7A.5 THE CLIMATE OF 2007 IN HISTORICAL PERSPECTIVE

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1. INTRODUCTION

The Climate Monitoring Branch at the National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) routinely produces State of the Climate reports on a monthly, seasonal, and annual basis (e.g., NCDC 2007). The purpose of these reports is to put observed climate conditions into historical perspective using numerous sources of instrumental and paleoclimate data.

In this paper, we present the major climate and weather events of 2007, focusing on the temperature and precipitation patterns observed during the past year and their relationship to inter-annual trends in these parameters across the U.S. and the globe.

It is important to note that this article was written and submitted to the AMS before the end of 2007. The analyses presented emphasize conditions for January-November 2007. In addition to the standard parameters of temperature and precipitation, other important regional and global climatic conditions are included, such as the ongoing drought conditions in the western and southeastern U.S. Other large-scale influences on global climate, such as the El Niño/Southern Oscillation are also discussed.

2. GLOBAL CLIMATE

The Jan.-Nov. globally averaged temperature anomalies for both land and ocean surfaces using data from the NCDC blended data set of land and ocean temperatures (Smith et al. 2005) are shown in Figure 1 (top). The observed global surface temperature anomaly was +0.56°C (+1.01°F) above the 20th century mean. Although this ranks the January-November period as the 4th warmest such period since global records began in 1880, the 2007 annual mean temperature may fall to fifth warmest if the cooler than average waters in the central and eastern equatorial Pacific strongly influence the global average surface temperature in December.

Including 2007, seven of the eight warmest years on record have occurred since 2001 and the 10 warmest years have all occurred since 1997. The global average surface temperature has risen between 0.6°C and 0.7°C since the start of the twentieth century, and the rate of increase since 1976 has been approximately three times faster than the century-scale trend.

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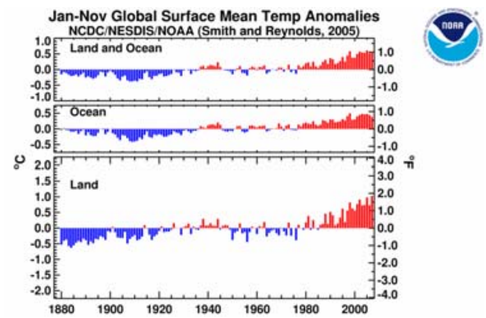


Figure 1. Global surface mean temperature anomalies (°C left and °F right) averaged over January-November for the period 1880-2007: (Top) land and ocean surfaces, (middle) oceans surfaces only, and (bottom) land surfaces only.

The greatest warming has taken place in high latitude regions of the Northern Hemisphere. Anomalous warmth in 2007 contributed to the lowest Arctic sea ice extent since satellite records began in 1979, surpassing the previous record low set in 2005 by a remarkable 23 percent. Areas often filled with ice in late summer were ice free. The absence of ice created a connection between the North Atlantic and North Pacific that was almost free of all sea ice, reportedly allowing for the passage of ships that had never before been possible. According to the National Snow and Ice Data Center, the low sea ice extent is part of a continuing trend in end-of-summer Arctic sea ice extent reductions of about 10 percent per decade since 1979.

3. ENSO AND THE TROPICAL PACIFIC

The El Niño/Southern Oscillation (ENSO) began 2007 in a weak warm phase (i.e., weak El Niño), which developed during September and October of 2006. The El Niño warm event peaked in December of 2006 and began to dissipate during January of 2007. As a result, the equatorial Pacific sea-surface temperature (SST) anomalies decreased during the first two months of 2007, eventually declining to near average by the end of March (Figure 2).

Neutral ENSO conditions persisted in the equatorial Pacific Ocean through the Boreal summer, and eventually the SST anomalies declined to significantly below average in July. The cooling trend continued in August, as below normal SST anomalies spread westward from the eastern tropical Pacific and the South American coast. The cooling ocean temperatures eventually reached the western equatorial Pacific, as the SST anomalies decreased to below-average in

August, breaking 15 consecutive months with above normal SST anomalies in the Niño 4 region (not shown).

Ocean surface and subsurface temperatures continued to cool throughout the remainder of 2007 in both the Niño 3.4 and Niño 4 regions. Figure 2 shows that the cooling trend in the equatorial zone in the Pacific basin continued to develop during the latter half of 2007.

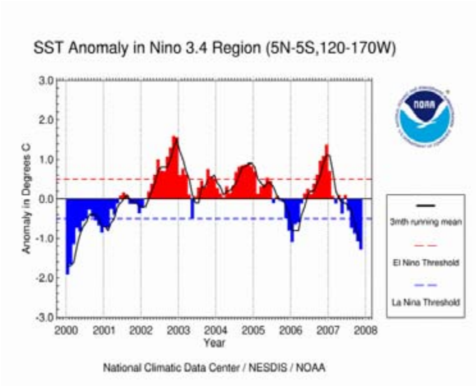


Figure 2. The monthly averaged sea surface temperature (SST) anomaly (red/blue bars in °C), and the three-month running mean SST anomaly (black line in °C), in the Niño 3.4 region during the period January 2000 through November 2007.

The observed cooling of the equatorial Pacific was most pronounced in the classical El Niño region of the eastern Pacific and along the South American coast (i.e., the Niño 1+2 regions) during May and September of 2007. The cooling of the eastern equatorial Pacific SSTs began as early as March.

By the end of November 2007, ocean surface temperatures in the equatorial Pacific had decreased to the lowest monthly anomalies of the La Niña event so far. SST anomalies were below -2.0°C (-3.6°F) across the equatorial Pacific from the South American coast to 140°W, with monthly averaged anomalies declining below -2.5°C (-4.5°F) in the eastern Pacific. Sub-surface temperature anomalies were also significantly below normal in November.

The Southern Oscillation Index (SOI) reflected the transition from a weak El Niño to a moderate La Niña during 2007 (Figure 3). During the first half of the year, the SOI was primarily negative, reflecting the relatively weak El Niño conditions in the Pacific basin. In fact, the SOI was negative for the first 5 months of 2007. Beginning in June, the SOI switched to a positive monthly value. Since August, the SOI had positive monthly values, indicative of a developing La Nina episode, and these continued through November.

At the beginning of 2007, the Outgoing Longwave Radiation (OLR) Index was strongly negative, which reflected the enhanced tropical convection and cloudiness across the equatorial Pacific (not shown). However, this changed significantly in June when the OLR Index increased to a monthly value of +0.6. Subsequently, the OLR Index was positive, and the index increased to +1.4 in October, which was the highest value of the year. The most recent monthly averaged OLR Index was again positive, but with a slightly lower value of +0.8 in November.

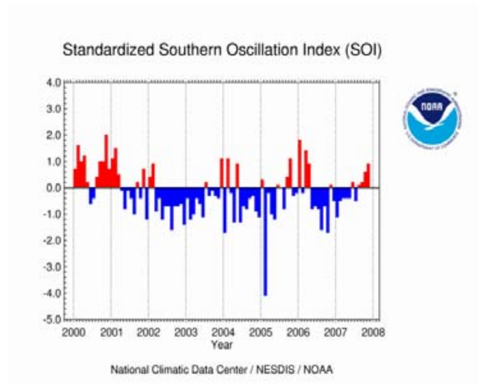


Figure 3. The monthly averaged Standardized Southern Oscillation Index during the period January 2000 through November 2007. The Southern Oscillation Index is a standardized index based on the observed sea level pressure differences between Darwin and Tahiti. The negative phase of the SOI represents below-normal air pressure at Tahiti and above-normal air pressure at Darwin. Prolonged periods of positive SOI values coincide with abnormally cold ocean waters across the eastern tropical Pacific typical of La Niña episodes.

4. U.S. TEMPERATURE

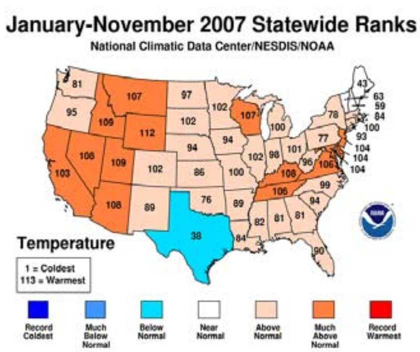
At the end of November, the year 2007 was on pace to become one of the 10 warmest years for the contiguous U.S. since national records began in 1895. The January-November average temperature was 13.39°C (56.10°F), approximately 0.8°C (1.5°F) above average, making the year-to-date period the 9th warmest in the 113-year record. One state (Texas) was cooler than average for the January-November period while 44 states were warmer or much warmer than average. Only two months (February and April) were cooler than average, while two months (March and August) were second warmest in the 113-year record. Statewide rankings for the January-November, March, and August are shown in Figure 4.

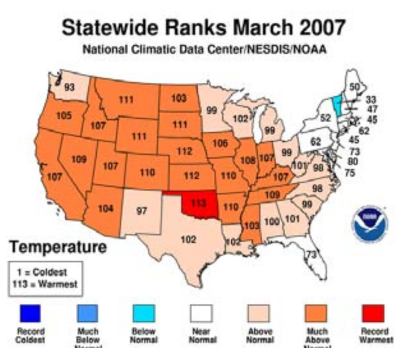
Although the December 2006-February 2007 winter season temperature was near average, the following three seasons were all within the warmest 10 such seasons on record. Spring began early in many parts of the central and eastern U.S. Exceptional warmth occurred during the latter half of March and led to premature growth of agricultural and horticultural crops in these regions. Parts of the western U.S. also experienced unusual warmth, and for the month as a whole more than 2500 daily high temperature records were set from the East to the West coast. The earliest high of 90°F (32°C) occurred in Las Vegas on 13 March, and the daily record was broken by 6°F (3.3°C). For the month as a whole more than 200 daily record highs of 90°F or greater occurred in California, Arizona, Texas, Oklahoma, and areas of the Southeast.

March was followed by a record cold air outbreak in early April. A pattern shift brought cold Arctic air southward into the central and eastern U.S., with unusually cold air penetrating much of this region from 4-10 April. Near-record to record cold temperatures occurred across parts of the central Plains and much of the Southeast.

Temperatures in some locations dropped into the teens and lower 20s (deg F) overnight with many hours of sub-freezing temperatures on multiple and subsequent days. As many as four to five nights of extremely cold temperatures coupled with sustained desiccating winds during the sub-freezing period made the event more harmful for plants and trees and brought extensive losses to agricultural interests. The combination of premature growth from the March warmth and the record-breaking freeze just a few weeks later caused more than an estimated $2 billion in losses to agricultural and horticultural crops in the affected regions.

In August, a severe heat wave occurred across much of the central and southeastern U.S. Numerous all-time record highs were set in August, along with scores of new daily maximum temperatures. Mean temperatures during the warmest periods from the 7th-11th and again from the 15th-17th were more than 6°C (10°F) warmer than average in many parts of the country. States from Kentucky to Florida had their warmest August on record, and along with Utah which also had its warmest August on record, the month ended as the second warmest for the contiguous U.S. since records began in 1895.





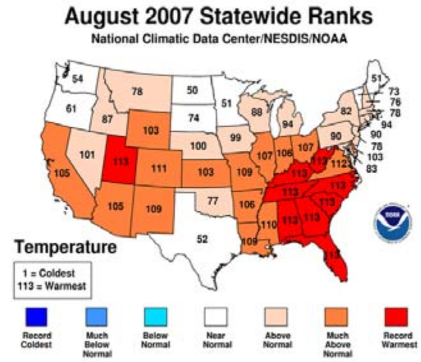


Figure 4. (Top) Statewide temperature ranks for the contiguous U.S. during the January-November 2007 period, (middle) spring (MAM) 2007, and (bottom) summer (JJA) 2007 statewide temperatures. The near normal, below normal, and above normal categories represent the middle, lower, and upper tercile. The upper and lower terciles are further delineated by rankings that are within the upper and lower ten percentile (much above and much below normal) as well as the record warmest and coldest. The numbers on the maps indicate the relative rankings, where 113 indicates the warmest and 1 indicates the coldest such period in the 1895 to 2007 record.

5. U.S. PRECIPITATION AND DROUGHT

Precipitation in the United States during the first 11 months of 2007 was variable throughout much of the country with periods of excessive rainfall, especially across the central third of the U.S., and a persistent and developing drought in the southeastern quarter of the country and the far western states. Through the first eleven months of the year, the central U.S. and much of the Northeast were wetter than average, while precipitation was below to much below average in much of the mid-Atlantic, Southeast and western U.S. (Figure 5).

The months of January and February were relatively wet in the South and North Central regions and relatively dry in the West and Southeast. For the spring months, it was the driest March-May on record in the Southeast. During summer, the remnants of Tropical Storm Erin brought excessive rain to Texas, Oklahoma and Kansas, giving portions of the southern plains its wettest summer on record. Meanwhile, much of the Southeast continued to suffer in drought with its 11th driest summer on record, following its driest spring. For the contiguous U.S. as a whole, seven of the first eleven months of the year were drier than average.

Drought conditions predominated much of the year across large parts of the Southeast, West, and Upper Great Lakes. The months of March, May, August, and November were especially dry over large areas. Increased evaporation from anomalously warm temperatures combined with the lack of precipitation to exacerbate the drought conditions, especially during the summer months. A new core dry area developed over the mid-Atlantic states during the summer and fall. Unusually wet conditions in the southern and central Plains and into the Lower Great Lakes by late summer and early fall kept the three main drought areas (West, Southeast, Upper Great Lakes) separated. Drought conditions at the start, middle, and near the end of the year are shown in Figure 6.

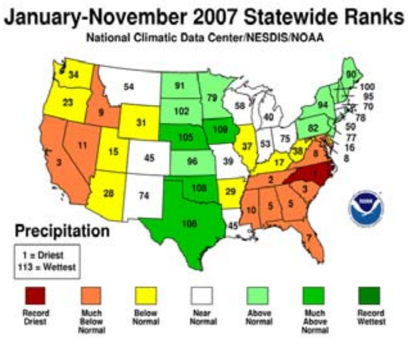
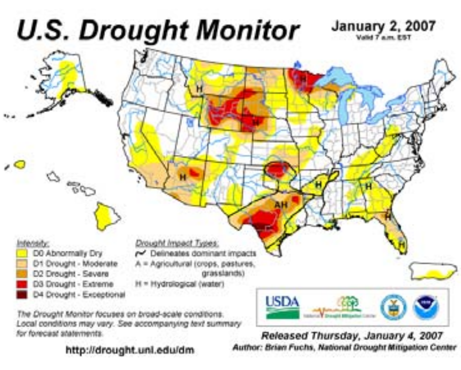
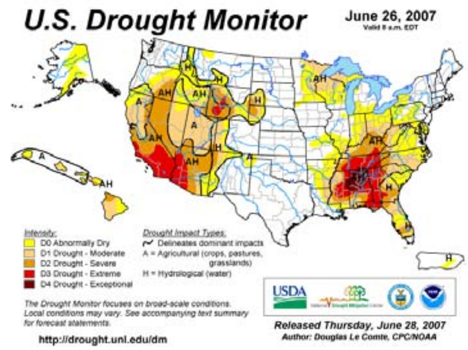


Figure 5. Statewide precipitation ranks for the contiguous U.S. during the January-November 2007 eleven-month period. The numbers on the maps indicate the relative rankings, where 113 indicates the wettest and 1 indicates the driest such period in the 1895 to 2007 record.

Several short-lived dry episodes occurred in other regions throughout the year, notably in the Ohio Valley and Northeast in May and the northern Plains in July. The percent area of the contiguous U.S. (as measured by the Palmer Drought Index [Palmer 1965]) experiencing moderate to extreme drought grew steadily from 16 percent in January to a peak of about 42 percent by August, and declined during the next two months but expanded again in November.

In contrast to drought in these regions, a series of storms brought flooding, millions of dollars in damages and loss of life from Texas to Kansas and Missouri in June and July. Making matters worse were the remnants of Tropical Storm Erin, which produced heavy rainfall in the same region in August. Texas and Oklahoma had their wettest summer on record and January-November totals in much of the region were well above average.





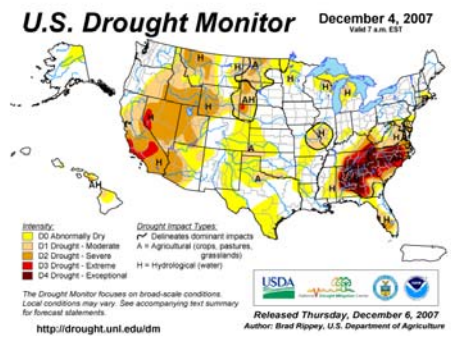


Figure 6. Drought conditions as depicted by the U.S. Drought Monitor. In early January 2007 (top), mid-year (middle), and in early December 2007 (bottom).

6. CONCLUSION

This paper summarized the global and U.S. climate conditions in 2007, focusing on year-to-date and seasonal values of temperature and precipitation. It should be noted that this work is a prelude to the international effort of preparing the State of the Climate report that will appear as a supplement to the *Bulletin of the American Meteorological Society* in July 2008. More than 150 scientists from more than 30 countries are expected to contribute to this report.

7. REFERENCES

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