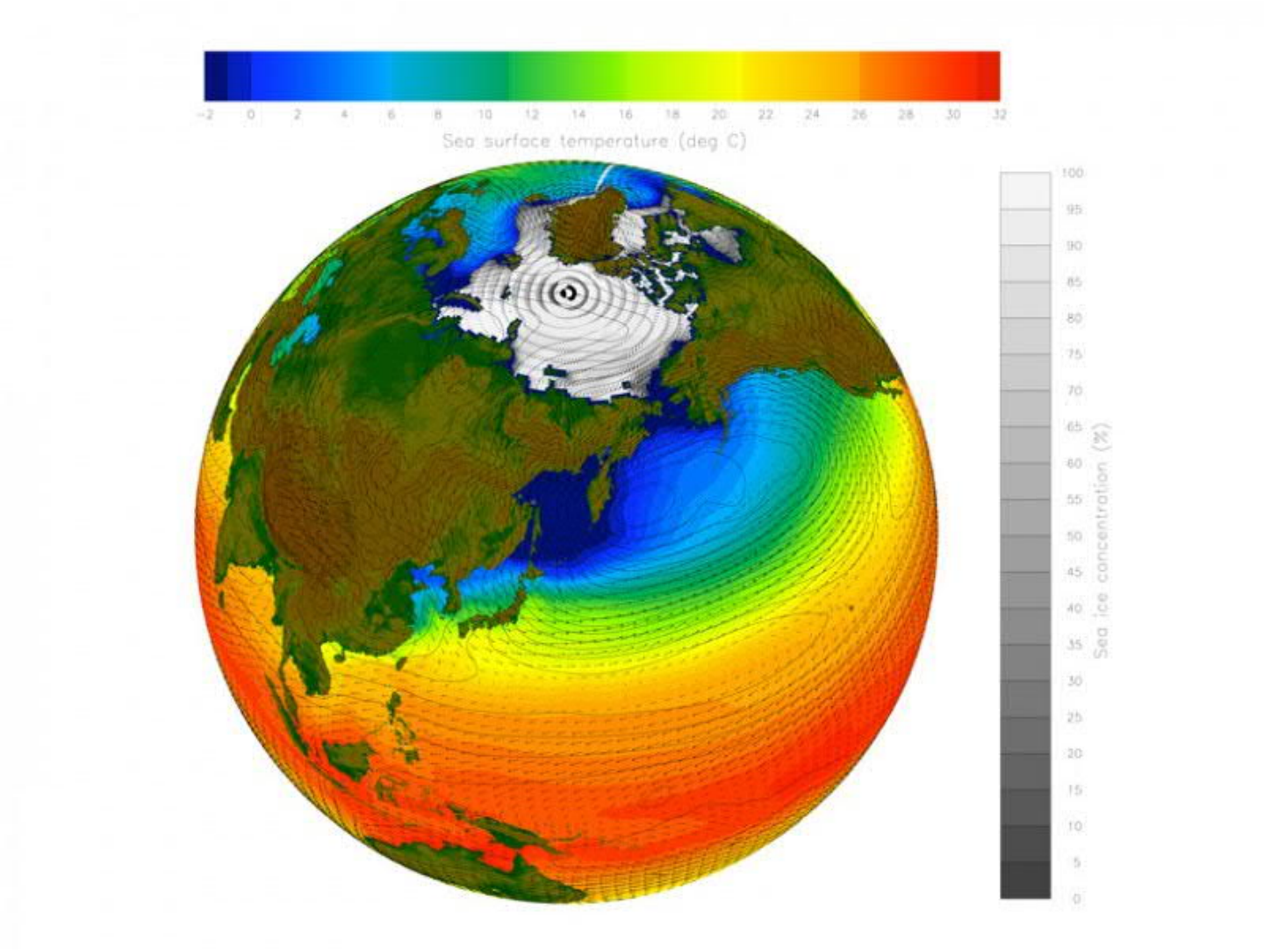
Future Directions for the World Climate Research Programme

The worldwide climate research community has talent, dedication, and a clear sense of knowledge gaps. It needs to close those gaps and convey its messages effectively to user communities.



This image, taken from a broader simulation of climate in the 20th century generated by the Community Climate Model (CESM), depicts environmental variables including sea surface temperatures and sea ice concentrations. Simulating past conditions and comparing them to past observations helps scientists verify a model's accuracy. Credit: UCAR

By Guy Brasseur and David Carlson 30 July 2015

As climate uncertainties increase on many fronts, the international climate research community is taking stock of its current research efforts and developing an evolving set of strategies to address these uncertainties with relevance and skill. The community displays a strong sense of urgency and commitment, even in the face of substantial social, political, and financial obstacles. However, representatives and leaders of the community must address cuts and redistribution of research funding, support the efforts of numerous volunteers, and develop and disseminate a compelling message to sustain the focus and commitment of this valuable research community.

With partners from the national and international assessments community, climate scientists urgently need to evaluate recent research as well as scientific and political outcomes from a mutual and timely vantage point: to view assessment report products in light of ongoing research and, conversely, to scrutinize the directions of ongoing climate research following recent national and international assessments. However, valid concerns have emerged within the research community about the present focus and impact of climate research and about the probable effort and impact of subsequent assessments. These concerns center around the quality of subsequent products: How can the research community ensure substantial rather than incremental improvements, and will the impacts justify the efforts?

To address these concerns, science leaders from the World Climate Research Programme (WCRP (http://wcrp-climate.org)) and the Intergovernmental Panel on Climate Change (IPCC (http://www.ipcc.ch)) are in deep collaboration. Together, they have outlined several knowledge gaps.

Speaking for WCRP, we recognize that addressing these knowledge gaps requires continual reexamination. WCRP's evolution must ensure relevant and timely science outcomes in the context of immediate and longer-term efforts to mitigate climate change while recognizing political and funding challenges.

Research and Assessment Communities Meet

In the absence of an internationally agreed-upon and funded climate research strategy, the WCRP, on behalf of the World Meteorological Organization, the International Council for Science, and the Intergovernmental Oceanographic Commission, assumes the daunting tasks of planning and coordinating international efforts on climate research. The WCRP, a multinational consortium established in 1980, has undergone internal refreshment and refocusing since 2011.

Following extensive engagement with the research community, WCRP identified five climate science "grand challenges (http://www.wcrp-climate.org/grand-challenges)." These call for community focus and rapid progress on the following topics:

clouds and atmospheric circulation

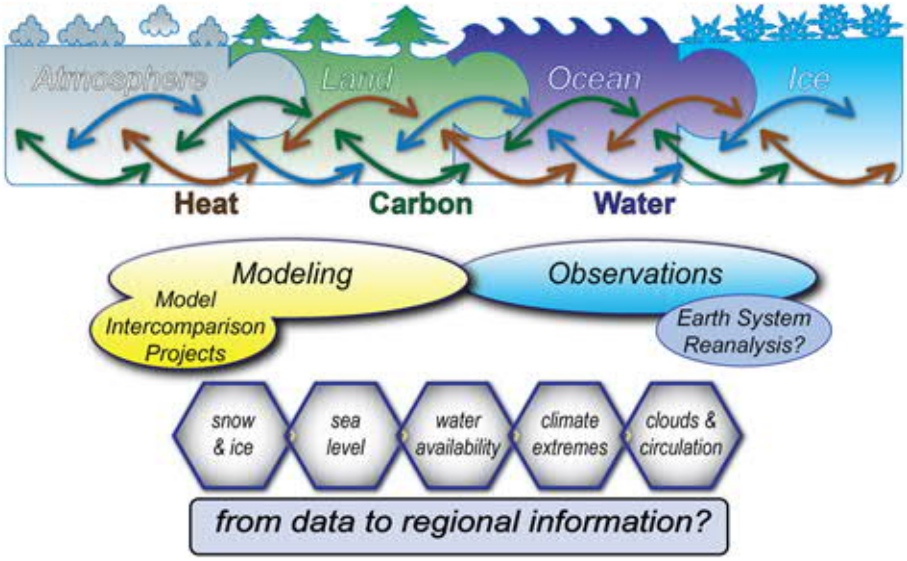
regional sea level

climate extremes

water availability

rapid cryosphere changes

As the WCRP grand challenges developed, the IPCC, the United Nations organization charged with producing periodic climate assessments, was working on its Fifth Assessment Report (AR5 (https://www.ipcc.ch/report/ar5/)). This report, based largely on WCRP-led or -coordinated research and modeling activities, was released in 2014. AR5 Working Group I (*Climate Change 2013: The Physical Science Basis* (http://www.climatechange2013.org)) placed special emphasis on WCRP's work.



(https://eos.org/opinions/future-directions-for-the-world-climate-research-programme/attachment/f-01_web)

The World Climate Research Programme (WCRP (http://wcrp-climate.org)) seeks to understand and predict present and future flows of heat, water, and carbon in atmospheric, land, oceanic, and ice systems through skillful use, intercomparison, and sharing of models and observations. WCRP presently focuses its efforts through grand challenges (hexagons). We recognize the need to increasingly ensure continuity and fidelity from global climate data to socially useful regionally focused information.

The Joint Scientific Committee (http://www.wcrp-climate.org/governance.shtml) of WCRP, working closely with Working Group I leaders, organized a "Lessons Learnt for Climate Change Research

(http://www.wcrp-climate.org/ipcc-wcrp-about)" meeting to discuss AR5 soon after its publication. WCRP invited more than 75 researchers to convene in Bern, Switzerland, in September 2014, where they simultaneously evaluated AR5 and revisited the WCRP grand challenges. The meeting participants, a good mixture of lead authors of IPCC AR5 and WCRP project leaders, evaluated climate science, WCRP directions and plans, and future needs for research and assessments.

The "Lessons Learnt" meeting was conducted in partnership with the Technical Support Unit of IPCC Working Group I and the International Space Science Institute at the University of Bern. It had substantial financial support from the Swiss Federal Office for the Environment. Attendees primarily discussed the Working Group I report, but they also considered the reports from Working Group II (*Climate Change 2014: Impacts, Adaptation, and Vulnerability* (http://www.ipcc.ch/report/ar5/wg2/)) and Working Group III (*Climate Change 2014: Mitigation of Climate Change* (http://www.ipcc.ch/report/ar5/wg3/)). A few weeks later, in November 2014, one of us (D.C.) attended the 7th Science Steering Committee (https://www.wmo.int/pages/prog/arep/wwrp/new/wwrp_jsc.html) meeting of the World Weather Research Programme (WWRP (https://www.wmo.int/pages/prog/arep/wwrp/new/wwrp_new_en.html)), where urban environments emerged as one convergent and overlapping area of mutual focus for WWRP and WCRP.

No Research Gaps, but Knowledge Gaps Remain

The "Lessons Learnt" group in Bern was asked to identify research gaps in AR5, particularly in the Working Group I report. Their response was emphatic: almost none. Nearly every researcher could identify areas of scientific progress since the 2012 and 2013 cutoff dates for the AR5 materials.

It was no surprise that systematic scrutiny, including a premeeting survey, turned up no serious omissions or weaknesses based on the research available at the time of the report. The conduct of AR5 and Working Group I processes were thorough, inclusive, and highly professional. Anticipating this result, the meeting's Steering Committee (http://www.wcrp-climate.org/ipcc-wcrp-committees) structured meeting topics and sessions much more around the issue of knowledge gaps—challenges ahead rather than omissions behind.

The overall approach of AR5 was to assign calibrated uncertainty language to key findings, either through specifying a qualitative level of confidence (e.g., medium or low confidence) or, where the science permitted, a quantified certainty of assessment conclusions. This allowed the Steering Committee to extract and expose a series of key uncertainties in observations, forcing factors, fundamental understanding, and global and regional projections.

The committee then challenged meeting participants to assess WCRP activities, particularly the

previously identified WCRP grand challenges, in light of these uncertainties. Perhaps not surprisingly (but certainly not inevitably), the group found a good match between goals of the WCRP grand challenges and knowledge gaps identified in the AR5 Working Group I report.

Matching Research Activities to Knowledge Gaps

Despite an overall coherence between AR5 Working Group I knowledge gaps and WCRP plans, a meeting-wide cross analysis of uncertainties versus ongoing activities exposed four areas for which the WCRP's grand challenges seemed either deficient or in need of broadened or expanded research.

Ocean Heating and Circulation. Ocean heating, particularly in the deep ocean, was identified within the WCRP sea level grand challenge and was prominent within the premeeting survey. However, ocean heating and circulation, linked to decadal prediction challenges, seemed too weakly represented in the meeting agenda and hidden or at least subdued in the WCRP grand challenges.

Annual to Decadal Time Scales. The need for greater emphasis on understanding natural variability and forced change on annual to decadal time scales is relevant, and indeed urgent, for predictions of climate extremes (particularly those related to water availability) and other climate impacts on regional spatial scales.

Short-Lived Climate Forcers. There is a need for better descriptions and incorporation of aerosols and other so-called short-lived climate forcers into understanding and prediction on annual to decadal time scales and on local to regional spatial scales.

Biogeochemical Cycles. The need is growing to incorporate interactive components of the carbon and other biogeochemical cycles, including terrestrial and oceanic geochemical and ecological sources and sinks, into analyses and models.

Thinking Decadally

The video (https://www.youtube.com/watch?v=dBHL_7dEpTg&feature=youtu.be) below, from the Deutsches Klimarechenzentrum and Max-Planck-Institut für Meteorologie, shows two emission scenarios used in AR5 and compared across the globe as time marches toward 2100.

Despite great progress in modeling potential future conditions, the goal of increased predictive skill on decadal time scales emerges as a clarion theme. This theme, although hardly new, suggests an encompassing challenge and direction for WCRP. As weather forecasting extends from daily to weekly out to seasonal scales, climate predictions must move from centennial scales through decadal toward seasonal.

Weather and climate communities recognize this need despite enormous scientific and technical challenges. We suspect that fragmented organizational structures, with various seasonal and decadal initiatives and projects scattered within WCRP and between WCRP and its weather research counterpart, WWRP, reflect a very real scientific complexity. Unfortunately, this fragmentation may portend a hesitant approach to integrating these efforts.

At the same time, we recognize a need for WCRP and WWRP to work together to address urban populations and environments where hourly to decadal time scales, regional geographic scales, and integrated coupled weather-climate modeling capabilities become more urgent and more challenging. In particular, we understand that local decisions about investments in, for example, coastal infrastructure require mutually consistent predictions of extreme storm events and climate trends.

Gathering Data

Virtually every speaker and every report given at the “Lessons Learnt” discussions in Bern emphasized a need for better and more systematic sources of and access to data. Recognizing the extremely positive impact of meteorological reanalyses across and beyond atmospheric research and modeling, we anticipate movement by the major modeling centers toward broader Earth system reanalyses.

It seems timely to initiate a broad effort to gather existing but so far narrowly used climate data products from across the physical, chemical, biological, and ecological communities into a more uniform and assimilation-friendly format. We recognize substantial technical challenges arising from variable spatial resolutions and temporal extents, but we contend that such a planetary diagnosis effort represents a long-avoided task whose implementation would reverberate strongly through science and data communities.

Challenges Ahead

As WCRP pursues new directions, we confront four interlinked obstacles:

Funding is decreasing generally, and it is increasingly earmarked and allocated for purposes other than fundamental climate research.
Despite confirmation of the validity, indeed urgency, of the WCRP grand challenges, we have only a mixed record of implementation and a weak record of public engagement.
Our tendency across WCRP is to overload and overwork a few key individuals, especially female individuals.
Our most careful and creative products continually and increasingly clash with social or political comfort and convenience.

WCRP has developed through the accretion of good ideas and worthy plans, reflecting the emerging complexity and expanding facets inherent in analysis and prediction of a rapidly evolving climate system. Although we describe here the recent and necessary reassessment of the WCRP activities, we see a need for additional and continual refinement in light of priorities and resources.

With a small number of staff serving management and coordination roles at the center and across the projects, WCRP always and increasingly relies on enthusiastic volunteers who build and sustain the international science community. We observe an optimistic sense of urgency and possibility within that community—the collective overt determination to not simply repeat past steps or continue past processes emerging from the “Lesson Learnt” meeting confirms their motivation.

If we as representatives and leaders fail to confront funding, implementation, capacity, and messaging issues, we risk a serious and disabling loss of confidence and commitment within and across this most valuable climate resource.

Acknowledgments

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