Tropical Cyclone Report
Hurricane Ophelia
6-17 September 2005

Jack Beven and Hugh D. Cobb, III
National Hurricane Center
24 January 2006
Updated track near Nova Scotia 14 June 2006

Hurricane Ophelia was a category 1 hurricane on the Saffir-Simpson Hurricane Scale that brushed the North Carolina Outer Banks, its center staying just offshore from that coast. The storm's erratic and slow movement in the vicinity of the North Carolina coastline was similar to Hurricanes Bonnie in August 1998 and Dennis in August 1999.

a. Synoptic History

Ophelia formed from a non-tropical weather system. A cold front moved off the eastern coast of the United States on 1 September. The front moved southeastward and became part of an elongated trough of low pressure that extended from Tropical Depression Lee east of Bermuda to near the Florida Peninsula. Two areas of low pressure formed in the trough on 4 September. The eastern low, south of Bermuda, eventually became Hurricane Nate. The western low, near the Bahamas, became Ophelia.

The pre-Ophelia low initially drifted southward. It began a northward drift on 5 September while the associated shower activity became better organized. Based on satellite, surface, and radar observations, it is estimated the low became a tropical depression near 0600 UTC 6 September between Andros and Grand Bahama Islands. The "best track" chart of the tropical cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1.

The depression moved generally northward, with the broad circulation center crossing Grand Bahama about 1600 UTC 6 September. It then moved north-northwestward parallel to the east coast of Florida, reaching a position about 70 n mi east-northeast of Cape Canaveral on 7 September. The cyclone became a tropical storm early on 7 September, and gradual strengthening would occur during the next 24 h as Ophelia made a slow counter-clockwise loop off the Florida east coast. Steering currents were very weak at this time, as Ophelia remained embedded in a broad trough that extended from Hurricane Maria east of Bermuda through the developing Nate and Ophelia and across Florida.

Ophelia was briefly a hurricane late on 8 September, with the cyclone weakening back to a tropical storm about 6 h later. A similarly short-lived hurricane phase occurred late on 9 September while Ophelia moved east-northeastward away from Florida. Ophelia became a hurricane for a third time on 10 September, this time holding hurricane status for 36 hours. The cyclone made a slow clockwise loop on 11-12 September, and it is possible that weakening back

to a tropical storm on 12 September was due to Ophelia passing over its wake of upwelled cooler water. After completing the loop, the storm drifted northwestward on 13 September.

Ophelia moved slowly northward early on 14 September and became a hurricane for the fourth time. A gradual turn toward the north-northeast brought the northern portion of the 50 n mi wide eye over the coast of North Carolina near Cape Fear later that day, although the actual center of circulation stayed offshore. Ophelia moved generally east-northeastward parallel to the North Carolina coast for much of 14-15 September, with the northern eyewall passing over the coastal area from Wilmington to Morehead City. During this time, the hurricane reached its peak intensity of 75 kt, although these winds remained offshore.

Ophelia turned eastward late on 15 September while passing south of Cape Hatteras. A combination of increasing vertical shear and dry air intrusion caused weakening, and Ophelia became a tropical storm early on 16 September. As an upper-level trough and associated surface front approached from the west, the storm turned northeastward and accelerated late on 16 September. This motion brought the center about 60 n mi southeast of the Massachusetts coast on 17 September, then over eastern Nova Scotia and Newfoundland on 18 September. Ophelia gradually lost organization during this period, and it became extratropical early on 18 September. As an extratropical low, Ophelia moved east-northeastward across the Atlantic on 19-20 September, then northeastward on 21-22 September. The cyclone dissipated over the North Sea on 23 September.

b. Meteorological Statistics

Observations in Ophelia (Figs. 2 and 3) include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), the Satellite Analysis Branch (SAB) and the U. S. Air Force Weather Agency (AFWA), as well as flight-level and dropwindsonde observations from flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command and the NOAA Aircraft Operations Center. Microwave satellite imagery from NOAA polar-orbiting satellites, the NASA Tropical Rainfall Measuring Mission (TRMM), the NASA Aqua, the NASA QuikSCAT, the Department of Defense WindSat, and Defense Meteorological Satellite Program (DMSP) satellites were also useful in tracking Ophelia.

The Air Force Reserve and NOAA Hurricane Hunter aircraft made 105 center fixes during Ophelia's lifetime. The maximum flight-level winds observed during the storm were 91 kt from a NOAA aircraft at 700 mb at 2124 UTC 11 September. While these winds would support surface winds of 80 kt using the normal 90% adjustment from 700 mb, the maximum surface winds the Stepped Frequency Microwave Radiometer (SFMR) were during the flight were only 64 kt. Winds from other flight-levels and dropsondes near that time also suggest surface winds closer to 65 kt. The peak intensity of 75 kt on 11 September is based on 85 kt winds at 700 mb at 0615 UTC that day, supported by a dropsonde wind of 80-kt at 13 m at 0434 UTC. The second peak intensity of 75 kt on 14-15 September is based on multiple occurrences of 80-85 kt winds at 700 mb, along with SFMR observations of 75-80 kt winds. A notable aircraft observation was a 74 kt wind at 925 mb on 16 September measured by the first ever

successful Aerosonde robotic aircraft mission into the core of a tropical cyclone. The lowest aircraft-observed central pressure was 976 mb at 1218 UTC 10 September.

Ship reports of winds of tropical storm force associated with Ophelia are given in Table 2. The most noteworthy observations include a report of 64-kt winds from the **Sanmar** (call sign V2EX) at 0000 UTC 15 September, and a report of 62-kt winds from the **Maersk New Orleans** (call sign ELZY3) at 0600 UTC 14 September. Both ships were about 85 n mi east-northeast of the center at those times. A pair of drifting buoys reported winds of 70 kt and 62 kt, although the accuracy of these reports is uncertain.

Ophelia brought hurricane conditions to portions of the North Carolina coast; selected surface observations from land stations and data buoys are given in Table 3. The strongest reported winds were from the Coastal Marine Automated Network (C-MAN) Station at Cape Lookout, which reported 2-min average winds of 65 kt (9.8-m elevation) at 2309 UTC 14 September with a gust to 80 kt. The National Ocean Service (NOS) station at Wrightsville Beach reported 6-min average winds of 59 kt at 1700 UTC 14 September with a gust of 69 kt. There was an unofficial report of a gust of 90 kt in Davis.

Ophelia also brought tropical-storm force winds to portions of the east-central coast of Florida and the northeastern coast of South Carolina. A NASA station at Cape Canaveral reported sustained winds of 34 kt at 1520 UTC 8 September with a gust of 52 kt. Myrtle Beach, South Carolina reported a gust of 38 kt.

The lowest pressure observed by a coastal station or buoy was 980.7 mb at the Frying Pan Shoals, North Carolina C-MAN station at 1300 UTC 14 September. The nearby NOAA buoy 41013 measured a 980.8 mb pressure three hours earlier as the large eye drifted across both stations. The NOS station at Wrightsville Beach measured a 984.9 mb pressure at 1854 UTC 14 September.

Ophelia caused storm surges of 4 to 6 ft above normal tide levels in the Pamlico Sound including the lower reaches of the Neuse, Pamlico, and Newport Rivers. Surges of 4 to 6 ft also occurred along the open coasts in Onslow and Cataret counties. Storm surges of 3 to 4 ft above normal tide levels were common elsewhere along the affected areas of the North Carolina coast. Ophelia also caused tides of 1 to 2 ft above normal along the Florida coast.

Ophelia's slow movement near the North Carolina coast helped produce locally heavy rains. The water treatment plant at Oak Island reported a storm-total rainfall of 17.50 in, while the Remote Automated Weather Stations (RAWS) station at the Nature Conservancy reported 11.74 inches.

No tornadoes have been reported with Ophelia.

c. Casualty and Damage Statistics

One death was directly associated with Ophelia – a drowning in high surf in Palm Beach County, Florida. One death was indirectly associated with Opehlia after it became extratropical – a fall from a roof during rain in Nova Scotia.

The American Insurance Services Group estimates the property damage from Ophelia at $35 million. Applying a doubling of this to cover damage to uninsured property yields a total damage estimate of $70 million. It should be noted that the Insurance Information Institute originally provided an estimate of $800 million in damage, which was the basis for the $1.6 billion reported in the annual summary released by the Tropical Prediction Center in December. This figure was an estimate of damage by a model, not an actual report of damage claims.

d. Forecast and Warning Critique

Average official track errors (with the number of cases in parentheses) for Ophelia were 23 (44), 38 (42), 53 (40), 68 (38), 103 (34), 157 (30), and 200 (26) n mi for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. These errors are considerably lower than the average official track errors for the 10-yr period 1995-2004[1] (42, 75, 107, 138, 202, 236, and 310 n mi, respectively), with the Ophelia errors being about 50% less than the average from 12-72 hr (Table 4). The official forecasts were quite good in depicting the overall slow motion of Ophelia and the turn toward the west on 12-13 September. However, there were some larger errors for forecasts on 11-12 September that resulted from forecasting too fast of a northeastward motion as Ophelia passed near North Carolina.

The consensus models CONU, GUNS, and GUNA had lower track forecast errors than the official forecast at all times. Amongst the dynamical models, the ensemble mean of the National Weather Service Global Forecasting System had errors lower than the official forecast from 12-48 hr, while the United Kingdom Meteorological Office global model had lower errors than the official forecast at 96 and 120 hr.

Average official intensity errors were 5, 6, 8, 8, 8, 14, and 21 kt for the 12, 24, 36, 48, 72, 96, and 120 h forecasts, respectively. For comparison, the average official intensity errors over the 10-yr period 1995-2004 are 6, 10, 12, 15, 18, 20, and 22 kt, respectively. The intensity forecasts were accurate in predicting that Ophelia's strengthening would be limited. Some errors resulted from the timing of the storm's intensity cycles, while others resulted from landfall forecasts that did not verify.

Table 5 shows the coastal watches and warnings issued for Ophelia.

The development of Ophelia was fairly well forecast in TPC products. The surface trough that spawned both Ophelia and Nate was noted in the Tropical Weather Outlook (TWO) on 2 September, and the potential for Ophelia to develop was noted in both the TWO and the TAFB danger graphic product on 4 September.

[1] Errors given for the 96 and 120 h periods are averages over the four-year period 2001-4.

Acknowledgements

Much of the data for this report was supplied by the National Weather Service WFOs in Melbourne and Jacksonville, Florida, Wilmington and Morehead City, North Carolina, and Charleston, South Carolina. Chris Fogarty of the Canadian Hurricane Center provided data showing that Ophelia made landfall in Nova Scotia as an extratropical low. NOAA buoy and C-MAN data were provided by the National Data Buoy Center, and were augmented by data from the Skidaway Institute of Oceanography, the Carolinas Coastal Ocean Observing and Prediction System (CARO-COOPS), the Coastal Ocean Research and Monitoring Program (CORMP), and the Gulf of Maine Ocean Observing System (GOMOOS). NOS data were provided by the NOAA National Ocean Service. Remote Automated Weather Stations (RAWS) data were provided by the National Interagency Fire Center. Much of the track for the extratropical portion of Ophelia was provided by the Ocean Prediction Center. Several of the unofficial observations were obtained from the Weather Underground web site.

Table 1. Best track for Hurricane Ophelia, 6-17 September 2005. East longitudes are expressed as negative numbers.

Date/Time (UTC)	Latitude (^{o}N)	Longitude (^{o}W)	Pressure (mb)	Wind Speed (kt)	Stage
06 / 0600	25.8	78.6	1009	25	tropical depression
06 / 1200	26.3	78.3	1010	25	"
06 / 1800	26.8	78.3	1010	25	"
07 / 0000	27.4	78.5	1006	30	"
07 / 0600	27.9	78.8	1003	35	tropical storm
07 / 1200	28.7	79.2	1000	40	"
07 / 1800	28.8	79.3	997	45	"
08 / 0000	28.8	79.3	994	45	"
08 / 0600	28.7	79.6	994	50	"
08 / 1200	28.6	79.6	988	55	"
08 / 1800	28.6	79.5	988	60	"
09 / 0000	28.6	79.3	990	65	hurricane
09 / 0600	28.9	79.3	990	55	tropical storm
09 / 1200	29.3	79.1	983	55	"
09 / 1800	29.8	78.5	983	65	hurricane
10 / 0000	30.2	77.5	983	60	tropical storm
10 / 0600	30.9	76.9	984	60	"
10 / 1200	31.5	76.6	976	65	hurricane
10 / 1800	31.7	76.2	977	70	"
11 / 0000	31.8	75.9	977	70	"
11 / 0600	31.7	75.9	978	75	"
11 / 1200	31.6	75.7	978	70	"
11 / 1800	31.4	75.9	978	65	"
12 / 0000	31.2	76.2	980	60	tropical storm
12 / 0600	31.2	76.6	985	60	"
12 / 1200	31.5	76.9	988	55	"
12 / 1800	31.7	77.3	989	60	"
13 / 0000	31.8	77.7	989	60	"
13 / 0600	31.9	77.9	990	60	"
13 / 1200	32.1	78.0	989	60	"
13 / 1800	32.3	78.1	988	60	"
14 / 0000	32.6	78.1	985	65	hurricane
14 / 0600	32.9	78.0	980	70	"
14 / 1200	33.4	77.7	980	75	"
14 / 1800	33.9	77.5	979	75	"
15 / 0000	34.2	76.9	979	75	"
15 / 0600	34.5	76.3	982	70	"
15 / 1200	34.7	75.8	984	65	"
15 / 1800	34.7	75.6	986	65	"
16 / 0000	34.6	75.1	987	60	tropical storm

Date/Time (UTC)	Latitude (^{o}N)	Longitude (^{o}W)	Pressure (mb)	Wind Speed (kt)	Stage
16 / 0600	34.7	74.8	993	55	"
16 / 1200	35.4	74.4	995	50	"
16 / 1800	36.4	73.6	993	55	"
17 / 0000	37.3	72.7	995	55	"
17 / 0600	38.7	71.4	1000	50	"
17 / 1200	40.0	69.7	997	50	"
17 / 1800	41.6	67.3	995	50	"
18 / 0000	43.2	64.9	996	45	extratropical
18 / 0600	44.8	62.6	1000	45	"
18 / 1200	46.2	59.9	1000	45	"
18 / 1800	47.4	56.2	999	45	"
19 / 0000	48.4	52.3	1000	45	"
19 / 0600	49.0	48.8	1001	45	"
19 / 1200	49.5	45.7	1000	45	"
19 / 1800	50.0	42.1	999	45	"
20 / 0000	50.9	38.5	998	45	"
20 / 0600	51.5	34.7	1000	40	"
20 / 1200	52.2	30.5	1003	40	"
20 / 1800	52.8	26.5	1001	40	"
21 / 0000	53.8	22.0	998	40	"
21 / 0600	55.3	17.7	998	35	"
21 / 1200	57.6	14.6	998	35	"
21 / 1800	59.8	11.9	996	35	"
22 / 0000	61.7	8.4	993	35	"
22 / 0600	63.6	4.5	993	35	"
22 / 1200	65.6	1.0	994	35	"
22 / 1800	67.5	-1.9	995	30	"
23 / 0000	68.8	-6.6	997	30	"
23 / 0600					dissipated
06 / 1600	26.6	78.3	1010	25	landfall on Grand Bahama Island
10 / 1200	31.5	76.6	976	65	minimum pressure
14 / 1200	33.4	77.7	980	75	maximum wind

Table 2. Selected ship and drifting buoy reports with winds of at least 34 kt for Hurricane Ophelia, 6-17 September 2005.

Date/Time (UTC)	Ship name/call sign	Latitude (^{o}N)	Longitude (^{o}W)	Wind dir/speed (kt)	Pressure (mb)
07 / 0100	**Lykes Liberator**	32.6	79.3	060 / 36	1016.5
07 / 1000	**CSX Discovery**	29.6	79.8	040 / 37	1008.0
07 / 1100	**CSX Discovery**	29.3	79.4	060 / 37	1006.0
07 / 1200	**P&O Nedlloyd Marseille**	33.3	76.8	090 / 38	1018.4
07 / 1800	**DSR Port Said**	33.5	77.2	040 / 35	1018.5
08 / 0600	**Leverkusen Express**	28.9	77.4	130 / 35	1010.0
08 / 1200	**Madison Maersk**	31.0	78.8	050 / 39	1013.0
08 / 1600	**Asphalt Commander**	29.5	77.5	190 / 50	1006.0
09 / 0000	**CSX Producer**	28.6	79.0	170 / 60	995.5
09 / 0300	Buoy 41542	29.0	78.1	*** / 54	1006.3
09 / 1100	**Lykes Navigator**	30.9	78.7	040 / 43	1007.0
09 / 1200	**Lykes Navigator**	31.2	78.7	030 / 44	1018.5
09 / 1800	**Paris Express**	31.9	79.9	020 / 41	1011.0
09 / 2100	9V6488	30.0	80.6	010 / 35	1010.0
09 / 2100	Buoy 41542	29.4	77.8	*** / 35	1000.8
09 / 2152	Buoy 41934	28.9	76.3	*** / 41	1007.2
09 / 2300	**Bonn Express**	30.4	76.9	130 / 45	1001.8
10 / 1800	**Star Istind**	32.8	76.2	050 / 44	1009.0
10 / 1800	**Singapore Bay**	33.7	74.8	090 / 40	1010.6
10 / 2100	**Green Dale**	33.7	77.0	040 / 40	1013.0
10 / 2200	**Singapore Bay**	32.2	74.8	260 / 39	1003.4
11 / 0019	Buoy 41935	31.2	76.3	*** / 62	1002.0
11 / 0236	Buoy 41935	31.2	76.3	*** / 70	1002.8
11 / 1700	**Fortune Pioneer I**	34.3	71.3	080 / 44	1021.0
11 / 2100	**Jens Maersk**	29.6	75.1	230 / 40	1010.5
11 / 2100	**OOCL Freedom**	33.6	77.1	030 / 47	1013.0
12 / 0600	**Shanghai Express**	29.9	78.4	320 / 35	1011.8
12 / 0600	ZCAM5	31.5	74.6	130 / 37	1009.5
12 / 1800	**Sealand Performance**	33.6	77.2	080 / 43	1007.5
12 / 2100	**Sealand Performance**	34.1	76.6	090 / 42	999.8
13 / 0000	**Overseas New Orleans**	33.1	78.1	050 / 45	1005.2
13 / 0600	**Sealand Liberator**	31.5	77.4	200 / 50	994.0
13 / 1800	**OOCL Freedom**	33.7	77.0	120 / 35	1007.5
14 / 0000	WABU	31.1	77.2	230 / 37	1006.4
14 / 0600	**Montebello**	31.4	77.7	240 / 51	1003.0
14 / 0600	**Maersk New Orleans**	32.4	76.5	160 / 62	1003.0
15 / 0000	**Sanmar**	34.5	75.3	150 / 64	1004.5
15 / 0300	**Sanmar**	34.3	75.2	210 / 51	1004.0
15 / 1200	**Jens Maersk**	32.8	74.5	180 / 35	1011.1

Date/Time (UTC)	Ship name/call sign	Latitude (^{o}N)	Longitude (^{o}W)	Wind dir/speed (kt)	Pressure (mb)
15 / 1500	SHIP	33.5	75.5	210 / 51	1007.0
16 / 0000	HPII	33.4	73.3	190 / 40	
17 / 0000	ZDGR8	33.3	72.7	190 / 45	1015.6
17 / 0600	V7DI7	36.2	69.6	210 / 36	1016.2
17 / 1800	**Afhankelijk**	40.9	65.7	190 / 45	1003.6
17 / 1900	**German Senator**	41.8	62.1	260 / 37	

Table 3. Selected surface observations for Hurricane Ophelia, 6-17 September 2005.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Florida								
Bings Landing (NOS)	09/0900	1009.5				1.55		
Cape Canaveral (NASA Wind Tower 394)			08/1520	34	52			
Fernandina Beach (NOS)	09/0900	1010.7	09/1000	16	28	1.65		
Mayport (KNRB)	09/0826	1009.5	08/0412	28	34			
Mayport (NOS)	09/0824	1010.1	08/1018		37	3.03		
Melbourne (NWS)								1.96
NAS Jacksonville (KNIP)	09/0848	1010.2	08/1838	33				
NASA Shuttle Landing Facility (KTTS)	08/0855	1006.4	08/1855	19	38			2.79
New Smyrna Beach (KEVB)	09/1055	1008.8	08/2250	31	40			
Patrick AFB (KCOF)	08/1955	1006.1	08/1955	25	36			2.03
St. Augustine (KSGJ)	09/0815	1008.8	07/1255	26	34			
Vilano Beach (NOS)						1.93		
North Carolina								
Back Island (RAWS)			14/2315		55			7.04
Beaufort (KMRH)	14/2356	991.8	14/2328	37[e]	55[e]			4.78
Beaufort (RAWS)			15/0615		39			3.92
Bogue Field (KNJM)	14/2033	993.2						
Cape Hatteras (KHSE)	15/1256	993.1	15/1256	57[e]	72[e]			2.85
Cherry Point (KNKT)	15/0555	994.2	15/0655	37	64			4.57
Croatan (RAWS)			15/0905		51			5.43
Elizabeth City (KECG)	15/0854	1008	15/1552	30	39			0.53
Elizabethtown (KEYF)	14/1820	1002.7						1.87
Hoffman Forest (RAWS)			15/0105		41			4.26
Kinston (KISO)			15/0643	23	34			
Kenansville (KDPL)			14/1903	23	35			
Kitty Hawk (KFFA)			15/1540	20	31			
Manteo (KMQI)			15/1726	28	33			

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Nature Conservancy (RAWS)			14/1715		53			11.74
New Bern (KEWN)	15/0354	1000.0	15/0241	32	44			3.46
New River (KNCA)	14/2156	994.2	14/2156	38	55			5.12
Newport (KMHX)	15/0420	990.5	15/0534	31	49			9.39
Onslow Beach (RSLN7)	14/2322	985.0	14/2125	53	68			
Pea Island (PEIN7)	15/0850	1003.0	15/1236		57			
Richlands (KOAJ)			15/0015	30	49			
Sandy Run (RAWS)			15/0015		40			5.06
Southport (KSUT)	14/1504	988.1	14/1824	36	56			7.38
Stumpy Point (SPON7)	15/0750	1004.0	15/0740		37			
Sunset Beach (CARO-COOPS)	14/1324	995.6	14/1300	33	47	2.85		
Sunny Point (RAWS)			14/1815		59			10.74
Swan Quarter (SWQN7)	15/0730	1000.0	15/0856		49			
Turnbull Creek (RAWS)			14/1815		42			2.81
Washington (KOCW)			15/0643	20	33			
Whiteville (RAWS)			14/1815		39			3.18
Wilmington (KILM)	14/1850	989.5	14/1658	42	59			8.23
Wrightsville Beach (NOS)	14/1854	984.8	14/1700	59	69	4.19		
South Carolina								
Charleston (KCHS)	13/2251	1006.8	13/2334	23	33			0.06
Charleston Harbor (NOS)						1.64		
Fripps Inlet (CARO-COOPS)						1.78		
Myrtle Beach (KMYR)	14/1050	1000.7	14/0455	25	38			
North Myrtle Beach (KCRE)	14/1336	999.7	14/1253	20	33			6.30
Oyster Landing (NOS)						2.75		
South Capers Island (CARO-COOPS)						1.74		
Springmaid Pier (NOS)	14/0942	1000.5	14/1800	24	37	2.81		

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Georgia								
Fort Pulaski (NOS)						1.87		
Saint Simons Island (KSSI)	09/0900	1011.5	09/1546	30		1.44		1.69
Buoy/CMAN								
NOAA Buoy 41001 (34.7N 72.7W)	15/2300	1011.5	16/1040	28[f]	37			
NOAA Buoy 41002 (32.3N 75.4W)	10/2200	998.7	11/2200	49	67			
NOAA Buoy 41004 (32.5N 79.1W)	13/2250	996.4	13/0030	45	57			
NOAA Buoy 41009 (28.5N 80.2W)	08/1050	1002.3	08/1750	37	47			
NOAA Buoy 41010 (29.0N 78.5W)	09/0820	1000.1	09/1350	37	49			
NOAA Buoy 41012 (30.0N 80.6W)	09/1100	1006.2	08/1300	30	43			
NOAA Buoy 41013 (33.4N 77.4W)	14/1000	980.8	14/1800	54	68			
CARO-COOPS Buoy 41024 (33.8N 78.5W)	14/1300	994.9	14/1500	38	41			
NOAA Buoy 41025 (35.0N 75.4W)	15/1500	988.7	15/1707	55[f]	73			
CARO-COOPS Buoy 41030 (32.5N 79.3W)			13/2330	38	45			
NOAA Buoy 41035 (34.5N 77.3W)	14/2120	982.0	14/2030	48[f]	62			
CORMP Buoy 41038 (34.1N 77.7W)			142100	50	52			
NOAA Buoy 44004 (38.5N 70.6W)	17/0800	1001.5	17/0730	40[f]	53			
NOAA Buoy 44008 (40.5N 69.4W)	17/1200	1001.1	17/1100	33	43			
NOAA Buoy 44014 (36.6N 74.8W)			16/1900	27[f]	35			
GOMOOS Buoy 44024 (42.3N 65.9W)	17/2100	996.9	17/1900	27	35			
Cape Lookout, NC (CKLN7)	15/0600	981.9	14/2309	65	80			
Cedar Island, NC (CITN7)	15/0840	988.0	15/0838		78			
Duck, NC (DUCN7)	15/0930	1008.5	15/1651	34	43			

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Frying Pan Shoals, NC (FPSN7)	14/1300	980.7						
Sabsoon Tower R8 (TYBG1)	13/2136	1005.4	13/0630	38	44			
Sabsoon Tower R2 (SPAG1)			13/0431	31	35			
Sabsoon Tower M2R6 (SKMG1)	13/1934	1007.2	13/0234	35	41			
St. Augustine, FL (SAUF1)	09/0905	1008.8	09/0105	34	43			
Settlement Point, Grand Bahama (SPGF1)	08/2300	1008.5	07/0630	25	34			
Unofficial Observations								
Florida								
Crescent City (CREF1)								3.02
Deland (COOP)								2.96
Hastings ARC (HTGF1)								3.65
Orange Springs (OSPF1)								1.59
Palm Bay (COOP)								2.11
Palm Coast (WOGF1)								3.95
Ponce Inlet (COOP)								2.65
Scottsmoor (COOP)								2.95
S. Merrit Island (Weather Underground)	09/2000	1005.3	09/2050		34			
Starke (SRKF1)								1.16
Titusville (COOP)								2.87
North Carolina								
Bald Head Island					73			
Cedar Point (Weather Underground)	14/2330	987.7	14/1730		45			
Davis					90			
Jacksonville (JEON7)								5.79
Jacksonville (Weather Underground)	14/2130	994.8	14/2335		43			
Kinston (KNNN7)								3.59

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)[c]	Storm tide (ft)[d]	Total rain (in)
	Date/ time (UTC)	Press. (mb)	Date/ time (UTC)[a]	Sustained (kt)[b]	Gust (kt)			
Kure Beach La Que Center					68			6.20
Morehead City					70			
Morehead City (waterfront)					74			
Morehead City (Weather Underground)	15/0530	986.7	15/0100		45			
Oak Island Brunswick Co Water Treatment Plant								17.50
Oak Island (Weather Underground)	14/1530	990.7	14/1815		57			
St. James (Weather Underground)	14/1530	985.7	14/1330		62			
Southport (Weather Underground)	14/1600	987.0	14/1600		51			
Surf City Pender Co NC								7.63
Tranters Creek (TRAN7)								3.98
Wallace (WCEN7)								3.28
Watha (Weather Underground)	14/1818	997.2	15/0358		43			
Wilmington (Weather Underground)	14/1821	989.4	14/1845		68			
Wrightsville Beach			14/1649		70			
Georgia								
Woodbine								1.90
South Carolina								
Charleston			13/1938	23	34			0.07
Isle of Palms	13/2330	1004.5	14/0230	22	37			0.18
Pineville			14/0102	19	32			

[a] Date/time is for sustained wind when both sustained and gust are listed.
[b] Except as noted, sustained wind averaging periods for C-MAN and land-based ASOS reports are 2 min; buoy averaging periods are 8 min.
[c] Storm surge is water height above normal astronomical tide level.
[d] Storm tide is water height above National Geodetic Vertical Datum (1929 mean sea level).
[e] Instrumentation failed
[f] 10-minute average

Table 4. Preliminary forecast evaluation (heterogeneous sample) for Hurricane Ophelia, 6-17 September 2005. Forecast errors (n mi) are followed by the number of forecasts in parentheses. Errors smaller than the NHC official forecast are shown in bold-face type. Verification includes the depression stage, but does not include the extratropical stage, if any.

Forecast Technique	Forecast Period (h)						
	12	24	36	48	72	96	120
CLP5	39 (45)	85 (43)	133 (41)	163 (39)	223 (35)	332 (31)	462 (27)
GFDI	25 (42)	42 (40)	54 (38)	75 (36)	157 (32)	278 (27)	383 (23)
GFDL*	30 (42)	44 (40)	59 (38)	71 (36)	136 (32)	252 (27)	353 (23)
GFNI	25 (42)	41 (39)	64 (37)	96 (35)	164 (31)	278 (26)	425 (22)
GFDN*	29 (41)	46 (39)	60 (36)	89 (34)	153 (30)	263 (25)	396 (22)
FV4	30 (41)	62 (40)	91 (39)	128 (37)	237 (33)	379 (29)	561 (25)
AF1I	38 (16)	68 (16)	102 (16)	150 (16)	294 (16)		
AFW1*	53 (8)	80 (8)	105 (8)	140 (8)	256 (8)		
COAI	34 (43)	57 (39)	86 (37)	120 (35)	191 (31)		
COAL*	36 (21)	59 (20)	79 (19)	109 (18)	177 (16)		
COEI	32 (24)	60 (24)	93 (24)	130 (22)			
COCE*	36 (12)	60 (12)	89 (12)	122 (11)			
ETAI	55 (41)	112 (39)	168 (37)	207 (34)	318 (23)		
ETA*	50 (41)	106 (39)	158 (36)	207 (30)	292 (22)		
GFSI	**20** (40)	**36** (38)	55 (36)	75 (34)	156 (30)	278 (26)	357 (22)
GFSO*	23 (40)	**34** (38)	53 (36)	69 (34)	133 (30)	247 (26)	343 (22)
AEMI	**21** (41)	**35** (39)	**47** (37)	**62** (35)	129 (31)	221 (27)	271 (23)
AEMN*	**22** (41)	**34** (39)	**44** (37)	**53** (35)	104 (31)	202 (27)	255 (23)
NGPI	24 (45)	43 (43)	57 (41)	74 (39)	112 (33)	168 (29)	275 (25)
NGPS*	24 (44)	40 (42)	54 (40)	70 (38)	112 (33)	167 (29)	289 (25)
UKMI	25 (43)	40 (41)	**52** (39)	**60** (37)	143 (33)	**129** (29)	**169** (25)
UKM*	27 (22)	45 (21)	50 (20)	68 (19)	116 (17)	**129** (15)	**120** (13)
CMC*	33 (18)	51 (17)	69 (16)	78 (16)	144 (14)	271 (6)	522 (5)
CEMN*	33 (10)	44 (9)	62 (9)	76 (8)	122 (7)	159 (6)	**127** (4)
EMXI	27 (23)	49 (22)	74 (21)	110 (20)	198 (18)	283 (16)	362 (14)
EMX*	24 (21)	44 (20)	62 (19)	89 (18)	167 (16)	267 (14)	354 (12)
EEMN*	42 (10)	67 (10)	92 (9)	128 (9)	216 (8)	283 (7)	238 (4)
A98E	35 (44)	55 (42)	91 (40)	124 (38)	227 (34)	404 (30)	515 (26)
A9UK	34 (20)	52 (20)	87 (19)	134 (18)	246 (16)		
BAMD	30 (43)	51 (41)	78 (39)	111 (37)	223 (33)	433 (29)	653 (25)
BAMM	34 (43)	58 (41)	85 (39)	105 (37)	151 (33)	257 (29)	382 (25)
BAMS	49 (43)	87 (41)	117 (39)	142 (37)	177 (33)	270 (29)	385 (25)
LBAR	29 (45)	58 (43)	105 (41)	181 (39)	450 (35)	576 (24)	592 (13)
CONU	**19** (44)	**30** (42)	**39** (40)	**48** (38)	**93** (33)	**131** (29)	203 (25)
GUNA	**18** (40)	**29** (38)	**38** (36)	**47** (34)	**96** (30)	**133** (26)	**180** (22)
GUNS	**20** (41)	**32** (39)	**41** (37)	**49** (35)	**99** (30)	**123** (26)	**181** (22)
FSSE	**18** (41)	**28** (39)	**44** (37)	**62** (35)	115 (31)	180 (27)	205 (23)
OHPC	29 (41)	43 (39)	54 (37)	68 (35)	**101** (31)	157 (27)	214 (23)
OFCI	25 (43)	42 (41)	60 (39)	79 (37)	118 (33)	165 (29)	216 (25)
OFCL	23 (44)	38 (42)	53 (40)	68 (38)	103 (34)	157 (30)	200 (26)
NHC Official (1995-2004 mean)	42 (3400)	75 (3116)	107 (2848)	138 (2575)	202 (2117)	236 (649)	310 (535)

* Output from these models was unavailable at forecast time.

Table 5. Watch and warning summary for Hurricane Ophelia, 6-17 September 2005.

Date/Time (UTC)	Action	Location
6 / 1500	Tropical Storm Warning issued	Florida east coast from Jupiter to Titusville
6 / 1500	Tropical Storm Warning issued	Grand Bahama, Abaco and Bimini Islands
7 / 0300	Tropical Storm Watch issued	Florida east coast from Titusville to Flagler Beach
7 / 0900	Tropical Storm Watch extended northward	Florida east coast from Flagler Beach to Fernandina Beach
7 / 0900	Tropical Storm Warning issued	Florida east coast from Sebastian Inlet to Flagler Beach
7 / 0900	Tropical Storm Warning discontinued	Florida east coast from Jupiter to Sebastian Inlet and the Bahamas
7 / 2100	Tropical Storm Warning discontinued	Sebastian Inlet to Cocoa Beach
8 / 2100	Tropical Storm Warning extended	Cocoa Beach to Sebastian Inlet
9 / 1500	All watches and warnings discontinued	Florida east coast
10 / 1500	Hurricane Watch issued	Savannah River, South Carolina to Cape Lookout, North Carolina
11 / 0900	Hurricane Watch discontinued	South Carolina coast from Savannah River to Edisto Beach
11 / 2100	Tropical Storm Warning issued	South Santee River, South Carolina to Cape Lookout, North Carolina
12 / 0900	Tropical Storm Warning extended	South Carolina coast from South Santee River to Edisto Beach
13 / 0300	Hurricane Warning issued	South Santee River, South Carolina to Cape Lookout, North Carolina
13 / 0300	Tropical Storm Warning issued	North Carolina coast from Cape Lookout to Oregon Inlet including Pamlico Sound
13 / 0900	Hurricane Watch issued	North Carolina coast from Cape Lookout to Oregon Inlet including Pamlico Sound
13 / 2100	Hurricane Warning issued	North Carolina coast from Cape Lookout to Cape Hatteras
13 / 2100	Hurricane Watch and Tropical Storm Warning issued	North Carolina coast from Oregon Inlet to NC/VA border
13 / 2100	Tropical Storm Watch issued	Virginia coast from the NC/VA border to Cape Charles Light
13 / 2200	Hurricane Warning extended	North Carolina coast from Cape Hatteras to Oregon Inlet including Pamlico Sound

Date/Time (UTC)	Action	Location
14 / 1500	Hurricane Warning issued	Oregon Inlet to NC/VA border including Albemarle Sound
14 / 1500	Hurricane Watch and Tropical Storm Warning issued	Virginia coast from the NC/VA border to Cape Charles Light including lower Chesapeake Bay
14 / 1500	Hurricane Warning discontinued	South Carolina coast from South Santee River to Little River
14 / 1500	Tropical Storm Warning discontinued	South Carolina coast south of South Santee River
14 / 1500	Hurricane Watch discontinued	South Carolina coast from Edisto Beach to Little River Inlet
14 / 2100	Tropical Storm Warning discontinued	South Carolina coast
15 / 0300	Hurricane Warning changed to Tropical Storm Warning	North Carolina coast from Cape Fear to Surf City
15 / 0300	Hurricane Warning discontinued	South of Cape Fear, North Carolina
15 / 0900	Hurricane Watch discontinued	Virginia coast from the NC/VA border to Cape Charles Light including lower Chesapeake Bay
15 / 0900	Tropical Storm Warning discontinued	North Carolina coast from Cape Fear to Surf City
15 / 2100	Tropical Storm Watch issued	Massachuestts coast from Woods Hole to Plymouth including Martha's Vineyard and Nantucket
15 / 2100	Hurricane warning changed to Tropical Storm Warning	Cape Lookout to Cape Charles Light
16 / 0300	Tropical Storm Watch extended	Plymouth, Massacuusetts to Point Judith, Rhode Island
16 / 0300	Tropical Storm Warning discontinued	Virginia coast from the NC/VA Border to Cape Charles Light including lower Chesapeake Bay
16 / 0900	Tropical Storm Watch issued	Nova Scotia from Yarmouth to Lunenburg
16 / 1500	Tropical Storm Warning issued	Watch Hill, Rhode Island to Plymouth, Massachuestts
16 / 1500	All warnings discontinued	North Carolina coast
16 / 2100	Tropical Storm Watch issued	Nova Scotia from Yarmouth to Halifax
17 / 0300	Tropical Storm Warning issued	Nova Scotia from Yarmouth to Lunenberg
17 / 0300	Tropical Storm Watch extended	Nova Scotia from Yarmouth to Truno
17 / 0300	Tropical Storm Watch extended	Nova Scotia from Lunenberg to Street Harbour

Date/Time (UTC)	Action	Location
17 / 0300	Tropical Storm Warning discontinued	Watch Hill, Rhode Island to Westport, Massachusetts
17 / 0900	Tropical Storm Warning discontinued	Massachusetts coast from Westport to Woods Hole
17 / 1200	Tropical Storm Warning issued	Nova Scotia except Cumberland and Colchester
17 / 1200	Tropical Storm Watch issued	Prince Edward Island
17 / 1200	Tropical Storm Watch issued	Nova Scotia from Cumberland to Colchester
17 / 1500	All warnings discontinued	Massachusetts coast

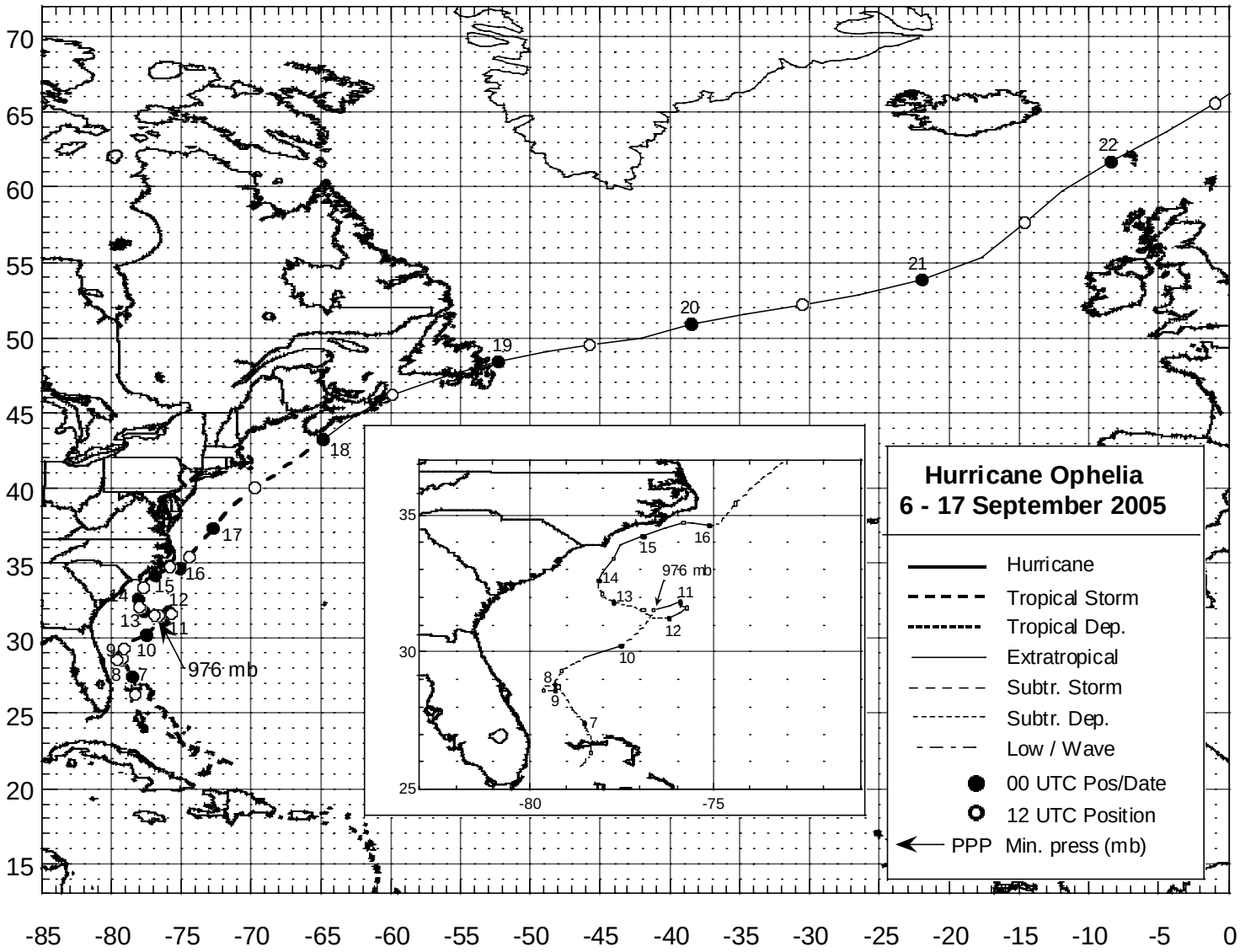

Figure 1. Best track positions for Hurricane Ophelia, 6 – 17 September 2005. Track during the extratropical stage is based on analyses from the NOAA Ocean Prediction Center.

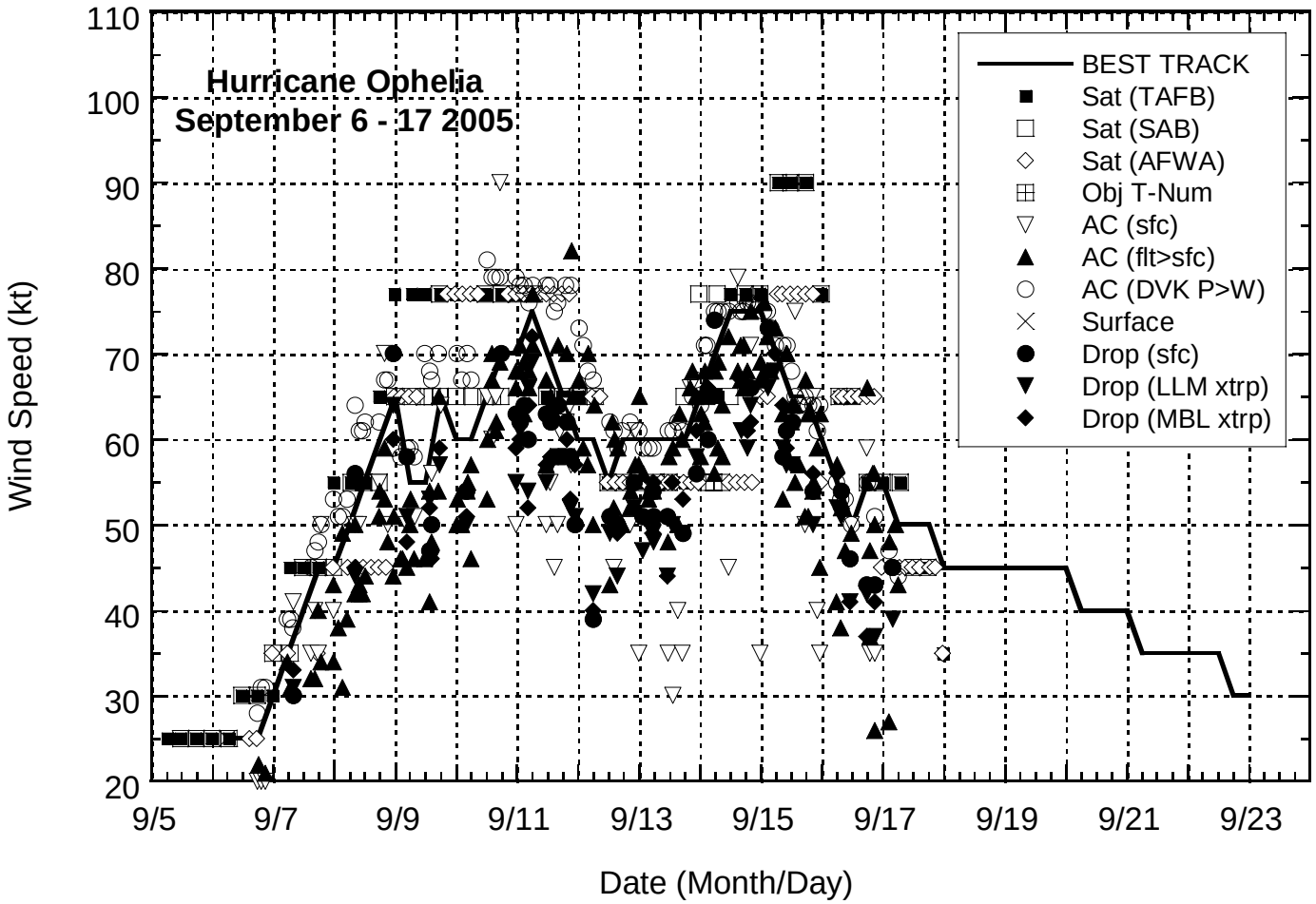

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Ophelia, 6-17 September 2005. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% reduction factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM), and from the sounding boundary layer mean (MBL). Objective Dvorak estimates represent averages over a three-hour period centered on the nominal observation time. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center.

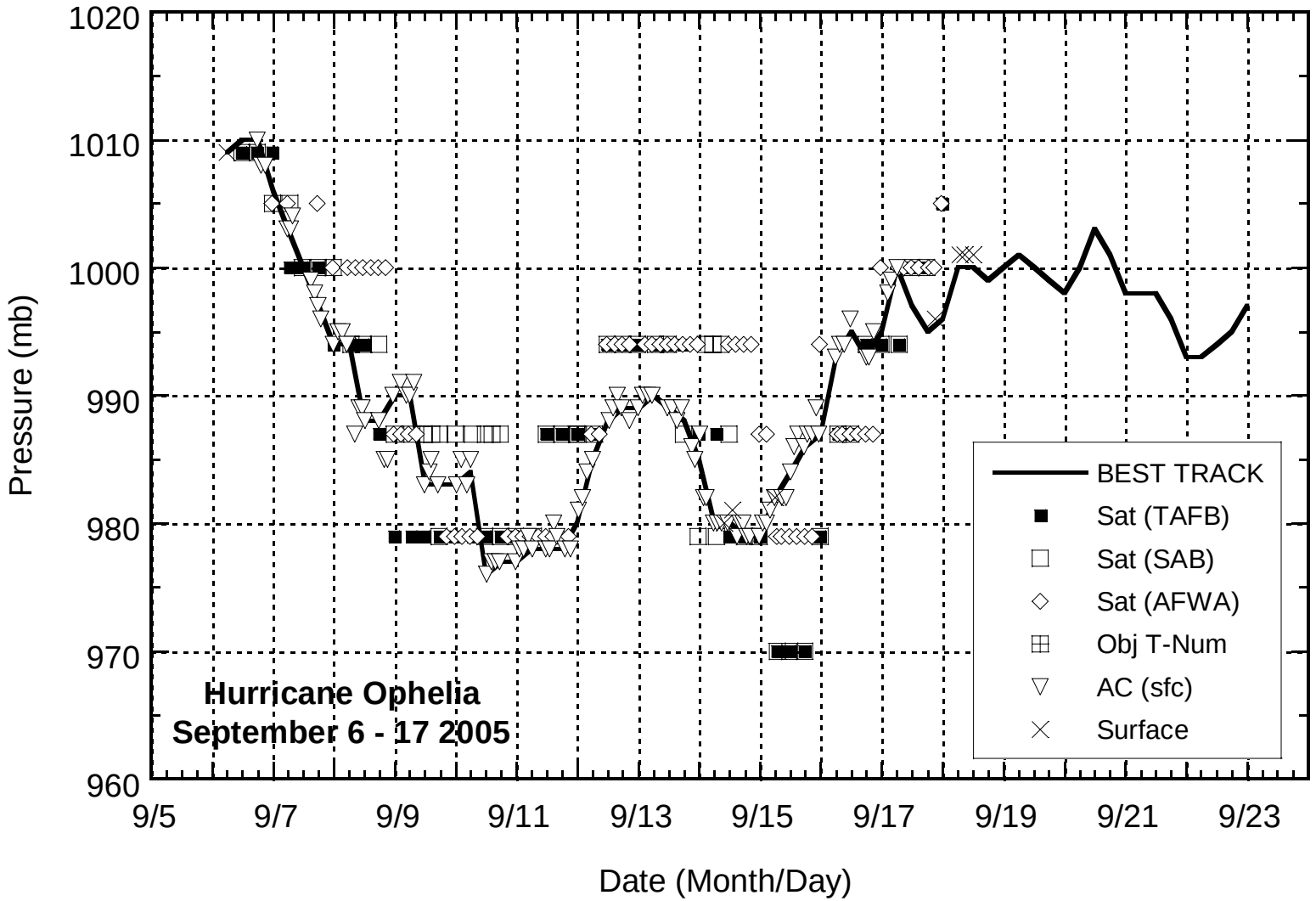

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Ophelia, 6-17 September 2005. Objective Dvorak estimates represent averages over a three-hour period centered on the nominal observation time. Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center.