World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
1	The WCRP strategic plan is organized by first, Overarching Scientific Objectives, then Scientific Emphases and finally, Imperatives. The distinction between these items is not always clear and there is some overlap and redundancy. For example "Observations for process understanding" and "sustained observations" are included in the "Imperatives" (paragraphs 19 and 20), while "Innovation through observation" (paragraph 15) is part of the "Emphases" section. Similarly "Engaging with society" is included in the "Scientific Emphases" section (paragraph 16) overlapping with "Societal engagement" in the "Imperatives" section (paragraph 24). My assessment is that whereas the scope of the "Overarching Scientific Objectives" and "Imperatives" sections are clear, the "Scientific emphases" needs to be rewritten to more closely focus on scientific questions, rather than tools (which are largely covered by the "Imperatives" section). For example, what are the questions which arise at the intersection between the natural climate system and society? What are the key questions/challenges we must tackle for integrating observations and models together to provide understanding of the climate system? Specific comments Paragraph 3, first sentence: I find this wording, combining "longest-running" and "only" confusing. If WCRP is the only program, of course it is the longest-running program! Perhaps this sentence could be rewritten as "WCRP is the longest-running initiative focused on coordination of international climate research, and the only one solely dedicated to this goal". Paragraph 3, line 8: Change "climate science is called upon to support the knowledge" to "climate science is called upon to provide the knowledge". The writing in the Scientific Emphases section could be sharpened considerably, and made less vague. Specific examples include: Paragraph 10, line 9: "It requires a..." - Don't begin a sentence with "it", particularly since I am unclear what "it" refers to in this context. Paragraph 11, line 4: "This in turn..." - what does "this" refer to? Paragraph 11, line 9: "potential for thresholds and surprises" - be more specific and scientific. Paragraph 12, line 7: "..effects are even more..." - what effects are being referred to here? Paragraph 12, line 12: "They are critical" - what does "they" refer to? Some other suggestions for improvement of the "Emphases" section: 1. Climate dynamics and extreme events (paragraph 11). Much more scientific information about modes of variability, outstanding questions and types of interactions between climate dynamics and extreme events could be mentioned here. 2. Changes in planetary cyles (paragraph 12). I recommend changing the title of this paragraph to "Changes in earth system cycles", since "planetary" might imply objects elsewhere in the solar system. This paragraph contains several specific examples, but they are connected together in a way that doesn't always make sense. For example, in the last two sentences there is an implied link between sea level rise and methane outbursts, which I don't think is intended. More effort is needed to make this paragraph explain the key processes, impacts and outstanding questions related to cycles of key quantities. Paragraph 14, line 5: "oceanic eddies and waves" - I suggest also adding "ocean mixing" as one of the key climate-relevant processes which needs better representation. Paragraph 14, line 8-11: I don't understand what is intended by this final sentence of this paragraph. Perhaps the sentence could be rewritten as "In order to advance support of climate services,improved downscaling tools are required to better represent regional and extreme phenomena." Paragraph 14 and 15: Somewhere in these two paragraphs, it is important to mention data assimilation, as a vital tool for combining models and observations, and initializing predictions. Paragraph 16, final sentence: I am not clear what is intended by this sentence. Paragraph 17, line 3: "These can be thought of" - what is "These" referring to in this context? I very much like the list of Imperatives, and in particular the concise way they are listed.	Thank you. We have changed the structure of the Strategic Plan so that there are only two, we hope self-evident, categories. Objectives and infrastructure. The proposed edits have been included in the text when possible. The sentence "the improvement of simulation capabilities for projection requires that models be confronted with observations at every opportunity." meant that model results should be compared with observations to make sure that they are robust. The final text has been reworded to emphasize the need for verification of simulation capabilities. The final sentence in Paragraph 16 has been reworded to clarify the issue.
2	This strategic plan presents a good balance between basic science and social connections. The vision statement is particularly apt, and we appreciate the emphasis that solid science is a priori imperative. For the graphic, which is really nice, it would be useful to give a bit more explanation and connect it with the text. Paragraph 9: You are only naming Future Earth here as an evolving partnership and for the rest it is "and others". You could name a few others or maybe this is not even necessary and you could just refer to page 9 where you can list these partnerships. Paragraph 17: To have a better overview, the number of imperatives (seven) should be stated in this paragraph already.	Thank you. The Plan emphasizes the need for strong connections to social sciences to make further progess. The vision and mission have been retained as in the draft. The graphic has been modified following comments received and the new structure of the Plan has been revised substantially. The partnerships are now highlighted at the beginning of the document as a key strategic requirement. The section on imperatives has been re-structured as well, with a number of elements moved elsewhere in the document.
3	Paragraph 9 - language in this paragraph ought perhaps to be better aligned with the language of Article 7 of the Paris Agreement. Propose expanding this paragraph to... "[...]Improving the usability and use of climate science — in urban areas, in the regions, and globally — provides fertile ground for collaboration with a wide range of international research communities and for enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change. [...]"	Thank you. This section has been revised substantially, as well as text refering to adaptation, resilence, etc elsewhere in the document. The Paris Agreement is referred to at the beginning of the Plan. The key elements of this suggested text have been incorporated in the Plan when possible.
4	While acknowledging that the WCRP Strategic Plan already covers all aspects of social-natural climate research, I would support the inclusion of further details on 'communication and society engagement'. Based on my recent work with the EU SWITCH-Asia programme, I observe a general lack of understanding of climate change and its impacts on societies' day-to-day lives -- not only in developing countries but also in the advanced ones. This would call for research on how to engage communities more strategically to bring hopefully a leap in understanding, since we could not afford delays in, for example, correcting our unsustainable consumption and production patterns.	Thank you. We agree that communication, society engagement in filling gaps in understanding the impacts of climate change in fundamental. We hope that our objective 4 on "Bridging climate science and society" and its explicit emphasis on "Engaging with Society" addresses this suggestion.
5	It is my pleasure to offer the response from the Mountain Research Initiative (MRI) to the WCRP Strategic Plan 2019-2029, as part of the call for inputs in its public consultation process. This response was compiled through consultations with members of the MRI Science Leadership Council (SLC), including specific and appreciated contributions from MRI SLCs Prof Ricardo Grau (Argentina) and Prof Kenichi Ueno (Japan). I also acknowledge the contributions and comments from Dr Aino Kulonen (MRI Scientific Officer), and Prof Jörg Balsiger, (MRI Co-Chair). Please note that a more detailed letter, that complements these comments, has been sent via email to wcrp@wmo.int Here, only specific comments relating to the WCRP Strategic Plan are outlined: Paragraphs 3 and 4: We congratulate and commend the WCRP for its broad and encompassing plan, which seeks to not only expand from its past achievements in strengthening fundamental climate science but also acknowledges society's increasing expectations and knowledge needs to adequately respond to complex processes and impacts of (climate) change. In view of this aspiration, we hope and look forward to seeing details in the implementation plan that outline concrete opportunities for scientists and scientific research networks such as ours, in fostering this meaningful engagement and co-production with actors outside of academic research and scientific realms. Paragraphs 6 and 20: Responding to the need for improved fundamental understanding of processes in the climate system, it is important to advance and support the development of interlinked surface observation networks in remote areas, thereby address those data gaps that are relevant to the improved understanding of these processes. As technologies for numerical simulation and remote-sensing continue to advance, in-situ observation data in remote areas such as across and along mountains ranges are important for data validation and understanding of processes, and where down-scaling remains a challenge. Paragraph 11: As per the GEWEX project stresses and demonstrates, understanding of processes in the water cycle in mountains are important for demonstrating and monitoring links between complex climate dynamics and the incidence of extremes events. This is particularly relevant given how extreme events at high elevations impact not only in the vicinity but also have ramifications for ecosystems, settlements and communities further down-stream. Paragraph 15: We welcome the acknowledgement and motivation to enhance innovation in climate science through improvements in observation. In view of this goal, we see a need to complement these improvements in climate observations with links to other potentially relevant observation data (e.g. ecological and/or socio-ecological data). Capitalising on the improved infrastructure and protocols for data collection and monitoring of climate variables, is the opportunity to also collect and link to variables amenable to the monitoring of socio-ecological systems, at same locations or at comparable scales. This is particularly important in instances where resources or capacities are limited for new installations, offering a prospect to ensure that climate data collected and made available for scientists, practitioners and policy-makers are compatible with data for social-ecological observing networks, such as the Global Network for Observations and Information on Mountain Environments, GEO-GNOME (see Part II). Paragraph 16: In seeking to engage with society to develop more actionable climate information, we recommend that WCRP also lends its focus to the development of such information in places where climate change expresses in environments affected by enhanced and/or amplified conditions, and where impacts and feedbacks are increasingly being experienced through extremes - such as in high-elevations and in polar regions. Elevation Dependent Warming (EDW, see Footnote 1) is one such phenomenon that warrants not only more effective observation and methods for its detection in terms of broader climate variables other than temperature. It also offers an opportunity to design actionable climate information that is relevant to effectively respond to, and adapt to the impacts in those extremes, and mitigate risks. We would also like to see more emphasis be placed on capacity building. In particular, it will be valuable to identify geographic and thematic gaps where governments (and potentially NGOs and other entities working closely with communities) lack the capacity to understand, manage, and downscale data and models to make them useful for local and regional purposes and application in decision making. In general, the new WCRP plan is very comprehensive in its scope and ambition, and we welcome the emphasis on efforts to steer scientific efforts that also account for and co-produce usable and actionable climate science and information with and for society. In this context, we wish to reiterate the importance of in-situ observation data for the developments foreseen and articulated in this plan, particularly in fostering and improving networked observation capacities in remote areas like mountains. Better infrastructure, design and observation processes that link climate and socio-ecological monitoring efforts are needed to provide data that improves understanding of complex and interlinked environmental processes, feedbacks and their impacts in remote areas. This is turn enables capacities to respond and manage associated risks and reduce losses of what is valued for ecosystems and communities in mountain areas. --- Footnote: 1. Mountain Research Initiative EDW Working Group. (2015). Elevation-dependent warming in mountain regions of the world. Nature Climate Change, 5:424–430. doi:10.1038/nclimate2563	We thank you for your warm response to the WCRP Strategic Plan. High elevation and polar regions will form part of regional analysis, which is currently being strengthened within WCRP. How this works in practice will be outlined in the WCRP Implementation Plan. Regarding capacity building, we have purposely restructured the Strategic Plan to place training, education, collaborations (incl. natutral-social science), engegement, enabling capacities, communication, citizen science and all these aspects that are so important at the beginning of the plan, as this will be part of everything that we do and stand for. We hope the Plan emphasizes the critical need for sustained observing networks and observations for process understanding generally. The Plan includes a specific emphasis on extremes, and strong references to actionable climate information and capacity building. The Implementation Plan will go into details and may include focus areas such as High Mountains.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
6	Paragraph 3 (page 2, lines 12-13): Says: "scientists being asked to deliver improved predictions and scenarios at finer spatial resolutions and on a wider range of timescales" Proposal: "scientists being asked to deliver improved predictions and scenarios at finer spatial resolutions, on a wider range of timescales, and more decision-relevant" Justification: Science needs to be more tuned to societal needs. See documentation for the Global Framework on Climate Services (https://www.wmo.int/gfcs/about-gfcs) and WMO-promoted "Multi-hazard Impact-based Forecast and Warning Services" (https://library.wmo.int/index.php?lvl=notice_display&id=17257). Par. 3 (p. 3, l. 1): Says: "research operations" Proposal: "research endeavours" Justification: It is unclear what the word "operations" is supposed to mean in this context. For an operational institution, research and operations are typically separate activities. On the other hand, "research operations" is reminiscent of "operations research", which is a field of study by itself. "Endeavours" seems appropriate to convey what I understand is intended, perhaps more than "activities" as it is broader. Par. 6, (p.4, l. 1-2, 9-13): Says: The overarching objective is "Fundamental understanding of the climate system", yet it is then stated that "The objective is to close [...] the budgets", which is a much narrower goal. It is furthermore said that "As a result, this objective [closing the budgets] cannot be achieved without strengthening the bedrock understanding of the physical, dynamical and biogeochemical processes that determine the dependencies of the system." Proposal "The objective is to achieve deeper understanding by attempting to close, within the limits of uncertainties, the budgets obtained from observations and models." "By trying to close the budgets we will strengthen the bedrock understanding of the physical, dynamical and biogeochemical processes that determine the dependencies of the system." Justification: This paragraph proposes lack of budget closure as indicators of incomplete understanding, but closure is not guarantee of the opposite. I understand that the proposal is a practical one: to try to close the budgets will result in deeper understanding. Yet the objective is the latter, not the former. Par. 6 (p. 4, l. 16-17): Says: "the influences of atmospheric, oceanic and cryospheric dynamics" Proposal: "the influences of the coupled atmospheric, oceanic, biospheric and cryospheric dynamics" Justification: The approach necessarilly has to consider the Earth system, in which the different components are coupled. The biosphere plays a key role not only in the budgets indicated above (energy, carbon, water, etc.) but also in key feedback processes that affect climate variability and change. Objective 2 (page 4): Says: "Advancing predictive skill on timescales up to a decade" Proposal: "Advancing predictive skill on timescales up to decadal" Justification: Objective 2 is related to "initialized climate prediction", which is not limited to exactly one decade. The current phrasing is too restrictive. Par. 7 (p.4, l. 4-6): Says: "Understanding predictability of the climate system, and the relative contribution of each of its components" Proposal: "Understanding predictability of the climate system, and the relative contribution of each of its components, as well as the limits on current predictive skill" Justification: Many studies of predictibility remain in the academic realm. This effort needs to be made explictly relevant to actual predictive skill in order to have relevance to decision making. Par. 9 (p. 5, l. 11-14): Says: "New opportunities can be explored for the co-production of project design and outcomes that are directly relevant to policy and decision makers. The time is right for a focus on these deeply collaborative efforts" Proposal: "Priority will be given to co-production, between the users and the climate and social science communities, of project design and outcomes that are directly relevant to policy and decision makers. The time is right for a focus on these deeply collaborative efforts" Justification: The loading-dock, top-down approach is clearly inadequate for providing services to society. The Global Framework for Climate Services (https://www.wmo.int/gfcs/) makes an explicit call for a bi-directional interface between the climate science and the users. However, we know that very rarely a climate scientist will have the knowledge for bridging the gap with the users (although many may wrongly believe so). Social science needs to be explictly brought into the process and WCRP should provide support for its practitioners to work in these issues. Additionally, the original text was too bland ("can be explored"). The commitment to this collaboration needs to be real. Par. 11 (p. 6, l. 9): Says: "potential for thresholds and surprises" Proposal: "potential for thresholds, abrupt changes, and surprises" Justification: Issues such as the abrupt collapse of the Amazon forest have profound societal implications but insufficient research effort. The word "thresholds" could imply irreversibility but not necessarily abruptness. Par. 24 (p. 8, l. 2-5): Says: "A focus on enabling capacities and the recognition of natural-social science collaborations is essential" Proposal: "A focus on enabling capacities and on natural-social science collaborations is essential" Justification: The natural-social science collaborations is essential and should be promoted, not just recognised.	Thank you. We hope that our Objective 4 captures the focus on actionable climate information, fully in line with GFCS priorities. The text now refers to "research and operations" and associated partnerships. We do not mention 'operations research' explicitly but this is embedded in our Objective 4 and will be further developed in the Implementation Plan. The scope of objective one has been broadened on process understanding instead of the initial focus on budgets and flows where the text has been adjusted as well. The role of coupling has been stressed in many sections of the document. The title of Objective 2 has been changed to "Prediction of the near-term evoluation of the climate system". Co-production and engagement with society have been further stressed in the Plan. We also believe that natural-social science collaborations are essential. In response, we have moved the imperatives on communication and social engagement to the beginning of the document, as this will be part of everything we do and stand for. The reference to thresholds and surprises has been adjusted.
7	Based on my experience as the president of CAS, WMO since 2013 I think it is good strategy. It takes into account that the climate research field has matured a lot over the lifespan of WCRP and that many results are close to applications. The draft also mentions explicitly GAW and WWRP as important partners. The draft retains the "international climate research coordination" as the identity of WCRP. That might be necessary. On the other hand for the environmental sciences, the distinction into scales, earth system components and issues (weather, water, climate, ecosystems, managed land, oceans, air pollution) is not so clearcut anymore. The same applies to research versus applications. It is all related and coupled, and there are strong flux and feedback mechanisms. Still the "cake" needs to be cut in some way to provide a manageable organisation. I would have liked an even stronger emphasis on the role of "translational" science in the draft, which would fit into item 4 of the "Overarching Scientific Objectives". With translational science is meant (in my view) the value cycle from discovery to translation to application, where a curiosity driven science component is needed everywhere in order to make the cycle as continuous and efficient as possible. As the draft is written, there is still quite a bit of traditional reluctance to engage with the applications in an intimate way, and it is done through reference for instance to Future Earth while I think it should be a more built-in mechanism in the new WCRP. The Scientific Emphases (§10 onwards) are mainly on "enabling technologies" (better models, extreme event understanding, planetary cycles, responses to man made emisions, better observations, provide information), while I think there should be a parallel emphasis on "enabling cultures", where the evolution of translational science is an important example. To further illustrate the value cycle discovery-translation-application, I think S-GDPFS is a good example. It is a test bed for research, a translation mechanism of mature results from research to operations, and it has a significant user interface which feeds experience back into R&D, in particular in NWP but more and more across all earth system components and issues. In a more concrete language, I see WMO as the only global, technical organisation which is the "home" of the backend of the global earth system forecasting system, while a number of international organisations feed on this backend system for their downstream postprocessing models or needs (IOC, UNESCO-hydrology, WHO, UNEP, FAO etc). The draft strategy emphasizes quite a bit the need for R&D in observational sciences, as well as better access to observations of known quality (§15). The interoperability and balance of observation systems across earth system components and issues is gaining importance, as the initialisation, verification and postprocessing of earth system (component) prognostic calculations, or reanalysis, develop. Data policy is a critical element here.	Thank you. We also believe that international climate research coordination is core to WCRP and that it is this that makes the Programme unique. We did try and get away from defining objectives by scales, Earth System components and issues, as the push now is towards integrative solutions. In the next 10 years, we believe that this is where major advances will be, but it does not discount the issues that are important to the environmental sciences on a range of scales. Indeed, we hope that if we cut the cake this way it will strengthen our ability to address such issues. We have changed the structure of the Strategic Plan so that there are only two, we hope self-evident, categories. Objectives and infrastructure. We hope that the new structure is clearer. We have moved the imperatives on communication and social engarement to the beginning of the document, as this will be part of everything we do and stand for. Although we do not make an explicit reference to "translational science", the structure of the four Objectives very much cover a value chain/cycle approach starting with fundamental science/discovery up to information and knowledge which may apply to various sectors and applications. Objectives 2 and 3 will require strong connections to back-end systems indeed.
8	The Strategic Plan reads very well and tackles the main challenges in climate science. I have just two minor comments: - The figure at p. 3 is cropped on its left side - For the 4th point of Scientific Emphases (paragraph 14 on improved modelling) I would explicitly state the increase in spatial resolution. People might think that "improving models" means adding more processes into them, while resolution is also key to have the emergence of specific features like western boundary currents or stratosphere-troposphere detailed interactions.	Thank you. We agree that many aspects of models require improvements. We have reworded to focus on the outcomes, rather than specifying the improvements themselves: "Improvements are critically required in representations of the hydrological cycle, including clouds and precipitation, oceanic eddies and waves, sea ice dynamics and river flow."
9	I consider that the draft seems is unattractive and too general. It could apply to the preceding decade as well as to the subsequent one as there is no consideration of the achievements on which this next decade should build. In addition, I do not see any clear rationale justifying two separate sections on "Overarching Scientific Objectives" and "Scientific Emphases" that are confusing for the non specialist. Finally it seems to me that the strategic plan should target in greater details the relations with decision-makers and the citizenry in the face of the scepticism that characterize some governmental and social circles. I do not see how such a vague document could encourage policy makers to fund any component of the programme!	Thank you. We have changed the structure of the Strategic Plan so that there are only two, we hope self-evident, categories. Objectives and infrastructure. We hope that the new structure is clearer. We hope that the new section on "Our Decadal Ambition" now better articulates the past achievements and new societal challenges ahead. Our emphasis on "Engaging with society" which refers to "actionable climate information" hopefully addresses the last concern.
10	These comments are mostly open questions / suggestions to consider, and not tied to specific line numbers: • Mission: WCRP also “advances understanding” through foundational research in addition to “coordinate” and “guide”. In other words WCRP convenes the research community (i.e. coordinates and guides) and conducts the research (i.e. advances understanding) • Weather and Climate information is no longer a limiting factor in decision making. The limiting factor is what information people need (in a way that is accessible). Given this, what is the balance between science push (i.e. blue sky research and science innovation) and user pull (e.g. meet requirements for climate information based on user needs) for WCRP? It is not clear from the Strategic Plan. • There is confusion out there about the scope of the weather enterprise versus the climate enterprise. Is there a boundary between the weather enterprise and the climate enterprise, or can we really view it as seamless? If the latter, then why aren’t we talking about an Earth System enterprise? • Since WCRP is co-sponsored by WMO, and weather and climate are seamless, it is important to lay out how WCRP will coordinate with WWRP and related WMO entities in the strategy. • Can the plan be a bit more outcome – oriented. Some indication of the expected outcomes for the program in 10 years time would help the community understand what WCRP intends to achieve. • Given the new climate reality, that we live in a world designed for an environment that no longer exists: • What new technologies do we need (e.g. data and tools; cloud computing; machine learning / AI)? • What technology is really going to surprise us in the next 10-20 years? Virtual reality? Truly smart sensors? Quantum computing? • There is too much data to put in the cloud. Which parts will be most useful? • How do we get people to understand that the interventions we make now to reduce cc will benefit them?	Thank you. We agree that WCRP “advances understanding” is part of WCRP’s focus. In the new version we say that WCRP "coordinates and facilitates international climate research to develop, share and apply the climate knowledge that contributes to societal well-being". The Plan addresses a number of limitations, including the need for much improved prediction skill (Objective 2) and actionable climate information (Objective 4, user pull). Objective 1 reflects the science push and the desire to advance understanding. How WCRP and WWRP will coordinate will be outlined in the implementaion plan, as we work toward finding the best ways of implementing the strategies outlined in this plan. The Implementation Plan will include details on expected outcomes.
11	I perceive it is too abstract to talk about "decision-relevant information" (paragraph 9, page 5) as if the decisions are not embedded into the complexity of every economic sector and policy domain. Because climate model output alone cannot be used by decision makers, the information needs to be integrated into the complexity of each economic sector. I miss very much these two words included in this paragraph: complexity and integration.	Thank you. We hope that Objective 4, in particular its emphasis on "Interactions with social systems" addresses those concerns.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
12	Paragraph 14 - lines 7 to 11. There is a gap in the document between the climate and water policy actors, which is in many cases is needed to bridge, in order to improve and better understand the relation between the hydrological cycle and the atmospheric system. A better engagement with the water policy actors at regional (i.e. European Union) and national level is essential in order to better adapt water policy to climate research findings. This interaction between both communities is not clear in the document. Paragraph 25- Institutional engagement box It would be also useful to look for an institutional engagement with the international water institutions, such as UNESCO - PHI, and regional water and environmental policy actors, such as the European Environment Agency.	Thank you. The list of key strategic partners mentioned in the Plan is of course not exhaustive. We shall note also that the Plan includes an explicit focus on the water cycle and hydrology.
13	WCRP plan must help accelerate progress of SDGs implementation	Yes, we agree. The Sustainable Development Goals are very important to us, as is sustainable development in general.
14	I fully agree with the Objectives (paragraphs 6-9) and emphases (especially par. 11). May I highlight the role that fossil-based research into past environments can play in enhancing our understanding? Current observation programmes can only go back decades, whereas fossil-based reconstructions of past environments can go back centuries to millennia or even longer, and are also essential to understand how extreme events can impact climate, ecosystems and humans. Past-environment research is a key aspect of IPCC's influential reports.	Thank you for your support. We had some comments regarding the structure and in response we have restructured the Strategic Plan so that there are only two, we hope self-evident, categories. Objectives and infrastructure. The need for observations is articulated in the Infrastructure section, and is multi-scale (time and space) and multivariate, to capture this fundamental requirement for our research.
15	(This exercise would be greatly facilitated by line numbers on the draft, obviating page paragraph and line counting for every comment) Page 1 The overall societal relevance, rationale and locus of WCRP should be clearly and comprehensively set out up front. It is in fact introduced incompletely, piecemeal in many places and is not clear. Para 3 line 1: If WCRP is the only programme then it is also by definition the longest serving and every other superlative. Tautology. P3 diagram: at the core, "Engagement" is not similar to the other objectives - a category error - and is not comparable or compatible. It also appears around the circumference which suggests some muddled thinking - and indeed it appears in the "mantle" also. I suggest you remove it from the core. In what way is engagement different from communication? This smacks of a desperation to ensure that it is clear you are keen on engagement. The left bracket of interactions also looks out of place, and the whole figure is desperately inclusive without giving much idea of direction or structure. Para 6: I am surprised that GAW and GOOS are quoted but not GCOS. Most of the relevant parts of both are included in GCOS, together with other important aspects not included in either. Para 7 line 1: It would be useful to be clear about which partnerships here, rather than much later quote one example. A clear statement about the importance of partnerships would be useful, together with some better examples. What is the more generic link to climate services? Tis is where relevance to society will be focussed. Para 8 line 8: the use of the word "functional" to describe factors due to external influence is a little confusing, or at least not specific. It would be better to describe these factors more clearly as being due to external influence, or whatever. Para 10: the marginal text is not related to the main text block, as it is elsewhere. Line 2: are these 6 emphases the six subsequent numbered paragraphs? If so then they do not really represent scientific emphases as such, and are objects of different classes itemised as a list. As in many publications the document suffers from too many lists and reductionist statements without giving a holistic view. This is the natural tendency of science but to be avoided. It leads to a twelve days of christmas resonance of the document. these six are then followed by a second list of 8 similarly disparate items. I think this approach takes us back to the problems of grand challenges, core projects etc and the false matrices form from which WCRP recently suffered. Para 25 here I see the partnerships mentioned several pages ago are listed. Why here and not there? or there and not here? overall I think there remains a lack of strategic perspective on exactly what and why the WCRP is about, and the document too easily slips into lists of things to be done. I think it needs reconsideration.	Thank you. We hope that the rationale and position of WCRP is outlined in the vision and mission. We have also restructured the plan to bring equality and societal engagement and partnerships (where we have included GOOS and GCOS) to the beginning of the plan, as this will be part of everything we do and stand for. We have now merged the lists into plain text to better integrate the various elements and focus on the strategic perspective.
16	P3#5 : « bedrock science ». My first reading was « bedrock of the ice sheet ». Maybe would it be worth to think of a difference wording. P3#6: I was wondering where is the biosphere. Is it considered as a reservoir or as a component of the climate system? P5#10 What is a systems approach, in particular compared to a system behavior? Most of my comments relate to the Figure (p3). It is a very nice and short summary supporting clearly the text. I wonder if the word 'predictability' in the center wouldn't be better than 'prediction'. Indeed the text does not discuss improving climate prediction but advancing predictive skill. I have concerns about the arrows in the figure. Some are counter-clockwise, others are clockwise or even in opposite direction. Why is it so? In the central part, three keywords are mentioned, while the text also includes climate-relevant compounds. Indeed we could also think about the ocean circulation, droughts, …. What is the message of 'forcing and mitigation actions'? I am not sure to understand the link here. It is the same for 'impacts and adaptation responses'. Why not four items? General comment. As PAGES, I am happy to see that WCRP is concerned with simulation of the past. However, the past is not only simulation, it is also 'observation'. This could maybe be included in #20.	Thank you. 'bedrock' has been replaced with 'fundamental'. The 'biosphere' and bio-geochemistry is mentioned in several places. More generally, there is a strong focus on an Earth Systems approach. We hope to have now clarified the distinction between the objective to improve predictions, the associated skill metric and the need to understand the intrinsic predictability of the system. The figure has been completely revisited. We mention the need for sustained observations under the 'Infrastructure' section in the broadest 'multiscale' sense, which covers also paleo-climate/proxy data records.
17	I like the plan overall. At 8 pages, it is appropriate for a strategic plan. It's well written, captures the complexity of the big picture, and offers a generic path forward, with open ends for pathways to take.	Thank you.
18	Page 25. An engagement with the Copernicus programme and its operational Climate Change service would be appropriate	Thank you. The partnership section has been re-organized into a focused list, which is by no means exhaustive. We very much look forward to strengthening our partnership with the relevant Copernicus services, such as C3S, CMEMS and CAMS.
19	Congratulations to the JSC and the entire team for an excellent strategic plan that is very well developed, with identified research priorities and recognition of their societal benefits. The partnerships and affiliation with programs and entities such as ISC, WMO, IOC are key to success for demonstrating the societal impacts of WCRP research. The research capacity development that WCRP is facilitating, especially for developing regions and nations, globally is worth emphasizing and supporting. WCRP in turn benefits greatly from the development of this next generation of leaders for supporting its mission/mandate.	Thank you for this positive feedback.
20	Overall, I agree with the strategy and vision set out. specific suggestions for revision: p2, para 4: "... with the structure and limitations of public and private institutions at every level ..." p5, para 9: I would like to see the aspect of "equitable" re-emphasized here, with the mentioned strategies truly reaching the end of the user chain in developed countries for example. p5, para 10: I would delete the first sentence which to me does not say anything and weakens the message. p5, side note: "Co-production of knowledge and co-design ...", out of context like this it is meaningless with just some buzzwords put together, all other side notes are specific and meaningful, I would delete this or rephrase. p6, side note: "in capacities" is unclear, I would put a dot after "investment". p6, para 14: Surprisingly, the carbon cycle is missing, I would revise "... in representations of the carbon and hydrological cycle...". p8, all para: I don't like the formulation with all paragraphs starting with demands "we require...", and it reads like a wish list that does not exist, but much of this is already in place or happening and building on a strong base, and as a result in effect it weakens the established role of WCRP and the existing efforts. I suggest to revise each paragraph, starting the section with "These imperatives are:" and then essentially remove "we require" from each paragraph. At least some readers can read this by adding the word "continued..." in their mind. p8, para 18: "gender equality?" p8, para 19: "A hierarchy of simulation tools" p8, para 19: remove "that are so essential", it would not be an imperative otherwise.	Thank you. We have "The task is formidable, both scientifically and technically complex while deeply interwoven with social and economic institutions at every level from local to international." An equitable world is now very explicitly stated within our decadal ambition. All side notes, including the one on 'co-production of knowledge' have been reviewed and better aligned with the text. We have reworded the section on co-production to take the comment into account. Investment in capacities refers to investment in increasing that capacity of people. The carbon cycle is mentioned in Objective 1. Carbon is also mentioned in Objectives 2 and 3. We have changed gender equity to equality in general, as we think that you are right... equity is giving everyone what they need to be successful while equality is treating everyone the same. We restructured the plan to bring equality and societal engagement to the beginning of the plan, as this will be part of everything we do and stand for. We have now made the start of the various infrastructure sections consistent.
21	Overarching science objectives 1 Fundamental understanding of the climate system One of objectives is to close the budget obtained from observations within the limit of uncertainties. Currently, a problem in closing budget is the global surface energy budget. Surface energy fluxes needed to close global surface energy budget is radiative, latent heat and sensible heat fluxes. At an annual scale, the sum of these fluxes should be close to the net radiation at the top-of-atmosphere. When all flux uncertainties are combined, the estimated uncertainty in the net surface energy flux estimated from satellites is 10 to 15 Wm-2 and the residual in closing the energy balance is about the same amount. Therefore, the surface energy budget is closed within the uncertainty. However, the uncertainty of observed surface energy budget of 10 to 15 Wm-2 is too large to constrain models. What is really needed in the near future is to both reduce the uncertainty and close the energy budget. 5. innovation through observation Satellite observations need to be included here. Satellite observations also play an important role in understanding processes and mechanism of the climate system. Only satellites can observe the earth system at a global scale. Because climate change is a global scale problem, satellite observations are indispensable to climate research. In addition, the challenge in observing the climate system is not limited to understanding processes and mechanisms. Quantifying the change of energy, water and carbon cycles occurring at a global scale (scientific objective 2) is also challenging because the changes are small compared to the calibration error and error in retrievals. Imperatives 3. Observations for process understanding No country can afford observing all essential climate variables by satellites. Therefore, satellite observations also require international coordination. Specifically, to achieve the scientific goal of quantifying changes occurring at a planetary scale, internationally coordinated continuation of observing essential climate variables at a global scale is necessary.	Thank you. We agree that ultimately we need to close the budgets and reduce their uncertainties. The sustained observations section includes of course all observations, in-situ and satellite. We recognize this and in the section Infrastructure 2 we say "We require well-coordinated international observational field and space-based programs, ..."
22	4. Sustained observations - this is an important aspect, but could be strengthened with a commitment to ensuring open access to all historical and current observations. There are still many countries (both developed and developing nations) which do not make such data available. Relatedly, the desire to improve the reanalyses is important but this progress will be limited without access to the billions of historical observations currently still in archives (either digitised or undigitised) in every corner of the world. A commitment to rescuing this data would be the fastest way to improve historical reconstructions.	Thank you. Open access to data and models is very important to WCRP and made explicit in the Plan, as also highlighted in our current data policy. We agree that the current lack of systematic data sharing is clearly a major barrier to progress.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
23	Sea ice is not mentioned explicitly or otherwise in the Draft Plan. Understanding sea ice variability and trend in the Arctic and Antarctic is critical to our understanding of the climate system as a whole. The absence of a reference to sea ice could be remedied by inclusion in the first scientific emphasis – Climate Dynamics and extreme events – the first sentence, by reference to the cryosphere (or marine cryosphere). It can also be included in the second Scientific Emphasis – Changes in Planetary Cycles. This Emphasis at present refers to Land Ice only. While land ice is of course important, the formation of sea ice is also a key factor in the global overturning circulation….. I understand that an implementation Plan follows, but inclusion of this important system component in the Draft Plan ensures that attention will be paid to it in the Implementation Plan.	Thank you. Sea ice is indeed a major climate indicator and is mentioned explicitly in the Plan.
24	I think you plan looks great. My only concern is that the report leaves open to interpretation where the time scales of interest are at shorter time scales. Objective 2 – "up to a decade" – I sort of understand why you might phrase it that way but I suggest at least including the words subseasonal, and seasonal within the text if indeed the plan includes those. Some might think of the conventional emphases of WCRP and the lack of mention of these time scales to mean the above aren't part of the focus of effort.	Thank you. We have now modified the title of Objective 2 into "2. Prediction of the near-term evolution of the climate system", which we defined as including subseasonal to decadal time scales
25	In general, its good, but I think a couple of things are somewhat lacking: 1. I think there needs more focus on the economic implications of climate change, both risks and vulnerabilities, as well as opportunities. 2. The first point will help this, but socially, I am concerned that climate science is becoming too partisan with a liberal/left wing preference. This presents the problem of climate action being held hostage to the whims of political swings. There are also groups with which engagement is minimal (eg. religious groups) who have little, even no awareness of the climate problem, I think partly because such groups tend to be more conservative and are therefore ignored to an extent. More works needs to be done to improve understanding and engagement in these areas, including how to tailor information services to these groups in an understandable way that removes the impression of political partisanship.	Thank you. The Plan articulates the need to connect natural and socio-economic aspects. However, WCRP is not concerned with advocacy in any way. Our ambition is to deliver the best science for fundamental understanding of the Earth system and to inform and support policy and services.
26	P6. "Changes in planetary cycles". Likely to be misunderstood by a casual non-expert reader (as meaning something to do with the effect on Earth of changes in the orbits of Jupiter, Mars etc). Sounds like astrology!	Thank you. This has been removed.
27	The strategic plan looks very nice and good. I have a few suggestions up for debate, as always: Overarching scientific objective 2: this might be an unpopular comment, but in the second half of the decade, forcing has more demonstrable skills in aspects of climate than the initial conditions (eg we had that for European regions for heatwave metrics, Hanlon et al., 2013 where almost all the skill was from forcing and indistinguishable to uninitialized runs). So I recommend to add a sentence along the line of 'This objective will draw both on skill from initial conditions and from external forcing.' Or something to recognize this? We have a whole WP in a H2020 project targeting services about merging intiallized and forced mainly predictions - this problem could also be mentioned Scientific emphasis topic 1:This could connect to the impacts and society issues by pointing out that extreme weather and climate events often are the mechanistic drivers of impacts of climate, much more so than mean changes, and that such impactful extremes are often compound events. Therefore both compound extremes and links between extremes and impacts would be good to explicitly refer to Imperatives topic2.: I would add that a multitude of models is vital to span uncertainty - so as you know the issue is not really that we want to understand how a coarse and a fine resolution model are different but we want to know the uncertainty we had seen had we run the fine model multiple times, and we want to understand added value and systematic differences between these different model families. imperatives 4.: I would here also mention maintenance and continued expansion of long-term datasets, including data rescue. Furthermore I would add information about past climates from documentary evidence and natural archives.	Thank you. We have adjusted the wording in Objectives 2 and 3 to address those suggestions. We have restructed the Strategic Plan and extremes is now linked under Objective 2, with an emphasis on 'Predicting Extreme events'. We begin the new Infrastructure section 1 with "We require a diversity of models... ". The need for sustained observations and records is made explicit in the plan and will require data rescue efforts to be detailed in the Implementation Plan.
28	No comments made	
29	Overall I think the structure and the scientific objectives are right and I very much appreciate the hard work put in by the writing team in getting this far. Perhaps my comments are more about the implementation but I wonder if we can be a bit more ambitious? This could be a interpreted as a 10-year strategy for 'more of the same'. What breakthroughs are we looking to facilitate in this period? Some more specific suggestions below. Para 14: Model errors and biases seem to me to be a major roadblock to making better predictions and projections. How can we accelerate improvements in models? Models are now so complex that it would be difficult for e.g. a PhD student to try some new idea involving some sort of structural change e.g. coupling dynamics to physics in some new way. Could the community develop some sort of open-source model that could be easily hacked by a group of PhD students to really try something new? Somehow WCRP needs to promote and support (more) careers in model development. Para 15: As a modeller, I find it very difficult to judge the quality of different observational and re-analysis products. Even for some basic variables like precipitation, there are major differences between observational products. This makes model evaluation very difficult. Could there be some major community effort here in comparing observational products and re-analyses to drive up quality and/or properly assess uncertainties? e.g Observational Intercomparison Projects (although the acronym doesn't work). Para 19: Yes we need a hierarchy of simulation tools but also we need a suite of techniques for evaluating those tools. There has been some innovation here but it seems quite diverse and scattered. Perhaps this area could benefit from closer coordination and standardisation? Para 23: This section only mentions open science conferences. Notwithstanding the carbon-intensity of these events, it seems to me that young people communicate in many different ways these days. WCRP should be at the forefront of driving innovation in on-line communication between researchers. Para 12: Perhaps a minor point but 'planetary cycles' sounds a bit like astronomy to me. Perhaps 'Changes in energy and constituent cycles'? I'm sure there is a better way of putting this.	Thank you. Objectives have been refined to emphasize more clearly what breakthrough is aimed for. Model development is part of the essential infrastructures required. Likewise, the development, collection, analysis and archiving of multi-variate, multi-scale observations of the climate system is a foundational activity of global scientific research, also reflected in the infrastructure section with a statement on "Frameworks for model evaluation and uncertainty estimation are required..." Regarding the use of the term 'open science conference', this means "a formal meeting of people with a shared interest, typically one that takes place over several days." We believe that the need to have conferences will continue in the next decade, but perhaps not in the current form. Conferences are increasingly including web-linked presentations and one could imagine in the future entire conferences conducted online. The word 'planetary' has been removed.
30	Good Work	Thank you.
31	It is disappointing that climate "prediction" as such remains under represented in the Strategic Plan compared to climate "simulation". Virtually all aspects of WCRP should have, a prediction component. This is a new and very active area of climate research and one which has great societal relevance. Climate prediction is suitably mentioned in para 7 but essentially disappears thereafter. The neglect of climate prediction is particularly notable in the Scientific Emphases section. "Improved modelling capability" in para 14 deals only with simulation and neglects the need for improvements in models for prediction (involving both initial and boundary condition aspects). Similarly, para 15 mentions only simulation and neglects the need for data for initialization, calibration, and verification of climate predictions. Same problem in paras 19 and para 22 (e.g. access to prediction info). The neglect of prediction and the stress on simulation has an unfortunate "more of the same" aspect and I think the prediction-focused aspect should get much more attention.	Thank you. The emphases on "Simulation capabilities" are now made very explicit in Objectives 2 and 3 and model development is included in the infrastructure section. Model initialization is now included in Objective 2, as well as verification, together with a clear focus on predicting extreme events.
32	I have commented on early drafts but a few points: p3 states "We need fundamental science to prepare society for challenges we cannot foresee." I think this has a negative tone given that we are supposed to be trying to foresee the challenges. Suggest "...prepare society for unprecedented challenges." p3 line 1: research AND operations? p3 para5: ...improving predictive skill.... p3: I could not understand the figure "A new decade for global climate research" Science Objective 1: The understanding objective is very focused on transports of energy, water etc. This sounds very GEWEX influenced and I do not believe this is the most important objective for improved understanding in climate science. In fact, many important chemical species such as CO2 are well mixed. Instead, other processes that affect regional climate are more crucial and poorly understood. These include local thermodynamic, radiative and hydrologic processes, the effects of local modes of atmospheric and oceanic variability and remote influences via the atmosphere and ocean. In many cases these are not related to transports or fluxes at all. Objective 2 is great but I would suggest "...ENSEMBLE regional and global climate prediction" Objective 3 probably needs rewording. "...on timescales that exceed our predictive skill for past and future climates." is not right, as there is obviously skill from the forced trends on long timescales. This is also grammatically incorrect, as skill is not directly comparable with a timescale. I would say instead "...on timescales beyond that associated with predictability from initial conditions." Also, the last sentence of objective 4 might be better as "...promises improved information on longer time horizons". Objective 4: "...building on partnerships with Future Earth and others." is vague so I suggest: "...building on partnerships with Future Earth, international research programmes and operational activities such as the Global Framework for Climate Services." Page 5 last sentence: I think this omits the prediction systems so I suggest: "...the continued development of a hierarchy of climate and Earth system models, development of improved climate prediction systems and the continued refinement of detection and attribution methodologies." Page 6: Item 1 on extreme events should also cover the effects of variability and internal dynamics. Suggest "We will improve our understanding of the mechanisms that lead to variability and change in the atmospheric and oceanic circulations. This in turn influences the frequency and intensity of extreme events that affect the biosphere and human society in many ways." Page 7 item 4: this does not mention prediction systems or ensembles so I suggest: "...this progress will also be embodied and further enhanced through improved ensemble prediction systems and improved downscaling tools to better represent regional and extreme phenomena." Item 2 on page 8: there is no mention of ensemble prediction systems so maybe the first sentence could be altered to say: "We require a diversity of models and prediction systems spanning a range of complexity, a range of representations of processes, and a range of spatial detail..." Items 3 and 4 on page 8 could perhaps be combined?	Thank you. We have reworded the sentence into "We need fundamental science to prepare society for unprecedented challenges." WCRP is not focused on operations, but partnerships with the operational community is essential in many ways and emphasized in the plan. Objective 1 has been reshaped beyond water, energy and carbon cycles to now capture a broader focus on fundamental science, process understanding, etc. Objective 2 includes now an explicit mention of 'ensemble' (also relevant to section "A hierarchy of simulation tools") which also addressed the later comment on 'ensemble prediction systems'. Objective 3 has been reworded to address the comment on skill. Objective 4 (and elsewhere): partnerships have been consolidated at the beginning of the document. The emphasis on extreme events now refers to climate change and variability. The section on imperatives now called Infrastructure has been substantially revised.
33	Very strong SP, but it needs careful/thorough copy editing. There are missing and misplaced commas; in paragraph 3 there are comparatives without anything to compare with - e.g. "expectations are higher", higher than what? I do not find the complex graphic on page 3 to be helpful: what do the arrows mean? why is energy and carbon listed, but not water? what is intended to be conveyed by the concentric circles? I think that in an effort to include everything, you've ended up with a graphic that has little salient impact. I suggest working with a graphic designer to come up with something much more simple, and thus, hopefully, more memorable. Paragraphs 19/20 - especially in an era of distributed ("cloud") computing, open access to models is as important as open access to observations. Paragraphs 20/22 Some mention should be made of developing and making use of unconventional new sources of observations (e.g. crowd-sourced obs from phones) - this ties into the citizen science element in paragraph 24. Paragraph 24: perhaps this is implicit in the word "engagement", but it likely deserves emphasis that this is fully 2-way, or, really, multidimensional. At least in the US, we now see that knowledge deficit models for providing scientific information to the public and to decision makers has failed. Also (again, this may be a parochial US perspective) there is implicit prioritization in numbering, With that in mind, my preference would be to promote imperative 7 to imperative 1.	Thank you. The graphic has been completely re-designed. Collaboration across model development is crucial and now captured in the Plan. Citizen science has indeed great potential, which is why we mention this at the start of the plan. How we facilitate citizen science project will be something that we consider as part of the WCRP Implementation Plan. Engagement is meant to be two-way and is actually clearly emphasized in the "Strategic partners" section with the text "New opportunities will be explored for the co-production of project design and outcomes that are directly relevant to policy and decision makers. ". There was no priority in the order of the imperatives, and there is none in the infrastructures.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
34	Overall this is a well thought out plan that follows clearly from the WCRP's historic foci while addressing emerging science priorities. Some specific comments: paragraph 14: "including clouds and precipitation, oceanic eddies and waves, sea ice dynamics and glacial flow." While oceanic waves have clearly emerged as a critical component in recent years, I'm not actually sure what is intended here. Does this refer to internal waves, surface gravity waves, tides, or all of the above? Many would argue that in order to advance climate modeling, we will need to address all of these components (along with improving the ocean mixed layer and Langmuir cell circulation). Sea ice dynamics and glacial flow are also critical components, but I would also add ice shelves: some of the most uncertain processes are associated with subglacial basal melting in the cavities underneath floating ice shelves. paragraph 15: Typo: "forms" --> "form" This is an interesting juncture in observational climate science. We see growing capabilities for autonomous sensors, and a growing desire for more refined observing system design. Do you want to address either of these issues?	Thank you. Waves is meant to be surface gravity waves mainly. Ice-sheet are covered under Objective 3. The Implementation plan will develop the details on possible autonomous sensing and methods to refine observing systems.
35	Thanks, the plan looks really good. Although I did notice there is no mention of "values". I guess it is how 'imperatives' such as 1, 6 and 7 feed back into 'emphases', especially number 6? Also a couple of minor edits to suggest: 1. Adjust the cropping of the schematic on page 3. Left side is currently over-cropped by some millimetres. 2. Page 6, upper-left sidebar: Replace "stresses" with "stressors". 3. Para 17, line 4: consider explicitly stating "Seven imperatives ..." as was done for the "six ... emphases" in para 10, line 2.	Thank you. WCRP is driven by the core values of its sponsors, WMO, IOC and ISC. We have changed the structure of the Strategic Plan so that there are only two, we hope self-evident, categories. Objectives and infrastructure. The text has been edited when possible.
36	(same as E12) The WCRP strategic plan is well-developed and structured. It skillfully and appropriately avoids addressing the challenging discussion of WCRP structure by instead focusing on the scientific objectives, foci, and imperatives/requirements. 1. The vision and mission are well-articulated. 2. The scientific objectives are appropriate and relevant. Critically important, and serving as an underpinning for the entire climate science enterprise is the first objective "Fundamental understanding of the climate system." Objectives 2 and 3 break the problem into two parts (subseasonal to decadal) and decadal to centennial – in recognition of the likely predictive capacity of the former and the more projection oriented focus of the latter. Finally the last objective connects the information gained from the first three objectives to society through services and policy-relevant information. 3. The Scientific Emphases are comprehensive in scope. Emphasis 5 ("Innovation through observation") could be strengthened by an explicit reference to the (necessary) development of fully-coupled data assimilation systems for the earth system. This is notionally contained in the last sentence of paragraph 15, page 7: "Improvement … requires that models be confronted with observations …" 4. The strategic plan identifies the required investments and commitments to realize the objectives in the Imperatives section. Again, investments in coupled earth system state estimation (data assimilation) should be emphasized in requirement 3 concerning observations for process understanding. Data assimilation provides context for (new) observations and enhances their value in fully comprehending processes. Additionally, requirement 8 concerning institutional partnerships should explicitly recognition of the global community of earth system scholars in the academic community/universities (perhaps in bullet 6 that considers capacity building organizations?)	Thank you for your support of the vision and mission statements, these have been retained as in the draft. Thank you for your support of the structure of the Objectives. Data assimilation is now mentioned under Objective 2. We will collaborate with partner programs to advance coupled data assimilation techniques and ensemble generation methods.
37	It is a very good idea to make a detailed Plan of WCRP's activities for the next 10 years as the world increasingly looks to the global climate science community to provide guidance and options to cope with an ever-changing climate and its weather manifestations. Such activities would also reassure the world that the climate science community is very interested in not just academic research on the changing climate, but also equally interested in helping in finding adaptation and mitigation options to cope with dry and wet epochs – including droughts of various intensities and durations, heavy rain and snow events, and devastating heat waves – and rising sea levels. This draft Plan, unfortunately, falls far short of the needs and does not reflect the state of knowledge in the second decade of the 21st century. It can even be said that, with minor modifications in language, this draft Plan can pass for having been written 30 years ago. I have the following suggestions to revise the draft Plan to better reflect the current state of knowledge and societal needs. 1. From the beginning, this draft Plan biases climate science towards anthropogenic climate change in spite of the dominant role played by natural climate variability in the evolution of the global civilization over the last several thousand years (Mehta, 2017). The importance of natural climate variability, especially that of natural decadal-multidecadal climate variability, is mentioned almost as an afterthought. The most recent assessment report by the Inter-governmental Panel on Climate Change specifically mentions (IPCC, 2013), "Natural internal variability will continue to be a major influence on climate, particularly in the near-term and at the regional scale. By the mid-21st century the magnitudes of the projected changes are substantially affected by the choice of emissions scenario." Thus, at least for the next 30 to 40 years, natural climate variability will continue to be at least as important as anthropogenic climate change. Considering that this WCRP draft Plan is for the next decade, a major emphasis on natural climate variability, especially on decadal-multidecadal variability, must be placed on activities planned and supported by WCRP. 2. For non-specialists in climate science and for general public, climate is an ambiguous word and is generally equated with anthropogenic climate change. For societal impacts, climate now encompasses droughts, floods, heat and cold waves, tropical and extra-tropical storms, soil moisture, unusual rain events, and other phenomena. These phenomena make different impacts on societies with different levels of affluence, infrastructure, and coping mechanisms. These phenomena also make different impacts even on the same society depending on the timescale – for example, a seasonal drought and a multiyear to decadal drought make very different impacts. For some societies, such as Least Developed Countries, a moderate drought lasting even a few seasons can be devastating. Lumping all such phenomena under "extreme events", as is the fashion, does not lead to better science or better use of whatever is known about such phenomena. Similarly, the scientific advances required for skillful seasonal drought prediction are very different from the advances required for skillful multiyear to decadal drought prediction. Unless such differences are explicitly recognized and actions planned to address them, the WCRP Plan and actions based on them would lead only to more of the same confused and biased approach to climate research in the next decade. 3. "Stakeholder interactions" is a fashionable phrase nowadays to pay lip service to climate science's responsibility to guide and help societies in adapting to and/or mitigating effects of the changing climate. However, there are few organized, worldwide programs to bring climate scientists and stakeholders together for continuing interactions; also, there are very few climate scientists who work regularly with stakeholders to understand their problems and make sincere efforts to help them. Therefore, this is a very important and useful opportunity to develop multi-sectoral programs of interactions with food-feed-fiber producers, water resources planners and managers, government officials at various levels, transportation systems, public health organizations, energy producers, social service organizations, civil society organizations, and other stakeholders. The goals of such programs should be to learn what stakeholder needs are, guide climate scientists to address these needs, and produce sound science based data and information to help stakeholders in each sector. Based on my personal experience of working with stakeholders in the Missouri River Basin for the last 12 years and in the Mississippi River Basin for the last 3 years, I am fully aware of the enormous difficulties of such activities, but therein lies the challenge for WCRP to make its mark on the continuing evolution of the global civilization. To use a much-maligned phrase, this may be the "Mother of all Grand Challenges". 4. The draft Plan mentions Institutional Partnerships, both within and outside the U.N. system. But, the record so far of such Partnerships is, unfortunately, not very encouraging. For example, I have it on good authority that there is hardly any interaction between the GFCS and WCRP's Grand Challenge on Near-Term Climate Prediction activity. Perhaps there are institutional or personality issues, but such "silo" mentality will have to be broken down, and WMO programs and U.N. organizations will have to work together as a team to bring fruits of climate and societal impacts research to bear on society's food, water, energy, and public health needs. To facilitate such team work, it might be useful to involve people with broad background and experience in climate science and climate impacts as advisors, planners, and executors in WCRP and other WMO programs, and other U.N. organizations. References IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Mehta, V.M., 2017: Natural Decadal Climate Variability: Societal Impacts. CRC Press, Taylor & Francis Group, Boca Raton, Florida, U.S.A.; 326 pages. www.crcpress.com/Natural-Decadal-Climate-Variability-Societal-Impacts/Mehta/p/book/9781466554528.	Thank you. We believe this plan, which builds on extensive community consultation, includes a fair balance between internal forcings/variability and imposed forcing. We argue that an important science question at hand is to determine their mutual contributions and also global and regional effects. We agree also that there is a clear distinction between climate and anthropogenic climate change. The emphasis on Decadal variability and change is a rapidly growing field of research and WCRP intends to play a major role in coordinating this key effort, for example in support of the paris Agreement and its Global Stocktake. We agree on the need to differentiate the types of extremes, time scales, and impact and adaptation capabilities. We also agree on this major challenge to bring scientists and stakeholder together, far from being obvious, yet much needed, hence our enmphasis on engaging more broadly with society. The Grand Challenge on Near-Term Climate Prediction has strong interactions with the CSIS component of GFCS and also the so-called WMO ET-OPSLS Expert Team. Thank you.
38	I had the occasion to make general comments to some JSC members during the writing process, therefore I only make here detailed remarks on the text. However in reading the document, I have the feeling that some reference could be made to the previous strategic plan 2005-2015 with some assessment of success, and possibly to the review recommendations. - par.5 line 3:replace "bedrock science for understanding" by "advancing fundamental scientific knowledge" for better homogeneity of the text - par 5 line 6: replace "connecting the natural sciences to the social sciences" by "connecting natural and social science aspects". - par 7 line 7: as well as on the uncertainties ... - par 8 line 6: there are limits to predictability, some of which are inherent to the system ... - par 8 line 8: is "functional" the right word? "due to external factors" may be better. - par 11 line 9: "surprises" sounds odd and could replaced by "unpredictable events" or "disruptions" or "non-linearities". - par 16, title: replace "engaging with society" by for example "responding to societal needs" (otherwise there seems to be duplication with the title of par.24) -par 20 line 6: possibly add "land surface data" -par 21 line 2: replace "observations" by "observational systems"	Thank you. We have aimed for a self-contained document which will be put in context when required (e.g. reference to previous Plans). We have replaced 'bedrock' by 'fundamental' throughout the text. We have also reworded the 'natural' to 'social sciences' linkages to clarify this. The text on limits to predictability has been adjusted in a side note. The wording 'engaging with civil society' has been retained. There is no longer a clash with another title, as we have moved the imperatives on communication and social engarement to the beginning of the document, as this will be part of everything we do and stand for. We have kept 'observations' to keep it more general, as it may or may not be part of a large network or system. It now reads: "We require the co-design of new observations and indicators, sustained and quality-controlled climate system observational records, and the continuous improvement and timely availability of temporally consistent datasets such as reanalyses".

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (online form)

No.	Comments	Responses from WCRP Joint Scientific Committee
39	Para 3: after ... new urgencies ... suggest that this is a good point to highlight the emerging importance of feedbacks and potential amplification of climate risk as a new challenge to both science and policy for the coming decade. 2: Para 4 Ln 2: ... effort ... to coordinated effort.... 3: Para 4: replace exciting observational ... with observing systems based on innovative technologies ... 4. Para 4: end: Two issues do not come across very clearly 1) the science challenge in the coming decade will be to understand, constrain and model feedbacks, abrupt change and tipping points 2) the links to the core programmes and the Grand Challenges 5. end Para 6: Highlight feedbacks as major gaps in fundamental understanding Para 10:the links between this strategy and the core programmes and the Grand Challenges are not clear Para 11: Title Climate Dynamics, Feedbacks and Extreme Events Para 14: ... representations of the carbon cycle, hydrological cycle ..... Para 19: need to develop a new generation of coupled climate / ES models Para 20: ... require well-coordinated, scale-sensitive, ...	Thank you. We noted your suggestion to highlight the emerging importance of feedbacks and potential amplification of climate risk as a new challenge to both science and policy. While important, we feel that this is too detailed for this introductory part of the plan. We cover feedback, etc in the Objectives. We have changed the wording 'effort' to 'coordinated effort'. The introduction now includes the following wording "There are also clear opportunities, to develop new partnerships for research and operations, to promote exciting observational and computational technologies, and to develop scientific capacities across the globe." We wanted to include computational technologies and we think that this is the most inclusive wording. Changes in the WCRP organizational structure will be developed in the Implementation Plan. The carbon cycle is mentioned in Objective 1. The need for coupled climate and Earth system models is clearly articulated in the corresponding emphases under Objectives 2 and 3. We have re-written the sentence into "We require well-coordinated international observational field programs". We don't use scale-sensitive, as these field programmes may apply on a range of scales.
40	Thank you for the opportunity to comment on the Plan. The Swedish government-funded Strategic Research Area MERGE (www.merge.lu.se), based at Lund University, Sweden, has as its focus the improvement of the representation of the biosphere and land-atmosphere interactions in global and regional climate models. To that end, we propose the following minor additions to the document: Paragraph 6 Please change "... the influences of atmospheric, oceanic and cryospheric dynamics ..." to "... the influences of atmospheric, oceanic, ecosystem and cryospheric dynamics ..." Paragraph 10 Please change "... between and within the atmosphere, ocean, land and cryosphere, ..." to "... between and within the atmosphere, ocean, land, biosphere and cryosphere, ..." or "... between and within the atmosphere, ocean, land cover and cryosphere, ..." Paragraph 14 Please change "... waves, sea ice dynamics ..." to "... waves, biosphere and sea ice dynamics, ..." or "... waves, ecosystem and sea ice dynamics, ..." Paragraph 20 Please change "... hydrological and cryospheric data ..." to "... hydrological, biospheric and cryospheric data ..." Regards, Paul Miller, MERGE Co-ordinator, on behalf of the MERGE Board.	Thank you. We have included the biosphere in several places in the Plan owing to its importance.
41	Paragraph #14, lines 9-11, perhaps replace "this progress will also be embodied and further enhanced in downscaling tools to better represent regional and extreme phenomena" with "this progress will also be embodied and further enhanced through mathematical tools and high resolution modelling to better represent regional and extreme phenomena". The suggested formulation is a bit more general (statistical and dynamical downscaling, possibly deep learning, and covers both regional and global modelling)	Thank you. We now mention explicitly dynamical and statistical downscaling. We shall also note that there is an explicit emphasis on exascale computing in the 'Infrastructure' section.
42	In paragraph 18, a goal/imperative of a diverse research community is stated, but no metrics or methods for achieving such a goal, or integration into other parts of the plan. Paragraph 5 mentions "better connecting the natural sciences to the social sciences." This is really important to my organization, but it is not followed up further in the plan how this will align with other goals in the plan.	Thank you. The methods and metrics will be part of the implementation plan. The connection to nature and social sciences can be seen as the end and beginning of the value cycle, under Objective 4, and hence feeds back to fundamental science and Earth System analysis (Objective 1) and builds on climate predictions (Objective 2) and projections (Objective 3).
43	The description is overall fine. Especially the texts out of the colum help the understanding the concept, direction and challenge of the WCRP, in the coming period.	Thank you.
44	The WCRP Strategic Plan is sound; its contents relevant, timely and presented in a salient manner. Overarching Strategic Objectives 2 and 3 should be combined as they reflect different dimensions of the same issue. There should be reference to specific issue areas as examples of how the Strategic Plan will be operationalized, in particular, polar regions and oceans.	Thank you. There have been many discussion on whether to combine Objectives 2 and 3 or keep them separate. It was felt that they were addressing sufficiently difference goals to remain separate, but we recognize also that there are clear commonalities. The operationalization of the Strategic Plan will be detailed in the Implementation Plan.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
1	WCRP should be commended for placing 1) Fundamental Understanding of the Climate System, followed by 2) Advancing Predictive Skill on Timescales up to a Decade as the leading two overarching scientific objectives of the entire program. Using the word "predictive" is a major step forward for the WCRP (they like to use predictability). Improved predictions are surely the most valuable thing that the WCRP can provide to society. But, this appears to be only lip service because the language after this resorts to "predictability". Nothing that follows targets improving predictions. It could be that the improvements in predictive models, in assimilation, in ensembles, in forecast products, etc wil done through their Institutional Partnerships. But, there is ample scope to include improved predictions in the Scientific Emphases. There is an emphasis on improved modelling capability but there is no mention or relevance to improving predictions. If WCRP is not going to tackle and coordinate improving predictions (at least for the timescales of relevance to the WCRP), then who is?	Thank you. We have now clarified and strengthened the emphasis on improving predictions under Objective 2. Predictability is part of this effort but the shift in this new Plan is clearly on improved predictions.
2	The plan has correctly recognized that "..... climate science is called upon to support the knowledge required for wise mitigation and adaptation choices in a changing world. Society's expectations of climate science are higher, with scientists being asked to deliver improved predictions and scenarios at finer spatial resolutions and on a wider range of time scales." However, the plan does not identify what are the key obstacles and how to overcome them. I can understand that a 25-page plan cannot say everything, but the section on "Advancing Predictive Skill on Timescales up to a Decade," seems to give the impression that the "partnerships" and coordination among programs are going to advance predictive skill. The plan should recognize that the most serious challenge in advancing predictive skill on timescales from days to decades is the fidelity of climate models. It is now well established, and therefore universally recognized (with the exception of a small minority of skeptics whose motives are not always based on science), that climate models are sufficiently realistic "in reaching the conclusions that human activities are responsible for the majority of observed climate change." However, WCRP should recognize that in order to make accurate and reliable regional climate predictions from days to decades, the fidelity of the climate models must be improved. WCRP should not hesitate in recognizing that the current generation of climate models are unable to realistically simulate some of the largest modes of climate variability, for example, the annual cycle.Recognition of model limitations by WCRP, and encouragement by WCRP to improve the models will help the global modeling communities in enhancing their efforts to improve the fidelity of climate models. There is a clear impression, not without justification, that global modeling communities spend large fractions of their time and effort to produce future projections of climate as expected by WCRP and IPCC. I am suggesting that the WCRP Strategic Plan clearly reflects the WCRP's ambition that the improvements in the fidelity of the climate models is one of the major objectives of climate research.	Thank you. We have now clarified the focus of this effort with two scientific emphases, namely the progress on simulation capabilities (data assimilation, ensemble genertion, initialization, etc) and the prediction of extremes, where the regional dimension is critical. We also hope that the plan balances focus between predictions and projections, each one having its simulation challenge requiring dedicated progress in modeling capabilities (see infrastructure section).
3	Note that ozone and stratosphere are not mentioned, neither is air quality, nor geoengineering.	Thank you. For simplicity, we have lumped all atmospheric constituents under "climate-relevant compounds". The stratosphere is by definition included in the atmosphere. Our focus on climate dynamics in Objective 1 also offers a clear opportunity for contributions from the atmospheric composition and stratospheric research community.
4	EXTENSION OF ONLINE COMMENTS: The new WCRP plan is very comprehensive in its scope and ambition, and we welcome the emphasis on efforts to steer scientific efforts that also account for and co-produce usable and actionable climate science and information with and for society. In this context, we wish to reiterate the importance of in-situ observation data for the developments foreseen and articulated in this plan, particularly in fostering and improving networked observation capacities in remote areas like mountains. Better infrastructure, design and observation processes that link climate and socio-ecological monitoring efforts are needed to provide data that improves understanding of complex and interlinked environmental processes, feedbacks and their impacts in remote areas. This is turn enables capacities to respond and manage associated risks and reduce losses of what is valued for ecosystems and communities in mountain areas.	Thank you. We fully agree on the critical need for observations, and hope that our section on infrastructures clearly articulates that.
5	SAME COMMENTS AS ONLINE COMMENT: I have read the WCRP Strategy draft, and I think it is quite good. It takes into account that the climate research field has matured a lot over the lifespan of WCRP and that many results are close to applications. The draft also mentions explicitly GAW and WWRP as important partners. The draft retains the "international climate research coordination" as the identity of WCRP. That might be necessary, on the other hand for the environmental sciences, the distinction into scales, earth system components and issues (weather, water, climate, ecosystems, managed land, oceans, air pollution) is not so clearcut anymore. The same applies to research versus applications. It is all related through strong flux and feedback mechanisms. Still the "cake" needs to be cut in some way to provide manageable organisation. I would have liked an even stronger emphasis on the role of "translational" science in the draft, which would fit into item 4 of the "Overarching Scientific Objectives". With translational science is meant (in my view) the value cycle from discovery to translation to application, where a curiosity driven science component is needed everywhere in order to make the cycle as continuous and efficient as possible. As the draft is written, there is still quite a bit of traditional reluctance to engage with the applications in an intimate way, and it is done through reference for instance to Future Earth while I think it should be a more built-in mechanism in the new WCRP. The Scientific Emphases (§10 onwards) are mainly on "enabling technologies" (better models, extreme event understanding, planetary cycles, responses to man made emisions, better observations, provide information), while I think there should be a parallel emphasis on "enabling cultures", where the evolution of translational science is an important example. To further illustrate the value cycle discovery-translation-application, I think S-GDPFS is a good example. It is a test bed for research, a translation mechanism of mature results to operations, and it has a significant user interface which feed experience back into R&D, in particular in NWP but more and more across all earth system components and issues. In a more concrete language, I see WMO as the only global, technical organisation which is the "home" of the backend of the global earth system forecasting system, while a number of international organisations feed on this backend system for their downstream postprocessing models or needs (IOC, UNESCO-hydrology, WHO, UNEP, FAO etc). The draft strategy emphases quite a bit the need for R&D in observational sciences, as well as better access to observations of known quality (§15). The interoperability and balance of observation systems across earth system components and issues is gaining importance, as the initialisation, verification and postprocessing of earth system (component) prognostic calculations, or reanalysis, develop. Data policy is a critical element here. These are some thoughts. I do not know if any of you are intending to send comments on the draft through the electronic submission mechanism, or if we should submit something from CAS? Perhaps a topic for discussion in 16 August telecon?	Thank you. See response in the table with online responses.
6	Thank you for sharing WCRP's draft strategic plan for 2019-2029. We in the Global Carbon Project (GCP) are excited with the new plan, including its focus and sharp objectives, emphasis on fundamental science and reducing uncertainty, and recognition of the need to create products and services of societal relevance. Carbon and other greenhouse gas research features prominently in the Objectives and Emphases underpinning the plan. The document highlights the carbon cycle, carbon budget and carbon-climate feedbacks, the very topics the GCP was created by WCRP and others to address. We look forward to continue working with WCRP to advance these goals. Your email also requested feedback on the draft strategic plan. One suggestion would be to broaden the first sentence of Objective #1 slightly to: "We will advance the science of both reservoirs and flows of energy, water, carbon, NITROGEN and OTHER climate- relevant compounds within and between the components of the climate system." The reason for this suggestion is to recognize the importance of nitrous oxide (N2O) as the third most-dominant greenhouse gas under human control. Over the next six months or so, GCP will launch our first Global N2O budget to complement our annual CO2 budget (http://www.globalcarbonproject.org/ carbonbudget/index.htm) and, as of 2016, biennial CH4 budget, next due out in 2019 (http://www.globalcarbonproject.org/ methanebudget/index.htm). With this email we wish to renew our formal link to WCRP through the research partnership we signed two years ago. We confirm our willingness and interest to support WCRP's implementation plan on all carbon and other greenhouse gas related components. We also welcome the chance to become even more closely involved in the creation of joint products with WCRP. We remain grateful for your scientific direction, successful outreach, and support.	Thank you. Likewise WCRP looks forward to collaborating very closely with GCP and developing joint products. We want to keep the Strategic Plan short and crisp and have lumped NITROGEN etc in"other climate-relevant compounds". We will for sure consider including other GHG such as CH4 and N2O in our detailed Implementation Plan.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
7	General: I have read the Strategic Plan 2019-2019 word by word. It is written perfectly by touching all necessary aspects which are included in objectives of WCRP plan. Although the Strategic Plan covers the research tasks for global and local climate systems, there is need to clearly include a paragraph/section about urban climate in this plan. It is as important and focused in present scenarios as climate change at global scale. The recent study "A global economic assessment of city policies to reduce climate change impacts" by Estrada et el. (2017) highlights that the importance of the UHI is enhancing the effects of global climate change. For the most populated cities (that is, the top 5%), the effects of UHI add 1.72°C, 2.08°C and 2.35°C to the temperature increase due to global climate change in 2015, 2050 and 2100, respectively. These estimates are 0.70°C, 0.84°C and 0.93°C for the maiden cities. About 20% of these cities could experience a total warming higher than 4°C in 2050 and about 25% could warm more than 7°C by the end of this century." Under these scenarios, the cities face paying twice the economic cost to fight climate change than the rest of the world (Estrada et el., 2017). Specific: Please find here the suggestions/corrections/addition etc for the improvement of initial draft of Strategic plan 2019-2019 of WCRP which you can accept or deny to incorporate in your final version. These are just my propositions/suggestions according to my own understanding. Paragraph 2, line 7: «WCRP research provides the climate science that underpins the United Nations Framework Convention on Climate Change and contributes…… » This sentence is not clear which can be changed as "the research findings of WCRP provide the climate science new ways, plans and strategies which underpin the United Nations Framework Convention on Climate Change and contributes…… Paragraph 3, line 13: "New urgencies are now emerging, but also new opportunities" This sentence is not clear even by reading in sequence with previous lines of the paragraph. It can be written as "Thus, new urgencies and opportunities about climate science are now emerging" References: Estrada F, Botzen WJW, Tol RSJ (2017) A global economic assessment of city policies to reduce climate change impacts. Nature Climate Change 7: 403–406.	We believe that the wording 'WCRP research provides the climate science that underpins the United Nations Framework Convention on Climate Change' is clear. WCRP is focussed on making sure that the research products and knowledge needed by the UNFCCC process is available. Regarding the last suggested change, the corresponding text has been completely revisited.
8	SAME AS ONLINE COMMENTS: Page 1 The overall societal relevance, rationale and locus of WCRP should be clearly and comprehensively set out up front. It is in fact introduced incompletely, piecemeal in many places and is not clear. Para 3 line 1: If WCRP is the only programme then it is also by definition the longest serving and every other superlative. Tautology. P3 diagram: at the core, "Engagement" is not similar to the other objectives - a category error - and is not comparable or compatible. It also appears around the circumference which suggests some muddled thinking - and indeed it appears in the "mantle" also. I suggest you remove it from the core. In what way is engagement different from communication? This smacks of a desperation to ensure that it is clear you are keen on engagement. The left bracket of interactions also looks out of place, and the whole figure is desperately inclusive without giving much idea of direction or structure. Para 6: I am surprised that GAW and GOOS are quoted but not GCOS. Most of the relevant parts of both are included in GCOS, together with other important aspects not included in either. Para 7 line 1: It would be useful to be clear about which partnerships here, rather than much later quote one example. A clear statement about the importance of partnerships would be useful, together with some better examples. What is the more generic link to climate services? Tis is where relevance to society will be focussed. Para 8 line 8: the use of the word "functional" to describe factors due to external influence is a little confusing, or at least not specific. It would be better to describe these factors more clearly as being due to external influence, or whatever. Para 10: the marginal text is not related to the main text block, as it is elsewhere. Line 2: are these 6 emphases the six subsequent numbered paragraphs? If so then they do not really represent scientific emphases as such, and are objects of different classes itemised as a list. As in many publications the document suffers from too many lists and reductionist statements without giving a holistic view. This is the natural tendency of science but to be avoided. It leads to a twelve days of christmas resonance of the document. these six are then followed by a second list of 8 similarly disparate items. I think this approach takes us back to the problems of grand challenges, core projects etc and the false matrices form from which WCRP recently suffered. Para 25 here I see the partnerships mentioned several pages ago are listed. Why here and not there? or there and not here? overall I think there remains a lack of strategic perspective on exactly what and why the WCRP is about, and the document too easily slips into lists of things to be done. I think it needs reconsideration.	Thank you. We hope that the Plan now clearly articulates its core mission, its engagement strategy, its partnerships and decadal ambition. We apologize for the earlier omission of GCOS in the list of partners. The Plan has also been retructured and there were indeed some category errors. The simpler structure will hopefully also lead to a simpler structure of the implementation plan. The contribution to climate services and GFCS is made quite explicit upfront. We have reworded many sections to take these useful comments into account. Thank you.
9	There are some impressive elements to this strategic plan. For a start, it is admirably short and easy to read. In fact, one hardly needs to read it because much of the information about it can be found in the Figure on page 3. The text then amplifies the four over-arching objectives (shown in the inner circle), and then the six scientific emphases shown in the next circle out. I, personally, was pleased to see that the "Grand Challenges" have been dropped. The Grand Challenges were: • Melting Ice and Global Consequences • Clouds, Circulation and Climate Sensitivity • Carbon Feedbacks in the Climate System • Weather and Climate Extremes • Water for the Food Baskets of the World • Regional Sea-Level Change and Coastal Impacts • Near-term Climate Prediction Though one or two of these are functioning well, not only are the ones related to food baskets and to carbon feedbacks struggling – they are in direct competition with similar initiatives undertaken by bodies such as scientific unions, or Future Earth, that are better qualified to undertake the requisite co-ordination and activity. Which brings me to the biggest danger of this Strategic Plan. It has been developed in the absence of a WCRP Director so that, presumably, it will be the template used by any future WCRP Director (if there is to be one) to guide their future work. Their interpretation of it will strongly guide the future actions of WCRP. My reading of it was that it failed sufficiently to deal with the "Elephants in the Room", the first of which is Future Earth. WCRP declined to be part of Future Earth, yet the Strategic Plan comes across as 'WCRP will do everything'. There is no demarcation of what is FE work that should be off limits to WCRP. Neither is there any evidence of a narrowing of focus. I, for example, did not interpret the Carbon, Water, Energy arrows on the edge of the inner circle as being strictly scientific investigations of these three fluxes but more as a desire (as with the grand challenges) to widen the remit into areas that are outside the traditional scope of climate research, but fall more into the climate applications area. The second "elephant in the room" is the relationship with WMO, which gives every appearance of wishing to take over WCRP and integrate its functions into regular WMO operations. The Strategic Plan makes no comment on governance, itself a vexing issue. I claim that it is a vexing issue as a result of my experience reviewing IRDR. I formed the conclusion that the success of WCRP had led to ICSU adopting the WCRP governance model as the "standard" governance model for all interdisciplinary bodies. The WCRP model consists of a Joint Science Committee – JSC – that is responsible for everything: finance, administration, science, planning. This model failed badly for IRDR, and is probably no longer appropriate for WCRP.	Thank you. Yes, we will sunset the Grand Challenges. The new/revised structure of WCRP will be addressed in the new Implementation Plan. We hope that the Plan now clearly articulates the strategic objectives being undertaken by WCRP and the role of partnerships in this context. The plan does not address governance as such, as this will be part of a process to re-calibrate the relationship between the 3 sponsors WMO, IOC and newly formed ISC and the respective roles of the JSC, the Joint Plannning Staff, etc. The plan now mentions explicitly ISC and its member groups. The Sponsors' Review will be published together with this new Plan, which is indeed a response to the Recommendation 1 of the Review. Climate Services also deal with reanalysis, prediction and projections. We shall also note that our Infrastructure section has a dedicated section on sustained observations, archiving etc.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
	One possible response to both of my comments is that the boxed item on page 9, labelled 'Institutional Partnerships' deals with such issues. Not so. It lists possible partners, including Future Earth and UN programmes but in keeping with the admirable brevity of the document does not really discuss the nature of any of these partnerships. In fact, there is no mention of international scientific unions in the partnership list. This has been problematic for all ICSU Inter-disciplinary bodies and a particular source of frustration for IUGG. Obviously neither IUGG nor IAMAS are seen as key entities for partnership. A more realistic response to my comments would be to note that governance issues were dealt with in the recent Review of WCRP. I only have an early draft of the Review report that makes the following recommendations: Recommendation 1: Science Strategy A new 10-year WCRP science strategy and related 5-year implementation plan must be developed as soon as possible in discussion with the sponsors and with wide consultation and community buy-in. Recommendation 2: Governance and the MoU The Review Panel recommends that a formal high-level Governing Board for WCRP be established to enable more effective engagement with the co-Sponsors and enable them to fulfil their responsibilities for the programme. A new MoU should be put in place to reflect changes in governance, operations and structure. Recommendation 3: Operations The Review Panel recommends that additional clarity be provided in the terms of reference, structure and functions of the Joint Planning Staff and the Director of the WCRP. Recommendation 4: Structure The WCRP leadership, with its newly created Governing Board, should work with the community to establish a new structure for the WCRP research effort that best serves its new strategy and involves a simplified set of delivery mechanisms. Recommendation 5: Financing In light of the importance to society of the goals of WCRP and the precarious level of current financial support for the JPS, the co-sponsors should re-double their efforts to support WCRP financially at a higher level of enabling funding so that it can operate more effectively. Recommendation 6: Science to service WCRP should take action to ensure its knowledge is brought to the service of society, especially in supporting the development of climate services. Recommendation 7: Partnership WCRP should seek to develop strategic and strong partnerships with other WMO research programmes (specifically WWRP and GAW), with GCOS, and with Future Earth. Thus this Strategic Plan is the response to Recommendation 1. Governance issues are separate as discussed in Recommendations 2 and 4. I also do not see that the Strategic Plan has dealt with Recommendation 6 as I would understand it. Following on the Panel Discussion on Climate Services held at the IUGG General Assembly in Prague, I interpret climate services as dealing with historical climate data – its collection, preservation, digitisation and analysis. This is an area that WCRP has never undertaken and, on the basis of the Scientific Plan, does not intend to undertake.	
10	1. General comments 1.1. The document is generally comprehensible, admirably short and easy to read. Overall, the Strategic Plan highlights the achievements of WCRP and makes a good case for its future development. 1.2. However, the document lacks bite and urgency, the sense of what's new and what's currently vital, in terms of scientific research, which policymakers demand, is often lacking. There is not a great deal that is new in the strategy, but then objectives such as fundamental understanding of the climate system, better observations, more computing power etc. are not going to change. Particularly: (i) Fundamental understanding of the climate system – this objective led to the establishment of WCRP almost 40 years ago; what specifically does WCRP now aim to resolve in terms of better understanding? This fundamental understanding is the core WCRP competency - it was originally seen as a meteorological understanding directed at energy and water fluxes. The inclusion of "climate-relevant compounds" starts to include atmospheric chemistry which may be a good thing being necessary for a proper understanding of climate. Although it may be a bad thing in that WCRP moves away from its core competencies. The same is true of carbon. A knowledge of carbon fluxes is vital, but as the whole topic has become so politicised, it can be a rationale for moving into the societal areas that Future Earth is supposed to be examining. What is the next step in understanding of the climate system? (ii) Advancing predictive skill on timescales up to a decade – uncertainties and sensitivity analysis form the core of any research related to nonlinear systems and their dynamics. If the temptation is to move into the societal arena by emphasising extreme events, then this activity is more related to IRDR (in research area) or Future Earth (in outreach activities) or climate services or GFCS (working with end-users). The Strategic Plan should list significant gaps in the research on predictability and how WCRP would like to fill the gaps, in addition to working together with WWRP. (iii) Constraining projections on decadal to centennial timescales – WCRP has been developing the research related to the projections for decades, and these projections have become well-known as a result of their use in IPCC reports together with their uncertainties; unfortunately, the Strategic Plan has little about significant reduction of uncertainties in projections. The WCRP Coupled Modelling Intercomparison Project (CMIP) has been the conduit for providing the modelling inputs to the IPCC reports. The timelines for CMIP5 were such as to enable outputs to be incorporated into the IPCC AR5 report. CMIP6 is presently underway so as to provide input into AR6. The CMIP process has been an outstanding success that has improved climate modelling skill internationally. The discovery that the multi-model ensemble has better predictive skill than any single model has enabled the predictive uncertainty to be reduced. That is a brilliant past. The Strategic Plan should more specifically discuss how WCRP considers to improve climate modeling and predictability for the next ten years. Particularly, the representation of the ocean in coupled models should be emphasized. A big test of coupled models is whether they can simulate the current climate and climate change over recent decades, and in my experience, some of the largest errors in CMIP5 were in the ocean circulation and ocean temperatures, which then affected the sea ice and atmospheric circulation. It would also have been good to stress the need for more information on past climate change through proxy records to aid in the detection of anthropogenic signals.	We thank you for your extensive feedback on the first draft of the strategic plan document. Below we articulate some responses to substantive comments received, and we also attached a table summarizing responses to recommendations received during the open comment periods. We have aimed for a short, focused and comprehensible document which can be used in various contexts and with a variety of audiences, capturing the key strategic priorities in response to the WCRP Sponsors' Review, which has been instrumental in shaping these priorities and particularly the emphasis on collaborative effort to move forward. This plan will be operationalized by an Implementation Plan which will similarly rely on wide community consultation. Strategic development, from past to future: • The establishment of WCRP 40 years ago was prompted by a specific focus on the fundamental science that was required to detect, simulate and attribute climate change in the Earth System. "Earth System" as a concept was initially construed very narrowly with the tools then available and has broadened over time, of course. Furthermore, there were and will remain other critical climate research endeavors. But the facilitation and promotion of climate research has been viewed by many as the core business of WCRP. • The climate research community has been successful in responding to the set of questions prompted by this focus. This is of course not to suggest that there are not significant gaps remaining in our understanding, but the advance of climate science specifically in response to this focus has been a signal achievement of the community. • This focus had the advantage of being a narrowly articulated goal. But there have been disadvantages as well, in that some research areas received less attention. Some of these areas are now understood as required for the kinds of demands now being made on climate science, such as large scale circulation dynamics of the deep ocean, or clouds physics. These areas may seem less compelling because they are not new, but they are critical for progress in climate services, understanding how extreme events interact with variability and change; the many roles of chemistry in the energy balance of the Earth system; etc.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
	Analysis of the interactions between climate, energy, water and carbon systems with downscaling to regional, national, and local levels would be useful for future research. Meanwhile the Carbon, Water, Energy arrows on the edge of the inner circle (Figure on page 3) could be interpreted as being strictly scientific investigations of these three fluxes, but are more likely to be seen as a desire (as with the grand challenges), to widen the remit into areas that are outside the traditional scope of climate research, but fall more into the climate applications area. "Grand challenges" have been dropped from the Strategic Plan, and perhaps it is a good sign. Though one or two of these are functioning well, not only are the ones related to food baskets and to carbon feedbacks struggling – they are in direct competition with similar initiatives undertaken by bodies such as ISC Scientific Unions, or Future Earth, that are better qualified to undertake the requisite co-ordination and activity. 1.3. The document is inadequate in its weak recognition of the intrinsic role of society in the climate system, as a coupled component rather than merely as a forcing, and lacks a deep view of the interaction between climate science, civic society and policymakers. The involvement of social scientists in reviewing this text would be beneficial. While there are several mentions of the social and the human (as desirable in the next decade's climate research), social scientific perspectives are not adequately specified in the new forms of 'engaged' climate science envisaged for the next decade. The concern is that these things are detailed far less fully than the details of past modelling and understandings of climate systems. These statements about the social and the human are broad and quite unable to be operationalised. There seems to be a lack of integration (or "weak recognition") of the critical importance of human and societal factor research into traditional natural and physical science research for climate. Although some sections of the plan are devoted to societal issues, still the document does not clearly demonstrate how human and societal factors will be integrated into traditional (natural & physical science) climate research and engagement is the next scientific strategy. This issue might even be revisited for a significant reframing of the fundamental Vision & Mission Statements for WCRP. This is potentially an opportunity missed for education as well. For example: [Current Mission Statement] "...WCRP leads the way in understanding the fundamentals of the climate system and in determining is interactions with human activities." This seems to separate the two (the science and the human activities), whereas a new climate science needs to highlight how human and societal actions are embedded in climate systems and in our approaches to understanding them. Presumably an innovative definition of climate systems, and climate science, could facilitate this understanding. [Possible Mission Statement Update] "...WCRP leads the way in better understanding the fundamentals and emergent behaviors of our complex climate system, the result of dynamic natural, physical, social, and economic systems interacting at multiple scales around the world..." p. 5. This lack of any serious attempt to incorporate the human is demonstrated in the following two sentences: "This behavior intersects profoundly with human activities and ambitions. It requires a quantitative understanding of physical, dynamic and biogeochemical processes on all scales; of intrinsic modes of variability; of the roles of teleconnections and feedback mechanisms; and of the underlying mechanisms of extreme meteorological and hydrological events." The first sentence recognizes a "profound" intersection with society, the second fails to rise to this challenge through the absence of a last phrase that would have captured its essence. p. 7. 6 – Engaging with society. This is a weak paragraph that reveals nothing about the nature of the engagement with that is needed. It does not make clear that it is not just a matter of providing "society" with the information that the WCRP thinks that society needs. p. 6. 3. This section refers to "societal responses" (responses to what by the way?) that directly influence the climate system without embedding these effectively in the logic of the document, as complex components in a coupled system. It then goes on to refer to emergent behaviour in a way that does not indicate whether it includes emergent human behaviour, with the sense of the sentence implying that it does not. 1.4. It would be beneficial to include a graph showing the current state of our climate and/or statement about recent hottest years on record. There is no call-out noting that the science has already clearly shown evidence for rising global temperatures, but that science, society, and governance structures now need to cooperate in understanding the science and effectiveness of climate change mitigation and adaptation. While the WCRP strategic plan language does note climate science will be focused on creating more "resilience" and "sustainability," stronger words and examples should emphasize the immediate challenges of global climate change as the core value proposition for critical, timely, and necessary WCRP work. 1.5. The mission statement refers to partnerships, which are of course crucial if the WCRP is indeed to coordinate scientific activity in the climate domain. But up to this point, there has been no mention of actual and potential partnerships. There is no need for such mentions to clutter up the main text, they could be contained in text boxes or in notes in lateral margin where a particular issue that will depend on coordination arises (the box on p.9 contains an inadequate list). Such inclusion would significantly strengthen the claim of WCRP to be a coordinator. "Deeply collaborative efforts" are referred to on p. 5, but there is no mention of their agents, with the exception of "Future Earth" on the same page, nor of coordination procedures. The document lacks clarity/strategy on the form of proposed institutional partnerships for the next decade. 'Institutional Partnerships' lists possible partners, including Future Earth and UN programmes but the document does not really discuss the nature of any of these partnerships. In fact, there is no mention of ISC international scientific unions and associations in the partnership list explicitly, but "other ISC bodies" are mentioned even though most readers would consider this to be ISC Interdisciplinary bodies rather than scientific unions. It is recommended that the Strategic Plan lists potential partners for the six scientific emphases. Another suggestion for consideration is that If other international groups/networks are undertaking some of the things that WCRP is proposing to go into, is it a good idea for WCRP to propose these things as major parts of its own future focus? Perhaps WCRP should stick to what it has done well in the past and focus on how its work will reduce the uncertainty of predictions in the next decade, and how it might coordinate more support for better anthropogenic signals of past climate change through proxy records. Then WCRP could collaborate specifically with other organisations who are tasked with integrating the social with the natural in climate science. 1.6. The Strategic Plan makes no comment on governance/structure. CliC, GEWEX, CLIVAR and other WCRP projects have been around for a long time and with the strong emphasis on cross-disciplinary research; maybe it is time to break down some of the barriers in the current system developing more interactions with the other programmes. 1.7. For a programme that is intended to be the global coordinator of international climate research and thus the lead for providing the best climate science to the UNFCCC and 2030 Agenda, there is an odd lack of clarity around how WCRP operationally provides leadership and/or interacts with its global partners and, therefore, how this strategic plan advances that critical element of its identity over the next 10 years. It is not clear from the document whether WCRPs 10-year plan will advance climate science: (i) through WCRPs innovative synthesis of existing climate research by and with partners, (ii) (through direct support of WCRP partners as they look to WCRP for best practices in developing their climate research, and/or (iii) (iii) through the direct development of new, foundational climate knowledge by WCRP itself? All of these (and more) are incredibly valuable roles for WCRP in its role as global leader and coordinator of climate research partnerships and it may do all of them, but it was not clear in the text what was prioritized and/or how. 1.8. It would be useful to know who this document is intended for, as content needs to be well- tailored to audience. The impression the document gives is that it is designed as a general public statement about strategy rather than as a document to inform relevant scientists about WCRP strategy. 1.9. The WCRP Review Report makes a number of recommendations. Thus, this Strategic Plan is the response to Recommendation 1 on the need to develop a science strategy. The Strategic Plan has not dealt with Recommendation 6 on Science to Services. 1.10. There is a concern that the plan has been developed in the absence of a WCRP Director so that, presumably, it will be the template used by any future WCRP Director to guide their future work. Their interpretation of it will strongly guide the future actions of WCRP. 2. Structure of the document Despite having strategic plan elements including clear and concise Vision and Mission Statements, it is not actually a strategic plan, as it does not provide a clear road maps for the reader - scientist, business person, or general public citizen – to read through and better understand the priorities, pathways, and metrics of an organization over a specific timeline. This document is currently missing core/key elements that would have it seen as a strategic plan, including: (1) Clearly stated Goals (2) Clearly stated Actions to meet the stated Goals (3) Clear identification of who is accountable for advancing the Actions & Goals1 (4) Clear identification of indicators to assess progress towards Actions & Goals2 Pages 3-5: While each Overarching Scientific Objective has a paragraph of text following it that includes WCRP intended actions, these actions are neither clearly stated nor clearly identified (e.g.	This is why we wish to foreground the fundamental science in this strategic plan. • As a result, while it would be satisfying to articulate a single next step in understanding the climate system, what we seek in this strategic plan is to make space for the diversity of fundamental research that speaks to these neglected areas. The details of focus priorities will come in the next stage – implementation. • It follows that the remaining three objectives seek to put this imperative into a framework of aspirations for the next decade. • Perhaps most critical is the aspiration to break down the barriers of time scale that have been created between meteorology and climate as broad disciplines towards a more seamless research agenda. To some extent there are good reasons for these barriers, in the separation of initial and boundary value problems for example, but the time is right to make a concerted effort to bring these communities together more effectively. The gaps in prediction are fuzzy boundaries to be pushed through collaboration. • To date, projections have been developed as scenarios. New scientific insight is revealing that there are inherent or emergent constraints, in other words intrinsic relationships, to the ways in which the system varies on a variety of timescales. This is the focus of the third objective. Intrinsic role of society in the climate system: • We are acutely aware that a substantive integration of fields of inquiry that, since the Enlightenment, have been deeply divided, is a complex and challenging task. While there are members of the JSC and the wider WCRP research community that possess expertise in some of the expertise required, coming to grips with this integration is a joint endeavor spanning many programs. We will seek the guidance of the co-sponsors in the development of approaches to move this forward as questions of implementation of Objective 4 are considered. • Furthermore, we strongly support the ISC Governing Board's recommendation to include in the process going forward researchers who focus on key aspects of social sciences that present to us, at this stage, the most tractable opportunities for enhanced and new integration of climate research disciplines which can move us forward on the stated objectives. Different parts of the WCRP research community are starting from different perspectives and understandings. Hence, this recommendation is for us the first step in a process to achieve meaningful and substantive integration of epistemologies that have been separated for centuries. Downscaling: • This is one technique among many to address the scientific questions rather than a domain of enquiry in itself. It can and will be part of the implementation of the strategy. Governance and operationalization: • The co-sponsors will understand that changes to the structure of WCRP to operationalize the aspirations of this strategy is necessarily a sensitive issue for the climate research community. The WCRP JSC are aware that (i) cohesive research communities that are critical for progress take time to form and (ii) it is no small thing that livelihoods depend on how the structure evolves. Hence, the implementation of the strategy is the next stage of what is, in our view, a social process for the climate research community to tackle collectively. These concerns are therefore explicitly omitted from this strategic plan. Science to Services: • We did not address Recommendation 6 of the WCRP Sponsors' Review. The role of WCRP is to provide the underpinning scientific understandings, approaches and technologies that will enable services, but that implementation of that goal is properly the domain of other entities; particularly, operational centres around the world, guided by international agreed frameworks such as the GFCS. General comments on the scope of WCRP • In our usage, consistent throughout the document, "natural sciences" refer to "physical, chemical and biological sciences" while being clear that WCRP does not span this entire domain. Similarly, we distinguish between climate system science (largely physical, dynamical and chemical sciences of the climate) and Earth system science (natural and social sciences of the Earth system). Attention has been paid to clarify the distinction between necessary partnerships when appropriate and necessary investment in new areas of research to make further progress in climate research. Some examples of such areas are hydrology, atmospheric chemistry. • On a broader scale, there is a clear push for more integration in climate and Earth system science. Whilst WCRP will continue its tradition and focus on observations, analysis and prediction, it will inevitably have to rethink, together with partner programmes, how the strategy will be implemented. This is unchartered territory. The challenge is huge, but so are opportunities to make a difference in the long-term.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
	Action 1.1, Action 1.2), so they cannot be easily reframed as clear and strategic Actions. Instead, these paragraphs seemed to mix lists of actions with justifications of the objective, descriptions of programs, partnership declarations, and definitions of climate research terms. Pages 5-9: Following these paragraphs and beginning on Page 5, the document introduces six “Scientific Emphases” and eight “Imperatives” that, the authors note, are needed to meet the four Overarching Scientific Objectives. This seems to imply they might be the actions needed to achieve the objectives/goals. Yet this doesn’t quite make sense when looking at the Page 3 graphic. This only seems to explain the larger WCRP conceptual framework for climate research, not how Emphases and Imperatives will be action steps to achieve the objectives of the 10-year WCRP Strategic Plan. As a suggestion for improving the structure, it may be helpful for the authors consider thinking about the four Overarching Scientific Objectives, all Scientific Emphases, and all Imperatives as six high-level Strategic Goals. For example: Goal #1 Advance Fundamental Understanding of Climate System Goal #2Advance Predictive Skill on Timescales up to a Decade Goal #3Constrain Projections on Decadal to Centennial Timescales Goal #4Connect Climate Science with Policy & Services Goal #5Utilize Systems Approach for Climate Science Emphasis Areas Goal #6 Develop Global Infrastructure Supporting Integrated Systems Approach for Climate Research This may not be correct, but - whatever organizational structure the authors choose - this document’s structure be revisited to more closely mirror the format of an actual strategic plan, or it should not be called a strategic plan. It is recommended that at the end of this document a complementary “implementation” document is attached or to be written in near future that will indicate (1) who will be tasked with implementing the actions to meet the WCRP goals (i.e., the person, organization, or governing body with authority and resources to achieve the goal), and (2) what kind of indicators will be used by WCRP to assess its progress towards its stated strategic goals over the next ten years. 3. More specific comments 3.1. p. 2 “The Next Decade”. This section is too generic. It would have been appropriate at almost any time during the last 2-3 decades. It gives no guidance to the reader on “what’s new for 2019-2029”. Or is it more of the same? The next section on overarching science is much more specific, and could be substituted for the text in “the next decade”. 1,2 If this document is actually the “10-year WCRP Science Strategy” as recommended by a WCRP Review Report, then (3) and (4) could be addressed in the “related 5-year implementation plan” that was also recommended to be developed in that report. Still, these critical strategic planning operational steps should be acknowledged somewhere in a document entitled “Strategic Plan.” 3.2. P 3 Diagram. Is this intended as a logo for the next decade, or is it intended to transmit information? If it is the latter it is unclear, and at least needs a text caption. 3.3. p 4. Advancing predictive skills .... The mention of extreme events begs to be linked to the increasing scientific input to disaster risk reduction as set out in the Sendai framework, and as promoted through bodies such as IRDR. There is also a potential link in 4. on page 5. 3.4.p. 5. Scientific Emphases. This appropriately stresses the centrality of a “systems approach”, but the following text is disappointing to a scientist in not going beyond a description of system analysis that could have been produced at any time during the last 3-4 decades. 3.5. p. 6. 4. There is no doubt that the WCRP committee is well aware of the dramatic advances in computer modeling that modern data resources, advanced HPC and machine learning technologies have enabled, but it would be useful in this section to get a sense that the advance of technology permits us to undertake modeling with massively enhanced capacity and potential, and that this potential is vital to the objectives set out in the strategy. 3.6. p. 7-8 – Imperatives 1-7. This is a useful wish list, but it would, again, be helpful to indicate what specific actions and what collaboration/coordination and at one level will be required. 3.7. Paragraph 3. ‘deliver improved predictions and scenarios at finer spatial resolutions’. If the large ensembles are correct this may not be possible because of intrinsic variability within the climate system. 3.8. Paragraph 8. It is good to see emergent constraints highlighted as this is an important, current area of research that has a lot of promise. 3.9.Paragraph 11. ‘determine the processes responsible for the existence of regional climate hotspots’. In scientific writing, this could be made clearer. Are we talking about areas that will have more extremes? Or are we talking about areas of higher temperature? 3.10. Paragraph 14. ‘Improvements are critically required in representations of the hydrological cycle, including clouds and precipitation oceanic eddies and waves, sea ice dynamics and glacial flow’. We also need to have better simulation of the different water masses in the ocean, such as Circumpolar Deep Water, which is critically related to the melt of the Antarctic ice sheet. 3.11. Paragraph 17 could be better worded. It is not clear what it is that can be thought of as ‘essential infrastructure’. But then if the challenges are essential infrastructure, the paragraph does not make sense. Nor does it if the objectives are the essential infrastructure. 3.12. In the list of Acronyms, ICTP should be spelled as “The Abdus Salam International Centre for Theoretical Physics”. Also the Global Ocean Observing System (GOOS) is mentioned in the Strategic Plan, but not in the list.	

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
11	Paragraph 3 Line 9: Please further specify 'wise' mitigation and adaptation, because 'wise' could be interpreted in different ways, please consider using more objective terminology. Line 10: Are these just a set of 'mitigation and adaptation choices' or more encompassing, highly dependent, and complex strategies? Please consider more action oriented wording here than `choices'. Possibly change `choices' into something along the lines of 'approaches or strategies'. Line 11: 'higher'; please specify higher than what exactly (because the impacts of climate change are being felt new urgencies and questions emerged? and/or more freely available information arriving faster to society due to advanced technologies, posing new challenges and expectations?). Please consider to avoid ambiguity for the reader's interpretation. Lines 11-13: `with scientists being asked' - Not sure if scientists are 'asked' directly. Maybe revise in slightly more general wording: 'turning to scientists'. Line 12 - 13: Please consider adding that these predictions need to be applicable/action-ready and/or translated into information. Line 14: Please consider to improve the clarity of this sentence, it's ambiguous what is meant by 'now' and 'new urgencies'. Haven't these urgencies been emerging over the last years/decade already in the light of past/ongoing climate change impacts? And/or please specify what these 'new urgencies' exactly are. Additionally, please consider adding a verb to the sentence: ' ,but also new opportunities'. Line 15 - end of paragraph: Why is it 'The same fundamental science…'? Perhaps it is also time to rethink the way we do `fundamental' science? Possibly replace 'The same….' with 'The fundamental climate science…'. Paragraph 4 Line 7: consider adding 'to promote and to take advantage of computational technologies' Last 2 lines of paragraph: WCRP`s main focus would possibly not be to 'deliver' climate information, but merely to improve climate science underpinning climate information and to generate climate information. Please consider revising accordingly. As this is the last sentence of this section is comes across as one of the key focus areas of WCRP described in the SP. Paragraph 5 Line 3: For improved readability, please consider to revise the first objective into 'advancing bedrock science for understanding', as the first objective is not written in the same form as the other three ("science for understanding" vs "improving", "refining", "connecting"). Paragraph 6 Line 4: `close' is very ambitious, and contradicts slightly with objective 3 and the related scientific challenges. Possibly consider slight modification to ease the wording. Line 18: '.... chemical species', please consider to revise to (bio) geochemical cycles, or chemical cycles. Paragraph 7 General remark: Consider to mention the aim for seamless predictions here, also identified as an Earth System Science Frontier by ECRs in Rauser et al. (2017) and possibly make the scales explicit ("from minutes to centuries and from meter to global spatial scales"). Paragraph 8 Last sentence: The idea that the reduction of uncertainties promises useful information on longer horizons overlook the improvement of the quality of information on the actual timescales under consideration. It could be rephrased to also imply this. Paragraph 9 The title of paragraph mentions 'services', but the paragraph doesn't explicitly. Line 4: Possibly mention climate services initiatives/institutions and/or GFCS among 'others'. Paragraph 11 Line 4: Please clarify what 'This' refers to. Paragraph 13 General remark: What is WCRP's position on climate engineering / geoengineering / climate intervention research? Though remaining controversial, WCRP may want to emphasize the need for research in this field. It will be crucial to enhance the fundamental climate research involved in this field to properly assess the potential effects, risks, and uncertainties of CE. Line 2:Maybe it is worth to distinguish between short- and longer- lived pollutants. Paragraph 14 Line 3-5: What about better representation of both land and ocean biosphere and their connection to climate? General remark: possibly mention that training the next generation of modelers is fundamental to this scientific goal. Increase the number of scientists trained and with in-depth knowledge, especially in developing countries, by creating a larger network of scientists capable of modeling the climate system (this could be mentioned in connection with paragraph 18/19/22). Paragraph 15 General remark: Possibly include emerging technologies for observations and citizen science. Citizen science is growing quickly. This will require a lot of attention/work from the scientific community for calibration/validation in the near future. ECRs believe this could offer a range of opportunities, as well as challenges that will play a crucial role in the future of observations, especially for currently data-sparse areas such as mountains, icefields or oceans. This was also discussed in detail during the YESS-YHS ECR workshop, 3-5 May, held in conjunction with the GEWEX OSC. Paragraph 18 General remark: YESS considers this as very important. YESS is very a diverse community and we hope to continue to be useful to different WCRP initiatives and try to increase the effective scientific collaborations between YESS and WCRP at all levels. Paragraph 19 General remark: ECRs strongly support an intensified collaboration across model development communities, especially between global and regional modellers. Mutually beneficial learning and collaborations between these communities could benefit the progress on climate model development and the generation of regional-local climate information. This was also discussed in detail during the YESS-YHS ECR workshop, 3-5 May, held in conjunction with the GEWEX OSC. Paragraph 20 Last 2 lines: ECRs strongly support open access data, not only for observational, but also for model data. Paragraph 25 Please consider to add to the list of partnerships: 'ECR partner organizations and ECR networks`or 'ECR networks and organisations such as YESS, APECS, YHS, ECR NoN, among others, or something along these lines.	Thank you Paragraph 3 Line 9: We omitted the word 'wise' to avoid ambiguity. Line 10: This was changed to "mitigation strategies and adaptation choices". Line 11-14: the text has been adjusted significantly to address these useful comments. Line 15: The word 'same' was omitted. we agree that it was not needed. Paragraph 4 Line 7: This has been reworded as - There are also clear opportunities, to develop new partnerships for research and operations, to promote exciting observational and computational technologies, and to develop scientific capacities across the globe. Last 2 lines: the wording has been adjusted accordingly Paragraph 5 Line 3: Changed to 'fundamental understanding of the climate' Paragraph 8 The improvement of the quality of infomation is another issue, but here we refer to the improvements due to the reduction of uncertainties and quantification of contraints. Paragraph 9 Services is now mentioned explicitly Paragraph 14 Geoengineering is embedded into the broader mitigation terminology Line 3-5: WCRP will place a special emphasis on improving representations of the hydrological cycle. Capacity buildingis a key priority of WCRP and has been moved to the beginning of the Plan. Paragraph 15 Citizen science and emerging technologies are mentioned explicitly in the text. Aditional remarks on the text have been taken into account where possible.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
12	(same as online response 36)I found the plan to be well developed. I was curious on others thoughts. Attached are my comments. I think explicit references to academic community and data assimilation are missing elements. I would imagine that the implementation plan would contain more direct links to WWRP activities. Report: The WCRP strategic plan is well-developed and structured. It skillfully and appropriately avoids addressing the challenging discussion of WCRP structure by instead focusing on the scientific objectives, foci, and imperatives/requirements. 1. The vision and mission are well-articulated. 2. The scientific objectives are appropriate and relevant. Critically important, and serving as an underpinning for the entire climate science enterprise is the first objective "Fundamental understanding of the climate system." Objectives 2 and 3 break the problem into two parts (subseasonal to decadal) and decadal to centennial – in recognition of the likely predictive capacity of the former and the more projection oriented focus of the latter. Finally the last objective connects the information gained from the first three objectives to society through services and policy-relevant information. 3. The Scientific Emphases are comprehensive in scope. Emphasis 5 ("Innovation through observation") could be strengthened by an explicit reference to the (necessary) development of fully-coupled data assimilation systems for the earth system. This is notionally contained in the last sentence of paragraph 15, page 7: "Improvement … requires that models be confronted with observations …" 4. The strategic plan identifies the required investments and commitments to realize the objectives in the Imperatives section. Again, investments in coupled earth system state estimation (data assimilation) should be emphasized in requirement 3 concerning observations for process understanding. Data assimilation provides context for (new) observations and enhances their value in fully comprehending processes. Additionally, requirement 8 concerning institutional partnerships should explicitly recognition of the global community of earth system scholars in the academic community/universities (perhaps in bullet 6 that considers capacity building organizations?)	Thank you. See response to the on-line comments.
13	I also like the WCRP strategic plan. I know this feedback is two days late, but here are a few thought from me. The predictability objective and emphasis on mechanisms of extreme events is particularly relevant to today's society. Compound events, where a double whammy or triple whammy really knocks out a region or community for a while, often have the greatest impact - it would be great to see some further study and attribution of compound events. Partnerships and impact data are essential for understanding climate impacts, but those data are much less organised and standardised than climate and weather data. If WCRP could encourage activity to regularise impact data that would be very helpful.	Thank you. Under our objective 2, we have an explicit focus to "determine the processes responsible for the existence of regional climate hotspots" which de-facto includes attribution work. Impact data are maybe not a core activitiy of WCRP but may be promoted through suitable partnerships.
14	The importance of model development to achieve the goals mentioned in the text is not emphasized enough. The basis for nearly all of the goals is the ability to produce good predictions or projections. The basis for this is model development. This was also underlined by WMO president David Grimes at the 5th WGNE workshop on systematic errors in weather and climate models in June 2017 in Montreal. The WCRP strategic plan should point this out clearly and encourage national and international funding organisations to provide resources for pure model development. Paragraph 4: It would be helpful to give a short overview of differences between objectives, emphases and imperatives here in order to understand these different categories right from the beginning. E.g. engagement is named in all three categories. Page 4: The green text "short summaries" next to paragraphs 6 and 8 (left side) should be changed in order so that the order of the main text is also followed in the short summaries. Paragraph 7 (9th line ff): The sentence "Working with…" does not fit to this headline ("2. Advancing predictive skill …") but should be moved to paragraph 9 ("4. Connecting climate science with policy and services") Paragraph 8 (p.5 l.4): Probably write "development of global and regional scenarios" in order to emphasize that the regional scale is as well important here. Paragraph 9: it would be good to include a sentence which highlights the importance of highly resolved data for services. E.g. (after 1st sentence of this paragraph: "For this purpose regional to local climate information is necessary to allow for proving reliable climate services". A link to CORDEX would also be beneficial. Paragraph 11: again the regional aspects are of huge importance. Perhaps insert "occurring on the regional to local scale" after "extreme events" (5th line) Paragraph 11 and 12: A lot of knowledge is already there and the knowledge grows faster and faster. There is a need to review and summarise the existing knowledge on a regular basis in order to keep an overview and to identify the important research directions. This should be organized systematically. Paragraph 13: I am not a native speaker but "… to inform policy and decisions" (3rd line) sounds odd to me. Is it rather "… to inform policy and decision makers"? Paragraph 13 (last sentence): "… must be incorporated into a comprehensive understanding of the climate system." should be changed to "…must be incorporated into a comprehensive understanding of the climate system and the prediction systems and earth system models." Paragraph 14 (p.7 l.6): Probably write "dynamical and statistical downscaling tools" in order to clarify which kind of downscaling tools might be applied. Paragraph 15: working on climate research long term time series are of paramount importance. I would like to suggest to aim for long term measurements coming together with the necessary metadata allowing for a homogenisation of the time series. Paragraph 24: maybe include: "WCRP aims to improve policy relevant information while not being policy prescriptive."	Thank you. Model development is now mentioned explicitly under the Infrastructure section. We have changed the structure of the Strategic Plan so that there are only two, we hope self-evident- categories. Objectives and infrastructure. We hope that the new structure is clearer. We have restructured the Strategic Plan so that partnerships appear under a single section at the beginning of the document. Regarding scenarios, we have retained a simple formulation to keep the text as concise as possible. The side notes have been adjusted and re-organized to better match the corresponding section. We have now references to regional issues in several sections where appropriate. We don't want to add 'regional to local scale' here however, as the regional and local scale overarches the entire plan, especially in response to societal needs. Paragraph 13 has been changed to: "...and other fundamental aspects of emergent behavior, will be incorporated into a comprehensive understanding of the coupled human-natural Earth system. " We have now added "dynamical and statistical downscaling tools" Remark on paragraph 15: we fully agree and have a corresponding text to that effect in the infrastructure section.
15	Page 2 paragraph 4, second sentence: This doesn't really make sense. "The task is formidable, both scientifically and technically complex while deeply engaged with the structure and limitations of social institutions at every level from local to international." May I suggest: "The task is formidable, both scientifically and technically complex while requiring engagement with the structure and limitations of social institutions at every level from local to international." Page 5, paragraph 9, first sentence – under the heading 4. Connecting climate science with policy and services Why do you only mention Future Earth in the first sentence? As you are talking about connecting with policy and services, may I suggest "….building on partnerships with Future Earth, IPCC, UNFCCC and others" (there may be more to list? Or be less specific but more comprehensive… "…building on partnerships with relevant international scientific and UN organizations and policy makers at all levels")	Thank you. The sentence in paragraph 4 has been changed to "The task is formidable, both scientifically and technically complex while deeply interwoven with social and economic institutions at every level from local to international.". The references to partnerships have now been restructured into a single section at the beginning of the document, but also mention Future Earth explicitly in Objective 4.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
16	Comments and Suggestions Overall, the draft WCRP SP is in good shape. It provides a broad vision on priorities. The imperatives are strong. Scientific emphases are appropriate, and in areas like extremes compelling. My comments and suggestions are minor; none are mandatory. They can be addressed with small edits as needed. The comments are intended to clarify points, help build the case for WCRP's value, and note fruitful areas for further collaborations with the WWRP. 1. Paragraph 3: To avoid a possible criticism, after "human activities are responsible for the majority of observed climate change" insert "since 1950" or otherwise specify a time period consistent with IPCC attribution findings. 2. All four science objectives start with "We will …" as, for example, Objective 3, "We will quantify the sensitivities, uncertainties and emergent constraints … ". If the SP is intended for a broader audience, there is a possibility for misinterpretation that the WCRP will conduct this research. To specifically emphasize WCRP's role as articulated in the mission statement, consider starting each objective with "WCRP", and modifying the text slightly as appropriate; e.g., Objective 2 becomes "WCRP will advance partnerships to …". 3. Objective 1. After the sentence listing sources for spurious budget imbalances that concludes "in observations", consider inserting an additional sentence on the implications of these imbalances: "Such deficiencies limit current capabilities to predict climate variability, confidently attribute causes for recent changes, and project future changes from global to regional scales." If this edit is made, then the text beginning "Furthermore …" to "As a result" can be deleted. 4. Objective 4. The section title includes "services", but the text does not call out connections to national or regional climate services, whether or not they are formally labeled as such. These are likely to be crucial to realizing and broadly disseminating benefits of research advances from WCRP-related efforts, especially on climate time scales of S2S (and potentially also S2D). In WWRP, relationships to NMHS are critical toward developing useful and usable science with broad public benefits, and there is value in identifying this sustained customer of WWRP. As climate services develop WCRP's central role toward achieving the GFCS is also not stated in the paragraph. It may be helpful to add brief text here emphasizing potential benefits of WCRP activities to existing national and regional climate services, innovating and testing new services, and achieving the objectives of the GFCS. 5. Emphasis 1. The importance of extreme events will be easily appreciated by nations and other end users. The connections to WWRP are especially strong on this topic. As in WWRP, WCRP should also consider variations and changes in other high-impact events that are not necessarily extreme. This is a specific area where working together with WWRP there is great potential to develop seamless information products so that societies can better anticipate and prepare for evolving risks for such events over time scales from climate change to weather. 5. Emphasis 2. First sentence: suggest changing "variabilities and interactions" to "variability, trends, and interactions." 6. Emphasis 3. First sentence, change "forcers" to "forcings". 7. Emphasis 4. The main emphasis of the paragraph is on improvements in physical process representation. While this is certainly crucial, for improved S2S and S2D predictions, there are also strong needs for improved initializations and data assimilation methods for the coupled climate system. Developing and testing CDA can also help reveal errors in model representations of physical processes, for example, coupling and flux errors at component interfaces. There is also a need to learn how to best optimize modeling strategies to better attribute, predict, and project changes in high impact phenomena that manifest at small spatial scales or occur in complex orographic regions that typically require very high model resolution. Collaborations between WWRP and WCRP in this area could contribute to improved assessments for evolving risks of such phenomena in a variable and changing climate. 8. Emphasis 5. The observational paragraph is excellent. Beyond the value of confronting the models with observations to test model fidelity, which is vital, model sensitivity experiments that incorporate special observations can help identify where deficiencies in current observing systems reduce predictive skill. This observations-model interplay can help determine new requirements for innovations in observations and observing system design. In the long run we are building the capability for ongoing Earth system analyses and reanalyses for real-time monitoring and a long-term record of global and regional changes. This will require advances in fundamental observations but also improvements in model-data integration. Developing this capability is another potential integrating activity that could involve WWRP, WCRP, and other partners.	Thank you. 1. We have now added 'since the mid 19th century' 2. The Plan is written by the JSC who has the lead on the strategy and its implementation. The use of the first plural voice is in the name of WCRP. 3. The text has been significantly revised, emphasizing the focus on fundamental understanding, of which the focus on reservoirs and flows is a science emphasis. 4. climate services and policy are now highlighted at the very beginning of the document. There are many aspects of predictions that will require improvement and innovation, including initializations and data assimilation methods. Comments on the emphases have all been dealt with when possible and integrated / merged with either the relevant objective or infrastructure section. We do look forward to collaborating very closely with WWRP in many areas of our Plan.
17	We are writing in our capacity as leaders of the WCRP Grand Science Challenge on Clouds, Circulation and Climate Sensitivity to provide feedback on the proposed WCRP strategic plan. There is a great deal to like about the draft strategic plan. It is broad, relevant to society and research and refreshingly addresses the major issues facing future climate science. The two tracks of 'Objectives' and 'Emphases' gave it an effective structure. What we thought worked less effectively was how the 'Objectives' were articulated, particularly given the 'Emphases'. We very much endorse the identification of 'Climate dynamics and extreme events' as the first point of Emphasis; but given the underlying content, it would be better titled 'Changing circulation systems' or 'Drivers of atmospheric and oceanic circulation changes' or 'Global circulations systems'. All of these titles more saliently identify the physical imperative to better understand global circulation systems and the consequences implied by their changes. Given the rightful emphasis on circulation, the too singular focus on budgets in the 'Objectives' text became discordant with the fact that there are, and rightfully so, two points of emphasis, i.e., process controls on budgets (of water, energy, and carbon), and drivers of global circulation systems. This discord could easily be addressed by slightly rewriting the first 'Objective' to better explain the importance of understanding global circulation, drivers of its changes, and its consequences for things like budgets and extremes. We would be happy to provide a specific text suggestion in this regard if that would be helpful. In this context we also wonder if splitting the different facets of the prediction problem into two components (Objective 2 and Objective 3), is really helpful. Why not simply have advancing skill in predictions and projections as a single objective? We understand the tradition of people thinking about different facets of the problem that are often articulated by shorter and longer time-scales; but given the seamless approaches, and increasing evidence that long-term bias has many of its seeds in short-term errors, this tradition has ceased to be helpful. Combining projections and predictions into a single objective would make the explanation of this objective a bit wordier, but appropriately so, and not out of balance with an expanded articulation of the first objective as advocated above. It would also bring a better balance to what would then be three objectives. In summary we urge you to consider three specific changes: 1. Better bringing out the importance of understanding drivers of circulation changes by rewriting the paragraph explaining the first objective. 2. Relabeling the first point of Emphasis to identify it with the idea that global circulations, and drivers of their changes, must be better understood. 3. Merging the prediction and projections objectives to have a better overall balance of the Objectives. As indicated above, we would be happy to assist in making these changes, if you would find it helpful.	Thank you. The structure of the Plan has been modified significantly. Climate dynamics is a major emphasis of Objective 1 and covers both oceanic and atmospheric circulation. This objective includes now a separate emphasis on reservoirs and flows. We have maintained Objectives 2 and 3 separate but the figure 1 does not have a separation betwen both, suggesting some seamless approach and softer boundary.

World Climate Research Programme Strategic Plan 2019-2028 - Public Consultation Comments and Responses (by email)

No.	Comments	
18	Thanks for the opportunity to provide some additional comments from the WWRP Scientific Steering Committee at the final stages of your strategy revision. These are based on the draft Version 14. You have already received – and responded to – comments from WWRP SSC members. A) Primary Objectives We appreciate and support the very prominent role given to the partnership with WWRP for Primary Objectives 1. Fundamental understanding of the climate and 2. Predictive skills in climate. We already have joint activities for both of these objectives and look forward to developing these further and initiating new activities as part of the implementation of the strategy. For objectives 3 and 4 we see the need to work in partnership to our mutual benefit also. Although other WCRP partners will be at the forefront for these objectives, we consider it important to refer to WWRP for these objectives. For 3. Understanding future earth system trajectories: There are strong interdependencies between the observations and observing systems needed to characterise the earth system at all time and space scales. We need to exploit synergies between research on the future development of the observing system as well as on techniques to diagnose and verify the models we use. The representation of regional and extreme phenomena in support of climate services should draw on the expertise in the weather science community. The knowledge of how such phenomena may be impacted by climate change should, through our partnership, feedback into the development of prediction systems at shorter time and space scales. For 4. Climate science connections with policy and services: The mission statement of WWRP includes “to enhance society’s resilience to high-impact weather and the value of weather information for users”. To this end we have strong emphases on the collaboration between natural, social and economic sciences through our working group on Societal and Economic Research applications as well as concrete activities in our three core projects: High Impact Weather, Polar Prediction Project and (our joint project) Seasonal-to-Subseasonal Prediction. Collaboration between WCRP and WWRP in this area will be important for both programmes. B) Infrastructure The WCRP strategy identifies key challenges with respect to infrastructure. These challenges must be addressed by considering all aspects of Earth System Prediction – across time and space scales, across compartments of the Earth System, and taking into account the manner in which weather, climate, water and environmental information must be made available. Thus a commitment to working in partnership is at least as important here as in the previous sections. In our view, the challenge associated with extreme-scale computing and data handling is not given enough emphasis either in the WWRP Implementation Plan or in the new WCRP strategy. In the former, the challenge is distributed across a number of different Action Areas. In the latter, the challenge is referenced but more with the view to taking advantage of advances rather than addressing a fundamental bottleneck. At the recent WWRP SSC meeting we identified the need to respond to this challenge with WCRP, GAW and other partners. The first draft of the rationale for this undertaking is as follows: https://mail.google.com/mail/u/1?ik=e841371fc0&view=pt&search=all&permmsgid=msg-f%3A1615052132680813269&simpl=msg-f%3A1615052132680813... 1/2 29/10/2018 Wmo.int Mail - Fwd: Comments from WWRP SSC on revised version of WCRP strategy “The progress in numerical weather and climate monitoring and prediction has been intimately connected with the progress in supercomputing. Over the years, more computing power has enabled us to increase the skill and detail of our forecasts through increasing spatial resolution, enhancing realism by adding more physical process detail, coupling with more Earth-system components and investing in ensemble techniques to characterize the uncertainty of initial conditions and forecasts. Better models and better data assimilation techniques have allowed us to exploit information on the Earth system from high-quality observations for producing initial conditions. As a computing task, data assimilation is as costly as producing forecasts and this cost grows along with model enhancements and with the increase in both volume and diversity of the assimilated observations. As prediction systems improve, the volume and diversity of the output data grows at similar rates or even faster than the computing cost. In the past, this growth in cost was mostly compensated by a comparable growth in computing and data handling capabilities arising from the ability to engineer more transistors onto microprocessors (Moore’s law) and from higher clock-speeds, while processor prices reduced. As transistor density reaches physical limits and clock-speeds stabilize to limit electric power consumption, added growth in performance can only be expected from much enhanced parallelization and from new processor technologies that combine such parallelism with enhanced power efficiency. Much of this technology is currently derived from commodity devices such as mobile phones. In about 10 years, typical operational weather prediction and climate projection workloads with high-resolution, coupled Earth-system model ensembles will lead to at least a factor of 1000 larger computing and data handling needs compared to today. This need cannot be fulfilled by the evolution of hardware technology alone, as in the past, but needs to be complemented by fundamental developments in numerical methods and mathematics but also in programming techniques that allow to optimally map the diverse range of computing tasks of models onto the emerging processor types ranging from CPU, GPU, FPGA to highly specialized ASIC devices. This range may widen even more in the future. A key upper limit imposed on HPC systems is the affordable electric power level. Present peta-scale (i.e. supercomputers allowing 1015 floating point operations per second for tasks running at peak performance) systems consume O(106) MW per year, which translates to O(106)$ cost for power and cooling per year. At present, most HPC centres are built on the assumption that their overall power budget will not exceed O(20MW), which falls way short of the above factor-1000 increase. Data communication is a central concern in this equation as moving data (on and off memory and between processors) consumes about 10 times more energy than performing the calculations themselves. Another major concern is how observational input and model output data are managed along the prediction workflow to enable efficient pre- and post-processing, again aiming to minimize data movement, reduce storage needs and ensure resilient forecast production at the same time. While the computing and data handling challenges increase drastically, the requirements for data usability and fast access by users rather tighten. The re-emergence of artificial intelligence methods sponsored by large-scale commercial applications has created opportunities for contributing to the much-needed efficiency gains. Their use for observational data pre-processing and model output post-processing can help to better distribute the data handling workload along the workflow, to extract useful information from large data volumes more effectively, and to reduce the computational burden of selected prediction model components by replacing them with surrogate neural networks for example. The above challenges pose a fundamental bottleneck for the future advancement of both weather and climate prediction capabilities. The awareness of this problem has led to large-scale research and development efforts in many developed countries which are supported by significant governmental and public-private funding efforts, for example by the Department of Energy in the US or the European Commission. The challenges clearly contribute to widening the capability gap between more and less developed countries further as they require a unique level of expertise, co- design and technological support. The need and urgency of a concerted effort between weather and climate science and computational science requires a much-enhanced representation of this issue in WMO’s strategic thinking.” We very much look forward to contributing to the development of the WCRP Implementation Plan and to strengthening the partnerships between WWRP and WCRP.	Thank you. We have restructured the Plan significantly and consolidated the partnership section at the beginning of the document as collaboration with WWRP will be critical in many areas. We agree that future earth trajectories. We note your comment on Objectives 3 and 4. Extremescale computing details will be addressed in the Implementation Plan and here again, we fully agree that we will need concerted efforts across research programmes.