15B.2 **STATISTICAL ANALYSIS OF SURAFCE WIND DISTRIBUTION OF TYPHOONS ON WESTERN NORTH PACIFIC OBSERVED BY SCATTEROMETER FOR 9 YEARS**

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1. INTRODUCTION

Surface wind distribution of typhoons over the western North Pacific is most important information for the safety of ships. For example, the Regional Specialized Meteorological Center (RSMC) Tokyo Typhoon Center in Japan Meteorological Agency (JMA) issues the advisories of analysis and forecasts of typhoons including maximum sustained wind speed and wind radii of over 50- and 30-knot wind areas. Such wind information is based on the hypothesis in which typhoons have almost axisymmetric surface wind distribution. On the other hand, from the observations by scatterometer on the low orbital satellite of QuikSCAT, it has been empirically understood that there are sometimes non-axisymmetric wind structures in typhoons.

In this study, typical surface wind distributions within typhoons over the ocean are revealed statistically for the first time by using the whole QuikSCAT observational data for typhoons from the start of its operation in 1999 to 2007. Especially, the asymmetry of the wind horizontal distribution is emphasized in this paper.

2. DATA AND METHOD

Sea surface wind data of tropical cyclones observed by QuikSCAT are archived in the web site of Remote Sensing Systems (RSS). The SeaWinds on QuikSCAT launched in June 1999 is a Ku-band (a frequency near 14 GHz) radar which works as a scatterometer to transmit a radar pulse down to the sea surface and measures the power scattered back from sea (Katsaros et al. 2001). The power of the backscattered radiation is proportional to the ocean surface roughness correlated with the near-surface wind speed and direction. It is considered that QuikSCAT can easily detect a TC as a closed circulation in the surface winds on the ocean.

In the RSS database, QuikSCAT sea surface wind was retrieved from the measurements of the power of the backscattered radiation by a geophysical model function called as Ku-2001 (Wentz et al. 2001). The wind speed and direction data are almost equivalent to those with averaging period of 8-10 minutes at a height of 10 meters. In this study, version-03a QuikSCAT surface wind swath data set was used.

First, QuikSCAT sea surface wind data which include typhoon observations were downloaded. Then the swath data were clipped within the square 1,000 km on a side centered on typhoon positions which were interpolated from JMA RSMC typhoon best track data adjusted to the QuikSCAT observational time. Finally, the clipped data were composited into the 1,000 km x 1,000 km horizontal 2-D with the resolution of 25 km relative to motion direction of typhoons in accordance with the purpose of each analysis. The motion speed of typhoons was not subtracted from the surface wind speed. The snapshots, which do not cover more than 50 % of the circle with radius 400 km from the center of typhoon, were eliminated from the analyses. In this study, there are 1,599 QuikSCAT observational cases on western North Pacific from 1999 to 2007 (Figure 1).

3. RESULTS

3.1 COMPOSITE IN ALL CASES

Figure 2 shows sea surface wind distribution composited in all 1,599 cases of QuikSCAT observation on western North Pacific. The averaged motion speed of typhoons is 2.9 m/s. The wind speed distribution is non-axisymmetric, and shows wave number 1. It is found the typhoons have basically asymmetric surface wind distribution. Maximum wind speed is more then 18 m/s, and is located on the right side of the center. This wind distribution is coincident with the fact of so-called dangerous semicircle, and reflects the adding from the motion speed of typhoons.

3.2 CLASSIFICATION BY MOTION SPEED OF TYPHOON

Figure 3 shows composited sea surface wind distributions classified by the motion speed of typhoon. In JMA, the speed of typhoon is divided into three classes which are stationary (Fig. 3 (a), STR, less than 1.5 m/s), slow (Fig. 3 (b), SLW, less than 2.6 m/s) and others (Fig. 3 (c), OTH, more than 2.6 m/s). The wind distributions in SLW and OTH is similar to those composted in all cases and show strong asymmetry (Fig. 1).

The distribution in STR is almost axisymmetric, but the small and clear peak is found in the first quadrant of the distribution. Because it is considered that the motion speed of typhoon has no effect on the surface wind distribution in STR cases, there is possibility of influences of another physical parameters. At this time, it is not clear what kind of parameters affect this asymmetry of the wind distribution in STR.

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3.3 SEASONAL VARIATION

The wind distributions within typhoons were composited on each month to reveal their seasonal variation (not shown here). It is found that in the warm season from Jun to Oct typhoons are bigger and stronger than in other month. On the other hand, in the cool season of Jan, Mar, Nov and Dec, typhoons become smaller and weaker. From this analysis it is concluded that there are seasonal variations of wind speed and wind radius of typhoons.

3.4 INTERANNUAL VARIATION

To find the interannual variation of sea surface wind distribution within typhoons, composites of these distributions were made in each year. In 2002, the maximum radius of the outer circle of wind speed more than 12 m/s is 500 km (Figure 4 (a)). On the other hand, the radius is only 250 km in 1999 (Figure 4 (b)). The maximum wind speed in 2002 is more than 22 m/s. Meanwhile, the maximum speed in 1999 is up to 16 m/s. It is noted that 2002 is El Nino (EN) year, and 1999 is La Nina (LN) year.

From these comparison between two years, it can be concluded that stronger and bigger typhoons in EN, and weaker and smaller typhoons in LN. This tendency is also coincident with the result of Chan and Yip (2003). But in 2007, the maximum radius of the outer circle of wind speed more than 12 m/s is 450 km, and the maximum wind speed is more than 20 m/s (not shown here). These characters of wind distribution in 2007 are similar to those in 2002, but 2007 is LN year. This discrepancy needs to be cleared in further investigation.

4. SUMMARY

Using the whole QuikSCAT data on western North Pacific in 1999-2007, the asymmetry of the surface wind distribution within typhoons is found. It can be estimated that this asymmetry is mainly affected by the motion vector of typhoons. But the asymmetry is still found even though in stationary typhoons.

It is also investigated that the surface wind distribution of typhoons has seasonal and interannual variations. In warm (cool) season, typhoons become bigger and stronger (smaller and weaker). There are tendencies of bigger and stronger typhoons in EN year and smaller and weaker typhoons in LN year. This corresponds with earlier study, but opposite tendency is found in 2007, which is LN year.

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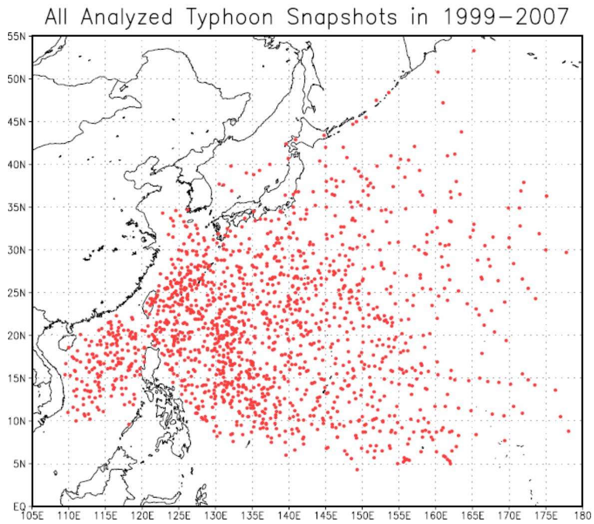

Figure 1. QuikSCAT typhoon observational distributions (red points).

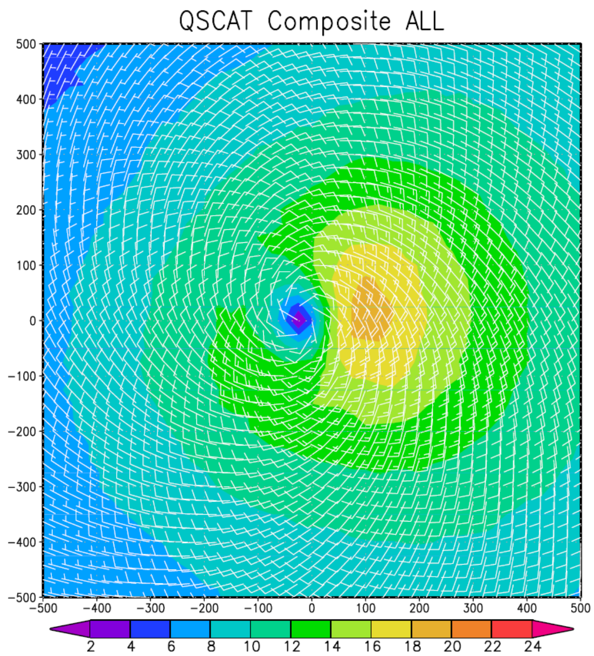

Figure 2. QuikSCAT sea surface wind barbs distribution composited in all 1,599 cases on western North Pacific within the square of 1,000 km x 1,000 km. The shade shows wind speed with color bars (unit: m/s).

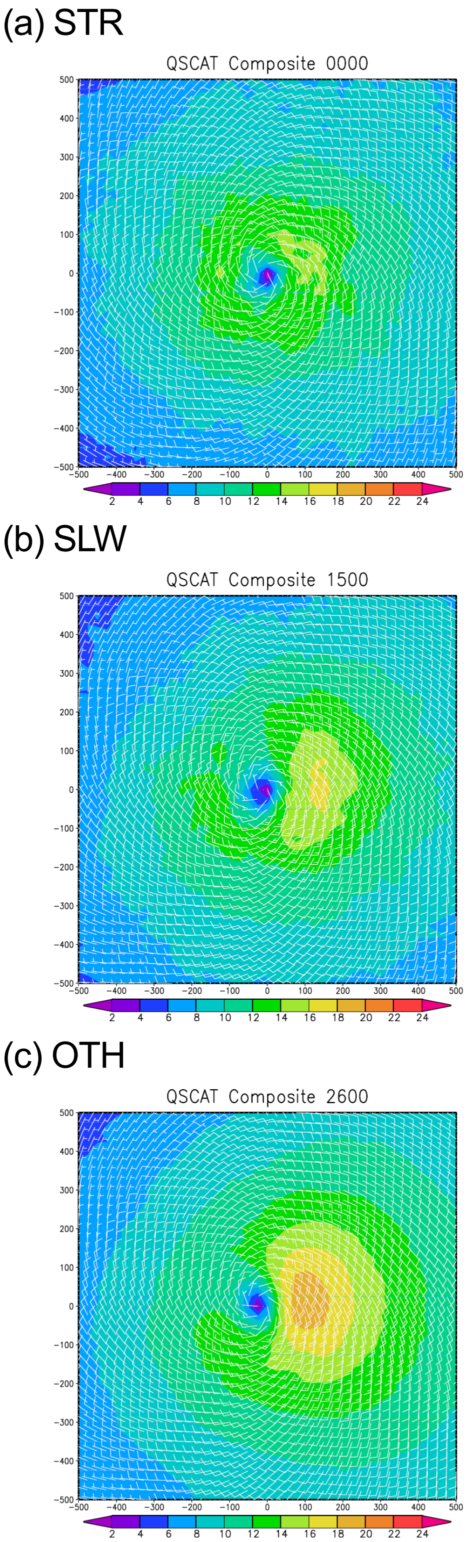

Figure 3. Same as figure 1 except for the stationary typhoons (STR) (a), slow moving typhoons (SLW) (b), and others (OTH) (c).

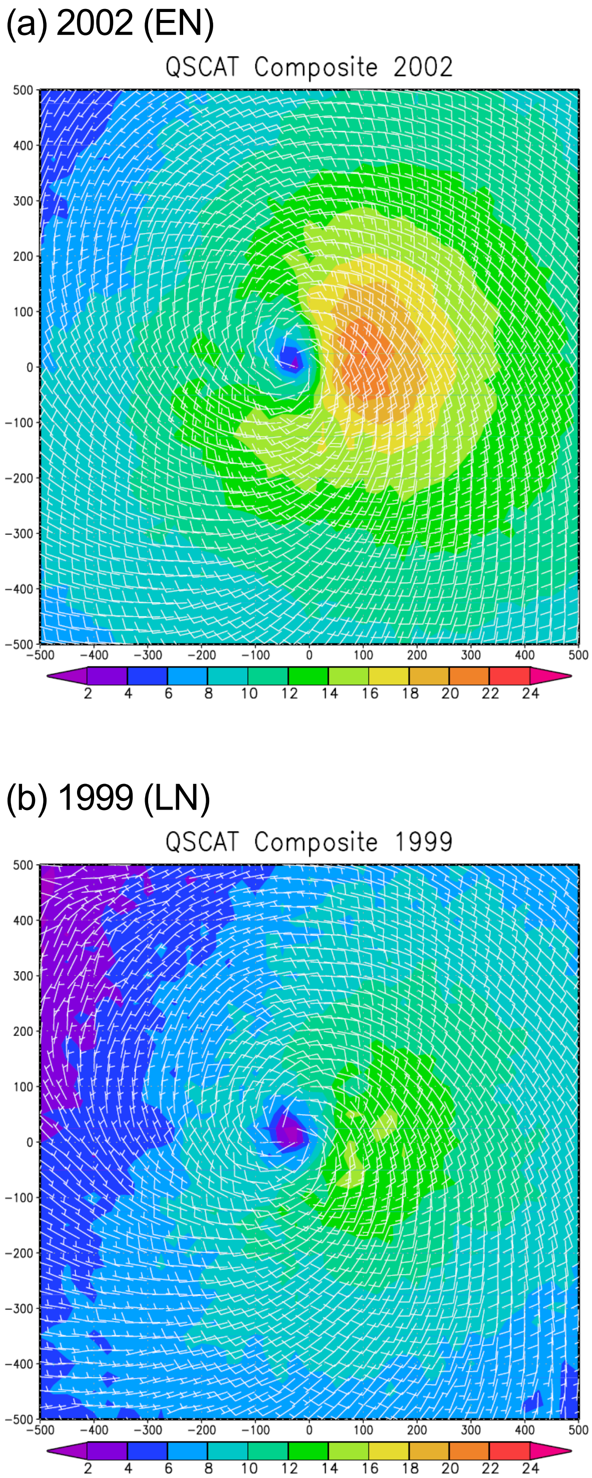

Figure 4. Same as figure 1 except for the typhoons in 2002 (El Nino year: EN) (a) and in 1999 (La Nina year: LN) (b).