NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM AGATHA

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2 - 5 July 2016

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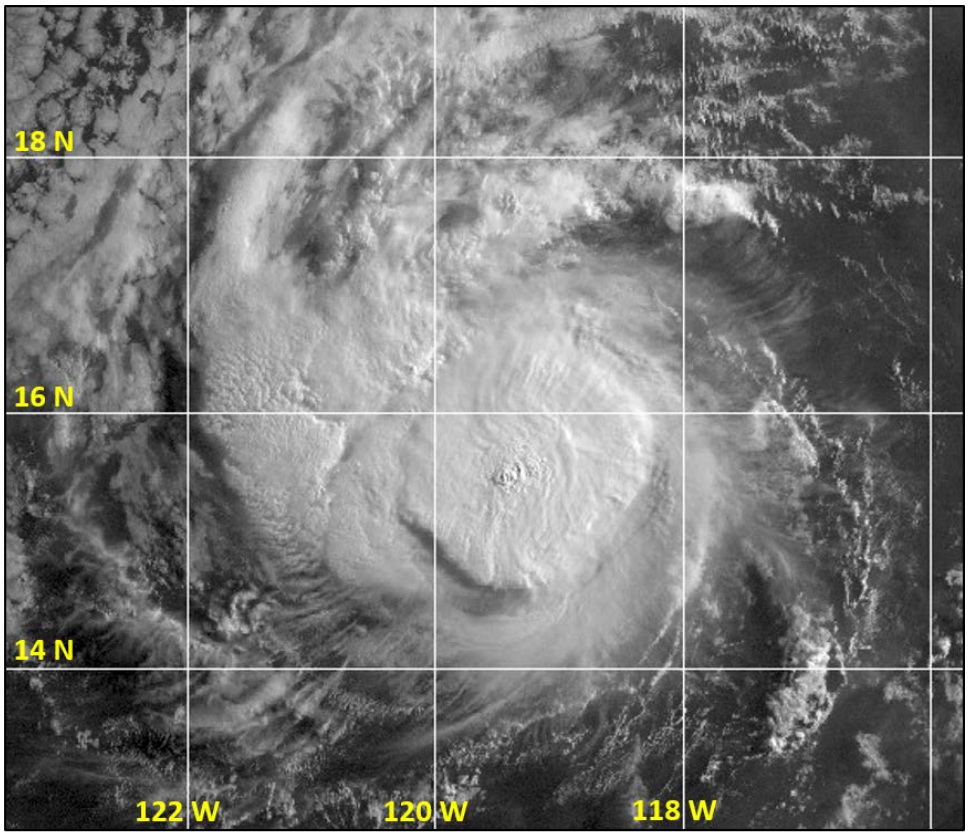

GOES-15 VISIBLE IMAGE OF AGATHA NEAR ITS PEAK INTENSITY ON 3 JULY. IMAGE COURTESY OF FNMOC/U.S. NAVY.

Tropical Storm Agatha remained over the open Pacific Ocean throughout its lifetime and did not threaten any land areas. Agatha was the second-latest first-named storm in this basin on record, behind only Ava, which became a tropical storm on 2 July 1969.

Tropical Storm Agatha

2 - 5 JULY 2016

SYNOPTIC HISTORY

The disturbance that spawned Agatha was a tropical wave that moved off of the west coast of Africa on 17 June. The wave moved briskly westward across the tropical Atlantic and southern Caribbean Sea over the next several days, crossing over Central America and Colombia on 23 June, and emerging into the eastern North Pacific basin on 24 June. The disturbance moved westward to west-northwestward over the next several days, remaining well south of the coast of Mexico. However, only sporadic convection developed due to strong northerly upper-level winds and dry mid-level air over Mexico being entrained into the system. By 30 June, the northerly vertical wind shear subsided enough for a broad low pressure system to develop when the disturbance was located several hundred n mi west-southwest of Manzanillo, Mexico. Early on 1 July, an intense burst of deep convection resulted in the spin-up of a tight low-level circulation center within the broader cyclonic gyre. Convection steadily increased and became better organized during the day, and a tropical depression formed by 0000 UTC 2 July about 600 n mi southwest of the southern tip of the Baja California peninsula of Mexico. 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 steadily west-northwestward for the next couple of days around the southwestern periphery of a deep-layer subtropical ridge that extended from northwestern Mexico and Baja California westward into the eastern Pacific. Only slow strengthening occurred during that time due to periodic intrusions of dry mid-level air. However, the small cyclone still managed to strengthen into a tropical storm by 1800 UTC 2 July, and even developed a small eyelike feature in microwave satellite imagery the following day (Fig. 4).

By late on 3 July, the combination of increasing southwesterly vertical wind shear, sea-surface temperatures less than 26^{O} C, and dry mid-level air, caused the deep convection to steadily erode, resulting in the onset of weakening. Agatha became a tropical depression late on 4 July and degenerated into a post-tropical remnant low by 0600 5 July while located about 1135 n mi west of the southern tip of the Baja California peninsula. The remnant low moved westward over the next three days and crossed 140^{O} W longitude into the Central Pacific basin around 1200 UTC 7 July. The low dissipated 24 h later about 700 n mi east of the Hawaiian Islands.

METEOROLOGICAL STATISTICS

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

There were no ship reports of tropical-storm-force winds associated with Agatha.

Agatha's analyzed peak intensity of 45 kt is based on a blend of Dvorak satellite intensity estimates of T3.0/45 kt from SAB and T2.5/35 kt from TAFB, and UW-CIMSS objective intensity estimates of 52 kt and 48 kt from the ADT and AMSU techniques, respectively.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Tropical Storm Agatha.

FORECAST AND WARNING CRITIQUE

The genesis of Tropical Storm Agatha was not very well anticipated. The system was first given a low probability (≤30% chance) of development in the 48-h and 5-day forecast periods only 30 h prior to genesis (Table 2). Probabilities were simultaneously increased to the medium category (40% - 60%) only 6 h prior to formation. The reason for the poor genesis forecasts was the expectation that moderate vertical wind shear and proximity to dry mid-level air to the north of the disturbance would prevent the development of persistent deep convection within the broad low-level circulation.

A verification of NHC official track forecasts (OFCL) for Agatha is given in Table 3a. Official forecast track errors were slightly lower than the mean official errors for the previous 5-yr period at 12-48 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. The NHC forecasts were outperformed by some global, regional, and consensus track models at all times. However, the OFCL errors were comparable and overall the errors were small.

A verification of NHC official intensity forecasts (OFCL) for Agatha is given in Table 4a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at all available forecast times. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. OFCL intensity forecasts outperformed all of the available intensity guidance at 12-36 h, with the exception of the Decay-SHIPS (DSHP) model at 36 h and the IVCN consensus model at 48 h.

No tropical cyclone coastal watches or warnings were issued in association with Agatha.

Table 1. Best track for Tropical Storm Agatha, 2-5 July 2016.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 0600	13.3	114.3	1008	25	low
01 / 1200	13.7	115.1	1008	25	"
01 / 1800	14.1	115.9	1008	25	"
02 / 0000	14.5	116.7	1007	25	tropical depression
02 / 0600	14.9	117.6	1006	30	"
02 / 1200	15.3	118.5	1006	30	"
02 / 1800	15.8	119.7	1005	35	tropical storm
03 / 0000	16.3	121.0	1004	40	"
03 / 0600	16.8	122.1	1002	45	"
03 / 1200	17.2	123.3	1002	45	"
03 / 1800	17.5	124.4	1004	40	"
04 / 0000	17.8	125.5	1004	40	"
04 / 0600	18.1	126.6	1006	40	"
04 / 1200	18.4	127.7	1007	35	"
04 / 1800	18.8	128.8	1008	30	tropical depression
05 / 0000	19.1	129.9	1008	30	"
05 / 0600	19.4	130.9	1008	30	low
05 / 1200	19.6	131.9	1009	25	"
05 / 1800	19.8	132.9	1009	25	"
06 / 0000	20.0	133.9	1009	25	"
06 / 0600	20.2	134.9	1010	25	"
06 / 1200	20.4	135.9	1010	25	"
06 / 1800	20.6	137.0	1010	25	"
07 / 0000	20.7	138.1	1010	25	"
07 / 0600	20.8	139.1	1010	25	"
07 / 1200	20.8	140.0	1010	25	"
07 / 1800	20.7	140.8	1010	25	"
08 / 0000	20.6	141.5	1010	25	"
08 / 0600	20.4	142.2	1010	25	"
08 / 1200					dissipated
03 / 0600	16.8	122.1	1002	45	minimum pressure & maximum intensity

Table 2. Number of hours in advance of formation of Agatha 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%)	30	30
Medium (40%-60%)	6	6
High (>60%)	0	0

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Agatha. 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	**22.1**	**34.5**	**42.7**	**55.6**	132.5		
OCD5	25.8	46.9	76.3	124.4	247.9		
Forecasts	11	9	7	5	1		
OFCL (2011-15)	23.4	36.4	47.2	59.4	89.0	123.6	159.5
OCD5 (2011-15)	36.6	74.2	116.5	159.7	245.6	331.1	427.4

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Agatha. 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	20.0	25.7	29.5	41.1			
OCD5	23.6	33.4	50.3	86.7			
GFSI	20.8	30.3	36.7	44.4			
EMXI	**18.9**	29.8	29.5	**16.2**			
UKMI	20.5	**20.1**	**20.1**	**16.9**			
CMCI	29.4	40.5	37.6	51.7			
AEMI	20.9	29.5	33.7	50.0			
HWFI	22.4	26.7	**26.7**	**21.1**			
GHMI	26.1	43.6	63.2	89.5			
CTCI	24.4	36.2	47.0	56.6			
TVCN	**19.7**	**25.1**	**28.2**	**33.9**			
TCON	**19.5**	26.2	30.9	**38.9**			
LBAR	38.9	83.0	135.8	198.0			
BAMD	50.6	90.1	131.2	196.9			
BAMM	35.5	65.5	101.2	160.2			
BAMS	22.3	42.3	59.0	95.2			
Forecasts	9	7	5	3			

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Agatha. 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	**1.8**	**2.8**	**3.6**	**5.0**	**5.0**		
OCD5	3.5	5.2	5.6	4.2	8.0		
Forecasts	11	9	7	5	1		
OFCL (2011-15)	5.9	9.8	12.5	14.0	15.5	16.3	14.9
OCD5 (2011-15)	7.7	12.8	16.4	18.8	21.1	20.9	19.7

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Agatha. 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	2.2	1.4	2.0	1.7			
OCD5	4.0	4.0	4.4	3.3			
HWFI	5.4	6.6	7.6	6.3			
GHMI	4.2	3.9	3.0	3.7			
CTCI	3.1	3.4	4.4	2.7			
DSHP	3.2	2.9	**1.2**	2.0			
LGEM	3.8	3.6	3.0	2.7			
IVCN	3.6	3.4	2.6	**1.3**			
ICON	4.0	3.6	2.4	1.7			
GFSI	5.2	3.6	3.8	4.3			
EMXI	5.1	5.3	6.2	4.0			
AEMI	6.0	5.4	6.4	4.0			
UKMI	3.8	3.7	3.8	2.3			
CMCI	5.3	6.3	5.4	3.0			
Forecasts	9	7	5	3			

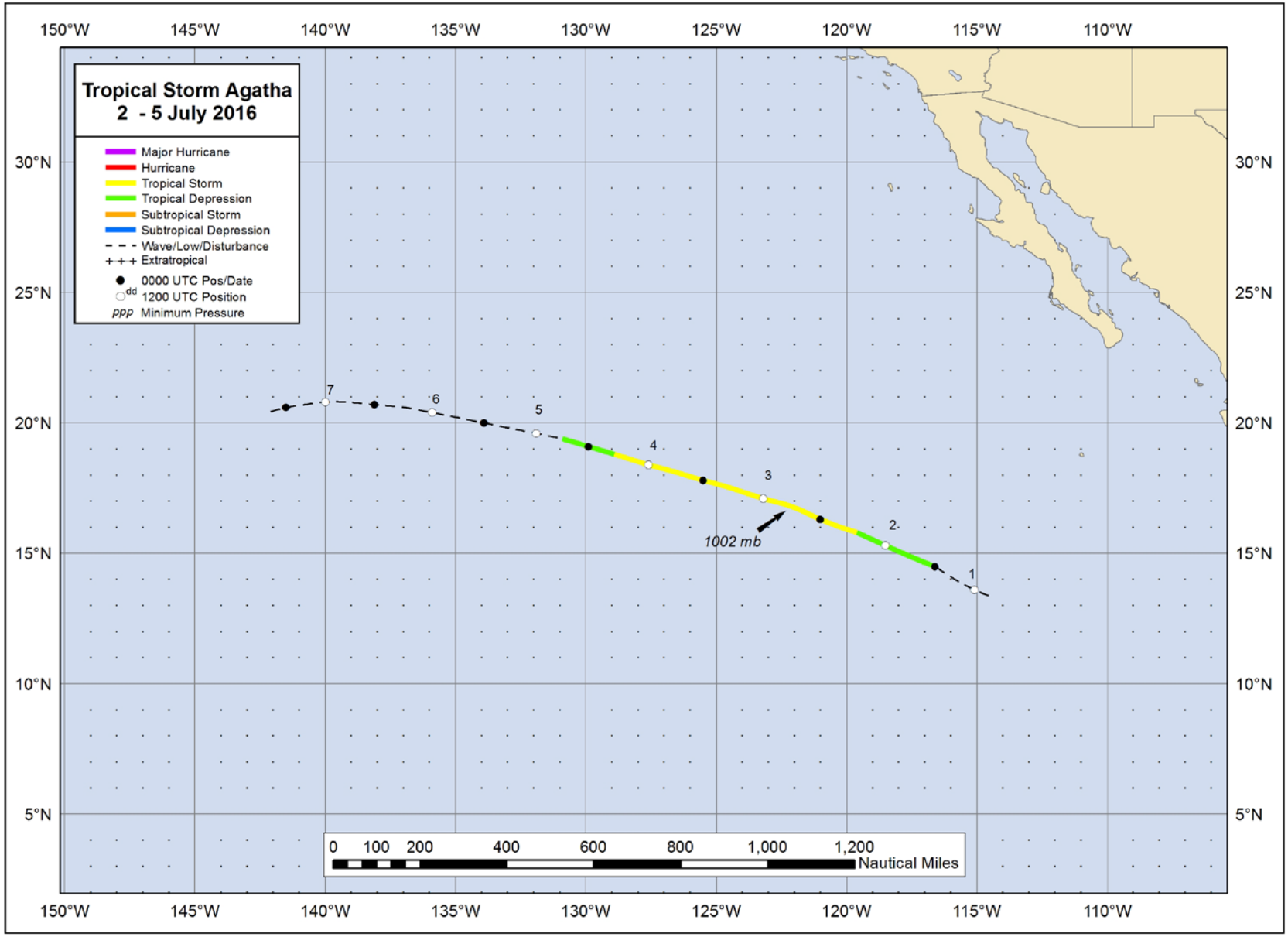

Figure 1. Best track positions for Tropical Storm Agatha, 2-5 July 2016.

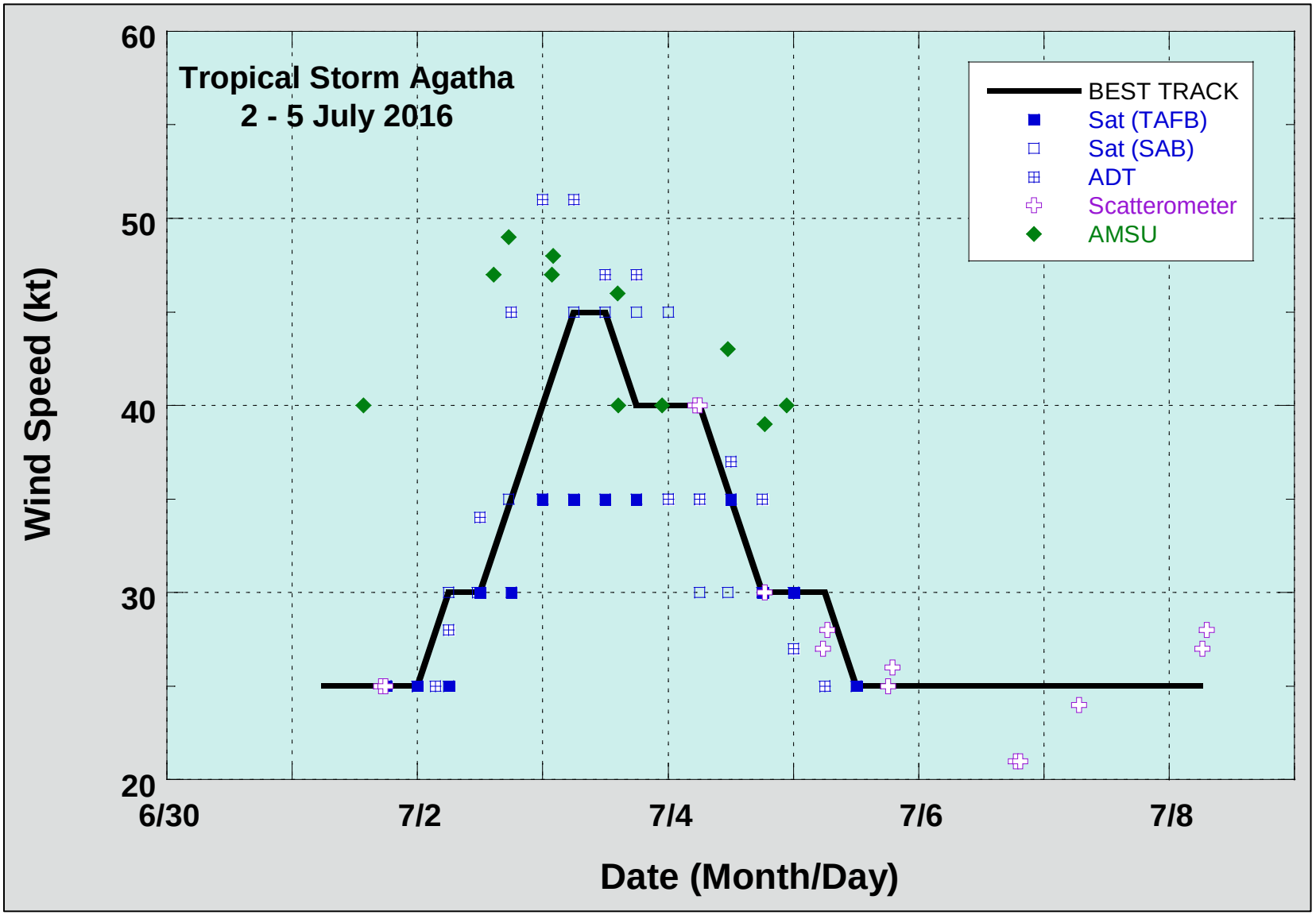

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Agatha, 2-5 July 2016. Dashed vertical lines correspond to 0000 UTC.

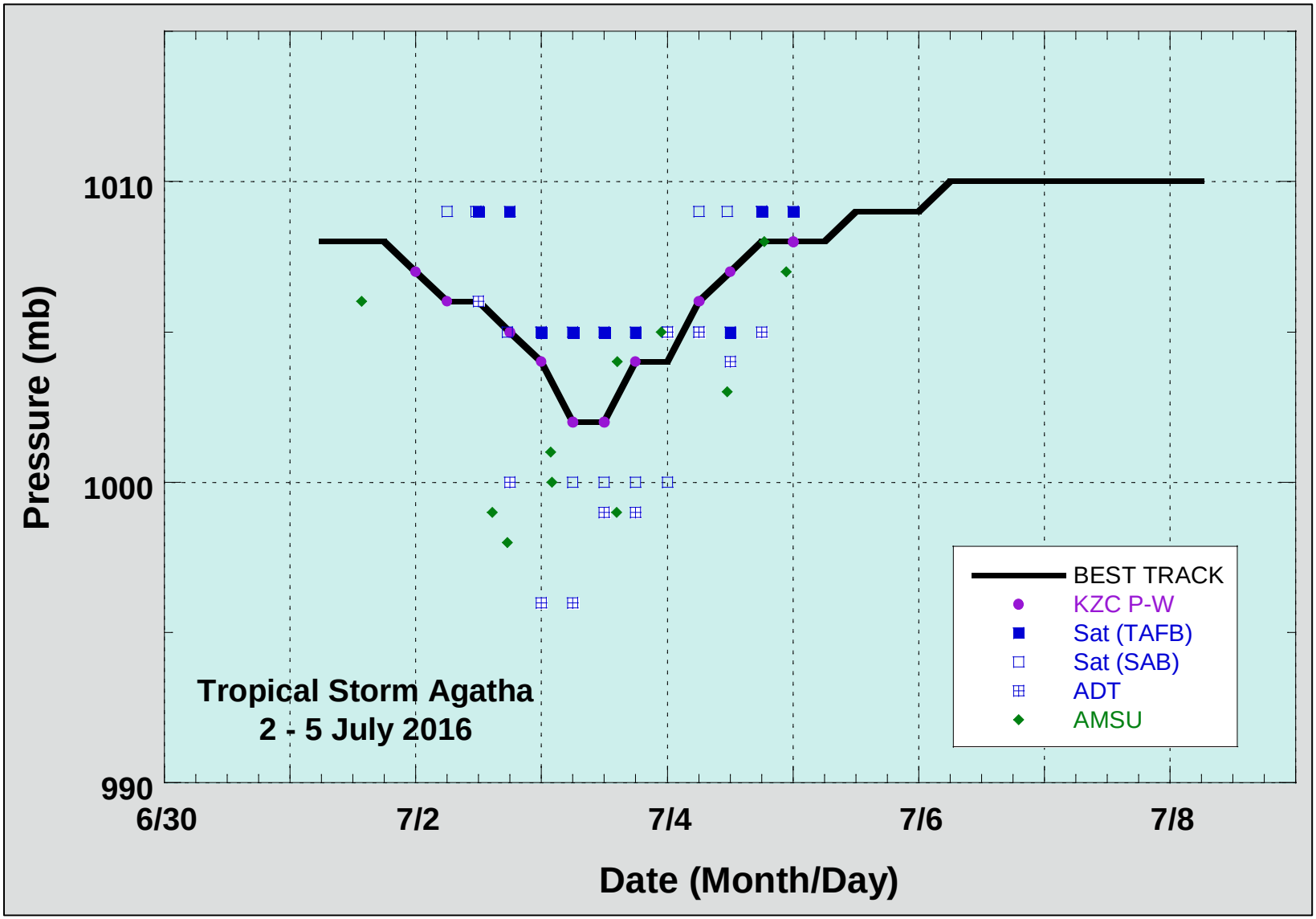

Figure 3. Selected pressure observations and best track minimum central pressure curve for Tropical Storm Agatha, 2-5 July 2016. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

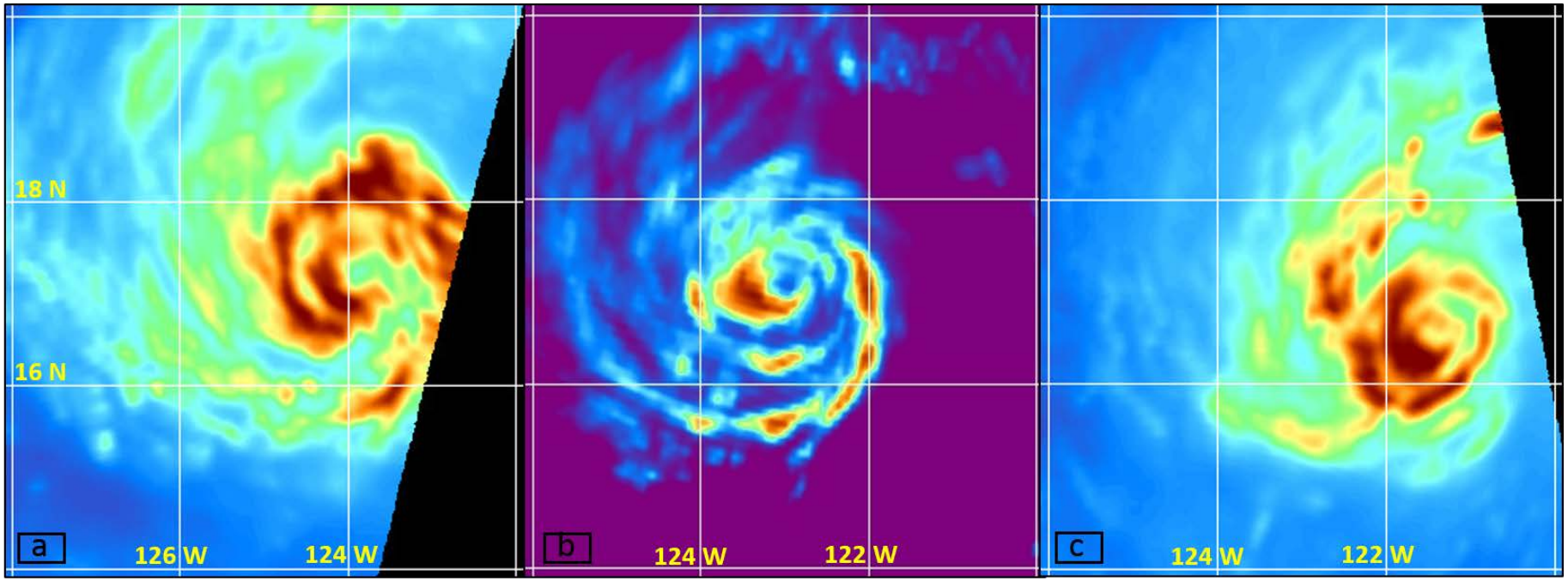

Figure 4. Passive microwave satellite imagery showing the evolution of Agatha's small, low-level eye feature during the peak intensity period on 3 July 2016 -- (a) WindSAT 37 GHz/H, 1458 UTC; (b) GCOM 37 GHz/H, 0932 UTC; (c) WindSAT 37 GHz/H, 0226 UTC.