CENTRAL PACIFIC HURRICANE CENTER TROPICAL CYCLONE REPORT

TROPICAL DEPRESSION NINE-C

(CP092015)

31 DECEMBER 2015

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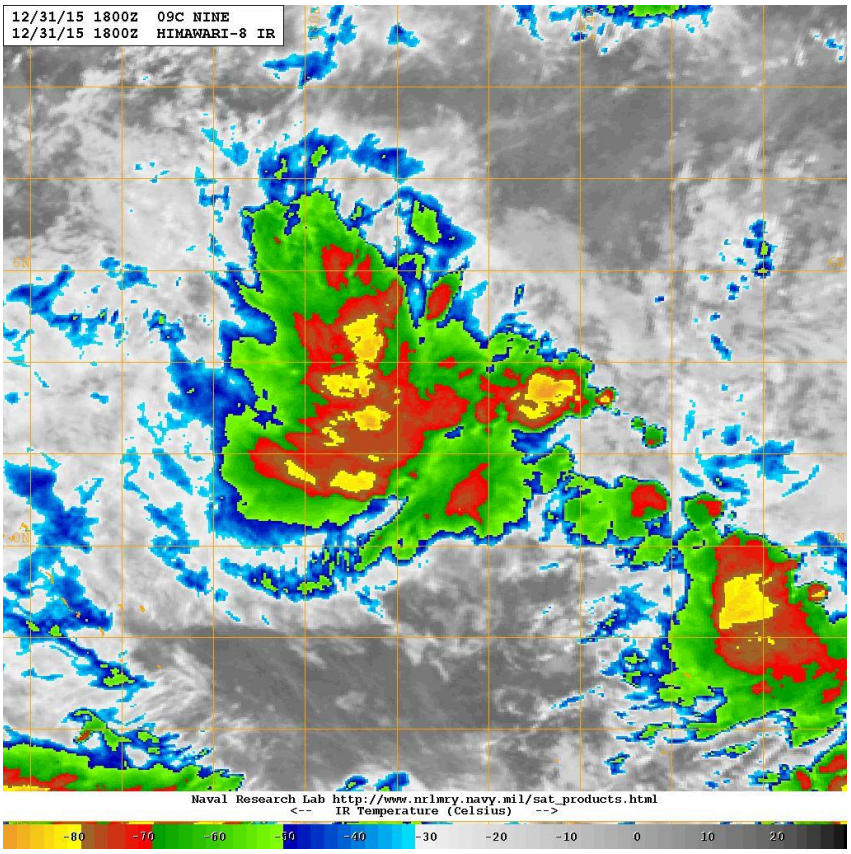

HIMAWARI INFRARED IMAGE OF T.D. NINE-C AT 1800 UTC 31 DECEMBER 2015. IMAGE COURTESY OF THE NAVAL REAEARCH LABORATORY.

Nine-C was a short-lived tropical depression that formed in the Central North Pacific basin at the end of 2015.

TROPICAL DEPRESSION NINE-C

31 DECEMBER 2015

SYNOPTIC HISTORY

Tropical Depression Nine-C likely developed from a tropical disturbance related to a belt of anomalously strong low-level westerly winds that was located along and just south of the equator toward the end of December 2015. The low-level convergence and upper level diffluence associated with these strong westerly winds allowed deep convection to develop and persist for a few days prior to the end of the calendar year, even though last day of the official Central Pacific 2015 hurricane season was on 30 November. In addition, the above normal sea surface temperatures and ample ocean heat content in the tropical Central Pacific Ocean due to the strong El Nino of 2015-16 also likely contributed to the development and maintenance of the thunderstorms in the vicinity of this system. The initial disturbance, which can be traced back to a near-equatorial system located just west of the International Date Line on 27 December 2015, moved slowly eastward on 28 December. This feature then moved toward the east-northeast on 29 December, before turning northward and gaining additional latitude away from the equator on 30 December. The low-level circulation center (LLCC) of the disturbance appeared to be embedded within an east to west oriented surface trough based on a 1751 UTC 30 December Windsat pass. The first advisory for Nine-C was issued at 0300 UTC 31 December when the persistent deep convection associated with the disturbance became sufficiently organized according to the subjective Dvorak intensity estimates from all of the satellite fix agencies. The "best track" chart of the tropical cyclone's path is given in Figs. 1 and 2, while the best track positions and intensities are listed in Table 1[1].

The poor organization of the tropical depression and its close proximity to the equator made locating the LLCC challenging. As a result, some of the real-time LLCC position estimates were erroneous. For example, the 0600 UTC 31 December position for the LLCC was aided by Himawari satellite imagery and a 0211 UTC 31 December AMSU pass. As a result, the system was actually about 2° of longitude east of its initial real-time position. Nine-C remained poorly organized as it tracked slowly westward during the next 18 h, while maintaining estimated maximum sustained surface wind speeds of near 30 kt. Environmental vertical wind shear was around 20 kt in the vicinity of the depression, so no intensification occurred. Also, an area of deep convection that had been in the vicinity of Nine-C moved rapidly toward the west-northwest, leaving behind a broad near surface circulation center with little deep convection. As a result, a 0855 UTC 1 January 2016 ASCAT pass over the system revealed an east-northeast to west-southwest oriented surface trough with no well-defined LLCC evident. As a result, Tropical

[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.

Depression Nine-C was considered to have weakened to a post-tropical remnant low as of 0000 UTC 1 January 2016, before dissipation by 1200 UTC 1 January.

METEOROLOGICAL STATISTICS

Observations in Nine-C include subjective satellite-based Dvorak technique intensity estimates from the Satellite Analysis Branch (SAB), the Central Pacific Hurricane Center (CPHC), and the Joint Typhoon Warning Center (JTWC) using satellite imagery from the Himawari and GOES-15 satellites. They also include objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the European Space Agency's Advanced Scatterometer (ASCAT), WindSat, and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Nine-C.

There were no surface observations of tropical-storm-force or greater winds from Nine-C.

CASUALTY AND DAMAGE STATISTICS

There were no reports of damage or casualties associated with Nine-C.

FORECAST AND WARNING CRITIQUE

The genesis of Nine-C was somewhat anticipated in advance, even though it occurred well after the end of the prolific official Central Pacific hurricane season of 2015. An Invest was started for the precursor disturbance a few days before the depression developed. However, the first official mention of a possibility of development was in a Special Tropical Weather Outlook issued at 2010 UTC on 30 December, when the chance of development was considered to be low (30% or less) during the next couple of days. In reality, genesis occurred about 4 h later. The difficulty of forecasting development of a tropical cyclone in December is primarily due to the very unusual occurrence of these systems well after the end of the official Central Pacific hurricane season (Tropical Storm Omeka of 2010 is the most recent example of a post-season tropical cyclone; note that Hurricane Pali also developed in January 2016 about a week after Nine-C dissipated).

A verification of CPHC official track forecasts for Nine-C is provided in Table 2a. Since Nine-C was only considered to be a viable tropical cyclone for 24 h, there were only two 12 h forecasts available for verification. The official forecast track errors were much greater than the average official 12 h forecast errors for the previous 5-yr period. This was mainly due to a great deal of uncertainty in the initial position of Nine-C. Also, most of the guidance appeared to suggest the system would likely move slowly toward the west-northwest, while in reality it drifted slowly

westward. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. Most of the model guidance also struggled with the Nine-C track forecasts. The official track forecast errors were generally worse than the model guidance errors. The variable consensus model, TVCE, as well as the GFDL and the GFS ensemble mean, had the lowest errors for the 12 h track forecasts. Note that the BAMS output also had a relatively low track error, which was likely due to the weak system following the low-level flow rather than the deep layer mean flow.

A verification of CPHC official intensity forecasts for Nine-C is given in Table 3a. The official forecast intensity error was near zero for the 12 h forecasts, which indicates the CPHC forecasts showing little significant change in the depression once it formed were verified. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The official intensity forecast error was also lower than ALL of the intensity guidance. In regards to the guidance, the variable consensus model, ICON, as well as the LGEM, HWRF and GFDL, had the lowest errors for the 12 h intensity forecasts compared with all of the guidance.

Coastal watches and warnings were not necessary for Tropical Depression Nine-C.

Table 1. Best track for Tropical Depression Nine-C, 31 December 2015. Note that the depression weakened to a post-tropical low as of 1 January 2016.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
31 / 0000	2.2	175.5	1001	30	tropical depression
31 / 0600	2.2	175.7	1001	30	"
31 / 1200	2.2	175.9	1001	30	"
31 / 1800	2.2	176.2	1001	30	"
01 / 0000	2.2	176.4	1003	25	low
01 / 0600	2.2	176.6	1003	25	"
01 / 1200					dissipated

Table 2a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Depression Nine-C, 31 December 2015. Mean errors for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	106.2						
OCD5	118.6						
Forecasts	2						
OFCL (2010-14)	27.9	44.1	56.7	73.9	132.3	183.7	258.9

Table 2b. Homogeneous comparison of selected track forecast guidance models (n mi) for Tropical Depression Nine-C, 31 December 2015. Errors smaller than the CPHC official forecast are shown in boldface type.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	106.2						
OCD5	118.6						
GFSI	**81.6**						
GHMI	**43.2**						
HWFI	**74.2**						
TVCE	**60.3**						
AEMI	**61.1**						
BAMS	**55.6**						
BAMM	161.4						
BAMD	223.0						
Forecasts	2						

Table 3a. CPHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Depression Nine-C, 31 December 2015. Mean errors for the previous 5-yr period are shown for comparison.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	0.0						
OCD5	10.0						
Forecasts	2						
OFCL (2010-14)	4.8	8.6	11.6	13.8	18.5	19.3	20.4

Table 3b. Homogeneous comparison of selected intensity forecast guidance models (kt) for Tropical Depression Nine-C, 31 December 2015.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	0.0						
OCD5	10.0						
HWFI	2.0						
GHMI	2.0						
DSHP	2.5						
LGEM	1.5						
ICON	2.0						
IVCN	2.5						
GFSI	8.0						
Forecasts	2						

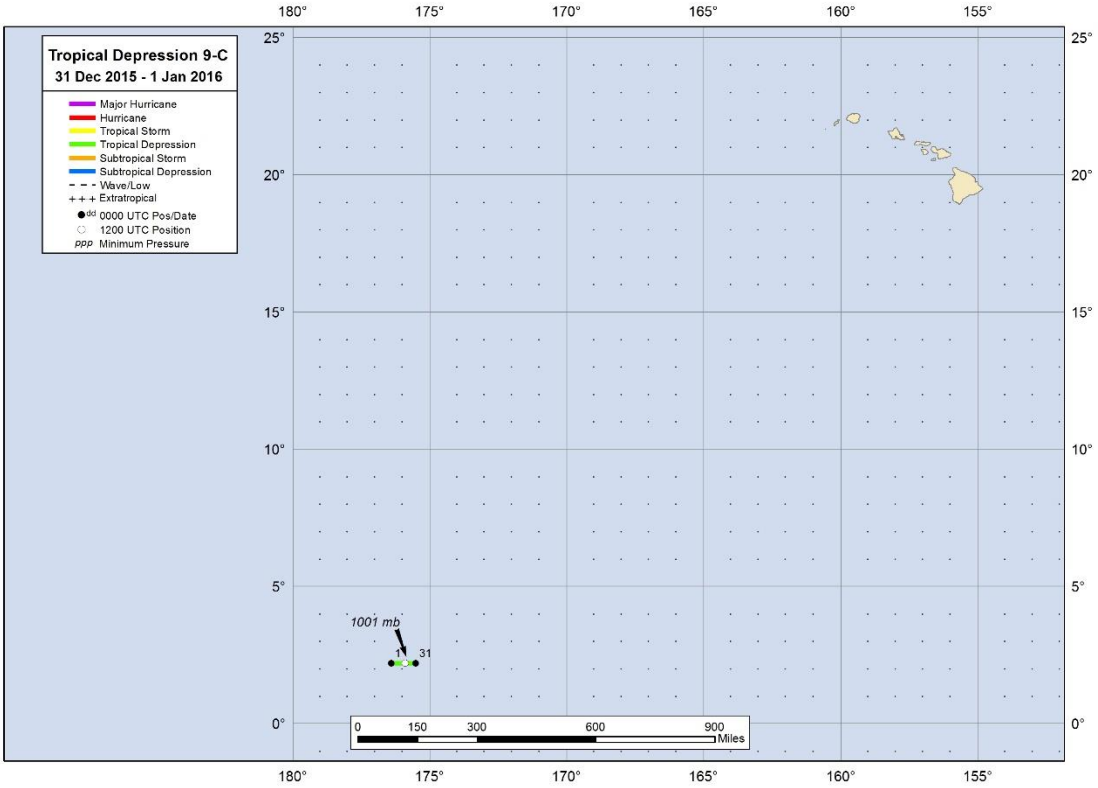

Figure 1. Large-scale map showing best track positions for Tropical Depression Nine-C, 31 December 2015.

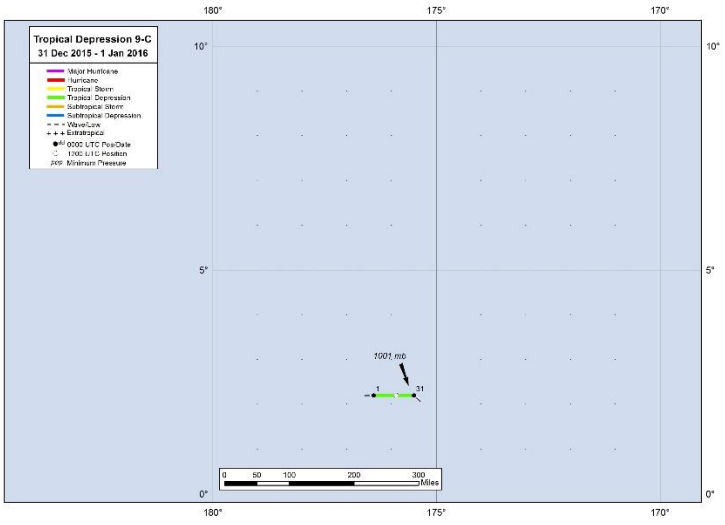

Figure 2. Zoomed in map showing best track positions for Tropical Depression Nine-C, 31 December 2015.