

Global weather and climate Extremes Platform Draft for JSC-42

Overview

Weather and climate extremes, and their societal impacts, increasingly preoccupy the users of WCRP science. The WCRP is responding actively through the many science questions concerning extremes that are being addressed by almost all WCRP core projects and most of the new Lighthouse activities (LHAs). Nevertheless, the delivery of information and science related to extremes by the WCRP's new structure could be further strengthened in a number of ways. This includes i) creation of a public facing website that provides users with current information about the state of weather and climate extremes and WCRP science on extremes, ii) provision of the capacity to develop and collate an extremes related database that serves both research and user communities, and iii) a place for collecting and exchanging ideas and approaches on extremes among core projects and LHAs. This platform is designed to bridge these gaps so that the WCRP is well positioned to support international climate policy, including via the UNFCCC, by providing science, information, and data concerning extremes in a well-synthesized format and to prepare the community for the IPCC's AR7 assessment. The platform centres on four pillars: 1) global weather and climate extremes assessment; 2) development and maintenance of a climate extremes indices data base; 3) facilitation of structured internal communication; and 4) important topical areas that are part of Grand Challenge on Weather and Climate Extremes (GC on Extremes) and that complement existing core projects and LHAs. It is envisioned to be a 5-year project to demonstrate its potential and success. The Nanjing University of Information Science and Technology (NUIST, which evolved from the Nanjing Institute for Meteorology) has generously agreed to support the platform for an initial 5-year period, as detailed below. The expectation is that this support will be renewed and extended after a joint WCRP and NUIST review before the end of the first 5-year period.

Incorporating the GEP into the new WCRP Structure

The suitable home for this activity would be within the Earth System Modelling and Observations (ESMO) Core Project, justified by the fact that its main activities are of global nature and because observational data development supports model evaluation as outlined below. However, it is important to note that the activity is also highly relevant to the Regional Information for Society (RIFS) Core project as it would provide links from large to regional scale (science support/question, attribution), global and regional information, partnership for indices development and characterization of extremes.

Almost all core projects and most of LHAs include extremes and coordinate relevant activities and science topics from their perspectives. The GEP's connection is obvious. However, it should be stressed that the GEP is not meant to be an overarching cross-WCRP coordination of extreme-related activities. It adds to and enhances these activities by leading synthesis and data development, by providing a common place for exchange of ideas, and by complementing planned activities of LHAs. For example, GEP's compound events activity would focus more on

theoretical and methodological issues would be expected under the My Climate Risk LHA while GEP's detection and attribution focus would consider different time scales than are apt to be considered in the Safe Landing Climate and Explaining and Predicting Earth System Change LHAs. The synthesis activities such as those timed for Global Stocktakes 2023 and 2028 will provide opportunities for integration of WCRP science on extremes, cross-pollination and identification of evolving new science questions and developments on mechanism, modelling, attribution and prediction of extremes including compound events. The training and capacity building elements will contribute to the WCRP Academy.

The four pillars

1. Global weather and climate extremes assessment

The scientific goal of Pillar 1 is to provide a clear picture of the current status of research and attribution capabilities concerning weather and climate extremes. A starting point for this activity would be the main conclusions of Chapter 11 of AR6 WGI report, with content updated annually to reflect new developments. This will include annual updates on the status of extremes and their attribution to human influences on the climate (e.g. including global temperature and precipitation extremes on land, drought, marine heatwaves, and tropical and extratropical cyclones), including new developments from the WCRP core projects and LHAs. The first (minor) update will be timed for the Global Stocktake 2023 and a more substantial update will be timed for the Global Stocktake 2028 to inform Parties to the UNFCCC via the Research and Systematic Observation (RSO) activity under the Subsidiary Body for Scientific and Technological Advice (SBSTA). It will also provide annual updates of data (coming from Pillar 2) that are frequently used for monitoring changes in extremes and for extreme event attribution. This Pillar will also focus on the development of information and methodologies for mitigation verification from the perspective of changes in weather and climate extremes.

All this information will be made available for a wider community via a dynamic website that would serve as a one-stop-shop to showcase WCRP's research on weather and climate extremes from core projects and LAHs.

2. Climate extreme indices

The WCRP has made numerous major contributions to the monitoring of changes in extremes through the development and application of a range of easily calculated extremes indices. The ETCCDI (Expert Team on Climate Change Detection and Indices; 1998-2018) was jointly sponsored by the WCRP and the WMO's Commission for Climatology and the Joint WMO-IOC Commission for Oceanography and Marine Meteorology, with WCRP providing the science leadership for the team. The ETCCDI developed a set of indices that continue to be widely used to this day. On the WMO side, the Expert Team on Sector-specific Climate Indices (ET-SCI; 2011-2020) added a number of indices that can be used to study impacts of extremes on specific socio-economic sectors related to agriculture and health that are focused on heat waves, droughts, and extreme rainfall. Within the WCRP, most indices related activities were folded into the Document theme

of the GC on Extremes. The collation and the development of global indices data products, including the HadEX/HadEX2 datasets as well as those disseminated via the www.climdex.org and www.climpact-sci.org websites, along with those derived from model simulations, has played an important role in enabling global and regional analysis of changes in climate extremes, in prompting regional and international collaborations and in regional capacity building for less developed world on the subject. In fact, the majority of the literature about changes in extremes assessed in the AR5 and AR6 cycles is based on or related to these datasets. Currently, the maintenance and updating of websites like www.climdex.org and www.climpact-sci.org are done with research grants from groups involved in the activities of the GC Extremes. However, this is not sustainable in the long term and a more permanent solution with institutional support to operate, maintain and further develop these websites is needed. There is also a need to support coordinated research to further develop and study extremes indices to include compound events, spatial-dimension of extreme events, data fusion of different sources, and comparison between typically point estimate in the observations and area mean from the models. These new activities, which Pillar 2 would undertake, would also provide the right connection between research activities under WCRP and WMO commissions' activities on extremes and regional capacity building.

3. Facilitation of structured cross WCRP internal communication on extremes

As a key part of the new WCRP strategic plan and its implementation, extremes-related activities are widely dispersed across core projects and LHAs. Boundaries between groups within the WCRP are also barriers for knowledge exchange and collaboration for extremes linking both climate science and users. The term 'extreme' can mean different things depending on the applications and across the programme. Thus, there is a need for an internal mechanism for discussion, the exchange of concepts and ideas, cross-pollination and knowledge integration.

One way this can occur is through a program of workshops and summer schools that cross core project and LHA boundaries, with workshop and summer school proceedings (lectures, syntheses, research projects, etc) providing an ongoing legacy. Such a program will enable communication and dissemination and provides a means for exchange of ideas and detection of synergies. This activity would build on previous highly successful examples of this type, including the WCRP-ICTP Summer School on Attribution and Prediction of Extreme Events of 2014 that included topics on data set development, detection and attribution, extreme events prediction and event attribution, and the Institute of Advanced Studies in Climate Extremes and Risk Management of 2019 that brought together the physical science of extremes with risk management concepts. It can also draw from recent experience of the Workshop on Extremes in Climate Prediction Ensembles from which we are learning different meanings for the identification and characterization of extremes by forecast community and by the climate change research community. Another way this can occur is through organization of pan-WCRP workshops on extremes (that could be timed so that they can also gather input for the Global Stocktakes 2023 and 2028) as well as through other mechanisms that are co-designed with the core projects and LHAs.

4. Scientific advance of strategic topics

a) Compound events

Multiple stressors or hazards that occur concurrently or sequentially in one place or multiple places can quickly exceed the coping capacity of social-economic systems. Many major weather- and climate- extreme caused catastrophes are of such a compound nature. Risk associated with extreme events can be easily underestimated if the hazards associated with an event are considered individually as opposed to jointly. For example, the joint occurrence of extreme winds, storm-surge and rainfall during a tropical cyclone present much greater risks than would be the case for the occurrence of just one of those hazards. Yet there are multiple challenges in properly quantifying compound hazards including from the perspectives of physical process understanding and statistical analysis, and in bridging climate scientists, engineers, social scientists, impact modellers and decision-makers, who need to work closely together to understand these complex events. As the global warming continues, many types of extremes are projected to increase and as such an accelerating increase in risk from the compounding of these extremes. The GC on Extremes made some progress in this important emerging research area including a very successful workshop on compound events and the resulting publication of a perspective paper that laid a foundation of concepts and outlined the directions of future research. This effort should continue with a focus on coordinated research that develops theoretical frameworks and supporting tools for risk assessment and attribution that explicitly account for compound events. This would contribute significantly to My Climate Risk and Safe Landing spaces and other lighthouse activities by supporting consistent approaches to compound events and their associated risks, which is an area of research that appears to be outside the scope of the lighthouse activities.

b) Detection and attribution

Despite significant progress in the detection and attribution of long-term changes in extremes as well as in event attribution, understanding the extent to which humans are responsible for changes in extremes and particularly individual extreme weather is still a challenging topic, despite the endorsement of the US National Academies of this topic in 2016. For example, detection and attribution of changes in extremes at impact relevant scales, which is of crucial relevance for the proper interpretation of future projections, is still difficult. There is also a lack of systematic evaluation of reliability of extreme event attribution and it is difficult to synthesize event attribution results for across events and regions. This topic is mentioned in 'explaining and predicting earth system changes', but it would be very useful to have a holistic view of detection and attribution from trend to events to projections. The aim of this activity is to bridge these gaps.

c) Information on extremes for regions

Building on IPCC AR6, the aim of this activity would be to fill gaps on changes in weather and climate extremes on regional scale, by providing and prompting regional analysis, supporting IPCC AR7. The emphasis is on robust, useful/relevant info that can be obtained at regional scales and to use such information to guide adaptation. Regional climate scientists will be involved in this activity, in particular from underrepresented

regions such as Africa, Asia and South America. This complements risk-based bottom-up approach of MCR LHA and supports Building Block #2 of RfS

Connection among the four Pillars

Activities under the four Pillars are inter-connected internally. For example, Pillar #1 draws upon on data product and analysis from Pillar #2 as well as understanding of past changes, causes and projection at both global and regional scale (Pillar #4) including compound events. It provides a platform for and draws from the outcome of cross-WCRP knowledge exchange and integration. Data focused activities of Pillar #2 also supports all topics under Pillar #3.

Connections beyond the WCRP

Given the topic, there can be a very large list of connections that extend beyond the WCRP, in particular when the GEP acts as a store-front of WCRP on issues related to extremes. The full list of potential connections and how the GEP interacts with other programs and organizations still needs to be scoped out, but some strategic partners of obvious importance are listed below:

- Future Earth's RISK-KAN: The GC on Extremes has been involved as a partner of RIOSK-GC since its initial development. Linkage to RISK-KAN provides connection to both Future-Earth and IRDR regarding impacts of climate extremes and risk and disaster management.
- WMO's SERCOM Expert Team on Climate Information for Decision-Making: This expert team inherits the Expert Team on Sector-specific Climate Indices and expands its original mandate. Partnership with this ET will ensure integration of indices development, data collections and integration, and regional capacity building.
- HIWeather of WRRP: synergy between HIWeather and the GEP will benefit both, with the GEP providing insights on relevant event definitions, particularly for short duration, high intensity events and from the historical perspective, and HIWeather exploring questions that focus on processes and predictability.
- SBSTA, as a key user of the GEP's assessment and Global Stocktake activities. .

Resources and support

Support Unit

NUIST has generously offered to provide a support unit with at least two staff members and associated operating costs as well as the use of the WMO regional training facility at the university to support training programs, workshops etc for the initial 5-year period. Continuation beyond the initial 5 years is likely if the project is successful, as judged by a joint WCRP and NUIST review. While details will need to be negotiated and agreed between NUIST and WMO, here are the planned use of these resources:

- One staff member for the coordination of GEP activities, organization of workshops, management of operation, and assist with web content updates.

- One staff member for data and IT support including the operation and maintenance of ClimDex and CLIPACK web portals and the GEP website, indices data quality control and gridded data product development, and annual indices updates and summaries.
- A third staff is possible if deemed necessarily.
- Normal office operation including office space and teleconferencing facilities.
- Costs associated with the use of commercial cloud-based web portals for GEP, ClimDex and CLIPACK.
- The use of the WMO regional training centre in the university for training programs and workshops. Note that the centre is a well-oiled machine for international training programs. In fact, it was recently used to very successfully deliver the Institute of Advanced Studies in Climate Extremes and Risk Management of 2019
- In order for this support unit to be established at NUIST, it is necessary that the JSC approves this activity and that a MoU between NUIST and WMO is established shortly after the JSC's approval.

There will be in-kind support from Environment and Climate Change Canada (including 20% of Xuebin Zhang's time to work on the project and to provide oversight for the support unit) and ETH.

Governance

Full governance structure will be discussed and agreed among interested groups within WCRP, but the initial coordination group would be made up of members of the GC on Extremes plus representatives from interested LHAs and core projects. In the longer term, there will be a need for a steering group providing oversight for the GEP, along with separate task forces and working groups that undertake the activities for each Pillar. Pillar #1 would include a representative from RISK-KAN to connect to Future Earth and IRDR, and a representative from RSO/SBSTA to provide two-way communication. Pillar #2 would include a representative from WMO's SERCOM Expert Team on Climate Information for Decision-Making for integration. Pillar #3 would include representatives from core projects and LHAs to identify joint training programs. Pillar #4 would include two separate task forces for compound event and detection and attribution. Pillar #4.c will in particular include regional climate scientists from underrepresented regions such as Africa, Asia and South America. Inclusiveness will be an important part when forming the governance structure.

Implementation and milestones

Short-term

- First 6 months: staffing two support-unit positions at NUIST, development of governance structure and long-term implementation plan
- First 12 months: development of a prototype of the GEP website under Pillar 1, and migration of datasets, indices and tools from www.climdex.org and www.climpact-sci.org. Task forces/working groups are in place and functional.

- Post-AR6 stocktake workshop on extremes, with three objectives: to gather info for mini-update on extremes in time for Global Stocktake 2023, to perform gap analysis to position WCRP for IPCC AR7, and to facilitate internal communication; participants including WGI/WGII lead authors, core projects, LHAs. Ideal timing would be in the second half of 2022 after the release of the WGII report and before RSO/SBSTA conversation.
- WCRP OSC 2023

Long-term

- First annual state of extremes and attribution to be released by the end of 2023
- Joint LHAs/projects workshops/summer schools (one per year TBD by LHAs/core projects)
- A workshop on compound event(?)
- WCRP/UNIST review during the second half of 2026
- Pan-WCRP workshop on changes in weather and climate extremes, second half of 2026
- Major update on changes in weather and climate extremes in time for Global Stocktake 2028, informed by the 2026 workshop (this would be a sunset activity if GEP is not deemed successful)
- Extremes index data supporting the AR7 cycle

Annex: email from Prof Jiang of NUIST

Subject: Proposal for hosting a WCRP project office at NUIST

Dear Professor Seneviratne and Dr. Zhang

I am writing you to follow up our previous informal discussions with you and Dr. Boram Lee on the possibility for Nanjing University of Information Science and Technology (NUIST) to host a WCRP project office for Global Extremes Project. As a vice-president of NUIST in charge of international cooperation, I would like to confirm our commitment to support this important WCRP initiative.

NUIST is renowned for its reputation in meteorological education and research, with the Laudatory Title of Cradle of Meteorological Talents. The discipline of Atmospheric Science ranks No.1 with A+ grade in the national discipline evaluation conducted by the Ministry of Education. This discipline enjoys a good fame throughout the world as our graduates are now working in almost all leading meteorological centers in the world. In 2017, it was listed as Double First-Class discipline. Currently, there are mainly 5 schools (School of Atmospheric Sciences, Atmospheric Physics, Applied Meteorology, Environmental Science and Engineering and Hydrology & Water Resource), and about 400 faculties focusing on this discipline. Up to now, we have trained over 10,000 students majored in Atmospheric Science.

NUIST is committed for international meteorological education and training and has enjoyed a great success. NUIST has a long history of collaboration with WMO, governed by two Memorandums of Understanding (MoUs) between NUIST and WMO. One MoU provides a formal recognition of and support to the WMO Regional Training Center (RTC) Nanjing, China that was established at NUIST almost 30 years ago, on 30 May 1993. Recent years have witnessed the fast growth of our training programmes as it expands collaborative mechanisms with WMO, MOFCOM and CMA, etc.. It has trained almost 4,000 professionals through over 180 bilateral and multi-lateral training courses. On our trainee list there are 11 heads of national meteorological and hydrological services and numerous scientific, technical and administrative officers from 157 countries and regions. It is now one of the largest and most active members in WMO educational and training network. Another is concerned with the NUIST-WMO Fellowships Education Programme through which NUIST provides up to five undergraduate scholarships annually through WMO.

NUIST has successfully collaborated with WCRP for which we enjoy very much. We hosted the JSC-39 from 16 to 20 April 2018 with the presence of WMO's Deputy Secretary-General Madam Elena Manaenkova and JSC's chair at the time Prof. Guy Brasseur. More recently, we invested significant effort and resources, both in terms of human resources and financial resources to host and to support the WCRP Institute of Advanced Studies in Climate Extremes and Risk Management, a two-week training school from 21 October to 1 November 2019 along with the support from WCRP, IRDR and APN. The school was successful, with IPCC WGI, WGII lead authors as lecturers and 29 post-PhD level students from 17 countries and 10 local students attending.

Additionally, NUIST faculties Prof. Huijun Wang is a current JSC member and Prof. Hong Liao was a JSC member previously.

With shared and common objectives of fostering international collaboration on climate research and serving the society between WCRP and NUIST, it is optimum time for us to extend our long and successful collaboration with WMO to have a more active involvement with WCRP. It is of our interest and honor to support WCRP at the time when the resource for WCRP is more limited as we believe a well-supported WCRP benefits all. We will also benefit from the collaboration with WCRP, in particular in providing more convenient access to great work and scientists of WCRP community to our faculties and students.

We learned your interest about establishing a Global Extremes Project last year, and we are committed to provide office support to this project. It is envisioned that we will provide at least two full-time positions/employees dedicated for the project office along with necessarily facility and operational office costs to enable the project office to function. Additionally, we may be able to use our training facility to support high-talent training programmes and advanced seminars or meetings. We have a strong interest to support this project as Prof. Huijun Wang, in his capacity as science Director of our Key Laboratory of Meteorological Disaster, is leading a large team, with over 60 faculties, to study weather and climate extremes and their related impacts. Additionally, Dr. Francis Zwiers is helping the university to establish the Research Center on Weather and Climate Extremes; this center has a narrower focus on weather and climate extremes under changing climate. We could formalize this commitment by extending the scopes of current MoUs between NUIST-WMO or establishing a new MoU with WMO.

We'd appreciate yours and JSC's consideration for this proposal and we are fully committed to support this important WCRP activity. Please let us know if you have questions and we look forward to fruitful collaboration with WCRP.

Best regards

Yours,

Prof. Zhihong Jiang, Vice President (international cooperation)

Copy to:

Dr. Jürg Luterbacher, Chief Scientist of WMO

Dr. Detlef Stammer, Chair of JSC/WCRP

Dr. Helen Cleugh, vice Chair of JSC/WCRP

Dr. Michael Sparrow, Head of the WCRP Secretariat

Prof. Huijun Wang, member of JSC