THE TYPHOON RUTH AND ATMOSPHERICS*

ATSUSHI KIMPARA

Department of Electrical Engineering

(Recieved May 30, 1953)

Abstract

The author observed atmospherics concerning the Typhoon Ruth which attacked Japan in October, 1951. He found that origins of atmospherics are not only scattered over the convergence area of the typhoon as in the case of the Typhoon Kezia in September, 1950, but also they are distributed in the convergence area in front of the trough of westerly waves as well as easterly waves, both of which are very likely connected with the typhoon.

In this case he employed fairly sensitive cathode ray direction finders, and he expects to be able to find more detailed characteristics of typhoons and other similar meteorological phenomena by using more sensitive apparatuses and waveforms measuring equipments.

Résumé

L'auteur a observé les atmosphériques concernant le Typhon Ruth qui a attaqué Japon en octobre 1951. Quoiqu'il soit certain que les origines des atmosphériques se trouvent dispersés dans la région de convergence du typhon de la même façon au cas du Typhon Kézia en septembre 1950, les autres origines se trouvent aussi distribués dans la région de convergence devant la vallée des ondes occidentales de la haute atmosphère ainsi que celle des ondes orientales, et d'ailleurs il est très semblable que tous les deux ont la relation intime avec le typhon concomitant.

En cette occasion nous avons employé les radio-goniomètres à rayon cathodique bien sensitives, et nous attendrons que l'on peut fournir une méthode nouvelle afin d'étudier les caractéristiques du typhon et les autres phénomènes similaires en employant les appareils pour mesurer la direction ainsi que la forme d'atmosphériques.

1. Introduction

The author derived formerly a general law of generating atmospherics by which he explained atmospherics due to the Typhoon Kezia at that time.[1)2)3)] The characteristics of typhoons vary in accordance with seasons of the year and the geographical location. In the present article the author intends to describe the principal features of atmospherics attributed to the Typhoon Ruth in October, 1951,

* This paper was communicated by Dr. K. Wadachi, M. J. A., at the ordinary meeting of Japan Academy in October, 1952 and read by the author at the general assembly of the Society of Terrestrial Magnetism and Electricity of Japan in October, 1952 and at the ordinary meeting of the Japanese National Committee of U.R.S.I. in November, 1952.

comparing with those to the Typhoon Kezia in September, 1950.

The Typhoon Ruth was found on 6 October, 1951 as a tropical depression on the Southern Pacific Ocean east of the Caroline Islands. At 09.00 JMT, 9 October, she became a tropical storm and was named "Ruth" on the sea west of Guam Island; at 09.00 JMT, 10 October, she developed to typhoon on the sea south of Okino-Tori-Shima Island, and reached to the most active period at 21.00 JMT, 12 October, indicating 924 mb at the centre.[4]

The observation was held from 20.50 JMT, 7 October, 1951 to 20.52 JMT, 11 October, 1951 at Ohira-Observatory (35°36′ N, 140°28′ E) and at Toyokawa-Observatory (34°50′ N, 137°22′ E). The distance between two stations is about 300 km and the observation was made in accordance with the following programme, taking into account the schedule of preparing weather maps:

02.50 to 02.52, 08.50 to 08.52, 14.50 to 14.52, 17.50 to 17.52, and 20.50 to 20.52 JMT.

At each station we employed cathode ray direction finders with recording cameras; 10 kc/s was adopted as the observing frequency, taking advantage of its low attenuation characteristics in the day time, smaller night errors, and higher energy levels. In order to obtain strictly synchronizing observation, we inserted time marks on the film at every second, taken from the standard waves emmitted by the Radio Regulatory Agency of Japan. The film speed of every recorder was adjusted to 10 mm/s.

2. Results of Observation and Interpretation

Origins of atmospherics were determined by triangulation based upon observed directions of arrival, and we studied the correlation of atmospherics with weather phenomena concerning the Typhoon Ruth by comparing with meteorological informations in the upper atmosphere as well as on the surface of earth.

In the case of the Typhoon Kezia we found origins of atmospherics mainly on the right hand side of her course, while in the present case, the Typhoon Ruth, we found them not only in the places mentioned but also on the converging zone in front of the trough of westerly waves in the upper atmosphere such as in 700 or 500 mb region as well as in the similar region of easterly waves near the centre of the typhoon. The latter was, however, not so remarkable as the former. The converging region in the trough of easterly waves is generally situated behind it; consequently, origins of atmospherics scattered in front of the easterly trough may be one of the exceptional ones, in respect to the typhoon. Moreover, there were lightning flashes, showers, cumulo-nimbus, etc., which confirm clearly existence of heavy convergence in these districts.

There is another remarkable distribution of origins of atmospherics off the coast of the Japan Islands on the Pacific Ocean, sometimes prolonged over 180° E, between 30° and 40° N in a zonal form. This group of origins makes clear itself in autumn and winter, while in summer it is quite vague. It seems that this is due to convergence in the frontal zone in the upper atmosphere as well as on the surface of the earth. A jet stream in the upper atmosphere accompanies, in general, polar front under it, and therefore it is very likely that the zonal distribution of origins of atmospherics resulting from convergence on the frontal zone in the upper atmosphere indicates the position of jet stream, but the conclusive description should be postponed to future study. In these observations we found also many groups of origins of atmospherics in the southern tropical region, including

Philippine and Formosa, corresponding to thunderstorms, showers, cumulo-nimbus, etc., which are, however, independent of the typhoon. Although atmospherics due to cold front in the neighbourhood of the Japan Islands are very interesting, they are also independent of the typhoon.

2-1. Atmospherics due to the trough of easterly waves

On 7 or 8 October, when the Ruth was a tropical depression, there was a trough of easterly waves in 700 mb region which passed through the centre or western district of the Ruth and we observed many origins of atmospherics in front of the trough, i.e. on its west side. At 20.50 JMT, 11 October, when she developed remarkably as a typhoon and indicated 940 mb at the centre, there appeared a trough of easterly waves in 700 mb region in the south-eastern sector of the Ruth, and we observed remarkable distribution of atmospherics in front of the trough (Fig. 1). Lightning and cumulo-nimbus in the weather map indicate heavy convergence there. Generally speaking, there exists a convergence region in the rear of easterly waves and a divergence region in front of it; while in summer of 1950 we found very often heavy thunderstorms in front of troughs of easterly waves. In the Typhoon Ruth we found, moreover, many origins of atmospherics in front of troughs in easterly waves accompanying thunderstorms, showers, cumulonimbus, etc. as an indication of heavy convergence. It is, however, not yet clear whether it is due to the typhoon.

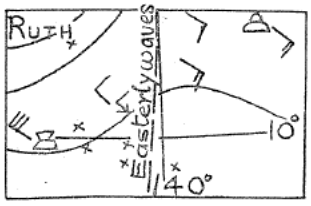


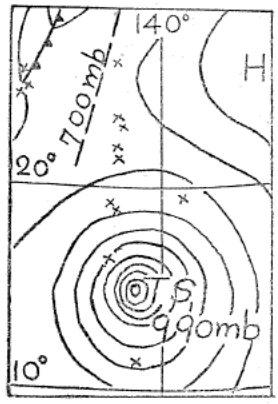
FIG. 1. Distribution of origins of atmospherics (×) at 20.50 JMT, Oct. 11, 1951.

2-2. Atmospherics due to the trough of westerly waves

We observed often troughs of westerly waves in 500 or 700 mb region which run through the centre of the typhoon or near the centre and extend to the north, and we found almost always conspicuous distribution of atmospherics in front of the troughs. This fact is quite coincident with the general theory that there appears convergence in front of the trough of westerly waves and divergence in the rear. Moreover, in our case, the hot and wet air masses accompanied by the typhoon entered into the convergence region of the trough and consequently heavy convergence phenomena were produced; it is because we found an outstanding distribution of atmospherics there.

For example, at 14.50 JMT, 9 October (Fig. 2); 08.50 JMT, 10 October; 20.50 JMT, 10 October; and 02.50 JMT, 11 October (Fig. 3), there were troughs of westerly waves in 700 mb region which run through a line at a distance of 500 km in front of the centre of the typhoon, and the distribution of atmospherics concerned appeared from a region about 300 km distant from the centre and scattered along the trough.

At 17.50 JMT, 10 October, the trough in 700 mb of westerly waves passed through near the centre of the typhoon. In this case, however, the flow of cold



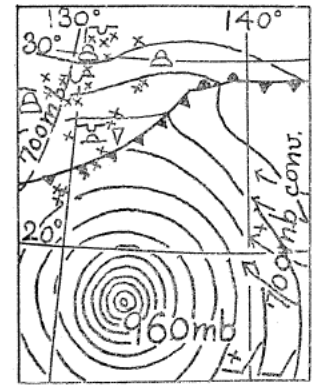
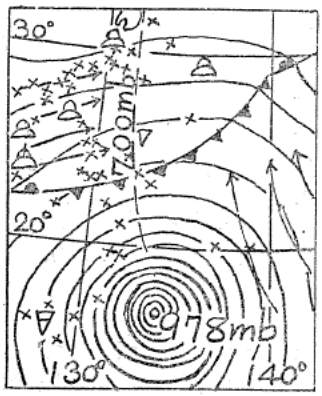


FIG. 2 (*left*). Distribution of origins of atmospherics (×) at 14.50 JMT, Oct. 9, 1951.
FIG. 3 (*right*). Distribution of origins of atmospherics (×) at 02.50 JMT, Oct. 11, 1951.

air masses on the west side of the trough due to a remarkable west wind and the powerful northward flow of the wet and warm air masses on the east side of the trough due to the typhoon made remarkable the distribution of atmospherics on the west side of the trough and in the neighbourhood of the trough, althrough such examples were rather rare (Fig. 4).

At 08.50 JMT, 10 October, there were troughs of westerly waves in 700 mb and 500 mb regions; the trough on 700 mb was found far apart in front of the centre, and the one in 500 mb quite near in front of the centre. Both of them extended themselves far to the north and showed a conspicuous distribution of atmospherics in front of the troughs in 700 mb and 500 mb respectively, suggesting a noticeable convergence over there (Fig. 5).



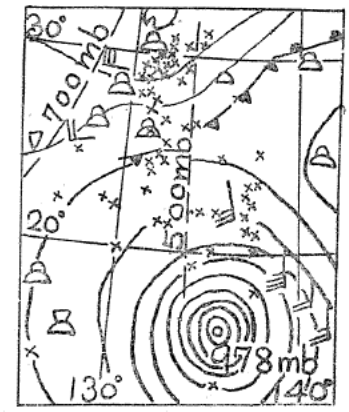


FIG. 4 (*left*). Distribution of origins of atmospherics (×) at 17.50 JMT, Oct. 10, 1951.
FIG. 5 (*right*). Distribution of origins of atmospherics (×) at 08.50 JMT, Oct. 10, 1951.

There were cases in which we could reasonably presume the existence of the troughs in view of the distribution of atmospherics as well as isobar, though we did not actually find notations of troughs on the weather maps. The following are the examples:

08.50 JMT, 8 Oct.; 20.50 JMT, 8 Oct.; 08.50 JMT, 9 Oct.; 14.50 JMT, 9 Oct.; 17.50 JMT, 9 Oct.; 20.50 JMT, 9 Oct.; 14.50 JMT, 9 Oct., etc.

The first two cases of them may be considered to be generated on the convergence line of wind produced between the centre of the typhoon and the northern high pressure (Fig. 6).

In these cases, there were generally cold fronts on the north side of the centre and therefore the distribution of atmospherics might be attributed to the convergence on cold fronts, but the atmospherics on the convergence area of the troughs of westerly waves were too clear to ascribe them to other causes and we could, moreover, find thunderstorms, lightning flashes, showers, and cumulo-nimbus as marks of heavy convergence in these places, whenever we could get meteorological informations there. These facts also confirm the law of generating atmospherics published by us recently.[1)2)3)]

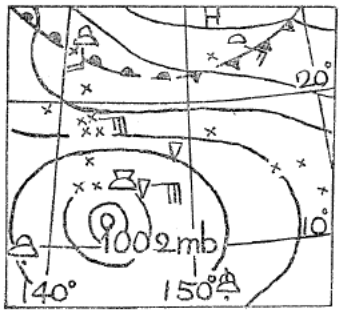


FIG. 6. Distribution of origins of atmospherics (×) at 08.50 JMT, Oct. 8, 1951.

2-3. Atmospherics due to convergence area of the typhoon

In the Typhoon Ruth there were also many occasions where we found remarkable convergence in 500 mb and 700 mb regions on the right hand side of the centre, from the east sector to the north; some of them may be considered as converging wind lines generated between the centre and the neighbouring high pressure. On these convergence areas of the Typhoon Ruth we could find always some outstanding distribution of atmospherics almost the same as those in the case of the Typhoon Kezia. We can point out easily examples of these kinds as in the case of 17.50 JMT, 10 October; 20.50 JMT, 10 October; 08.50 JMT, 11 October; 14.50 JMT, 11 October, etc. (Fig. 7).

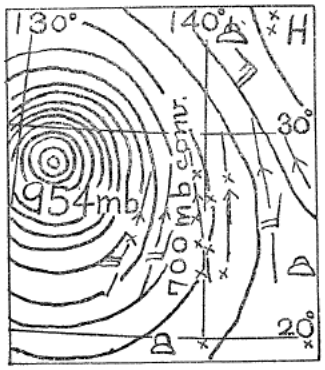


FIG. 7. Distribution of origins of atmospherics (×) at 08.50 JMT, Oct. 11, 1951.

3. Conclusion

The Typhoon Ruth, which came to Japan in the middle of autumn, belongs to one of the latest typhoon of the year, and consequently her characteristics differ somewhat from those of the Typhoon Kezia in September.

As to atmospherics, we observed a remarkable distribution of them on the convergence area of the typhoon, i.e. mainly on the right hand side of the centre as in the case of the Typhoon Kezia; we found, further, another remarkable distribution on the convergence area in front of the trough of westerly waves in 500 mb or in 700 mb region, and this trough is, moreover, often considered to be one of the phenomena to determine the course of the typhoon.

We found also a noticeable distribution of atmospherics in front of the trough of easterly waves as well as in the neighbourhood of fronts in the upper atmosphere and on the earth, in addition to, of polar fronts related to jet streams in the upper atmosphere. We shall investigate them, on another occasion, in connection with atmospherics due to cyclones in winter and fronts in the upper atmosphere.

These observations were made with the instruments of high sensitivity which made us enable to investigate the detailed construction of the typhoon through atmospherics. We would like to conclude that observation should be made with sensitivity as high as possible so far as it is compatible with the field work, if we intend to make radio-meteorology useful.

Acknowledgement

The author wishes to express his gratitude to Mr. A. Iwai and other members of our Institute for their enthusiastic and careful observation of atmospherics for a long time.

It is a pleasure to thank Mr. F. Kusakabe and his collaborators for their courtesy and co-operation in supplying meteorological informations.

I am also greatly indebted to Dr. Arakawa in C.M.O. for his useful suggestions. Finally I should like to express my cordial gratitude to Dr. K. Wadati, Dr. S. Katsunuma and Dr. M. Shibusawa for their incessant encouragements for our study.

References

1) A. Kimpara: The Typhoon Kezia and Atmospherics. Proc. Japan Acad., Vol. 27, No. 7, 1951.
2) A. Kimpara: *Ditto.* J. Geomag. Geoele., Vol. 3, No. 2, 1951.
3) A. Kimpara: *Ditto.* Memoirs Fac. Eng. Nagoya Univ., Vol. 3, No. 1, 1951.
4) Data of the Typhoon Ruth, Memoirs CMO Japan, Vol. 37, No. 1 and 2, 1952.