Detection of tropical cyclone centers using satellite data and spatial metrics

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Abstract

The Best track served by JTWC (Joint Typhoon Warning Center) is widely used for the reference data of Typhoon Center (TC). However, the center location data of typhoon is not available in real time from JTWC. In this study, we used both geostationary satellite-based data and polar orbited satellite-based data for specifying centers more early time. To detect center of typhoon, we used the Circular Variance Index for detecting center of top-cloud pattern and sea surface wind field and it refer to center of convection.

Keywords: Tropical cyclone, Center detecting, Remote sensing

1. Introduction

Tropical Cyclone is one of the most fatal natural disaster. Millions of people lose their property, home and families due to cyclone every year. According to 'Statista' (https://www.statista.com/) that is a Statistics Association in German reported Typhoon is the worst disaster that bring the most monetary damage last 10years. Many researchers have been trying to understand the process of tropical cyclone genesis and ideal process of cyclone genesis is already set up. Also, there are many global models for detecting the center of tropical cyclones and there are based on dynamics. Recently, meteorologists try to using satellite-based data and it gives more objectivity and higher accuracy than dynamics models. (Velden et al., 1998) Best track by JTWC (Joint Typhoon Warning Center) that is widely used for reference track data of tropical cyclones consider both satellite based data and dynamic models for detecting them. (Barcikowska et al., 2012) JTWC open to the public the track data few months later from the event occurs. In terms of that, we proposed the technology for detecting center of cyclone in real time using satellite-based data. It can exclude subjectivity and promote their objectivity and automation.

In this study, we proposed the automatic technique for detecting center of TCs using satellite-based data and extract the center by considering both top-cloud pattern and sea surface wind field.

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2. Data

Best track by JTWC (Joint Typhoon Warning Center) is widely used for reference data of tropical cyclone track data in many studies and it also be used for reference data in this study. MI (Meteorological Imager) sensor of COMS (Communication, Ocean and Meteorological Satellite) that is launched by South Korea in 2010 was used as geostationary satellite-based data. (National Meteorological Satellite Center, http://nmsc.kma.go.kr/) Windsat of CORIOLIS that is launched by Naval Research Laboratory (NRL) and Air Force Research Laboratory (AFRL) in 2003 was used for polar orbiting satellite based data.(Remote Sensing System, http://www.remss.com/missions/windsat) In this study, infrared1 channel images derived by COMS were used for extract brightness temperature and to consider sea surface wind field, wind direction data derived from CORIOLIS were used in this study.

3. Method

Park et al. (2016) proposed the method for detecting center of sea surface wind field using Circular Variance index. It can be consider the symmetry level of circulation and if they have a maximum value of circular variance index, it implied that the location is the center of circulation. The circular variance index is calculated as equation (1).

$$\mathrm{CV} = 1 - \frac{\left[\left(\sum_{i=1}^{n}\cos\theta_i\right)^2 + \left(\sum_{i=1}^{n}\sin\theta_i\right)^2\right]^{1/2}}{n} \quad (1)$$

Figure 1 shows an example of detecting center using circular variance index. Also it can be applied to brightness temperature of geostationary satellite based data. Concentration of low brightness temperature (< 210K) means that the location has atmospheric convection and it refers to center of

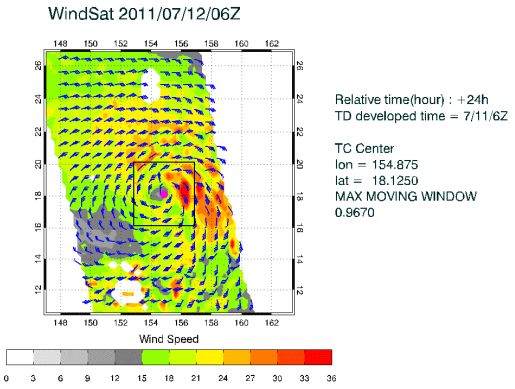

Figure 1. Example of center detecting using circular variance index apply to sea surface wind field data

TCs. (Zhuge et al., 2015) Based on this concept, the center location of TCs can be extracted by applying circular variance index to brightness temperature gradient index.

4. Results

Considering both the center of sea surface wind field and cloud-top convection center, we can extract by general center of TCs. Degrees of tilting between those centers are gradually decreased as they develop to mature stage of tropical cyclones. It was implied that the average of those centers refers to general center of cumulonimbus cloud of tropical cyclones.

References

Park, M. S., Kim, M., Lee, M. I., Im, J., & Park, S. (2016). Detection of tropical cyclone genesis via quantitative satellite ocean surface wind pattern and intensity analyses using decision trees. *Remote Sensing of Environment*, *183*, 205-214.

Zhuge, X. Y., Guan, J., Yu, F., & Wang, Y. (2015). A new satellite-based indicator for estimation of the western North Pacific tropical cyclone current intensity. *IEEE Transactions on Geoscience and Remote Sensing*, *53*(10), 5661-5676.

Fiolleau, T., & Roca, R. (2013). An algorithm for the

detection and tracking of tropical mesoscale convective systems using infrared images from geostationary satellite. *IEEE transactions on Geoscience and Remote Sensing*, *51*(7), 4302-4315.

Velden, C. S., Olander, T. L., & Zehr, R. M. (1998). Development of an objective scheme to estimate tropical cyclone intensity from digital geostationary satellite infrared imagery. *Weather and Forecasting*, *13*(1), 172-186.

Barcikowska, M., Feser, F., & Von Storch, H. (2012). Usability of best track data in climate statistics in the western North Pacific. *Monthly Weather Review*, *140*(9), 2818-2830.