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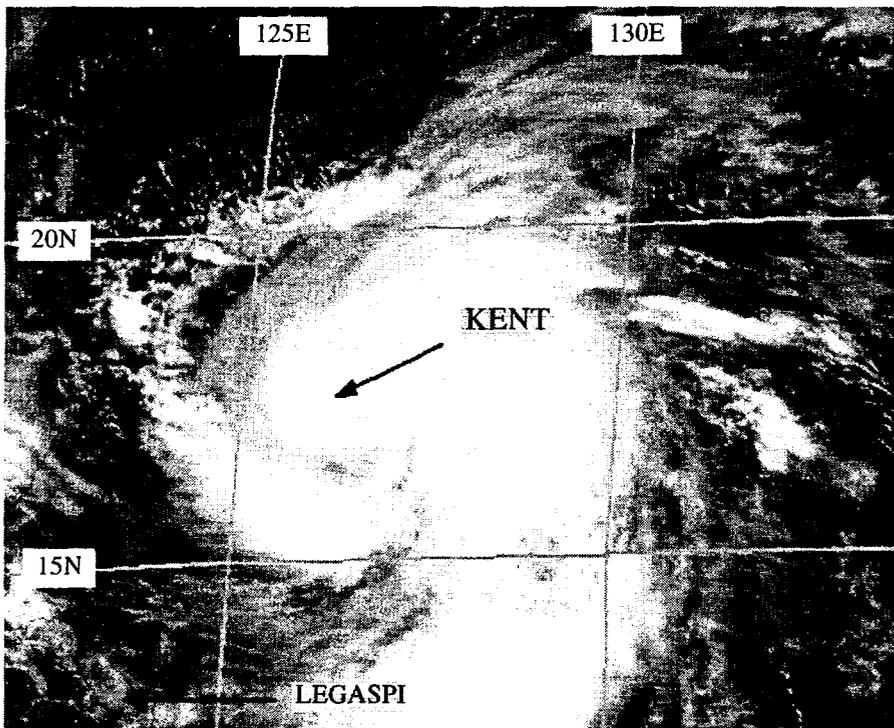
# SUPER TYPHOON KENT (12W)

## I. HIGHLIGHTS

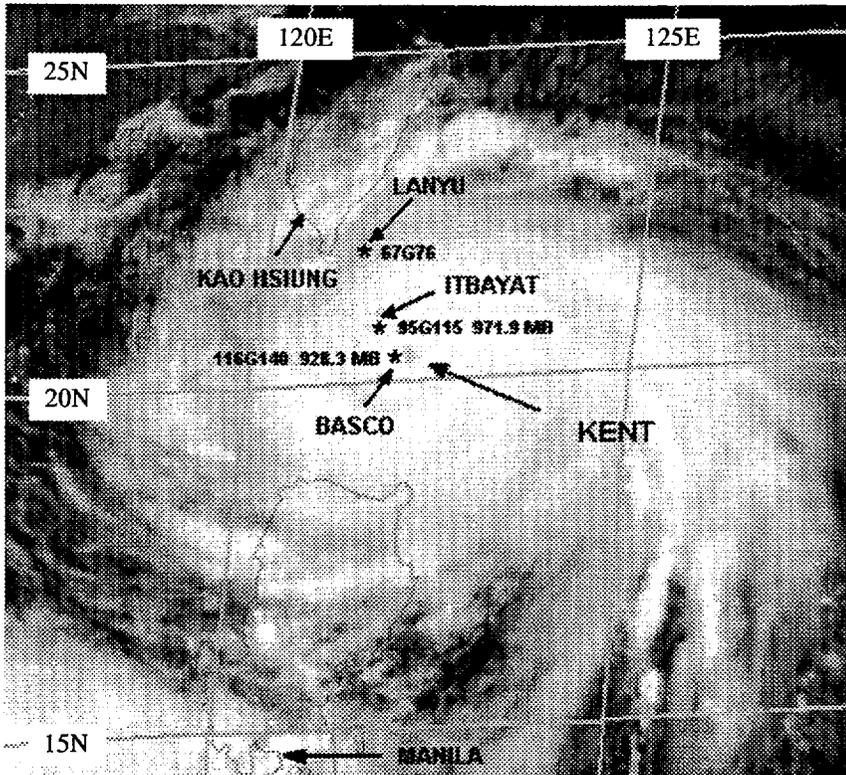
Kent was one of seven tropical cyclones and one of three typhoons to develop in August. It was also the first of five super typhoons to occur in 1995. Kent formed in the Philippine Sea and, after slow development, it rapidly intensified as it approached the Luzon Strait. Basco, Batan Island (WMO 98135), which was briefly in the northern part of Kent's eye, observed a peak wind gust of 140 kt, and a minimum sea-level pressure of 928 mb. Hourly radar images from Kaohsiung, Taiwan showed concentric eyewalls that persisted for at least 22 hours. Kent continued on a west-northwest track and made landfall in China, just east of Hong Kong.

## II. TRACK AND INTENSITY

The tropical disturbance that became Kent was first mentioned on the 250600Z August Significant Tropical Weather Advisory when satellite imagery indicated increased organization in an area of deep convection, located north-northwest of Palau. Scatterometer data from the ERS-1 satellite (which was not available to the JTWC in real time) revealed that, 24 hours earlier, this disturbance was accompanied by a low-level cyclonic vortex with a maximum intensity of 15 kt (8 m/sec). The disturbance moved to the northwest, and its satellite signature continued to improve. A Tropical Cyclone Formation Alert was issued by the JTWC at 251130Z. At 260000Z, Dvorak intensity estimates reached 35 kt (18 m/sec) and the first warning on Tropical Storm Kent was issued, valid at 260000Z. The tropical cyclone intensified at a greater-than-normal rate (i.e., greater than one "T" number per day), and at 270600Z, Kent was upgraded to a typhoon. After becoming a typhoon, Kent's rate of intensification slowed, as did its speed of translation. During its 48-hour period (261800Z to 281800Z) of slow (5 kt, or less) forward motion, satellite imagery (Figure 3-12-1) revealed restricted outflow of the cirrus to the northwest of the system.



**Figure 3-12-1** Kent with an intensity of 75 kt (39 m/sec) when 270 nm (510 km) east of Luzon (272331Z August visible GMS imagery).



**Figure 3-12-2** Kent nears Basco, with sustained winds estimated at 125 kt (64 m/sec). Maximum observed winds and minimum sea-level pressures are indicated for Basco and Itbayat Island during peak conditions (292331Z August visible GMS imagery).

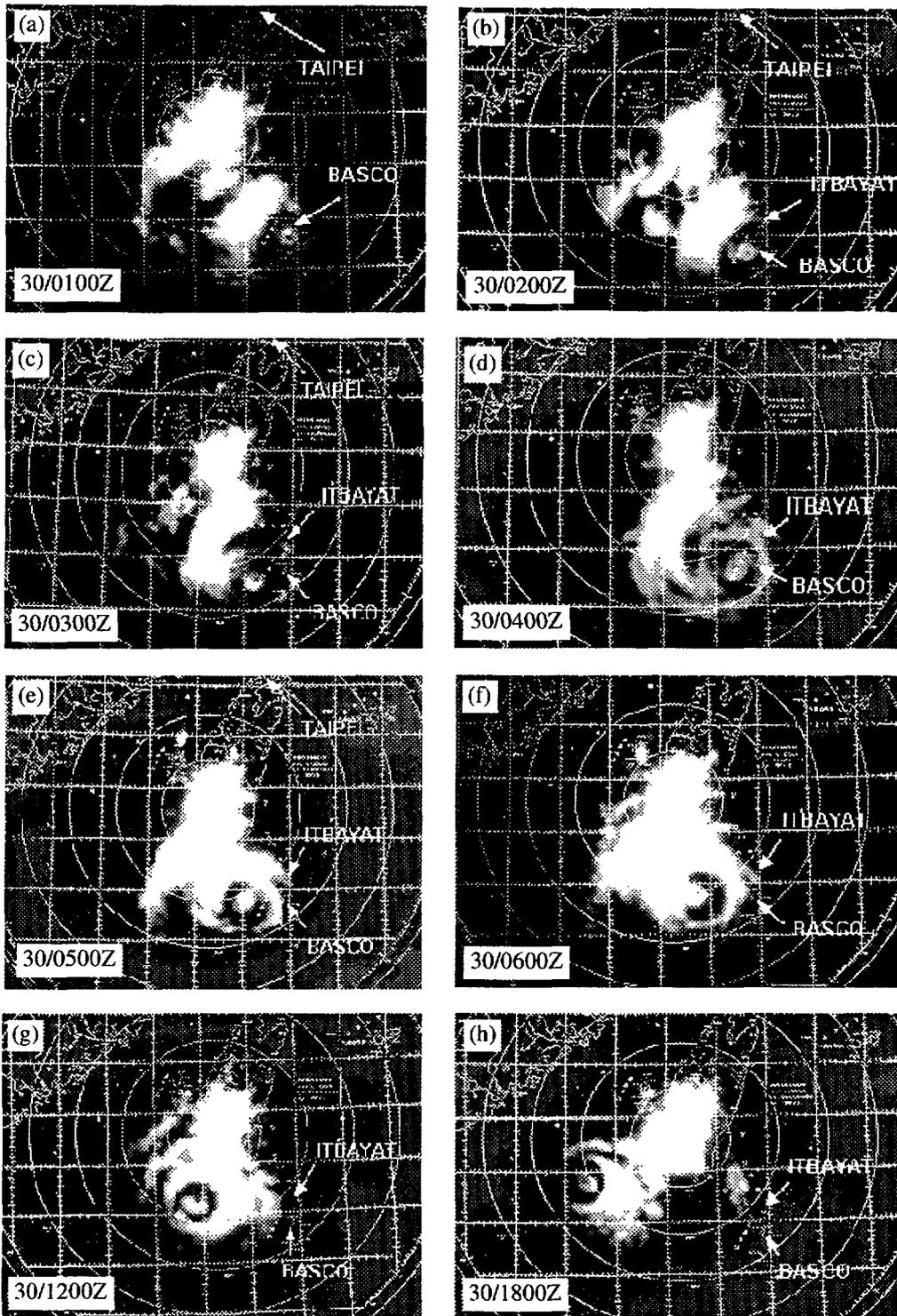
On 28 August, Kent developed a banding-type eye, and remained at 75 kt (39 m/sec) intensity until 281800Z, when it began to intensify. Kent reached its peak intensity of 130 kt (67 m/sec) at 291200Z. At 300100Z, the center of Kent's eye passed south of Basco. Satellite imagery (Figure 3-12-2) and radar imagery (Figure 3-12-3a-h) are available for this time period. Kent's passage over Basco afforded an opportunity for ground validation of the satellite-derived intensity. Kent's intensity (satellite-derived and ground-truth), and its structure as revealed by radar during its passage over Basco, are described more fully in the discussion section.

On 30 August, Kent began to weaken slowly. At the same time, it began to accelerate on its west-northwest track toward the China mainland (Figure 3-12-4). Kent made landfall at 310700Z approximately 50 nm (95 km) northeast of central Hong Kong. The final warning was issued, valid at 010000Z September, as Kent dissipated while passing over the rugged terrain of south central China.

### III. DISCUSSION

#### a. *The passage of Kent over Basco*

The passage of the eye of Kent just south of the Philippine meteorological station at Basco, Batan Island (WMO 98135), allowed for an excellent comparison between actual measured winds and the estimated winds given by the application of Dvorak's techniques to a very intense typhoon. At the time of the satellite image (292331Z) in Figure 3-12-2, Basco was entering the western wall cloud of the eye of Kent. The application of the digital Dvorak (DD) algorithm (see Oscar's (17W) summary for an in-depth discussion of the DD algorithm) to the 292331Z infrared image yielded an intensity estimate of T 6.1. This corresponds to a sustained 1-minute wind speed of 117 kt (60 m/sec) and a minimum sea-level pressure of 926 mb. The DD estimates of Kent's intensity during the six hours prior to its closest point of approach to Basco averaged approximately T6.5, which yields an equivalent 1-minute wind speed of approximately 130 kt (67 m/sec) and a minimum sea level pressure of 910 mb.



**Figure 3-12-3** Radar images from the Kaohsiung radar show the concentric eye-walls of Kent. Images (a) through (f) are hourly, and (g) and (h) are 6-hourly. (Radar images courtesy of the Central Weather Bureau, Taiwan).

For the purposes of postanalysis, research, and development of a high-confidence tropical cyclone intensity data base at the University of Guam, several international meteorological agencies have generously provided landfall/eye passage maximum wind information to researchers there. For Kent, critical data were provided by the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), the Royal Observatory Hong Kong, and the Central Weather Bureau,

Taiwan. These agencies report sustained winds as a 10-minute average, and when necessary for comparison with the JTWC, a conversion is made to the equivalent 1-minute sustained average. Critical wind and pressure data measured at various island locations that were affected by Kent have been superimposed on the satellite imagery of Figure 3-12-2. Table 3-12-1 summarizes the wind and pressure data recorded during Kent's passage over Basco.

The following conclusions can be drawn concerning Kent's passage over Basco: (1) the center of the eye may not have gone directly over Basco (the Kaohsiung radar images indicate that the center of the eye passed approximately 5 nm (10 km) south of Basco), but it did enter the northern edge of the eye given Basco's reported brief period (15 minutes) of lighter winds; (2) using the Atkinson/Holliday (A&H) wind-pressure relationship, the minimum sea-level pressure recorded at Basco of 928 mb corresponds to a sustained 1-minute wind speed of 114 kt (59 m/sec); (3) allowing for the fact the pressure in the exact center of the eye may have been approximately 10 mb lower (i.e., 918 mb), the corresponding sustained wind on the A&H scale would rise to 123 kt (63 m/sec); and, (4) the peak gust of 140 kt (72 m/sec) measured at Basco supports a sustained over-water 1-minute sustained wind of at least 115 kt (59 m/sec). The best-track indicates an intensity of 125 kt (64 m/sec) at 300000Z (and a gradual weakening trend) 50 minutes prior to Basco's peak gust and one hour prior to the minimum recorded sea-level pressure there. The peak wind and minimum sea-level pressure recorded at Basco are consistent with the intensity estimates from satellite imagery yielded by the DD algorithm.

#### b. *Radar depiction of Kent*

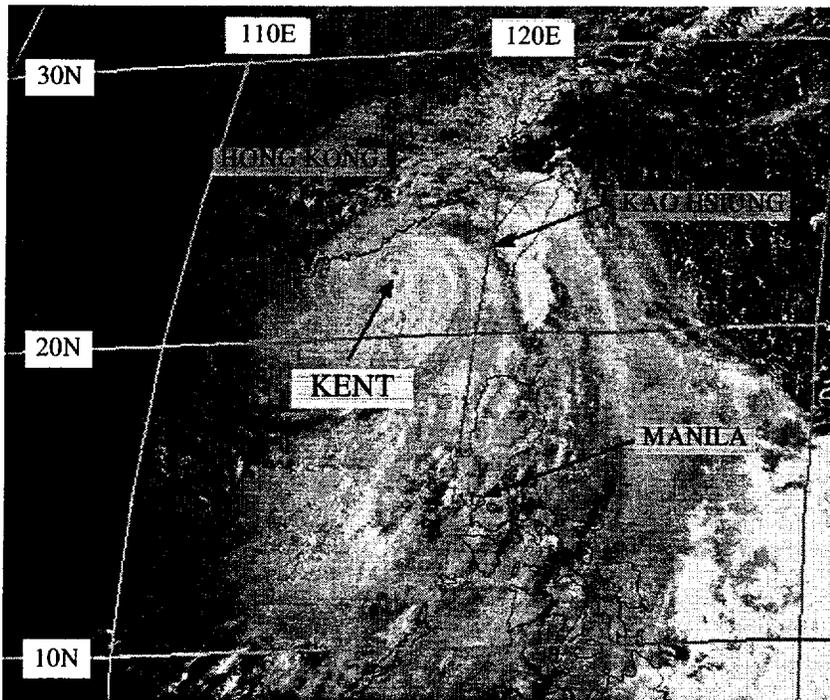
Radar images from Kaohsiung, Taiwan, (Figure 3-12-3a-h) indicated that Kent had concentric eye walls for at least 22 hours. Each hourly radar image from 300100Z to 302300Z (not all of these are shown in Figure 3-12-3a-h) shows an inner eyewall surrounded by an outer eyewall. The diameter of each eye appears to remain the same each hour, although the inner eye occasionally became open in one quadrant and the reflectivity appeared to fluctuate within the inner eyewall. The inner eye also appeared to wobble within the clear region separating the two eyewalls. The diameter of the inner eye was approximately 9 nm (17 km). The diameter of the outer eye fluctuated from 50-70 nm (93-130 km). There was no indication, however, that the inner eye disappeared or that as the outer eyewall shrank and replaced the inner eyewall (as in the eyewall replacement process described by Willoughby (1982, 1990)). A similar occurrence is discussed in the 1994 Annual Tropical Cyclone Report concerning Typhoon Gladys. In both cases, the inner and outer eye appeared to conserve their general characteristics for nearly a day.

#### IV. IMPACT

Damage at Basco (WMO 98135) was estimated at US\$2 million, and at Itbayat (WMO 98132) US\$50,000. Considerable flooding occurred on Luzon. In Pampanga province, 50 nm (95 km) north of Manila, 65,000 people were reported to have fled as heavy rains created mudflows from the slopes of Mount Pinatubo that buried entire communities. Five deaths were reported in Luzon. In southern China, Kent destroyed banana plantations and sunk many fishing boats. Thirty people were reported dead in Guangdong province, and 17 lost their lives in Hainan. Kent caused an estimated US\$87 million in damage in China. Hong Kong was spared serious damage.

**Table 3-12-1** Information about the eye passage of Super Typhoon Kent at Basco (WMO 98135). MWBE is the maximum sustained wind direction/speed/gust prior to eye passage; MWDE is the peak gust during eye passage; MSLP is the minimum sea-level pressure at eye passage; MWAE is the maximum sustained wind direction/speed/gust after eye passage. Sustained winds are one-minute averages. Time of occurrence is given below the meteorological information.

<u>MWBE(kt)</u>	<u>MWDE(kt)</u>	<u>MSLP(mb)</u>	<u>MWAE(kt)</u>
020/116/140	40	928.3	120/M/140
30/0050Z	30/0100Z	30/0100Z	30/0110Z



**Figure 3-12-4** Kent with an intensity of 105 kt (54 m/sec) when located about 175 nm (325 km) east of Hong Kong (302231Z August visible GMS imagery).