STATE OF THE CLIMATE FOR 2005

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1. INTRODUCTION

The Climate Monitoring Branch at NOAA's National Climatic Data Center (NCDC) routinely produces climate assessments on a monthly, seasonal, and annual basis. The purpose of these reports is to put the observed climatic conditions into historical perspective on global and regional scales. In this paper, we present the major climate and weather events of 2005, 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 globe.

It is important to note that this article is being written and submitted to the AMS before the conclusion of 2005. Therefore, the products and analyses presented here emphasize the year-to-date conditions (Jan-Sep) and seasonal values during the past winter (DJF), spring (MAM) and summer (JJA). In addition to the standard parameters of temperature and precipitation, other important regional and global climatic conditions are included, including drought conditions in parts of the U.S. and Western Europe, the extremely active Atlantic basin hurricane season, and the state of the El Niño/Southern Oscillation (ENSO).

2. GLOBAL CLIMATE

The year-to-date (Jan-Sep) globally averaged temperature anomalies for both land and ocean surfaces are shown in Figure 1. With an anomaly of +0.59 C, the average global temperature is the second warmest on record for the Jan-Sep period. Only 1998 stands out as a warmer year. Land surface temperatures were 3^{rd} warmest on record, while ocean temperatures were 2^{nd} warmest. This continues a trend toward warmer global temperatures that has occurred throughout the period of reliable global surface temperature records (1880-present). Although not a monotonic increase, global average temperatures have risen at a rate approximately 0.06º C/decade since 1900. During the past 30 years, the rate of increase is almost 3 times as great (0.17º C/decade).

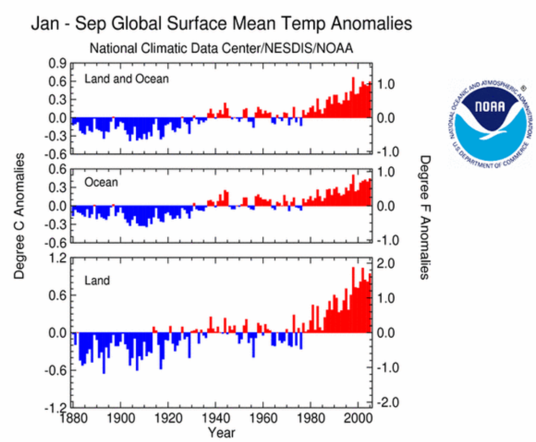

Figure 1. Global surface mean temperature anomalies (°C left and °F right) averaged over January-September for the period 1880-2005: (Top) land and ocean surfaces, (middle) oceans surfaces only, and (bottom) land surfaces only. Quayle et al. 1999

Through the end of September, warmer than average temperatures were present in almost all areas of the world. Anomalies of 2-3º C were present across large parts of North America, much of Asia and parts of Europe. Areas of below average temperatures included the west coast of Australia and some localized parts of Asia and South America. Widespread anomalously warm conditions were present in all three seasons as shown in Figure 2 along with fewer regions of colder-than-average temperatures.

The observed seasonal precipitation patterns over land surfaces are shown in Figure 3. During boreal winter (DJF), some patterns were consistent with those typically expected during El Niño, although El Niño was not the only contributing influence to the seasonal anomalies. For instance above normal precipitation in the southwestern US is consistent with the influence of El Niño, but much of the precipitation received during the Dec-Feb season was due to factors other than El Niño. Conversely, in Australia a long-term pattern of drier than average conditions continued across much of the continent. The warmer than average sea surface temperatures in the equatorial Pacific may have been a contributing factor.

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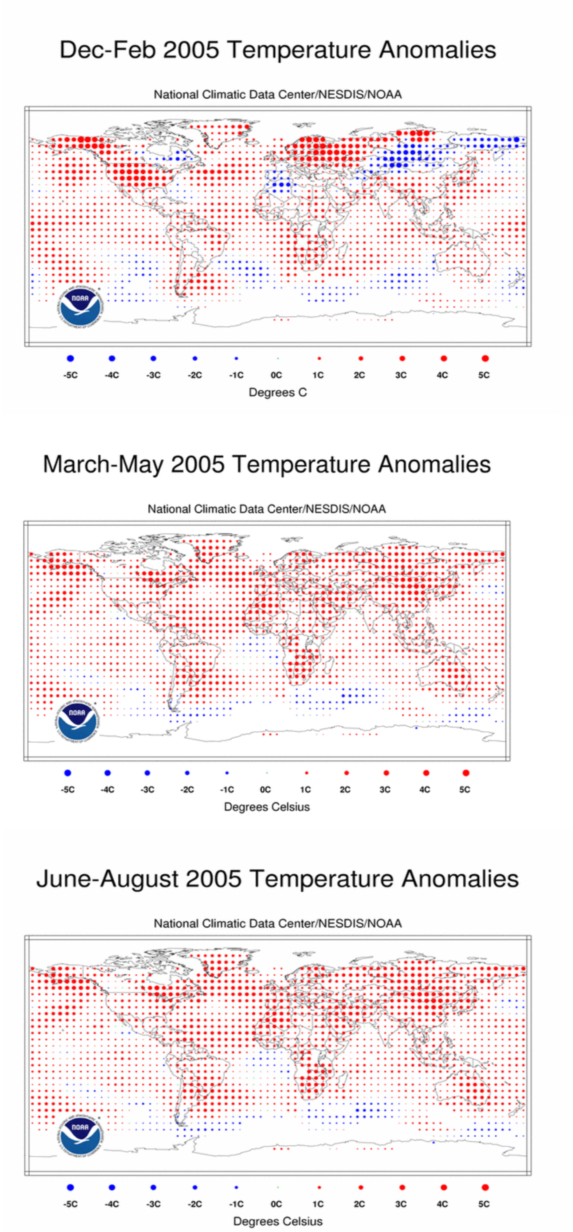

Figure 2. Seasonal global land surface mean temperature anomalies (in °C) for 2005: (Top) winter, (middle) spring, and (bottom) summer. Anomalies were determined relative to the 1961-1990 base period. Smith and Reynolds, 2005.

The MAM boreal spring was also drier than average throughout the eastern 2/3rds of Australia as well as large parts of Southeast Asia, southern Europe, and the south-central U.S. These seasonal totals don't reveal periods of heavy spring rainfall that brought flooding and landslides to places such as Taiwan, the Hunan province in China, Kenya, and Ethiopia in May.

Conversely, extremely dry conditions across large parts of Western Europe were present during the spring and continued throughout the boreal summer (JJA).

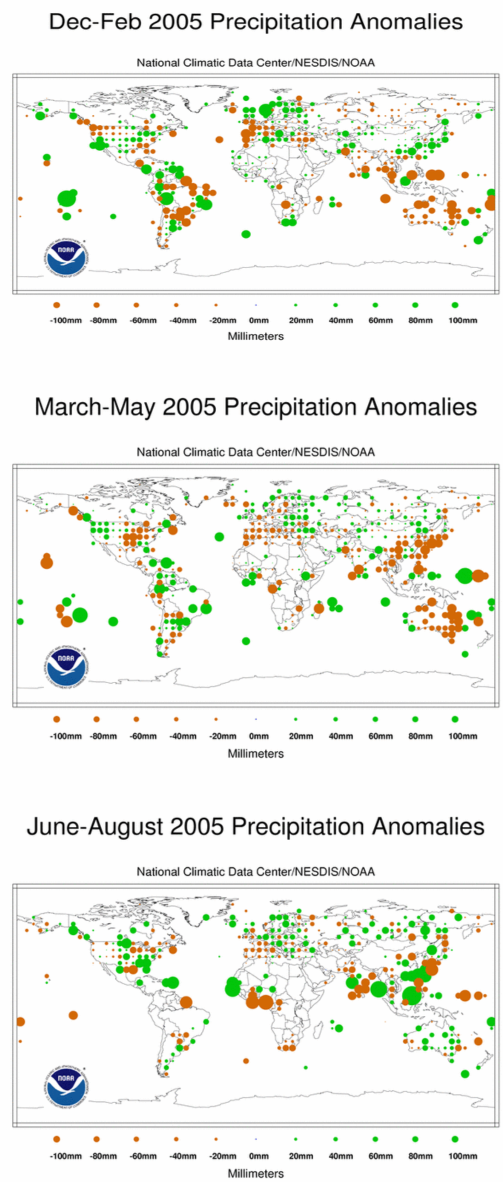

Figure 3. Seasonal global land surface precipitation anomalies (% of normal relative to the 1961-1990 base period) for 2005: (Top) winter, (middle) spring, and (bottom) summer.

Precipitation deficits as a percent of normal were greatest in Spain where the 12 months that ended in August were the driest on record. Precipitation for the September 2004 to August 2005 period was approximately 40% of normal for the country as a whole with parts of the south even drier.

3. ENSO AND TROPICAL PACIFIC

The year began with a weak positive phase of ENSO present in the equatorial Pacific. Monthly sea surface temperatures in the Nino 3.4 region (Figure 4) began increasing early in the year. A rapid warming trend ensued in July and August, and by September 2004, weak El Niño conditions were present. However, the episode never fully developed into a classic El Niño episode that brings warmer than average sea surface temperature anomalies to the west coast of Ecuador and Peru.

Warmer than average temperature anomalies in the Nino 3.4 region peaked in November 2004 at less than 1.0º C above average, indicative of the weak nature of this event. Monthly mean temperatures in this region remained slightly above 0.5º C during December and January before sharply decreasing in February 2005. They were near average in July and August, and the 3-month running mean remained below 0.5º C from February through September.

The monthly-averaged Outgoing Longwave Radiation (OLR) index shifted signs on almost a monthly basis but was generally near average throughout the first nine months of 2005. The exception was February, when the index dropped to its lowest value since the 1997-1998 El Niño episode. High frequency variability in OLR is typically associated with the Madden-Julian Oscillation and its related convective activity that propagates west to east in the near-equatorial region from the Indian Ocean into the Pacific Ocean approximately every 30-60 days.

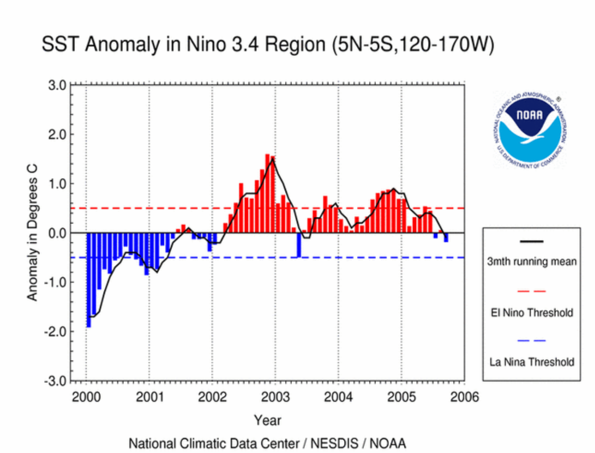

Figure 4. The monthly averaged sea surface temperature (SST) anomaly (red/blue bars in ^{o}C), and the three-month running mean SST anomaly (black line in ^{o}C), in the Niño 3.4 (top) and Niño 4 (bottom) regions during the period January 1998 to September 2005.

The Southern Oscillation Index (SOI) showed unusual behavior during the weak 2004-2005 El Niño event. On several occasions during the latter half of 2004, the monthly SOI was near-zero (indicating near-neutral conditions), but the index remained below average for seven consecutive months to end 2004. The SOI turned slightly positive in January 2005, dropped to a remarkably low value of less than -4 in February, and was near average in March and most other months through the end of September 2005, which was indicative of near-neutral ENSO conditions.

4. U.S. CLIMATE

The climate of the U.S. during the first nine months of 2005 was generally warmer than average throughout much of the country with a precipitation pattern that ranged from wetter than average to drier than average. The January-September mean temperature for the contiguous U.S. was 13.9º C, which was 0.7º C above the 1895-2005 mean and the 15th warmest such period since national records began in 1895. Only eight states were near average, while 11 states were much warmer than average (within the top 10% of warmest years on record). No state was cooler than average.

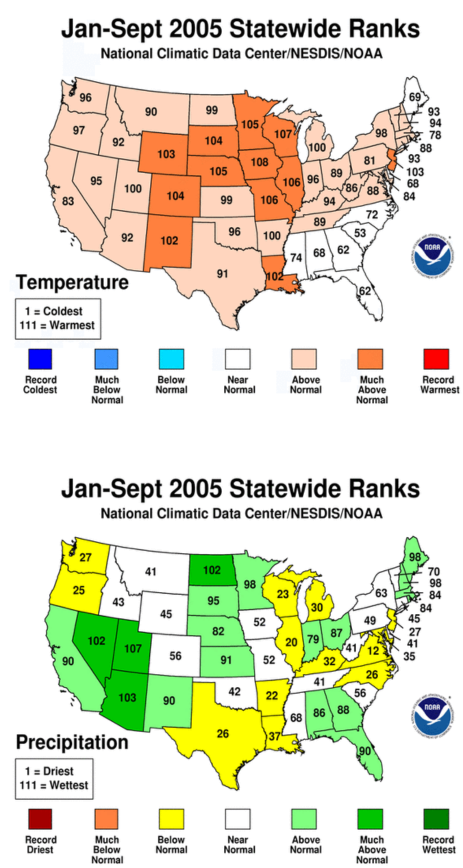

Figure 5. (Top) Statewide temperature (top) and precipitation (bottom) ranks for the contiguous U.S. during the January-September 2005 period.

Year-to-date precipitation for the contiguous U.S. was slightly wetter than average. Regions with above average precipitation included the Southwest, north central Plains, the extreme Northeast and parts of the Southeast. This contrasted with drier than average conditions in the Pacific Northwest, an area that stretched from the southern Plains to Illinois and

Michigan, and much of the mid-Atlantic from North Carolina to New Jersey.

The unusually dry conditions combined with much warmer than average conditions to produce severe drought in a large area from Arkansas to Illinois and Wisconsin in spring and summer. Large precipitation deficits adversely impacted agriculture and led to federal disaster declarations in the affected states. Moderate to extreme drought also affected parts of the West that have endured drought for much of the past six to seven years.

As shown in figure 6, at the end of September, 18% of the contiguous U.S. was in moderate to extreme drought, based on the Palmer Drought Index (Palmer, 1965). Drought was present in large parts of Washington, Oregon, Idaho, Montana, and Wyoming with drought stretching into the northern and central Plains. Other areas of drought included much of eastern Texas and developing areas in the mid-Atlantic and Southeast that were much drier than normal in September. Drought conditions in Arkansas, Missouri, and southern Illinois were much improved by late September due to the influence of tropical systems that made landfall along the Gulf Coast and tracked northward during the 2005 Atlantic Hurricane season.

5. NORTH ATLANTIC TROPICAL CYCLONES

The Atlantic Basin hurricane season was the most active on record. Twenty two named storms had formed by the fourth week of October, exceeding the previous record of 21 storms in 1933. Five named storms made landfall along the northern Gulf Coast between the Louisiana-Texas border and Pensacola, Florida. This included two tropical storms, two category 3 hurricanes and one category 4 storm.

Tropical Storms Arlene and Cindy made landfall respectively near Pensacola, Florida in June and Grand Isle, Louisiana in July. Hurricane Dennis had winds near 120 mph when it made landfall near Navarre Beach, Florida on July 10th. Hurricane Katrina, a category 4 storm, made landfall in eastern Louisiana on August 29 and will likely go down in the record books as the most costly natural disaster in U.S. history.

As Hurricane Katrina tracked through the Gulf of Mexico, its sustained winds reached 175 mph (150 knots) and its minimum central pressure dropped as low as 902 millibars - the fourth lowest on record for an Atlantic hurricane at the time. The storm's intensity diminished slightly as it approached the central Gulf Coast, but Katrina remained a strong Category 4 storm until landfall along the Louisiana and Mississippi coasts. Although its intensity at landfall was less than that of Hurricane Camille, which devastated coastal Mississippi

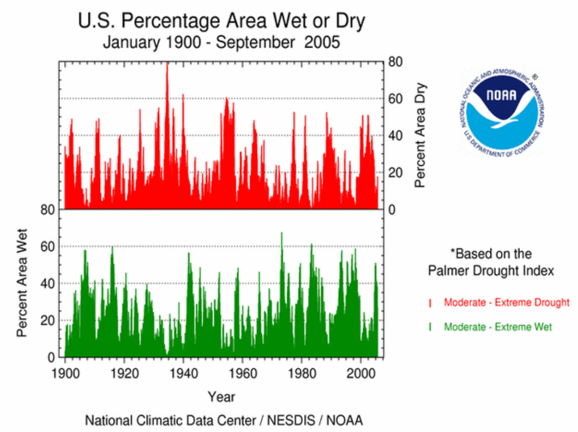

Figure 6. Percent of contiguous U.S. in moderate to extreme drought (top)/moderate to extreme wetness (bottom) on a monthly basis from January 1900 through September 2005 based on the Palmer Drought Index.

in August 1969, the size of Katrina, with hurricane force winds extending 120 mph from its center, was much larger and the destruction more widespread than Camille.

The associated storm surge reached as far east as Mobile, Ala., inundating parts of the city. Large parts of Biloxi and Gulfport, Miss., were covered with water as a result of a 20 to 30 plus foot storm surge that reached far inland. The combination of strong winds, heavy rainfall and storm surge led to breaks in the earthen levee system that separates New Orleans from surrounding lakes and canals, leaving large parts of New Orleans under 20 feet of water and forcing the abandonment of the city for weeks.

Hurricane Katrina was followed closely by Hurricane Rita, which was the 2nd category 5 storm to develop in the Gulf of Mexico in 2005, the only such seasonal occurrence on record. Hurricane Rita reached category 5 strength on the Saffir-Simpson scale on September 21. Winds eventually peaked near 175 mph and the minimum central pressure of the storm dropped to 897 mb, the third lowest on record for the Atlantic Basin at that time, after Hurricane Gilbert in 1988 (888 mb), and the 1935 Labor Day Hurricane (892 mb). It came ashore on the extreme southwest coast of Louisiana on September 24 in a sparsely populated area with wind speeds of approximately 120 mph causing widespread damage due to high winds and storm surge.

A fourth hurricane to strike the U.S. Gulf Coast in 2005, Hurricane Wilma, quickly intensified in the Caribbean Sea and became the third category 5 storm to form in the Atlantic Basin in 2005. This was the first year in which three category 5 storms formed in the Atlantic Basin in a single season. Wilma also broke all records for minimum central pressure in the Atlantic Basin when its pressure dropped to 882 mb. After moving slowly across the eastern tip of the Yucatan Peninsula and diminishing in strength, it reintensified as it tracked northeastward through the southern Gulf of Mexico and came ashore in southern Florida near Cape Romano as a category 3 storm on October 24.

6. SUMMARY

This paper summarized the global and U.S. climate conditions in 2005, focusing on year-to-date and seasonal values of temperature and precipitation. Additional data and information are available on the National Climatic Data Center website (2005). It should also be noted that this work is a prelude to the much larger effort of preparing the State of the Climate section that appears in the *Bulletin of the American Meteorological Society* each June (see e.g., Levinson, 2005). Therefore, a number of important climate parameters and related issues were not included, but will be addressed in the State of the Climate in 2005 article.

On a global scale, anomalously warm global temperatures continued in 2005, with many regions experiencing average to much above average temperatures. Over the January-September period, surface temperatures in 2005 remained well above the 1961-1990 average, with the January-September globally averaged temperature ranking 2^{nd} warmest on record.

The oceanic and atmospheric conditions in the tropical Pacific Ocean began the year in a weak El Niño state before transitioning to neutral conditions. The running three-month mean anomaly of SSTs in the Niño 3.4 region was less than 0.5°C from March through September. The SOI and OLR indices also reflected near-neutral ENSO conditions during same period.

The January-September mean temperature for the contiguous U.S. was 13.9º C, which was 0.7º C above the 1895-2005 mean and the 15^{th} warmest such period since national records began in 1895. Year-to-date precipitation for the contiguous U.S. was slightly wetter than average, but anomalously wet areas were offset by drier than average conditions in other parts of the country. Unusually dry conditions affected parts of most regions of the country at the end of September, although landfalling tropical systems helped ameliorate drought in areas such as the region stretching from Louisiana and extreme eastern Texas to southern Illinois.

The Atlantic Basin hurricane season was the most active on record. Twenty two named storms had formed by the fourth week of October, exceeding the previous record of 21 storms in 1933. Hurricane Katrina, a category 4 storm which made landfall in eastern Louisiana on August 29, will likely go down in the record books as the most costly natural disaster in U.S. history. This was followed closely by Hurricane Rita, which made landfall along the Louisiana-Texas border on September 24^{th} as a category 3 storm.

7. REFERENCES

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