Tropical Cyclone Report
Hurricane Philippe
(AL172011)
24 September – 8 October 2011

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Philippe was a long-lived tropical cyclone that twice became a category 1 hurricane (on the Saffir-Simpson Hurricane Wind Scale). Although it lasted for about two weeks, Philippe did not affect land.

a. Synoptic History

Philippe developed from a tropical wave that crossed the coast of Africa on 22 September. The wave had a strong circulation while it was over western Africa, and a closed area of low pressure formed around 0000 UTC 23 September, just after the wave crossed the coast. Deep convection consolidated and became organized in a band around the center, and the low became a tropical depression by 0600 UTC 24 September about 225 n mi south of the southernmost Cape Verde Islands. The depression strengthened to a tropical storm 6 h later. The "best track" of Philippe'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].

Philippe never had an ideal environment for significant intensification during its two-week existence, and it had four relative peaks in intensity, each one a little higher than the last. After becoming a tropical storm, Philippe moved west-northwestward to northwestward to the south of a weakening mid-level ridge and gradually strengthened in a light-shear environment, reaching an intensity of 50 kt over the tropical eastern Atlantic at 1200 UTC 26 September. Westerly vertical wind shear began to increase around that time, and Philippe subsequently weakened and turned toward the west in the trade wind flow. The shear increased further on 27 September with the low-level center becoming well removed from a small area of deep convection, and Philippe weakened to a tropical depression at 0000 UTC 28 September while located about 675 n mi west of the Cape Verde Islands.

Even though moderate west-southwesterly shear persisted over the cyclone, deep convection re-developed near the center, and Philippe re-strengthened to a tropical storm 12 h later. The tropical storm continued to move west-northwestward into the tropical central Atlantic, but it turned northwestward and then north-northwestward early on 29 September as it approached the western periphery of the subtropical ridge. Despite being affected by northwesterly vertical shear on 30 September and 1 October, Philippe reached an intensity of 60 kt at 1200 UTC 1 October. However, the cyclone was located on the western side of a mid-

[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.

latitude trough, and nearly 40 kt of northerly shear began impacting the system. The low-level center became exposed again, and Philippe weakened to an intensity of 40 kt on 2 October.

On 3 October, Philippe turned toward the west-southwest and then southwest due to a strengthening mid-level ridge to its north. Philippe intensified during that time, and a closed low- to mid-level eye became apparent in microwave satellite imagery (Fig. 4). It is estimated that Philippe became a 65-kt hurricane at 0000 UTC 4 October while located about 475 n mi northeast of the Leeward Islands. Philippe turned toward the west while the mid-level high was being eroded by a large mid-latitude trough near the east coast of the United States. The cyclone weakened to a tropical storm by 1200 UTC 4 October and then made a slow but sharp turn toward the northwest and north over the western Atlantic on 5 October and early on 6 October.

The vertical shear abated while Philippe turned northward, and the cyclone intensified one final time, again becoming a hurricane about 400 n mi south-southeast of Bermuda at 0600 UTC 6 October. Embedded in deep southwesterly flow, the hurricane turned northeastward later that day, continued to intensify, and reached its maximum intensity of 80 kt around 1800 UTC. Philippe maintained that intensity for almost 24 h and then began to weaken on 7 October when deep-layer southwesterly shear increased to between 40 and 50 kt. The hurricane weakened to a tropical storm around 0600 UTC 8 October while approaching the north wall of the Gulf Stream, and Philippe became an extratropical cyclone 12 h later when it merged with a cold front. The extratropical cyclone was then absorbed by a larger area of low pressure after 0000 UTC 9 October over the north-central Atlantic Ocean about 600 n mi west of the westernmost Azores.

b. Meteorological Statistics

Observations in Philippe (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 UW-CIMSS Advanced Microwave Sounding Unit [AMSU] intensity estimates), the NASA Tropical Rainfall Measuring Mission (TRMM) and Aqua, 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 Philippe.

The post-analysis of Philippe's intensity suggests that the cyclone reached or nearly reached hurricane strength twice before the time it was operationally designated as a hurricane on 6 October. On 1 and 2 October, two ASCAT passes showed winds of 55 kt, suggesting that Philippe's intensity could have been higher, given the instrument's low bias and resolution. However, Philippe did not have the signature of a cyclone near hurricane intensity in conventional or microwave imagery, and neither subjective nor Dvorak ADT estimates were above 55 kt. While it is possible that Philippe could have attained hurricane intensity during this period, the preponderance of the data suggests otherwise. The signature of the cyclone, especially in microwave data, did improve on 3 and 4 October. Subjective Dvorak estimates ranged from 55 to 65 kt, but 3-h averaged objective Dvorak estimates were about 75 kt and even

reached 85 kt at one point. Based on these data, it is estimated that Philippe became a hurricane after 1800 UTC 3 October, coincident with the time when a distinct eye was evident in microwave imagery (Fig. 4).

Philippe's analyzed peak intensity of 80 kt from 1800 UTC 6 October to 1200 UTC 7 October is based on subjective satellite intensity estimates of 77 kt from TAFB and SAB, and peak 3-h averaged estimates of 85 kt from the UW-CIMSS ADT. Intensity estimates from AMSU data generally ranged from 35 to 50 kt during Philippe's existence and were not particularly useful in the post-analysis of this cyclone.

There were no ship reports of tropical-storm-force winds in association with Philippe.

c. Casualty and Damage Statistics

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

d. Forecast and Warning Critique

The genesis of Philippe was not forecast particularly well, presumably because it developed so quickly after moving off the coast of Africa. The precursor low was introduced in the Tropical Weather Outlook (TWO) and given a "low" (<30%) chance of genesis over the next 48 h at 1200 UTC 23 September, only 18 h before it became a tropical depression. The low was given a "medium" (30 – 50%) chance 12 h before genesis and a "high" (>50%) chance at the time of genesis as determined by the post-analysis.

A verification of NHC official track forecasts for Philippe is given in Table 2a. Philippe was not a well-behaved storm according to its CLIPER (OCD5) errors, which were higher than the mean CLIPER errors for the previous 5 yr. This was especially true after Philippe turned toward the west and southwest on 2 and 3 October (Fig. 5b). The official forecast track errors were comparable to the mean official errors for the previous 5-yr period and were lower only at 48 and 72 h. However, these forecasts had significant skill over CLIPER at all forecast times, as much as 60% at 48 and 72 h. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. In general, the Global Forecast System (GFSI) and European Centre for Medium-Range Weather Forecasts (EMXI) global models had errors similar to or lower than the official track errors. The most difficult period of the forecast occurred while Philippe was east of 45°W, when the GFSI model (Fig. 5c), among others, erroneously indicated a northward turn around 40°W and subsequently influenced the official forecasts (Fig. 5a). On the other hand, the EMXI model (Fig. 5d) only showed a northward turn on two forecast cycles and otherwise correctly forecast the westward turn into the central Atlantic. Several of the consensus models had lower errors than the official forecasts, but only during the first 48 h.

A verification of NHC official intensity forecasts for Philippe is given in Table 3a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr

period between 12 and 72 h and were slightly higher at 96 and 120 h. Based on SHIFOR (OCD5) errors, the intensity forecasts were easier than for an average Atlantic storm over the past 5 yr, but the official intensity forecasts were not skillful relative to SHIFOR. In general, the official forecasts had high biases during periods when Philippe weakened and had low biases during periods when Philippe strengthened. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The statistical-dynamical models (DSHP and LGEM), the intensity consensus models (ICON and IVCN), and the Florida State Superensemble (FSSE) excelled in relation to the official forecasts at almost all forecast times. The dynamical models (GHMI, HWFI, and GFNI) had lower errors than the official forecasts during the first 48 h.

There were no coastal watches or warnings in association with Philippe.

Table 1. Best track for Hurricane Philippe, 24 September – 8 October 2011.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
23 / 0000	8.3	17.5	1010	20	low
23 / 0600	8.6	19.1	1010	20	"
23 / 1200	9.0	20.6	1010	25	"
23 / 1800	9.5	22.0	1009	25	"
24 / 0000	10.4	23.3	1008	30	"
24 / 0600	11.0	24.7	1007	30	tropical depression
24 / 1200	11.1	26.1	1006	35	tropical storm
24 / 1800	11.2	27.3	1006	35	"
25 / 0000	11.5	28.4	1006	35	"
25 / 0600	12.1	29.4	1006	40	"
25 / 1200	12.7	30.3	1006	40	"
25 / 1800	13.2	31.2	1005	45	"
26 / 0000	13.8	32.1	1005	45	"
26 / 0600	14.4	33.0	1004	45	"
26 / 1200	14.9	33.6	1003	50	"
26 / 1800	15.3	34.1	1003	50	"
27 / 0000	15.4	34.4	1004	45	"
27 / 0600	15.5	34.7	1004	45	"
27 / 1200	15.6	35.2	1005	40	"
27 / 1800	15.7	35.8	1006	35	"
28 / 0000	15.8	36.6	1007	30	tropical depression
28 / 0600	16.0	37.4	1007	30	"
28 / 1200	16.2	38.4	1006	35	tropical storm
28 / 1800	16.6	39.4	1005	40	"
29 / 0000	17.1	40.5	1005	40	"
29 / 0600	17.8	41.5	1004	45	"
29 / 1200	18.7	42.3	1004	45	"
29 / 1800	19.7	43.0	1005	45	"
30 / 0000	20.7	43.6	1007	40	"
30 / 0600	21.7	44.2	1007	40	"
30 / 1200	22.5	44.8	1006	45	"
30 / 1800	23.2	45.6	1005	45	"
01 / 0000	23.8	46.3	1003	50	"
01 / 0600	24.1	47.0	999	55	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 1200	24.4	47.6	997	60	"
01 / 1800	24.8	48.4	995	60	"
02 / 0000	25.2	49.3	993	60	"
02 / 0600	25.8	50.3	998	50	"
02 / 1200	26.2	51.2	1004	40	"
02 / 1800	26.3	52.3	1004	40	"
03 / 0000	26.2	53.2	1004	45	"
03 / 0600	25.6	54.0	1001	50	"
03 / 1200	24.9	54.8	998	55	"
03 / 1800	24.3	55.6	995	60	"
04 / 0000	23.8	56.6	992	65	hurricane
04 / 0600	23.7	57.7	992	65	"
04 / 1200	23.8	58.7	993	60	tropical storm
04 / 1800	24.0	59.6	994	60	"
05 / 0000	24.3	60.2	994	60	"
05 / 0600	24.7	60.7	994	60	"
05 / 1200	25.2	61.0	995	55	"
05 / 1800	25.5	61.1	995	55	"
06 / 0000	25.9	61.1	992	60	"
06 / 0600	26.5	61.0	987	65	hurricane
06 / 1200	27.4	60.4	983	70	"
06 / 1800	28.2	59.7	977	80	"
07 / 0000	28.7	58.8	976	80	"
07 / 0600	29.0	57.7	976	80	"
07 / 1200	29.3	56.5	977	80	"
07 / 1800	29.7	55.1	981	70	"
08 / 0000	30.1	53.5	986	65	"
08 / 0600	30.9	51.4	987	60	tropical storm
08 / 1200	32.3	48.7	987	60	"
08 / 1800	34.4	46.0	987	50	extratropical
09 / 0000	37.5	43.6	987	45	"
09 / 0600					absorbed
06 / 1800	28.2	59.7	977	80	maximum wind
07 / 0000	28.7	58.8	976	80	minimum pressure

Table 2a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Philippe, 24 September – 8 October 2011. Mean errors for the 5-yr period 2006-10 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	35.1	56.2	71.0	**88.2**	**132.4**	181.0	230.6
OCD5	48.4	99.5	163.3	227.7	348.5	434.3	506.4
Forecasts	56	54	52	50	46	42	38
OFCL (2006-10)	31.0	50.6	69.9	89.5	133.2	174.2	214.8
OCD5 (2006-10)	47.7	98.3	156.4	218.1	323.3	402.2	476.1

Table 2b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Philippe, 24 September – 8 October 2011. 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 2a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	33.3	51.9	67.2	86.2	135.1	189.6	285.3
OCD5	47.2	99.8	167.8	242.7	379.5	462.5	523.0
GFSI	**32.2**	54.1	68.6	**78.0**	**128.2**	**175.7**	315.9
GHMI	**32.1**	57.2	87.8	111.2	166.7	259.8	420.7
HWFI	33.8	58.9	82.6	101.5	167.7	268.8	457.7
GFNI	43.2	73.5	104.3	135.8	245.2	414.3	684.6
NGPI	42.3	74.4	109.4	147.2	271.3	494.7	748.8
EGRI	36.7	56.5	81.1	109.8	214.2	394.4	588.2
EMXI	**31.2**	**50.6**	67.5	**84.4**	**125.6**	**146.8**	**197.2**
CMCI	**32.7**	59.3	90.8	131.6	212.6	389.5	529.3
AEMI	**33.0**	59.1	83.3	105.3	147.5	**189.4**	346.0
FSSE	33.7	55.9	71.5	92.1	156.3	264.9	490.2
TCON	**31.1**	**50.8**	68.9	88.5	150.7	267.2	464.6
TCCN	**31.3**	**48.7**	**66.2**	**85.4**	144.4	244.9	409.6
TVCA	**30.7**	**50.5**	67.4	**83.6**	140.8	227.7	395.5
TVCC	**31.6**	**50.1**	67.6	87.7	150.8	247.0	420.8
LBAR	42.3	80.5	120.4	164.4	303.2	559.9	1000.1
BAMD	55.0	103.5	150.7	187.8	274.3	397.8	755.9
BAMM	36.8	63.5	86.9	113.0	156.2	208.1	299.3
BAMS	48.7	96.9	153.8	211.8	293.6	289.3	359.5
Forecasts	47	46	45	41	34	25	13

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Philippe, 24 September – 8 October 2011. Mean errors for the 5-yr period 2006-10 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	**6.5**	**9.4**	**11.1**	**13.4**	**16.3**	19.2	20.4
OCD5	6.5	9.3	10.5	9.5	10.2	11.1	9.3
Forecasts	56	54	52	50	46	42	38
OFCL (2006-10)	7.2	11.0	13.2	15.1	17.2	17.9	18.7
OCD5 (2006-10)	8.5	12.3	15.4	17.8	20.2	21.9	21.7

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Philippe, 24 September – 8 October 2011. 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	6.8	9.7	11.3	13.4	16.3	19.0	21.3
OCD5	**6.6**	**9.5**	**10.8**	**9.7**	**10.1**	**10.3**	**9.1**
GHMI	**6.4**	**8.2**	**8.5**	**11.6**	19.3	23.9	26.0
HWFI	**6.2**	**7.2**	**11.1**	14.5	18.5	19.8	27.6
GFNI	**5.7**	**8.9**	**10.6**	**12.5**	20.2	22.5	23.4
FSSE	**6.3**	**7.9**	**9.0**	**10.3**	**12.8**	**13.7**	**13.5**
DSHP	6.8	**9.1**	**9.8**	**11.4**	**13.2**	**13.4**	**16.1**
LGEM	7.2	9.9	**10.9**	**13.0**	**14.7**	**15.4**	**18.6**
ICON	**5.9**	**7.3**	**8.3**	**9.3**	**12.0**	**13.1**	**15.9**
IVCN	**5.7**	**7.0**	**8.1**	**9.2**	**12.5**	**13.1**	**14.7**
Forecasts	54	52	50	48	44	40	36

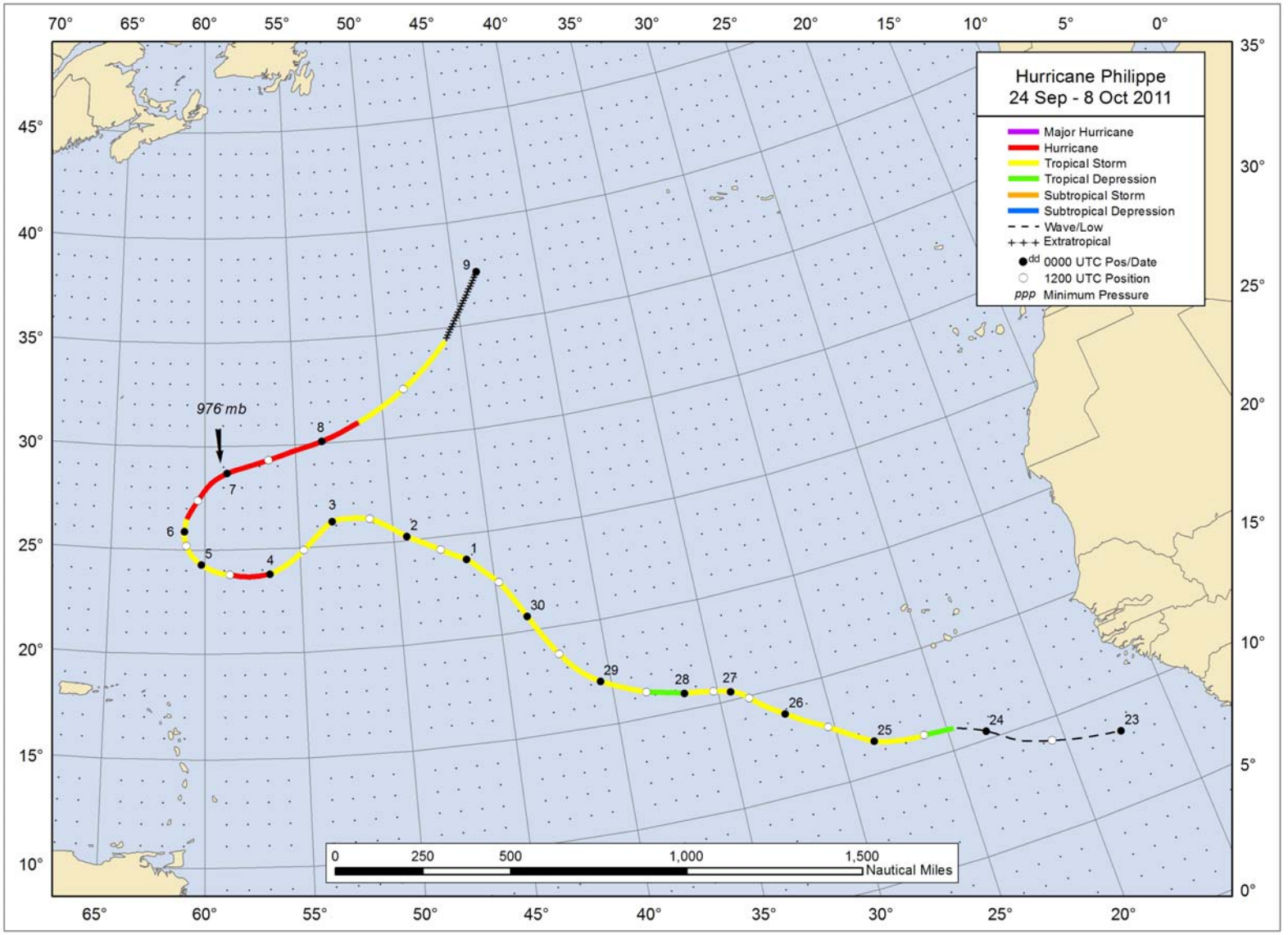

Figure 1. Best track positions for Hurricane Philippe, 24 September – 8 October 2011.

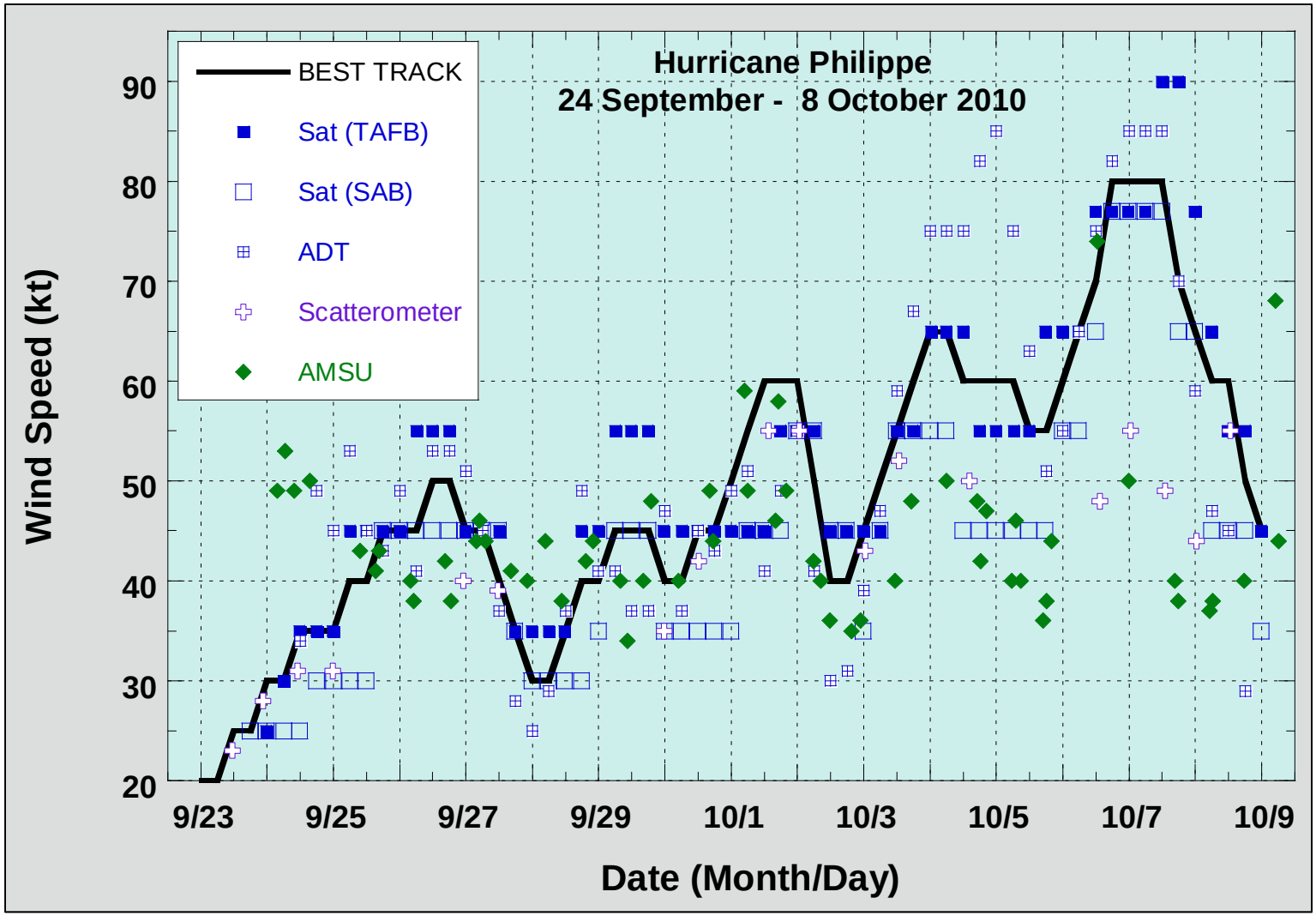

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Philippe, 24 September – 8 October 2011. ADT points represent linear averages of UW-CIMSS Advanced Dvorak Technique estimates over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the UW-CIMSS technique. Dashed vertical lines correspond to 0000 UTC.

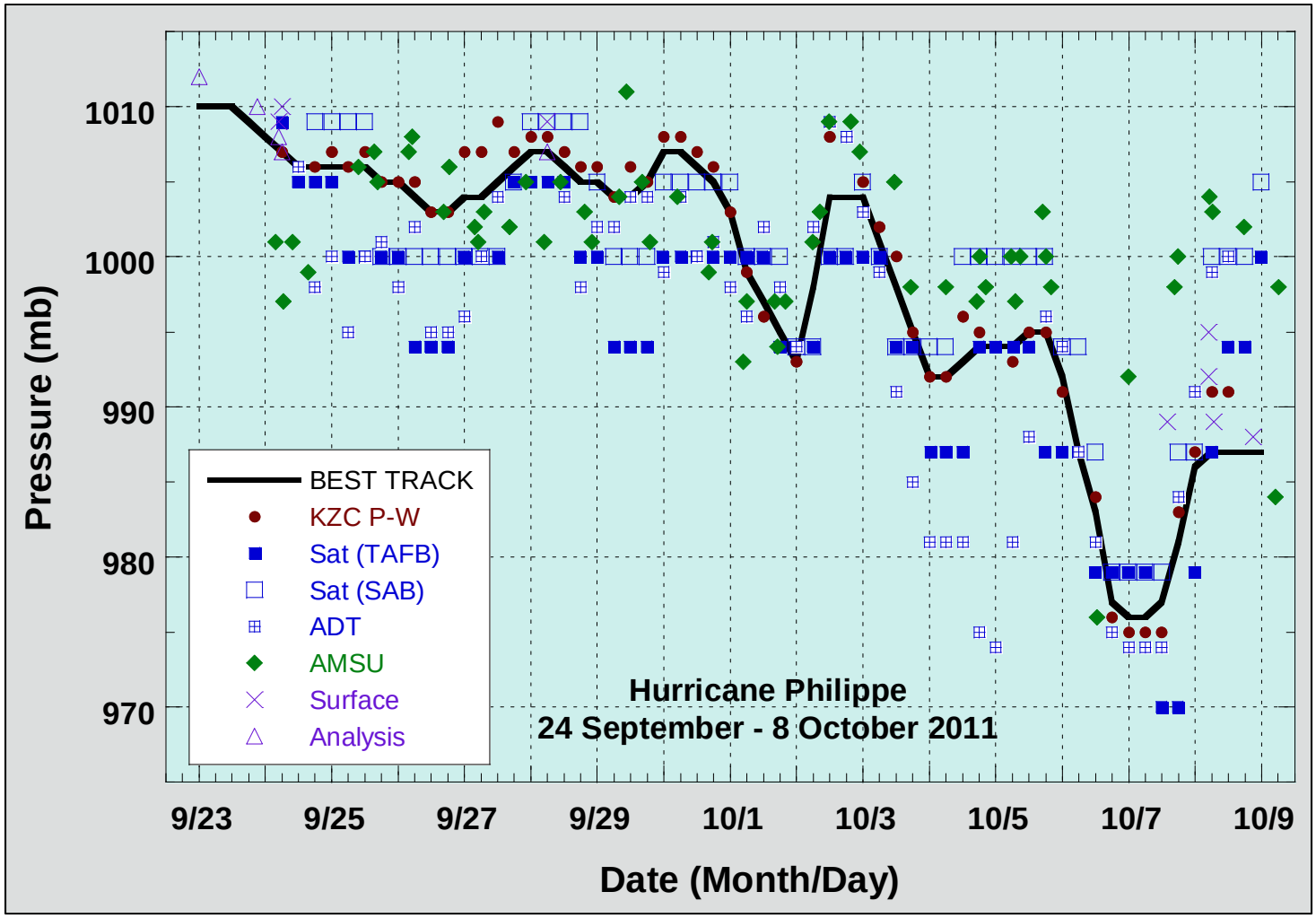

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Philippe, 24 September – 8 October 2011. ADT points represent linear averages of UW-CIMSS Advanced Dvorak Technique estimates over a three-hour period centered on the nominal observation time. AMSU intensity estimates are from the UW-CIMSS technique. KZC P-W refers to pressure estimates using the Knaff-Zehr-Courtney pressure-wind relationship based upon best track intensity values. Dashed vertical lines correspond to 0000 UTC.

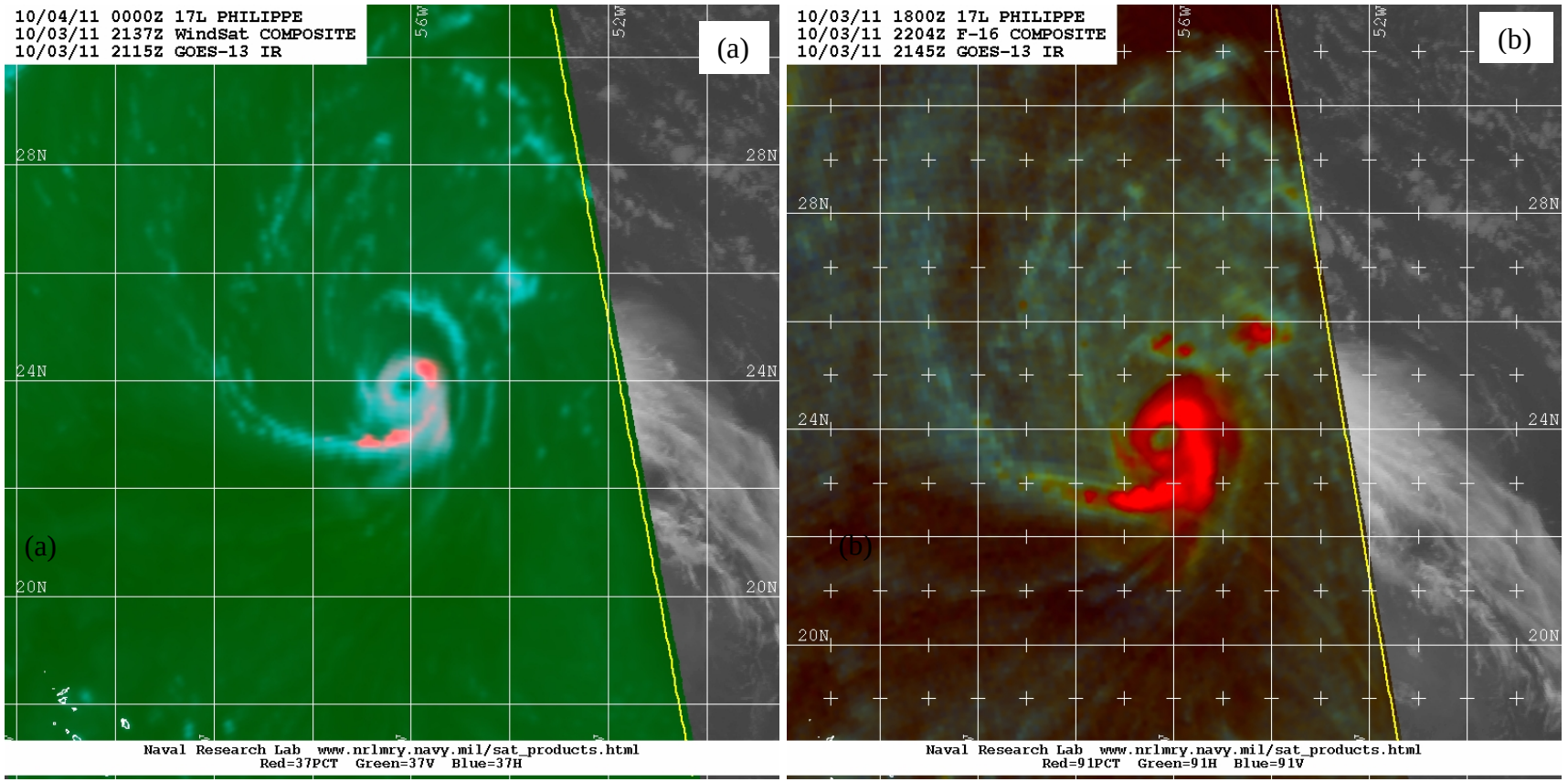

Figure 4. (a) 37 GHz color composite WindSat image at 2137 UTC 3 October (left) and (b) an 85 GHz color composite SSMIS image at 2204 UTC 3 October (right) around the time Philippe first reached hurricane intensity. Images courtesy of the Naval Research Laboratory, Monterey, CA.

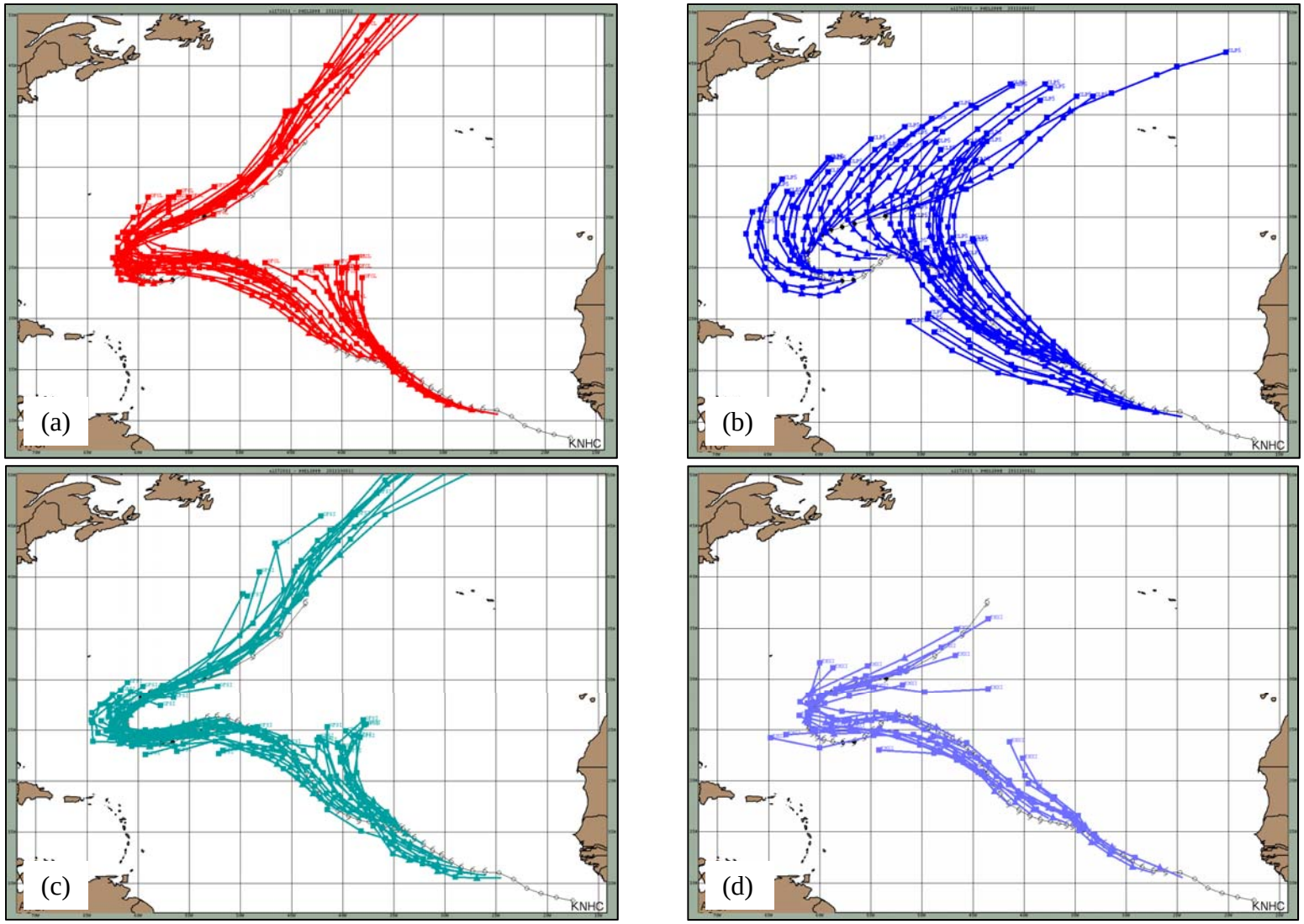

Figure 5. (a) NHC official, (b) CLIPER, (c) GFSI, and (d) EMXI track forecasts from 0600 UTC 24 September through 1200 UTC 8 October 2011 for Hurricane Philippe. The best track is given by the black line with positions shown at 6 h intervals.