# CLIMATE VARIABILITY AND PREDICTIONS

## A NOAA–USAID Global Climate Training Workshop Series

BY WASSILA M. THIAW, A. SEZIN TOKAR, R. KUMAR KOLLI, AND ISMAIL GUNES

Climate variability and change pose enormous challenges to society, and there is an urgent need to expand capacity to provide the best possible climate services in support of climate risk management and adaptation. The World Climate Conference-3 (WCC-3) held in Geneva, Switzerland, 31 August–4 September 2009, established a Global Framework for Climate Services (GFCS) to serve as stewardship for the delivery and application of science-based climate prediction and services. An overarching pillar of the GFCS is capacity building in the areas of 1) observation and monitoring; 2) research, modeling, and prediction; 3) the climate services information system; and 4) a user interface platform. Recognizing that many developing countries have limited capacity and resources to meet the requirements for climate services, the National Oceanic and Atmospheric Administration's (NOAA's) Climate Prediction Center (CPC) in partnership with the Office of U.S. Foreign Disaster Assistance (OFDA) of the U.S. Agency for International Development (USAID) conducts a strong international training program annually called the International Training Workshop Climate Variability and Predictions (ITWCVP). ITWCVP builds on the National Centers for Environmental Prediction (NCEP) International Training Desks to strengthen capacity in the area of climate predictions and monitoring through improved understanding of the global climate system, its variations, regional impacts, and the delivery of the climate services that society requires. The NOAA–USAID international training workshop series are organized in collaboration with the World Meteorological Organization (WMO) and several national meteorological and hydrological services (NMHSs). These training workshops, which began in 2009, exemplify the successful partnership of NOAA, USAID, and WMO, which helps to broaden and to deepen the capacity

### THE FIFTH INTERNATIONAL TRAINING WORKSHOP CLIMATE VARIABILITY AND PREDICTIONS

WHAT: This annual NOAA and U.S. Agency for International Development (USAID) training workshop to improve operational climate predictions in a global framework gathered 35 trainees and 23 lecturers and instructors from 30 countries around the globe to build capacity in operational climate monitoring and predictions and to improve climate services.
WHEN: 17–28 June 2013
WHERE: Istanbul, Turkey

**AFFILIATIONS:** THIAW—NOAA/NCEP/Climate Prediction Center, College Park, Maryland; TOKAR—Office of the U.S. Foreign Disaster Assistance, U.S. Agency for International Development, Washington, D.C.; KOLLI—World Meteorological Oganization, Geneva, Switzerland; GUNES—Turkish State Meteorological Service, Ankara, Turkey
**CORRESPONDING AUTHOR:** Wassila M. Thiaw, Climate Prediction Center, NOAA/NCEP, 5830 University Research Ct., College Park, MD 20740
E-mail: wassila.thiaw@noaa.gov

DOI:10.1175/BAMS-D-13-00260.1

In final form 19 March 2014

development efforts in the spirit of the emerging Global Framework for Climate Services.

This report summarizes the Fifth International Training Workshop Climate Variability and Predictions (5ITWCVP), which included all ocean basins around the globe, rather than regional basins as in previous workshops. (See Table 1 for countries grouped according to common ocean basins that contribute large-scale influences on their seasonal climate.) The 5ITWCVP was dovetailed with the Global Symposium Climate Variability, Predictions and Services (GSCVPS), and was organized as a single package. The Turkish State Meteorological Service (TSMS) hosted these events.

**OBJECTIVES.** The objectives of the 5ITWCVP and GSCVPS were to 1) assess the mastery of climate prediction techniques by selected participants from the four previous workshops supported by NOAA and USAID; 2) reinforce some of the concepts taught in previous workshops; 3) introduce new concepts such as forecast verifications; 4) discuss ideas that would help develop a strategy for future training workshops; and 5) provide trainees with insights into recent advances in climate science and applications in various socioeconomic sectors such as disaster response and risk management.

**ACCOMPLISHMENTS.** A total of 33 countries from Africa, Asia, the Caribbean and Central America, southeastern Europe, and South America were represented at the workshop and symposium. The 35 trainee participants were climate forecasters and scientists at national meteorological services (NMSs) and students from 23 countries. The two events were supported by 23 lecturers, including climate modelers and experts in climate diagnostics and predictions, drawn from expertise in various national and international agencies as well as academic institutions, including the Centro de Previsão de Tempo e Estudos Climáticos (CPTEC) of Brazil; the Indian Institute of Tropical Meteorology (IITM); the International Centre for Theoretical Physics (ICTP); the Institut National des Sciences et Technologie de la Mer in Tunisia; the International Research Institute (IRI) for Climate and Society; the Istanbul Technical University; the Korean Meteorological Administration (KMA); NOAA; TSMS; USAID; WMO; the University of Buenos Aires in Argentina; the University of Colorado Boulder, the University of Maryland, College Park; and the University of Nairobi in Kenya. These institutions contributed a total of 33 lectures.

As part of the hands-on training, the participants applied the IRI-developed Climate Predictability Tool (CPT) to conduct several diagnostics studies to improve forecast skill in their regions or countries of interest. CPT is an easy-to-use statistical software package that runs on a Windows or Linux machine. It includes canonical correlation analysis (CCA) and principal component regression, enabling the user to conduct physically based climate diagnostics and to design prediction experiments to assess forecast skills and to develop operational prediction systems. The participants also worked in teams to solve real-life forecasting problems and forecast verification exercises for a cumulative 22-h laboratory. The participants then contributed a combined 30 presentations on various topics, including climate monitoring, predictions, applications in health, and climate change projections. The workshop and symposium materials were recorded and distributed to the participants as a resource to guide them in their efforts to improve predictions in their respective countries. These materials are also available through the CPC website, but only to trainees (username and password required), or upon request.

In addition, breakout groups were formed and organized such that all continents were represented in each group. The objective was to capture the trainees' input to identify gaps and needs in the NOAA–USAID training workshop series, which would enable NOAA, USAID, and WMO to develop a strategy for future training workshops. Each group presented its report in a plenary session during the GSCVPS and the findings were discussed. In the plenary, the participants

**Table 1. Chronology of the NOAA–USAID training workshop series.**

| Workshop | Date | Host country | Ocean basin | Regions |
|---|---|---|---|---|
| 1ITWCVP | June 2009 | Vietnam | Indian Ocean | East Africa, South Asia |
| 2ITWCVP | June 2010 | Turkey | Mediterranean | Middle East, North Africa, southeast Europe |
| 3ITWCVP | June 2011 | Senegal | Atlantic | Caribbean, Central America, South America, West Africa |
| 4ITWCVP | August 2012 | Costa Rica | Pacific | Central America, South America, Southeast Asia |
| 5ITWCP | June 2013 | Turkey | Global | Africa, Americas, Asia, Europe, Middle East |

recognized that scientists from developing countries and emerging nations have an important role to play in the understanding of global climate variability, change, and adaptations. A clear first step is to build capacity in the latest techniques to downscale global and regional climate information to national and local scales through the rigorous training of scientists with a good potential to succeed. Discussion focused on the relevance of spatial and temporal scales and the need to tailor climate information to address users' needs by developing robust tools and strategies to improve the predictions of extreme events, including floods, droughts, and the mitigation of the impacts of such events. Several recommendations came out of the discussion and they are summarized in the next section.

**RECOMMENDATIONS.** *General recommendations.*

- There is a consensus that the NOAA–USAID series is contributing to developing capacity in climate monitoring and predictions at NMHSs. Recognizing that capacity development is a long-term process, participants recommended that the training series needs to be sustained. They also requested a continuation of the series in 2014.
- It was agreed that it would be most beneficial to NMHSs to bring back most of the trainees of the 5ITWCVP to the 2014 training workshop so there would be a hands-on approach to addressing some of the training gaps that have been identified and listed below under the heading of specific recommendations.
- To reinforce the knowledge and understanding of the physical basis of the climate system, it was recommended that the lectures presented during the workshop and symposium be developed into instructional materials that can be published in the WMO Technical Report Series, which will serve as a reference for the trainees, other professionals, and students. These materials might also be a valuable teaching resource for WMO's training activities under its World Climate Services Program (WCSP) and the GFCS.
- It was considered essential to encourage collaboration between universities/academic institutes and NMHSs and to find mentors for the trainees to foster communication between research scientists and professional meteorologists with the goal of sustaining the knowledge gained as well as enabling research and development (R&D) targeted to improving predictions.
- In addition, the trainees are strongly encouraged to work with their leadership to pursue the needed support to improve and update skill and performance.

*Specific recommendations.* Advancing predictions.

- It is desirable that future workshops include instructional materials on the forecasting of climate anomalies that are most challenging, but relevant to the end users. These include the following.

  - *Onset date of the rainy season, and wet and dry spell frequencies.* The economy of most developing countries depends on rain-fed agriculture and most areas in the tropics alternate wet and dry seasons throughout the rainfall annual cycle. Thus, an evenly distributed rainfall amount throughout the wet season is vital to healthy plants and crop growth. However, more and more frequent extreme events cause real challenges to farmers in developing countries to plan for a selection of crops that will help maximize production. On one hand, deficits in water availability restrict plant development and are an impediment to increased crop yield. On the other hand, too much water causes flooding and harmful fungus growth that can destroy crops. NMHSs in developing countries are now faced with an increased demand from governments and society to provide forecasts for the onset of the rains and outlooks for dry and wet spells within the season. Several factors can contribute to a delayed or early onset of the rains or to the variability of rainfall within the crop season. These include boundary moisture supply, sea surface temperature (SST), Rossby and Kelvin waves, dry air intrusions, the Madden–Julian oscillation (MJO), etc. Recent advances in numerical predictions have enabled a better representation of some these factors in weather and climate models. While research continues to better understand these processes and their influence on weather regimes and regional climate variations, introducing these concepts to scientists in developing countries at least allows NMHSs to provide some guidance to their respective governments and users to enable advance planning to take actions to reduce risks.

  - *Access to global climate forecast products.* The access and use of operational climate databases and the interpretation of products from the global centers producing long-range forecasts (GPCs) is critical to the improvement of operational seasonal forecasts in the tropics. Studies have shown that statistical downscaling of multimodel ensemble (MME) forecasts from

GPCs can tremendously enhance forecast skill in some areas. There is now a concerted effort from the international community led by WMO to foster collaboration between GPCs, the WMO regional climate centers (RCCs), and NMHSs to enable effective use and applications of GPC products in forecast operations. Future training workshops should include instructions on GPC data access, forecast interpretation, statistical downscaling, and forecast verifications. The training must be sustained and coordinated among GPCs, RCCs, and NMHSs to allow for tangible improvement of forecast operations and services.

- *Climate forecast verifications.* Climate forecast verifications are essential, as they can help assess the skill of the forecasts that were provided and form a basis for adjustments to the forecast method. WMO has established standardized metrics for forecast verifications. There are now online tools that help make forecast verifications accessible to users, especially from developing countries. One of these tools is the Forecast Evaluation Tool (FET) developed by the University of Arizona that focuses on the CPC seasonal climate forecast by climate division, season, and lead time. Such tools need to be included in the revised curriculum for future training workshops.

Technical skill.

- *GIS and GrADS.* There clearly is a need to enhance the technical skills of professionals at NMHSs beyond providing routine operational forecasts. It was recommended that future training workshops include geographical information system (GIS) applications, PC Grid Analysis and Display System (GrADS), and other applications tools that require minimal programming or resources. Integrating these tools into NMHSs' information system framework will enable them to considerably improve their products and services. The NOAA–USAID series plan is to include the teaching of these tools in the curriculum for the 2014 workshop.

- *Communication of forecasts and forecast uncertainty.* NMHSs face a significant challenge in effective communication of climate forecasts and forecast uncertainty to the public and policy makers. As NMHSs expand and improve their climate products, they will need to improve their communication of the information they generate to enable decision making in the application sectors.

- *Climate monitoring tool.* Recognizing the fact that operational climate forecasting systems need to build on a solid climate monitoring system, it is important to develop instructional materials geared to improve NMHSs' climate monitoring systems. Tools such as the CPC developed Climate Monitoring Tool (CMT), which enables routine monitoring of the climate system, need to be made widely available. CMT is a free software package that can operate in both Windows and Linux machines. It enables the display of time series and spatial maps to allow for continuous monitoring of the evolution of precipitation, temperature, and/or any other variable at any given location around the world. These tools have been proven effective in early warning systems and are currently being used at NMHSs that have had access to the training.

**CONCLUSIONS.** As a follow up to these recommendations, NOAA, USAID, and WMO are currently discussing the training needs assessments and developing a plan for future training workshops to address some of the gaps identified during the 5ITWCVP and GSCVPS. The broader capacity development needs identified under the GFCS implementation priorities are also taken into account. Plans for the 2014 workshop are currently underway. The curriculum of the 2-week training workshop will include access to GPCs products, statistical downscaling of MME forecasts, seasonal forecast verifications, GIS, and communication. These will help reinforce the knowledge gained during the four previous workshops and help NMHSs improve their operational support to climate services.

**ACKNOWLEDGMENTS.** The 5ITWCVP and GSCVPS was primarily funded by grants from USAID through WMO and the U.S. National Weather Service (NWS). TSMS provided in-kind contributions, and worked with WMO to arrange logistics for the workshop and symposium. The workshop and symposium were supported by lecturers from Africa, Asia, Europe, North America, and South America. We are grateful for the quality instructional materials they prepared and presented. Lecturers and participants contributed to a most productive discussion that culminated in the set of recommendations listed herein.