Arabian/Persian Gulf and the Sea of Oman is being scheduled for Spring 2022, with cooperation of SIBER and support from POGO.

Pacific Region Panel (PRP)

Two new working groups were established within PRP during 2020-2021 – one is on ENSO Conceptual Model and the other is on Tropical Pacific Decadal Variability. [CLIVAR 2020 ENSO Metrics Package](#) was released in collaboration with PCMDI, IPSL/LOCEAN, and NOAA to evaluate ENSO variability, teleconnections, and processes in climate models. An AGU-100 monograph on '[ENSO in a Changing Climate](#)' was published in November 2020 and a synthesis on [Changing El Niño–Southern Oscillation in a warming climate](#) was published in *Nature Review Earth and Environment* (Cai et al., 2021) to assess the potential future changes of multiple aspects of ENSO and the underlying processes behind such changes and a review on '[Decadal climate variability in the tropical Pacific: Characteristics, causes, predictability, and prospects](#)' published in *Science* (Power et al., 2021). Meanwhile, PRP is also working closely with the North Pacific Marine Science Organization (PICES) to promote the interdisciplinary cooperation, mainly through the join Working Group on 'Climate and Ecosystem Predictability' (WG-40), and a new WG on 'Climate Extremes and Coastal Impacts in the Pacific' being proposed.

Atlantic Region Panel (ARP)

The [Tropical Atlantic Observing System \(TAOS\) Review Report](#) was published in May 2021, with close cooperation of PIRATA. ARP strongly connected and supported the implementation of AtlantOS and other observational networks in the Atlantic Ocean, as well as the multidisciplinary international fieldwork, such as [EUREC⁴A](#) (EUREC⁴A-OA, Europe) and [Atlantic Tradewind Ocean-](#)

[Atmosphere Mesoscale Interaction Campaign](#) (ATOMIC, US). The [CLIVAR AMOC Task Team](#) was established and kicked off in April 2021, with close cooperation of US CLIVAR AMOC Science Team and UK RAPID. The future priorities of ARP are: AMOC, coastal sea level change and coastal resilience tools, and air-sea interaction from the high-latitudes to the Tropics.

Global Synthesis and Observations Panel (GSOP)

GSOP was established to:

1. Develop, promote, and seek to implement strategies for the synthesis of global ocean, atmosphere and coupled climate information. Methods will include observation-based syntheses and model-based syntheses e.g. Reanalyses.
2. Define CLIVAR's requirement for globally sustained observations and promote the use of resulting data sets in global synthesis efforts. Provide strategic advice and supporting evidence in collaboration with WMO and IOC bodies, to help sustain, evolve, and optimise the global ocean observing system based on new science and reanalysis insights.
3. Develop metrics to evaluate ocean and coupled syntheses, to promote the utility of synthesis products for climate applications, including initialisation of coupled forecasts, detection/attribution of climate change and variability, and determining the ocean's role in the global heat, water and biogeochemical cycles.
4. Provide strategic advice and direction to CLIVAR/WCRP data management and processing activities within the Framework for Ocean Observing, related to production of climate quality global ocean synthesis products.
5. Liaise and collaborate with WCRP Councils, Panels and Working Groups in identifying the requirements for, and coordinating the development of, a sustainable Earth system monitoring and prediction system.

Topics that the group is discussing for next year and that are relevant to SCOR include:

- Improved understanding of ocean heat content, sea-level rise, freshwater change
- Understanding how observations are integrated into products, and observational requirements for model-applications. Establishing links between the observational and modelling communities.
- Climate reconstructions, data assimilation, model validation.
- Inter-comparison of reanalyses.
- Collaboration with other groups

Tropical Basin Interactions Research Foci (TBI)

The interactions among the tropical Pacific, Atlantic, and Indian Ocean basins are increasingly recognized as a key factor in understanding climate variability on interannual to decadal timescales. While recent years have seen progress toward understanding tropical basin interactions, much remains to be learned. This includes a deeper understanding of the mechanisms, the preferred pathways, and the potential benefits for seasonal-to-decadal prediction. The RF TBI aims to make progress in these areas by fostering research activities and holding workshops and summer schools.

Two specific outcomes are the coordination of new climate model experiments and the compilation of a paleo proxy archive.

Since the inception of the RF in March 2020, the group has held 7 general meetings to discuss the current understanding of TBI and ways to advance it. They also held a session on TBI at the 2020 AGU Fall Meeting (convened by panel members Richter, Taschetto, Stuecker and Keenlyside), and a dedicated WCRP/CLIVAR workshop in February 2021. In addition, many panel members have actively participated in studies on TBI.

WCRP and CLIVAR look forward to further exploring collaborations in ocean related activities with SCOR in the future. Please contact Hindumathi Palanisamy (WCRP - hpalanisamy@wmo.int) or Jose Santos (CLIVAR - jose.santos@clivar.org) to discuss further.