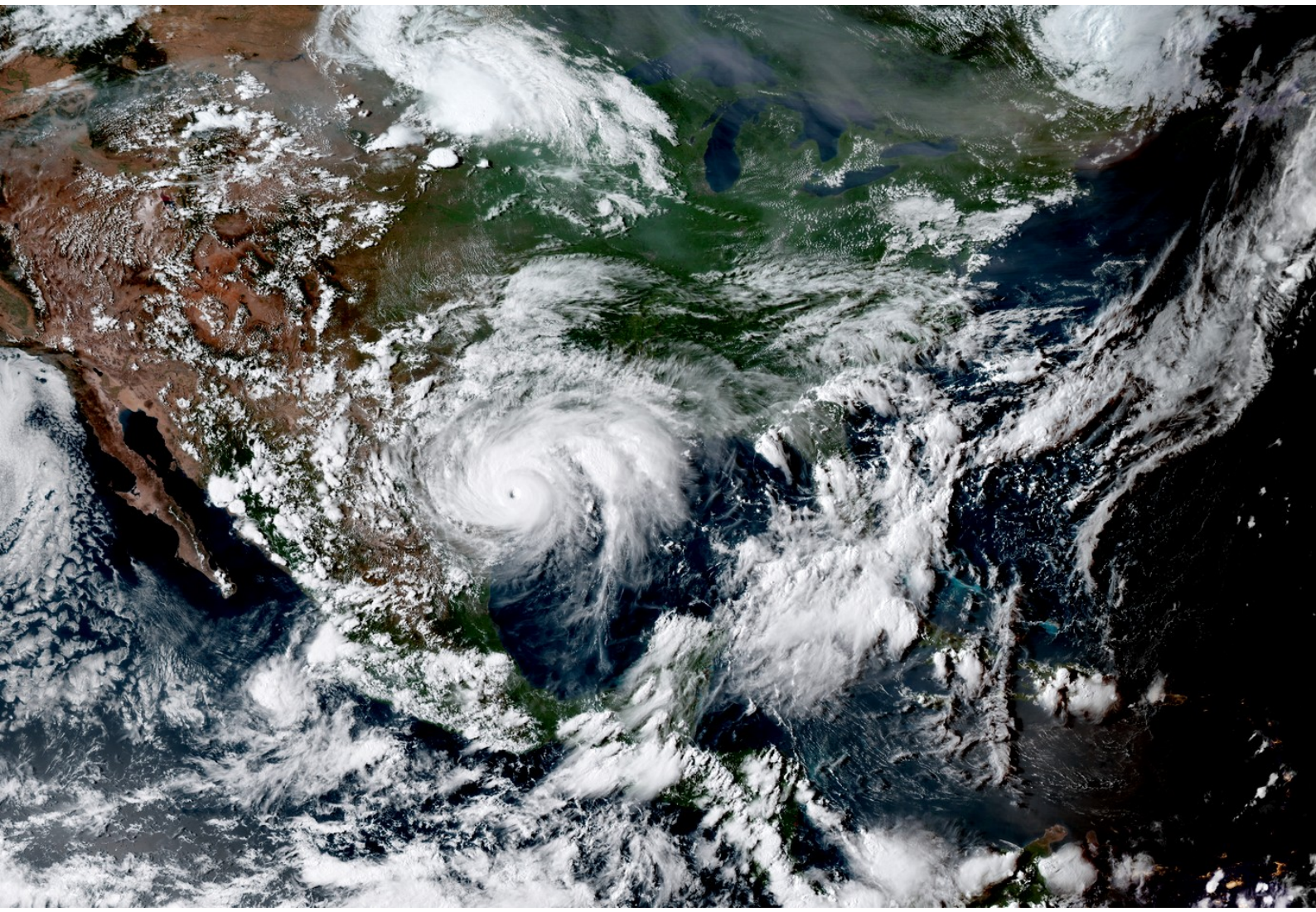
2017

Force Thirteen Cyclone Reports

Hurricane Harvey (09L)



Hurricane Harvey was the eighth named storm of the 2017 season, and was the first storm to make a major hurricane landfall in the United States since 2005, ending the longest such gap in United States history. Harvey is also tied for the fourth strongest hurricane landfall along the coast of Texas.

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Cover photo: True-colour image of Hurricane Harvey and its surroundings at 22:00 UTC on August 25, 2017

Contents

1.1. Synoptic History

In mid-August, several tropical waves emerged from the coast of Africa, including a wave which emerged from the coast of Senegal and Gambia on August 13th. Initially very broad and disorganised, these waves competed for energy and began acquiring rotation by the 15th. Both waves were being monitored by the National Hurricane Center, and it soon became apparent that the first wave would be the dominant one, and began to resemble the appearance of a tropical cyclone by the 17th, and was named Harvey at the beginning of the next day after a circulation was found.

By this point, the storm was already upon Barbados and crossed through the Lesser Antilles on the morning of August 18th, affecting all islands from Grenada to Martinique. Harvey, whilst never particularly impressive to begin with, began to struggle later on August 19th into the 20th, and degenerated into a tropical wave. The wave became ill-defined as it passed near and over Nicaragua and Honduras, but was closely monitored into August 23rd when it was finally redesignated as a tropical depression.

Early on August 24th, Harvey generated deep convection which sustained itself throughout the day, and before the end of the day an eye began to clear out as it progressed towards the northwest. Hurricane Watches had already been issued for Texas, and by 6pm UTC the storm reached winds of 80mph.

Regular reconnaissance plane coverage saw Harvey's pressure continually drop, generally at a rate of 1mb per hour, until more rapid intensification began to occur on August 25th in the run-up to landfall. By that afternoon, the eye temperature entered positive temperatures, indicating a significantly strong hurricane, by which point cold cloud tops had wrapped around most of the eye. This process continued until later in the day, with Harvey peaking as it was making landfall, with winds likely of 140mph and a pressure in the 930s in millibars.

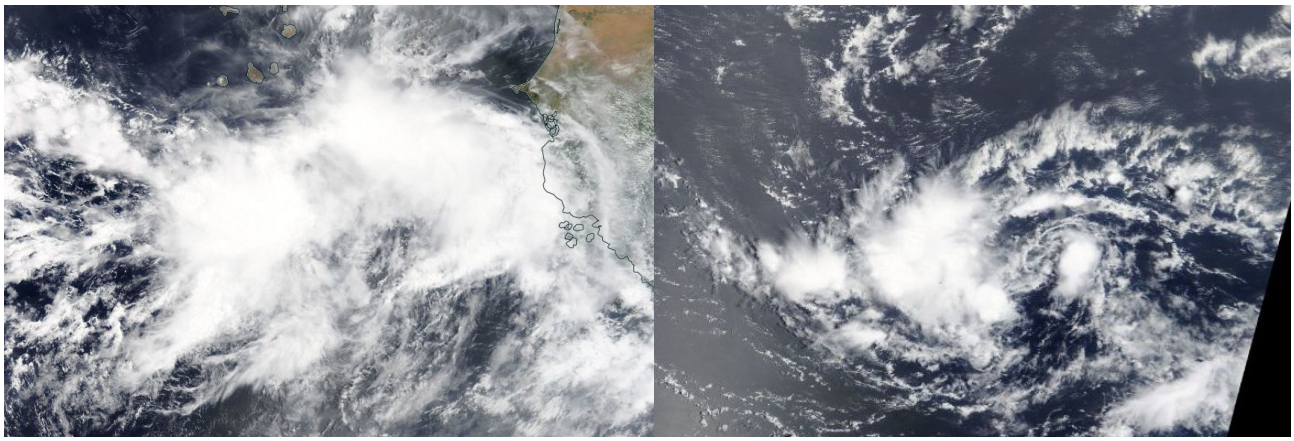
Officially, the National Hurricane Center rated the storm with winds of 130mph and a pressure of 938mb, though their post analysis is likely to upgrade this figure, backed by satellite imagery indications of winds in the 140s.

Harvey made landfall northeast of Corpus Christi, Texas, who as a whole avoided hurricane force winds, but locations to the northeast such as Rockport and Port Aransas saw more severe consequences.

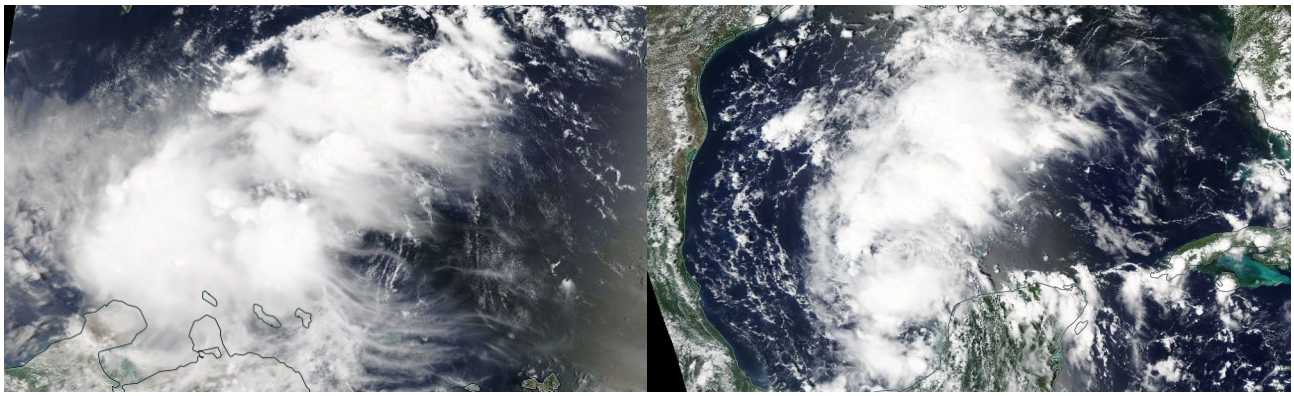
Harvey's eye remained for eight hours after landfall before disappearing entirely, and rapid weakening took place as the storm continued north, slowing down and then stalling over inland Texas, and delivering unprecedented storm rainfall totals to the region.

On August 28th, Harvey emerged back over the Gulf of Mexico and was still a minimal tropical storm, and some intensification took place as it rounded towards the east and then northeast into its final landfall along the Texas/Louisiana border with winds of 40mph on August 30th. Rainfall continued into the beginning of September as the storm remained identifiable as a depression, before being pushed off towards the northeast and turned post-tropical.

1.1. Synoptic History

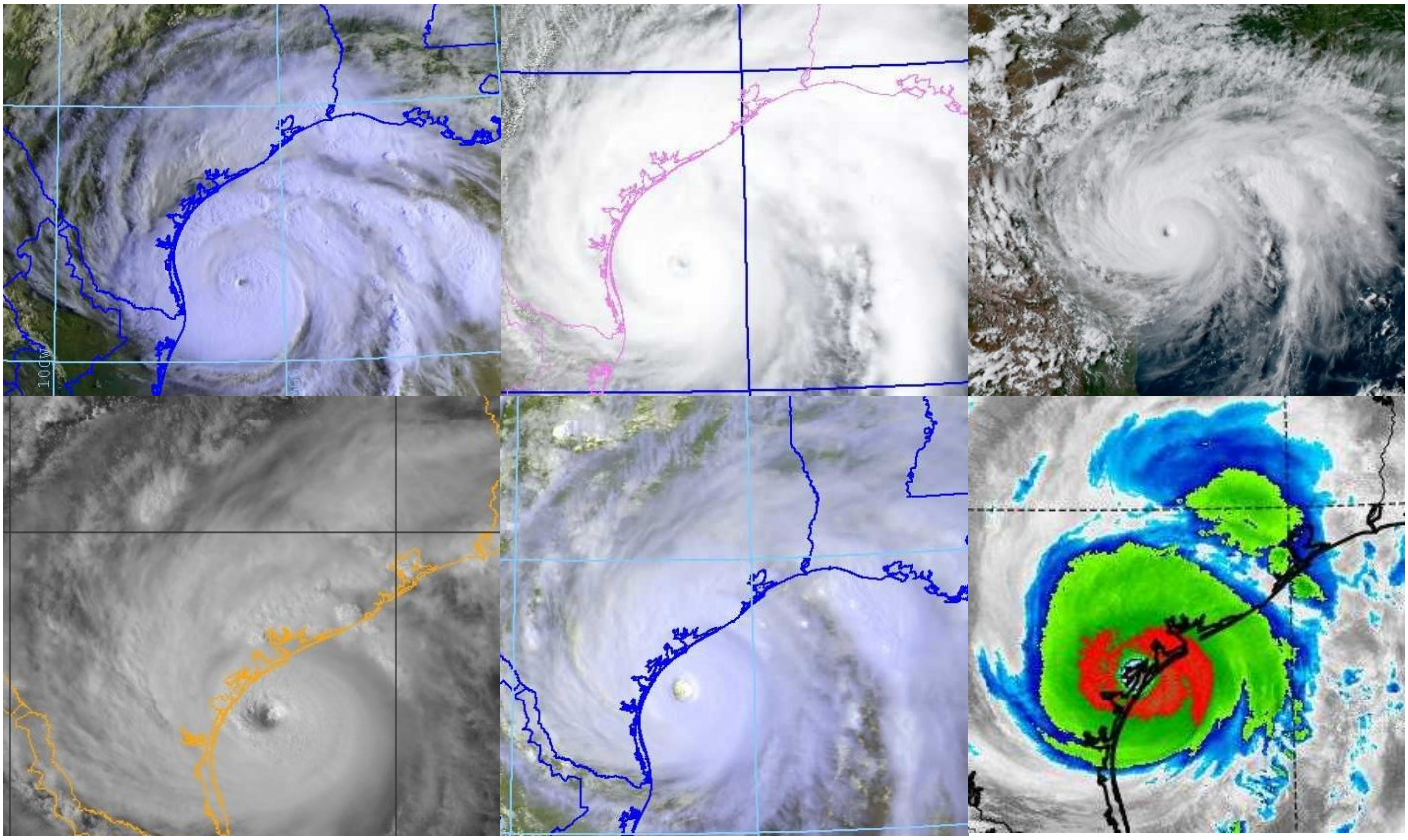


August 13th | August 16th



August 19th | August 23rd

Landfall Progression



1.2. Best Track

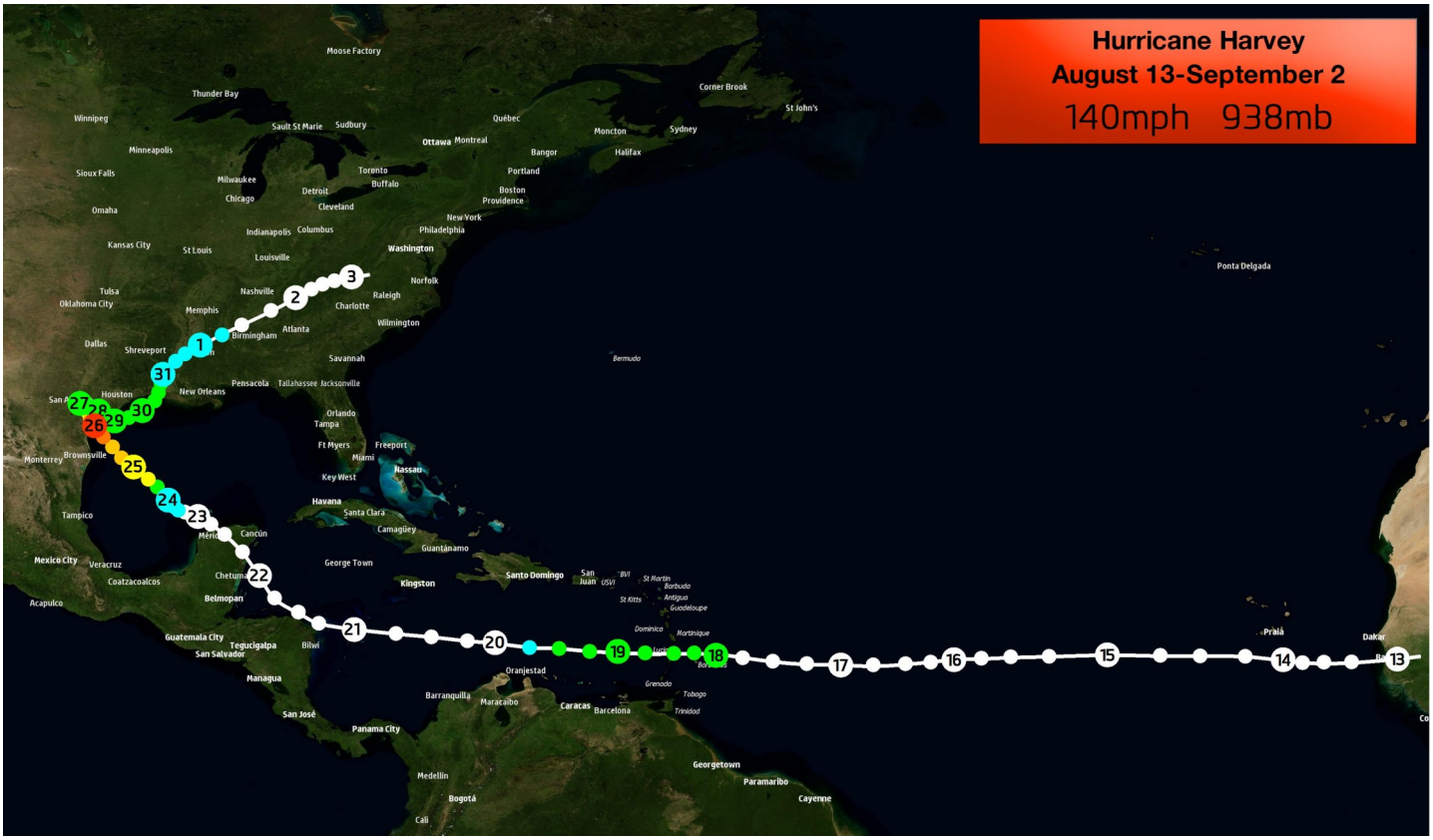
Below is the best track analysis from Force Thirteen, using Force Thirteen's SATOPS—a tool which uses infrared satellite imagery and cloud temperatures to estimate a storm's wind speed and air pressure. SATOPS does not take precedence over surface observations.

Date (dd/mm/yyyy)	Time	Latitude	Longitude	F13	F13	Stage
13/08/2017	00:00	13.4	-14.8	20	1012	Tropical Disturbance
13/08/2017	06:00	13	-17.5	25	1011	Tropical Disturbance
13/08/2017	12:00	12	-27.4	25	1010	Tropical Disturbance
13/08/2017	18:00	12	-29	30	1009	Tropical Disturbance
14/08/2017	00:00	12.2	-30.7	25	1011	Tropical Disturbance
14/08/2017	06:00	12.4	-32.3	25	1011	Tropical Disturbance
14/08/2017	12:00	12.6	-34	25	1010	Tropical Disturbance
14/08/2017	18:00	12.9	-35.6	30	1010	Tropical Disturbance
15/08/2017	00:00	13.2	-37.3	30	1010	Tropical Disturbance
15/08/2017	06:00	13.5	-39.3	30	1010	Tropical Disturbance
15/08/2017	12:00	13.7	-41.1	30	1010	Tropical Disturbance
15/08/2017	18:00	13.8	-42.8	30	1010	Tropical Disturbance
16/08/2017	00:00	13.8	-44.3	30	1010	Tropical Disturbance
16/08/2017	06:00	13.7	-45.8	30	1010	Tropical Disturbance
16/08/2017	12:00	13.7	-47.4	30	1010	Tropical Disturbance
16/08/2017	18:00	13.6	-49	30	1010	Tropical Disturbance
17/08/2017	00:00	13.6	-50.6	30	1009	Tropical Disturbance
17/08/2017	06:00	13.4	-52	30	1009	Tropical Disturbance
17/08/2017	12:00	13.1	-53.3	35	1008	Tropical Disturbance
17/08/2017	18:00	13	-55	40	1006	Tropical Disturbance
18/08/2017	00:00	13	-56.6	40	1004	Tropical Storm
18/08/2017	06:00	13	-58.3	40	1003	Tropical Storm
18/08/2017	12:00	13.1	-60.2	40	1004	Tropical Storm
18/08/2017	18:00	13.4	-62	40	1003	Tropical Storm
19/08/2017	00:00	13.6	-63.2	40	1004	Tropical Storm
19/08/2017	06:00	13.7	-65	45	1002	Tropical Storm
19/08/2017	12:00	13.8	-67	40	1005	Tropical Storm
19/08/2017	18:00	14	-68.9	35	1007	Tropical Depression
20/08/2017	00:00	14.1	-71	35	1009	Remnant Low
20/08/2017	06:00	14.2	-73	30	1008	Remnant Low
20/08/2017	12:00	14.4	-75	35	1006	Remnant Low
20/08/2017	18:00	14.7	-76.8	35	1007	Remnant Low
21/08/2017	00:00	15.1	-78.6	35	1008	Remnant Low
21/08/2017	06:00	15.7	-80.4	30	1009	Remnant Low
21/08/2017	12:00	16.4	-82.5	30	1009	Remnant Low
21/08/2017	18:00	17.4	-84.6	30	1009	Remnant Low
22/08/2017	00:00	18	-86.4	30	1008	Remnant Low
22/08/2017	06:00	18.6	-87.8	30	1008	Remnant Low
22/08/2017	12:00	19.4	-88.8	30	1009	Remnant Low
22/08/2017	18:00	20	-89.7	30	1010	Remnant Low
23/08/2017	00:00	20.4	-90.5	30	1009	Remnant Low
23/08/2017	06:00	20.8	-91.5	35	1008	Remnant Low
23/08/2017	12:00	21.4	-92.4	35	1006	Tropical Depression
23/08/2017	18:00	21.5	-92.4	35	1005	Tropical Depression
24/08/2017	00:00	22	-92.5	35	1003	Tropical Depression
24/08/2017	06:00	22.6	-92.6	45	997	Tropical Storm
24/08/2017	12:00	23.7	-93	65	985	Tropical Storm
24/08/2017	18:00	24.4	-93.6	80	977	Category 1
25/08/2017	00:00	25.1	-94.5	85	972	Category 1

1.2. Best Track

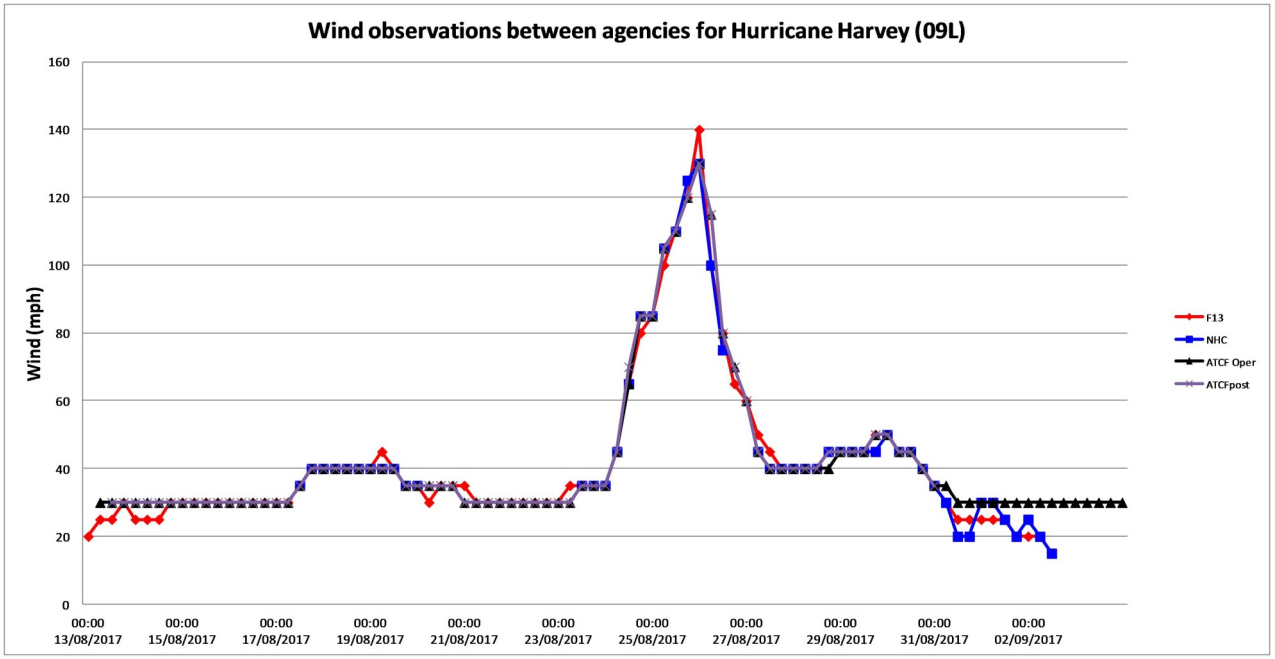
Date (dd/mm/yyyy)	Time	Latitude	Longitude	F13	F13	Stage
25/08/2017	06:00	25.6	-95.1	100	966	Category 2
25/08/2017	12:00	26.4	-95.9	110	952	Category 2
25/08/2017	18:00	27.1	-96.3	120	944	Category 3
26/08/2017	00:00	27.8	-96.8	140	938	Category 4
26/08/2017	06:00	28.2	-97.1	100	958	Category 2
26/08/2017	12:00	28.7	-97.2	80	980	Category 1
26/08/2017	18:00	29.1	-97.6	65	989	Tropical Storm
27/08/2017	00:00	29.2	-97.4	60	993	Tropical Storm
27/08/2017	06:00	29.3	-97.6	50	996	Tropical Storm
27/08/2017	12:00	29	-97.5	45	999	Tropical Storm
27/08/2017	18:00	29	-97.2	40	1000	Tropical Storm
28/08/2017	00:00	28.9	-96.8	40	1000	Tropical Storm
28/08/2017	06:00	28.7	-96.4	40	1000	Tropical Storm
28/08/2017	12:00	28.6	-96.2	40	998	Tropical Storm
28/08/2017	18:00	28.5	-95.9	45	997	Tropical Storm
29/08/2017	00:00	28.2	-95.4	45	997	Tropical Storm
29/08/2017	06:00	28	-95	45	997	Tropical Storm
29/08/2017	12:00	28.2	-94.6	45	997	Tropical Storm
29/08/2017	18:00	29.1	-94.4	50	995	Tropical Storm
30/08/2017	00:00	28.7	-93.9	50	993	Tropical Storm
30/08/2017	06:00	29.3	-93.5	45	992	Tropical Storm
30/08/2017	12:00	30.2	-93.5	45	992	Tropical Storm
30/08/2017	18:00	30.6	-93.3	40	995	Tropical Storm
31/08/2017	00:00	31.3	-92.6	35	998	Tropical Depression
31/08/2017	06:00	32.3	-92	30	998	Tropical Depression
31/08/2017	12:00	32.5	-91.4	25	1001	Tropical Depression
31/08/2017	18:00	33.8	-90.5	25	1000	Tropical Depression
01/09/2017	00:00	34.3	-89	25	1001	Tropical Depression
01/09/2017	06:00	35.7	-87.2	25	1001	Tropical Depression
01/09/2017	12:00	36.4	-87.1	25	1002	Post-tropical
01/09/2017	18:00	36.7	-85.4	20	1005	Post-tropical
02/09/2017	00:00	37.5	-84.8	20	1009	Post-tropical
02/09/2017	06:00	38.2	-85	20	1010	Post-tropical
02/09/2017	12:00	38.1	-84.9	15	1013	Post-tropical

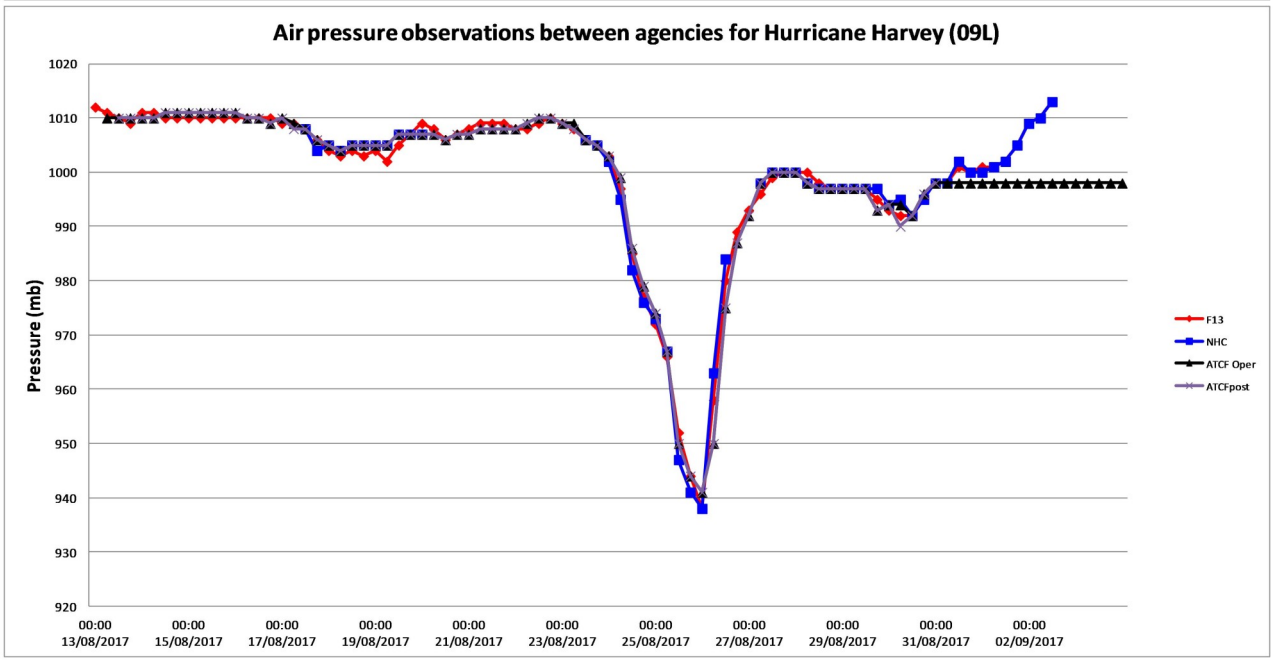
1.3. Track Chart



1.4. Comparison with other agencies

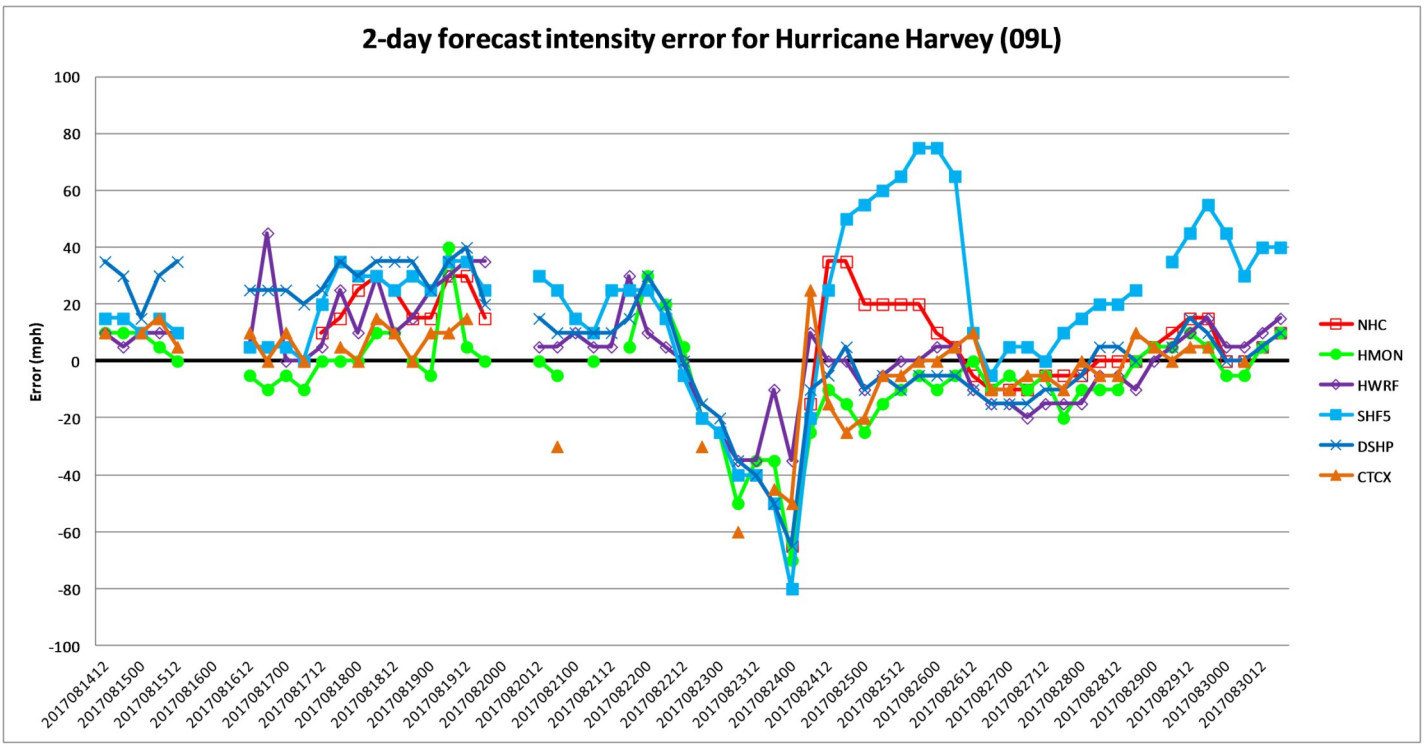
Harvey was monitored by the National Hurricane Center in Miami, Florida, and was observed by the US Navy.
Below shows comparisons between the agencies, and Force Thirteen's best track.

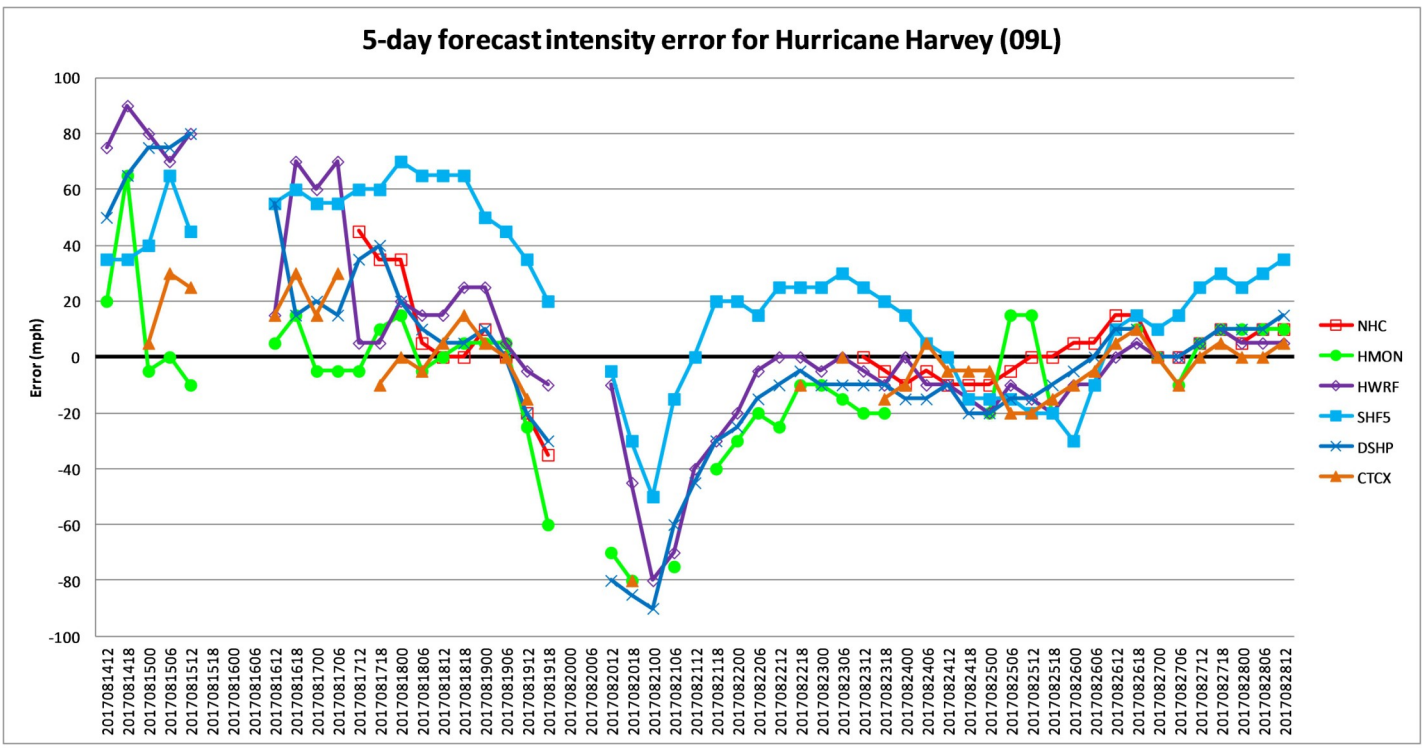




2. Forecasting Critique

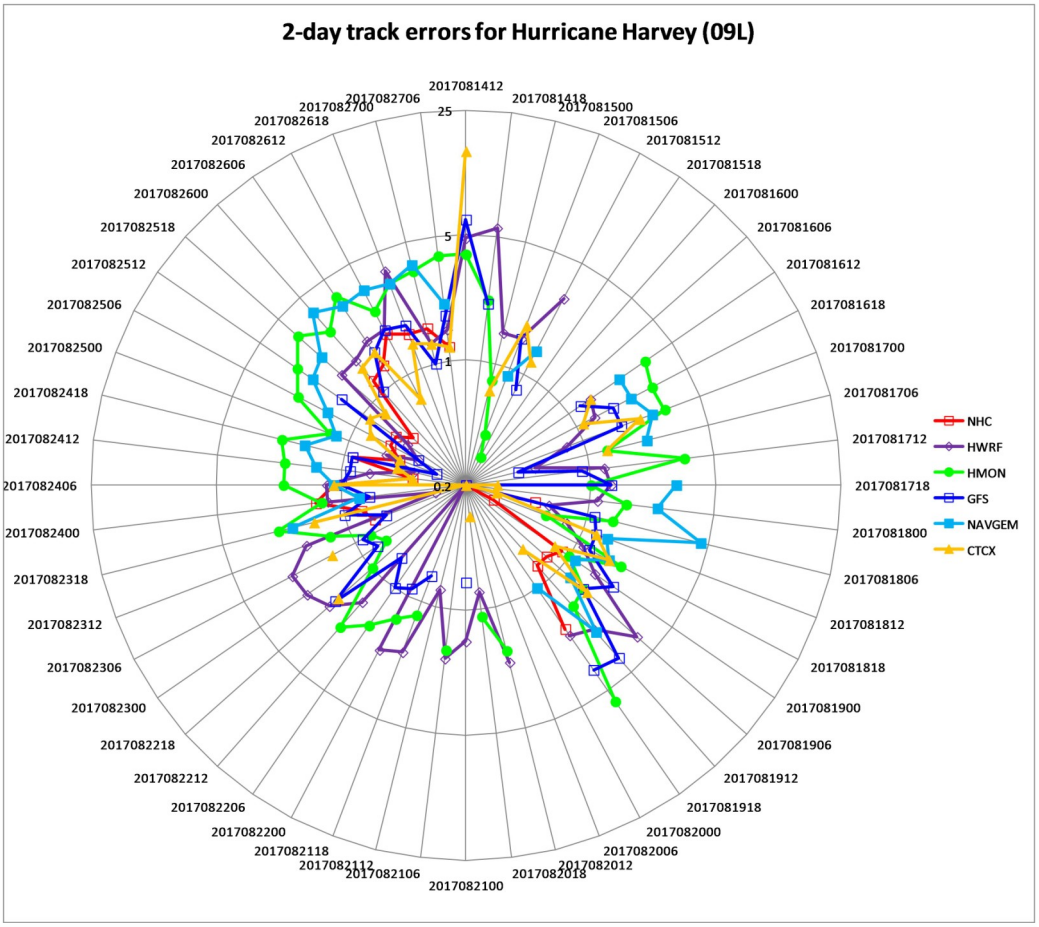
The next pages show the track and intensity forecast errors from the computer models and the National Hurricane Center.
The intensity error charts show how many miles per hour the model predictions were from the observed intensity two and five days later. A value of 0 denotes a perfectly accurate prediction. Negative values correspond to predictions lower than the observation, and positive values show predictions higher than the observation.

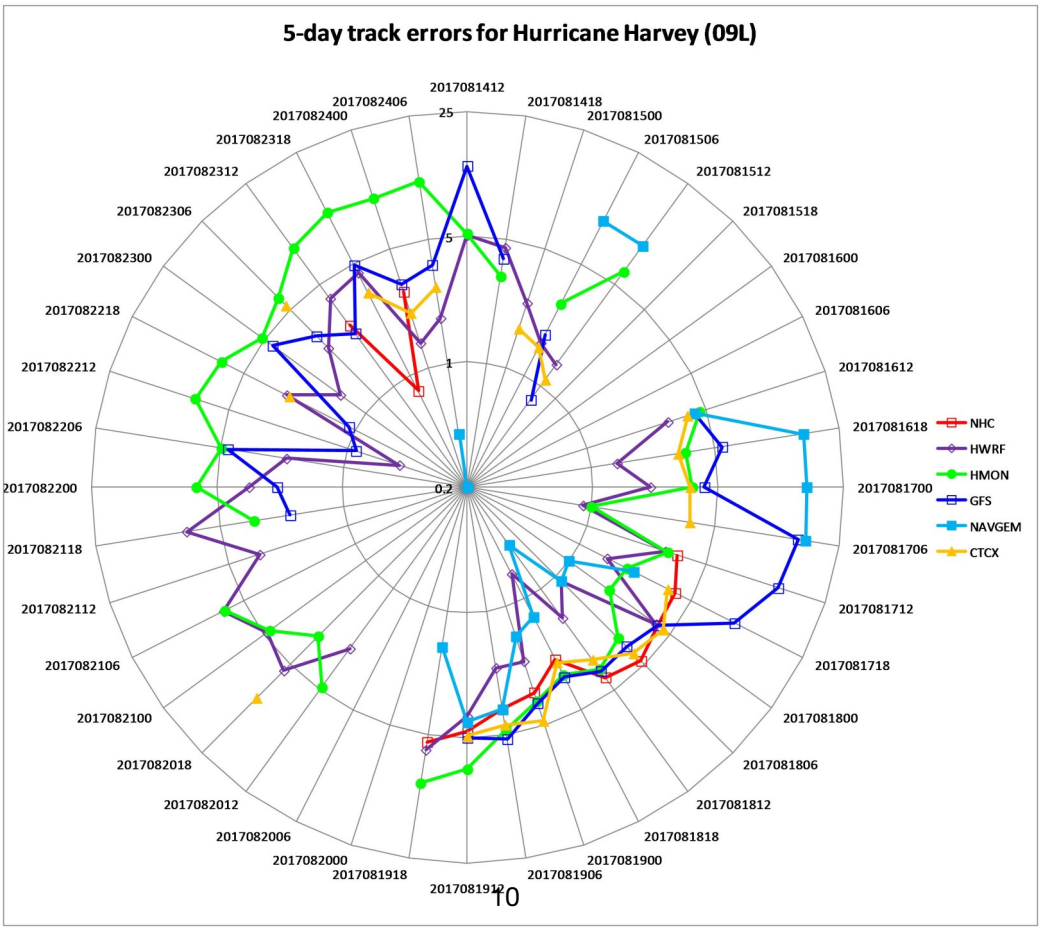




2. Forecasting Critique

The track error graphics show how far away from a perfectly accurate positional prediction the computer models and the NHC predicted two and five days before the fact. Values are expressed in angular degrees, and a value closer to 0 (the center of the graphic) indicates a more accurate prediction.





2. Forecasting Critique

Data from the charts are published below.

2-day forecast intensity error							
Run	NHC	HMON	HWRF	SHF5	DSHP	CTCX	**Average**
2017081412		10	10	15	35	10	**16**
2017081418		10	5	15	30		**15**
2017081500		10	10	10	15	10	**11**
2017081506		5	10	15	30	15	**15**
2017081512		0	10	10	35	5	**12**
2017081612		-5	5	5	25	10	**8**
2017081618		-10	45	5	25	0	**13**
2017081700		-5	0	5	25	10	**7**
2017081706		-10	0	0	20	0	**2**
2017081712	10	0	5	20	25		**12**
2017081718	15	0	25	35	35	5	**19**
2017081800	25	0	10	30	30	0	**16**
2017081806	30	10	30	30	35	15	**25**
2017081812	25	10	10	25	35	10	**19**
2017081818	15	0	15	30	35	0	**16**
2017081900	15	-5	25	25	25	10	**16**
2017081906	30	40	30	35	35	10	**30**
2017081912	30	5	35	35	40	15	**27**
2017081918	15	0	35	25	20		**19**
2017082012		0	5	30	15		**13**
2017082018		-5	5	25	10	-30	**1**
2017082100			10	15	10		**12**
2017082106		0	5	10	10		**6**
2017082112			5	25	10		**13**
2017082118		5	30	25	15		**19**
2017082200		30	10	25	30		**24**
2017082206		20	5	15	20		**15**
2017082212		5	0	-5	0		**0**
2017082218		-20	-20	-20	-15	-30	**-21**
2017082300		-25	-25	-25	-20		**-24**
2017082306		-50	-35	-40	-35	-60	**-44**
2017082312	-40	-35	-35	-40	-40		**-38**
2017082318	-50	-35	-10	-50	-50	-45	**-40**
2017082400	-65	-70	-35	-80	-65	-50	**-61**
2017082406	-15	-25	10	-20	-10	25	**-6**
2017082412	35	-10	0	25	-5	-15	**5**
2017082418	35	-15	0	50	5	-25	**8**
2017082500	20	-25	-10	55	-10	-20	**2**
2017082506	20	-15	-5	60	-5	-5	**8**
2017082512	20	-10	0	65	-10	-5	**10**
2017082518	20	-5	0	75	-5	0	**14**
2017082600	10	-10	5	75	-5	0	**13**
2017082606	5	-5	5	65	-5	5	**12**
2017082612	-5	0	-10	10	-10	10	**-1**
2017082618	-10	-10	-15	-5	-15	-10	**-11**
2017082700	-10	-5	-15	5	-15	-10	**-8**
2017082706	-10	-10	-20	5	-15	-5	**-9**
2017082712	-5	-5	-15	0	-10	-5	**-7**
2017082718	-5	-20	-15	10	-10	-10	**-8**

2. Forecasting Critique

Data from the charts are published below.

2-day forecast intensity error							
Run	NHC	HMON	HWRF	SHF5	DSHP	CTCX	**Average**
2017082800	-5	-10	-15	15	-5	0	**-3**
2017082806	0	-10	-5	20	5	-5	**1**
2017082812	0	-10	-5	20	5	-5	**1**
2017082818	0	0	-10	25	0	10	**4**
2017082900	5	5	0			5	**4**
2017082906	10	5	5	35	5	0	**10**
2017082912	15	10	10	45	15	5	**17**
2017082918	15	5	15	55	10	5	**18**
2017083000	0	-5	5	45	0		**9**
2017083006	0	-5	5	30	0	0	**5**
2017083012	5	5	10	40	5		**13**
2017083018	10	10	15	40	10		**17**

Model	**Average Error**	**Predictions**
NHC	16.4	40
HMON	11.4	59
HWRF	12.7	61
SHF5	28.2	60
DSHP	18.3	60
CTCX	11.7	45

5-day forecast intensity error							
Run	NHC	HMON	HWRF	SHF5	DSHP	CTCX	**Average**
2017081412		20	75	35	50		**45**
2017081418		65	90	35	65		**64**
2017081500		-5	80	40	75	5	**39**
2017081506		0	70	65	75	30	**48**
2017081512		-10	80	45	80	25	**44**
2017081612		5	15	55	55	15	**29**
2017081618		15	70	60	15	30	**38**
2017081700		-5	60	55	20	15	**29**
2017081706		-5	70	55	15	30	**33**
2017081712	45	-5	5	60	35		**28**
2017081718	35	10	5	60	40	-10	**23**
2017081800	35	15	20	70	20	0	**27**
2017081806	5	-5	15	65	10	-5	**14**
2017081812	0	0	15	65	5	5	**15**
2017081818	0	5	25	65	5	15	**19**
2017081900	10	5	25	50	10	5	**18**
2017081906	0	5	5	45	0	0	**9**
2017081912	-20	-25	-5	35	-20	-15	**-8**
2017081918	-35	-60	-10	20	-30		**-23**
2017082012		-70	-10	-5	-80		**-41**
2017082018		-80	-45	-30	-85	-80	**-64**
2017082100			-80	-50	-90		**-73**
2017082106		-75	-70	-15	-60		**-55**
2017082112			-40	0	-45		**-28**
2017082118		-40	-30	20	-30		**-20**
2017082200		-30	-20	20	-25		**-14**
2017082206		-20	-5	15	-15		**-6**

2. Forecasting Critique

Data from the charts are published below.

5-day forecast intensity error							
Run	NHC	HMON	HWRF	SHF5	DSHP	CTCX	**Average**
2017082212		-25	0	25	-10		**-3**
2017082218		-10	0	25	-5	-10	**0**
2017082300		-10	-5	25	-10		**0**
2017082306		-15	0	30	-10	0	**1**
2017082312	0	-20	-5	25	-10		**-2**
2017082318	-5	-20	-10	20	-10	-15	**-7**
2017082400	-10		0	15	-15	-10	**-4**
2017082406	-5		-10	5	-15	5	**-4**
2017082412	-10		-10	0	-10	-5	**-7**
2017082418	-10		-15	-15	-20	-5	**-13**
2017082500	-10	-20	-20	-15	-20	-5	**-15**
2017082506	-5	15	-10	-15	-15	-20	**-8**
2017082512	0	15	-15	-20	-15	-20	**-9**
2017082518	0	-20	-20	-20	-10	-15	**-14**
2017082600	5		-10	-30	-5	-10	**-10**
2017082606	5		-10	-10	0	-5	**-4**
2017082612	15	10	0	10	10	5	**8**
2017082618	15	10	5	15	10	10	**11**
2017082700	0	0	0	10	0	0	**2**
2017082706	0	-10	0	15	0	-10	**-1**
2017082712	5	5	5	25	5	0	**8**
2017082718	10	10	10	30	10	5	**13**
2017082800	5	10	5	25	10	0	**9**
2017082806	10	10	5	30	10	0	**11**
2017082812	10	10	5	35	15	5	**13**

Model	**Average Error**	**Predictions**
NHC	10.3	31
HMON	18.8	44
HWRF	23.4	52
SHF5	31.3	52
DSHP	25.1	52
CTCX	11.7	38

Overall 2-day and 5-day intensity errors combined

Model	**Average Error**	**Predictions**
NHC	13.7	71
HMON	14.6	103
HWRF	17.6	113
SHF5	29.6	112
DSHP	21.4	112
CTCX	11.7	83

2. Forecasting Critique

Data from the charts are published below.

2-day forecast track error							
Run	NHC	HWRF	HMON	GFS	NAVGEM	CTCX	Average
2017081412		4.8	3.9	6.1		14.7	7.4
2017081418		5.6	2.2	2.1			3.3
2017081500		1.5	0.8			0.7	1.0
2017081506		1.5	0.4	1.5	0.9	1.8	1.2
2017081512		3	0.3	0.8	1.4	1.2	1.3
2017081612		1.4	3.3	1.2	2.2	1.4	1.9
2017081618		1.3	3	1.7	2.2	1.1	1.9
2017081700		0.8	3.1	1.7	2.6	2.2	2.1
2017081706		0.5	1.3	0.4	2.2	1.3	1.1
2017081712		1.2	3.4	0.9			1.8
2017081718		1.3	1	1.3	3	0.3	1.4
2017081800	0.2	1.1	1.6	0.2	2.4	0.2	1.0
2017081806	0.5	0.6	1.4	1.1	4.5	0.3	1.4
2017081812	0.2	0.8	0.6	1.2	1.4	1.2	0.9
2017081818	0.3	1.1	1.9	1.2	1.6	1.6	1.3
2017081900	0.9	1.5	1	2	1.1	0.8	1.2
2017081906	0.8	3.8	1.5	1.5	1.2	1.6	1.7
2017081912	0.8	2.4	1.6	3.9	2.5	0.6	2.0
2017081918	1.9	2.1	5.9	3.6	1		2.9
2017082012		2.1	1.8				2.0
2017082018		0.8	1.1			0.3	0.7
2017082100		1.5		0.7			1.1
2017082106		1.9	1.7				1.8
2017082112		0.8					0.8
2017082118		2	1.2	0.7			1.3
2017082200		2.2	1.4	0.9			1.5
2017082206		0.2	1.8	1			1.0
2017082212		1.5	2.3	0.7			1.5
2017082218		2.1	1	1.9		1.8	1.7
2017082300		2.4	0.7	0.8			1.3
2017082306		2.5	0.8	0.9		1.4	1.4
2017082312	0.7	1.8	1.3	0.6			1.1
2017082318	0.8	0.3	2.4	1	2	1.5	1.3
2017082400	1.4	1.2	1.3	0.7	0.8	0.2	0.9
2017082406	1.1	1.2	2.1	1	1.1	1.1	1.3
2017082412	0.4	0.7	2.1	0.9	1.4	0.4	1.0
2017082418	0.9	0.4	2.3	0.9	1.7	0.5	1.1
2017082500	0.5	0.6	1.3	0.3	1.2	0.5	0.7
2017082506	0.6	0.4	2.3	0.4	1.5	0.8	1.0
2017082512	0.6	0.5	2.8	1.4	2.2	0.9	1.4
2017082518	0.5	1.7	3.6		2.4	0.8	1.8
2017082600	1.2	1.7	2.8	1	3.9	1.5	2.0
2017082606	1.3	1.9	3.8	1.6	3.3	1.6	2.3
2017082612	1.8	1.9	2.5	1.9	3.4	0.7	2.0
2017082618	1.6	3.8	3.2	1.8	3.2	1.4	2.5
2017082700	1.6	1.3	3.4	1	3.7	1.3	2.1
2017082706	1.2	1.5	3.9	1.8	2.1	1.2	2.0

Model	Average Error	Predictions
NHC	0.9	24
HWRF	1.6	47
HMON	2.1	45
GFS	1.4	41
NAVGEM	2.1	30
CTCX	1.4	34

5-day forecast track error							
Run	NHC	HWRF	HMON	GFS	NAVGEM	CTCX	Average
2017081412		5.1	5.2	12.4			7.6
2017081418		4.5	3.1	3.9			3.8
2017081500		2.4				1.7	2.1
2017081506		1.6	2.8	1.8	9.3	1.5	3.4
2017081512		1.4	6.1	0.8	9.2	1.1	3.7
2017081612		3	4.6	4.3	4.3	3.9	4.0
2017081618		1.4	3.4	5.5	15.8	3.1	5.8
2017081700		2.1	3.6	4.2	15.6	3.5	5.8
2017081706		0.9	1	14.7	16.2	3.6	7.3
2017081712	3.4	2.9	3	13.3			5.7
2017081718	4	1.5	2	9.4	2.2	3.6	3.8
2017081800	4.1	4	1.9	4.1	1	4.5	3.3
2017081806	4.7	1.1	3.1	3.6	1.1	4.1	3.0
2017081812	4.1	1.6	3.6	3.7	0.5	3.1	2.8
2017081818	2.4	0.7	3	3.1	1.3	2.5	2.2
2017081900	3.2	2.1	3.6	3.7	1.5	4.7	3.1
2017081906	3.6	2.1	4.7	5.3	3.6	4.4	4.0
2017081912	4.6	3.8	7.5	5	4.1	4.9	5.0
2017081918	5.5	6.1	9.4		1.6		5.7
2017082012		2.6	4.8				3.7
2017082018		5.6	3			9.2	5.9
2017082100		4.8	4.6				4.7
2017082106		6.7	6.6				6.7
2017082112		3.3					3.3
2017082118		7.7	3.2	2			4.3
2017082200		3.3	6.5	2.3			4.0
2017082206		2.1	4.9	4.5			3.8
2017082212		0.5	7.9	0.9			3.1
2017082218		2.7	6.9	1.1		2.6	3.3
2017082300		1.5	5.2	4.4			3.7
2017082306		2.5	6.2	3.1		5.4	4.3
2017082312	2.6	4	8.9	2.3			4.5
2017082318	0.8	4.4	10.5	4.9		3.3	4.8
2017082400	2.8	1.4	9.9	3.1	0.2	2.1	3.3
2017082406		1.8	10.6	3.6	0.4	2.7	3.8

Model	Average Error	Predictions
NHC	3.5	13
HWRF	2.9	35
HMON	5.1	33
GFS	4.7	28
NAVGEM	5.2	17
CTCX	3.6	21

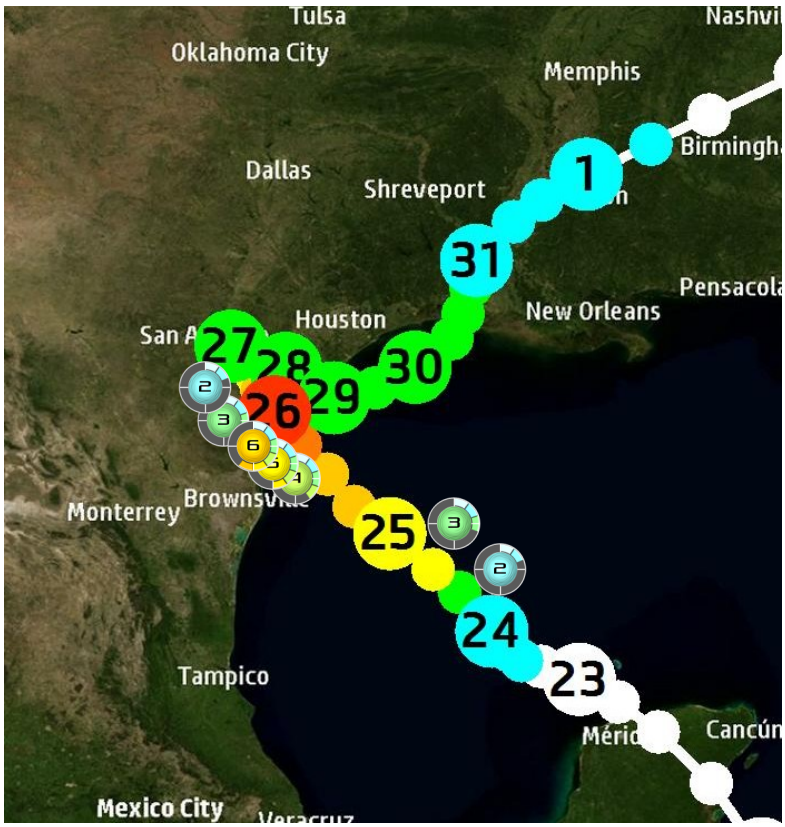
Overall 2-day and 5-day track errors combined

Model	Average Error	Predictions
NHC	1.8	37
HWRF	2.2	82
HMON	3.4	78
GFS	2.7	69
NAVGEM	3.2	47
CTCX	2.3	55

3. Cyclone Destruction Potential Scale

The Cyclone Destruction Potential Scale (CDPS) is a new way of measuring cyclone impacts in a more meaningful way. For the past 45 years, storms worldwide have been measured using the Saffir-Simpson Hurricane Wind Scale, split into five categories. However, this scale measures wind alone, and does not correlate well with actual impacts on land, measured by monetary damage.
The CDPS measures other factors, such as storm size and forward speed as well as intensity to create a ten tiered scale that encompasses tropical storms as well as hurricanes.

Stage 1—Small or weak storms that are unlikely to cause a significant impact.
Stage 2—Generally disorganised storms that can cause significant damage.
Stage 3—Further organised systems that are likely to cause significant damage.
Stage 4—Somewhat powerful storms that are likely to cause extensive damage.
Stage 5—Powerful storms that are likely to cause devastating damages.
Stage 6—Very powerful storms that are likely to cause catastrophic damage.
Stage 7—Extremely powerful storms that are likely to cause catastrophic damage.
Stage 8—Super storms that are likely to cause incredible damage.
Stage 9—Super storms that may cause total damage.
Stage 10—Super storms that are likely to cause total damage.



Hurricane Harvey was observed by Force Thirteen using the CDPS—a method which was adopted in January 2017.

Harvey reached CDPS Stage 6.

The Cyclone Destruction Potential Scale was created by Devon Williams in 2016. More information can be found at: https://drive.google.com/file/d/0B7pEWk6yHKggSE1STHg2UFJmbHM/view

4. Force Thirteen's Coverage on Harvey

Force Thirteen issued seventeen hours of live coverage, thirteen recorded updates in English, and four recorded updates in Spanish on Hurricane Harvey. Two of the live coverage hours were produced by Force Thirteen AU, on behalf of Force Thirteen.

The videos received a 96% approval rating overall.

Overall, the channel reached approximately 84,115 viewers during the life of Harvey, broken down geographically:

United States	47,272
Philippines	3,585
United Kingdom	2,901
Canada	1,996
Mexico	2,074
Hong Kong	1,060
Puerto Rico	932
Vietnam	906
India	827
Australia	749

Whilst Harvey was active, other storms also occurred and the viewing figures may not be a reflection on the audience attained for Harvey alone.

Comments, suggestions and inquiries should be directed to contact@force-13.co.uk, or any of Force Thirteen's online platforms.