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Action Items

WCRP Open Science Conference (OSC)

- Review the process of finalisation of OSC Concept papers, including a period of consultation and perhaps an internal review (end August; Detlef, Helen, WCRP Secretariat)

WCRP Core Projects and Activities

- Build connection and engagement between RfS and GFCS (end 2023; WCRP Sec., RfS co-chairs, Chris Hewitt)
- S2S: Ensure further discussions between SPARC and ESMO about S2S and its legacy; follow up on the continuation/future of S2S within WCRP as well as with WWRP (potential links between WGSIP and S2S to be developed following the S2S summit). (Ongoing; WCRP Secretariat, SPARC, ESMO, S2S co-chairs)
- CORDEX and CMIP to discuss the best mechanism to ensure uninterrupted dialogues between their activities, especially with a view to CMIP7 (end 2023; CMIP and CORDEX IPOs, WCRP Sec; CMIP and CORDEX Chairs).
- Ensure WCRP has a platform and database for collaborative interactions between CPs and LHAs and include this in the S&I plan (ASAP; WCRP Secretariat)
- GEWEX AsiaPex and monsoons panel interactions to be strengthened /initiated (ongoing; Secretariat and GEWEX leads).
- WCRP to work closely with the IPCC Task Force on National Greenhouse Gas Inventories (to be discussed at proposed IPCC/WCRP workshop) (by end of year; WCRP and IPCC leadership)
- Re-energize the discussion with IPCC to plan a joint workshop between WCRP and IPCC (workshop planned for early 2024; JSC leadership, WCRP Sec., newly elected IPCC leadership)
- Update SPARC name to APARC; provide JSC feedback to SPARC Science Plan and ask APARC to provide a new version to the JSC (ASAP; SPARC leadership; WCRP Secretariat)
- Conduct a virtual meeting of the JSC to finalise plans for Climate Intervention research activities in WCRP structure (where it fits in structure; plans e.g., stocktake article and WCRP statement) (by mid-June; Detlef, Jim, WCRP Secretariat)
- Finalise GPEX Science plan based on JSC feedback and update WCRP Structure to include GPEX as a new Lighthouse Activity (by October 2023; GPEX leads, JSC leadership, WCRP Secretariat)
- JSC Liaisons to provide short feedback to Core Project leaders (ASAP; JSC Liaisons and WCRP Secretariat)
- JSC to consider the Academy's proposed new governance model and provide feedback and support (by end October JSC)
- JSC Chairs and liaisons to CliC to work with the CliC Chairs, CliC project office and WCRP Secretariat to conduct a review of the CliC Core Project (outcome to be presented by JSC 45; JSC Chair, JSC Liaisons to CliC, CliC chairs, IPO and WCRP Secretariat)
- Draft 2024 budgets for all CPs and LHAs to be prepared and submitted to the JSC (JSC Secretariat and CP liaisons, by July 2023)
- Budget meeting of the JSC to be held to decide 2024 budget (JSC and Secretariat, July 2023)

Decisions on Membership

- GEWEX: GEWEX to come back to the JSC with a package of three members, one of which must be female, and should include representation from the Global South and earlier career stage.
- SPARC: Membership proposals accepted. Amadou will work with APARC leadership and WCRP Secretariat to find African representative
- CLIVAR: Membership proposals accepted. New person should be female and ideally from the Global South
- ESMO: Membership accepted. Also include Maria Molina as member (i.e., increase membership by one person).
- CliC: Membership - JSC Chair and liaisons (Tim and Krishnan) to discuss with the CliC leadership the outcomes (bearing in mind the proposed CliC review).
- Digital Earths: Membership proposal accepted.

WCRP Science and Implementation (S&I) Plan

- Develop clear guidelines for input from Core Projects and Lighthouse Activities to Science and Implementation Plan (ASAP; JSC Chair/Vice Chair, WCRP Secretariat) (in particular Section 3)
- Core Projects to contribute to Section 6.3 (Capacity Building) of the S&I plan (after guidelines have been provided (by end July; CPs)

Carbon Footprint Guidelines

- Add in the Carbon Footprint guidelines that (1) all WCRP meetings should aim for a hybrid component (2) travel for Early Career and Global South scientists should be prioritised (ASAP; WCRP Secretariat & Pierre)
- Decision: Carbon Footprint guidelines approved.

General

- Produce WCRP Science and Activity highlights on a regular basis, including an annual “brochure”; WCRP Secretariat to consider how best to provide more regular updates based on Core Project etc. Publications (by end of year; WCRP Secretariat)
- WCRP to further discuss WCRP Global South Fellowship scheme (by end of year; JSC leadership and secretariat)
- Lisa, Pierre and Cristiana to work with Nico on an updated Code of Conduct, taking into account feedback received (ASAP; Nico, Lisa, Pierre, Cristiana)
- Provide feedback on proposed logo and branding to the design company and work with them to produce a new version (Detlef, Narelle, Pierre, Susanna and Tercio; feedback to Parenti Designs by 31 May 2023)

Contents

1. Introduction	9
2. Strategic initiatives and issues	11
2.1. New and emerging issues	11
2.2. The Global Precipitation Experiment (GPEX)	12
2.3. Cycles and Budgets Task Team	13
2.4. Climate Intervention Task Team	14
2.5. Future of climate modelling	14
2.6. Future of CMIP: CMIP 7	16
2.7. Future plans of CORDEX	18
2.8. General Discussion on WCRP Modelling activities	19
3. Presentations and Discussion of WCRP Core Activities	19
3.1. Earth System Modelling and Observations (ESMO) Core Project	19
3.2. Regional Information for Society (RIfS) Core Project	21
3.3. Climate and Cryosphere (CliC) Core Project	23
3.4. Climate and Ocean Variability, Predictability and Change (CLIVAR) Core Project	24
3.5. Global Energy and Water Exchanges (GEWEX) Core Project	25
3.6. Interactions with WMO Hydro and Cryosphere Activities	26
3.7. Stratosphere-troposphere Processes and their Role in Climate (SPARC) Core Project	26
3.8. The Explaining and Predicting Earth System Change (EPESC) Lighthouse Activity	27
3.9. Safe Landing Climates Lighthouse Activity	28
3.10. My Climate Risk Lighthouse Activity	29
3.11. Digital Earths Lighthouse Activity	30
3.12. WCRP Academy Lighthouse Activity	32
4. Breakout Sessions	33
4.1. Breakout group on the Explaining and Predicting Earth System Change Lighthouse Activity	34
4.2. Breakout group on the Safe Landing Climates Lighthouse Activity	34
4.3. Breakout group on the My Climate Risk Lighthouse Activity	35
4.4. Breakout group on the Digital Earths Lighthouse Activity	35
5. Partnerships	36
5.1. Engagement between WCRP and IPCC	36
5.1.1. IPCC Working Group 1	36
5.1.2. IPCC Working Group 2	37
5.1.3. IPCC Working Group 3	37
5.2. Engagement with WMO's Global Framework for Climate Services (GFCS)	39
5.3. GCOS/WCRP collaborations	39
5.4. World Weather Research Programme	40
5.5. Global Atmosphere Watch	41

5.6. Future Earth, including 10NICS and other potential partnerships with WCRP	42
5.7. Short interventions from other partners	43
5.7.1. Asia Pacific Network (APN)	43
5.7.2. European Space Agency (ESA)	43
5.7.3. GEO	44
5.7.4. Copernicus/ECMWF	44
5.7.5. Global Ocean Observing System (GOOS)	44
5.7.6. Ocean Observation Physics and Climate Panel (OOPC)	45
5.7.7. Past Global Changes (PAGES)	45
5.7.8. Surface Ocean Lower Atmosphere Study (SOLAS)	45
5.7.9. US Global Change Research Program (USGCRP)	46
5.7.10. Young Earth System Scientists (YESS)	46
5.7.11. Scientific Committee on Oceanic Research (SCOR)	47
5.7.12. Climate science and society in the Andes	47
6. WCRP Science and Implementation Plan	47
7. WCRP's Future Carbon Footprint	48
8. WCRP Open Science Conference	49
9. WCRP Branding	50
10. WCRP Secretariat and Finance	50
11. Outcomes from the JSC-Only Session	51
11.1. Budgets and Finance	51
11.2. Decisions on Membership	51
11.3. Core Projects and Lighthouse Activities	52
11.4. Global South Fellowships	52
11.5. WCRP Code of Conduct	52
11.6. WCRP Logos and rebranding	53
Annex 1 - List of Participants	54
Annex 2 - Acronyms	58

1. Introduction

Chair, Detlef Stammer, and Vice-Chair, Pascale Braconnot, of the World Climate Research Programme's (WCRP) Joint Scientific Committee (JSC) welcomed attendees (both in-person and online) to the 44th Session of the JSC. Valerie Trouet, Scientific Director of the Belgian Climate Centre that kindly hosted the meeting, also welcomed everyone, and provided an overview of the new centre, stating that "the climate centre seeks to maximize the impact of scientific research on climate mitigation and adaptation."

Detlef noted that this is the first in-person JSC Session since 2019. Since that time, a lot of intense work was conducted online as we evolved into a new WCRP. He noted that the JSC is now close to finalizing the first version of the WCRP Science and Implementation Plan, which will continue to evolve over the years to come. He further explained that in this meeting the WCRP Core Projects and Lighthouse Activities will report on their progress and the work of some new activities will be presented so that the JSC can consider how they will move forward.

Detlef also briefed participants on the WCRP International Project Offices (IPOs), as several IPOs are new or just established. These offices are a fantastic voluntary contribution from countries and from the institutes where they are hosted.

At the end of 2022, the following JSC members completed their final term on the JSC: Helen Cleugh (outgoing vice-chair), Jens Hesselbjerg Christensen, Thomas Peter, and Martin Visbeck. Detlef thanked all these outgoing members for their valuable contributions to WCRP. New members appointed for 2023 onwards are Eleanor Blyth, Amadou Gaye, Cristiana Stan, and Tim Naish (<https://www.wcrp-climate.org/jsc-contacts>) and Detlef welcomed them to WCRP and to their first JSC meeting.

Representatives from each of WCRP's co-sponsors, WMO, ISC, and IOC-UNESCO provided short interventions. WMO Secretary General, Petteri Taalas, welcomed participants on behalf of WMO, updating the meeting on the recent release of the WMO State of the Climate Report. Prof. Taalas discussed how we continue to break records in terms of high carbon dioxide levels, temperature increases, higher sea level rise, low sea ice levels, glacial mass loss, and we are experiencing the third La Niña in a row. Flood and extreme drought events have been experienced in multiple locations, affecting millions of people worldwide. He explained that WMO is currently preparing for WMO Congress, including the proposition of new initiatives on early warning services for all, greenhouse gas monitoring, and high-resolution climate modelling. In addition, the IPCC is preparing to decide on special reports for the next round, with important topics potentially including climate tipping points and geoengineering/ climate intervention.

Salvatore Arico, Chief Executive Officer of the International Science Council (ISC) gave a welcome on behalf of ISC. He noted that there is a growing need for actionable knowledge and outlined that science is suffering from a crisis of miscommunication, misinformation, and a lack of trust. There is a new initiative at ISC that will address 'trust in science'. Another priority is looking at the future of science systems. These are becoming increasingly complex, and it is important that funding agencies are aware of science priorities. Salvatore commented that ISC considers the WCRP Open Science Conference (OSC) as an important opportunity to engage the Global South. ISC is looking at how its affiliated bodies and global research programmes can work in a better way to promote synergies. This will be discussed at the 2023 Mid-term Meeting

of ISC Members in Paris at the same time as this JSC meeting, where Martin Visbeck will represent WCRP.

Vladimir Ryabinin (Executive Secretariat of IOC-UNESCO) sent a recorded welcome message and apologised that he could not be present in person but noted that Kirsten Isensee would represent the IOC at the meeting. He also noted that there are some issues with financially supporting WCRP and called for patience due to issues with IOC's budget that may be resolved in November 2023. He also said that this will be his last presentation to the JSC, as he will soon retire. He asked WCRP to mainstream its contributions to the Decade of Ocean Science for Sustainable Development. He also noted that the idea of sustainable ocean climate is now gaining traction and will be promoted in the UN system. Kirsten then highlighted work at IOC on ocean acidification, deoxygenation, blue carbon, and ocean carbon research.

Philippe Tulkens (European Commission) welcomed participants to Brussels. The role of his department is to shape new research on climate change, towards the decarbonisation of Europe in line with the green deal. The science community will play an important role in this. He noted that the European Commission would like to work more with WCRP and invited the programme to produce a document outlining the key research innovation gaps so they can integrate this in the programming of their activities. He stated that he would be interested in knowing, for major activities such as CMIP, whether any structural funding would be of interest to support the work. He outlined the missions of Horizon Europe – four of the five missions involve climate (e.g., adaptation to climate change). WCRP might be in a position to contribute to these. The European Commission is very interested in climate neutrality, including the greening of the activities of the administration. He noted that they are interested in working with WCRP on the science-policy interface.

Petra Manderscheid (JPI-Climate) gave an overview of JPI-Climate, an intergovernmental initiative gathering European climate research funders to jointly fund new research and connect climate knowledge to support decision-making. They focus on everything from fundamental science to advanced climate services. The current call is on societal transformation in the face of climate change. There are six action groups; the action groups that may be of most interest to WCRP are 'next generation climate science' and 'greenhouse gas emissions, removals and management systems'. They work with JPI-Oceans, which is also linked to IOC, and JPI on Food, Agriculture and Climate Change. She noted that they recently held a summit to link climate with policy and that a European Climate Change Conference is planned in June 2023. The WMO State of the Climate for Europe will be launched at this meeting. In closing, she stated that JPI Climate is informed by WCRP science and JPI-Climate would like to work more closely with WCRP.

The Head of the WCRP Secretariat, Mike Sparrow, welcomed all participants, outlined the guidelines for in-person and online attendees and highlighted logistical issues.

Detlef then asked everyone in the room and online to introduce themselves. The agenda of the meeting was approved. All documents and presentations from the meeting are available at: <https://www.wcrp-climate.org/jsc44-documents>

2. Strategic initiatives and issues

2.1. New and emerging issues

Pascale highlighted that WCRP provides an authoritative voice for climate science, coordinates high quality climate science from around the world, with a focus on diversity, and transparent communication, addresses major climate challenges in an energetic, agile and dynamic way, with strong community engagement, relevance and profile, and is successfully engaged with funding agencies around the world. She explained that WCRP's major ongoing science foci (Figure 1) include elements that are already ongoing in the Programme as well as possible new elements. The Grand Challenges have now finished, with ongoing important elements moved elsewhere in the Programme. The accomplishments of the Grand Challenges will be celebrated at the [WCRP Open Science Conference](#), which will take place in October 2023.

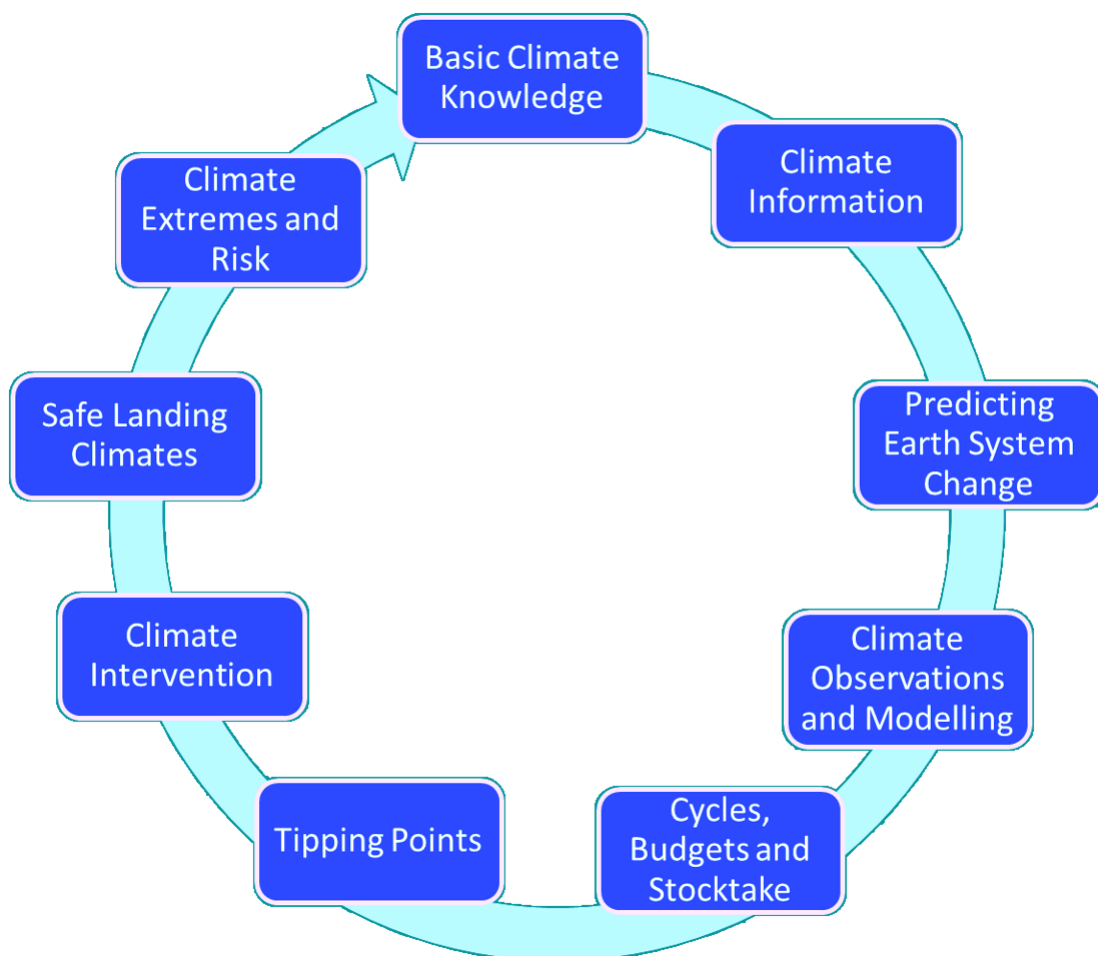


Figure 1: WCRP major ongoing science foci

Pascale continued to explain that emissions are continuing to grow, and the world is experiencing accelerating warming and the associated impacts, such as weather and climate extremes. Climate risks will be enhanced under progressively greater warming, and the extent of these impacts depends on our success in meeting our emissions targets. Anthropogenic climate

change even with a 1.5°C warming brings significant challenges and risks that affect almost all aspects of life: droughts, heavy rain and flooding, heatwaves, extreme fire weather, loss of mountainous water storage, and coastal inundation. These are just some examples of what is already occurring and where amplified risks and impacts in the future will threaten millions of people around the world.

2.2. The Global Precipitation Experiment (GPEX)

Xubin Zeng (chair of the GPEX Tiger Team) gave a report on progress with the planning of a Global Precipitation Experiment (GPEX). He noted that despite progress in the past few decades, the improvement of precipitation prediction and projection skill has been slow. He explained that WCRP has asked GPEX to plan a new, exciting, and visionary pan-WCRP project. Plans for GPEX were first explored by the U.S. Global Change Research Program (USGCRP) in 2020 in response to this and it is hoped that GPEX will be launched at the WCRP OSC in October 2023. The science questions are:

- Q1: What are the sources of uncertainties of quantitative precipitation estimates over global land and ocean, particularly over mountainous, high-latitude, and tropical regions, and how can we address them?
- Q2: How is precipitation produced by complex moist processes and their interactions with atmospheric dynamics and other components of the Earth system?
- Q3: What are the sources of precipitation biases in climate models and how can we reduce them to improve predictions and projections of precipitation at different temporal and spatial scales?
- Q4: How can we enhance regional and local capacity building for precipitation measurements, process understanding, prediction, and projection?

These activities will include a WCRP Year of Precipitation, which will engage and coordinate with national and international funding agencies to coordinate global field campaigns with *in situ*, airborne, and satellite measurements of the atmosphere, land, and ocean, focusing on different storm types for different seasons. It will also include precipitation databases, working with other projects to ensure data is available. In addition, it will coordinate multi-scale analysis and precipitation forecasts, and support the establishment of multi-model databases, along with common evaluation metrics, leveraging current efforts across WCRP and with partners. Lastly, it will support capacity development by entraining scientists and graduate students into a Year of Precipitation, particularly from the Global South. Xubin outlined the requirements and budget for the project, which will hopefully have support from USGCRP for one staff position. The GPEX activity will be completed and fully integrated into the WCRP Core Projects 1-3 years after the Year of Precipitation – in 5-10 years from its launch. Xubin called for participants to provide actionable inputs to the GPEX Science Plan and to share it with colleagues.

Detlef noted that there is an opportunity right now to do a precipitation and carbon measurement campaign at the same time (in line with the WMO Global Greenhouse Gas Watch). Andrew Gettelman (Chair, Digital Earths) noted that they would push modelling as one of the major themes of GPEX. Digital Earths is looking at elements in the models that need attention, and it may be that precipitation and the links to land-atmosphere coupling and the hydrological system

will be important.

Krishnan Raghavan (JSC Member) noted that in relation to monsoons there are a lot of cross-cutting elements across the seasons. This was agreed by Xubin, but there needs to be some way of identifying different elements.

Tim Naish (JSC Member) asked about precipitation in the cryosphere: Is it an important part of GPEX? Xubin confirmed that CliC is represented in the science team by A. P. Dimri and it is an important element of the experiment. The sources of glaciers for water are included. Andrew noted that there was a discussion on precipitation in complex terrains during discussions, including mountains.

Francois Engelbrecht (CLIVAR co-chair) asked about observational campaigns – particularly in Africa. Will this link to WMO initiatives? Xubin said that there are not enough resources in Africa to fund the observational networks. There will need to be international investment. GPEX should bring projects together for a united effort.

Cristiana Stan (JSC Member) noted that there could be a modelling component added to this project. She noted that the Subseasonal to Seasonal (S2S) Project has a modelling database. Xubin confirmed that modelling will be an important part of the experiment. Tom asked how to develop low-cost instrumentation? Detlef noted that the experiment will use the low-cost instrumentation that comes along. This needs to be thought about. Ken noted that at the last GEWEX meeting they started to draft a GPEX program for the Andes.

2.3. Cycles and Budgets Task Team

Jan Polcher (Co-lead of the Cycles and Budgets Task team) presented the work of the Cycles and Budgets Task Team. There was a survey conducted to better understand the assumptions made in previous cycle quantifications. There were some interesting results, but only a small number of responses were completed. There will be a workshop in Paris 22-23 June to assess the state of knowledge of each cycle (water, carbon, energy) and to see how to integrate the coupling between cycles and transfer expertise. It is hoped that this will establish the state of the art for each cycle, establish how the interactions between cycles can be exploited, establish the needs to be achieved in terms of accuracy and precision to quantify trends or shifts in the cycles, identify observational priorities and qualities, and formulate some good practices for cycle and budget studies.

Sonya Legg (Co-chair CLIVAR) said that she would like to see some interaction with the Integrated Ocean Carbon Research (IOC-R) (Annalisa Bracco is the WCRP representative). It was agreed that this would be a good connection to make. There was a discussion about the sources and sinks and transports and how these work for the different cycles and it was agreed to add experts on the ocean carbon cycle to the workshop. There were several interjections that noted that the Cycles and Budgets Survey was not structured in a way that some people found easy to answer, especially around the three cycles being treated distinctly. Pierre Friedlingstein (JSC Member) said that there is a misunderstanding as to what the object of this task team is. In his view it was to connect the three cycles and not to treat them independently. It was agreed that there needs to be very good representation by carbon cycle scientists at the June workshop.

Helene Hewitt (co-chair, CMIP Panel) asked if sea level budgets are included in the scope of the

Task Team. Jan said that sea level is a diagnostic as it is the coupling of the energy and water cycle. Detlef said that this will not be excluded, but it is a slightly different focus.

Xubin asked what the top things are that this effort can do for the cycles. Jan said that satellites can monitor the Earth in a way that water and energy cycles can be quantified accurately, and we know why precipitation changes are the way that they are. Detlef said that this effort needs to be fully integrated and we look forward to an update after the June workshop.

2.4. Climate Intervention Task Team

Jim Hurrell (JSC Member and task team chair) provided a recorded presentation on the climate intervention (geoengineering) task team. He started by defining geoengineering as the deliberate large-scale manipulation of the planetary environment to counteract anthropogenic climate change. This was changed to the term 'climate intervention' in 2015 (US National Research Council). We know that there are important challenges, including that carbon dioxide removal (CDR) most likely cannot be implemented rapidly enough to meet emissions targets. Solar climate interventions don't reduce emissions and are a temporary measure but have been proposed by some to address the problem. In that case, it is very important that we understand the repercussions of such interventions.

Jim outlined that this task team was put together to look at the role that WCRP can play in understanding the potential impacts and risks of climate intervention and was not in any way an endorsement of climate intervention actions. WCRP could set the stage for a comprehensive assessment process, as the Programme covers much of the climate science required for a holistic assessment of climate intervention, working with partners. WCRP could help this to be done transparently, with international involvement. WCRP could help to identify what should not be done in relation to climate intervention due to the likely outcomes.

Jim noted that this effort would take coordination across WCRP and with partners, including workshops, webinars, a website presence etc. There could be a regular assessment process, provided as a basis for governance and decision making. It could also promote a climate intervention Code of Conduct and WCRP should make a statement that is in support of climate intervention research, noting the ethical, moral etc. issues involved. This should be made before the OSC in October 2023 and should be done in coordination with WMO, IOC-UNESCO and ISC where possible. Jim also noted that WCRP doesn't really need another major activity. It could leverage existing efforts (e.g., Safe landing Climates), but also reflected that it is quite a large effort and so perhaps there needs to be a Lighthouse Activity just on this topic. He outlined that WCRP should appoint a steering or advisory group to advance this effort and deliver a Climate Intervention Science and Implementation Plan within 18-24 months.

Kirsten Isensee suggested linking with the WMO-IOC working group on Ocean Interventions for Climate Change Mitigation.

2.5. Future of climate modelling

Cathy Hohenegger started the presentation with a snapshot of the Earth as taken by the EUMETSAT satellite, Meteosat Third Generation – Imager 1 (MTG-I1). She highlighted that the image could have been from a model as currently we are in position to simulate the Earth to a similar resolution as we observe it. This was then compared with a simulated image of the Earth–

an integrated simulation at 1km resolution for both ocean and atmosphere for a full day – the first time at such a high resolution where storms in the atmosphere and eddies in the ocean are visible. She said that this would be the future of climate modelling, but we are not there yet. Cathy proceeded by showing examples of coupled simulations that are currently possible, giving the example of global mean temperature. The modelling community is not only capable of coupling atmosphere to ocean but also to carbon, e.g., ocean biogeochemistry models. Currently around 15 modelling centres can perform the km-scale global simulation of which about four centres can run coupled models. Cathy also emphasised the need for such high-resolution modelling to better understand small scale climate systems, extremes, tipping points etc. High resolution modelling will also help in resolving atmospheric storms that are not yet well understood and, as a result, will help in understanding precipitation distribution in the tropics. She also addressed the workflow issues in global km-scale modelling. Most of the criticism received is that the simulations are nearly impossible to work with because of the data size. Cathy mentioned that this is not true if new output strategies are applied, for example dividing images to smaller tiles (tile maps). CMIP workflow strategies can't be used and instead one may apply data chunking, usage of HEALPix grid etc.

Cathy also emphasised the importance of 'supporting' activities that will aid in the development of km-scale modelling initiatives. She mentioned a recent activity that supported the modelling initiatives - [the Km-scale modelling workshop in Oct. 2022](#) - that enhanced the connections between global and regional, ice and hydrology communities etc. The workshop also discussed various techniques, data access. Cathy also briefly mentioned the DE LHA as well as the upcoming Earth Virtual Engine (EVE) that will work on developing operational climate prediction at km-scale. EVE is conducting a workshop in Berlin in July 2023.

Piers Forster continued the presentation with focus on the [Future of Climate Modelling workshop that took place \(virtually\) in March 2022](#). The main idea of the workshop was to identify: (1) detailed, improved and actionable climate change information for society and policy makers, (2) advancements in climate science. Piers explained how the workshop rolled out with presentations from a diverse group of speakers with different science and applications backgrounds. Specific questions such as main priorities for climate model development and improvement, model requirements to address society relevant climate information, technical developments needed to cope with future hardware generations, and most importantly how WCRP should adjust its modelling approaches to meet the scientific and societal challenges were addressed. He ended by summarising the major recommendations/focus questions that came out at the workshop:

- What are the main priorities for climate model improvements and developments?
- What are the main model requirements to cope with societal needs for climate information?
- Which technical developments are required to cope with future hardware generations?
- How does WCRP need to adjust its modelling approaches to meet scientific and societal challenges?

Vaishali then took over and mentioned that in addition to the value of km-scale modelling being recognised at the workshops, opinions were expressed on the need for multiple approaches to address science questions. This, in turn, would require strong coordination of the science community with regions and stakeholders. WCRP should take this into consideration.

Ken asked if there are any new ideas on integrating regional knowledge in the modelling approaches for which Andrew of DE responded that DE has been very much thinking in terms of regional problems and putting these together. A short discussion on the EVE Berlin Summit followed where a few members mentioned not being aware of this meeting.

Pascale responded that the workshop was an invitation-only event and more information on this can be made available to anyone interested. Cathy informed the community about a white paper currently under preparation that will be presented at the summit.

Detlef reiterated that WCRP supports 1km modelling initiatives and if a “CERN for km-scale modelling” is being planned, the community needs to discuss this first. He also emphasised the requirement for modelling diversity in the 1km modelling.

Xubin mentioned that horizontal scale is always connected to vertical scale in earth system modelling. But most of the time, we are always talking only about the horizontal scale? If so, what about the vertical scale? Cathy responded that consideration of both horizontal and vertical scales depends on the variable that one looks at.

Eleanor highlighted that a land component is not much considered in high resolution modelling and that for land, it is not so much about the resolution but more about the complexities. Cathy agreed that the land component is missing and this needs to be taken into account in future discussions.

2.6. Future of CMIP: CMIP 7

Helene Hewitt (CMIP co-chair) started the presentation with a summary of the progress and achievements of CMIP during the last year, including the establishment of the IPO at ESA in the UK and a new website. The CMIP Panel governance has been restructured. A Core Panel (up to eight members with two positions unfilled to allow for new members from the Global South) plus the WIP co-chairs provides overview and decision making with an expanded Full CMIP Panel incorporating co-leads of the seven task teams, VIACS and ScenarioMIP representatives and leads of the Early Career Researcher (ECR) activity, Fresh Eyes on CMIP. Additionally, there has been extensive community engagement.

She detailed the future plans for CMIP7:

- The need for multi-model ensembles beyond CMIP6
- CMIP provides proven method for testing and validating climate models
- Enhanced process understanding enabled by model fidelity improvements
- Opportunities for observational comparisons (e.g., Argo) that motivate new diagnostics
- CMIP objectives help address the four WCRP Scientific Objectives
- Evolving CMIP7 structure
- The existing runs will continue
- Modelling comparison projects will also continue
- On the IPCC time scale, we will identify what's really needed on a shorter time scale
- Planning of the CMIP7 timeline is currently a crucial aspect of CMIP
- IPCC WG1 should be out in 2027-2028
- Modelling centres must start simulation in about a year which is very challenging.
- CMIP has also been working on addressing concerns of the community based on

- their experience with CMIP6 and how improvements to CMIP7 can be made
- CMIP6, although important, was a burden on modelling centres. CMIP is now reducing the number of experiments to help redress this
- IPCC timeline is a significant pressure on CMIP and as a result CMIP will now propose streamlined experiments on the IPCC timeline
- Need for more focus on climate impact and adaptation. CMIP7 will address this via updated scenarios tailored for mitigation and impact policy applications and by facilitating downscaling efforts
- CMIP may develop more task teams through open calls, as required, for extensive community engagement
- CMIP will establish ECR groups in addition to promoting inclusion of members from the Global South in their panels. As part of this, a new working group called 'Fresh eyes on CMIP' will be set up with scientists, practitioners, researchers etc. in early career and will sit along the CMIP7 task teams

As for the next immediate steps, Helen elaborated that the CMIP is now working on refining its vision, goals and structure of CMIP7, ongoing MIP engagement, planning of ScenarioMIP workshop, work on the carbon footprint of CMIP6-7 etc. Helen also addressed potential CMIP linkages with other WCRP activities such as leveraging CMIP6 infrastructure that can benefit wider WCRP activities, determining sustainable funding model for CMIP infrastructure, supporting CMIP and wider activities evolution through next generation forcings testing etc.

The current joint activities include a joint session planned with CORDEX at the OSC, CMIP IPO providing support to the obs4MIPs group as well as active engagement with the WCRP LHAs. CMIP also expressed CMIP's willingness to connect its 'Fresh eyes on CMIP' activity with WCRP Academy.

As for partnerships outside of WCRP, Helene mentioned that CMIP has strong collaborations with nearly 50 modelling centres, 30 data nodes as well as funders and ESGF. CMIP also put forth a few recommendations to WCRP seeking WCRP's support for the following:

- Open discussion regarding ESMO governance to reduce duplication of effort and maximise synergies
- Consideration to be given to the role/scope of the WGCM Infrastructure Panel
- High level WCRP support for promoting sustainable collaborative global funding for the infrastructure
- Establishment of a WCRP Code of Conduct and complaints protocol providing a consistent approach across all WCRP activities

Helene also briefly addressed how CMIP is planning to evolve especially considering the enthusiasm and interest from the community for CMIP. CMIP will focus on the challenges where a multi model approach is essential. Helene concluded the presentation with a set of requests to the JSC:

- Any input on key scientific questions for CMIP7?
- How can we best interact with other modelling communities?
- Ideas for developing global collaboration towards sustainable funding for CMIP
- Suggestions for new members from the Global South
- Suggestions for key partners to engage with

In the discussion Helene clarified that CMIP has been recommending MIPs to work across different model types. For the km-scale activity (including Digital Earths) there should be further collaboration, but further discussion was needed. For the ECR activities, YESS and other Early Career networks should be engaged. Detlef at the end emphasised that ESMO will carry the science questions that will be needed to develop CMIP7.

2.7. Future plans of CORDEX

Silvina Solman (CORDEX co-chair) started the presentation with a brief overview of CORDEX's vision. CORDEX serves as a platform or facilitator for coordination and cooperation for regional and local climate information. CORDEX uses the CMIP models for regional climate modelling at medium resolution (CORDEX standard) to be able to reach the regional 1-3 km scale modelling capability (example, Very High-Resolution Convection Permitting Model). She briefed participants on the CORDEX flagship pilot studies which are local or regional challenges with large socio economic impact. She also gave examples of how the CORDEX data is being used for impact assessment, for example., climate change projections of heat stress in Europe and its impacts.

In terms of progress over the last year, there has been strong involvement in IPCC reports and in the COP process e.g., at COP 27: RfS and CORDEX were represented. For future plans, CORDEX is always one step behind CMIP as we need CMIP models for regional model simulations. CMIP6 standard downscaling is going on and will be available for all domains. There will be several CORDEX white papers, the topics of which will be discussed during the conference in September 2023.

There have been discussions with the community to:

- Coordinate and standardise high resolution convection permitting simulations for smaller domains
- Increase interest on RESMs and very high resolution, small area simulations that also include event-based simulations for better understanding of involved processes
- Combine statistical and dynamic downscaling products.
- With the user community CORDEX are planning to:
 - Enhance connections with users to shape models (urban, lakes, valleys)
 - Use information from workshops to understand the need for high resolution or more complex models
 - Enhance dialogue with climate services community
 - Climate service data delivery and connections with other activities with non WCRP communities (e.g., COP)

Ken raised the issue that the Global South is not always able to access heavy 3-D data and asked if there was a way to address this. Silvina responded that CORDEX does not have the capability to provide such a platform unless regionally some initiatives occur (e.g., IITM ESFG node). Helene mentioned that one of the MIPs task team is about data access for everyone including the Global South.

Detlef asked about urban-scale modelling. Silvina responded that a synthesis first needs to be done based on the outcomes of the activity carried out in Europe (the Europe heat stress study). This could serve as an example for looking at cities all over the continents. This also links to the new Digital Earths urban working group which would work with CORDEX.

2.8. General Discussion on WCRP Modelling activities

After the various modelling presentations Detlef opened the floor to a general discussion on WCRP modelling activities. Gabi picked up on Piers' point about how models might capture tipping points. This was about choosing the right model for the right question. Detlef added that in preparation for the [EVE summit](#) there is discussion in the background on the use of very high-resolution modelling for studying tipping points.

The link between climate services and research was discussed. Instead of separating these we should be looking at increasing the synergies. Cath Senior said it was more about how we deliver information in the best way for different needs.

Helene emphasised that it was important to find a mechanism to continue dialogue between CMIP and CORDEX else they would go in different directions.

3. Presentations and Discussion of WCRP Core Activities

3.1. Earth System Modelling and Observations (ESMO) Core Project

Susann Tegmeier (co-chair of ESMO) presented ESMO progress over the last year- establishment of ESMO IPO at DKRZ, Germany; SSG nominations sent to the JSC etc. She briefly explained the current structure of ESMO and the working groups within the Core Project.

- WGs on modelling activities, observations for MIPs WG, S2S ending soon, Earth System Reanalysis WG proposed, need for new observational and AI/ML WG. She then presented each Working Group and its activities to date:

Working Group on Subseasonal to Interdecadal Prediction (WGSIP):

- WGSIP: annual meeting took place in Reading in March 2023
- WCRP Symposium on Frontiers in Subseasonal to Decadal Prediction, hybrid event right after WGSIP meeting
- Challenges for WGSIP: (1) need to find a home for the archive, (2) membership is static since 2020. Significant membership changes to be proposed to ESMO SSG in 2024

Decadal Climate Prediction Project (DCPP):

- Panel meeting in March 2023
- SPARC-DCPP volcanic response readiness exercise
- Membership renewal in 2023
- Challenges: tension between suggestions for "slimmed down" CMIP7 DCPP versus the value of large ensembles, frequent initialization, and high resolution

Obs4MIPs:

- Achievements – 218 datasets on ESGF
- Nine topics for task groups identified and four active among nine so far

- Next plan would be proposing recommendations about its future within ESMO
- Challenges: interim governance status to improve; create more community awareness.

Working Group on Numerical Experimentation (WGNE):

- WGNE blue book providing yearly updates on model system development (deadline soon)
- Summary paper to BAMS to be submitted based on the 6 WGNE workshop on systematic errors in weather and climate models (Oct.-Nov. 2022)

S2S:

- S2S is coming to an end in 2023 with the main summit taking place in July 2023
- Legacy of S2S:
 - WWRP new Applications for Agriculture and Environment (SAGE) project
 - WWRP Polar Coupled Analysis and Prediction and WWRP/WCRP Monsoon project Office activities
 - S2S database will continue at ECMWF for now and establishment of a new lead centre for databases is planned.
 - New WMO Lead Centre for sub-seasonal to seasonal forecasts (LC-SSFMMME) hosted by ECMWF

Most pressing future plans are to finalise the ESMO Strategic Plan, and to include a strong focus on reanalysis and Data Assimilation. There have been several high-level modelling workshops organised in 2022 and 2023. ESMO will oversee the strategic direction of the future of climate modelling, taking into account the outcomes from these workshops, JSC strategic direction and international community activities including CMIP and CORDEX (with RfS). There will be opportunities to engage on these topics across the ESMO WGs and with the other Core Projects and LHAs at the WCRP 6th International Conference on Reanalysis (November 2024, Tokyo, Japan).

The ESMO Strategic Plan will include a strong focus on reanalysis and data assimilation. In order to move this forward, ESMO may create a WG or Panel on Data Assimilation, which will develop activities in close coordination with other WCRP Core Projects and Lighthouse Activities.

With regards to observations, the plan is to establish two additional observational WGs:

- WG on Observational Requirements within WCRP (WGOR)
- WG on Systematic Errors in observational Data (WGSED)

With regards to links with other Core Projects and Lighthouse activities, there is already strong collaboration with Digital Earths on the 1km-scale activity. ESMO will be presented at various meetings of the CPs as more detailed plans and collaborations are needed. For partnerships with external entities, these include GCOS, GOOS, Working Group on Climate (WG Climate); the World Weather Research Programme (WWRP) and the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO); Future Earth; and the Global Carbon Project. ESMO will foster all existing collaborations of its WGs with external partners and will establish currently missing collaborations via specific activities and events.

During the discussion, Ted asked about the legacy of S2S within WCRP. This will continue within WGSIP as well as under WMO initiatives such as the new WWRP project “Sub-seasonal to Seasonal Applications for Agriculture and Energy” (WGSIP will be invited into the steering committee). Sonya made the point that the ocean modelling community has interactions with ESMO and that the main connections are with CLIVAR’s Global Synthesis and Observations Panel (GSOP). The point was made that *within* ESMO the modelling community is currently better organised than the observational side. This is something that we need to build on. Obs4MIPs works together with CMIP and CMIP office provides support to Obs4MIPs. ESMO IPO should discuss with CMIP IPO. Detlef highlighted that there had been excellent progress with ESMO.

Actions:

- *Ensure further discussions between SPARC and ESMO about S2S and its legacy;*
- *Follow up on the continuation/future of S2S within WCRP as well as with WWRP (potential links between WGSIP and S2S to be developed following the S2S summit). (Ongoing; WCRP Secretariat, SPARC, ESMO, S2S co-chairs);*
- *CORDEX and CMIP to discuss the best mechanism to ensure uninterrupted dialogues between their activities, especially with a view to CMIP7 (end 2023; CMIP and CORDEX IPOs, WCRP Sec; CMIP and CORDEX Chairs).*

3.2. Regional Information for Society (RIfS) Core Project

Sara Pryor (RIfS co-chair) started the presentation by introducing the Vision (*to understand, develop, and enhance the effective flow of relevant information among scientists, decision makers and society developing policy-relevant climate research*) and Mission of the Regional Information for Society (RIfS) Core Project. She also noted that there is now a [new IPO](#) in Canada.

An important aim of RIfS is to develop connections with stakeholder communities. The RIfS Science Plan has four main clusters: climate projections, predictions, extremes, and communication-societal engagement. It is important to optimally ensure that they don’t become silos. The structure of RIfS is globally connected, but regionally focused.

Bruce Hewitson (RIfS co-chair) reminded people that focusing on “Information for Society” means focusing on the Global South since this is where more than 80% of the global population is, and the context in a heterogeneous world is therefore important.

RIfS focuses on three overarching challenges:

1. How to optimally identify, understand, and model the relevant climate processes and their interactions which are most critical to manage the socio-ecological risks at the decision scales within regions
2. How to optimally integrate multiple lines of evidence from observations, understanding of physical climate processes, and data from dynamical and statistical regional and global models to inform society’s climate information needs
3. How to best undertake engagement between stakeholders and the science community in different regional contexts to maximise the information benefit for the stakeholder and ensure that the user context is integrated into the design and execution of relevant climate research

These are addressed via 12 objectives as outlined in the [RfS Science Plan](#).

Highlights from 2022-2023 include: sessions at AGU 2022 and the upcoming WCRP OSC; establishment of the Global Extremes Platform (GEP), CORDEX (see below), African Alliance now has funding, involvement in FOCUS-Africa, DELTA CASCADES, HEAT etc.

Plans included that the IPO needs to be established and then move ahead with comms, website etc. How the SSGs function in a strategic manner needs to be finalised. Proposals for a RfS webinar series are under consideration. Finally, a face-to-face RfS SSG meeting is being planned for September.

With regards to links with other CPs and LHAs, this is being explored with several activities. So far there are strongest potential links with My Climate Risk, GEWEX (e.g., ANDEX), GPEX etc. Silvina (RfS and CORDEX co-chair) then presented on CORDEX in the context of RfS. CORDEX is focused on global cooperation, regional/local climate phenomena and variability, coordinated, easy to use, climate information for regions, on understanding/knowledge transfer/capacity development and providing information for decision makers.

The CORDEX CMIP6 simulations are still ongoing. An important paper has been published on [Empirical Statistical Downscaling](#). There is a plan for future CORDEX white papers – topics will be discussed at the CORDEX Conference in September 2023. CORDEX has a strong history on capacity building activities, with many regional or local activities organised aiming to promote capacity building within regions.

With regards to linkages between CORDEX and other WCRP activities, Silvina highlighted that there were many e.g., already strong engagement with ESMO, CMIP, WGCM, WGSIP, WGNE, GEWEX, CLIVAR, Digital Earth, MCR. As an example, there were discussions with CORDEX-Africa for potential engagement in a subsequent phase and well as linkages with ANDEX. With respect to external partners, Silvina also highlighted many activities, including workshops with SMHI, Future Earth, with GCOS etc.

Sonya highlighted that this was an ideal opportunity for CLIVAR to talk with RfS. CLIVAR doesn't have anything about connecting with user communities, through MCR yes, but not through RfS and now CLIVAR and RfS should start engaging in discussions.

Amy mentioned that there was no clear understanding of what CliC can offer to RfS. Sara responded that the RfS SSG doesn't have an obvious person that can bring forward relations with CliC, though there is a member from Denmark who could help make the connections. In general, when regions are considered, we tend to focus on highly populated regions, but it is true that we should be looking at communities in Greenland etc. Bruce added that there was perhaps a need to have a clear definition of regions as "a region" as such is contextual. Amy asked if the Arctic could then be considered a region. Bruce and Sara agreed that it could be and that RfS was about informing regions even if there is no specific definition/boundary for the region. Amy and Bruce agreed to start discussion on CliC regions that would be of interest to RfS (CliC has a focus on both poles, the Andes, and the Himalayas).

Ken mentioned that the ANDEX project has strong links with RfS objectives with respect to knowledge transfer. He mentioned that Andes could then be a 'RfS' region as the community is working towards common goals in that region. He also mentioned that AI is changing the ways of

knowledge transfer. Bruce emphasised AI is a critical issue in terms of climate services especially when it comes to ethical issues.

Tom asked about links between stakeholder engagement and socio economic expertise. Bruce responded that in Africa, stakeholders are considered as peer partners to understand socio economic situations and not as being at the end of the supply chain. Silvina further responded that this is very regional and national specific and therefore would depend on where one is and what the priorities are. Sara mentioned this was where external partnerships are very important. For example, working with IAI (Argentina), we need to use agencies that already have political connectivity such as IAI. Otherwise, it would become overwhelming for us. Bruce mentioned that the value of RfS was on the principles of engagement instead of recipes for engagement.

Xubin inquired about the efforts of research communities in terms of predicting the future. What is RfS' track record for representing regional communities in terms of projections? Sara responded that the community has projected fidelity in terms of winds, mean precipitation etc. but also agreed that it has been a huge task for RfS.

Cristiana asked if RfS was thinking of anything like citizen science projects, i.e., local specific events that are smaller scale than a region. Bruce mentioned that it is too ambitious for now. Silvina further added that CORDEX were already doing such activities at local scale, but the difficult part was creating and providing useful information.

Pascale added two points – (1) CORDEX: the need for a downscaling part for paleo and that this also needed links with society. (2) would RfS also engage and have a paleo aspect? Bruce responded for the latter that it was not a question of if but when. Silvina added that on the CORDEX side, there were not many discussions on paleo simulations. The community needs to engage with the activity, and we coordinate. If there is no community interest in using such kinds of simulations, CORDEX will not do them. Tim mentioned that this would also be a request to ESMOS's modelling capability to think about the paleo aspect.

3.3. Climate and Cryosphere (CliC) Core Project

Amy Lovecraft (CliC co-chair) presented progress with the Climate and Cryosphere Core Project. The CliC leadership had discussions with the leaders of the CliC activities to discuss their strategy for the next five years. Most CliC activities have achieved their goals and will reorganise, appoint new leadership, set new objectives, and identify knowledge gaps. CliC grants for Early Career Scientists have been very successful with a substantial number of applications (more than 40) and with a good regional and disciplinary coverage. Most of the grants support field work for the grantees. One of the CliC grantees was nominated for SSG membership.

For the implementation of the CliC Strategic Plan (2022-2031), it is envisioned that a number of new activities will be launched, including some with a focus on working with communities that are affected by the impacts of climate change on the cryosphere and on engaging with groups in the Global South. CliC will also look at strengthening linkages with WMO's Global Cryosphere Watch, its polar regional climate centres and outlook fora. WMO has provided additional funds for CliC grants to encourage these linkages. CliC is also historically active in providing science advice and input to the Arctic Council (and its working groups) and the Antarctic Treaty system. It also works closely with other science bodies with an interest in the cryosphere such as the Scientific Committee on Antarctic Research (SCAR) and the International Arctic Science

Committee (IASC), amongst others. CliC is discussing how to launch and coordinate, with partners, initiatives such as a Report Card for Antarctica, similar to the [Arctic counterpart](#). CliC is also discussing plans for a CliC Open Science Conference in 2025, focusing on the cryosphere, with the inclusion of social scientists.

There are several ongoing collaborations with other groups in WCRP and CliC plans to build additional links with groups and activities where there is a common interest. For example, CliC works with CLIVAR on the joint Northern and Southern Ocean Regional Panels, with SPARC on the Polar Climate Predictability Initiative and with GEWEX on e.g., the ANDEX RHP. Cryosphere modelling activities are relevant across ESMO and RfS/CORDEX (e.g., Polar CORDEX and the cryosphere related MIPs). For the Lighthouse Activities, CliC has started working with Safe Landing Climates and the Sea Level Rise working group, though there is also the potential to work with e.g., permafrost and methane mitigation. With the Digital Earths LHA, it was noted that it is important that the cryosphere is well represented, and needs, gaps and challenges are properly identified. Also, there are important connections with groups outside WCRP (such as ASPeCt, ISMASS, BEPSII and PCN, which are co-sponsored with other organisations). There is a need to strengthen interactions between the Ice-sheet Mass Balance & Sea Level (ISMASS) group and other activities such as SCAR's [INSTANT \(Instabilities and Thresholds in Antarctica\)](#) Scientific Research Programme. CliC has been invited by WWRP to be involved with their new polar activity "Polar Coupled Analysis and Prediction for Polar Services". The comment was made that although the incorporation of social science into CliC was important, the optimal balance was still not clear (from the presentation) and warranted further discussion.

3.4. Climate and Ocean Variability, Predictability and Change (CLIVAR) Core Project

Sonya Legg and Francois Engelbrecht (CLIVAR co-chairs) presented an update on the Climate and Ocean Variability, Predictability and Change (CLIVAR) Core Project. CLIVAR has developed over many years and focused on "Research Foci" (3-5 years). Now there are two active Research Foci groups: *Tropical Basin interaction* and *Marine Heat Waves*. The Indian Ocean Regional Panel has developed the "Skill Development, Awareness, and Application" (SDA2) framework for ECR capacity building and will be used at the upcoming ICTP/CLIVAR Marine Heat Waves summer school. Several review papers have been produced with progress made by interaction among groups.

Many capacity building activities have been organised in 2022 by CLIVAR, and more are planned for 2023. All activities do have a hybrid component to increase participation. The WCRP Academy may help advertise the CLIVAR capacity building activities through their network and include the archived training materials into the WCRP training repository. Organisers of CLIVAR capacity building activities are encouraged to coordinate with the WCRP Academy before and after events.

In relation to ocean model development, the Ocean Model Development Panel will continue its active role in contributing to CMIP7, particularly through the Ocean Model Intercomparison Project. A new ocean forcing dataset based on ERA-5 is planned to be developed by the Ocean Model Development Panel, to replace the soon to be discontinued JRA-55-do forcing dataset.

CLIVAR has many longstanding partnerships: OOPC, PICES, SOLAS and has been involved in many activities linked to the United Nations Ocean Decade. Several comments were made that

with increasing demands from society for climate information, CLIVAR is anticipated to provide information of strong societal relevance and to have more interaction with other communities. This includes connecting with stakeholders related to fisheries and coastal countries, particularly those impacted by marine heatwaves.

There is strong interest from the EPESC in many aspects of variability and predictability of large-scale circulation. The CLIVAR Climate Dynamics Panel is probably the best connection but many activities related to this topic are being developed by individual regional panels.

Many comments relate to sea level rise research and link to practitioners. With the end of the Sea Level Grand Challenge, there is no focal point for this topic in WCRP. Some aspects are related to MCR, SLC and ESMO but there is a danger in getting too fragmented. Connections to practitioners could be under RfS. CLIVAR also needs to develop further interaction with GPEX for the design of the air-sea interaction experiments.

3.5. Global Energy and Water Exchanges (GEWEX) Core Project

Jan Polcher and Xubin Zeng (GEWEX co-chairs) updated attendees on the Global Energy and Water Exchanges (GEWEX) Core Project. This was followed by a presentation on WMO hydro and cryosphere activities to help build linkages between GEWEX in particular. GEWEX has incorporated the process understanding of coupled energy, water, and carbon cycles into its strategic planning, and discussions have been made on launching related projects related to irrigation and urbanisation. It has strengthened the interaction with WMO Hydrology, and will launch related projects on groundwater and surface water. A major publication was submitted to BAMS on [30 Years of GEWEX](#).

GEWEX panels have been developing many new activities. The 10th GEWEX Open Science Conference is being planned to take place in July 2024 in Sapporo, Japan. New Regional Hydroclimate Projects targeting Central Asia, Africa and New Zealand/Oceania and cross-cutting projects on flooding, groundwater and surface water are in the development phase. Many projects have been developed already with some WCRP groups and many discussions ongoing with other WCRP groups. There has also been substantial interaction with partners outside WCRP.

Precipitation is a challenge that needs to be further understood, and process understanding is essential through the use of different resources and tools. Ongoing activities related to the assessment of model resolution and how these explain several processes are crucial. It is also essential to understand some of the regional aspects, e.g., ANDEX, which will look at observations and km-scale modelling and impacts of orography in those models.

Several activities linked with the carbon cycle over land are being developed, with discussions ongoing with the community on observations, with some satellite missions allowing us now to observe some parts of the vegetation, connecting carbon and water cycle. There is a strong opportunity to engage with Fluxnet. It is an important network to connect with as it is a good opportunity to also link carbon and water cycles, with joint observations.

In relation to West Africa and development of RHPs in the region: AMMA has been a success story and is connected to the community and they will continue this connection. AMMA can apply as part of the current network of RHPs in Africa but needs further coordination with other

communities. The WCRP Open Science Conference in Kigali may be an opportunity for these connections to take place as there has been limited success in Africa regarding the connection with groups outside the classic WCRP groups.

Action: GEWEX AsiaPex and monsoons panel interaction to be strengthened /initiated (ongoing; Secretariat and GEWEX leads).

3.6. Interactions with WMO Hydro and Cryosphere Activities

Stefan Uhlenbrook, WMO Director of Hydrology and Cryosphere, gave a brief presentation on potential interactions between WCRP and WMO cryosphere and hydro activities. It is essential that a connection between research, with an Earth System approach, and information and services exists. WMO supports operational activities needed by WMO members but there are several challenges, including political aspects. Examples of this are how water management in some parts has impacts in other areas as there are interconnections from watersheds.

WMO has long-term ambitions for hydrology and will prepare assessment guidelines for flood forecasting and early warning. Drought management is also critical. But this is only possible in the context that science should provide a sound basis for operations. WMO's hydrology research strategy has been prepared by the WMO Research Board, with several objectives related to data, observations, and forecasting. It is also important to note how data can and should be used to provide the correct information to stakeholders.

HydroSOS, the WMO Global Hydrological Status and Outlook System, has a focus on S2S and seasonal, via integration of data available and hydrological models, and making it useful and accessible to users. It focuses on producing globally consistent and accessible water information across scales: basin, national, regional, and global scales. Information about attribution of extreme events is important for adaptation: some are not natural disasters; they are hazards that become disasters because of anthropogenic choices. By framing a disaster as only the result of climate change can take the pressure off policy makers, so many aspects (e.g., land management) need to be taken into consideration. WMO will not provide the information about attribution, that's a research activity. HydroSOS will work with local stakeholders, in many regions, working with water management.

The Second Annual State of Water report is in preparation and inclusion of more relevant model results would be useful.

The UN Water Conference was a milestone as it was the first time that the whole water cycle was discussed. However, in the Conference Statement, there was a specific mention to early warning but no mention to research was made. Observations are critical and essential, but aspects of research are also very important.

In WCRP, GEWEX needs help from WMO to connect with regional forecast centres so that research groups can have open access to historical forecasts, and the track record on how those forecasts have been successful. Otherwise, it is not possible to claim that progress on better forecasts is being made.

3.7. Stratosphere-troposphere Processes and their Role in Climate (SPARC) Core Project

Amanda Maycock and Karen Rosenlof (SPARC co-chairs) provided an update on the Stratosphere-troposphere Processes and their Role in Climate (SPARC), including a potential name change to be approved by the JSC. SPARC successfully organised its 7th General Assembly, in a multi-hub format, with very good feedback from in-person and online participants. Several major review papers have been published by members of the SPARC community, who also contributed to the 2022 WMO/UNEP Ozone Assessment Report.

The SPARC Strategic Plan 2022-2030 was approved by the SSG and presented to the SPARC community at the General Assembly, with ambitious new plans to take SPARC forward this decade, with the implementation phase in 2023 and 2024.

The SPARC IPO contract at DLR ends this year. It will be a critical period for the project as adequate support in the IPO is needed to implement the ambitious new structure and deliver on SPARC's objectives.

Several new activities are being planned, and links with other WCRP Core Projects and Lighthouse Activities are in the process of being established. Direct contribution to CMIP7 will be done initially through preparation of forcing datasets. SPARC is also preparing to contribute to the 2023 Ozone Assessment particularly in relation to trends and observations. In relation to coupled Earth system reanalyses, ESMO may benefit from the experience from phase 1 of the S-RIP activity, which has just published its final report.

SPARC is also proposing a name change: APARC (Atmospheric Processes And their Role in Climate). This name change shows an evolution of the community and reflects the new direction of the Strategic Plan. But it will be important for SPARC to continue discussions with the other Core Projects and Lighthouse Activities to identify new ways of working with them since the name change implies a broader role of processes identified in SPARC.

3.8. The Explaining and Predicting Earth System Change (EPESC) Lighthouse Activity

Rowan Sutton (EPESC co-chair) started by outlining the overall objective of the LHA: *“To design, and take major steps toward delivery of, an integrated capability for quantitative observation, explanation, early warning and prediction of Earth System Change on global and regional scales and annual to decadal (A2D) timescales”*. He mentioned that process understanding is fundamental to the modelling/prediction of annual-to-decadal climate. Requirements vary and can be hard; correct identification of the requirements is therefore necessary. He addressed the three themes of the LHA: Working Group (WG) 1. Monitoring and Modeling Earth System Change; WG 2. Integrated Attribution, Prediction and Projection; and WG 3. Assessment of Current and Future Hazards. The Science Plan has now been published in [BAMS, 2023](#).

In terms of outputs and outcomes, the near-term outputs (2024 onwards) includes contributions to the WMO State of the Climate and Global Annual-to-Decadal Climate Update reports and advice to GCOS on observational requirements for explaining and predicting Earth system change. In terms of the LHA's benefits to society, these are focussed on:

- Quantitative process-based explanation of ongoing and emerging changes in the climate system
- Understanding and quantification of changes in classes of meteorological hazards on A2D scales
- Improved predictions and early warnings

A lot has already been done over the past year, such as publication of an [expanded science plan](#), initialization of the Large Ensemble Single Forcings Model Intercomparison Project, a webinar series and several presentations at high-level events. Rowan detailed the activities of each of the working groups. The WG3 – Assessment of Current and Future Hazards – has identified three priority hazards (1) tropical cyclones, (2) heatwaves and (3) compound events. EPESC already has strong collaborations with GEWEX, SPARC, and Safe Landing Climates, and are exploring how best to link with others, in particular with My Climate Risk and RIFS (WG3), CLIVAR (WG1, WG2) and ESMO (WG1).

In terms of emerging issues, the need for a collaborative platform was highlighted, for example, “Slack” to enable live discussions, results sharing etc., without having to rely on emails. A key challenge is to secure research funding aligned to the goals of EPESC. Various research proposals are in preparation.

During the discussion Sonya mentioned that there are more collaborations possible with CLIVAR e.g., for WG1 and annual to decadal variability working with A2D working with the Atlantic panel (AMOC), with the CLIVAR Climate Dynamic Panel and Earth’s energy imbalance. Various suggestions were made by the attendees e.g., webinars on early warning activities, the need to focus more on the southern hemisphere and the linkages between EPESC and the Global Extremes Platform, and the need to link to CliC for the cryosphere.

3.9. Safe Landing Climates Lighthouse Activity

Gabi Hegerl (SLCs co-chair) updated attendees on progress with the Safe Landing Climates Lighthouse activity. Gabi introduced the five research themes of the LHA:

- Theme 1:** Understanding High Risk Events: tipping points, large scale high-risk events across earth system and Earth/human system
- Theme 2:** Perturbed Carbon Cycle: carbon feedback, overshoot scenarios, reversibility, risks from negative emission scenarios
- Theme 3:** Water Resources: focus on Amazon and its teleconnections
- Theme 4:** Sea Level Rise: identifying limits to habitability, engagement with user communities
- Theme 5:** Safe Landing Pathways: identifying risks on way to mitigated climate => gaming approaches, collaboration with industry

Gabi highlighted progress and achievements over the past year, which included submission of a position paper to Nature Climate Change which addressed key scientific questions that form the framework of the SLC LHA; continuation of the Tipping Point Discussion Series; and initiation of a Safe Landing Pathways webinar series.

An in-person workshop held in March 2023 and resulted in better-defined set of LHA activities to be pursued in the coming years:

- CMIP7 project, to better capture threshold crossing and tipping elements across the Earth System; include new scenarios to represent different pathways (overshoot scenarios); and evaluate selected tipping impacts
- Gaming and decisions/scenario exploration, to develop scenarios that are more relevant outside the climate sphere
- Water variability impacts to address resilience of water-use sectors, valuation and optimal allocation of water, and 'green finance' in various future scenarios of (greater) water variability
- Signposts for sea level rise: indicators of change => implications for the future => integrated in communication strategies
- High-risk cascading shocks, including impacts on the carbon cycle and quantification of costs
- Connecting across the IAM-GCM-impact hierarchy, to better represent hazards in the coupled Earth/Human system. Possible joint project with ESMO
- Transient Climate Response to cumulative Emissions (TCRE) community Assessment

Emerging issues were highlighted, including the need to recruit additional working group and advisory committee members, the need to be kept abreast of WCRP activities on climate intervention, and the possibility of developing an ice sheet/rapid sea level rise activity. Links with other WCRP activities were also discussed. The LHA has potential links with all the CPs and LHAs. Links with RIFS are not developed yet but will be discussed (through extremes project).

During the discussion, Jan offered to help the linkages between GEWEX and the WG on water resources. A number of other potential linkages were highlighted, and it was agreed these would be explored further during the breakout sessions. It was noted that there was not a strong representation from the Global South in the membership, something that the LHA was aware of and working to change.

3.10. My Climate Risk Lighthouse Activity

Ted Shepherd (MCR co-chair) updated attendees on progress with the My Climate Risk Lighthouse Activity, starting with the motivation behind the LHA: how can we bring the wealth of climate information to local communities? The "[Small is beautiful: climate-change science as if people mattered](#)" MCR article was then discussed. Ted addressed the three main aspects in the article that directly connect with the MCR ambitions: grappling with complexity, the importance of simplicity, and empowering local communities.

My Climate Risk Regional Hubs

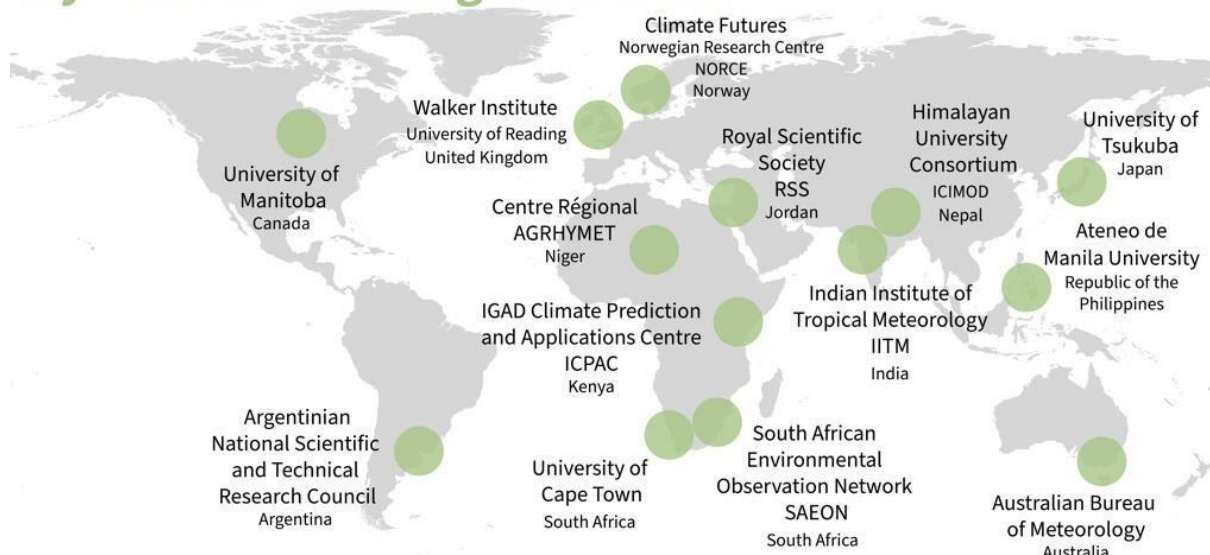


Figure 2: My Climate Risk Hubs (as of June 2023)

MCR's goal is to develop a bottom-up approach to regional climate risk. The MCR Science Plan fosters a non-hierarchical ecosystem of communities of practice. The progress made by MCR so far was then discussed. It is important to note that MCR is organised by communities (MCR Hubs) and not activities. The hubs work on the MCR bottom-up approach with the priority to reach regions not well represented within WCRP. Ted presented the structure of the MCR LHA. A key objective is for the community to not be dominated by the Global North. To have a global activity with full engagement with the Global South, in person meetings will not work. So MCR has only virtual meetings twice a year (a General Assembly). The activities happen organically from the hubs directly.

As for the progress made over the last year, six more hubs were established in addition to the establishment of an education working group. There were two webinar series (led by Ateneo de Manila University) on "Climate voices on the group" and "Climate Research" and on the Open Science Conference and publication of a Storying climates book. There are many activities planned over the next year or near future: e.g., a Learning Lab at the WCRP OSC, and CONICET and the Walker Institute are to host a series of webinars.

Links with other WCRP activities were presented. The links are to occur at the Hub levels, e.g., GEWEX, ANDEX and MCR. Links with CLIVAR, SLC, CORDEX etc., and others are being explored. WWRP is represented in MCR through WWRP's SERA (Societal and Economics Research Application).

During the discussion, Amanda Maycock asked if the Hubs are intended to be focal points for the scientists in other parts of the world? How are the Hubs connecting more widely than their local community? Ted responded that the Hubs will not necessarily be coordinating with other Hubs for more engagement- "Like minded hubs can engage if they wish to. Not meant to be franchising. North is well resourced, but many other hubs are small, and we can't give them more work to do".

Bruce mentioned that it was very important to frame MCR activities.

Pierre asked what science was being discussed within the MCRs. Ted responded that some were about methodologies of making sense of climate information that exists, some about system thinking. Example: How tropical cyclones are intensifying faster than before, and whether existing warning systems were fit for purpose.

3.11. Digital Earths Lighthouse Activity

Andrew Gettelman (DE co-chair) started with an explanation of why a Digital Twin is different to a classical model. A Digital Twin is "a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation to help decision-making". A Digital Earth (DE) is a Digital Twin of the Earth. The goals of the DE LHA is "*to support the design and building of integrated interactive digital information systems that provide global and regional information on the past, present, and future of our planet, including both natural and human systems*".

The DE concept could be regional, even urban scale. The LHA is also thinking about hierarchy of models. Andrew showed two examples: from Destination Earth and the US Department of Energy (earth system models coupled with multi sector Dyn models).

The LHA will focus on three areas of activity:

- **Fully coupled km-scale regional and global models:** Need a global research network in km-scale modelling of the Earth system and individual components
- **Data assimilation for climate:** Establish an active community in data assimilation for climate, expanding on the existing numerical weather prediction and re-analysis effort
- **Beyond the Physical Earth System:** Include human interactions on and impacts to human systems in ESMs

As for the progress made so far, there have been two major workshops on Data Analysis for climate, and on km-scale modelling. Beyond the physical system, the LHA is also building bridges with society e.g., with the GEWEX RHPs. He presented the 1km-scale model efforts regionally and globally – 21 different efforts (12 global, nine regional). The science focus (issue) areas of the LHA were then presented:

- Many km-scale model applications are best done with regional models
- Km-scale models (global and regional) should learn from established mesoscale model developers. Build teams including them
- Investigate how better representing processes at km-scales feeds back onto the larger scale circulation and how it improves the simulation of climate and weather phenomena
- Key science issues for the atmosphere: Organisation and intensity of deep convection (1km-4km), shallow convection (4km-100m), extratropical storms. Collaborate with GEWEX GASS & GLASS
- Engage km-scale ocean and sea ice communities with CLIVAR Ocean Model Development Panel and CliC for process understanding
- Km-scale models could have a big impact improving hydrology simulations: coupling to water at the surface. Engage with existing land modelling efforts (GEWEX GLASS and GHP), and Regional Hydroclimate Projects (RHPs) to improve hydrology in km-scale land models.

Several technical issues for the LHA were also highlighted, and Andrew proposed the LHA's recommendations on addressing these. As for current ongoing activities, he mentioned various joint activities with CORDEX, GASS, the UK Met. Office, NCAR, ECMWF, OMDP of CLIVAR, DAOS of WWRP etc. The main goal of the activities is to enhance discussions that would lead to products such as catalogues, links to resources, white or review papers, model intercomparison activities, tutorials etc. The DE LHA governance is in transition in terms of the co-chairs. The initial focus of the DE LHA is on workshops, but a sustainable structure is being discussed. Andrew also presented a mind map on existing links with other WCRP and external activities as well as proposed collaborations. The LHA has links with ESMO, SPARC, GPEX, GEWEX and CORDEX and this would be further discussed during the breakout sessions.

During the discussion Sonya asked if there has been much interaction with the Digital Twins of the Ocean (DITTO)? Andrew said not so far, but he would explore this. Sonya continued that there are other CLIVAR panels like GSOP that can be of interest to DE.

Eleanor and Pascale stressed it was important to include land-surface models. Eleanor would follow up with Andrew on this.

Jens raised the issue of including the ice sheets and how the coupling would be considered in the km-scale modelling. Andrew responded that the coupling would be considered within each of the earth system components (ocean, atmosphere, cryosphere and land).

Detlef highlighted that Data Assimilation exists in ESMO as well and that we need to discuss how these activities will be coordinated. Cristina asked if we realistically have the resources available to conduct these kinds of simulations at climate scales? Andrew answered that he didn't view this as building one or a few models at 1km resolution, but rather that regionally, people can run 1km-scale models at climate scales.

Tom Peter asked how you include human interactions on impacts to human systems? Andrew replied that scenarios for bio-fuel – food spaces, storage energy etc., exist and these can be used. Jan highlighted that interaction with the land surface is critical. Many food and water demands are linked to climate. GEWEX GLASS has a focus to simulate irrigation needs.

Kirsten Findell (EPESC co-chair) highlighted that for EPESC the connection on the Data Assimilation for Climate is really important here. She would like to invite representatives from DE to the next GLASS panel workshop to discuss further.

Finally Andrew reminded people that its grassroots interest defines the activities without dictating what needs to be done. People are engaged in certain activities, which DE takes up.

3.12. WCRP Academy Lighthouse Activity

Chris Lennard and Melissa Hart (Academy co-chairs) led a discussion focussed on the Academy Lighthouse. This took into account feedback provided by the other Lighthouse activities and Core Projects as well as outcomes of the breakout sessions in order to explore how the Academy can best function across WCRP and with partners. The WCRP Academy has gone through a challenging period with several changes in the leadership, and SSG members, with few connections with other WCRP groups. Despite this, it has conducted two surveys. The first survey has responses with good regional and gender distribution, with follow-up interviews. These interviews highlighted several challenges, particularly in the Global South. The second survey was focused on training providers. It concluded that there is a good match between training recipients and providers in terms of the type of training that can be made available through the Academy, but there is a mismatch in terms of the number of opportunities available. The Academy is also developing the “World Climate Science Academy” which will serve as a portal and catalogue, with a repository of materials.

The website catalogue needs to be populated with activities from the WCRP Core Projects and Lighthouse Activities, with further links developed to explore avenues for collaboration. Partnerships are also being developed with groups with similar experiences, e.g., the International University Climate Alliance. Activities will focus on priority areas for quick progress. The Academy website will be formally launched at the WCRP OSC in Kigali.

The Academy does not fit the general model of a WCRP Lighthouse Activity: it does not conduct research and does not have a limited lifetime. A new structure is being proposed and a new

business model will be developed to help secure appropriate funding. This would include a dedicated Support Unit that would be key for implementing the long-term objectives for the Academy:

- Collate and promote in-house WCRP training activities and educational materials
- Systematically review the global climate education landscape, to identify gaps in training and development opportunities
- Develop a subscriber base of training providers and users
- Be an acknowledged broker between training providers and users of training, both within and outside of the WCRP

During the discussion, it was pointed out that the links with IOC-UNESCO should be strengthened. UNESCO has a mandate in capacity building and IOC has developed a large number of materials and training, although focused on ocean issues and not on stakeholders. Ocean literacy is important and needs to be further highlighted. Mentoring is an important point to be considered by the Academy, even if not implemented immediately. The CLIVAR Indian Ocean Region Panel has early career ambassadors mentored by panel members. SPARC has started discussions about a mentoring scheme, that would be at a SPARC workshop, with continuation of mentees spending three months in the mentor's institution. Potentially, funding for such a scheme, if under the Academy, could generate interest from funders so it will be important for the Academy to create a portfolio of activities. In Future Earth, a fellowship scheme, which includes travel and mentoring, is done regionally. Perhaps this model can be attractive to the Academy.

A key objective of the Academy is to provide resources for the next generation of climate scientists with sharing of appropriate material. However, all material available needs to not only be curated but also checked before being included in the portal. Engagement also with the Office for Climate Education (co-hosted by UNESCO) is also important. IPCC has a role in this initiative and WCRP could collaborate there.

Action: JSC to consider the Academy's proposed new governance model and provide feedback and support (by end of October; JSC).

4. Breakout Sessions

Breakout sessions were devoted to a discussion between Core Projects and LHAs to identify joint activities and synergies, initiate further collaborations and to provide the ground for a revision of the respective text in the Science and Implementation Plan. The session had several elements switching between plenary and breakout sessions.

The session started with Detlef noting that the connections between Core Projects and Lighthouse Activities are driven by the identified need of the activities to talk together about their plans. There were two breakout sessions, the first on Explaining and Predicting Earth System Change (EPESC) and Safe Landing Climates (SLC) and the second on My Climate Risk (MCR) and Digital Earths (DE). The charge to each of the breakout sessions was to:

- Revisit SPs of selected Lighthouse Activities (LHAs)
- Identify existing links and connections to Core Projects (CPs)
- Identify missing /potential collaborations

- Discuss future interactions and fertilisations

Peter van Oevelen (GEWEX IPO Director) highlighted that it is important to not overload the community, in that we should not start a lot of new activities when we also need to talk about other things like how to communicate better.

Ted Shepherd (Co-chair MCR) supported this and noted that we also need to grow the community. It should not be the same people doing things every time, as those same people get overloaded.

Cristiana noted that the community should identify short- and longer-term goals. Detlef confirmed that this should be reflected in the Science Plan.

Gabi Hegerl (Co-chair SLC) suggested entraining early career researchers in the activities to help make the connections, as they have a lot of energy and can contribute. Pascale noted that the interactions between the Core Projects and Lighthouse Activities are complex. The WCRP Science and Implementation Plan currently does not reflect the interactions in all cases, and this should be part of the discussion.

Below follows a summary of the BOG discussions. Detailed notes and recommendations from the respective breakout sessions will be sent directly to the LHA leadership.

Action: Ensure WCRP has a collaborative platform and database for interaction between CPs and LHAs and include this in the S&I plan (ASAP; WCRP Secretariat)

4.1. Breakout group on the Explaining and Predicting Earth System Change Lighthouse Activity

Rowan Sutton summarised the discussion in this breakout group.

Several interactions have already been established with many of the CPs. Where gaps in the interactions for activities have been identified, it is important that individuals are also identified for those connections to be maintained. Participants in this breakout group suggested the development of a topic related to the annual to decadal variability in tropical circulation and land impacts, extreme precipitation and drought. CLIVAR has some activities related to this topic and would be very interested in additional collaboration. Further understanding, including a review of the literature, on the impact of atmospheric circulation over land is essential, and activities related to this can be established within EPESC's WG2 and WG3. Links between WG3 and My Climate Risk and RIFS have been identified, particularly related to the impacts of hazards. Establishment of connections with the Global Extremes Platform needs to be done, but it is a good time to engage with that group and they are also in the initial stages of planning. Connection with CliC was also discussed in relation to North Atlantic and sea-ice change in the Arctic, and also, potentially the role of circulation in the Antarctic sea-ice changes. But for that, it is necessary to identify individuals with the correct expertise.

4.2. Breakout group on the Safe Landing Climates Lighthouse Activity

Gabi Hegerl reported on the discussions in this session.

Interactions with CLIVAR are related to large scale circulation and water availability, with extremes and links to tipping points. In relation to RlfS, activities may be developed on regional representation of extremes. Links to CORDEX on regional expression of vegetation and water change. With SPARC, links to the risk for large events related to ozone. Related to CliC, assessments of tipping points in the Arctic, but also for the ice sheets at both poles. Important also to develop links with SCAR INSTANT, as they are working on tipping points in the Antarctic. With GEWEX, analysis of risk to water resources for large regions due to the decline of major forests, with analysis of vegetation change over the Amazon (carbon and water changes), and monsoons. Need to understand better the deep connections in coupled modelling. Modelling activities will be the main link with ESMO, particularly related to model hierarchies. Good links are already established with CMIP related to better capturing threshold crossing and tipping elements across the Earth System; including new scenarios to represent different pathways (overshoot scenarios), and evaluation of selected tipping point impacts.

4.3. Breakout group on the My Climate Risk Lighthouse Activity

Ted Shepherd reminded attendees that the My Climate Risk Lighthouse Activity is organised by Hubs, not science topics (see previous section).

The main objective is to build an ecosystem community of practices, and this will be a legacy for WCRP. It is important to note that, despite connections with a multitude of local stakeholders, climate services are not part of My Climate Risk. The My Climate Risk Implementation Plan has been superseded by the WCRP Science and Implementation Plan. The full benefit of My Climate Risk is being an ambassador for WCRP, making it more recognised. And it will make the connection for the Global North-South dialogue, filling the regional gaps that exist in WCRP. The My Climate Risk Hubs can build on many WCRP connections in the regions. One example is the Ocean Hubs (IITM and SEON), with activities being jointly developed via CLIVAR. These activities follow a bottom-up and regional approach, with the need to understand the gaps of regional knowledge, and methodologies that are being applied.

4.4. Breakout group on the Digital Earths Lighthouse Activity

Andrew Gettelman facilitated the breakout session and reported on the discussions.

The main areas of activity for that group are (i) km-scale modelling, which is the better developed area to date, (ii) Data Assimilation for climate, which needs more discussion and further development, and (iii) beyond the physical Earth System. There is a natural link with ESMO, particularly with WGCM and WGNE, and the components of the development of Earth System Modelling. There is also potential for collaboration on discussion related to infrastructure, which goes beyond what has been done for CMIP. This discussion should not be restricted to data archiving and accessibility but new ways for data analysis, for example, in the cloud, as well as Data Assimilation, Reanalysis and model-data fusion, particularly related to reduction of uncertainty. With GEWEX, there are lots of synergies and connections already underway with GASS and GLASS related to process studies. Potential exists for further development of activities related to km-scale modelling and activities at urban scale, including hydrology. Discussions are already ongoing with CORDEX in respect to the Flagship Pilot Study on Urban areas, with the objective of sharing appropriate mechanisms for working at the same scale with different perspectives. It is also important to make connections with activities under WWRP on this theme. With CLIVAR, discussions will take place with the Ocean Model Development Panel

and the Global Synthesis and Observations Panel. With SPARC, in the context of high-resolution modelling, it is important to notice the role of aerosols, and also learn from the experiences of S-RIP activities. Further connections need to be established with CliC relating to high-resolution ice sheets.

5. Partnerships

5.1. Engagement between WCRP and IPCC

Pascale introduced the objectives of the session. She emphasised that discussions on the next IPCC assessment are underway and WCRP's role in that needs to be discussed as WCRP provides major scientific input to the assessment reports. She mentioned a few highlights of the upcoming discussion. The WCRP community is anxious for the AR7 IPCC agenda and the alignment with the scientific agendas: new science, scenarios, simulations (global, regional), regional integration. What are the critical steps for strengthening the WCRP-IPCC interface? For example, WCRP takes on board science gaps. Do we miss any? This discussion will help identify potential gaps, organisational aspects, highlighting actions and opportunities to revisit WCRP-IPCC collaboration to prepare for the next cycle.

5.1.1. IPCC Working Group 1

Valérie Masson-Delmotte (WG1 Co-chair) began her presentation by reminding attendees how the previous assessment, AR6, was prepared.

With regards to the AR7, the election of the next IPCC bureau will be finalised by the end of July 2023. A plenary session at the end of 2023 will discuss and decide the timeline alignment, either with the Paris Agreement Global Stocktake (2028) or longer (perhaps 2030). Valérie highlighted the importance of WCRP's efforts in producing scientific activities within WG1. In terms of some AR6 WG1 highlights:

- AR6 emphasised climate information relevance for risk assessment and to inform regional adaptation
- ECRs were involved in reviews of WG1 reports: more than 120 ECRs
- Enhancing climate literacy
- Inclusion of ethical issues

A survey result from AR6 WG1 authors was shown. The results showed the need for increased coordination, problems with the late availability of CMIP6 results, slow access for the Global South, importance of IPCC and CMIP7 timelines alignment especially with respect to early data availability. The survey results also flagged the importance of regionally coordinated activities by WCRP.

Several knowledge gaps were mentioned in the presentation such as deep uncertainty in ice sheets, tipping points, Antarctic sea-ice etc. Valérie also mentioned that WCRP may not go far enough exploring the interface between climate change, ecosystems, and biodiversity.

Building on AR6, Valérie mentioned that we need to think further about coordinated initiatives to advance relevant regional knowledge. The use of AI in the IPCC process will also be considered

(e.g., systematic literature review methodologies). Valérie ended her presentation by discussing the preparations for AR7 and how WCRP input was important.

This included:

- Updating the good practice IPCC guidance
- Assessing and combining multi-model projections
- Attribution including methodologies for the attribution of single, composite, compound events
- Methodologies associated with the use and assessment of scenarios (including their plausibility considering biogeophysical limits)
- How to enhance the relevance of the physical climate information for the business sectors
- Engagement with practitioners
- Information relevant for climate stress tests of supply chains (including agro climate zones, tree crops)
- Information targeted to the integrity and accuracy of corporate responsibility reporting
- Evidence to support the Loss and Damage mechanisms (in the spirit of the IPCC Task Force inventories)
- Assessment of the effects of implemented adaptation and mitigation responses into the profiles of climate impact-drivers

5.1.2. IPCC Working Group 2

Elvira Poloczanska gave some highlights from IPCC WG2.

In AR6, WG2 strengthened integration through cross-WG activities. AR7 will continue to strengthen the regional focus. AR6 improved understanding of risk transitions compared to AR5. AR7 will work on improving understanding of risk assessments (including complex risks) at regional and local scales and understanding our limits to adaptation. AR7 will also address literature lag without losing quality of the science results in the report.

5.1.3. IPCC Working Group 3

Jim Skea presented on IPCC WG 3.

The three WGs collectively ran a workshop on scenarios at the end of April 2023 (results yet to be published). CMIP7 will use scenarios that originated in the WG3. IPCC does not own the scenarios but is rather a user and helps highlight the scenarios to a wider community. Important to think about the flow of information across the three WGs.

Detlef opened the floor for discussion. Peter van Oevelen said that Valérie's overview of the objectives to be addressed were excellent, but they would add too much pressure on the scientists. How can the scientists address all these wishlists and still continue with their science? Valérie responded that partnerships would be the answer and that it is currently critical to establish these so the objectives could be met later. This could include jointly supervised PhDs, post-docs, labs working on processes, and understanding of the processes, models etc. and can partner with other sectors.

Ted mentioned that AR7 should perhaps be better organised to serve its purpose well. Valérie

responded that a better structure and flow of information especially with regards to regional climate information is required. AR6 was not that great in sectoral information, including information-sharing between WGs. She mentioned that flow of information also means anything published can be considered but it's crucial to identify the priority elements and consider only those. Jim Skea responded that WG1 and WG3 collaboration was very strong. Most climate scientists in WG1 participated actively in WG3. The nexus needs to continue through a coordinated approach from the early stages. Pascale asked if this could be done through specific workshops. Jim responded that cross-WG boxes in AR6 helped a lot.

Rowan asked if, for AR7, WG co-chairs could put a short summary on the priorities of the synthesis report? Valérie responded that scoping the synthesis report depends on the new office. Jim mentioned that an earlier start to the synthesis report can be made. Jim also added that AR6 neglected expert workshops since it was dealing with a lot of special reports and that this was a lesson learnt. Valérie also mentioned that it was always a thin line between doing an assessment and developing new research. Closer partnership with WCRP might help. Detlef emphasised that it could be an assessment out of WCRP.

Helen then thanked the IPCC team for the discussion and asked Valérie if a closer link between WCRP physical science and biodiversity can be created. Elvira responded that WG2 sits between WG1 and WG3. Challenge was to stimulate the WG2 community to be able to access scenarios and perhaps there needs to be scoping on how such connections can be made.

Pierre commented that with the Global Carbon Project reporting from countries is different from the calculations produced by scientists. It's hard to reconcile. With regards to the CMIP scenarios, for AR6, a group of scientists discuss and come together with a set of scenarios. Are we going to do the same and rely on a group of experts to come out with these scenarios in AR7? Valérie mentioned that the main outcome of a recent meeting was to ensure that experts from different countries are a part of a group that will think about scenarios and come up with suggestions that could be considered.

Valérie also mentioned that WCRP, along with other organisations, as IPCC observers can also contribute to the scoping of the report, including its framing, and identify interfaces. Authors of the report should find a way to engage with WCRP. Jim also added that in terms of scenarios, we might expect something similar to AR6 (five scenarios) as this was what was practically manageable. The question would be how these five scenarios would be identified. Transparency and openness about the scenarioMIP process is crucial and this process should open up to experts interested.

Huge disappointment during the last cycle, more than 90% of WG3 scenarios were based on SSP2 (middle of the road scenarios). This didn't allow WG3 to analyse adequately. More variety needed in terms of equity and justice for WG3 and taking into account a wide range of socio economic backgrounds.

Detlef thanked IPCC for the great discussion. First time all three were present at a WCRP JSC meeting. It was critical to organise the workshop between WCRP and IPCC – to lay out a pathway in a better way.

Actions: Re-energise the discussion with IPCC to plan a joint workshop between WCRP and IPCC (workshop planned for early 2024; JSC leadership, WCRP Sec., IPCC leadership)

WCRP to work closely with the IPCC Task Force on National Greenhouse Gas Inventories (to be discussed at proposed IPCC/WCRP workshop) (by end of year; WCRP and IPCC leadership)

5.2. Engagement with WMO's Global Framework for Climate Services (GFCS)

Chris Hewitt gave an overview on WMO's Global Framework on Climate Services (GFCS) and how WCRP can best be engaged. He explained that climate services are the provision and use of climate information to assist decision-making. The goals of GFCS are to:

1. Reduce the vulnerability of society to climate-related hazards
2. Advance the key global development goals
3. Mainstream the use of climate information in decision-making
4. Strengthen the engagement of providers and users of climate services
5. Maximise the utility of existing climate service infrastructure

He also spoke about the timescales that the climate services need to address that can vary from the past to long-term future. Often, there is an overlap with weather services. Chris briefed the attendees on the goals of WMO's GFCS and the efforts (working with other UN agencies) made to achieve these goals. GFCS is structured around five priority areas at global, regional and national levels. Chris outlined the links with WCRP: many of WCRP's high level science questions and gaps are of interest to GFCS for climate services and decision making. He emphasised that WCRP is essential to provide the scientific basis, the data, the information and the knowledge that current climate services are built on as well as future climate services.

During the discussion, Rowan raised the issue that there is rapid growth and demand from the finance sector. Did GFCS plan to address this? Chris: The issue is there are no agreed standards for climate services, though there are some efforts to develop such standards e.g., in the UK and now the European Commission.

Ted asked how you manage the challenge that if standards are set by the Global North and it is disenfranchising for the South. How do you manage this challenge? Chris replied that there is no answer yet but discussions are underway. Eleanor made the point that looking at the priorities - agriculture, food, water, disaster risk reduction - and asked should we not be investing more in the modelling of these impacts?

Bruce highlighted that GFCS looks like a value chain. Will a co-production mentality happen in GFCS? Chris replied that we are slowly working toward this. It's not an easy task but things are moving in the right direction. Detlef highlighted that the first step is to engage a closer collaboration between GFCS and RfS for co-production of activities.

Action: Build connection and engagement between RfS and GFCS (ASAP; WCRP Sec., RfS co-chairs, Chris Hewitt)

5.3. GCOS/WCRP collaborations

Anthony Rea, Director of WMO Infrastructure Department (including GCOS) gave a brief presentation on GCOS/WCRP collaborations. He began by highlighting that both GCOS and WCRP have three co-sponsors in common (GCOS also has UNEP) and that WCRP also co-sponsors the three GCOS panels. He highlighted the past involvement of WCRP at GCOS

events e.g., 2022 GCOS Climate Conference. In terms of upcoming interactions, GCOS will participate at the WCRP OSC and has a GCOS poster cluster and there is a joint WCRP-GCOS workshop on cycles and budgets. GCOS also has strong links with WCRP through its OOPC panel with CLIVAR. Anthony highlighted that GCOS can bring strong links to WCRP with respect to observational aspects – satellites, direct links with national meteorological services, hydrological community etc.

During the discussion, Detlef mentioned that GCOS has always been an interface for the observational community and continuing links with WCRP were important.

Xubin asked about how the activities of GCOS were planned. Anthony responded that GCOS collects and documents the data needs for monitoring the climate system and assesses the impacts of climate variability and change. GCOS regularly produces status reports, which assess the progress and unmet requirements in the climate observing systems, and propose actions for its improvement. These periodic reports are submitted every five years to the United Nations Framework Convention (UNFCCC) and are recognized by the Conference of the Parties (e.g. Decision 19/CP.22).

The GCOS Implementation Plan addresses the observational gaps and key observational priorities (including data curation) in terms of Essential Climate Variables (ECVs). It is an essential element for space agencies, national environmental and meteorological services to plan their observational programmes etc. One of the goals of GCOS is to communicate at a higher level, the operational and observational needs of the community, building a connection between the scientific community and the government.

Chris asked if GCOS has any leverage on national meteorological services to make their observational data available? Anthony responded that GCOS proposed requirements to the member states as a resolution to obligate the member states to have the historical observational data made available. The WMO's infrastructure commission also emphasises this. GCOS works closely with the commission to make this happen.

Lisa mentioned that previous WMO resolutions did not make differences earlier in practice. She asked what was different now. Anthony responded that making such efforts work is not an easy process and that GCOS is moving towards that slowly but steadily.

5.4. World Weather Research Programme

Estelle De Coning presented the World Weather Research Programme (WWRP) and highlighted the objectives of WWRP. She provided details on the new WWRP Implementation Plan that will work on advancing Earth System science for Services from minutes to months, enhancing the warning process, to quantify, reduce and communicate prediction uncertainty. The drivers for the new WWRP Implementation Plan directly relate to the objectives of WMO. She briefly presented each of the new projects of WWRP (see Figure 3, below).



Figure 3: New WWRP Projects

A brief explanation on the working mechanism of WWRP projects was provided that also included the composition of the Steering Group, and key linkages and partnerships with WCRP activities, of which there are several.

Detlef enquired about WWRP's participation at the OSC. Estelle mentioned that one of the WWRP's experts would be a keynote speaker at the OSC. Detlef also proposed a short discussion on S2S and future collaboration. Estelle assured that WWRP-WCRP S2S collaboration will continue. As an example, an opportunity for those representing S2S in ESMO can be provided to sit on steering groups in WWRP.

Nico mentioned that potential collaborations between WGSIP and WWRP will follow the S2S summit.

5.5. Global Atmosphere Watch

Sara Basart (Science Officer, GAW) presented the mission and objectives of the WMO Global Atmosphere Watch (GAW) Programme.

GAW's mission is to *“Advance and enhance science, services and infrastructure related to atmospheric composition, and support policies for society through applied research aimed at improving the understanding of the roles of aerosols, reactive gases, stratospheric ozone and greenhouse gases and their interactions in the Earth System.”*

She also highlighted the importance of the various scientific publications and technical reports that come out of GAW. Sara presented the GAW observational and research infrastructure that aims to strengthen the atmospheric composition measurement and data infrastructure, and contribute to understanding trends and variability and extremes. GAW's innovation and applied research works towards improving predictive capabilities and analysis through applied research aimed at advancing the understanding of the roles and fate of aerosols, reactive gases, stratospheric ozone and greenhouse gases and their interactions in the Earth System. GAW's science for services works on advancing the application of atmospheric composition information in support of policies and conventions. GAW also works on integrated Global Greenhouse Gas information system, warnings and air quality services model intercomparisons. Connections between GAW and WCRP were highlighted: ozone depletion, carbon cycle, aerosol interactions and ocean geochemistry through SPARC, CLIVAR, ESMO etc.

During the discussion the connections between IGAC (Future Earth), NDAC etc., and GAW were briefly discussed. COPERNICUS and NASA are providing open access reanalysis on aerosol components that help with the atmospheric variables. GAW and WCRP will continue to interact and explore new areas of cooperation.

5.6. Future Earth, including 10NICS and other potential partnerships with WCRP

Sophie Hebden presented on Future Earth, the 10 New Insights in Climate Science, and other potential linkages with WCRP. Future Earth's global Vision and Mission are:

- Future Earth is a global network of scientists, researchers, and innovators collaborating for a more sustainable planet.
- Our mission is to advance research in support of transformations to global sustainability.
- Our vision is of a sustainable and equitable world for all, where societal decisions are informed by openly-accessible and shared knowledge.

Sophie briefed the attendees about various Future Earth-related activities such as 10NICS, work on building and mobilising global networks through SRI etc. She also highlighted their custodian, partner organisations, funders etc. FE's 27 Global Research Networks have international program offices all over the world called 'hubs'. Together they address the complex interactions between natural, social and technological systems, and how those interactions affect, across time and space, the planet's life support systems, socio economic development, and human wellbeing. Future Earth and WCRP have formalised their partnership to jointly address major societal challenges in 2020 even though this has been active even before. WCRP has a seat in the governance body that advises the Governing Council on the directions of Future Earth. Sophie also addressed various Future Earth activities such as AIMES (Analysis, Integration and Modeling of the Earth System) and its potential synergies with ESMO and Digital Earths. The AIMES working groups also have overlapping ambitions with the WCRP Safe Landing Climates Lighthouse activity to improve understanding of risks associated with the coupled human-Earth system. FE activities and collaborations such as through 10NICS, SRI were also highlighted.

In the open discussion, Tercio Ambrizzi (JSC member) enquired about South American

representation in Future Earth. Sophie responded that this is under discussion and depends on funding possibilities too. Hubs are set up based on discussions between the FE governing council, local institutions etc.

Detlef mentioned close collaborations between FE activities, ESMO, SLC etc., and expressed interest in closer collaboration. He enquired about potential collaborations with WCRP Academy and modelling aspects. Sophie responded that the modelling aspect needs to be mindful. The best approach would be to connect ESMO and AIMEs IPOs.

On the WCRP Academy, Erica Key (FE US Hub) mentioned that there is interest in linking the WCRP Academy to the developing Future Leaders program together with the Belmont Forum.

Ken also questioned about bringing in more scientists into FE from S. America, especially from the social science aspect. Wendy responded that FE works closely with American Global Change Research that works with social and natural sciences. They would bring these aspects and links in a workshop at the SRI 2023.

Ted also mentioned the connections between MCR and RiskKAN. Eleanor emphasised about the land modelling activities and that iLEAPS, AIMEs and GEWEX are already connected. Helen mentioned that Kigali can be the ideal place for these discussions.

5.7. Short interventions from other partners

There were opportunities for WCRP's other partners to give short interventions (if they wished) focussed on their interactions with WCRP.

5.7.1. Asia Pacific Network (APN)

Fred Tanglin introduced APN and its various activities in its regions. APN does not fund pure scientific research but rather research that has capacity development, social engagement, science-policy relevance etc. He mentioned that of the projects funded between 2020-2022 almost 80% were led by countries from the Global South and 60% led by ECRs. Many of CORDEX SEA outputs have been funded by APN. CORDEX SEA outputs have been used by VIA groups and national assessment of climate change (Vietnam, Indonesia, Philippines). Dynamical downscaling of CMIP6 GCMs 25km is ongoing and further downscaling into 5km, 2km. CORDEX SEA and APN are looking forward to working closely with WCRP.

Detlef enquired about the relatively low participation from the Asia-Pacific region at WCRP OSC. Fred suggested that most of the participation will be at the CORDEX conference in September 2023. Fred highlighted that there needs to be more opportunities through funding, capacity building etc., for many in the region to be more involved with WCRP. There is also a potential connection through establishment of a MCR Hub.

5.7.2. European Space Agency (ESA)

Susanne Mecklenburg presented ESA's new plans and projects from 2025 onwards. ESA's Climate Change Initiative (CCI) has been approved to continue. This project addresses various ECVs and is looking forward to enhancing connections with the climate modelling and observational communities. ESA is hosting the CMIP office in the UK, which has led to new potential connections between ESA and WCRP. In addition to ECVs produced, ESA's portfolio on

research and development will also be focussed. ESA is planning to look into more on water-energy-carbon cycles and budgets, tipping points, cross ECVs. Over the next two years, ESA will focus on establishing new climate science activities. ESA is also a sponsor for the OSC-poster sessions, side events and training events. Details on active physical presence of ESA at the OSC will be decided soon.

To a question on whether ESA is looking at both regional and global tipping points, Susanne answered that ESA is looking at both aspects and this was discussed at a recent workshop on tipping points. Review papers as an outcome of the workshop will soon come out. ESA is also interested in getting involved in the WCRP tipping point concept paper.

5.7.3. GEO

Sara Venturini presented an update from GEO. GEO is moving towards more climate applications and services. GEO works with various partners – NGOs, research institutions, WCRP, member states, Intergovernmental Organisations etc. GEO works to improve the availability, access, understanding and use of Earth observations for the benefit of society across policy areas. GEO work programme until 2025 has flagship projects focusing on – 1. biodiversity, 2. ocean and coastal monitoring, 3. mountain monitoring, 4. regional focus. GEO collaborates with global technology partners such as AWS, Microsoft etc., for computing capabilities to run models and store observational data.

For post-2025, GEO is currently in a process leading to the GEO Ministerial Summit. Future GEO has identified several priority themes with new partners and is involved in fundraising.

GEO Summit 2023 (in person only) to be held between 6-10 November.

5.7.4. Copernicus/ECMWF

Jean-Noel Thepeut gave an overview of Copernicus and ECMWF. Copernicus is the European Union's operational Earth Observation and Monitoring programme, looking at our planet and its environment for the ultimate benefit of everyone. They are an observational service that brokers the observations required by users, delivering observations, datasets and tools on past, present and future climate. This includes CMIP6 projections and CORDEX domain simulations. He highlighted the Copernicus Interactive Climate Atlas, which is a contribution by the Universities of Cantabria and Predictia. The full C3S Interactive Climate Atlas may be available for 2025 as a possible initial point for the IPCC-IA for AR7. Jean-Noel noted that Copernicus/ECMWF will act as a liaison with the CMIP IPO and will do so with the ESMO IPO once it is established.

5.7.5. Global Ocean Observing System (GOOS)

Toste Tanhua presented an update on the Global Ocean Observing System (GOOS), which provides global coordination of *in situ* ocean observations and supports the ocean observing community, the end users and investors, i.e., GOOS is the broker between those who make the ocean observations and those who use them. The aim is a healthy and safe ocean, which is fundamental to the Earth. Long-term ocean observing is essential to our ability to provide relevant information to support a sustainable ocean. He explained the steering committee, strategy, ocean observing value chain, and gave an overview of the essential ocean variables and *in situ* observing network status of GOOS. He outlined an interest in identifying gaps and requirements, which can be a focus of the cooperation between GOOS and WCRP. Sonya noted

that CLIVAR collaborates with GOOS and are reinvigorating their interactions with OOPC. Kirsten mentioned that recognising where the observation system is doing well and where there are gaps is something that EPESC is interested in. It was agreed to follow up offline in this respect.

5.7.6. Ocean Observation Physics and Climate Panel (OOPC)

Sabrina Speich presented an overview of the Ocean Observation Physics and Climate Panel (OOPC), a vital component of GOOS, GCOS, and WCRP. OOPC's primary mission involves evaluating and optimising the Ocean Observing System to meet user needs. This includes integrating basin and tropical systems, assessing and prioritising Essential Ocean and Climate Variables (EOVs/ECVs), identifying gaps, and promoting consistency across the networks.

OOPC collaborates with other panels and groups, reviews the observing system, and advocates for its improvement. They coordinate/integrate with other organisational and community panels, review/evaluate the observing system, advocate for the Ocean Observing System, work with the Observations Coordination Group (OCG) and regional bodies to coordinate observing networks. She highlighted the financial challenges associated with sustaining the global ocean observing system. She also outlined the comprehensive work plan for the upcoming five years, which encompasses initiatives such as the development of oceanic indicators forging connections with GCOS ECVs. Furthermore, there is a pronounced eagerness to strengthen collaborative ties with WCRP, including engagement with the Lighthouse Activities, with an emphasis on aligning with the Ocean Decade's objectives.

Importantly, Speich acknowledged the ongoing efforts to engage with the Climate and Ocean: Variability, Predictability, and Change (CLIVAR) program, emphasising that the success of these collaborations relies on the interactions and commitment of individuals involved. She noted that they try and engage with CLIVAR, but it all depends on people and the interactions between them.

5.7.7. Past Global Changes (PAGES)

Marie-France Loutre presented an update from Past Global Changes (PAGES). They aim to improve the understanding of past climate, with the aim of also improving future predictions and to inform policy. Existing collaborations with WCRP include with PALSEA (PALeo constraints on SEA level rise), which is a group interested in understanding the physical processes involved in ice sheet collapse and its solid earth response. There is also a link with PAGES-PMIP Working Group on Quaternary Interglacials, which works on last interglacial experiments. She outlined the PAGES contributions to the WCRP OSC and also highlighted where PAGES could work more closely with WCRP, including with Digital Earths in the area of data assimilation, with SLC on tipping points, high-impact events and sea level rise, and in terms of ECR events with the Academy. There are also potential links with CliC on sea ice etc., CLIVAR on climate variability, and ESMO on PMIP. PAGES has been a partner with WCRP since 2014 and she expressed hope that this can continue.

5.7.8. Surface Ocean Lower Atmosphere Study (SOLAS)

Liselotte Tinel gave the presentation for the Surface Ocean Lower Atmosphere Study (SOLAS). SOLAS has five themes, greenhouse gases and the oceans, air-sea interface and fluxes of mass and energy, atmospheric deposition and ocean biogeochemistry, interconnections between aerosols, clouds, and marine ecosystems, and ocean biogeochemical controls on atmospheric

chemistry. They are also getting more involved in science and society. There are a lot of activities that take place under the SOLAS umbrella, including 32 national and regional networks. She outlined the WCRP-SOLAS interactions, including IOC-R, BEPSII and SOLAS Climate Intervention. She highlighted the Safe Landing Climates Lighthouse Activity discussion session on Crosswinds in Safe Landing Climates at SOLAS OSC 2022 in Cape Town and SOLAS will have a side event at the WCRP OSC. Upcoming events were also highlighted.

5.7.9. US Global Change Research Program (USGCRP)

Jin Huang presented on behalf of the United States Global Change Research Program (USGCRP). USGCRP coordinates research and investments to improve understanding of the forces shaping the global environment, both human and natural, and their impacts on society. Through USGCRP, 14 member agencies work together to coordinate and advance global change research across the US government. Jin outlined the use of research results and products to inform decisions relating to risk management in a changing climate, and to deliver products (i.e., National Climate Assessment, Annual report to Congress “Our Changing Planet”, and Decadal Strategic Plan).

USGCRP fosters international research cooperation. USGCRP’s Interagency Groups, such as the International Activities Interagency Working Group (IAIWG) and the Interagency Integrated Water Cycle Group (IWCG), serve as the primary vehicle for coordinating and implementing global change research activities within and across agencies. Through international cooperation, USGCRP and its member agencies are leveraging existing and emerging scientific knowledge to accomplish programmatic goals and strategic priorities. In support of these efforts, the IAIWG currently engages with international organisations and initiatives in a variety of ways, including contributing to the core support of several international organisations such as Future Earth, START, and WCRP. This includes working with regional networks such as the Inter-American Institute for Global Change Research (IAI) and AmeriGEO on topics of mutual interest; and Engaging with the Belmont Forum, an international partnership that catalyses funding for scientific research in support of resilience and sustainability. Jin highlighted the work of LACI, which is a recently established USGCRP interagency and international collaboration. LACI’s overarching vision is to provide opportunities for partnerships between Caribbean, Latin American, and North American countries to enhance capacity for climate risk and vulnerability assessments that would support local and regional decision-making in response to climate change impacts.

5.7.10. Young Earth System Scientists (YESS)

Fatan Bahar gave a presentation on behalf of YESS. YESS is focussed on (but not limited to) PhD students, post-docs, Master students and early career researchers across the world. Developments in the 2020-2023 period include the YESS contribution to the OSC in Kigali, YESS participation in international events (EGU, SRI, WCRP JSC, COP26) and initiatives (GEWEX/GASS Panel, WCRP LHAs, GAW SSC, WMO RB, FE Governing Council), an article on growing data-intensive activities in climate research, 13 webinar series between June 2020 and July 2023 (more than 30 webinars), the first YESS learning groups on Machine Learning, YESS science interviews, and a manuscript about the IPCC group review.

YESS has been working closely with WCRP on several projects and activities, including the EMCR Symposium at the WCRP OSC 2023, where up to three sessions will be led by YESS; the GEWEX-YESS-YSH ECRs workshop at the 13th AARSE International Conference. YESS

members are involved in many different committees, boards and initiatives throughout WCRP. YESS will have a meeting in 2025 and are looking for support.

5.7.11. Scientific Committee on Oceanic Research (SCOR)

Patricia gave a recorded presentation on SCOR. It has been developing capacity and advancing ocean sciences since 1957. She presented the portfolio of activities of SCOR, including the research projects, such as SOLAS and IMBeR, working groups, infrastructure projects and capacity development. SCOR is contributing to the UN Ocean Decade. She also gave an overview of opportunities for ocean scientists in SCOR. Their annual meeting will be held in Ecuador (hybrid) from 17-19 October 2023.

5.7.12. Climate science and society in the Andes

Ken gave a short intervention on climate science and society in the Andes. The national and regional climate change strategy in Peru has no scientific paper references. This makes it hard for decision makers to know how robust the information is. There is a lot of scientific research conducted on the Andes, but we need to assess what is and is not useful. They are working with scientists, including ANDEX, to decide what is useful research, extracting it, translating it, and making the language accessible. They are then making a database of this information (<http://cienciaclimatica.igp.gob.pe>) that is accessible to users when they need it, including to local authorities and to scientists. He noted that research can then also be guided by what information is missing. GEWEX contributes to this, through ANDEX, and there is a growing collaboration with MCR. Links with RfS, IPCC, and IAI could be established. Ken asked whether they could organise a Climate Research Forum in 2023 to consider further collaborations. Detlef suggested a newsletter article on this type of activity.

6. WCRP Science and Implementation Plan

Detlef Stammer, Pascale Braconnot and the outgoing Vice Chair, Helen Cleugh, led a discussion session on the WCRP Science and Implementation Plan.

The current draft includes sections on Strategy, Goals and Priorities, Partnerships, Governance, Communication and Coordination, Timelines and Measures of Success. All sections have been drafted and Section 3 (Goals and Priorities) includes input from all WCRP Core projects and Lighthouse Activities. Further feedback is still needed on Sections 6.3 (Capacity building), 7 (Strategic partnership), and 8 (Timelines).

Several comments have been shared particularly on further details for the implementation, including resources. A JSC task team will address some of these issues and details will be useful for funding agencies to assess what their contributions will be used and given credit for. It is also important to have a clear definition of success, including the metrics to measure it. Initiatives should also involve co-production and co-design between users of the science and WCRP groups, and it needs to be reflected in the governance, leadership and membership.

An Executive Summary is essential to capture the highlights of the documents and a suggestion was also made to develop a “Summary for co-sponsors”. Concrete guidelines will be provided to all Core Projects and Lighthouse Activities for revision of their contribution. Feedback received was for the document to be more structured but as activities are different, some flexibility may be required on how individual sections are written. This is particularly important for some joint

panels (e.g. CLIVAR/CliC Northern and Southern Ocean Panels), as it could be referred to in the section in more than one Core Project. For some of the activities (e.g., CMIP, CORDEX) these would be highlighted in call-out boxes. Such an approach could also be used for cross-cutting topics, e.g., Extremes and Monsoons.

The Capacity building strategy needs to be developed, and WCRP leadership needs to make sure this is done across the board. Core Projects should be asked to strongly contribute to this discussion. Section 8, particularly on the measure of success and performance indicators, is difficult to finalise. That was a key component required by reviewers who contributed to the review of WCRP. It is important to also acknowledge the need for alternative measures of success that are fit for the Global South.

Timeline for the completion of the WCRP Science and Implementation Plan:

- Revise section 3 by the end of July
- Revision of other sections by the end of September
- Version to co-sponsors by the end of November
- First edition: January 2024

Action: Develop clear guidelines for input from Core Projects and Lighthouse Activities to Science and Implementation Plan (ASAP; JSC Chair and Vice-chair, WCRP Secretariat) (in part. Section 3)

Action: Core Projects to contribute to Section 6.3 (Capacity Building) of the S&I plan (after guidelines have been provided (by end July; CPs)

7. WCRP's Future Carbon Footprint

It is important that WCRP takes a lead on reducing its Carbon footprint, particularly as organisations such as the European Commission are also doing so. WMO has an initiative that maps the emissions from travel and building use.

The WCRP travel guidelines developed will monitor the annual carbon footprint from travel, with reporting by every Core Project and Lighthouse Activity. The JSC was asked to endorse the guidelines, which will use the year of 2023 as baseline (taking into account that the OSC will represent a spike in travel). The JSC could also consider alternating face-to-face and virtual meetings for JSC meetings and all core activities. Comments were made that in addition to travel guidelines, it is important to consider a recommendation that every meeting organised by any group in WCRP should have a virtual component to allow online participation to those who cannot travel, and also to be more inclusive. However, it is also important to note that not everybody has a good internet connection. Large meetings should also consider a multi-hub approach. The SPARC General Assembly showed that this approach had a four-time reduction in the emission due to travel than if the meeting was in the same place.

Comments were made that the effectiveness of meetings also need to be taken into consideration because in many cases, face-to-face meetings can be more effective. Also a Eurocentric approach is not the way forward, and from the Global South, it is important to attend

meetings in person and join peers that they may not have the opportunity otherwise. All these issues need to be taken into consideration.

From the International Project Offices perspective, it is essential to have clear steps and monitoring guidelines, including which meetings should be considered, for consistency.

Beyond travel, the carbon footprint of modelling activities also needs to be taken into consideration. From discussions at the Future of Climate Modelling workshop, it was suggested that the protocol used by the Barcelona Supercomputing Center should be followed, after the analysis of the Computer Performance Model Intercomparison Project (CPMIP). The CMIP Panel has been discussing the wider carbon footprint of climate modelling activities and will provide further input to the discussion.

Action: Add in the Carbon Footprint guidelines that (1) all WCRP meetings should aim for a hybrid component (2) travel for Early Career and Global South scientists should be prioritised (ASAP; WCRP Secretariat & Pierre)

Decision: Carbon Footprint guidelines approved.

8. WCRP Open Science Conference

Detlef Stammer led a discussion on the upcoming WCRP Open Science Conference (<https://wcrp-osc2023.org/>). Around 1700 abstracts were submitted to the conference and the concept papers are being developed. The main programme is concrete and so is the Early and Mid-Career Researchers (EMCR) Symposium. Detlef proceeded to provide the latest updates on the OSC – status on abstract review, funding decisions, EMCR selection etc. He explained the hybrid arrangements of the OSC. He also acknowledged the difficulties of hosting a hybrid meeting as well as the expenses involved. Sonya and Tom both emphasised the importance of a hybrid platform. Ken mentioned that with the time difference, it will be hard for participants from S. America to be on the virtual platform. There was a brief discussion on AGU withdrawing the hybrid aspect for their upcoming conference. Detlef and Helen assured the audience that the OSC will be hybrid and every attempt is being made to make it work (irrespective of the costs involved).

Nico Caltabiano provided additional information on how the hybrid platform is being organised. He also explained the structure of poster presentations (40 Poster Sessions and 40 Poster Clusters) that will also be hybrid. The poster sessions will open many weeks before the OSC. Posters will be available online at least two weeks before the OSC.

Detlef then briefed the attendees on the status of the parallel science sessions. There will be three keynote speakers per session in addition to oral presentations. Side events are now complete, and some events will begin a few days before the OSC. He showed the typical programme of each day at the OSC.

Helen began her presentation with the abstract submission status for the OSC. Over half of the abstracts submitted were from the Global South, with one-third from Africa. Detlef commented that some sessions (as well as the dome plenary) also had trouble finding speakers which may

be due to the location. Helen discussed the dome plenary program with a session every morning and one every evening. She briefly explained the planned dome plenary session topics and speakers for each day.

Detlef updated the attendees on the fundraising status as well as the financial aspects of the OSC. He highlighted that the fundraising has been successful and that the OSC is in good hands, but more funding will mean more participants can be funded to travel. Ken asked how many participants WCRP is currently able to support. Nico clarified that we are currently able to fund around 200 participants. A discussion on ranking and abstract submission reviews followed.

Detlef also spoke about the concept paper topics and displayed the list with the inviting author. He mentioned that an additional concept paper focusing on the Arabian region is also under discussion. All these are being planned to be published in a high-level, cutting-edge journal. There will also be a 'Kigali Declaration' that will be a statement of the WCRP OSC that will go into the COP28. He also showed a draft version of topics that the declaration can derive from.

Ted questioned whether the wording of the Climate Intervention topic could be improved, stressing the importance of using the right vocabulary for this. Helen suggested: Risks and Consequences of climate intervention. Pierre agreed with Ted as this declaration will represent WCRP and hence the concept papers should represent WCRP's view. Pierre mentioned that the concept papers should ideally have a review process at the draft level before being published. Ted highlighted that one needs to be careful with the concept papers as depending on how the lead author is and how many other co-authors are involved, the participation of everyone in the author list may be impacted. Ted proposed an idea that the concept paper can have more than one lead author. Detlef mentioned that the final responsibility of these concept papers will be on him and Helen. It would be their responsibility to ensure that the message/outcome conveyed through the concept papers is not controversial. Detlef clarified that the 'inviting authors' are not imposed to be the 'lead authors'. The group is free to choose who leads and how they take this forward.

Action: Review the process of finalisation of OSC Concept papers, including a period of consultation and perhaps an internal review (ASAP; Detlef, Helen, WCRP Secretariat)

9. WCRP Branding

Detlef Stammer and Narelle van der Wel informed attendees about thoughts on a new branding of WCRP. Further discussion was moved to the JSC only session (see below).

10. WCRP Secretariat and Finance

Mike presented the secretariat update and the WCRP budget and expenditure, including the draft 2024 budget, noting that final decisions would be taken at the JSC-only session (see Section 11.1, below).

Action: Produce WCRP Science and Activity highlights on a regular basis, including an annual "brochure"; WCRP Secretariat to consider how best to provide more regular updates based on Core Projects, Publications etc. (by end of year; WCRP Secretariat).

Detlef thanked the Secretariat for organising the meeting, the hosts for providing the venue, and

everyone for attending.

11. Outcomes from the JSC-Only Session

Following the previous procedure, the JSC had a JSC-only meeting to make final decisions on finance, membership etc. The main outcomes of this meeting are summarised below.

11.1. Budgets and Finance

The revised 2023 budget was approved (including the additional funds for the MCR Hub representatives to attend the WCRP OSC). For 2024, the JSC felt they needed to have another virtual meeting as e.g., decisions were needed on the Global Fellowships, GPEX needed to be included as a new Lighthouse Activity, and more detail was needed on the Core Project proposed expenditure.

Action: Draft 2024 budgets for all CPs and LHAs to be prepared and submitted to the JSC (JSC Secretariat and CP liaisons, by July 2023).

Action: Budget meeting of the JSC to be held to decide 2024 budget (JSC and Secretariat, July 2023).

11.2. Decisions on Membership

The following decisions were made on membership:

- GEWEX: GEWEX to come back to the JSC with a package of three members, one of which must be female, and should include representation from the Global South and earlier career stage.
- APARC: Membership proposals accepted. Amadou will work with APARC leadership and WCRP Secretariat to find an African representative.
- CLIVAR: Membership proposals accepted. New person should be female and ideally from the Global South.
- ESMO: Membership accepted. Also include Maria Molina (I.e., increase membership by one person).
- CliC: Membership - JSC Chair and liaisons (Tim and Krishnan) to discuss with CliC leadership bearing in mind proposed CliC review (below).
- Digital Earths: Membership proposal accepted.

The JSC held a discussion on the importance of the JSC liaisons to the Core Projects. The JSC liaisons provide advice and guidance and ensure there is a pathway linking WCRP's highest-level leadership with WCRP's Core Projects. The JSC liaisons should be invited to the steering meetings of the core projects and be consulted with regards to the selection of new membership and other high-level decisions. They can bring any concerns or issues from the core projects to the attention of the JSC.

After some discussion the following people were appointed:

- CLIVAR: Ken and Krishnan
- GEWEX: Eleanor, Jim and Amadou
- CliC: Tim and Krishnan
- SPARC: Tercio and Cristiana

- ESMO: Pierre, Huijun and Susanna
- RfS: Lisa, Maria, Roberto and Ken

Action: JSC Liaisons to provide short feedback to Core Project leaders (ASAP; JSC Liaisons and WCRP Secretariat).

11.3. Core Projects and Lighthouse Activities

During the JSC-only session the decision was made to start internal reviews of WCRP's Core Projects, starting with CliC, since CliC has a new strategic plan, relatively new leadership, and a new International Project Office (IPO) generously hosted by the University of Massachusetts. The idea behind such an internal review is that it should not be too onerous, should be constructive, and should help CliC identify future opportunities.

Action: JSC Chairs and liaisons to CliC to work with the CliC Chairs, CliC project office and WCRP Secretariat to have an internal review of the CliC Core Project (outcomes to be presented by JSC 45; JSC Chairs, JSC Liaisons to CliC, CliC chairs, IPO and WCRP Secretariat).

During the JSC-only discussion the JSC agreed to the name change from SPARC to APARC. It was felt that the Science Plan, although good, was more an Implementation Plan and could do with some adjustments.

Action: Update SPARC name to APARC; provide JSC feedback to SPARC Science Plan and ask APARC to provide a new version to the JSC (ASAP; SPARC leadership; WCRP Secretariat).

The plans and way ahead for the new Climate Intervention and GPEX activities were discussed. The JSC were very happy with progress.

Action: Conduct a virtual meeting of the JSC to finalise plans for Climate Intervention research activities in WCRP structure (where it fits in structure; plans e.g., stocktake article and WCRP statement) (by mid-June; Detlef, Jim, WCRP Secretariat).

Action: Finalise GPEX Science plan based on JSC feedback and update WCRP Structure to include GPEX as a new Lighthouse Activity (by October 2023; GPEX leads, JSC leadership, WCRP Secretariat).

11.4. Global South Fellowships

Detlef introduced the concept of a Global South Fellowship scheme. Funds have been set aside in the latest USGCRP grant for these.

Action: WCRP to further discuss WCRP Global South Fellowship scheme (by end of year; JSC leadership and secretariat).

11.5. WCRP Code of Conduct

The need for a Code of Conduct for WCRP was raised, both by funding agencies and by the chairs of some WCRP groups.

Action: Lisa, Pierre and Cristiana to work with Nico on an updated Code of Conduct, taking into account feedback received (ASAP; Nico, Lisa, Pierre, Cristiana).

11.6. WCRP Logos and rebranding

The latest designs for the WCRP rebranding were not approved by the JSC.

Action: Provide feedback on proposed logo and branding to the design company and work with them to produce a new version (Detlef, Narelle, Pierre, Susanna and Tercio; feedback to Parenti Designs by 31 May 2023).

Annex 1 - List of Participants

For a meeting the annexes should include a list of participants and the meeting agenda. All reports should include a list of acronyms or abbreviations.

Name	Affiliation
Michael Sparrow	Head WCRP Sec.
Catherine Michaut	IPSL
Beatriz Balino	BCCR
Narelle Van der Wel	SO/WCRP
Nico Caltabiano	SO/WCRP
Hindumathi Palanisamy	SO/WCRP
Valery Detemmerman	Consultant
Gonzalo Del Arco Ortiz	Intern
Detlef Stammer	Chair
Cristiana Stan	New Member
Tim Naish	New Member
Amadou Gaye	New Member
Eleanor Blyth	New Member
Lisa Alexander	Member
Tercio Ambrizzi	Member
Pascale Braconnot	Member
Susanna Corti	Member
Pierre Friedlingstein	Member
James Hurrell	Member
Krishnan Raghavan	Member
Ken Takahashi	Member
Hui-Jun Wang	Member
Maria Ivanova	Member
Roberto Sánchez-Rodríguez	Member
Helen Cleugh	Ex-vice-Chair
Martin Visbeck	Ex-Member
Jens Hesselbjerg Christensen	Ex-Member
Thomas Peter	Ex-Member
Guy Brasseur	Ex-Chair
Edward Hanna	CLiC co-chair
Amy Lovecraft	CLiC co-chair
Francois Engelbrecht	CLIVAR co-chair
Sonya Legg	CLIVAR co-chair
Jan Polcher	GEWEX co-chair

Xubin Zeng	GEWEX co-chair
Amanda Maycock	SPARC co-chair
Karen Rosenlof	SPARC co-chair
Seok-Woo Son	SPARC co-chair

Susann Tegtmeier	ESMO co-chair
Cath Senior	ESMO co-chair
Bruce Hewitson	RfS co-chair
Silvina Solman	RfS co-chair
Sara Pryor	RfS co-chair
Andrew Gettelman	Digital Earths
Christian Jakob	Digital Earths
Regina Rodrigues	My Climate Risk
Ted Shepherd	My Climate Risk
Rowan Sutton	Explaining and Predicting Earth System Change
Kirsten Findell	Explaining and Predicting Earth System Change
Christopher Lennard	WCRP Academy
Melissa Hart	WCRP Academy
Gabi Hegerl	Safe Landing Climates
Steven Sherwood	Safe Landing Climates
Jose Luis Santos Davila	Director CLIVAR IPO
Peter J. Van Oevelen	Director GEWEX IPO
Mareike Heckl	Director SPARC IPO
Irene Lake	Director CORDEX IPO
Hyung Jin Kim	S2S ICO
Yu-Kyung Hyun	S2S ICO
Rajagopal Ekkattil	Director IMPO
Eleanor O'Rourke	Director CMIP IPO
Vladimir Ryabinin	IOC
Ariel Troisi	IOC
Henrik Enevoldsen	IOC
Kirsten Isensee	IOC
Katsia Paulavets	ISC
Peter Gluckman	ISC
Mathieu Denis	ISC
Salvatore Arico	ISC
Petteri Taalas	WMO
Elena Manaenkova	WMO
Jürg Luterbacher	WMO
Helene Hewitt	CMIP co-chair

John Dunne	CMIP co-chair
Valerie Trouet	Host - Brussels Climate Centre
Ella Jamsin	Host - Brussels Climate Centre
Piers Forster	Future of Climate Modelling (University of Leeds)
Vaishali Naik	Future of Climate Modelling
Cathy Hohenegger	Future of Climate Modelling
Lina Patino	NSF

Maria Uhle	NSF/FE
David Considine	NASA
Jack Kaye	NASA
Wayne Higgins	NOAA
Jin Huang	NOAA
Mike Kuperberg	USGCRP
Katia Kontar	USGCRP
Lisa Vaughan	NOAA
Philippe Tulkens	EU
Rune Floberghaven	ESA/ESRIN
Simonetta Cheli	ESA/ESRIN
Susanne Mecklenburg	ESA
Jean-Noel Thepaut	COPERN.
Paolo Ruti	EUMETSAT
Fredolin Tangang	APN
Valérie Masson-Delmotte	WG 1/IPCC - IPSL/LSCE
Panmao Zhai	IPCC WG1
Hans-Otto Pörtner	IPCC WG2
Debra Roberts	IPCC WG2
Pryadarshi R. Shukla	IPCC WG3
Jim Skea	IPCC WG3
Jo Post	UNFCCC
Florin Vladu	UNFCCC
Cecilia Kinuthia-Njenga	UNFCCC
Annett Moehner	UNFCCC
Sirkku Juhola	Future Earth
Sophie Hebden	Future Earth
Erica Key	Future Earth
Nicole Arbour	Belmont Forum ED
Han Dolman	GCOS
Josep (Pep) Canadell	GCP
Mark Rounsevell	AIMES
Minhan Dai	SOLAS Co-chair

Cecile Guieu	SOLAS Co-chair
Liselotte Tinel	SOLAS rep
Victoria Barlow	IPO Exec. Officer, iLEAPS
Abdus Salam	IGAC
Sebastian Ferse	Exec. Officer Future Earth Coasts
Marie-France Loutre	PAGES
Valentina Rabanal	YESS
Marisol Osman	YESS
John Claydon	IMBER
Benjamin Poulter	iLEAPS
Yana Gevorgyan	Director, GEO

Sara Venturini	Climate Coordinator, GEO
Chandrika Naith	SCAR Director
Sinjaee Yoo	SCOR
Estelle de Coning	WWRP
Chris Davis	WWRP
Greg Carmichael	GAW
Toste Tanhua	GOOS
Thelma Krug	TOPC
Martin Herold	TOPC
Peter Thorne	AOPC
Nadia Smith	AOPC
Sabrina Speich	OOPC
Weidong Yu	OOPC
Johan Stander	WMO
Chris Hewitt	WMO (GFCS/Services)
Stefan Uhlenbrook	WMO Hydro
John Nairn	WMO/WHO Extreme Heat advisor
Anthony Rea	WMO

Annex 2 - Acronyms

AARSE - African Association of Remote Sensing of the Environment

AGU - American Geophysical Union

AI - Artificial Intelligence

AIMES - Analysis, Integration, and Modeling of the Earth System

AMMA - African Monsoon Multidisciplinary Analysis

AMOC - Atlantic Meridional Overturning Circulation

ANDEX - African Network of Data and Information Exchange

APARC - Asia Pacific Adaptation Centre

APN - Asia-Pacific Network for Global Change Research

AR5 - Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report

AR6 - Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report

AR7 - Intergovernmental Panel on Climate Change (IPCC) Seventh Assessment Report

ASAP - Accelerated Sea-Level Rise

ASP - Antarctic Sea Level Change Processes and Impacts

AWS - Antarctic Weather Stations

BAMS - Bulletin of the American Meteorological Society

BEPSII - Biogeochemical Exchange Processes at the Sea-Ice Interfaces

BOG - Board of Governors

BY - Belarus

C - Carbon

C3S - Copernicus Climate Change Service

CASCADES - Deltas, Vulnerability, and Climate Change: Migration as an Adaptation

CC - Climate Change

CCI - Climate Change Initiative

CDR - Carbon Dioxide Removal

CERN - European Organization for Nuclear Research

CH - Switzerland

CMIP - Coupled Model Intercomparison Project

CMIP6 - Coupled Model Intercomparison Project Phase 6

CMIP7 - Coupled Model Intercomparison Project Phase 7

CONICET - National Scientific and Technical Research Council (Argentina)

COP - Conference of the Parties (referring to UN Climate Change Conferences)

COP26 - 26th UN Climate Change Conference of the Parties

COP28 - 28th UN Climate Change Conference of the Parties

COPERNICUS - European Union Earth Observation Programme

CORDEX - Coordinated Regional Climate Downscaling Experiment

CP - Core Project

CPMIP - Coupled Model Intercomparison Project Phase 6 – Paleoclimate

DAOS - Data Assimilation and Observing System

DCPP - Decadal Climate Prediction Project

DE - Digital Earth

DELTA - Deltas, Vulnerability, and Climate Change: Migration as an Adaptation

DITTO - Distributed Infrastructure for Tropical and sub-Tropical Observations

DKRZ - German Climate Computing Center

DLR - German Aerospace Center

ECMWF - European Centre for Medium-Range Weather Forecasts

ECR - Early Career Researcher

ECV - Essential Climate Variable

EGU - European Geosciences Union

EMCR - Early to Mid-Career Researcher

EOV - Essential Ocean Variable

EPESC - Expert Panel on Ecosystem Services and Environmental Change

ERA - European Research Area

ESA - European Space Agency

ESFG - Earth System Federated Data Centres Global Network

ESGF - Earth System Grid Federation

ESM - Earth System Model

ESMO - Earth System Modelling and Observations

ESMOS - Earth System Model Operators Summit

EUMETSAT - European Organisation for the Exploitation of Meteorological Satellites

EVE - Earth Virtual Engine

FE - Fresh Eyes

FOCUS - Full value Of Climate Information Services

GASS - Global Atmosphere Watch Aerosol and Surface Science

GAW - Global Atmosphere Watch

GCM - General Circulation Model

GCOC - Global Climate Observing System Steering Committee

GCOS - Global Climate Observing System

GEO - Group on Earth Observations

GEP - Global Extremes Platform

GEWEX - Global Energy and Water Exchanges Project

GFCS - Global Framework for Climate Services

GHP - Global Hydrology Programme

GLASS - Global Land Atmosphere System Study

GOOS - Global Ocean Observing System

GPEX - Global Precipitation Estimation Experiment

GROUP - Governance of and for Urban Local and Regional Development and Planning

GSOP - Global Synthesis and Observations Panel

HEALP - High-Elevation Asia and the Tibetan Plateau

HEAT - Heatwaves: European Action Towards Climate Service I1 - Imager 1

IA - Implementation Arrangement

IAI - Inter-American Institute for Global Change Research

IAIWG - Inter-American Institute for Global Change Research Working Group

IAM - Integrated Assessment Modeling

IASC - International Arctic Science Committee

ICTP - International Centre for Theoretical Physics

IGAC - International Global Atmospheric Chemistry

IGO - Intergovernmental Organization

IITM - Indian Institute of Tropical Meteorology

IMB - Institute of Marine Biology

INSTANT - Indian Ocean Subtropical Mode Water Dynamics Experiment

IOC - Intergovernmental Oceanographic Commission

IPCC - Intergovernmental Panel on Climate Change

IPO - Indian Pacific Oscillation

ISC - International Science Council

ISMASS - Ice Sheet Mass Balance and Sea Level

IWCG - International Water Cycle Group

JPI - Joint Programming Initiative

JRA - Japan Meteorological Agency Reanalysis

JSC - Joint Scientific Committee

KAN - Knowledge Action Network

LACI - Land-atmosphere Coupling and Intensification

LC - Lead Centre

LEAPS - Long-term Ecosystem and Atmosphere Research Platform

LHA - Large Ensemble

MCR - Multi-Decadal Climate Predictions Research

MIP - Model Intercomparison Project

ML - Machine Learning

MTG - Meteosat Third Generation

NAME - North American Monsoon Experiment

NASA - National Aeronautics and Space Administration

NCAR - National Center for Atmospheric Research

NDAC - National Data and Analytics Center

NGO - Non-Governmental Organization

OCG - Ocean Carbon and Biogeochemistry

OMDP - Ocean Model Development Panel

OOPC - Ocean Observations Panel for Climate

OSC - Ocean Surface Currents

PAGES - Past Global Changes

PAL - Paleoclimate Archive of the Southern Ocean

PALSEA - Palaeo-sea-level Working Group

PCN - Prognosis Copernicus Network

PICES - North Pacific Marine Science Organization

PMIP - Paleoclimate Modeling Intercomparison Project

Q1 - Quarter 1

Q2 - Quarter 2

Q3 - Quarter 3

Q4 - Quarter 4

R - Research

RB - Risk and Benefit

RESM - Regional Earth System Model

RHP - Regional Hydroclimate Project

RI - Radiative Index

RIP - Regional Integrated Projects

S - Steering Committee

S2S - Subseasonal to Seasonal Prediction Project

SAGE - Sub-seasonal to Seasonal Prediction in the Arctic and Global Environment

SCAR - Scientific Committee on Antarctic Research

SCOR - Scientific Committee on Oceanic Research

SDA2 - Sustaining the Discovery of the Atmosphere Initiative

SEA - South-East Asia

SEON - South East Observing Network

SERA - Scientific Expert Reviewer and Review Editor

SLC - Sea-Level Change

SMHI - Swedish Meteorological and Hydrological Institute

SOLAS - Surface Ocean-Lower Atmosphere Study

SOS - Sea-Level Observing System

SP - Strategic Plan

SPARC - Stratosphere-troposphere Processes And their Role in Climate

SRI - Southern Regional Inequity

SSC - Scientific Steering Committee

SSFMME - Subseasonal to Seasonal Forecast Model MME

SSG - Scientific Steering Group

SSP2 - Shared Socioeconomic Pathway 2

START - Global Change System for Analysis, Research, and Training

TCRE - Transient Climate Response to Cumulative Emissions

UK - United Kingdom

UN - United Nations

UNEP - United Nations Environment Programme

UNESCO - United Nations Educational, Scientific and Cultural Organization

US - United States

USGCRP - U.S. Global Change Research Program

VIA - Vulnerability, Impact, and Adaptation

WCRP - World Climate Research Programme

WG - Working Group

WG1 - Working Group 1

WG2 - Working Group 2

WG3 - Working Group 3

WGCM - World Climate Research Programme (WCRP) Working Group on Coupled Modelling

WGNE - Working Group on Numerical Experimentation

WGOR - Working Group on Observation Requirements

WGSED - Working Group on Surface Energy Datasets

WGSIP - Working Group on Subseasonal to Interdecadal Prediction

WMO - World Meteorological Organization

WWRP - World Weather Research Programme

YESS - Young Earth System Scientists

YSH - Youth Steering Committee for the Southern Hemisphere

**The
World Climate
Research Programme
(WCRP)**

*facilitates analysis and
prediction of Earth system change
for use in a range of practical
applications of direct relevance,
benefit and value to society.*

