Report: The 2004 Hurricane Season and Its Impacts in North Carolina

Sol Wuensch, Jennifer Ast, Scott Curtis
East Carolina University

Introduction

November 30, 2004 put a close to one of the most destructive and emotionally draining Atlantic hurricane seasons on record. In the U.S. 151 deaths were either directly or indirectly attributed to hurricanes and property damage totaled 42 billion dollars, making 2004 the costliest season on record (Levinson 2004; Nowell 2005). Florida was the target for most of the hurricanes, enduring a record four direct hits, three of them coming in the span of a month. The 2004 Hurricanes: Charley, Ivan, and Frances were rated second, third, and fourth most destructive hurricanes in U.S. history, with only Hurricane Andrew (1992) being more costly (Levinson, 2004). While Florida suffered greatly from the 2004 season, the rest of the Southeast, including North Carolina, did not escape unscathed.

North Carolina can be affected by "direct-hit" hurricanes from the Atlantic and "back-door" storms which usually hit the Gulf coast as hurricanes and make a turn to the northeast, crossing over the western mountains as extratropical storms. The former category of storm is characterized by strong winds, storm surge, and tornadoes. The latter type can be as equally devastating since mountains in the western part of the state force warm tropical air upward, dumping copious amounts of rain that can lead to flash flooding and landslides in the region's steep terrain. In 2004 North Carolina was impacted by three "direct-hit" (Alex, Charley, and Gaston) and three "back-door" hurricanes (Frances, Ivan, and Jeanne). In addition, Tropical Storm Bonnie, which hit the Florida panhandle, brought rain and a tornado to eastern North Carolina as an extratropical system. This paper summarizes the impacts of the seven tropical systems on North Carolina. In particular, we examine precipitation amounts and make some comparisons with previous hurricane seasons.

Tropical Storms and Hurricanes of 2004 and Their Impacts

Figure 1 displays the National Hurricane Center tracks of the seven weather systems with tropical origins to impact North Carolina. No other state, including Florida, had as many storms (six) pass through its borders in 2004. According to the hurricane climatology of the State Climate Office of North Carolina (http://www.nc-climate.ncsu.edu/hurricanes/) 2004 was the busiest season in over 50 years.

Hurricane Alex, which never made landfall, brought the strongest wind and largest storm surge to North Carolina. The Category 2 Hurricane just brushed past the Outer Banks (Fig. 1), coming within 9 nautical miles of Cape Hatteras on August 3. On that day maximum sustained winds reached 85 knots and the pressure dipped to 972 millibars. The highest estimated storm surge was 6 feet on the sound side of the Outer Banks at Buxton and Ocracoke Village. These locations were flooded and winds caused minor structural damage to homes and businesses. One person drowned in a strong rip current off the Outer Banks two days after Alex passed by. The estimated damage from Alex is not more than 5 million (Franklin 2004).

Tropical Storm Bonnie and Hurricane Charley delivered a one-two punch to eastern North Carolina as Bonnie tracked through on August 13 and Charley followed a day later. Bonnie's only reported casualties were three deaths from a tornado in Pender County

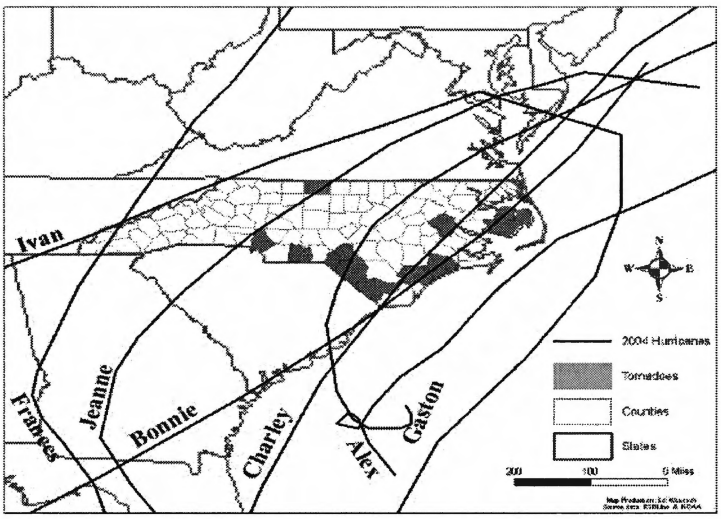

Figure 1. Tracks of the seven storms with tropical origins to impact North Carolina in 2004. The counties having confirmed reports of storm-related tornadoes are shaded.

(Avila 2004). Charley was the lone Hurricane to directly hit North Carolina. On August 14 Charley made its second landfall in the United States, after crossing Florida, at the North Carolina/South Carolina border with maximum sustained winds of 65 knots. It was downgraded to a tropical storm at landfall and quickly moved up through Duplin, Pitt, and Bertie Counties before entering the Virginia Beach area (Fig. 1). Five tornadoes in Onslow, Pitt, Hyde, Tyrrell, and Dare Counties were reported on August 14. These tornadoes did not cause any deaths but the Dare County tornado produced F1 damage in Kitty Hawk. New Hanover, Brunswick, and Columbus Counties experienced high wind speeds, uprooted trees, downed power lines, and peeled roofs. Twenty-five million of the 4 billion dollars of U.S. property damage occurred in North Carolina (Hartsoe 2004; Pasch et al. 2004; Schreiner 2004; Schreiner and Fennell 2004).

Hurricane Gaston made landfall in the U.S. just north of Charleston, S.C. on August 30 and continued northward, entering North Carolina at Robeson County the following day as a tropical depression and then tracking through Wake and Halifax Counties before entering southeastern Virginia (Fig. 1). Two tornadoes were confirmed in Scotland and Hoke Counties. Damage from Gaston in North Carolina included downed limbs, power outages, and beach erosion at Bald Head Island. The effects of Gaston were felt weeks afterward as the Lumber river crested nearly 8 feet above flood stage in Lumberton. Fifteen million of the 130 million dollars of U.S. property damage occurred in North Carolina (Franklin et al. 2004)

Hurricane Frances entered the far western portion of the state on September 8 as a tropical depression (Fig. 1). Of the 101 tornadoes formed by Frances 11 touched down in North Carolina in Robeson, Anson, Columbus, and Mecklenburg Counties. Most of the damage was due to heavy rains, explored in the next section, which led to flooding and six mudslides along the Blue Ridge Parkway (Beven II 2004; Mitchell and Yongquist 2004; Sparks and Yongquist 2004).

Hurricane Ivan was North Carolina's deadliest and costliest storm in 2004. It tracked to the northeast along the North Carolina-Tennessee border as a tropical depression on September 17 before curving southward over Virginia (Fig. 1). Eleven people died in North Carolina, four in the Peeks Creek community in Macon County, after water ripped mud and trees down a cove. Two residents of Florida also died

in Macon County in their attempt to escape the hurricane. A tornado touched down in Rockingham County, destroying at least five homes and damaging dozens more (Stewart 2004).

Finally, Hurricane Jeanne passed though the central portion of the state, from Gaston to Rockingham Counties, as an extratropical system on September 28 (Fig. 1). It added to the already high rainfall totals for the month. Initial damage estimates for Jeanne are at 15 million (Lawrence and Cobb 2004).

Precipitation Totals for Selected Days in August and September of September 2004

Figure 2 shows rainfall totals for selected days during Alex, Charley, Gaston, Frances, and Ivan. The data is displayed with 2 inch contours of precipitation gridded at 0.25° latitude by 0.25° longitude resolution. Rainfall estimates on August 3 and 4 are obtained from a combination of satellites calibrated to NASA's Tropical Rainfall Measuring Mission (TRMM) (http://trmm.gsfc.nasa.gov). Satellite information is useful in this case, as much of the rain associated with Alex was offshore and thus rain gauge recorded data was not available. The rainfall data for the remaining days is displayed through a modified Cressman gridded analysis of at least 500 stations across the United States and Mexico as produced by the Climate Prediction Center. (http://www.cpc.ncep.noaa.gov/products/precip/realtime/US_MEX/index.html).

For all tropical systems, at least two inches of rain fell somewhere in North Carolina. For Tropical Storm Alex daily rainfall totals in excess of 6 inches were centered over Cape Hatteras (Fig. 2). The Okracoke gauge recorded 7.55 inches of rain from Alex. Tropical Storm Charley affected the coastal plain with Greenville experiencing the most rain at 5.05 inches. Gaston crossed the state in two days, dumping at least 2 inches of rain in a swath from Fayetteville to Roanoke Rapids (Fig. 2). Robeson County received five inches of rain with some local flooding. Tropical Storm Frances affected the western half of the state with a broad area receiving over 6 inches of rain (Fig. 2). The maximum reported rainfall for the duration of Frances was 18.07 inches in Linville Falls. Almost 17 inches of rain fell in the Edgemont community along the border of Avery and Caldwell Counties, and many stations throughout the Appalachians received over 10 inches of rain. Another four inches of rain fell in the same area only nine days later as the remnants of Hurricane Ivan moved through the region (Fig. 2). Local totals reached 9.3 inches in Jackson County, 8 inches in Haywood and Burke Counties, and more than 6 inches in Buncome, Avery, and Mitchell Counties.

Figure 3 displays August and September rainfall totals for both 2004 and the 1895 to 2004 climatology by the eight North Carolina climate divisions. Table 1 shows the exact values. Based upon climatology, North Carolina receives more rainfall in August than September and precipitation totals decrease from east to west. In August 2004 Climate Divisions 6, 7, and 8 (coastal plain and Piedmont, Fig. 3) received 183%, 168%, and 165%, respectively, of normal August precipitation (Table 1). Of the 110 years on record, August 2004 ranked as the twelfth rainiest for Climate Division 8, ninth rainiest for Climate Division 7, and fifth rainiest for Climate Division 6. The mean precipitation for North Carolina, a spatially weighted average of all eight climate divisions in the state, was the fifteenth highest value since 1895. Climate Divisions 1, 2, 4, and 5 (western half of the state) received 371%, 289%, 202%, and 228%, respectively, of normal September precipitation (Table 1), and represent the counties inundated by the rains of Frances and Ivan (Fig. 3). September 2004 ranked as the eighth rainiest for Climate Division 4, fourth rainiest for Climate Division 5, second rainiest for Climate Division 2 and the rainiest ever recorded for Climate Division 1. The time series of September precipitation for Climate Division 1 is displayed in Figure 4. The total of 15 inches in 2004 is 150% of the next highest value of approximately 10 inches in 1924. In fact, considering all months on record for Climate Division 1, September 2004 is only second in total rainfall to August 1940. The mean precipitation for the entire state of North Carolina ranked as the ninth rainiest September on record.

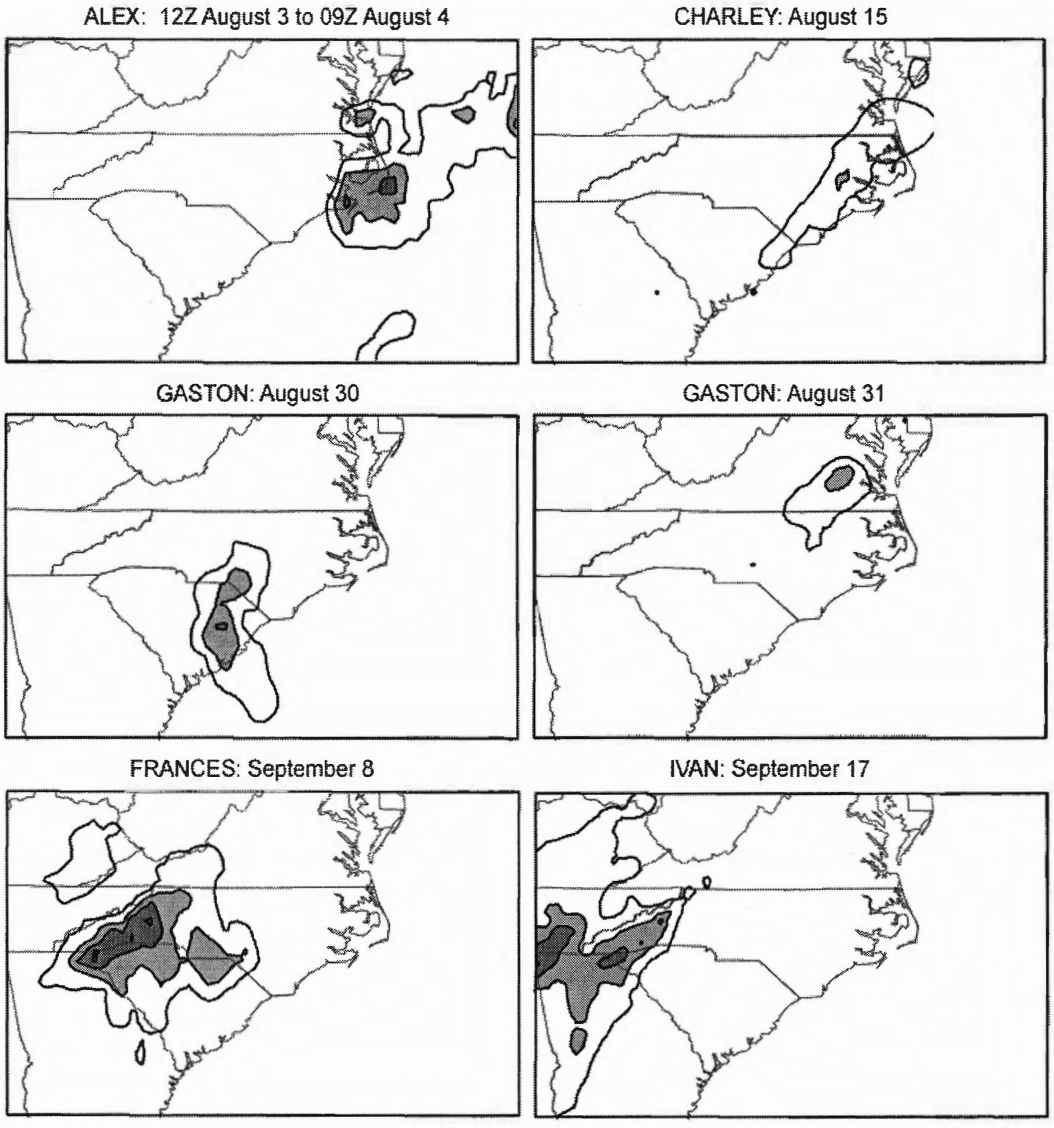

Figure 2. Daily precipitation during Alex, Charley, Gaston, Frances, and Ivan. Contour intervals are: 2inches (no shading), 4 inches (light shading), 6 inches (medium shading), and 8 inches (dark shading).

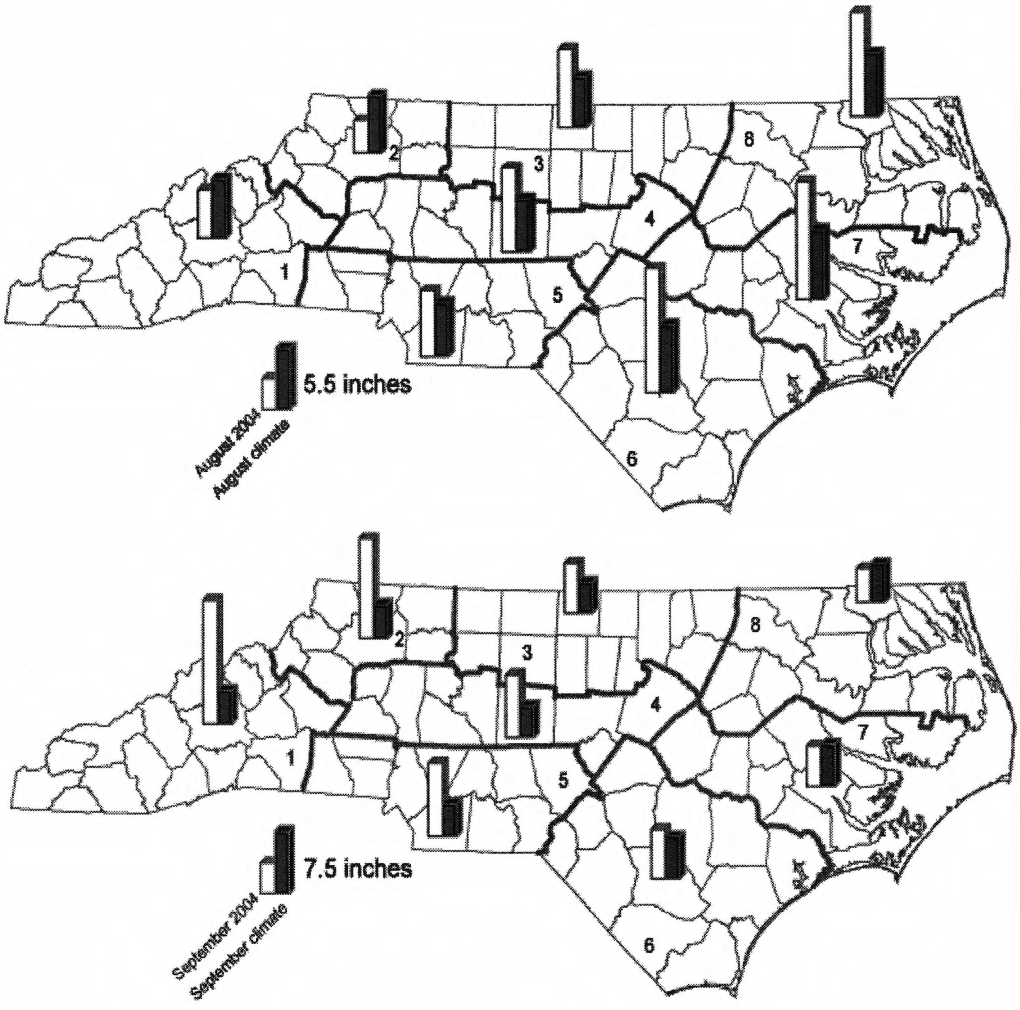

Figure 3. Precipitation (inches) for the eight climate divisions in North Carolina in August and September 2004 (open bars) and the 1895-2003 climatology (solid bars). Bars are proportional to the climatoligy legends: 5.5 inches for August and 7.5 inches for September.

Table 1. Precipitation (inches) for the eight climate divisions in North Carolina in August and September 2004 and the 1895-2003 climatology (AVG).

	1	2	3	4	5	6	7	8
August 2004	4.30	2.86	6.99	7.47	5.79	10.99	10.39	9.25
AVG August	5.25	5.15	4.55	4.69	4.76	6.02	6.17	5.62
September 2004	15.00	12.07	5.99	7.59	8.77	5.99	4.89	3.98
AVG September	4.04	4.17	3.7	3.76	3.85	5.10	5.14	4.58

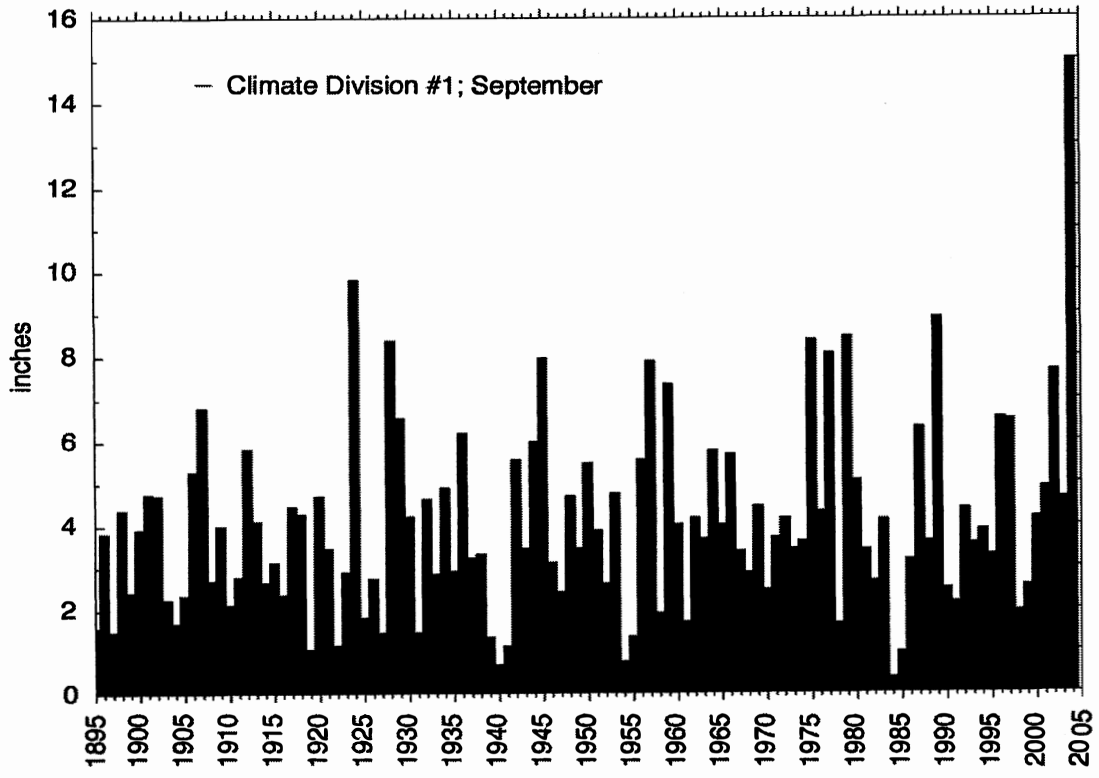

Figure 4. Precipitation (inches) for Climate Division 1 in North Carolina for all Septembers from 1895 to 2004.

Summary

Given the focus of the media on the hurricane devastation in Florida in 2004, one may overlook the impacts of the season upon North Carolina. The state suffered over $200 million in property damage and 15 fatalities. A total of 20 tornadoes were reported in 13 counties across the state. Rainfall records were also shattered as the western most climate division received more rainfall in September than ever before. Overall, 2004 can be considered the most active and damaging hurricane seasons for North Carolina as seven storms affected every corner of the state, making it a true state-wide disaster.

REFERENCES:

Avila, L. A. National Hurricane Center. 2004. Tropical Cyclone Report: Tropical Strom Bonnie. Accessed online: http://www.nhc.noaa.gov/2004bonnie.shtml

Beven II, J. L. National Hurricane Center. 2004. Tropical Cyclone Report: Hurricane Frances. Accessed online: http://www.nhc.noaa.gov/2004frances.shtml

Franklin, J. L. National Hurricane Center. 2004. Tropical Cyclone Report: Hurricane Alex. Accessed online: http://www.nhc.noaa.gov/2004alex.shtml

Franklin, J. L., Brown, D. P., and **McAdie, C.** National Hurricane Center. 2004. Tropical Cyclone Report: Hurricane Gaston. Accessed online: http://www.nhc.noaa.gov/2004gaston.shtml

Hartose, S. 2004. *Responding to Tragedy a Delicate Balance for Government Leaders.* The Associated Press State and Local Wire (Raleigh, N.C. office). Friday, August 20.

Lawrence, M. B., and **Cobb, H. D.** National Hurricane Center. 2004. Tropical Cyclone Report: Hurricane Jeanne. Accessed online: http://www.nhc.noaa.gov/2004jeanne.shtml

Levinson, D. NOAA/National Climatic Data Center. 2004. Climate of 2004 Atlantic Hurricane Season. Accessed online: http://www.ncdc.noaa.gov/oa/climate/research/2004/hurricanes04.html

Mitchell, M., and **Youngquist, S.** 2004. *Easley Declares Emergency for Whole State.* Winston-Salem Journal (Winston-Salem, NC). Wednesday, September 8.

Nowell, P. 2005. *Storm Season Rough on N.C.* Daily Reflector (Greenville, NC). Sunday, January 2.

Pasch, R. J., Brown, D. P., and **Blake, E. S.** National Hurricane Center. 2004. Tropical Cyclone Report Hurricane Charley. Accessed online: http://www.nhc.noaa.gov/2004charley.shtml

Schreiner, M. 2004. *After the Storm: What Now?* Star News (Wilmington, NC). Sunday, August 15.

Schreiner, M., and **Fennell, B.** 2004. *In Our Area/ After the Hurricane; Who pays? It's too early to tell.* Star News (Wilmington, NC). Tuesday, August 17.

Sparks, J., and **Youngquist, S.** 2004. *Rains From Frances Pound Western N.C., Flooding, Mudslides Sock Several Counties More Than 215 Roads Closed When Rivers, Streams Flood Their Banks.* Winston-Salem Journal (Winston-Salem, NC). Thursday, September 9.

Stewart, S. R. National Hurricane Center. 2004. Tropical Cyclone Report: Hurricane Ivan. Accessed online: http://www.nhc.noaa.gov/2004ivan.shtml