

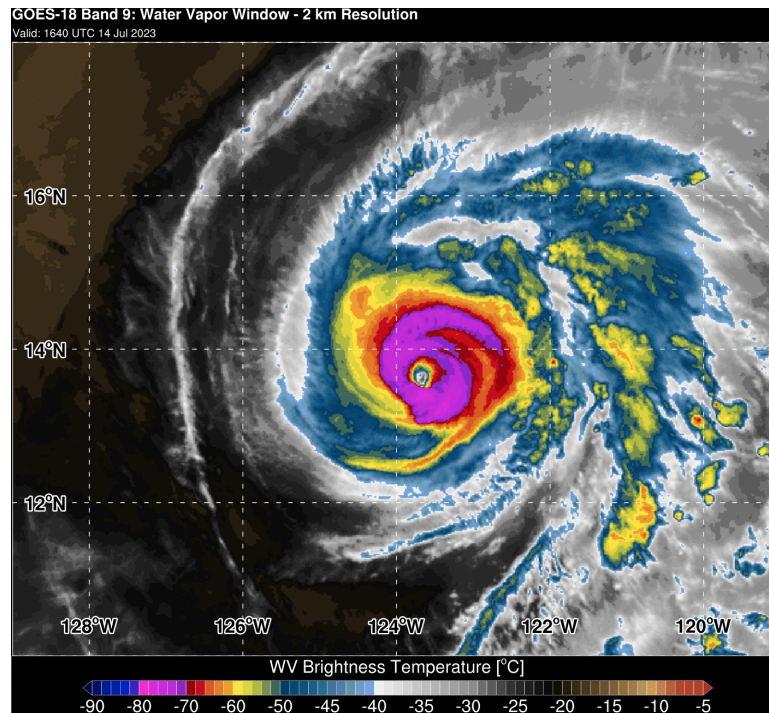


# NATIONAL HURRICANE CENTER TROPICAL CYCLONE REPORT<sup>1</sup>

## HURRICANE CALVIN (EP032023)

11–19 July 2023

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National Hurricane Center  
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GOES-18 WATER VAPOR IMAGE AT 1640 UTC 14 JULY 2023, SHOWING HURRICANE CALVIN NEAR ITS PEAK INTENSITY.  
DATA USED TO CREATE THIS SATELLITE IMAGE COURTESY OF THE NOAA BIG DATA PROJECT

Calvin was a category 3 hurricane (on the Saffir-Simpson Hurricane Wind Scale) that originated in the eastern Pacific and crossed into the central Pacific basin as a tropical storm. Calvin briefly produced tropical storm conditions on the Big Island of Hawaii before opening into a trough axis to the south of the island chain.

<sup>1</sup> This report is based on Calvin's history in the National Hurricane Center's area of responsibility in the eastern Pacific basin (east of 140°W longitude). The report will be updated once the Central Pacific Hurricane Center completes their analysis of Calvin in the central North Pacific basin (west of 140°W longitude).

# Hurricane Calvin

11–19 JULY 2023

## SYNOPTIC HISTORY

Calvin's origins appear to be related to a convectively active monsoon trough in the eastern Pacific basin that was also assisted by a low-latitude tropical wave that slowly crossed Central America between 4–6 July. While the northern portion of this wave axis moved into the Gulf of Mexico, the southern part of this wave axis interacted with the monsoon trough between 6–8 July, producing a large area of showers and thunderstorms in the eastern Pacific to the south of Central America. This convective activity was also enhanced by an eastward-propagating convectively coupled Kelvin Wave (Fig. 1) that was moving through the region during this time. The system slowly became better organized, with scatterometer data indicating a well-defined center had formed along the area of low pressure by 0600 UTC 10 July. It took an additional day and one more large convective burst persisting into the early morning hours of 11 July for the system to be designated as a tropical cyclone. Earlier scatterometer imagery indicated the system was already producing winds of at least 35 kt, so Tropical Storm Calvin formed by 0600 UTC 11 July about 390 n mi to the south-southwest of Zihuatanejo, Mexico. The "best track" chart of Calvin'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>2</sup>.

At genesis, Calvin was already embedded in an environment of low vertical wind shear, warm sea-surface temperatures, and ample deep-layer moisture, but it took another day or so for the system to develop an inner core that would take advantage of the favorable conditions. Calvin was initially steered westward by a well-established deep-layer subtropical ridge to its north over northwestern Mexico, and a portion of this ridge migrated westward, maintaining the tropical cyclone's westward motion over the first few days of its life. The system began to intensify on 12 July as a prominent curved band wrapped around the southern semicircle of the tropical cyclone (Fig. 5a). Calvin became a hurricane the following day at 1200 UTC 13 July as it began rapidly intensifying, culminating in the hurricane reaching its peak intensity as a 110-kt (Category 3) hurricane by 1800 UTC 14 July, while located about 970 n mi to the west-southwest of the southern tip of the Baja California Peninsula. At peak intensity, the major hurricane had a small but well-organized inner core, as evident on both geostationary satellite (cover photo) and microwave imagery (Fig. 5b). Calvin's motion had also started to bend more west-northwestward as it moved farther along the west-southwestern periphery of the well-established mid-level ridge now centered over California.

Calvin's peak intensity was short-lived. The hurricane began to move over cooler ocean waters, while also entraining some dry air that disrupted the small inner core (Fig. 5c). After a

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<sup>2</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 *bt* directory, while previous years' data are located in the *archive* directory.

brief recovery in Calvin's structure on 15 July (Fig. 5d), continued cooling sea-surface temperatures and an increase in westerly vertical wind shear caused the cyclone to resume weakening. Calvin dropped below hurricane intensity at 1200 UTC 16 July, with it weakening down to 45 kt as the tropical storm crossed into the central Pacific basin shortly before 1200 UTC 17 July. As the cyclone became less vertically deep, its motion gradually turned more westward with some acceleration as it became steered primarily by the low-level trade wind flow.

Calvin then continued westward across the Central Pacific basin, with the tropical storm's closest approach to Hawaii occurring at approximately 1200 UTC 19 July, about 80 n mi to the south of the South Point of the Big Island. Additional details about the synoptic history west of 140°W will be provided once the Central Pacific Hurricane Center has completed its post analysis of Calvin.

## METEOROLOGICAL STATISTICS

Observations in Calvin (Figs. 3 and 4) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB), and the Satellite Analysis Branch (SAB), the Central Pacific Hurricane Center (PHFO), and the Joint Typhoon Warning Center (JTWC), as well as objective Advanced Dvorak Technique (ADT) estimates and Satellite Consensus (SATCON) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Observations also include flight-level, stepped frequency microwave radiometer (SFMR), and dropwindsonde observations from four flights of the 53<sup>rd</sup> Weather Reconnaissance Squadron of the U.S. Air Force Reserve Command. 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 Calvin.

Selected surface observations from land stations and data buoys are given in Table 2. There were no ship reports of tropical-storm-force winds in Calvin.

### *Winds and Pressure*

Calvin's peak intensity of 110 kt at 1800 UTC 14 July is based on a blend of subjective and objective satellite intensity data. Subjective intensity estimates from TAFB and SAB were both T6.0/115 kt, but ADT peaked at a lower T5.8/110 kt. SATCON, which blends ADT data with other microwave sounder estimates, peaked at 108 kt at 2040 UTC 14 July, after the structure on satellite imagery had started to decay.

The estimated minimum pressure of 953 mb is based on the Knaff-Zehr-Courtney pressure-wind relationship, though it is worth noting that the pressure estimates made by the subjective Dvorak estimates were a few millibars lower.

Select surface observations from land stations and data buoys are given in Table 2. Additional information about these observations will be provided by the Central Pacific Hurricane Center as they complete their post analysis of Calvin in the Central Pacific.

### ***Rainfall and Flooding***

As Calvin's center moved to the south of the Big Island of Hawaii, heavy rainfall moved quickly over the island on 18–19 July, producing rainfall totals of 4–8 inches. Additional information about rainfall associated with Calvin will be provided by the Central Pacific Hurricane Center after they complete their post analysis in the Central Pacific.

## **CASUALTY AND DAMAGE STATISTICS**

As of this writing, there have been no reports of casualties<sup>3</sup> associated with Calvin. Additional information about the damage associated with Calvin will be provided by the Central Pacific Hurricane Center after they complete their post analysis in the Central Pacific.

## **FORECAST AND WARNING CRITIQUE**

The genesis of Calvin was well anticipated with more than 5 days of lead time in the 7-day outlook (Table 3). The feature from which Calvin developed was introduced in the low category (< 40%) in the Tropical Weather Outlook 138 h prior to genesis. The probabilities were increased to the medium (40–60%) category 114 h and then high (>60%) 90 h before the system developed. In the 2-day probabilities, a low chance was also introduced 90 h before Calvin formed, though there was more uncertainty on the precise timing of development. The disturbance was given medium and high changes of forming only 24 h and 6 h before genesis, respectively. The location of Calvin's genesis was also well forecast (Fig. 6), with every 7-day area capturing Calvin's correct location of genesis.

A verification of NHC official track forecasts (OFCL) for Calvin is given in Table 4a. Official track forecast errors were lower than the mean official errors for the previous 5-yr period at all forecast times, likely related to the well-established steering flow pattern during the majority of Calvin's lifespan. A homogeneous comparison of the official track errors with selected guidance models is given in Table 4b. OFCL outperformed the vast majority of the deterministic guidance, though several of the simple and corrected consensus aids did better at differing forecast lead times. HCCA performed a little better than OFCL at shorter forecast lead times from 12–24 h and

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<sup>3</sup> 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.



48–60 h, while TVCE performed better at longer lead times between 60–120 h, though most of these track improvements were only 6 n mi or less compared to OFCL.

A verification of NHC official intensity forecasts (OFCL) for Calvin is given in Table 5a. Official intensity forecast errors were lower than the mean official errors for the previous 5-yr period for all forecast lead times after 12 h. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 5b. Once again, OFCL outperformed most of the deterministic guidance for all forecast lead times except 120 h, a feat made more impressive given the period of rapid intensification Calvin underwent between 13–14 July. The only guidance aid that consistently outperformed OFCL (albeit barely) was HCCA, which had 1-kt or lower intensity errors compared to OFCL from 12–60 h.

The Central Pacific Hurricane Center will also provide a verification of their forecasts beyond 140°W once their analysis is complete.

Coastal watches and warnings associated with Calvin are given in Table 6.

## ACKNOWLEDGEMENTS

Data in Table 2 were compiled from Post Tropical Cyclone Reports and Public Information Statements issued by the Honolulu NWS Forecast Office.



Table 1. Best track for Hurricane Calvin, 11–19 July 2023. The portion of the best track west of 140°W in the central Pacific basin is preliminary and will be updated once the Central Pacific Hurricane Center completes its post-analysis.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
10 / 0600	10.4	98.0	1009	20	low
10 / 1200	10.5	99.4	1008	25	"
10 / 1800	10.7	101.0	1008	30	"
11 / 0000	11.2	102.5	1008	30	"
11 / 0600	11.7	104.2	1006	35	tropical storm
11 / 1200	12.1	105.8	1006	35	"
11 / 1800	12.3	107.2	1006	35	"
12 / 0000	12.4	108.5	1005	35	"
12 / 0600	12.4	109.8	1004	40	"
12 / 1200	12.4	111.3	1002	45	"
12 / 1800	12.4	112.8	998	55	"
13 / 0000	12.4	114.3	995	60	"
13 / 0600	12.3	115.4	995	60	"
13 / 1200	12.5	116.6	993	65	hurricane
13 / 1800	12.7	118.0	990	70	"
14 / 0000	13.0	119.7	976	85	"
14 / 0600	13.1	121.3	966	95	"
14 / 1200	13.4	122.6	959	105	"
14 / 1800	13.7	123.9	953	110	"
15 / 0000	14.0	125.3	962	100	"
15 / 0600	14.4	126.7	969	90	"
15 / 1200	14.6	128.2	971	90	"
15 / 1800	14.9	129.7	973	90	"
16 / 0000	15.2	131.2	977	80	"
16 / 0600	15.5	132.6	982	75	"
16 / 1200	15.7	134.0	990	65	"
16 / 1800	16.0	135.6	993	60	tropical storm
17 / 0000	16.4	137.2	995	55	"



Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
17 / 0600	16.6	138.8	998	50	"
17 / 1200	16.7	140.5	1000	45	"
17 / 1800	17.0	142.4	1000	45	"
18 / 0000	17.2	144.4	1004	40	"
18 / 0600	17.3	146.5	1002	40	"
18 / 1200	17.4	148.5	1002	40	"
18 / 1800	17.6	150.4	1002	45	"
19 / 0000	17.8	152.3	1003	50	"
19 / 0600	17.7	154.3	1003	45	"
19 / 1200	17.7	155.9	1006	40	"
19 / 1800	17.9	157.7	1009	35	low
20 / 0000					dissipated
14 / 1800	13.7	123.9	953	110	maximum wind and minimum pressure



Table 2. Selected surface observations for Hurricane Calvin, 11–19 July 2023. This information will be updated once the Central Pacific Hurricane Center completes its post-analysis.

Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Estimated Inundation (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
<b>Hawaii</b>									
<b>International Civil Aviation Organization (ICAO) Sites</b>									
Bradshaw Army Air Field (PHSF) (19.78°N 155.55°W)			19/1353	34	39				
Kahului Airport (PHOG) (20.89°N 156.44°W)	19/1341	997.0	18/1813	19	35				
Hilo International Airport (KHTO) (19.72°N 155.06°W)	19/1353	998.0	19/1510	14	22				
Keahole Airport Kona (KHKO) (19.74°N 156.05°W)	19/1253	989.0	18/1813	21	28				
Lanai City Airport (PHSF) (20.79°N 156.95°W)	19/1349	998.0	18/2156	27	35				
Honolulu International Airport (PHNL) (21.33°N 157.94°W)	19/0253	997.0	19/0953	24	31				
Lahiani West Maui (PHJH) (20.96°N 156.67°W)	19/1254	993.0	19/2154	27	36				
Molokai Airport Kaunakakai (PHMK) (21.15°N 157.10°W)	19/0354	995.0	19/0454	22	36				
Kamuela/Waimea (PHMU) (20.00°N 155.67°W)			19/1059	31	41				
<b>Hydrometeorological Automated Data System (HADS) Sites (NWS)</b>									
Kulani NWR (KNWH1) (19.55°N 155.31°W)									6.63
Laupohoehoe (LPHH1) (19.99°N 155.24°W)									6.16
Waiakea Uka (WKAH1) (19.66°N 155.13°W)									5.92
Papaikou Well (PPWH1) (19.79°N 155.13°W)									5.81
Mountain View (MTVH1) (19.55°N 155.11°W)									5.29
Glennwood (GLNH1) (19.51°N 155.17°W)									5.00
<b>Remote Automated Weather Stations (RAWS)</b>									
Kealakomo #2 (KMOH1) (19.29°N, 155.11°W)			18/2144	30	50				
Waikoloa (WKVH1) (19.92°N 155.79°W)			18/2035	26	47				





Location	Minimum Sea Level Pressure		Maximum Surface Wind Speed			Storm surge (ft)	Storm tide (ft)	Estimated Inundation (ft)	Total rain (in)
	Date/time (UTC)	Press. (mb)	Date/time (UTC) <sup>a</sup>	Sustained (kt) <sup>b</sup>	Gust (kt)				
Kohala Ranch (KHRH1) (20.09°N 155.83°W)			18/2135	24	43				
Puu Mali (PMLH1) (19.92°N 155.42°W)			19/0800	23	44				
Lanai 1 (LHIH1) (20.87°N 157.01°W)			18/2337	29	42				
Hakalau (HKUH1) (19.55°N 155.33°W)									7.02
Nene Cabin (NENH1) (19.26°N 155.61°W)									5.18
<b>US Geological Survey (USGS)</b>									
Honolii Stream (NLIH1) (19.76°N 155.15°W)									7.24
Saddle Quarry (SDQH1) (19.69°N 155.29°W)									7.12
Kawainui Stream (KWSH1) (20.09°N 155.68°W)									5.87
West Wailuaiki (WWKH1) (20.81°N 156.14°W)									5.46
Puu Kukui (PKKH1) (20.89°N 156.59°W)									4.35
<b>Offshore</b>									
<b>NOAA Buoys</b>									
Southeast Hawaii (51004) (17.54°N 152.23°W)	19/0200	1005.4	18/2350	28	33				
Western Hawaii (51003) (19.29°N 160.57°W)	20/0300	1012.6	20/0600	25	33				

<sup>a</sup> Date/time is for sustained wind when both sustained and gust are listed.

<sup>b</sup> Except as noted, sustained wind averaging periods for C-MAN and land-based reports are 2 min; buoy averaging periods are 8 min.



Table 3. 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%)	90	138
Medium (40%-60%)	24	114
High (>60%)	6	90



Table 4a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Calvin in the eastern Pacific. 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	<b>16.2</b>	<b>20.8</b>	<b>24.8</b>	<b>28.1</b>	<b>37.6</b>	<b>45.6</b>	<b>63.4</b>	<b>70.8</b>
OCD5	28.4	54.6	90.3	131.7	174.3	212.2	305.3	409.0
Forecasts	23	23	23	23	22	20	16	12
OFCL (2018-22)	22.1	34.0	45.4	56.0	70.9	78.7	100.5	117.8
OCD5 (2018-22)	36.7	73.4	114.0	156.9	193.2	244.5	317.0	376.0

Table 4b. Homogeneous comparison of selected track forecast guidance models (in n mi) for Calvin in the eastern Pacific. 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	16.2	20.8	24.8	28.1	37.6	45.6	63.4	70.8
OCD5	28.4	54.6	90.3	131.7	174.3	212.2	305.3	409.0
GFSI	<b>15.1</b>	24.8	33.6	46.2	61.1	72.3	97.6	118.7
EMXI	<b>15.7</b>	22.7	26.8	32.4	43.4	58.4	81.7	86.5
CMCI	20.7	30.3	35.5	42.4	53.1	62.6	85.1	95.1
NVGI	28.8	43.2	50.9	62.9	87.7	114.1	163.4	201.9
HFAI	18.2	24.6	31.5	37.1	43.0	48.9	71.7	88.6
HFBI	17.5	25.9	30.1	38.6	51.1	64.1	96.9	121.1
HWFI	19.5	28.2	31.5	38.1	46.7	57.4	77.3	88.1
HMNI	<b>15.9</b>	25.7	33.3	42.0	49.9	57.4	<b>62.9</b>	89.8
CTCI	19.4	29.7	37.1	46.1	53.3	61.2	72.3	88.5
HCCA	<b>15.6</b>	<b>20.1</b>	24.9	<b>27.6</b>	<b>35.6</b>	49.4	82.4	118.7
TVCE	<b>14.5</b>	21.7	<b>24.7</b>	28.7	<b>35.3</b>	<b>41.5</b>	<b>58.0</b>	<b>66.7</b>
TVDG	<b>14.6</b>	21.4	24.8	28.3	<b>33.3</b>	<b>40.0</b>	<b>58.5</b>	<b>66.0</b>
TVCX	<b>14.8</b>	20.9	<b>24.5</b>	28.6	<b>34.7</b>	<b>40.9</b>	<b>56.6</b>	<b>67.0</b>
AEMI	17.1	28.3	32.9	40.5	49.4	54.3	73.0	85.6
GFEX	<b>14.4</b>	<b>20.6</b>	26.3	36.7	49.5	60.6	80.6	92.1
TABS	23.8	41.3	57.5	71.2	83.8	95.1	117.9	161.6
TABM	23.2	36.9	48.9	68.8	87.2	103.5	138.1	182.5
TABD	23.3	44.5	75.9	116.0	154.3	181.0	237.1	289.5
Forecasts	23	23	23	23	22	20	16	12

Table 5a. NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Calvin in the eastern Pacific. 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	6.5	<b>7.8</b>	<b>7.8</b>	<b>11.1</b>	<b>11.1</b>	<b>9.0</b>	<b>6.6</b>	<b>6.2</b>
OCD5	9.4	12.7	14.4	18.3	19.7	18.1	17.4	12.8
Forecasts	23	23	23	23	22	20	16	12
OFCL (2018-22)	5.4	8.9	11.0	12.8	14.3	15.8	17.0	17.6
OCD5 (2018-22)	6.9	12.1	15.9	18.6	18.7	21.0	22.3	22.1

Table 5b. Homogeneous comparison of selected intensity forecast guidance models (in kt) for Calvin in the eastern Pacific. 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	6.5	7.8	7.8	11.1	11.1	9.0	6.6	6.2
OCD5	9.4	12.7	14.4	18.3	19.7	18.1	17.4	12.8
HFAI	7.3	10.9	10.6	12.3	14.0	13.7	<b>6.5</b>	<b>4.2</b>
HFBI	7.2	9.9	10.2	12.3	13.8	11.9	7.1	<b>6.0</b>
HWFI	9.9	10.6	12.0	13.4	13.4	12.6	8.8	<b>5.1</b>
HMNI	7.7	11.0	11.8	13.2	13.5	12.4	10.3	6.9
CTCI	8.8	10.5	10.8	12.3	13.6	14.3	14.6	12.8
DSHP	7.6	8.8	9.4	11.3	12.2	10.9	8.2	9.2
LGEM	8.1	9.4	11.0	13.3	13.6	11.8	8.8	<b>4.8</b>
HCCA	<b>6.0</b>	<b>6.1</b>	<b>6.7</b>	<b>10.1</b>	<b>10.9</b>	10.2	7.8	7.3
IVCN	7.2	8.5	9.4	11.7	12.0	10.5	7.1	<b>3.8</b>
ICON	7.7	8.6	9.9	11.6	11.9	10.4	7.1	<b>3.8</b>
IVDR	7.0	8.6	9.9	11.9	12.0	10.8	7.3	<b>5.1</b>
GFSI	7.0	8.8	12.0	14.3	15.0	13.1	8.8	7.7
EMXI	9.4	14.0	17.9	20.3	19.5	16.9	8.1	6.3
Forecasts	23	23	23	23	22	20	16	12



Table 6. Watch and warning summary for Hurricane Calvin, 11–19 July 2023.

<b>Date/Time (UTC)</b>	<b>Action</b>	<b>Location</b>
<b>17/1500</b>	Tropical Storm Watch Issued	Island of Hawaii
<b>18/0300</b>	Tropical Storm Watch changed to a Tropical Storm Warning	Island of Hawaii
<b>19/2100</b>	Tropical Storm Warning discontinued	Island of Hawaii

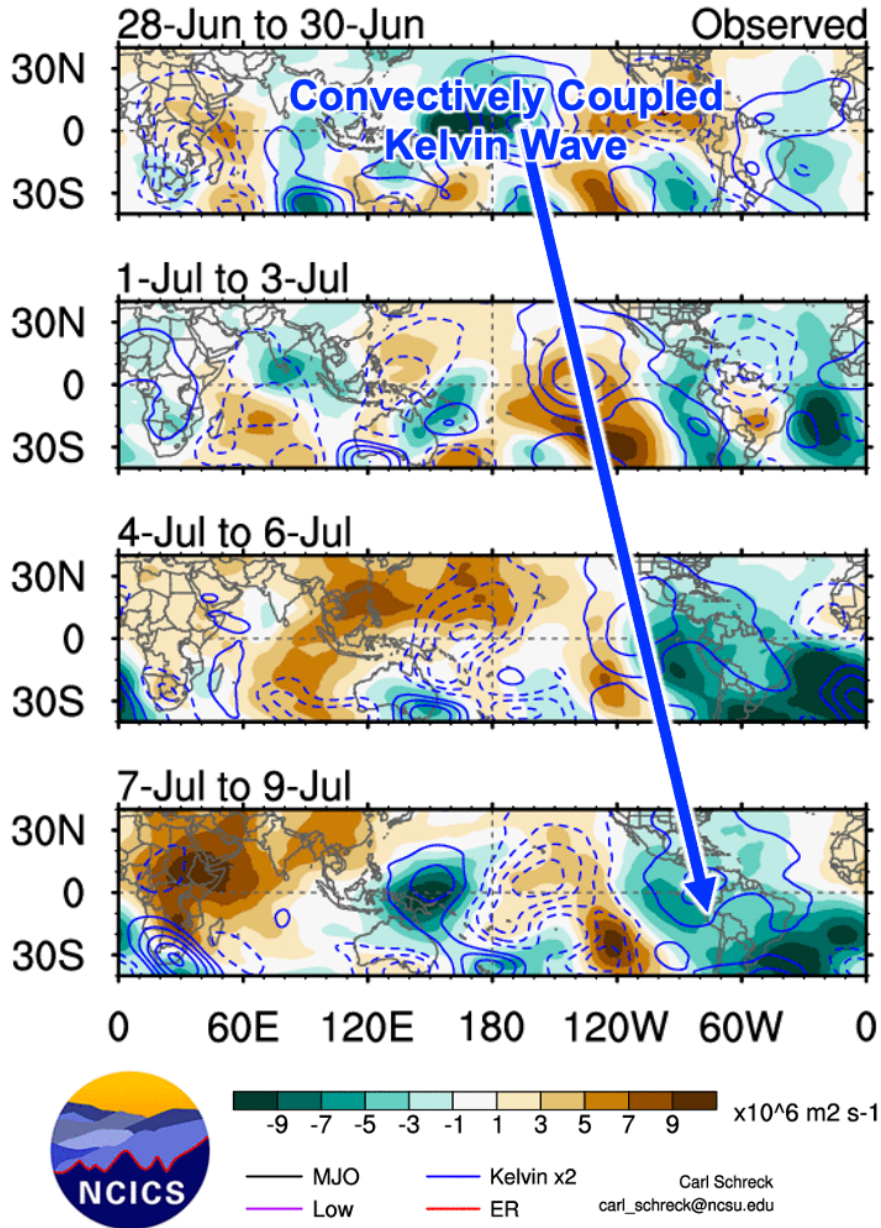


Figure 1. CFS model analysis unfiltered Velocity Potential Anomalies at 200 mb (shaded,  $\times 10^6 \text{ m}^2 \text{ s}^{-1}$ ) over the globe covering the eastern Pacific from 28 June–9 July 2023, where green (brown) shading shows areas of upward (downward) motion favored by the upper-level velocity potential field. Blue solid (dashed) contours indicate where the velocity potential has been filtered for upward (downward) motion associated with Kelvin Waves, with annotations highlighting where a convectively coupled Kelvin Wave that moved eastward and enhanced upward vertical motion near the pre-Calvin disturbance. Image has been adapted from Carl Schreck of North Carolina Institute for Climate Studies, accessible at <https://ncics.org/portfolio/monitor/mjo>.



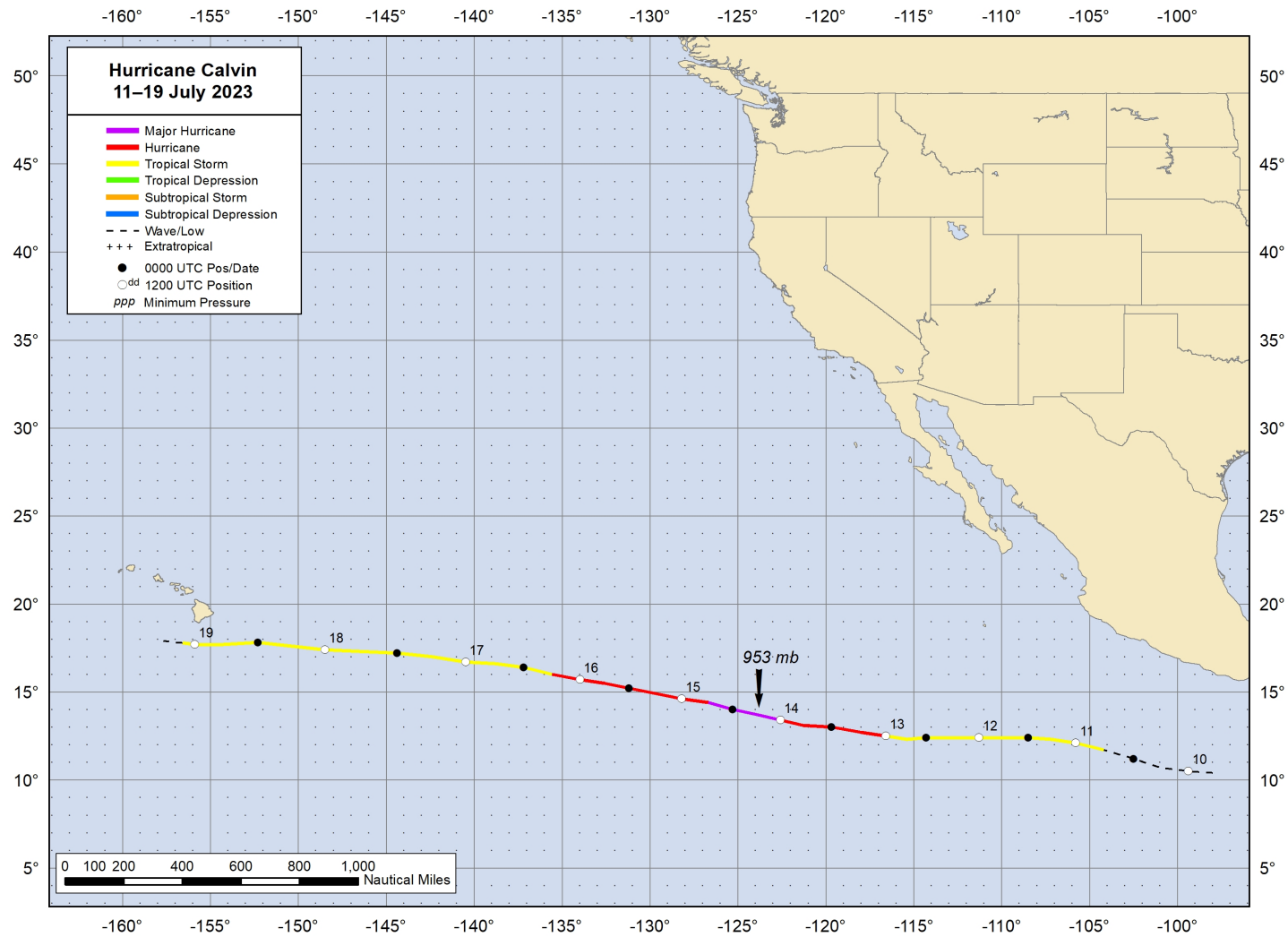


Figure 2. Best track positions for Hurricane Calvin, 11–19 July 2023. The portion of the track west of 140°W in the central Pacific basin is preliminary and reflects near real-time estimates from the Central Pacific Hurricane Center.

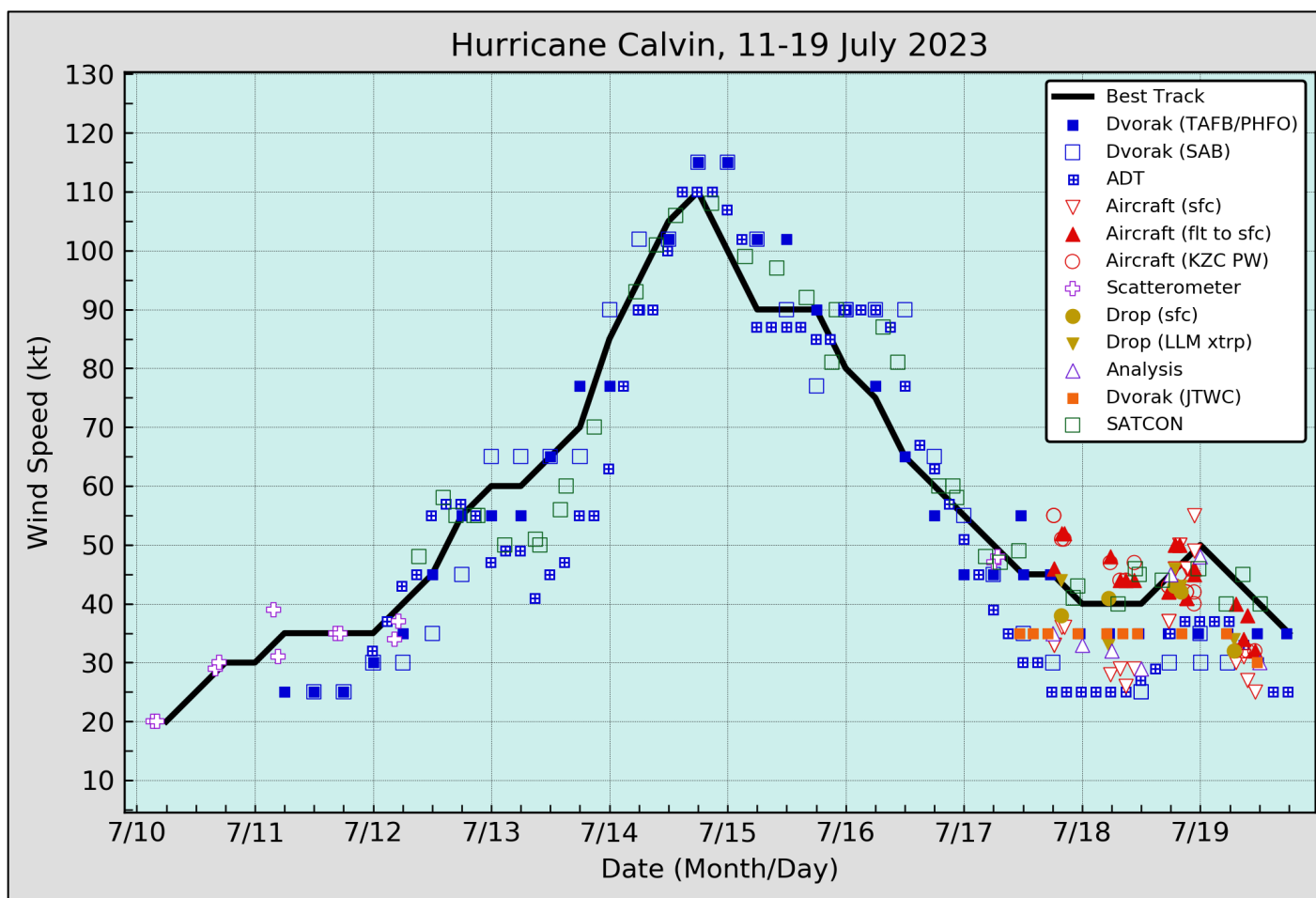


Figure 3. Selected wind observations and best track maximum sustained surface wind speed curve for Hurricane Calvin, 11–19 July 2023. Aircraft observations have been adjusted for elevation using 90%, 80%, and 75% adjustment factors for observations from 700 mb, 850 mb, and 925 mb, respectively. Dropwindsonde observations include actual 10 m winds (sfc), as well as surface estimates derived from the mean wind over the lowest 150 m of the wind sounding (LLM). 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. The best track after 0600 UTC 17 July in the central Pacific basin is preliminary and reflects near real-time estimates from the Central Pacific Hurricane Center.

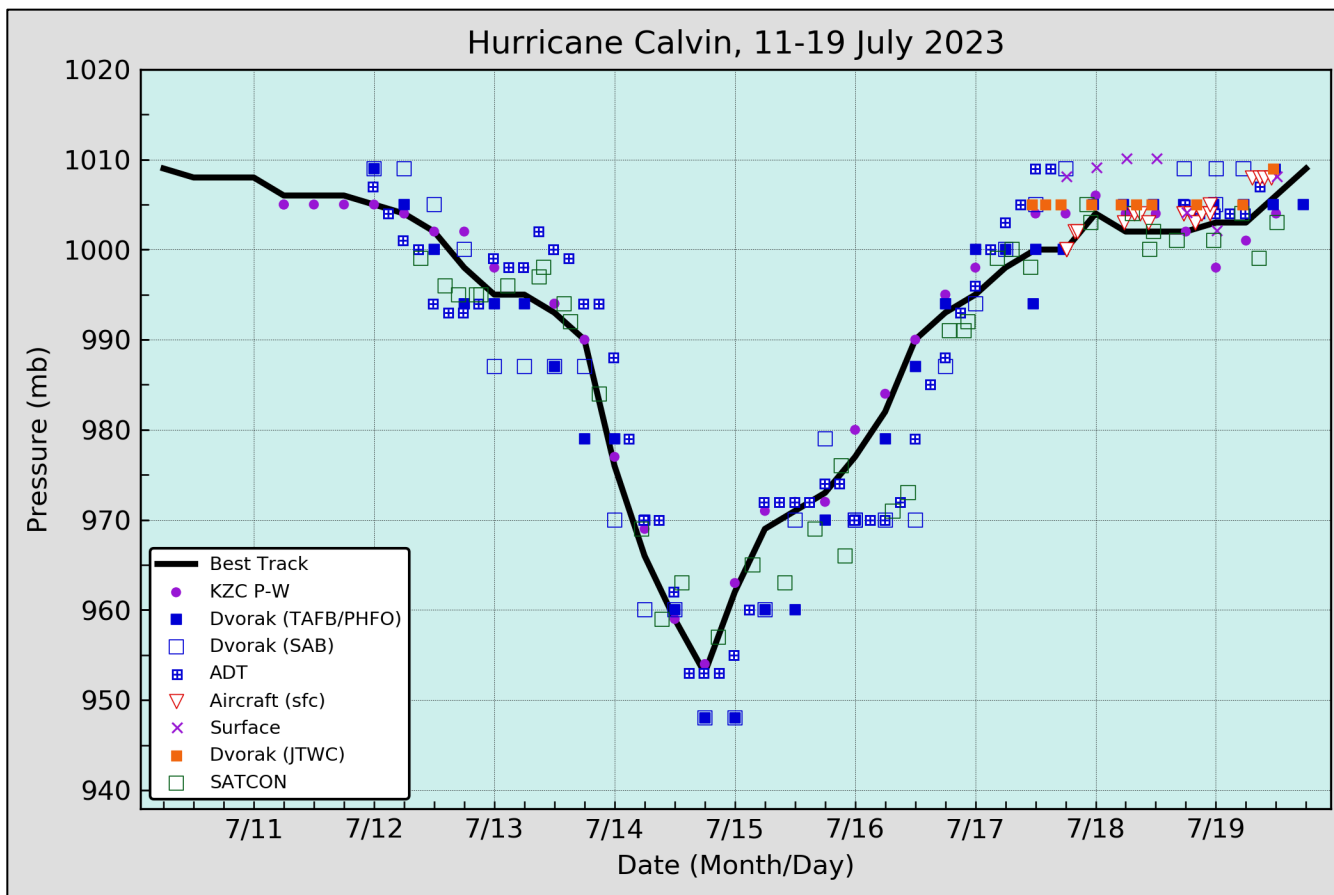


Figure 4. Selected pressure observations and best track minimum central pressure curve for Hurricane Calvin, 11–19 July 2023. Advanced Dvorak Technique estimates represent the Current Intensity at the nominal observation time. SATCON intensity estimates are from the Cooperative Institute for Meteorological 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. The best track after 0600 UTC 17 July in the central Pacific basin is preliminary and reflects near real-time estimates from the Central Pacific Hurricane Center.

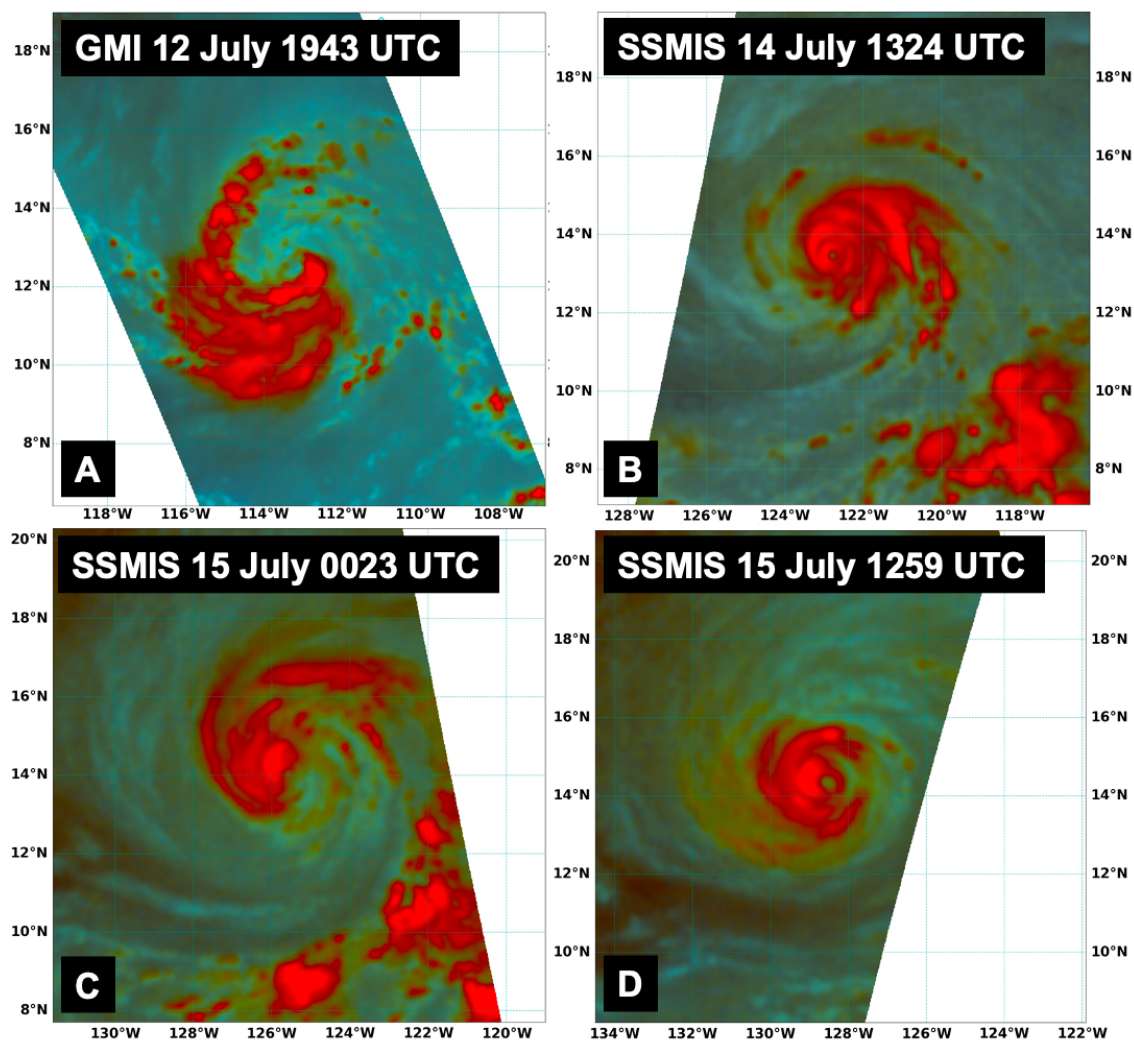


Figure 5. Passive microwave satellite 89–91-GHz color composite imagery showing Calvin’s structural evolution from 12–15 July 2023. (a) 1943 UTC 12 July GMI pass showing Calvin as an intensifying tropical storm. (b) 1324 UTC SSMIS pass depicting Calvin near peak intensity with a small eye and eyewall. (c) 0023 UTC 15 July SSMIS pass showing Calvin weakening as dry air was entrained into its inner core. (d) 1259 UTC 15 July SSMIS pass showing Calvin attempting to reorganize with a nearly closed eyewall.

### Calvin 7-day Tropical Weather Outlook Areas

From: 1200 UTC 5 Jul 2023 to 0600 UTC 11 Jul 2023

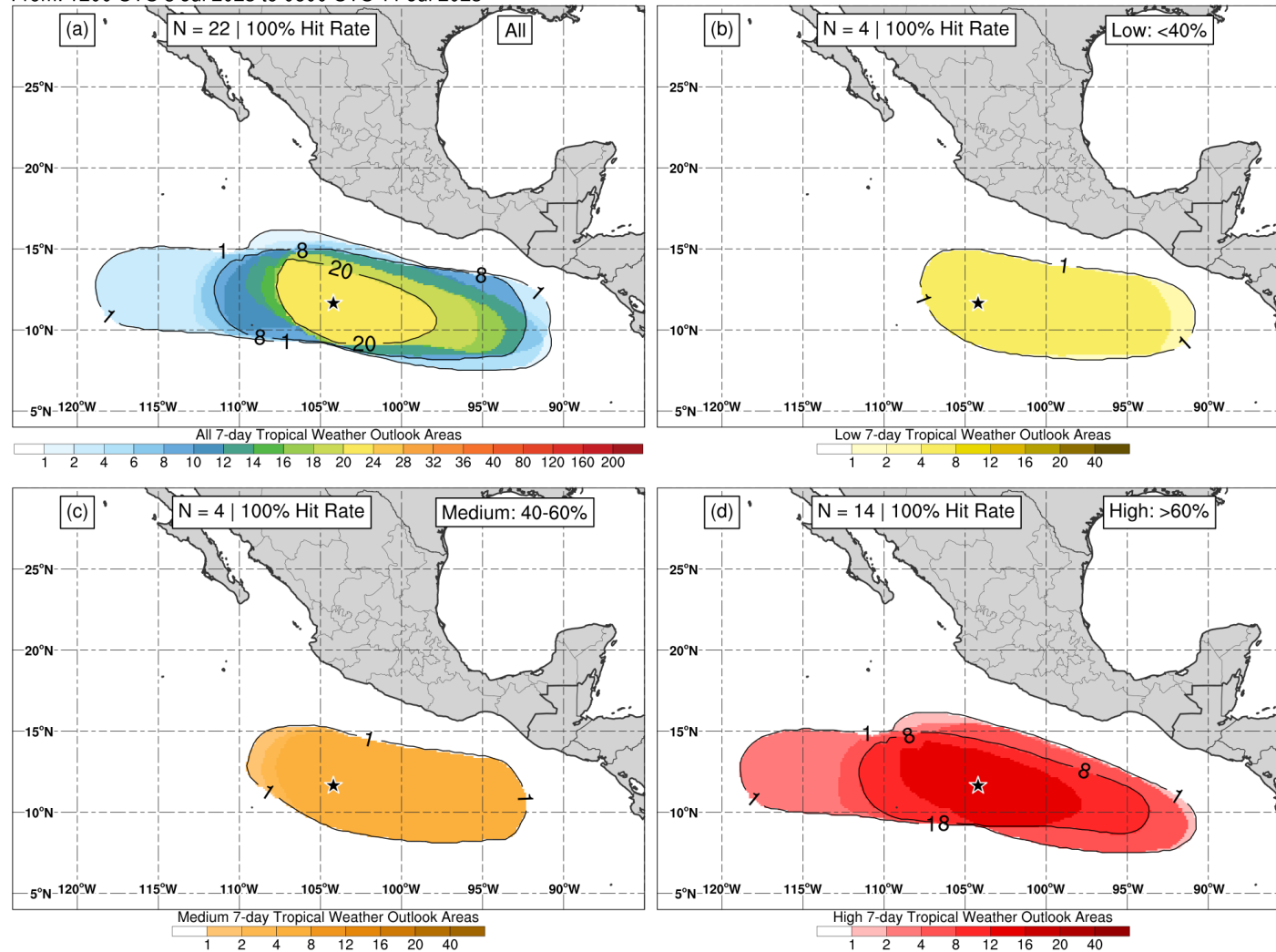


Figure 6. Composites of 7-day tropical cyclone genesis areas depicted in NHC’s Tropical Weather Outlooks prior to the formation of Calvin for (a) all probabilistic genesis categories, (b) the low (<40%) category, (c) medium (40–60%) category, and (d) high (>60%) category. The location of genesis is indicated by the black star.