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Advancing drought understanding, monitoring and prediction

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Abstract

Despite recent advances in drought understanding, monitoring and forecasting, current drought capabilities still fall short of users' needs, especially the need for skillful and reliable drought forecasts at regional and local scales. To tackle this outstanding and challenging problem, NOAA's Drought Task Force was established in October 2011 as a focused and coordinated research effort drawing from excellence across the broad drought research community, with the ambitious goal of achieving significant new advances in the ability to understand, monitor and predict drought over North America. The NOAA Drought Task Force Meeting (held October 25-26, 2012 in Fort Collins) had the goal to assess work status and advances after the first year of activities, develop future plans and assess near-term research gaps. Highlights of the Drought Task Force meeting and its outcomes are provided in this summary.

TITLE: NOAA Drought Task Force Meeting

What: Over 40 participants including Drought Task Force scientists from multiple academic and federal institutions and invitees from drought service and operational organizations met to discuss the latest drought research advances, prospects for improving current capabilities and outstanding research gaps.

When: October 25-26, 2012

Where: Fort Collins, Colorado

Having the capacity to monitor droughts in near-real time and providing accurate drought prediction from weeks to seasons in advance can greatly reduce the severity of social and economic damage caused

by drought, a leading natural hazard for North America. The congressional mandate to establish the National Integrated Drought Information System (NIDIS, Public Law 109-430) in 2006 was a major impulse to develop, integrate and provide drought information to meet the challenges posed by this hazard. Significant progress has been made on many fronts. On the research front, efforts by the broad scientific community have resulted in improved understanding of North American droughts, and improved monitoring and forecasting tools. We now have a better understanding of the droughts of the 20th Century including the 1930s' "Dust Bowl"; we have developed a broader array of tools and datasets that enhance the official North American Drought Monitor based on different methodologies such as state-of-the-art land-surface modeling (e.g. the North American Land Data Assimilation System) and remote sensing (e.g., the Evaporative Stress Index) to better characterize the occurrence and severity of drought in its multiple manifestations. In addition we have new tools for drought prediction (including the new NCEP Climate Forecast System v2 for operational prediction and an experimental National Multi-Model Ensemble) and have explored diverse methodologies including ensemble hydrologic prediction approaches. Broad NIDIS-inspired progress is influencing the development of a Global Drought Information System (GDIS) under the auspices of the World Climate Research Program.

Despite these advances, current drought monitoring and forecasting capabilities still fall short of users' needs, especially the need for skillful and reliable drought forecasts at regional and local scales. To tackle this outstanding, challenging problem, focused and coordinated research efforts are needed, drawing from excellence across the broad drought research community. To meet this challenge, NOAA's Drought Task Force was established in October 2011 with the ambitious goal of achieving significant new advances in the ability to understand, monitor and predict drought over North America. The Task Force (duration is October 2011 – September 2014) is an initiative of NOAA's Climate Program Office Modeling, Analysis, Predictions, and Projections (MAPP) program in partnership with NIDIS. It brings

58 together over thirty leading MAPP-funded drought scientists from multiple academic and federal
59 institutions (involves scientists from NOAA's research laboratories and centers, NASA, U.S.
60 Department of Agriculture, NCAR and many universities), in a concerted research effort that builds on
61 individual MAPP research projects. These projects span the wide spectrum of drought research needed
62 to make fundamental advances, from those aimed at the basic understanding of drought mechanisms to
63 those aimed at testing new drought monitoring and prediction tools for operational and service purposes
64 (as part of NCEP's Climate Test Bed). The Drought Task Force provides focus and coordination to
65 MAPP drought research activities, and also facilitates synergies with other national and international
66 drought research efforts, including those by the GDIS (more information about the NOAA Drought Task
67 Force can be found at
68 http://cpo.noaa.gov/ClimatePrograms/ModelingAnalysisPredictionsandProjections/MAPPTaskForces/DroughtTa
69 skForce.aspx).

70 The NOAA Drought Task Force Meeting was held with the intent to assess work status and advances
71 after the first year of activities, develop future plans and assess near-term research gaps (for more
72 information regarding the Drought Task Force meeting visit
73 http://cpo.noaa.gov/ClimatePrograms/ModelingAnalysisPredictionsandProjections/MAPPTaskForces/DroughtTas
74 kForce/DTFYear1Meeting.aspx). The first day of the meeting was conducted jointly with NOAA's 37th
75 Climate Diagnostics and Prediction Workshop in order to share Drought Task Force research with the
76 broader community, receive feedback, and identify synergies with other activities. Day 1 included oral
77 sessions on *Drought Monitoring and Data Assimilation*, *Drought and Hydroclimate Prediction*, *Physical*
78 *Mechanisms and Case Studies for Extreme Hydroclimate Events*, *Drought Information and Services*, and
79 an evening poster session. The multiple presentations by Drought Task Force investigators showing
80 results from their ongoing research projects were complemented by presentations from the broader

community. The second day dedicated most of its time to planning and discussion with several main goals: 1) Make direct connections between the Drought Task Force participants and service organizations that have a stake in Drought Task Force research outcomes; 2) Sum-up Year One Drought Task Force accomplishments and make plans for Year Two; and 3) Discuss near-term drought research gaps and explore linkages with the developing GDIS. Invitees of the Day 2 meeting included all Task Force participants and selected representatives of the drought service organizations (including representatives from the Drought Mitigation Center, Regional Integrated Sciences and Assessment teams (RISAs), NIDIS Pilots, and Regional Climate Centers). Highlights of the Drought Task Force meeting outcomes are provided below.

Summary of Drought Task Force Year One activities As part of its Year One efforts, the Task Force has developed a drought test-bed framework that individual research groups can use to test/evaluate methods and ideas. Central to this is a focus on three high-profile North American droughts which are key areas for NIDIS early warning system development (1998-2004 western US drought, 2006-2007 SE US drought, 2011- 2012 Tex-Mex drought over the Southern Plains). The framework facilitates collaboration among projects, defines metrics to assess the quality of monitoring and prediction products, and helps to develop an experimental drought monitoring and prediction system that incorporates and assesses recent advances. Three working groups (WG) were formed to address the major aspects of the test-bed: 1) WGI - Metrics: to define and apply metrics to evaluate advances in drought monitoring and prediction 2) WGII - Case Studies: to analyze drought cases by integrating all aspects of drought research and 3) WGIII - Experimental System: to incorporate research advances in an experimental drought monitoring and prediction system and assess improvements. To date, the Drought Task Force has proposed a *Journal of Hydrometeorology* special collection entitled “Advances in

Drought Monitoring and Prediction" that will include research papers from individual Task Force members as well as a number of collective papers.

Drought Task Force Plans for Year Two In the coming year, the Drought Task Force plans to build on the foundation of collaboration established in Year One by continuing to press the overarching goal of evaluating drought science, and by concentrating efforts in several specific areas. High-level goals include:

1. Improving our understanding of the nature of drought, its manifestations and causes, and improving narrative communication thereof (key issues include the role of soil moisture, ocean conditions, evaporative demand, land surface-precipitation-temperature relationships, cross-temporal and cumulative aspects of drought risk).
2. Quantifying current monitoring and prediction capabilities, and particularly improvements attributable to the Drought Task Force projects.
3. Identifying and investigating areas that offer the most promise for improving operational capabilities, and strengthening the drought research to operations connection with active linkages, in preparation for Year Three.

In order to achieve the above goals, the Task Force activities will be organized around specific themes consisting of 1) drought relevant science issues, 2) drought narratives, and 3) research to operational capabilities (RtC, for short). These themes recognize the multiple and important roles the Drought Task Force can play to advance drought science and service capabilities. Specific roles include 1) stimulating progress on basic drought science issues, 2) addressing the ongoing North American drought and possible future droughts to facilitate discussions on causes and develop narrative explanations thereof,

and 3) assessing recent progress in drought monitoring and prediction, with an eye towards advancing operational/service capabilities, building on the metrics and case studies framework developed during Year One. The planned "narrative" activities will occur twice a year and focus on the analysis of recent past droughts and provide a venue to discuss research results regarding manifestations and scientific explanations of the droughts. The "RtC" activities will also take place on a six-monthly basis and in contrast to the "narrative" activities will focus primarily on the three historical test-bed droughts selected by the WG-Case Studies and the application of the metrics agreed upon by the WG-Metrics to provide a benchmark against which to test new operational and service capabilities. The Drought Task Force "narrative" activities will result in Drought Reports describing and explaining, from a research perspective, recent past droughts. The findings from the RtC activities will be summarized in an RtC Report, a "living document" assessing progress in capabilities that will be regularly updated.

Near-Term Research Gaps Attendees discussed near-term drought research gaps and potential future research directions focusing on drought 1) understanding, 2) monitoring, 3) prediction, and 4) improving drought information systems. Questions that stimulated discussion included: *What are current gaps in understanding the mechanisms that control the development (onset, duration, demise, intensity, frequency) of U.S. drought in its various manifestations? Are there gaps in current capabilities to monitor U.S. drought? How does our prediction skill compare with expected predictability over the U.S.? What are the most promising new methodologies, models and observations to be explored to improve drought prediction? What are the gaps in current leading drought information (monitoring and prediction) systems contributing to NIDIS? Which of these gaps are "science-limited" and requiring research? What major contributions can the Drought Task Force bring in the broader international context?* A collective Drought Task Force paper, in preparation for the *Journal of Hydrometeorology*

special collection, will summarize major outcomes of this discussion.

Overall, the meeting represented an important milestone for the NOAA Drought Task Force. It helped assess progress since its inception and reinforce collaborations among Drought Task Force participants and make new connections within and outside of the Task Force. It provided a major push towards formulating a plan forward for the group that takes into account diverse input, including that of the drought research stakeholders and individual scientists involved in the research, hence building upon the foundation of user-requirements, impacts assessments, applications, and on-going research projects.

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