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The Joint Scientific Committee and WCRP community remember

Arthur (Art) Alexiou

1930 - 2020

Paul Josef Crutzen

1933 - 2021

Sir John Houghton

1931 - 2020

Konrad (Koni) Steffen

1952 - 2020

and acknowledge their extraordinary contributions to climate science.

Their legacy will live on.

Decisions and action items

To quote items please use the format: 21-JSC42-XXX, when XXX refers to the decision or action number.

Membership

Decisions

D01: CliC SSG Co-chair nomination approved (E. Hanna).
D02: GEWEX SSG Co-chair nomination approved (X. Zeng).
D03: SPARC SSG membership Co-chairs (K. Rosenlof and A. Maycock) and membership (renewal: H. Hendon and D. Wuebbles; new members: W. Tian and S. Szopa) approved.
D04: S2S Steering Group membership proposal approved (C. Spillman).

Actions

A01: Discuss with the CliC leadership and IPO on how they can address regional diversity in the CliC SSG membership, in order to seek new nominations (noting that CliC previously cut its SSG membership by two) (JSC Chair, Vice-Chair, Core Project JSC liaisons, WCRP Secretariat; discussion by end August 2021).
A02: Discuss with the GEWEX leadership and IPO how they can address gender diversity in the GEWEX SSG membership, in order to seek new nominations to be approved by November 2021 (JSC Chair, Vice-Chair, Core Project JSC liaisons, WCRP Secretariat; discussion by end August 2021).

Lighthouse Activities

Decision

D05: All Lighthouse (LHA) Science Plans approved.

Actions

A03: Communicate JSC approval of all LHAs Science Plans, with further specific details at a later stage in 2021 (JSC Chair, Vice-chair and WCRP Secretariat; by mid-July 2021).
A04: The WCRP Secretariat and LHAs to summarise the specific support requirements that the LHAs need and provide these to the JSC (WCRP Secretariat working with LHA Chairs; by 1 October 2021).
A05: Establish a plan and call for support units for the Lighthouse Activities (JSC Chair, Vice-chair, LHA Chairs, WCRP Secretariat; support units established by JSC-43 if possible).

New Core Projects

Decisions

D06: ESMO and RIfS draft plans are approved.
D07: The JSC confirm that RIfS is responsible for approving the membership changes and budget requests of CORDEX.

Actions

A06: Communicate JSC approval of ESMO and RIfS (including a separate communication to CORDEX) draft plans, noting that the interim SSG and ICG have more time to develop their implementation plans, including governance and membership. Bi-lateral discussions with the other Core Projects and the Lighthouse Activities is encouraged (JSC Chair, Vice-chair and WCRP Secretariat; advise by mid-July 2021, deliver updated draft science plan by end of 2021).
A07: Establish international project offices for ESMO and RIfS (JSC Chair, Vice-chair, JSC Core Project liaisons, ESMO and RIfS leadership, WCRP Secretariat; call opened by mid-October 2021, established ideally by JSC-43).

Finance

Decision

D08: The JSC endorsed the 2022 draft WCRP budget. (Noting that a discussion will be held to fine-tune the budget before the November JSC-only meeting)

Actions

A08: Produce guidelines for a streamlined budget process, where a sub-group of the JSC works with the Core Projects and Lighthouse Activities to determine a pre-negotiated budget, perhaps with a mid-year review (ongoing from JSC-41) (WCRP Secretariat, JSC Chair, Vice-chair, JSC liaisons, by 1 September 2021).
A09: Request Core Projects and LHAs prepare an expenditure plan for 2022 and an outlook for 2023, to be approved at a JSC-only meeting in November 2021 (WCRP leadership supported by WCRP Secretariat; by 15 September 2021).

Science gaps

Decision

D09: Global Extremes Platform (GEP) plan approved in principle, with details of its implementation to be developed. This reflects the importance of the topic of Extremes to WCRP's research priorities while acknowledging that the GEP must be well integrated within the WCRP's current (new) structure and not a stand-alone activity. The JSC also seeks feedback from the Core Project and LHA leadership about their needs for the GEP.

Actions

A10: Discuss implementation with Global Extremes Platform leadership, including linkages with other WCRP activities (Global Extremes Platform leadership, JSC Chair, Vice-chair, Lisa Alexander; by end August 2021)
A11: Discuss the Global Extremes Platform at the next WCRP leadership meeting(s), in order to agree on the way forward (JSC Chair, Vice-chair; next leadership meeting(s)).
A12: Discuss heat-water-carbon cycles themes at the next WCRP leadership meeting(s), in order to agree on the way forward (JSC Chair, Vice-chair; next leadership meeting(s)).
A13: Set up an *ad hoc* group to discuss climate intervention jointly with other groups including plans for a scoping workshop (JSC members, WCRP leadership; set up by end September 2021).
Engagement, communication and coordination

Decisions

D10: Establish an *ad hoc* group on Engagement, Communication and Coordination to develop an "action plan" that draws on the discussions at the respective Breakout Groups at JSC42, identifies prioritised actions, and assigns these tasks to the appropriate members of the WCRP Leadership, Secretariat, and IPOs. This action plan will form the basis for the relevant sections in the Implementation Plan being developed. The *ad hoc* group to comprise: Science and Communication Officer, JSC Vice-chair, Pascale, additional members drawn as needed from the WCRP leadership and be formed before 1 September 2021.
D11: Continue WCRP leadership meetings (e.g., every 3-4 months) to facilitate coordination and communication across WCRP; reduce overlaps; and enhance integration and synergies and strengthen the "value-add" of WCRP. It will do this through information sharing and discussions on specific topics of relevance. It will be an important way to provide input into decisions made by the JSC.

Action

A14: Develop a chart of all WCRP components, and internal and external interactions for inclusion in the Implementation Plan (WCRP Secretariat, by 1 November 2021). **21-JSC42-A15:** Update membership guidelines, including issues on diversity, to provide clear information on procedures and timelines for all WCRP activities and to provide clarity on how people can become members of committees. (JSC Chair, Vice-Chair, WCRP Secretariat; by JSC-43).

Next JSC Meeting

Action

A16: Schedule a JSC-only Meeting for November 2021 (WCRP Secretariat; Send Doodle by 1 August 2021).

Contents

1. Introduction and session opening

Detlef Stammer, Chair of the World Climate Research Programme (WCRP) Joint Scientific Committee (JSC), welcomed all participants to the 42nd Session of the WCRP JSC (JSC-42), which opened on 28 June 2021 at 15:00 CEST. Detlef noted that this was the third Session of the JSC to be held in a virtual format. Helen Cleugh, Vice-chair of the WCRP JSC, also welcomed participants and both Detlef and Helen thanked everyone in the WCRP family for working very hard on writing science plans and reviewing the Core Projects over the last months.

Detlef stated that this meeting is a pivotal point for WCRP, where we agree on the future and move forward, while remaining dynamic, noting that "the new WCRP is excellent and authoritative in climate science." He said, "it aims to be energetic, agile, and dynamic, with enhanced diversity and transparent communication and strong community engagement, relevance, and profile. The new WCRP will be effectively engaged with funding agencies around the world. Whatever we plan, the science needs to be supported on a national level." Detlef outlined that the goals of this session are to hear back from the WCRP family on the science/business plans of our activities; to come to decisions that will finalize the soft implementation of these elements and associated organizational structures; to discuss coordination mechanisms, communication strategies, new investment strategies and improved interaction with partners; and to initiate a new way of business for the JSC and WCRP family, which includes an annual meeting dedicated to brainstorming and strategic discussions.

Detlef welcomed representatives of the WCRP co-sponsors: the World Meteorological Organization (WMO), the International Science Council (ISC), and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, each of whom gave an opening statement.

Elena Manaenkova, Deputy Secretary-General, WMO - Elena thanked the JSC for the invitation to attend the Session. She recognized that WCRP is making a lot of progress, including science plans for the implementation of WCRP's Strategic Plan, new Lighthouse Activities, which are crucial for people's lives, as well as WCRP's contributions to the State of the Climate reports, Intergovernmental Panel on Climate Change (IPCC) assessments, Arctic Council work, Antarctic Treaty, and a myriad of other organizations that are all very important components of the credible science advice that WMO, ISC and IOC provide. Elena highlighted that we are facing urgent problems. We are approaching the 1.5°C boundary, we have the 26th UN Climate Change Conference of the Parties (COP-26) in Glasgow in November, and there remains "very little awareness in the countries about what we are adapting for, what we can accept, what is unavoidable, and what we can do about this."

Elena clearly stated that we do not have the luxury of time for WCRP to do research and then for WMO to think about how to utilize it. "We have created a framework where WCRP can work hand in hand with those who are more on the operational side to operationalize as much as possible so that new knowledge of change can be used by practitioners," she said. Elena encouraged the WCRP family to be well-connected with the wider WMO family to help make the bridge from science to society. She also noted her admiration for the new WCRP Climate Research Forums to reach out to regional communities. She offered a link to the WMO Climate Outlook Forums, which are popular and gather a number of different disciplines in one place. Lastly, Elena noted that WCRP is one of the most important contributors to WMO strategic objectives and that we should find a way to ensure that new findings from WCRP activities can be more easily utilized.

Mathieu Denis, Science Director, ISC - On behalf of the ISC, Mathieu thanked everyone for joining the session. He noted that the positive messages that Elena sent to the JSC and WCRP

are echoed by ISC. He reported that ISC values the collaboration and relationship with WCRP, which has come a long way in the last few years, noting that we are not only focusing on the traditional co-sponsor role, but more and more are seeing how we can work together to address other audiences as well.

Mathieu highlighted the work WCRP and ISC are doing together around the Global Forum of Funders, promoting targeted missions for science. He noted that ISC and WCRP are working together on aspects of COP-26, including on the Transform 21 knowledge platform which profiles work that is relevant to COP-26 negotiations. He noted that ISC were recently asked to comment on a global call to action for science for COP 26, which included WCRP input. He noted that ISC are looking to reach out to broader audiences, including by partnering with the British Broadcasting Company (BBC) to produce short documentaries on solutions to science. WCRP have been invited to be part of this BBC initiative. Mathieu highlighted that an ISC General Assembly will be held in 2021, where a new Action Plan for 2022-24 (draft will be out soon for comment) will be launched. This will potentially include a new activity on 'systematic risk and global emergencies' as well as other new initiatives.

Vladimir Ryabinin, Executive Secretary, IOC - Vladimir began by highlighting that it is important to understand where the world is heading to and where IOC sees its role, also in relation to WCRP. There are critical areas of concern related to climate, biodiversity, human wellbeing, and the economy. In terms of the convention on climate and the Paris Agreement we are moving to a world that is 3-4 degrees warmer on average compared to pre-industrial levels, resulting in species loss and major inequalities in the world. He noted that IOC are thinking about the role of the ocean in addressing these issues.

Vladimir reported on major developments related to the Decade of Ocean Science and from a high-level panel on sustainable ocean economy. Research findings suggest that the ocean can sustainably generate six times more food, 40 times more renewable energy, an order of magnitude more money, and we can close the carbon gap by 20 percent to achieve the Paris Agreement. "This will be done through integrated ocean management, based on plans that are based on science. Fourteen countries already announced that they will start managing their oceans sustainably by 2025. We will call on other countries to do the same, meaning exclusive economic zones for the entire world. We will mainstream carbon and adaptation considerations in ocean management and this will be a huge contribution to the UN Framework Convention on Climate Change (UNFCCC) because it is experiencing problems with nationally determined contributions," he said. Vladimir outlined that there will be 34 different Ocean Decade programs, covering a huge breadth of issues. Vladimir invited WCRP to combine work done in the Core Projects and Lighthouse Activities and propose a Flagship Program to the Ocean Decade. "We can combine communities and create communities of practice to ensure that the ocean is managed on the basis of science. The same thing is needed for climate. Managing the ocean will be beneficial for climate. The ocean-climate nexus is an opportunity to embark and make a big difference in the years to come," he outlined.

Mike Sparrow, Head of the WCRP Secretariat, then welcomed everyone to the session and highlighted that an exciting new WCRP now has an exciting new Secretariat. He explained that in the last year WCRP has been very busy ensuring that we have the staff in place to support the JSC and WCRP activities. New staff members include Nico Caltabiano (Scientific Officer, from May 2021) and Hindumathi Palanisamy (Scientific Officer, from July 2021). Narelle van der Wel, who has worked for the Secretariat for five years as a consultant, is newly appointed as a Science and Communication Officer (from June 2021). The Secretariat also includes Michel Rixen (Senior Scientific Officer, until August 2021), Wenchao Cao (Junior Professional Officer, shared with the World Weather Research Programme (WWRP)), and Catherine Michaut (supported by the

Institut Pierre-Simon Laplace (IPSL), Paris). Mike also thanked the WCRP international project offices for their ongoing support.

2. WCRP implementation: the way forward

Detlef summarized the progress made in implementing the WCRP Strategic Plan by reminding people that WCRP leads the way in addressing frontier scientific questions related to the coupled climate system – questions that are too large or too complex to be tackled by a single nation, agency or scientific discipline. He explained that we are living at a time when we are seeing unprecedented changes in our climate. He noted that global mean temperature is now around 1.2°C warmer than pre-industrial times (WMO, 2020), global sea level rise is accelerating, ocean heat storage and acidification are increasing, with significant impacts on marine biodiversity, livelihoods, sustainability and the ocean's capacity to moderate climate change. Detlef reflected on the dramatic changes we are seeing in the Arctic and Antarctic, where minimum Arctic sea-ice extent was the second lowest on record in September 2020 and ice sheet mass loss in the Antarctic, which started accelerating around 2005, today loses ~175 to 225 Gt of ice per year (WMO, 2020).

Detlef explained that concentrations of the major greenhouse gases continued to increase despite short-term emission reductions in 2020 related to COVID-19 (Friedlingstein et al., 2020). He noted that it is obvious that stabilizing global mean temperature at 1.5°C to 2°C above pre-industrial levels by the end of this century will require a dramatic societal transformation as the basis for an ambitious reduction of greenhouse gas emissions. Detlef explained that this does not appear to be possible at this point in time and potential pathways for global emissions imply that temperatures will continue go up beyond 1.5°C, although reaching an RCP 8.5 concentration level does not appear plausible (Stammer et. al., 2021). "To keep global temperatures to within 1.5°C of the pre-industrial baseline will require the reduction of global greenhouse gas emissions by 45 per cent from 2010 levels by 2030, reaching net zero emissions by 2050," he explained.

Considering these developments, Detlef asked "what will future climate look like? The pathway that emissions, and thus temperature, will take is unknown. However, the details of the pathway matter. What will a 3-degree or 4-degree warmer world look like? Detlef explained that WCRP needs to provide this information. We need to develop the information that is required by decision makers. Some of the anticipated impacts for society are concerned with the energy of the system and heat waves; severe changes to the water cycle; and extremes, risks, and impacts. The energy in the system will increase because there is an imbalance at the top of the atmosphere, raising the heat content of the ocean. This has impacts on oxygen content, ecosystems, and biogeochemistry. Marine heatwaves are an important example of marine extremes, with huge consequences for ocean ecosystems. On land, there are increased droughts, with some 9.8 million displacements, largely due to hydrometeorological hazards and disasters, recorded during the first half of 2020 (Blunden and Arndt, 2020). There is ongoing research into climate change, as it appears that this is leading to worsening extreme fire weather and will affect ignition.

Detlef explained that the next decade will bring urgent climate challenges. Society requires decision-relevant, evidence-based climate information to support adaptation planning and mitigation strategies. This needs to be realized in the context of the United Nations Sustainable Development Goals (SDGs), where it is important to understand that we are dealing with a landscape of problems and that reaching climate goals is in competition with other goals that we also would like to achieve.

Detlef reviewed the WCRP Strategic Plan, with its Vision, Mission and Scientific Objectives. He explained that we are now in the process of implementing this plan to deliver the information required over the next 10 years to make progress. The Lighthouse Activities were created to

prioritize our science and build urgency into the implementation. Enhancing diversity is critical, as is co-designing with partners and funders. The established Core Projects, Climate and Ocean Variability, Predictability and Change (CLIVAR), Global Energy and Water Exchanges (GEWEX), Climate and Cryosphere (CliC) and Stratosphere-troposphere Processes And their Role in Climate (SPARC), will continue as major WCRP brands and are now joined by two new Core Projects, Earth System Modelling and Observations (ESMO) and Regional Information for Society (RIfS). These Core Projects will be linked with each other and with the Lighthouse Activities. Detlef went on to recognize that the WCRP Grand Challenges (GCs) have produced some excellent results and explained that they are now due to sunset at the end of 2022. He concluded by asking, when looking at the new WCRP, "what science is missing? What do we need to implement to expand the effectiveness of WCRP in the future?" Detlef outlined eight focus areas for JSC-42. These were:

1. Co-ownership of the Lighthouse Activities
2. Missing science and required structural elements
3. Coordination, governance, and communication
4. Improved diversity and early career researcher entrainment
5. Improved interaction with partners and co-design
6. New post-COVID19 investment strategies (finance)
7. Interaction with funding agencies around the world
8. Initiating the Implementation Plan writing process

Detlef explained that we must keep in mind that the Core Projects and Lighthouse Activities are one layer, with the intent that the Lighthouses draw on all WCRP's core activities and are co-owned. This requires constant attention and excellent communication practices. There are some elements, such as the heat, carbon, and water cycles as well as weather and climate extremes, that are cross-cutting across WCRP, and we have to decide how to organize them. Some other aspects, such as climate intervention, need investigation and we need to find ways to ensure that our new structure is sufficiently flexible to bring in new scientific endeavors and opportunities.

It is clear that engaging the next generation of scientists and improving the diversity of WCRP leaders – across nations, regions and disciplines – is important to WCRP, as is the interaction with partners and the co-design of our activities, to ensure that society has the climate knowledge that it needs for decision-making.

3. Initial lessons from WCRP Climate Research Forums

Helen explained that the WCRP Climate Research Forums (CRFs) are a new initiative that was agreed to at JSC-41 as part of the implementation of the new WCRP. The aims were to inform and seek feedback from the community on the new WCRP and to explore ways to exchange ideas, discuss new activities, and engage in the regions. Helen outlined that the CRFs are held online and to date 5 have taken place in Australia, Eastern Asia, North America, Southeast Asia, and Europe and Western Asia. She also noted that CRFs are planned in the near future in South America, New Zealand, the Pacific Islands, Africa, and Southern Asia. So far, the CRFs have reached over 1000 people (**Error! Reference source not found.**). Helen explained that the forums are typically 2 and 3.5 hours long, including a series of presentations describing WCRP and also panels and talks designed by our Regional Focal Points.

Helen explained that we are often asked about the audience for the CRFs. We can say that the audience has a reasonable gender representation, with at least 40% of the audience being female. The forums have entrained people from most career levels - from undergraduates and early career researchers to senior researchers. The audience has included researchers as well as people who work in climate (outside academia), stakeholders and user groups, and funding

agency representatives. Helen outlined that we have learned from online polling that our audience already had a good awareness of WCRP and that they agreed that WCRP goals and the Lighthouse Activities are addressing critical science questions. The audience also showed some regional differences in what they were moist interested in. For example, in Southeast Asia there was a strong interest in the Coordinated Regional Climate Downscaling Experiment (CORDEX), CLIVAR, and capacity building. In Europe and Western Asia, audience interest was strongest in the Lighthouse Activities. Polls conducted in the Southeast Asia and the North and Central America, the Caribbean and Greenland forums showed that people see a strong role for WCRP in the coordination of climate-related activities and, particularly in Southeast Asia, in targeting user needs and addressing them. This is useful information when we engage with the regions about what is meaningful for them.

Helen explained that feedback on the Lighthouse Activities during the CRFs was really useful, with themes on linking with other WCRP core activities, increasing engagement, and addressing user needs and practical issues. The surveys also provided feedback on WCRP, including how WCRP can use its position and voice to make a difference, raise its profile, and engage better with funding agencies in the regions. Lastly there was clear feedback on engagement, especially on how to better engage with low income, less developed, Global South nations and regions. We got a lot of ideas on how to do this better and also how to make it clearer how early career researchers can be involved in WCRP activities.

Table 1: Climate Research Forum Registration and Participation

Region	Southeast Asia	Eastern Asia	EWA[1]	NCACG[2]	Oceania[3] (Australia)	TOTAL
Registration	404	420	232	434	Unknown	1490
Attendance	277	269	170	200	204	1120
Percentage Attending	69%	64%	73%	46%	Unknown	75%
Duration (hrs)	2	2	3.5	2.5	1.5	

1: Europe and Western Asia
2: North and Central America, the Caribbean and Greenland
3: Registration for the CRF in Australia was part of a larger conference's registration process

In considering the lessons learned from the forums so far, Helen provided a simple SWOT[1] analysis (Table 2). She explained that we now know how to do these forums and there are many opportunities, but we also recognize that they require significant resources, and we need to make sure sufficient resources are available if we are to sustain these in the longer term.

[1] SWOT = Strengths, Weaknesses, Opportunities and Threats

Table 2: SWOT[1] Analysis

Strengths	Opportunities
• Having Regional Focal Points (RFPs) worked well. • Support from International Project Offices (IPOs), WCRP Secretariat, and the Coordination Office for Regional Activities (CORA) were all critically important. • We now have a template for future CRFs [positive feedback about length, format, content]. • Slido best for engagement and feedback. • Zoom webinar best videoconference platform. This enabled engagement with over 1100 members of the WCRP community	• WCRP's contact database. Added 659 (half from Asia) and ca. 200 personal invitations. • RFPs provide a larger, more diverse pool of researchers for WCRP's core activities. • Interest from early career researchers. • Ongoing engagement with partners and funders; and consultation with researchers. • Interests and needs in regions are better understood.
Weaknesses	**Threats**
• Significant workload; resource intensive [organisation, logistics, analysis, and follow-up] • How to keep RFPs engaged, in a mutually beneficial way? • Follow up: Sustainable engagement with stakeholders in the region	• Resources to sustain and follow-up. • Managing expectations of engagement.

4. WCRP Lighthouse Activity reports

4.1. WCRP Academy

Andrew Charlton-Perez (Co-chair, WCRP Academy) gave an overview of the discussions and plans for the WCRP Academy Lighthouse Activity. He outlined that the key idea for the WCRP Academy is to provide training opportunities for future generations of climate scientists and to be a 'marketplace' for climate science training (Figure 1). The Academy will consolidate and register all WCRP training activities, provide guidance and support to them as required, and will help to build a community focused on training. But also, in the long term, it could become a one stop shop for training opportunities from external providers, also identifying training gaps and facilitating new initiatives, particularly in developing countries.

Andrew explained that one of the first activities of the WCRP Academy will be an annual stocktake of research training requirements. Results from the stocktake will be shared widely and openly with the climate science community. It will identify both where there are gaps in training provision and where sustainable markets for training delivery exist. The first version of this survey is almost ready and will be shared soon.[2]

Andrew noted that human resources to support the WCRP Academy are essential, and ideally would include personnel to manage and also provide technical support and web development for

[2] See www.wcrp-climate.org/academy-survey

the web portal. Discussions have already taken place with some groups and networks, with some potential interest to provide support. Another possibility would be support from within the WCRP International Project Offices.

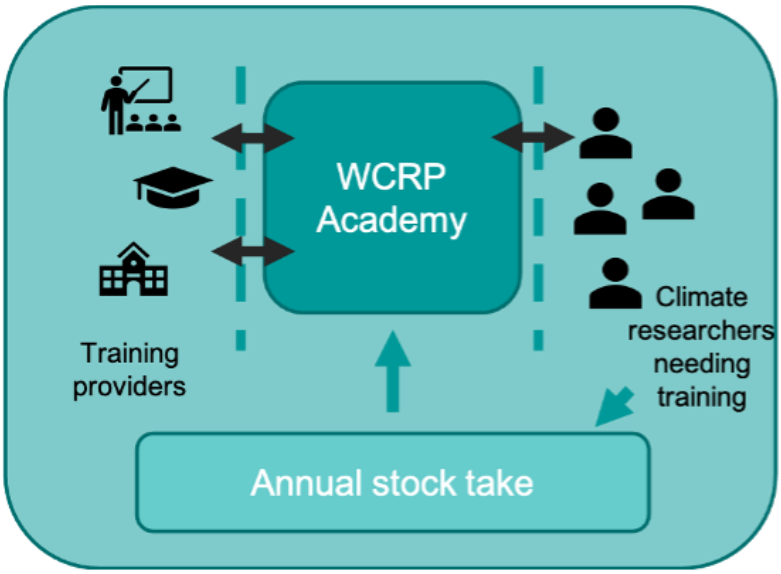


Figure 1: The WCRP Academy will act as a marketplace for climate science training.

Please see the WCRP Academy Draft Science Plan.

Discussion

Roberto Sánchez-Rodríguez (JSC Member) agreed that the WCRP Academy is an exciting initiative. He noted that the focus seems to be on climate science but, as WCRP is seeking to engage more with societal actors, he asked if the WCRP Academy was considering whether it could expand its approach and support training for a new generation of climate scientists that are aware of the need to engage with broader communities. In reply, Andrew reminded everyone that the Academy is not a training provider, but it will work with entities that are to ensure essential topics in climate science and societal impacts are included.

Ken Takahashi (JSC Member) asked about the links that the WCRP Academy has or may establish with WMO Regional Centres. Andrew replied that the goal of the Academy is to be a marketplace, linking groups that can provide training and support the sustainability of long-term activities in regions, particularly in developing countries. This will include facilitation of logistical aspects and removal of some barriers that can hinder the success of those training initiatives.

Sophie Hebden (Future Earth, liaison to the European Space Agency) asked what the WCRP Academy plans are for quality assurance of training provision. Andrew commented that this is still under discussion. The view of the Science Team is that this is an extremely important matter, and it is necessary to ensure quality. However, the process should also not be a burden for training providers.

Detlef and Helen mentioned that some feedback from the Climate Research Forums showed the need for training in other languages in order to connect with local and regional audiences. They noted that this would be important for the WCRP Academy to discuss and perhaps to involve WMO in the process. Andrew said that there are already some good initiatives, like 'Train the

Trainers', where basic material is provided in different languages so that it can be used in training activities. He hoped that the training stocktake survey will define these needs.

4.2. Safe Landing Climates

Gabi Hegerl (Co-chair, Safe Landing Climates Lighthouse Activity) outlined the plans for the Lighthouse Activity. The key aspect for Safe Landing Climates is to look for safe landing pathways (Figure 2), where we can determine how to avoid high-risk events taking into consideration risks (including those associated with mitigation and adaptation options), and also to explore present-to-future pathways for achievement of key Sustainable Development Goals (SDGs).

The five main scientific themes proposed by the Safe Landing Climates Lighthouse Activity are:

1. Safe landing pathways
2. Understanding high risk events
3. Perturbed carbon cycle
4. Water resources
5. Sea level rise

Gabi mentioned that although the themes proposed are driven by science questions, they are linked to social impacts and the workshops that the activity plans to hold will be essential to establish and/or strengthen links with several communities. Please see the Safe Landing Climates Draft Science Plan.

Discussion

Rowan Sutton (Co-chair, Explaining and Predicting Earth System Change Lighthouse Activity (EPESC)) asked whether the Safe Landing Climates Lighthouse Activity has discussed monitoring of early warning, which would be a natural link between this and the EPESC Lighthouse Activity. Gabi responded that the issue of monitoring is very important but noted that they are still in the process of identifying which tipping elements they will focus on. There are several topics related to early warning, with different communities, so the science team will have to discuss this further.

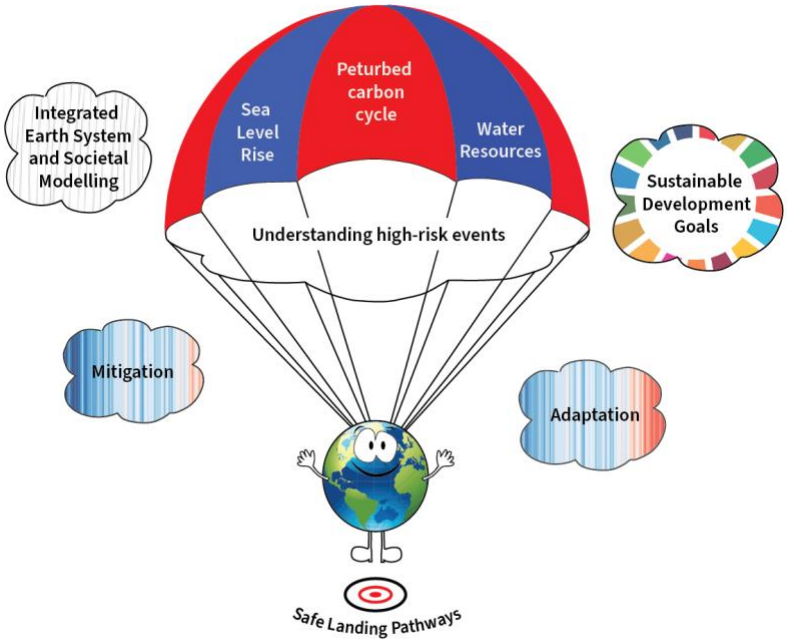


Figure 2: Safe Landing Climates will look at safe landing pathways, where we can determine how to avoid high-risk events taking into consideration risks and explore present-to-future pathways for achievement of key SDGs.

Jan Polcher (Co-Chair, Global Energy and Water Exchanges (GEWEX) Scientific Steering Group (SSG)) raised the issue that the points mentioned on the water cycle are classic themes for WCRP. However, he questioned whether this Lighthouse Activity had discussed that a safe landing climate is one where everyone has access to water. He wondered whether WCRP should aim for a more transdisciplinary vision, for example, how melting glaciers contribute to water availability and impacts on ground water level. This would not only look at specific topics but at how those topics interconnect. Gabi agreed with this view but pointed out that it is difficult to tackle many issues at once. She noted that there is a need to be selective. For example, the Lighthouse Activity will look at large-scale rather than regional-scale drought.

Detlef commented that the five scientific themes are very important, and the one of sea level rise could be a home for follow up activities of the Grand Challenge on Regional Sea-level Change and Coastal Impacts. Gabi responded that it will be necessary to have further discussions on that to see how this work aligns.

4.3. Explaining and Predicting Earth System Change (EPESC)

Rowan began his presentation by putting the plans of the Lighthouse Activity into context. The overarching objective of EPESC is to design, and take major steps toward, delivery of an integrated operational capability to observe, explain quantitatively, provide early warning, and predict Earth System Change on global and regional scales and multi-annual to decadal timescales. This will contribute to WMO's aim to bring research and operations closer together, particularly in the situation of a climate emergency that we live in.

EPESC's science plan is structured into three major themes:

Theme 1: Monitoring and modelling Earth system change
Theme 2: Integrated attribution, prediction, projection, and early warning
Theme 3: Assessment of current and future hazards

The presentation was then continued by Kirsten Findell (Co-chair, EPESC Lighthouse Activity) where she presented some of the initial activities and highlighted potential collaboration and engagement opportunities for the Lighthouse Activity within and outside of WCRP.

The first activity of EPESC is the development of the "Workshop on attribution of multi-annual to decadal changes in the climate system," to take place online in September 2021. The main objective of the workshop is to bring the community together to discuss problems related to attribution using methodologies that work on different time scales. The workshop will also establish whether models are up to the task of attributing multi-annual to decadal change, including an investigation of the signal-to-noise paradox.

Kirsten explained that in the long term, EPESC aims to establish methodologies for novel case study applications, develop an open-access multi-model archive of seasonal-to-decadal hindcast and forecast data, improve capabilities for prediction of multi-annual to decadal changes in the climate system and their impacts on hazards, and develop quantitative assessments of the current and future risk under defined scenarios of specific hazards. These will only be achieved if strong links are established and maintained with other internal WCRP activities and external groups. Please see the Explaining and Predicting Earth System Change Draft Science Plan.

Discussion

Pierre Friedlingstein (JSC Member) asked if EPESC is considering looking at the changes in forcings and responses of concentrations or if they are just looking at the climate response. He explained that if there is mitigation of emissions, there will be changes in concentrations much faster than the climate response. He noted that it is critical that we observe the changes in concentrations before the actual impact. Rowan pointed out that although there was not much discussion within the EPESC science team about this, it is clear that a conversation with Safe Landing Climates Lighthouse Activity is necessary, particularly about monitoring early warning.

Tom Peter (JSC Member) mentioned the large number of connections that ESPEC is planning to establish and highlighted specific collaborations with the Global Climate Observing System (GCOS). Rowan replied that the science team has close links to GCOS and that they will follow up with them, particularly because observations are extremely important for attribution studies.

4.4. My Climate Risk

Regina Rodrigues (Co-chair, My Climate Risk Lighthouse Activity) began by describing the ambition for the My Climate Risk Lighthouse Activity. The goal of the Lighthouse is to develop and mainstream a 'bottom-up' approach to regional climate risk, which starts from the decision context (and the decision scale) and enables relevant climate information to be brought into that context. My Climate Risk will largely draw on existing stakeholder engagement studies that have already generated knowledge on stakeholder needs, working closely with locally grounded partners. This will mainly be done via a network of regional hubs and local labs. Regina explained that labs in this context are non-hierarchical communities of practice that share resources and that are anchored by regional hubs. There are some challenges, in terms of the current funding model, stakeholder exhaustion, difficulties in documenting and publishing transdisciplinary work, and ensuring equity and legitimacy, especially in terms of Global North-South inequalities.

Regina outlined some of the activities that My Climate Risk has been involved in so far, including a round table session at the Sustainability Research and Innovation Congress in June 2021 and collaborations with the Himalayan University Consortium and International Centre for Integrated Mountain Development (ICIMOD), including a workshop called "Storying Climes of the Himalaya,

Andes and Arctic," to take place in October 2021. The Lighthouse Activity is also involved in Ocean Climate Risk (as part of the UN Ocean Decade) and has a special session planned at the American Geophysical Union (AGU) Fall Meeting 2021. The next steps of My Climate Risk will be to grow their network of regional hubs and the evolution of their science team. Please see the My Climate Risk Draft Science Plan.

Discussion

Martin Visbeck (JSC Member) congratulated the My Climate Risk Science Team and mentioned possible connectivity with several Future Earth networks. Regina replied that contact has been made with Ocean-KAN and Risk-KAN but that they need more time to mature those connections. It was highlighted that networks will be very important to the success of this and other Lighthouse Activities.

Bruce Hewitson (Co-chair RIfS Interim Coordinating Group (ICG)) mentioned that RIfS can connect quickly with this Lighthouse Activity as there are many points of common interest. One point to note is that long term sustainability of regional hubs is always difficult, especially in the Global South. Ted Shepherd (Co-chair, My Climate Risk Lighthouse Activity) explained that some connections being made are with groups that already exist, and My Climate Risk and WCRP would help those groups in obtaining continuous financial support. Regina commented that the United Nations Decade of Ocean Science for Sustainable Development can serve as a model, as some of those activities are already funded.

Helen felt really encouraged that local science and research groups would be entrained and are considered important. However, she said that the question remains on how to engage with other groups that WCRP is not aware of and how to connect with them. Regina explained that My Climate Risk is using the network provided by the members of the science team and noted that the regional focal points in the WCRP Climate Research Forums are helping to expand local connections.

Daniela Jacob (Co-chair, CORDEX Science Advisory Team (SAT)) mentioned that some of these activities are very close to climate services, which also needs to connect with providers and users of information for impact assessment. Ted agreed and commented that these activities can empower climate services in regional areas, and that RIfS may be the home for the long-term underpinning of these activities.

4.5. Digital Earths

Christian Jacob (Co-chair, Digital Earths Lighthouse Activity) introduced the Digital Earths Lighthouse Activity and explained that it is an interactive information system describing past, present, and future states of the Earth. He noted that it is a very ambitious activity, that will require us to work together and that will need to deeply integrate with advances in digital technology and in our computational abilities. He was clear that Digital Earths is a framework, rather than an implementation. Through this activity, WCRP will support systems being built all around the world.

Digital Earths propose four main areas of activity (Figure 3) to:

- Establish a global research network with expertise in ultra-high-resolution (kilometer-scale or finer) of the global Earth system and its individual components

- Establish an active research community in data assimilation for climate that builds on the existing numerical weather prediction and re-analysis efforts and significantly expands them to fulfil the needs of Digital Earths applications
- Support the establishment of both global and regional Digital Earths demonstration projects across the globe and provide a collaborative network for their development
- Enable the above by optimally exploiting extreme-scale computing and data handling resources through inter-operable software infrastructures

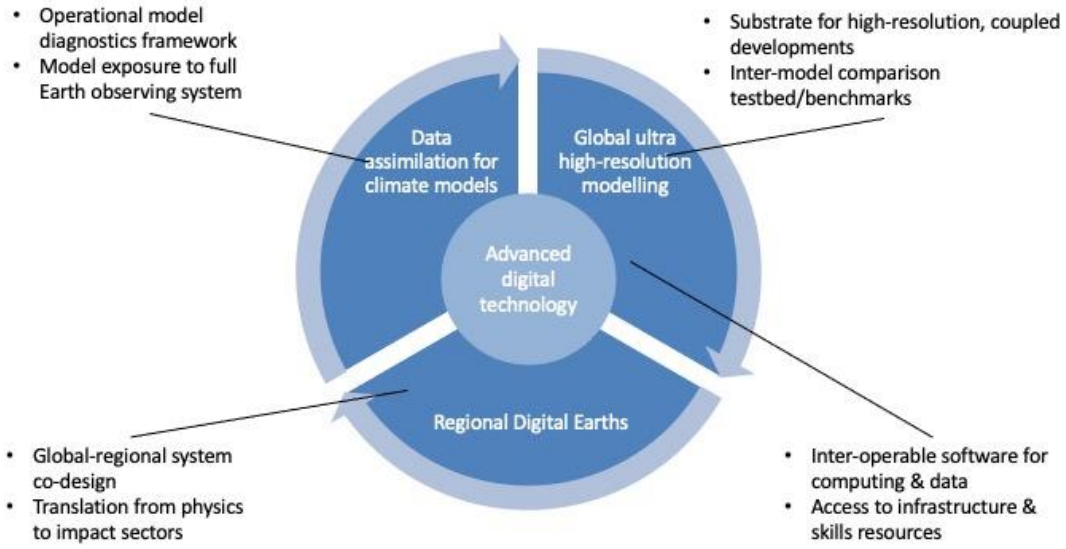


Figure 3: The four main areas of activity of the Digital Earths Lighthouse Activity

The first three are activities that would take place within WCRP. The fourth one would think about how to connect to the wider digital technologies' world.

Christian asked the JSC for feedback on the activity, first steps, and longer-term suggestions. He explained that they need support for their initial engagement with the Core Projects and other Lighthouse Activities. He also highlighted that communication of the importance of the Digital Earths' activity is necessary for its long-term success, explaining that it will have succeeded when the Lighthouse Activity is fully integrated in WCRP core activities. Please see the Digital Earths Draft Science Plan.

Discussion

Sonya Legg (Co-chair, Climate and Ocean Variability, Predictability and Change (CLIVAR) SSG) commented that data assimilation for understanding climate is something that oceanographers have been doing for some time and it is important to include that expertise in Digital Earths. The CLIVAR Global Synthesis and Observations Panel (GSOP) Panel has people who are experts in data assimilation and state estimation. She said that Digital Earths should use this expertise. Christian agreed and highlighted that what we need to do is bring all this expertise, from all spheres, together.

Daniela noted that it would be advantageous for Digital Earths to connect with CORDEX, also because CORDEX has communities in many regions. She explained that it would be good to see how Digital Earths connects to CORDEX's Flagship Pilot Studies, which are on a 1-2 km scale.

Christian confirmed that every member of the WCRP family will need to engage and partner with Digital Earths and noted that CORDEX will be a key player in the regional digital Earth world.

Detlef congratulated Christian on the progress made in this activity. He explained that the Lighthouse Activities were created to be something ambitious where we can make a big step forward, and where everyone can be involved. Digital Earths is a really good example of this. He made it clear that we need to work with the funding agencies to make sure that this can move forward.

5. WCRP Core Projects reports

5.1. Earth System Modelling and Observations (ESMO)

Cath Senior (Co-chair, ESMO interim SSG) introduced the new WCRP Core Project Earth System Modelling and Observations (ESMO). She explained that ESMO brings together modelling and observation activities from across WCRP. It was felt that this is needed so that modelling and observations efforts could be better coordinated towards a full Earth system approach and new technologies, such as artificial intelligence and machine learning, could be considered in an integrated way across the Programme.

Cath outlined the ESMO vision as being to:

> *Address overall coordination mechanism across all model data, and observations activities within the World Climate Research Programme*

The priorities for ESMO are:

1. Research
    - Seamless and value-chain model-data-observation approach
    - Work across Earth system components, disciplines, time, and spatial scales
    - Focus on coupled model systematic biases and development
    - Observational requirements to monitor, understand and predict the climate system
2. Infrastructure
    - Integrated modelling and data infrastructures, data policy, protocols, and standards
3. Access and communication
    - Share best practices, data, knowledge, opportunities
    - Communication across WCRP constituencies, communities, partners, stakeholders
    - Particular attention to engagement, equal access, and inclusion of the ‘global south’
4. Partnerships
    - Identify stakeholders, scientific ambition, and resourcing needs
    - Remove fragmentation, duplications, and suboptimal aspects in the programme

The ESMO interim SSG were set up in April 2021, with representatives from the existing working groups and partners. In June 2021, the governance and structure (Figure 4) were considered, recognizing that governance is a unique challenge for ESMO to both ensure representation of existing groups and to entrain new thinking and engagement. She outlined that there is still much work to do, including the need to establish an international project office to support ESMO, the organization of a kick-off event in the second half of 2021, and a number of workshops. A new SSG is expected to be in place in January 2022.

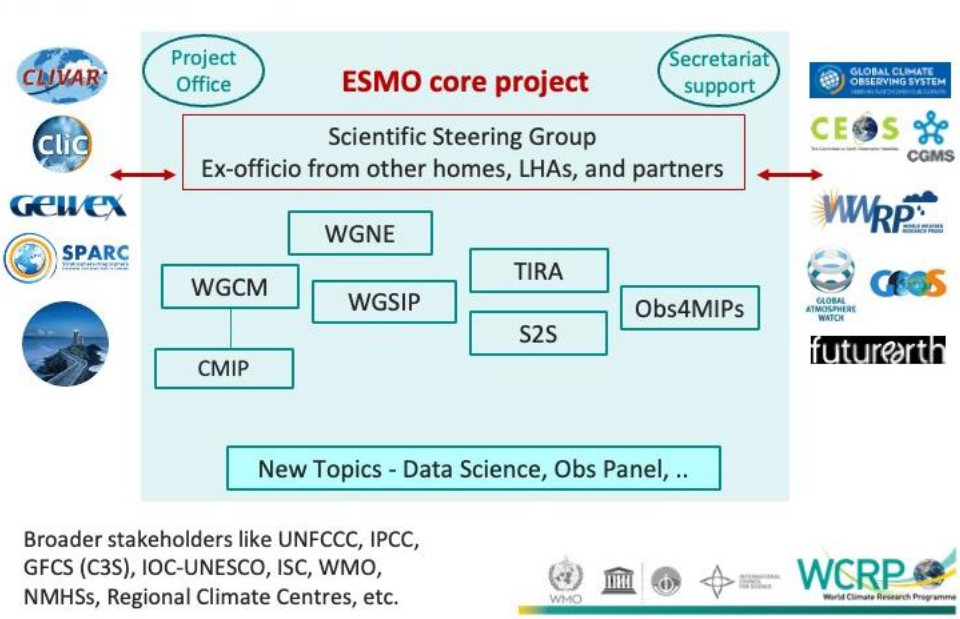


Figure 4: Initial proposed structure of ESMO in 2021.

Cath showed the initial mapping of the ESMO structure, looking at existing groups and mapping them in terms of resolution to complexity, and multi-decadal to weather timescales (
Figure 5). She explained that from this they identified a need for a new observations panel, to interface across WCRP and interact with other bodies such as GCOS. In addition, ESMO could be a home for the km-scale modelling effort, and other cross-cutting modelling themes. Underpinning this are science on tools and methodologies, that will also need consideration.

Cath explained that it is important that ESMO adopt a common ground and ensure buy-in and merge communities and find routes to manage cross-cutting issues, e.g., communities of practice, workshops, and joint annual meetings. To maintain momentum, ESMO will keep current successful activities with their own priorities and momentum intact and adopt an evolutionary approach to the structure and to identifying new groups.

Cath gave a brief overview of science highlights and the primary science issues and challenges of the Working Groups and projects within ESMO: Working Group on Coupled Modelling (WGCM), Coupled Model Intercomparison Project (CMIP) Panel, and the WGCM Infrastructure Panel (WIP); Working Group on Seasonal to Interdecadal Prediction (WGSIP); Working Group on Numerical Experimentation (WGNE); Sub-seasonal to Seasonal Prediction Project (S2S); Observations for Model Intercomparison Projects (Obs4MIPs); and the Task Team for the Intercomparison of Re-Analysis (TIRA). Please see the ESMO report for full details.

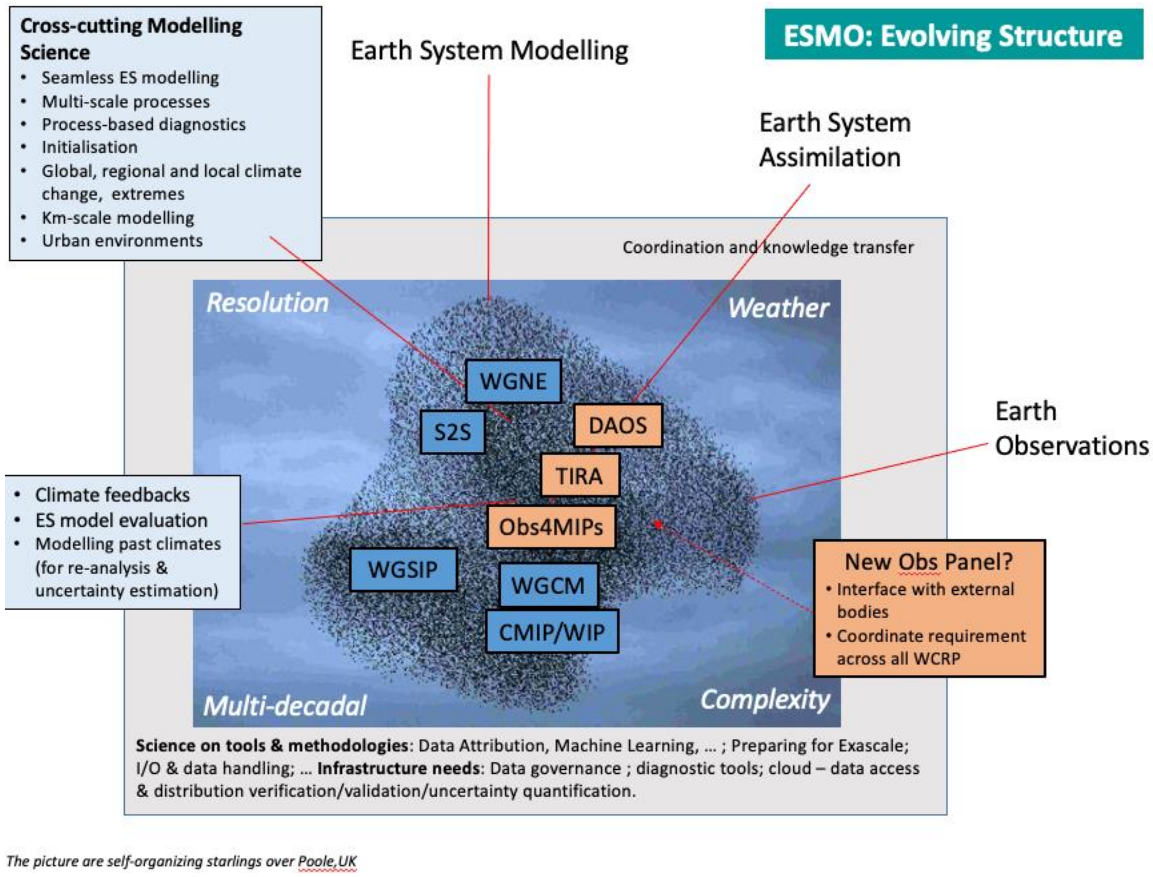


Figure 5: The evolving ESMO structure. Existing groups are mapped in terms of resolution to complexity, and multi-decadal to weather timescales to make sense of the natural organization.

Discussion

Ted noted that in the past there have been challenges in bringing modelling and observations together, but now we have a reason to do it – to solve problems. The Lighthouse Activities provide the pull to bring the modelling and observation groups out of their comfort zones. Cath agreed that having a practical issue to address forces the community to talk together to come up with a solution. This is the way forward.

Gabi agreed that there are a lot of opportunities for the Lighthouse Activities to engage with ESMO. Safe Landing Climates would like to connect with ESMO in relation to closed system feedbacks and tipping elements that come from cross-system interactions. Cath agreed and noted that the workshops that ESMO will hold will need significant participation from the Lighthouse Activities.

Christian observed that a lot of workshops are being discussed. He suggested that a lot of thought be put into workshop creation to ensure that there are not too many and the 'future of modelling workshop' should be one workshop, not many. Cath agreed but noted that many of the workshops she mentioned are happening in any case and the 'future of modelling' would be more of an umbrella over them. She explained that they would like to have some of these workshops face to face, if possible, since this is the start of a new community. Christian stated that we need to rationalize this and work together.

Martin commented that now ESMO is a bit more organized, it is a good time to look at how to interact better with GCOS, so it makes it easier for them to work better with us on the modelling and for us to work better with them on observations. Cath agreed that this is a good opportunity.

Detlef congratulated Cath on the progress made on ESMO. He noted that we need to ensure that the observation and assimilation panels connect across WCRP to existing efforts in the Core Projects. He agreed that we need to pull the regional and global modelling together. He asked Cath if she can see an evolution of the existing panels and how the memberships will evolve. Cath stated that this is the next topic of discussion for the interim SSG. She explained that it is challenging because there are so many established groups and diversity is also a consideration.

Daniela noted that CORDEX is planning the next international conference on regional climate (end of 2022, early 2023) and it will have distributed hubs in different regions. She explained that it would be nice to connect this to the plans of ESMO and the Lighthouse Activities.

5.2. Regional Information for Society (RIfS)

Bruce started with an overview of the development of the RIfS Core Project. The Interim Coordination Group (ICG) was set up in early 2021, with three co-chairs, one of whom is, by design, a co-chair of CORDEX. A Working Group on Building Blocks, which is looking at the structure of RIfS, and a Governance Planning Committee have also been established.

Bruce outlined that the intention of RIfS is to leverage the science in and beyond WCRP to serve the society decision scale and to think about the climate information needs of society. He stated that they plan to augment this collaboration through targeted research where there are gaps. The science plan has three main aspects:

- Understanding climate drivers of regional climate variability and change related to impacts
- Exploring how to better integrate across the approaches to produce climate information
- Learning from society's decision makers, policy communities, and other stakeholders to enhance physical climate science research agendas and activities

Bruce explained that the science plan seeks to advance the:

- Understanding of the stakeholder and climate services landscape
- Dialogue with stakeholders on context-relevant climate information
- Assessment and articulation of skill and uncertainty in regional predictions/projections
- Approaches to the integration and construction of regional information
- Identification and understanding of multi-scale climate drivers of regional risk

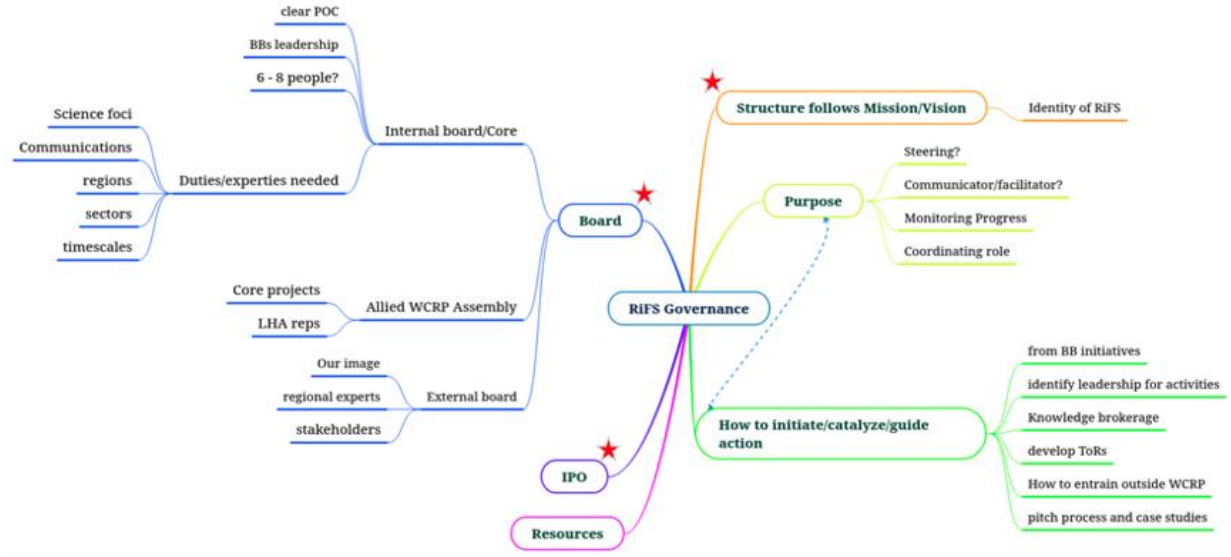
RifS has the desired outcomes of:

- Enhanced reduction of systemic risk to climate change and variability
- A clear and sustained dialogue with major users that is regionally context relevant
- Improved understanding to develop and deliver context-dependent climate science
- Increased collaboration within and beyond WCRP in relevant knowledge co-production

Bruce noted that RifS is neither a replacement for existing regionally relevant activities within WCRP nor a climate service.

The next steps for RIfS are to refine the governance, which is under discussion, and secure a RIfS International Project Office (as CORA, which is currently supporting RIfS, will come to an

end at the end of 2021). Currently the RIfS ICG propose a structure with three tiers: a RIfS Internal Board; an Assembly of allied WCRP Core and Lighthouse representatives; and an External Board with regional representatives and stakeholders (
Figure 6). Bruce highlighted that those partnerships will be important and RIfS will target initial pilot regions to catalyze joint activities and develop community interfaces. Please see the RIfS Draft Science Plan.



- Three elements to governance: Internal board, WCRP Assembly, External Board
- RifS International Project Office
- JSC reporting in parallel with CORDEX

Figure 6: Draft Structure of RIfS

Daniela Jacob (Co-chair, CORDEX) also presented an update for CORDEX. Please see the CORDEX Report for full details.

Discussion

There was a discussion on urban climate around CORDEX's Flagship Pilot Study on URBan environments and Regional Climate Change (URB-RCC). It was noted that in moving to higher resolution in urban areas, we start to talk to different communities. Daniela explained that this will also be important for Digital Earths. She noted that there is a research gap regarding what should be included in terms of modelling human activities. Estelle De Coning (Head, WWRP Secretariat) noted that WWRP have a very nice project to provide high resolution urban scale data for the Paris Olympics in 2024, both for the organizers and athletes. There are also ongoing connections with the WMO Global Atmosphere Watch (GAW) and other WMO activities on the urban scale.

Detlef congratulated RIfS on the progress made and confirmed that it is a high priority to set up international offices for both RIfS and ESMO. He asked Bruce if CORDEX is a pillar or a partner of RifS and made it clear that RIfS will need a high-level committee with a steering element. Bruce confirmed that CORDEX is a central pillar inside RIfS. He noted that the dynamic with the relationship with CORDEX is still being explored and confirmed that the Internal Board would have a steering element and would be analogous to an SSG.

Ted noted that the most popular WCRP activity in the regions is CORDEX. CORDEX and RIfS, together with the Climate Research Forums, provide a huge opportunity for community building for all the activities that are struggling to diversify. Bruce explained that RIfS envision that the External Board, with its regional representatives and stakeholders, will be the starting point to establish that engagement across WCRP.

Martin commented that while RIfS is not a climate service, it does think from the research point of view about what a climate service can do as an innovation agent. He also suggested that RIfS could consider having a steering committee for decisions and a board with the task of engagement and shaping the project. Bruce agreed on Martin's first point and noted that the governance ideas are still playing out and need more time to be finalized.

Helen agreed with Martin, noting that RIfS may need something more focused as a steering group. She also congratulated CORDEX on their engagement in the regions, noting that in the Climate Research Forums, particularly in Southeast Asia and South America, there is a really strong CORDEX community. She explained that this is an excellent opportunity for WCRP, to build on what CORDEX has done in the regions, the Climate Research Forum Regional Focal Points, and some of the regional work that the Lighthouse Activities are discussing. She reflected that some strategic thinking needs to be done in this area. Bruce agreed and noted that this is timely for WCRP and there are a lot of motivated people to help make this happen.

Daniela commented that it would not be good to assume that the same traditional setup that the other Core Projects have is the best for RifS. She explained that engagement relies on the flexibility to be visible in WCRP and the ability to act.

Ted highlighted the need to understand the implications of separating CMIP and CORDEX – we need to ensure that the global and regional modelling communities are well connected. Daniela explained that CORDEX are aware of this and noted that the connections between CORDEX and CMIP are getting stronger. She said that she doesn't foresee any problems due to CORDEX and CMIP not being in the same Core Project.

5.3. Climate and Cryosphere (CliC)

Tim Naish (Chair, WCRP Grand Challenge on Melting Ice and Global Consequences (GC Melting Ice)) gave a presentation on CliC's activities and main research highlights on behalf of CliC's co-chairs. Given that the GC Melting Ice's activities are very much integrated with CliC's, the presentation covered both CliC and GC Melting Ice.

Tim explained that GC Melting Ice Model Intercomparison Project (MIP) activities are at the heart of modelling activities in CliC, and have strong links to other Core Projects, external partners, and with several groups in the cryosphere community. There is, however, recognition that more connections should exist with the Grand Challenge on Regional Sea Level and Coastal Impacts (GC Sea Level).

Tim outlined that CliC is developing a new Strategic Plan for 2022-2031. While the CliC Strategic Plan is still officially a draft, the new vision is:

> *A system description of different cryosphere regions (polar seas, frozen and snow-covered land, glaciated regions including ice sheets and mountainous regions) and of the global cryosphere as a whole, including climate, ecosystems, residents and their connections and feedbacks to global climate and society.*

and the new mission is:

> *CliC will facilitate collaborative, international research, and its communication, targeting the global cryosphere and regional cryosphere systems - bridging across climate, ecosystems, humans - and their change to address societal needs.*

with goals to:

1. Provide integrated assessments of global cryosphere change
2. Provide a forum for launching new activities aimed at addressing the priorities of:
    a. Engagement of the broad and diverse community in cryosphere research
    b. Projection of future Ice loss and Impacts
    c. Cryosphere ice loss-assessment and impacts
    d. System description of the cryosphere regions
    e. Knowledge syntheses and communication to stakeholders
3. Leverage cross-disciplinary and international collaboration to address cryosphere priorities
4. Provide input and participate in WCRP Lighthouse Activities and link to the new RIfS Core Project.

Tim explained that the five future priorities (2a-e) are envisioned to provide stronger links with the Lighthouse Activities and with RIfS. The next steps for CliC are to refine the Strategic Plan and open up a call for new ideas for working groups and projects. To increase diversity, they plan to establish a fellowship for early career scientists from under-represented regions to participate in or visit institutions or to attend conferences. Please see the CliC Report.

Discussion

Tom asked about the future of the CliC IPO. Beatriz Balino (Executive Director, CliC IPO) responded that currently the Bjerknes Centre and Research Council of Norway provide support for an Executive Director (0.50 FTE) until the end of 2022. Discussions are ongoing with the University of Massachusetts for it to host the CliC office with further financial support. Should this be successful, the IPO in Norway would continue to exist in addition to the US office until the end of 2022.

Martin asked how climate and cryosphere science can be co-designed and made useful for policy makers, for instance, information about changes in the cryosphere due to climate change and discussions about adaptation? Tim replied that this is something that CliC is discussing in the context of the new Strategic Plan and that traditionally they have concentrated more on the physical science side, such as projections of change. He noted that projections, such as of sea level rise, are of huge interest to decision makers and that there is a gap in how we communicate the science, uncertainties, and how to use the information in decision making. This will be a cross-WCRP issue. The real challenge is how we co-produce something and communicate this in the context of regional impacts.

Detlef asked about the links and connections with the other Core Projects within WCRP. Tim mentioned that CliC brings together the whole of the cryosphere community and galvanises the science around this theme within WCRP. However, he noted that there are many further opportunities for joint projects and activities with other WCRP groups.

Regina mentioned that the Lighthouse Activities can be a place to provide the link between the WCRP science community and local communities and should be taken advantage of for local

connections. As an example, the Himalayan workshop that My Climate Risk are organizing will engage local communities and can serve as a pilot project. Tim agreed and said that the Safe Landing Climates and My Climate Risk Lighthouse Activities are natural places for connections on tipping points and impacts.

Nils Wedi (Co-chair, WGNE) mentioned coupled modelling and more integrated approaches in modelling related to snow cover and the hydrological cycle and asked if CliC is working on such topics. Tim replied saying that it is still a challenge to work on coupled models of ice sheets, with lots of effort taking place. He said that model development at high spatial resolutions in this area is also an important topic.

Beatriz said that CliC is embarking on new decade of activities and will be looking much more at societal impacts.

5.4. Stratosphere-troposphere Processes And their Role in Climate (SPARC)

Seok-Woo Son (Co-chair, SPARC Scientific Steering Group) presented highlights of recent activities of the Core Project, as well as SPARC-related publications and special issues. SPARC is developing a new strategy for the next 5-10 years, which includes a new structure and an implementation plan. In this new structure, SPARC is looking at broadening their expertise to include more tropospheric topics, i.e., moving towards a whole-atmosphere approach. SPARC's thematic expertise fall under three main topics:

1. Atmospheric circulation (Rossby wave dynamics, dynamical coupling, feedback mechanisms, understanding variability, extreme/compound events, local impacts of climate change, role in predictability)
2. Atmospheric composition (long-term records, cloud processes, air quality)
3. Model assessment (consistency checks, understanding model bias and internal variability, understanding prediction skill)

SPARC is also planning its next General Assembly in October 2022, as a multi-hub (Asia, Europe, and North America) in-person meeting. This aims to increase participation while minimising the event's carbon footprint. Please see the SPARC Report.

Discussion

Detlef thanked Neil Harris (Co-chair, SPARC SSG), who is stepping down as Co-chair of the SPARC SSG at the end of 2021, for his contributions to SPARC and WCRP over many years.

Tom welcomed SPARC's direction to intensify their work in the troposphere, which would increase links with the International Global Atmospheric Chemistry (IGAC) project and better address air quality issues. He asked how discussions in this area are progressing. Seok Woo replied that discussions with IGAC are still taking place and limited progress has been made due to the current pandemic situation. Neil agreed and added that several links already exist with IGAC, but it is necessary to define what the key issues are for WCRP in relation to tropospheric composition. SPARC should also strengthen links with the Surface Ocean-Lower Atmosphere (SOLAS) and WWRP (also through WGNE).

Detlef emphasised that SPARC is seen by the WMO Research Board as an important project within WMO and we can strengthen that. He noted that SPARC could elaborate more on how they plan to be involved in the new International Monsoons Project Office and another important connection to be made will be with ESMO on the topic of data assimilation. Seok Woo noted that

SPARC is working on the atmospheric chemistry and dynamics of the Asian Monsoon, complementing what has been done by GEWEX and CLIVAR.

Detlef also asked Neil what happened to the ideas of regional cross-WCRP project (Himalayas "Third Pole", Greenland, and the Andes) ideas that came up a few years ago. Neil noted that at the time there was so much restructuring going on in WCRP that these ideas were put on hold. He noted that he is happy to see the "Third Pole" is being picked up in the Lighthouse Activities.

5.5. Climate and Ocean Variability, Predictability and Change (CLIVAR)

Sonya opened her presentation with an overview of CLIVAR's structure and new initiatives, including:

- Tropical Basins Interaction Research Foci, launched in March 2020
- CLIVAR Atlantic Meridional Overturning Circulation (AMOC) Task Team, launched in April 2021
- Pacific Region Panel El Niño–Southern Oscillation (ENSO) Conceptual Model Working Group, launched in June 2020
- Pacific Region Panel Tropical Pacific Decadal Variability Working Group, launched in May 2021

Sonya outlined the many science highlights, publications, and events that the CLIVAR community have produced in the last year, clearly showing that the Core Project has made significant progress.

Sonya listed a number of upcoming events, including the CLIVAR-First Institute of Oceanography (FIO) Summer School on Ocean Macroturbulence and Its Role in Earth's Climate in July 2022 and a pan-CLIVAR workshop and school on ocean observations in May 2022. She noted that CLIVAR will be placing an even stronger emphasis on engaging with early career researchers in the future, including involving them in all CLIVAR panels and more widely in CLIVAR and WCRP activities. Likewise, CLIVAR will be strengthening interactions with partners, including the Ocean Observations Physics and Climate Panel (OOPC), the North Pacific Marine Science Organization (PICES), the Indian Ocean Region Panel (IORP), the Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER), and SOLAS. The Core Project also plans to better cooperate and contribute to the UN Decade of Ocean Science for Sustainable Development. Sonya confirmed that CLIVAR will place a greater emphasis on encouraging virtual meetings, reserving in person meetings for early career focused activities, and will encourage cross-panel activities and connections between modelling and observation communities. There will also be an emphasis on enhancing connections with the WCRP Lighthouse Activities and other Core Projects. Please see the CLIVAR Report.

Discussion

Salvatore Arico (Head of the Ocean Science Section, IOC-UNESCO) said that he was very impressed with CLIVAR's outcomes and noted that IOC-UNESCO are convening an Integrated Ocean Carbon Research (IOCR) Workshop in Paris next year. He invited CLIVAR and CliC to participate, noting that there are clear opportunities for further synergies between CLIVAR and CliC in terms of sea level rise. In terms of the Eastern Boundary Upwelling System (EBUS) Research Foci, Salvatore noted that there will be an Open Science Conference in Peru in September 2022, back-to-back with a conference on a high carbon dioxide world. Sonya thanked Salvatore for the information and invitations.

Tom congratulated Sonya, noting that CLIVAR is a huge program that is very well structured. He agreed that having to sunset certain activities is complicated, but sunsetting is needed to ensure new activities can start. Sonya agreed and said that this is why CLIVAR have the research foci, with achievable objectives for a short period of time. She explained that CLIVAR maintain expertise in the research panels.

Detlef noted that we have a lot of results coming out of the Core Projects, but we need to lift these results up so not just the Core Projects see it. He asked Sonya whether the question has been considered of whether CLIVAR is too complex? Sonya explained that they have concentrated on making sure that the panels are not siloed by encouraging them to connect well with each other. She admitted that there is some inertia, but that they are trying to make more activities that are cross cutting.

5.6. Global Energy and Water Exchanges (GEWEX)

Jan Polcher (Co-chair, GEWEX Scientific Steering Group) opened the presentation by recognizing the work of past GEWEX Co-chair Graeme Stevens, who has stepped down this year. Graeme initiated a lot of the GEWEX activities that we see today. Jan noted that Xubin Zeng has been appointed as the new GEWEX Co-chair and Sandrine Bony has agreed to take over as Co-chair of the Global Atmospheric System Studies (GASS) Panel.

Jan explained that the draft GEWEX Science Plan is now available after two years of work. There is a strong focus on process studies at all spatio-temporal scales. He noted that the restructuring of GEWEX activities is ongoing. The GASS Panel is expanding and continues to work successfully with WWRP and WGNE. There are also new GEWEX-wide cross-cutting activities being set up, including on precipitation and evaporation. The GEWEX Hydroclimatology Panel (GHP) is working on three new Regional Hydroclimate Projects (RHPs) in Central Asia, the USA and mountainous Africa (together with START). There is also stronger collaboration between the GEWEX panels, achieved by adding liaison members. Jan noted that the Pan-GASS meeting that was supposed to be held in 2021 in the United States will now be held in July 2022.

Jan outlined the primary science issues currently being undertaken by the GEWEX Panels and also explored the potential connections to the Lighthouse Activities. He highlighted the importance of interactions between WCRP activities and noted that, with the addition of new project offices, communication among all Core Projects and Lighthouse Activities becomes more challenging. He suggested that there is a need for expanded WCRP Secretariat support for more coordination and facilitation.

Jan also reflected that with the increased importance of water resources in a changing climate within the whole of WMO, WCRP should take the lead and better coordinate efforts between WCRP (e.g., GEWEX, My Climate Risk, Safe Landing Climates), the WMO Hydrology Department, and UNESCO Intergovernmental Hydrological Programme. He noted that the WCRP reorganization is important and should not be rushed to ensure that there is clarity on the terms of references. See the GEWEX Report.

Discussion

Detlef noted that the WMO issue will be followed up with the WMO Research Board. Martin (in his capacity as WMO Research Board interim Co-chair) confirmed that the Research Board are thinking about an S2S-type activity on water. He noted that he would like GEWEX to bring forward an idea for a program that focuses on the research side of that. Jan noted that WMO (and ISC, IOC-UNESCO) needs to have a water strategy and suggested the Global Hydrological Status

and Outlook System (HydroSoS) Activity of WMO on seasonal drought prediction could provide a candidate where GEWEX could contribute to the research side. Jan asked that the Research Board provide further guidance on this.

6. WCRP Grand Challenge reports

6.1. Weather and Climate Extremes

Gabi Hegerl (Co-chair, Grand Challenge on Weather and Climate Extremes (GC Extremes)) reminded participants of the four themes of GC Extremes: documenting, understanding, attributing, and simulating extremes. She reported that the Grand Challenge has had a number of important outcomes, including a flagship workshop on compound events that has been well taken up by the community (see, for example, Future climate risk from compound events. Nature Climate Change). Gabi explained that the Grand Challenge has resulted in on-going collaboration with the International Precipitation Working Group (IPWG) and the GEWEX Data and Analysis Panel (GDAP) and has led to the Frequent Rainfall Observations on GridS (FROGs) database and related publications. She outlined that CMIP and IPCC have been strongly influenced by the Grand Challenge's research on extremes including in a number of MIPs (GLACE-CMIP5, LUMIP, LS3MIP, also DAMIP, VOLMIP), the Half A degree additional warming, Projections, Prognosis and Impacts (HAPPI) experiment, and in the preparation and writing of the IPCC Sixth Assessment Report (AR6). She also noted that the Grand Challenge was successful in training early career scientists, with summer schools held in 2014 and 2019.

Gabi noted that Extremes are very important across all the new Lighthouse Activities – in the themes associated with safe pathways and habitability, regional risk, attribution, simulating extremes, and how to reduce risk, including through training. She also noted that extremes will continue to be at the heart of GEWEX activities along with climate sensitivity, clouds, feedbacks, and rainfall changes, particularly extreme rainfall. She noted that as extremes are featured right across WCRP, there really needs to be a way to bring these efforts together for consistency and so that we can learn from one another. She further noted that the breadth of the problem (how to define extremes, the different scales involved, and the many possible applications) makes integration challenging.

Gabi went on to explain that this was the thinking behind the proposed Global Extremes Platform (GEP), which would act as a public facing contact point to provide users (decision makers and the public) with current information about the state of weather and climate extremes and related WCRP science. It would offer a capability to develop and collate an extremes-related database to serve both research and user communities and it would be a common place for the internal exchange of ideas for knowledge integration and cross-fertilization. There would be four pillars:

- Global weather and extremes assessment (annual updates and to support the Global Stocktakes in 2023/2028)
- Climate extremes indices
- Facilitation of cross-WCRP communications on extremes
- Topical areas (e.g., compound events, detection and attribution, information for regions).

GEP would include some of the ongoing work of GC Extremes. Gabi explained that this would be a 5-year project, with a possible extension. Nanjing University of Information Science and Technology (NUIST) has offered to host a support unit for the activity and there would be some additional in-kind support from Environment and Climate Change Canada (ECCC) and ETH Zürich. Gabi noted that GEP would possibly sit under ESMO due to global scale and

observational data and would also have strong connections to RIfS and to the Lighthouse Activities. See the GC Extremes Report and the Proposal for the Global Extremes Platform.

Discussion

Helen thanked Gabi for the presentation and for all the work that has been put into designing the GEP. Martin noted that GEP could also be discussed with WMO Services Commission as an additional partner. Gabi confirmed that this is an interesting idea but noted that they don't want to lose the research angle.

6.2. Clouds, Circulation and Climate Sensitivity

Bjorn Stevens (Co-chair, Grand Challenge on Clouds, Circulation and Climate Sensitivity (GC Clouds)) noted that the Grand Challenge was arranged around four questions:

1. What role does convection play in cloud feedbacks?
2. What controls the position, strength and variability of storm tracks?
3. What controls the position, strength and variability of the tropical rain belts?
4. What role does convective aggregation play in climate?

He explained that GC Clouds ignited a lot of intellectual activity in the community. In addition, there were two community assessments on climate sensitivity and aerosol forcing, that led to review papers that brought together multiple lines of evidence around new approaches to meaningfully, and for the first time, narrow the uncertainty surrounding central qualities of climate science. The paper on climate sensitivity, led by Sherwood et. al. (2020), was one of the breakthroughs announced by Science magazine. It is the intellectual foundation on which the AR6's assessment of climate sensitivity is based and it changes the way in which evidence is used to look at climate sensitivity. Another assessment by Bellouin et. al. (2019) was on bounding aerosol radiative forcing.

Bjorn outlined that a second outcome of GC Clouds was the EUREC^{4}A field experiment (film) that took place in 2020 and that developed and exploited new techniques and experimental strategies to quantify how clouds couple in circulation (and in the upper ocean) in ways that were previously not possible. This field experiment is guiding the development of a new generation of Earth-system models and observations.

Bjorn then came back to the four questions, explaining that communities developed around each of the questions, supporting and initiating MIPs, field studies, research programmes and individual research. There are some answers to the questions and some work is ongoing, but Bjorn concluded that understanding question 4 is central to further progress on questions 1 and 3, is a major motivation for new approaches to modelling (storm-resolving Earth system models) and is motivating a new generation of field studies.

Bjorn explained that due to the pandemic they have decided to forgo a conference on the lessons learned from the Grand Challenge in favor of a transition that pivots around the question of convective aggregation and how this could be taken up by diverse activities in WCRP. This is interesting for WCRP as it strongly influences Earth's energy budget, it influences precipitation and, hence, hydrological extremes, it determines how effectively clouds couple to circulation, (convection aggregates less over land than over the ocean), and CMIP models are built on the assumption that the mesoscale doesn't matter. Bjorn also noted that WCRP was useful to the Grand Challenge because of its name, its ability to bring people together, its international cachet, and its organization support. However, he reflected that it could have done more than just give

its blessing, explaining that "people don't organize around activities, they organize around stories – people need stories." He said that he hoped that WCRP finds a way to tell its stories.

Discussion

Ted asked if there a gap in terms of where the research that Bjorn is advocating on convective aggregation can happen in WCRP, as he noted that to his understanding GEWEX doesn't work over the ocean. Bjorn replied that the more we create structures, the more we create gaps. He noted that GEWEX seems to have evolved into it being about land, rather than about energy and water. He explained that this confusion happens when we talk about activities, rather than questions. We need to attend to our stories and then the gaps will take care of themselves.

Krishnan Raghavan (JSC Member) commented that for monsoon clouds the vertical structure of latent heating by clouds is important. Bjorn confirmed that the way that clouds organize affects the vertical structure, latent heating, and circulation, which then feeds back on the clouds. He noted that the mesoscale (2-200 km scale) heating scale is important.

Detlef noted that Bjorn said in the beginning that this Grand Challenge will end. Is this the end? He explained that WCRP are in the process of organizing an Open Science Conference to celebrate the Grand Challenges in 2023, adding that the storylines that Bjorn noted could play a big role in that conference. Bjorn agreed and also highlighted Sandrine's intellectual contributions to this Grand Challenge and to CMIP, which have been outstanding.

6.3. Near-Term Climate Prediction

Adam Scaife (Co-chair, Grand Challenge on Near-Term Climate Prediction (GC NTCP)) presented the update on the Grand Challenge. Adam reported that GC NTCP has met their objective to operationalize decadal prediction. In 2019, a white paper, Kushnir et al. (2019) was published to show that decadal predictions are at least as good as seasonal predictions. They then worked closely with other areas of WMO, establishing Global Producing Centers (GPCs) and a Lead Centre (LC) for operational predictions (website). A key outcome is the annual Global Annual to Decadal Climate Update.

Considering the future, Adam noted that the final activities of the Grand Challenge are now underway. They are documenting applications of decadal prediction, they are giving a number of talks, and there will be a review paper. Adam noted that they will finish at the end of 2021. He suggested that RIfS could take forward the regional use of decadal prediction information using the WMO LC and CMIP6. Mike added that there were also several connections to the EPESC Lighthouse Activity, noting, for example, that Doug Smith is involved in both activities.

Adam then highlighted an outstanding research issue – the signal to noise paradox. He explained that we know that around the Atlantic sector in particular, but also elsewhere, that the ensemble mean signal is much weaker than it should be in models. This seems to occur in all Global Climate Models and at all timescales. He suggested that this is a critical research issue that should be carried forward in WCRP. Please see the GC NTCP Report.

Discussion

Helen congratulated the Grand Challenge and recognized the high-profile outputs that have been produced.

Ted noted that it is very important to show the things that would not happen without WCRP. This Grand Challenge is a strong argument for this. Ted asked RIfS how much focus there will be in

that Core Project on near-term (annual to decadal) timescales. Sara Pryor (Co-chair, RIfS ICG) commented that RIfS are thinking of a greater transition to include the near term, as many of the stakeholders are interested in these timescales. She said that it raises some challenges in terms of thinking about internal climate variability versus change, but there is a need to focus on timescales that are actionable. Bruce added that there is a strong interest in the sub-seasonal to seasonal scale, not just because of its importance to society but also because it is a nice near-term verifiable vehicle for testing some of the methodological developments that we would like to pursue around reconciling different sources of information.

Rowan noted that one of the issues that motivated the EPESC Lighthouse Activity is the quantification of current risk – future information that is continuous with the assessment of current risk. He asked if this has been discussed. Adam agreed that there is a gap. The attribution and prediction communities are not well interleaved. The issues that affect the attribution community are very similar to those of the prediction community and they could be working closer together. The seamless provision of information is a great target. The methods and technical side of work done by the attribution community is moving towards using initialized predictions in some cases, so it may be plausible to do this in the next few years. Many users don't care where risk information comes from. The information could be merged. Most people do not plan for multi-decadal time frames. Most businesses and government departments are interested in the decadal timescale.

Detlef asked whether there are any specific plans for the sunsetting of this Grand Challenge. Adam stated that the signal to noise ratio is a core research question for WCRP. He noted that he would really like to see a Lighthouse Activity make use of the decadal prediction information and seamlessly stitch that to risk.

6.4. Regional Sea-level Change and Coastal Impacts

Robert Nicolls (Co-Chair, Grand Challenge on Regional Sea-level Change and Coastal Impacts (GC Sea Level)) reported on the Grand Challenge, starting with an overview of the people involved and the six work packages covering science questions and linking to the use of information. He outlined that GC Sea Level are currently working on a Special Issue on coastal climate services (in *Frontiers in Marine Science*, 2021), a high-end research paper on subsidence and relative sea level rise, an assessment of subsidence for practitioners, a global assessment of sea-level rise scenarios in practice (2021-2022), and a Sea Level Conference in Singapore in 2022 that will officially close the Grand Challenge.

Robert discussed linking current sea level research to the future structure of WCRP. He noted that the leaders of the Grand Challenge have defined a set of questions about how sea level research needs to move forward in the next decade. Some of the questions are science questions, some are operational, and some are stakeholder questions. He noted that it is interesting to think about where these might fit in the future WCRP structure.

Discussion

Detlef commented that there are a lot of opportunities for continuing sea level work across WCRP. He noted that it would be good to see a draft program of the Sea Level Conference so that people can find out how to contribute. Sea level should also have visibility in the Open Science Conference in 2023 and he invited Robert to be involved in an integrated way. Robert said that more information on the Sea Level Conference will be shared in September 2021.

6.5. Carbon Feedbacks in the Climate System

Pierre Friedlingstein (Co-chair, Grand Challenge on Carbon Feedbacks in the Climate System (GC Carbon)) presented the recent work of the Grand Challenge. GC Carbon played a major role in contributing to the Coupled Climate Carbon Cycle Model Intercomparison Project (C4MIP) and the Zero Emissions Commitment Model Intercomparison Project (ZECMIP), as well as to the Decadal Climate Prediction Project (DCPP) simulations including the carbon cycle. The Grand Challenge pushed CMIP6 beyond its boundaries with emission driven large ensemble simulations (historical and Shared Socio-economic Pathways (SSPs)) as well as emission driven decadal predictability simulations.

Pierre outlined how GC Carbon has made a direct contribution to AR6 and resulted in 12 Grand Challenge related papers. The Grand Challenge contributed to climate-carbon cycle feedbacks, the Transient Climate Response to cumulative carbon Emissions (TCRE) and compatible emissions, carbon cycle response in high and low warming worlds, predictability of carbon sinks and atmospheric carbon dioxide, and two carbon cycle figures in the *Summary for Policymakers*. Pierre noted that the last release of the Global Carbon Budget (GCB), as part of the Global Carbon Project (GCP), was in December 2020 and the next one is scheduled for around COP 26 (November 2021). The data show no change in global carbon dioxide, as land sinks mean that one year of reduced emissions is not enough to see it in the atmosphere (Friedlingstein et al., 2020).

Pierre outlined the future plans of the Grand Challenge. There is an ongoing assessment of the emergent constraints on TCRE. GC carbon also plans to develop a robust annual to decadal carbon prediction of the global carbon cycle to support the annual GCB. There is some new work on mitigation metrics and carbon sinks efficiency to feed into the GCB. Lastly, a C4MIP workshop is planned in the northern-hemisphere autumn to look at lessons learned from CMIP6.

Pierre explained that in the longer term some of the Grand Challenge's work will continue, especially in terms of the GCB reports. He noted that there is no equivalent home for carbon in the new structure, so it is hard to see how the GC Carbon momentum will continue. See the GC Carbon Report.

Discussion

Helen noted that carbon research will take place in Safe Landing Climates and there is also some in GEWEX. Pierre noted that he was pleased to hear Jan mention carbon in the GEWEX presentation, as carbon is essential to the water cycle on land. Part of what GC Carbon does is also to do with the development of Earth System Models, which will fit within ESMO. In some of the Lighthouse Activities, such as Safe Landing Climates, there are topics to do with carbon, but these are much more applied questions. The development of process understanding needs to be somewhere or there needs to be very strong links to Future Earth.

Ted noted that this work would probably have happened without WCRP. He asked where WCRP provided greater value above and beyond what would have happened anyway. Pierre explained that the decadal activity is an area of research that was developed through WCRP. He also noted that the international dimension is an area where being part of WCRP made a difference. He explained that he cannot think of another way to interact with non-EU partners without WCRP. Detlef asked where Pierre sees the continuation of this work. Pierre reflected that carbon is everywhere in WCRP.

6.6. Water for the Food Baskets of the World

Jan Polcher (Co-chair, Grand Challenge on Water for the Food Baskets of the World (GC Water)) explained that the water cycle on continents is changing, sometimes due to climate change and sometimes beyond what can be explained by climate change. He explained that WCRP has a responsibility to advance attribution work with relation to water, as we don't know how water usage feeds back on the water cycle. He noted that to make progress we need to be able to predict the managed continental water cycle. He asked whether CORDEX and CLIVAR (in relation to change in continental freshwater at the coast) would be interested in this work.

Jan explained that currently the Grand Challenge is advancing this topic with the Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment (LIAISE) field campaign. It will focus on the impact of water management on evaporation and changes in the boundary layer structure. The European Space Agency (ESA) has also funded a large project called IRRIGATION+, which aims to explore, develop, and validate advanced Earth Observation-based algorithms and techniques for irrigation mapping, quantification and detection of seasonal timing of irrigation from field to regional/global scale. There is also an effort on irrigation within GEWEX, bringing GHP and the Global Land/Atmosphere System Study (GLASS) together to evaluate how well the geophysical driver for irrigation can be predicted.

Jan stated that he believes that in the future GC Water should be integrated into GEWEX. The GEWEX panels have shown interest in this, especially in terms of irrigation. There should also be some cross-panel coordination within the evaporation theme. He noted that all of the Lighthouse Activities will probably need GEWEX expertise on these topics. He said that we need to build bridges between water availability and water scarcity and the safe landing of water resources should be a major concern for future research. See the GC Water Report.

Discussion

Helen commented that partnerships with the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS), where GEWEX already have links, and the flux community would be beneficial for evaporation work. She also noted that in terms of water scarcity and managed landscapes, CORDEX may be interested in linking some of their urban research.

Ken noted that climate drives water requirements for crops, so irrigation is responsive to climate. He asked if irrigation should be dynamically modelled in Earth system models. Jan replied that his personal response is that, yes, it should, as it represents about 70% of water usage on continents. The amount of water that is redirected to the atmosphere due to irrigation, is about the same as the discharge from the Amazon. This is a large quantity. One question that we need to answer is whether this level of agriculture and irrigation will be sustainable in a warmer climate.

7. Implementing the WCRP Strategy

Detlef started the session by outlining the charge for the breakout groups. In order to investigate how to progress on some issues of strategic importance to WCRP, the discussion in these three breakout groups was focused on (1) coordination and communication; (2) science gaps; and (3) engagement (all held on day four of the JSC Session). A fourth theme of strategic investments was scheduled but did not take place due to a low number of sign-ups for this topic.

7.1. Coordination and communication

The breakout session on coordination and communication identified the following themes and ideas:

Memberships, Engagement, and Participation

- Develop a clear description of roles and responsibilities for all WCRP committees and members (code of conduct)
- Identify and address barriers to inclusive engagement

Greater flexibility with our current "governance"

- Review current organizational structures to determine which aspects might be hampering WCRP's mission and purpose
- Identify an optimal blend of top-down guidance and direction and "bottom-up" grass roots involvement

Coordination across projects and joint activities

- Consider more widespread utilization of ex-officio members and liaisons to enhance communication
- Encourage workshops/activities on topics spanning groups to create more opportunities for communication/collaboration
- Make better use of IPOs to support horizontal communication, coordination, and integration

Wider and clearer dissemination of information

- Make better use of digital technologies to facilitate information exchange and more informal interactions
- Develop a WCRP family database of people and their expertise and research interests
- Build a web-based network map that describes the functional connections between parts of WCRP

The group noted that transparency, communication, and trust are paramount to a culture of collaboration.

7.2. Science gaps

The breakout session on science gaps reflected on three main themes: the interaction of climate forcing with radiation (including the impacts of climate intervention/ geoengineering); how climate extremes will occur in the future; and how reservoirs of heat, water, and carbon might change in the future. The breakout session identified the following themes and ideas:

Interaction of climate forcing with radiation

- This is an important research topic in WCRP (e.g., SPARC, Safe Landing Climates, modelling efforts) and needs cooperation with partners, such as SOLAS, IGAC, and GAW.
- It is important to consider other (non-CO_2 forcing) gases: e.g., volatile organic compounds, aerosols, nitrous oxide.
- It is important to understand how climate change will affect the urban scale and aviation.
- The group discussed where climate intervention would fit in this work. It was recognized that climate intervention in a controversial topic, with a lot of interest and expectations. It is also critical that we have an idea about the outcomes of climate intervention proposals.

The groups recommended developing a review and modelling paper summarizing the current state of knowledge in this area.

Climate extremes

- Work on extremes should be organized as an integrating, cross-cutting, element.
- It is important that the human element is included in the research undertaken in this area.
- It was acknowledged that the proposed Global Extremes Platform is potentially crucial to coordinate who does what and follows up. It was suggested that GEP sit under ESMO, but that it be also strongly linked to other parts of WCRP.

The group recommended that extremes research be an integrating theme across WCRP core activities.

Reservoirs of heat, water, and carbon

- Budgets and cycles of heat, water, and carbon are a cross-cutting research theme, with strong interests in SPARC, CLIVAR, GEWEX, ESMO and potentially the Safe Landing Climates Lighthouse Activity.
- The carbon cycle is closely linked to the other cycles, as it is a coupled problem. Key partners include iLEAPS, SOLAS, and the Integrated Marine Biosphere Research (IMBeR).
- The energy cycle is central to GEWEX research but highly relevant to other WCRP activities, such as CLIVAR. Other partners, such as GCOS, also have an interest.
- It is important to integrate the different components of the cycles. This requires a system where we look at planetary cycles in an integrated way - including human interactions.
- Current models have significant biases around these cycles. We need to focus on the underlying mechanisms.
- It is best use of observations and models (reanalysis). We need to be able to separate natural and anthropogenic signals. Some processes are not included in the reanalyzes, which may need improvement.

The group recommended the formation of a fixed term project on cycles and budgets, especially to identify what aspects in the budgets are not correct and why.

7.3. Engagement

The breakout session was focused on discussion about engagement with Early Career Researchers (ECRs), regions, and partners. Below are the key messages.

We speak a lot about it but need to act now:

- We need to start by implementing existing rules/guidelines to address the unbalanced representation of ECRs and regions in WCRP.
- A people database, collected from different workshops, fora etc, would be useful to enlarge future contribution and engagement.
- Based on success stories, it is easier for new activities such as the Lighthouse Activities, to achieve diversity.

The door is open, but where is the door:

- We need to communicate where the opportunities are but also need to create more opportunities for new people to engage in WCRP's scientific activities and panels.
- We should engage ECRs in actual scientific activities and take into account multiple levels of ECRs including students, postdocs, and middle career researchers.
- We should give ECRs scientific leadership opportunities such as leading short-term projects with high-level outcomes and give them the flexibility to fail.

Barriers identified:

- There is a lack of turnover in panels and activities and a lack of confidence in promoting science due to language and culture barriers.
- We should engage with regional/local communities and groups. Personal engagement in small groups on local and regional scales was recognized as important.
- ECRs often face unstable jobs and a lack of resources. We need to make sure that the engagement is useful for their career development.
- Resources are required for ECRs such as fellowships, cloud computing recourses and other facilities, or support for coordination of synthesis papers.

The group noted the issue of diversity in WCRP groups and recommended implementing rules/guidelines to address this.

8. Science partnerships, WCRP impact, and resources

In order to investigate how to improve WCRP's long-term impact, three breakout sessions on (1) science partnerships; (2) the impact of WCRP science; and (3) resources were held on the fifth day of the JSC Session.

8.1. Science partnerships

WCRP has a huge range of partners including other activities of its co-sponsors (such as GAW, WWRP, and GCOS in WMO, and Future Earth in ISC), 'external' partners such as IGAC and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), as well as national agencies and institutions. All are important for WCRP to be able to achieve its mission and support others to achieve theirs.

This session focused on two main questions:

1) Does the new WCRP structure provide the appropriate means to engage with your science community in a partnership mode?

2) Are there specific actions the WCRP community could take to improve the connectivity to your science community?

The many partners represented at this session were all given the opportunity to air their views on the above questions. Several themes came out from the discussions:

- It's important that we collaborate rather than duplicate efforts
- When it comes to how partners interact with WCRP's new activities, particularly with the Lighthouses, it's important that the practicalities of how this is done are worked out and made clear.
- WCRP should consider other opportunities for partnership beyond the traditional (natural) climate sciences.

8.2. The impact of WCRP science

Detlef started the session framing the topic of "impact of WCRP science" and who are the groups that WCRP should be reaching out to for contributions. Some examples are IPCC, the Conference of Parties (COP) of UNFCCC and the Sustainable Development Goals. Participants added other groups and initiatives that have links with the Core Projects:

- WMO- United Nations Environment Programme (UNEP) assessments (e.g., the ozone assessment)
- National communication for climate change assessments and also national adaptation plans
- Sendai Framework for Disaster Risk Reduction
- Global Framework for Climate Services
- UNFCCC Global Stocktake
- Independent Group of Scientists for the 2023 Global Sustainable Development Report (GSDR)
- Global Climate Observing System
- Global Ocean Observing System
- UN Ocean Decade
- Antarctic Treaty
- Social movements

Silvina Solman (Co-chair, CORDEX SAT) and Sonya commented on the important role of WCRP science for some more high-profile groups. An example is the work done by CMIP that feeds into IPCC assessments. Often CMIP is referred as part of the IPCC, and not WCRP. It is important to promote and publicise the scientific outputs of WCRP better. Detlef agreed with this comment and commented that WCRP needs to appear more prominently even within WMO, such as in the State of Climate report.

Pascale mentioned that it is important to keep the focus on developing new science and analyses as part of assessments. The engagement with other groups is not only about communication, although this is important. It is mainly about formulating scientific questions that are useful for the groups involved and bringing in elements of science output.

Tom noted that is important to systematically strengthen the engagement with other groups and to make sure that it is clear to those groups that WCRP plays an important role that enables their science. Detlef added that review papers can be valuable documents that show the current status, gaps, challenges, and way forward of science topics. Shipra Jain (Representative of the Young Earth System Scientists Community (YESS) community) mentioned that WCRP should go beyond white papers but also develop material that society reads. Detlef agreed and said that these white papers should produce spin-offs that could be developed by the Secretariat. Ken Takahashi mentioned that development of policy briefs in several languages, in addition to review papers, could be a way to promote WCRP science to policymakers. Other participants agreed about the importance of producing material in languages other than English in order to engage with a larger community.

Detlef led the discussion to a concrete example for highlighting WCRP science and explained that WCRP is discussing its presence at COP-26 and, together with Future Earth and other groups, its participation in some of the pavilions, which are the appropriate avenues for communicating with participants at the event. Detlef asked for ideas and how to interact. It was noted that My Climate Risk is planning some activity with Future Earth's Risk KAN. Pascale agreed that it is important for WCRP to have a presence and that they should bring a mixture of ECRs and senior scientists that would show diversity. Pedro Monteiro mentioned that one suggestion would be to have a joint panel discussion with the IPCC on the newly released IPCC Working Group I report, and this would be a good opportunity to highlight contributions.

8.3. Resources

Helen noted that there is a very strong connection between partnerships, impact, and resources. This breakout session looked at resources, where the group recognized that resources could

mean science or science support resources. There are resources needed to undertake the foundational work of WCRP, such as the underpinning fundamental climate science that is funded by national agencies and that continues to be critically important. There are also resources for coordination support, which our IPOs and Secretariat provide, that cannot be taken for granted and that we need to sustain or grow.

The group talked about the role of philanthropy and other donors, as there was a strong appetite to look to these sources to grow what we do. Helen explained that this requires a strategic approach undertaken at a WCRP leadership level with an interest in aligning organizational strategies and priorities. The group recognized that there are a lot of institutional and bureaucratic barriers that make it hard to access funding and that we need to think about how to overcome these.

Bruce explained that if we really want to engage with the Global South, then WCRP needs to promote investing in people. While the Global North is rich in resources, it is much harder for scientists in the Global South to find research funding, especially early career scientists. He explained that we need sustained rather than parachuted activities and we need communication that is contextually relevant. Bruce highlighted that while philanthropic organizations are funding climate issues, the average researcher has no access to these organizations or these funds. WCRP could play a strong brokerage role, not just with the philanthropic organizations but also with brokering the coal-face research ideas up to the large funding organizations. He commented that there is a challenge in matching funding agency mission to research vision. Compromise and dialogue are needed to find complementarity and overlap between the coal-face researcher and the funding agency. WCRP could play a role in facilitating this relationship. Martin noted that investing in people has also been discussed in ISC and Helen reflected that it would be good for WCRP to work on this with this co-sponsor.

9. Way forward and next steps

9.1. Collaboration with co-sponsors and partners

Detlef Stammer led the discussion on WCRP's collaboration with our co-sponsors and allied programmes and activities. There has been more regular interaction with Future Earth, with the development of concrete activities like the publication of the "10 New Insights in Climate Science 2020" (10NICS) report, also jointly with the Earth League. Several Memorandum of Understanding (MoUs) with Future Earth projects are in development. The Lighthouse Activities are also discussing the involvement of Future Earth's projects in the planning phase of their activities.

In relation to interaction with WMO's Research Board and other WMO programmes, it was felt that the Research Board is beneficial, providing a platform for regular interactions and further engagement with other programmes in WMO (e.g., WWRP, GAW, and GCOS), and for discussions on specific WMO activities, e.g., the WMO Vision and Strategy for Hydrology and its associated Action Plan. The Research Board is also a stage for strengthening existing partnerships and for the development of new ones.

WCRP has also established good interactions with the U.S. Global Change Research Program (USGCRP). Recently, USGCRP co-hosted the WCRP Regional Climate Forum for North America and the Caribbean. WCRP also had a US Agency proposal funded to enhance its activities, and also received funding for the organisation of the WCRP Open Science Conference. Helen Cleugh commented that the Regional Climate Forum for North America and the Caribbean

was also co-organised by the Inter-American Institute for Global Change Research (IAI), which shows the potential for partnerships. Detlef and Helen thanked USGCRP and IAI for their support.

Helen then discussed recent interactions with the Belmont Forum and Future Earth at the Sustainability Research & Innovation (SRI) Congress 2021. Several activities were jointly organised by WCRP, including a pre-event workshop, a science session organised by the My Climate Risk Lighthouse Activity, and a panel discussion on atmospheric science. The next SRI Congress will be organised in South Africa in 2022 and WCRP should look at ways to be involved in that. Erica Key (Belmont Forum Executive Director) mentioned the workshops that Belmont Forum will organise for specific calls on climate, environment and health that will be rolled out within a year, and where there are good cross-links to be developed with the Lighthouse Activities and Core Projects.

Martin detailed the opportunities for engagement with the United Nations Decade of Ocean Science for Sustainable Development (UN Ocean Decade). CLIVAR has been successful in engaging with the community and having some activities officially approved. Also, with IOC-UNESCO as a strong partner, a suggestion was to organise a day of the WCRP Open Science Conference focused on the ocean-climate nexus in the context of the UN Ocean Decade, with links to RIfS and stakeholder engagement.

9.2. COP 26, UNFCCC, State of the Climate

Mike Sparrow briefed participants on WCRP links with UNFCCC and preparations for COP-26. There has been a long-term engagement with UNFCCC through Subsidiary Body for Scientific and Technological Advice (SBSTA). In 2021, there was active engagement via the Research Dialogues and Mike, Ted and Daniela gave presentations at those events. Regarding COP-26 preparations, due to the COVID-19 pandemic, guidance about the meeting has been continually changing and the format of the event is still unclear. WCRP's involvement is via and with several partners (Future Earth, ISC, WMO departments). For the next COP, WCRP will explore registering as an observer which will allow the submission of its own event proposals.

Detlef reminded everyone that WCRP is involved in the 10NICS report and that the next phase will probably start soon after COP-26. WCRP needs to continue to strengthen their involvement and include feedback from the scientific community, particularly in the discussion about which topics should be highlighted. Wendy Broadgate (Future Earth Global Hub Director) mentioned that the official launch of the policy brief, which is a summary of the published report, is done every year in a press conference during COP, jointly with the UNFCCC Executive Secretary. Daniela noted that WCRP could provide expertise on new topics to be included in the 10NICS, which has a very inclusive process, and that the engagement of WCRP experts should be enhanced.

9.3. Forthcoming events, meetings, and conferences

Detlef continued by briefing participants on forthcoming events, meetings, and conferences that WCRP is organising or co-organising. Within WCRP, it is important to recognise the need to optimize and co-design workshops between groups as so many have been proposed. The first step, a "stocktake" of all planned workshops and meetings in the coming 18-months, will be undertaken by the Secretariat.

The organisation of the "Future of Climate Modelling" workshop, which will look at the cutting-edge topics in climate modelling, has been delayed because of travel restrictions imposed by the COVID-19 pandemic, as organisers find it essential for this meeting to be in person. ESMO will

now provide input, with the workshop taking place probably within the next six months, with several follow-up workshops in 2022.

Similarly, a workshop on climate observations should take place, with ESMO as the lead organizer. Detlef noted that the GCOS/WCRP Conference has been postponed to 2022. He further noted, regarding topics related to the IPCC, that in 2014 WCRP organised a workshop to take stock of the IPCC AR5 process and outcomes, and a similar workshop should be organised, jointly with IPCC, for AR6. The aim would be to identify gaps, challenges, and opportunities that will help with the ongoing IPCC process.

At AGU Fall Meeting 2021, which will be a hybrid event in New Orleans, USA, sessions have been proposed by three of the Lighthouse Activities. Some other climate related sessions may be co-sponsored by WCRP. Detlef will have a discussion with AGU organisers in order to check the potential of running a WCRP Town Hall on the new structure. The WCRP sea level conference will be organised in Singapore in 2022, as a follow on to the previous conference organised in New York in 2017.

Regarding the organisation of WCRP Open Science Conference (OSC) in 2023, the WCRP Secretariat is in the process of receiving the “letters of intent” from potential hosts, and the next step will be the setting up of the Scientific Organising Committee. The WCRP OSC will celebrate the success of the sunsetting Grand Challenges and start the new WCRP science. In 2025, WMO, jointly with ISC, IOC-UNESCO and partners, is planning an Open Science Conference which may be more focused on the link between science and services.

9.4. WCRP Secretariat report

Mike Sparrow reported on WCRP Secretariat activities, connections to other support units, and the WCRP budget. In terms of staffing, the previous 18 months were very challenging due to changes in the Secretariat, because of WMO restructuring, and due to staff on long term sick leave. Recently, new staff have joined the Secretariat or are about to start. This challenging period has been offset by the dedication of the JSC Chair and Vice-chair and by the valuable support provided by the IPOs. The IPOs, which exist due to national contributions to WCRP activities, have been essential and are gratefully acknowledged by WCRP. ESA has been selected as the host for the new CMIP IPO and the search for its director is underway. Calls for institutions to host the ESMO and RIfS IPOs will be issued before the end of the year. Daniela mentioned that the CORA office is supporting RIfS in its implementation but will close in December 2021. If continuous support is necessary during this period without an IPO, it is necessary for a discussion to take place between WCRP and the Climate Service Center Germany (GERICS).

Mike also provided a summary of the income and expenditure for 2020 and 2021, with a draft budget for 2022 to be discussed at the JSC only session. One point to consider was a suggestion made at the JSC meeting in 2020 for projects to provide an expenditure plan for the next 2-3 years. Daniela commented that due to the current situation, it may be difficult to plan for travel in 2021 and 2022. However, given the regional focus of several activities in WCRP, these may require more financial support as before. The current model follows expenditure pattern from previous years, but this may not be true in the current WCRP structure and plans.

9.5. Regional consultations / Climate Research Forums

Helen reminded everyone of her presentation during the first session of the JSC Session when she provided details of the Climate Research Forums that have already taken place. In terms of future sessions, the one in South America will happen in September 2021 with others in New

Zealand, Southern Asia, Africa, and the Pacific Islands planned for 2022. Helen and the Secretariat will continue to analyse the feedback received through these forums. At the same time, it is important to keep the enthusiasm and interest generated with these events alive. Some early feedback provided was for the organisation of more tailored events in the regions.

Sonya asked if it would be possible for the Core Projects to have access to the database of participants in the Climate Research Forum if they want to find potential panel members from different regions. Narelle explained that although this would be possible, further investigation and advice on issues related to data privacy needs to be done.

9.6. Update on WCRP carbon footprint

Pierre Friedlingstein updated participants on the activities of the WCRP Carbon Footprint Working Group and the discussions regarding the calculation of travel emissions. In Phase 1, through an agreement with Cranfield University that will soon be finalized, a proof of concept has been completed and a carbon calculator developed.

In Phase 2, a pilot study will be developed with the SPARC IPO, with further training and discussions between this working group, the WCRP Secretariat and IPOs on how to implement the carbon calculator, with the objective to create draft guidelines for reporting on WCRP carbon emissions from travel, with a full proposed text to be presented at JSC-43. The ambition of this exercise is to reduce travel and therefore emissions.

There was a lively discussion on the need to balance travel, budget, and carbon emissions. Neil reminded everyone that this activity and the discussion around it is about reducing carbon emissions, and not about the WCRP budget. The tool that is being developed will help with strategic planning that may have impacts on the budget.

9.7. Adjustments to finances and governance

Helen summarised some of the previous discussions and the commitment to provide support for the new Core Projects and Lighthouse Activities. The JSC and the Secretariat will move quickly to set up IPOs for ESMO and RIfS and explore the option of establishing Project Support Units to support the approved Lighthouse Activities.

9.8. Implementation plan writing

Detlef briefly explained the process that will be followed for the writing of the Implementation Plan. It will be a dynamic and living document that will be regularly reviewed and refreshed, which will also reflect the discussions during this JSC Session. The recommended steps and timeline are as follows (noting that these dates may need to be revised):

1. Agree on outline (August 2021)
2. Pulling material together (August/September 2021)
3. Compilation of first draft (September/October 2021)
4. Revision by leadership team (November 2021)
5. Final editing and agreement by JSC (December 2021)
6. Agreement by co-sponsors (January 2022)

Gaby Langendijk (Representative of the YESS community) enquired as to how ECRs could be involved in the Implementation Plan writing process, noting that this process could be useful to engage new members. They should be entrained earlier in the process and not only during

consultation. Helen replied that engagement with ECRs in this process will happen and some chapters will seek direct input from all career stages.

9.9. Wrap up and close of open session

Detlef and Helen thanked all participants for attending to the meeting. In particular, thanks were extended to CORA, which ends in 2021, and to Neil Harris, who will step down as Co-chair of the SPARC SSG. Concluding remarks noted that the new WCRP is now launched and, as a community, we can now build on, develop, and implement those plans.

10. JSC actions and decisions

Detlef and Helen started the JSC-only session by reviewing some of the key actions from JSC-41 and JSC-41B. All actions were either addressed or underway and pending actions were discussed by the JSC. The JSC noted that the transition to the new WCRP is now complete and they, together with the WCRP community, are eager to start developing and working on the new science proposed. Detlef reflected that the JSC should identify any issues or gaps that have not been fully addressed at the open meeting.

10.1. Membership

The JSC reviewed all nominations for membership of the Core Project SSGs, for the term starting on 1 January 2022. Their consideration took into account the expertise of candidates and the regional and gender diversity of the nominations. CLIVAR did not submit any new nominations for 2022. SPARC SSG membership was approved. S2S Steering Group nominations, which had previous been approved by WWRP, were also approved by the JSC. CliC and GEWEX Co-chair were approved. It was felt that further discussion was necessary for the other CliC and GEWEX membership nominations in order to improve diversity. New nominations will be requested from CliC and GEWEX to be approved by November 2021.

Decisions
D01: CliC SSG Co-chair nomination approved (E. Hanna).
D02: GEWEX SSG Co-chair nomination approved (X. Zeng).
D03: SPARC SSG membership Co-chairs (K. Rosenlof and A. Maycock) and membership (renewal: H. Hendon and D. Wuebbles; new members: W. Tian and S. Szopa) approved.
D04: S2S Steering Group membership proposal approved (C. Spillman).

Actions
A01: Discuss with the CliC leadership and IPO on how they can address regional diversity in the CliC SSG membership, in order to seek new nominations (noting that CliC previously cut its SSG membership by two) (JSC Chair, Vice-Chair, Core Project JSC liaisons, WCRP Secretariat; discussion by end August 2021).
A02: Discuss with the GEWEX leadership and IPO how they can address gender diversity in the GEWEX SSG membership, in order to seek new nominations to be approved by November 2021 (JSC Chair, Vice-Chair, Core Project JSC liaisons, WCRP Secretariat; discussion by end August 2021).

10.2. Lighthouse Activities

JSC members were pleased with the progress made in the Lighthouse Activities that culminated in the delivery of their draft science plans. The JSC noted that the Lighthouses are now ready to start the implementation of those plans, fine tuning their governance structure, and organize their

pilot/inception activities. The JSC also agreed that it is essential for the Lighthouse Activity leadership to receive clear feedback about their science plans.

Support for the Lighthouse Activities was also discussed by the JSC. Several suggestions were made but it was also noted that not all Lighthouses have the same requirements or need for support. The way forward would be consult with the Lighthouse Activities on what support they need, and how their expectations can be met. Once this is done, a plan can be put together and a decision made on how support can be best provided to this key component of the WCRP new structure.

Decision
D05: All Lighthouse (LHA) Science Plans approved.

Actions
A03: Communicate JSC approval of all LHAs Science Plans, with further specific details at a later stage in 2021 (JSC Chair, Vice-chair and WCRP Secretariat; by mid-July 2021).
A04: The WCRP Secretariat and LHAs to summarise the specific support requirements that the LHAs need and provide these to the JSC (WCRP Secretariat working with LHA Chairs; by 1 October 2021).
A05: Establish a plan and call for support units for the Lighthouse Activities (JSC Chair, Vice-chair, LHA Chairs, WCRP Secretariat; support units established by JSC-43 if possible).

10.3. New Core Projects

The JSC was pleased with progress made by both new Core Projects, ESMO and RIfS, and approved their draft plans. The JSC also confirmed that in the new structure, CORDEX will be reporting directly to the RIfS SSG, once it is in place.

Decisions
D06: ESMO and RIfS draft plans are approved.
D07: The JSC confirm that RIfS is responsible for approving the membership changes and budget requests of CORDEX.

Roberto raised one point that may require further discussion. The new Core Projects, RIfS and ESMO, have not had long to develop their science plans and links with the other Core Projects and Lighthouses. Detlef agreed that both new Core Projects need more time to further develop their new science plan and their governance structure. Roberto reiterated that would be key to communicate this decision to ESMO and RIfS leadership so they can plan their discussions accordingly.

The JSC also reiterated its commitment to set up IPOs for ESMO and RIfS, following a similar process of an open call as was done for the newly established CMIP IPO.

Actions
A06: Communicate JSC approval of ESMO and RIfS (including a separate communication to CORDEX) draft plans, noting that the interim SSG and ICG have more time to develop their implementation plans, including governance and membership. Bi-lateral discussions with the other Core Projects and the Lighthouse Activities is encouraged (JSC Chair, Vice-chair and WCRP Secretariat; advise by mid-July 2021, deliver updated draft science plan by end of 2021).

A07: Establish international project offices for ESMO and RIfS (JSC Chair, Vice-chair, JSC Core Project liaisons, ESMO and RIfS leadership, WCRP Secretariat; call opened by mid-October 2021, established ideally by JSC-43).

10.4. Finance

Mike presented to JSC members the detailed budget for 2021 and a proposed budget for 2022. In 2021, expenditure has been less than 10% of the budget, with contributions from some countries arriving later in the year. WCRP will also receive funds from NOAA in support of the planning and organization of the WCRP Open Science Conference 2023. Regarding the budget for 2022, there will be a smaller contribution from WMO to research activities but also a larger expenditure for the WCRP office operation due to Joint Climate Research Fund (JCRF) contributing to WMO costs. The JSC noted these issues and endorsed the draft WCRP budget for 2022.

It was noted that there have been enquiries from some Core Projects about the possibility of carrying forward to 2022 their unspent budget of 2021. Mike explained that different decisions have been taken in different years. The JSC agreed that unspent budget should not be allowed to carry forward, but special requests can be made for extra expenditure, and these will be evaluated on a case-by-case basis.

Martin noted that the JSC had previously agreed to discuss the budget requests with each Core Project before they submit it to the JSC for approval. Mike commented that for this to happen it would be necessary to establish a clear process, with advice provided by the JSC. The JSC also noted that it would be very helpful for Core Projects, including RIfS and ESMO, and Lighthouse Activities to provide an expenditure plan for 2022, with an outlook for 2023, for approval at the JSC meeting in November 2021.

Decision
D08: The JSC endorsed the 2022 draft WCRP budget. (Noting that a discussion will be held to fine-tune the budget before the November JSC-only meeting)

Actions
A08: Produce guidelines for a streamlined budget process, where a sub-group of the JSC works with the Core Projects and Lighthouse Activities to determine a pre-negotiated budget, perhaps with a mid-year review (ongoing from JSC-41) (WCRP Secretariat, JSC Chair, Vice-chair, JSC liaisons, by 1 September 2021).
A09: Request Core Projects and LHAs prepare an expenditure plan for 2022 and an outlook for 2023, to be approved at a JSC-only meeting in November 2021 (WCRP leadership supported by WCRP Secretariat; by 15 September 2021).

10.5. Science gaps

At the open session of the JSC meeting, Gabi Hegerl presented the proposal for the Global Extremes Platform (GEP), which would be an integrator of activities related to extremes within WCRP. The JSC recognised that weather and climate extremes is a very important topic in the new WCRP science agenda, as discussed at the “science gaps” breakout session. In previous discussions with the proposers of this new activity, it was made clear that the GEP should be an integrating activity, with links to all Core Projects and Lighthouse Activities. The GEP plan reflects that in part and the JSC must now provide advice on how it will be implemented. Also, it is important to reach out to the Core Projects and request their views on the proposal and how the

interaction would take place. In addition to that, the WCRP leadership meeting would be the appropriate forum for further discussion. In terms of governance, it was suggested that GEP could be placed within the ESMO structure, and it was noted that initial discussions with the ESMO leadership have already taken place. However, given that ESMO implementation plan is still under development, no agreement has been made. It was suggested that alternative arrangements may need to be identified.

Decision
D09: Global Extremes Platform (GEP) plan approved in principle, with details of its implementation to be developed. This reflects the importance of the topic of Extremes to WCRP's research priorities while acknowledging that the GEP must be well integrated within the WCRP's current (new) structure and not a stand-alone activity. The JSC also seeks feedback from the Core Project and LHA leadership about their needs for the GEP.

Actions
A10: Discuss implementation with Global Extremes Platform leadership, including linkages with other WCRP activities (Global Extremes Platform leadership, JSC Chair, Vice-chair, Lisa Alexander; by end August 2021)
A11: Discuss the Global Extremes Platform at the next WCRP leadership meeting(s), in order to agree on the way forward (JSC Chair, Vice-chair; next leadership meeting(s)).

In addition to 'extremes', the breakout session on science gaps discussed two other topics: the interaction of climate forcing with radiation (including the impacts of climate intervention/ geoengineering); and how reservoirs of heat, water, and carbon might change in the future. Regarding the topic of heat-water-carbon cycles, Pedro Monteiro (JSC Member) noted that there is no need for changes in the WCRP structure in order to accommodate any new initiative. WCRP should play a very important role in bringing these communities together and lead the discussion of an integrated approach to heat-water-carbon cycles research, instead of looking only at specific connections (e.g., heat-ocean, carbon-land). The JSC agreed to have further discussions on how to implement this at the next WCRP leadership meeting.

Regarding the theme of climate intervention, Jim Hurrell (JSC Member) reminded everyone that there has been some strong interest from SOLAS on this topic and perhaps a good way forward is to organize a scoping workshop to identify the research questions and what WCRP uniquely can do in an international coordination role. Martin agreed with this and mentioned that Future Earth should also be involved in the planning of such a workshop. Roberto mentioned that climate intervention is not only about climate science and therefore a wider community should also be included in the discussion, particularly from some regional bodies, like IAI, who could bring different communities into the discussion.

Actions
A12: Discuss heat-water-carbon cycles themes at the next WCRP leadership meeting(s), in order to agree on the way forward (JSC Chair, Vice-chair; next leadership meeting(s)).
A13: Set up an *ad hoc* group to discuss climate intervention jointly with other groups including plans for a scoping workshop (JSC members, WCRP leadership; set up by end September 2021).

10.6. Engagement, communication, and coordination

There has been extreme good discussion at both breakout sessions on engagement and communication, with some overlaps regarding suggestions on how to improve engagement,

particularly of ECRs, and how best communicate with groups within and outside WCRP. The JSC felt that the best way forward was to establish a group to develop an action plan that will feed into the WCRP Implementation Plan. JSC members also found that the WCRP leadership meetings have been very positive and are a good way to increase integration of activities and internal communication, and they noted that these should continue.

Decisions
D10: Establish an *ad hoc* group on Engagement, Communication and Coordination to develop an "action plan" that draws on the discussions at the respective Breakout Groups at JSC42, identifies prioritised actions, and assigns these tasks to the appropriate members of the WCRP Leadership, Secretariat, and IPOs. This action plan will form the basis for the relevant sections in the Implementation Plan being developed. The *ad hoc* group to comprise: Science and Communication Officer, JSC Vice-chair, Pascale, additional members drawn as needed from the WCRP leadership and be formed before 1 September 2021.

D11: Continue WCRP leadership meetings (e.g., every 3-4 months) to facilitate coordination and communication across WCRP; reduce overlaps; and enhance integration and synergies and strengthen the "value-add" of WCRP. It will do this through information sharing and discussions on specific topics of relevance. It will be an important way to provide input into decisions made by the JSC.

One very prominent topic in the discussions on engagement was the difficulty, particularly for ECRs, to find a way to participate in WCRP activities or to get involved in the Core Projects. This was thought to not be due to a lack of communication on activities and opportunities but more because of the lack of explanation of how WCRP operates and of the links between groups, both inside the Programme and with partners. A suggestion was to map all existing internal and external links in a way to explain these connections, which could also help identify synergies and gaps. Also, clear identification of roles and an explanation of how to become involved in groups would be useful. For this, it would be important to update the membership guidelines, in order to reflect the changes in the WCRP structure.

Actions
A14: Develop a chart of all WCRP components, and internal and external interactions for inclusion in the Implementation Plan (WCRP Secretariat, by 1 November 2021).
A15: Update membership guidelines, including issues on diversity, to provide clear information on procedures and timelines for all WCRP activities and to provide clarity on how people can become members of committees. (JSC Chair, Vice-Chair, WCRP Secretariat; by JSC-43).

10.7. Next JSC Meeting

It was decided by the JSC that the next meeting of the JSC will take place in November 2021 and that this will be only for the JSC and WCRP Secretariat. The date of the 43rd Session of the JSC will be decided at that meeting.

Actions
A16: Schedule a JSC-only Meeting for November 2021 (WCRP Secretariat; Send Doodle by 1 August 2021).

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Annex 1 – List of invited participants

All acronyms are listed at the end of this report.

First Name	Last Name	Function/Affiliation
Joint Scientific Committee Members		
Detlef	Stammer	JSC Chair
Helen	Cleugh	JSC Vice-chair
Lisa	Alexander	JSC Member
Tercio	Ambrizzi	JSC Member
Pascale	Braconnot	JSC Member
Jens Hesselbjerg	Christensen	JSC Member
Susanna	Corti	JSC Member
Pierre	Friedlingstein	JSC Member
James	Hurrell	JSC Member
Maria	Ivanova	JSC Member
Thomas	Peter	JSC Member
Krishnan	Raghavan	JSC Member
Roberto	Sánchez-Rodríguez	JSC Member
Pedro	Scheel Monteiro	JSC Member
Igor	Shkolnik	JSC Member
Ken	Takahashi	JSC Member
Martin	Visbeck	JSC Member
Hui-Jun	Wang	JSC Member
Core Project Chairs		
Wenju	Cai	CLIVAR Co-chair
Neil	Harris	SPARC Co-chair
Bruce	Hewitson	RIfS Co-chair
Daniela	Jacob	CORDEX Co-chair
Sonya	Legg	CLIVAR Co-chair
Jan	Polcher	GEWEX Co-chair
Sara	Pryor	RIfS Co-chair
James	Renwick	CliC Co-chair
Andy	Robertson	S2S Co-chair
Cath	Senior	ESMO Co-chair
Silvina	Solman	CORDEX Co-chair/RIfS Co-chair
Seok-Woo	Son	SPARC Co-chair
Fiamma	Straneo	CliC Co-chair
Susann	Tegtmeier	ESMO Co-chair
Frédéric	Vitart	S2S Co-chair
Xubin	Zeng	GEWEX Co-chair

Lighthouse Activity Chairs		
Peter	Bauer	Digital Earths Co-chair
Andrew	Charlton-Perez	WCRP Academy Co-chair
Kirsten	Findell	Explaining and Predicting Earth System Change Co-chair
Gabi	Hegerl	Safe Landing Climates Co-chair
Christian	Jakob	Digital Earths Co-chair
Angela	Maharaj	WCRP Academy Co-chair
Regina	Rodrigues	My Climate Risk Co-chair
Ted	Shepherd	My Climate Risk Co-chair
Steven	Sherwood	Safe Landing Climates Co-chair
Rowan	Sutton	Explaining and Predicting Earth System Change Co-chair
Grand Challenge Leaders		
Sandrine	Bony	Clouds, Circulation and Climate Sensitivity
Bjorn	Stevens	Clouds, Circulation and Climate Sensitivity
Tim	Naish	Melting Ice and Global Consequences
Xuebin	Zhang	Climate Extremes
Gabriele C.	Hegerl	Climate Extremes
Sonia	Seneviratne	Climate Extremes
Lisa	Alexander	Climate Extremes
Rob	Nicholls	Regional Sea-Level Change and Coastal Impacts
Kathleen	McInnes	Regional Sea-Level Change and Coastal Impacts
David	Behar	Regional Sea-Level Change and Coastal Impacts
Roderik	van de Wal	Regional Sea-Level Change and Coastal Impacts
Peter J.	Van Oevelen	Water Availability
Jan	Polcher	Water Availability
Roy	Rasmussen	Water Availability
Adam	Scaife	Near Term Climate Prediction
Terry	O'Kane	Near Term Climate Prediction
Tatiana	Ilyina	Carbon Feedbacks in the Climate System
Working Group Chairs		
Clare	Goodess	WGRC Co-chair
Carolyn	Reynolds	WGNE Co-chair
Jean-Francois	Lamarque	CMIP Panel Chair
Nils	Wedi	WGNE Co-chair
William	Merryfield	WGSIP Co-chair
June-Yi	Lee	WGSIP Co-chair
Cath	Senior	WGCM Co-chair
Greg	Flato	WGCM Co-chair

Coordination Office for Regional Activities (CORA)		
Paul	Bowyer	GERICS/Germany
Tore	Furevik	BCCR/Norway
Daniela	Jacob	GERICS/Germany
Anke	Schluensen-Rico	GERICS/Germany
Sponsor Organizations		
Salvatore	Arico	IOC
Mathieu	Denis	ISC
Heide	Hackmann	ISC
Jürg	Luterbacher	WMO
Elena	Manaenkova	WMO
Katsia	Paulavets	ISC
Daya	Reddy	ISC
Vladimir	Ryabinin	IOC
Petteri	Taalas	WMO
Deon	Terrblanche	WMO (RB)
Ariel	Troisi	IOC
Partner Invitees		
Josef	Aschbacher	ESA/ESRIN
Victoria	Barlow	IPO Executive Officer, iLEAPS
Wendy	Broadgate	Future Earth
Viktor	Brovkin	AIMES
Josep (Pep)	Canadell	GCP
Greg	Carmichael	GAW
John	Claydon	IMBeR
Chris	Davis	WWRP
Langley	DeWitt	IGAC
Han	Dolman	GCOS
Sebastian	Ferse	Exec. Officer Future Earth Coasts
Albert	Fischer	GOOS
Jessica	Gier	Exec. Dir, SOLAS
Sophie	Hebden	ESA
Wayne	Higgins	NOAA
Jin	Huang	NOAA
Shipra	Jain	YESS
Jack	Kaye	NASA
Erika	Key	Belmont Forum
Katia	Kontar	USGCRP
Mike	Kuperberg	DOE
Gaby	Langendijk	YESS
Cliff	Law	SOLAS Co-chair
Li	Li	Deputy Executive Director, SOLAS
Marie-France	Loutre	PAGES

Valérie	Masson-Delmotte	WG 1/IPCC - IPSL/LSCE
Susanne	Mecklenburg	ESA/ECSAT
Belén	Míguez	OOPC
Chandrika	Naith	SCAR Director
Jo	Post	UNFCCC
Benjamin	Poulter	iLEAPS
Valentina	Rabanal	YESS
Signe	Ratso	European Commission/European Union
Paolo	Ruti	EUMETSAT
Marie-Alexandrine	Sicre	SCOR
Giles	Sioen	Future Earth
Sabrina	Speich	OOPC
Seiji	Tsutsui	APN
Maria	Uhle	Belmont Forum
Judit	Ungvari	Future Earth
Florin	Vladu	UNFCCC
Roger	Wakimoto	NSF
Weidong	Yu	OOPC
Directors and Staff of WCRP International Offices		
Beatriz	Boasso Balino	CliC and CORA IPOs
Mareike	Heckl	Director SPARC IPO
Yu-Kyung	Hyun	S2S ICO
Hyung Jin	Kim	S2S ICO
Rupa	Kumar Kolli	Executive Director ICMPO
Irene	Lake	Director CORDEX IPO
Armelle	Remedio	CORA (GERICS)
Jose Luis	Santos Davila	Director CLIVAR IPO
Peter J.	van Oevelen	Director GEWEX IPO
WCRP Secretariat Staff		
Michael	Sparrow	Head WCRP Secretariat
Nico	Caltabiano	WCRP Secretariat
Wenchao	Cao	WCRP Secretariat
Catherine	Michaut	WCRP Secretariat (at IPSL, Paris)
Hindumathi	Palanisamy	WCRP Secretariat
Narelle	van der Wel	WCRP Secretariat

Annex 2 – Agenda

42nd Session of the WCRP Joint Scientific Committee (JSC-42)
Online Outline Agenda

Videoconference 28 June - 2 July (all) and 8 July (JSC/WCRP Secretariat only)

Background

- This 42nd meeting of WCRP's Joint Scientific Committee (JSC-42) aims to take a number of important decisions for the programme, including the approval of the plans for the new Lighthouse Activities, the new "Core Projects" on "Earth System Modelling and Observations" and "Regional Climate Information for Society" as well as progress with the current Core Projects, Grand Challenges and other major activities.
- The JSC and leadership of our activities will discuss and decide on the next steps for the "soft" implementation of WCRP's Strategic Plan including the format and structure of the Implementation Plan itself.
- The sessions will be via the WMO Zoom system (details in this document) so we can also have breakout sessions.
- Presentations and/or reports will be made available in advance of the meeting. Due to the limited meeting time, please make sure you read through the full presentations/reports beforehand. See https://www.wcrp- climate.org/jsc42-documents.
- During the virtual meeting questions can be submitted via the Chat Box. A member of the WCRP Secretariat will moderate the chat and notify the chair as applicable.
- Wenchao (wcao@wmo.int) in the WCRP Secretariat will run all presentations to ensure a smooth transition between sessions.
- If you have any technical issues during the session, please contact Catherine (catherine.michaut@ipsl.fr).
- Attendance at this virtual JSC-42 is by invitation only. Should you wish to attend please contact Mike Sparrow (msparrow@wmo.int).

All times in the below agenda are quoted in Geneva/Paris (CEST) time.

Day 1 (28th June): 15:00-18:20, Geneva/Paris time

15:00 – 15:35 Session 1: JSC Opening Session (35 mins)
(Chair D. Stammer, Rapporteur N. Van der Wel, Chat Moderator A. Caltabiano)

- Opening and Goal of JSC-42 from JSC Chair and Vice-Chair [10 mins] *(*D. Stammer, H. Cleugh*)*
- Welcome from Co-sponsors [3 mins each] E. Manaenkova (WMO), M. Denis (ISC), V. Ryabinin (IOC)
- Welcome and introduction of new WCRP Secretariat [5 mins] (M. Sparrow*)*
- Approval of Agenda [5 mins] *(*D. Stammer, H. Cleugh*)*
- Guidelines for running JSC-42 via videoconference [5 mins] *(*N. van der Wel*)*

15:35 – 16:20 Session 2: WCRP Implementation: The Way Forward (35 min.)
(Chairs: H. Cleugh and D. Stammer, Rapporteur N. van der Wel, Chat Moderator A. Caltabiano)

- From here on forward [15 mins] *(*D. Stammer, H. Cleugh*)*

- Initial lessons from Climate Research Forums (H. Cleugh) [10 mins]
- Attention required during JSC-42 *(*D. Stammer*)* [10 mins]

10 minute break

16:20-18:20 Session 3: Discussion and Plans for the Lighthouse Activities and new Core Projects (120 mins)
(Chair: J. H. Christensen, *Rapporteur A. Caltabiano, Chat Moderator N. Van der Wel*)

- WCRP Academy [30 mins] (A. Charlton-Perez)
- Safe Landing Climates [30 mins] (G. Hegerl)
- Explaining and Predicting Earth System Change [30 mins] (R. Sutton/K. Findell)
- My Climate Risk [30 mins] (R. Rodrigues)

End of Day 1
Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30+ mins)

Day 2 (29th June): 08:00-11:15, Geneva/Paris time

08:00-10:00 Session 3: Discussion and Plans for the Lighthouse Activities and new Core Projects cont. (120 mins)
(Chair: *P. Braconnot; Rapporteur: N. Van der Wel; Chat Moderator A. Caltabiano*)

- Digital Earths [30 mins] (C. Jakob)
- Core Project on Earth System Modelling and Observations [40 mins] *(Includes reporting on CMIP, WGNE etc.)* (C. Senior)

10 min break

- Core Project on Regional Climate Information for Society (B. Hewitson) [40 mins] *(Includes reporting on CORDEX) (*D. Jacob*)*

10:00-11:15 Session 4: Discussion and Plans for the current Core Projects and Grand Challenges (75 mins)
(*Chair*: T. Peter, *Rapporteur A. Caltabiano, Chat Moderator N. Van der Wel*)

- CliC & GC Melting Ice [45 mins] (T. Naish)
- SPARC [30 mins] (S.-W. Son/ N. Harris)

End of Day 2
Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30+ mins)

Day 3 (30th June): midday-14:40, Geneva/Paris time

Midday – 14:40 Session 4: Discussion and Plans for the current Core Projects, Grand Challenges (continued) (160 mins)
(Chair H. Cleugh; Rapporteur N. Van der Wel; Chat Moderator A. Caltabiano)

- CLIVAR [30 mins] (S. Legg)
- GEWEX [30 mins] (J. Polcher)
- GC Extremes [15 mins] (G. Hegerl)
- GC Clouds [15 mins] (B. Stevens)

- GC NTCP [15 mins] (A. Scaife)

10 min break

- GC Water [15 mins] (J. Polcher)
- GC Carbon [15 mins] (P. Friedlingstein)
- GC Sea Level [15 mins] (R. Nicholls)

End of Day 3
Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30+ mins)

Day 4 (1st July): 21:00-midnight, Geneva/Paris time

21:00-midnight Session 5: Implementing the Strategy: Science gaps, Governance, Communications, Engagement and Budgetary Support (180 mins)
(Chair: D. Stammer; Rapporteur A Caltabiano; Chat Moderator N Van der Wel)

1. Introduction [15 mins]
2. Parallel breakout discussion groups (focused on WCRP) [120 mins including break]:
    a. Coordination and Communication (Chairs: H.Cleugh and J. Hurrell; Rapporteur N. Van der Wel)
    b. Science Gaps (Chair D. Stammer; Rapporteur M. Sparrow)
    c. Engagement (with ECRs, with regions, with partners). Including Climate Research Forums, addressing inclusion and diversity needs. (Chair P. Braconnot; Rapporteur W. Cao)
    d. Strategic investments (i.e., what are the priority areas and activities that require investment) (Chair J. Christensen; Rapporteur A. Caltabiano)
3. Plenary discussion [45 mins]

End of Day 4
Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30+ mins)

Day 5 (2nd July): 15:00-18:30, Geneva/Paris time

15:00- 16:30 Session 6: Science Partnerships, WCRP impact, and Resources (90 mins)
(Chair D. Stammer; Rapporteur N. Van der Wel; Chat Moderator A. Caltabiano)
Introduction [10 mins]
Three parallel 50 Minute Break out sessions on the "external" facing topics covered during the previous day *(under development):*

A. Science Partnerships (Future Earth, GCOS, WMO-RB, UN Decade, Space. etc.) (Chair: M. Visbeck; Rapporteur M. Sparrow)
B. Impact of WCRP science (IPCC, COP, Sustainable Goals) (Chair: D. Stammer; Rapporteur A. Caltabiano)
C. Resources (National funding, World Bank, office support, meeting support, foundations) (Chair: H. Cleugh; Rapporteur N. Van der Wel)

Brief summaries from breakout sessions [20 mins]

10 min break

16:30 - 18:30 Session 7: Way Forward and Next Steps (120 mins)
(Chair H. Cleugh; Rapporteur A. Caltabiano; Chat Moderator N. Van der Wel)

- Enhancing WCRP's collaboration with our co-sponsors and allied programmes and activities [15 mins] (D. Stammer/H. Cleugh)
- Preparation for COP 26 and UNFCCC [10 mins] (D. Stammer/M. Sparrow)
- WCRP Secretariat report on activities, connections to other support units, expenditure [10 mins]
- Regional Consultations / Climate Research Forums (Helen, 10 mins)
- Forthcoming events, meetings and conferences (e.g., the WCRP Open Science Conference) (Detlef/Helen/Mike) [10 mins]
- Update on WCRP Carbon footprint [10 mins] (P. Friedlingstein)
- New and emerging science issues [15 mins] (H. Cleugh, D. Stammer)
- Adjustments to finances and governance [15 mins] (D. Stammer, H. Cleugh, M. Sparrow)
- Communication across WCRP [10 mins] (N. Van de Wel/H. Cleugh)
- Implementation plan writing [15 mins] (D. Stammer, H. Cleugh)
- Wrap-up and close of the open session of JSC-42 *(*D. Stammer, H. Cleugh*)*

18:30 - 19:30 After Session Social Hour (up to 60 mins)

End of Day 5

Day 6 (8th July): 21:00 to midnight CEST *JSC-only meeting*
Note: Day 6 is for ***JSC Members and the WCRP Secretariat only*** **21:00 - 21:30 Internal JSC only (no WCRP Secretariat)**
21:30 - Midnight WCRP - JSC Business
(Chairs D. Stammer and H. Cleugh; Rapporteur A. Caltabiano; Chat Moderator N. Van der Wel)

Note that additional documents will be provided to the JSC only via a DropBox link

- Review of Actions from JSC41 and JSC 41B [15 mins] (M. Sparrow)
- WCRP Secretariat session: budget, staff planning etc. [15 mins] (M. Sparrow)
- *Future strategies for WCRP resource investments [15 mins] (D. Stammer, H. Cleugh)*
- JSC future membership [10 mins] *(D. Stammer, H. Cleugh, M. Sparrow)*
- Core-activity memberships [30 mins] *(D. Stammer, H. Cleugh, M. Sparrow)*
- Updates on international project offices and plans for other support units (as needed) [15 mins] *(D. Stammer, H. Cleugh, M. Sparrow)*
- *Missing science and further developments [15 mins] (D. Stammer, H. Cleugh)*

10 min break

- *Enhancing collaborations and communications* (e.g., interactions with e.g. Belmont, Future Earth etc.) *[15 mins] (D. Stammer, H. Cleugh)*
- AOB *(all)*
- Closing *(D. Stammer, H. Cleugh)*
  The JSC are asked to comment and approve as applicable

Annex 3 – Acronyms

10NICS	10 New Insights in Climate Science 2020
AGU	American Geophysical Union
AIMES	Analysis, Integration and Modelling of the Earth System
AMOC	Atlantic Meridional Overturning Circulation
AR6	Sixth Assessment Report (IPCC)
BCCR	Bjerknes Centre for Climate Research
C4MIP	Coupled Climate Carbon Cycle Model Intercomparison Project
CEST	Central European Summer Time
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellite
CliC	Climate and Cryosphere (WCRP)
CLIVAR	Climate and Ocean Variability, Predictability and Change (WCRP)
CMIP	Coupled Model Intercomparison Project
CMIP6	CMIP Phase 6
COP	Climate Change Conference of the Parties (UN)
COP-26	26th COP
CORA	Coordination Office for Regional Activities (WCRP)
CORDEX	Coordinated Regional Climate Downscaling Experiment
COVID-19	Coronavirus Disease 2019
CRF	Climate Research Forum (WCRP)
DAMIP	Detection and Attribution Model Intercomparison Project
DAOS	Data Assimilation and Observing Systems (WWRP)
DCPP	Decadal Climate Prediction Project (WCRP)
EBUS	Eastern Boundary Upwelling System
ECCC	Environment and Climate Change Canada
ECR	Early Career Researcher
ECSAT	European Centre for Space Applications and Telecommunications
ENSO	El Niño-Southern Oscillation
EPESC	Explaining and Predicting Earth System Change (WCRP)
ES	Earth System
ESA	European Space Agency
ESMO	Earth System Modelling and Observations (WCRP)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
ESRIN	ESA Centre for Earth Observation
FIO	First Institute of Oceanography (of the Ministry of Natural Resources) (China)
FROGs	Frequent Rainfall Observations on GridS
GASS	Global Atmospheric System Studies (GEWEX)
GAW	Global Atmosphere Watch (WMO)
GC	Grand Challenge (WCRP)
GC Carbon	GC on Carbon Feedbacks in the Climate System (WCRP)
GC Clouds	GC on Clouds, Circulation and Climate Sensitivity (WCRP)
GC Extremes	GC on Weather and Climate Extremes (WCRP)
GC Melting Ice	GC on Melting Ice and Global Consequences (WCRP)
GC NTCP	GC on Near-term Climate Prediction (WCRP)
GC Sea Level	GC on Regional Sea-Level Change and Coastal Impacts (WCRP)
GC Water	GC on Water for the Food Baskets of the World (WCRP)
GCB	Global Carbon Budget
GCOS	Global Climate Observing System (WMO)
GCP	Global Carbon Project
GDAP	GEWEX Data and Analysis Panel (GEWEX)

GEP	Global Extremes Platform (WCRP)
GERICS	Climate Service Center Germany
GEWEX	Global Energy and Water Exchanges (WCRP)
GFCS	Global Framework for Climate Services
GHP	GEWEX Hydroclimatology Panel
GLACE-CMIP5	Global Land–Atmosphere Coupling Experiment–Coupled Model Intercomparison Project phase 5
GLASS	Global Land/Atmosphere System Study
GOOS	Global Ocean Observing System (IOC-UNESCO)
GPCs	Global Producing Centers (WMO)
GSDR	Global Sustainable Development Report
GSOP	Global Synthesis and Observations Panel (CLIVAR)
HAPPI	Half A degree additional warming, Projections, Prognosis and Impacts
HydroSOS	Global Hydrological Status and Outlook System (WMO)
IAI	Inter-American Institute for Global Change Research
ICG	Interim Coordination Group
ICMPO	International CLIVAR Monsoon Project Office
IGAC	International Global Atmospheric Chemistry
iLEAPS	Integrated Land Ecosystem-Atmosphere Processes Study
IMBeR	Integrated Marine Biosphere Research
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IOCR	Integrated Ocean Carbon Research
IORP	Indian Ocean Region Panel
IPCC	Intergovernmental Panel on Climate Change
IPWG	International Precipitation Working Group
IPO	International Project Office
IPSL	Institut Pierre-Simon Laplace
ISC	International Science Council
JCRF	Joint Climate Research Fund (WCRP)
JSC	Joint Scientific Committee (WCRP)
JSC-4*n*	*n*th Session of the JSC
LC	Lead Centre (WMO)
LHA	Lighthouse Activity
LIAISE	Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment
LS3MIP	Land Surface, Snow and Soil moisture Model Intercomparison Project
LSCE	Laboratoire des sciences du climat et de l'environnement
LUMIP	Land Use Model Intercomparison Project
MIP	Model Intercomparison Project
MoU	Memorandum of Understanding
NMHS	National Meteorological and Hydrological Services
NSF	National Science Foundation
NUIST	Nanjing University of Information Science and Technology
Obs4MIPS	Observations for Model Intercomparison Projects
OOPC	Ocean Observations Physics and Climate
OSC	Open Science Conference
PAGES	Past Global Changes
PICES	North Pacific Marine Science Organization
RB	Research Board (WMO)
RCP	Representative Concentration Pathway
RFP	Regional Focal Point
RHPs	Regional Hydroclimate Projects

RIfS	Regional Information for Society (WCRP)
S2S	Subseasonal to Seasonal Prediction Project (WCRP, WWRP)
SAT	Science Advisory Team
SBSTA	Subsidiary Body for Scientific and Technological Advice (UNFCCC)
SDG	Sustainable Development Goal (UN)
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SIBER	Sustained Indian Ocean Biogeochemistry and Ecosystem Research
SOLAS	Surface Ocean - Lower Atmosphere Study
SPARC	Stratosphere-troposphere Processes And their Role in Climate (WCRP)
SRI	Sustainability Research & Innovation (Congress 2021)
SSG	Scientific Steering Group (WCRP)
SSPs	Shared Socio-economic Pathways
TCRE	Transient Climate Response to cumulative carbon Emissions
TIRA	Task Team for the Intercomparison of Re-Analysis
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization (UN)
UNFCCC	United Nations Framework Convention on Climate Change (UN)
USGCRP	U.S. Global Change Research Program
VOLMIP	Volcanic Forcings Model Intercomparison Project
WCRP	World Climate Research Programme
WGCM	Working Group on Coupled Modeling (WCRP)
WGNE	Working Group on Numerical Experimentation (WCRP, RB)
WGSIP	Working Group on Subseasonal to Interdecadal Prediction (WCRP)
WIP	WGCM Infrastructure Panel (WCRP)
WMO	World Meteorological Organization
WWRP	World Weather Research Programme
YESS	Young Earth System Scientists Community
ZECMIP	Zero Emissions Commitment Model Intercomparison Project

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