NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT[1]

HURRICANE KIRK

(AL122024)

29 September–7 October 2024

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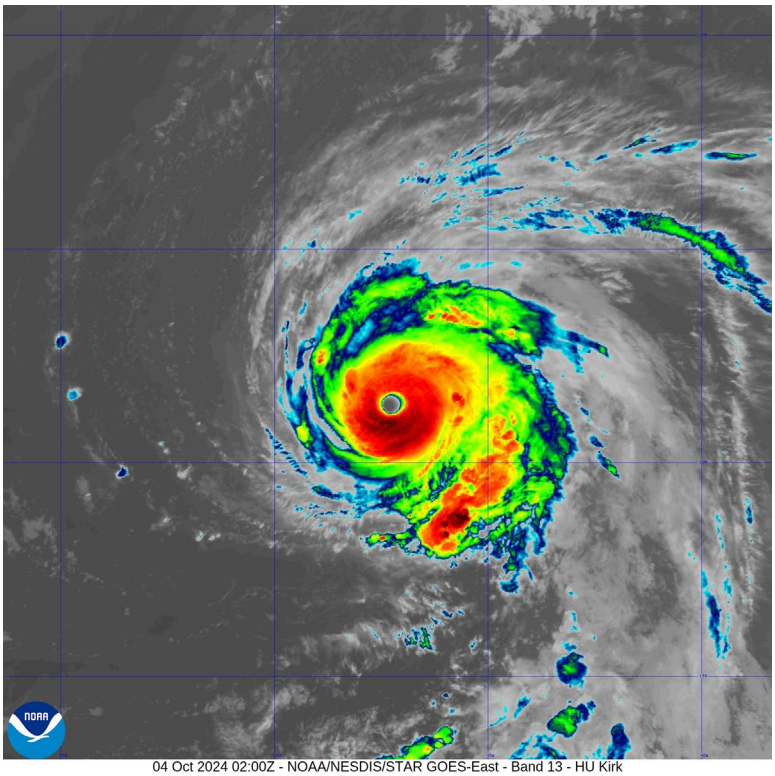

GOES-16 INFRARED SATELLITE IMAGE OF HURRICANE KIRK NEAR PEAK INTENSITY AT 0200 UTC 4 OCTOBER 2024. IMAGE COURTESY OF NOAA/ NESDIS/STAR.

Kirk was a late-season Cabo Verde Hurricane that reached category 4 intensity (on the Saffir-Simpson Hurricane Wind Scale) and remained at sea over the Atlantic.

[1] This is an abbreviated Tropical Cyclone Report since there were no coastal watches or warnings issued and no direct fatalities reported in association with Kirk while it was a tropical cyclone.

Hurricane Kirk

29 SEPTEMBER–7 OCTOBER 2024

BEST TRACK

The "best track[2]" positions and intensities for Hurricane Kirk are listed in Table 1. The best track chart of Kirk's path is given in Fig. 1, with the wind and pressure histories along with available observations[3] shown in Figs. 2 and 3, respectively.

There were no ship reports received of winds of tropical storm force associated with Kirk while it was a tropical cyclone.

Kirk formed from a tropical wave that moved off the west coast of Africa on 25 September. The wave moved through the Cabo Verde Islands on 27 September accompanied by a few showers and thunderstorms. Deep convection associated with the system became better organized on 28 September while a broad low-level circulation formed. On the following day, showers and thunderstorms continued to become better organized. By 1800 UTC 29 September, the system had acquired sufficient organized convection and a well-defined circulation to designate the formation of a tropical depression while centered about 450 n mi west of the southwestern Cabo Verde Islands.

Over the following week the cyclone, which eventually strengthened into a major hurricane, moved on a long parabolic track over open waters. A couple of days after becoming an extratropical cyclone over the north Atlantic on 7 October, the system affected portions of western Europe, bringing some locally severe weather to that region.

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[2] 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.

[3] Observations include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) 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 Advanced Scatterometer (ASCAT), and Defense Meteorological Satellite Program (DMSP) satellites, and the Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats (TROPICS) satellites, among others, were also useful in constructing the best track of Kirk.

Peak Intensity and Minimum Pressure

Kirk's peak intensity of 130 kt early on 4 October is based on a blend of subjective Dvorak estimates from SAB and TAFB with objective ADT estimates.

The estimated minimum central pressure of 928 mb is based on the Knaff-Zehr-Courtney pressure-wind relationship.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Kirk while it was a tropical cyclone. The extratropical remnant of the system brought flooding, strong gusty winds, and power outages to portions of Portugal, Spain, and France. One person drowned on 9 October when his boat capsized near the south of France.

FORECAST AND WARNING VERIFICATION

Kirk's genesis was not predicted very far in advance. Global models, such as the GFS and ECMWF, showed little or no indication of TC formation more than about 3 days before genesis. Table 2 provides the number of hours in advance of formation with the first NHC Tropical Weather Outlook (TWO) forecast in each likelihood category. It was first noted in the TWO 54 hours before development that an area of low pressure could form over the eastern tropical Atlantic in several days, and the 7-day genesis probability was set to low (less than 40%). A low 48-hour genesis chance was introduced 42 hours prior to development, and never reached the high category before Kirk developed into a tropical cyclone. The 7-day genesis chances were increased to the high category (>60%) only 24 hours before development.

Figure 4 shows composites of 7-day TWO genesis areas for each category prior to the formation of Kirk. In general, these areas did not encompass the location of development very well (only a 40% hit rate) and indicated that the NHC forecasts were predicting Kirk's formation later than the actual occurrence.

Overall the predictions of Kirk's track were good. A verification of NHC official track forecasts for Kirk is given in Table 3a. Official track forecast errors were lower than the long-term means at all forecast intervals. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. In general, the ECMWF model and HCCA guidance were the best objective track prediction aids for Kirk.

A verification of NHC official intensity forecasts for Kirk is given in Table 4a. Official intensity forecast errors were comparable to or a little lower than the mean official errors for the previous 5-yr period. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The mean official intensity forecasts were comparable to those from the more reliable intensity guidance models, such as IVCN and DSHP. Kirk's overall

strengthening and weakening trends were reasonably well forecast, especially for a system that underwent rapid intensification on 2–3 October.

There were no coastal watches or warnings issued for Kirk while it was a tropical cyclone.

ACKNOWLEDGEMENTS

Philippe Papin of NHC produced Fig. 4.

Table 1. Best track for Hurricane Kirk, 29 September–7 October 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
29 / 1800	13.8	32.1	1006	30	tropical depression
30 / 0000	13.8	32.8	1006	30	"
30 / 0600	13.6	33.4	1004	35	tropical storm
30 / 1200	13.4	34.3	1001	45	"
30 / 1800	13.7	35.3	999	50	"
01 / 0000	14.2	36.3	998	50	"
01 / 0600	14.7	37.5	995	50	"
01 / 1200	15.2	38.7	988	60	"
01 / 1800	15.9	39.7	986	65	hurricane
02 / 0000	16.5	40.6	986	65	"
02 / 0600	17.1	41.6	982	70	"
02 / 1200	17.8	42.7	979	75	"
02 / 1800	18.5	43.5	975	80	"
03 / 0000	19.1	44.1	959	100	"
03 / 0600	19.6	44.7	955	105	"
03 / 1200	20.1	45.5	948	110	"
03 / 1800	20.7	46.3	944	115	"
04 / 0000	21.2	47.1	928	130	"
04 / 0600	21.9	47.9	928	130	"
04 / 1200	22.5	48.6	938	120	"
04 / 1800	23.3	49.1	942	115	"
05 / 0000	24.3	49.7	943	115	"

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
05 / 0600	25.4	50.1	945	110	"
05 / 1200	26.8	50.4	949	105	"
05 / 1800	28.7	50.2	949	105	"
06 / 0000	30.6	49.9	951	100	"
06 / 0600	32.6	49.5	955	95	"
06 / 1200	34.5	48.6	959	85	"
06 / 1800	36.4	47.2	959	80	"
07 / 0000	37.9	45.0	964	70	"
07 / 0600	39.5	42.4	966	65	"
07 / 1200	41.2	39.9	966	65	extratropical
07 / 1800	42.7	36.6	966	60	"
08 / 0000	43.3	33.3	968	55	"
08 / 0600	43.5	29.6	968	55	"
08 / 1200	43.5	25.4	972	55	"
08 / 1800	42.9	20.9	975	55	"
09 / 0000	43.0	15.5	980	50	"
09 / 0600	43.5	9.5	980	50	"
09 / 1200	45.5	4.0	980	45	"
09 / 1800	48.0	-2.0	980	40	"
10 / 0000	51.0	-8.0	982	30	"
10 / 0600					dissipated
04 / 0000	21.2	47.1	928	130	maximum winds and minimum pressure

Table 2. Number of hours in advance of formation 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	**168-Hour Outlook**
Low (<40%)	42	54
Medium (40%-60%)	12	42
High (>60%)	0	24

Table 3a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Hurricane Kirk, 29 September–7 October 2024. 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	60	72	96	120
OFCL	**21.6**	**31.1**	**37.7**	**44.4**	**51.9**	**58.1**	**97.0**	**187.9**
OCD5	40.2	79.9	129.0	169.2	189.5	200.7	239.8	375.5
Forecasts	29	27	25	23	21	19	15	11
OFCL (2019-23)	23.9	36.5	49.3	63.4	79.2	93.4	132.9	190.4
OCD5 (2019-23)	45.7	97.1	153.0	205.4	254.9	297.8	372.7	439.1

Table 3b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Hurricane Kirk, 29 September–7 October 2024. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	21.6	31.1	37.7	44.4	51.9	58.1	97.0	187.9
OCD5	40.2	79.9	129.0	169.2	189.5	200.7	239.8	375.5
GFSI	24.3	33.8	45.7	57.6	70.5	85.5	141.3	240.9
EMXI	22.4	**30.5**	**34.2**	**38.1**	**45.1**	**56.3**	**94.8**	**170.6**
CMCI	23.6	35.4	49.5	67.6	88.0	116.5	176.9	188.3
HWFI	22.4	35.1	48.4	63.4	83.0	105.1	161.5	288.4
HMNI	22.6	32.3	41.5	51.6	63.9	90.6	177.2	245.5
HFAI	24.7	38.2	48.4	56.4	59.9	68.4	98.5	**162.7**
HFBI	24.8	33.9	42.8	50.7	54.6	60.5	105.9	192.4
HCCA	**19.6**	**27.9**	**33.2**	**40.5**	**50.2**	59.3	**77.7**	**175.2**
AEMI	24.2	37.3	50.2	61.5	73.9	85.2	126.7	207.0
GFEX	21.8	**29.4**	**36.5**	**41.3**	**50.7**	63.7	112.1	197.9
TVCA	**20.9**	**29.5**	**37.5**	46.4	54.0	65.3	113.1	199.8
TVCX	**20.7**	**29.4**	**37.1**	45.6	**51.7**	63.4	109.8	195.9
TVDG	**20.9**	**28.9**	38.2	45.5	53.4	65.0	114.6	201.3
TABD	26.3	45.0	69.2	98.4	123.4	130.4	121.8	**177.5**
TABM	24.9	33.0	44.4	61.2	80.6	97.1	132.3	224.8
TABS	54.6	100.0	135.2	157.8	184.0	220.7	246.0	245.2
Forecasts	29	27	25	23	21	19	15	11

Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Hurricane Kirk, 29 September–7 October 2024. 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	60	72	96	120
OFCL	5.7	7.6	10.4	10.0	**7.9**	**9.5**	13.0	**9.1**
OCD5	7.8	12.9	18.6	24.2	29.7	33.8	37.6	30.0
Forecasts	29	27	25	23	21	19	15	11
OFCL (2019-23)	5.0	7.3	8.5	9.7	10.4	10.9	12.9	15.5
OCD5 (2019-23)	6.6	10.2	13.1	15.6	17.2	18.6	21.8	22.6

Table 4b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Hurricane Kirk, 29 September–7 October 2024. Errors smaller than the NHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)							
	12	24	36	48	60	72	96	120
OFCL	5.7	7.6	10.4	10.0	7.9	9.5	13.0	9.1
OCD5	7.8	12.9	18.6	24.2	29.7	33.8	37.6	30.0
HWFI	7.0	7.7	**9.6**	11.2	14.6	15.4	16.7	13.1
HMNI	6.5	7.9	**8.6**	**8.5**	10.1	12.2	**12.2**	9.7
HFAI	6.7	8.5	11.5	13.0	15.3	17.4	16.7	11.5
HFBI	7.1	8.9	11.2	12.8	13.1	11.1	**7.9**	**7.9**
DSHP	6.8	9.4	11.9	13.6	13.2	12.2	**8.6**	**9.0**
LGEM	7.1	9.8	12.7	12.9	11.0	10.6	**9.0**	**6.5**
ICON	6.3	7.6	**9.7**	10.4	10.1	11.0	**10.3**	**8.5**
IVCN	**5.5**	**7.1**	**9.5**	10.1	10.8	11.1	**9.6**	**5.4**
IVDR	**5.3**	**6.9**	**9.4**	10.3	11.7	12.3	**10.9**	**5.2**
HCCA	5.7	**6.0**	**7.7**	**9.0**	10.6	12.4	17.6	14.6
GFSI	7.7	11.7	15.7	18.9	22.8	25.6	25.9	14.5
EMXI	8.0	13.7	19.2	22.5	24.4	27.4	31.7	23.7
Forecasts	29	27	25	23	21	19	15	11

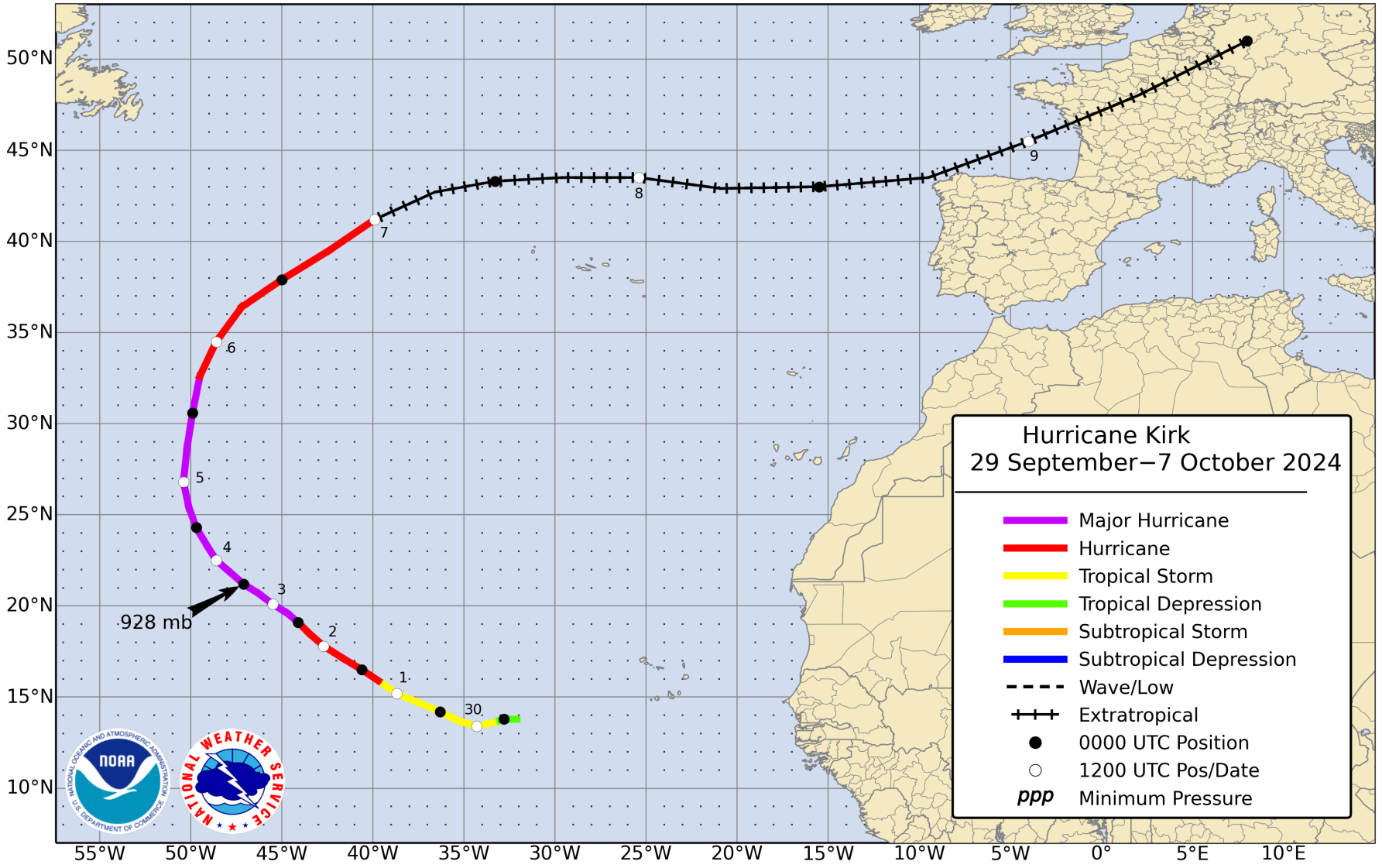

Figure 1. Best track positions for Hurricane Kirk, 29 September–7 October 2024. Track during the extratropical stage is partially based on analyses from the NOAA Ocean Prediction Center.

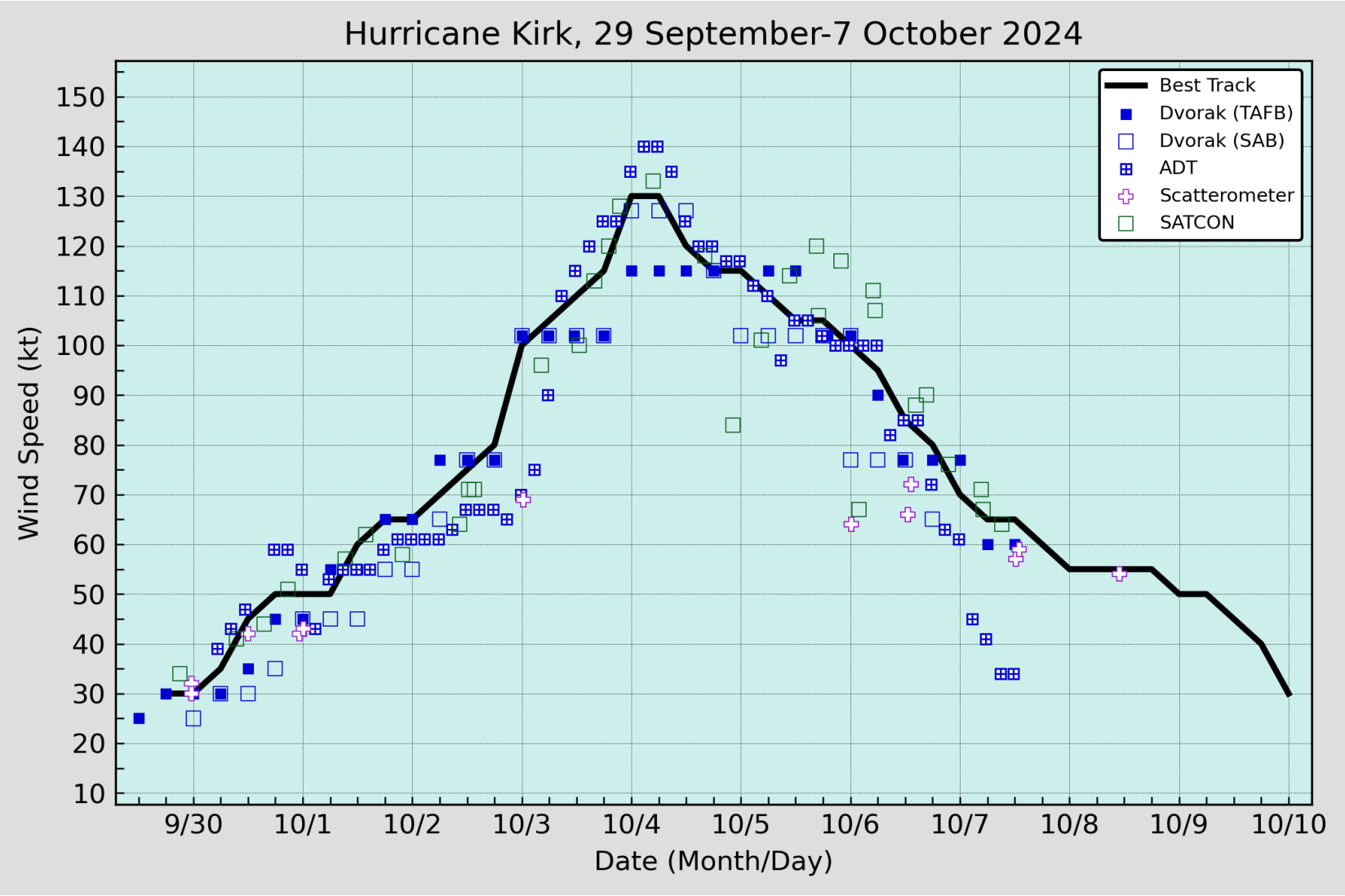

Figure 2. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Kirk, 29 September–7 October 2024. Advanced Dvorak Technique (ADT) estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.

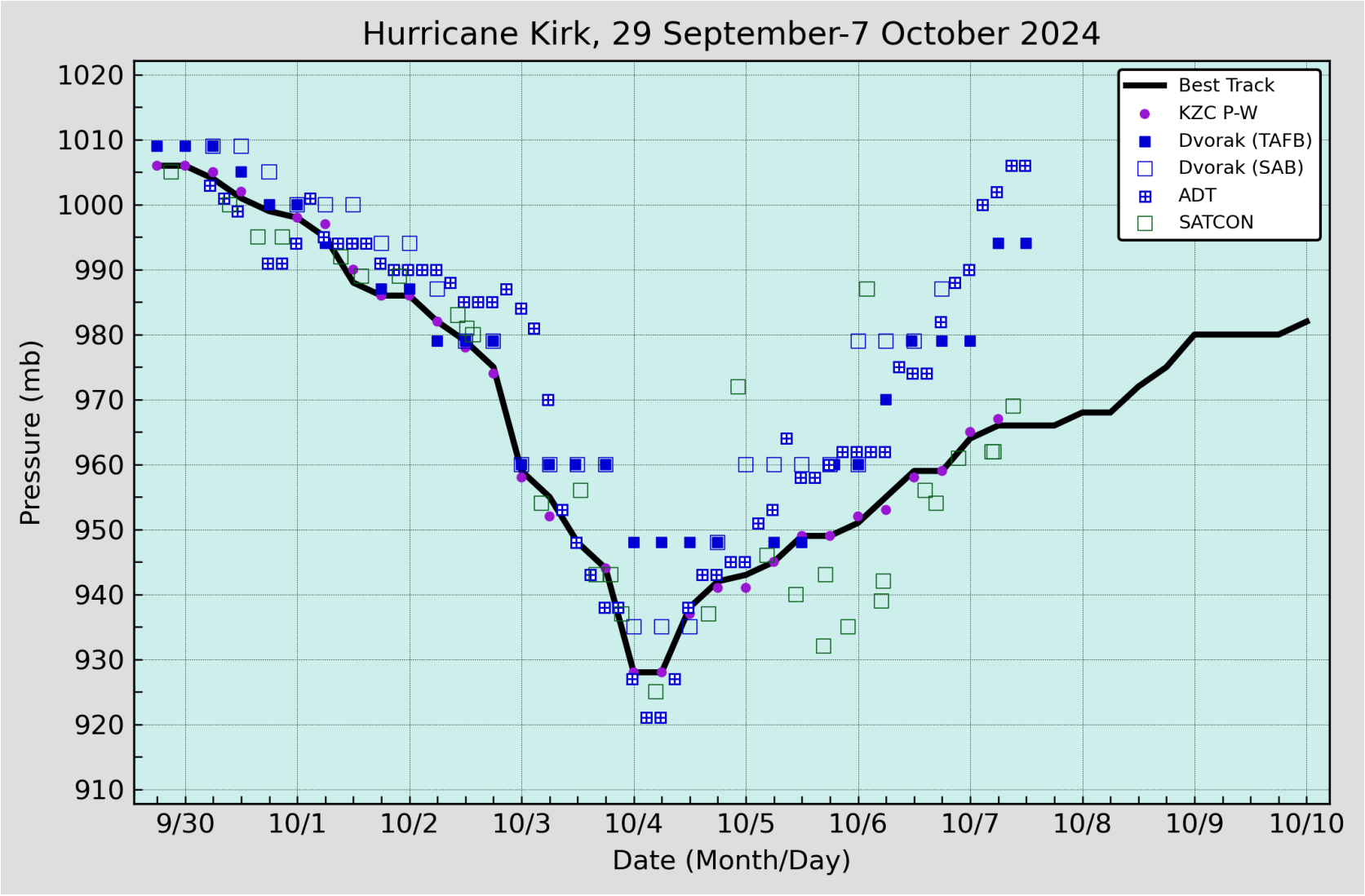

Figure 3. Selected pressure observations and best track minimum central pressure curve for Hurricane Kirk, 29 September–7 October 2024. Advanced Dvorak Technique (ADT) estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC.

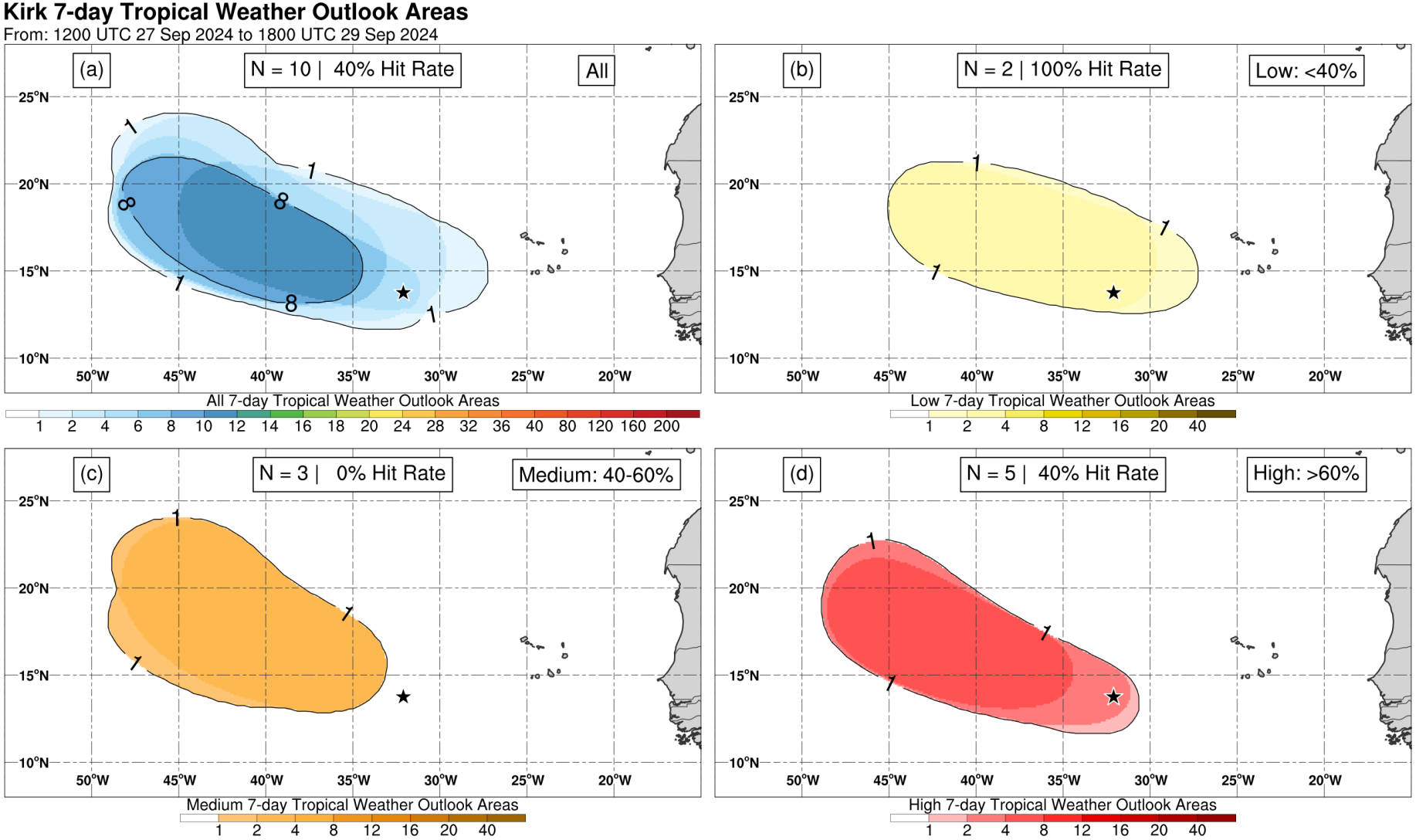

Figure 4. Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Kirk for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.