CLIMAS Update

News from the Climate Assessment for the Southwest Project

Integrating science, policy, and community

THE UNIVERSITY OF ARIZONA.

Volume 5, Number 1, May 2002

CLIMAS Contributes to Streamflow Forecasts

The American Geophysical Union 2002 spring meeting will be held May 28-31, 2002 in Washington, DC. More info: http://www.agu.org/.

The American Meteorological Society's 13th Conference on Applied Climatology will be held May 15-16, 2002 in Portland, OR. More information: http://www.ametsoc.org/AMS/.

The Udall Center for Studies in Public Policy is co-sponsoring a meeting on environmental conflict resolution, May 14-16, 2002 in Tucson. More information at (520) 670-5299, or http://conference.ecr.gov.

The Mississippi River Climate and Hydrology Conference, sponsored by GEWEX Americas Prediction Project and the AMS, will be held May 13-17, 2002 in New Orleans. The meeting will feature sessions on Regional Integrated Assessments and Human Health and Climate Variability. For more info contact Kathy Watson, 301-427-2089 ext. 110.

CLIMAS Mission

CLIMAS was established to assess the impacts of climate variability and longer-term climate change on human and natural systems in the Southwest. Our mission is to improve the ability of the region to respond sufficiently and appropriately to climatic events and climate changes.

Background

Traditionally, the National Weather Service (NWS) River Forecasting Centers (RFCs) employ linear statistical models to develop seasonal water supply outlooks. This method provides a single, deterministic predicted streamflow value, rather than a probabilistic range of streamflow predictions that would reflect the uncertainty inherent in future meteorological or hydrological conditions. More recently, the NWS has developed a procedure called Ensemble Streamflow Prediction (ESP), which uses historical meteorological data, in conjunction with process-based conceptual hydrologic models available in the NWS River Forecasting System (NWSRFS), to create multiple estimates (an ensemble) of possible streamflow values. A statistical analysis of the ensemble results in a multi-valued forecast that has an associated probability of exceedance (a measure commonly used by hydrologists to express the probability of exceeding a certain streamflow value). ESP forecasts encompass the uncertainty in the models, initial basin states, and meteorological information, as well as streamflow estimates.

As water demand increases and water management operations become more constrained, forecast users will require more and better information about the uncertainty associated with the forecasted streamflow. The ESP forecasts may be more informative and useful to water supply forecast users than the single-value forecasts that are currently issued because they allow users to assess the risks involved in their decision making processes based on the forecast uncertainty.

The Colorado Basin River Forecast Center, a CLIMAS stakeholder, expressed a desire to have ESP more thoroughly evaluated. The project was undertaken by CLIMAS team member Kristie Franz, and produced results that are sure to be useful to the NWS RFCs and other stakeholders who produce and utilize streamflow predictions.

ESP

Ensemble streamflow predictions are produced using hydrologic models and historical meteorological data. Information about the state of the watershed at the beginning of the forecast period is input into the model. ESP assumes that past meteorological events are possible representations of future events. Thus historical temperature and precipitation data are used as inputs to the models in order to generate streamflow estimates for future forecast periods. Each set of precipitation and temperature data from different years and spanning the forecast period produces a single streamflow trace (simulation). The resulting traces are analyzed and uncertainties in the forecasted streamflows are estimated.

Methodology

Because ESP has only recently been available at all NWS RFCs, there are only a small number of operational forecasts available for evaluation. Therefore, it was

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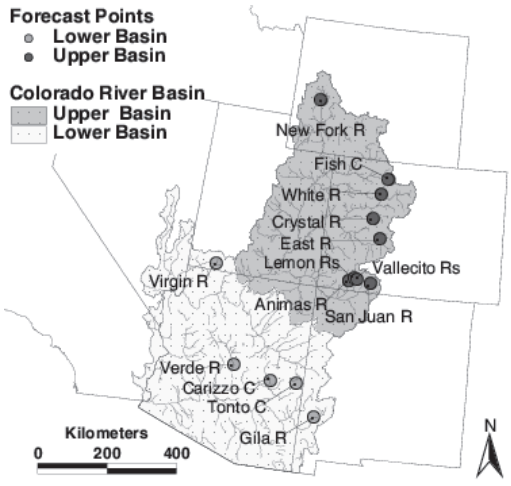

Figure 1. NWS River Forecasting System sites used to generate ESP forecasts.

What We've Been Up To…

CLIMAS was well represented at the 98th Annual Meeting of the Association of American Geographers, which took place March 20-23, 2002 in Los Angeles:

- Barbara Morehouse and Gregg Garfin organized and chaired two sessions about fire and climate. Garfin presented a paper entitled, "Climate Variability and Fire Management in the U.S. Southwest;" Morehouse's presentation was entitled, "Climate, Fire and Society in the Western United States."
- Korine Kolivras presented a poster about her work on "Exploring Links Between Climate and Influenza Outbreaks."
- David Brown, along with his colleague J.E. Diem, presented "An urban-induced summertime moisture signal in central Arizona."
- Diana Liverman presented a paper entitled, "Environmental Institutions and Non-Governmental Organizations on the U.S.-Mexico Border," and was a panelist in a session regarding "Career Paths of Women in Academic Geography: Senior Faculty."

Tom Pagano has written a student editorial for the April issue of Weatherzine entitled, "Life as an Interdisciplinary Scientist: Am I being set up?" The editorial is available at http://sciencepolicy.colorado.edu/zine/.

Thanks to Holly Hartmann and Tom Pagano for representing CLIMAS and the UA by serving as judges in the Aquila Seasonal Forecasting Competition. With their help, the second of six seasonal $50,000 prizes was awarded. The Aquila prize offers meteorologists, climatologists and other scientific professionals the opportunity to demonstrate their long-range forecasting skills.

The Climate Report, a quarterly publication of Climate Risk Solutions, Inc. (CRS), recently devoted an entire issue to CLIMAS research projects. The issue included articles by Barbara Morehouse on "An Integrated Approach to Evaluating Climate Impacts in the Southwestern U.S.;" Holly Hartmann, Tom Pagano and Soroosh Sorooshian on, "How Good are Seasonal Climate Forecasts;" and Korine Kolivras and Andrew Comrie's piece on "Predicating Valley Fever Incidence Based on Climate Conditions." CRS provides climate-related products and services to clients in the private and public sectors. More information is available at http://climaterisksolutions.com/.

Barabara Morehouse and the entire team of CLIMAS principal investigators and postdocs contributed to a session held at the American Meteorological Society annual meeting in Orlando, Florida, in January 2002. The session, entitled "Structuring climate services through stakeholder-driven assessment," summarizes the CLIMAS experience in working with stakeholders using various social science approaches.

Also at the January AMS meeting, Kristie Franz, Holly Hartmann, Soroosh Sorooshian and Roger Bales presented their recent work on "Evaluation of Colorado River Basin Ensemble Streamflow Predictions." More information on this project can be found on the first page of this issue of *CLIMAS Update.*

In January, CLIMAS Postdocs Gregg Garfin and Holly Hartmann attended a special meeting in Boise, ID, convened by the National Interagency Coordination Center (NICC) predictive services unit. The meeting was convened in order to present recent cutting-edge fire-related science to fire program managers at the National Interagency Fire Center. Garfin presented an overview of the CLIMAS fire-climate workshops, results of surveys compiled from the workshops, and the usefulness of the forecast evaluation tool developed by Hartmann and colleagues in the UA's Department of Hydrology and Water Resources. Hartmann demonstrated this new tool to program managers and others (who were unanimously impressed), and was invited for a return visit to NICC predictive services in order to give a complete demonstration of the tool's capabilities.

Finally, congratulations and best wishes to Tom Pagano in his new position with the USDA Natural Resource Conservation Service (NRCS) Water and Climate Center. Tom will be moving to Portland, Oregon as of May 1 to be the lead seasonal supply forecaster for the Colorado and Rio Grande river basins. The NRCS forecasts are critical for water and land management activities, and date back to the 1930s. While the forecasts are currently based on snow measurements, Tom will help the agency develop ways to integrate climate information, involving phenomena such as El Niño and Pacific Decadal Oscillation, into their forecasts.

Submissions and Publication Information

CLIMAS Update is published quarterly and welcomes the submission of items of interest. The editorial staff reserves the right to select and edit copy submitted for publication. All material in the newsletter may be reproduced, provided CLIMAS is acknowledged as the source. The newsletter is provided through the support of the National Oceanic and Atmospheric Administration (NOAA).

Deadline for next issue: September 1, 2002
Send to: Gregg Garfin at GMGarfin@email.arizona.edu
Newsletters are archived at: http://www.ispe.arizona.edu/climas/archive.html

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River Forecasting (continued)

necessary for Franz to create simulated operational forecasts for historical time periods using all available streamflow, temperature, and precipitation data. Water supply forecasts were generated using NWSRFS data for 14 locations in the Colorado River Basin (Figure 1) for the forecast periods used by the NWS. The Colorado River forecast points were then separated into two groups, the Upper Basin (UC) and the Lower Basin (LC), based on the fact that annual precipitation and streamflow generally increases, and average temperatures and streamflow variability decrease with increased latitude and elevation in the Colorado River Basin. Water supply forecasts for the UC are produced bimonthly from Jan 1 to June 1 and they report April through July streamflow volumes; forecasts for the LC are produced bimonthly from Jan 1 to April 1 and report future streamflows beginning with the date of the forecast through May.

Franz used a variety of skill measures (see figures) to analyze both deterministic and probabilistic forecasts that can be produced from ESP ensembles.

Results

In order to determine whether there were limitations to choosing the median trace, a practice commonly used by those familiar with single valued forecasts, Franz analyzed ESP deterministic forecasts. She found that the trace with the lowest absolute error (the "best" trace) provides superior forecast accuracy (Figure 2). Thus, valuable probabilistic information is lost when the median is chosen for deterministic forecasts.

Franz found that the probabilistic ESP forecasts performed better than forecasts using average (climatology) values from the beginning of the forecast season, and that forecast performance continued to improve as the season progressed (Figure 3). She found that while, on average, forecasts made early in the season (5-7 month lead times) are unable to accurately predict in which part of the flow distribution the streamflow will occur, they are able to predict which flow level is least likely to occur—thus providing useful information for forecasters and users. Franz also found that by the end of the forecast season, the ESP forecasts are, on average, correctly assigning the highest probability values to the low flow category. She found similar levels of accuracy for forecasts issued prior to an observation of high flows; however, forecasts for flows in the middle 40 percent category were significantly poorer.

Franz found that the reliability of ESP forecasts to predict flow levels with different probability varies throughout the season. Peak reliability for the UC occurs around March 15 (Figure 4), whereas peak reliability for the LC occurs around March 1. Although the overall reliability may not be perfect later in the forecast season, Franz found that forecasts are reliable for certain levels of forecast probability. Her statistical reliability assessment documents the accuracy of the forecasts and therefore allows forecast adjustment where necessary. Thus the probabilistic ESP forecasts provide forecasters with the flexibility necessary to take advantage of seasonal forecast accuracy, and to adjust for periods during which the model is less accurate.

Currently, Franz is conducting a study in conjunction with the NWS to apply the probabilistic statistical analyses described to a variety of operational NWS hydrologic forecasts. This study is being funded by the NWS to assess the types of forecasts these methods can be applied to, and the feasibility of their incorporation into their forecast evaluation procedures.

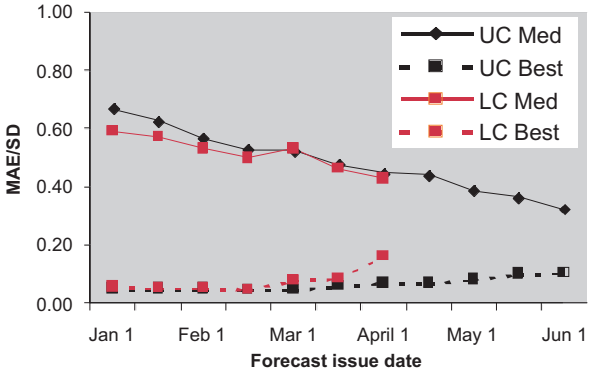

Figure 2. Mean absolute error (MEA) divided by the standard deviation for the median (med) forecast trace and the best forecast trace. UC – Upper Colorado River Basin; LC – Lower Colorado River Basin.

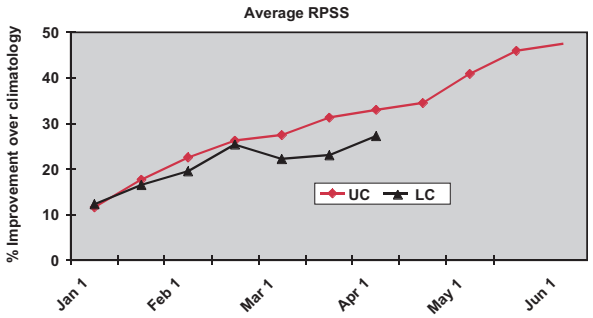

Figure 3. Ranked Probability Skill Score (RPSS) for Upper Colorado (UC) and Lower Colorado (LC) River Basin ESP forecasts. ESP forecast skill, as compared to climatology, increases during the course of the forecast season.

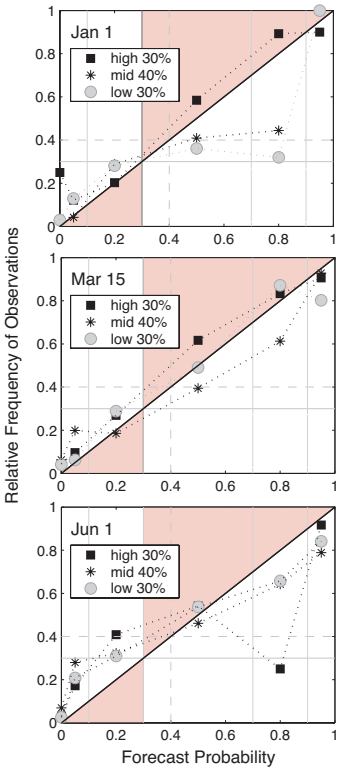

Figure 4. Reliability diagrams for ESP forecast performance. Higher forecast reliability is indicated by proximity to the thick diagonal line.

Fire in the West Workshop

CLIMAS, along with the Laboratory of Tree-Ring Research, ISPE, the program for Climate, Ecosystems and Fire Applications (CEFA) and the National Weather Service (Tucson), hosted its 3rd workshop to bring together climatologists, regional-level fire managers, and fire scientists from across the nation.

The Fire in the West Workshop combined research symposia and climate forecast talks. One symposium focused on fire-climate research on topics ranging from smoke management to continental-scale fire history reconstructions. The second, on human dimensions of fire management, highlighted efforts to engage community members in fire management practices, as well as social science research on and community perceptions of fuel management practices.

This year's workshop also included two groundbreaking sessions in which climate forecasters and fire managers produced fire season forecasts. Climate experts from around the country combined the results of forecast models to create a March-August 2002 national climate forecast specifically tailored to the needs of fire managers (available at http://www.cefa.dri.edu/).

In the second session, experts from the Southwest Coordination Center, CEFA, and NICC combined information from the national climate forecast with fuels assessments for Arizona and New Mexico to create a forecast of regional fire season conditions (http://www.fs.fed.us/r3/fire/).

Workshop proceedings will be available by summer 2002.

CLIMAS to Report on Anticipated El Niño

Starting this summer, CLIMAS will provide detailed updates and interpretation of the implications of El Niño forecasts for the Southwest. This will include information about past El Niño impacts, and will be available in paper copies and on our web site (http://www.ispe.arizona.edu/climas). We will also work with select stakeholders to get feedback about the utility of the information we provide.

Analyses by both the CPC and the IRI indicate that the early stages of El Niño are taking place, and that mature El Niño conditions will likely develop over the next 3-9 months. However, an El Niño event is not guaranteed, and it is important to remember that no two El Niños are alike. A projection of the ultimate strength of the El Niño and the associated impacts will be possible by summer 2002.

Summer 2002 Outlook: Drought, Fire, El Niño

Abnormally dry conditions in New Mexico noted in the January 2002 *CLIMAS Update,* have accelerated due to poor winter snowpack and a general lack of significant winter and early spring precipitation. The drought has manifested itself in poor range conditions, exceedingly low reservoir levels (some of which are at less than 30% of average), low streamflow levels, and an early fire season with continued high fire danger.

Climate forecasts from both NOAA's Climate Prediction Center (CPC) and the International Research Institute for Climate Prediction (IRI) indicate an increased likelihood of higher than average temperatures during the summer and early fall months. However, both CPC and IRI have reserved judgment with regard to summer precipitation in the Southwest.

CPC and IRI forecasters have expressed increased confidence that a mild-to-moderate El Niño event will develop during the next 3-9 months. Depending on the timing and strength of the forecasted El Niño, the Southwest might get some relief from drought conditions during the winter of 2002-2003. Based on the anticipated development of El Niño later this year, CPC is forecasting slightly increased probabilities of above average precipitation (based on May 1971-2000 average) during the fall and early winter.

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