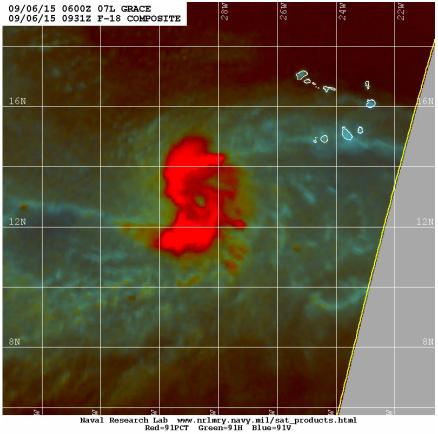# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL STORM GRACE

(AL072015)

5 – 9 September 2015

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National Hurricane Center
21 November 2015

09/06/15 0600Z 07L GRACE
09/06/15 0931Z F-18 COMPOSITE

Naval Research Lab   www.nrlmry.navy.mil/sat_products.html
Red=91PCT   Green=91H   Blue=91V

85 GHZ COLOR COMPOSITE IMAGE OF GRACE AT 0931 UTC 6 SEP 2015.

Grace was a short-lived tropical storm that formed in the eastern tropical Atlantic and dissipated well east of the Lesser Antilles.

Tropical Storm Grace

5 – 9 SEPTEMBER 2015

SYNOPTIC HISTORY

Grace formed from a well-organized, westward-moving tropical wave that left the coast of western Africa on 3 September. A large increase in the wave's convection occurred late on 2 September, likely leading to the development of a broad low with banding features the next day. Although the associated thunderstorms remained active on 4 September, the system's circulation remained elongated. A burst of convection early on 5 September resulted in the formation of a tighter circulation, and it is estimated that a tropical depression formed around 0600 UTC that day about 150 n mi south of Cabo Verde. Twelve hours later, the depression became a tropical storm. 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[1].

Grace gradually strengthened over the next couple of days while it remained over warm waters and in light-to-moderate vertical wind shear. The storm reached an estimated peak intensity of 50 kt around 1200 UTC 6 September, near the time that a mid-level eye feature was noted in microwave data (cover image). As Grace was moving over cooler waters and through abundant dry air in the mid-levels of the atmosphere, westerly shear increased the next day from a trough over the central Atlantic; this combination of factors caused the cyclone to gradually weaken, and Grace decayed to a tropical depression on 8 September. Scatterometer data indicated that Grace no longer had a closed surface circulation and had degenerated to a trough by 1200 UTC 9 September about 650 n mi east of the Lesser Antilles. The remnants of Grace brought gusty winds and heavy rains to the northeastern Leeward Islands and Puerto Rico a couple of days later.

METEOROLOGICAL STATISTICS

Observations in Grace (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Global Precipitation Mission (GPM), the European Space Agency's

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[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 *btk* directory, while previous years' data are located in the *archive* directory.

Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Grace.

The estimated 50-kt peak intensity of Grace is based on a blend of Dvorak satellite intensity estimates from TAFB and SAB, and ADT values from UW-CIMSS.

There were no ship reports or surface observations of winds of tropical storm force associated with Grace.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Grace.

FORECAST AND WARNING CRITIQUE

The genesis forecasts for Grace were of mixed quality (Table 2). The system that became Grace was introduced into the Tropical Weather Outlook (TWO) with appropriate lead times: with a low (< 40%) probability of formation during the next 5 days 96 h before genesis, and in the 48-h TWO 48 h before formation. However, the system was removed from the 5-day outlook shortly after introduction and only was re-inserted in the outlook 54 h before formation. In addition, the genesis probability in the 48-h TWO only reached the high category (> 60% chance of formation) 6 h before formation.

A verification of NHC official track forecasts for Grace is given in Table 3a.   Official forecast track errors were lower than the mean official errors for the previous 5-yr period at all time periods. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The NHC official forecasts were generally superior to much of guidance, except for the ECMWF model. The UKMET and GFDL models were some of the poorer-performing aids for Grace.

A verification of NHC official intensity forecasts for Grace is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period through 24 h, then higher after that. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. Much of the guidance bested the NHC intensity predictions. The official forecasts had a high bias (Fig. 4, panel a) due to the expectation that Grace would reach its peak intensity a bit later and become stronger than it actually did. While the HWRF (panel c) performed well for this storm, the GFDL (panel b) had a large high bias. The GFS and the ECMWF (panel d) also did quite well for Grace.

There were no watches or warnings on land associated with Grace.

Table 1.   Best track for Tropical Storm Grace, 5-9 September 2015.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
05 / 0600	12.0	23.1	1010	25	tropical depression
05 / 1200	12.2	24.4	1008	30	"
05 / 1800	12.3	25.7	1007	35	tropical storm
06 / 0000	12.4	26.9	1005	40	"
06 / 0600	12.5	28.0	1002	45	"
06 / 1200	12.7	29.2	1000	50	"
06 / 1800	12.9	30.5	1002	45	"
07 / 0000	13.2	31.9	1002	45	"
07 / 0600	13.5	33.4	1002	45	"
07 / 1200	13.7	35.0	1004	40	"
07 / 1800	13.8	36.7	1004	40	"
08 / 0000	13.9	38.4	1005	35	"
08 / 0600	14.0	40.1	1005	35	"
08 / 1200	14.0	41.8	1006	30	tropical depression
08 / 1800	14.0	43.4	1006	30	"
09 / 0000	14.0	44.9	1006	25	"
09 / 0600	14.0	46.4	1006	25	"
09 / 1200	-	-	-	-	dissipated
06 / 1200	12.7	29.2	1000	50	minimum pressure and maximum winds

Table 2.   Number of hours in advance of formation of Grace associated with the first NHC Tropical Weather Outlook forecast in the indicated likelihood category. Note that the timings for the "Low" category do not include forecasts of a 0% chance of genesis.

	Hours Before Genesis	
	48-Hour Outlook	**120-Hour Outlook**
Low (<40%)	48	96
Medium (40%-60%)	18	48
High (>60%)	6	12

Table 3a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Grace. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**21.4**	**31.2**	**40.9**	**55.5**	**87.7**		
OCD5	33.9	72.6	123.7	176.3	260.2		
Forecasts	14	12	10	8	4		
OFCL (2010-14)	28.4	45.0	60.4	77.1	113.1		
OCD5 (2010-14)	48.3	101.5	161.5	222.6	329.8		

Table 3b.   Homogeneous comparison of selected track forecast guidance models (in n mi) for Grace. 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 3a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	21.2	33.5	43.9	60.4	71.4		
OCD5	32.9	72.2	127.3	185.2	285.3		
GFSI	23.6	37.3	47.2	78.4	116.6		
GHMI	27.6	52.4	68.4	87.9	134.8		
HWFI	24.9	37.4	49.5	64.0	85.2		
EGRI	28.2	54.1	82.3	111.1	138.8		
EMXI	21.5	**28.0**	**34.3**	**58.4**	**57.6**		
AEMI	23.7	35.7	47.4	69.5	139.2		
FSSE	22.3	**30.0**	**38.0**	62.4	81.6		
TVCN	22.1	36.8	47.2	65.1	99.7		
LBAR	44.3	92.8	138.6	186.6	353.5		
BAMM	35.9	61.1	70.5	85.7	150.4		
BAMD	58.9	121.0	187.7	268.7	435.1		
BAMS	36.1	57.3	69.5	90.7	148.0		
Forecasts	12	11	9	7	2		

Table 4a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Grace. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**4.6**	**7.9**	13.0	14.4	20.0		
OCD5	5.3	10.0	16.0	23.4	32.0		
Forecasts	14	12	10	8	4		
OFCL (2010-14)	6.2	9.4	11.5	13.3	14.6		
OCD5 (2010-14)	7.3	10.8	13.3	15.3	17.7		

Table 4b.   Homogeneous comparison of selected intensity forecast guidance models (in kt) for Grace. 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.

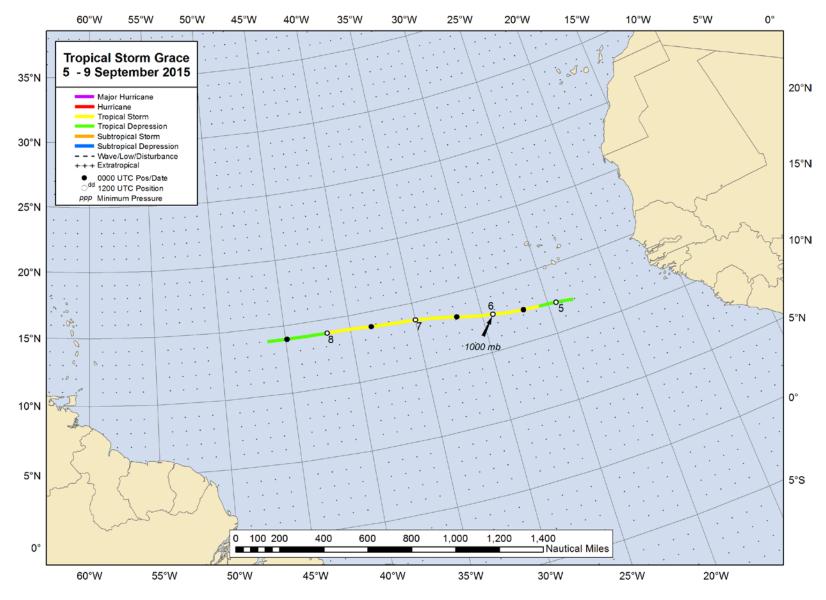| Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	4.2	7.3	13.9	15.7	17.5		
OCD5	5.3	9.9	17.7	25.6	33.0		
GHMI	4.7	11.3	21.2	23.6	30.5		
HWFI	5.7	**6.5**	**7.2**	**7.4**	**8.5**		
IVCN	4.3	**7.2**	**13.0**	17.0	21.5		
FSSE	4.8	**6.6**	**11.6**	**14.4**	18.5		
DSHP	**4.0**	**6.6**	**12.0**	17.6	22.5		
LGEM	**3.8**	**6.8**	**12.2**	18.1	24.0		
GFSI	5.0	**6.2**	**10.7**	**13.9**	**14.5**		
EMXI	5.8	**7.1**	**8.3**	**9.3**	**4.5**		
Forecasts	12	11	9	7	2		

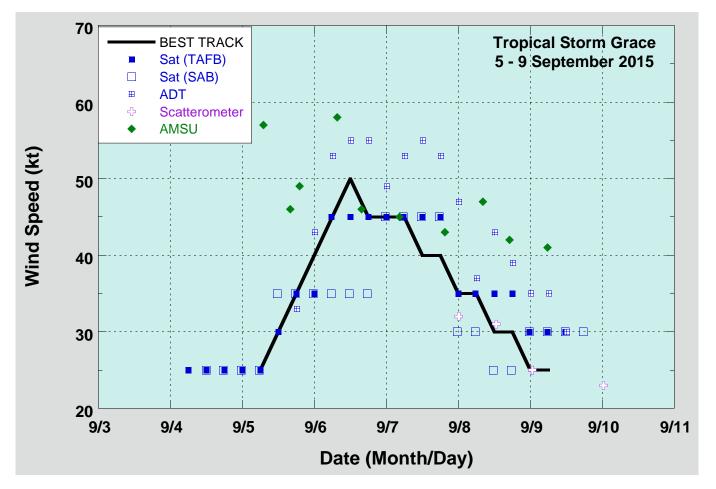Figure 1.   Best track positions for Tropical Storm Grace, 5-9 September 2015

Figure 2.   Selected wind observations and best track maximum sustained surface wind speed curve for Grace. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed lines refer to 0000 UTC.
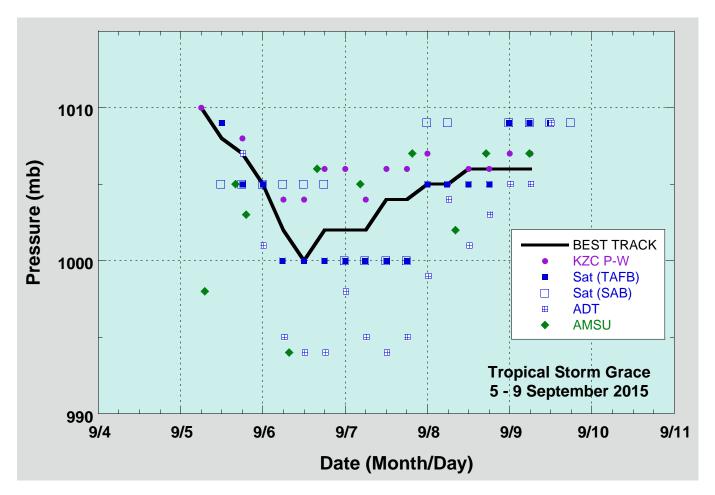
Figure 3.   Selected pressure observations and best track minimum central pressure curve for Grace. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed lines refer to 0000 UTC.
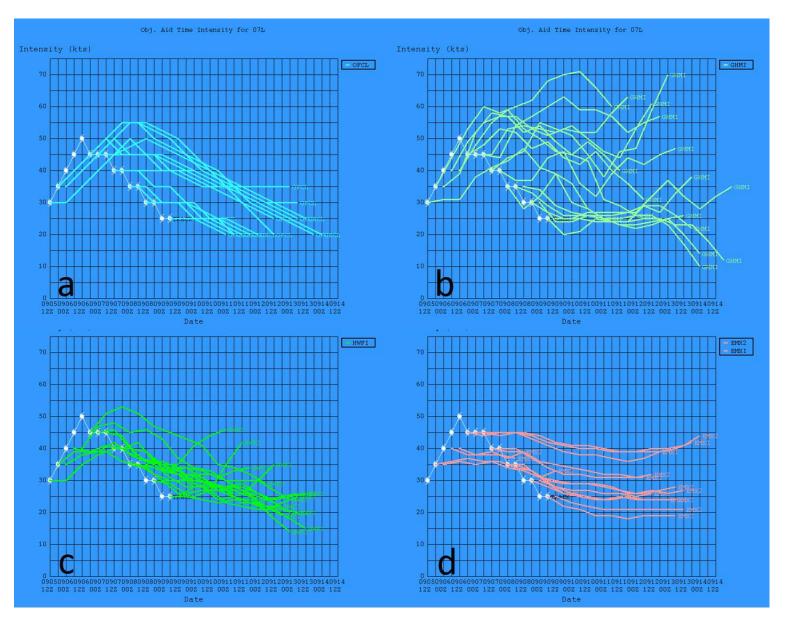
Figure 4.   Various intensity forecasts (colored lines) and verifying intensities (tropical cyclone symbols) for selected models during Grace. (a) OFCL, (b) GHMI, (c) HWFI, (d) ECMWF