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THE CRCES WORKSHOP ON DECADAL CLIMATE VARIABILITY

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The importance of decadal climate variability (DCV) research is being increasingly recognized, including by international research programs such as the World Climate Research Program (WCRP) and the U.S. National Research Council. This brief article (workshop presentations available online at www.DecVar.org/auditorium.php) summarizes a consensus view of a research community workshop[1] attended by approximately 45 scientists. Gaps in our knowledge of DCV and its societal impacts were identified, as were areas of needed research and anticipated benefits of research. It is a major challenge to implement recommendations of this and other such workshops on climate research in this era of declining earth science budgets. Therefore, a phased implementation is recommended, with highest priority recommendations outlined in a sidebar to this summary.

CRCES DECADAL CLIMATE VARIABILITY WORKSHOP

What: Researchers discuss a strategy to describe, understand, and predict decadal climate variability and its societal impacts.
When: 17–20 October 2005
Where: Warrenton, Virginia

OBSERVATIONS. In this workshop, many examples of externally forced and internally generated patterns of DCV were presented, ranging in time scales from eight years to several decades. In some cases, DCV is manifested in a long-term modulation of interannual phenomena such as the North Atlantic/Arctic Oscillation, the Antarctic Oscillation, and El Niño–Southern Oscillation (ENSO). In other cases, the phenomena are more distinct, that is, the Pacific

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and Atlantic decadal variability and the Atlantic Multidecadal Oscillation. External forcings, including the radiative forcing of the Earth by the regular 11-yr and longer-term irregular variations in the sun's irradiance and by intermittent volcanic aerosol production, have been shown to affect the atmosphere–ocean system in climate records and in climate simulations. Internally generated variations include those arising from ocean–atmosphere–land–ice interactions via momentum, heat, and freshwater fluxes. We need to differentiate and quantify the responses of the Earth's climate system to external forcings and internally generated variability.

The major challenges are to produce internally consistent time series of ocean, atmosphere, and land observations, including the lengthening of satellite records and essential in situ observations; to identify recurring, physical modes of DCV against the noise background; and to design and develop technologies and techniques to measure small-amplitude, large-scale DCV signals. We also need to know if DCV patterns have quantifiable impacts on extreme weather events such as heavy precipitation, tropical and extratropical cyclones, and summer heat waves. Although, in this era of declining earth science budgets, it is a major challenge to continue measurements, we must ensure that existing time series of external forcings, ocean vector winds, sea surface height, sea surface temperature (SST) and subsurface temperature, surface and subsurface salinity, over-ocean evaporation, rainfall, and paleoclimate data continue over the next decades. In addition, we must quantify and improve the accuracy of air–sea heat, freshwater, and momentum fluxes.

THEORY AND MODELING. Some progress can be made in the need to differentiate and quantify the responses of the climate system by analyzing existing long, global climate model runs [e.g., model runs for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)] to compare major DCV patterns, both with observed patterns and among the models. These models have been integrated with and without anthropogenic forcings, and therefore can be used to distinguish between natural variability and anthropogenic change. Regional, decadal hydrometeorological variability, including variability of extreme weather events and ENSO variability at decadal time scales, simulated by these models should be examined with reference to observed variability. These activities will also help assess model fidelity and foster connections between the DCV and IPCC modeling communities, so that the DCV community can provide input when planning for new model runs. Additionally, coupled climate data assimilation and reanalysis systems with realistic representations of mean ocean and atmosphere states, the global water cycle, atmospheric cyclones, and western boundary currents capable of assimilating hydrometeorological observations should be developed to extend the observational record to unobserved quantities and regions.

ASSESSMENTS, PREDICTABILITY, AND PREDICTION. Accurate assessments of present DCV conditions relative to the recent or distant past and predictions of climate evolution over one or more decades are of high societal relevance and require knowledge of natural seasonal, interannual, and decadal climate variations, as well as anthropogenic climate change. Initial studies with statistical models have shown that SST anomalies associated with the North Pacific DCV can provide several months of enhanced prediction skill for daily wintertime precipitation in the southwest United States and summertime temperatures in coastal California. Initial studies with dynamical models suggest

NEAR-TERM PRIORITIES FOR DCV RESEARCH

- Recurring physical modes of DCV should be identified against the noise background, and it should be ascertained if these modes have quantifiable impacts on extreme weather events.
- The climate model runs in support of the fourth IPCC assessment should be analyzed to compare major DCV patterns; the model runs should also be compared to observed patterns. Regional, decadal hydrometeorological variability, including variability of extreme weather events and ENSO variability at decadal time scales, simulated by these models should be examined with reference to observed variability.
- Potential predictability at multiyear-to-multidecadal time scales should be surveyed using observed datasets and dynamical models, and experimental predictions of decadal climate outlook should be made if/where possible.
- Potential users of multiyear-to-decadal predictions/outlooks should be identified and their views on what would be useful if predicted and how they would use such information should be elicited. A conference of specialists in DCV research and climate impacts research should be organized to formulate plans for a DCV and impacts research program. The conference can also develop an outreach and public involvement program with the help of public relations specialists.

that the North Atlantic Ocean circulation, SST, and surface air temperature as well as SSTs in the tropical Pacific, the Southern Ocean, the tropical Atlantic, and the North Pacific may be predictable one or more decades in advance. Atmospheric quantities in the North Atlantic, however, appear to be predictable only one year in advance at most, and there appears to be very little predictability of the atmosphere over neighboring land regions.

Beyond these initial studies, however, it is neither known whether there are regions where atmospheric climate and hydrometeorology, including extreme weather events, ocean circulations, temperature, upper-ocean heat content, and salinity, and the frequency, intensity, and tracks of Atlantic hurricanes and other tropical cyclones are potentially predictable beyond a few seasons, nor whether decadal-scale climate evolution can be predicted independently of accurate ENSO predictions. Therefore, potential predictability at multiyear-to-multidecadal time scales should be surveyed using observed datasets and dynamical models, and experimental predictions of a decadal climate "outlook" should be made if/where possible.

SOCIETAL IMPACTS. A high-priority objective of the DCV community should be to deliver relevant and useful knowledge of DCV, including decadal variability of extreme weather events, to the public and policymakers. In particular, assessments and predictions on decadal time scales could be applied to improve preparedness for DCV-driven hazards. In its simplest form, the predictions could be informed projections of persistence of the assessed current conditions; in a more ambitious form, the timing of anticipated DCV regime changes (e.g., the end of drought or hurricane lull) would be provided. Also, knowledge about the changing conditions on decadal time scales will help to better describe the long-term risks and opportunities associated with climate variability (e.g., construction standards and flood risk). In order to understand the potential impacts of the DCV regimes that we aim to assess and predict, we must, with the participation of specialists in these fields, develop an understanding of societal vulnerabilities to DCV, resilience, and coping capacity, as well as social constructions of risks and opportunities. Toward this goal, the DCV community must begin organized interactions with agronomists, hydrologists, engineers, political scientists, economists, coastal engineers, and sociologists, among others. Also, a global search should be undertaken to document evidence of the societally relevant impacts of DCV. Potential users of multiyear-to-decadal predictions/outlooks should be identified and their views on what would be useful if predicted and how they would use such information should be elicited. The information so assessed could guide a conference in which specialists in DCV and climate impacts research come together to formulate plans for a DCV and impacts research program.

Methods and models for assessment of societal vulnerability and resilience, and consequent impacts of DCV should be developed and tested in region- and sector-specific studies (e.g., drought impacts on food and water security in the Great Plains of North America, northeast Brazil, or the Sahel). In view of the heightened awareness of the general public about extreme weather events and potential global warming, this may be an opportune time to engage the public in climate variability issues and to work with them to develop coping strategies and vulnerability reduction. The earlier-mentioned conference can also develop an outreach and public involvement program with the help of public relations specialists.

COORDINATION. Multiple research activities spanning multiple agencies and programs are necessary to implement recommendations of this workshop. Also, the recommended DCV activities and other parts of the U.S. climate research enterprise would derive mutual benefits from a coordinate implementation. The U.S. CLIVAR program enjoys strong links to the international CLIVAR community, and works directly with the U.S. research community and with multiple agencies and programs. Therefore, a detailed implementation plan for the recommended DCV and impacts research activities should be developed by a DCV and impacts working group, and national and international coordination should be provided by the U.S. CLIVAR Program Office.

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