

Typhoon Induced Precipitation Characteristics over Japan

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Introduction:

Typhoons are considered as one of the most dangerous extreme weather events in the world that triggered widespread flooding in the landfall area. Plenty of typhoons have approached Japan over the year and many of them have impacted lots of properties by bringing heavy rainfalls (Takemi, 2019). In a recent study, Nayak and Takemi (2020) investigated the spatial and temporal characteristics of four typhoons those landfalled over Northern Japan and highlighted that these typhoons brought relatively more frequent heavy precipitations (>20-30 mm/h) that last from 6 to 9 hours over northern Japan. However, studies are limited to understand the spatiotemporal structure of precipitation over other regions across Japan. In this study, we analyzed the precipitation characteristics from 120 typhoons that approached Japan during 2006-2019 (Fig. 1).

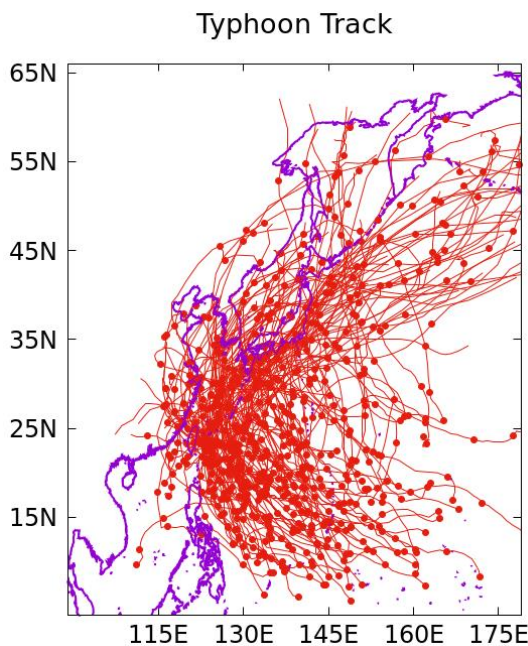


Fig 1: Track of 120 typhoons approached through Japan during 2006-2019.

Data and Methods:

We analyzed the precipitation datasets from the Radar Automated Meteorological Data Acquisition System (Radar-AMeDAS) which are available at ~1 km spatial resolution over Japan. The best track data from the Regional Specialized Meteorological Center (RSMC) Tokyo was utilized to identify the typhoon tracks along and their active periods over Japan. To capture the typhoon-induced precipitation amount and the duration over a region of various radii (10~300) from the typhoon center, we consider the overlapping area between the desired region and the typhoon size. The following equations are used to find the overlapped/ intersected area.

Overlapped

$$\begin{aligned} Area = & \text{Typhoon Size}^2 \cos^{-1}\left(\frac{d_1}{\text{Typhoon Size}}\right) \\ & + \text{Desired Radius}^2 \cos^{-1}\left(\frac{d_2}{\text{Desired Radius}}\right) \\ & - d_1 \sqrt{\text{Typhoon Size}^2 - d_1^2} \\ & - d_2 \sqrt{\text{Desired Radius}^2 - d_2^2} \end{aligned}$$

Where

$$d_1 = \left(\frac{\text{Typhoon Size}^2 - \text{Desired Radius}^2 + d^2}{2d} \right)$$

and

$$d_2 = \left(\frac{\text{Desired Radius}^2 - \text{Typhoon Size}^2 + d^2}{2d} \right)$$

d is the distance between the typhoon center and the center of desired region.

Finally, we collected independent spell durations of precipitations exceeding various percentile of thresholds starting from 5 mm to 20 mm rainfall and stratified them into various duration bins.

Preliminary Results:

The probabilities of the spell durations of precipitation exceeding various thresholds of 5, 10, 20 mm over the Pacific Ocean side of the Eastern Japan (EP) are shown in Fig. 2. The spell durations are computed over five different regions considering various radii from the center of that region. The regions are hereafter referred as Region with radius 10 km, Region of radius 50 km, Region with radius 100 km, Region with radius 200 km and the Region with radius 500 km.

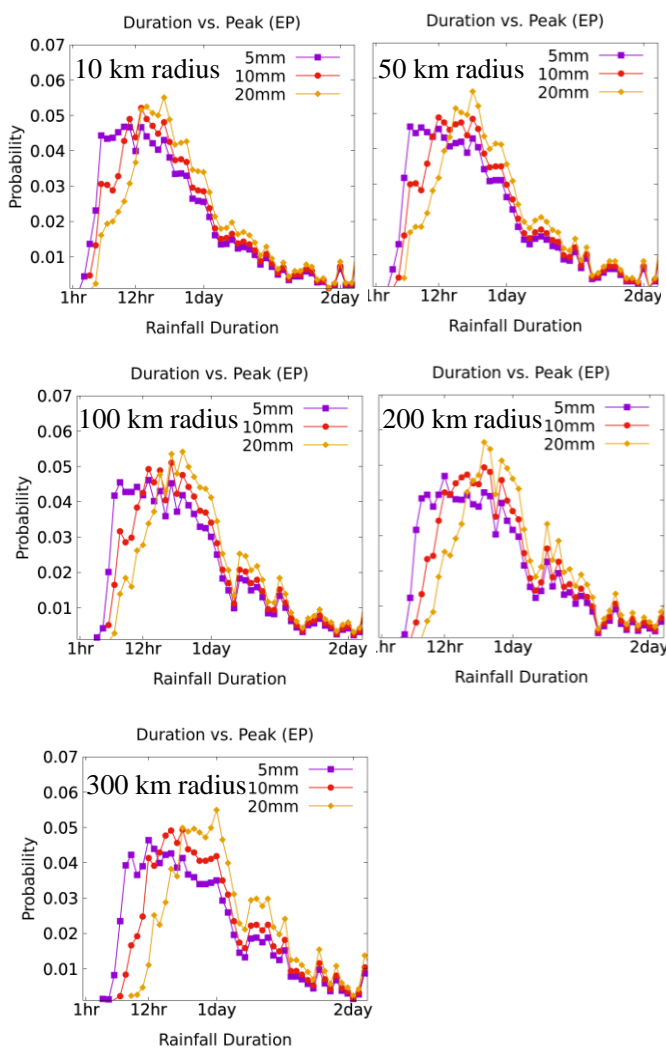


Fig 2: The probability of precipitation durations induced by the 120 typhoons approached over the Pacific Ocean side of the Eastern Japan.

The results indicated that the spell durations, obtained from all three types of precipitation thresholds, are

qualitatively same for all the five regions selected in this study. The heavier precipitations show higher probability and last up to a day, while the lighter precipitations last about 12 hours. The long-lived precipitations are also noticed for all the three types of precipitation cases which lasts up to 2 days and more, although they don't occur so frequently. The occurrences of spell durations are found to be the same over all the five regions within 300 km radius, perhaps due to the fact that the size of most of the typhoons is in general higher than 300 km. Thus results may be different if higher radii values are considered.

Summary:

In this study, we have investigated the spell duration of the precipitation carried by 120 typhoons over the Pacific Ocean side of the Eastern Japan during 2006-2019. Our results indicated that the heavier precipitations occurred more frequently during the typhoon active periods and last up to a day compared to lighter precipitation cases which last about 12 hours. The long-lived precipitations are also found that last up to 2 days, but they don't occur so frequently. We would like to discuss more on this with considering other regions of Japan.

Acknowledgments:

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References:

- Nayak, S., & Takemi, T. (2020). Typhoon-induced precipitation characterization over northern Japan: a case study for typhoons in 2016. *Progress in Earth and Planetary Science*, 7(1), 1-12.
- Takemi, T. (2019). Impacts of global warming on extreme rainfall of a slow-moving typhoon: a case study for Typhoon Talas (2011). SOLA.