SUPER TYPHOON BING (19W)

I. HIGHLIGHTS

Super Typhoon Bing (STY) (19W) was the third of four tropical cyclones that would form within the monsoon trough during a period of eight days. It produced heavy rainfall while tracking near Guam as a tropical storm on 29 August. Rapid intensification began as Bing moved west of Guam, and two days later it became the fifth super typhoon of the 1997 season.

II. TRACK AND INTENSITY

By 26 August, the monsoon trough extended from the South China Sea to north of the Philippine Islands, through the central Mariana and Marshall Islands to the dateline. Low level westerly winds were observed all the way to 177E. During a normal year, the monsoon trough usually does not extend past 160E. The observed eastward extension was most likely an effect of El Niño.

The disturbance that became STY Bing (19W) started in the eastward extension of the monsoon trough near the Marshall Islands. The disturbance formed to the south-southeast of a large scale upper level anticyclone. Vigorous convection associated with the disturbance was enhanced by strongly divergent upper level wind flow. At 2330Z on 25 August, the Significant Tropical Weather Advisory (ABPW) was re-issued to add the disturbance as a suspect area. However, the convection (see Figure 3-19-1) quickly organized and a Tropical Cyclone Formation Alert (TCFA) was issued only eight hours later. At 0600Z on the 24th, the disturbance was upgraded to a Tropical Depression (TD).

The newly formed TD 19W tracked westward at speeds of 13 to 15 kt (24 to 28 km/hr). This was due to strong low to mid-level easterly steering flow south of the subtropical ridge. This westward track continued as it passed near Guam and Rota on 29 August. Fortunately for the islands, only slow intensification took place as it approached. At 1800Z on the 28th, Bing was upgraded to tropical storm intensity, but had an intensity of only 40 kt (21 m/sec) during its passage through the Marianas (Figure 3-19-2). Shortly after passing the Marianas, the system underwent a period of rapid intensification, beginning about 1200Z on 30 August and ending 54 hours later with a peak intensity of 135 kt (69 m/sec). Figure 3-19-3 shows visual satellite imagery which illustrates how quickly the central cloud structure changed in little more than a day. The satellite image at left shows Bing as a 80 kt (41 m/sec) typhoon with a developing eye, while the image at right, when Bing's intensity was near 130 kt (67 m/sec), shows a smooth eyewall with a very well defined eye. This represented a change of approximately two Dvorak "T" numbers. During the intensification process, mid-level ridging began to build to the east-southeast of the tropical cyclone causing the steering flow to gradually shift from an easterly to south-southeasterly. At approximately the same time, mid-latitude disturbances moving down the east side of a large mid-level ridge over eastern Asia were acting to weaken the mid level subtropical ridge structure north of the tropical cyclone. Both factors were significant in causing Bing’s forward motion to slow as a turn to the north developed on 30 August. On 31 August, the

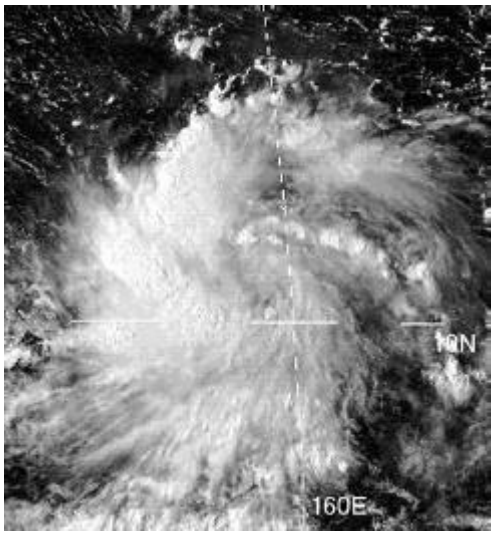


Figure 3-19-1 Visible satellite imagery of the tropical disturbance that became Bing. Valid time of imagery is 260533Z.

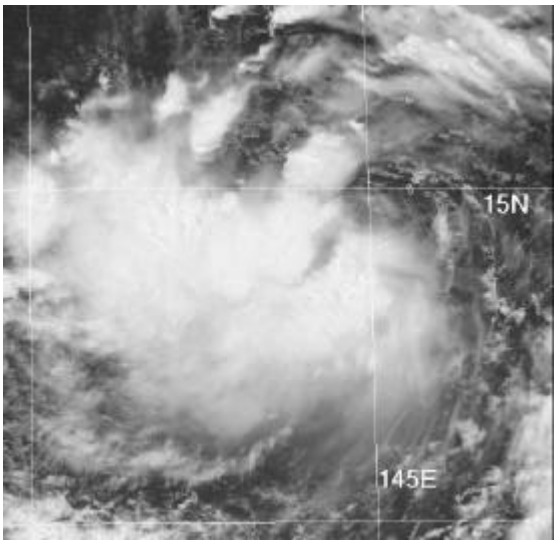
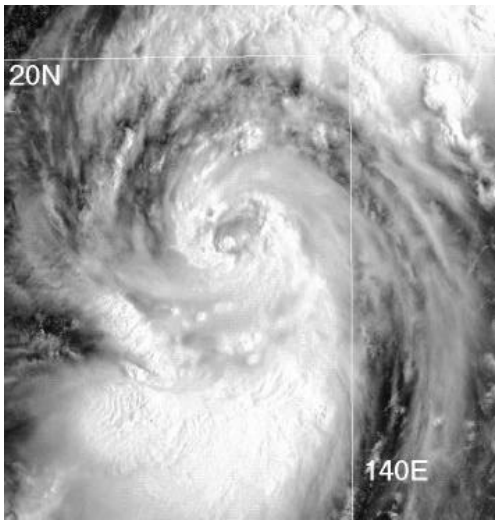


Figure 3-19-2 Visible satellite imagery of Tropical Storm Bing (19W) as it passed through the Rota Channel on 290333Z August.



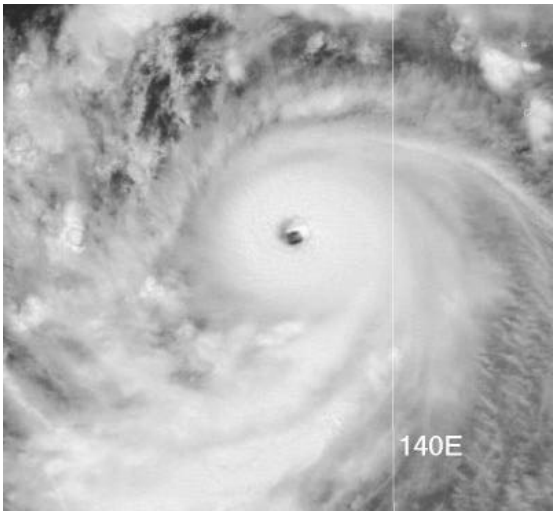


Figure 3-19-3 Visual Satellite imagery of Super Typhoon Bing (19W) during rapid intensification. The valid time of the left image is 302330Z August and the intensity was 80 kt (41 m/sec). The valid time of the right image is 010334Z September and the intensity was near 130 kt (67 m/sec).

cyclone began following a northward oriented track with speeds between 11 and 13 kt (20 to 24 km/hr), thus completing the transition from a Standard (S) to a Poleward Oriented (PO) synoptic pattern as described by the systematic and integrated approach of Carr and Elsberry (1994). As the cyclone continued north, it passed west of the islands of Iwo Jima and Chi Chi Jima on 01 and 02 September, respectively. During the closest point of approach, each island reported sustained winds of 30 kt (15 m/sec) with peak gusts ranging from 52 kt (26 m/sec), at Iwo Jima, to 40 kt (21 m/sec), at Chi Chi Jima. By 02 September, STY Bing was located south of the Japanese island of Honshu. Although the system was beginning to weaken, it remained a threat to Honshu. However, a shift in the sub-tropical ridge over Honshu enabled a band of relatively strong westerly winds to develop across the Japanese islands, causing the steering flow to become more westerly. Bing's track shifted to the northeast, and Honshu was spared.

By 03 September, Bing had moved far enough northward that it began to merge with a strong mid- and upper-level westerly wind flow. Accordingly, Bing turned towards the east-northeast and accelerated to speeds above 30 kt (15 m/sec) by 04 September. By 1000Z on the 4th, Special Sensor Microwave/Imager (SSM/I) indicated that upper-level westerly winds had sheared the system's convection and left the low-level circulation center exposed. Figure 3-19-4 shows Bing on 05 September. Although there was no longer central convection, it remained a potent extratropical cyclone with maximum sustained winds estimated to be 55 kt (28 m/sec).

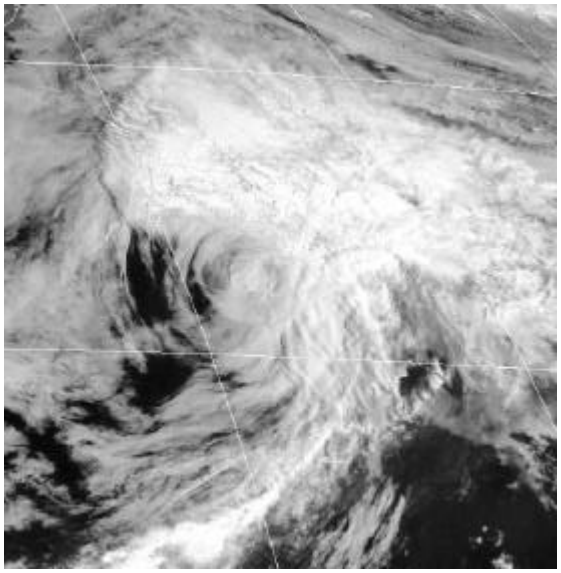


Figure 3-19-4 Visible satellite imagery of Super Typhoon Bing (19W) as a potent extratropical system with maximum sustained winds estimated to be 55 kt (28 m/sec). Valid time of image is 042227Z September.

III. DISCUSSION

a) Heavy Rainfall over Guam

Although STY Bing (19W) was a minimal tropical storm as it passed through the Rota channel, just north of Guam, it did bring a lot of rain. The National Weather Service Office at Tiyan reported 5.19 inches (13.2 cm) as Bing passed on 29 August. Andersen Air Force Base reported 6.17 inches (15.7 cm) of rain during a 36 hour period beginning at 0900Z on 28 August. The soil on the island was already saturated from repeated rainfall during the month, and the additional rain resulted in flooding of low-lying areas and around small streams. The excessive rainfall triggered a landslide in the village of Santa Rita on 30 August that caused extensive local damage. August 1997 turned out to be the wettest month in Guam's history as the final rainfall total reached 39.5 inches (100 cm). This was partially due to the monsoon trough being positioned over the southern and central Mariana Islands, allowing numerous tropical disturbances to track close to the island.

b) The Formation of Concentric Eye Walls

After Bing reached its peak intensity of 135 kt (69 m/sec), satellite and microwave imagery indicated the development of concentric eyewalls. Figure 3-19-5 shows the development over a 48 hour period. The image at the left shows Bing at peak intensity with a very small eye and intense convection in the eyewall. The middle image is about 24 hours later, when the cyclone had an intensity of 110 kt (56 m/sec). The central convection has diminished although a small eye feature is still discernable. However, convection in the outer bands has started to increase and wrap around the center. The image at right shows a newly formed, very large outer eye measuring approximately 90 nm (167 km) in diameter. The inner eye has almost disappeared with only a very small area of central convection remaining. At this point, the intensity has weakened to 85 kt (44 m/sec). This eyewall cycling process was very similar to that which occurred in STY Winnie (14W), TY Amber (18W) and STY Paka (05C) during the 1997 Western Pacific season.

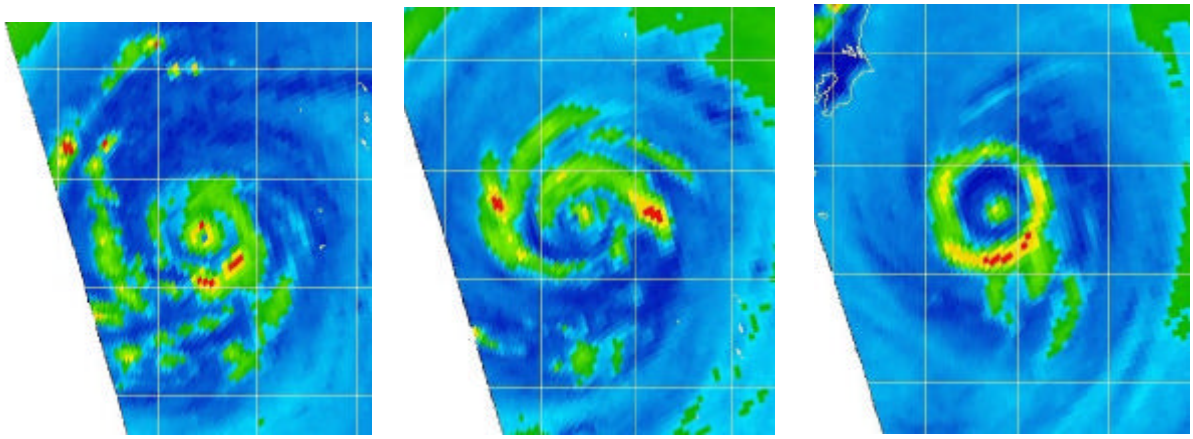


Figure 3-19-5 The development of concentric eye walls in Super Typhoon Bing (19W) as seen by SSM/I. From left to right, the valid times are 001011Z, 021205Z, and 030946Z September.

c) A comparison between two objective aids in forecasting Super Typhoon Bing's (19W) motion track

Many objective aids (forecast models) are used by the Typhoon Duty Officer (TDO) in determining the track forecast of a tropical cyclone. In order to produce the best forecast product possible, TDOs are thoroughly trained in the weaknesses and strengths of the various objective aids under certain synoptic conditions. Some examples of these strengths and weaknesses can be seen in an analysis of Bing's track. An example is the Colorado State University Model (CSUM), which is a statistical-dynamical model based on the work of Matsumoto (1984). The model is further discussed in Chapter 5, section 2.3.2. Because CSUM uses statistically developed regression equations, it has a problem predicting future changes in the synoptic environment which could alter the tropical cyclone's motion. This is illustrated in Figure 3-19-6. Although a distinct poleward bias can be seen, CSUM does a reasonable job of predicting the future track as long as the system remains south of the subtropical ridge. For example, during a 24-hour period beginning at 0000Z on the 28th, CSUM's 72-hour forecast errors averaged about

1.5 times lower than the Naval Oceanographic Global Atmospheric Prediction System (NOGAPS), a purely dynamical model. However, one to two days prior to the development of a poleward/poleward oriented pattern, CSUM continues to indicate westward motion. Westward forecasts continue until the model determines that the tropical cyclone is on the subtropical ridge axis, which is itself triggered by a northward (330 to 029 degrees) motion vector. Once the northward motion has been detected, CSUM begins to forecast northward motion. Bing's track was predominately northward by 1800Z on 30 August.

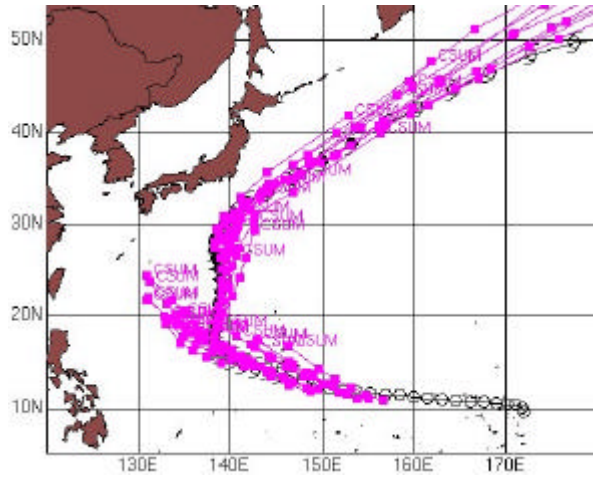


Figure 3-19-6 Forecast tracks given by CSUM for Super Typhoon Bing (19W).

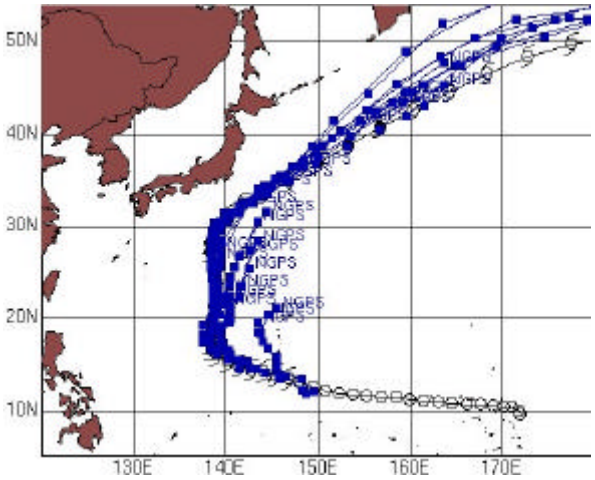
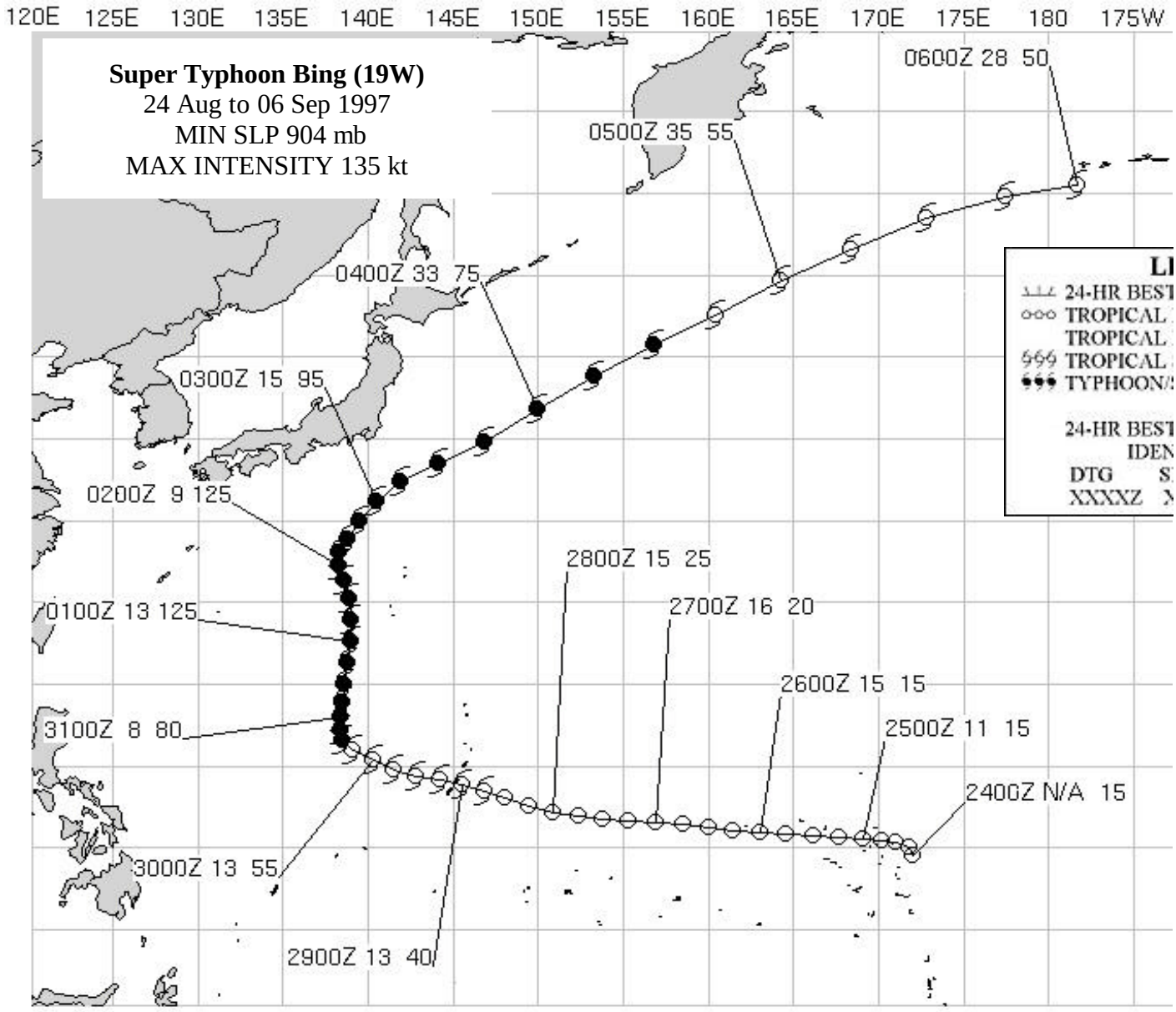


Figure 3-19-7: Forecast tracks given by NOGAPS for Super Typhoon Bing (19W).

On the other hand, NOGAPS is known to do fairly well when compared to other models in transitioning from a Standard/Dominant Ridge (S/DR) to a Poleward/Poleward Oriented (P/PO) environment. One documented bias of NOGAPS is to indicate northward motion for a TC a few days before it actually occurs. In the case of Super Typhoon Bing (19W), this is illustrated by Figure 3-19-7. Both NOGAPS and CSUM had a tendency to be right of the forecast track during the northward motion portion of the track. However, during the 54-hour period beginning at 0000Z on 31 August during which northward motion was prevalent, NOGAPS errors were about 2.3 times lower than CSUM. The tendency of NOGAPS to surpass CSUM in this synoptic regime has also been documented. These and other model tendencies are known by the TDOs, greatly enhancing their ability to choose among a plethora of aids during forecast development.

IV. IMPACT

The main impact on the island of Guam was heavy rainfall and associated flooding. The previously mentioned landslide in Santa Rita caused extensive damage to the Namo Falls Tourist Park, as well as some broken sewage pipes, which allowed open sewage to flow into the Namo River. However, there were no reports of injuries. There were no reports of injuries or damage from the islands of Iwo and Chi Chi Jima.


120E 125E 130E 135E 140E 145E 150E 155E 160E 165E 170E 175E 180 175W
Super Typhoon Bing (19W)
24 Aug to 06 Sep 1997
MIN SLP 904 mb
MAX INTENSITY 135 kt
0600Z 28 50
0500Z 35 55
0400Z 33 75
0300Z 15 95
0200Z 9 125
0100Z 13 125
3100Z 8 80
3000Z 13 55
2900Z 13 40
2800Z 15 25
2700Z 16 20
2600Z 15 15
2500Z 11 15
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TYPHOON/
24-HR BEST
IDEN
DTG
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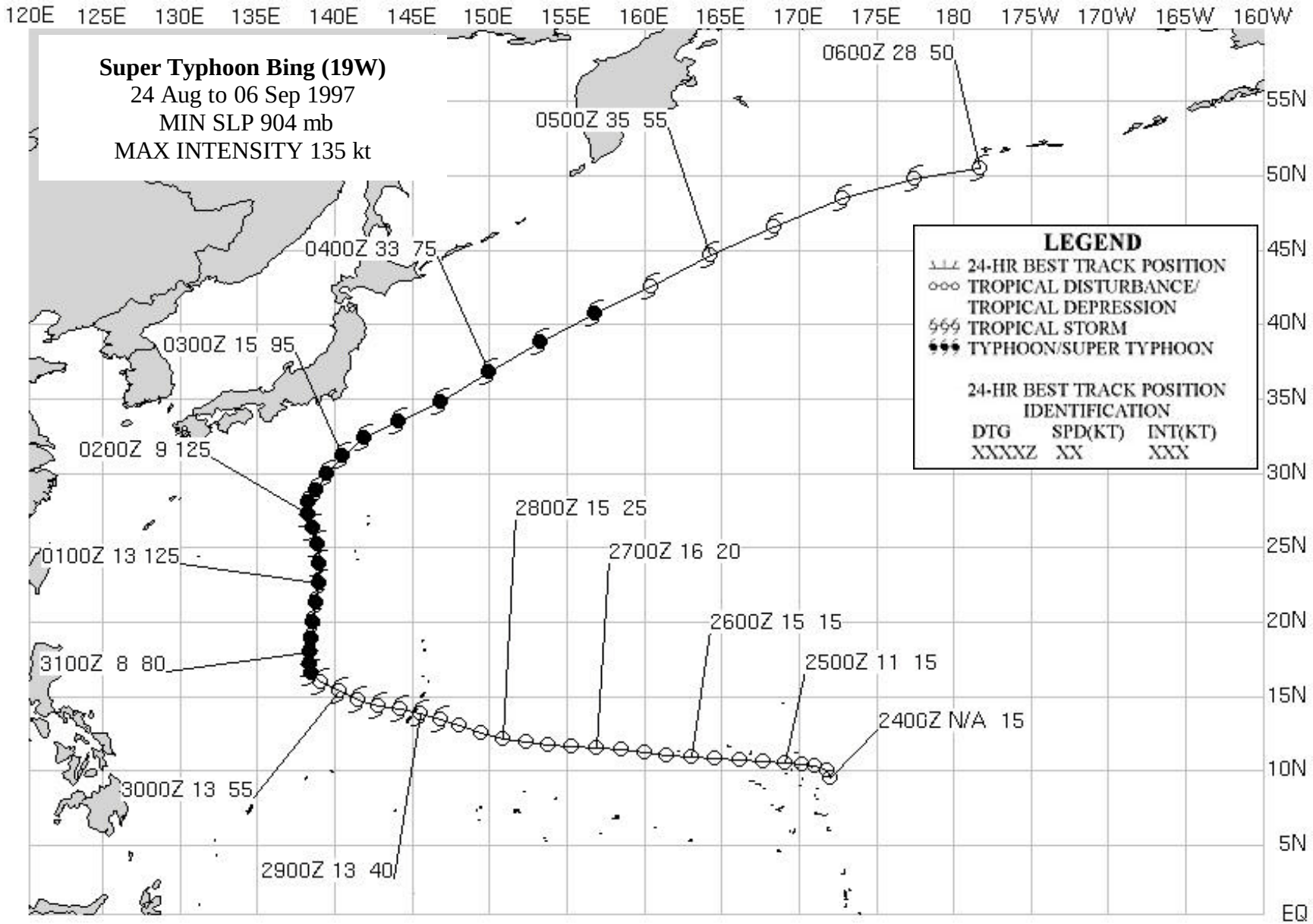
Super Typhoon Bing (19W)
24 Aug to 06 Sep 1997
MIN SLP 904 mb
MAX INTENSITY 135 kt
120E 125E 130E 135E 140E 145E 150E 155E 160E 165E 170E 175E 180 175W 170W 165W 160W
55N 50N 45N 40N 35N 30N 25N 20N 15N 10N 5N EQ
0600Z 28 50
0500Z 35 55
0400Z 33 75
0300Z 15 95
0200Z 9 125
0100Z 13 125
3100Z 8 80
3000Z 13 55
2900Z 13 40
2800Z 15 25
2700Z 16 20
2600Z 15 15
2500Z 11 15
2400Z N/A 15
LEGEND
24-HR BEST TRACK POSITION
TROPICAL DISTURBANCE/ TROPICAL DEPRESSION
TROPICAL STORM
TYPHOON/SUPER TYPHOON
24-HR BEST TRACK POSITION IDENTIFICATION
DTG SPD(KT) INT(KT)
XXXXZ XX XXX