

Tropical Cyclone Report
Hurricane Bill
(AL032009)
15-24 August 2009

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21 October 2009

Bill was a category 4 (on the Saffir-Simpson Hurricane Scale) Cape Verde hurricane that traversed the Atlantic Ocean around the periphery of the Azores-Bermuda High. It brushed Bermuda and Nova Scotia as a hurricane, and crossed the southern tip of Newfoundland as a tropical storm.

a. Synoptic History

Bill's genesis can be traced to a vigorous tropical wave with an associated broad area of low pressure that emerged from western Africa on 12 August, and moved westward well south of the Cape Verde Islands a day later. By 14 August, the deep convection associated with the system became more consolidated and a few curved rainbands developed primarily on the south side of the disturbance. It is estimated that a tropical depression formed at 0600 UTC 15 August, about 330 n mi west-southwest of the Cape Verde Islands. Bill's path is shown in Figure 1, and time series of the tropical cyclone's maximum sustained wind and minimum central pressure are displayed in Fig. 2 and Fig. 3, respectively. The best track positions and intensities are listed in Table 1¹.

An environment of light vertical wind shear prevailed over the east-central tropical Atlantic, allowing the depression to strengthen fairly steadily. It became a tropical storm around 1800 UTC 15 August and a hurricane by 0600 UTC 17 August, when it was located about midway between the Cape Verde Islands and the Lesser Antilles. Bill continued strengthening and reached its estimated peak intensity of 115 kt at 0600 UTC 19 August when it was centered about 300 n mi east-northeast of the northern Leeward Islands, and remained a category 4 hurricane for about a day. Figure 4 shows Bill during the period that it was a 115-knot hurricane.

From its formation, Bill was steered on a west to west-northwest heading at a steady speed of 14 to 16 kt for several days by deep easterlies to the south of a subtropical ridge. It then accelerated to near 20 kt as it turned northward while embedded within the flow between the subtropical high and a large mid-tropospheric trough nearing the east coast of the United States. By then the shear began to increase and Bill slowly weakened. Bermuda was spared the core of Bill, when the hurricane passed about 150 n mi west of the island with category 2 strength during the morning of 22 August. However, Bermuda did experienced tropical-storm-force winds from

¹ A digital record of the complete best track, including wind radii, can be found on line at <ftp://ftp.nhc.noaa.gov/atcf>. Data for the current year's storms are located in the *brk* directory, while previous years' data are located in the *archive* directory.

the large hurricane. The hurricane then recurved and turned to the northeast with increasing forward speed, brushed the south coast of Nova Scotia early on 23 August, and made landfall as a tropical storm near the Burin Peninsula of Newfoundland. It crossed the southeastern portion of Newfoundland as a tropical storm early on 24 August, but with signs of transition into an extratropical cyclone. By 1200 UTC, Bill had become extratropical. It then moved eastward for a couple of days, becoming absorbed by a larger extratropical cyclone near the British Isles early on 26 August.

b. Meteorological Statistics

The NOAA Hurricane Research Division (HRD) scheduled several research missions during Bill using the NOAA P-3 aircraft and the high altitude G-IV jet. These missions provided a large volume of observations that were very useful both operationally and in the post-analysis of Bill. In addition, there were flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from routine flights of the 53rd Weather Reconnaissance Squadron of the U. S. Air Force Reserve Command. Observations in Bill (Figs. 2 and 3) also include satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB). Data and imagery from NOAA polar-orbiting satellites, including the Advanced Microwave Sounding (AMSU) instrument, the NASA Tropical Rainfall Measuring Mission (TRMM), the NASA QuikSCAT, Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Bill.

The analyzed maximum intensity of 115 knots is a compromise between surface-adjusted flight-level winds and surface data from the SFMR. The cloud pattern had the best presentation at 0600 UTC 19 August, when there was a distinct eye surrounded by very cold convective tops. During that period, the 3-h average objective T-numbers reached 7.0 (140 kt) on the Dvorak scale and these numbers were the highest observed through the entire life of the hurricane. However, available reconnaissance aircraft data during that period did not support winds that strong. The peak 700 mb flight-level wind measured during the entire life of Bill was 140 knots at 2323 UTC 19 August. Data from most of the reconnaissance flights, primarily near the time when this peak wind was measured, indicated that the surface winds were lower than the standard 90% adjustment from the flight level (as revealed in Fig 2). It has been noted in previous hurricanes with large eyes (e.g., Isabel of 2003) that the standard 90% reduction does not always hold and this appears to be the case with Bill.

The lowest pressure of 943 mb was measured by a reconnaissance plane and occurred when the eye of Bill was becoming larger and winds began to decrease. The Bermuda Maritime Operation Center reported sustained winds of 65 knots as shown in the table. However, that measurement was taken at 255 ft above the sea level. Ship reports of winds of tropical storm force associated with Bill are given in Table 2, and selected surface observations from land stations and data buoys are given in Table 3.

c. Casualty and Damage Statistics

There were two deaths associated with Bill. A 7-year-old girl died in Acadia National Park, Maine when she was swept into the water by large waves, and a 54-year-old swimmer drowned in New Smyrna Beach, Florida in rough seas caused by Bill.

The large hurricane fueled high waves over a large portion of the Atlantic basin for several days. The Meteorological Service of the Dominican Republic reported that these waves produced coastal flooding and damage along the north coast of the Dominican Republic. Reports from Environment Canada indicate that in Nova Scotia power outages were common (tens of thousands of residences lost power) and there were road washouts and localized fresh water flooding. Coastal flooding from surge and waves was widespread along much of the Atlantic coast. Some coastal infrastructure damage resulted from the high waves at the coast. In Newfoundland, there were road washouts and localized fresh water flooding.

d. Forecast and Warning Critique

The genesis of Hurricane Bill was well forecast. The precursor of the tropical cyclone was introduced in the Tropical Weather Outlook at 0600 UTC 12 August, about three days before genesis. A “high” chance of formation (greater than 50%) was indicated 42 hours before genesis. The tropical wave from which Bill developed was quite distinct over Africa and most of the global models correctly forecast the development of the tropical cyclone.

A verification of NHC official track forecasts for Bill is given in Table 4a. Official forecast track errors were lower than the mean official errors for the previous five-year period at all time periods. However, Bill was embedded within a well established and persistent steering flow around the subtropical high and there was no interaction with mid-latitude troughs during the first half of the life of the cyclone. This synoptic pattern made the track forecasts relatively straightforward.

A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. On average, the Florida State Super-Ensemble (FSSE) performed better than the official forecast at all times while the GFS, the ECMWF and the GFDL did very well at the 3 to 5 day periods. It is interesting to note that the HWRF, which was quite skillful last year in the Atlantic basin, performed very poorly during Bill.

A verification of NHC official intensity forecasts is given in Table 5a. Official forecast intensity errors were lower than the mean official errors for the previous five-year period for the 12, 24, 48 and 120 h forecast periods. It is also noted that the OCD5 errors for Bill were much larger than the five-year mean OCD5 errors beyond 48 hours, indicating that Bill’s intensity was more difficult than average to forecast. After Bill reached its peak intensity, the official forecasts and the models insisted in additional strengthening but it never occurred. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. Some models were better than the official forecast at some forecast times but only the LGEM performed better at all times.

Watches and warnings associated with Bill are given in Table 6.

Table 1. Best track for Hurricane Bill, 15-24 August 2009.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
15 / 0600	11.8	32.0	1007	30	tropical depression
15 / 1200	11.5	33.3	1006	30	"
15 / 1800	11.2	34.5	1004	35	tropical storm
16 / 0000	11.2	35.5	1004	35	"
16 / 0600	11.5	36.5	1002	40	"
16 / 1200	12.0	37.8	997	50	"
16 / 1800	12.6	39.4	994	55	"
17 / 0000	13.1	41.3	990	60	"
17 / 0600	13.5	43.2	987	65	hurricane
17 / 1200	13.9	44.6	977	75	"
17 / 1800	14.4	46.0	970	80	"
18 / 0000	14.8	47.5	967	85	"
18 / 0600	15.3	49.0	965	90	"
18 / 1200	15.7	50.3	963	95	"
18 / 1800	16.2	51.7	962	100	"
19 / 0000	16.9	52.9	955	105	"
19 / 0600	17.6	54.2	954	115	"
19 / 1200	18.3	55.6	949	115	"
19 / 1800	19.3	56.9	947	115	"
20 / 0000	20.2	58.2	945	115	"
20 / 0600	21.1	59.6	949	115	"
20 / 1200	22.1	61.0	952	105	"
20 / 1800	23.1	62.4	948	110	"
21 / 0000	24.1	63.7	943	110	"
21 / 0600	25.5	64.9	951	105	"
21 / 1200	27.1	66.0	954	100	"
21 / 1800	28.6	66.9	956	95	"
22 / 0000	30.4	67.6	957	90	"
22 / 0600	32.3	68.4	960	90	"
22 / 1200	34.1	68.8	961	85	"
22 / 1800	36.0	68.9	961	80	"
23 / 0000	38.1	68.4	961	80	"
23 / 0600	40.1	67.3	962	75	"
23 / 1200	42.4	65.4	965	70	"
23 / 1800	44.4	62.5	970	65	"
24 / 0000	46.3	57.9	973	65	"
24 / 0200	46.8	56.4	974	60	tropical storm
24 / 0600	48.0	53.0	980	60	"
24 / 1200	49.2	47.2	980	60	extratropical
24 / 1800	50.0	41.2	980	60	"
25 / 0000	50.3	35.4	980	60	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
25 / 0600	50.7	29.6	980	60	"
25 / 1200	51.2	23.8	980	60	"
25 / 1800	52.0	18.0	982	50	"
26 / 0000	53.0	13.0	985	40	"
26 / 0600					absorbed
19 / 0600	17.6	54.2	954	115	maximum winds
21 / 0000	24.1	63.7	943	110	minimum pressure
24 / 0300	46.9	56.0	978	60	Landfall Burin Peninsula, Newfoundland

Table 2. Selected ship reports with winds of at least 34 kt for Hurricane Bill, 15-24 August 2009.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
24 / 0300	VEP717	46.7	48.7	210 / 38	1012.8
24 / 0600	VEP717	46.7	48.7	200 / 56	1004.3
24 / 0600	VOXS	46.7	48.0	180 / 38	1006.7
24 / 0900	HP6038	46.7	48.4	210 / 46	996.6
24 / 1200	DAQZ	42.8	50.2	250 / 38	1015.5
24 / 1200	DHDE	44.5	48.9	250 / 38	1008.5
24 / 1200	HP6038	46.7	48.4	240 / 45	996.6
24 / 1500	VCXF	46.4	48.4	300 / 47	1004.1
24 / 1500	VEP717	46.7	48.7	300 / 52	1003.4
24 / 1500	HP6038	46.7	48.4	280 / 45	1002.6
24 / 1800	VCXF	46.4	48.4	320 / 36	1009.6
24 / 1800	VEP717	46.7	48.7	320 / 45	1009.3
24 / 1800	HP6038	46.7	48.4	310 / 35	1009.1
25 / 0600	SKPE	47.8	24.5	180 / 39	995.4
25 / 1200	SKPE	47.0	26.1	280 / 36	993.6
25 / 1800	DDSD2	46.8	16.7	210 / 35	
26 / 0200	9HOB8	49.6	5.5	190 / 40	1001.0

Table 3. Selected surface observations for Hurricane Bill, 15- 24 August 2009.

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)			
Bermuda								
Bermuda Air. (TXKF)		1011.3	21/2344	40	52			.55
Bermuda Maritime Operation Centre (elev. 255 ft) 1-min			22/0412	65	68			
Fort Prospect (elev. 230 ft)			21/2320	34	58			
St. David's (elev. 159 ft)			22/0340	45	64			
Commissioner's Point (elev. 262 ft)			21/2340	53	85			
Canada								
Sable Island, NS	23/2000	994.1	23/2000	52	67			0.37
Cape Race, NL	24/0500	988.9	24/0500	50	71			0.11
St. Paul Island, NS			24/0000	45	55			0.72
Sagona Island, NL	23/0300	983.7	24/0700	43	55			
McNabs Island, NS			23/1900	38	48	2.1		
Grant Etang, NS	23/2200	989.7	24/0000	38	48			
Argentia, NL	24/0500	985.4	24/0000	37	51	2.5		1.20
Hart Island, NS	23/2000	981.5	24/0000	37	50			
Bonavista, NL	24/0600	986.1	24/0900	37	49			1.05
East Point, PE	23/2100	992.3	23/2000	36	49			2.15
St. Lawrence, NL	24/0300	983.5	24/0400	34	52	3.1		
Charlottetown, PE	23/2000	996.0	23/2000	26	35	2.3		0.90
Shediac, NB						2.3		
Queensport, NS								2.83
Gander, NL								2.80
Alliston, NL								2.63
St. Stephen, NB								1.86
Buoys								
41041 (14.3°N 46.2°W)	17/1808	972.1	17/1652	50	60			

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)			
41044 (21.6°N 58.7°W)	20/0358	991.7	20/0358	67	80			
41049 (27.5° N 63.0°W)	21/0847	1000.7	21/1146	44	50			
41048 (31.9° N 69.6 °W)	22/0736	993.1	22/0911	52	62			
44008 (40.5° N 69.3 °W)	23/0550	993.6	23/0353		39			
44011 (41.1 °N 66.5° W)	23/0850	965.5	23/0700	42	58			
44150 (42.5° N 64.0 °W)	23/1300	980.8	23/1300	58	73			
44137 (42.3° N 62.0 °W)	23/1500	1001.1	23/1500	46	62			
44139 (44.3 °N 57.1° W)	24/0100	1000.5	23/2300	40	54			
44251 (46.5° N 53.4 °W)	24/0500	992.0	24/0300	38	52			
44141 (43.0° N 58.0° W)	23/2200	1007.8	23/2200	38	50			
44138 (44.3 °N 53.6° W)	24/0500	1006.6	24/0600	38	50			
44024 (43.3° N 65.9° W)	23/1200	974.7	23/1400	33	42			
44636 (45.8° N 56.3° W)	24 / 0300	992.1	21/0300	56				
44258 (44.5° N 63.4° W)	23/1700	982.3	23/1600	31	44			

^a Date/time is for sustained wind when both sustained and gust are listed.

^b Except as noted, sustained wind averaging periods for land-based reports are 10 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).

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Bill. Mean errors for the five-year period 2004-8 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	26.6	41.2	55.6	72.2	109.9	160.0	231.0
OCD5	48.5	100.5	151.7	204.2	313.9	417.5	548.0
Forecasts	35	33	31	29	25	21	17
OFCL (2004-8)	32.1	54.9	77.1	99.0	147.0	200.3	263.6
OCD5 (2004-8)	45.8	95.7	152.8	208.6	306.2	393.6	472.9

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Bill. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 4a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	24.0	37.1	54.6	72.3	118.8	177.2	256.0
OCD5	41.0	86.3	147.8	208.9	360.3	497.4	653.4
GFSI	22.7	38.7	55.0	72.7	101.3	145.4	206.0
GHMI	29.3	48.2	66.8	81.8	110.2	146.7	208.1
HWFI	27.6	46.8	62.6	79.8	135.9	235.4	362.7
GFNI	29.5	54.5	79.6	105.7	149.5	197.8	239.5
NGPI	27.1	47.7	70.9	103.2	178.2	239.8	338.5
UKMI	29.9	48.6	71.6	104.5	189.0	305.0	453.4
EMXI	23.1	38.1	60.0	75.8	129.9	166.6	200.6
AEMI	26.4	42.3	58.6	78.3	128.7	178.2	221.1
FSSE	23.6	34.3	39.6	50.1	79.9	132.6	208.6
TCON	22.7	37.7	55.4	76.5	125.3	189.0	278.0
TCCN	27.1	49.0	73.0	99.1	151.3	249.2	432.0
TVCN	22.0	36.9	56.1	75.6	122.7	179.3	249.1
TVCC	26.4	48.0	72.0	97.8	149.1	238.2	355.5
GUNA	24.1	40.1	58.3	79.1	125.1	182.1	263.1
CGUN	28.4	51.2	75.0	101.9	151.8	241.4	420.9
BAMD	32.8	60.7	91.4	126.2	205.7	258.1	340.3
BAMM	32.2	60.6	96.3	132.3	220.3	277.0	353.1
BAMS	30.1	53.9	87.1	115.9	210.8	285.7	351.5
Forecasts	26	26	26	24	20	15	11

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Bill. Mean errors for the five-year period 2004-8 are shown for comparison. Official errors that are smaller than the five-year means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	5.6	10.5	13.2	14.3	19.4	19.8	18.5
OCD5	5.7	10.8	15.1	19.1	26.0	28.7	24.1
Forecasts	35	33	31	29	25	21	17
OFCL (2004-8)	7.1	10.5	12.8	14.7	18.1	19.0	20.9
OCD5 (2004-8)	8.5	12.3	15.3	17.7	20.8	23.1	23.2

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Bill. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 5a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	7.0	11.7	13.1	13.5	17.9	15.9	15.4
OCD5	6.8	11.3	15.3	18.6	24.6	26.9	21.9
HWFI	6.5	11.6	15.2	15.3	17.7	21.5	29.8
GHMI	8.8	13.2	16.0	15.9	18.1	15.4	13.7
DSHP	6.9	12.3	16.2	16.9	18.6	18.6	17.2
LGEM	5.5	7.2	9.9	10.7	10.5	9.4	8.2
GFNI	9.4	14.8	17.6	18.4	18.8	18.6	23.5
ICON	6.6	10.9	14.0	14.0	15.7	15.8	15.3
IVCN	7.1	11.5	14.7	15.0	16.2	16.1	16.5
FSSE	7.1	11.3	14.2	14.9	21.0	23.5	24.9
Forecasts	27	27	27	26	21	16	12

Table 6. Watch and warning summary for Hurricane Bill, 15-24 August 2009.

Date/Time (UTC)	Action	Location
20/ 1500	Hurricane Watch issued	Bermuda
20 / 2100	Tropical Storm Warning issued	Bermuda
22 / 0900	Hurricane Watch changed to Tropical Storm Warning	Bermuda
22 / 0900	Tropical Storm Warning issued	Martha's Vineyard to Nantucket Island
22 / 0900	Tropical Storm Warning issued	Woods Hole to Sagamore Beach
22 / 1500	Tropical Storm Watch issued	Point Aconi to Tidnish, Canada
22 / 1500	Tropical Storm Watch issued	Victoria to Lower Darnley
22 / 1500	Tropical Storm Watch issued	Parsons Pond to Arnolds Cove
22 / 1500	Tropical Storm Watch issued	Fort Lawrence to Charlesville
22 / 1500	Tropical Storm Warning issued	Charlesville to Ecum Secum
22 / 1500	Hurricane Watch issued	Ecum Secum to Point Aconi
22 / 1800	Tropical Storm Warning discontinued	Bermuda
22 / 2100	Tropical Storm Watch modified to	Parsons Pond to Harbour Deep
22 / 2100	Tropical Storm Warning modified to	Charlesville to Point Aconi
23 / 0900	Tropical Storm Watch modified to	Parsons Pond to Stone's Cove
23 / 0900	Tropical Storm Warning issued	Stone's Cove to Bonavista
23 / 1200	Tropical Storm Warning discontinued	Martha's Vineyard to Nantucket Island
23 / 1200	Tropical Storm Warning discontinued	Woods Hole to Sagamore Beach
23 / 1800	Tropical Storm Watch discontinued	Point Aconi to Tidnish
23 / 1800	Tropical Storm Watch discontinued	Fort Lawrence to Charlesville
23 / 1800	Tropical Storm Warning discontinued	Charlesville to Point Aconi
23 / 1800	Tropical Storm Warning issued	Hubbards to Lismore
23 / 2100	Tropical Storm Watch modified to	Victoria to Woods Islands East
23 / 2100	Tropical Storm Watch modified to	Parsons Pond to Burgeo
23 / 2100	Tropical Storm Watch modified to	Fogo Island to Harbour Deep
23 / 2100	Tropical Storm Watch issued	Brule to Malagash
23 / 2100	Tropical Storm Warning discontinued	Hubbards to Lismore
23 / 2100	Tropical Storm Warning discontinued	Stone's Cove to Bonavista
23 / 2100	Tropical Storm Warning issued	Ecum Secum to Brule
23 / 2100	Tropical Storm Warning issued	Burgeo to Fogo Island
23 / 2100	Tropical Storm Warning issued	Savage Harbor to Wood Islands East
23 / 2100	Hurricane Watch discontinued	All
24 / 0300	Tropical Storm Watch discontinued	Brule to Malagash
24 / 0300	Tropical Storm Watch discontinued	Victoria to Woods Islands East
24 / 0300	Tropical Storm Watch discontinued	Savage Harbor to Lower Darnley
24 / 0300	Tropical Storm Warning discontinued	Ecum Secum to Brule
24 / 0300	Tropical Storm Warning discontinued	Savage Harbor to Wood Islands East
24 / 0900	Tropical Storm Watch discontinued	All
24 / 0900	Tropical Storm Warning discontinued	All

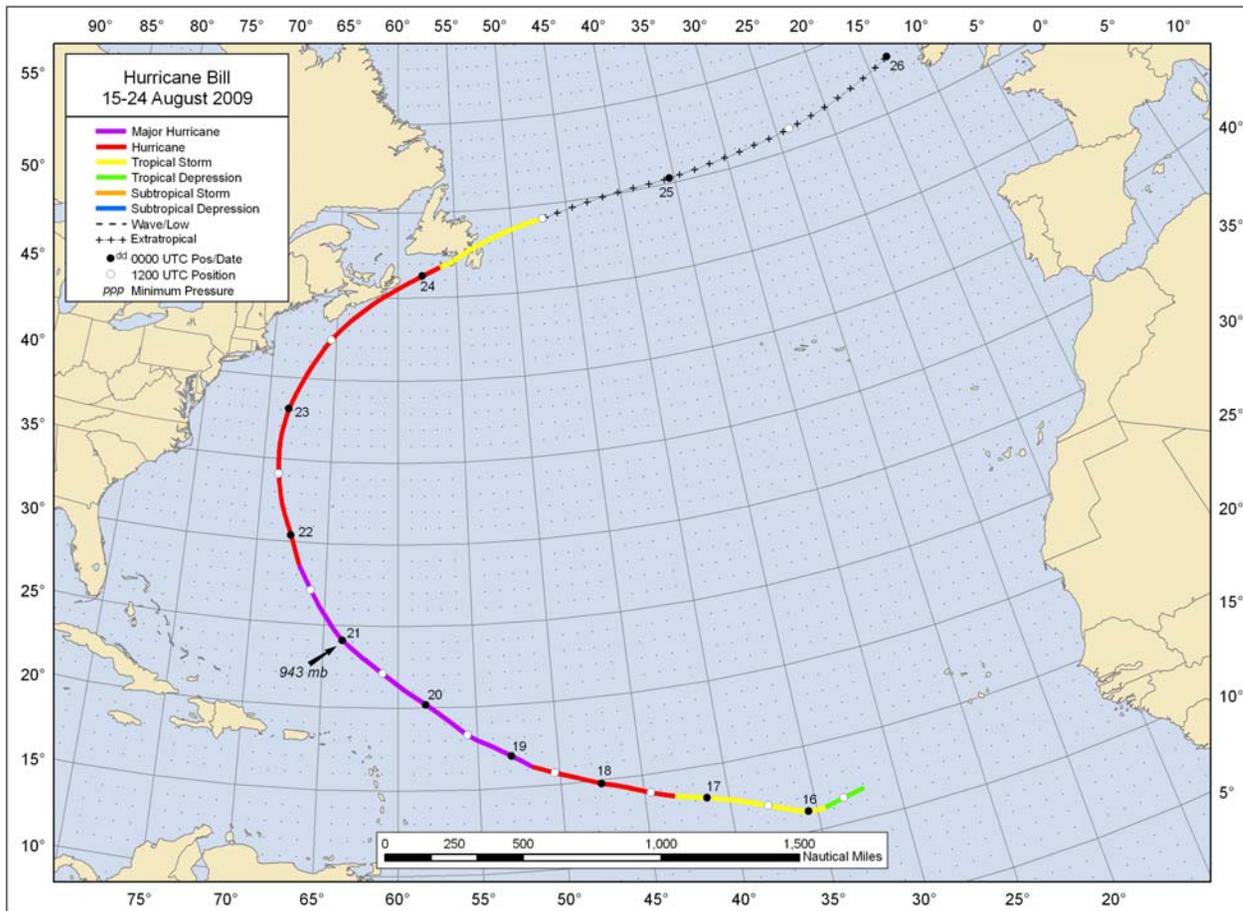


Figure 1. Best track positions for Hurricane Bill, 15-24 August 2009. Track during the extratropical stage is based on analyses from the NOAA Ocean Prediction Center.

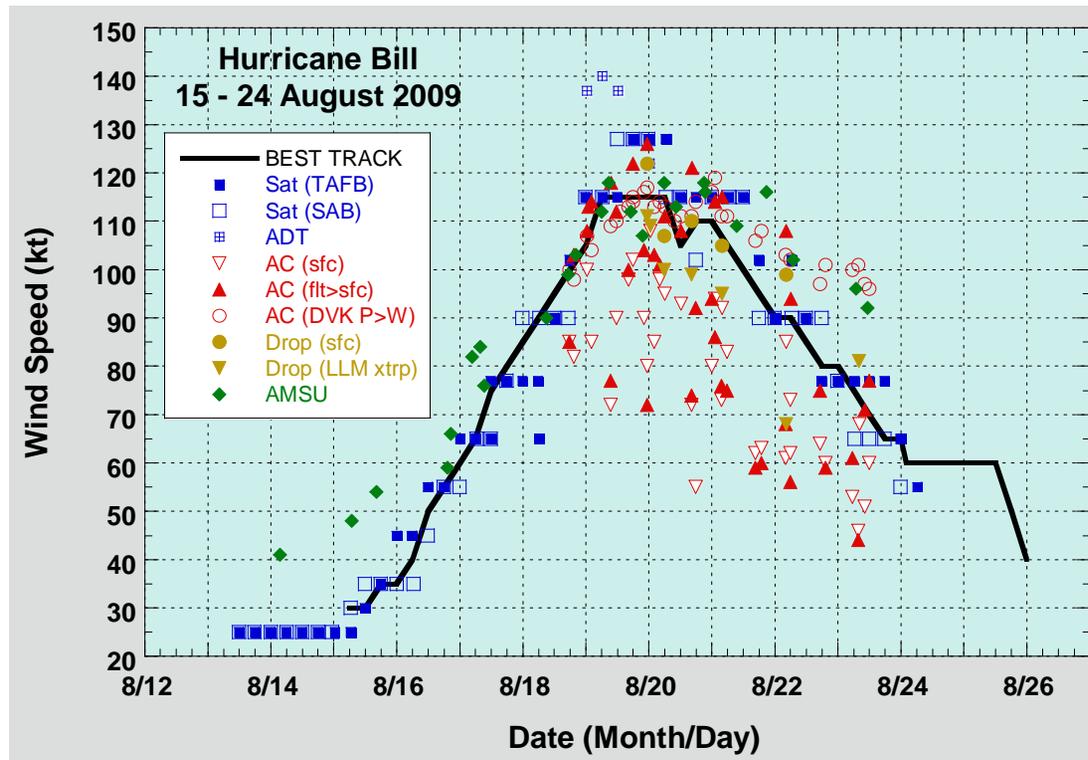


Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Bill, 15-24 August 2009. Aircraft observations have been adjusted for elevation using 90%, 80%, and 80% adjustment factors for observations from 700 mb, 850 mb, and 1500 ft, respectively. Dropwindsonde 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). Advanced Dvorak Technique estimates represent linear averages over a three-hour period centered on the nominal observation time and were provided by the Cooperative Institute of Meteorological Satellite Studies (CIMSS). Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center. Dashed vertical lines correspond to 0000 UTC.

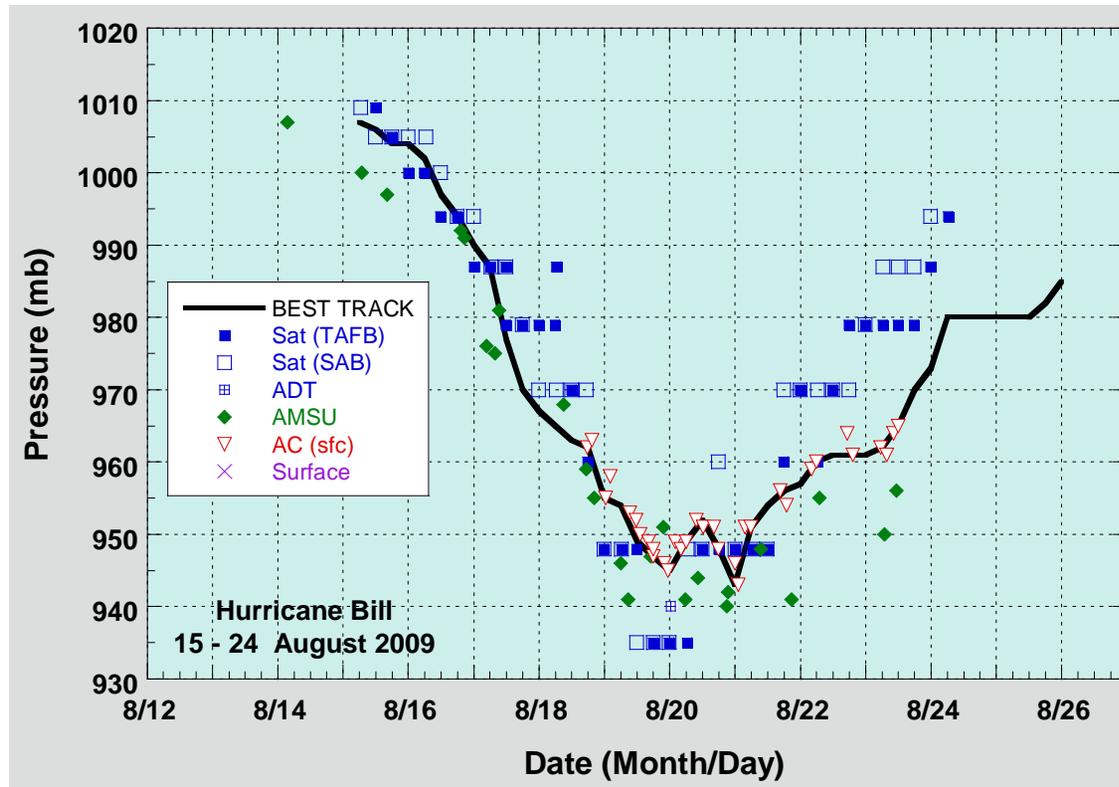


Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Bill, 15-24 August 2009. Advanced Dvorak Technique estimates were provided by the Cooperative Institute of Meteorological Satellite Studies (CIMSS). Estimates during the extratropical stage are based on analyses from the NOAA Ocean Prediction Center. Dashed vertical lines correspond to 0000 UTC.

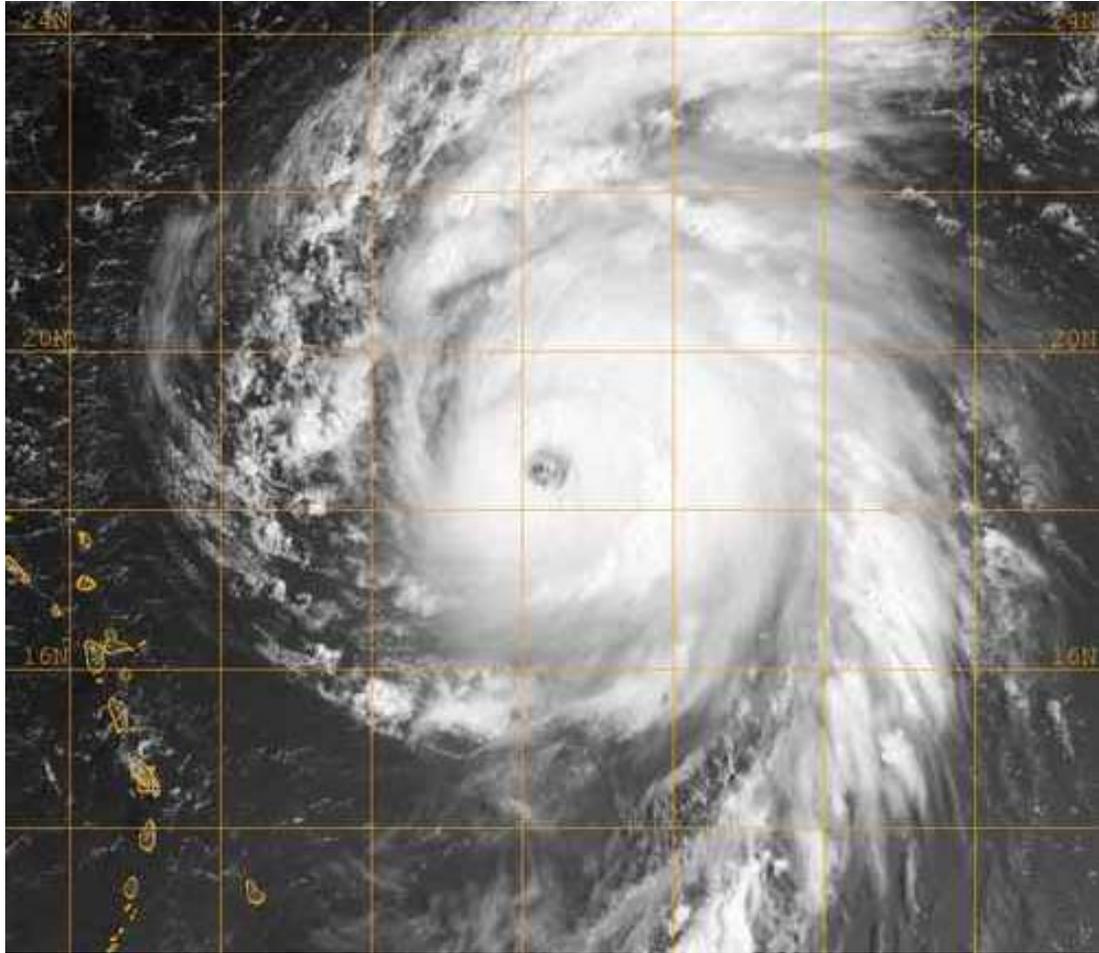


Figure 4. Visible satellite image of Hurricane Bill at 1045 UTC 19 August. Image courtesy of the Naval Research Laboratory (NRL)