

Preliminary Report
Hurricane Opal
27 September - 6 October 1995

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Hurricane Opal made landfall near Pensacola Beach, Florida as a marginal Category 3 hurricane on the Saffir/Simpson Hurricane Scale, causing extensive storm surge damage to the immediate coastal areas of the Florida panhandle. It was the first major hurricane to strike the Florida panhandle since Eloise in 1975.

a. Synoptic History

Satellite imagery and synoptic analyses indicate that Opal originated from a tropical wave that emerged from the west coast of Africa on 11 September. The wave moved westward across the Atlantic into the western Caribbean Sea by 23 September and merged with a broad area of low pressure centered in the vicinity of 15°N 80°W. The combined system drifted west-northwestward toward the Yucatan peninsula over the following few days without significant development. Deep convection increased near the center of the low and the post-analysis "best track" in Figure 1 shows that a tropical depression formed about 70 n mi south-southeast of Cozumel, Mexico at 1800 UTC 27 September. Best track position, central pressure and maximum one-minute sustained wind speed are listed for every six hours in Table 1.

Steering currents were weak and the tropical depression moved slowly over the Yucatan peninsula for the following three days. Convective banding increased and ship reports suggest that the depression became Tropical Storm Opal at 1200 UTC 30 September while centered near the north-central coast of the Yucatan peninsula. The storm gradually strengthened and moved slowly westward into the Bay of Campeche.

Air Force Reserve unit aircraft investigating Opal over the southwestern Gulf of Mexico reported that the minimum central pressure steadily dropped. Aircraft reports and satellite estimates suggest that Opal strengthened into a hurricane near 1200 UTC 2 October while centered about 150 n mi west of Merida, Mexico. A banding type eye appeared in satellite imagery later in the day while a large amplitude mid- to upper-level trough moving into the central United States began turning Opal slowly toward the north.

On 3 and 4 October, the hurricane turned toward the north-northeast to northeast and gradually accelerated. During this

period, the water temperature beneath the hurricane's circulation was near 28 to 29C, and a large upper-level anticyclone was well established over the Gulf of Mexico. Rapid intensification occurred not only as a result of these favorable environmental conditions on the large scale but, and perhaps more importantly, due to significant changes on a smaller scale within the hurricane's inner core. Opal intensified into a category four hurricane on the Saffir/Simpson Hurricane Scale early on 4 October at which time reconnaissance aircraft reported a small, 10 n mi diameter eye. The minimum central pressure of 916 mb, with maximum sustained surface winds estimated at 130 knots, occurred when the hurricane was centered about 250 n mi south-southwest of Pensacola, Florida near 1000 UTC 4 October. The peak intensity appears to have occurred near the end of an eyewall contraction cycle. Soon thereafter, the small inner eyewall diminished as an outer eyewall became more dominant. The hurricane weakened during this process, but was still a marginal Category 3 hurricane as the center made landfall at Pensacola Beach, Florida near 2200 UTC 4 October. The collapse of the inner eyewall, reduced sea surface temperatures along the Gulf coast and increased upper-level westerlies likely contributed to the weakening.

The hurricane was moving north-northeastward near 20 knots at landfall with the sustained hurricane force winds in the eastern quadrants of the circulation primarily between Pensacola Beach and Cape San Blas. **The minimum central pressure at landfall was 942 mb. Maximum sustained surface winds are currently estimated at 100 knots in a narrow swath at the coast near the extreme eastern tip of Choctawhatchee Bay about midway between Destin and Panama City.** Although no official reports of surface winds were received within this area, data from reconnaissance aircraft and Doppler radar suggest that the peak winds occurred in this location. It should be emphasized that the strongest winds were in a very limited area and most of the coastal areas of the Florida panhandle experienced winds of a Category 1 or Category 2 hurricane (between 65 and 95 knots). Although the winds were diminishing at the time of landfall, extensive damage due to storm surge and breaking waves occurred over most of the coastal areas of the Florida panhandle.

Opal weakened rapidly after moving inland, becoming a tropical storm over southern Alabama and a tropical depression over southeastern Tennessee. The cyclone was declared extratropical on the best track as it moved northeastward over the Ohio Valley and eastern Great Lakes into southwestern Quebec. The strongest winds occurred well away from the center of the cyclone during the extratropical stage.

b. Meteorological Statistics

Figures 2 and 3 show the curves of minimum central pressure and maximum one-minute wind speed, respectively, versus time, along with the observations on which they are based.

U.S. Air Force Reserve aircraft provided a total of 38 operational center fixes during approximately 122 flying hours of reconnaissance on this hurricane. The minimum central pressure reported by aircraft was 916 mb at 0945 UTC 4 October. This represented a 53 mb drop in pressure within 24 hours and a 42 mb fall within about 12 hours. This was a very rapid rate of deepening, but it is not unprecedented. Several western North Pacific typhoons have deepened at an even faster rate. The maximum winds of 152 knots from a flight-level of 700 mb were measured shortly after the 916 mb pressure report. At 2006 UTC, approximately two hours prior to landfall, the aircraft reported 126 knots 59 n mi east of the center. At 2203 UTC, near the time of landfall, the aircraft reported 115 knots 54 n mi east of the center. In addition to the Air Force Reserve reconnaissance, a NOAA aircraft flew a 10 hour research mission at the time of landfall.

A ship with call sign **XCKX** reported 75 knot winds at 1200 UTC 4 October while located about 90 n mi west-southwest of the hurricane center. Several other ship reports were helpful in defining the extent of tropical storm force winds. Table 2 lists ship reports of at least tropical storm force winds in the vicinity of Opal.

The strongest winds reported by a land station were 73 knots with gusts to 125 knots from Hurlbert Field, Florida. Table 3a lists selected surface observations, and Table 3b lists selected observations made by NOAA's National Data Buoy Center (NDBC) platforms near the path of Opal.

Isolated tornadoes were reported from the Florida panhandle to the mid-Atlantic states. One fatality occurred in Crestview, Florida as a result of a tornado. Another tornado injured several people and severely damaged a number of structures as it swept through Charles, Prince Georges and Anne Arundel Counties in Maryland.

At the time of this report a post-storm high water mark survey was being conducted by the U.S. Army Corps of Engineers and the U.S. Geological Survey. Many high water marks remain to be surveyed and "tied into" bench marks. The locations of the maximum values cannot be finalized until the survey is complete. However, initial survey results show an extensive storm surge from southeastern Mobile Bay and Gulf Shores, Alabama, eastward through the Florida panhandle to Cedar Key, Florida. Still water mark elevations inside of buildings or tide gage maximums, which damp out breaking wave effects and are indicative of the storm surge, ranged from 5 to 14 feet above mean sea level. Outside water marks on buildings or debris lines on sand dunes within 200 feet of the Gulf of Mexico shoreline generally ranged from 10 to 21 feet. For example, the tide gage at the Panama City Beach pier recorded a maximum of approximately 8.3 feet above mean sea level, indicative of storm surge. At the end of the pier a debris line elevation of

approximately 18 feet above mean sea level was recorded. Thus, the breaking waves on top of the storm surge added approximately 10 feet. Many structures in this combined storm surge and breaking wave zone that were not elevated high enough suffered major structural damage.

The combination of Opal and a frontal system resulted in heavy rains along the path of the hurricane. Rainfall totals generally ranged from 5 to 10 inches over portions of the Florida panhandle, Alabama and Georgia. Rains in South Carolina averaged 2 to 4 inches while in North Carolina 3 to 5 inches were common. Highlands, North Carolina recorded 8.95 inches and Robinson Creek, North Carolina recorded 9.89 inches. Elsewhere, 1 to 3 inch totals occurred over portions of the northeast U.S. from Maryland northward. These rains have been described as beneficial to areas of the northeast U.S. that had been experiencing a prolonged dry period.

c. Casualty and Damage Statistics

The total number of deaths directly associated with Opal is currently set at 63, and were distributed as follows:

- Guatemala - 31 (from flooding during the developing stages of Opal)
- Mexico - 19 (from flooding)
- U.S. - 13 including
 - Florida (1 from a tornado)
 - Alabama (2 from a tree falling on a mobile home)
 - Georgia (9, 5 of which were caused by falling trees)
 - North Carolina (1 from a tree falling on a mobile home)

There were no reported deaths due to storm surge flooding, which is remarkable in view of the vulnerable population and extensive salt water damage observed.

The Insurance Information Institute preliminary estimate of insured property damage for the United States is \$2 billion. Considerable uncertainty exists concerning the amount of additional damage due to flood claims, uninsured property damage (including damage to roads and bridges and other government property) and the cost of cleanup. If the estimate of insured property damage proves to be correct, the total damage estimate from Hurricane Opal could reach \$3 billion. Without adjustments for inflation, Opal could rank as high as third on the list of costliest twentieth-century U.S. hurricanes. With adjustments for inflation, Opal will likely still be ranked in the top ten on that list. *Note - In 2011 the U.S. damage estimate for Opal was revised to \$5.142 billion, an amount that in 2011 made Opal the 14th-most costly U.S. hurricane.*

Most of the severe structural damage occurred at the coastline. The crumbled piers, demolished homes and eroded or submerged

highways were primarily a result of the storm surge. In addition, however, strong winds spread damage well inland. Opal downed numerous trees, knocking out power to nearly 2 million people in Florida, Alabama, Georgia and the Carolinas. The Robert Trent Golf Course in Opelika, Alabama lost over 7000 trees during the storm. Many people in Florida were without water for several days.

d. Forecast and Warning Critique

During the time when Opal was of tropical storm or hurricane strength, the mean official track forecast errors of 42 (18 cases), 102 (16 cases), 161 (14 cases), 231 (12 cases) and 326 (8 cases) n mi at 12, 24, 36, 48 and 72 hours respectively were slightly larger than the long-term averages from the previous ten years.

The intensity forecasts showed a negative bias (i.e., intensity was underestimated). The trend for the strengthening of Opal while over water was correctly forecast by the NHC, but the amount of rapid deepening was not anticipated by the official forecasts or by any available objective intensity prediction techniques.

Table 4 lists the coastal watches and warnings issued during Opal. Approximately 31 hours elapsed between the time a hurricane watch was issued and the time of landfall on the Florida panhandle. Approximately 19 hours elapsed between the time of issuance of a hurricane warning was issued and the time of landfall.

TABLE 1. Preliminary best track, Hurricane Opal, 27 September - 6 October 1995.

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat. (°N)	Lon. (°W)			
1800	19.1	87.3	1004	25	Trop. Depression
28/0000	19.4	87.5	1004	25	" "
0600	19.4	87.9	1004	25	" "
1200	19.3	88.2	1003	25	" "
1800	19.3	88.4	1003	25	" "
29/0000	19.4	88.4	1003	25	" "
0600	19.5	88.4	1003	25	" "
1200	19.6	88.3	1003	25	" "
1800	19.8	88.2	1003	30	" "
30/0000	20.1	88.2	1002	30	" "
0600	20.6	88.3	1002	30	" "
1200	21.1	88.5	1001	35	Tropical Storm
1800	21.4	89.1	1000	40	" "
01/0000	21.3	89.9	994	45	" "
0600	21.1	90.7	987	45	" "
1200	20.9	91.2	986	45	" "
1800	20.8	91.6	985	50	" "
02/0000	20.7	91.9	984	55	" "
0600	20.8	92.1	980	60	" "
1200	21.0	92.3	973	65	Hurricane
1800	21.2	92.3	972	65	"
03/0000	21.7	92.2	970	70	"
0600	22.2	92.0	969	75	"
1200	22.8	91.6	968	80	"
1800	23.5	91.0	965	85	"
04/0000	24.5	90.1	953	100	"
0600	25.9	89.4	935	110	"
1200	27.3	88.5	919	130	"
1800	29.0	87.7	938	110	"
05/0000	31.0	86.8	950	80	"
0600	33.2	86.2	974	50	Tropical Storm
1200	35.4	85.7	982	30	Trop. Depression
1800	38.5	83.5	986	40	Extratropical
06/0000	40.5	82.3	989	40	"
0600	42.0	80.5	991	40	"
1200	43.3	78.4	997	35	"
1800	44.5	76.5	1002	30	"

04/1000	26.6	88.8	916	130	Minimum Pressure
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Landfall:

Pensacola Beach, Florida

04/2200	30.3	87.1	942	100	Hurricane
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TABLE 2. Ship encounters of 34 knots or higher associated with Hurricane Opal.

Tropical Cyclone Winds (ship encounters of 34 knots or higher)							
Tropical Cyclone	Ship Call Sign	Date Mo/Da	Time UTC	Position LatN LonW	Wind (kt) Dir/Speed	Pressure (mb)	
Opal	C6CM7	9/29	0000	22.6 85.0	120/35	1006.4	
	KAFG	9/30	1800	20.9 85.0	140/38	1005.7	
	C6JN	10/01	1800	21.9 94.7	340/34	1003.3	
	C6JN	10/02	0600	19.2 94.5	290/40	1000.8	
	3EWJ9	10/03	1200	20.6 86.5	140/58	1007.0	
	C6KE8	10/03	1800	27.6 94.4	010/34	1003.0	
	WBVY	10/04	0000	27.5 91.4	030/38	997.3	
	C6KJ5	10/04	0600	23.1 86.6	160/37	997.5	
	XCKX	10/04	0600	27.2 88.8	110/48	991.0	
	ELIU2	10/04	1200	24.7 84.3	160/40	-	
	SHIP	10/04	1200	26.8 84.7	170/46	997.2	
	XCKX	10/04	1200	26.8 90.1	340/75	984.0	
	KGBE	10/04	1200	27.6 86.0	140/48	993.0	
	VSBZ5	10/04	1200	28.4 88.8	080/55	983.5	
	ELIU2	10/04	1800	24.4 84.5	170/40	1008.5	
	XCKX	10/04	1800	26.7 90.3	290/40	997.0	
	KGBE	10/04	1800	27.4 85.6	210/52	994.6	
	VSBZ5	10/04	1800	27.5 89.3	310/47	988.0	

TABLE 3a. Hurricane Opal selected surface observations, October 1995.

Location	Minimum sea-level pressure		Maximum surface wind speed (knots)		Date/time (UTC) *	Storm surge (tide height above normal) (ft)	Rain (storm total) (in)
	Pressure (mb)	Date/time (UTC)	Sustained	Peak gust			
Louisiana							
New Orleans (MSY)	990.9	04/1953	23	30	04/2150		0.34
New Orleans (NEW)	991.2	04/1951	30	41	04/2352		1.17
Mid Lake Ponchartrain Causeway			32	39	04/2320		
Mississippi							
Gulfport	985.4	04/1947	30	38	04/2147		
Keesler AFB (BIX)	984.5	04/2125	35**	55**	04/1956		3.66
Meridian (MEI)	991.6	05/0303	24	34	04/2335		
Alabama							
Evergreen	980.0	04/2119	30	43	04/2115		8.10
Mobile (MOB)	978.5	04/2250	33	51	04/2339		7.48
Downtown Mobile			45	57	04/2100		
Ft. Rucker (OZR)	978.4	05/0059	65	85	05/0024		
Maxwell AFB (MXF)	974.1	05/0355	41	78	05/0327		
Montgomery (MGM)	969.4	05/0256	41	55	05/0245		3.23
Auburn (AUB)	980.0	05/0400	24	45	05/0300		
Birmingham (BHM)	976.7	05/0655	27	42	05/0453		3.79
Anniston (ANB)	989.0	05/0631	25	35	05/0335		6.09
Huntsville (HSV)	982.4	05/0856	37	48	05/0627		2.44
Florida							
Pensacola	948.2	04/2302	43	63	94/2247		
I-10 & East Bay							
Pensacola Airport (FAA)			54	62	04/2041		
Pensacola (PNS)				69	04/1930		7.27
Pensacola (NPA)	955.0	04/2225	52	67	04/2043		6.93

* Time of sustained wind speed unless only gust is given.

** Estimated.

TABLE 3b. Hurricane Opal selected NDBC observations, October 1995.

	Minimum sea-level pressure		Maximum wind speed (knots)		Platform/ Location (UTC)
	Pressure (mb)	Date/time (UTC)	Peak average*	Date/time gust	
Grand Isle, LA C-MAN GDIL1 / 29.3N 90.0W	990.0	04/1900	40	52	04/1400
Southwest Pass, LA C-MAN BURL1 / 28.9N 89.4W	985.4	04/1700	64	75	04/1700
Dauphin Island, AL C-MAN DPIA1 / 30.2N 88.1W	970.0	04/2126	53	67	04/2150
Keaton Beach, FL C-MAN KTNF1 / 29.8N 83.6W	998.0	04/2000	30	47	04/2100
Cedar Key, FL C-MAN CDRF1 / 29.1N 83.0W	1000.2	04/2100	32	46	04/2300
42001 / 25.9N 89.7W	963.7	04/0600	53	66	04/1000
42003 / 25.9N 85.9W	992.8	04/1200	43	54	04/0900
42007 / 30.1N 88.8W	979.5	04/2100	52	68	04/1900
42036 / 28.5N 84.5W	995.4	04/2100	35	43	04/1800

*NOAA buoys report an 8-minute average wind and C-MAN stations report a 2-minute average wind.