NOTES AND CORRESPONDENCE

Oceanic Thunderstorms in the Tropical and Subtropical Pacific

By Toshio Takeuchi and Masahiro Nagatani

Research Institute of Atmospherics, Nagoya University, Toyokawa

 manuscipt received 15 July 1974, in revised form 7 September 1974

1. Introduction
Meteorological conditions for thundercloud development over ocean may be different from those over land, and, the characteristics of the oceanic storms would reveal some difference from those of land storms. On the other hand, the investigation of the oceanic storm activity is very important for the study of so called global circuit in the field of atmospheric electricity. In spite of such importances, there have been published only a few reports on the oceanic storms (WMO, 1953 and 1956; Krumm, 1962; Mühliesen, 1967; Trent and Gathman, 1972). This is the reason why we have observed thunderstorms on board of the research vessel Hakuho-Maru in the Western Pacific during July through September 1973.

2. Cruising route and instruments used
Fig. 1 shows the course of this cruise together with the locations where we observed the storms. The field changes due to lightning discharges were measured with a field mill and recorded on the recording charts.

A sferics counter tuned at 3 kHz was also used in this observation. The counter with 1.6 kHz band width can count the sferics with field strength larger than 1.5 V/m. The exact determination of the effective range of this counter is difficult because of large variation of the intensities for individual lightning discharges. Only a rough estimation has been made using the data reported by Pierce et al. (1962) and Taylor (1963). Intensive sferics in VLF region are generally emitted from return strokes (Malan, 1958) and their intensities deduced from the above two reports are about 0.1 V/m for 1 kHz band width at 100 km from the discharges. The threshold value of this counter is about ten times higher than this value. However, considering the wide scattering in the intensities of individual lightning discharges, we have deduced the maximum effective range of this counter to be about 100 km. In distances up to a few hundred km, the ground wave of the sferics is expected to be dominant (Pierce et al., 1962), so that all the discussion in this paper are made without any consideration about the effects due to an ionosphere.

3. Diurnal variations of the oceanic storm activities
The diurnal variation of the oceanic storm activities can be deduced from Fig. 2 showing the results obtained with the counter. The diurnal variation of the storm activity on the sea in the area among/near Philippine Islands and at the Port of Cebu, Philippinen, shown in Fig. 2(a) indicates a peak in the afternoon similar to the variation on the ordinary land storms in summer, but the activity keeps its high level till midnight.
Fig. 2(a). The diurnal variation of occurrence frequencies of sferics on the sea in the area among/near Philippine Islands and at the Port of Cebu (9 days).

Fig. 2(b). The diurnal variations of occurrence frequencies of sferics.

- a: From the equator to the point shown with the cross in Fig. 1 except near/at Fiji (10 days).
- b: From Japan to the equator except near/at Japan and Guam (32 days).
- c: From Philippine Island to Japan except near/at Philippine Islands and Japan (7 days).

showing a different pattern from that of the land storms. This feature is thought to be derived in part by the characteristics of the oceanic storms as described below. The diurnal variations of the storm activities shown in Fig. 2(b), which were obtained during the cruises amidst the Western Pacific, indicate different pattern as compared with that of the ordinary land storm. In other words, the peak activities are attained at the time between midnight and early in the morning. The diurnal variation of the land storm activity depends mainly on heating of the earth surface by solar radiation, but such an effect for the oceanic storm activity is relatively little because of the large heat capacity of the ocean. In other words, variation of the oceanic surface temperature is small through all day. This is the reason why there appears no peak in the afternoon for the oceanic storm activities. At night instability occurs by radiative cooling in the top part of the cloud and this instability continues until early in the morning (Watanabe, 1959). By this reason, the peak activities of the oceanic storms appear at the time between midnight and early in the morning.

4. Activity of individual storm

An occurrence frequency of discharges is thought
to be one of indices for storm activity and a life time, defined herein as a duration between the first discharge and the last one, indicates one of the storm characteristics. As shown in Fig. 3, the occurrence frequencies of the discharges except one storm were on the average about 0.5/min. and the life times were less than 1/2 hour, indicating rather low frequencies and short life times than the ordinary land storms in summer.

5. Conclusion

The diurnal variation of the oceanic storm activity shows different pattern as compared with that of the ordinary land storm. The peak activity of the oceanic storm appears in the time between midnight and early in the morning. The activity of the individual storm is found to be rather low compared with that of the land storms in the summer.

Acknowledgements

We are grateful to Prof. Tomoda, Ocean Research Institute, University of Tokyo, for his help to this observation. We wish also to thank to Prof. Ishikawa and Mr. Nakano, Research Institute of Atmospherics, Nagoya University, for their useful discussions to this paper.

References

WMO/OMM: 1953 and 1956: World Distribution of Thunderstorm Days, TP 6 and 21, No. 21, Geneve.

熱帯及び亜熱帯太平洋上での海洋雷

竹内利雄，長谷正博
名古屋大学空電研究所