THE REASONS FOR A REANALYSIS OF THE TYPHOONS INTENSITY IN THE WESTERN NORTH PACIFIC

Karl Hoarau[1] , Ludovic Chalonge[1] and Jean-Paul Hoarau[2]

1. Introduction

At the time where a recent article (Webster and al., 2005) claimed that the number of intense tropical cyclones have significantly increased since 1975, it was very urgent to have a view as objective as possible on the quality of the best track data. We chose the western North Pacific because this basin is the more active, it has the greatest number of cyclones at the hurricane/typhoon's intensity (at least 33 m/s) and the more important number of cyclones with a sustained wind at or over 60 m/s (at least Category 4 of Saffir-Simpson). This basin is original too because the aerial reconnaissance missions did exist in the cyclones until August 1987 (ATCR, 1987).

During this period, the cyclones intensity was primarily based on these reconnaissance data. Since August 1987, the satellite data analysis via the Dvorak's Technique (1984) is the only tool to estimate the cyclones intensity. There are two databases concerning the cyclones of the western North Pacific, respectively made by the official Regional Specialized Meteorological Center of Tokyo (RSMC) and by the Joint Typhoon Warning Center (JTWC) now based in Hawaii. Even if the RSMC of Tokyo uses the sustained wind over 10 minutes and JTWC the wind over 1 minute, this does not explain frequent substantial difference in the cyclones intensity estimate between these two agencies since the end of the aircraft reconnaissances.

Moreover, there is another important issue : is the tropical cyclones database before August 1987 more reliable because there were reconnaissance aircraft ? The preliminary research seems to show that both the database after the aerial reconnaissances in August 1987 and the one before this date would need to be reanalysed.

[1] M.R.T.E Laboratory, Cergy-Pontoise University, FRANCE
Email : Khoarau@aol.com

[2] Professor of Physics, Reunion Island, FRANCE

1. The reanalysis with the satellite data after the reconnaissances era since August 1987

The most significant case was Typhoon Sally in September 1996 which was moving west-north-west when it was located east-north-east of the Philippines (ATCR, 1996). JTWC estimated the maximum intensity at 72 m/s on 7th September at 1800Z while the RSMC of Tokyo gave a sustained surface wind of 41 m/s at the same time and 44 m/s at 0000Z on 8th (JMA, 1996). 41 m/s and 44 m/s over 10 minutes match respectively with T 5.2 and T 5.5 in the Dvorak'scale used by Tokyo. As JTWC used the sustained winds over 1 minute and that 72 m/s represents T 7.0 in the 1984 Dvorak'scale, this means that there was a difference of almost 2 T-numbers at 1800Z on 7th and 1.5 T-number at 0000Z on 8th. The 72 m/s estimated by JTWC have been primarily based on the Objective Dvorak Technique (ODT) tested with the typhoons displaying an eye in the western North Pacific between 1995 and 1998 (ATCR; Velden and al., 1998). The satellite pictures showed that Typhoon Sally had ODT 's numbers of 7.0 during 5hrs from 1230Z with a peak of 7.5 at 1730Z on 7th September.

We run ODT with typhoons during the recon era which had a small size like Sally and which have reached an intensity at least of 72 m/s after a period of rapid deepening. These typhoons reached their maximum intensity 12hrs after ODT numbers peaked and maintained this level. Moreover, these typhoons were at their peak 6hrs to 9hrs after the manual Dvorak T-numbers reached their maximum and maintained this high level. In the case of Sally, the manual Dvorak T-numbers were at 7.0 during only 4hrs. Therefore, it seems that the intensity of Typhoon Sally has been overestimated. Indeed, a reanalysis made with the manual Dvorak Technique gave a maximum sustained wind of 65 m/s which match with a T-number of 6.5 which was still much higher than the 41 m/s estimated by Tokyo at 1800Z. Other typhoons estimated with ODT numbers need to be reanalysed between 1995 and 1998 to see if they have been overestimated as well.

In another hand, we found typhoons which had been underestimated by JTWC from August 1987 until 1990, just after the end of the reconnaissance missions. The most significant case was Typhoon Holly in September 1987. JTWC (ATCR, 1987) estimated Holly at 72 m/s on 9 September at 1200Z and 1800Z. Actually, the reanalysis from the satellite data gave an intensity of 72 m/s earlier on 7th at 1200Z whereas JTWC estimated Holly's intensity at only 51 m/s. This matches with a difference of 1.5 T-number. Moreover, the data showed that Holly probably reached a maximum sustained wind

of 77 m/s - 80 m/s on 8 September at 1200Z and 1800Z. At this time, JTWC'best track was only at 60 m/s.
At the end, based on the satellite data, we strongly believe that STY Angela (November 1995) and STY Gay (November 1992) were more intense than STY Tip (85 m/s in October 1979). And they reached the top of the Dvorak scale (87 m/s - 90 m/s), not only because the ODT's numbers reached figures of 8.7 never reached in other tropical cyclones before, including Tip (Hoarau and al., 2004), but because too the manual Dvorak T-numbers were at the maximum possible of 8.0 during a period of at least 9 hours which is a near garranty that the current intensity has had time to cath up the satellite data as studied in the strongest typhoons of the WPAC from 1981 to 1987 when there were aircraft reconnaissances.
Here are presented isolated examples but there are enough cases to consider a reanalysis of the best track data after the reconnaissances era.

2. The reanalysis with the satellite images and the recon data before August 1987

During the recon era which endded in August 1987, the more reliable data representative of the intensity which was recorded was the sea level pressure. In fact, it was very frequent that the radar signal of the aircraft was attenuated by the strong rain, preventing an accurate wind speed measurement (ATCR, 1979). Moreover, in many instances, the flight path was through the weak sector of the cyclone. In a few cases, the eyewall was so small (like Hurricane Wilma in October 2005 in the Atlantic) that the aircraft could not record the right wind at 700 hPa.

But in a few cases, the intensity estimate could be partly made with the reconnaissances data. To have a more reliable reanalysis, we used satellite data too. We found an interesting case with Typhoon Marge in December 1986 (ATCR, 1986). We extrapolated the estimated sustained surface winds from the 700 hPa level flight in using the same ratio than the NHC in the Atlantic (Franklin, 2000) :

Surface wind = 700 hPa wind x 90%

Based on the recon data (Table 1), it looks like Typhoon Marge had an intensity of 60 m/s on 20 December 1986 around 2100Z - 2330Z when the aircraft recorded a sea level pressure fall of 7 hPa in 2hrs (from 954 hPa to 947 hPa) and a maximum 700 hPa wind of 65 m/s. The satellite data showed that the manual Dvorak T-numbers were already at 6.0 since 0600Z and they even increased at 6.5 from 1200Z until 0000Z on 21th (Fig. 1, 2, 3). JTWC estimated that Typhoon Marge was at its peak of 49 m/s on 20 December at 0600Z at the time the pressure was still at 969 hPa.
And finally, JTWC considered that Typhoon Marge had a current intensity of 947 hPa and 49 m/s. This case clearly shows that the intensity of the wind was deviated towards the sea level pressure seen in the Atkinson and Holliday (1977) wind-pressure relationship used in the western North Pacific.

Most of the time, the aircraft did not record the maximum 700 hPa wind but only the sea level pressure and this could partly explain why the number of typhoons at least of 80 m/s is much lower from 1980 to 1987 than in the 1990's for a comparable period. In fact, the satellite data indicate that it shoud have had 6 typhoons at this intensity instead of only 2 from 1980 until August 1987 when the recon aircraft endded.
Here again, it is obvious that the best track of the recon era need a reanalysis in using mainly the satellite pictures and sometimes the flight wind level..

3. Conclusion

The few cases displayed here show that all the best track data after the aerial reconnaissances era and before as well need a reanalysis. After August 1987, the current intensity of cyclones should be estimated mainly from the satellite data analysed with the Dvorak's Technique (1984). And one should use a simple procedure still in application today in all the basins, the manual Dvorak rather than the Objective Dvorak Technique for example which probably led to an overestimation of a few intense typhoons intensity in the 1995-1998 years. The tropical cyclones best track data should be reanalysed with the satellite images and the winds recorded at 700 hPa by the aircraft during the aerial reconnaissances if these winds are considered as representative since there are well identified cases when the winds recorded could not be the strongest flight wind. But to make the database more reliable would require a long work.

4. References

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Date	Recorded SLP (hPa)	Wind at 700 hPa		Extrapolated surface wind (m/s)	Official Best Track (m/s)
		Dir (deg)	Speed (m/s)		
19-0020Z	974	120	45	41	36
-1110Z	964	120	51	45	41
-1341Z	959	140	54	49	44
20-2121Z	957	090	65	59	46
-2322Z	947	320	59	53	46

* Typhoon Marge was moving from 080° at 12 kt on 20th around 2100Z-2300Z

Table 1 : the aerial reconnaissance data of Typhoon Marge.

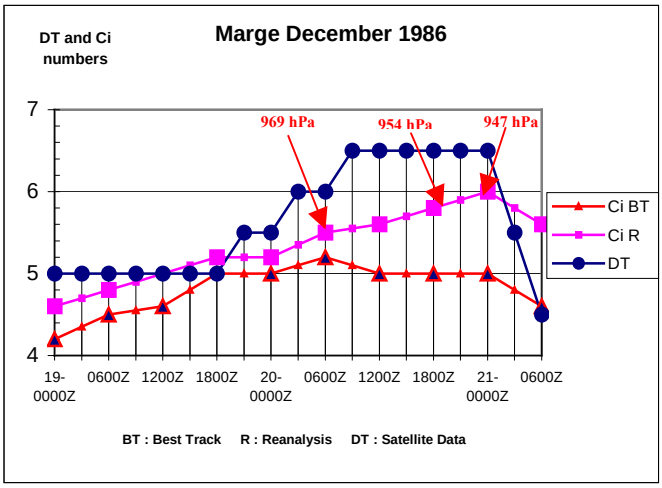

Figure 1 : the satellite data and the current intensity of Typhoon Marge.

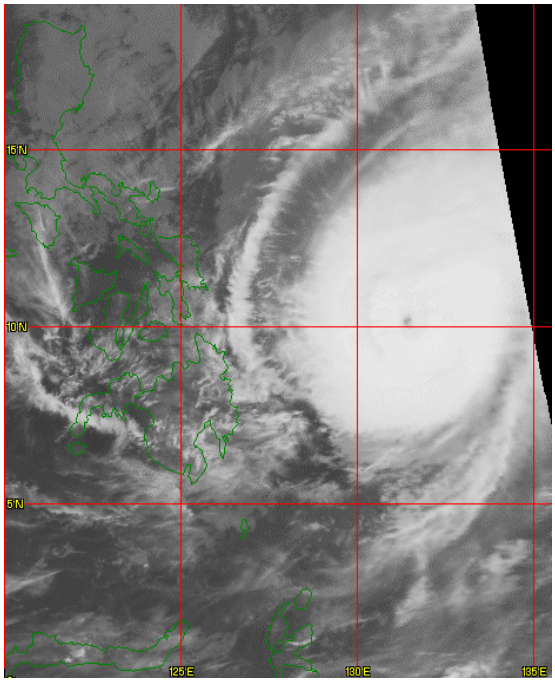

Figure 2 : the IR Noaa 10 picture of Marge on 20 December 1986 at 1118Z.

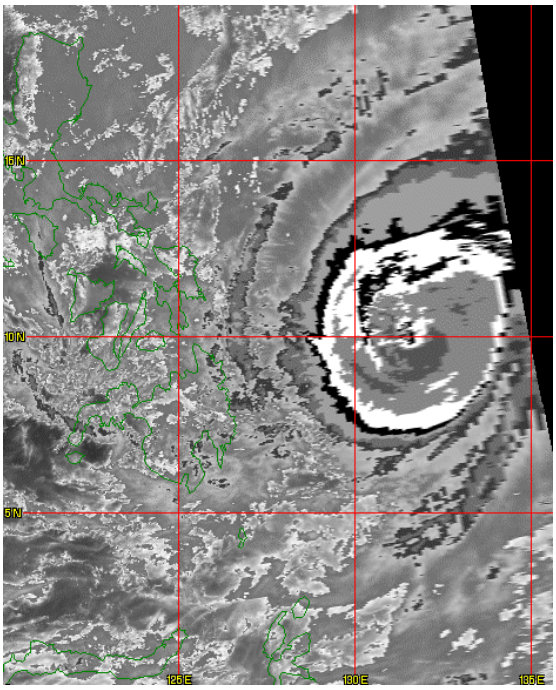

Figure 3 : the BD Noaa 10 picture of Marge on December 1986 at 1118Z.