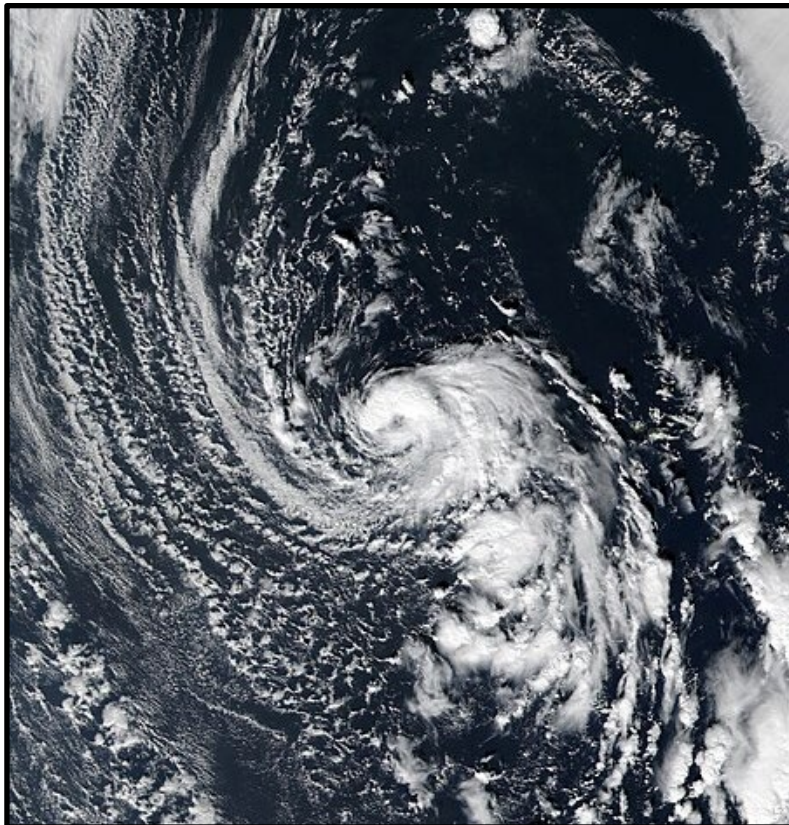# NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM PATTY
(AL172024)
1–4 November 2024

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National Hurricane Center
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GOES-16 GEOCOLOR SATELLITE IMAGE OF SUBTROPICAL STORM PATTY AT 1500 UTC 2 NOVEMBER AROUND THE TIME OF ITS PEAK INTENSITY.

Patty originated from an extratropical cyclone over the central Atlantic that transitioned to a subtropical and then tropical storm. This system produced tropical-storm-force winds and areas of heavy rain across portions of the Azores. Minor damage occurred across the eastern Azores.

Tropical Storm Patty

1–4 NOVEMBER 2024

SYNOPTIC HISTORY

Satellite data indicate that a well-defined storm-force extratropical low formed over the central Atlantic on 31 October. At this time, the maximum sustained winds were estimated to be around 55 kt. The extratropical low moved northeastward during the next 12 to 24 hours while gradually losing frontal characteristics and its upper-level support. Consequently, the storm weakened slightly during that time. Despite being over cool SSTs of around 20-22° C, deep convection began to form near the center and in some bands around it on 1 November due to an unstable environment. The cyclone had hybrid characteristics at this time, including a broad wind field that lacked frontal features, co-location with an upper-level low, embedded in a cool airmass, and an area of concentrated convection. Therefore, it was designated as a subtropical storm at the time of genesis (Fig. 1). When Patty formed, its maximum winds were around 45 kt, and it was centered about 250 n mi west-northwest of the western Azores. The "best track" chart of Patty'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[1].

Patty turned eastward after it became a subtropical storm and deep convection continued to increase and organize near the center. As a result, the subtropical storm gained strength and reached its peak intensity of 55 kt around 1200 UTC 2 November when it was located about 100 n mi west of Flores in the western Azores (cover image). Around that time, the storm accelerated east-southeastward in the stronger mid-latitude flow, and it slowly weakened while its parent upper-level low filled. The center of Patty passed about 60 n mi south of Flores around 1800 UTC 2 November, and the storm likely produced some tropical-storm-force winds on the island. However, scatterometer data indicated that the strongest winds missed the island and were located on Patty's south side, primarily due to its fast motion and asymmetric wind field. Continuing swiftly east-southeastward, Patty moved just south of the central Azores between 0000 and 0600 UTC 3 November, but again the strongest winds missed those islands since Patty maintained an asymmetric wind field.

The forward motion of the storm slowed later on 3 November and Patty continued to weaken. Despite the storm losing strength, it developed an increasingly tropical appearance with the surface wind field contracting and upper-level low dissipating. It is estimated that Patty transitioned to a tropical storm by 1200 UTC that day when it was located between the islands of São Miguel and Santa Maria in the eastern Azores. Both of these islands likely experienced tropical storm conditions for a few hours on 3 November. Increasing westerly vertical wind shear and dry, stable air caused deep convection to decrease and become displaced well to the east of

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[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.

the center when the storm passed the eastern Azores by 0000 UTC 4 November. Satellite images and scatterometer data indicate that Patty opened into a trough by 1200 UTC that day over the northeastern Atlantic. The remnants of Patty contributed to areas of heavy rain across Portugal and Spain a day later.

METEOROLOGICAL STATISTICS

Observations in Patty (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), 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, among others, were also useful in constructing the best track of Patty.

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

Winds and Pressure

Patty's estimated peak intensity of 55 kt from 1200 to 1800 UTC 2 November as a subtropical storm is based on ASCAT-B data that showed peak winds around 50 kt. Given the known undersampling due to the instrument's resolution likely not capturing Patty's tight core, the estimated peak intensity is set above this measurement. This peak intensity estimate was higher than the objective and subjective Dvorak classifications, which are limited for subtropical systems. It is worth noting that a Synthetic Aperture Radar (SAR) observation showed a higher intensity value than the peak estimate in the best track. The validity of SAR data for estimating peak sustained winds in tropical cyclones is still being evaluated, and therefore is not used directly to estimate intensity.

There was one land station, on Santa Maria in the eastern Azores, that reported sustained tropical-storm-force winds. A weather station on the island recorded a sustained wind of 35 kt with a gust of 48 kt at 1500 UTC 3 November. Elsewhere, a gust of 38 kt was reported at 1200 UTC 3 November on São Miguel, and a gust of 34 kt was observed in Flores at 1300 UTC 2 November.

The estimated minimum pressure of 982 mb at 1200 and 1800 UTC 2 November is primarily based on the Knaff-Zehr-Courtney pressure wind relationship. The lowest pressure recorded in the Azores was 991 mb on Faial Island early on 3 November when the center of Patty was about 50 n mi south of the island.

Although Patty did not officially make landfall in the Azores, the center of the storm passed roughly halfway between (20-30 n mi from) the islands of São Miguel and Santa Maria.

CASUALTY AND DAMAGE STATISTICS

No direct fatalities[2] were reported in association with Patty. The storm was responsible for isolated minor damage in portions of the Azores. Most notably, on the island of São Miguel, a landslide occurred in Ribeira Grande and some homes were flooded there and in surrounding towns[3]. There is currently no monetary damage estimate available.

FORECAST AND WARNING CRITIQUE

The genesis of Patty was not well anticipated. The extratropical low that transitioned into Subtropical Storm Patty was first included in the Tropical Weather Outlook (TWO) only 24 hours prior to the transition. The chances of tropical or subtropical development failed to reach the medium or high categories in the TWO prior to the post-analyzed formation of Patty. In general, predicting extratropical to subtropical/tropical transition is often a challenge. These transitions require the associated fronts to dissipate, deep convection to develop near the center, and for the radius of maximum wind to contract. The global models often struggle to simulate these changes in characteristics, and that was no different in this case. The location of Patty's genesis was well predicted for the small number of genesis forecasts (Fig. 5).

A verification of NHC official track forecasts for Patty is given in Table 3a. Official track forecast errors were notably lower than the mean official errors for the previous 5-yr period for all verifying forecasts. Figure 6 shows that the official forecasts were fairly consistent and accurate, but there was a slight northward bias in the first couple of forecasts. A homogeneous comparison of the official track errors with selected guidance models is given in Table 3b. No model consistently outperformed the official forecasts, but CMCI generally had the lowest errors for the small number of verifying forecasts.

A verification of NHC official intensity forecasts for Patty is given in Table 4a. Official intensity forecast errors were also significantly lower than the mean official errors for the previous 5-yr period at all applicable forecast times. Although NHC did not anticipate Patty to strengthen as a subtropical storm, the forecasts correctly captured the weakening phase when it moved near and east of the central and eastern Azores (Fig. 7). A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 4b. The dynamical (hurricane and global) models performed better than the statistical aids.

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[2] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered "indirect" deaths.

[3] Mau tempo causa seis ocorrências nos Açores. *Acoriano Oriental*. 3 November 2024. https://www.acorianooriental.pt/noticia/mau-tempo-causa-seis-ocorrencias-nos-acores-365150

Coastal watches and warnings associated with Patty are given in Table 5.

ACKNOWLEDGEMENTS

Table 1.   Best track for Tropical Storm Patty, 1–4 November 2024.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
31 / 1800	39.2	41.0	977	55	extratropical
01 / 0000	39.6	40.0	977	55	"
01 / 0600	39.9	38.9	979	50	"
01 / 1200	40.2	37.7	981	50	"
01 / 1800	40.6	36.5	983	45	subtropical storm
02 / 0000	40.6	35.4	985	45	"
02 / 0600	40.3	34.6	986	50	"
02 / 1200	39.4	33.3	982	55	"
02 / 1800	38.4	31.6	982	55	"
03 / 0000	37.9	29.2	985	50	"
03 / 0600	37.7	27.0	988	45	"
03 / 1200	37.5	25.1	990	40	tropical storm
03 / 1800	37.4	23.3	990	40	"
04 / 0000	37.6	21.3	993	40	"
04 / 0600	37.9	19.2	996	35	"
04 / 1200					dissipated
02 / 1200	39.4	33.3	982	55	maximum wind 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%)	24	24
Medium (40%-60%)	-	-
High (>60%)	-	-

Table 3a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Patty, 1–4 November 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	**22.8**	**27.4**	**21.9**	**48.2**				
OCD5	81.3	159.2	371.3	492.7				
Forecasts	7	5	3	1				
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 Tropical Storm Patty, 1–4 November 2024. 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	60	72	96	120
OFCL	22.8	27.4	21.9	48.2				
OCD5	81.3	159.2	371.3	492.7				
GFSI	24.9	29.3	36.0	78.0				
HWFI	26.9	39.6	44.9	65.9				
HMNI	24.5	36.8	34.2	**36.0**				
HFAI	30.1	47.3	40.9	**14.2**				
HFBI	30.8	42.1	33.1	**6.0**				
EGRI	**21.7**	37.6	58.7	53.0				
EMXI	23.5	36.4	36.4	72.2				
CMCI	23.6	30.8	**21.2**	**43.0**				
CTCI	31.2	32.7	68.2	115.0				
AEMI	22.8	29.2	42.2	78.6				
HCCA	24.3	31.6	27.8	**40.8**				
TVCA	23.7	32.2	26.6	48.2				
TVDG	23.8	32.1	28.2	53.5				
Forecasts	7	5	3	1	0	0	0	0

Table 4a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Patty, 1–4 November 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	**3.6**	**4.0**	**3.3**	**0.0**				
OCD5	6.7	7.0	11.7	13.0				
Forecasts	7	5	3	1				
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 Tropical Storm Patty, 1–4 November 2024. 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	60	72	96	120
OFCL	2.5	3.8	2.5					
OCD5	6.0	8.0	15.0					
HWFI	3.3	**1.8**	4.0					
HMNI	4.5	3.8	9.0					
HFAI	4.7	**2.5**	6.5					
HFBI	4.0	**2.8**	5.5					
CTCI	6.0	7.2	6.5					
DSHP	6.3	10.8	12.5					
LGEM	6.3	10.0	14.5					
IVCN	5.2	5.0	6.5					
HCCA	5.0	4.5	6.0					
FSSE	4.8	**3.5**	5.5					
GFSI	4.0	**3.5**	7.0					
EMXI	4.0	**2.2**	5.0					
Forecasts	6	4	2	0	0	0	0	0
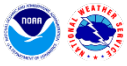
Table 5.   Coastal watch and warning summary for Tropical Storm Patty, 1–4 November 2024.

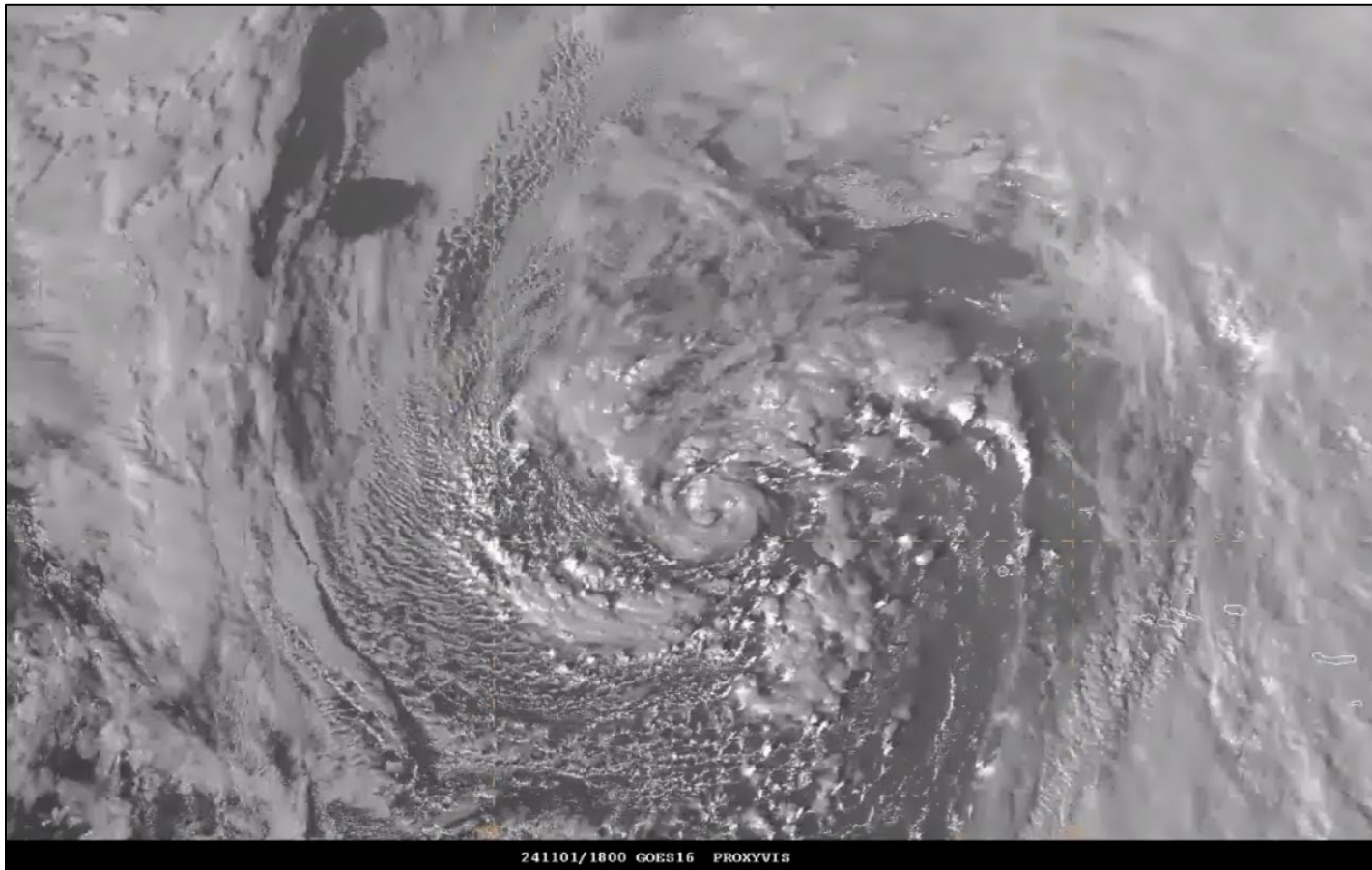| Date/Time (UTC)	Action	Location
2 / 1205	Tropical Storm Warning issued	All of the Azores
3 / 1800	Tropical Storm Warning discontinued	All of the Azores

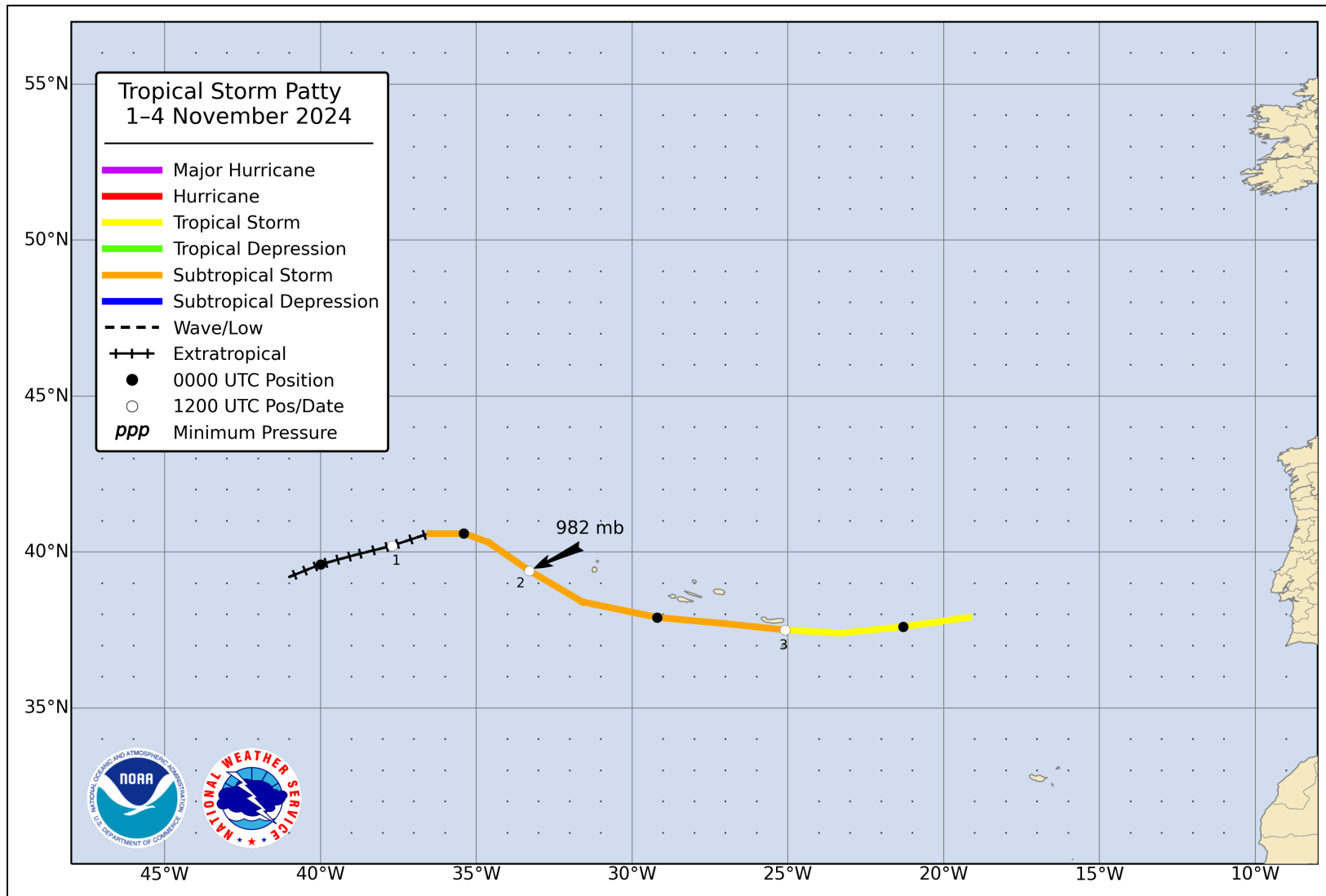Figure 1.   GOES-16 visible satellite image at 1800 UTC 1 November of Subtropical Storm Patty (estimated time of genesis).

Figure 2.   Best track positions for Tropical Storm Patty, 1–4 November 2024. Tracks during the extratropical stage are partially based on analyses from the NOAA Ocean Prediction Center.
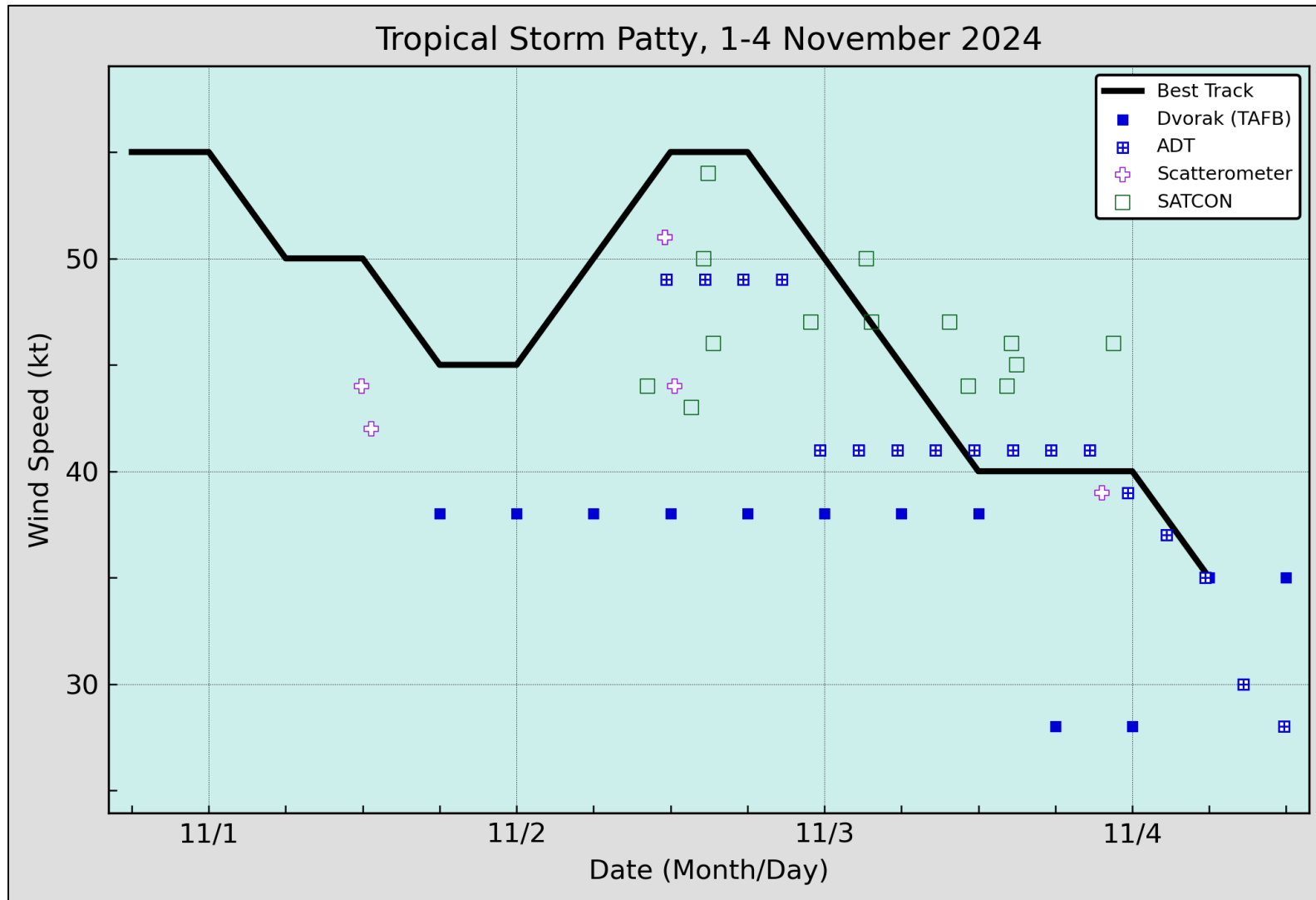
Figure 3.   Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Patty, 1–4 November 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies. Dashed vertical lines correspond to 0000 UTC.
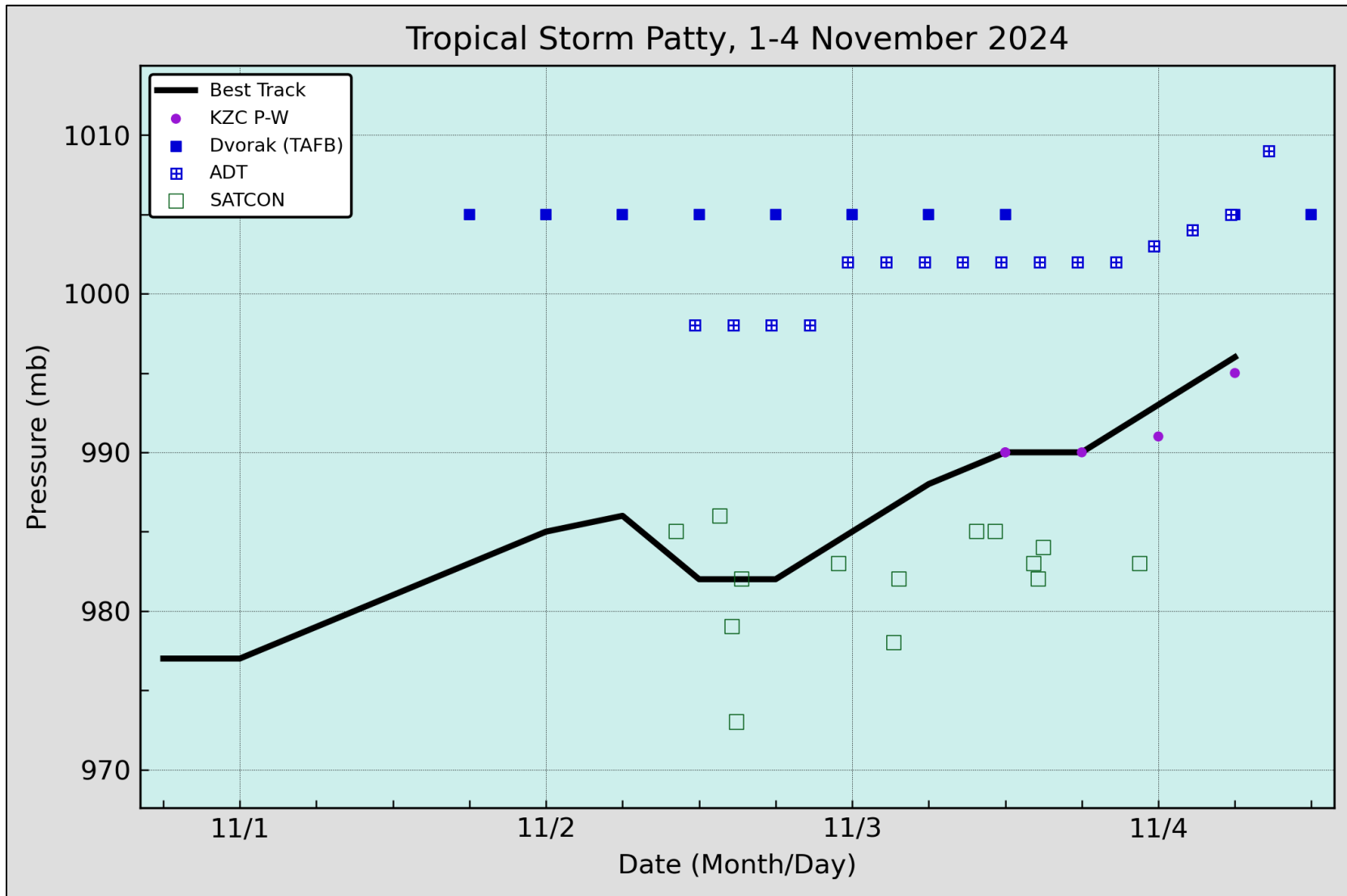
Figure 4.   Selected pressure observations and best track minimum central pressure curve for Tropical Storm Patty, 1–4 November 2024. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for 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.
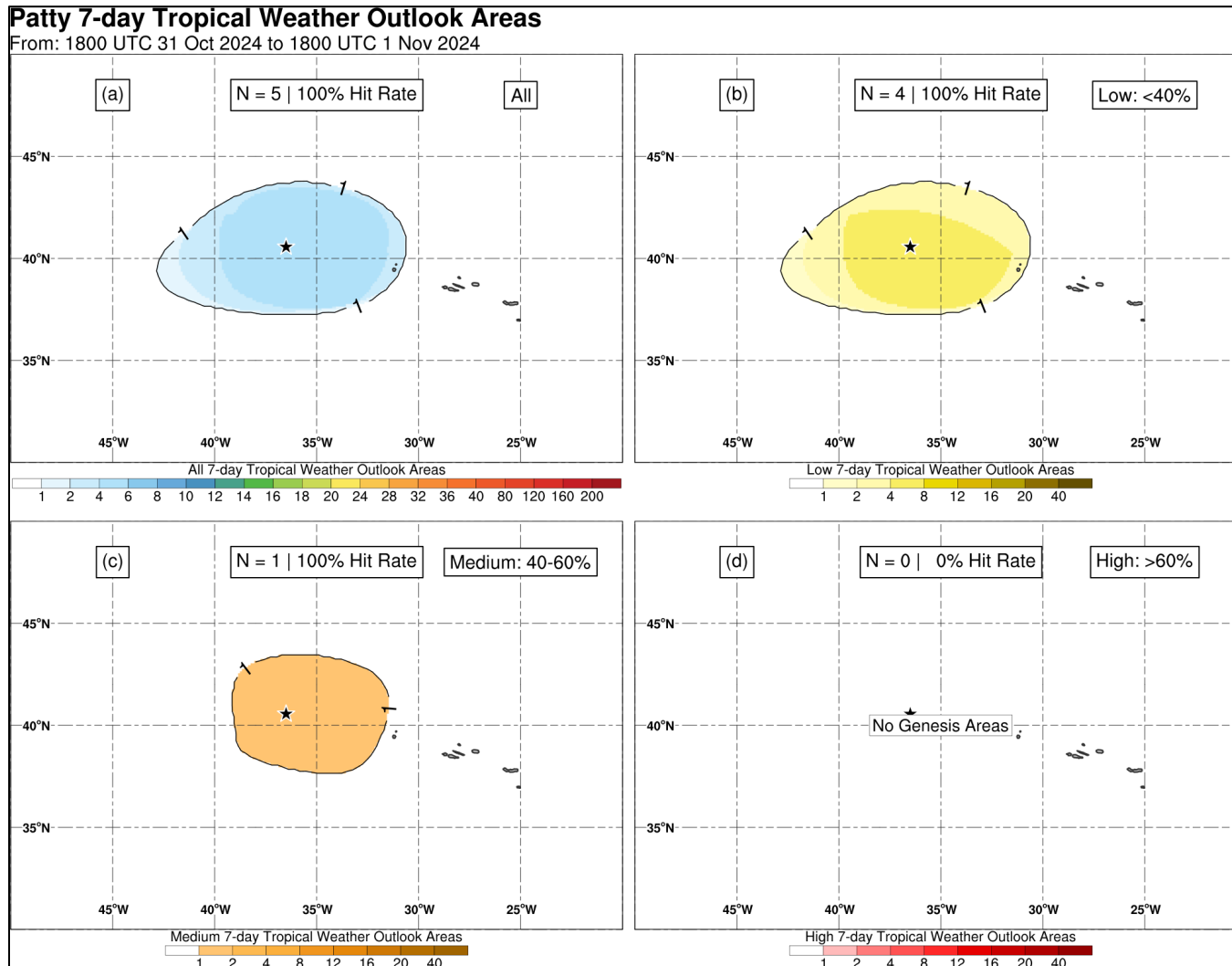
Figure 5.   Composites of 7-day tropical cyclone genesis areas depicted in NHC's Tropical Weather Outlooks prior to the formation of Patty for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.
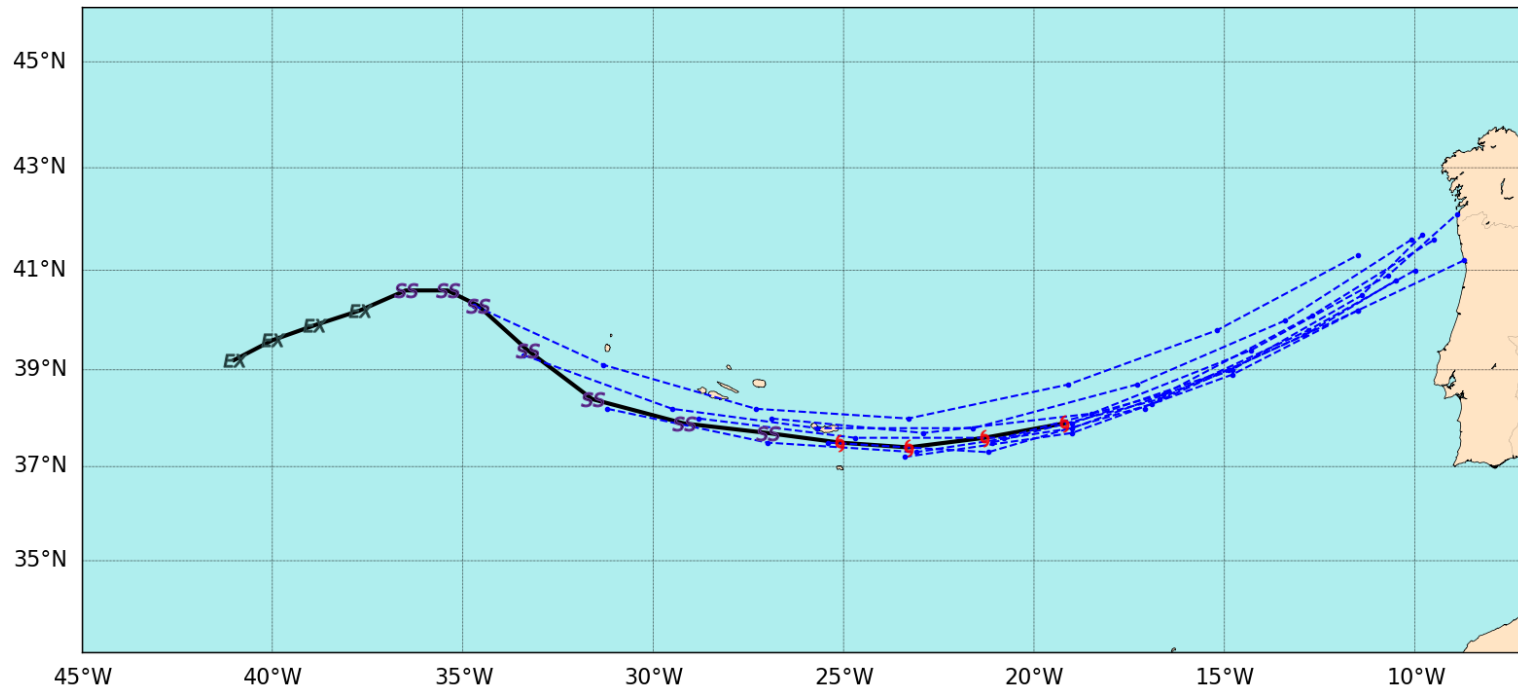
Figure 6.   Official track forecasts (blue lines) for Tropical Storm Patty from 0600 UTC 2 November to 1200 UTC 4 November 2024. The best track is given by the black line with positions and designations given at 6-hour intervals.
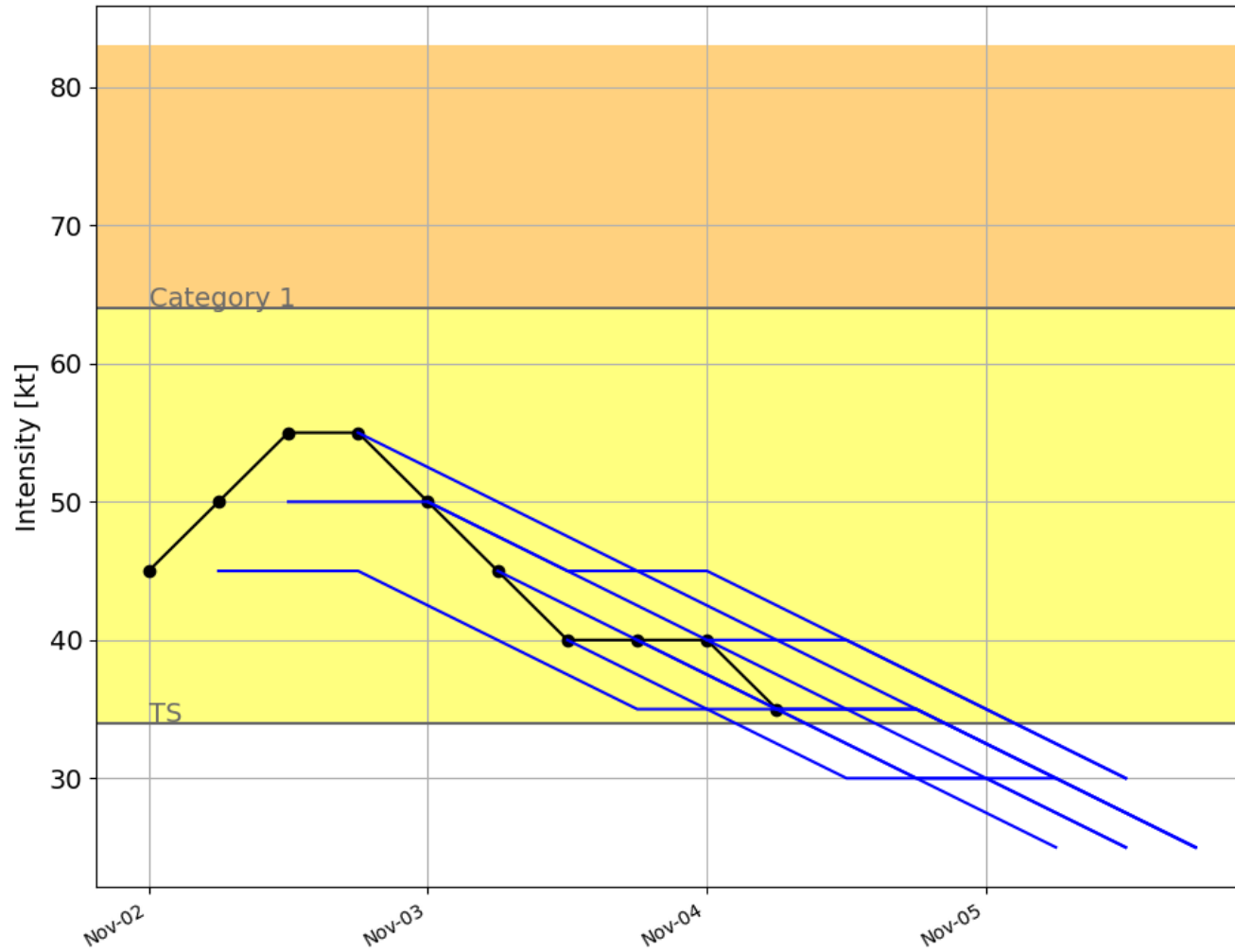
Figure 7.   Official intensity forecasts (blue lines) for Tropical Storm Patty from 0600 UTC 2 November to 1200 UTC 4 November 2024. The best track is given by the black line with intensities shown at 6-hour intervals.