

## **“Weather and Climate Extremes in a Changing Climate” NOAA and U.S. Climate Change Science Program**

### *Excerpts on the Midwestern and Southern United States*

A consensus science report commissioned by the U.S. Climate Change Science Program and conducted by the National Oceanic and Atmospheric Administration concludes that human-induced warming has contributed to warmer average temperatures, increased “heavy precipitation events,” and more frequent heat waves. The frequency of cold days and nights is declining and the number of frost days is decreasing.

Many of the report’s findings apply throughout the continental United States, but some are of particular interest in the Midwest and the Southern U.S. where, for instance, heat waves and heavy precipitation events have had particular impact.

The report finds “...the amount of precipitation falling in the heaviest 1% of rain events increased by 20% during the 20<sup>th</sup> century, while total precipitation increased by 7%.” (p. 47)

The report also finds that hurricane “intensity has increased over the period 1959-1997 across both mid- and high latitude cyclone intensity, with the upward trend more significant for the high latitudes than for the mid-latitudes (p. 65). And that “it is likely that hurricane/typhoon wind speeds and core rainfall rates will increase in response to human-caused warming.” (p. 81)

The report, “Weather and Climate Extremes in a Changing Climate” issued in June 2008, is available online at <http://www.climate-science.gov/Library/sap/sap3-3/final-report/>.

### **Precipitation**

“One of the clearest trends in the United States observational record is an increasing frequency and intensity of heavy precipitation events...One measure of this is how much of the annual precipitation at a location comes from days with precipitation exceeding 50.8 mm(2 inches).” (p. 46)

“...the amount of precipitation falling in the heaviest 1% of rain events increased by 20% during the 20<sup>th</sup> century, while total precipitation increased by 7%.” (p. 47)

“Over the last century there was a 50 % increase in frequency of days with precipitation over 101.6 mm (four inches) in the upper Midwestern U.S.; this trend is statistically significant.” (p. 47)

“Over most regions, precipitation is likely to be less frequent but more intense, and precipitation extremes are very likely to increase.” (p. 81)

“Upward trends in the amount of precipitation occurring in the upper 0.3% of daily precipitation events are statistically significant for the period of 1908-2002 within three major regions (the South, Midwest, and Upper Mississippi...) of the central United States...The upward trends are primarily a warm season phenomenon when the most intense rainfall events typically occur. A time series of the frequency of events in the upper 0.3% averaged for these 3 regions shows a 20% increase over the period of 1893-2002 with all of this increase occurring over the last third of the 1900s.” (p. 47)

### **Flooding**

“On the main stems of large river basins, significant flooding will not occur from short duration extreme

precipitation episodes alone. Rather, excessive precipitation must be sustained for weeks to months. The 1993 Mississippi River flood, which resulted in an estimated \$17 billion in damages, was caused by several months of anomalously high precipitation. A time series of the frequency of 90-day precipitation totals exceeding the 20-year return period...indicates a statistically significant upward trend. The frequency of such events during the last 25 years is 20% higher than during any earlier 25-year period... The trend over the entire period is highly statistically significant.” (p. 50)

### **Precipitation Shifts:**

“Over the 20<sup>th</sup> century, there was considerable decade-to-decade variability in the frequency of snowstorms of six inches or more. Regional analyses suggest that there has been a decrease in snowstorms in the South and lower Midwest of the United States, and an increase in snowstorms in the upper Midwest and Northeast. This represents a northward shift in snowstorm occurrence, and this shift, combined with higher temperatures, is consistent with a decrease in snow cover extent over the United States.” (p. 36)

### **Temperature Extremes**

“Abnormally hot days and nights and heat waves are very likely to become more frequent. Cold days and cold nights are very likely to become much less frequent. The number of days with frost is very likely to decrease. Climate models indicate that currently rare extreme events will become more commonplace. For example, for a mid-range scenario of future greenhouse gas emissions, a day so hot that it is currently experienced only once every 20 years would occur every three years by the middle of the century over much of the continental U.S...By the end of the century, it would occur every other year or more.” (p. 4)

“Several recent studies have addressed explicitly possible future changes in heat waves . . . the more intense and frequent summertime heat waves over the southeast and western U.S. were related in part to base state circulation changes due to the increase in GHGs (greenhouse gases). An additional factor for extreme heat is drier soils in a future warmer climate...” (p. 100)

### **Heat Waves**

“Several recent studies have addressed explicitly possible future changes in heat waves (very high temperatures over a sustained period of days), and found that in a future climate there is an increased likelihood of more intense, longer-lasting and more frequent heat waves.” (p. 100)

### **Temperature Shifts**

“Annual maximum ice cover on the Great Lakes has been monitored since 1963. The maximum extent of ice cover over the past four decades varied from less than 10% to over 90%...A majority of the mildest winters with lowest seasonal average ice cover over the past four decades occurred during the most recent 10-year period (1997 to 2006). Analysis of ice breakup dates on other smaller lakes in North America with at least 100 years of data show a uniform trend toward earlier breakup dates (up to 13 days earlier per 100 years).” (p. 40)

### **Hurricanes and Storm Surge**

“Northern Hemisphere ETC (Extra-Tropical Cyclone) intensity has increased over the period 1959-1997 across both mid- and high latitude cyclone intensity, with the upward trend more significant for the high latitudes than for the mid-latitudes...Using reanalysis data covering the period 1949-1999, Paciorek et al. found that extreme wind speeds have increased significantly in both basins (Atlantic and Pacific).” (p. 65)

“The observed increase in the PDI (Power Dissipation Index) since the 1970s and increases in land-falling hurricane frequency since the 1970s are consistent with the measured increasing wave heights.” (p. 72)

“It is likely that hurricane/typhoon wind speeds and core rainfall rates will increase in response to human-caused warming. Analyses of model simulations suggest that for each 1 degree Celsius increase in tropical sea surface temperatures, hurricane surface wind speeds will increase by 1 to 8% and core rainfall rates by 6 to 18%.” (p. 81)

“Storm surge levels are likely to increase due to projected sea level rise, though the degree of projected increase has not been adequately studied.” (p. 82)

“There are likely to be more frequent deep low-pressure systems (strong storms) outside the tropics, with stronger winds and more extreme wave heights.” (p. 82)