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Action Items

Number	Action	Responsible	Due Date
1	GEWEX to share their white paper on the science direction and implementation needs for GEWEX for the next decade.	GEWEX Chairs and IPO	Before GEWEX Scientific Steering Group Meeting
2	Determine how best to tackle the issue of geoengineering/climate intervention, including: i) where it sits structurally in the new WCRP, and ii) developing a focused workshop with partners on the science of climate intervention	JSC Chairs, WCRP leadership	March 2021
3	Investigate and report on how best to facilitate communication and collaboration throughout WCRP, between Homes, Lighthouse Activities and other WCRP elements towards a new Communication Plan (part of the Implementation Plan)	WCRP Secretariat (in consultation with community)	Conclusions in advance of JSC-42
4	Determine how to incorporate Artificial Intelligence and Machine Learning practices more fully within WCRP and with partners	Digital Earths, Model-Data Home with WCRP Co-sponsors	JSC-42
5	Determine mechanisms to connect local and regional scale activities to our global framing	JSC and regional consultation leads	JSC-42
6	Investigate mechanisms for engaging with partners to ensure that multiple conversations on similar topics of relevance to WCRP are not occurring	WCRP leadership, Secretariat and international offices	JSC-42
7	Explore whether a cross-cutting working group on tipping points and early warning systems has merit (bearing in mind activities of LHAs)	JSC and WCRP leadership	JSC-42
8	Facilitate coordination between the Grand Challenges and Lighthouse Activities/Homes to map how the lessons learned and activities of the Grand Challenges can be taken forward into the other activities, where appropriate; discuss with Grand Challenge leads how they will sunset and contribute to the WCRP Open Science Conference.	WCRP Secretariat, JSC Chairs, Grand Challenge and Core Project leads etc.	JSC-42

Number	Action	Responsible	Due Date
9	Consider the benefits and outcomes of a 'lessons learned from the IPCC process' workshop to take place after summer 2021	JSC, WCRP leadership	September 2021
10	Provide advice and support to the WCRP Academy Lighthouse Activity on funding possibilities and structures	WCRP Secretariat	January 2021
11	Finalize Core Project/Home reviews/plans	Core Project/Home Chairs	JSC-42
12	Develop drafts of the LHA Science Plans, ensuring an adequate consultation process	Lighthouse Activity Chairs	JSC-42
13	Identify pilot or inception activities for the Lighthouse Activities	Lighthouse Activities	March 2021
14	Develop a strategy to ensure that WCRP increases its geographical diversity across the Programme	JSC	Plan by JSC-42
15	Streamline and expand WCRP Secretariat and international office support. This includes determining how best to provide long-term support (financial and human) to the WCRP Lighthouse Activities.	WCRP Head, JSC leadership	Ongoing with report to JSC-42
16	Establish two working groups on 1) governance and 2) budget and communications	JSC	prior to JSC-42
17	Write a letter to the Extremes team explaining how to frame the Global Extremes Project proposal	JSC Chair and Vice-Chair, Lisa Alexander	February 2021
18	Determine a process for approving cross-cutting project proposals (including any office support) that makes the best use of opportunities without altering the high-level WCRP structure	JSC, WCRP Secretariat	JSC-42
19	Send a note to the JSC about the Seasonal to Subseasonal (S2S) membership proposal	WCRP Secretariat	December 2020
20	Establish a budget process, where a sub-group of the JSC works with the Core Projects to determine a pre-negotiated budget, perhaps with a mid-year review.	JSC, Head WCRP	prior to JSC-42
21	Send an annual communication to Nations explaining WCRP's use of previous contributions and new plans.	WCRP Secretariat	start process by Q1 2021

Number	Action	Responsible	Due Date
22	Develop an externally-focused high-level brochure about the new WCRP	WCRP Secretariat	February 2021
23	Determine how to promote the Grand Challenge accomplishments: a series of products to celebrate the accomplishments (brochure, paper, video) of the Grand Challenges and other sunsetting activities	Grand Challenges, JSC WCRP Secretariat	JSC-42
24	Determine and report back on how to better involve the JSC in the 10 New Insights in Climate Science and also for the next WMO report and other similar cases	JSC Chair and Vice-Chair, Head WCRP	March 2021

Decisions

Number	Decision
1	The JSC decided to hold a focused workshop with partners on the science of climate intervention (geo-engineering).
2	The JSC endorsed the community's agreement to support, in principle, the soft implementation to a new WCRP structure. This effectively means that the WCRP will move towards its new structure from 2021 onwards, as presented in the timeline at JSC41B. This also means that our research activities will start operating within the new structure before all new Core Projects/Homes and Lighthouse Activities are fully designed and implemented.
3	The JSC decided that Core Projects/Homes and Lighthouse Activities must ensure diversity (gender, geopolitical etc.) in their planning and transition. Linked to ACTION 14.
4	The JSC supported recommendations from the CMIP-IPO selection committee and will enter the negotiation phase with the top-ranked proposer. The agreement will be passed by the JSC before signing.
5	The JSC endorsed the 2021 draft WCRP budget
6	The JSC will work with the two new Homes (Earth System Modelling and Observational Capabilities and Regional (Climate) Information for Society) to develop a workshop for each

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1. Introduction and session opening

An Extraordinary Session of the WMO/IOC-UNESCO/ISC Joint Scientific Committee (JSC) of the World Climate Research Programme (WCRP) was held from 30 November to the 9 December 2020. The open part of the Session took place from 30 November – 3 December, with three-hour-long online meetings each day, and a closed (JSC-only) meeting was held online on 9 December. The participant list and agenda can be found in Annexes 1 and 2, respectively. Online documents can be found on the [WCRP website](#).

1.1. Terminology

The Extraordinary Session of WCRP JSC was principally convened to discuss and decide on the transition of the Programme to a new structure, including plans for new projects and activities. Some of the new entities proposed have yet to settle on their final names resulting in a few cases where multiple names are being used for the same entity. For clarity, please note:

- “Core Projects” and “Homes” refer to the same structural element. In the old structure, WCRP had four Core Projects. In the new structure there are six Homes (the 4 Core Projects and two additional projects). The term ‘Home’ is not final, but in this report both Home and Core Project are used depending on the discussion that was had.
- The two new Homes referred to above are officially called 'Earth System Modelling and Observation Capabilities' and 'Regional (Climate) Information for Societies.' The former is often referred to as the 'Model-Data' Home and the latter is often shortened to 'RIfS', which stands for Regional (Climate) Information for Society. Society is used sometimes in the singular and sometimes in a plural form.

The final names for these and other new entities will be finalized at the 42nd Session of the JSC in June 2021.

In addition, when we refer to the 'regional consultations,' we are talking about the 'Climate Research Forums' that are starting in 2021.

1.2. Session opening

The Extraordinary Session of WCRP JSC (JSC-41B) opened online at 15:00 Geneva/Paris time on 30 November 2020. The Session was opened by the JSC Chair, Detlef Stammer, JSC Vice-Chair Helen Cleugh, and the Head of the WCRP Secretariat, Mike Sparrow.

Detlef Stammer began by welcoming everyone to the Session. He noted that the Extraordinary Session is a follow up to, and will build on discussions from, the 41st Session of the JSC (JSC-41) that was held in May 2020. During JSC-41, a draft of what the new WCRP would look like was agreed, but it was necessary to do some 'homework' throughout the community to determine how the structure might work. Detlef explained that during JSC-41B, community leaders will report back and decisions will be made on the transition phase to a new structure. Detlef stressed that it will take time to finalize all of the details, so a soft transition will be implemented at the beginning in 2021. He stated, "the goal of this meeting is to mark the transition to the new WCRP structure and decide on what that new structure will look like."

Helen Cleugh welcomed everyone and introduced and welcomed the two new JSC members, Maria Ivanova and Roberto Sanchez-Rodrigues, giving a brief introduction to each. Detlef then

introduced the representatives of the three WCRP co-sponsors: The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), the World Meteorological Organization (WMO), and the International Science Council (ISC).

Vladimir Ryabinin, Executive Secretary of IOC-UNESCO gave a brief statement, noting that there are major advances happening in relation to the ocean and the ocean-climate nexus. He explained that this combination is the source for new thinking, especially about the state of the ocean and how to manage it. We are facing major issues that require science to contribute to the Ocean Science Decade and Sustainable Development Goals (SDGs). For the Ocean Science Decade there are 10 challenges and one of them is on the nexus between climate and ocean. Vladimir invited WCRP, with the community's huge intellectual potential, to be involved in this challenge and respond to the call for action (deadline in January 2021). The Ocean Decade will make a strong contribution to climate change and the energy, carbon, and water cycles and to many other research areas that are part of WCRP core activities.

Jürg Luterbacher (Director of Research and Chief Scientist, WMO) welcomed participants on behalf of WMO and Elena Manaenkova (Deputy Secretary General of WMO). He noted that WMO remains a strong co-sponsor of WCRP and is looking forward to connecting with WCRP's new Lighthouse Activities (LHAs) and structures.

Heide Hackmann (Executive Director of ISC) was not available to attend the Session.

Mike Sparrow welcomed everyone and asked participants for approval of the agenda. There were no changes requested.

2. WCRP Implementation Plan and future structure: update on progress to date

Detlef and Helen provided an overview of progress made since the [WCRP Strategic Plan 2019 – 2028](#) (WCRP, 2019) was approved in 2019. The Strategic Plan defines WCRP's Vision and Mission, provides four Scientific Objectives (Figure 1), and outlines the infrastructure required and the coordination needed to achieve them. They noted that the Strategic Plan was, on purpose, a fairly lean document and did not provide the finer details of the Scientific Objectives. This was because a ten-year plan needs to be flexible.

To think about the detail required when implementing the Strategic Plan, Detlef explained that two implementation priorities were established:

1. Foster and deliver the scientific advances and future technologies required to:
 - Advance understanding of the multi-scale dynamics of Earth's climate system
 - Quantify climate risks and opportunities
2. Develop new institutional and scientific approaches required to:
 - Co-produce cross-disciplinary regional to local climate information for decision support and adaptation
 - Inform and evaluate mitigation strategies

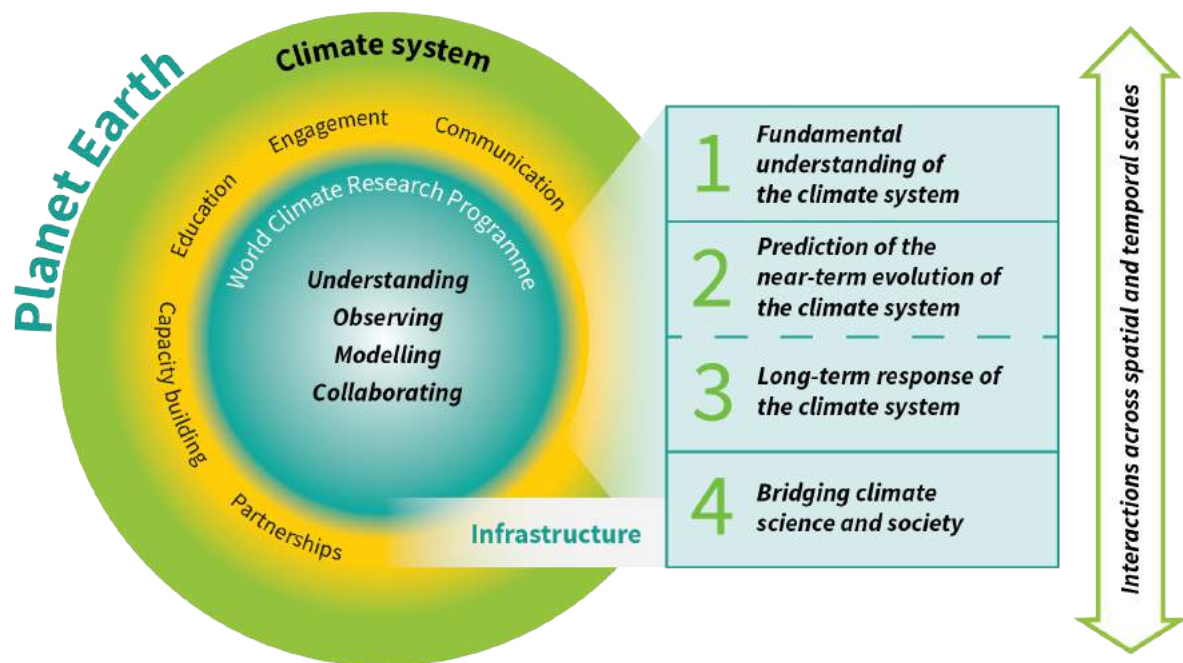


Figure 1: The four Scientific Objectives of the WCRP Strategic Plan 2019 – 2028.

Detlef noted that, over the next decade, climate science and society will need to take a big step forward – there is real urgency. Detlef then gave an overview of the proposed Lighthouse Activities (LHAs) (Table 1). These are big-ticket items where WCRP can make a real difference – not alone, but with partners.

Table 1 - WCRP Lighthouse Activities

Provisional Name	Objective
Explaining and Predicting Earth System Change	To design, and take major steps toward delivery of, an integrated capability for quantitative observation, explanation, early warning, and prediction of Earth System Change on global and regional scales, with a focus on multi-annual to decadal timescales.
My Climate Risk	To develop a new framework for assessing and explaining regional climate risk to deliver climate information that is meaningful at the local scale.
Safe Landing Climates	To explore the routes to climate-safe landing 'spaces' for human and natural systems, on multi-decadal to centennial timescales; connecting climate, Earth system, and socio-economic sciences. Explore present-to-future "pathways" for the achievement of key SDGs.
Digital Earths	To develop a digital and dynamic representation of the Earth system, optimally blending models and observations, to enable an exploration of past, present, and possible futures of the Earth system.
WCRP Academy	To establish one or more targeted capacity exchange climate programmes, working with one or more of the other lighthouses and established climate education providers, including universities.

Further information is available on the [WCRP website](https://www.wcrp.org/).

Detlef also noted that there are many high-level science questions that will be addressed as “dynamic” activities, i.e. that may need to be answered by different homes and LHAs working together throughout the Programme.

Detlef explained that in this Session we are here to come to conclusions. As a community, we want to move from the old to a new structure, which is proposed as shown in Figure 2. He then outlined the possible timeline for the soft transition (Figure 3).

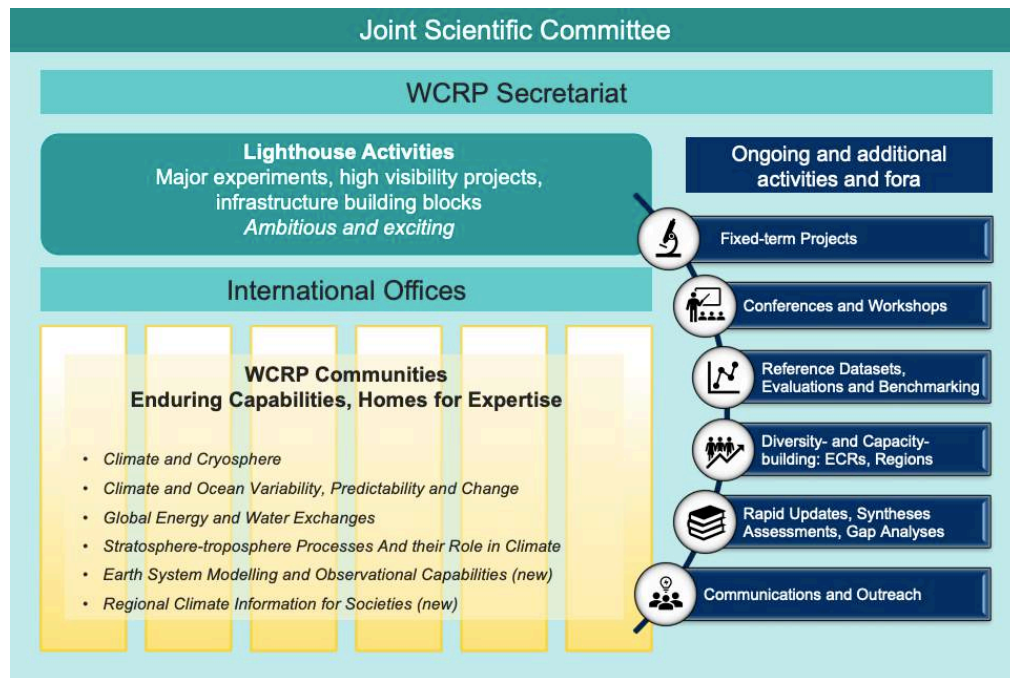


Figure 2 - Draft WCRP Structure

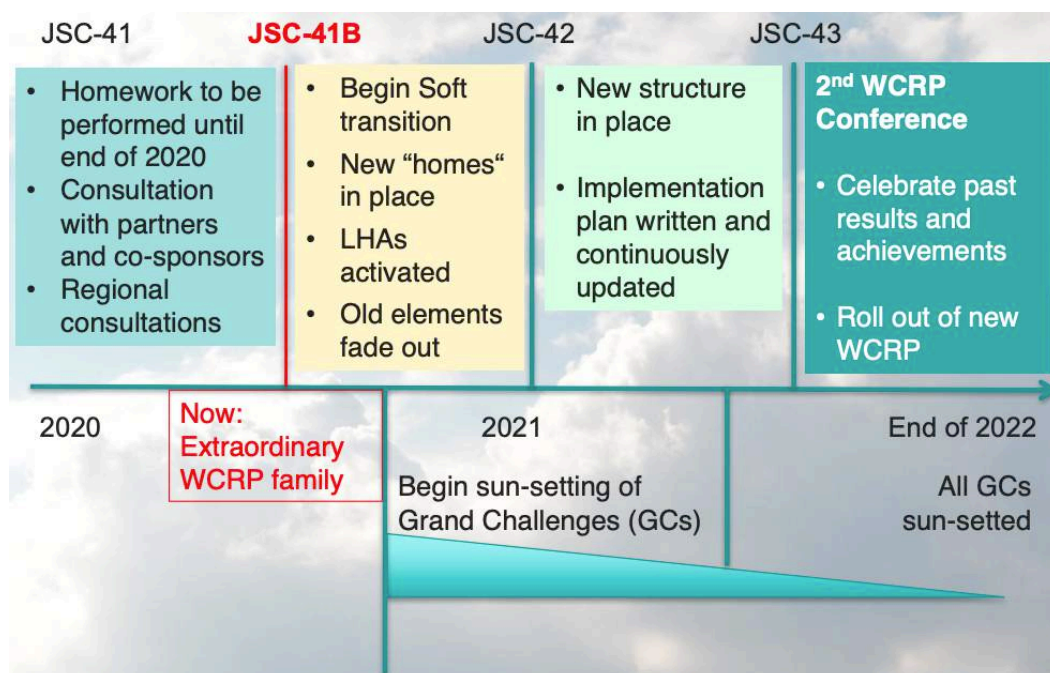


Figure 3 - Proposed timeline for a soft implementation of the new WCRP.

Helen highlighted activities that have been initiated since JSC-41. We have embarked on the consultation and co-design of a new WCRP structure and elements ('Lighthouse Activities' and 'Homes'). She noted that engagement with our partners and funders is critically important. We have been talking with people over the last months and we have plans to continue to develop these discussions in 2021. We also want to make sure that we are engaging with the next generation of scientists and a broader range of communities around the world. This is a work in progress but it is something that we take very seriously. To do what we want to do – to develop and utilize the highest quality science and align with users – by engaging with agencies and partners around the world is very important. In the initial discussions that we have had, there is a lot of enthusiasm and excitement.

Helen outlined that one mechanism for engaging with partners and funders will be the regional consultations ([Climate Research Forums](#)). These came about in response to feedback at JSC-41 that many in our community and family were not as aware of the implementation process for WCRP as they could be. We took this initiative to ensure that we communicate to our own family and to provide a platform for engagement with partners and funders. To do this we defined key regions around the world and asked our core activities to nominate Regional Focal Points. We have had initial discussions with all regions apart from Europe and Western Asia, which is scheduled for January 2021. The virtual meetings that result, called 'Climate Research Forums,' will provide a platform to engage with our broader community, partners, and funders, by marrying top-down and bottom-up approaches.

Helen then went on to explain that the other major development over the last months has been the LHAs. We set up a Science Plan Development Team for each LHA, including nominees from each of the WCRP core activities. The chairs of these teams will present their ideas and progress during this meeting. They are looking at science questions, but they will also look at strengthening the diversity of their teams and fostering communication and engagement inside and outside of the WCRP community.

Detlef and Helen then discussed engagement with partners and funders. Detlef explained that there is now a [Joint Statement](#) between WCRP and Future Earth, and that we now need to build on that and engage with the Future Earth programs¹. Helen explained that there is a renewed connection to START. She outlined that there was a discussion held recently with Jon Padgham (START Executive Director) about the LHAs and the regional consultations and noted that it was very good to reignite that connection. She explained that START can help us to identify new communities to engage with in Africa, Central Asia and Southeast Asia.

Detlef noted that there has been increased interaction with funding agencies, including with the Belmont Forum, the European Commission and the Green Climate Fund. WCRP is coordinating international climate science, but those who are doing the science are funded by national funding agencies. He explained that this is why engaging in the regions is so important. We have submitted a funding proposal to the United States Global Change Research Program (USGCRP) to bring new funding into WCRP activities. He noted that in recent years WCRP's coordination effort has been somewhat hampered due to inadequate funding and we hope that this will soon improve. Mike intervened to support Detlef's statement and noted that funding is being sought on both national and international levels, including a proposal to the UK Royal Society.

Detlef then brought the discussion back to the draft structure, explaining that we now want to turn the blueprint that we have into a fully functioning WCRP, and stating that our soft transition starts

¹ Lisa Miller (SOLAS) asked for WCRP not to refer to programs that are sponsored by Future Earth as Future Earth programs, as it is only part of who they are.

this week: "We will renovate the rooms of our new homes from the inside once we are living in them." He noted that we now have to discuss how we will do this by looking at the budget and governance, by discussing any concerns and new ideas, and by seeing if there is anything that we have overlooked.

Discussion

Maria Ivanova (incoming JSC Member) raised a question about the term 'Lighthouse Activities,' asking if the synonym 'beacon' had been considered since that denotes a point of reference that can guide anything. A beacon could be much more dynamic. Detlef noted that these names are all up for discussion. Greg noted a lighthouse usually marks a hazard to marine navigation that should be avoided. Narelle noted that the term 'beacon' was suggested at the Hamburg workshop in February 2020, but after some discussion the participants had decided to take the name 'Lighthouse' forward.

Victor Brovkin (Analysis, Integration and Modelling of the Earth System (AIMES)) asked about the Memorandum of Understanding with AIMES, explaining that it has been stuck due the pending agreement with Future Earth. Detlef was supportive and Josh Tewksbury stated that he is happy to make the introductions to move this forward. Victor also noted that AIMES now has two new working groups focused on human-environmental interactions (Modeling Earth System and Human interactions (MESH)) and on tipping elements and cascades in the Earth System. He noted that he needs to talk to WCRP about the collaboration of these Working Groups with the LHAs, but it is not yet clear to him how to proceed. It was noted that the LHAs will present on Day 3 of the meeting.

Greg Flato (Co-chair, Working Group on Coupled Modelling (WGCM)) raised the issue of budgets, asking whether there is an update of the situation within WMO. He explained that it is important for WCRP activities to know that there is a sufficient budget and support to achieve the tasks that we are setting ourselves. Mike and Jürg both noted that this will be discussed on Day 4 of the Session. Detlef explained that there is some improvement regarding both the Secretariat positions and also for funding in general. He noted that, post COVID-19, it is unlikely that we will go back to our previous approach in relation to travel. Up to 50% of our meetings may be online, so we should be in a better financial position moving forward. He noted that there remains concern over staffing levels of the Secretariat, even given the new staff positions currently being advertised.

(Rupa) Kumar Kolli (International Climate and Ocean Variability, Predictability and Change (CLIVAR) Monsoons Project Office) stated that the Climate Research Forums are an excellent concept. They engage the community on a larger scale. He asked whether they will be focusing only on regional aspects or also on other topics, such as monsoons and extremes. He also noted that there should be links with the WMO Regional Climate Outlook Forums. Helen responded that we have made connections to the WMO Regional Climate Outlook Forums and that we will utilize what WMO – and our other co-cosponsors – are doing and work together in regions where this will add value. We know that for our community that there needs to be coherency. Whether the WCRP Climate Research Forums are regional or broader is up to the Regional Focal Points who form the local organizing committees. She explained that the Climate Research Forums will start off discussing WCRP generally and then will be based on what is needed. They might be sector based but will be aligned with the core business of WCRP. She confirmed that they are intended to support and complement existing WCRP core business, while engaging with grass roots communities.

Ken Takahashi (JSC Member) noted that WMO Regional Association III – South America established a Working Group on Research last week that should be engaged in the Forums and more generally. His understanding was that WMO Regional Association IV – North America will most likely also create one.

Roberto Sánchez-Rodríguez (incoming JSC Member) expressed his excitement at being part of the WCRP community. He asked whether the WCRP Climate Research Forums are also an opportunity to engage and strengthen linkages with end users of climate science in society. Helen explained that they are one mechanism, but we also have other mechanisms. To address Scientific Objective 4 of the WCRP Strategic Plan (Science for Society), we will establish a new Regional (Climate) Information for Society Home and a new LHA on climate risk (My Climate Risk). The Regional Focal Points have fed back to us that they want to have panel discussions and other formats that will work to engage with users in the Climate Research Forums.

There was a discussion in the chat window on the decolonization of data. Ted Shepherd (Co-chair, My Climate Risk LHA) noted that this will be discussed on Day 3 as part of the My Climate Risk LHA discussion. He also noted that partnerships and governance need to be thought through and may differ for the different activities across WCRP. There may be some cases where partnerships do not facilitate things, such as when you join things up at too many levels so that things become bogged down. In that case a lot of the same people are involved in multiple activities, rather than new people. He further noted that the scope of activities can be too broad. If you end up having things co-sponsored by five groups then it is hard to put a value on individual contributions. He emphasized that we need to think about how partnerships can work in the most productive way possible.

2. Core Projects review: progress report and discussions

2.1. Global Energy and Water Exchanges (GEWEX)

Chair: Lisa Alexander

Graeme Stephens and Jan Polcher (Co-chairs of the GEWEX Scientific Steering Group (SSG)) presented for GEWEX. Graeme began by stating that GEWEX's approach has primarily been through model-data integration, with a focus on process understanding and model improvement. He explained that they connect to society through their regional activities and programs. In the next years, GEWEX will further emphasize satellite and surface-based observations on varying scales in modelling and process understanding. He emphasized that the next decade will be an exciting period for GEWEX, as there will be some fairly major Earth observing activities that are aligned with GEWEX objectives.

Graeme outlined that they began a review of GEWEX more than two years ago, both internally and externally. A new framework was set up to reframe their research questions. They drafted a white paper that articulated the science direction and implementation needs for GEWEX for the next decade, including mapping their activities to the LHAs. It is currently being internally reviewed and he expects it to be completed by the next GEWEX SSG meeting. He noted that they plan to have it reviewed by other groups of WCRP and the World Weather Research Programme (WWRP) as well as by external stakeholders such as USGCRP.

Graeme explained that an overarching theme from GEWEX is to underscore the human impact on the water cycle and focus on the role of high-resolution modelling in influencing our ability to quantify this. The more we go down in scale to represent the hydrological cycle, the more influential the human footprint becomes. This implies careful coordination of the human impact on the water cycle as part of the digital twin of the Earth efforts. The Digital Earth LHA will serve to monitor non-observable variables in the Earth system and one of the prime applications will be water resource monitoring. Therefore, it is important to involve land-based sciences from the onset. As Digital Earths LHA will provide information on time and space scales that we can't observe, GEWEX process studies will be useful to this effort.

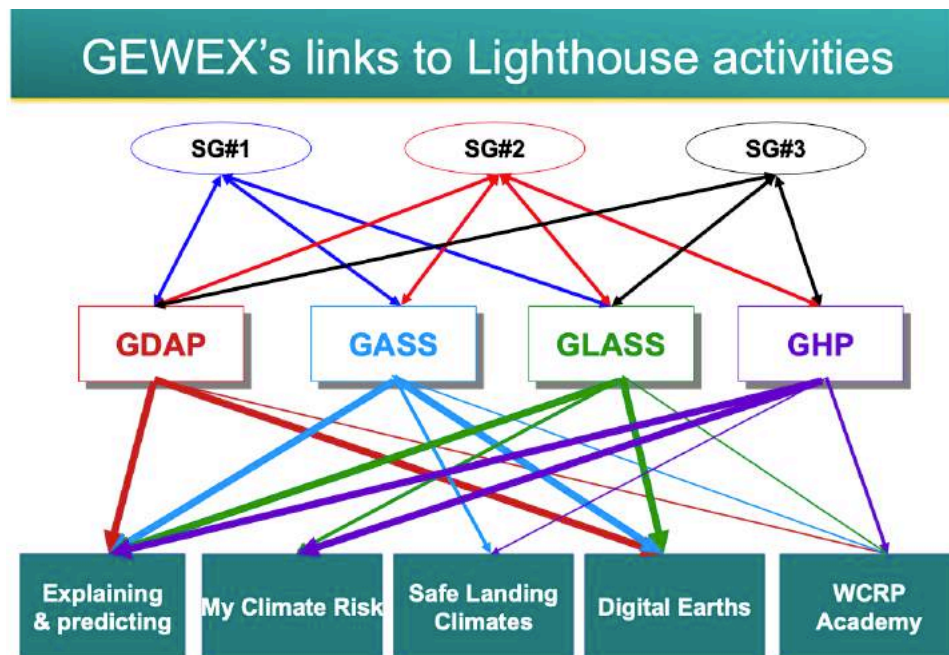
Graeme reported that GEWEX's structure, with its four panels, works well. However, they do see a need to refine GEWEX's goals. They also will continue to integrate activities, both within GEWEX and more widely with WCRP, WMO (including WWRP) and Future Earth (and its programs). The International GEWEX Project Office is in good shape, but its ability to support meetings and new initiatives remains limited.

Graeme noted that GEWEX has been consulting with partners in wide-ranging ways. One of our panel chairs is a member of WWRP. Both the Global Atmospheric System Studies (GASS) and Global Land/Atmosphere System Study (GLASS) panels have ex-officio members within the Working Group on Numerical Experimentation (WGNE). There is an ongoing discussion with WMO on hydrology and the cryosphere. The relationship between WCRP and Global Climate Observing System (GCOS) needs a wider discussion, with GEWEX data activities being coordinated by the GEWEX Data and Analysis Panel (GDAP). Future Earth has a strong connection with GLASS and aerosol activities, through the Integrated Land Ecosystem-Atmosphere Processes Study (iLEAPS). GEWEX engages with START for capacity building activities, in close collaboration with the GEWEX Hydroclimatology Panel (GHP). He noted that they also see a joint GEWEX and USGCRP focus on precipitation and its prediction emerging.

Graeme explained that GEWEX have been actively engaging with START to entrain more participants from developing countries and more early career scientists. They have been promoting Regional Hydroclimate Projects outside of the dominant WCRP regions (e.g. ANDEX and the Pannonian Basin Experiment (PannEx)). GEWEX actively seeks early career researchers as panel members and for activities and proactively seeks to enhance diversity in GEWEX's leadership.

Graeme outlined GEWEX's three science goals: 1 - Determine the extent to which Earth's water cycle can be predicted; 2 - Quantify the inter-relationships between Earth's energy and water cycles to advance our understanding of the system; and 3 - Quantify anthropogenic influences on the water cycle and our ability to understand and predict changes to Earth's water cycle. He noted that these map quite well to the LHAs.

Jan then presented how the GEWEX science goals map to the proposed LHAs in more detail (Figure 4). He explained that the GEWEX panels helped to define the science goals, which then bind the panels together.



Panel to LHAs arrows should become bidirectional over time !

Figure 4 - Mapping of the GEWEX Science Goals, GEWEX Panels and the Lighthouse Activities (LHAs)

Jan explained that the arrows between the GEWEX Panels and the LHAs in Figure 4 seek to prioritize the importance of the panels for those LHAs. There are thick arrows from all panels to Explaining and Predicting Earth System Change LHA, as this is where GEWEX thinks that the panels will contribute most. GDAP, with its data, and GASS and GLASS, the modeling and prediction panels, will strongly contribute to Digital Earths LHA. GHP, which tries to understand the regional specificities of the water cycle and human interactions, will contribute strongly to the My Climate Risk LHA. He explained that scientists need to disseminate their knowledge, so there are thinner arrows from all panels to the WCRP Academy LHA. There are intermediate arrows between the panels and the LHAs based on the expertise in the panels. He expressed hope that these arrows will become two-way over time.

Jan then commented on the two new Homes. For the 'Earth System Modelling and Observational Capabilities' (Model-Data) Home, Jan explained that GEWEX believes that options 1 and 2 (from a number of governance options presented to the community, for further information refer to the Model-Data Home presentation) are the only workable options. He noted that option 2, which proposed widening the Coupled Model Intercomparison Project (CMIP) brand to include a framework for model-data coordination, would turn the new structure into an Intergovernmental Panel on Climate Change (IPCC) service. Option 1, which proposed a Model and Data Scientific Steering Committee, was in Jan's view more favorable to model-data integrations. For the 'Regional (Climate) Information for Society' (RIfS) Home, Jan outlined that information for regions needs to serve society and should be based on climate knowledge built in WCRP. He noted that the Coordinated Regional Climate Downscaling Experiment (CORDEX) has some difficulties in finding its place in the structure. CORDEX should perhaps be shared between the Model-Data and RIfS Homes. He explained that it could be the panel to link both new homes and other core projects together. Jan also noted that the Digital Earths LHA needs to be a broad and integrative effort. Over land it needs to involve other disciplines (also outside of WCRP) as the model-data integration needs to span many geophysical cycles. He suggested that regional configurations should be key milestones of this LHA.

Discussion

Detlef opened the discussion by asking about Figure 4 (above) showing the links between GEWEX and the LHAs. He noted that there are no links to other Core Projects/Homes. He asked how the GEWEX panels and the new Homes will work together and where the connections are in terms of, for example, observations. In particular, he asked how GEWEX would interact with the Model-Data Home. Jan stated that in terms of observations, GEWEX are looking at observations of the energy and water cycles. That is GEWEX's focus. The LHAs are broader than any one area, so he noted that he thinks that this is where the community will meet, that is, the LHAs are the meeting places of the Core Projects/Homes. Graeme noted that the figure misses another dimension, which is the Core Projects. He explained that we should intersect with the other Core Projects through the LHAs.

Roberto asked if the LHAs could be a two-way dialogue for information on human impact on the water cycle. Jan noted that the anthropogenic influence on the water cycle studies are by nature regional, as each region manages its water differently. GEWEX brings the scientific expertise and community to the table. He noted that GEWEX scientists, however, work on an academic level and do need to know how to talk to users. GEWEX does not have the tools to help users build information for decision makers. We hope that My Climate Risk LHA and the RfS Home will help GEWEX to build a strategy to do that.

Pierre Friedlingstein (JSC Member) stated that the science questions of GEWEX are mostly focused on the energy and water cycles and that they need to include the carbon cycle. He asked why they don't move from a physical to an Earth system-based approach. Jan noted that in that case each Core Project would become a mini WCRP. He explained that the LHAs allow us to go beyond our specialty and to contribute to the wider objectives of WCRP.

Josh Tewksbury (Future Earth) noted that Future Earth are exploring GEWEX data product integration into [PREPdata](#) and are exploring ways to connect GEWEX and WCRP more generally within the PREP partnership.

Sonya Legg (Co-Chair CLIVAR SSG) noted that there are panels that are joint between Core Projects, such as the Monsoons Panel. This is another mechanism by which the Core Projects can interact. Detlef and Helen noted that joint panels between Core Projects is a good idea.

Paco (Francisco) Doblas-Reyes (Co-chair WCRP Modelling Advisory Council (WMAC)) was interested in knowing why option 2 for the Model-Data Home would turn it into an IPCC service. Jan responded that we need panels that are about model integration and building Earth System Models (ESMs), understanding ESMs, and confronting ESMs with data. He explained that CMIP models are important but they are not the only component needed. Graeme added that addressing model biases should be a task of the Model-Data Home.

Keith Williams (Co-chair, WGNE) explained that identifying systematic errors and working with GASS and GLASS to investigate and address them is the main interaction between WGNE/GASS/GLASS at the moment. Greg noted that CMIP plays a key role in illustrating and documenting these systematic errors via coordinated model experiments that are universally accessible, have a common format, and have a growing community and number of tools for analysis. Keith agreed that CMIP is an essential dataset for identifying systematic errors, but there are other sources that can provide additional information on those errors, such as initialized experiments under [TIGGE](#) (global ensemble forecast data). He noted that WGNE tried to pull all

of this information together, for example, through the WGNE Systematic Errors Workshop, and then work with GASS and GLASS to investigate it.

Jan noted that we all have our disciplinary backgrounds so it is good that we have the Core Projects to interact scientifically. The LHAs are where we should meet for interdisciplinary work.

ACTION 1: GEWEX to share their white paper on the science direction and implementation needs for GEWEX for the next decade (GEWEX Chairs and IPO; before GEWEX SSG)

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

Chair: Pascale Braconnot

Sonya Legg opened by reminding everyone of the structure of CLIVAR. CLIVAR focuses on the role of the ocean in climate. It has a scientific plan that was developed a few years ago. Sonya explained that CLIVAR are not reexamining that but are thinking about how to connect to the LHAs and new WCRP structure. They have polled all of CLIVAR's many panels to gauge their interest in the LHAs. Many of the panels are co-sponsored, so there is a strong precedent for this type of structure.

Sonya outlined that CLIVAR has conducted a review. This involved explaining to the panel co-chairs the plans for the LHAs and discussing how CLIVAR can fit into these. A questionnaire was sent out in October 2020 and they have now examined the responses. The decisions based on this review are still under discussion and Sonya expects them to be finalized in early 2021 at the next CLIVAR SSG meeting.

Preliminary recommendations based on the questionnaire are:

- CLIVAR could possibly make GSOP (Global Synthesis and Observations Panel) and OMDP (Ocean Model Development Panel) joint panels with the new Earth System Modeling and Observational Capabilities Home. This is because OMDP connections could be improved with WGNE and other working groups.
- CLIVAR would like to retain all of the regional panels as homes of regional expertise but encourage direct links with relevant LHAs and new homes. CLIVAR has very good regional representation due to the regional panels. However, they want to encourage better integration of models and observations to focus on specific science questions.
- CLIVAR want to strengthen communication between their panels, e.g. with cross-panel workshops.
- Post-pandemic, CLIVAR wants to retain virtual meetings for panel business and in person meetings for focused science workshops.
- In terms of diversity, CLIVAR already considers geographical and gender diversity for panelists. They would like to include more people from countries that are not well represented and early career scientists (e.g. from the Young Earth System Scientists (YESS) Community) on all panels, especially from less well represented countries. More virtual meetings will enable better early career participation.
- The Grand Challenge on Regional Sea-Level Change and Coastal Impacts (GC Sea Level) is a model for connecting scientists across disciplines with the user community. They need to retain these links within the LHAs.
- WCRP must ensure mechanisms for the Core Projects to connect their expertise with the LHAs. We need a mechanism for dynamic, ongoing, two-way interactive communication. We want to make sure expertise is transferred to the LHAs when it is needed. We also have a lot of data and we want to make sure that this data gets fed into the Model-Data Home and into the LHAs.

Sonya outlined that CLIVAR has communicated the new WCRP plans with the Scientific Committee on Oceanic Research (SCOR), the Integrated Marine Biosphere Research (IMBeR) Project, the Partnership for Observation of the Global Ocean (POGO), the Surface Ocean Lower Atmosphere Study (SOLAS), and the North Pacific Marine Science Organization (PICES) (joint working group on climate and ecosystem predictability). She noted that the UN Ocean Decade is a route for connecting CLIVAR/WCRP science with partners/public/user communities.

Discussion:

Detlef stated that joint panels would be a good way forward and could also resonate with GEWEX. It could be a good model for bringing the work and the expertise into all entities involved. Helen noted that, as the LHAs and Core Projects are thinking about their governance, they should consider that joint panels are useful for shared oversight. There are other mechanisms as well, such as jointly designing a research project.

Marie-France (Executive Director, Past Global Changes (PAGES)) noted that PAGES was not mentioned as a partner of CLIVAR. Sonya responded that her list was of partners consulted so far and that this has mostly depended on the timing of meetings. They very much wish to continue collaborating with PAGES.

Detlef noted that the Grand Challenges (GCs) will sunset. These groups need to think about whether some parts need to be continued and where that should sit on the new structure. For the Grand Challenge on Sea Level and Coastal Impacts (GC Sea Level), there might be a home in the RfS Home or in the My Climate Risk LHA. Sonya agreed, but noted that this needs to be set up so we don't lose the connections and knowledge. Jing Li (Staff Scientist, CLIVAR) noted that the six working packages of the GC Sea Level have their own science priorities, and these should be considered moving forward under the new structure of WCRP. They are the basis for generating information and services for society.

Rowan Sutton (Chair, Explaining and Predicting Earth System Change LHA) confirmed that it is important to have communication mechanisms in mind. He asked Sonya if CLIVAR had ideas on how to proceed. Sonya noted that they did not talk about specifics, but perhaps Slack channels etc. could work. Helen stated that the need for effective communication and engagement is very much on her and Detlef's minds. She asked everyone to think what would work for them. Maybe we can establish some principles and protocols. Slack channels are one option. Paco added that we could go to wikis and ticketing systems. Sonya noted that it would be nice to have something top-down that is established from the start. Then new people can get involved and we have continuity as well. Detlef noted that wikis are popular, but you still have to look there. We may need to bring Core Project and LHA leads together regularly. There will be multiple levels of communication needed. Sonya noted that WCRP's strongest role is connecting people around the globe. Research funding is national or regional. We should make that connection an integral part of WCRP.

Gaby Langendijk (YESS) expressed that it is great that CLIVAR is thinking about having early career researchers on each of its panels and noted that YESS would be happy to work with CLIVAR on implementing this initiative. Sonya confirmed that having YESS scientists on all of the panels may also help the panels to communicate better. Mike noted that in addition to YESS there are other early career networks (e.g. Association of Polar Early Career Scientists (APECS), Young Hydrologic Society (YHS)). Gaby noted that certainly it would be important to engage with all relevant early career networks and have transparent processes to engage/appoint early

career researchers in activities/panels to ensure all those who are interested can apply. She noted that YESS collaborates closely with APECS and YHS.

Pascale Braconnot (JSC Member) reflected that Sonya noted that the regional approach is very important in the CLIVAR panels. She asked Sonya what elements she sees as being very important to keep as part of CLIVAR activities. Sonya responded that it is important to keep the expertise around each ocean basin, so that there is a picture of the physics in each basin. Then we want to connect across basins to examine processes/phenomena, including modelling. Going forward there can be more cross-panel workshops, focusing of different scientific processes. The panels can work through virtual activities.

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

Chair: Tercio Ambrizzi

Seok-Woo Son (Co-Chair of the SPARC SSG) presented on behalf of SPARC, explaining that SPARC has put together a Strategy Task Team that reviewed the current structure and its strengths and weaknesses, and discussed possible future science topics and the future structure of SPARC. Seok-Woo explained that the YESS Community and the International Global Atmospheric Chemistry (IGAC) Project of Future Earth were represented in the Task Team. He noted that, going forward, discussions will continue within SPARC, the Task Team, and the community. The new SPARC strategy and implementation plan will be completed in time for the JSC-42 Session (June 2021).

Seok-Woo reminded attendees that SPARC is positioned at the interface of the weather and climate communities – bridging WCRP and WWRP. Its current foci include to:

- Encourage focused research activities in the context of the LHAs
- Provide dynamical insights into modeling studies and technical support for model analysis
- Take the lead in emerging areas e.g. Machine Learning (ML) / data science topics
- Collect code bases, data, open-source tools and make them accessible
- Maintain and advance long-term climate records for large assessments (IPCC, WMO/United Nations Environment Programme (UNEP) Ozone, etc.) and mission planning
- Address local impacts of climate change
- Consider climate intervention/geoengineering (i.e., radiation management)

Seok-Woo explained that the SPARC Task Team highlighted the need to take on a whole-atmosphere approach. Focused activities were still needed but some current activities could be merged. It was found that there needs to be better engagement with early career scientists and other less well represented communities. A more regional approach to issues was encouraged.

In terms of the way in which SPARC might work in the future, the Task Team suggested that this could be a mixture of traditional workshops on specific topics, for example, on i) the use of CCMI (Chemistry-Climate Model Initiative) model runs on chemical impacts of geoengineering to connect to other geoengineering communities; ii) a heat storage in the Earth system publication as a joint outcome of SPARC/CLIVAR/GEWEX, as well as online seminars and platforms. New forms of SPARC products could be considered. The need to reach out more to users and policy makers was also highlighted.

In terms of consulting with key partners, Seok-Woo highlighted collaboration with IGAC as being key for many activities (e.g. tropospheric expertise; connection to regional communities). Collaboration with the Global Atmosphere Watch (GAW) Programme of WMO has always been important. This will be emphasized more now that the initial stage of the SPARC review is complete. SPARC has always had a strong engagement with the Subseasonal to Seasonal (S2S) community and this should be explored further as WCRP moves into the new structure.

Discussion:

Helen commented that there was a lot to take in from this excellent review. She picked up on the role of WCRP in geoengineering/climate intervention, suggesting that WCRP could have a focused workshop or activity on the topic. Mike reminded attendees that the science behind geoengineering/climate intervention is also considered in two of the Model Intercomparison Projects (MIPs) as well as in UN bodies such as the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP). Estelle added that this topic is also considered by the WWRP Weather Modification Expert Team.

Neil Harris (Co-Chair SPARC SSG) commented that because SPARC doesn't have panels like the other Core Projects it is sometimes not as easy to develop connections with other WCRP activities, so perhaps SPARC needs to rethink its structure a little more. He noted that it is also important to emphasize the need to work with GAW and others on, for example, ozone research. Connections with S2S and the role of SPARC in monsoons research also need to be considered. This will all be discussed in the next stage of the SPARC review.

ACTION 2: Determine how best to tackle the issue of geoengineering/climate intervention, including: i) where it sits structurally in the new WCRP, and ii) developing a focused workshop with partners on the science of climate intervention (JSC Chairs, WCRP leadership; March 2021)

DECISION 1: The JSC decided to hold a focused workshop with partners on the science of climate intervention (geo-engineering).

2.4. Climate and Cryosphere (CliC)

Chair: Jens Hesselbjerg Christensen

James Renwick (Co-Chair of the Climate and Cryosphere (CliC) SSG) highlighted where CliC fits into the proposed new WCRP structure, in particular with relation to the LHAs (Figure 5). As an example, the new CliC Fellowships are relevant to the WCRP Academy LHA.

James explained that a lot of CliC's energy has been directed towards negotiations regarding the CliC offices (there is now a 50% position in Norway with an additional proposal being revised in the United States). CliC is working to better engage with partners, in particular the Scientific Committee on Antarctic Research (SCAR), the International Arctic Science Committee (IASC) and the Arctic Council's Arctic Monitoring and Assessment Programme (AMAP). It needs to work more on increasing diversity to bring in under-represented nations, improve gender diversity and work more with early career researchers. An important issue is to ensure that the work under the Grand Challenge on Melting Ice and Global Consequences (GC Melting Ice) that is contributing to CMIP is preserved and finds a new home in CliC or elsewhere.

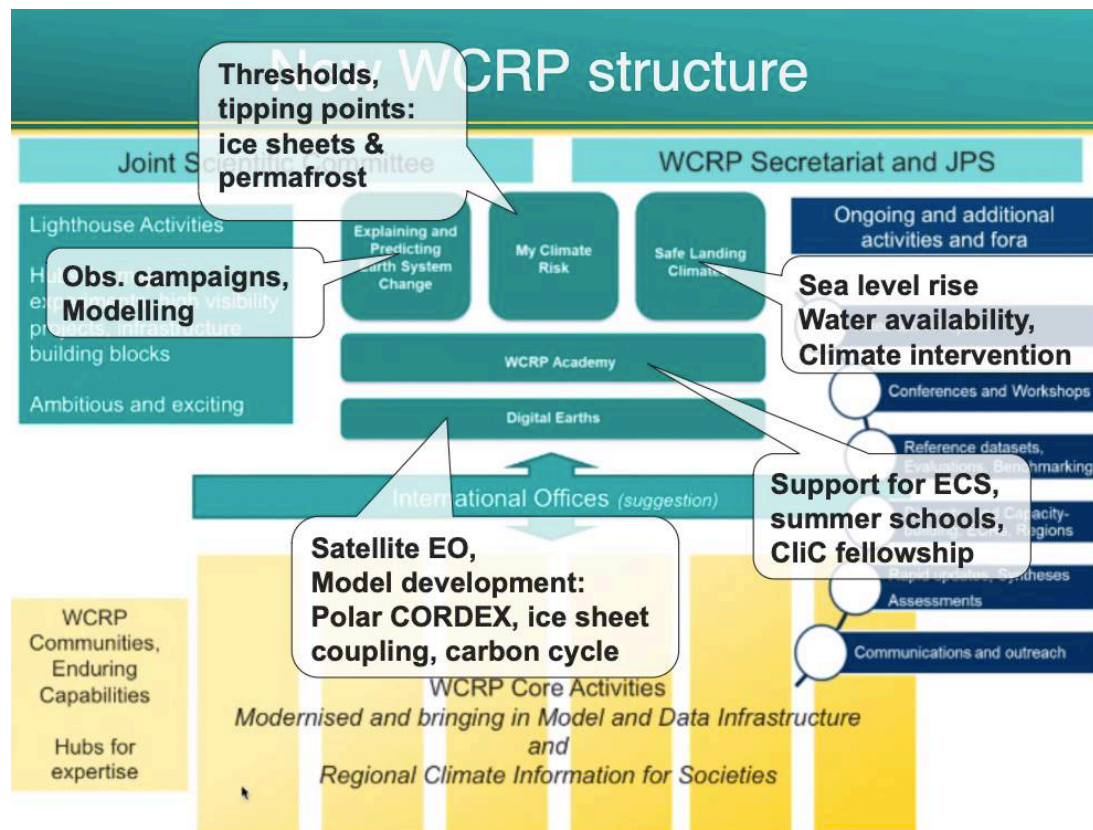


Figure 5 - Connections between CliC and other elements of the new WCRP Structure

Discussion:

Jason Box (CliC SSG) made the point that satellite Earth observations and data assimilation are rapidly rising topics for CliC and beyond. We have the Digital Earths LHA, there is the Copernicus constellation, and new European Space Agency (ESA) – European Commission collaborations are also ramping up.

Martin Visbeck (JSC Member) commented that one disadvantage that CliC has is that there are many other groups with a cryosphere remit. It is important that CliC works in partnership and highlights where it adds value. Mike agreed and added that there are already good examples of this within CliC, such as ASPeCt (Antarctic Sea-ice Processes and Climate) with SCAR and ISMASS (Ice Sheet Mass Balance) with SCAR and IASC.

Jan commented that the connection with GEWEX, particularly in the high mountain regions, is important. Helen emphasized that it's important to engage with and across communities. Lisa M. added that CliC and SOLAS have an extremely active joint activity on Biogeochemical Exchange Processes at Sea-Ice Interfaces (BEPsII), which is tackling issues across almost all of the LHAs. Daniela suggested that we might want to enhance the thematical work cross-cutting WCRP organizational structures through 'scientific question oriented' dynamic teams, which would form for a dedicated time and topic and then stop when done.

Ted commented that its particularly important for the LHAs to be aware of the different parts of WCRP, but that this is not enough. He noted that WCRP sometimes has a tendency to work in silos, so connections are crucial. Daniela agreed, adding that when the content of the LHAs is clearer we can think about connections or an information platform. We need this tool for the

WCRP community. Mike mentioned that we should also ask others, such as Future Earth, what has or hasn't worked for them in terms of communication platforms.

ACTION 3: Investigate and report on how best to facilitate communication and collaboration throughout WCRP, between Homes, Lighthouse Activities and other WCRP elements towards a new Communication Plan (part of the Implementation Plan). (WCRP Secretariat (in consultation with the community); Conclusions in advance of JSC-42).

2.5. Earth System Modelling and Observational Capabilities (Model-Data Home)

Chairs: Detlef Stammer and Helen Cleugh

Francisco "Paco" Doblas-Reyes (Co-chair, WMAC) introduced the purpose of the Earth System Modelling and Observational Capabilities (Model-Data) Home as addressing the overall coordination of modelling, data, and observation activities within WCRP. The aim was defined at the last JSC Session (JSC-41, May 2020) and a task team, led by the chairs of the Modelling and Data Councils (WMAC; WCRP Data Advisory Council (WDAC)) was established to provide feedback on how this could be achieved. The challenges include achieving strong buy-in from the community, noting that this structural change was requested by the community in the past and it is very much appreciated that the JSC responded to this request. Paco noted that we do, however, need to ensure that there are efficient links to the other Homes and LHAs.

Paco outlined that the Model-Data Home vision of serving as an overall coordination mechanism across necessary model, data, and observations activities within WCRP has the following aims:

1. To foster a seamless and value-chain model-data-observation approach across Earth system components, fundamental and applied disciplines, time and spatial scales, infrastructures in support of research, services and policy to optimize the Earth system model developments and formulate the observational requirements to better monitor, understand and predict the climate system (Scientific Objectives 1-4 of the WCRP Strategic Plan)
2. To bring about integrated modelling and data infrastructures, data policy, protocols and standards to serve the broader interest of the Programme (Critical Infrastructures of the WCRP Strategic Plan).
3. To share best practices, data, knowledge, challenges and opportunities, and ensure efficient communication across WCRP constituencies, communities, external partners and stakeholders, with a particular attention to engagement, equal access and inclusion of the 'global south' (Engagement and Partners of the WCRP Strategic Plan). This has been a challenge for a very long time and needs attention.
4. To identify critical stakeholders, scientific ambition and resourcing needs along this model-data-observation value chain, to develop risk mapping and mitigation measures, and to remove fragmentation, duplications and suboptimal aspects in the Programme on those matters.

Paco noted that the aims are very generic, but they have to be fine-tuned with many people going forward. He further explained that they have identified a number of items with regard to the scientific scope of the home. This is a non-exhaustive list:

Data science

- Foster a stronger Earth system approach for reanalyses/assimilation, which currently are largely uncoupled
- Coordinate observations, reanalyses, data science and data management research issues across the programme and across WMO

Modelling

- Promote the understanding and reduction of the many systematic errors found in Earth system models
- Explore the comprehensive use of data science and machine learning

Computing and data infrastructures

- Adopt seamless climate data management – we are facing massive heterogeneity
- Promote the adaptation of codes for exascale computing architectures, data infrastructures and the necessary efficient output management

Paco also noted relationships that they have identified, both internal and external, and again not exhaustive:

Internal

- Linkages to WCRP constituencies, Homes and LHAs

External

- WWRP, GAW, GCOS, space agencies (via the Committee on Earth Observation Satellites (CEOS)/Coordination Group for Meteorological Satellite (CGMS) Working Group on Climate) and Future Earth (e.g., AIMES, PAGES, SOLAS)
- Engagement with data standardization initiatives like NetCDF/CF and the World Data System (WDS) of ISC
- Broader stakeholders like the United Nations Framework Convention on Climate Change (UNFCCC), IPCC (IPCC TG-Data and the IPCC Data Distribution Centre), Global Framework for Climate Services (GFCS) (and initiatives like the Copernicus Climate Change Service (C3S)), IOC-UNESCO, ISC, WMO entities like WMO Lead Centres and Global Producing Centres, National Meteorological and Hydrological Services (NMHSs), Regional Climate Centres, and others

Paco explained that questions that have emerged are what the role for broader engagement opportunities with non-governmental organizations, industry and regional activities is and how to handle the deficit in the global south. We need to break the power relationship between the global north and south (access to data, ability to analyze data, and formulating experiments).

Paco then gave an overview of elements that could be included in the new structure (Figure 6). He noted that there are some question marks about whether the WWRP Working Group on Data Assimilation and Observing System (DAOS), CORDEX and CMIP would be part of the structure in terms of governance, although they all have modelling components and are key elements for a successful Model-Data Home. Paco explained that it has been proposed to have a SSG reporting to the JSC, as well as ex-officio members from other homes, LHAs, WWRP, GAW, GCOS, and others. This would make the Home a horizontal dimension across other homes as

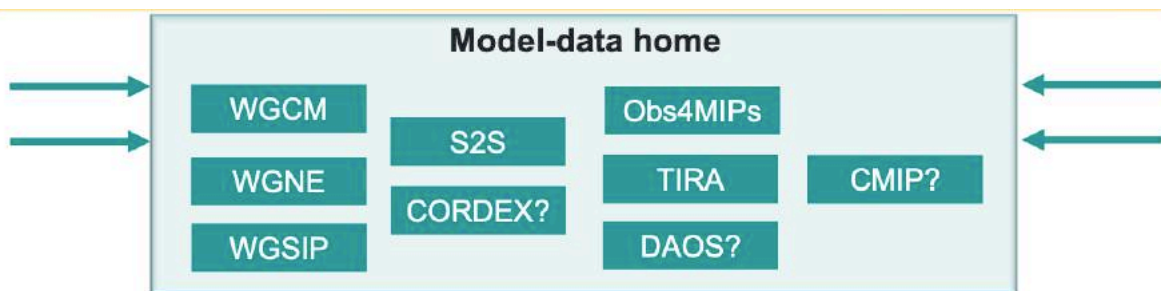


Figure 6 - Groups that may become part of the Model-Data Home. TIRA is the Task Team for Intercomparison of ReAnalyses, WGSIP is the Working Group on Subseasonal to Interdecadal Prediction, and Obs4MIPs is the Observations for Model Intercomparisons Project. The other acronyms have been mentioned in the text and all are available in the list of acronyms in Annex 3.

all of the other homes use data and model simulations. The SSG could be jump started from the representatives of the existing Councils (WMAC and WDAC) and groups brought in, with members rotated to lead to an independent SSG after 2-3 years. There is also the possibility of making use of the excitement around Artificial Intelligence (AI) and Machine Learning (ML) by setting up a new working group in this arena.

In terms of resources, Paco noted that an international office is necessary because we are trying to pull the community together. There is a lot of coordination to be done and information to be shared. The Home is initially taking on a coordination role of existing groups, with their own priorities and momentum. The ambitious objectives will require specific actions to ensure buy-in, adopt a common ground, and merge communities. Paco explained that these efforts need long term funding to not be vulnerable to changes in the availability of soft money.

In terms of the timeline, Paco noted that the schedule will be refined after the JSC-41B Session. A team of 6-8 volunteers (Table 2) is proposed to design the implementation as follows:

Year 1: Set the home's governance, initial SSG, high-level contributions to both LHA and core activities. Define secretariat support arrangements for JSC approval in 2021. Organize a kick-off event to also close the WCRP Data Advisory and Modelling Advisory Councils.

Year 2: Develop/update/revise governance and set specific research priorities with the Home's constituencies and establish the external partnership arrangements for JSC's approval in 2022.

Years 3-5: Implementation of research priorities, resource mobilization, communication and outreach.

Years 6-10: Implementation of a revised plan following a mid-term review taking place in year 5.

Paco noted that additional members should be added to the proposed list (Table 2, below), as there is an underrepresentation of women and of the global south and as the group should also take into consideration the participation of early career researchers.

Table 2 - WCRP leaders who have volunteered to help to implement the Model-Data Home

Member	Representing
Bill Merryfield	WGSIP co-chair
Carolyn Reynolds	WGNE co-chair
Nils Wedi	Incoming WGNE co-chair
Ben Galton-Fenzi	CLIC and WDAC
Tingjun Zhang	CLIC and WDAC
Mark Dowell	former WDAC member and former CEOS/CGMS WG Climate chair
Joerg Schulz	WDAC incoming co-chair and leaving CEOS-CGMS WG Climate chair
Susann Tegtmeier	WDAC co-chair
Gokhan Danabasoglu	OMDP and WMAC
Martin Visbeck	JSC liaison
Masa Kimoto	JSC liaison

Paco ended the talk by explaining that there were four main governance/support options proposed and developed during the Model-Data Home consultation (percentages are preference given by 30 respondents to the survey):

- **Option 1:** Model-Data Home including CMIP governance; separate offices for respective Model-Data Home and CMIP coordination (23%)
- **Option 2:** Equivalent to option 1 but using CMIP branding, slightly revised CMIP framework, office(s) carry the CMIP brand (60%)
- **Option 3:** Model-Data Home NOT including CMIP governance; separate offices for respective Model-Data Home and CMIP coordination (4%)
- **Option 4:** Merger of current Councils without dedicated office support (13%)

The majority of the support from respondents was for Option 2.

Discussion

Keith welcomed the idea of DAOS joining the Model-Data home. He asked whether they know about it and would they like to be involved. Paco said that they know about the establishment of the Home, but there has been no commitment yet as it is at an early phase and we still need to establish the boundaries of the home.

Sonya noted that there is also a possible relationship with CLIVAR panels GSOP and OMDP. Michel Rixen (WCRP Senior Scientific Officer) responded that this is covered under links to the other homes. A practical question is at what level we 'engineer' this connection (e.g. at SSG level or panel level). Sonya responded that the relevant CLIVAR panels would like to be included in communications with this new Home at an early stage. To her, it makes sense to make the connection directly with the experts in the panels.

Ted noted that WCRP should be setting up working groups for areas that need additional attention. AI/ML are not in that category. He noted that things like AI should take place across the Programme. Paco responded that he was talking about creating a group that would cut across Core Projects, rather than boxing it in. He noted that WCRP needs to have a strategy on AI/ML and that WGNE has taken steps along these lines. It is clear, also from SPARC's interest, that it cuts across WCRP. It could sit in the Model-Data Home and be crosscutting. Detlef noted that

WCRP may not need to push things that already have a lot of attention. We need to identify things that don't have so much attention but are important. Paco responded that he did not mean that this would be about pushing AI/ML but more about coordinating efforts that are taking place and keeping everyone aware of what is going on. This was broadly agreed.

Estelle De Coning (Acting Head, WWRP) noted that Earth system modelling, Earth system observations and AI/ML are very important topics for the WMO Research Board, with Concept Notes on these topics being developed to form a guideline for research across WCRP, WWRP and GAW in the near future. Neil noted that we could have a co-sponsored meeting of the different homes on ML/AI and not over-formalize what we do there. He said that SPARC would be very interested. Helen noted that 'a community of practice' could be the way forward. Daniela explained that it will be important to understand which parts of AI/ML will be in WCRP and how the connections to the computer science community are formed.

Rowan asked about the timeline for the CMIP International Project Office (IPO) and the process going forward? Detlef explained that the selection process is on-going and there is a firm plan that all Core Projects/Homes will get their own international office. The CMIP IPO is not currently planned to be the same as the Model-Data IPO.

Ken noted that stakeholders would include countries who need to run regional climate models (RCMs) taking advantage of the large CMIP database but access to such a huge amount of data is a limitation. He suggested that the Model-Data Home and the RfS Home could coordinate the availability of cloud resources for running RCMs (e.g. Weather Research and Forecasting running on Google Cloud) or other tools (e.g. ML) for climate change scenarios.

Jan explained that as we move to ESMs, we need to use more non-conventional climate data. He noted that in GEWEX they struggle to get the global datasets that they need, such as vegetation, lake levels etc. He asked whether they could work together with the Model-Data Home to find ways to work better with the relevant communities to aggregate this data at the global level. Paco agreed that this is a challenge, also for urban climate. We need validation data that may be available but not standardized in a way that we can use it. We will need it to respond to societal challenges. Jan explained that the geography community has these solutions and we should utilize and invest in them. Detlef noted that we need to think about the data sets and machinery that we need and explained that we can also work with partners to achieve these aims.

Steve Sherwood (Co-chair, Safe Landing Climates LHA) asked how broad the modelling scope of the Model-Data Home will be. Will it include vegetation, carbon cycle, models, ice sheet models, Integrated Assessment Models (IAMs) etc.? Paco responded that he wasn't sure about IAMs (that has not been discussed yet), but it would definitely include the carbon (biogeochemistry) and chemistry components of ESMs. The Home will not do all the work to develop these models but will coordinate the elements. He noted that we will need to take into account the modeling needs of the community and that the task is very ambitious. Victor stated that in the AIMES project there is a Working Group on Land Data Assimilation focused on assimilation of carbon fluxes. He suggested that this working group would be a good partner for the Model-Data Home.

Ted raised the importance of CMIP, with its high visibility. He gave his view that it is important to separate the framework of CMIP from the timing of phases, which is driven by the IPCC timetable and can have a negative impact on climate science. He asked why we don't allow the CMIP brand to expand and cover a wider range of activities. Paco responded that this same perspective

has been around, and it is not easy to respond to. CMIP is an important element for the Model-Data Home (and is part of WGCM), but it is not the only element. Greg Flato (Co-Chair, WGCM) explained that IPCC *assesses* science, and CMIP underpins a large body of science that is of course very relevant to IPCC. He did not see CMIP as 'serving' IPCC except in the broad sense that it serves climate science.

Gaby asked what Paco's or the new Home's perspective is on how to strengthen collaboration and scientific exchange between the global and the regional climate modelling communities. For example, in the context of moving to higher resolutions of Global Climate Models (GCMs), further mutual exchange could be beneficial. Mike noted that CORDEX provides such a link, but certainly we need to look into this connection.

Helen commented that in terms of engaging with other partners and stakeholders, Digital Earths LHA and the WCRP Academy LHA may also be thinking about some of the things that have been discussed as well in the context of modelling.

ACTION 4: Determine how to incorporate Artificial Intelligence and Machine Learning practices more fully within WCRP and with partners (Digital Earths, Model-Data Home with WCRP Co-sponsors (in particular WMO); JSC-42).

2.6. Regional (Climate) Information for Society (RIfS)

Chairs: Detlef Stammer and Helen Cleugh

Daniela Jacob (Co-chair, CORDEX Scientific Advisory Team (SAT)) presented the current ideas and progress on the new Regional (Climate) Information for Society (RIfS) Home. She noted that the discussion from May to September was complicated. Regional information has many homes or connections and is closely linked to all other activities.

Daniela explained that initially the Task Team on Regional Activities (TTRA), under the charge of the JSC, identified where the work on regional activities takes place within WCRP. Over the last six months, this group began discussing content, rather than structure. There was a strong push to initiate pilot studies to better understand how regional information is developed and linked to scientific information on different scales from data and modelling activities within WCRP. It is also important to know how it is linked to societal demands and needs. The TTRA started to produce a template to look at best practice in case studies (Global Water Futures and others). She explained that they are looking at how these groups develop regional information, the role of experts, and how knowledge is shared with stakeholders.

Daniela discussed how the TTRA, the Working Group on Regional Climate (WGRC) and CORDEX members then started the dialogue to define the new RIfS Home structure. Daniela outlined that there is an ongoing discussion to identify scientific goals, objectives, and scope. She explained that they have developed a living document with inputs from the WCRP community, including how to deliver the dialogue with society. The expected outcomes of this scoping exercise are:

1. Provision of new and promising approaches to harmonize/distill/summarize decision- and scale-relevant climate information from across data sources, data types, and relevant scales of time and space through leveraging the multiple sources from WCRP and related external programs.

2. Enhanced understanding by the WCRP community of the nature and issues inherent in climate services and stakeholder communities.
3. Production of guidance material about multiple sources of information, for climate service providers, users, and end users.
4. Producing assessments, organizing information, capacity building and development, upscaling best practices.

The leadership team envisions two-way interactions with all WCRP activities: LHAs, Core Projects and new Homes. Daniela explained that the RIfS Home would have a cross-cutting structure across WCRP, with strong linkages. She further explained that there is strong interest in linkages to the RIfS and in how people can contribute (over 50 participants of a call regarding the RIfS). External partners would be:

- Scientists from the social, economics, communication communities
- Practitioner community associations
- IOC-UNESCO
- Early career scientists
- WMO's WWRP SERA (Societal and Economic Research Applications) and HIWeather (High-Impact Weather Project)
- Climate service community
- Stakeholders
 - Operational community, e.g. climate service providers
 - End-users (e.g. VIA (Vulnerability and Impact Assessment) entities, risk management communities)
- Preliminary consultations with service partners
- Future Earth (PRECP/WCRP collaboration)

She noted that geographical and gender diversity was already well balanced among the combined members of the CORDEX, WGRC, and early career researchers involved in current discussions.

Daniela then outlined the draft structure of the RIfS Home (Figure 7). The structure includes a number of the Building Blocks (BB), which are the thematical content of the Home. The CORDEX SAT agreed that CORDEX should not be split, but of course it should have strong links to the Model-Data Home and to the Core Projects. The BBs are built from the time and scale perspective.

- BB1: Regional climate science, with a major focus on regional coordination for climate change (including dynamical and statistical modelling) (CORDEX)
- BB2: Global information for regions with a major focus on the harmonization of multiple sources (global data sets from which we would extract regional information, modelling data, observation data etc.)
- BB3: Prediction, with a focus on seasonal to decadal timescales
- BB4: Dialogue with society (where a lot science is needed. We need to learn how to ensure that the dialogue with society is useful and that the data is used).

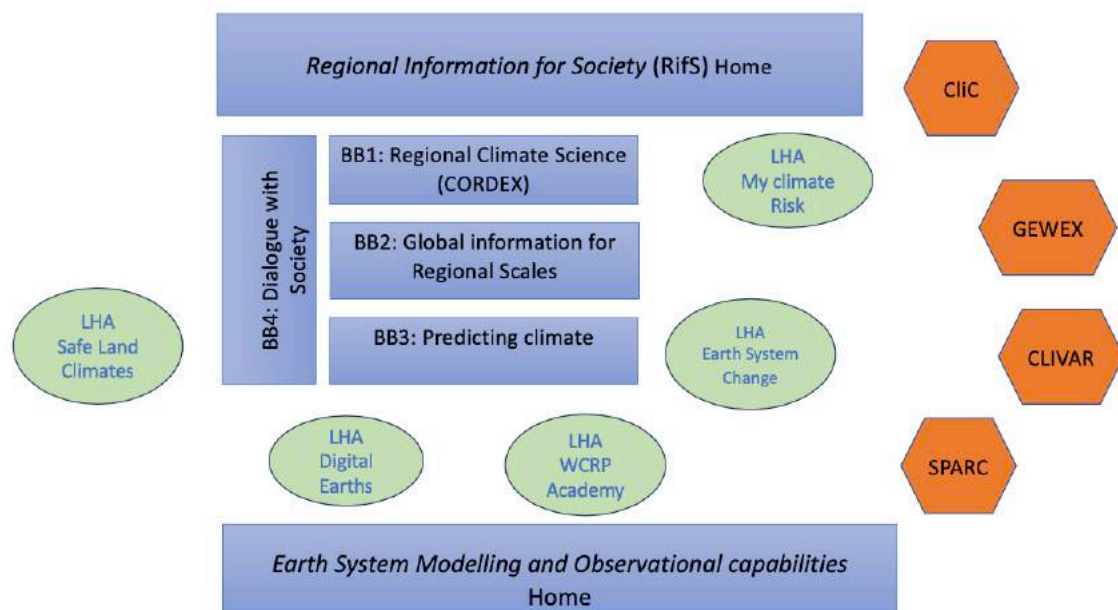


Figure 7 - Draft structure of the Regional (Climate) Information for Society (RIfS) Home

Daniela outlined that resources that are needed include:

- An international office, which will be essential to assist the leadership, coordinate initiatives and activities, and serve to channel communications within the Home and across other WCRP elements. The existing Coordination Office for WCRP Regional Activities (CORA) jointly hosted by the Climate Service Center Germany (GERICS) and the Bjerknes Centre for Climate Research (BCCR), could serve in this capacity. CORDEX will keep its IPO given the multiple ongoing activities and capacity building work.
- Expected support that allows leveraging the proposed activities.

She further explained that the timeline has not yet been discussed but the next steps will include the design of the RIfS Home (science plan, structure, governance and implementation plan), which will continue in 2021. Several meetings and/or workshops among this community will be organized for this purpose and to agree on regional pilot studies. A white paper (living document) will be developed for presentation at JSC-42 (end of June 2021) with some reflections from the group that will help in defining the roadmap.

Discussion

Sonya encouraged connecting the RIfS Home with GC Sea Level, which links science to impacts and coastal management. Mike noted that David Behar (Co-chair of GC Sea Level) has been involved in the RIfS discussions.

Detlef questioned how we move forward, asking if they would be ready to start in early 2021. Daniela confirmed this and noted that it is unclear to them whether they currently represent all of the interests of the WCRP community. She invited further people to join. She explained that they will set up a series of workshops and meetings to design the home further, including the governance structure. Detlef asked whether this task team would be the initial SSG. Daniela noted that the four chairs (two CORDEX Co-chairs and two WGRRC Co-chairs) have been driving

this effort and that others may join this interim steering group. Helen asked whether the Home would be ready in the first quarter of 2021. Daniela confirmed that they are currently developing the rooms in the homes which is why they are hesitant to establish a firm governance.

David Behar (GC Sea Level) talked about work package five of GC Sea Level (Sea level science for coastal zone management). He explained that they are working towards a practitioner workshop. They want the Singapore conference to include the decision perspective and actionable information. It may be possible to connect these things and draw them together over time. Daniela stated that she would look forward to working on this together with him.

Bruce Hewitson (Co-chair, WGRC) discussed the Building Block on the climate science–society interface. We need to be clear that we are not trying to do climate services. It is about interfacing with society and climate services. It is a core component, not a downstream backend activity. Irène Lake (CORDEX Director) agreed with Bruce and noted that we should use the term 'capacity exchange' rather than 'capacity development' – learning from each other and taking advantage in a two-way sense of all existing expertise and knowledge.

There was a discussion on the connection between the homes and the LHAs. Ted noted that the LHAs may be differently organized and there may not be one single model. The LHAs should be nimbler than the homes, which may have more structure to them. Ted thought that people will generally be part of one home, although some people may cross back and forth. In his view the LHAs should not be separately branded or be separate entities. They are how WCRP interacts with a much broader world. It is important that everyone in WCRP sees themselves as part of the LHAs. WCRP has often had a coordination role for science areas. In the regional landscape we need to engage a growing number of people that are not as well defined. This is a challenge that we will need to face. Detlef confirmed that the LHAs need to be co-owned and dynamic.

Estelle agreed that co-design is crucial so that the needs of communities are identified. She noted that Science for Services is another topic of a Concept Note of the WMO Research Board.

Irène commented that CORDEX, being part of the RfS Home, has an ongoing exchange with the High Resolution Model Intercomparison Project (HighResMIP) and also other modelling groups across the CORDEX community as well as with other parts of WCRP. Links are also considered in white papers and downscaling standard documents that CORDEX have been working on and that are soon to be published. In addition, CORDEX works a lot with climate service/VIA communities in various workshops and has a good communication channel with CORA, as many other regional activities have. She noted that, as Daniela indicated, CORDEX has good ground to build on for regional climate information for society with many links already established. She noted that if we can also have more elaborated common platforms, as discussed here earlier, that would facilitate further interaction.

Jens Hesselbjerg Christensen (JSC Member) noted that one of the things that is specific to this Home is that it is about regional information for society. WCRP generates a lot of scientific information. In this structure we need to focus on the societal aspect. This is not just about regional information, but it has to be the information that society needs. This should be catered for by the way we define the boundaries with other programs and how we communicate with them. Daniela responded that they are trying to have a bottom-up approach, with some top-down guidance. This is why they need to discuss this in detail and build strong communication channels across WCRP. Detlef confirmed that the LHAs need to be co-owned by the homes and be dynamic. This is essential for the LHAs to flourish. He also noted that the word 'regional' has been used in many ways. What we mean is the information for society, that may be regional or

even local. What communities do we need to have in this? Who do we need to engage with who we have not thought about? Daniela responded that this is part of the discussion. We are doing a kktake of the WCRP community, including the non-standard climate data community. Then there is the bridge to social science. There are already good communities in existence. We need to think about how to connect local and regional scale activities to our global framing. This was generally agreed.

ACTION 5: Determine mechanisms to connect local and regional scale activities to our global framing (JSC and regional consultation leads; JSC-42)

3. Lighthouse Activity science plans: progress report and discussions

Chairs: Detlef Stammer and Helen Cleugh

3.1. Explaining and Predicting Earth System Change

Rowan (Chair, Explaining and Predicting Earth System Change LHA) began by outlining the overarching objective of the LHA. That is:

To design, and take major steps toward delivery of, an integrated capability for quantitative observation, explanation, early warning and prediction of Earth System Change on global and regional scales, with a focus on multi-annual to decadal timescales.

He noted that 'regional' in this context broadly means basin and continental scale. Changes in ocean and atmospheric circulation are likely to be a specific area of interest.

Rowan explained that the focus of his talk would be on the development of the LHA science plan, as the Science Plan Development Team was formed only about a month ago. The team has broad expertise and there is good representation from Core Projects/Homes, but there is much to do in terms of diversity (gender/regional) and inclusion. The LHA is also in the process of identifying a co-chair.

Rowan outlined that to date there have been two virtual meetings and the team have started developing the science plan. They have identified five major areas of work and they must now start to flesh out the substance. They have agreed on important aspects of the scope including areas of collaboration with other LHAs. The five linked activities are:

- A. Monitoring and observing Earth system change
- B. Modelling change
- C. Integrated attribution, prediction, and projection underpinned by process understanding
- D. Assessment of current and future hazards
- E. Early warning of high impact events including potential abrupt/regime changes

Rowan then showed how these five activities fit together (Figure 8). The central activity, "Integrated attribution, prediction, and projection", is key. Rowan explained that the research that has gone on in decadal prediction in recent years has been divorced from work on attribution. This is not sustainable or scientifically appropriate. This was demonstrated with the hiatus in global mean surface temperature rise, where the community was confused over the causes of this episode and it took a long time to reach a consensus on the major reasons for the slowdown

of the rise as it was not predicted. Rowan explained that confidence in predictions relies on demonstrating that we can explain what has already happened. We need to bring these two activities together in a way that is scientifically robust. Attribution is fundamental to quantifying current risk of a whole range of weather hazards, including tropical cyclones. If we don't understand to what extent trends that are observed in these events are natural variability or anthropogenic change, we cannot quantify current risk let alone future risk. He clarified that they are not talking about event attribution, but attribution of classes of events occurring on multi-annual to decadal time scales.

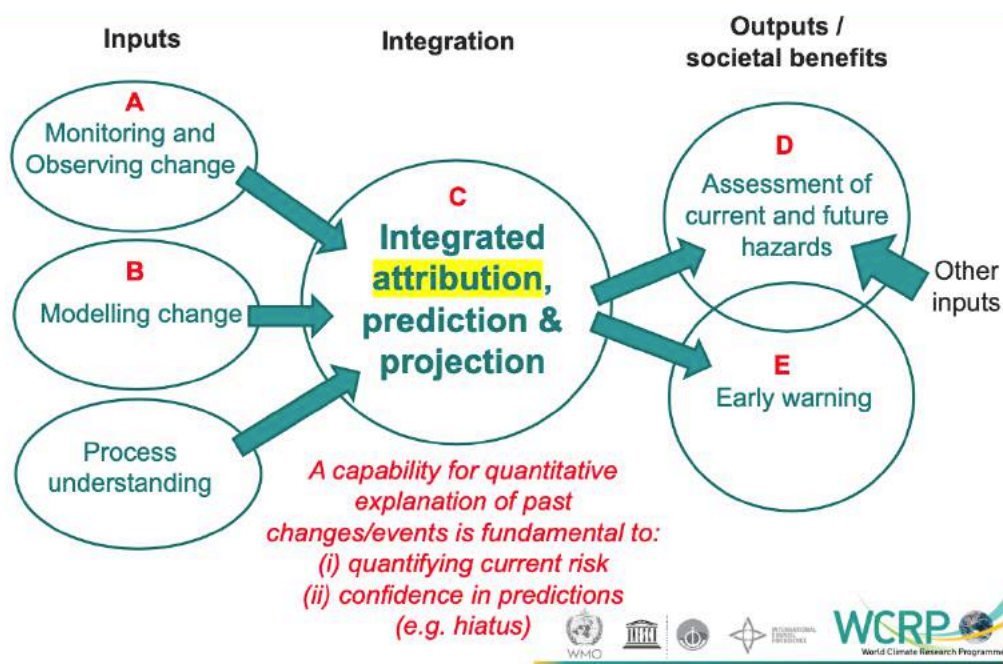


Figure 8 - Inputs, integration and outputs of the Explaining and Predicting Earth System Change LHA. A and B are inputs, as is process understanding. C is the main focus of the activity. The outputs, which are fundamental to delivering societal benefits, are D and E.

Rowan highlighted that a number of high-profile publications, such as the 'State of the Global Climate in 2020', the 'Global Annual to Decadal Climate Update' and the 'State of the Climate in 2019' had substantial quantification on explaining changes on multi-annual to decadal timescales, but a 'major attribution gap'. We don't have the science to do it in a rigorous, robust, and consistent way. Another example of a headline output of this activity is what the current probability of different hazards are in different parts of the world. Rowan noted that this year we saw an exceptional hurricane season in the Atlantic. This raises questions of how the likelihood of these events may be changing and what the cause are. These are challenging research questions and extremely important for decision making. These type of questions are a key dimension of this LHA. Rowan also gave an overview of Topics B, C and D in Figure 8 (Box 1). Topics A and E were still under discussion.

Box 1: Overview of three Explaining and Predicting Earth System Change sub-topics

Topic B - Modelling change

What are the modelling requirements needed to have confidence in our ability to explain and predict changes in:

1. Global Earth system properties (e.g. energy and carbon budgets) – collaboration with Safe Landing Climates LHA
2. Global and regional circulation of the ocean and atmosphere
3. Weather and climate hazards (e.g., hurricanes, floods, severe storms, droughts)?

The primary focus will be on global models and large ensembles. We foresee collaboration with Digital Earths LHA.

Topic C - Integrated attribution, prediction and projection underpinned by process understanding

The scope of this topic is to provide a process-based understanding of recent multi-annual to decadal climate changes and quantify the roles of internal variability and external drivers including greenhouse gases, aerosols, solar, volcanoes, ozone, land-use etc. It should include temperature, rainfall, atmosphere and ocean circulation, energy, carbon, sea level, sea ice, risks of extremes, and biogeochemistry. It should also assess predictability and sources of skill.

The key knowledge and capability gaps are that there is almost no current capability for attributing multi-year changes. Studies have tended to focus on temperature, so other aspects need further assessment (especially hydroclimate and energy). There is also a lack of observations (especially for the ocean) and predictability hampered by weak modelled signals. We are thinking about how to design a (quasi-operational) system for attribution of observed changes in the climate system on multiannual timescales. Can we take underestimated modelled signals into account? Can we use AI? Can we provide information at regional scales?

Topic D - Assessment of current and future hazards

The scope of topic D is to understand (explain), quantify and predict weather/climate hazards. The focus will be on specific target phenomena (e.g., tropical cyclones, extratropical cyclones, heat waves). Attribution in this LHA does not focus on individual high impact events but on understanding the natural and anthropogenic drivers of variability and change in classes of weather/climate hazards. This topic will most likely have collaboration with the My Climate Risk LHA.

This topic will require new methodologies to quantify the likelihood of hazards, such as the UNSEEN (UNprecedented Simulated Extremes using ENsembles) approach to exploit hindcasts (current risk), perhaps extending this into forecasts and projections. Another possibility is the design and use of large ensembles in assimilation, attribution, prediction, and projections to enable better risk assessment. The topic may also use an extended 'event' attribution methodology with coupled models that enable attribution and explanation of decadal timescale 'events'.

Rowan explained that there has been some discussion about the overlap of Explaining and Predicting Earth System Change LHA with the other LHAs. (Figure 9). The area of common interest with Safe Landing Climates LHA is global Earth system change. Safe Landing Climates LHA is focusing on the longer timescales, multi-decadal to centennial, whereas Explaining and Predicting Earth System Change LHA will focus on multi-annual to decadal timescales. Rowan noted that we will need to find mechanisms to interact on intermediate timescales on issues like carbon cycle change. Explaining and Predicting Earth System Change LHA will have a focus on weather-related hazards, but My Climate Risk LHA will take the lead in areas of risk associated with vulnerability and exposure and all the dimensions that are important for decision making. With Digital Earths LHA the challenges with observing and modelling change are common to both LHAs. Rowan explained that Safe Landing Climates LHA has a broad interest in tipping points, but there are issues, such as abrupt change in circulation, that are of interest to Explaining and Predicting Earth System Change LHA. He noted that in all cases we will need to work out effective mechanisms for interacting.

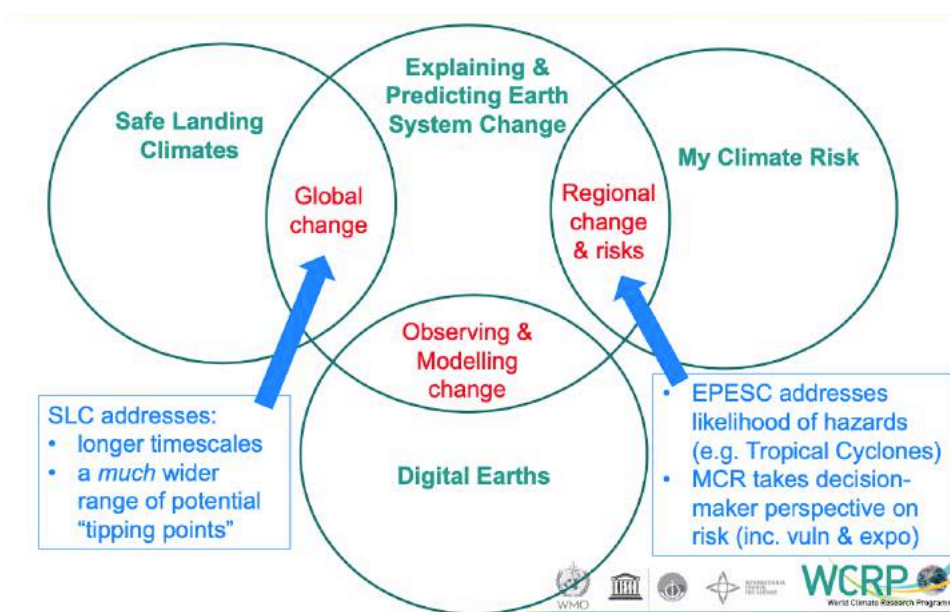


Figure 9 - Areas of overlapping interest between Explaining and Predicting Earth System Change, My Climate Risk, Safe Landing Climates and Digital Earths LHAs (from an Explaining and Predicting Earth System Change LHA perspective).

Rowan explained that in terms of partners, interactions within WCRP will be incredibly important (all Homes and the LHAs). External partnerships will also be important and this still needs discussion. Obvious partners include GCOS and the ESA Climate Change Initiative. It would be useful to have a joined-up view across WCRP regarding mechanisms for engaging with external partners so we do not have multiple conversations going on. Resource requirements still need to be discussed. He noted that the LHAs may get some support from existing International Offices. He would like to hear more about those ideas.

Rowan gave the timeline for the Explaining and Predicting Earth System Change LHA as:

2021: Develop science plan

- Preparation and consultations
- Complete first draft: June
- Further consultations and revisions
- Final version: December

2022:

- Launch
- Implementation

Discussion

Cath Senior (Co-Chair, WGCM) noted that an important aspect would be to feed back to the Model-Data Home any requirements so that this can inform model development. Rowan agreed that this is important. Anca Brookshaw and Markus Donat are on the Explaining and Predicting Earth System Change Team, but he would be happy to hear other ways of interacting offline.

Paco said that he found the talk really exciting. The attribution of multi-year signals is a great idea to focus on and is very much needed. However, he noted that the example about the study of the temperature hiatus is not a fair view of what happened. His impression is that the decadal prediction community showed that it could have been predicted using decadal prediction systems, but there was a decision to ignore that information because it was thought that decadal prediction systems were not mature at the time. The lesson to be learned from that is that it is important to use the tools that are available from different perspectives and think outside of the box. Rowan responded that we can all agree that we are at an immature stage of decadal prediction and we don't have an integrated capability of attribution and prediction.

Pascale noted that millennium simulations can play a role in the LHAs. There are lots of new opportunities from long paleo simulations and high-resolution records (coral, tree rings etc.) to make progress on the interaction between changes in the mean state, multi-decadal/centennial, and interannual/decadal variability for the Holocene and even previous time periods. Tipping points are not the only area of interaction with Safe Landing Climates LHA. Paleo records can play a role in the linkages to process understanding. This LHA could be linked to PAGES groups on variability. Rowan responded that this could be of common interest with this and Safe Landing Climates LHA.

Victor noted that in AIMES there is a working group on early warning signals and asked who they should cooperate with. Should we contact you or should there be a crosscutting working group dealing with tipping points and early warning signals? Rowan responded that he sees that as a common interest between Explaining and Predicting Earth System Change and Safe Landing Climates LHAs, but the two activities will have different interests. For example, the potential for abrupt changes in circulation in the monsoons or jet streams would be of interest to Explaining and Predicting Earth System Change LHA. The potential for abrupt changes in the carbon cycle would be led from Safe Landing Climates LHA. We need to get more specific. There could be value in a cross-cutting working group on tipping points and early warning. Victor noted that the methodology of reanalysis (blend of observations and models towards a reconstruction of the climate) is much the same, so the activity should be cross cutting.

Andrew Robertson (Co-chair, S2S Prediction Project Steering Group) asked how the WCRP Scientific Objectives map onto the LHA. There seems to be a lot of Scientific Objective 1, fundamental understanding of the climate system, and Objective 2, prediction of near-term evolution of the climate system. He asked if it would make sense to consider a broader set of timescales, from sub-seasonal onwards. In the fundamental science, initialized prediction cuts across timescales. He asked how we can ensure that we have a timescale integrated approach. Rowan agreed that the activity primarily maps onto Scientific Objectives 1 and 2. His view is that these LHAs should not try and do everything within the scope of WCRP. They should be very focused. We see multi-annual and decadal time scales as a gap, which is important for the LHA.

If we try to do everything we will lose focus and make less rapid progress. Helen noted that we still have the Core Projects that can focus on some of these problems as well. The LHAs do not have to do everything. There was a discussion on including subseasonal to annual scales to be consistent with the "seamless" prediction approach, but many also agreed that the LHAs need a narrower scope to ensure they can achieve their goals.

Sandrine Bony (GC on Clouds, Circulation and Climate Sensitivity (GC Clouds)) commented that we have been talking a lot about consulting with the Core Projects in preparation for the science plans. It is also important to connect with the Grand Challenges, which are sunsetting. She explained that they have learned a lot and can contribute. She noted that it will be important to prioritize a few key questions to make the research effort efficient. Rowan noted that it would be helpful if the Grand Challenges could look at the LHAs and identify where there are lessons learned or specific activities that would fit into the scope of the LHAs. Helen noted that we should also think about how to facilitate that in a coordinated way. Rowan noted that it would be good to map how lessons learned and activities of the Grand Challenges can be taken forward into the LHAs.

Detlef agreed that prioritizing is important for the science plans. We have to pick the really important problems first. The science plans will always be able to evolve. A first version by the summer would be helpful, but we should actually never have a final one. It should be able to change in response to changing priorities. In terms of connections to Homes and other LHAs - we need to work this out. The LHAs are not an extra level, they are meant to be integrating. We need to see how to entrain the communities. In terms of partnerships, not every LHA will have the same partners and the JSC does not want to micro manage this. Dialogue with partners is welcome on the working level and we will also talk with the same partners at a higher, more general level. Partner discussions will vary between LHAs. The international office support also still needs to be worked out.

Mike noted that the Global Annual to Decadal Update came from the WCRP GC on Near Term Climate Prediction (GC NTCP). Paco explained that it is one of the legacies of GC NTCP that will have a life on its own in an operational environment. Kumar stated that the Global Annual to Decadal Update will need continued WCRP leadership and engagement, even if the routine production comes under the responsibility of operational entities (Global Producing Centres for Annual-to-Decadal Climate Predictions). Mike responded that it would be good to have relevant services/operational folk (from e.g. WMO and IOC) involved in this since the original concept note talked about support to the development of climate services and this worked well for GC NTCP.

Jürg noted that there are a few papers out on detection of multiannual events with emphasis on post the Tambora eruption. Krishnan (JSC member) noted that the role of volcanic forcing on seasonal prediction is also an important science problem (e.g. [Singh et al., 2020](#)). Sonya noted that CLIVAR would like to make sure that the ocean is not forgotten in this LHA, including in the hazards (e.g. marine heatwaves) to be considered. She also asked what concrete plan is being made to bring in better gender balance and more people from the global south. It was agreed that these issues need attention, but it will take some time to work out.

ACTION 6: Investigate mechanisms for engaging with partners to ensure that multiple conversations on similar topics are not occurring (WCRP leadership, Secretariat and international offices; JSC-42)

ACTION 7: Explore whether a cross-cutting working group on tipping points and early warning systems has merit (bearing in mind activities of LHAs) (JSC and WCRP leadership; JSC-42).

ACTION 8: Facilitate coordination between the Grand Challenges and Lighthouse Activities/Homes to map how the lessons learned and activities of the Grand Challenges can be taken forward into the other activities, where appropriate; discuss with Grand Challenge leads how they will sunset and contribute to the WCRP Open Science Conference. (WCRP Secretariat, JSC Chairs, Grand Challenge and Core Project leads etc.; JSC-42).

3.2. My Climate Risk

Regina Rodrigues (Co-chair, My Climate Risk LHA) began by outlining the vision of the My Climate Risk LHA. The new science that is envisaged within My Climate Risk is not around models, or observations, or process understanding, but on how they are all used together within a context of deep uncertainty. This is where conflicting information and disagreement on which aspects of information are most important occurs. The goal of My Climate Risk LHA 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. By developing a new framework for assessing and explaining the physically plausible climate drivers of regional climate risk, climate information will be made meaningful at the local scale. Whilst any application of the framework will inevitably be specific and tailored to local concerns, the framework itself will be generic, hence flexible and applicable across a number of region types and is intended to become a much-needed scientific support for the development of climate services.

In terms of the governance structure, Regina explained that the My Climate Risk LHA seeks to operate in a way that is non-hierarchical, in the form of labs. These should be dynamic, exploratory, transdisciplinary, and are environments rather than physical infrastructures. These will take a case study approach and become communities of practice. The labs will be bottom-up, community driven, and neither coordinated nor endorsed by My Climate Risk LHA.

Regina then gave an example from South America. There was recently an unprecedented drought during the austral summer. An energy company came to Regina and wanted to know how often extremes like that are likely to happen in the next two decades. A water supply company needed to know the same thing, except for the next five decades. The farmers needed to know if the next season would be as extreme. How can we help a researcher to answer these questions? Which protocols should we use, who should we talk to? Regina explained that they see My Climate Risk LHA as guiding the local community to answer these questions. This will lower the risk for the local community.

Regina noted that the My Climate Risk LHA Science Plan Development Team comprises 14 people and was established in October 2020. There are representatives of all of the WCRP Homes except for CliC (this is in discussion). The gender balance and career stage diversity is reasonably balanced, but there is very poor regional representation. The group met twice and split into sub groups, working in parallel on the draft science plan. Ted and Regina will synthesize the input from those sub groups for the first draft of the science plan.

The initial consultation with the Science Plan Development Team led to the identification of three major challenges. These were:

Complexity - The non-hazard aspects of risk represent a huge and very complex scope, beyond WCRP expertise. Proposed solution - Not partnering at a high level with other bodies to tackle the entire climate risk landscape (unwieldy, too top-down). Rather the suggestion is to work in specific risk applications with end users using a bottom-up approach (Labs).

Overlapping - Coordination with the other LHAs and homes, especially with the RfS Home, given the significant potential overlap in scope. We should avoid any sense of competition. Proposed solution - Drawing on all relevant parts of WCRP; filling gaps; building on what is already working well. Having all parts of WCRP represented on the My Climate Risk LHA Science Plan Development Team.

Demand - Making progress, given the ever-increasing demands on people's time, in particular during the COVID-19 pandemic. Proposed solution - This type of pressure is likely to become a permanent reality. The way forward involves following a realistic and practical approach, along the lines of E.F. Schumacher's "small is beautiful" concept. This will mean distinguishing between what needs to be done, in terms of research in general, and the role of WCRP within that (these are different). Not everything in science requires international coordination. It is also essential to seek and cultivate leadership from early- to mid-career researchers, including from developing countries, so they can provide the driving force to make My Climate Risk LHA a success. There needs to be mentorship from more senior researchers and there needs to be incentives to join, including by minimizing the price of entry in terms of bureaucratic obligations.

Regina outlined that My Climate Risk LHA has internal and external partners. Internal partners will include the RfS Home and other Homes, Explaining and Predicting Earth System Change LHA, Digital Earths LHA, and the WCRP Climate Research Forums. External partners will include WMO, GCOS, WWRP, Future Earth (including Risk Knowledge Action Network (KAN)), the Climate Services Partnership (CSP), the World Adaptation Science Programme (WASP), the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and UNESCO. Other partnerships should be established at more of a grass-roots level given the highly focused approach (labs). A few more members are envisioned on the Science Plan Development Team. There is a concern that if partnerships are established at too high a level, they will rely on over-committed individuals who are only able to take a broader view. There is also a need to increase the diversity of the team and the North-South partnership. Given the intended highly focused approach, partnerships will likely be better established at a grass roots level in the context of particular activities.

Regina explained that in terms of resources, it is still too early to say what will be needed. Secretariat support will be required, as well as support for workshops and support for early to mid-career researchers. External support from science councils should be encouraged, but it is anticipated that support for regional representatives will be a challenge. Local-sized councils are resource limited. Regina outlined that the timeline for the science plans to be completed is by mid-2021, the launch of the LHA in 2022, and that eventually the labs will become self-sustaining activities.

Discussion

Mike noted that it would be good to include services and operational colleagues from IOC and WMO in discussions. There is a good example in the past of where GC NTCP involved the operational and services folk at a very early stage and so it was fluid moving from the science concept to services and the production of the Decadal Climate Outlook.

Andrew R. noted that the work going on in S2S involves operational centers, co-developing interdisciplinary science with users. S2S Real-time Pilot Initiative for developing applications of S2S forecasts and the WGSIP information for decision making project look very relevant to this LHA. Both are focused on co-development of interdisciplinary research toward developing climate services.

Ted noted that My Climate Risk has already had a preliminary discussion with the Future Earth Risk-KAN. Xuebin Zhang (GC Extremes) noted that GC Extremes is connected to the Risk-KAN (Jana Sillmann represents the GC). Ted confirmed that they have talked to Jana already.

Giles Sioen (Future Earth) commented that with the Future Earth KANs, they have governance plans that require the Steering Committees to consist of representatives of every major populated continent. He explained that it is a rational policy, and in the application processes for people to join they have to tick off where they are based (as one of several criteria). He noted that if WCRP haven't found people from other places around the world that work on these topics then he suggests finding other ways to reach out.

Ted noted that one of the concerns that they have is the global north-south imbalance (in terms of more people from the global north being involved). He explained that we really have to fight that. While My Climate Risk LHA can certainly consult, he and Regina do not want the team to get too big. They also want to enable climate services that are not in rich countries.

Adam Scaife (GC NTCP) explained that with the GC NTCP they really engaged the operational part of WMO and got as far as designating centers that are providing real-time predictions as part of an operational service. He noted that this is really important for WCRP and these new activities. The plans should identify which groups outside of WCRP but within WMO that they will connect efficiently with.

Ken noted the WMO Regional Association III - South America just created a Working Group on Research that could be a good connection to operational users in this region. Regina explained that her experience in Brazil is that sometimes the climate service does not work for every region. She explained that they only have one official climate service provider in Brazil and it does not work for her region. She emphasized that it is important that you know how things work in the country and not just to work with the main climate services provider.

Detlef reflected that WCRP is not just WMO, but also IOC-UNESCO and the ISC as well as being linked to Future Earth. He asked about the timescale that the My Climate Risk LHA is focusing on and whether starting in the new structure in 2021 would be feasible. Regina explained that the timeline she presented reflected the time to spin up the labs. She also noted that My Climate Risk LHA will mostly focus on a regional-local scale and on shorter time scales. Ted confirmed that while they do not want to exclude long timescales, it is likely to be S2S timescales (near-term and seasonal) outwards and a regional scale.

Jan asked whether climate services were not a matter for the research community rather than operational services. Daniela noted that it is both and Ted explained that this is what he was referring to when he talked about "deep uncertainty"; that is not something that operational services tend to deal with. Jan suggested that in this case we are within our role to promote research on climate services. Daniela agreed that research can be on and for climate services. Irène agreed that it is both. She noted that in Sweden they try to make climate services at least semi-operational and the core services of the Swedish Meteorological and Hydrological Institute (SMHI) work with the research department, which simplifies the use, including for instance in

terms of accessibility and understanding. Estelle agreed and noted that science and services involve two-way communication, which is also highlighted in the WMO Research Board concept note on Science for Services.

Mike agreed but noted that, as Adam pointed out, this link works better if relevant climate services folk are involved. He emphasized that the key, as Regina was saying, is ensuring the right people are involved. Kumar added that whether it is operational services or the research community, it is important to ensure that there is an adequate mandate within the local context to base decisions on the climate information provided, particularly when the decision has a socio-economic cost. Irène provided the link to a portal developed by WMO/WCRP/SMHI for the Green Climate Fund (GCF), based on CMIP Phase 5 (CMIP5) and CORDEX results ([Climate Information Portal](#)).

Ken noted that in Peru they have been working on implementing operational climate services for agriculture, but there are knowledge gaps, not only in the underlying predictions but also in the social aspects of service delivery. He explained that in countries where prediction is not provided operationally, WMO Regional Climate Centers or the International Research Institute for Climate and Society (IRI) could be the providers, but we should try to reduce these dependencies.

Robert Nicolls (GC Sea Level) noted that My Climate Risk LHA seems to fit with GC Sea Level. He explained that they have taken a decision-orientated approach and will have a conference in Singapore next year. These activities may need to be sustained by a balance of top-down and bottom-up activities. After the Singapore conference the sea level work may become more fragmented within the WCRP structure. Regina said that one My Climate Risk LHA lab might be ocean related. That would have to be discussed in the group but it could include some of the work of GC Sea Level and link to CLIVAR.

Sebastian Ferse (Executive Officer Future Earth Coasts) noted that, for a coastal context, [Future Earth Coasts](#) is planning a number of engagements with local and regional stakeholders to develop a common understanding of their coasts and future prospects, to co-produce innovative coastal sustainability initiatives and pathways to achieve desired outcomes, and to realize the SDGs. There certainly seems good potential for collaboration with this LHA.

Lisa Miller (SOLAS) commented that it's an important point that a number of people have made about establishing partnerships from the grass roots, rather than trying to establish a formal structure for them. She explained that effective partnerships do need to be based on the needs of the individual project. The catch is that diversity and representation require specific and focused effort.

Daniela noted that there are groups out there working on risk topics, also driven by private sector and consultancies. She said that it is important to understand the boundaries and see where the niche is. Regina explained that My Climate Risk LHA is not doing the service but will provide support.

Martin commented that the interest in this LHA shows how timely it is to pick up this topic across WCRP activities. We can connect with the International Day for Disaster Reduction (IDDR), ISC and the UN Disaster Risk Reduction Framework (Sendai Framework for Disaster Risk Reduction). They focus on disasters much more broadly but they would probably appreciate the connectivity. This will help to determine where the science needs are. We can see what they would expect from us and build the process out. Regina agreed and explained that connecting with the local community will include relevant partners that have the necessary expertise. We

don't want to expand the Science Plan Development Team too much. At the same time, we do not want to exclude conversations. Ted added that we will have to see how the connection goes. We will have to see what bubbles up at the grass roots level. Many scientists at that level don't wear just one hat. We want the main linkages. We don't want to join at the hip at the highest level, as that will not work.

Kumar asked how vulnerability and exposure will be handled, as much of it is outside WCRP. It can depend on the local context. Ted agreed that this is the first challenge – to step into the risk space and look back at the hazard from the perspective of vulnerability and exposure. We need to work out how we bring climate information in. In those communities of practice, the WCRP community may be a minority in the group.

Giles commented that he very much agrees that the research agenda and priorities should be part of a living document as things change rapidly. The Future Earth Health KAN published its first version just a few days ago ([Ebi and others, 2021](#)) (which will evolve and links to some of the work here as well).

3.3. Safe Landing Climates

Steven Sherwood (Co-Chair, Safe Landing Climates LHA) introduced the Lighthouse Activity and noted that so far the Science Plan Development Team have only had one meeting and that he is coming to this with some uncertainties and questions and looks forward to getting feedback. The Safe Landing Climates LHA is an exploration of the routes to climate-safe landing 'spaces' for human and natural systems. It will explore present-to-future "pathways" for achievement of key, if not all, the SDGs. The time scale is multi-decadal to millennial. One way of paraphrasing this is that we are worried about 'global climate risk management.' One of the distinctions about this LHA and My Climate Risk LHA, other than the time scale, is the type of risk that we are looking at.

Steve explained that so far the team have mostly discussed options for the science plan. There are a few areas that we have been discussing that require feedback. Some of the concerns/questions about the Hamburg outline are:

- The role of Integrated Assessment Models (IAMs) and socio-economic coupling – we either need to bring in new people or connect with external communities.
- The role for geoengineering – it is relevant to looking at future pathways but we have to think about how we want to treat it.
- "User oriented" tools and stakeholder/client engagement – it is an open question about whether we can do this without over-extending.
- Model development— this is needed for some of the areas of focus of the LHA. Who would drive that: us or other elements of WCRP?

Key areas of focus/concern were:

- "Tipping points" (used in the broadest sense) and unknown unknowns – this could include the possibility of rapid transitions in the system, carbon releases, sudden changes in the cryosphere, unexpected changes in the biosphere, collapses of vegetation, and limits in adaptation of biological and human system (breaking points).
- Defining "safe" – this is a framing issue
- Risk communication – how do we communicate these risks to governments, stakeholders and others.

There is a need to focus on a few things where we can make a difference.

Steve explained that the partners in this activity would include the other LHAs, especially Explaining and Predicting Earth System Change and My Climate Risk LHAs. Key partners will also be all four existing Core Projects, possibly the two new Homes, and the Grand Challenges, especially the ones related to sea level and the carbon cycle. We really need to get the questions defined and then we can see which of the other organizations we will want to interact with (e.g. Future Earth (SOLAS, AIMES, PAGES, iLEAPS); Integrated Assessment Modelling Consortium; Belmont Forum; Earth Commission; UNFCCC; SCAR; CMIP (ISIMIP, LS3MIP).

In relation to the resources required, Steve explained that it is hard to say what financial resources will be needed at this stage. In terms of challenges, he noted that they realize that it will be difficult to achieve meaningful links across WCRP and that it will take time. Fundamental uncertainties may require better models or new observations (permafrost/clathrates/ice sheets/biome responses to climate change and CO₂). He noted that they envision having meetings and doing some kind of outreach (e.g. web tools for communication to stakeholders).

Steve explained that in terms of the timeline, they will develop a draft science plan by June 2021. In thinking about this, he noted that a possible plan may be to have two phases. “Phase I” (first few years) would focus on key biophysical problems, while at the same time building social-sciences partnerships outside WCRP. Then they would move toward “Phase II” on non-stationary interactions between humans and natural systems. He noted that they may want to start more WCRP focused and develop relationships with external organizations related to a specific goal. It will be important to have conversations with people in the Core Projects to come to a common agreement on where the links are. For example, he explained that he would see Safe Landing Climates LHA interacting with GEWEX, potentially through GLASS. However, in GEWEX’s presentation there was no link between Safe Landing Climates LHA and GLASS. Jan confirmed that vegetation and safe landing indeed points towards GLASS. Steve expanded on that by saying that he would also see the Safe Landing Climates LHA interacting with CliC, SPARC, and CLIVAR. Sonya noted that CLIVAR would be keen to be involved in aspects such as global heat and carbon budgets, and sea-level.

Lastly Steve outlined that the geographic range of the Safe Landing Climates LHA Science Plan Development Team needs improvement. He noted that they could use more early career researchers and that they may add to the team or liaise in other ways as they move to more specific goals.

Discussion

Rowan began the discussion by noting that the link with IPCC/UNFCCC could be central to this LHA. If it went well then it could have an impact on the Synthesis Report for the IPCC Seventh Assessment Report (AR7). He explained that the team would need to ask themselves what the LHA could do and achieve to have an impact. It could also help to integrate IPCC’s WGI and WGIII (Ted also noted that Safe Landing Climates could help to link WGI and WGIII and My Climate Risk could do the same between WGI and WGII, in both cases where there are currently big gaps). Steve agreed regarding linking WGI and WGIII. As far as the Synthesis Report, he noted that the question would be to figure out how the Synthesis Report might have fallen short in order to know what could be done to improve it and where they could have the most impact.

Lisa M. noted that Safe Landing Climates LHA seems to be the proper home for geoengineering within the LHAs. SOLAS, with some other organizations, is talking about submitting a proposal

for a UN Ocean Science Decade for Sustainable Development activity on geoengineering. She noted that they are prepared to lead that but it may make more sense for WCRP to lead it through this LHA. She said SOLAS plan to put in a Statement of Intent in January 2021 with a full proposal in September 2021. She asked what the best way forward on that would be. Steve responded that he would like to talk offline about the objectives of the proposal. Helen added that, from a JSC perspective, they have wondered about how to address the geoengineering aspect so it is worth having some further discussion about it and it could be that this LHA would be the place for it. She noted that many of the Core Projects as well as this LHA have identified geoengineering as a topic of relevance for WCRP, as well as outside of WCRP as well. Mike noted that there are other WCRP activities on this topic, including model intercomparison projects.

Pierre Friedlingstein (JSC Member) returned to the point regarding IPCC and noted that there is a disconnect between IPCC's WGI, WGII, and WGIII. He noted that WGIII is producing new scenarios, WGI is using existing scenarios for climate assessment and WGII is using existing climate assessments for impact assessments, so there is always a delay for the process. For example, for the Sixth Assessment Report (AR6), WGI are using CMIP6 but WGII will essentially be using CMIP5, and WGIII are already ahead and thinking of Shared Socioeconomic Pathways and new scenarios. Having this LHA would help to have these assessed at the same time and in the same framework. This would be extremely helpful, especially for the Synthesis Report and we could aim for the AR7 deadline. In terms of geoengineering, Pierre explained that we do need to consider it, especially Carbon Dioxide Removal (CDR). He was clear that he was not saying that we have to deal with the management, but CDR is critical and implicitly included in all high mitigation scenarios. The way we deal with it at the moment in WGI and CMIP6 is that it is seen as negative (i.e., a deficit of) emissions. Emissions are lower in the future thanks to this removal, but we don't address the issue of land resources or impact of deforestation on other SDGs (like water and food availability). This LHA could try and tackle that.

Neil noted that SPARC see Solar Radiation Management (SRM) as a SPARC contribution to this LHA. Other geoengineering proposals also need including so SOLAS involvement would be good. Lisa M. replied that a number of SRM proposals (not just CDR techniques) do have ocean implications, for example, bubble production, seawater aerosols, and sea-ice management.

Tatiana Ilyina (Co-Chair, GC Carbon Feedbacks in the Climate System (GC Carbon)) supported Pierre's point on CDR, confirming that we cannot ignore it. It is included in all of the scenarios of future climate change projections except 8.5 and in ESM projections it is ignored and we don't consider the loss of carbon taken out of the system. She explained that there have been attempts in the past to do this and there are some studies out there. The other point that Tatiana made was that the LHA's are becoming very broad in their scope. We should not hang too much on them. She noted that the GCs are distinct landmarks in the current landscape. They have worked in the way that there was an emerging topic identified that needed to be focused on and people were identified who were passionate. These two things made the GCs unique – acting as an elevator to bring the topic up to the top. She wondered whether we are losing the focus a bit with the LHAs and also asked if there will be a GC type project in the new WCRP landscape. Steve agreed and noted that they do want to find a narrower focus, but it will take longer because the LHAs are supposed to be more interdisciplinary than the GCs were. Helen noted that this is good guidance for the JSC to consider and pay attention to, noting that "there is a craft there to get this just right".

Rowan totally agreed with the need for a sharp focus on where each LHA can make a difference. In the case of Explaining and Predicting Earth System Change LHA he envisages that some of

the subtopics should be led by others (e.g. the Models-Data Home) with LHA input rather than the other way round.

Victor asked how WCRP wants to involve science partners in the preparation of the LHA science plans. Steve responded that Victor is on his list of people to talk to. He explained that it will be an iterative process. We will need to look at the opportunities and then we can get to having meetings. Helen added that we do want to talk to allied partners earlier rather than later.

Martin added that with most of the LHAs we started out with grand opportunities. Taking it from that down to something that suits WCRP well is not easy. It will take time to develop the science plan. Responding to the GC discussion, Martin noted that even from the start some GCs were very focused and some were broader. He noted that some of the more disciplinary questions that were raised in this talk could be developed within the homes. He explained that the LHAs can explore the wider community a bit and go beyond the core activities of WCRP. They can be an outward facing part of WCRP. Ted agreed with Martin's point about the LHAs being 'engagement' activities for WCRP.

Martin further noted that another dimension could be climate proofing. When you look at scenarios that come out of the development community for the 2030 Agenda for Sustainable Development, some of the futures are not climate proofed. He asked whether we can be a sounding board for other parts of the development agenda and answer questions about whether scenarios are 'safe' development scenarios from a climate perspective. He asked whether this, together with Future Earth and the National Science Council, would be an attractive option for them. He added that we should engage with outside communities to take this forward. Rowan commented that Martin's question would seem to be, "to what extent is Safe Landing Climates LHA seeking to address needs in relation to adaptation and resilience in addition to needs in relation to mitigation." Pierre responded that one could frame it as follow: low emissions scenarios have impacts on mitigation strategies (without CDR and an impact on food, etc.); high emission scenarios have impacts on adaptation (can society adapt to a +3°C world?). In both cases, it questions the feasibility/plausibility of these low-end or high-end scenarios.

Daniela asked about the time plans for delivery of results from the LHAs. She noted a high risk of 'being too late' due to the heavy coordination work which they seem to need. She further noted that a connection to the new RIfS Home needs to be established, if possible.

Sonia Seneviratne (GC Extremes) noted the connection between IPCC WGI, WGII, and WGIII is where the new frontier is regarding the connection of scenarios. WGIII emission scenarios have not been future proofed as to whether they are safe. This is a topic that needs to be investigated further. There are some new research activities in this area, such as the development of emulators for ESMs so that you can speed up the connection between the representation of climate and these scenarios. Tatiana noted that this was a good point and Sonia highlighted the important connection between extremes and carbon-cycle research communities.

Sonia further explained that there are some plans for a Global Extremes Project (including a funded IPO), led by Xuebin Zhang. There could be support for some of the LHA's work on topics of extremes. There may be an opportunity after the IPCC work is completed next summer (summer 2021) to have a workshop on lessons learned from the IPCC process. Steve confirmed that there is a central role of developing better models and finding a way of integrating all of these pieces and looking at them together to avoid a domino effect.

ACTION 9: Consider a 'lessons learned from the IPCC process' workshop after August 2021 (JSC, WCRP leadership; September 2021).

3.4. Digital Earths

Peter Bauer (Co-Chair, Digital Earths LHA) began the talk by emphasizing that this LHA is a bit new in the sense that it brings in expertise stimulated by new requirements to WCRP and perhaps to WMO as a whole. He explained that this is the decade where we need deviation from business as usual and incremental progress. We need to do things faster and get information quicker. Some of that is limited by digital technologies and that is where this activity can help.

Peter noted that the Digital Earths Science Plan Development Team fell short in terms of gender and geographical balance and that they plan to improve that as they go along and bring in new expertise, seeing the team as dynamically evolving. He noted that both he and Christian plan to only co-chair this activity for the next six months or so until the science plan is developed in order to be able to bring in new people and balance things a bit better.

Peter went on to explain that this LHA works across the others. There will be a lot of opportunities to help the other LHAs achieve what they want to do with better efficiency. You might ask why one would do a LHA on this topic. This comes back to thinking about areas where breakthroughs are hindered or are not fast enough due to limitations and access to digital technology.

1. Extreme-scale computing and data handling

Peter explained that one break-through needed is running models at higher resolutions and making them more complex and faster at dealing with the data they produce. They have a very big footprint. Our data volumes between CMIP exercises have grown exponentially and will grow more in the future. If we want to advance towards more realistic models and have a better combination between simulations and observations, there needs to be progress.

2. Full integration of policy sectors in monitoring and prediction workflow

Peter noted that another thing that has been mentioned is the integration of policy sectors that right now sit at the receiving end of a lot of Earth system information. There is room for integrating them more and better into workflows that start with Earth system science problems to begin with, such as energy, food, water, finance, and risk management.

3. Open and interactive access to data, software and workflows for users

Peter outlined that a lot of what we do is very monolithic in terms of single institutions or a single group of institute developments that are very hard to interchange. They are not interoperable in terms of software, to a certain degree data, and certainly not for workflows. If we want our generation of knowledge that comes with software and data to be more open and interoperable, we need to remove the expert-only access to those. We need to facilitate access and operability for non-experts.

He confirmed that the time is right in investing in these things, and in the science itself.

Peter outlined that Digital Earths:

- Is a digital and dynamic representation of the Earth system
- Has an optimal blend of models and observations
- Will enable exploration of past, present, and possible futures of the Earth system
- Will provide open access to data, methodologies, and software
- Will create innovation in support of the WCRP Scientific Objectives

- Will push co-development of modelling with digital technologies (High Performance Computing (HPC), Big Data, and ML)
- Is a key instrument to achieve the goals of the other Lighthouse Activities
- Will be a joint activity with existing/novel, technology driven national and international projects
- will enable WCRP to implement selected versions for topics where significant progress is required (e.g. other LHAs)

The core of Digital Earths is to:

- Develop generic software-hardware solutions that allow simulation models and data assimilation to perform several orders of magnitude more efficiently. This should help teams and work beyond borders and outside the monoliths that were mentioned before. Some of this is interoperability and some is just efficiency. As we make our models more complex and include more variables at higher resolution, there will be a natural limit to what we can do unless we invest here.
- Facilitate the extraction of Earth-system sector specific information from vast amounts of environmental data, both simulated and observed. This is the translation exercise between data and information. Some of it is limited by the knowledge on how to do that translation, but some of it is limited by technical capabilities.
- Allow us to invest in efficiency gains in upgrading simulations, ensembles and/or running more comprehensive scenarios. This will allow us to upgrade scientific accuracy and reliability of the things we do at the front end.

Peter explained that the team has begun by asking themselves some very generic questions to determine the focus. The first was 'why would we do this?', which can be broken down into:

- What is the biggest challenge that is presently limited by digital technologies?
- What can the Digital Earths LHA do that existing national and international programmes can't do?

The discussion on these points led to the definition of what the Digital Earths LHA will be.

The next question was 'how would we do this?':

- How should the LHA interact with existing national and international programmes?
- What could be realistic milestones in 12, 24, 48 months?
- Can we assign/build up responsibilities in this team?
- Can the LHA create new funding opportunities?
- How do we organize ourselves (one vs several teams)?

This led to a definition of implementation and success for the Digital Earths LHA within the WCRP strategy timeframe. The outcomes of those discussions were:

What will Digital Earths LHA be?

- Both resolution and complexity are needed to develop more realistic Earth-system models:
 - Both come with significant computing and data footprint (this needs a solution; we need our own investment in co-designing this)
- The link to impact models is weak:
 - Expert knowledge is required everywhere (monoliths)
 - Information gets lost between processing steps
- Keys to the effective use of resources are:
 - Staff investment

- Inter-operable models and data, facilitating research and R2O (Research to Operations)
- Easy-to-use tools for data analytics and data exploration (Google Earth) - We produce petabytes of data. Individual scientists can't access that.
- Access to extreme-scale HPC and BD resources and their cost-effective use
- Generic software infrastructures that are portable between systems (global – regional, well developed – less well developed)
- The LHA should work on those parts of modeling systems that can be standardized, provide inter-operability, and efficiency/scalability:
 - (Shared) workflows
 - (Shared) data structures and their use by model components
 - (Shared) tools for comparison with observations (à la data assimilation) and other models
 - (Shared) hardware optimized back-ends

Peter concluded that we need a shared solution. Some of this has been tried in individual projects without great success, but not across communities.

Peter then outlined that in terms of establishing partnerships, the first action is to do the housekeeping; assessing what has been done, what exists. and where true potential lies. The second action is to partner up with:

- Main national funding agencies supporting digital infrastructure development (e.g. European Commission's EuroHPC, (Department of Energy, Japan's MEXT and RIKEN etc.); philanthropic support
- WWRP and GAW, national hydro-meteorological services, national climate centres
- Copernicus in Europe, Earth Cube in US, International Society on Digital Earth
- HPC and software industry
- Existing weather/climate-computational science efforts, e.g. US Energy Exascale Earth System Model (E3SM), European Centre for Medium-Range Weather Forecasts (ECMWF) Scalability Programme, Centre of Excellence in Simulation of Weather and Climate in Europe (ESiWACE), InfraStructure of the European Network for Earth System Modelling (IS-ENES)
- Academia (model/data assimilation development, computational science)

He then explained that the third action will be to select certain use-cases, possibly tied to other LHAs, which will need discussion. Peter also emphasized that this exercise does not have a single agenda towards resolution. There are three schools of thought on model development:

1. "Resolution": Focus on spatial resolution to eliminate parametrizations → Computing?.
2. "Traditional": Focus on models holistically, relies on parameterizations → Realism?
3. "Technology": Focus on machine learning and data driven modelling → Training?

They all come with advantages and disadvantages, but Digital Earths LHA should allow us to trial all options within the same framework.

Peter explained that they see the Digital Earths LHA as a framework, rather than an implementation, noting that "Digital Earths in WCRP should be a fostering framework to develop activities across the globe." He explained that it sits between the other LHAs, with generic development in terms of better models, observations, data simulations, user interactions and co-

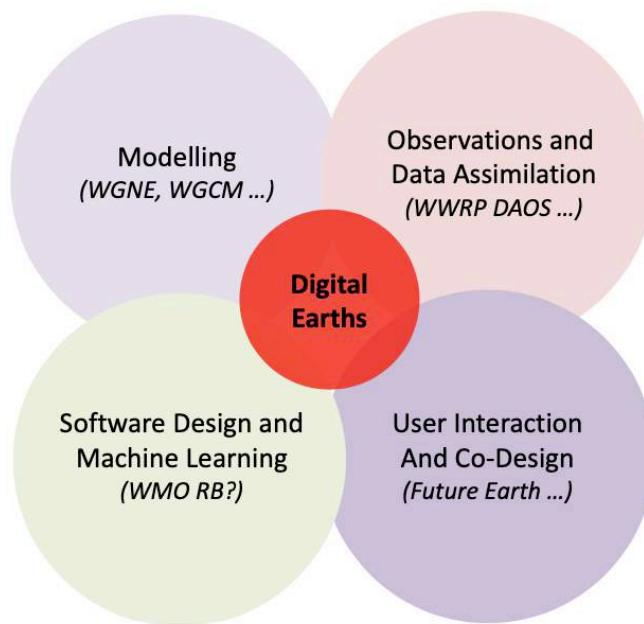


Figure 10 - Digital Earths elements

design, software design, and machine learning (Figure 10). He noted that they should work with WMO in some of these areas. This requires creating science activities with software outcomes that are open and freely available, modular and interoperable, and built to agreed upon standards. We envisage both global and regional Digital Twins will be developed under this framework.

Peter noted that he is involved in Destination Earth, which is a European Commission funded program that will be launched soon. That has a climate change axis as well. If WCRP and this activity can define the requirements for this action, it would help this LHA and WCRP as a whole to make that step and progress faster and it could be picked up by Destination Earth. This would allow the LHA to have an immediate effect.

Discussion

Mike noted that Digital Earths is relevant to both weather and climate timescales. Chris Davis (WWRP) noted that this is highly relevant to WWRP. Building these kind on models with observations and data assimilation is a key piece of how we represent the Earth digitally.

Jan asked where we stop with the Earth system and start with impacts, giving an example of whether hydrology and vegetation are part of the Earth system or part of impacts? Peter said that we can discuss it but we should not lose too much time on thinking about borders or terminology. If it belongs together in terms of what we are trying to achieve, then it is part of it whether we call it an impact model or not². Jan noted that for GEWEX it is essential because one cannot close the water cycle if hydrology and vegetation are not properly treated. It was noted that this is a discussion to hold with the Core Projects.

² There was a lot of discussion on what is included in an 'impact model'. Daniela noted that 'impact model' is used for many different modeling approaches in several sectors, including physical, bio-geo-chemical impacts and impacts on human systems, including health, food, finances etc. Sonya noted that vegetation and hydrology and ocean biogeochemistry are in Earth system models; while impacts are things like disease, economics, human health etc. Most people agreed with the division Sonya provided.

Martin pointed out that we are not talking about a single digital twin. It is a framework within which you can develop many digital twins. He noted that "this is a science enabler". It involves informatics and many other things, which are not core WCRP business but we could partner with others. He asked who the partners would be. Peter explained that it is about creating generic infrastructures that allows you to design your 'Digital Vietnam' or 'Digital Buenos Aires'. He noted that there is work going on outside of WMO (HPC, the way data is managed, etc.), and weather and climate has obvious societal relevance, noting that, "we need to put climate science on their map. Even if it is not part of their business model it is part of their public relations model. The challenge for us is that we have to move away from our comfort zone in Earth system science to areas where we do not have enough expertise. We need to think about how to do that in a sustainable way." As an example, Peter noted that Bjorn Stevens gave the [keynote talk](#) at the Supercomputing Conference this year. He explained that they chose this case as their lead application to support, and we have to make that work for us. It is not easy, but there is potential. We need very clear requirements about what we want from them.

Daniela noted that we see in the presentations of the last LHAs that there can be a lot of overlap and room for connection. This is also true for the new homes and CORDEX may be important for the regional twins. She offered help in connecting Digital Earths LHA to the RfS Home. She made a second point about the Digital Twins in Europe (Destination Earth) Workshop. The digital twins concept for the European Commission goes beyond the technicalities. Knowledge creation and the dialogue required to co-design the digital twins to ensure that they deliver the knowledge needed by society was discussed heavily and is an important part of this. She asked if this was also a part of this LHA. Peter confirmed that he had discussed three breakthroughs – one is on technology; one is on the link between Earth system science and integrating impact sectors; and the third is about user interaction. This third one is very strong for the European Commission. This will be about how different users interact with the digital twins.

Andrew R. commented that, regarding data access, there are several existing databases of forecasts and hindcasts (S2S, Subseasonal Experiment (SubX), North American Multi-Model Ensemble (NMME), Climate-system Historical Forecast Project (CHFP)) of relevance. Several are interoperable via the IRI Data Library. Krishnan Raghavan (JSC Member) noted that explicitly calculated convection at 1 km resolution has shown promise for short range predictions. Whether this concept can be extended to longer time-scales (S2S and climate) could be explored. Kumar noted that the WMO Global Data Processing and Forecasting System (GDPFS) needs to be effectively engaged with this LHA, mainly in terms of standards and data exchange protocols. Martin noted that this LHA provides an opportunity for all of our data 'solutions' to become truly interoperable. Paco noted that for the technological part there is important capacity building to take into account. Young model developers might have to develop their codes using different paradigms to what we have used so far.

Martin commented that WCRP is actually a pretty broad community with community models, data analysis tools, etc. and we have also established ways to run activities at the local (university) and global (larger center) scale and coordination activities (CMIP). These are all components we can bring into the 'digital twin of the Earth' world.

Detlef commented that it would be useful to know what the timeline and actions would be to develop these requirements for Destination Earth. Peter agreed and added that Adam Scaife mentioned operational production on multi-annual to decadal time scales. If that would be something that is really important for WCRP, it could be that those requirements could be formulated and funneled into this activity.

Rowan noted that Explaining and Predicting Earth System Change LHA has a very specific requirement: to pioneer a system for quantitative attribution of Earth system change. This is about integrating the observations and the models, adds huge value to Earth observations, and goes beyond saying what is changing but also how and why things are changing, which is important to decision making. Peter confirmed that they should follow up on that fairly quickly, in early January 2021.

3.5. WCRP Academy

Andrew Charlton-Perez (Co-Chair, WCRP Academy LHA) began by explaining that this LHA is rather different to the other four LHAs. The Science Plan Development Team had its first meeting a couple of weeks prior to this Session and the second meeting will be the week after this Session concludes. He noted that Angela Maharaj has agreed to co-chair this activity. The first meeting was focused on establishing the founding principles of the Academy. We needed to narrow down the focus to something that could be achieved and that is not too broad. The second meeting will refine the working groups and agree on the timeline. The team have reasonable geographical and career stage diversity, including two members from the YESS community.

Andrew C. outlined that the Academy aims to be the 'marketplace' for climate science training (Figure 11). There is a lot of good training available, both in person and online. It is delivered by training providers (universities, WCRP Core Projects, ad hoc) and they don't always know what is needed and they can't always find the right audience. There are a huge number of people that require training in many different aspects of climate science. They may find it difficult to find the training that they need. There is no central resource that provides a list of recommended training that people can draw on to enhance their research capabilities. The Academy would provide the bridge between training providers and the people who need the training.

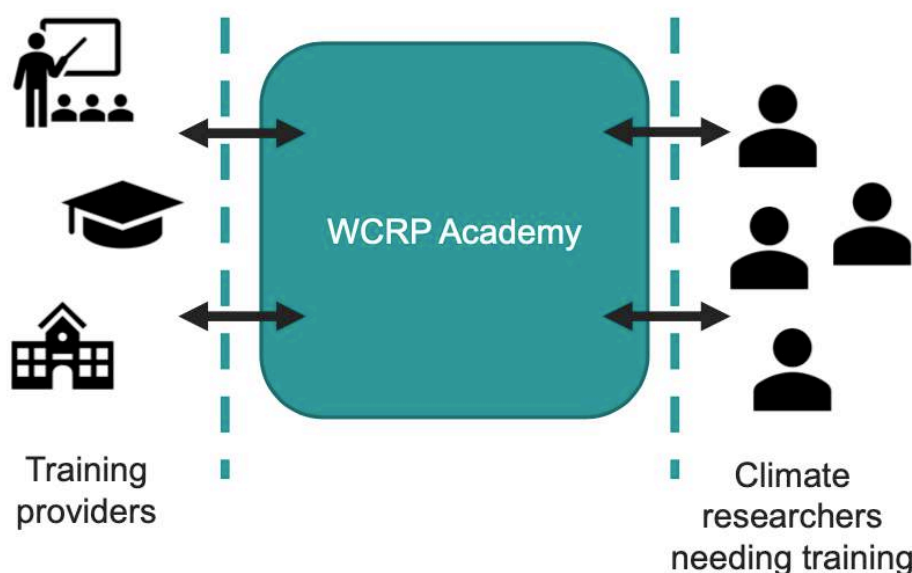


Figure 11 - The WCRP Academy as a marketplace between training providers and climate researchers needing training

Andrew C. explained that they see the key role of the Academy as a facilitator (something that WCRP can do very well), both broadening the access to training for those who need it and by identifying training needs and encouraging providers to match those needs. He noted that they do not see the Academy as having an external 'outreach' role or as a training provider.

Andrew C. noted that partners are very important. Andrew C. and Angela see their role as trying to connect to a lot of different projects and there are many different partners. He noted that they obviously need to work with the Core Projects and Homes (so far discussed in SPARC SSG only, but the team are from all the key projects). It is important to talk to WMO (so far discussed with Patrick Parrish, WMO Education and Training Office), as they have a training function as well. Mike noted that there should also be connections to our other cosponsors (IOC-UNESCO and ISC), who both also have education activities. Andrew C. went on to explain that there are many other external partners, such as Future Earth, IRI, Funders/Philanthropy, and others. He noted that they will need to think about this in terms of generating sustainable funding. A key point is that they didn't want to go out too broadly until they had a clear sense of their objectives. He noted that they are getting to the stage where those objectives are becoming clearer.

Andrew C. explained that in the short term the needs of the Academy include 1) professional help for design, distribution and data collection for a stocktake survey; and 2) establishment of an Academy website and development of name/logo/identity (web and/or graphic designer, hosting). In the longer-term the Academy will need 1) a small full-time staff and a business plan for this development; 2) long-term funding for the two center pieces of the Academy (the portal and the annual stocktake); and 3) seed funding to develop training where this is not currently provided, which will help to ensure a well-functioning marketplace.

Andrew C. outlined that the Academy would work on a 2-year timeline to implementation (Figure 12), noting that it should be up and running at that point, followed by a rolling operational phase. Andrew C. explained that there are three linked working groups (Stock-take, Identity, and Funding). After this 2-year start-up period the plan is to rotate the science team. During 2021 there will be bi-monthly meetings for the Science Plan Development Team and four meetings are planned in 2022.

The three WCRP Academy working groups are:

1. Stock-take Working Group

We need to design a mechanism to understand what training is available and what is needed. We will need to work very clearly with lots of partner organizations to make sure that this function goes out as far as possible to gain the best possible understanding of the needs. This is why professional help in designing the collection mechanism (survey) in an effective way is important and we need to make sure that we collect enough information to make this a meaningful exercise. This function needs to be operationalized for the future on an annual basis as training needs will change hugely over the lifetime of the Academy.

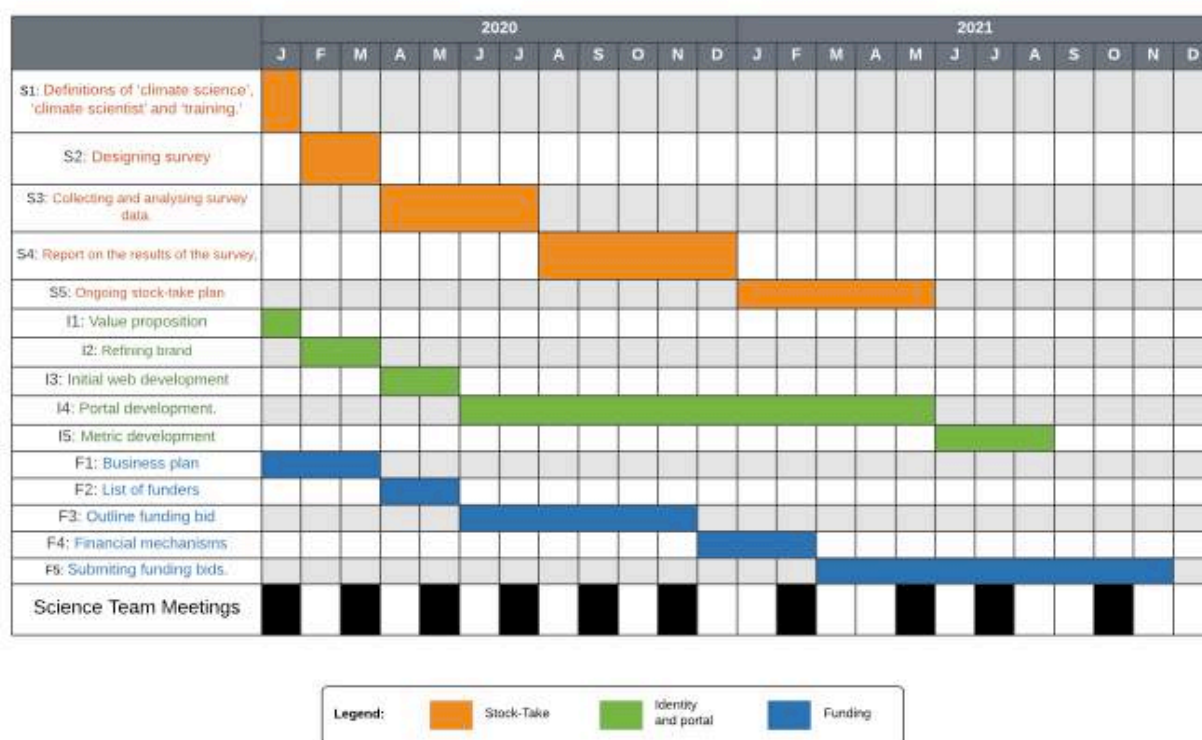


Figure 12 - WCRP Academy Work Plan

2. Identity and Portal

The second working group is about establishing how we do that marketplace role. It is about the identity and branding of the Academy, and its value proposition to users and to WCRP. It is also about developing what the (web) portal will look like and where we can best connect the different groups. As we become more established, it will be about guiding the development of the platform, making sure it is fit for purpose, that it is working, and looking at how can we improve the service we are providing.

3. Finance

Finance will be a core part of this LHA. This working group will be about establishing the business model, building a proposal, and seeking options for funding. In the long term it will be about the mechanisms for long-term financial sustainability.

Andrew C. ended the presentation with some questions. We would like to approach many different organizations for long-term funding outside our typical base of government and international organization funding (e.g. individual and corporate philanthropy). We want to check that this fits with the WCRP mandate. It would help our finance working group to have help and guidance about the possible financial structures (e.g. non-profit status) and where these would be hosted. Lastly, connections will be vital here, once the working groups are established the co-chairs plan to make this their top priority – any help in securing invitations/connections would be much appreciated.

Discussion

Jose noted that summer courses and workshops geared to early career researchers are an important activity of all the Core Projects, so even though CLIVAR and the Core Projects would not become a primary provider of training, they do generate important material that needs to have a wider outreach. Sonya agreed that the Core Projects do provide a lot of training material and

are the providers of training. Even if the Academy does not intend to be a content creator, the Academy can help the Core Projects to disseminate the WCRP materials that they create. Irène agreed and stated that facilitating knowledge of training would include what is already in WCRP. Andrew C. confirmed that he is aware of this and agreed.

Ken asked if Andrew C. had considered the possibility that the Academy could facilitate the interaction between global researchers who could be interested in mentoring young scientists from less developed countries to add to capacity building. Andrew C. responded that this is an excellent idea and that it can be included in the stocktake to understand if that is something that is required at large scale.

Gaby noted that it was great to see that two YESS members were appointed to the team to bring in the ideas of early career researchers, which are crucial for the Academy to thrive. She noted that from the presentation it became quite clear how this LHA could work, but she asked Andrew C. to clarify what type of training they were envisioning. Would it be mainly skills building or broader than that? Possibly there could be a connection to the ISC activity, [TROP ICSU](#), which WCRP and YESS have links to. Gaby also wondered whether we could go beyond the idea of solely training the next generation. It would be good to foster the thought-leaders of the next generation – people who will push the frontiers of science. The next generation of scientists will work in a cross-disciplinary way and may have a different way of working. How can we accommodate them and what are the needs and skills that these people will need? For example, Gaby noted, in Digital Earths it was clear that model codes of the future may look very different. How will the vision of the next generation change? How can we ensure that they build their own vision and have their own ideas?

Andrew C. responded that he was not thinking of this purely about skills training. The Core Projects do excellent training in aspects of climate science, including summer/winter schools. This should not be a solely online or in person initiative. It can be core competencies as well as generic skills. There is a huge focus on early career researchers and we will all need to retrain a lot during our careers. The idea of encouraging younger scientists into leadership roles is an interesting one and we will try and capture that in the stocktake. There are a lot of people on the call today who have a lot of experience in leadership roles. We should draw on that expertise. It is a good example of where the Academy can act as a market-maker. If there is a need for that type of training, then we can advocate for that to be provided. Kumar commented that the stocktake should start with a mapping of the target audience and competency requirements.

Helen thanked Andrew C. and the team. She explained that the Academy had started a bit later than the other LHAs and that they have done a lot of work in a short time. She commented that she sees the Academy as a broker, where all of WCRP are internal partners. The Academy can add value to what is being done in the other parts of WCRP. She explained that the idea around mentoring made her think about the discussions that have been had on what she calls 'succession planning'. The Academy might think about how we can do some more explicit mentoring, as may complement the other things we are putting in place to address our diversity. It would be good for the Academy to engage with the WCRP Climate Research Forums. This will be another place to do some brokering, as there is an important nexus there. Andrew C. agreed, noting that it speaks to Gaby's point about the cross-disciplinarity of our future constituents. It may be that someone has natural training in SPARC topics, but they need some training in CliC topics. This could also aid in breaking down the silos in WCRP a little bit. We are not looking at expanding the core science team very much, but there is room for incorporating others into our working groups. This would be a smaller time commitment for people as well.

Mareike Heckl (SPARC Director) noted that a lot of early career scientists enjoy getting connected to the science community and stay in contact. The Academy could help people get connected to the wider community and stay connected through some way of exchanging experiences. Andrew C. agreed and noted that this mirrored his own experience. He explained that they discussed in the group whether this activity needs both online and in person training. They concluded that we need a mix. If the last year has taught us anything, the opportunities for connecting to people online are so much greater than they have ever been. However, there are vital parts of that which involve in person connections as well. We should try and facilitate both of these. There was mention of the [WMO Global Campus](#) and its [Innovations Report](#) (WMO, 2020a). Andrew noted that the WMO Global Campus is a very important initiative that he is also a member of. An important point that came from that initiative is that to do the scale of training that we need, we can't do it solely with in person training. There are not enough resources. The Academy needs a strong online component, but it can be mixed in the future.

Maria commented that the Academy is an interesting tool to expand diversity in this community and there needs to be a mix of online and in person training. She is currently working with the UN Environment Programme and they were supposed to have an in person meeting in Kigali in June 2020. It was turned into an online course for national focal points for environmental conventions. They are currently creating this course and carrying it out weekly for five weeks for governments in East Africa. She noted that she would be happy to connect this LHA to that activity and offered to work in one of the working groups of the Academy. Andrew C. said this would be great. He said that it sounds like a great initiative produced for governments of a particular part of the world. He wondered whether the purpose of the Academy could be to see whether that information might be usefully propagated to other governments. He explained that it is good when all the hard work that goes into building these training resources can be utilized as much as possible. They agreed to connect offline. Detlef noted it would be good to make a stronger link between the Academy and the WCRP Climate Research Forums, as that will be a connection to the community and others and could lead to stronger links.

Irène added that CORDEX has had many workshops during the Northern Hemisphere Fall. She noted that in Africa, Asia, and Central/South America, a large network of scientists and others have participated and she could reach out to them regarding the Academy. Silvina Solman (Co-chair CORDEX) asked how these CORDEX activities can be connected to the Academy. Irène responded that they have a lot of experience in sharing information, cooperating online, and building networks that can be brought into the Academy and also to the other LHAs (at least when it comes to diversity expansion).

Jing Li (CLIVAR) commented that the knowledge and skills that people can gain through the WCRP Academy should take into account the needs of people at different levels (e.g. from basic to advanced level). It cannot cover everything, so maybe it needs to focus on WCRP science objectives and priorities, with inputs from all elements of WCRP (LHAs, Core Projects, and cooperation with partners). It could also link to career development and applicable skills. She noted that it is important to maintain and follow up with trainees and provide continuous support where needed and possible. She noted that a well-maintained documenting system for the training material (video, audio, documents, presentations, etc.) would be of great value.

Several participants provided resource links. Jürg noted a new WMO publication on training materials and best practices for chemical weather/air quality forecasting ([WMO, 2020b](#)). Michel noted that there were [resources](#) available from the WCRP Summer School on Climate Model Development held in Hamburg in 2015. Huijun Wang (JSC Member) noted that there is a WMO Regional Training Center in Nanjing University of Information Science and Technology (NUIST).

Sonya commented that the LHAs that are deficient in their geographical representation must add additional members to address this as an urgent priority. "We cannot be the 'World' Climate Research Programme if science plans are being created by teams dominated by people from just North America, Europe, and Australia," she said, noting that the imbalance in the geographical distribution of LHA chairs was also striking. Roberto supported Sonya's comment, concluding that it would be good to nominate people to the LHAs from regions that are not as well represented. Detlef supported the comment. He closed by saying that the LHA presentations were all fantastic. Progress has already been made. Diversity in our membership is a homework assignment.

ACTION 10: Provide advice and support to the WCRP Academy Lighthouse Activity on funding possibilities and structures (WCRP Secretariat; January 2021).

4. WCRP way forward and other business

The fourth day of the Extraordinary Session of the WCRP JSC was dedicated to deciding on the way forward with regard to the new WCRP structure and elements and all other WCRP business, including an update on the WCRP Secretariat and international offices, the 2021 budget, future events, and other areas of interest to the community. On 9 December 2020, a closed session of the JSC was held to discuss and decide on open issues.

NOTE: The relevant discussion, decisions, and actions from the closed JSC session are provided in the sections below in the green boxes.

4.1. Way forward and next steps

Detlef noted the very constructive discussions over the Extraordinary JSC Session and concluded that there seems to be an overall agreement on the new structure, with a soft transition to the new elements starting now, the development of science plans during the first half of 2021, the sunseting of the Grand Challenges by the end of 2022, and a large celebration at a second pan-WCRP conference in 2022/2023.

There was much discussion over these plans, as some concerns were expressed about the fast pace of this process and the fact that decisions and workload rely for the time being on a limited group of 40-50 people. It was noted that linkages between WCRP elements are currently unclear as well as those with the broader 'world' community and their engagement in our research challenges. It was commented that there are lessons to be learned from the GCs, which should be taken into account to implement the LHAs. There are still hard questions to address, but a key point is to ensure buy-in from the community and leverage the WCRP family as opposed to a top-down approach. A question was raised on the resources available for the various elements. Detlef clarified that each Home will have support from an international office, and, in the short term, the Lighthouse Activities will have assistance from Secretariat staff in Geneva. It was agreed that there is support 'in principle' for the soft transition, but that full support would depend on how the transition progresses in the next six months.

The main tasks for the next six months are:

- The implementation of new structure and governance from early 2021
- Core Projects/Homes will finalize their reviews and proposals by JSC-42
- LHAs will finalize their draft science plans by JSC-42

- LHAs will identify “pilot” or “inception” activities
- WCRP Climate Research Forums will be rolled out across the regions
- The GC science teams will be transitioned to new structures and elements/activities as appropriate
- A dynamic Implementation Plan will be drafted
- Improved diversity (not just to tick the box) of Core Projects and Lighthouse Activity Teams will be implemented (or planned as part of future membership changes).

It was suggested an ‘advisory’ group could develop some options for governance questions, engagement and communication issues, also building on suggestions made in some of the LHA and core activity presentations.

JSC discussion and outcomes:

The JSC endorsed the communities 'in principle' support for the soft transition to the new WCRP structure. The main tasks of the next six months were endorsed and the following decisions and actions decided.

DECISION 2: The JSC endorsed the community's agreement to support, in principle, the soft implementation to a new WCRP structure. This effectively means that the WCRP will move towards its new structure from 2021 onwards, as presented in the timeline at JSC41B. This also means that our research activities, in some cases, will operate within the new structure before all new Core Projects/Homes and Lighthouse Activities are fully designed and implemented.

ACTION 11: Finalize Core Project/Home reviews/plans (Core Project/Home Chairs; JSC-42).

ACTION 12: Develop drafts of the LHA Science Plans, ensuring an adequate consultation process (Lighthouse Activity Chairs; JSC-42).

ACTION 13: Identify pilot or inception activities for the Lighthouse Activities (Lighthouse Activities; March 2021)

DECISION 3: The JSC decided that Core Projects/Homes and Lighthouse Activities must ensure diversity (gender, geopolitical etc.) in their planning and transition. Linked to ACTION 14.

ACTION 14: Develop a strategy to ensure that WCRP increases its geographical and gender diversity across the Programme (JSC; Plan by JSC-42).

ACTION 15: Streamline and expand WCRP Secretariat and international office support (WCRP Head and JSC leadership; Ongoing with report to JSC-42)

ACTION 16: Establish two working groups on 1) governance and 2) budget and communications (JSC; prior to JSC-42).

4.2. WCRP Secretariat

Mike recalled that the WCRP Secretariat's role is to empower the JSC and the WCRP community, to engage co-sponsors and partners in WCRP, to work with the JSC and co-sponsors to reach collective goals, implement joint strategies, mobilize extra budgetary resources and to coordinate WCRP activities, facilitate cooperation, and build collaboration with partners. The WCRP secretariat sits within the WMO Science and Innovation Department, together with WWRP and GAW. He then reviewed the current staffing situation (one Head, one Senior Scientific Officer (until March 2021), one Junior Professional Officer (shared with WWRP), one consultant (part time until February 2021) and one support person from Institut Pierre Simon Laplace (IPSL) (part time)). He noted the on-going recruitment of one Science Officer and one Science and Communication Officer and the planned recruitment of an additional Science Officer in January 2021.

There was a question regarding the difference between the World Climate Research Division and the WCRP Secretariat, which Mike explained is mainly a structural difference related to WCRP staff being also part of the WMO Secretariat. This was thought to be somewhat confusing and perhaps warranted additional clarification at another point in time.

4.3. Existing and planned international office support

Detlef reviewed the existing and planned international office support (often called international project offices, but not all being related to projects). The current WCRP international offices are:

- SPARC International Project Office at the Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany
- CliC International Project Office at the BCCR, Norway (there is a pending application to partly host this office in the USA)
- International CLIVAR Project Office (ICPO) joint IPO, First Institute of Oceanography, China and the CLIVAR Monsoons Project Office (ICMPO) at the Indian Institute of Tropical Meteorology, India
- International GEWEX Project Office, George Mason University, USA
- CORDEX International Project Office at SMHI, Sweden.
- S2S International Coordination Office at KMA/APEC Climate Center (APCC), Republic of Korea (recently relocated)
- WCRP Coordination Office for Regional Activities (CORA) jointly at GERICS, Germany, and BCCR, Norway
- CMIP Office (decision on the open call for this office is under discussion)

Detlef noted that these offices represent indirect national contributions to WCRP in excess of \$3M per annum and are gratefully acknowledged.

New international offices to be discussed and decided upon include:

- Earth System Modelling and Observational Capabilities (Model–Data) Home
- Regional (Climate) Information for Society (RIfS) Home

It was noted that the international offices are holding regular conference calls every other month or so to update themselves on plans, implementation, and to coordinate their activities and operations. It was further explained that there is an opportunity for a project office to host research on extremes. This proposition would be discussed more in the closed JSC Session.

JSC discussion and outcomes:

The JSC discussed how best to support the LHAs. It was felt that a model where the existing IPOs support the LHAs would not promote integration across all Homes (as with some of the GCs that became part of the Core Projects). It was also thought unmanageable for the LHAs to be supported by two or more IPOs, although there was some support for the spirit of that arrangement. Overall most support was given to the idea of the LHAs having five 'light-touch' Project Support Units (PSUs). These would include a project manager, with a role of coordination and engaging with partners and community (outward facing). There would need to be some administrative and communication support, but some of that support could be shared. It would also be important to ensure that there is a governance model that supports coordination across the Homes and LHAs.

The JSC also reviewed recommendations from the Coupled Model Intercomparison Project (CMIP) Office Open Call Selection Committee and, supporting the recommendation of the Committee, decided to proceed with the top ranked proposal to establish the office, keeping the second one as a backup. They noted that the quality of all of the applications was very high and that the two top bids were both seen as excellent options for the CMIP Office.

A proposal for a Global Extremes Project (led by Xuebin Zhang) was presented to the JSC by Lisa Alexander. The Global Extremes Project would coordinate research on weather and climate extremes across WCRP, building on the work of GC Extremes, WMO activities, the Expert Team on Climate Change Detection and Indices (ETCCDI), and other projects. The team has support for the project from WMO and for a project office at NUIST. On the proposer's behalf, Lisa requested WCRP endorsement and asked where the Project would fit in the new WCRP structure. The JSC decided that while they supported the project, how to place additional project offices in the structure would need further consideration. Helen offered to work with the team proposing the activity to find a way forward.

Mike noted that the proposal for the Monsoons Office is now with CLIVAR and GEWEX, so it was agreed to bring this to the JSC at a later date.

DECISION 4: The JSC supported recommendations from the CMIP-IPO selection committee and will enter the negotiation phase with the top-ranked proposal. The agreement will be passed by the JSC before signing.

ACTION 17: Write a letter to the Extremes team explaining how to frame the Global Extremes Project proposal (JSC Chair and Vice-Chair, Lisa Alexander; February 2021).

ACTION 18: Determine a process for approving cross-cutting project proposals (including any office support) that makes the best use of opportunities without altering the high-level WCRP structure (JSC; WCRP Secretariat).

4.4. Membership

Due to time constraints it was decided that a decision on the Seasonal to Subseasonal (S2S) Project membership proposal submitted to the JSC would be made by email.

ACTION 19: Send a note to the JSC about the Seasonal to Subseasonal (S2S) membership proposal (WCRP Secretariat; December 2020).

4.5. WCRP budget update

Mike presented a draft WCRP budget for 2021 (**Table 3**). The budget assumes that 50 percent or more of future meetings will take place online, that the new WCRP structure will gradually be put in place, and that some activities, such as the GCs, will sunset by the end of 2022. Rather than allow 100 percent carry forward from 2020 to 2021, the suggestion is that the allocations to WCRP activities are increased and requests for additional funds be considered on a case-by-case basis. Expenditure plans should be provided for all activities to WCRP Secretariat. Mike noted that there was significant underspending in 2020, despite higher than usual expenditure on temporary staffing. Resources are being mobilized on several fronts (USGRCP, National Academies, UK Royal Society, Belmont Forum, and others).

Comments were made that the new homes bring a lot of activities under their umbrellas, therefore their operating costs may be potentially challenging with the proposed allocated resources. It was also noted that it remains unclear how the funding will be allocated internally within each home. Several participants indicated that excitement around the new WCRP, especially in terms of the LHAs, should offer opportunities to mobilize additional resources. It was clear that resources from WMO are not necessarily guaranteed for the future and additional fundraising would also prepare the Programme for future resourcing scenarios.

JSC discussion and outcomes:

The JSC discussed and endorsed the draft budget for 2021. They also discussed the possibility on producing pre-negotiated budgets in the future, where a sub-group of the JSC would work with the Core Projects/Homes and the WCRP Secretariat to determine each of their budgets. The JSC would have oversight and make any decisions needed and it may include a mechanism for revisiting the budget mid-year.

It was also noted that better communication with all Nations should be a priority and should explain where we spend our funds on an annual basis.

DECISION 5: The JSC endorses the 2021 draft WCRP budget.

ACTION 20: Work on a streamlined budget process, where a sub-group of the JSC works with the Core Projects to determine a pre-negotiated budget, perhaps with a mid-year review. (JSC, Head WCRP; prior to JSC-42).

ACTION 21: Send an annual communication to Nations explaining WCRP use of previous contributions (WCRP Secretariat; start process by Q1 2021)

Table 3 - WCRP Income and Expenditure 2021

	Budget ('000 CHF)
<i>Proposed Expenditure</i>	
Geneva Staff Operation	
Temporary staffing	15
Geneva Staff Operation	60
JSC Steering Meeting and JSC travel	60
Climate and Ocean Variability, Predictability and Change	85
Climate and Cryosphere	85
Global Energy and Water Exchanges	85
Stratosphere-troposphere Processes And their Role in Climate	85
Earth System Modelling and Observational Capabilities	85
Regional (Climate) Information for Society	85
Lighthouse Activities x 5	150
Fixed-term Projects, Capacity Building, etc.	20
Grand Science Challenges	60
Other e.g. GCOS or other items not in above	25
Implementation Activities	50
TOTAL EXPENDITURE	950
Estimated reserve at beginning of 2021 (including unspent funds because of COVID)	905
<i>Income during 2021 (Estimate)</i>	
WMO Contribution to JCRF* Trust Fund	280
IOC Contribution to JCRF Trust Fund	23
Voluntary: National (country) contributions	354
TOTAL ESTIMATED INCOME**	657
Estimated reserve at the beginning of 2022	612

Notes:

*JCRF - Joint Climate Research Fund

**This does not take into account proposals e.g. USGCRP 350k)

4.6. Communication and future events

Helen addressed the communication strategy around the new WCRP structures, noting that it is of critical importance to build stronger linkages with all the parts of WCRP and enhance the focus on connections between people, teams, and projects, which includes addressing the ‘why’ (information flow and exchange, engagement and transparency, co-production and co-design, bridges to allied disciplines), the ‘who’ (internally between elements and externally to co-sponsors, partners, funders, etc.), the ‘what’ and the ‘how’. Some early thought on how to move forward include principles (e.g. maybe more videoconferencing and less email, learn from others), infrastructures (e.g. tools, collaboration platforms and communication model), meetings and workshops (e.g. in person meetings are still needed to build new relationships and solve problems but online meetings reduce our carbon footprint). Intercultural differences is an important aspect of a communication strategy and will need attention.

Helen noted that some important events planned for 2021-2022 are:

- A workshop on future modelling challenges, May 2021
- Regional (Climate) Information for Society Workshop. Date TBD
- A partners Workshop, planned with: WWRP, GAW, GCOS, Future Earth Programs (SOLAS, PAGES, AIMES, GCP and others). Date TBD
- Second Pan-WCRP Conference in 2022 or 2023

On the last point, Detlef presented the plans for a Pan-WCRP Conference at the end of 2022 or beginning of 2023, a decade after the 2011 Denver WCRP Open Science Conference. He explained that the conference should be organized in collaboration with partners, focusing on WCRP’s science to celebrate past successes, roll out the new WCRP, bring in the next generation of scientists, allow global geographic representation, and to engage with funders and stakeholders. He noted that this effort requires input and support from all WCRP activities and we will need to establish some key roles and teams to organize the event.

JSC discussion and outcomes:

The JSC recognized that many people will be struggling to understand the new WCRP structure, as the transition introduces uncertainty in terminology (Core Projects vs Homes) and of the place of existing science in the new framework. They discussed producing a brief high-level brochure about the new WCRP. This would be externally focused and complement the more inwardly focused Implementation Plan.

The JSC also felt that a discussion with the Grand Challenge leaderships should take place to determine how to promote the accomplishments of these initiatives.

Lastly, the JSC discussed that the list of workshops proposed in the open session would be a worthwhile activity for the development of the new Homes and should be supported. Progress should also be made on the Open Science Conference organization, as per a pending action from the 41st Session of the JSC.

ACTION 22: Develop an externally-focused high-level brochure about the new WCRP (WCRP Secretariat; February 2021).

ACTION 23: Determine how to promote the Grand Challenge accomplishments: a series of products to celebrate the accomplishments (brochure, paper, video) of the Grand Challenges and other sunset activities (Grand Challenges, JSC WCRP Secretariat; JSC-42).

DECISION 6: The JSC will work with the two new Homes, Earth System Modelling and Observational Capabilities and Regional (Climate) Information for Society, to develop a workshop for each.

4.7. Summary of regional consultations – status and feedback

Helen summarized the status of the regional consultations, which was an action from the 41st Session of the JSC. [Regional Focal Points](#) have been appointed for all defined regions. Discussions have been initiated with all Regional Focal Point teams across Regions (Asia/Oceania; Africa; South America; North America are complete; Europe and Western Asia are planned for January 2021). The initial WCRP-hosted “Climate Research Forums” are progressing, but slower than originally planned. It was noted that as part of the regional consultations, it is important to provide an overview of the WCRP Strategy, its implementation, the new structure, new activities (including LHAs), and the status of the Climate Research Forums to the WCRP family.

The current thinking on implementing the Forums is that they will depend on region and interests, would typically last 90 minutes via videoconference (with registration to help maintain a database), and would be hosted by an internal project office or partner/co-sponsor organization. The program would generally include an overview of WCRP, science talks, and/or discussions to engage beyond the Forums. The target audience includes not only the WCRP family but wider co-sponsor communities, partners, agencies, and others.

4.8. Our future way of working and WCRP's carbon footprint

Detlef recalled that COVID-19 has forced us to change how we do business. Post COVID-19, WCRP's mode of operations will evolve. It is envisioned that in the future at least 50 percent of interactions and meetings will be virtual. This comes with many benefits, including a reduced carbon footprint, reduced travel costs, wider inclusion, and better engagement with a broader community. This also requires us to take a fresh view on WCRP business plans and expenditure.

It was commented by the group that the target of 50 percent was perhaps over-simplified and not ambitious enough and may need to be refined and detailed so that WCRP can set a good example.

Pierre reported on progress in relation to the recommendations from the carbon footprint report submitted to the 41st Session of the JSC, which included the monitoring of WCRP travel-related carbon emissions. He noted the need to collaborate with the core activities and project offices to co-design this activity, including to define what information is needed and how it is used, to determine a baseline to monitor future progress, and to report to the WCRP Joint Scientific Committee on an annual basis. An online carbon calculator tool is currently planned in

collaboration with Cranfield University (Chikage Miyoshi, Neil Harris), the agreement of which will hopefully be approved soon by WMO.

4.9. The WMO Research Board

Mike provided a short report on the WMO Research Board on behalf of Jürg Luterbacher. This new body of WMO delivers on Long Term Goal 3 of the WMO Strategy "Advance Targeted Research" to promote seamless Earth system modelling across weather, water, atmosphere/environment, ocean, and climate and interoperable observation systems of Earth system components. Apart from general oversight of the WMO research programmes, the Research Board includes WGNE (co-sponsored by WCRP) and two newly established Task Teams on 'Exascale computing and Artificial Intelligence' and on 'SARS-CoV-2/COVID-19'. Concept notes are currently being developed and will be finalized in January 2021. The concept notes are intended to articulate the high-level scientific priorities and key activities to the scientific community and partners, including funding agencies and stakeholders. The aim is to enable the research programmes to work more effectively on cross-cutting aspects, to facilitate interactions within WMO, to provide an inclusive framework for partners of WMO, including Regional Associations, and to help initiate future activities and potentially attract funding agencies. The Research Board will hold its first session online on 28-29 January 2021. Some examples of activities include the joint WWRP-WCRP S2S project, the planned joint WWRP and WCRP Monsoons Office in India, and cooperation between WCRP and both the Services Commission and Infrastructure Commission of WMO.

4.10. Collaboration with Future Earth

Detlef noted that a joint statement of collaboration has been developed between WCRP and Future Earth. He explained that given the highly complementary nature of our aspirations and purpose, and strengths and expertise, there is great benefit in Future Earth and WCRP harnessing synergies to jointly investigate and answer the most pressing societal questions associated with climate and environmental change, through co-design and co-delivery between our respective communities.

He explained that the purpose of this statement of intent is to explicitly describe these areas of synergy, and the ways in which both WCRP and Future Earth can leverage our historical collaboration to significantly strengthen the partnership between our two research programmes. The goal is to achieve a step-change in the breadth and depth of our collaborative work so that we can collectively deliver more relevant, timely, integrated, and robust programmes, products, and outcomes to benefit society. This goal is a decadal ambition, but the intent of both programmes is to develop a "roadmap" of shorter- and longer-term actions that will ensure this stronger collaboration begins immediately and grows in breadth and depth over the decade ahead.

The joint statement will be complemented by dedicated Memorandums of Understanding (MoUs)/Scientific Partnerships between WCRP and specific projects to continue and formalize fruitful collaborations with Future Earth Global Research Projects, for example AIMES, the Global Carbon Project (GCP), iLEAPS, PAGES, SOLAS and IGAC. This will entail reconfirming existing, or establishing new agreements, shared memberships on Steering Committees and Working Groups and ongoing shared communication, joint planning, co-design and co-delivery of activities.

4.11. Collaborative reports

JSC discussion and outcomes:

Detlef Stammer briefly outlined the need for wider JSC involvement in collaborative reports, such as the 10 New Insights into Climate Science (10NICS) (with Future Earth and the Earth League), the WMO State of the Global Climate Report, the United in Science Report, and others. He noted that it would be necessary to determine a mechanism for JSC involvement.

ACTION 24: Determine and report back on how to better involve the JSC in the 10NICS and also for the next WMO report and other similar cases (JSC Chair and Vice-Chair, Head WCRP; March 2021).

5. Next Session

The JSC confirmed, as previously arranged, that the 42nd Session of the JSC will take place from 28 June - 2 July 2021 and will almost certainly be an online Session.

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- WMO, 2020b. Training Materials and Best Practices for Chemical Weather/Air Quality Forecasting. ETR- No. 26. https://library.wmo.int/doc_num.php?explnum_id=10439.

Annex 1 – List of Participants

Acronyms provided in Annex 3

	Last Name	First Name	Function/Affiliation
1	ALEXANDER	Lisa	JSC Member
2	AMBRIZZI	Tercio	JSC Member
3	ARICO	Salvatore	IOC-UNESCO
4	BAUER	Peter	Digital Earths LHA
5	BEHAR	David	GC Sea Level
6	BOASSO BALINO	Beatriz	CliC Director and CORA Coordinator
7	BONY	Sandrine	GC Clouds
8	BOX	Jason	Incoming CliC Co-chair
9	BRACONNOT	Pascale	JSC Member
10	BROVKIN	Viktor	AIMES
11	CAO	Wenchao	WCRP Junior Professional Officer
12	CHANDRIKA	Nath	SCAR
13	CHARLTON-PEREZ	Andrew	WCRP Academy LHA
14	CHRISTENSEN	Jens Hesselbjerg	JSC Member
15	CLEUGH	Helen	JSC Vice-chair
16	CORTI	Susanna	JSC Member
17	DAVIS	Chris	WWRP
18	DE CONIN	Estelle	WWRP
19	DEWITT	Langley	IGAC
20	DEWITT	Langley	IGAC
21	DOBLAS REYES	Francisco	Co-chair WMAC
22	DOLMAN	Han	GCOS
23	FERSE	Sebastian	Executive Officer, Future Earth Coasts
24	FLATO	Greg	WGCM Co-chair
25	FRIEDLINGSTEIN	Pierre	JSC Member
26	GIER	Jessica	Executive Director, SOLAS
27	GOODESS	Clare	WGRC Co-chair
28	HANNAH	Liddy	AIMES
29	HARRIS	Neil	SPARC Co-chair
30	HAYMAN	Gary	iLEAPS
31	HECKL	Mareike	Director SPARC IPO
32	HEWITSON	Bruce	WGRC Co-chair
33	HURRELL	James	JSC Member
34	ILYINA	Tatiana	GC Carbon
35	IVANOVA	Maria	JSC Member

	Last Name	First Name	Function/Affiliation
36	IVANOVA	Maria	JSC Member
37	JACKSON	Rob	GCP
38	JACOB	Daniela	CORDEX Co-chair
39	KAYE	Jack	NASA
40	KEY	Erica	Belmont Forum
41	KIMOTO	Masahide	JSC Member
42	KOLLI	Rupa Kumar	Executive Director ICMPO
43	LAKE	Irene	Director CORDEX IPO
44	LANGENDIJK	Gaby	YESS
45	LEGG	Sonya	CLIVAR Co-chair
46	LI	Jing	CLIVAR
47	LIPING	Yin	CLIVAR
48	LOUTRE	Marie-France	PAGES
49	LUTERBACHER	Jürg	WMO
50	MEEHL	Gerald	WMAC Co-chair
51	MERRYFIELD	William	WGSIP Co-chair
52	MICHAUT	Catherine	IPSL
53	MILLER	Lisa	SOLAS
54	NICHOLLS	Rob	GC Sea Level
55	NILSSON	Lindha	CORDEX
56	O'KANE	Terry	GC NTCP
57	PAULAVETS	Katsia	ISC
58	PETER	Thomas	JSC Member
59	POLCHER	Jan	GEWEX Co-chair, GC Water
60	POSTEMA	Meagan	Future Earh
61	POULTER	Benjamin	iLEAPS
62	RABANAL	Valentina	YESS
63	RAGHAVAN	Krishnan	JSC Member
64	RENEWICK	James	CliC Co-chair
65	REYNOLDS	Carolyn	WGNE Co-chair
66	RIXEN	Michel	WCRP Secretariat
67	ROBERTSON	Andrew	S2S Co-chair
68	RODRIGUES	Regina	My Climate Risk LHA
69	RUTI	Paolo	EUMETSAT
70	RYABININ	Vladimir	IOC
71	SÁNCHEZ-RODRÍGUEZ	Roberto	JSC Member
72	SANTOS DAVILA	Jose Luis	Director CLIVAR IPO

	Last Name	First Name	Function/Affiliation
73	SCAIFE	Adam	GC Near Term Climate Prediction
74	SCHLUENSEN-RICO	Anke	CORA
75	SENEVIRATNE	Sonia	GC Weather and Climate Extremes
76	SENIOR	Cath	WGCM Co-chair
77	SHEPHERD	Ted	My Climate Risk LHA
78	SHERWOOD	Steve	Safe Landing Climates LHA
79	SHORES	Amanda	SPARC
80	SIOEN	Giles	Future Earth
81	SMITH	Doug	WGSIP Co-chair
82	SOLMAN	Silvina	CORDEX Co-chair
83	SON	Seok-Woo	SPARC Co-chair
84	SPARROW	Michael	Head WCRP Secretariat
85	STAMMER	Detlef	JSC Chair
86	STEPHENS	Graeme	GEWEX Co-chair
87	SUTTON	Rowan	Explaining and Predicting Earth System Change LHA
88	TAKAHASHI	Ken	JSC Member
89	TANIMOTO	Hiroshi	IGAC
90	TEWKSBNRY	Josh	Future Earth
91	UNGVARI	Judit	Future Earth
92	VAN DE WAL	Roderik	GC Sea Level
93	VAN DER WEL	Narelle	WCRP Consultant
94	VAN OEVELEN	Peter J.	Director GEWEX IPO, GC Water
95	VISBECK	Martin	JSC Member
96	VITART	Frédéric	S2S Co-chair
97	WANG	Hui-Jun	JSC Member
98	WEDI	Nils	WGNE IncomingCco-chair
99	WILLIAMS	Keith	WGNE Co-chair
100	ZHANG	Xuebin	GC Weather and Climate Extremes

Annex 2 – Agenda

Extraordinary Session of the WCRP Joint Scientific Committee (JSC-41B) Outline Agenda

DRAFT: 30 Nov 2020

**Videoconference
Nov 30 to Dec 3, 2020**

Background

- This is an extraordinary, online, meeting that is an adjunct to JSC-41 held in May 2020.
- The extraordinary JSC-41B meeting aims to make significant progress towards a “soft” implementation of the new WCRP structure and discuss the implementation of the WCRP Strategic Plan 2019-2028. We will hear back from the WCRP family on progress toward the implementation of the new WCRP, get reports and proposals for changes and new elements and come to conclusions and decisions that will allow the soft implementation of new structures, the respective governance and additional activities required leading up to the JSC-42 meeting at which the implementation will be concluded.
- As background to the meeting we suggest you look at "The 'new' WCRP will soft launch in 2021. What can you expect?": <https://www.wcrp-climate.org/news/wcrp-newsletter/wcrp-news-articles/1626-new-wcrp-2021>
- The focus of the meeting will be on the implementation and future elements. Reporting would be limited to results from “homework” assignments.
- Attendance at this virtual JSC-41B is by invitation only.
- Should you wish to attend please contact Mike (msparrow@wmo.int) in the first instance.
- 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/jsc41B-about>. Wenchao (wcao@wmo.int) in the WCRP Secretariat will run all presentations to ensure a smooth transition between sessions.
- During the virtual meeting questions can be submitted via the Chat Box in GoToMeeting. A member of the WCRP Secretariat will moderate the chat and notify the chair as applicable.
- If you have any issues with GoToMeeting please contact Catherine (catherine.michaut@ipsl.fr). We have also set up a Bluejeans meeting that we can circulate should there be any last-minute issues with GoToMeeting.

All times in the attached agenda are quoted in Geneva/Paris time. Please see e.g. <https://www.timeanddate.com/worldclock/meeting.html> for the correct times in your area.

Outline Agenda

DAY 1 (30/11/20 3-6pm, Geneva time)

(Rapporteur Narelle Van der Wel; Chat Moderator Michel Rixen)

1. **Welcome (including comments from co-sponsors if they wish), Goals and Agenda** (Detlef Stammer, Helen Cleugh, Mike Sparrow; 25 mins)
2. **WCRP Implementation Plan and Future Structure: Update on progress to date** (65 mins)
(Chair: Helen Cleugh)
 - i) Draft structure and elements (Detlef Stammer and Helen Cleugh; 15 mins)
 - ii) Engagement with, and feedback from, partners (e.g. Future Earth, WWRP and GAW) and funders (USGCRP, EC, ...) (Detlef Stammer, Helen Cleugh, Mike Sparrow; 20 mins)
 - iii) Discussion (All; 30 mins)

(Break: 10 mins)

3. **Core Projects review: progress report and discussions** (80 mins):
(Chairs: Pascale Braconnot (CLIVAR) and Lisa Alexander (GEWEX))
 - GEWEX (Jan Polcher; 20 min presentation and 20 min discussion)
 - CLIVAR (Sonya Legg; 20 min presentation and 20 min discussion)

Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30 mins)

(30 min coffee/wine and catchup social for those others who wish to).

END Day 1.

DAY 2 (01/12/20 8-11 am, Geneva time)

(Rapporteur Mike Sparrow; Chat Moderator Michel Rixen)

4. **Core Project review cont.: progress report and discussions** (80 mins):
(Chairs: Tercio Ambrizzi (SPARC) and Jens Hesselbjerg Christensen (CliC))
 - SPARC (Seok-Woo Son; 20 min presentation and 20 min discussion)
 - CliC (James Renwick; 20 min presentation and 20 min discussion)

(Break: 10 mins)

5. **New “Home” discussions: progress report and discussions** (90 mins):
(Chairs: Detlef Stammer and Helen Cleugh)
 - “Earth System Modelling and Observational Capabilities” (Francisco “Paco” Doblas-Reyes; 20 min presentation and 25 mins discussion)
 - “Regional (Climate) Information for Societies” (Daniela Jacob; 20 min presentation and 25 mins discussion)

Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30 mins)
(30 min coffee/wine and catchup social for those others who wish to).

END Day 2.

DAY 3 (02/12/20 midday-3pm, Geneva time)
(Rapporteur Narelle Van Der Wel; Chat Moderator Mike Sparrow)

6. Lighthouse Activity Science Plans: progress report and discussions (180 mins):
(Chairs: Detlef and Helen)

- Explaining and Predicting Earth System Change (Rowan Sutton; 15 min presentation and 20 min discussion)
- My Climate Risk (Regina Rodrigues; 15 min presentation and 20 min discussion)

(Break: 5 mins)

- Safe Landing Climates (Steven Sherwood; 15 min presentation and 20 min discussion)
- Digital Earths (Peter Bauer; 15 min presentation and 20 min discussion)
- WCRP Academy (Andrew Charlton-Perez; 15 min presentation and 20 min discussion)

Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30 mins)
(30 min coffee/wine and catchup social for those others who wish to).

END Day 3.

DAY 4 (03/12/20 9pm-midnight, Geneva time)
(Rapporteur Michel Rixen; Chat Moderator Narelle Van Der Wel)

7. Summary of Regional consultations – status and feedback (Helen Cleugh and Detlef Stammer; 10 mins)

8. Other Elements of the new Structure (short term projects, assessments etc.) (5 min introduction (Helen Cleugh) + 15 min discussion (Chair: Detlef Stammer))

- Open (moderated) discussion on other elements required in the WCRP new structure.

9. Way forward and next steps, including drafting of Implementation Plan. (Detlef Stammer, Helen Cleugh, Mike Sparrow; 10 mins presentation + 20 mins discussion)

(Break: 5 mins)

10. Any other business

- a. WCRP Conference: progress and discussion (Detlef Stammer; 15 mins)
- b. The future of way of working, including short update report on WCRP Carbon Footprint Working Group (Detlef Stammer, Pierre Friedlingstein; 15 mins)

- c. The WMO Research Board (Jürg Luterbacher; 10 mins)
- d. Collaboration with Future Earth Programmes (Detlef, Helen; 5 mins)
- e. Update on WCRP Secretariat (Mike Sparrow; 10 mins)
- f. Existing and planned International Project Offices (Detlef Stammer and Helen Cleugh; 10 mins)
- g. WCRP Budget update; USGCRP and other country proposals etc. ... (Mike Sparrow, Detlef Stammer, Helen Cleugh; 15 mins)
- h. Final comments from co-sponsors and partners (15 mins)

General Discussion: 10 mins

Debrief for JSC Chair, Vice-Chair, Officers and Head WCRP Secretariat (30 mins)

(30 min coffee/wine and catchup social for those others who wish to).

END Day 4.

(NOTE: JSC Only session is arranged for 9pm-midnight Geneva/Paris time on the 9th December.)

Annex 3 – Acronyms

10NICS	10 New Insights in Climate Science
AI	Artificial Intelligence
AIMES	Analysis, Integration and Modelling of the Earth System
AMAP	Arctic Monitoring and Assessment Programme (Arctic Council)
APECS	Association of Polar Early Career Scientists
AR6	Sixth Assessment Report (IPCC)
AR7	Seventh Assessment Report (IPCC)
ASPeCt	Antarctic Sea-ice Processes and Climate (CliC/SCAR)
BB	Building Blocks (RIfS)
BCCR	Bjerknes Centre for Climate Research
BEPSII	Biogeochemical Exchange Processes at Sea-Ice Interfaces (CliC/SOLAS/SCAR)
C3S	Copernicus Climate Change Service
CCMI	Chemistry-Climate Model Initiative (SPARC/IGAC)
CDR	Carbon Dioxide Removal
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellite
CHFP	Climate-system Historical Forecast Project
CliC	Climate and Cryosphere (WCRP)
CLIVAR	Climate and Ocean Variability, Predictability and Change (WCRP)
CMIP	Coupled Model Intercomparison Project
CMIP5	CMIP Phase 5
CMIP6	CMIP Phase 6
CORA	Coordination Office for Regional Activities (WCRP)
CORDEX	Coordinated Regional Climate Downscaling Experiment
COVID-19	Coronavirus Disease 2019
CSP	Climate Services Partnership (UNDP/UNEP)
DAOS	Working Group on Data Assimilation and Observing Systems (WWRP)
DLR	Deutsches Zentrum für Luft- und Raumfahrt (German Aerospace Center)
E3SM	Energy Exascale Earth System Model
ECMWF	European Centre for Medium-Range Weather Forecasts
ESA	European Space Agency
ESiWACE	Centre of Excellence in Simulation of Weather and Climate in Europe
ESM	Earth System Model
ETCCDI	Expert Team on Climate Change Detection and Indices
EuroHPC	European High Performance Computing
FAO	Food and Agriculture Organization (UN)
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)
GCOS	Global Climate Observing System (WMO/IOC-UNESCO/UNEP/ISC)
GCM	Global Climate Model
GCP	Global Carbon Project
GDAP	GEWEX Data and Analysis Panel (GEWEX)
GDPFS	Global Data-processing and Forecasting System (WMO)
GERICS	Climate Service Center Germany
GEWEX	Global Energy and Water Exchanges (WCRP)
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

GFCS	Global Framework for Climate Services
GHP	GEWEX Hydroclimatology Panel
GLASS	Global Land/Atmosphere System Study (GEWEX)
GCF	Green Climate Fund
GSOP	Global Synthesis and Observations Panel (CLIVAR)
HighResMIP	High Resolution Model Intercomparison Project
HIWeather	High-Impact Weather Project (WWRP)
HPC	High Performance Computing
IAM	Integrated Assessment Model
IASC	International Arctic Science Committee
ICMPO	International CLIVAR Monsoon Project Office
IDDR	International Day for Disaster Reduction
IGAC	International Global Atmospheric Chemistry (Future Earth)
IRI	International Research Institute for Climate and Society
iLEAPS	Integrated Land Ecosystem-Atmosphere Processes Study (Future Earth)
IMBeR	Integrated Marine Biosphere Research
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IPO	International Project Office
IPSL	Institut Pierre Simon Laplace
ISC	International Science Council
IS-ENES	InfraStructure of the European Network for Earth System Modelling
ISIMIP	Inter-Sectoral Impact Model Intercomparison Project
ISMASS	Ice Sheet Mass Balance and Sea Level (CliC/SCAR/IASC)
JCRF	Joint Climate Research Fund (WCRP)
JSC	Joint Scientific Committee (WCRP)
JSC-41	41st Session of the JSC held in May 2020
JSC-41B	Extraordinary Session of the JSC held in November/December 2020
JSC-42	42nd Session of the JSC to be held in June/July 2021
JSC-43	43rd Session of the JSC
KAN	Knowledge Action Network (Future Earth)
LHA	Lighthouse Activity
LS3MIP	Land Surface, Snow and Soil moisture Model Intercomparison Project
MESH	Modeling Earth System and Human interactions (AIMES)
MEXT	Ministry of Education, Culture, Sports, Science and Technology of Japan
MIP	Model Intercomparison Project
ML	Machine Learning
MoU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NetCDF/CF	NetCDF Climate and Forecast
NMHS	National Meteorological and Hydrological Service (WMO)
NMME	North American Multi-Model Ensemble
NUIST	Nanjing University of Information Science and Technology
Obs4MIPs	Observations for Model Intercomparisons Project
OMDP	Ocean Model Development Panel (CLIVAR)
PAGES	Past Global Changes
PannEx	Pannonian Basin Experiment
PICES	North Pacific Marine Science Organization
POGO	Partnership for Observation of the Global Ocean
PRECP	PRocessing of Emissions by Clouds and Precipitation
PREP	Partnership for Resilience and Preparedness
PREPdata	An open-source data platform of the Partnership for Resilience and Preparedness
PSU	Project Support Unit
R2O	Research to Operations
RCM	Regional Climate Model
RIFS	Regional (Climate) Information for Society (WCRP)
Risk-KAN	Knowledge-Action Network on Emergent Risks and Extreme Events (Future Earth)

SAT	Scientific Advisory Team (CORDEX)
SDGs	Sustainable Development Goals (UN)
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SERA	Working Group on Societal and Economic Research Applications (WWRP)
SOLAS	Surface Ocean - Lower Atmosphere Study
SMHI	Swedish Meteorological and Hydrological Institute
SPARC	Stratosphere-troposphere Processes And their Role in Climate (WCRP)
SRM	Solar Radiation Management
SSG	Scientific Steering Group (WCRP)
START	SysTem for Analysis, Research and Training
SubX	Subseasonal Experiment
S2S	Subseasonal to Seasonal (also S2S Prediction Project (WCRP, WWRP))
TG-Data	Task Group on Data Support for Climate Change Assessments (IPCC)
TIRA	Task Team for Intercomparison of ReAnalyses (WDAC)
TROP ICSU	Trans-disciplinary Research Oriented Pedagogy for Improving Climate Studies and Understanding
TTRA	Task Team on Regional Activities (WCRP)
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)
UNSEEN	UNprecedented Simulated Extremes using ENsembles
USGCRP	United States Global Change Research Program
VIA	Vulnerability and Impact Assessment
WASP	World Adaptation Science Programme (UNFCCC)
WCRP	World Climate Research Programme
WDAC	WCRP Data Advisory Council (WCRP)
WDS	World Data System (ISC)
WGCM	Working Group on Coupled Modeling (WCRP)
WGI	Working Group I (IPCC)
WGII	Working Group II (IPCC)
WGIII	Working Group III (IPCC)
WGNE	Working Group on Numerical Experimentation (WCRP/WMO Research Board)
WGRC	Working Group on Regional Climate (WCRP)
WGSIP	Working Group on Subseasonal to Interdecadal Prediction (WCRP)
WHO	World Health Organization (UN)
WMAC	WCRP Modelling Advisory Council (WCRP)
WMO	World Meteorological Organization
WWRP	World Weather Research Programme
YESS	Young Earth System Scientists
YHS	Young Hydrologic Society

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

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

