ATMOSPHERICS DUE TO FRONTS IN THE UPPER ATMOSPHERE*

ATSUSHI KIMPARA

Abstract—For a long time a distinctive zonal distribution of atmospherics has been observed on the Pacific Ocean in lat. 30° to 40° N all the year round especially in autumn and winter. Although they are not so strong as those from southern districts, they are often found even in the interior of Asia at night and have a fairly narrow zonal distribution.

Abundant meteorological informations in the upper atmosphere, furnished by airplane observations and radio-soundings in the neighbourhood of Japan, show that they are generated in the convergence region of fronts in the upper atmosphere such as polar fronts. By extending this idea to the middle of the Pacific as well as in the inland of Asia, where no reliable informations are obtained, we could explain with ease the zonal distribution of atmospherics in lat. 30° to 40° N and long. 80° to 180° E.

1. Introduction

We have observed for long a remarkable distribution of atmospherics off the eastern coast of the Japan Islands on the Pacific Ocean in a zonal form in lat. 30° to 40° N all the year round. As they are not so strong as those in India, the Sunda Islands, Australia, etc., we can not find them easily without using sensitive instruments.

According to a masking effect by strong atmospherics in the neighbourhood of Japan it is rather difficult to find these atmospherics in summer; while in spring and autumn, especially in winter they appear explicitly in lat. 30° to 40° N and long. 80° to 180° E in a zonal form, and in fact they are found mainly in the Pacific Ocean, though sometimes specifically at night they are also detected in China, Tibet, Turkistan, etc.

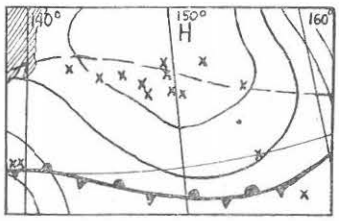
In the neighbourhood of Japan, where we have fairly ample meteorological informations in the upper atmosphere, these atmospherics are found to be scattered over the frontal zones in the upper atmosphere and the area between these zones and the fronts on the earth. Therefore, if we extend the above idea to regions in the middle of the ocean or inland, where any reliable informations are hardly obtained, we can understand with ease the existence of these atmospherics by assuming polar fronts there, *i.e.* they are produced in the convergence zone where the ascending warm air flow from the south creaps above the cold air masses from the north. Really, this kind of atmospherics are scattered in a zonal form in lat. 30° to 40° N, making a long wave which moves slowly in the north-south direction, revealing certain similarities with characteristics of jet streams in the upper atmosphere.

* Published in Bul. Res. Inst. Atm. Vol. 2, No. 2, 1951.

2. Examples and Discussions

Fig. 1 shows a distribution of atmospherics at 20.50 JMT on October 11, 1951. A lot of origins of atmospherics are found to exist along a front in 700 mb region, although it is observed as a high pressure area in accordance with informations on the earth.

Fig. 2 shows a distribution of atmospherics at 17.50 JMT on October 9, 1951. Noticeable distribution of origins of atmospherics are found in the convergence area of 700 mb region between the front in the upper atmosphere and a warm front on the earth accompanied by a low pressure.



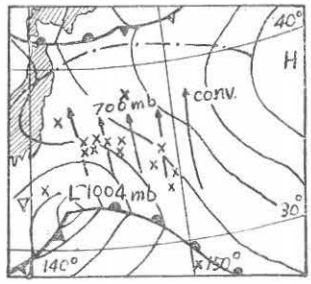
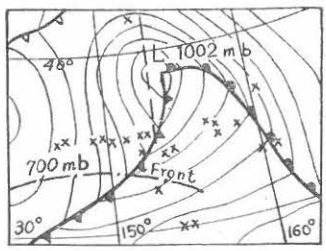


FIG. 1 (*left*). Distribution of origins of atmospherics (×) at 20.50 JMT on Oct. 11, 1951.
FIG. 2 (*right*). Distribution of origins of atmospherics (×) at 17.50 JMT on Oct. 9, 1951.

Fig. 3 shows a distribution of atmospherics at 20.50 JMT on October 10, 1951. Remarkable distribution of origins of atmospherics are found to be scattered along a north side of a front in 700 mb region, where there is also a low pressure accompanied by a cold and a warm fronts.

Fig. 4 shows a distribution of atmospherics at 02.50 JMT on October 8, 1951. A number of origins of atmospherics are scattered in the neighbourhood of fronts in 700 mb and 500 mb region as well as along a cold front on the earth.



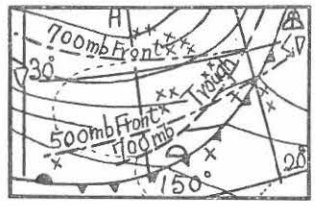


FIG. 3 (*left*). Distribution of origins of atmospherics (×) at 20.50 JMT on Oct. 10, 1951.
FIG. 4 (*right*). Distribution of origins of atmospherics (×) at 02.50 JMT on Oct. 8, 1951.

By observing these examples we may conclude that in the neighbourhood of Japan, where we have abundant meteorological informations in the upper atmosphere as well as on the earth, the zonal distribution of atmospherics off the coast of Japan Islands are generated in the convergence region of the frontal zone in the upper atmosphere as well as on the earth. Although in the middle of the Pacific Ocean and the inland of Asia, there are no reliable meteorological informations, if we extend the above reasoning about the distribution of atmospherics,

and assume the existence of fronts in the upper atmosphere such as polar fronts, we may be able to explain these distribution of atmospherics on the Pacific.

Fig. 5 shows a distribution of atmospherics at 02.50 JMT on February 1, 1952. Distribution of atmospherics from Kamchatka to the Japan Sea by way of Skhalin and Hokkaido Island should be attributed mostly to snow showers or snow storms there; while it would be very difficult to explain those on the Pacific scattered in lat. 35° to 40° N in a zonal form without assuming the existence of convergence in the polar front in this district. At 00.00 JMT on Feb. 1 in the neighbourhood of Japan a strong westerly air current (110 to 140 knots) in the upper atmosphere below 500 mb passes through from lat. 33°–34° N, long. 130° E to lat. 36°–38° N, long. 140° E. The zonal distribution of atmospherics coincides fairly well with the location of westerlies, and it seems that the atmospherics exist in the region of strong westerlies exterpolated from the above position both on the east and west side, *i.e.* to the continent and to the Pacific.

Table 1 shows the distribution of westerlies near Japan from Jan. 28 to Feb. 3 with the indication of wind velocities in the region below 500 mb. Fig. 6 shows some examples which show very clearly the zonal distribution of atmospherics. There we see that from Jan. 28 to 30 the westerlies and the zonal distribution of atmospherics move slowly but clearly north-ward, while after Jan. 30 both movements do not indicate clear tendency; however, if we inspect in detail, the atmospherics returns to the south on Jan. 31 and the westerlies too. On Feb. 1 the atmospherics move north-ward again, and the westerlies too at 12.00 JMT on Jan. 31, and return to the south at 00.00 JMT on Feb. 1. On Feb. 2 and 3 the movements of westerlies are quite irregular which seems to ascertain the branching and irregular movements of atmospherics. In fact, the atmospherics moves to the north again on Feb. 1 and on Feb. 2, and then it splits into two branches, the one moving to the north the other to the south. On Feb. 3 the north branch returns to the south, while the south one stands still. All the origins of atmospherics in these days are scattered in lat. 33° to 43° N. Taking into consideration of above results, it seems very likely that the zonal distribution of atmospherics in lat. 30° to 40° N is produced in the convergence region of the polar fronts under the jet streams in the westerlies of upper atmosphere.

TABLE 1. Passage of Westerlies in the Neighbourhood of Japan

Date	Time in JMT	Lat. ° N in long. 130° E	Lat. ° N in long. 140° E	Velocity of wind in the region below 500 mb. (in knot)
Jan. 28	00.00	35–36	35–36	80– 95
	12.00	35–36	35–36	80– 95
29	00.00	36–38	36–38	80
	12.00	36–40	38–43	120–145
30	00.00	36–42	42–44	80–120
	12.00	34–36	36–38	95–150
31	00.00	34–38	36–40	80–125
	12.00	35–40	36–44	70–100
Feb. 1	00.00	33–34	36–38	80
	12.00	33–35	36–38	110–140
2	00.00	36–38	38–41	100–165
	12.00	34–36	37–40	90–100
3	00.00	38–40	38–40	85– 95
	12.00	33–35	34–36	100–120

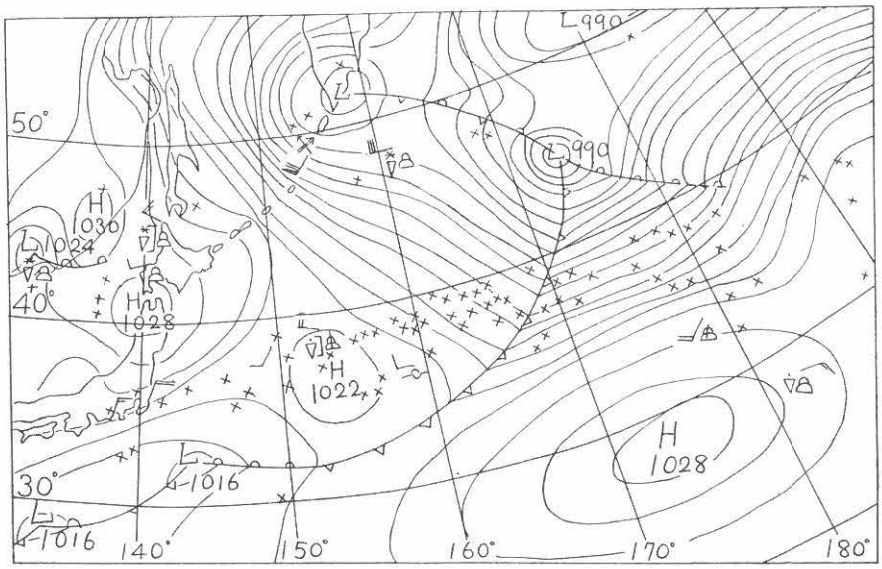


FIG. 5. Distribution of origins of atmospherics (×) at 02.50 JMT on Feb. 1, 1952.

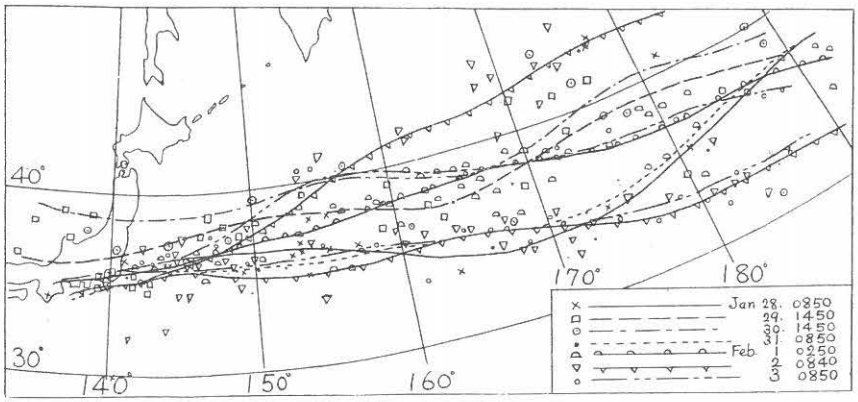


FIG. 6. Movement of zonal distribution of atmospherics from Jan. 28 to Feb. 3, 1952.

3. Conclusion

We made extensive observation of the zonal distribution of atmospherics in lat. 30° to 40° N and long. 80° to 180° E in its active seasons such as autumn and winter, and investigated its correlation with meteorological phenomena by consulting the informations in the upper atmosphere as well as on the earth furnished by the Central Meteorological Observatory.

We found at first the close relation which exists between the distribution of atmospherics with the degree of convergence in the upper atmosphere as well as on the earth, in studying carefully the informations obtained amply in the neighbourhood of Japan; afterwards, we extended cautiously our notion to the case in the middle of the Pacific Ocean and the inlands of Asia such as Tibet, Eeastrn Turkistan, Mongolia, etc. where the reliable meteorological informations are hardly obtained

in general; and, referring to the results of observation of westerlies in the upper atmosphere near Japan, we could finally conclude that this kind of atmospherics is produced in the convergence region of the polar fronts, *i.e.* in the strong ascending warm air flows above the cold air masses. The general position of the polar fronts obtained from meteorological theory is fairly well coincident with the location of the particular zonal distribution of atmospherics above-mentioned. Therefore, further study of position and nature of atmospherics will probably reveal us more useful informations concerning behaviour and location of the polar fronts and also jet streams related to in the upper atmosphere.

4. Acknowledgements

The author is greatly indebted to Mr. A. Iwai and other members of the Research Institute of Atmospherics in our university for their cordial assistance in observation of atmospherics and arrangement of informations.

He desires to tender his acknowledgements to Dr. Arakawa, Mr. Kusakabe and other members of C.M.O. in Tokyo for their courtesy and co-operation in giving useful suggestions and in supplying meteorological informations.

The author should like, in conclusion, to express his indebtedness to Dr. K. Wadati, Dr. M. Shibusawa and Dr. S. Katsunuma for their incessant encouragements for the study.

5. References

1) A. Kimpara: The typhoon Kezia and Atmospherics. Proc. Japan Acad., Vol. **27**, No. 7, 1951.
2) A. Kimpara: *Ditto.* J. Geomag. Geoele. Japan, 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.