

# Improving Climate Forecasts for the Southwest

By Klaus Wolter, Climate scientist at the NOAA-CIRES Climate Diagnostics Center



Dr. Klaus Wolter, a climate scientist with the NOAA-CIRES Climate Diagnostic Center (CDC) and the Western Water Assessment, has been conducting research to improve climate forecasting in the American Southwest. In this work, he hopes to make improvements over the current

official climate forecasts issued by the NOAA Climate Prediction Center by incorporating information on factors influencing Southwest climate that are only used in a limited way in the official forecast (see page 14).

## The Current State of Forecasting

NOAA's Climate Prediction Center (CPC) began producing and disseminating seasonal climate forecasts for the U.S. in the 1950s. The devastation to agricultural land and the economy caused by the dust bowl in the 1930s motivated the Federal government to develop forecasts inspired by prior efforts to predict the Indian monsoon<sup>1</sup>. Over the years, the most reliable tools have proven to be the state of ENSO and its climate impacts over the U.S. and "Optimum Climate Normals" (OCN), which are long-term trends in climate. CPC forecasters used these two tools in tandem with significant success in the late 1990s, but continued improvement in CPC forecasts has been elusive due to weak ENSO conditions since 2001 and, according to Dr. Wolter, the limited use of other climate factors in the CPC forecast.

The debate surrounding the best climate factors to use in forecasting reflects the subjective nature of much current climate forecasting, in which forecasters use their professional judgment to choose the appropriate mix of predictors to create the forecast. Furthermore, due to the chaotic nature of the climate system, climate forecasts are 'probabilistic', with a range of possible outcomes. Most climate forecasts assign probabilities to the occurrence of above-, below-, and near-normal conditions (terciles)<sup>2</sup>, because it would be scientifically unjustified to claim an exact and single possible outcome.



## New Strategies for Forecasting

For the past five years, Dr. Wolter has been researching the utility of other predictors for climate forecasts in the interior Southwest. Along with ENSO and OCN, Dr. Wolter uses regional sea surface temperature (SST) anomalies off the shores of California, as well as the Gulf of Mexico, and Indian Ocean SST anomalies to create his monthly climate forecasts of the Interior Southwest (AZ, CO, NM, UT). These additional predictors increase the diversity of climate factors in his forecast, and Dr. Wolter believes that this helps increase the accuracy of his forecasts.

To include new predictors in his climate forecast scheme, Dr. Wolter searches for "teleconnections" between the monitored climate factor (e.g, SST) and climate impacts to the SW region (e.g, dry winters). For example, western U.S. drought conditions since late 1999 are part of a much larger drought complex spanning the globe from the Mediterranean Sea across southwest Asia and into much of the southern U.S. Although persistent La Niña conditions explained at least part of this pattern, recent modeling studies point to the persistent warmth of the Indian Ocean and western Pacific Ocean as an additional causal factor. In addition, land surface conditions in the western U.S., such as the late season snowpack, may be linked to the strength of the summer monsoon in the southwest.

To create his statistical climate forecasts, Dr. Wolter screens his predictors in a 'Stepwise Linear Regression' (SLR), a statistical approach used in climate forecasting since Sir Gilbert Walker and his co-workers applied it for Indian monsoon predictions in the early 20th century. Predictors are added to the SLR only if they explain at least 10% additional variance in the forecast. The forecasts then are cross-validated by creating ensemble forecasts based on at least five different training periods, i.e., out of a five decade period, the forecast is created for four decades and then verified against one sliding decade of data, with a different decade held out each time. The forecasts are "bias corrected" or calibrated, by checking how well anomalously dry or wet conditions are predicted in the held-out portions of the record, and the new predictions are adjusted accordingly. Finally, the forecast is assigned to the tercile categories and created as a map.

<sup>1</sup> Walker, G. T., and E. W. Bliss, 1932: World Weather. *V. Mem. Roy. Meteorol. Soc.*, 4, 53-84

<sup>2</sup> For a detailed explanation of tercile categories, see the notes sections on either the Temperature or Precipitation Outlook pages (p. 13 or 14).



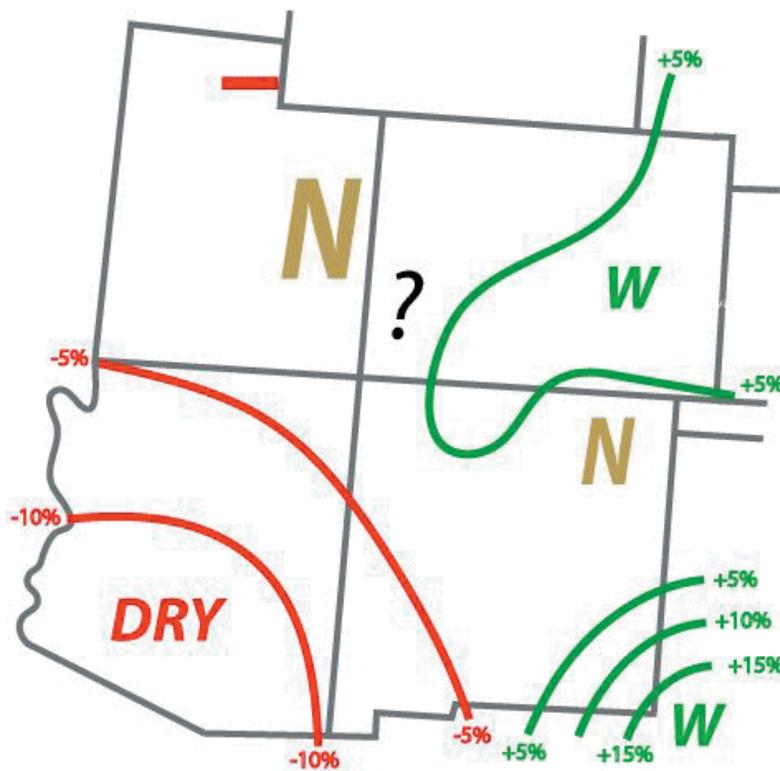
**A New Climate Product for the Southwest**

The Climate Forecast for the Interior Southwest for July-August-September, shown here as a map (Figure 14), indicates that eastern Colorado and southeastern New Mexico have favorable odds for a wet summer, while there is increased risk for a dry monsoon season in Arizona. The remainder of Colorado has roughly climatological odds (“equal chances”, in CPC terminology) for the summer. In the system of NOAA official and experimental forecasts, Dr. Wolter’s climate predictions are considered experimental guidance, because CDC is responsible for experimenting with new climate products and CPC produces official forecasts. This experimental guidance product, including a discussion and executive summary, is generally updated monthly and is available on the web at: <http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html>.

**Notes**

The experimental guidance for seasonal future precipitation in Figure 14 shows most recent forecast of shifts in tercile probabilities for July - September 2005. In order to be shown on this map, a forecast tilt in the odds has to reach at least 3% either towards wet (*above-average*), dry (*below-average*), or near-normal (*average*). Shifts towards the wettest (driest) tercile are indicated in green (red), and are contoured in 5% increments, while near-normal tilts of at least 3% are indicated by the letter “N”. Shifts over 10% considered significant. Positive (negative) shifts between three and five percent are indicated by a green (red) plus (minus) sign, while minor shifts of one or two percent are left blank in this display.

**Experimental CDC July-September 2005 Precipitation Forecast June 15, 2005**



**Figure 14.** Experimental guidance for seasonal precipitation in the southwest for July - September 2005.

**Streamflow Outlooks and Information On the Web**

- For more information about NRCS water supply forecasts based on snow accumulation and access to the graph on this page, visit: <http://www.wcc.nrcs.usda.gov/wsf/>.
- The official NOAA streamflow forecasts are available through the following websites of individual River Forecast Centers:
  - Colorado Basin (includes Great Basin): <http://www.cbrfc.noaa.gov/>
  - Missouri Basin (includes South Platte and North Plate): <http://www.crh.noaa.gov/mbrfc/>
  - West Gulf (includes Rio Grande): <http://www.srh.noaa.gov/wgrfc/>
  - Arkansas Basin: <http://www.srh.noaa.gov/abrfc/>

