Some Observational Result from a New Doppler Radar at Green Island

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Abstract

A 5-cm C-band weather Doppler radar was built at Green Island in 1997. The radar was not operated before last May 1998. Since the radar locates at the SE side of Taiwan. Has a very good position to observe typhoons when they come close to Taiwan. Last couple month, from May to Aug. 1998, the radar had detected two typhoons, namely Nichole and Otto. Observations from the radar showed that topographic effect plays an important role in enhancing the gust wind within the eye wall of a typhoon as it hits Taiwan. Therefore, from radar observational point of view even a typhoon was not in good shape and was in light intensity, can blow a gust wind up to the range of 90 KTS due to topographic effect.

1 Introduction

There were many researchers put their effort into the influences on a typhoon by terrain recently. Lin et. al. (1977) had studied the topographic influence on propagating tropical cyclones. Wu et. al. (1997) did a numerical study of the effcet of Taiwan terrain on typhoon Gladys (1994). Yeh et. al. Also did a numerical study of topographic effect on typhoon Herb. Wang et. al. (1997) used a different way of approach. They had addressed the structure changes during the landfall of Yancy and Gladys revealed by Doppler radar analysis. Recently more researchers are using Doppler radar data to study the influences by terrain as a typhoon landed Taiwan. A 5-cm C-band weather Doppler radar was built at Green Island in 1997. The radar locates at the SE side of Taiwan. Has a very good position to observe typhoons when they moving closed to Taiwan. Last couple month, from May to Aug. 1998, the radar had detected two typhoons, namely Nichole and Otto. Nichole was formed in the Taiwan Straits and landed at the southwestern coastal region of Taiwan. Otto was formed and came from ocean water to the southeast side of Taiwan. Both produce an unexpected strong gust wind as they hit Taiwan. The heaviest damages produced by them were interestingly narrowed down to a relatively small area. It is the purpose of this article, try to find out what causes the phenomenon.

2 Discussion

2.1 Nichole case

On the day of 08 Jul. 1998, a tropical depression began to show the characteristic of a tropical storm at Taiwan Straits. Next early morning at 1800 UTC (0200 LST) a typhoon Nichole was named by JTWC (table 1). Through the lifetime of Nichole the strongest intensity issued by JTWC was 45G55 KTS. Figure 1 showed the column max corrected intensity data collected at 1140 UTC on 09 Jul. 1998 from radar at Green Island. Though we don't see a symmetrical circulation type of echo from the Figure, we do see a clear and well-defined eye of Nichole near the southern coastal line of Taiwan. Two surface stations near by the coast, RCAY and RCNN, reported a 32 KTS gust wind (Table 2). Nothing seems wrong at this point. Four hours later, 1540 UTC, the eye of Nichole began to move unusually toward the southeast direction (Fig. 2) and landed the coast region between RCAY and RCNN surface station. After the eye of Nichole landed its moving direction changed to the northeast, instead of moving further inland it moved back to the coastal region again (Fig. 3,4). Its moving track is like a kind of a loop type. The radar observations did proved this loop pattern. The max wind reported by surface station was amazingly increased. A 48G80 KTS max wind was reported by RCAY at 0200 LST 10 Jul. (1800 UTC 09 Jul). A 80 KTS wind was not expected from JTWC. From 2400L (1600 UTC) to 0600L (2200 UTC) Nichole's high wind did bring very heavy damages to the southwestern coastal region of Taiwan. Most damages were within the region where eye wall of Nichole passed. Since the eye wall made a loop back to the coast that helped to reduce the damaged region into a rather narrow region near the coast as Nichole landed. From radar observations, we are able to point out that the high wind within the eye wall is the main cause of those damages. Since the track of the eye was curved back and dissipated at the coast. Therefore, the damages were limited to a relative narrow area.

Table1 Max wind changes during the lifetime of Typhoon Nichole (data from JTWC)

Date	Time UTC	Eye Position N	E	Max Wind KTS
0708	0000	22.6	118.7	25G35
	0600	22.3	118.7	30G40
	1200	22.5	118.7	30G40
	1800	22.8	118.7	35G45
0709	0000	22.9	119.2	35G45
	0600	23.1	119.4	35G45
	1200	23.2	119.4	45G55
	1800	23.0	119.6	35G45
0710	0000	22.8	120.0	35G45
	0600	23.2	120.2	30G40
	1200	23.3	118.1	25G35
	1800	24.3	119.3	25G35

Table 2 Surface wind data at RCNN and RCAY airport from 0709 2000L to 0710 0500L 1998

date Jul.	Time LST	RCAY (KTS)	Time LST	RCNN (KTS)
9	2000	100/22G32	2000	120/22G32
	2100	150/22G32	2100	110/22G32
	2200	170/22G32	2200	090/21G31
	2300	180/22G32	2300	110/19G29
	2400	140/22G32	2400	080/20G30
10	0100	180/44G70	0100	060/23G33
	0200	180/48G80	0200	060/32G45
	0300	160/44G70	0300	030/31G41
	0400	180/38G56	0400	300/32G43
	0500	240/26G36	0500	300/22G34
	0600	250/10	0600	280/08

2.2 Otto case

Otto was named by JTWC on 00 UTC Aug. 2, 1997. Its max wind intensified very fast from 35 KTS to 65 KTS within 24 hours (table.3). Fig. 5 showed

Table 3 Max wind changes during the lifetime of Typhoon Otto (data from JTWC)

Date	Time UTC	Eye Position N	E	Max Wind KTS
0802	0000	14.8	126.7	30G40
	0600	14,7	125.5	30G40
	1200	14.8	124.7	35G45
	1800	15.7	124.4	35G45
0803	0000	16.9	124.2	35G45
	0600	18.7	124.0	45G55
	1200	20.3	123.1	65G80
	1800	21.4	122.5	65G80
0804	0000	22.2	121.8	65G80
	0600	23.6	121.1	65G80
	1200	24.6	120.3	60G75
	1800	25.1	119.8	65G80
0805	0000	25.9	118.8	50G65

Table 4 Surface wind data from 0800 to 1424 LST 04 Aug. 1998 at Green Island airport

Time LST	Max wind KTS	Time LST	Max wind KTS
0800	020/34G54	1100	330/54G93
0819	020/30G48	1128	220/71G99
0900	020/38G63	1200	210/59G79
0902	020/45G68	1225	200/52G75
0926	010/50G73	1244	210/46G61
0939	360/57G79	1300	210/46G63
0952	360/61G85	1400	210/40G53
1000	360/61G85	1424	210/37G51
1023	350/61G93		

the column max corrected intensity data collected at 1200 UTC on 03 Aug. 1998 from radar at Green Island. The eye itself of typhoon Otto was well defined. Most echoes were concentrated at the forward flank relative to the eye. Up to 0140 UTS 04 Aug. 1998, the time when eye of Otto is about to hit Green Island, we are still able to point out the eye sit very closed to the radar (Fig.6, center of eye at the SE side near by radar). Due to the topographic effect the echo of precipitation continuously stayed at eastside of Taiwan from 1200 UTC to 0140 UTC. In table 4 list the wind data from 0800 LST (0000 UTC) to 1424 LST (0624 UTC) at Green Island airport. Notice that the surface max wind is increasing rapidly before 1128 LST (0328 UTC). The max wind at surface reached a peak value of 71 KTS with a gust wind 99 KTS, and wind shifted sharply from north to west at the same time. That is the time when center of the eye passed Green Island. After the max wind reached its peak value the wind at surface was down to 37 G51 KTS at 0637 UTC, and wind changed from west to south-south-ease also. There is a big difference between actual wind and the estimated wind from JTWC at the period from 0139 to 0400 UTC. It was the period when the eye wall of Otto moved near by, passed the radar, and then landed at mainland Taiwan. Topographic effect has played an important role in enhancing the gust wind within the eye wall of Otto at that very important moment. That explained why the heaviest damages produced by them were interestingly narrowed down to a relatively small area.

3 Summary

The Doppler radar built at Green Island gives us another tool or datum to study typhoons near Taiwan. The case study in this article showed that the topographic effect did enhancing the max wind intensity at eye wall region as it approaching land. The effect stops as the eye reaches mountain region. The dramatic changes of wind direction and speed within the eye wall causes the heaviest damages. That's one thing we need to put more concern as we issued a warning when a typhoon heading Taiwan.

Reference

Lin, Y. L., D. W. Hamilto and C. Y. Huang, 1977: Orographic influence on propagating tropical cyclones. Preprints, 22nd Conference on Hurricanes and Tropical Meteorology. Amer. Meteo Soc., Fort Collins, Co, 244-245.

Wang, T. C., C. Li, G. Y. Leu and H. M. Chen, 1977: Structural changes during the landfall of Yancy and Gladys through Doppler radar analysis. Preprints, 22nd Conference on Hurricanes and Tropical Meteorology. Amer. Meteo Soc., Fort Collins, Co, 88-89.

Wu, C. C., and Y. T. Cho, 1977: A numerical study of the effect of Taiwan terrain on typhoon Gladys(1994). Preprints, 22nd Conference on Hurricanes and Tropical Meteorology. Amer. Meteo Soc., Fort Collins, Co, 240-241.

Yeh, T. C., K. N. Huang and D. S. Chen 1977: A numerical study of orography effect on typhoon Herb. Preprints, 22nd Conference on Hurricanes and Tropical Meteorology. Amer. Meteo Soc., Fort Collins, Co, 242-243.

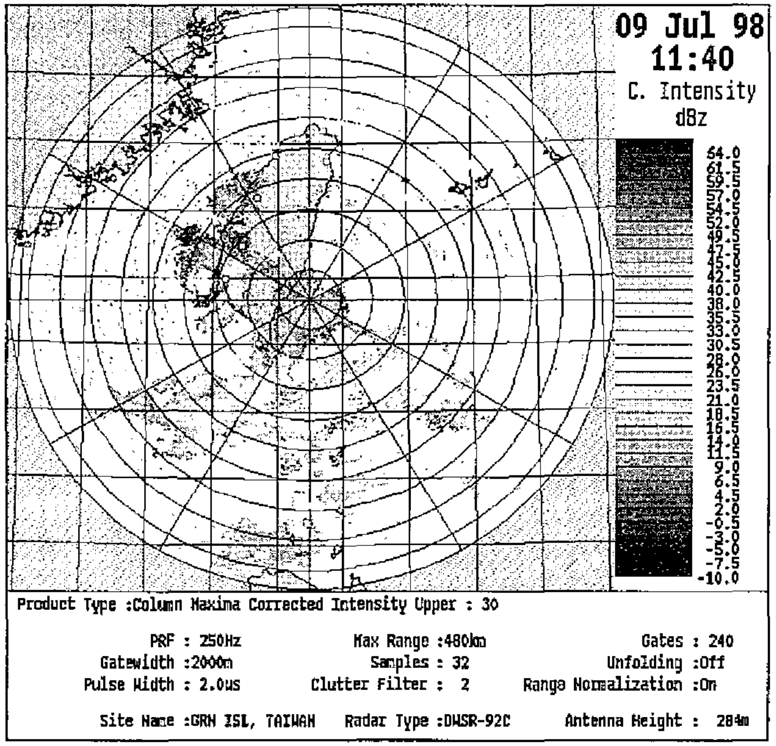

Fig. 1 Column max corrected intensity display from Green Island radar on 1140 UTC 09 Jul 1998.

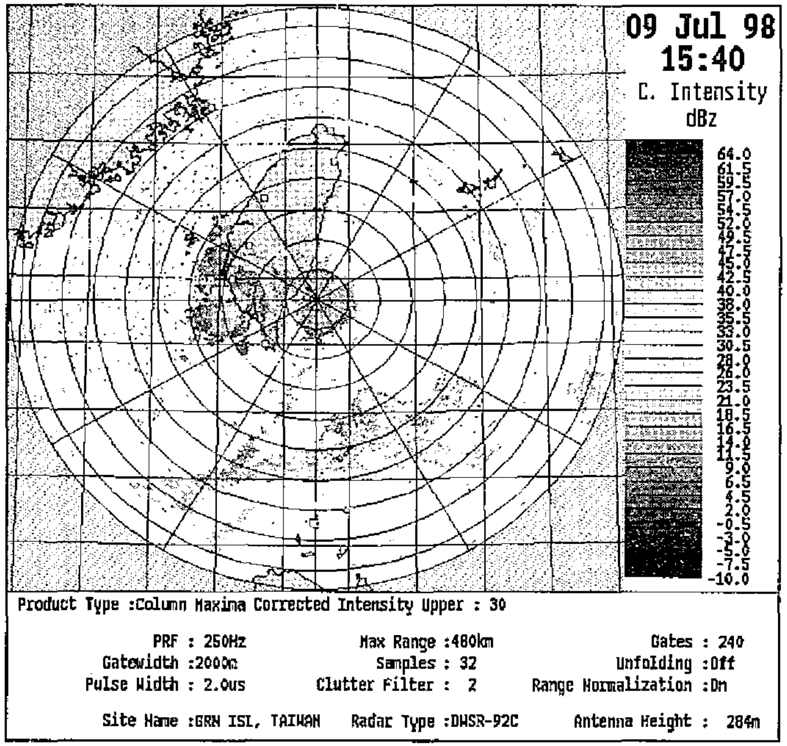

Fig. 2 Column max corrected intensity display from Green Island radar on 1540 UTC 09 Jul 1998.

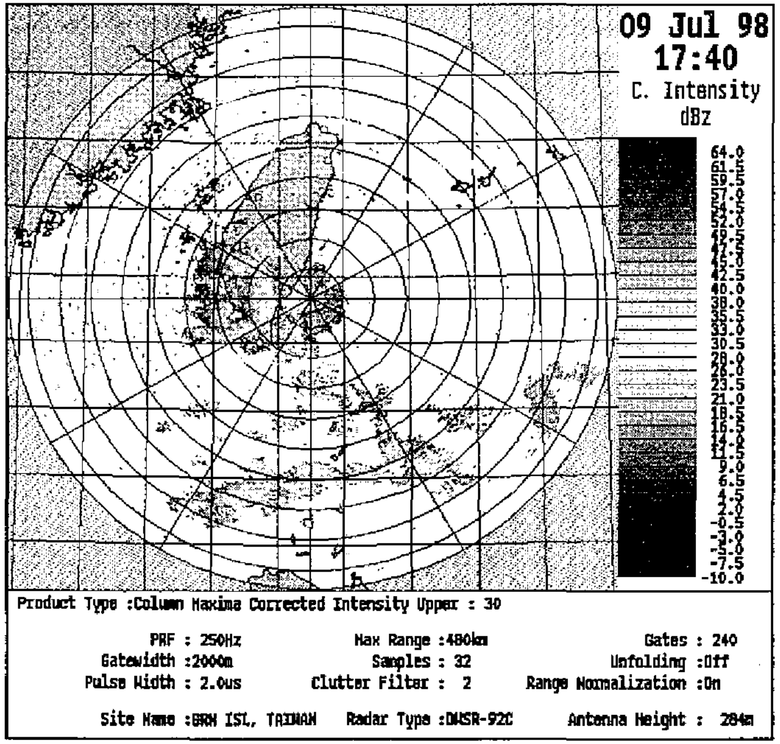

Fig.3 Column max corrected intensity display from Green Island radar on 1740 UTC 09 Jul 1998.

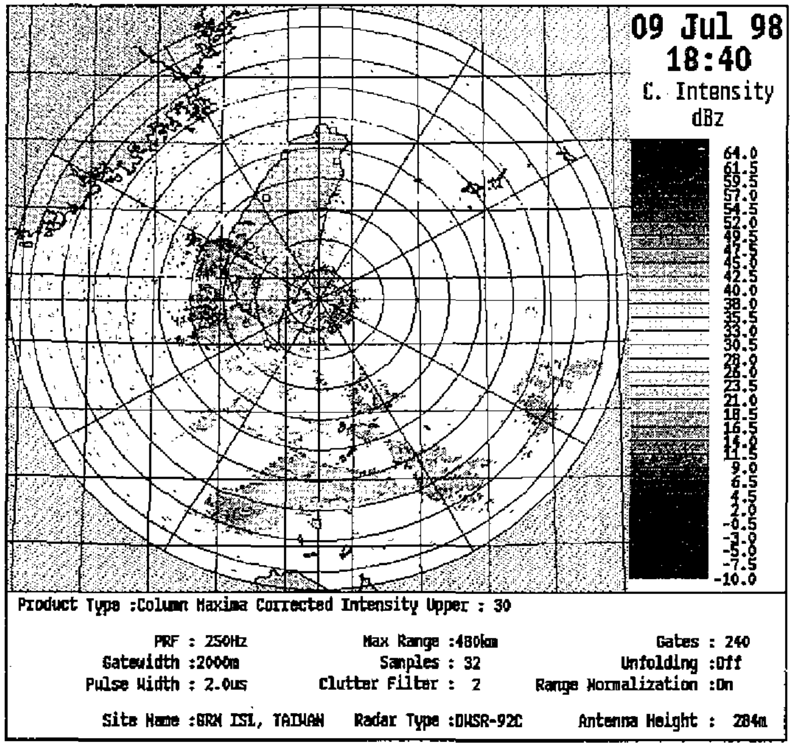

Fig. 4 Column max corrected intensity display from Green Island radar on 1840 UTC 09 Jul 1998.

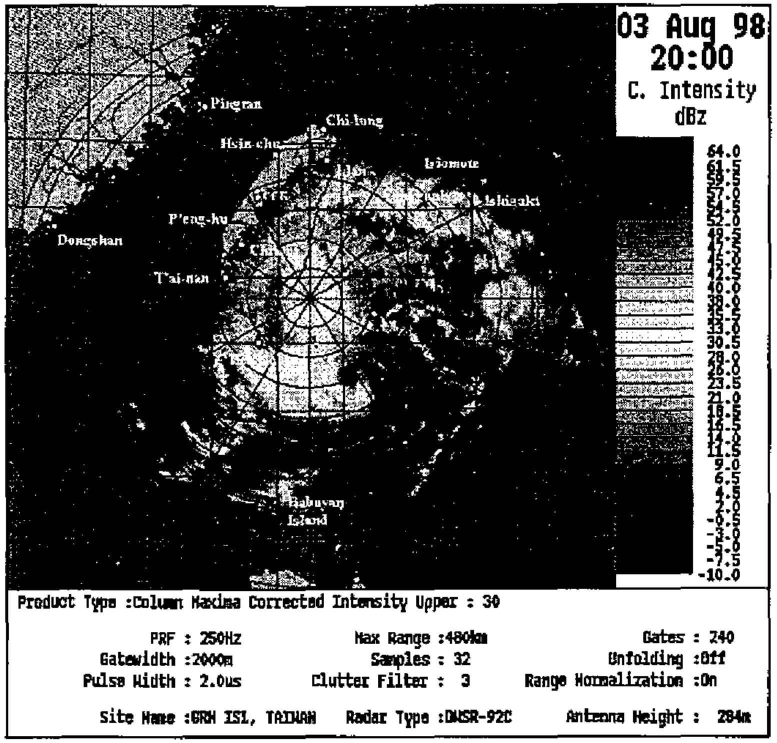

Fig. 5 Column max corrected intensity display from Green Island radar on 2000 UTC 03 Aug 1998.

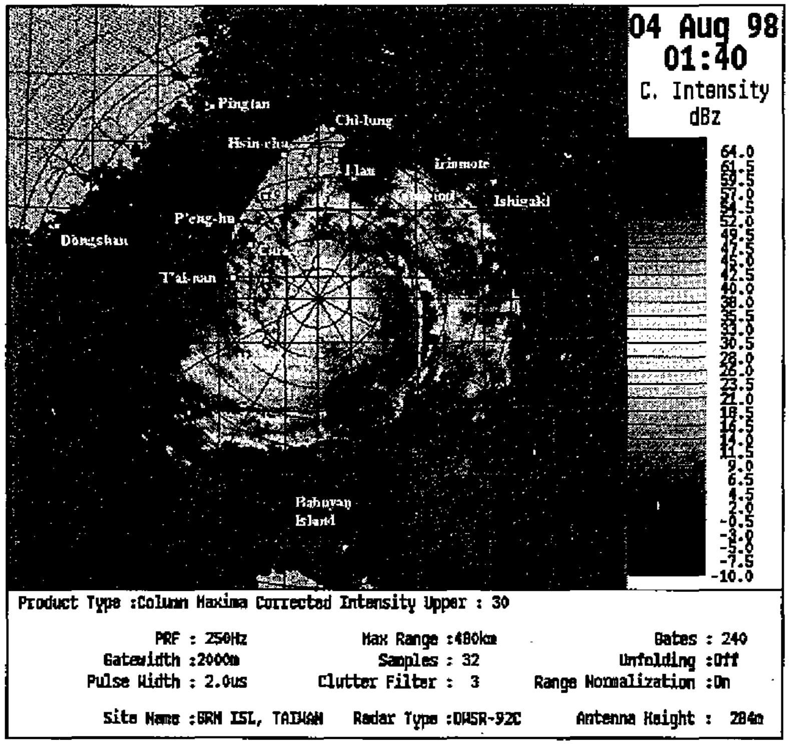

Fig. 6 Column max corrected intensity display from Green Island radar on 0140 UTC 04 Aug 1998.