World Climate Research Programme

Introduction

WCRP activities broadly fall into three categories:

- research on physical climate system as a part of the Earth System,
- use of climate science for development of practical applications of high societal significance, and
- capacity development and support to early career climate scientists.

As in the past, WCRP made a very strong contribution to the latest IPCC Working Group I Fifth Assessment Report (AR5), which was unveiled in September 2013. Many WCRP-affiliated scientists served as IPCC Coordinating Lead Authors, Lead Authors, Contributing Authors and Reviewers of the report. Under the fifth phase of the Coordinated Model Intercomparison Project (CMIP5), new climate simulations became available to the community through the Earth System Grid Federation. This unprecedented data source stimulated hundreds of research articles referred to in the AR5. Also, WCRP has led the development of the Research, Modelling and Prediction Annex (RMP Annex) of the GFCS Implementation Plan and will coordinate the related initiatives. WCRP is engaging its wide research community and partners in implementing the Plan.

Part of the GFCS mandate is to develop effective climate services at regional level. WCRP has recently established the Working Group on Regional Climate to act as the primary interface between WCRP science and GFCS. The WCRP Coordinated Regional Downscaling Experiment (CORDEX) continues to expand the number of domains covered by regional climate models. WCRP, in partnership with the European Commission and IPCC organized a very successful CORDEX conference in November 2013. Improved ability to predict climate at regional scale provides new opportunities for capacity development and training for Early Career Scientists and students in many countries. A dialogue between producers and users of climate information to develop the regional climate research agenda was the main objective of the recent WCRP African Climate Conference (Arusha, Tanzania, 15-18 October 2013) and the Latin America and Caribbean Conference (Montevideo, Uruguay, 17-21 March 2014). These research conferences complement a significant number of WCRP past and forthcoming capacity development activities in all regions of the world.

Validation with observations is at heart of climate model development. The new WCRP Modelling and Data Advisory Councils promote consolidation of approaches used in the development of models and observations. Through the Earth System Grid Federation WCRP continues to broaden the open access of model outputs and observational products to the scientific community, with data available on the same grids, in a standard format, and with comprehensive metadata. The emerging capacity to effectively validate models against datasets will accelerate the improvement of the model quality and skill of climate predictions. This is key for the ultimate success of GFCS. The WCRP Working Groups on Coupled Modelling (WGCM) and Seasonal to Interannual Prediction (WGSIP) are planning a new generation of experiments on the range of time scales from weeks to years and from decades to centuries, including the follow-on model intercomparison experiment CMIP6.

Several aspects of the climate science that are of major importance to society are still particularly challenging. WCRP has captured the highest priorities of climate research in the concept of Grand Challenges. The Grand Challenge on ***Regional Climate Information*** will focus on predictability of regional climate and provision of corresponding information and climate services. The ***"Clouds, Circulation and Climate Sensitivity"*** Grand Challenge will improve our understanding on how the interactions between clouds, greenhouse gases and aerosols affect changes in temperature and precipitation in response to the increase in greenhouse gas concentrations. The ***"Cryosphere in Changing Climate"*** will make needed improvements in our ability to observe, model and predict cryosphere-related changes in the climate system and will involve research on climate predictability in polar regions. The Grand Challenge on ***Regional Sea Level*** will comprise studies of both global-mean sea level and its regional variations, enabling assessments of the future sea level for coastal zone protection and management. The "***Attribution and Prediction of Climate Extremes"*** will strengthen the theoretical and observational foundation for climate-related disaster risk reduction. The "***Water Availability***" Grand Challenge will help to better understand and predict precipitation and support water resources management.

Highlights in the domain of research on climate extremes

WCRP Grand Challenge: Science Underpinning the Prediction and Attribution of Extreme Events
(Excerpts from the WCRP White Paper on Climate Extremes)

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 predictions of extremes on time scales from days to seasons and centuries. To meet this societal need, the world climate research community has to address several overarching questions, as follows:

1. How do we improve the quality of observational datasets for the investigation of extremes, considering both ground and remote-sensing measurements? How can the collection and dissemination of data from existing monitoring networks be improved, and what additional data are needed for properly characterizing extremes of different space and time scales and their change?
2. Can models be further improved to better simulate, predict and project extremes?
3. What are the interactions between large-scale drivers and regional-scale land-surface feedbacks that affect extremes? How can these contributions be assessed from observation- based analyses, and how can the ability of models be improved to capture these processes?
4. What are the causes of changes in extremes both internal and external to the climate system? To what extent can detected changes be attributed to forcing external to the climate system and/or to internal factors such as modes of variability?
5. What factors have contributed to the risk of a particular observed event?
6. How has drought changed in the past and what were the causes, and how will it change in the future?
7. Are changes in the frequency and intensity of extremes predictable at seasonal to decadal scale? If so, how can we best realize that potential, and how can society best use such forecasts?
8. How will large-scale phenomena such as monsoons and modes of variability change in the future, and how does this affect extremes?

A plan should to address these science questions will be discussed at the pan-CLIVAR and pan-GEWEX meetings in July 2014 in The Hague.

Xuebin Zhang, Gabriele Hegerl, Sonia Seneviratne, Ronald Stewart and Francis Zwiers. – The white paper is accessible at: http://www.wcrp-climate.org/images/documents/grand_challenges/GC_Extremes_v2.pdf.

Change in the Odds of Warm Years and Seasons Due to Anthropogenic Influence on the Climate
(Based on abstract)
The new Hadley Centre system for attribution of weather and climate extremes provides assessments of how human influence on the climate may lead to a change in the frequency of such events. Two different types of ensembles of simulations are generated with an atmospheric model to represent the actual climate and what the climate would have been in the absence of human influence. Estimates of the event frequency with and without the anthropogenic effect are then obtained. Three experiments conducted with the new system are analyzed in this study to examine how anthropogenic forcings change the odds of warm years, summers, or winters in a number of regions where the model reliably reproduces the frequency of warm events. In all cases warm events become more likely because of human influence, but estimates of the likelihood may vary considerably from

year to year. In more than half of the 10 cases considered here anthropogenic influence results in warm events being 3 times more likely and extreme events 5 times more likely during September 2011–August 2012.

Christidis N. and Stott P.A., Journal of Climate, doi: 10.1175/JCLI-D-13-00563.1

WCRP-ICTP 2014 Summer school on Attribution and Prediction of Extreme Events

(21 July to 01 August 2014 - Trieste, Italy)

The Abdus Salam International Centre for Theoretical Physics (ICTP) is organizing, in collaboration with the World Climate Research Programme (WCRP), a Summer School on Attribution and Prediction of Extreme Events. The purpose of the school is to train students with outstanding research potential in the techniques that will be required to better understand observed and future changes in extremes. There is a pressing need to educate future researchers in the techniques given the prominence and importance of societal and scientific questions about extreme events that are receiving increasingly intense attention in the minds of the public and their policy makers. The school will be organized around three broad topic areas:

- Statistical theory underpinning extreme value analysis,
- Detection and attribution of observed changes in the frequency and/or intensity of extremes, and
- Event attribution, and the physical mechanisms that are involved in amplifying and/or extending the duration of some specific extreme events such as heat waves.

The school will also educate students in the development of some of the key data resources that are used to place current extremes into a historical context, and will provide insights into some of the emerging thinking on the near term prediction of the likelihood of extreme events. The school will also teach the importance of understanding the physical mechanisms that produce many of the most impactful extreme events, including "complex" hydrologic extremes such as drought and the role of coupled land-atmosphere feedback mechanisms in amplifying extreme temperature events.

Additional information is available at http://www.wcrp-climate.org/index.php/ictp2014-about.

Attributing intensification of precipitation extremes to human influence

(Based on Abstract)

This study provides estimates of the human contribution to the observed widespread intensification of precipitation extremes. We consider the annual maxima of daily and 5-day consecutive precipitation amounts over the Northern Hemisphere land area for 1951–2005 and compare observed changes with expected responses to external forcings as simulated by multiple coupled climate models participating in WCRP Coupled Model Intercomparison Project Phase 5. The effect of anthropogenic forcings can be detected in extreme precipitation observations, both individually and when simultaneously estimating anthropogenic and naturally forced changes. The effect of natural forcings is not detectable. We estimate that human influence has intensified annual maximum 1-day precipitation in sampled Northern Hemisphere locations by 3.3% on average. This corresponds to an average intensification in RX1day of 5.2% per degree increase in observed global mean surface temperature consistent with the Clausius-Clapeyron relationship. This also translates to more frequent extreme precipitation events of a fixed size: the annual maximum 1-day precipitation that was expected to recur once every 20 years on average in the early 1950s is estimated to have become a 15-year event in the early 2000s with the increased frequency being attributable to human influence.

Xuebin Zhang, Hui Wan, Francis W. Zwiers, Gabriele C. Hegerl, and Seung-Ki Min, Geophysical Research Letters, doi: 10.1002/grl.51010

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