NOAA Technical Memorandum NWSTM PR-52

2004 Tropical Cyclones Central North Pacific

Andy Nash
Tim Craig
Roy Matsuda
Jeffrey Powell

Central Pacific Hurricane Center
Honolulu, Hawaii

February 2005

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Overview of the 2004 Central North Pacific Tropical Cyclone Season

Total activity for the tropical cyclone season was slightly below normal, with three systems occurring within the area of responsibility of the Central Pacific Hurricane Center (CPHC). One tropical cyclone (01-C) developed within the central Pacific and the other two, Darby and Estelle, moved into the area from the eastern Pacific. Estelle was the strongest of the three systems and the only one of tropical storm intensity. There were no deaths recorded or property damage reported in the central North Pacific due to these three tropical cyclones.

Table 1. List of Tropical Cyclones
** denotes information for only that portion of the storm's lifetime in the central north Pacific (CPHC's area of responsibility).

Name	Dates	Minimum Pressure (hPa)	Maximum Sustained Winds (kt)
Tropical Depression 01-C	**July 5-6**	**1007**	**25**
Tropical Depression Darby	**August 1 ****	**1007 ****	**25 ****
Tropical Storm Estelle	**August 21-25 ****	**990 ****	**60 ****

Table 2. Overall Track Verification

Table entries are track forecast errors, measured in nautical miles. Values in parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	**44 (21)**	**70 (17)**	**93 (14)**	**139 (11)**	**197 (8)**	**252 (4)**	**n/a**
CLP5	**51 (22)**	**87 (18)**	**154 (14)**	**239 (12)**	**368 (8)**	**352 (4)**	**n/a**
GFDL	**40 (19)**	**60 (16)**	**80 (12)**	**105 (11)**	**129 (8)**	**99 (4)**	**n/a**
AVNI	**47 (20)**	**61 (16)**	**71 (14)**	**90 (12)**	**156 (8)**	**240 (4)**	**n/a**
AVNO	**59 (21)**	**79 (17)**	**78 (14)**	**93 (12)**	**143 (8)**	**216 (4)**	**n/a**
BAMS	**49 (22)**	**65 (18)**	**80 (14)**	**97 (12)**	**140 (8)**	**175 (4)**	**n/a**
BAMM	**50 (22)**	**71 (18)**	**89 (14)**	**111 (12)**	**139 (8)**	**153 (4)**	**n/a**
BAMD	**55 (22)**	**88 (18)**	**126 (14)**	**169 (12)**	**272 (8)**	**493 (4)**	**n/a**
LBAR	**33 (18)**	**72 (16)**	**119 (14)**	**155 (12)**	**216 (8)**	**293 (4)**	**n/a**
GUNA	**32 (18)**	**52 (15)**	**78 (13)**	**90 (12)**	**116 (8)**	**164 (4)**	**n/a**

Table 3. Overall Wind Verification.

Table entries are errors in maximum sustained wind speed forecasts, measured in knots. Values in the parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	**4 (21)**	**9 (17)**	**10 (14)**	**11 (11)**	**14 (8)**	**11 (4)**	**n/a**
AVNI	**5 (20)**	**7 (17)**	**10 (14)**	**12 (12)**	**17 (8)**	**28 (4)**	**n/a**
AVNO	**6 (21)**	**5 (17)**	**3 (14)**	**2 (12)**	**2 (8)**	**2 (4)**	**n/a**
GFDL	**9 (19)**	**9 (16)**	**10 (12)**	**9 (11)**	**13 (8)**	**14 (4)**	**n/a**
SHIP	**5 (22)**	**10 (18)**	**9 (14)**	**10 (12)**	**9 (8)**	**11 (4)**	**n/a**
SHFR5	**5 (22)**	**11 (18)**	**13 (14)**	**16 (12)**	**21 (8)**	**25 (4)**	**n/a**

TROPICAL DEPRESSION 01-C

5-6 July 2004

HISTORY: Tropical Depression (TD) 01-C developed out of an organized thunderstorm cluster along the Inter-tropical Convergence Zone (ITCZ). Based upon the satellite appearance of persistent cold cloud tops and a well defined cirrus outflow,CPHC issued its initial advisory for tropical depression (TD) 01-C at 0300 UTC 5 July. The center of 01-C was near 6.8°N 164.7°W or about 700 miles south-southeast of Johnston Island. Maximum sustained winds were estimated to be 25 kt. TD-01C moved rapidly west at 15kt and ultimately never developed any stronger. Within 24 hours, the convection had diminished and TD 01-C quickly dissipated. On a historical note, TD-01C was the farthest south a central North Pacific tropical cyclone has developed since the February and March 1992 off-season tropical cyclones Ekeka and Hali developed between 4°N and 5°N.

SYNOPTIC FACTORS: QuikSCAT satellite data indicated that 01-C formed well south and within the seasonal east to west surface trough. Conditions appeared generally supportive for some development

as high pressure ridging was firmly positioned at all levels to the north of01-C, which was indicative of minimal directional shearing, and sea surface temperatures (SST) were near 28°C. On the negative, the rapid westward movement of 01-C likely indicated strong speed shear within the surrounding environment. Despite the fact that global numerical models, forecast guidance and the official CPHC forecast all were indicating that 01-C would move northwest into a more favorable environment and intensify, it instead rapidly dissipated within 24 hours. The demise of 01-C was likely due to a combination of strong environmental vertical wind speed shear and convergence within the ITCZ creating convection on the edge of the system and thus interfering with 01-C's developing circulation.

Table 4. Best Track Data

Date/Time (UTC)	Latitude (N)	Longitude (W)	Pressure (hPa)	Wind Speed (kt)	Stage/Notes
05 / 0000	6.8	164.7	1007	25	tropical depression
05 / 0600	6.8	166.4	1007	25	"
05 / 1200	6.8	167.0	1007	25	"
05 / 1800	6.8	167.5	1008	20	"
06 / 0000	7.0	167.9	1010	20	dissipating

Table 5. Overall Track Verification.
Table entries are track forecast errors, measured in nautical miles. Values in parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	122 (3)	165 (1)	n/a	n/a	n/a	n/a	n/a
CLP5	130 (4)	153 (2)	n/a	n/a	n/a	n/a	n/a
GFDL	93 (3)	154 (1)	n/a	n/a	n/a	n/a	n/a
AVNI	111(2)	n/a	n/a	n/a	n/a	n/a	n/a
AVNO	101 (3)	143 (1)	n/a	n/a	n/a	n/a	
BAMS	101 (4)	128 (2)	n/a	n/a	n/a	n/a	n/a
BAMM	94 (4)	119 (2)	n/a	n/a	n/a	n/a	n/a
BAMD	103 (4)	112 (2)	n/a	n/a	n/a	n/a	n/a
LBAR	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GUNA	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Table 6. Overall Wind Verification.

Table entries are errors in maximum sustained wind speed forecasts, measured in knots. Values in the parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	**3 (3)**	**10 (1)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
AVNI	**4 (2)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
AVNO	**1 (3)**	**6 (1)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
GFDL	**20 (3)**	**19 (1)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
SHIP	**11 (4)**	**24 (2)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**
SHFR5	**8 (4)**	**20 (2)**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

Figure 1. Best Track for TD-01C

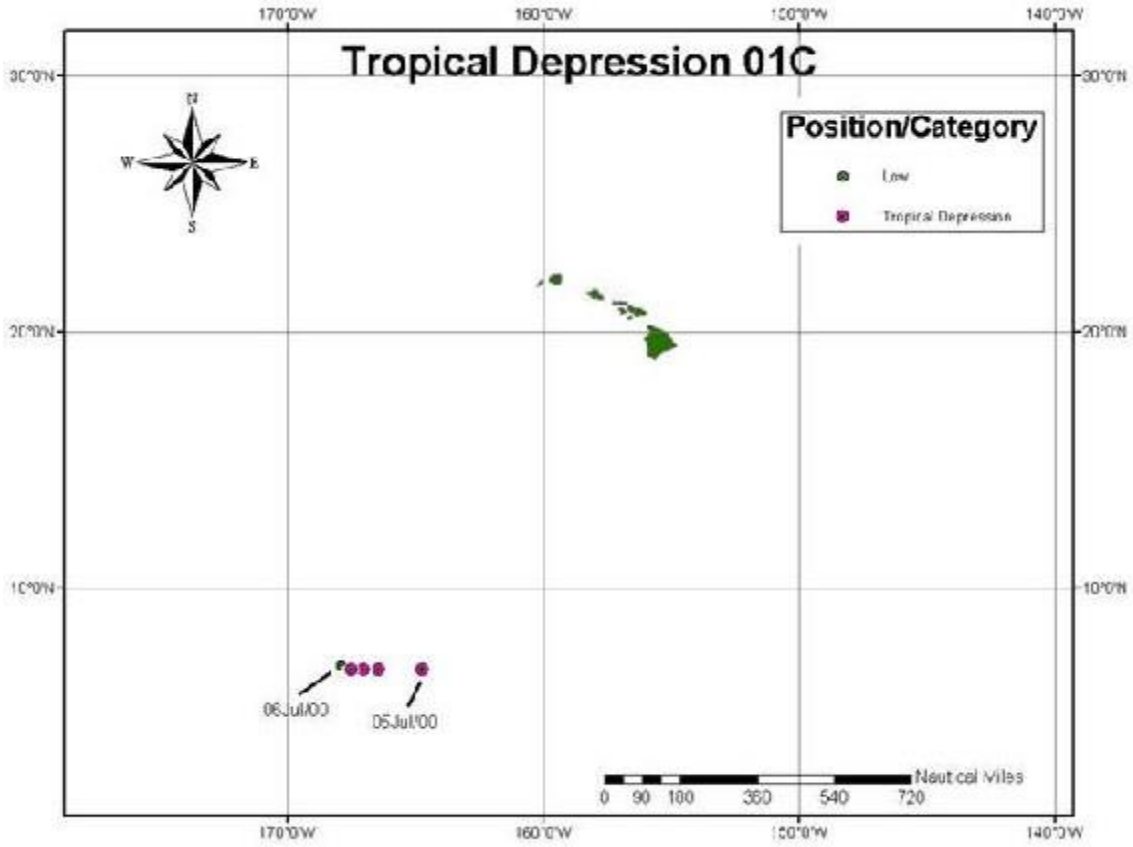
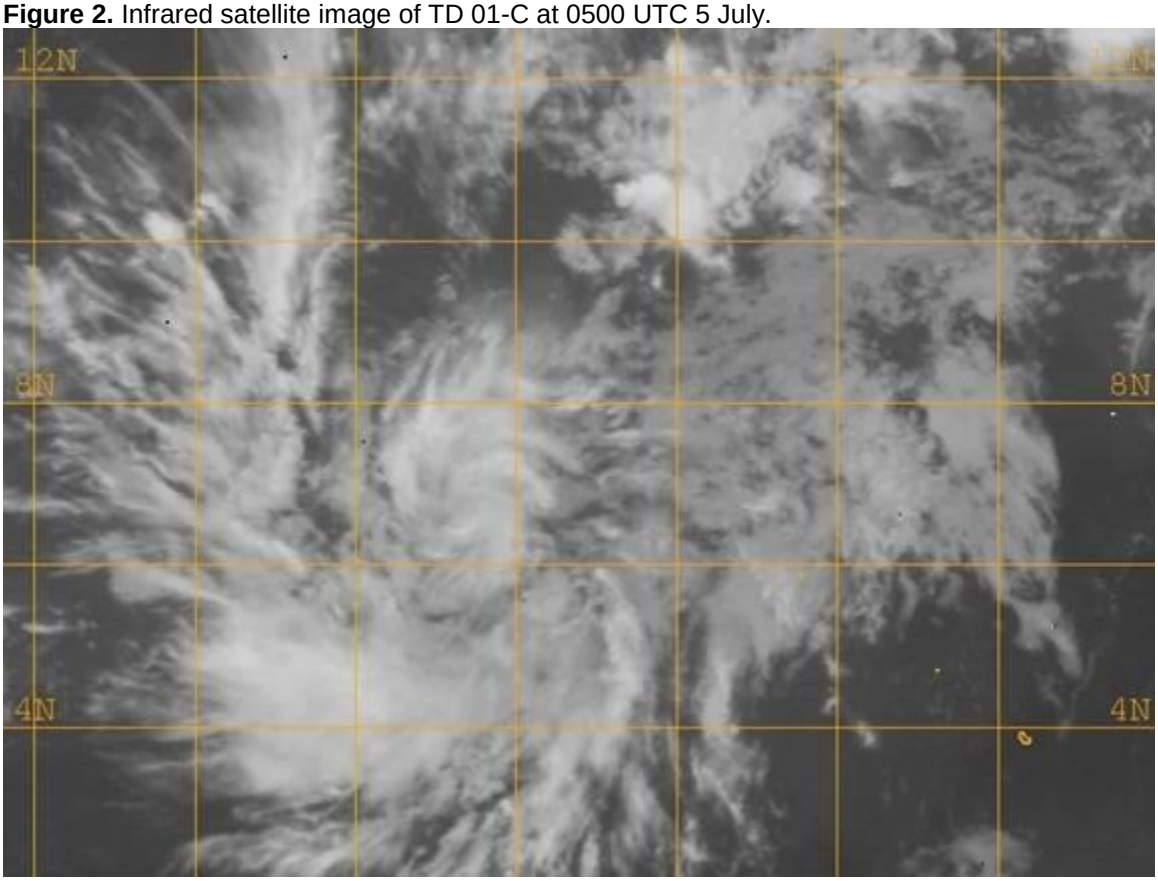


Figure 2. Infrared satellite image of TD 01-C at 0500 UTC 5 July.



TROPICAL DEPRESSION DARBY

1 August 2004

HISTORY: On 26 July, the Tropical Prediction Center (TPC) classified a persistent organized area of convection as TD 05-E in the eastern North Pacific. The system continued to intensify and was given the name Darby. Darby reached peak intensity of 105 kt on 29 July and then began rapidly weakening as it moved west. Darby crossed into the central North Pacific and the CPHC area of responsibility near 19°N at about 2100 UTC 31 July as a 25 kt depression with no associated deep convection. CPHC only issued two bulletins on Darby before it was declared a remnant low at 0600 UTC 1 August. Darby remained a well defined low level cloud system for several days with sporadic short-lived episodes of deep convection occurring as it continued moving west toward the main Hawaiian Islands. Ultimately moisture from the Darby remnants spread across the state and produced locally heavy rainfall. Due to the short lifetime of less than 12 hours that Darby existed in the central Pacific as a tropical cyclone, no forecast verification results are available.

SYNOPTIC FACTORS: As Darby crossed 140°W, the center of circulation was marked by a well-defined swirl of low clouds, keeping fix confidence high, but deep convection had ceased. Vertical shear was never favorable west of 140°W for Darby. An upper trough west of the main Hawaiian Islands provided steadily strengthening southwest to northeast flow west of 145°W, ensuring that even if Darby did redevelop it would be quickly sheared. Although SSTs were about 1°C above average across the tropical portion of the central North Pacific, SSTs were slightly cooler than needed for tropical cyclone development and maintenance in the vicinity of Darby (around 26°C). As rotational momentum

dissipated, the remnant surface circulation opened into a trough by the time it reached 150°W. The upper trough west of the Hawaiian Islands played a shower-enhancing role as the moisture field from the remnants of Darby moved across the islands.

IMPACTS: As a tropical cyclone, Darby had no significant impact in the central North Pacific. However the moisture field from Darby's remnants passed over the islands from 2 August to 5 August. An upper level trough was located just to the northwest of the main islands, and this made the atmosphere slightly unstable and produced favorable dynamics for precipitation over Hawaii. As the remnant swirl of Darby moved closer to the unstable region, thunderstorms began to develop. First impacted was the Big Island of Hawaii where locally heavy rainfall occurred, particularly over the normally dry Kona side. Rainfall amounts of 2 to 5 inches over a few hours were reported, and this led to flooding and closures of several roads. The following day heavy rains occurred on the southeast flank of Mount Haleakala on Maui producing minor stream flooding. Thunderstorms redeveloped as the moisture spread to Oahu, producing 2 to 5 inches across the island. This resulted in flooding of some streams and roadways.

A total of 3.06 inches fell at the Honolulu Airport. This helped make it the wettest August on record in Honolulu, since official records began in 1947. The previous wettest August was in 1959 when heavy rains occurred in concert with the passage of Hurricane Dot.

Table 7. Best Track Data

Date/Time (UTC)	Latitude (N)	Longitude (W)	Pressure (hPa)	Wind Speed (kt)	Stage/Notes
01 / 0000	19.0	140.4	1007	25	tropical depression
01 / 0600	19.3	142.0	1007	25	"
01/1200	19.5	143.8	1009	20	remnant low

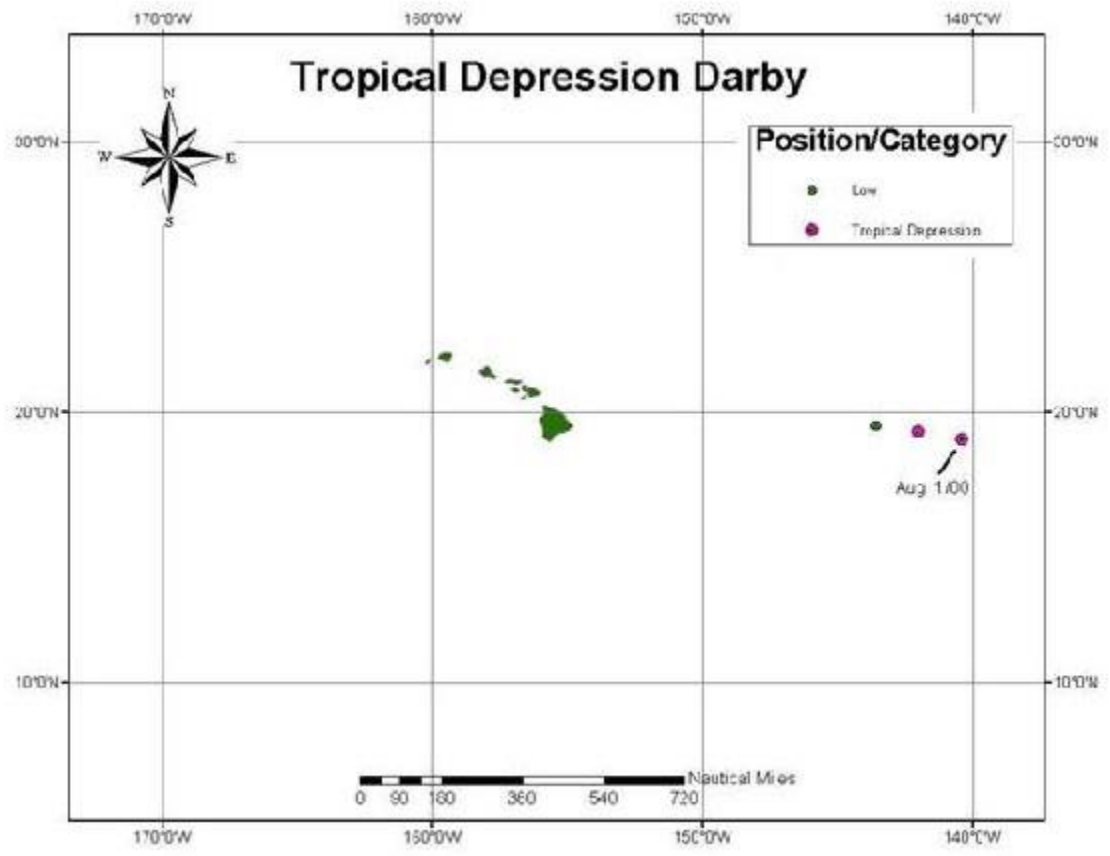
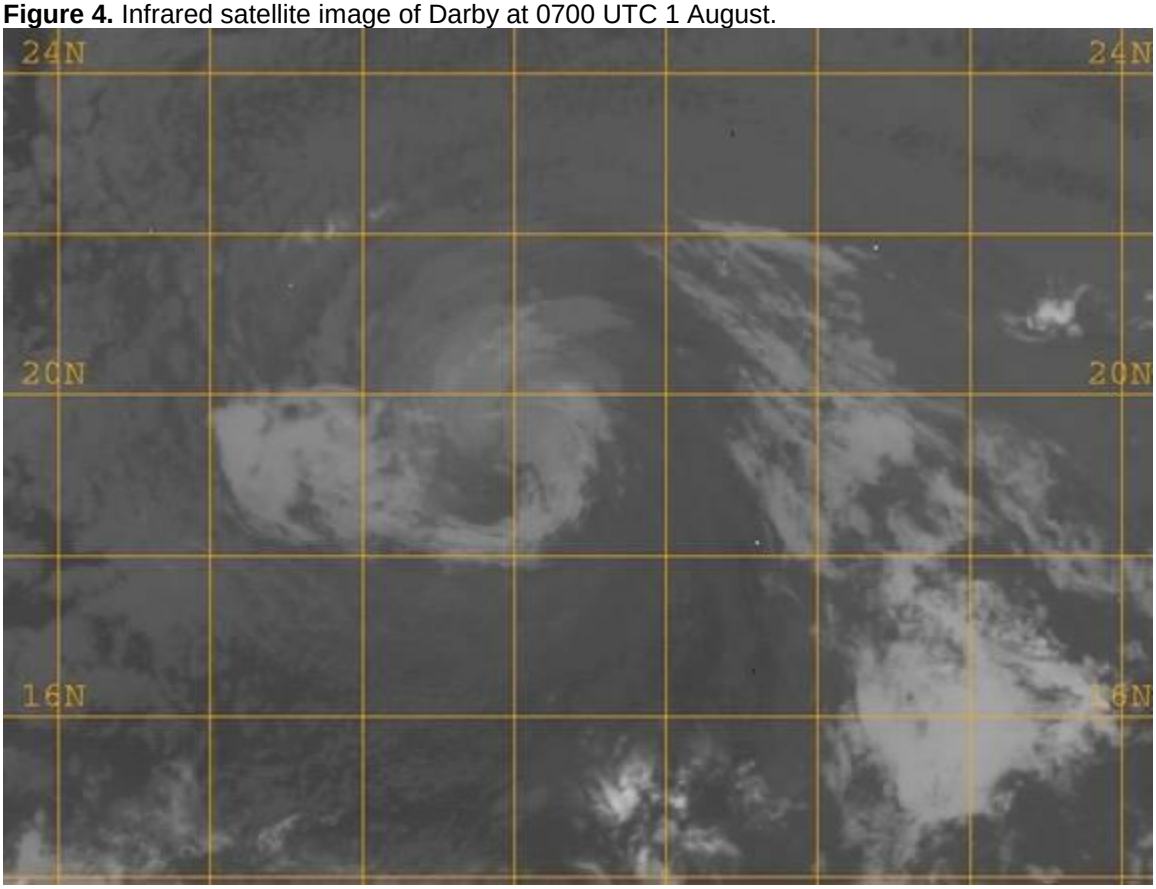

Tropical Depression Darby
Position/Category
Low
Tropical Depression
N
W
E
S
170°0'W
160°0'W
150°0'W
140°0'W
30°0'N
20°0'N
10°0'N
Aug 1 00
Nautical Miles
0 90 180 360 540 720

Figure 4. Infrared satellite image of Darby at 0700 UTC 1 August.



TROPICAL STORM ESTELLE

21 - 25 August 2004

HISTORY: Estelle formed over the Eastern Pacific as TD 07-E on 19 August about 1250 nm east-southeast of Hilo Hawaii. TD 07E gradually intensified over the next two days, becoming Tropical Storm (TS) Estelle at 0600 UTC 20 August. Following a west northwest course, Estelle, with maximum 1-minute sustained winds estimated near 55 kt, crossed 140°W near 14.6°W at 0600 UTC 21 August.

Estelle turned to the northwest and intensified during the early overnight of 21 August, reaching maximum sustained winds estimated at 60 kt. The near hurricane force winds did not last long, however, and by 0000 UTC 22 August, Estelle started to wind down. At 0000 UTC 23 August, Estelle was downgraded to a TD after making a turn to the west-southwest. Finally, at 1800 UTC 24 August Estelle became a remnant low about 310 nautical miles south of South Point on the Island of Hawaii. CPHC wrote the last bulletin on the system at that time. The remnant low continued to move west-southwest before finally dissipating shortly before 0000 UTC 26 August.

SYNOPTIC FACTORS: Estelle assumed a northwest course after crossing 140°W, the result of a weakness in the subtropical ridge northwest of the storm. The system was compact and well-organized with a cold central dense overcast. With sea surface temperatures of 27°C and only minimal vertical wind shear, Estelle reached maximum intensity just west of 140°W.

Global numerical models were correct in indicating that the subtropical ridge was going to strengthen and build westward, and that Estelle would turn to the west and accelerate. After making the turn, Estelle moved over sea surface temperatures of 25 to 26°C, and began to slowly spin down.

Of more importance, the models indicated that a Tropical Upper Tropospheric Trough (TUTT) would remain over Hawaii while the surface ridge strengthened. This meant that Estelle would move into increasing east northeast low level winds south of the surface ridge and increasing southwest winds aloft east of the upper level trough. The unfavorable shear environment quickly weakened Estelle to a TD. The resultant low level circulation with limited deep convection was then caught up in the trade flow, eventually becoming a remnant low well south of Hawaii.

Table 8. Best Track Data

Date/Time (UTC)	Latitude (N)	Longitude (W)	Pressure (hPa)	Wind Speed (kt)	Stage/Notes
21 / 0600	14.6	140.1	992	55	tropical storm
21 / 1200	15.0	140.8	989	60	"
21 / 1800	15.4	141.2	990	60	"
22 / 0000	15.8	141.6	995	55	"
22 / 0600	16.0	142.1	996	50	"
22 / 1200	16.1	142.4	998	35	"
22 / 1800	16.2	142.8	998	35	"
23 / 0000	16.4	143.4	998	30	tropical depression
23 / 0600	16.4	144.2	1002	30	"
23 / 1200	16.3	145.1	1006	30	"
23 / 1800	16.2	145.9	1008	30	"
24 / 0000	16.0	147.0	1010	25	"
24 / 0600	15.7	148.2	1012	25	"
24 / 1200	15.3	149.2	1012	25	"
24 / 1800	15.0	150.5	1012	20	remnant low
25 / 0000	14.5	151.5	1012	20	"
25 / 0600	14.3	152.5	1012	20	"
25 / 1200	14.2	153.2	1012	20	"
25 / 1800	14.0	154.0	1012	20	"

Table 9. Overall Track Verification.

Table entries are track forecast errors, measured in nautical miles. Values in parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	**31 (18)**	**64 (16)**	**93 (14)**	**139 (11)**	**197 (8)**	**252 (4)**	**n/a**
CLP5	**33 (18)**	**78 (16)**	**154 (14)**	**239 (12)**	**368 (8)**	**352 (4)**	**n/a**
GFDL	**30 (16)**	**54 (15)**	**80 (12)**	**105 (11)**	**129 (8)**	**99 (4)**	**n/a**
AVNI	**40 (18)**	**61 (16)**	**71 (14)**	**90 (12)**	**156 (8)**	**240 (4)**	**n/a**
AVNO	**52 (18)**	**75 (16)**	**78 (14)**	**93 (12)**	**143 (8)**	**216 (4)**	**n/a**
BAMS	**37 (18)**	**57 (16)**	**80 (14)**	**97 (12)**	**140 (8)**	**175 (4)**	**n/a**
BAMM	**40 (18)**	**65 (16)**	**89 (14)**	**111 (12)**	**139 (8)**	**153 (4)**	**n/a**
BAMD	**45 (18)**	**85 (16)**	**126 (14)**	**169 (12)**	**272 (8)**	**493 (4)**	**n/a**
LBAR	**33 (18)**	**72 (16)**	**119 (14)**	**155 (12)**	**216 (8)**	**293 (4)**	**n/a**
GUNA	**32 (18)**	**52 (15)**	**78 (13)**	**90 (12)**	**116 (8)**	**164 (4)**	**n/a**

Table 10. Overall Wind Verification.

Table entries are errors in maximum sustained wind speed forecasts, measured in knots. Values in the parentheses indicate the number of forecasts. Values in bold represent guidance forecast errors equal to or less than the official CPHC forecast.

Forecast	12-hr	24-hr	36-hr	48-hr	72-hr	96-hr	120-hr
CPHC	**4 (18)**	**8 (16)**	**10 (14)**	**11 (11)**	**14 (8)**	**11 (4)**	**n/a**
AVNI	**5 (18)**	**7 (16)**	**10 (14)**	**12 (12)**	**17 (8)**	**28 (4)**	**n/a**
AVNO	**7 (18)**	**4 (16)**	**3 (14)**	**2 (12)**	**2 (8)**	**2 (4)**	**n/a**
GFDL	**6 (16)**	**9 (15)**	**10 (12)**	**9 (11)**	**13 (8)**	**14 (4)**	**n/a**
SHIP	**4 (18)**	**9 (16)**	**9 (14)**	**14 (10)**	**12 (9)**	**8 (11)**	**n/a**
SHFR5	**5 (18)**	**10 (16)**	**13 (14)**	**16 (12)**	**21 (8)**	**25 (4)**	**n/a**

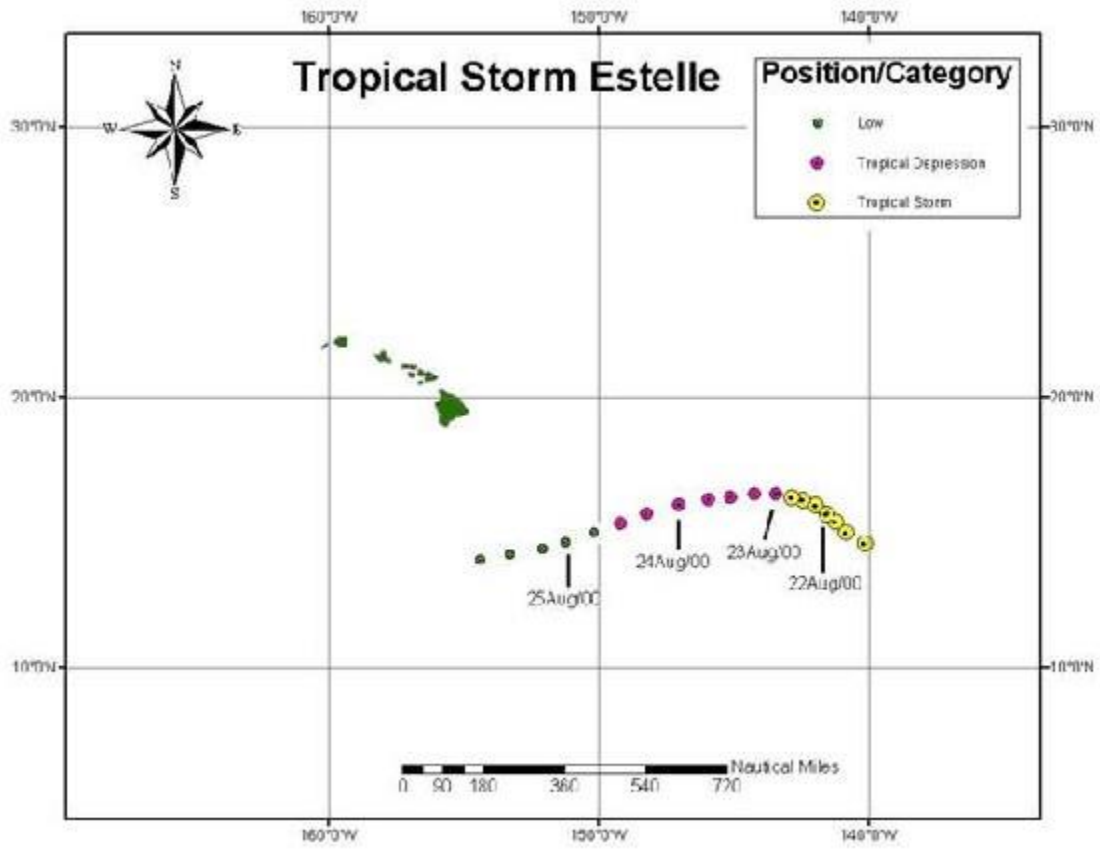
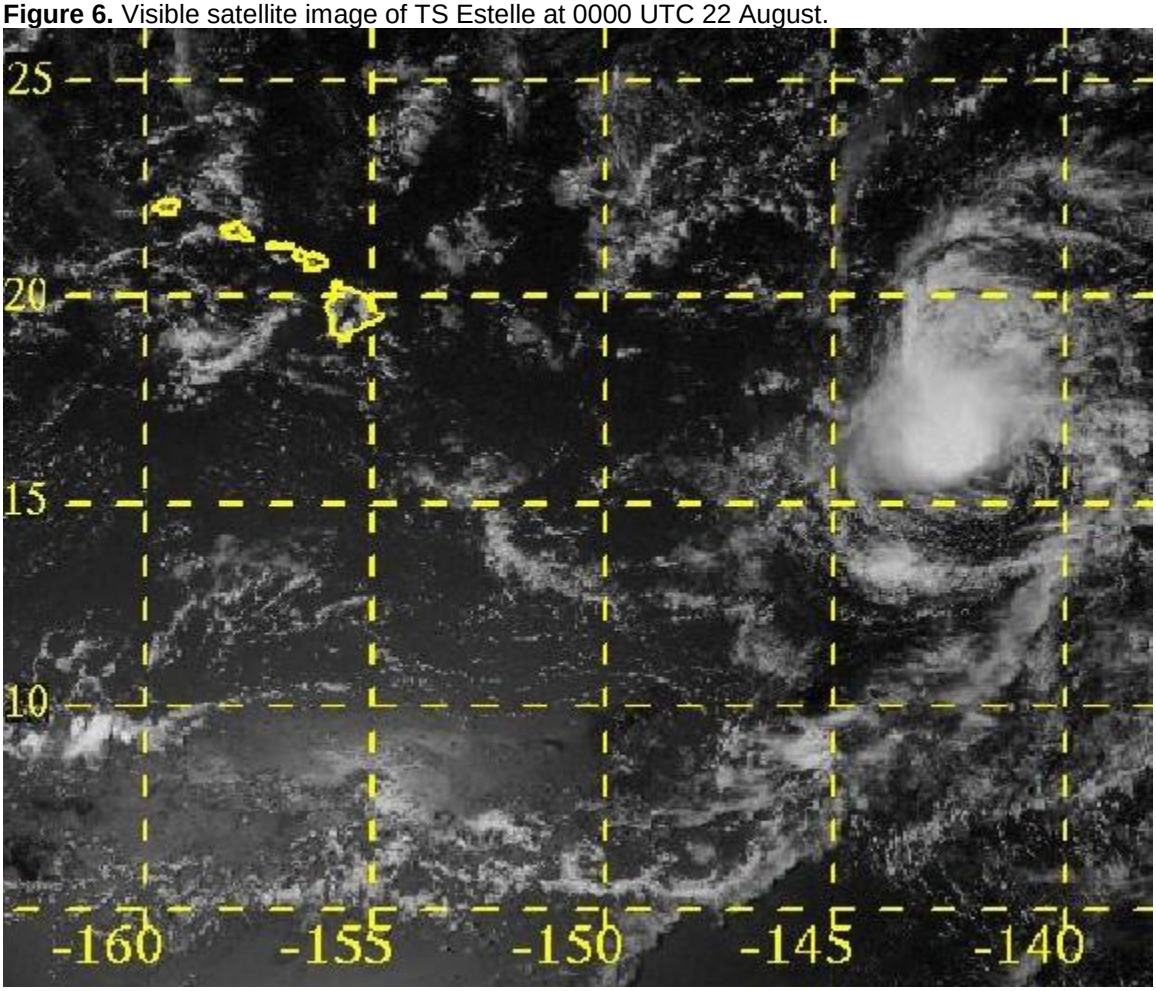

Tropical Storm Estelle
Position/Category
Low
Tropical Depression
Tropical Storm
160°0'W
150°0'W
140°0'W
30°0'N
20°0'N
10°0'N
N
W
E
S
25Aug'00
24Aug'00
23Aug'00
22Aug'00
Nautical Miles
0 90 180 360 540 720

Figure 6. Visible satellite image of TS Estelle at 0000 UTC 22 August.



ACRONYMS that may have been used in this report.	
Acronym	**Full Spelling/Definition**
AOR	**Area of Responsibility**
AVNO	**Operation global forecast system model**
BAMD	**Deep Layer Beta Advection Model (mean layer averaged between 850 hPa and 250 hPa)**
BAMM	**Medium Layer Beta Advection Model (mean layer averaged between 850 hPa and 400 hPa)**
BAMS	**Shallow Layer Beta Advection Model (mean layer averaged between 850 hPa and 700 hPa)**
CLIP	**Climatology and Persistence**
CPHC	**Central Pacific Hurricane Center**
GFDL	**Geophysical Fluid Dynamics Laboratory model**
hPa	**Hectopascal (formerly millibar)**

ITCZ	**Inter-tropical Convergence Zone**
JTWC	**Joint Typhoon Warning Center**
kts	**knots**
LBAR	**Barotropic limited area sine transform**
mb	**millibars**
NA	**Not Available**
NGPS	**NOGAPS (Navy Operational Global Atmospheric Prediction System) Vortex Tracking Routine**
NHC	**National Hurricane Center**
nm	**nautical miles**
P91E	**Pacific Statistical Dynamic Model (adapted from NHC90 for the Eastern Pacific)**
SHIFR	**Statistical Hurricane Intensity Forecast**
SHIP	**Statistical Hurricane Intensity Prediction**
SST	**Sea Surface Temperature**
TD	**Tropical Depression**
TPC	**Tropical Prediction Center, Miami, FL**
TUTT	**Tropical Upper Tropospheric Trough**
UTC	**Universal Time Coordinated**
WFO	**Weather Forecast Office**