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WHAT WE KNOW ABOUT THE WEATHER: SHORT- AND LONG-TERM WEATHER TRENDS

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Abstract

In the last few decades, advances in high-performance computing and a better understanding of oceanic and atmospheric processes have allowed forecasters to make more accurate short- and long-term weather predictions. By tracking jet-stream oscillations and quickly changing phenomena such as the North Atlantic Oscillation and the Pacific/North America pattern, short-term forecast models provide reasonable day-to-day accuracy out to approximately two weeks. Long-term forecast models may provide some accuracy several months in advance in certain situations, such as the presence of El Niño or La Niña during the cold season. Effects of annual (e.g. El Niño/Southern Oscillation) to decadal (e.g. Pacific Decadal Oscillation) variations are better understood than the processes that cause them.

A Look Back at 2003 Weather

In order to gain a better understanding of future (short- and long-term) conditions in the Cotton Belt, it will help to briefly look back at the weather that the South experienced in 2003. From the Delta to the southern Atlantic region, last year featured generally cooler-than-normal weather. For example, Mississippi marked its 29th-coolest year since records began in 1895 (figure 1). In contrast, persistently warmer-than-normal weather was observed from the southern High Plains westward into California. In fact, Arizona noted its hottest year during the 109-year period of record.

Abundant precipitation accompanied the cool weather pattern in the Southeast, highlighted by the wettest year on record in Virginia and North Carolina (figure 2). However, drought was a major problem for dryland cotton on the southern High Plains, while water-supply issues remained in the headlines across the Southwest. New Mexico reported its fifth-driest year on record.

Current Conditions

A recent U.S. Drought Monitor shows locations currently experiencing drought (figure 3). In the Cotton Belt, areas from southern California to the southern High Plains are entrenched in long-term drought. Although rangelands, pastures, and dryland crops continue to be adversely affected in the Southwestern drought area, an even greater concern is long-term water supplies. Meanwhile, a recent Palmer Drought Severity Index map reflects the long-term wetness affecting the Southeast (figure 4).

Selected Short- and Long-Term Forecast Tools

A brief look at short-term forecast tools for the Cotton Belt includes the Pacific/North America pattern (PNA) and the North Atlantic Oscillation (NAO). Both of these phenomena have been locked into relatively persistent phases (positive and negative, respectively) for more than a year and continue to influence weather patterns across the South. In fact, PNA+ and NAO- phases continue to work together to contribute to a cool, wet meteorological winter (December-February) weather pattern in the Southeast, as shown in figures 5 and 6. The only surprise with the persistent and ongoing PNA+/NAO- pattern has been a westward shift in the area of expected dryness, leaving the Southeast saturated and the southern Plains parched.

El Niño and La Niña: The Southern Oscillation

Commonly known by its warm- and cold-phase (positive- and negative-phase) names of El Niño and La Niña, the Southern Oscillation (ENSO) represents a measure of oceanic and atmospheric conditions in the eastern equatorial Pacific. ENSO's effects on weather in the Southern U.S. are profound, especially during the autumn, winter, and spring. Typical January-March effects of El Niño and La Niña are shown in figure 7. Generally speaking, El Niño typically produces wet weather in the Cotton Belt and cool conditions in the Gulf Coast region. La Niña typically provides a dry signal for the South, excluding the Delta, and often results in warmer-than-normal weather. However, the current state of ENSO is nearly neutral, meaning that neither characteristics of El Niño or La Niña are evident. As a result, ENSO is not a good forecast tool for the upcoming spring.

The Pacific Decadal Oscillation

The Pacific Decadal Oscillation also has a warm and cold (negative and positive) phase, but changes much more slowly than ENSO (figure 8). In the way that the PNA pattern and the NAO can work together in the short term, ENSO and the PDO can help to amplify long-term weather signals. In fact, the cold (positive) phase of the Pacific Decadal Oscillation (PDO+) is considered "El Niño friendly," and sometimes results in a long-term trend toward wetter conditions in the Cotton Belt. Conversely, PDO- can work with La Niña to induce drought across the southern High Plains and the Southwest, and may have played a role in the Southwestern drought of the 1950's. More recently, the combination of the 1998-2001 La Niña and a turn toward more negative values of the PDO may have sparked the development and persistence of drought across the Plains and Western U.S.

Western Water Supplies

The long-term Western drought that began to develop in the late 1990's has taken a toll on water supplies. On a statewide level, only California among the 11 Western states retains near-normal reservoir supplies for this time of year (figure 9). All other Western states report below-normal reserves, with New Mexico, Utah, and Nevada reporting less than 40 percent of their typical reservoir storage for December 1.

The National Weather Service's Drought and Long-Lead Outlooks

Once a month, the National Weather Service issues a drought outlook and a set of long-lead outlooks. The drought outlook specifically focuses on conditions expected in the nation's drought areas for the following three months. The drought outlook released on December 18, 2003, is valid for conditions expected through March 2004 (figure 10). The concurrent release of the long-lead outlooks covers temperature and precipitation forecasts for the next month and for thirteen overlapping three-month periods extending out more than a year. For example, the December 18 outlooks feature forecasts for January and for the thirteen overlapping periods from January-March 2004 to January-March 2005 (figures 11, 12, and 13).

Skill Scores and Conclusions

On its Web site, the National Weather Service's Climate Prediction Center publishes skill scores for its long-lead outlooks. Historically, the outlooks only have limited skill, but are most reliable during the cold-season months, especially in the presence of a strong El Niño or La Niña signal. Long-lead forecasting is in its infancy, in part because the effects of annual to decadal climate variations are better understood than the processes that cause them. Still, understanding of ocean-atmosphere interactions have greatly improved in recent decades. Consider that just two decades ago, prior to the strong El Niño of 1982-83, the far-reaching effects of ENSO were not yet well understood. By the time a similarly strong El Niño unfolded in 1997-98, its effects were widely expected and reasonably well predicted across the globe.

References

Francis, R. C. and S. R. Hare. 1994. Decadal-scale regime shifts in the large marine ecosystems of the Northeast Pacific: a case for historical science. Fish. Oceanogr. 3: 279-291.

Ropelewski, C. F. and M. S. Halpert. 1987. "Global and Regional Scale Precipitation Associated with El Niño/Southern Oscillation." Monthly Weather Review. 115: 1606-1626.

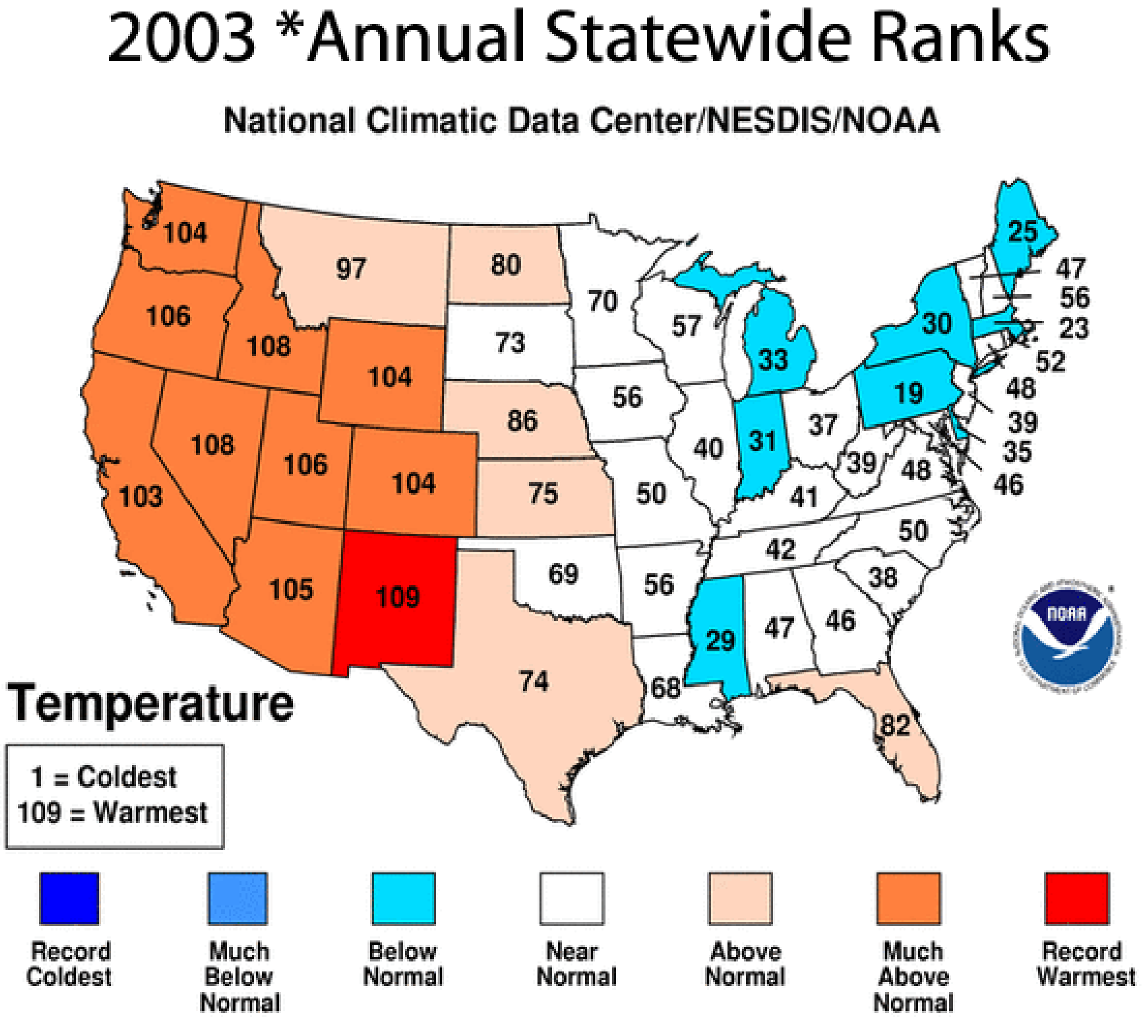


Figure 1. Preliminary 2003 statewide temperature rankings from the National Climatic Data Center.

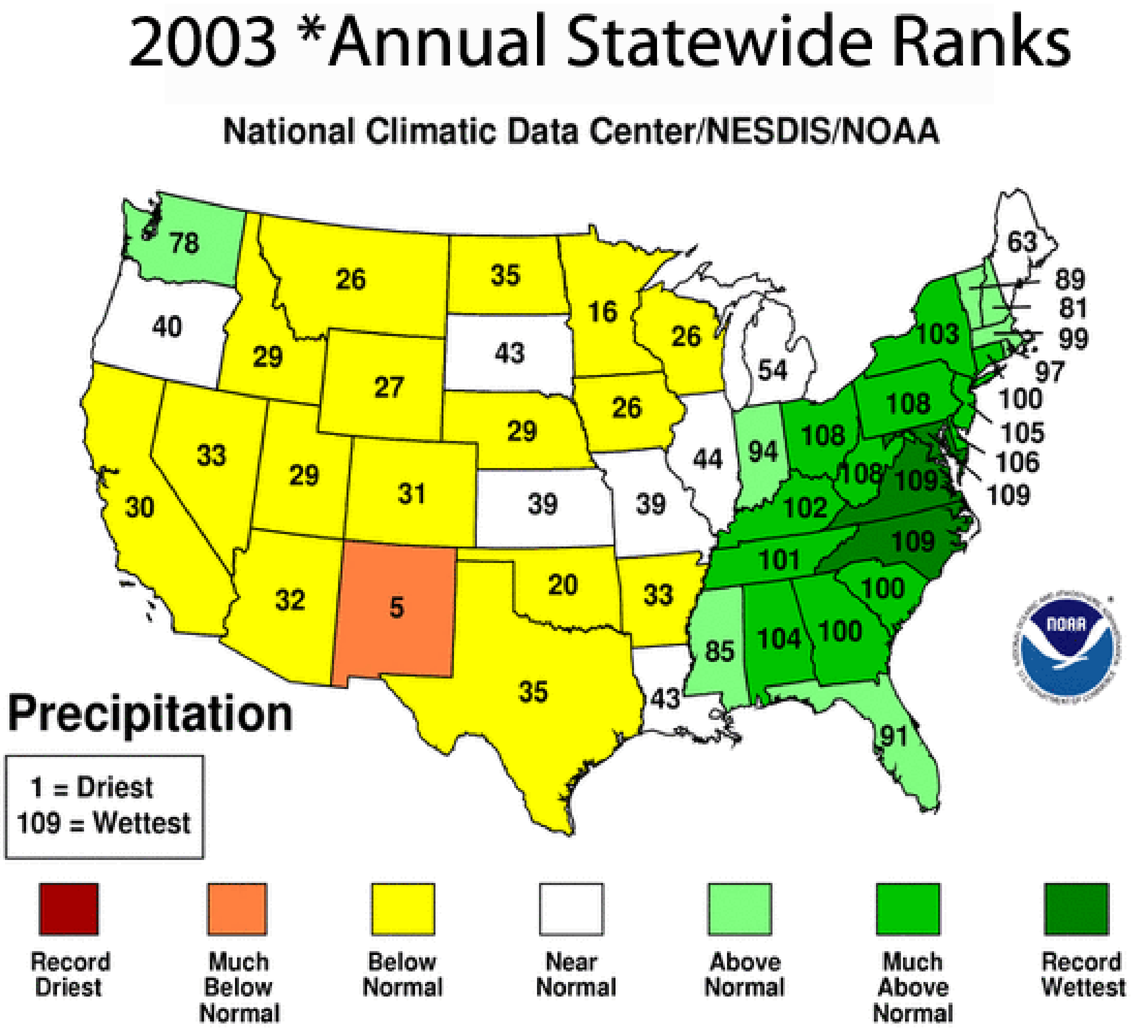


Figure 2. Preliminary 2003 statewide precipitation rankings from the National Climatic Data Center.

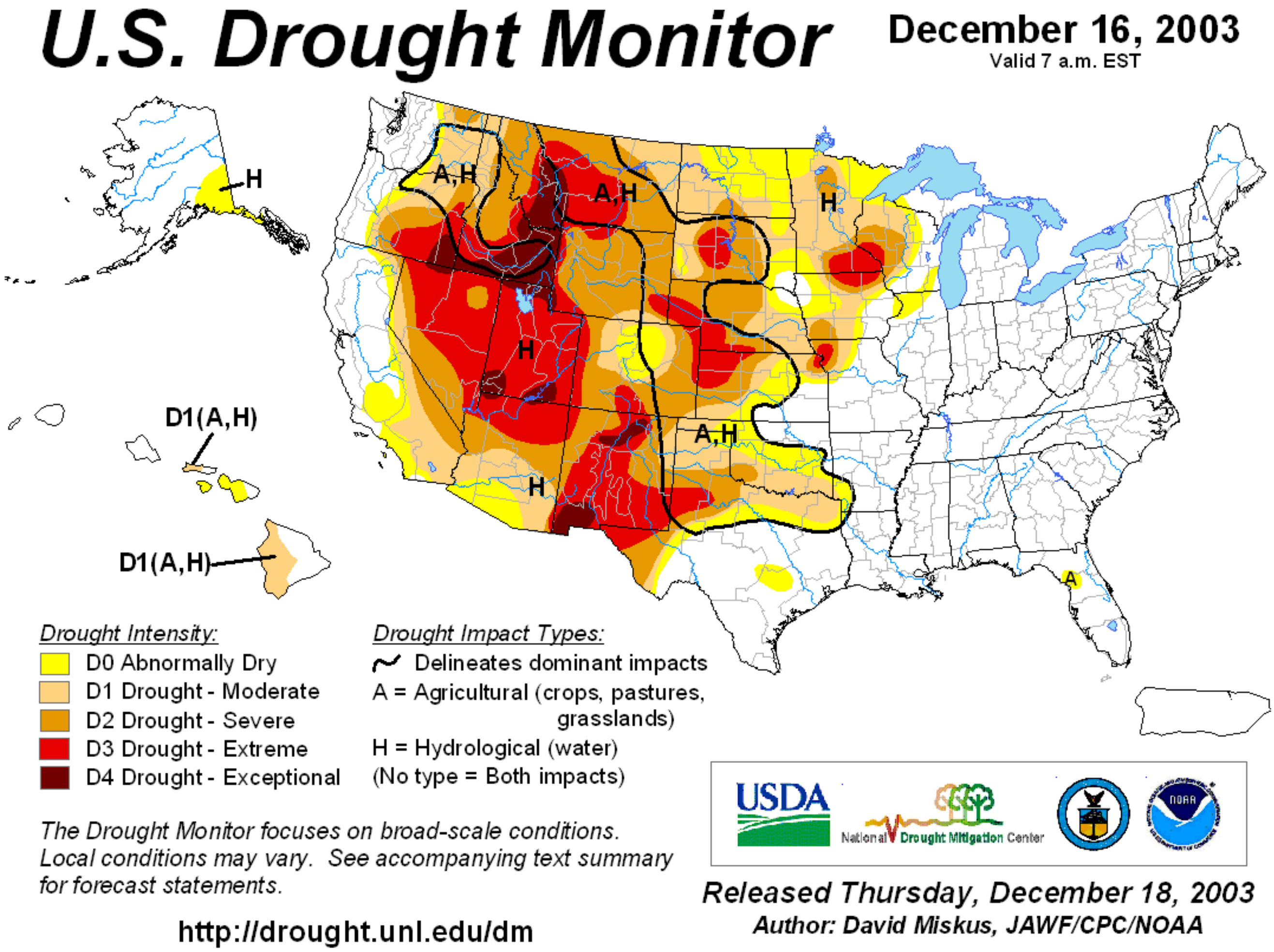


Figure 3. U.S. Drought Monitor, valid December 16, 2003.

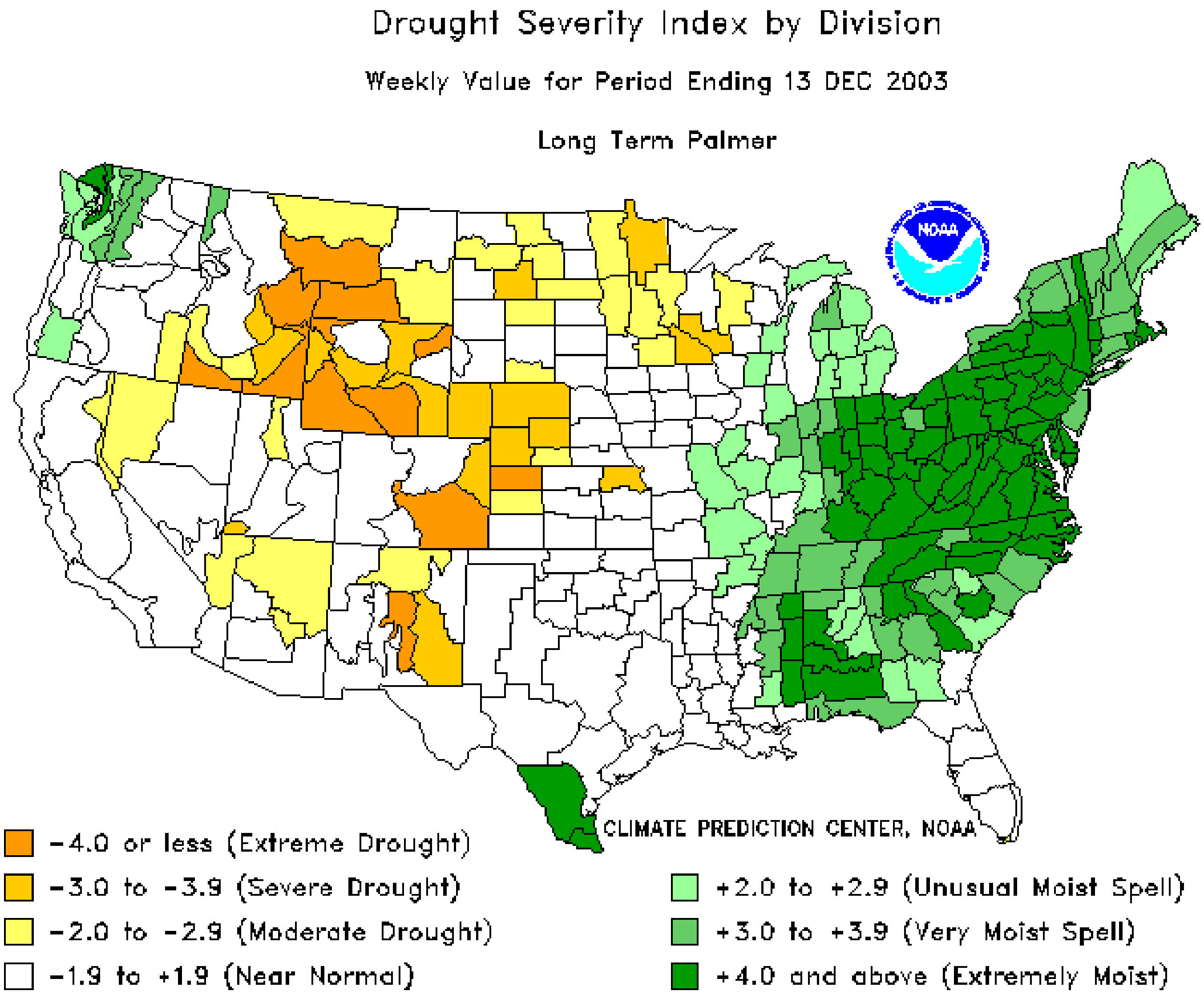
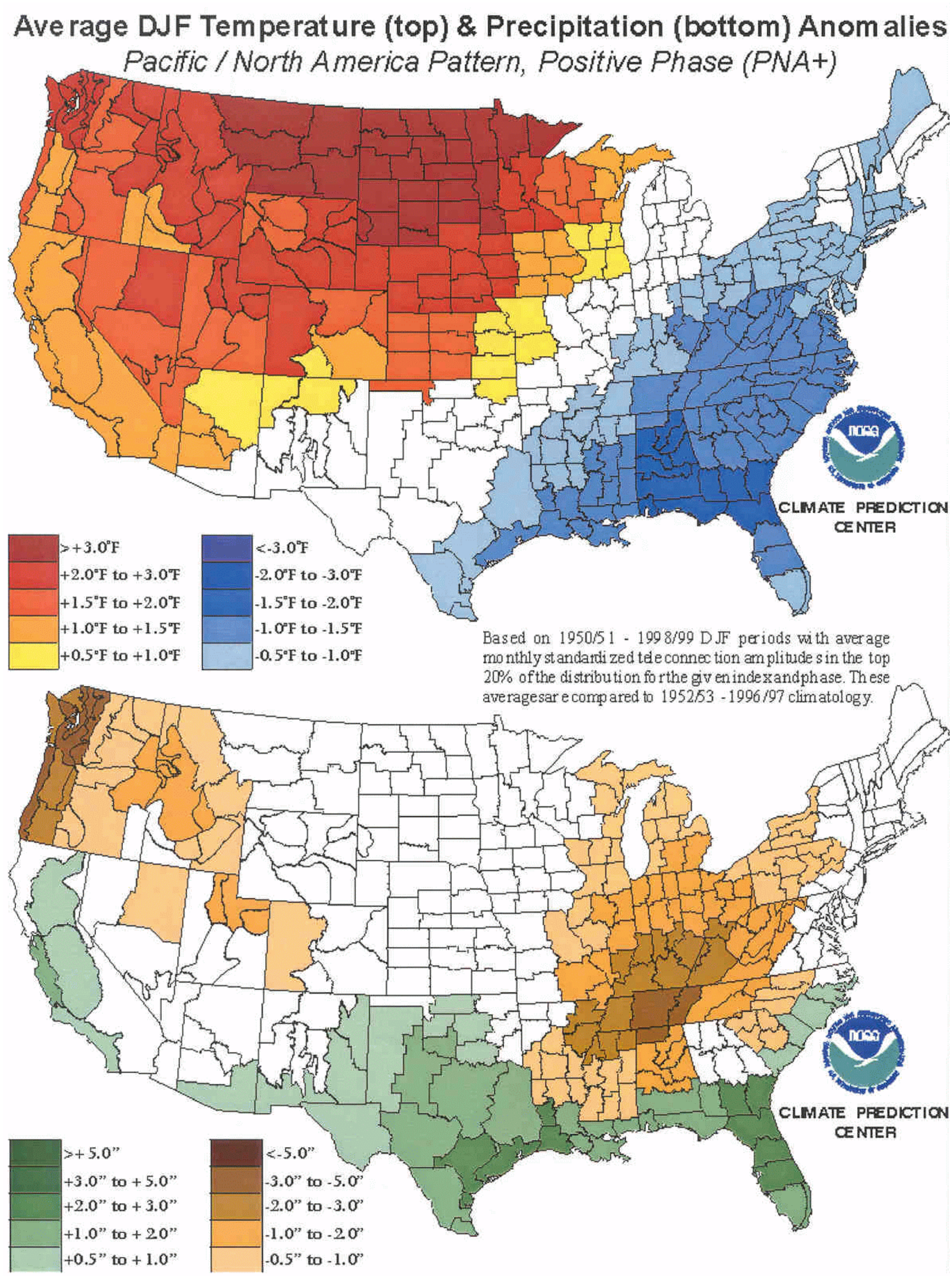


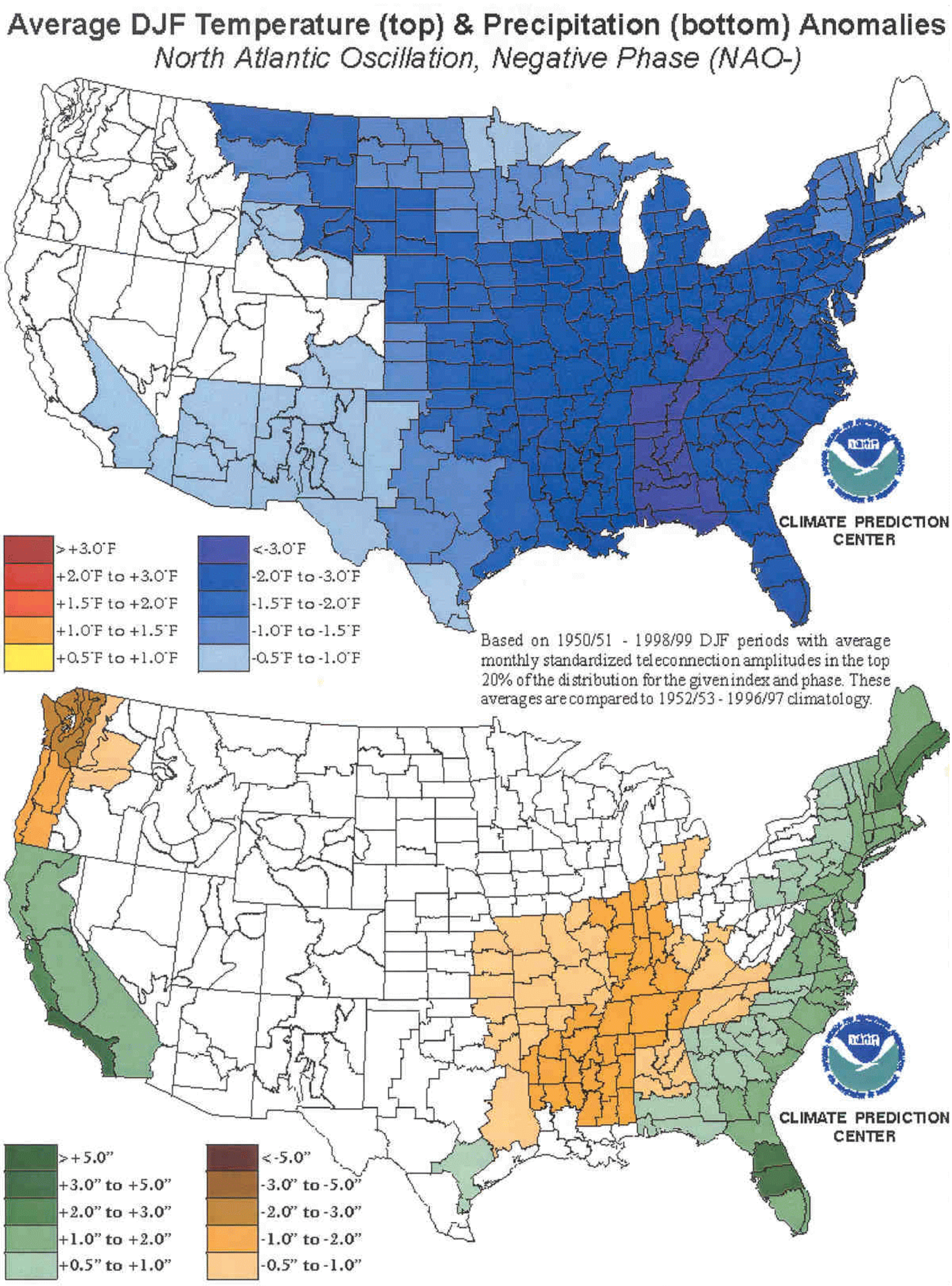
Figure 4. Palmer Drought Severity Index, by climate division, valid December 13, 2003.


Average DJF Temperature (top) & Precipitation (bottom) Anomalies

Pacific / North America Pattern, Positive Phase (PNA+)

Based on 1950/51 - 1998/99 DJF periods with average monthly standardized teleconnection amplitudes in the top 20% of the distribution for the given index and phase. These averages are compared to 1952/53 - 1996/97 climatology.

Figure 5. Averaged effects of the positive phase of the Pacific / North America (PNA+) pattern, December-February.



Based on 1950/51 - 1998/99 DJF periods with average monthly standardized teleconnection amplitudes in the top 20% of the distribution for the given index and phase. These averages are compared to 1952/53 - 1996/97 climatology.

Figure 6. Averaged effects of the negative phase of the North Atlantic Oscillation (NAO-) pattern, December-February.

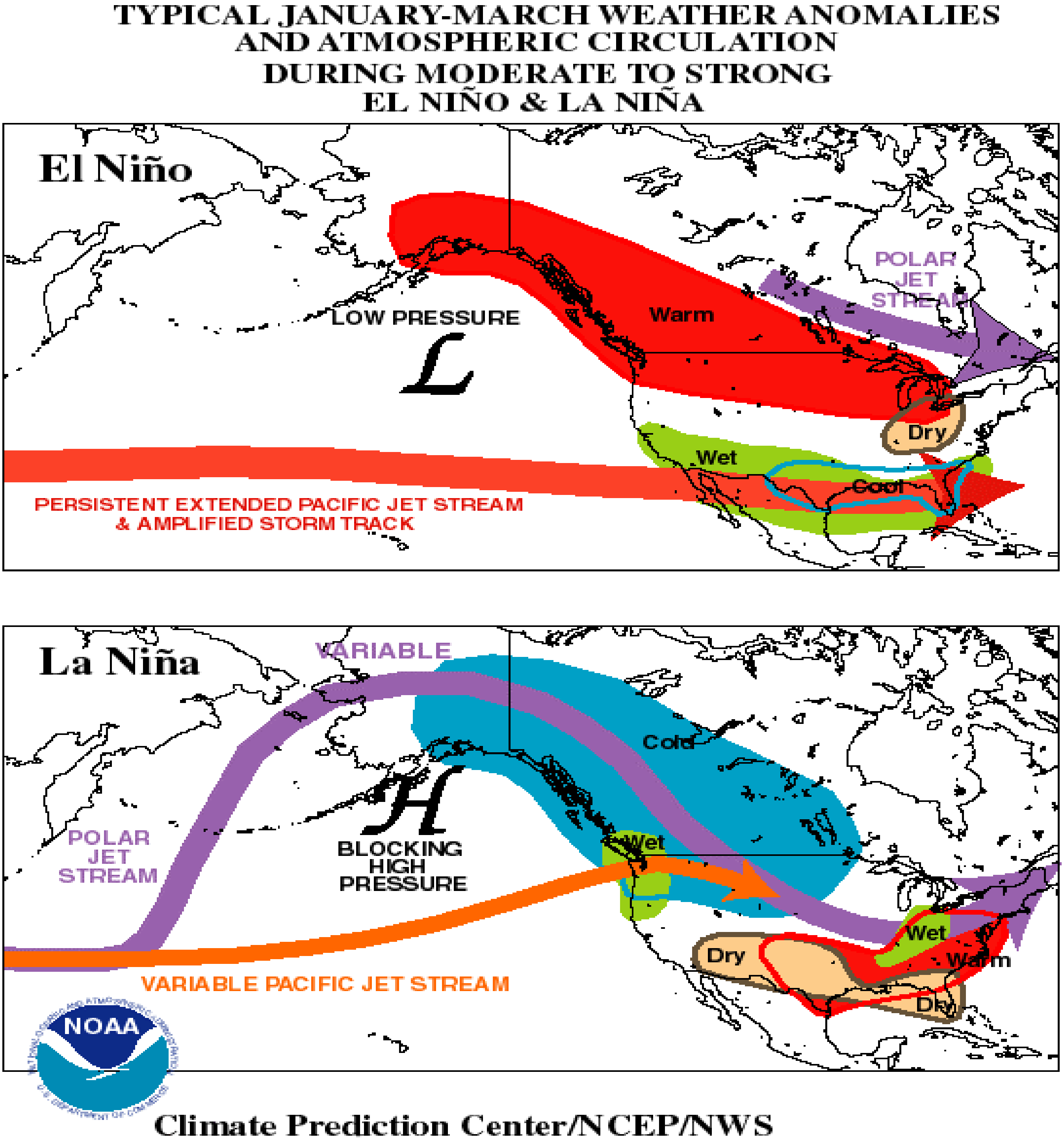


Figure 7. Typical North American weather anomalies related to El Niño and La Niña, January-March.

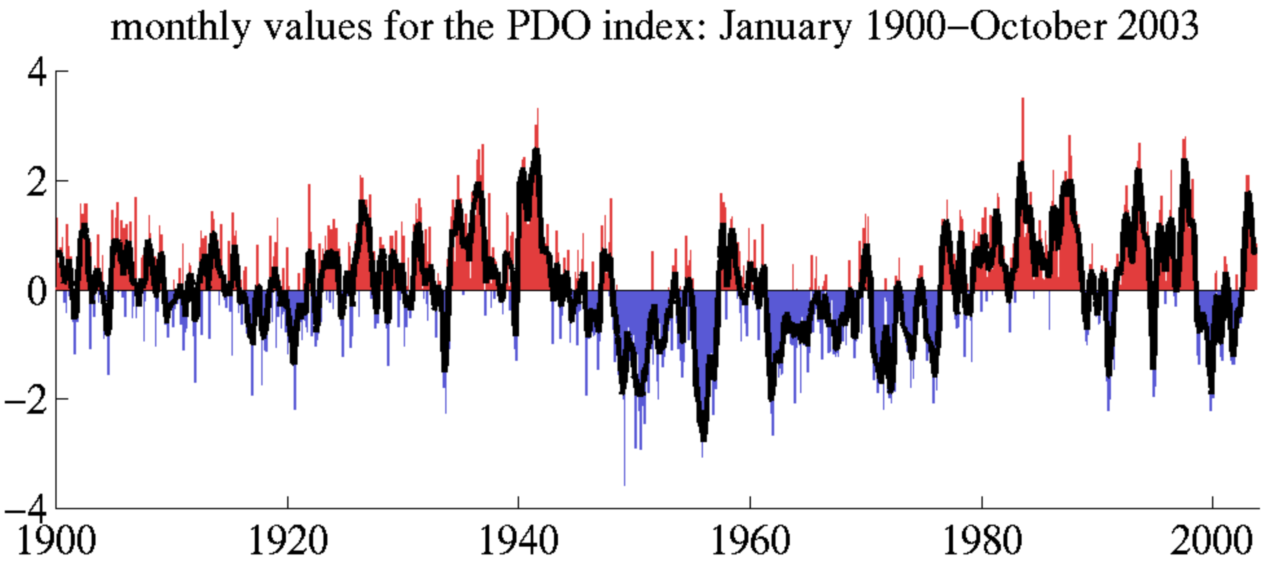


Figure 8. Monthly values of the Pacific Decadal Oscillation (PDO) Index since January 1900.

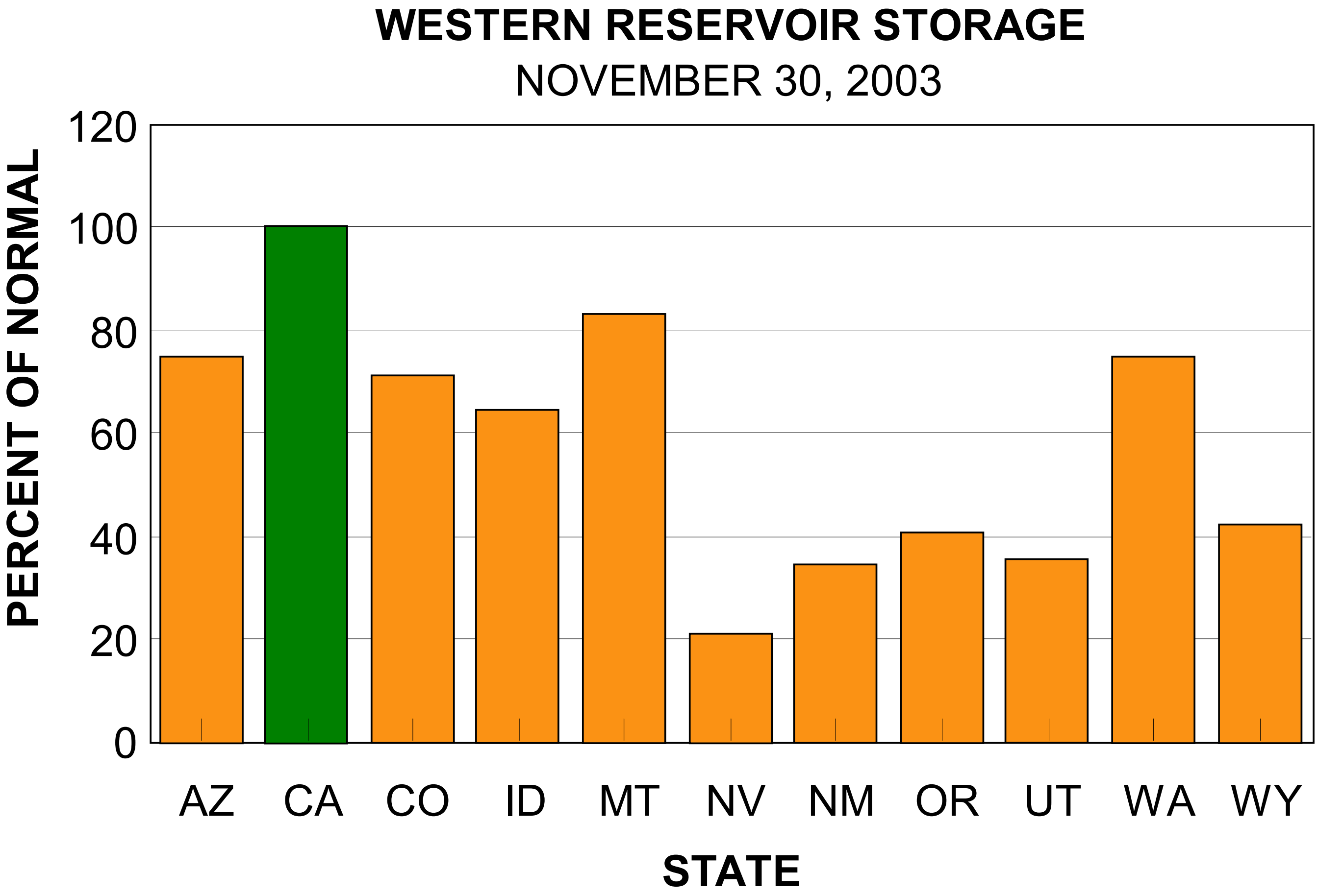
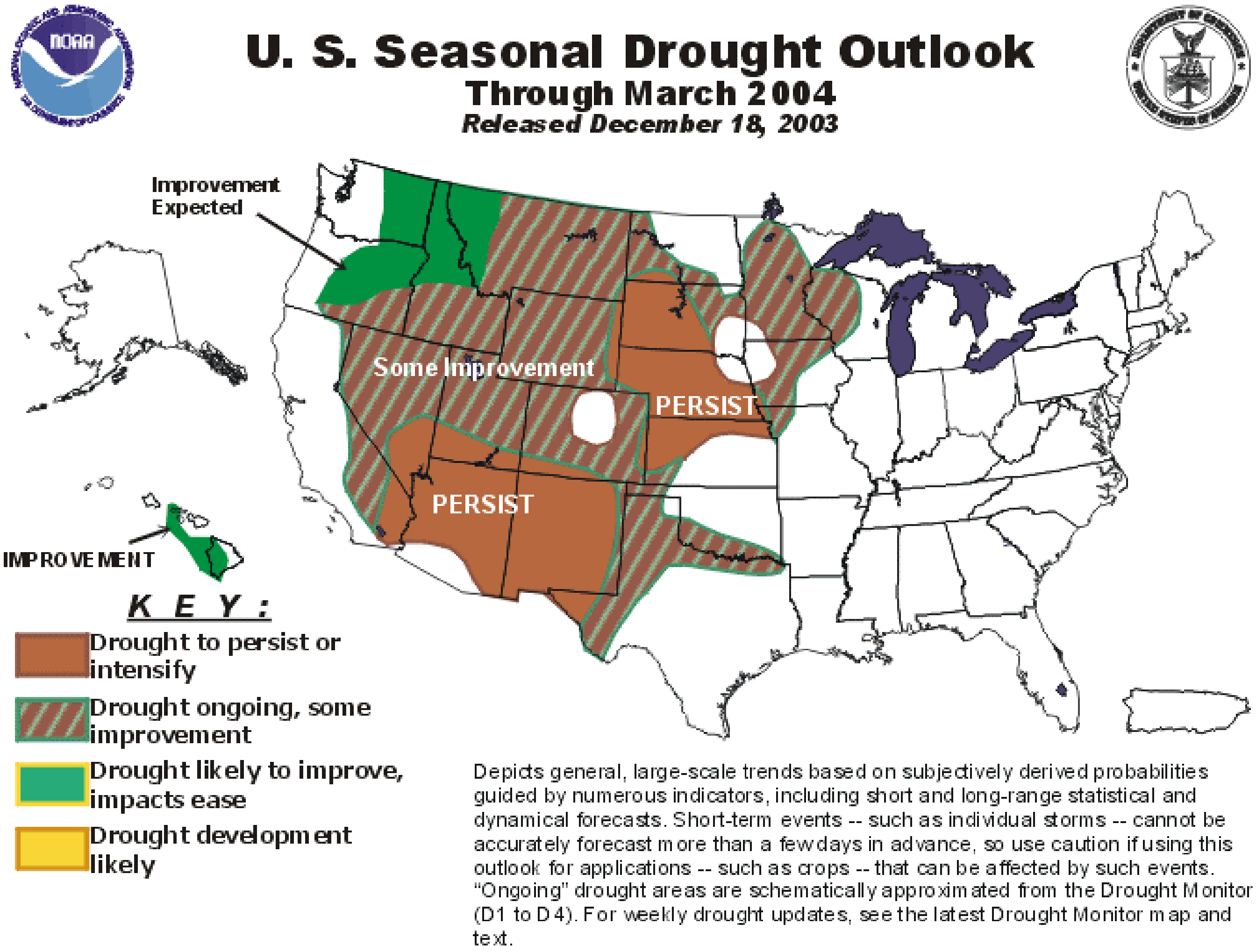
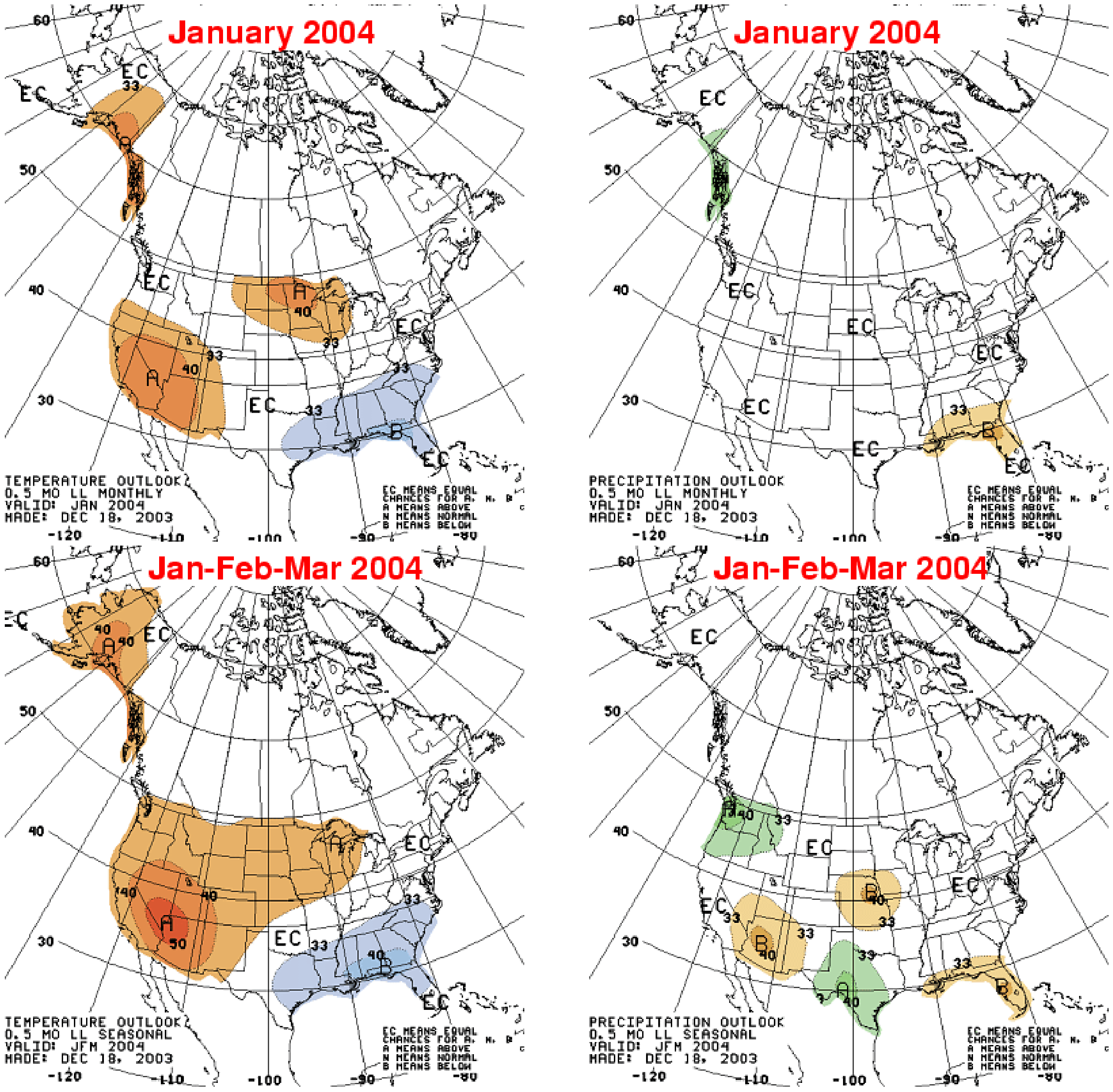


Figure 9. Western reservoir storage by state, as compared to normal for November 30.



Depicts general, large-scale trends based on subjectively derived probabilities guided by numerous indicators, including short and long-range statistical and dynamical forecasts. Short-term events -- such as individual storms -- cannot be accurately forecast more than a few days in advance, so use caution if using this outlook for applications -- such as crops -- that can be affected by such events. "Ongoing" drought areas are schematically approximated from the Drought Monitor (D1 to D4). For weekly drought updates, see the latest Drought Monitor map and text.

Figure 10. The latest U.S. Seasonal Drought Outlook, valid through March 2004.

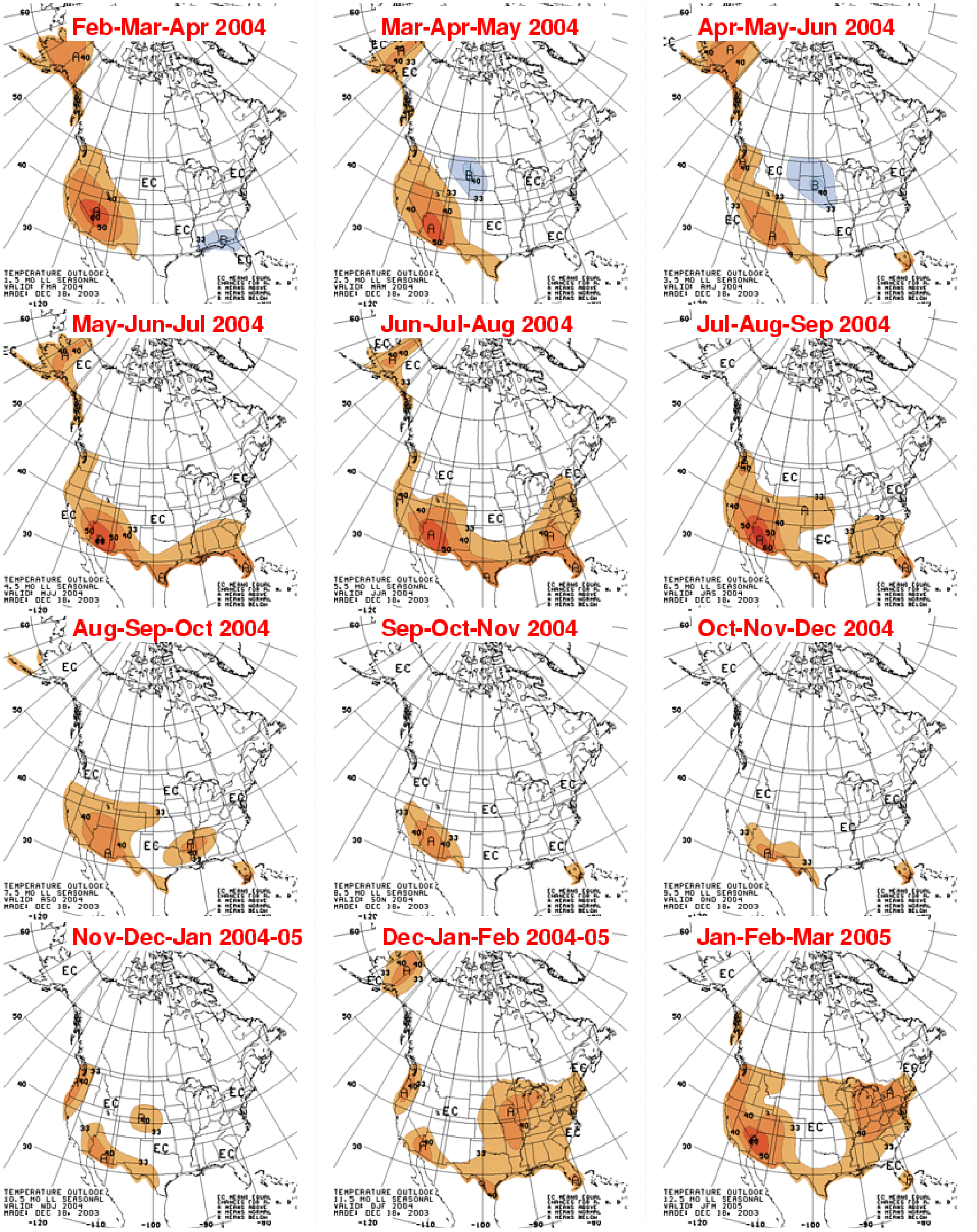

January 2004

January 2004

Jan-Feb-Mar 2004

Jan-Feb-Mar 2004

Figure 11. National Weather Service (NWS) temperature and precipitation outlooks for January and January-March 2004.



Feb-Mar-Apr 2004

Mar-Apr-May 2004

Apr-May-Jun 2004

May-Jun-Jul 2004

Jun-Jul-Aug 2004

Jul-Aug-Sep 2004

Aug-Sep-Oct 2004

Sep-Oct-Nov 2004

Oct-Nov-Dec 2004

Nov-Dec-Jan 2004-05

Dec-Jan-Feb 2004-05

Jan-Feb-Mar 2005

Figure 12. NWS temperature outlooks for overlapping three-month periods, February-April 2004 to January-March 2005.

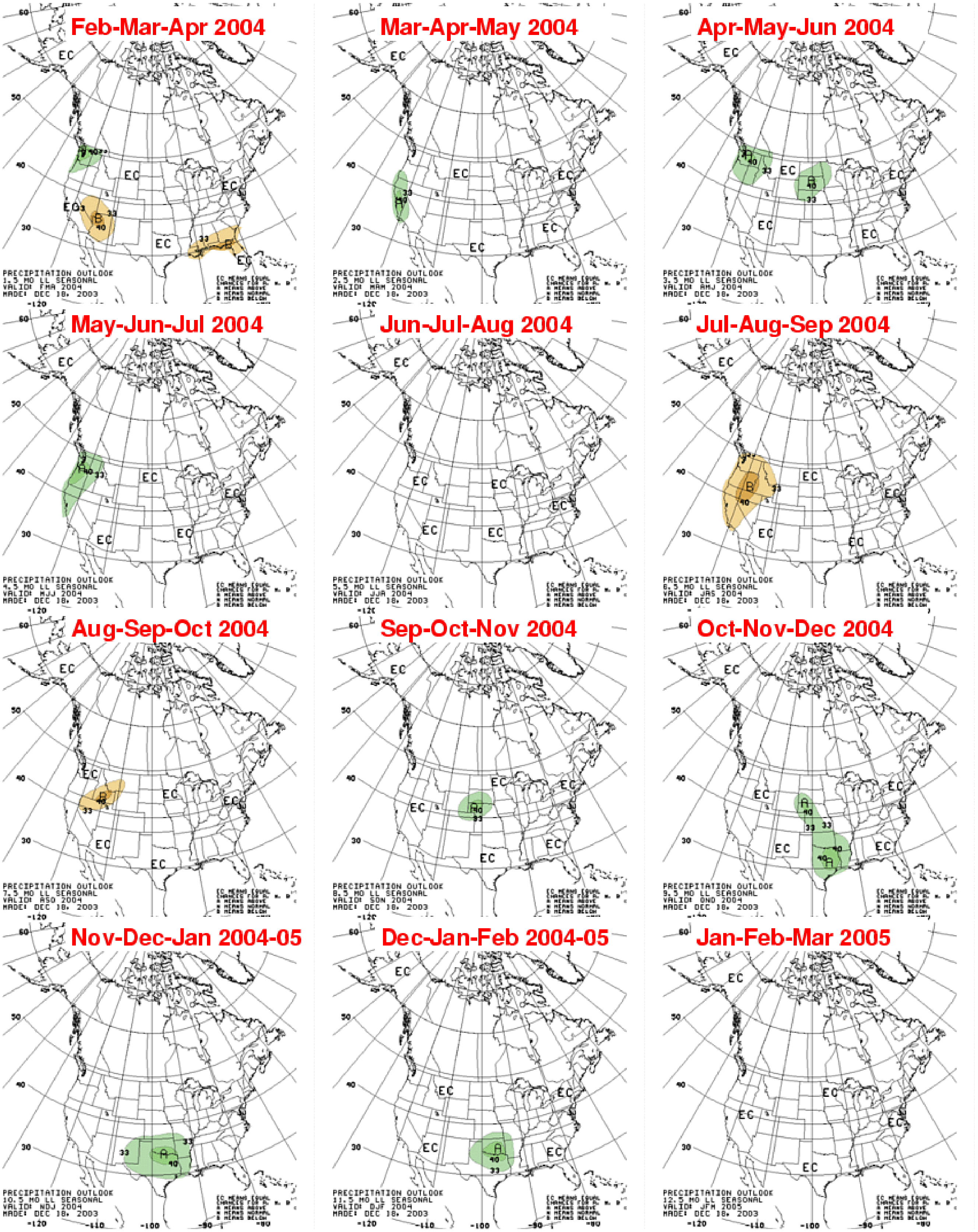


Figure 13. NWS precipitation outlooks for overlapping three-month periods, February-April 2004 to January-March 2005.