Relationships between tropical cyclone motion and surrounding flow with reference to MSW and LR

(Maximum Sustained Wind) (Longest Radius)

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1. Introduction

- The motion of the tropical cyclone has been focused on by a number of previous researches (e.g., George and Gray 1976; Chan and Gray 1982; Carr and Elsberry 1990; Yokoi and Takayabu 2012).
- It is commonly accepted that the cyclone motion is primarily controlled by the larger-scale wind around a cyclone.
- However, that tropical cyclone track is slightly deflected to the left of the steering flow, and that the leftward bias is greater at higher latitudes due to the β-drift (e.g., George and Gray, 1976, Brand et al.,1981, Chan and Gray, 1982, and Carr and Elsberry, 1990).
- The β-drift is significantly affected by longest radius (LR) and maximum sustained wind (MSW) of the tropical cyclone (DeMaria 1985 and Chan and Williams 1987).

The purpose of this study is to investigate how relationships between the motion of the tropical cyclone and steering flow change in association with the MSW and LR.

2. Data

- Best track dataset over the WNP basin (Fig. 1) compiled by the JMA: position, the position of tropical cyclone center, central pressure, MSW, LR, size grade and symmetricity for every 6 hour).
- JRA/JCDAS data
- Period : 1998-2012 (for 15 years).

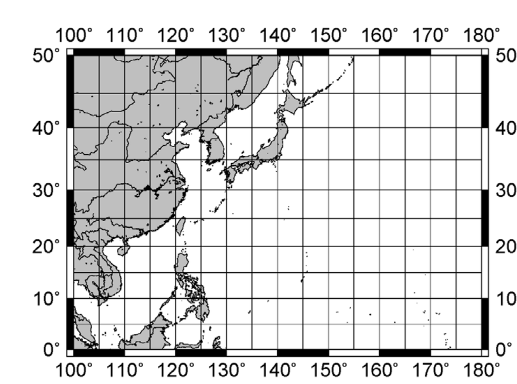
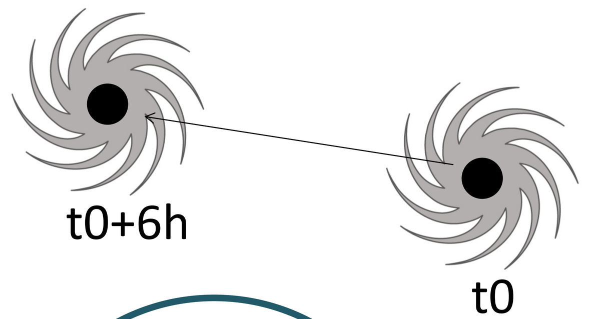


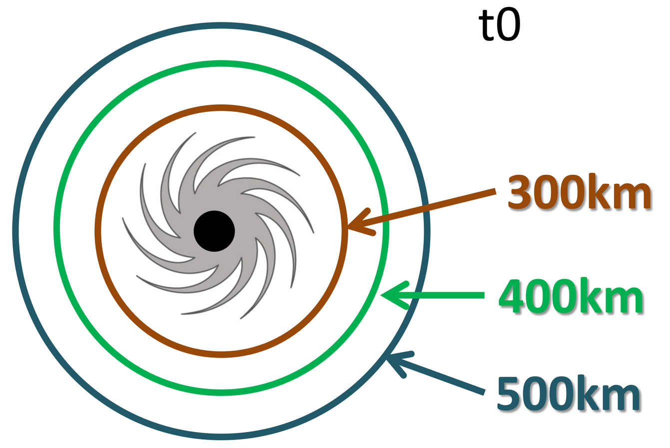
Fig.1: The Western North Pacific (WNP) basin, which is the target area of the present analysis.

3. Methodology

- **Propagation velocity of a tropical cyclone (Ut, Vt)** : The velocity is calculated by the sequent positions of a cyclone in the zonal and meridional directions for 6 hours.
- **Ambient wind velocity (Ue, Ve)** :



1. Horizontal winds are integrated from 1000 hPa to 300 hPa levels, and normalized by the mass between the two levels.
2. The mass-weighted winds are further averaged over the area within 300 km, 400 km, and 500 km radiuses from the center of a cyclone.



4.Results

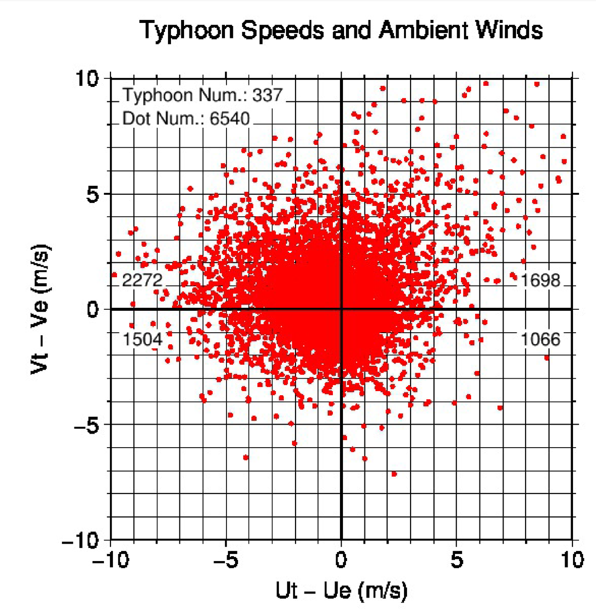


Fig.2: Differences between the propagation velocity of the tropical cyclone (Ut,Vt) and ambient wind velocity (Ue,Ve). Abscissa and ordinate indicate the difference of the speeds in the zonal and meridional directions, respectively.

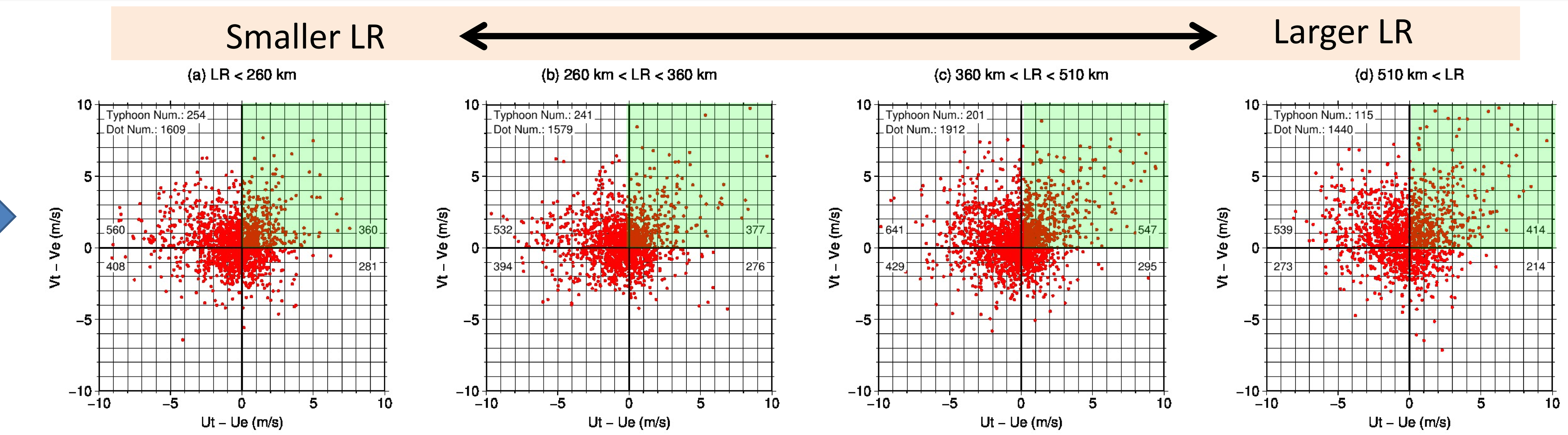


Fig.3: Same as Fig. 2, except that the cyclone is divided with reference to the LR.

- Dots are more scattered in the first quadrant, when the LR is larger.
- The tropical cyclone in the first quadrant propagates to the north-east direction relative to the steering flow.

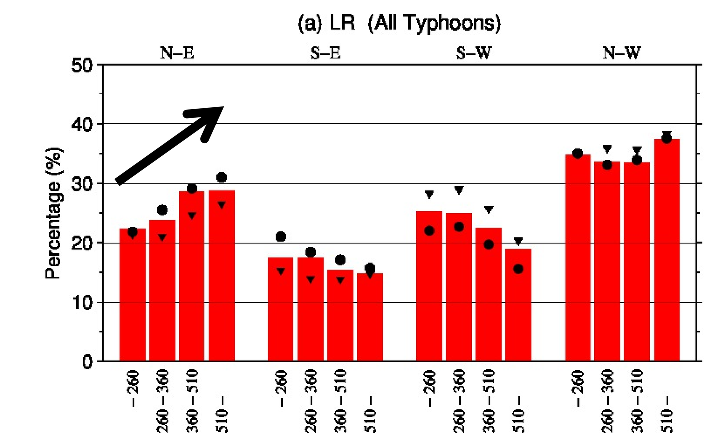


Fig.4: Fractions of the tropical cyclone that propagates to the north-east (left), south-east (middle-left), south-west (middle-right), and north-west (right) directions relative to the steering flow. The cyclone is sorted with respect to the LR. The circle, bar and triangle in the panel corresponds to the result with the use of the ambient wind averaged over areas within 300 km, 400 km, and 500 km radius around the cyclone, respectively.

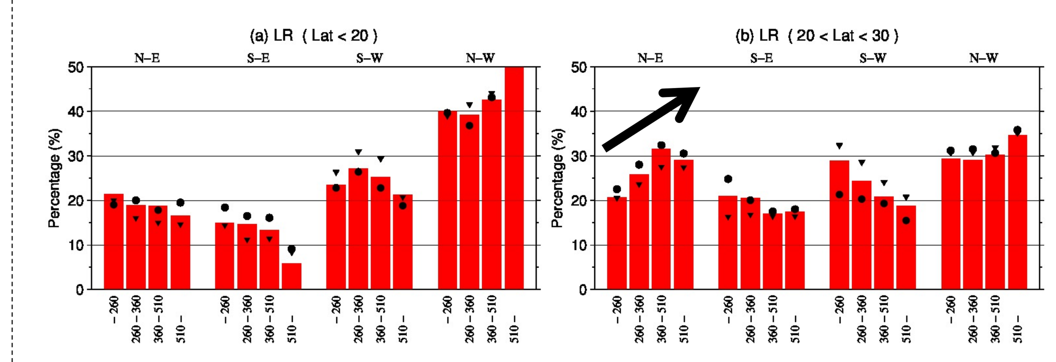


Fig.5: Same as Fig. 4, except that the tropical cyclone is divided into mid-latitude and lower latitude ones with a border at 20° N.

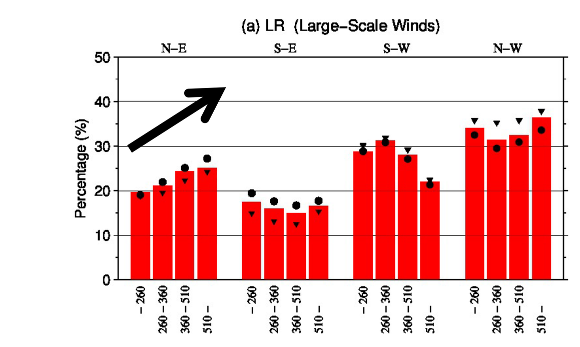


Fig.6: Same as Fig. 4, except that smaller-scale perturbations are excluded from the ambient wind field.

Components with less than about 12° latitude–longitude in wavelength are filtered from the total wind field.

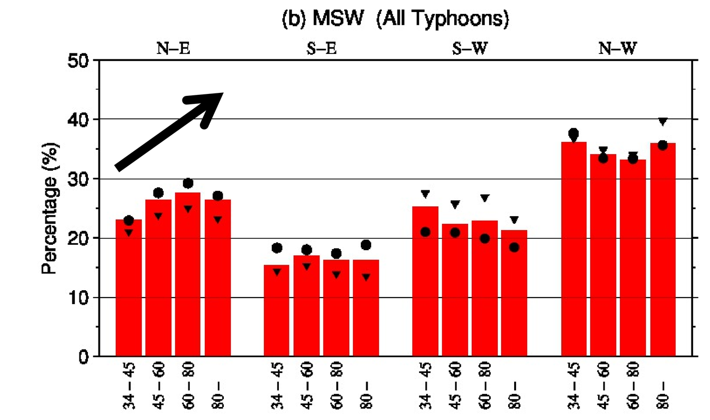


Fig.7: Same as Fig. 4, except that the tropical cyclone is sorted with respect to the MSW.

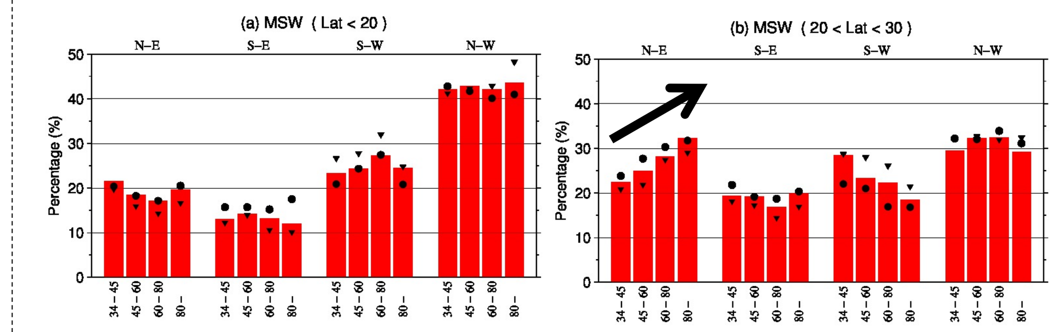


Fig.8: Same as Fig. 7, except that the tropical cyclone is divided into mid-latitude and lower latitude ones with a border at 20° N..

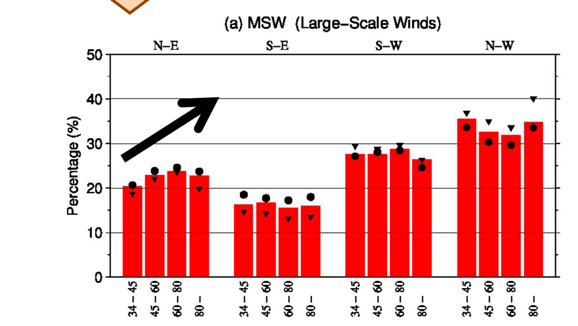


Fig.9: Same as Fig. 7, except that smaller-scale perturbations are excluded from the ambient wind field.

- [Figs. 4 and 7] : Fractions of the tropical cyclone propagating in the north-east direction relative to the ambient wind increase with the LR and MSW, regardless of the averaging radius for the calculation of the steering flow (300 km, 400 km, or 500 km).
- [Figs. 5 and 8] : The increase of the tropical cyclone propagating to the north-east direction is prominent only in the mid-latitude.
- [Figs. 6 and 9] : The increase of the tropical cyclone propagating to the north-east direction is also prominent, even if smaller-scale perturbations are excluded for the calculation of the steering flow.