Applying Satellite Data to Analyze the Precursor of Typhoon and Heavy Rainfall Formation

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Since the 1960s, satellites have become a powerful tool in monitoring tropical cyclones. The formation and rainfall of such storms has become a key research area in satellite remote sensing. One of the aims of this research is to employ the Special Sensor Microwave Imager (SSM/I) data in retrieving the air-sea parameters for different typhoons in finding the possible signals or thresholds as whether tropical cyclones will occur or not. The other one is to improve the original Tropical Rainfall Potential (TRaP) technique (Kidder et al., 2005; Liu et al., 2008) to predict the accumulated rainfalls by typhoons in Taiwan.

For typhoon formation, the air-sea energy parameters (Liu et al., 2001; Liu et al., 2002) were calculated for three cyclogenesis conditions - (I) stable clear sky, (II) clear skies developing into cloud clusters but subsequently dispersing, (III) clear skies developing into typhoons (Fig 1). Afterwards, the typhoon cases were categorized by the Niño 3.4 indices into three groups - Niño years, normal years, and Niña years. Results show that this research was able to accurately obtain the thresholds in predicting whether or not tropical cyclones will occur. This research discovered that the threshold values were significantly different for three different categories. Finally the typhoon cases in 2007 were used to verify the threshold values’ effectiveness. Most typhoons in 2007 could be predicted successfully before their actual formation, revealing a potential opportunity for researchers to predict when a typhoon could form. In other words, we could have extra preparation time instead of only waiting until the JTWC issues a typhoon warning.

For typhoon rainfall, it is based on the TRaP technique but is considered the terrain effect with three ways: “Rainfall re-distributing” (Liu, 2009), “Total rainfall re-adjusting”, and “Environment wind classifying”. This study used SSM/I-derived rainfalls to construct the TRaP and estimate new rainfall patterns, and then were validated with by CWB automatic rainfall station observations. The results show the improved TRaP technique indeed could obtain a much better performance than the original TRaP. For typhoon Morakot in 2009, the correlation increases from 0.37 to 0.91 and the RMSE decreases from 497.0mm to 297.2mm (Fig 2). It shows that TRaP technique can be significantly improved by considering the terrain effect and environment wind convection in Taiwan area.

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References:
Liu, C.-C., 2009: The influence of terrain on the tropical rainfall potential technique in Taiwan.


Fig 1. The total energy variations of Typhoon Lekima (2001) and two nearby (clear sky and cloud cluster) window areas.

Fig 2. (a) Observed total rainfall distribution of Typhoon Morakot (2009), (b) same as (a) but for original TRaP technique, (c) same as (a) but for improved TRaP technique, and (d) the total rainfall verification of observed and improved TRaP technique.