

Preliminary Report
Hurricane Dean
31 July - ~~4 September~~ 1989
8 August

a. Synoptic History

On 27 July a westward moving tropical wave emerged from the northwest coast of Africa, as detected in analyses of rawinsonde data from Dakar and in METEOSAT imagery. On 31 July the wave showed sufficient deep convection and a persistent enough cloud system center to be classified using the Dvorak technique by satellite analysts at the NHC. The weather system became the fifth tropical depression of the 1989 hurricane season near 0600 UTC on the 31st while located midway between the Lesser Antilles and the Cape Verde Islands.

The depression generally moved westward near 15 knots, and based on satellite intensity estimates, attained tropical storm strength by 0600 UTC on 1 August. Tropical Storm Dean moved toward the west-northwest while continuing to strengthen, and was upgraded to a hurricane near 1200 UTC on 2 August immediately after the first report of hurricane force surface winds from an Air Force reconnaissance plane.

By 3 August, Dean decreased in forward motion and turned toward the northwest, in response to a collapsing ridge to the north and a developing upper-level trough off the U.S. east coast. By 4 August, Dean turned more toward the north as the upper trough off the U.S. deepened. This northward direction of motion continued with an increase in forward speed to near 15 knots, bringing the eastern eyewall over the island of Bermuda near 1800 UTC on 6 August. This was the first time sustained hurricane force winds were recorded at Bermuda since hurricane Emily passed over the island in 1987.

The lowest pressure reported by reconnaissance aircraft was 970 mb, just after the hurricane passed Bermuda. However, after the last aircraft penetrated the cyclone, the cloud pattern observed in satellite imagery became even better organized with a well-defined eye embedded within a small but cold central dense overcast. Based on satellite estimates, the minimum pressure and maximum winds likely occurred near 0000 UTC on 7 August.

After passing Bermuda, Dean turned toward the northeast and accelerated in response to an upper level trough moving eastward across the northeast U.S. The cyclone passed over Sable Island Nova Scotia, then began to slowly lose tropical characteristics as it moved over southeastern Newfoundland. The cyclone became extratropical over the north Atlantic while moving toward the northeast at about 45 knots.

The synoptic 6-hourly positions by latitude and longitude, along with lowest sea-level pressure, maximum winds and classification by stage are shown in Table 1. The track of Hurricane Dean with 0000 UTC and 1200 UTC positions is shown in Figure 1.

b. Meteorological Statistics

Figures 2 and 3 show the best track pressure and wind curves as a function of time, along with the observations on which they are based. There are no surface observations from any of the islands in the northeast Caribbean on these figures, since tropical storm force winds were not reported as Dean remained at least 40 nautical miles from the closest island.

As the eastern eyewall passed over Bermuda, the highest sustained wind reported was 70 knots with gusts to 98 knots at the U.S. Naval Annex on the western end of the island. The 24 hour rainfall at Bermuda associated with Dean was 2.45 inches. Sable Island Nova Scotia reported sustained hurricane force winds while St. Pierre Island off the south coast of Newfoundland and Bonavista on the northeast coast of Newfoundland both reported sustained tropical storm force winds. See Table 2 for a list of selected meteorological surface observations.

Although the hurricane remained well offshore of the U.S. east coast, tides of 1.7 feet above normal were reported on the outer banks of North Carolina, and were apparently generated by swells from hurricane Dean.

c. Casualty and Damage Statistics

There were no reported deaths due to Hurricane Dean. Since the hurricane veered away from the northeast Caribbean, no significant damage was reported from the Leeward or Virgin Islands. However, two persons on a sailboat en route from the Virgin Islands to Bermuda narrowly escaped disaster when caught in the hurricane. An Air Force plane on a reconnaissance mission into the eye of Dean spotted the sailboat, which reportedly was not equipped with a radio to receive the latest marine advisories.

Personal injuries reported on Bermuda totalled sixteen. Eleven of these were minor, while the more serious injuries included glass in eye, broken arm, dislocated shoulder and head injuries. Although it is difficult to accurately assess the total cost of damage caused by Dean, the common estimate given by public officials on Bermuda is \$5 million. Insurance companies reported claims for damage on 648 buildings, 72 boats, 36 vehicles and 1 pier. In addition to this cost, \$3.9 million in damage occurred to the U.S. Naval base, bringing the total damage assessment on Bermuda to \$8.9 million.

No significant damage or injuries were reported on Sable

Island or Newfoundland, although the Canadian Coast Guard had to rescue three Frenchmen after their sailboat was demasted by the hurricane off the coast of Nova Scotia.

d. Forecast and Warning Critique

One of the more difficult forecasting periods occurred as Dean approached the northeast Caribbean. Although most official forecasts called for Dean to skirt just north of the northeasternmost Caribbean islands, the track prediction models were not always consistent, and enough uncertainty existed to justify the posting of watches and warnings for the northern Lesser Antilles and Puerto Rico. Even when the reconnaissance and satellite fixes first indicated the turn toward the northwest, the official track continued to show a more westward track toward the Bahamas. The more westward track was the course of least regret, since it was not known at the time if the hurricane was undergoing a temporary trochoidal motion or an actual change in direction. The reasoning behind the more westward track was explained in the Tropical Cyclone Discussion.

Once Dean turned northward, the hurricane watch and warning were posted well in advance of any possible threat to Bermuda. As the hurricane approached Sable Island and Newfoundland, the forecast track and appropriate warnings were coordinated with the Canadian Weather Service Office in Nova Scotia.

See Table 3 for a summary of watches and warnings associated with Dean, and see Table 4 for a list of probabilities on the hurricane.

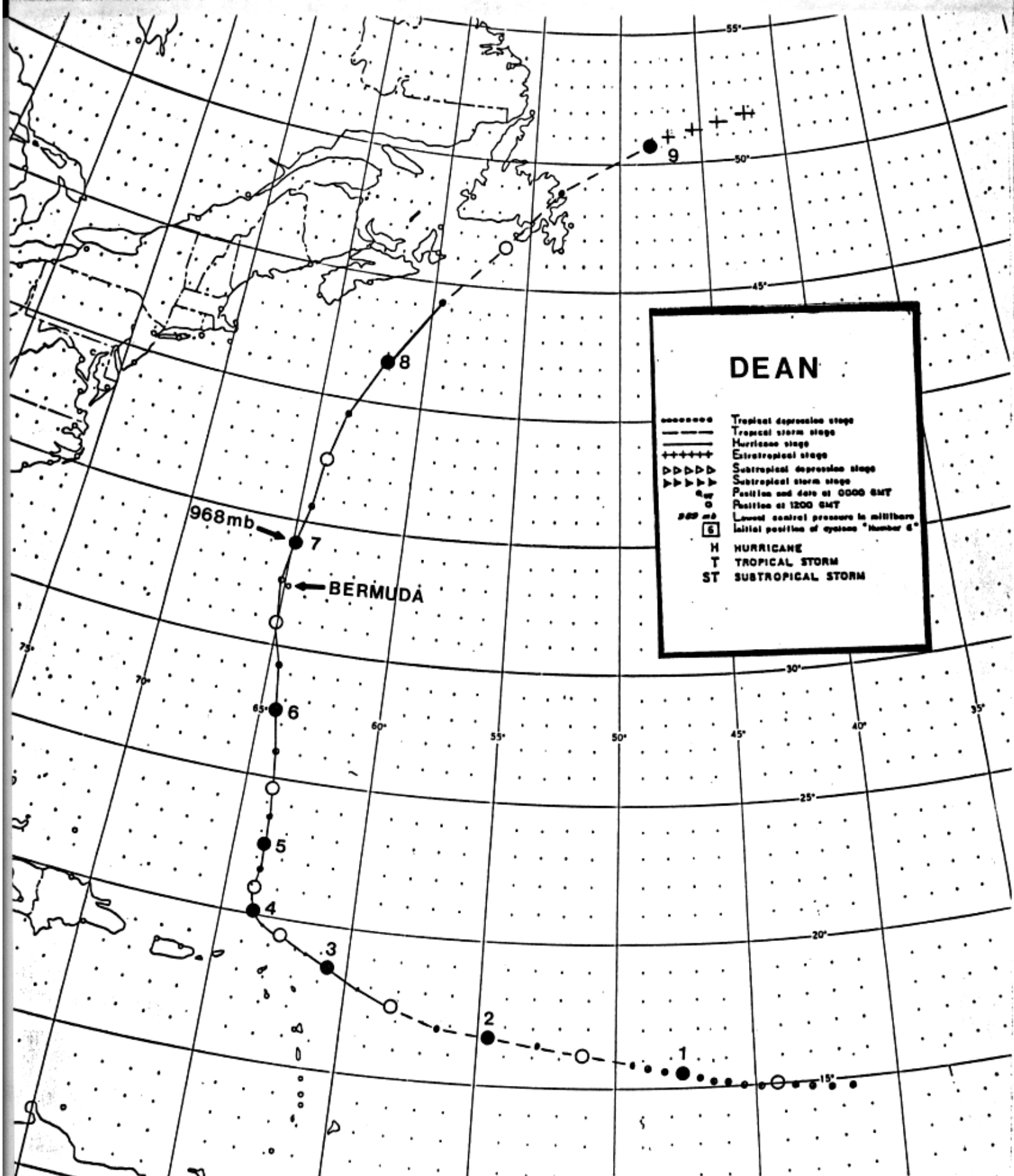
Max Mayfield
First Draft 10/22/89
Final Draft 11/19/89

Figure Captions:

Fig. 1. Best track positions for Hurricane Dean, 31 July - 9 August 1989.

Fig. 2. Best track minimum central pressure curve for Hurricane Dean, 31 July - 9 August 1989.

Fig. 3. Best track maximum sustained wind speed curve for Hurricane Dean, 31 July - 9 August 1989.



DEAN

- Tropical depression stage
- Tropical storm stage
- +—— Hurricane stage
- +++++ Extratropical stage
- ▷▷▷▷ Subtropical depression stage
- ▷▷▷▷ Subtropical storm stage
- Position and date at 0000 GMT
- Position at 1200 GMT
- 968 mb Lowest central pressure in millibars
- 6 Initial position of cyclone "Number 6"
- H HURRICANE
- T TROPICAL STORM
- ST SUBTROPICAL STORM

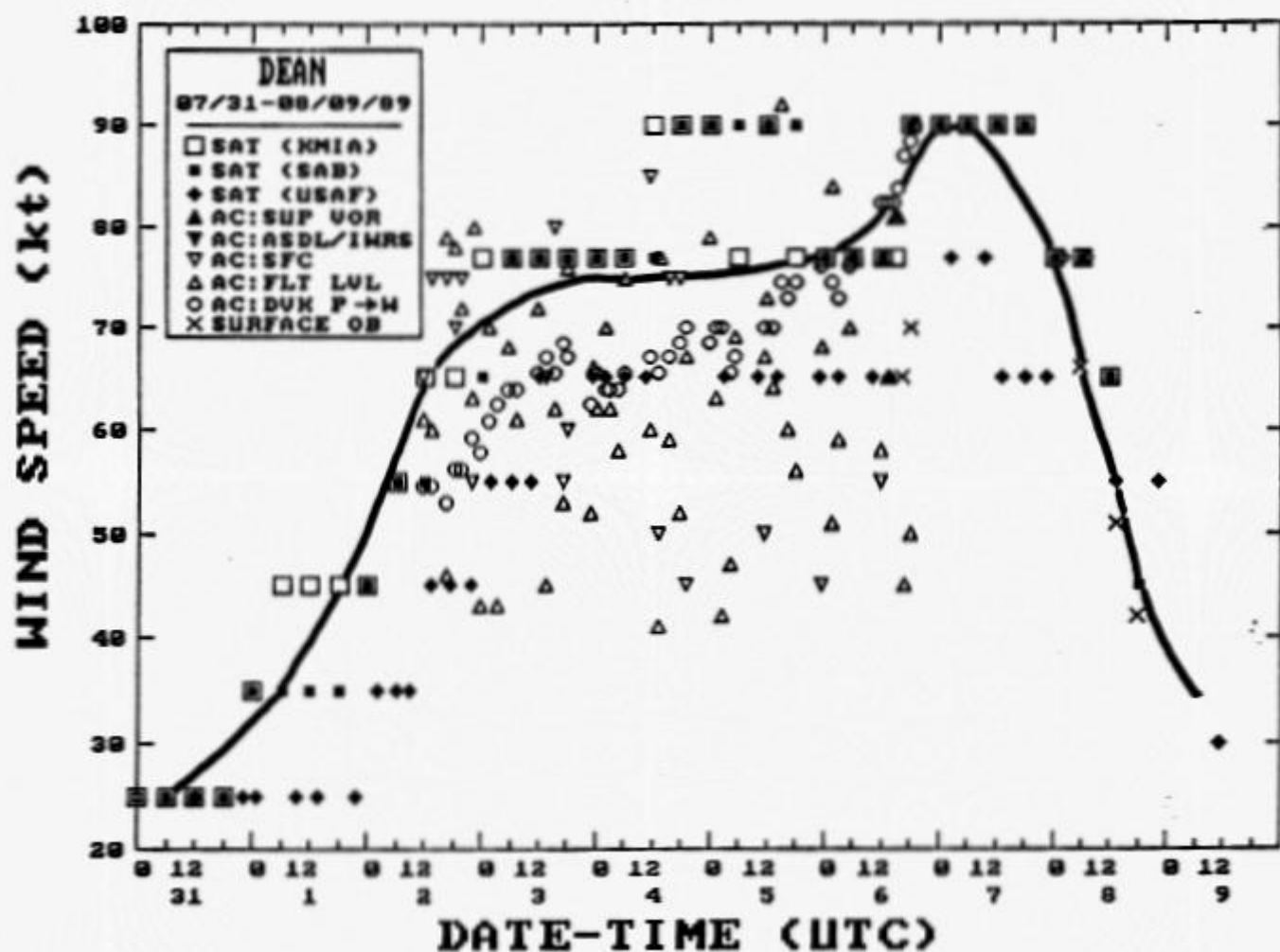
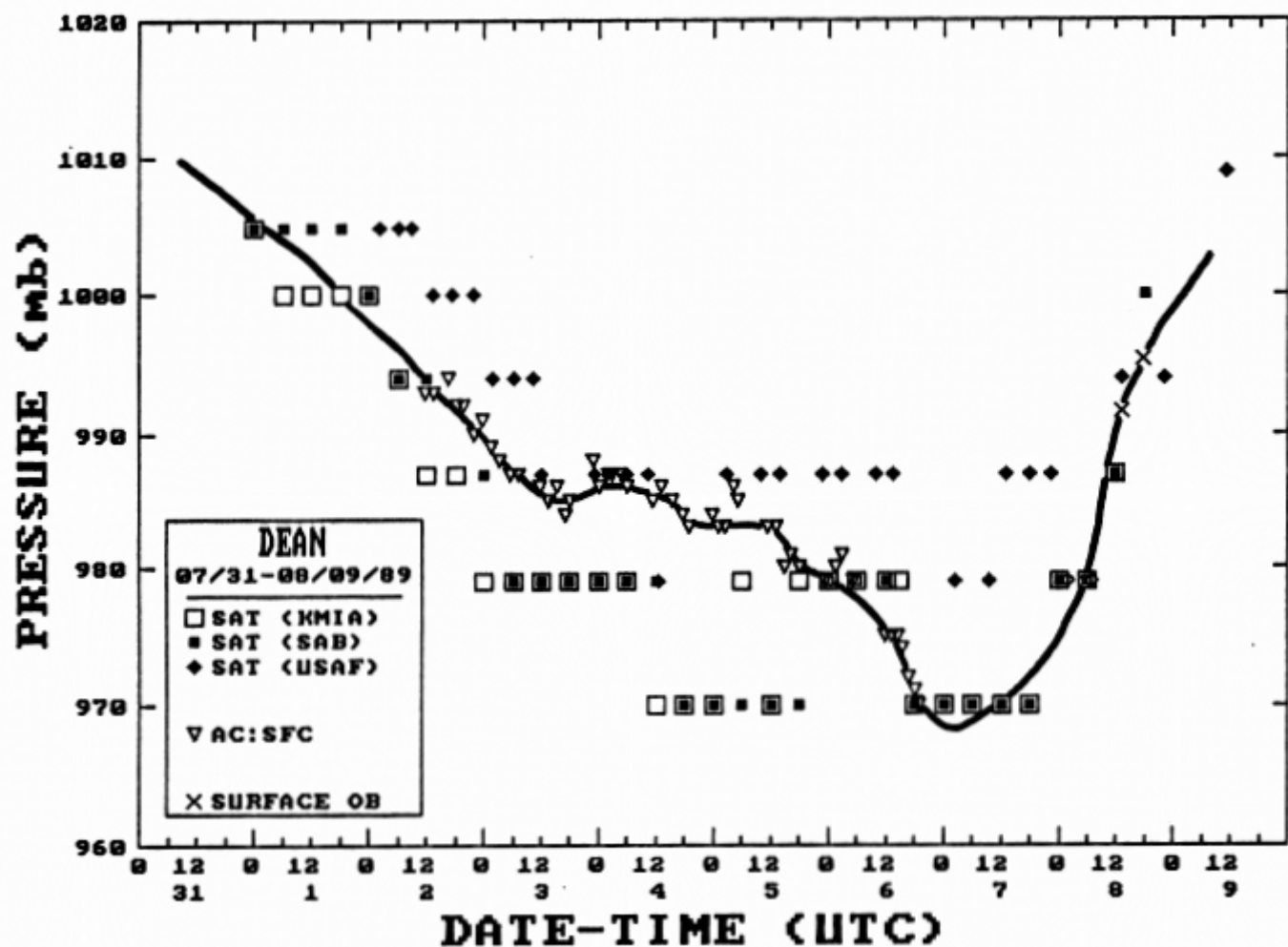


TABLE 1. Preliminary best track, Hurricane Dean, 31 July - 9 August 1989.

Date/Time (UTC)	Position		Pressure (mb)	Wind Speed (kt)	Stage
	Lat.	Lon.			
31/0600	14.8	41.8	1010	25	trop. depression
1200	15.0	44.1	1009	25	" "
1800	15.1	46.0	1008	30	" "
01/0000	15.4	47.6	1006	30	" "
0600	15.8	49.3	1004	35	trop. storm
1200	16.1	51.1	1002	40	" "
1800	16.4	52.9	1000	45	" "
02/0000	16.6	54.6	998	50	" "
0600	16.9	56.4	996	60	" "
1200	17.3	58.1	994	65	hurricane
1800	17.9	59.5	992	70	"
03/0000	18.5	60.7	990	70	"
0600	18.9	61.7	987	70	"
1200	19.3	62.7	985	75	"
1800	19.7	63.4	985	75	"
04/0000	20.1	63.8	986	75	"
0600	20.4	63.9	986	75	"
1200	20.9	63.9	985	75	"
1800	21.6	63.8	984	75	"
05/0000	22.5	63.8	983	75	"
0600	23.5	63.8	983	75	"
1200	24.7	63.9	983	75	"
1800	26.0	64.0	980	75	"
06/0000	27.6	64.3	979	75	"
0600	29.2	64.6	978	80	"
1200	30.8	65.0	975	80	"
1800	32.4	65.1	971	85	"
07/0000	34.0	64.9	968	90	"
0600	35.6	64.5	969	90	"
1200	37.5	64.0	970	85	"
1800	39.4	63.4	972	80	"
08/0000	41.7	62.1	975	75	"
0600	44.1	59.7	978	65	"
1200	46.5	56.5	991	55	trop. storm
1800	48.8	53.2	995	45	" "
09/0000	50.8	48.1	1000	40	extratropical
0600	51.8	41.9	1003	35	"
<hr/>					
Minimum pressure:					
07/0000	34.0	64.9	968	90	hurricane
Landfall:					
08/1300	46.9	55.9	991	55	trop. storm

Table 2. Selected meteorological surface observations for Hurricane Dean, 31 July - 9 ~~September~~ ^{August} 1989.

<u>Location</u>	<u>Date/Time (UTC)</u>	<u>Min Press. (mb)</u>	<u>Max Wind (kt)</u>
Bermuda Ship at U.S. Naval Annex	06/1600	-----	65 G75
Bermuda U.S. Naval Annex	06/1800	-----	70 G80
Bermuda U.S. Naval Annex	06/2000	-----	G98
Sable Island, Nova Scotia	08/0530	978.8	66 G77
St. Pierre Island, Newfoundland	08/1300	991.6	51 G71
Bonavista, Newfoundland	08/1730	995.4	42 G55

Table 3. Summary of watches and warnings on Hurricane Dean.

<u>LOCATION</u>	<u>TYPE</u>	<u>EFFECTIVE</u>	<u>DISCONTD</u>
Guadeloupe	Hurricane Warning	02/1300Z	02/2200Z
Islands of the northeast Caribbean from Antigua to U.S. Virgin Islands	Hurricane Warning	02/1300Z	03/1300Z
Dominica	Hurricane Watch	02/1300Z	02/2200Z
Martinique	Hurricane Watch	02/1300Z	02/2200Z
Puerto Rico	Hurricane Watch	02/1300Z	02/1600Z
Puerto Rico	Hurricane Warning	02/1600Z	03/1300Z
Turks and Caicos Islands	Hurricane Watch	03/1600Z	04/0400Z
Bermuda	Hurricane Watch	05/1600Z	06/0100Z
Bermuda	Hurricane Warning	06/0100Z	07/0100Z
Sable Island, Nova Scotia	Hurricane Warning	07/2200Z	08/1000Z
Southeast Newfoundland	High Wind Warning	07/2200Z	08/2200Z

TABLE 4. Chances of the center of Hurricane Dean passing within 65 miles of listed locations by date and time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	01/NOON 04/8AM	01/6PM 04/8AM	01/1030PM 04/8PM	02/6AM 05/2AM	02/9AM 05/2AM
17.2N 57.0W	39	39	--	--	--
18.6N 62.1W	16	16	--	--	--
20.0N 67.0W	10	10	--	--	--
SKPG 12.5N 71.7W	2	2	--	--	2
TNCC 12.2N 69.0W	3	3	--	--	--
TGPY 12.0N 61.8W	2	2	--	--	--
TBPB 13.1N 59.5W	4	4	--	--	--
TVSV 13.1N 61.2W	5	5	--	--	--
TLPL 13.8N 61.0W	7	7	2	--	--
TFFF 14.6N 61.0W	10	10	4	--	3
TDPR 15.3N 61.4W	12	12	8	4	9
TFFR 16.3N 61.5W	14	14	16	17	26
TAPA 17.1N 61.8W	15	15	23	31	38
TKPK 17.3N 62.7W	15	15	20	28	32
TNCM 18.1N 63.1W	15	15	22	33	34
MDSD 18.5N 69.7W	7	7	9	11	13
MDCB 17.6N 71.4W	6	6	7	8	10
MTPP 18.6N 72.4W	5	5	6	8	9
MTCA 18.3N 73.8W	4	4	5	6	8
MKJP 17.9N 76.8W	2	2	2	3	5
MUGM 20.0N 75.1W	2	2	4	5	7
MDPP 19.8N 70.7W	6	6	8	11	12
MBJT 21.5N 71.2W	5	5	8	10	11
MYMM 22.4N 73.0W	3	3	5	8	9
ST CROIX VI	12	12	15	20	23
ST THOMAS VI	12	12	16	22	24
SAN JUAN P.R.	11	11	14	18	20
PONCE P.R.	10	10	13	16	18
18.3N 60.9W	--	--	40	--	--
19.0N 63.0W	--	--	24	--	--
MKJS 18.5N 77.9W	--	--	2	3	4
MYSM 24.1N 74.5W	--	--	3	5	6
MYEG 23.5N 75.8W	--	--	2	4	5
MUCM 21.4N 77.9W	--	--	--	3	4
MYAK 24.1N 77.6W	--	--	--	2	3
MYNN 25.1N 77.5W	--	--	--	2	3
MYCG 19.3N 81.4W	--	--	--	--	2
MUCF 22.1N 80.5W	--	--	--	--	2

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	02/NOON 05/8AM	02/6PM 05/8AM	02/9PM 05/8PM	02/MIDNIGHT 05/8PM	03/6AM 06/2AM
TFFR 16.3N 61.5W	17	17	--	--	--
TAPA 17.1N 61.8W	57	57	26	26	--
TKPK 17.3N 62.7W	52	52	50	50	--
TNCM 18.1N 63.1W	59	59	79	79	23
MDSD 18.5N 69.7W	16	16	18	18	4
MDCB 17.6N 71.4W	12	12	9	9	2
MTPP 18.6N 72.4W	12	12	11	11	3
MTCA 18.3N 73.8W	10	10	8	8	2
MKJP 17.9N 76.8W	6	6	5	4	--
MKJS 18.5N 77.9W	5	5	5	4	--
MWCG 19.3N 81.4W	3	3	3	3	--
MUGM 20.0N 75.1W	9	9	10	10	3
MUCM 21.4N 77.9W	6	6	8	7	2
MUCF 22.1N 80.5W	3	3	5	5	--
MUSN 21.6N 82.6W	2	2	3	3	--
MUHA 23.0N 82.4W	2	2	3	3	--
MDPP 19.8N 70.7W	16	16	20	20	6
MBJT 21.5N 71.2W	14	14	19	19	10
MYMM 22.4N 73.0W	11	11	16	15	8
MYSM 24.1N 74.5W	8	8	12	12	7
MYEG 23.5N 75.8W	7	7	11	11	5
MYAK 24.1N 77.6W	5	5	8	8	4
MYNN 25.1N 77.5W	4	4	8	8	4
MYGF 26.6N 78.7W	2	2	6	5	3
ST CROIX VI	36	36	47	47	4
ST THOMAS VI	39	39	57	57	13
SAN JUAN P.R.	31	31	44	44	9
PONCE P.R.	25	25	32	32	4
MARATHON FL	2	2	4	4	--
MIAMI FL	2	2	4	4	2
W PALM BEACH FL	2	2	4	4	2
KEY WEST FL	2	2	3	3	--
19.5N 67.0W	--	--	41	--	--
23.0N 72.0W	--	--	17	--	--
25.5N 73.5W	--	--	12	--	--
BERMUDA	--	--	2	3	6
FT PIERCE FL	--	--	3	3	2
COCOA BEACH FL	--	--	3	3	2
DAYTONA BEACH FL	--	--	2	2	--
MARCO ISLAND FL	--	--	3	3	--
FT MYERS FL	--	--	3	3	--
VENICE FL	--	--	2	2	--
TAMPA FL	--	--	2	2	--

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	03/NOON 06/8AM	03/6PM 06/2PM	03/9PM 06/8PM	03/MIDNIGHT 06/8PM	04/6AM 07/2AM
20.0N 65.0W	64	--	--	--	--
TNCM 18.1N 63.1W	26	--	4	4	--
MDSD 18.5N 69.7W	6	2	6	6	--
MDCB 17.6N 71.4W	3	--	3	3	--
MTPP 18.6N 72.4W	4	--	4	4	--
MTCA 18.3N 73.8W	3	--	3	3	--
MUGM 20.0N 75.1W	4	2	3	3	--
MUCM 21.4N 77.9W	3	2	2	2	--
MUCF 22.1N 80.5W	2	--	--	--	--
MDPP 19.8N 70.7W	9	5	7	7	2
MBJT 21.5N 71.2W	11	9	9	9	3
MYMM 22.4N 73.0W	9	8	7	7	3
MYSM 24.1N 74.5W	8	8	5	5	3
MYEG 23.5N 75.8W	6	5	4	4	2
MYAK 24.1N 77.6W	5	4	2	2	--
MYNN 25.1N 77.5W	5	5	2	2	2
MYGF 26.6N 78.7W	4	4	--	--	--
BERMUDA	6	7	4	4	10
ST CROIX VI	7	--	4	4	--
ST THOMAS VI	20	--	8	8	2
SAN JUAN P.R.	14	2	9	9	2
PONCE P.R.	8	--	7	7	--
MARATHON FL	2	2	--	--	--
MIAMI FL	3	2	--	--	--
W PALM BEACH FL	3	3	--	--	--
FT PIERCE FL	3	2	--	--	--
COCOA BEACH FL	2	2	--	--	--
DAYTONA BEACH FL	2	2	--	--	--
KEY WEST FL	2	--	--	--	--
MARCO ISLAND FL	2	2	--	--	--
FT MYERS FL	2	--	--	--	--
22.0N 66.5W	--	49	--	--	--
MYRTLE BEACH SC	--	2	--	--	--
WILMINGTON NC	--	2	--	--	--
MOREHEAD CITY NC	--	2	--	--	--
CAPE HATTERAS NC	--	2	--	--	--
TKPK 17.3N 62.7W	--	--	2	2	--

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	04/NOON 07/8AM	04/6PM 07/2PM	04/1030PM 07/8PM	05/6AM 08/2AM
23.0N 65.0W	36	--	--	--
MDSD 18.5N 69.7W	2	--	--	--
MDPP 19.8N 70.7W	3	--	--	--
MBJT 21.5N 71.2W	5	2	--	--
MYMM 22.4N 73.0W	4	2	--	--
MYSM 24.1N 74.5W	4	2	--	--
MYEG 23.5N 75.8W	3	--	--	--
MYAK 24.1N 77.6W	2	--	--	--
MYNN 25.1N 77.5W	2	--	--	--
MYGF 26.6N 78.7W	2	--	--	--
BERMUDA	9	11	16	17
ST THOMAS VI	2	--	--	--
SAN JUAN P.R.	2	--	--	--
PONCE P.R.	2	--	--	--
CAPE HATTERAS NC	2	2	--	--
25.0N 64.5W	--	37	--	--
30.2N 64.5W	--	--	21	--
36.5N 65.5W	--	--	10	--
26.0N 64.0W	--	--	--	67
28.5N 64.0W	--	--	--	36

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	05/NOON 08/8AM	05/6PM 08/2PM	05/9PM 08/8PM	05/MIDNIGHT 08/8PM	06/6AM 09/2AM
BERMUDA	18	28	66	66	74
NEW YORK CITY NY	2	2	3	3	--
MONTAUK POINT NY	2	3	5	5	3
PROVIDENCE RI	2	3	5	5	3
NANTUCKET MA	3	4	7	7	6
HYANNIS MA	3	3	6	6	5
BOSTON MA	2	3	5	5	4
PORTLAND ME	--	2	4	4	4
BAR HARBOR ME	2	3	5	5	7
EASTPORT ME	2	3	6	6	8
ST JOHN NB	2	3	6	6	9
MONCTON NB	--	3	6	6	9
YARMOUTH NS	3	5	8	8	10
HALIFAX NS	3	6	8	8	12
SABLE ISLAND NS	4	8	10	10	14
SYDNEY NS	2	5	7	7	12
EDDY POINT NS	2	5	8	8	12
PTX BASQUES NFLD	--	4	6	6	11
BURGEO NFLD	--	4	6	6	11
ILE ST PIERRE	2	5	7	7	11
CAPE RACE NFLD	2	5	6	6	9
HIBERNIA OILFLD	--	3	3	3	6
39.5N 64.2W	--	--	16	16	--
OCEAN CITY MD	2	--	2	2	--
ATLANTIC CITY NJ	2	--	2	2	--
CAPE HATTERAS NC	2	--	--	--	--

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	06/NOON 09/8AM	06/6PM 09/2PM	06/9PM 09/2PM	06/MIDNIGHT 09/8PM	07/6AM 10/2AM
BERMUDA	99	--	--	--	--
NANTUCKET MA	2	--	--	--	--
HYANNIS MA	2	--	--	--	--
PORTLAND ME	2	--	--	--	--
BAR HARBOR ME	4	2	4	--	--
EASTPORT ME	6	4	6	2	--
ST JOHN NB	7	5	8	3	--
MONCTON NB	8	7	10	4	2
YARMOUTH NS	9	7	10	4	2
HALIFAX NS	13	12	15	10	8
SABLE ISLAND NS	17	18	21	22	31
SYDNEY NS	13	14	17	15	15
EDDY POINT NS	14	14	17	15	14
PTX BASQUES NFLD	12	12	14	12	11
BURGeo NFLD	12	13	16	15	16
ILE ST PIERRE	13	14	17	17	22
CAPE RACE NFLD	12	13	16	16	22
HIBERNIA OILFLD	9	10	12	12	16
42.9N 60.0W	--	--	--	--	37
49.7N 48.0W	--	--	--	--	20

TABLE 4. Chances of the center of Hurricane Dean passing
(cont.) within 65 miles of listed locations by date and
time (EDT) indicated; probabilities in percent.

ADVISORY DATE/TIME PROBABILITY TIME	07/NOON 10/8AM	07/6PM 10/2PM	07/9PM 10/8PM	07/MIDNIGHT 10/8PM	08/6AM 11/2AM
HALIFAX NS	5	4	--	--	--
SABLE ISLAND NS	44	67	84	84	99
SYDNEY NS	16	24	16	16	99
EDDY POINT NS	14	20	9	9	6
PTX BASQUES NFLD	9	13	8	8	22
BURGeo NFLD	16	25	23	23	65
ILE ST PIERRE	28	40	53	53	70
CAPE RACE NFLD	29	34	40	40	13
HIBERNIA OILFLD	22	26	17	17	7