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White Paper on Climate Applications/Services theme for WCRP

(Submitted by Professors Carolina Vera, Julia Slingo and Fred Semazzi)

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Carolina Vera, Fred Semazzi, Julia Slingo, Vikram Mehta

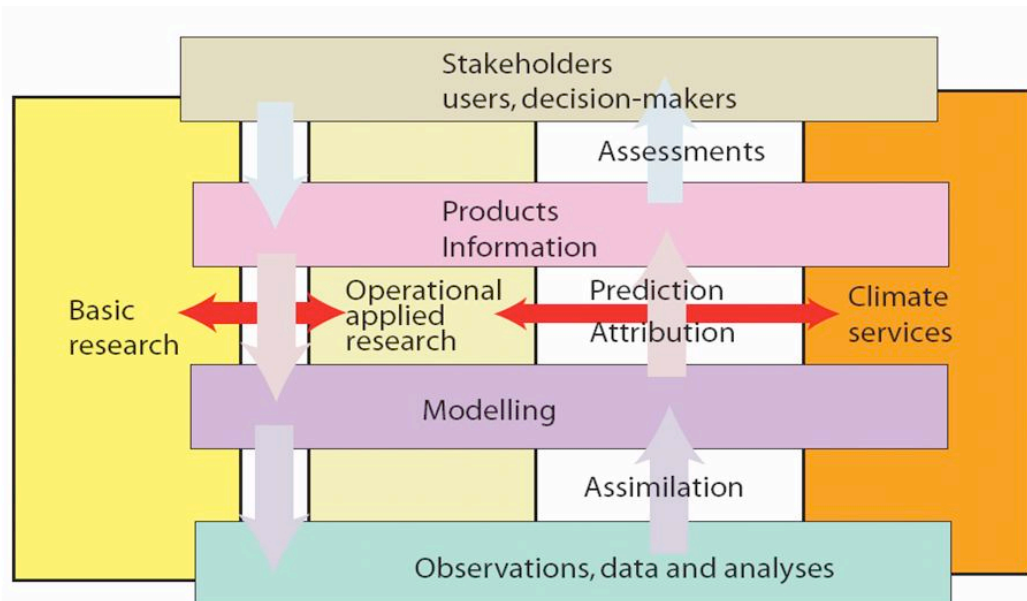
Draft: 23 January 2010 – Julia Slingo

Introduction

The importance and visibility of climate information systems that provide products and services relevant to climate-related risk management and decision-making has risen dramatically in the last few years, a trend that is likely to continue. In the last World Climate Conference-3 (WCC-3), the World Meteorological Organization (WMO) and its partners agreed to establish a Global Framework for Climate Services (GFCS) to strengthen production, availability, delivery and application of science-based climate predictions and services on all timescales from months to decades.

The progress made by World Climate Research Program (WCRP) on observing, understanding and predicting seasonal to decadal climate variability, along with potential human-induced climate changes, already provides a strong foundation for the delivery of a wide range of climate services. It is therefore the right time to consider the future development of WCRP, and especially its role in the GFCS. In this context, WCC-3 (2009) concluded, that *'major new and strengthened research efforts are required to increase the time-range and skill of climate prediction through new research and modeling initiatives; and to improve the observational basis for climate prediction and services, and the availability and quality control of climate data.'*

It is important not to consider climate services as an end in themselves. WCC-3 also concluded that *'the most urgent need is for closer partnerships between the providers and users of climate services'*. WCRP should go further than this and promote climate services as part of the whole process from basic, underpinning research, through applied research to the providers of predictions and the products and services that flow from those predictions. This holistic approach is captured well in the following diagram provided by Kevin Trenberth:



It emphasizes the essential role that observations, research, modeling and prediction systems must play – all within the remit of the WCRP – but especially the dialogue that must be maintained between the developers and users of climate services, and those engaged in the fundamental research and delivery of predictions. It will only be when researchers embrace this concept and set their research in the context of societal needs that real progress will be achieved.

The WCC-3 commissioned a number of white papers addressing the needs for climate information on various timescales which have served to inform the following priorities for WCRP.

Priorities for WCRP

1. Science needs for delivering more reliable predictions on all timescales

Society is increasingly vulnerable to hazardous weather and climate extremes, be it heavy rainfall and flooding, high winds, storm surges, sea level rise, prolonged drought, heat waves or poor air quality. Many of the most dangerous effects of climate change may come through the increased incidence and/or intensity of extreme events, and communicating those risks to society presents significant challenges.

A key need for any climate service is the provision of timely and reliable forecasts of the likelihood of hazardous weather and climate. Detecting, attributing and predicting possible changes in the frequency and characteristics of hazardous weather and climate as the planet warms requires some major advances in observing, modeling and prediction systems. Defining what hazardous means, for whom and where, will require detailed understanding of the vulnerability of society and key systems (e.g. food and water) to changes in the patterns and characteristics of weather and climate. And it will need to consider how interactions with other components of the earth system act to mediate the impacts of hazardous weather and climate (e.g. soil moisture in intensifying heat waves, atmospheric chemistry in linking blocking to poor air quality, oceans and the cryosphere in determining sea level rise), along the underpinning research required to represent those processes. These multi-scale, interdisciplinary challenges will require the WCRP to work closely with WWRP, IGBP and IHDP.

(a) Interactions between climate and weather

One of the most relevant climate information needs in water resources and agriculture sectors, and probably in some others also, is information about high-frequency weather, variability associated with interannual to decadal climate variability. This is also true about possible changes in weather statistics associated with climate change projections. For example, the same seasonal-average rainfall can make very different impacts on crop yields if distributed differently over the season. While it is possible to use available rainfall, temperature, winds, and other daily or higher-frequency weather data in statistical studies of association between various phases of ENSO or PDO or tropical Atlantic gradient variability and high-frequency weather variability, there is very little understanding of how large-scale climate variability/changes influence fundamental atmospheric dynamics and their interactions with the underlying land. This understanding is very important not only in itself but also for the development of dynamical models for research, prediction, and future climate projection. A WCRP initiative to develop research programs on climate and weather interactions can be very useful for science as well as for GFCS, and would help in bringing CLIVAR, GEWEX and even THORPEX, closer.

(b) Improved modeling capability

There must be a targeted effort to build better climate models, capable of capturing hazardous weather and climate extremes more faithfully, by increasing horizontal and vertical resolution and by a systematic programme of improvements to the representation of the physics of the atmosphere, oceans and land surface. These improvements will require a much greater understanding of the multi-scale nature of the atmosphere and oceans and potentially new methods for representing sub-grid scale processes (e.g. stochastic physics). The evaluation of climate models should have a greater emphasis on those processes and phenomena that directly influence our capability to capture those aspects of regional climate variability and change that directly impact society and the key systems on which society depends. The WCRP should foster more insightful model intercomparisons and assessments.

(c) Observations and monitoring

A fundamental component of climate services must be the provision of historical climate data and assessments of the current climate. Improved reanalyses drawing on the latest developments in models and data assimilation should be promoted as fundamental to climate services. At the same time, attribution of hazardous weather and climate extremes will become increasingly important and this again requires improved modelling capabilities and analyses of historical data. The WCRP should promote the need for further investment in reanalyses and call for robust and transparent assessments of trends in observations.

(d) Developing prediction systems and assessing predictability

Climate services will need to provide probabilistic predictions which allow users to manage their own risks in an objective way. Ensemble prediction systems (EPS) are now well established in extended range and climate forecasting, but the techniques to represent forecast uncertainty and sample adequately the phase space of the forecasts are quite diverse. These range from initial condition uncertainty (including optimal perturbations and ensemble data assimilation), through stochastic physics to represent the influence of unresolved processes, to the use of perturbed parameters in the parametrizations to represent model uncertainty. The WCRP should consider how these diverse approaches can be brought together and the relative value of each assessed.

Monthly to decadal prediction is still in its infancy and the potential predictability in the climate system for these timescales is largely unknown and probably underestimated because of model shortcomings and the methods used to initialize the predictions. Along with a move to higher resolution in climate models, the WCRP should promote activities around data assimilation and initialization for the fully coupled system.

2. Promoting partnerships to focus on the integration of climate research and application needs

In spite of statements of intent to interact closely with stakeholders and policymakers in climate research and applications programs, there is still very little meaningful, two-way, and continuous interaction with user communities. It is clear however, that the boundaries between scientific and stakeholder communities have become blurred during the past decade. A “user” may be a decision maker acting individually or as part of a collective. A “user” may also be a translator of information regarding climate variability or its associated impacts such that the information can be used by decision makers. Similarly, a “provider” may be the climate scientist running global climate models or may be the translator that modifies the initial forecast information into a more usable format for the policy or decision maker. Also, a “provider” may be the one that takes the information from the climate model and feeds it through a hydrology model or crop model. The blurring of boundaries between these communities began when it became clear that effective climate risk management could not be accomplished for certain communities. It has been an important realization, but much work remains.

Building partnership systems that link stakeholders, users and decision making sectors, and climate information providers (including those in climate prediction, climate observations and analysis as well as operational climate sectors), is crucial. Partnerships systems must be based on an interdisciplinary framework containing expertise in both climate science and the various sector sciences. Systems like these building on interdisciplinary (from social to climate sciences) and trans-sector (from stakeholders to researchers) are the only way to provide the climate information that can be effectively used by the different sectors of society. It is apparent that the way forward must embrace an iterative approach involving two-way interaction between researchers working on relevant climate problems and the end-user community.

If the GFCS is to succeed, WCRP should be part of the collective leadership for exploiting this opportunity to engage user communities in climate research. Rather than including interactions with users to assess their climate information needs in a tentative manner in individual projects, this should be done systematically to include users as full partners in the climate research and prediction endeavors. Experience shows that climate scientists alone are not well suited by training and temperament to undertake this in a sustained manner and usually have little idea of what kind of information is required for meaningful applications by users. WCRP might address this initiative in cooperation with the other global programs involved in ESSP and by involving key sectors in its activities. A good example is the developing relationship between climate prediction and the insurance industry. Also, WCRP might have a role in strengthening the science collaboration between the global prediction centers, the regional climate centers and even the future national climate centers or meteorological and hydrological centers.

In addition, WCRP should consider developing a group of climate and societal impacts scientists, along with experts in scientific communications, to develop methodologies for interacting with users. Indeed the WCRP should address the need for the development of innovative mentoring and training programs to generate a new generation of researchers that can conceptualize,

develop and implement research that bridges the gap between science and applications. This could be done by working in partnership with the UNESCO and other organizations?

Since most, if not all, societal impacts of climate variability and changes are heavily influenced by local conditions, the amount of work necessary to involve users in developed and developing countries must not be underestimated. However, this would be a very rewarding activity to further stimulate climate research and prediction efforts, and also can provide the justification to ask governments for increased resources for climate research and prediction activities.

3. Promoting more research and investment to translate available climate information into the spatial scales and relevant variables required for decisions.

This activity must address the needs for:

- a) Improved knowledge of the multi-scale nature of the full range of climate variability, and including climate-change trend, impacting on a specific socio-economic sector.
- b) Characterization of the uncertainties associated with climate predictions including properly accounting for those aspects that are and are not predictable.
- c) Better determination and availability of an agreed and reliable set of datasets/variables required to address specific socio-economic sector vulnerability. Identification of the specific regions where society is most vulnerable to changes in the near-future climate is needed.
- d) Development of quantitative climate information for a wide range of variables. There is a general agreement that besides the value that climate prediction outputs may add, valuable climate information can still be extracted from observations.
- e) Regional-to-local scale verification work of the climate information must be pursued together with a dynamical understanding of the processes behind the predictability.
- f) Tailoring of the larger scale information on climate variability and change to local scales, which will often be site and/or problem specific.

The initiative strongly relates with the activity 3) described in the White Paper on WCRP Modeling Theme. It must involve not only the current WCRP modeling groups but also the regional programs of the Core projects.

Concluding remarks

It is clear that the context of this paper depends strongly on the other WCRP White Papers on modeling, observations and processes. It will be important to review these interdependencies and ensure that structures are in place to maximize the effectiveness of our actions arising from these papers.