meeting summary

Proceedings of the NASA Workshop on Decadal Climate Variability

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1. Introduction

The study of natural variability of the climate system at decadal–multidecadal timescales has a long history but is receiving increased attention over the last two decades. During much of its history, this field was mired in controversy because the majority of decadal climate variability studies were confined to sunspot cycle–terrestrial climate variability correlations. But this field has now emerged from this controversy and is fast becoming an important area of climate research because

1) decadal–multidecadal climate variability affects the lives of several billion people via its long-lived effects on agriculture, water resources, fisheries, and public health;
2) ENSO and the Asian–Australian monsoons, and their predictabilities, are known to vary at decadal–multidecadal timescales;
3) natural climate variability at decadal–multidecadal timescales has the potential to interact with anthropogenic climate change; and
4) it is possible/likely that some societies are more vulnerable to decadal climate anomalies than to shorter-term climate anomalies because of those societies' resilience against shorter-term variability.

As an indication of its importance, several national and international workshops on decadal climate variability have been organized in the 1990s to assess the progress of research in this area and to develop research programs. One of the major components of the International Climate Variability and Prediction (CLIVAR) project, organized by the World Climate Research Program, is the study of decadal- to centennial-scale climate variability.

The objectives of the present workshop were

1) to bring together researchers active in decadal climate variability and continue the discussions begun in April 1996 in the Joint Center for Earth System Science–CLIVAR workshop and in the various CLIVAR meetings that have taken place since then;
2) to provide input to the National Aeronautics and Space Administration's (NASA) Earth Science Enterprise from the decadal climate variability research community; and
3) to continue to develop an integrated framework of research in the description, physics, prediction, and societal applications of decadal climate variability and its interaction with seasonal-to-interannual and anthropogenic climate phenomena.

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There were approximately 50 participants in this workshop, 38 of whom made oral presentations on various aspects of decadal climate variability and its societal impacts. In addition to the oral presentations, there were six sessions in which various aspects of decadal climate variability were discussed. The participants included program managers from NASA and the National Oceanic and Atmospheric Administration, and a representative from the International CLIVAR project.

2. Workshop conclusions

1) The relative shortness and quality of the instrument-measured climate record only allows us to quantify characteristics of climate variability at timescales up to 10–20 yr.
2) There are global-scale, decadal, and interdecadal variations in SST, rainfall over continents, SLP, upper-ocean heat content, near-surface winds over oceans, and surface temperatures over the United States. The SST and upper-ocean heat content anomalies appear to rotate in the oceanic gyre circulations in observations and in the National Center for Atmospheric Research–Department of Energy global coupled ocean–atmosphere model. The interdecadal SST variations appear to modulate tropical cyclone activity in the Pacific region.
3) There are also regional-scale patterns of SST, SLP, rainfall over continents, near-surface winds, and sea ice variations at decadal–multidecadal timescales in the Atlantic.
4) The ENSO phenomenon, its predictability, and its influence on the North American, Australian, and Asian climates exhibit strong, decadal–multidecadal variations. The strength of the ENSO–droughts connection in the eastern United States, southern California, and the Mississippi River valley has fluctuated at multidecadal timescales during the twentieth century. Observations suggest that the above-mentioned decadal climate anomalies in the tropical–subtropical Pacific may be responsible for modulations of ENSO.
5) The following "targets" appear promising for further investigations:
   (i) Decadal variations in the North Pacific and North Atlantic climate systems, and the associated global rainfall anomalies;
   (ii) Decadally varying, meridional teleconnection pattern involving the tropical South Atlantic SSTs, SLP variations over the North Atlantic, deep convection in the Labrador Sea, sea ice and heat flux perturbations in the Greenland–Iceland–Norwegian Seas, and possibly the cross-equatorial SST gradient in the tropical Atlantic; and
   (iii) Decadal variability of ENSO, its predictability, and its teleconnections.
6) Further investigations with instrument-measured and paleoclimate datasets, and a variety of analysis techniques are necessary to further clarify characteristics of these targets, other global- and regional-scale decadal climate variations, and the relationship(s) between them.
7) Recent observational and modeling work has not shown evidence of coupled ocean–atmosphere modes of decadal variability in the extratropics. The model results suggest that integration of atmospheric forcings by the ocean may be the primary mechanism of decadal SST variability in the extratropics.
8) Coupled ocean–atmosphere GCMs and ocean-only GCMs generate variations in the North Atlantic thermohaline circulation at 50–70-yr timescale; observations suggest that phase locking between these internally generated climate variations and multidecadal solar irradiance variations may be responsible for the observed multidecadal climate variations.
9) A preliminary assessment indicates that there is low predictability of decadal climate anomalies in dynamical, coupled ocean–atmosphere models; a statistical predictability study shows high-skill, multiyear lead time predictability of decadal SST variations in the tropical Atlantic.
10) Analyses of satellite data products based on infrared and microwave sounder radiance profiles show that intersatellite calibration errors can be corrected to compile high-accuracy, geophysical datasets for long-term climate variability research.

3. Workshop recommendations

1) A strategy to provide decade(s)-long, space-based, geophysical data products should be developed by space agencies. This encompasses the need to work carefully to maintain calibration and validation for long periods despite changes in technology, agency responsibility, and evolving science requirements. Long, global, well-maintained, instrumental time series are critical to climate studies.

2) It is important to maintain high quality measurements of sea surface height and extend the time series of global ocean winds. These are important quantities in decadal climate variability and in decadal variability of ENSO. A program to demonstrate the feasibility of making high-accuracy, global measurements of sea surface salinity and precipitation from space-based platforms is needed as well because these variables are likely to have critical feedbacks in climate models. Solar irradiance variations must be tracked and compared with climate records.
3) In support of this space-based observing program, there should be an in situ measurement/calibration program using buoy- and float-mounted instruments. In view of the observations and model results showing a likely association between the subtropical gyres, and decadal SST and upper-ocean heat content anomalies, extensions of the tropical atmosphere–ocean and Pilot Research Moored Array in the Tropical Atlantic arrays to the equatorward sides of the subtropical gyres is worth considering. To observe gyre circulations and potential subduction processes, globally deployed Profiling Autonomous Lagrangian Circulation Explorer floats in the Atlantic and the Pacific are required that would reside along a particular subsurface density surface and profile to the surface intermittently. The assimilation of these in situ observations in global ocean–atmosphere models should be an integral part of this program.
4) More effort is needed to develop and rigorously analyze global ocean–atmosphere models to understand mechanisms of decadal climate variability, its predictability, and its interaction with ENSO, its predictability, and its global teleconnections.
5) U.S. scientists and their international collaborators need increased support for development of global instrumental and proxy databases through special projects, including data archaeology and rescue projects. A hierarchy of quality-controlled ocean, atmosphere, and land datasets ranging from the basic datasets containing original measurements to various levels of derived datasets should be established. The databases, developed as a result of such projects, will support efforts in climate system modeling and remote sensing.
6) There should be a program to rigorously analyze these historical (instrument-measured and proxy) datasets to quantify characteristics of decadal climate variability, decadal variability of ENSO and its teleconnections, and to conduct empirical predictability studies.

The last two recommendations may easily be given a very high priority. They are relatively inexpensive and will be the most useful in the near term.