

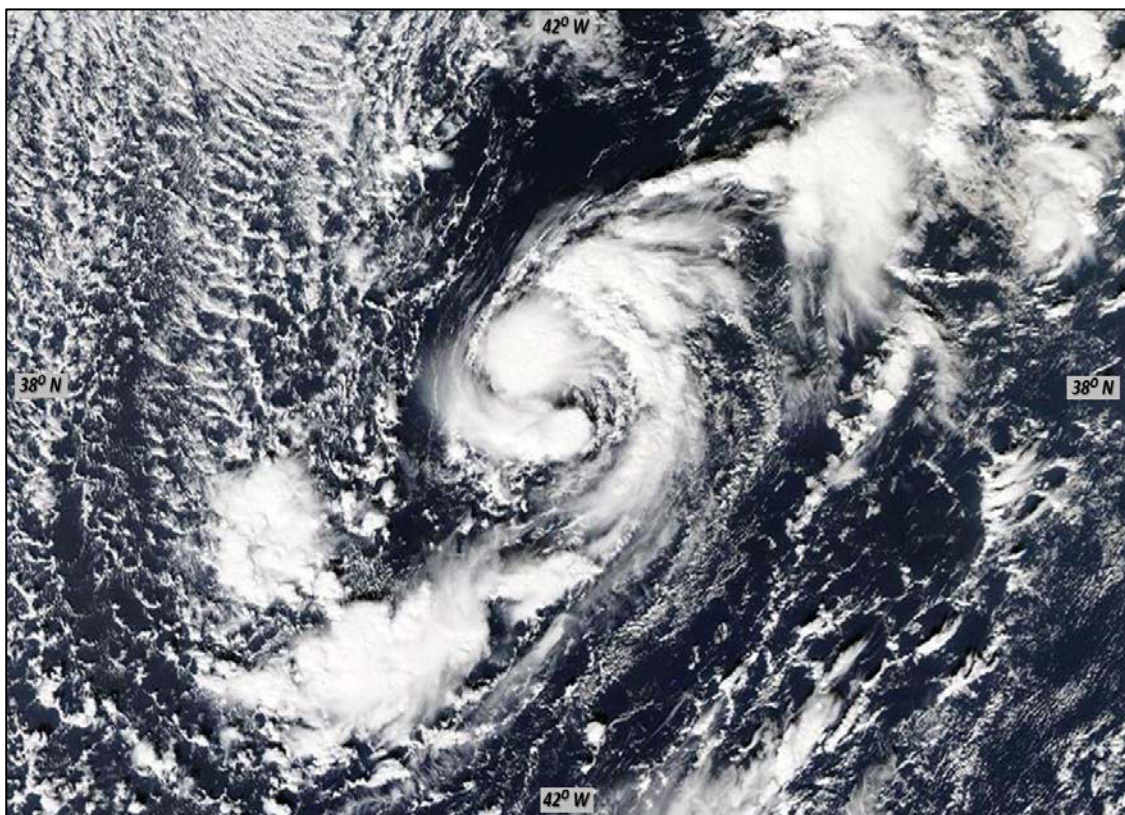


# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT

## SUBTROPICAL STORM REBEKAH (AL192019)

30 October–1 November 2019

Stacy R. Stewart  
National Hurricane Center  
9 December 2019



MODIS-AQUA VISIBLE SATELLITE IMAGE AT 1605 UTC 30 OCTOBER 2019 WHEN REBEKAH WAS AT ITS PEAK INTENSITY OF 45 KT AS A SUBTROPICAL STORM OVER THE FAR NORTHERN ATLANTIC OCEAN. IMAGE COURTESY OF NASA.

Rebekah was a short-lived subtropical storm that formed over the far northern Atlantic Ocean that passed just north of the Azores as a weakening extratropical low pressure system.

# Subtropical Storm Rebekah

30 OCTOBER–1 NOVEMBER 2019

## SYNOPTIC HISTORY

Rebekah evolved from a large extratropical low pressure system that had formed in response to strong dynamical forcing generated by a powerful upper-level trough and low that dug southeastward over the far northern Atlantic Ocean. Interaction between this deep tropospheric feature and a stationary front induced the formation of a frontal low about 400 n mi south of Cape Race, Newfoundland, by 0000 UTC 27 October. The extratropical low moved eastward and explosively deepened 36 mb in 18 h, reaching an estimated central pressure of 968 mb by 1800 UTC that day. During that time, the low produced hurricane-force winds and an expansive field of gale-force winds that extended outward more than 300 n mi from the center.

The very large and powerful extratropical low steadily weakened while making two counter-clockwise loops about 600 n mi southeast of Cape Race on 28 and 29 October. During that time, the cyclone moved over water temperatures colder than 20°C while the 200-mb temperatures warmed to -52°C (Fig. 1). This vertical thermal profile stabilized the troposphere and inhibited the development of organized deep convection near the low-level center. While the intensity of the large low pressure system decreased, scatterometer surface wind data (not shown) indicated that a smaller inner-core wind field -- more reminiscent of a tropical cyclone -- had developed within the parent extratropical low. By early on 30 October, the smaller low had moved southward, passing south of the north wall of the Gulfstream and over 21°C sea-surface temperatures (SST), which was coincident with the 200-mb temperatures cooling to -58°C (Fig. 1). The warmer water and colder air aloft increased the tropospheric instability, resulting in the formation of deep convection near the center of the smaller low around 1200 UTC that day, and it is estimated that the low transitioned to a subtropical cyclone at that time. Since the small cyclone already possessed gale-force winds, along with an unusually small radius of maximum winds (RMW) of about 50 n mi, the cyclone was designated Subtropical Storm Rebekah at 1200 UTC 30 October when it was located about 550 n mi west of Flores island in the westernmost Azores archipelago. The “best track” chart of the subtropical cyclone’s path is given in Fig. 2, with the wind and pressure histories shown in Figs. 3 and 4, respectively. The best track positions and intensities are listed in Table 1<sup>1</sup>.

Still embedded within the southern periphery of the larger low-level circulation of the parent extratropical low, Rebekah turned eastward by late on 30 October, and then moved east-northeastward on 31 October. This motion brought the cyclone back over cooler water and into a much drier air mass (Fig. 1), resulting in significant weakening and erosion of the central deep convection. The combination of cooler water, dry mid-level air characterized by relative humidity

---

<sup>1</sup> 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.

values near 30%, and westerly vertical wind shear increasing to more than 20 kt (Fig. 1) resulted in the rapid demise of Rebekah, with the cyclone becoming extratropical again by 0600 UTC 1 November, and then dissipating by 1800 UTC that day about 100 n mi north of the Azores.

## METEOROLOGICAL STATISTICS

Observations in Subtropical Storm Rebekah (Figs. 3 and 4) include subjective satellite-based Hebert-Poteat (H-P) subtropical cyclone technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB). 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 Rebekah.

Rebekah's estimated peak intensity of 45 kt from 1200 UTC 30 October to 0000 UTC 1 November is based on a blend of scatterometer data (allowing for some undersampling) and H-P subtropical cyclone satellite classifications from TAFB. The estimated minimum pressure of 982 mb is based on a blend of numerical model pressure analyses and interpolation of an *in situ* observation near Rebekah's center from ship *OOCL Europe* (call sign **VRBX7**) that measured a pressure of 985 mb along with 31-kt winds at 1200 UTC 30 October.

Rebekah's subtropical storm status *in lieu* of tropical storm status is due to the cyclone never completely separating from the influence of the parent upper-level low. AMSU thermal data (not shown) also revealed that occasional intrusions of warm, lower-stratospheric air and likely upper-level vorticity continued from the extratropical stage into the subtropical stage, which is not a physical characteristic of pure warm-core tropical cyclones. Rebekah also never established any upper-level anticyclonic outflow, which is a distinguishing characteristic of a warm-core tropical cyclone.

Ship reports of gale-force winds associated with Rebekah when it was an extratropical cyclone are given in Table 3. There were no reports of gale-force winds received when Rebekah was a subtropical storm due to ship traffic specifically avoiding the core of the cyclone.

## CASUALTY AND DAMAGE STATISTICS

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

## FORECAST AND WARNING CRITIQUE

The genesis of Rebekah was poorly forecast, which isn't unusual for systems that transition from extratropical to subtropical status. The parent extratropical low from which Rebekah formed was first introduced in the Tropical Weather Outlook 48-h and 120-h forecast periods with a low probability (<40% chance) 54 h prior to formation (Table 2), but the genesis probabilities never reached the medium (40–60%) or high (>60%) categories. The primary reason for the poor genesis forecasts was due to uncertainty in the timing of when deep convection was going to increase and become sufficiently organized near the low-level center, especially at such a high latitude and over relatively cold water with sea-surface temperatures of 20–21°C.

Due to Rebekah's short lifetime, there were only four 12-h forecasts and two 24-h forecasts that verified. Thus, a comprehensive verification of NHC official (OFCL) and guidance track and intensity forecast errors is not provided. The four 12-h and two 24-h OFCL track forecasts had mean track errors of 38.0 n mi and 59.0 n mi, respectively, which were more than 60% higher than the 5-yr average forecast track errors. In contrast, official forecast intensity errors were 70% to 100% lower than the mean official errors for the previous 5-yr period at 12 h (0.0 kt) and 24 h (2.5 kt).

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

Table 1. Best track for Subtropical Storm Rebekah, 30 October–1 November 2019.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
27 / 0000	40.5	51.5	1004	35	extratropical
27 / 0600	40.4	48.0	989	50	"
27 / 1200	40.2	45.0	976	60	"
27 / 1800	40.2	43.1	968	65	"
28 / 0000	40.5	41.1	965	70	"
28 / 0600	41.2	39.5	966	70	"
28 / 1200	42.4	39.4	967	65	"
28 / 1800	42.9	40.4	969	60	"
29 / 0000	42.2	40.1	971	55	"
29 / 0600	42.3	38.5	973	55	"
29 / 1200	43.0	38.9	975	55	"
29 / 1800	43.4	40.6	977	50	"
30 / 0000	41.8	42.7	979	50	"
30 / 0600	39.9	43.7	980	50	"
30 / 1200	38.3	42.8	982	45	subtropical storm
30 / 1800	38.1	41.5	984	45	"
31 / 0000	38.4	40.0	986	45	"
31 / 0600	39.3	37.7	988	40	"
31 / 1200	40.3	36.2	990	40	"
31 / 1800	41.0	34.5	992	40	"
01 / 0000	40.8	32.4	995	35	"
01 / 0600	40.6	30.2	1002	35	extratropical
01 / 1200	40.5	27.5	1016	35	"
01 / 1800					dissipated
30 / 1200	38.3	42.8	982	45	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	120-Hour Outlook
Low (<40%)	54	54
Medium (40%-60%)	0	0
High (>60%)	0	0

Table 3. Selected ship reports with winds of at least 34 kt for Subtropical Storm Rebekah, 30 October–1 November 2019, during the extratropical low periods.

Date/Time (UTC)	Ship call sign	Latitude (°N)	Longitude (°W)	Wind dir/speed (kt)	Pressure (mb)
27 / 1200	DFDE2	36.5	40.4	220 / 36	999.9
27 / 1500	DFDE2	36.6	39.2	220 / 35	995.5
27 / 1800	DFDE2	36.7	38.1	220 / 40	993.6
27 / 1800	VRBQ6	46.7	40.5	060 / 47	996.0
28 / 0000	VREO9	41.4	34.4	080 / 50	995.0
28 / 0900	VRBQ6	47.6	36.2	090 / 35	995.0
28 / 1400	V7WX3	44.9	48.7	360 / 45	1005.0
28 / 1500	D5OX2	48.4	40.6	090 / 35	998.0
29 / 1500	D5OX2	45.2	47.9	010 / 42	1004.0
29 / 1800	D5OX2	44.6	48.7	360 / 41	1005.0
30 / 0000	PCSZ	49.1	40.5	350 / 36	1010.8
30 / 0300	D5OX2	43.0	51.1	360 / 42	1013.0

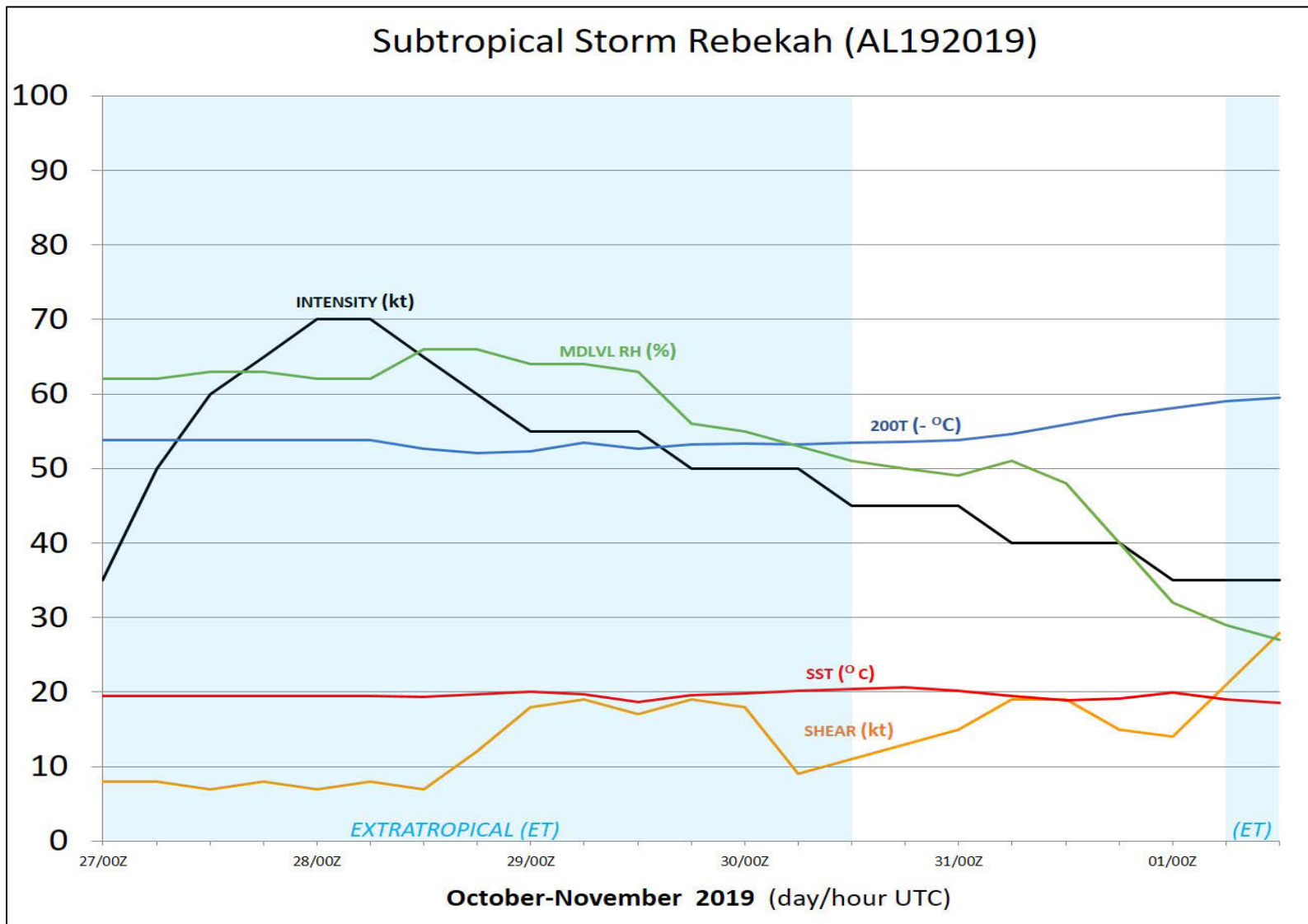


Figure 1. Time series of Subtropical Storm Rebekah’s actual intensity (solid black line) versus GFS-based SHIPS model analyzed environmental parameters: 850–200-mb vertical wind shear (**SHEAR, kt**), sea-surface temperature (**SST, °C**), 700–500-mb average relative humidity (**MDLVL RH, %**), and 200-mb temperature (**200T, -°C**). Time period covered is from 0000 UTC 27 October to 1200 UTC 1 November 2019, which includes Rebekah’s extratropical periods (blue shading).

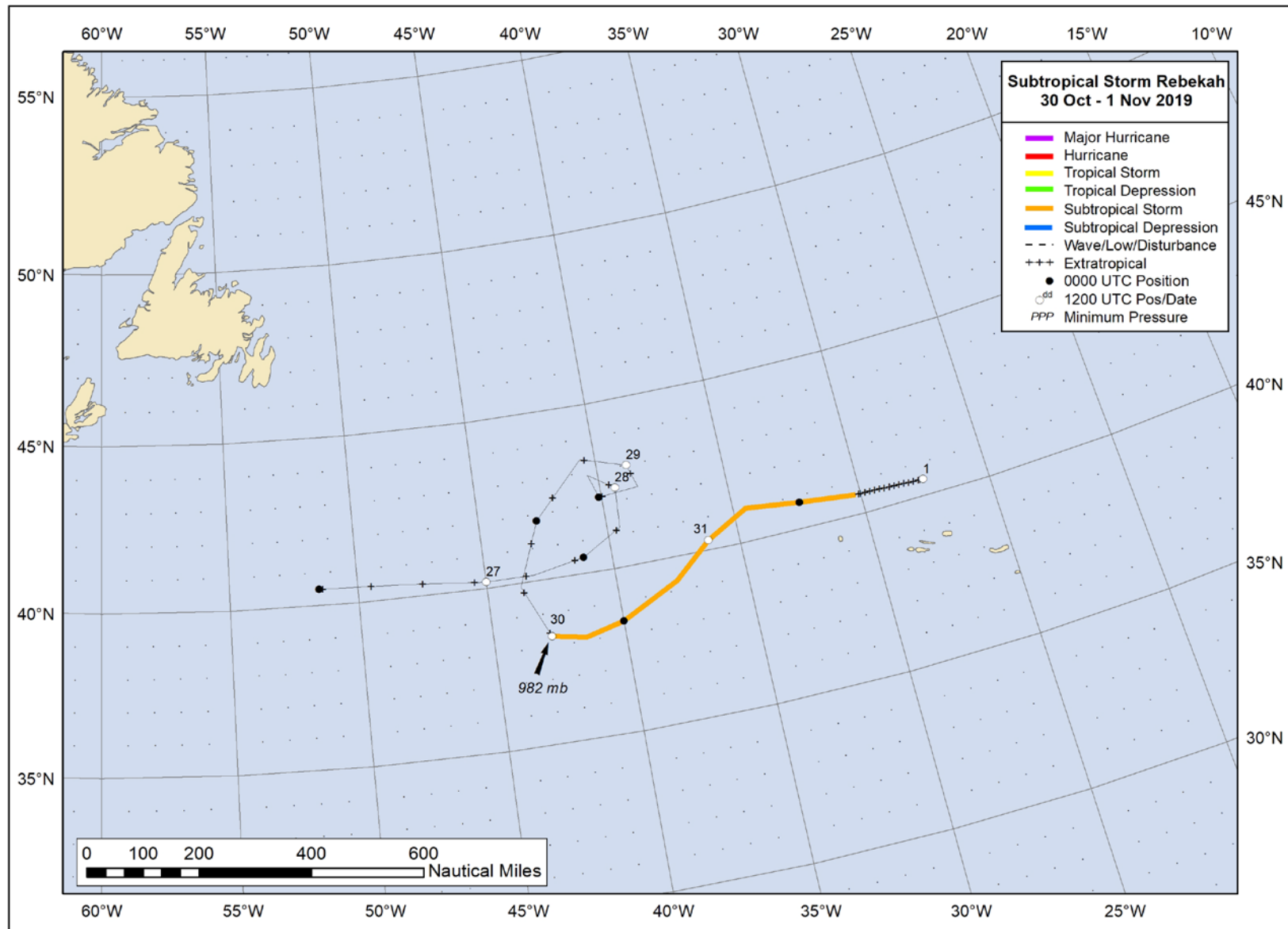


Figure 2. Best track positions for Subtropical Storm Rebekah, 30 October–1 November 2019. Positions during the two extratropical periods are partly based on analyses from the NOAA Ocean Prediction Center.



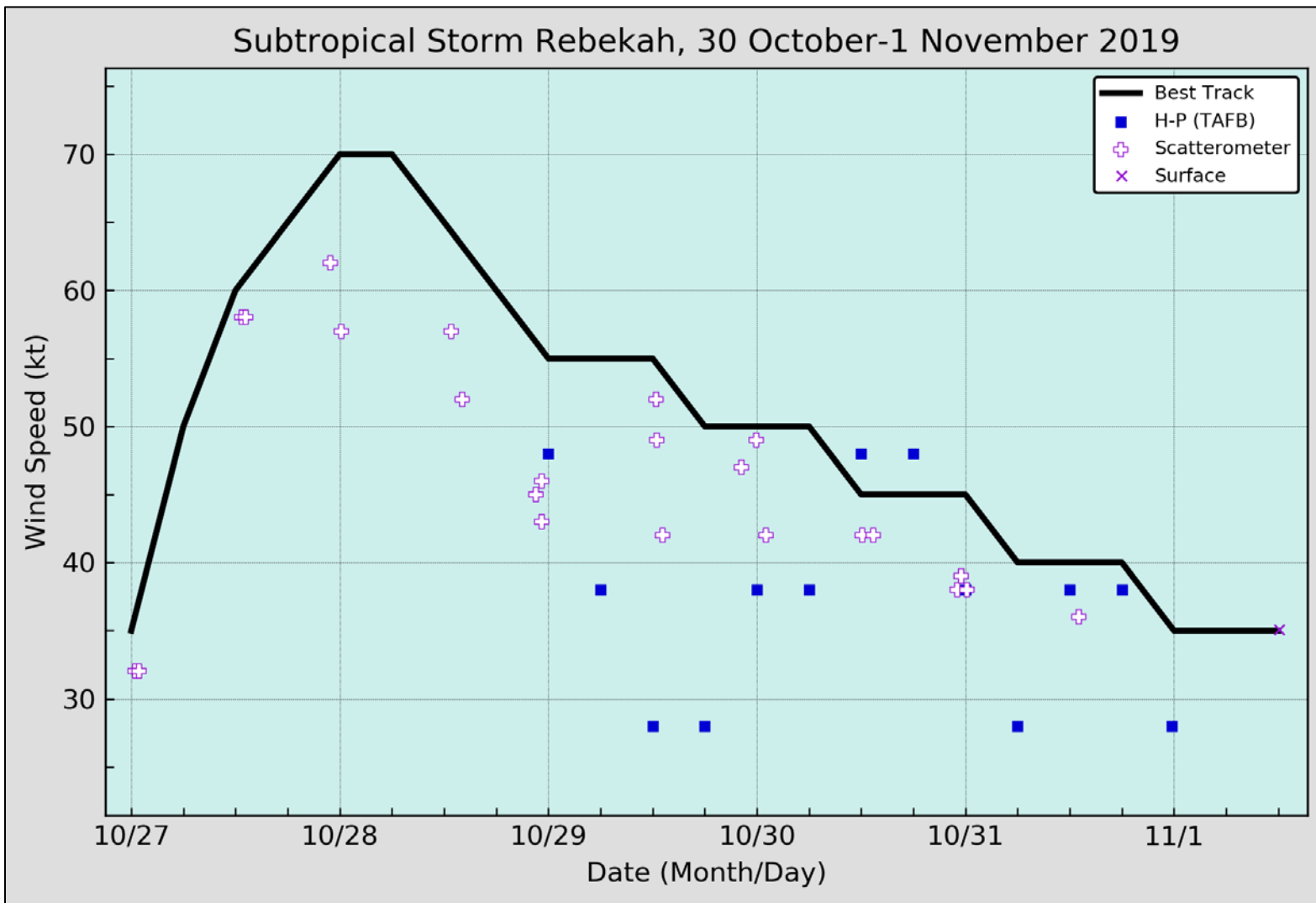


Figure 3. Selected wind observations and best track maximum sustained surface wind speed curve for Subtropical Storm Rebekah, 30 October–1 November 2019. Hebert-Poteat (H-P) Subtropical Cyclone Technique intensity estimates from TAFB represent the Current Intensity at the nominal observation time. Dashed vertical lines correspond to 0000 UTC. Intensities during the two extratropical periods are partly based on analyses from the NOAA Ocean Prediction Center.

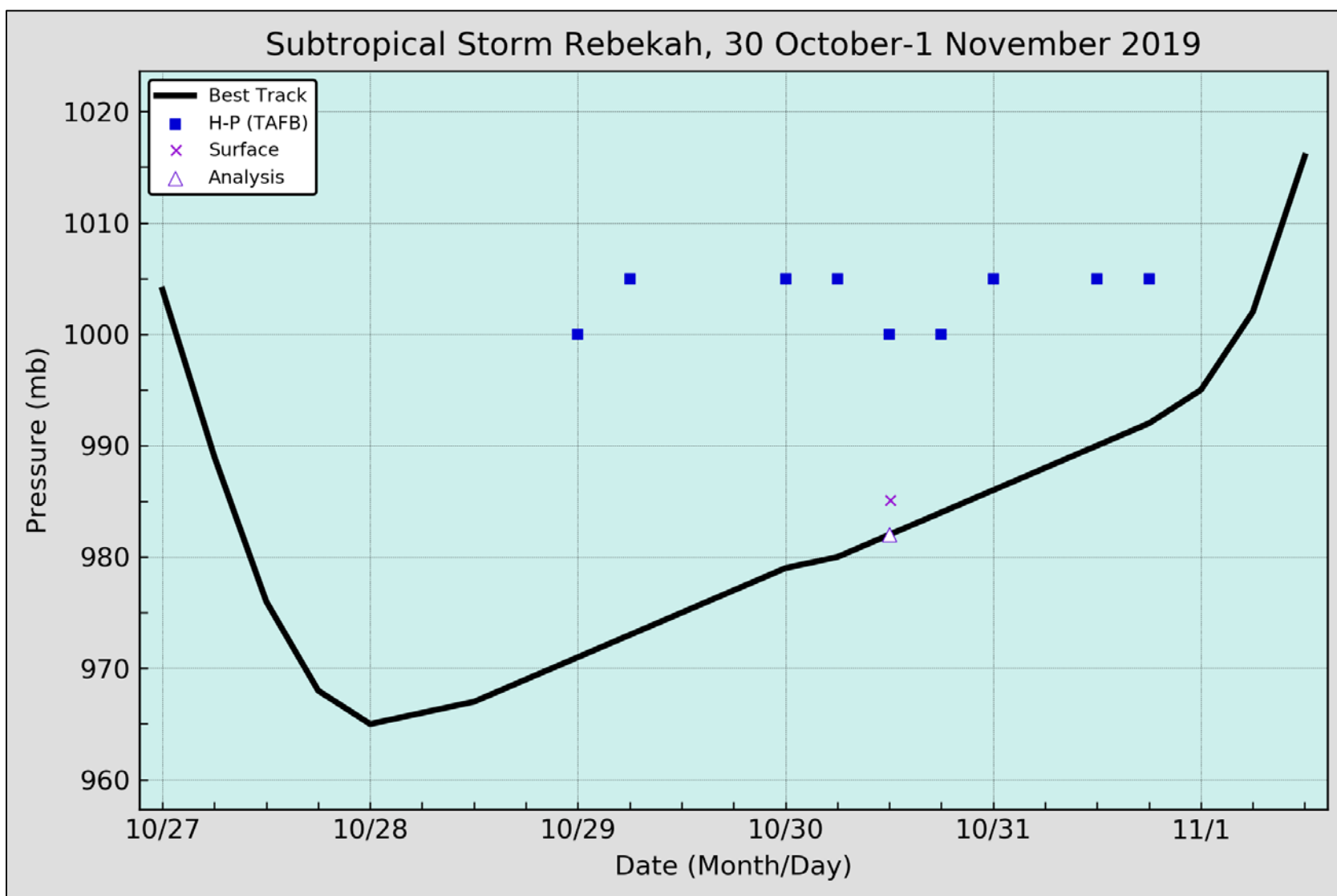


Figure 4. Selected pressure observations and best track minimum central pressure curve for Subtropical Storm Rebekah, 30 October – 1 November 2019. Hebert-Poteat (H-P) Subtropical Cyclone Technique pressure estimates from the TAFB represent the pressure at the nominal observation time. Dashed vertical lines correspond to 0000 UTC. Pressures during the two extratropical periods are partly based on analyses from the NOAA Ocean Prediction Center.