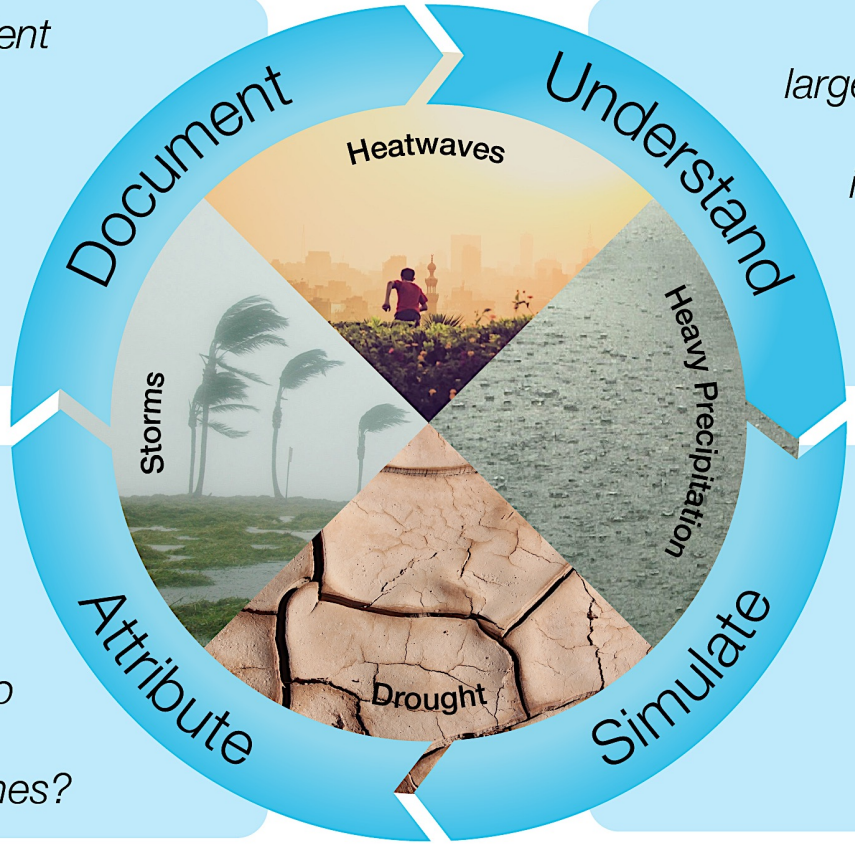
WCRP Grand Challenge on
Weather and Climate Extremes

4 main extremes, 4 overarching themes

Are existing observations sufficient to underpin the assessment of extremes?

What are the relative roles of large-scale, regional and local scale processes, as well as their interactions, for the formation of extremes?



What are the contributors to observed extreme events and to changes in the frequency and intensity of the observed extremes?

Are models able to reliably simulate extremes and their changes, and how can this be evaluated and improved?

WORLD METEOROLOGICAL ORGANIZATION
United Nations Educational, Scientific and Cultural Organization
Intergovernmental Oceanographic Commission
International Science Council
WCRP World Climate Research Programme

GC extremes Success stories

- Compound events (supported via workshop) well taken up and now widely recognized as part of research agenda; (e.g. *Zscheischler J., et al. incl. Sonia I Seneviratne, Xuebin Zhang (2018): Future Climate Risk from Compound events. Nature Climate Change 8, 469-477*)
- On-going collaboration with GDAP/IPWG has led to the FROGs database and ERL Special Issue
- CMIP strongly influenced by research needs of extremes including GLACE-CMIP5, LUMIP, LS3MIP, also DAMIP, VOLMIP and HAPPI
- Very large IPCC presence (3 CLA, 3 LA, RE) meant agenda was well pursued, but less visible in last year or two
- Training of young scientists (WCRP summer school in 2014, Nanjing fall school in 2019)

Role of extremes in draft lighthouse activities

- **Safe landing climates**: Large scale extremes key risk in topic 2 (fireball earth, habitability, tipping elements). Reliable prediction of extremes hazardous to society, ecosystems and crops essential to characterize safe landing spaces
- **My climate risk** needs regional extremes as a key risk point
- **Explaining and predicting Earth system science** has a large attribution element including for extremes
- **Digital Earth** simulates extremes which is one of its key challenges, and **WCRP academy** will aim to reduce risk from extremes

GEWEX and extremes

- Extremes will continue to be at the heart of GEWEX activities along with climate sensitivity, clouds, feedbacks, and rainfall changes, particularly extreme rainfall
- Extremes feature across the board and need a home to be brought together for consistency and learning across programs (for example, local impact connected extremes linked to vulnerability can ask scientifically challenging questions about feedbacks)
- The breadth of the problem (how to define extremes, different scales (e.g. drought vs microburst) and applications etc) makes integration challenging

A case for a Global Extremes Platform (GEP)

Extremes have broad and diverse coverage across core projects and LHAs. The delivery of information and science related to extremes by the WCRP's new structure could be further strengthened if there is:

- A public facing store front to provide users (decision makers and the public) with current information about the state of weather and climate extremes and related WCRP science
- A capability to develop and collate an extremes related database to serve both research and user communities
- A common place for internal exchange of ideas for knowledge integration and cross-pollination
- Some of GC Extreme's activities need a new home

Four pillars

- Global weather and extremes assessment
  - Annual updates on the status of extremes and attribution
  - Supporting global Stocktakes 2023/2028
- Climate extreme indices
  - Extreme *GC's document theme/ETCCDI*
  - Indices of extremes data collation and dissemination
  - Coordinated research on indices to include compound events, spatial-dimension of extreme events, data fusion of different sources
- Facilitation of structured cross WCRP internal communication on extremes
  - Organization of cross boundary training program
  - Organization of cross-WCRP workshops (see implementation)
- Topical areas
  - Compound events: coordinated research on theoretical frameworks and supporting tools, *Extreme GC's theme*, to support relevant LHAs
  - Detection and attribution: to provide a holistic view of detection and attribution from trend to events to projections, *Extreme GC's attribution theme*
  - Information on extremes for regions: focuses on robust, useful/relevant info that can be obtained at regional scales and its proper use in adaption, complements risk-based bottom-up approach of MCR LHA and supports Building Block #2 of RIfS

GC extremes sunset activities and transition

- Transition
  - Document ➔ Global Extremes Project (GEP) Pillar 2
  - Attribution ➔ GEP Pillar 4
  - Compound event ➔ GEP Pillar 4
  - Predict ➔ key aspects in LHAs (my climate risk, safe landing spaces)
- Sunset activities
  - Development of GEP and transition to GEP
  - Post-AR6 stocktake workshop
    - Initially planned for 2021, very positive feedback and strong support from Juerg Luterbacher
    - Postponed to second half of 2022 to accommodate the release of WGII report
    - Possible update to WGI report findings in time for Global Stocktake 2023
    - Gap analysis to position WCRP for AR7 on extremes
    - Opportunity for cross projects/LHAs knowledge exchange
  - WCRP OSC presence

Available resources for GEP

Nanjing University of Information Science and Technology (formally Nanjing Institute of Meteorology) offers to provide a support unit:

- A staff member for the coordination of WEP activities, organization of workshops, and assist with web content updates
- A staff member for data/IT support including the operation and maintenance of ClimDex and CLIPACK web portals and the GEP website, indices data product development, annual indices updates and summaries
- A third staff is possible if deemed necessary
- Costs for office operation
- Costs for the use of commercial cloud-based web portals for WEP, ClimDex and CLIPACK
- The use of the WMO regional training centre in the university for training programs and workshops.

Additional in-kind support from ECCC and ETH

Some thoughts on implementation

Short term

- First 6 months: staffing, development of governance structure and long-term implementation
- First 12 months: prototype of the GEP website, migration of datasets, indices and tools from www.climdex.org and www.climpact-sci.org.
- Post-AR6 stocktake workshop
- WCRP OSC 2023

Longer term

- Operation/ maintenance /development of indices datasets
- 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 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

Intergration in the new WCRP structure

- Five-year project with possible extension
- Possibly under ESMO due to global scale and observational data
- Strong connection to RIfS and LHAs


International
Science Council


Links to the WCRP Strategic and Implementation Plans

Extremes: Scientifically challenging and great societal needs

- **Strategic Plan:**
  - Fundamental Understanding of the climate system: *'understanding…the ways in which extreme events are manifest in a non-stationary climate'*
  - Prediction of the near-term evolution of the climate system: '*attention on societally relevant outcomes such as meteorological, oceanic, and hydrological extremes, including compound events*'
  - Bridging Climate and Society '*The timescales on which society requires this information range from near-term extreme events to long-range planning horizons, while spatial scales range from local to global.'*
  - Critical Infrastructure *'Sustained observations and reference datasets'*
- **Implementation priorities:**
  - Quantify climate risk and opportunities
  - Co-produce regional climate info for decision support and adaptation
  - Inform and evaluate mitigation
  - Advance understanding of multi-scale dynamics

Emerging issues

A case for a Global Extremes Platform:

- a consensus about the importance of extremes from both science and service perspectives
- a need for a true partnership between climate science and its users
- Extremes play a key role and opportunity across most of the proposed lighthouse activities; facilitating exchange and synergy is needed

Initial activities could included:

- Global and regional monitoring and global stocktake (ETCCDI)
- Annual updates on the status of extremes and attribution
- Cross-WCRP exchange and integration of extreme-related activities; identification of evolving new science questions and developments on mechanism, modelling, attribution and prediction of extremes including compound events
- Capacity building for applications and developing true partnership with users