13.4 METHOD TO ESTIMATE TROPICAL CYCLONE INTENSITY USING TRMM PR/TMI DATA

Shunsuke Hoshino*, Tetsuo Nakazawa
Meteorological Research Institute / Japan Meteorological Agency

1. INTRODUCTION

The most popular method to estimate intensity of tropical cyclones is the Dvorak technique (Dvorak, 1975, 1984). It is based on the cloud pattern in satellite imagery, but not based on a physical parameter. To complement this weak point, additional methods to estimate intensity of tropical cyclones will be needed.

Nowadays, we can get the data of physical parameters from microwave instruments on satellites, such as TRMM PR/TMI. So we are now developing an objective method to estimate intensity of tropical cyclones with such data. At first, we are preparing a database to extract characteristic features in TMI brightness temperature data.

Edson(2001) said that lower-base rain appears warm in 85GHz-h brightness temperature and cool in 37GHz-v, and rain with deeper convection appears cool in 85GHz-h and warm in 37GHz-v.

Several research trying to estimate intensity of tropical cyclones with SSM/I data have already done. For example, Cecil and Ziper(1998) researched the relationship between PCT(Polarization Corrected temperature) and maximum wind speed of tropical cyclones, and revealed that PCT parameter is corelated with future intensity rather than current intensity.They also revealed that mean PCT and area which PCT is below 250K have higher correlation than minimum PCT.

2. DATA

We use TRMM TMI 1B11 data to get the brightness temperature data. We use brightness temperature of 37GHz-v(TB37v) and 85hGHz-h(TB85h) data. We also used PCT :

$$PCT = 1.818\ TB85v - 0.818\ TB85h$$

to eliminate the radiation from ocean.

We use maximum wind speed data in besttrack by NHC and JMA , and in QuikSCAT (version 3) data for references of intensity of tropical cyclones. We also used location data of center in besttrack.

3. METHOD

We calculated the mean value of PCT, TB85h, TB37v within every 0.5° lat radius circles and annuli from center of tropical cyclone(Fig.1) as same way in Cecil and Zipser(1999). We determine the location of the center by interpolation from besttrack data. We calculated minimum value of PCT and TB85h, maximum value of TB37v and percentage of area that PCT and TB85h is over 250K and TB37v is below 255K in the same way.

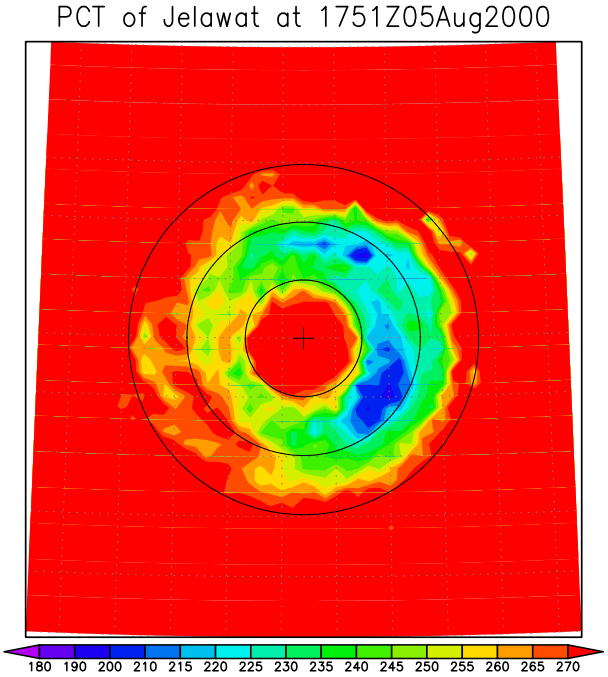

FIG. 1: PCT snapshot of Jelawat at 2000/08/05 1751Z. Three concentric circles (radius = 0.5° ,1.0° ,1.5° lat) that parameters are calculated within are drawn. Parameters are also calculated within the each 0.5° lat-wide annuli.

And to see the organization around the core region, we use three more parameters as same way in Bankert and Tag(2002). First, we calculate warmest/coldest pixel value (WPC/CPC) for PCT,TB85h / TB37v within 0.5° radius of the center. Second, the surrounding temperature(ST) is determined as the coldest value in the set of warmest(coldest) values on each 0.05°-wide annuli (0.25° - 1.5° lat) (See Fig.2). And we use WPC(CPC)-ST as the third parameter. If the tropical cyclone is organized to have eye, WPC-ST became bigger.

We analyzed the correlation of these parameters and maximum wind speed of tropical cyclone from besttrack or QuikSCAT. We also analyzed correlation with the intensity 12 hours after the TMI data to see the relationship

*Corresponding autor adress: Shunsuke Hoshino , MRI/JMA, 1-1 Nagamine, Tsukuba, Ibaraki, 305-0052,Japan; e-mail: shoshino@mri-jma.go.jp

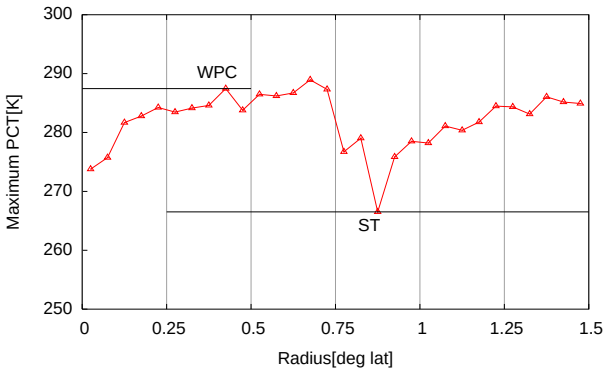

FIG. 2: Maximum PCTs within each 0.05° lat-wide annuli of Jelawat at the same time with Fig.1. WPC is calculated as the maximum value in 0.5° lat annuli (upper black line), and ST is calculated as the minumum value in 0.25° to 1.25° annuli(belower black line).

with "future intensity". Time collocation is 3 hours for besttrack and 6 hours for QuikSCAT.

We analyzed 12 tropical cyclones in 2000 season.

4. RESULTS

The tendency of TB85h parameters is assumed as similar as the tendency of PCT,so we will display the results about PCT and TB37v parameter. Fig.3 is correlation of each parameter and intensity. The mean values and percentages of area have higher correlation than minimum (maximum) value. It consistents with Cecil and Zipser(1999). Correlation between TB37v and wind speed is higher than PCT and wind speed. PCT is assumed that indicates activity of convection and TB37v is associated with stratiform rain, so it is unexpected result.

For mean value and percentage of area, correlation of wind speed and parameter within 0.5° lat is smaller than outer parameter. It suggests that information of physical parameter surrounding core region is important.

WPC/CPC , ST and WPC/CPC-ST parameters is not so highly correlated with wind speed by QuikSCAT, but WPC-ST of PCT has higher correlation with by besttrack. Most of other parameters are less correlated with besttrack than QuikSCAT, but these parameters shows opposite characteristc.

PCT and TB37v parameters have opposite tendency for comparison of current intensity and future intensity. PCT parameters seem to have higher correlation with future intensity than current intensity. But TB37v parameters seem opposite. Fig.4 is the time series of maximum wind speed and percentage of area that TB37v $\leq$ 255K of Hurricane Lane. The area in 1.0° and 1.5° lat radius from center has similar tendency with wind speed.

5. FUTURE ISSUE

Now we are only preparing database and analyz-

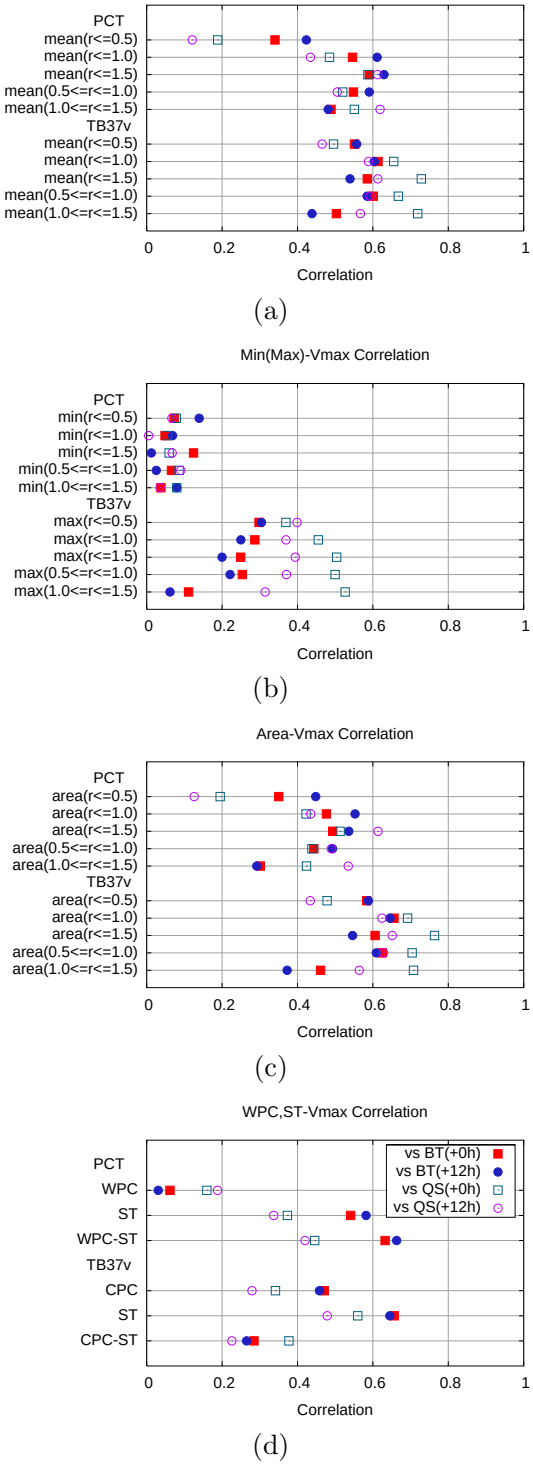

FIG. 3: Correlation of parameters and maximum wind speed.(a)mean PCT and TB37v,(b)minimum PCT and maximum TB37v,(c)area PCT $\geq$ 250K and area TB37v $\leq$ 255K,(d)WPC/CPC and ST. Red square is for current besttrack wind speed, blue bullet is for besttrack wind speed 12 hours after, green open square is for current QuikSCAT wind speed, and purple open circle is for QuikSCAT wind speed 12 hours after.

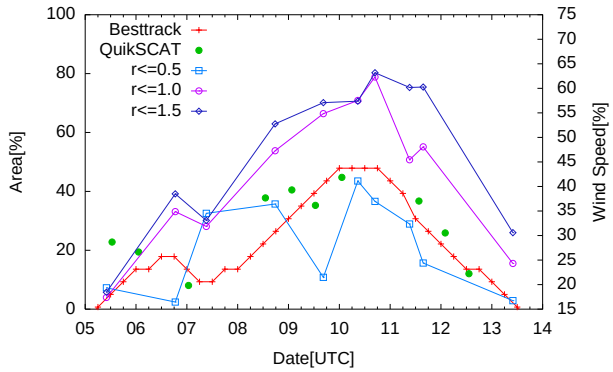

FIG. 4: Time series of percentage of area that TB37v $\leq$ 255K and wind speed of Hurricane Lane case. Area in 1.0° and 1.5° lat circles seems to have similar tendency with wind speed. Area in 0.5° lat circle is different from area in 1.0° and 1.5° lat circles.

ing statically, so there are many issues left to make estimating method with microwave data. We don't considerate the characteristics of tropical cyclone such as eye (none/single/double) , spiral band and stage(developing ,extratropical transition stage, and so on). Such characteristic information might be needed to estimate intensity,so objective method to categorize the characteristic will be needed.

We are now using parameters from brightness temperature, but it's not the real "physical parameter". So we should know which physical parameter we are watching via microwave data exactly for future research.

To complement Dvorak method, we should extract the cases that wind speed from Dvorak method (besttrack) is too larger or smaller than from QuikSCAT and know difference with the cases that wind speed from Dvorak method matches with from QuikSCAT (or other observations).

6. REFERENCES

Bankert, R. L. and P. M. Tag , 2002: An Automated Method to Estimate Tropical Cyclone Intensity Using SSM/I Imagery. *J.Appl.Meteor.* , **41**, 461-472.

Cecil, D. J. and E. J. Zipser , 1999; Relationships between Tropical Cyclone Intensity and Satellite-Based Indicators of inner Core Convection: 85GHz Ice-Scattering Signature and Lightning. , *Mon. Wea. Rev.*, **127**, 103-123.

Edson, R.T. , 2001; Recent Findings in the Operational Use of MICROWAVE Data as related to Tropical Cyclone Forecasting. , CIRA/CSU Seminar.