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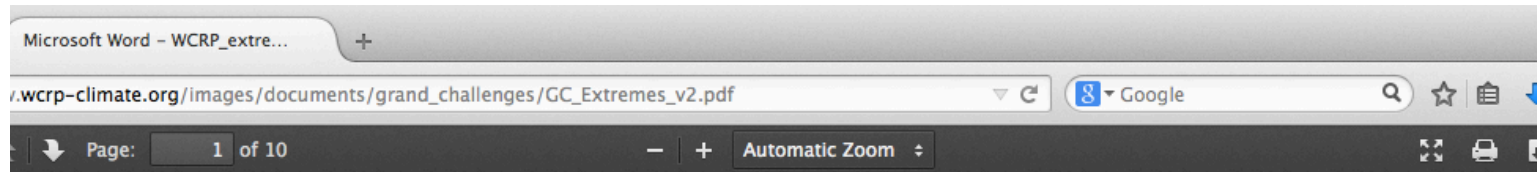
Understanding and predicting weather and climate extremes: a WCRP Grand Challenge

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Draft white paper - 8 questions posed



WCRP Grand Challenge: Science Underpinning the Prediction and Attribution of Extreme Events

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Summary

Weather and climate extremes are an inherent part of climate. There is overwhelming evidence that the climate and its extremes are changing. As extremes affect every aspect of our society, decision- and policy makers, and stakeholders are increasingly asking for reliable predictions of extremes on time scales from days to seasons and centuries. To meet this societal need, the world climate research community is challenged by underlying science questions and the quality and coverage of the observational data that are used to monitor and understand extremes. Both the questions and the data need urgent attention in order to better identify the factors and mechanisms that determine the location, intensity, and frequency of various climate extremes including droughts, floods, heavy precipitation events, heat waves, cold spells, tropical and extratropical storms, coastal sea level surges and ocean waves. This information is needed in the near term (from a season to a year) to mitigate risks to society and ecosystems, and in the longer

Key scientific questions – Q1

How can we improve the collation, dissemination and quality of observations needed to assess extremes and what new observations do we need?

Q1 - Actions

- Coordination of new observational extremes datasets (in situ, satellite, radar, etc - GHP, GDAP, ETCCDI)
- Selection of extremes indices (ETCCDI, GLASS, GHP, WGRC) including e.g. drought, sub-daily precipitation extremes, impacts-relevant
- Standardised QC, Metadata, Data rescue efforts (ACRE, IEDRO), availability essential

Key scientific questions – Q2

Can models be further improved to better simulate, predict and project extremes?

Q2 - Actions

- Scaling issues (time, space) – dedicated workshop
- Metrics for model evaluation of extremes (statistics and dynamics)
- Consistency and inter-comparability of observational products
- Better process understanding of conditions leading to rare extremes

Key scientific questions – Q3

What do we understand about the interactions between large-scale drivers and regional-scale land-surface feedbacks that affect extremes and how can these processes be improved in models?

Q3 – Actions

- GEWEX GLASS activities (GLACE-CMIP5, LUCID, GSWP3, LUMIP/CMIP multi-model projects), CLIVAR ocean heat content activities.
- GEWEX-CLIVAR (GLASS-WGSIP) GLACE-2 follow-up initiatives
- Role of distinct drivers and feedbacks for extremes, complemented with new observations
- CORDEX to help physical understanding of links between large-scale drivers and regional-scale responses

Key scientific questions – Q6

How has drought changed in the past and what were the causes, and how will it change in the future?

Q6 - Actions

Monitor, quantify and understand the global distribution of droughts and their trends using observational information (DIG, WGRC, GEWEX/CLIVAR panels, ETCRSCI)

Develop Global Drought Information System (GDIS) and produce 20C reanalysis of land conditions (GEWEX GSWP3)

Promote activities that characterize the variety of droughts and societal interactions (WGRC)

Key scientific questions – Q4

To what extent can detected changes in extremes be attributed to forcing external to the climate system and/or to internal factors such as modes of variability?

Q4 - Actions

- Address data availability, quality and consistency of daily or sub-daily events (also item #1).
- Engagement with IDAG on D&A
- Links to CLIVAR activities on modes of climate variability
- CMIP, CORDEX to provide foundational modelling support

Key scientific questions – Q5

What factors have contributed to the changes in probability of a particular observed event?

Q5 - Actions

- Engagement ACE/EUCLEIA to provide robust attribution information
- Coordinate to address communication challenges/opportunities (WGRC)
- Improvement in reliability to enhance early warning systems for extremes
- Identify and quantify factors that compound extreme impacts events (e.g. blocking and drought combined with heatwaves).
- Contribute to BAMS ACE

Key scientific questions – Q7

Are changes in the frequency and intensity of extremes predictable at seasonal to decadal scale and if so, how can we best realize that potential, and how can society best use such forecasts?

Q7 - Actions

- Produce skilful and reliable predictions of the frequency and intensity of extreme events on regional scales (WGSIP, WGNE, WGCM, GLACE, GLACE-2, CLIVAR, ETCCDI).
- ‘Seamless’ weather to climate using common metrics.
- Identify suitable datasets of state of lands, ocean and cryosphere for initialization of seasonal to decadal forecasts

Key scientific questions – Q8

How will large-scale phenomena such as monsoons and modes of variability change in the future, and how will this affect extremes?

Q8 - Actions

- Coordinate across relevant groups (Monsoon, other CLIVAR activities, GEWEX, SPARC, CliC)

Some thoughts on implementation

- **A WCRP-led international symposium on climate extremes in 2017/18**
 - exchange progress, identify future research needs.
 - Widely promoted so community has a target to meet (like IPCC)
- Prompt **WCRP-wide coordination of extreme related research** activities and communication of new findings to key organizations e.g. WMO, GEO, Future Earth, as well as contributions to GFCS

Some thoughts on implementation

- Foster **actionable research** for accelerating exchange across the community (**datasets, software, reference articles**)
- Prompt the Grand Challenge through **major international conferences** (e.g. AGU, EGU, IUGG, etc., by organizing special symposia)
- **Train next generation leaders** through targeted training workshops
- Organize 2-3 workshops over the next 1-2 years to bring the appropriate communities together to **make significant progress in strategic areas**

Actions underway

- **Feedback from this meeting to be used to update white paper (deadline Sep)**
- **WCRP summer school on extremes (ICTP, July 2014, Trieste. Organization: F. Zwiers, S. Seneviratne with support from a steering committee and WCRP)**

Near term actions

- Climate Symposium 13-17 Oct 2014 (Darmstadt, Germany, a session on extremes by Francis Zwiers and Gabi Hegerl)
- International Global Drought Information System Workshop (GDIS, Caltech, 11-13 December 2014)
- WCRP/IPCC Workshop (Bern, Sept, 2014)
- Potential **data workshop in Australia** (Lisa Alexander, UNSW, Australia)
 - Some funding confirmed, details/scope TBD, early 2015)

Near term actions (cont.)

- Potential **process workshop in Oslo** (Jana Sillmann, Cicero center, Norway)
 - some funding from Norway confirmed, details TBD, spring or fall 2015
 - dynamical and physical processes and model representation of these processes
 - development of stats methods and tools to evaluate model performance and prediction
- Main thematic session on recent development in extreme values theory at the 13th International Meeting on Statistical Climatology, Canada, 2016.