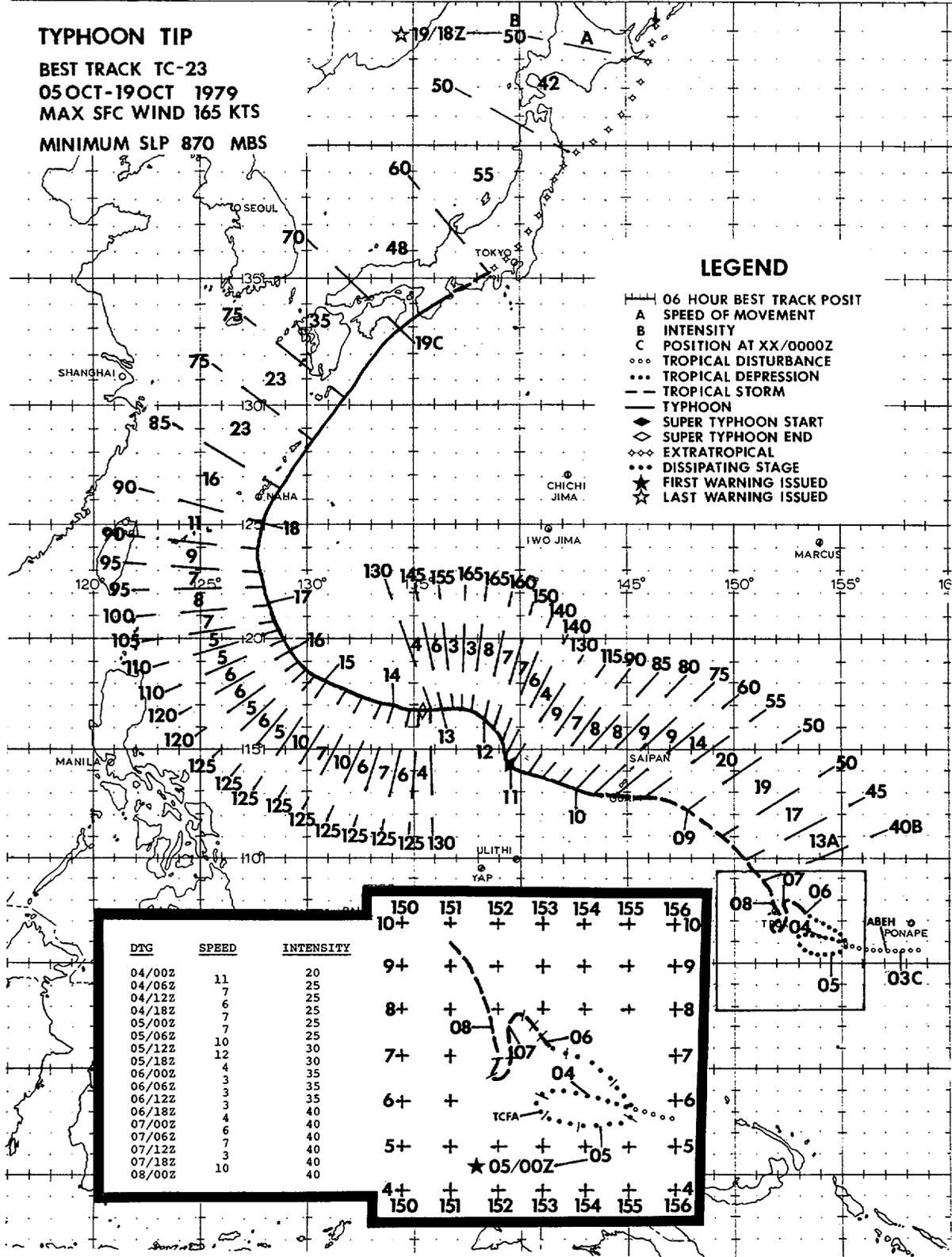


120° 125° 130° 135° 140° 145° 150° 155° 160°

TYPHOON TIP

BEST TRACK TC-23
05 OCT-19 OCT 1979
MAX SFC WIND 165 KTS
MINIMUM SLP 870 MBS



LEGEND

- 06 HOUR BEST TRACK POSIT
- A SPEED OF MOVEMENT
- B INTENSITY
- C POSITION AT XX/0000Z
- TROPICAL DISTURBANCE
- TROPICAL DEPRESSION
- TROPICAL STORM
- TYPHOON
- ◆ SUPER TYPHOON START
- ◇ SUPER TYPHOON END
- ◇◇ EXTRATROPICAL
- DISSIPATING STAGE
- ★ FIRST WARNING ISSUED
- ★ LAST WARNING ISSUED

DTG	SPEED	INTENSITY
04/00Z	11	20
04/06Z	7	25
04/12Z	6	25
04/18Z	7	25
05/00Z	7	25
05/06Z	10	25
05/12Z	12	30
05/18Z	4	30
06/00Z	3	35
06/06Z	3	35
06/12Z	3	35
06/18Z	4	40
07/00Z	6	40
07/06Z	7	40
07/12Z	3	40
07/18Z	10	40
08/00Z	10	40

Super Typhoon Tip was the most significant typhoon of the 1979 season, and possibly the most significant tropical cyclone this century. Forty aircraft reconnaissance missions were flown on Tip, which produced 60 fixes, and thus made it one of the most closely watched cyclones in recent memory. Aircraft and synoptic data showed that Tip achieved the lowest sea-level pressure ever observed in a tropical cyclone (870 mb) and also had the largest circulation pattern on record (nearly 1200 nm (2222 km) in diameter).

Satellite and synoptic data during the early part of October revealed an active monsoon trough that extended from the Marshall Islands through the Caroline Islands to Luzon. Three distinct circulations developed in this trough: One near Manila, which would become Typhoon Sarah; another southwest of Guam, which would become Tropical Storm Roger; and the last between Truk and Ponape, which was destined to become Super Typhoon Tip.

It is not possible to discuss the development of Tip without, at the same time, examining the development of TS Roger. The surface analysis for 030000Z showed the three circulations in the monsoon trough with strong cross-equatorial flow, most of which was feeding into TS Roger. This situation was enhanced, in part, by an extratropical trough north of Roger over Southern Japan. The split in the surface flow pattern near Guam tended to keep Tip from developing rapidly while southeast of Guam. The upper-level analysis at the same time showed a large anticyclone north of Guam in close association with TS Roger and a developing TUTT cell about 300 nm (556 km) east of Marcus Island. The TUTT cell was moving slowly westward. Only strong upper-level northeasterlies existed over Truk and Ponape.

The satellite signature of the tropical disturbance near Truk continued to show improvement despite the initially unfavorable upper-air pattern. A Tropical Cyclone Formation Alert was issued at 040900Z, when a reconnaissance aircraft found a closed surface circulation about 120 nm (222 km) southeast of Truk with a MSLP of 1003.9 mb and a maximum observed surface wind of 25 kt (13 m/sec).

A reconnaissance aircraft fixed the disturbance the following day about 100 nm (185 km) southeast of the previous position. Based on indications of continual development, the first warning on TD 23 was issued at 050000Z. Although the surface pressure did not drop significantly, the observed surface winds did increase, and as a result, TD 23 was upgraded to Tropical Storm Tip at 060000Z.

During the period from 050000Z to 071800Z, TS Tip gave the JTWC forecasters a striking example of what the term "erratic movement" really means. TS Tip first executed a cyclonic loop southeast of Truk, then accelerated to the northwest, only to stall and meander to a position south of Truk. It was difficult to keep track of

TS Tip's surface position during this period. The best track is based almost entirely on aircraft surface positions, because the satellite fixes were based on upper-level outflow centers, and even the 700 mb center, as observed by aircraft reconnaissance, was considerably displaced from the surface center. Changes in the surface wind direction reported by Truk assisted JTWC in monitoring TS Tip during this period of erratic behavior.

Post-analysis shows that Tip's slow development and early erratic behavior are related to the weak, yet extensive circulation patterns that were associated with TS Roger. While near Truk, TS Tip was still competing with TS Roger for strong southerly surface inflow and, until the 8th, was coming out second best. During the period of erratic movement, JTWC continued to forecast a northwestward track with passage south of Guam. These forecasts were based primarily on the mid-level steering winds observed at Guam and obtained by the reconnaissance aircraft. These fairly strong winds were from the southeast and were expected to steer Tip toward Guam. However, at this stage of development, Tip was evidently too far south of this wind band and the steering in the immediate vicinity of Tip remained weak.

On 8 October, the expected northwest movement began. Roger was far to the north becoming extratropical, and the southerly winds that had been flowing north began to veer toward Tip. The TUTT cell earlier near Marcus Island migrated to a position northwest of Guam, affording Tip an excellent outflow channel to the north. Synoptic and subsequent aircraft data revealed that the southeasterly mid-level winds finally began to influence TS Tip, and the 080208Z aircraft fix confirmed that Tip was heading toward Guam at approximately 13 kt (24 km/hr). The minimum sea level pressure dropped to 995 mb and surface winds were 40 kt (21 m/sec).

Tropical Storm Tip continued to intensify and accelerate, eventually to 20 kt (37 km/hr) as he headed toward Guam. Until 6 hours before reaching Guam, Tip's persistence track and JTWC's forecasts indicated that he would pass directly over the center of the island. Six hours before expected landfall, however, reconnaissance aircraft and radar positions from Andersen AFB showed that TS Tip had turned to the west. Tip actually passed south of Guam, reaching CPA at about 25 nm (46 km) south of the southern end of the island at 091015Z. Maximum winds of 48 kt (25 m/sec) with gusts to 64 kt (33 m/sec) were recorded at the Naval Oceanography Command Center on Nimitz Hill. Andersen AFB recorded 6.5 inches of rain between 081800Z and 091800Z, and an additional 2.61 inches between 091800Z and 091900Z.

Shortly after passing Guam, Tip reached typhoon strength and continued on a basic west-northwest track. The analyses over the next few days showed that Typhoon Tip was moving into an area of strong upper-level divergence which appeared to cover most of

the western Pacific. Rapid intensification was forecast based upon the favorable upper-level pattern and the continued drop in surface pressure as observed by the reconnaissance aircraft. Intensification was much more rapid than expected, however, as the pressure between the 9th and the 11th dropped 98 mb to 898 mb. Tip reached super typhoon strength at that time with maximum winds of 130 kt (67 m/sec) reported by aircraft reconnaissance. The surface analyses revealed that the circulation pattern associated with Typhoon Tip had increased to a diameter of 1200 nm (2222 km) which broke the previous record of 720 nm (1333 km) set by Typhoon Marge in August 1951.

Super Typhoon Tip intensified still further, and at 120353Z, a reconnaissance aircraft recorded the lowest sea-level pressure ever observed in a tropical cyclone: 870 mb. This was 6 mb lower than the previous record set by Super Typhoon June in November 1975. The 700 mb height was 1944 meters and the 700 mb temperature within the eye was an exceptionally high 30° C (Fig. 3-23-1). The Aerial Reconnaissance Weather Officer (ARWO) on that particular mission remarked that "...one unusual feature was the spiral striations on the wall cloud. It looked like a double helix spiraling from the base of the wall cloud to the top, making about two revolutions in

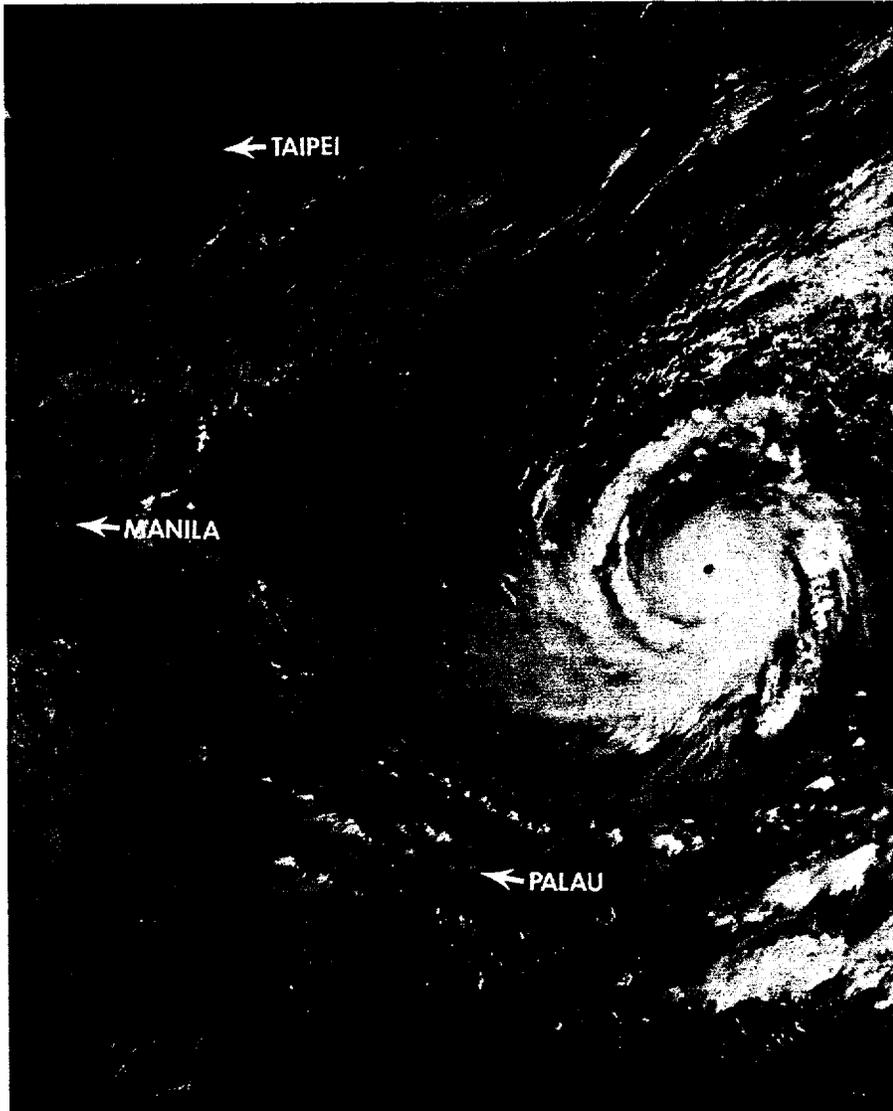


FIGURE 3-23-1. Super Typhoon Tip shortly before the record MSLP of 870 mb was observed by reconnaissance aircraft, 12 October 1979, 0012Z. (DMSP imagery).

climbing."1 Tip maintained super typhoon strength for the next 54 hours while moving to the northwest at between 3 and 7 kt (6 and 13 km/hr). Estimated maximum wind intensity of 165 kt (85 m/sec) was reached at 120600Z.

The immense circulation pattern associated with Typhoon Tip extended from the surface through 500 mb (and probably higher) and essentially split the subtropical mid-tropospheric ridge south of Japan. This would have allowed an average typhoon to recurve sharply to the north, but Tip was an atypical system and the northwestward movement persisted for the next three days.

Steering forecast aids were useless during this period because they merely steered Tip in his own large storm-induced flow. Persistence and climatology became the primary forecast aids during this stage in Tip's life.

From the 13th to the 17th, the radius of surface and gradient-level 30 kt (15 m/sec) or greater winds extended over 600 nm (1111 km) from Typhoon Tip's center. The radius of over 50 kt (26 m/sec) winds was over 150 nm (278 km) (Fig. 3-23-2). The aircraft reconnaissance data likewise showed that 700 mb winds of 105 kt (54 m/sec) existed more than 120 nm (222 km) from Tip's center during this period (Fig. 3-23-3).

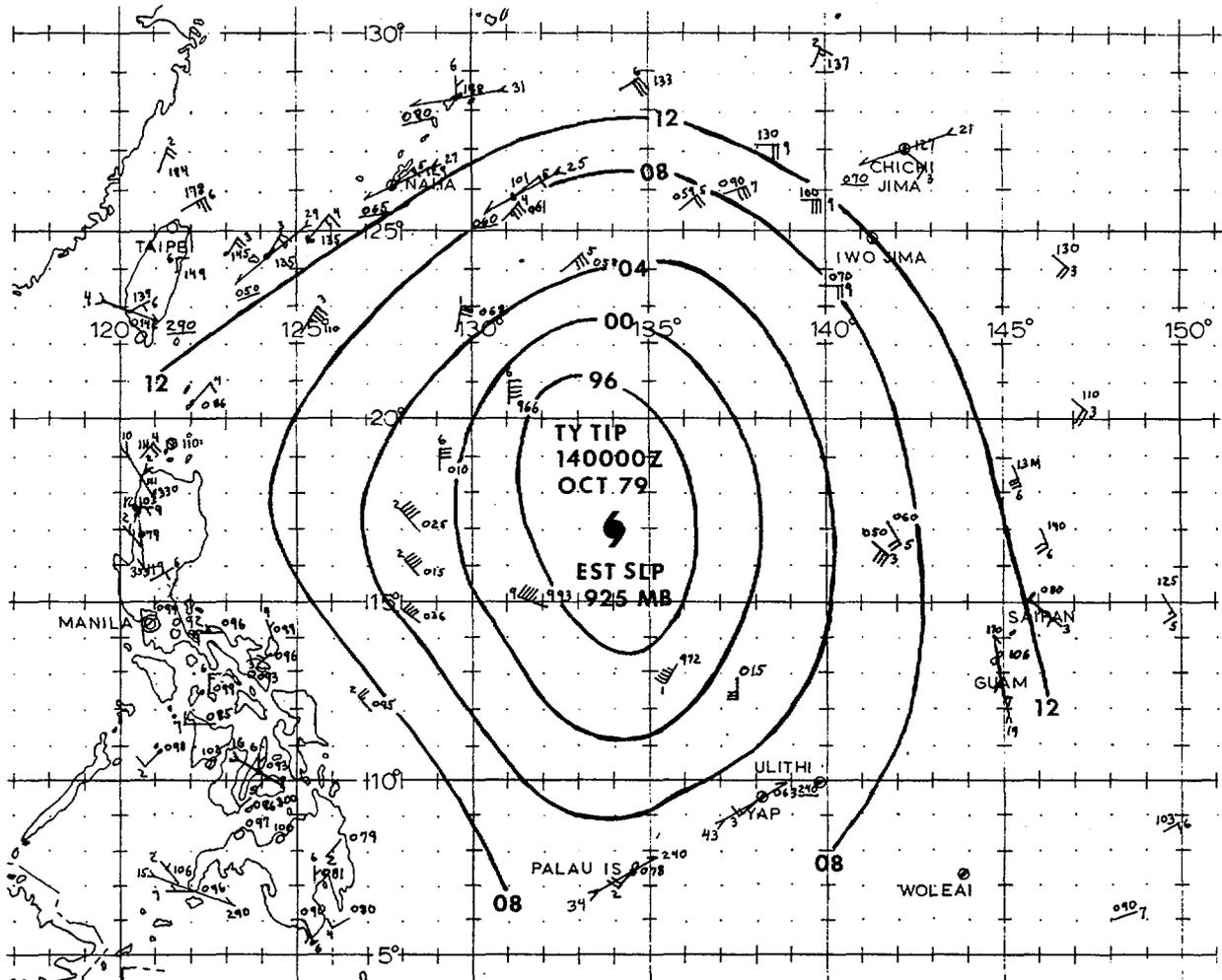


FIGURE 3-23-2. The 140000Z October 1979 surface (—) / gradient-level (ddd—(fff)) wind data and pressure analysis in the vicinity of Super Typhoon Tip. Wind speeds are in knots.

1PATRICK W. GIESE, Capt, USAF: Mission ARWO.

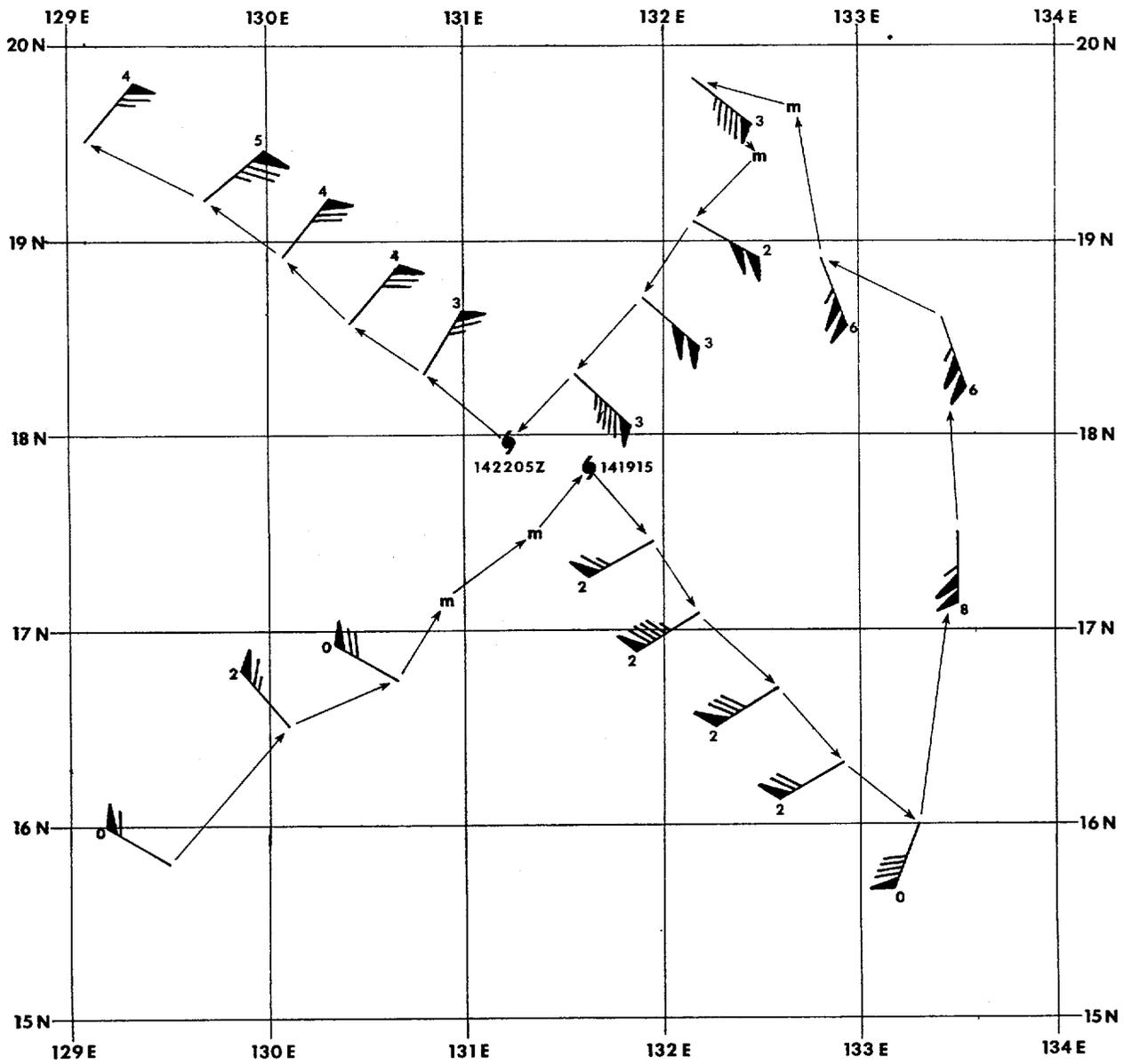


FIGURE 3-23-3. Plot of aircraft reconnaissance data from the 26th mission into Super Typhoon Tip on 15 October 1979. Tip's positions were fixed at 141915Z and 142205Z. Wind barbs are the measured 700 mb winds. The tens digit of the wind direction is also plotted with the wind barbs. An "m" indicates no 700 mb wind data available.

After the 17th, Tip began to weaken as the large circulation pattern began to shrink. This, together with the effects of a mid-level trough moving toward Japan from China, caused Tip to begin tracking northward. By the 18th, he was accelerating to the northeast under the influence of the increased mid-level southwesterlies.

During recurvature, Tip passed within 35 nm (65 km) of Kadena AB on Okinawa, which reported maximum sustained winds of 38 kt (20 m/sec) with gusts to 61 kt (31 m/sec).

At approximately 190100Z, after reaching a forward speed of between 35 and 45 kt (65 and 83 km/hr), Typhoon Tip, with maximum winds of 70 kt (36 m/sec), made landfall on the Japanese island of Honshu, about 60 nm (111 km) south of Osaka. Synoptic and radar data from stations on the island showed that Tip maintained a speed in excess of 45 kt (83 km/hr) as he passed to the north of Tokyo and eastward into the Pacific Ocean. According to satellite imagery, Tip completed extratropical transition over Honshu.

The extratropical low pressure center (the remnants of Tip) maintained winds of storm force, 48 kt (25 m/sec), until the 21st when it moved to a position east of Kamchatka and finally began to fill rapidly.

The majority of the severe damage occurred in Japan where the agricultural and fishing industries sustained losses into the millions of dollars. Flooding from Tip's rains also breached a fuel retaining wall at Camp Fuji, west-northwest of Yokosuka. The fuel caught fire causing 68 casualties, including 11 deaths, among the U.S. Marines stationed there.

Considering the size and strength of Super Typhoon Tip, the Western Pacific fared well. Luckily, the maximum intensity was reached while the system was still far from any inhabited areas. The potential for mass destruction was always there, but from a strictly meteorological standpoint, Tip was also a thing of great beauty. One of the Aerial Reconnaissance Weather Officers stated, shortly after she returned from a mission, that "...the second penetration was beyond description. This is unquestionably the most awe-inspiring storm I have ever observed. In the 2½ hours that transpired between the first and second fixes, the moon had risen sufficiently to shine into the eye through an 8 nm clear area at the top of the eyewall. To say it was spectacular is totally inadequate...'awesome' is a little closer."¹

¹CAROL L. BELT, 1LT, USAF: Mission ARWO.