PREFACE

Drought: Advances in Monitoring, Preparedness, and Understanding Drought Characteristics

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Recent droughts in the United States and around the world have once again focused attention on our ability to monitor, prepare for, predict, and understand drought. The 2011 drought in Texas and the southern Great Plains of the United States was unprecedented in its intensity. Record dry conditions were present during much of the year, especially between March and August, and summer temperatures were the warmest ever recorded in Texas. The 12-month rainfall was the driest on record across much of western, central, and southern Texas, and many locations received less than 25% of normal precipitation. The record drought caused significant agricultural losses because of the impacts on crops and cattle. Many rivers and reservoirs dried up and a number of towns in Texas ran out of drinking water. Wildfires ravaged the state destroying homes and lives. The drought also caused serious environmental damage, and a Texas A&M Forest Service survey estimated that 301 million trees in Texas were killed by this drought.

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The 2011 drought is but one example of how drought can have a significant impact on both the environment and society. An improved understanding of the causes, impacts, and predictability of drought will facilitate the adoption of appropriate adaptation, mitigation, and avoidance strategies. Significant attention has been devoted to drought research in recent years, and this special collection on drought in *Earth Interactions* focuses on new research that 1) describes new methods for monitoring drought and detecting drought (McEvoy et al. 2012; Mishra and Singh 2012; Vicente-Serrano et al. 2012); 2) documents the impacts of precipitation variability and drought (Lafon and Quiring 2012); 3) introduces new tools for drought monitoring (Heim and Brewer 2012); and 4) investigates current trends and potential future changes in drought frequency, severity, and duration (Long et al. 2012; Mo et al. 2012). These papers demonstrate that significant progress is being made in our understanding of drought and our ability to monitor and predict drought conditions.

Mo et al. (Mo et al. 2012) provide useful guidance for water resource managers and decision makers by demonstrating that not all of the phase 3 of the Coupled Model Intercomparison Project (CMIP3) models provide accurate projections of future drought conditions and water availability. They evaluate the ability of seven different coupled atmosphere–land–ocean models to accurately simulate drought and persistent wet spells over the United States. Their study is motivated by the need for understanding future changes in the frequency and severity of meteorological and agricultural droughts. Mo et al. (Mo et al. 2012) demonstrate that only coupled atmosphere–land–ocean models that capture both the west–east moisture gradient across the continental United States and realistically simulate the seasonal cycle are able to accurately represent drought and persistent wet spells. Since ENSO is the dominant mode that modulates precipitation over the United States, to realistically simulate drought, the coupled models also need to capture precipitation responses to ENSO. Their research is significant because it helps to identify the coupled models that provide the most accurate representations of future hydroclimatic extremes.

Long et al. (Long et al. 2012) investigates trends in temperature and precipitation extremes in the U.S. High Plains between 1958 and 2010. They identified statistically significant decreases in extreme temperature range over much of the High Plains, which were mainly driven by increases in minimum temperatures. Long et al. (Long et al. 2012) also showed that in the High Plains, like many other regions around the world, there has been a notable increase in the number of warm nights. Trends in precipitation extremes were much less spatially coherent than the temperature extremes. Many of the wetter locations in the study region (e.g., eastern High Plains) had statistically significant increasing trends in daily precipitation intensity, while drier locations (e.g., western High Plains) had decreasing trends. Their findings are in general agreement with Intergovernmental Panel on Climate Change (IPCC) Working Group I (WG1) Fourth Assessment Report (AR4) projections, which suggest that wetter locations will receive more precipitation and drier locations will receive less precipitation. Long et al. (Long et al. 2012) also examined trends in the 1-month standardized precipitation index (SPI) and found that there has been a decrease in severely dry ($SPI < -1.5$) areas within the High Plains and an increase in wet areas ($SPI > 1.0$). Overall, there is a decreasing trend in the number of dry months in the High Plains. The relatively short length of the observational record and the significant natural variability in the climate system make it difficult to identify robust trends in climate extremes, especially for precipitation. However, this study demonstrated that changes in temperature and precipitation patterns are already occurring in the High Plains, and these changes have implications for agriculture and water resources.

Heim and Brewer (Heim and Brewer 2012) introduce the Global Drought Monitoring Portal (GDMP), a new tool for drought monitoring. Drought is a global phenomenon and the GDMP serves as a clearinghouse for drought information and as a platform to support drought monitoring and mitigation efforts around the world. The Global Drought Monitor and GDMP are an outgrowth of the U.S. National Integrated Drought Information System (NIDIS), and they represent a collaboration between the North American Drought Monitor, European Drought Observatory, and African Drought Monitor. The GDMP incorporates information from Africa, Europe, and North America, and future plans include further expansion to provide drought information on Asia, Australia, and South America. Heim and Brewer have been instrumental in developing this important tool that has the potential to serve as an integrated, proactive global drought early warning system.

Lafon and Quiring (Lafon and Quiring 2012) examine the impact of precipitation variability on wildfire activity. Similar to Mo et al. (Mo et al. 2012) and Long et al. (Long et al. 2012), their work is not restricted to drought events. To date, most of the work linking climate and wildfire activity has focused on the western United States. Lafon and Quiring (Lafon and Quiring 2012) fill a critical knowledge gap by considering how hydroclimatic extremes influence wildfire activity in the eastern United States. Climatic conditions, especially moisture conditions, are a fundamental control of wildfire activity. Lafon and Quiring (Lafon and Quiring 2012) demonstrate that locations with intermediate moisture conditions (i.e., not too wet or too dry) provide the best habitat for fire since they provide sufficient moisture for developing fuel loads, but they also experience prolonged dry periods that are conducive to wildfire occurrence. Precipitation variability is identified as being an important control of fire activity in the eastern United States since environments with high precipitation variability experienced more fires and had a greater areal extent of burning than locations with relatively little precipitation variability. Despite its humid climate, the southeastern United States has more wildfires annually than any other region of the United States.

As noted by Vicente-Serrano et al. (Vicente-Serrano et al. 2012), there has been a major effort to develop tools/methods for monitoring drought, most commonly drought indices. This has resulted in the creation of dozens of different drought indices. Vicente-Serrano et al. (Vicente-Serrano et al. 2012) have made a significant contribution to drought monitoring by undertaking a comprehensive global performance evaluation of the SPI, the standardized precipitation evapotranspiration index (SPEI), and four different versions of the Palmer indices. These drought indices were compared to streamflow, soil moisture, forest growth, and crop yield to determine which indices are most suitable for monitoring hydrological, meteorological, and agricultural drought. Vicente-Serrano et al. (Vicente-Serrano et al. 2012) determined the SPEI and SPI outperformed all of the Palmer indices and that, of the two, the SPEI is slightly better than the SPI during the summer since it accounts for evapotranspiration. This is the first global study to objectively evaluate the degree to which commonly used drought indices can characterize drought impacts such as crop yield and streamflow. This study demonstrates that the SPEI is the best index to use for most drought monitoring tasks.

McEvoy et al. (McEvoy et al. 2012) also focused on evaluating drought indices. They compared the performance of the SPI and SPEI for monitoring hydrological drought using streamflow, lake, and reservoir levels from Nevada and eastern California. McEvoy et al. (McEvoy et al. 2012) determined that the SPEI was superior to the SPI because it is able to better account for evaporative demand. These findings are in agreement with those of Vicente-Serrano et al. (Vicente-Serrano et al. 2012). Both of these studies also note that it may be possible to further improve the SPEI by utilizing more reliable and physical-based estimates of potential evapotranspiration rather than the temperature-based approaches that were employed here.

Mishra and Singh (Mishra and Singh 2012) are interested in simulating hydrological drought. They compared hybrid wavelet Bayesian regression models and Bayesian regression models to determine which method is most appropriate for predicting the Palmer hydrological drought index (PHDI). They found that the wavelet–Bayesian regression model was a better approach. However, when this method was utilized for simulating the PHDI based on data from general circulation models, it did not perform well.

Drought is a complex, multiscalar, and multifaceted phenomenon. The papers in this special collection illustrate the breadth and depth of contemporary drought research and they demonstrate that progress is being made in improving our understanding of drought and our ability to monitor and predict drought conditions. The long-term goal of drought research is to improve our ability to monitor and predict drought so that appropriate adaptation and mitigation strategies can be employed. The devastation wrought by the 2011 Texas drought reminds us of the importance of this work and how much remains to be done.

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