ATMOSPHERICS DUE TO FRONTS IN THE UPPER ATMOSPHERE*

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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 of 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.

Résumé

Pendant long temps une distribution des atmosphériques en zone distinctive a été observée sur l'Océan Pacifique en lat. 30° à 40° N toute l'année, particulièrement en automne et en hiver. Quoiqu'ils ne soient pas si forts que les arrivés de la région tropicale, ils se trouvent la nuit souvent dans l'intérieur de l'Asie et ont toujours la distribution zonale assez étroite.

Beaucoup des informations météorologiques dans la haute atmosphère, obtenues à l'observation par avion ainsi que les radio-sondés, indiquent que les atmosphériques précités sont produits dans la région de convergence sur les fronts dans la haute atmosphère telles que les fronts polaires. En étendant cette idée au centre de l'Océan Pacifique et aussi à l'intérieur de l'Asie, où l'on ne peut trouver riens des informations dignes de confiance, nous avons pu commenter sans difficulté la distribution zonale des atmosphériques en lat. 30° à 40° N et long. 80° à 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.

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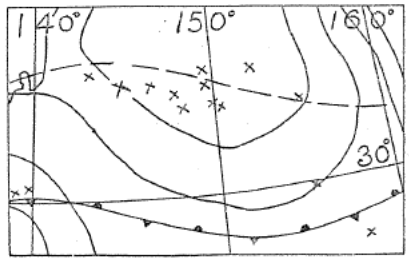
Suffering from a masking effect by strong atmospherics in the neighbourhood of Japan it is rather difficult to find these atmospherics in summer; while in spring and autumn, especially in winter they appear explicitly in lat. 30° to 40° N and long. 80° to 180° E, in a zonal form, and in fact they are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

In the neighbourhood of Japan, where we have fairly ample meteorological informations of 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 creeps above the cold air masses from the north. Really, this kind of atmospherics are scattered in a zonal from 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 inthe upper atmosphere.

2. Examples and Discussions

Fig. 1 shows a distribution of atmospherics at 20.50 JMT, 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 of the earth surface.

Fig. 2 shows a distribution of atmospherics at 17.50 JMT, October 9, 1951. Noticeable distribution of origins of atmospherics is 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.



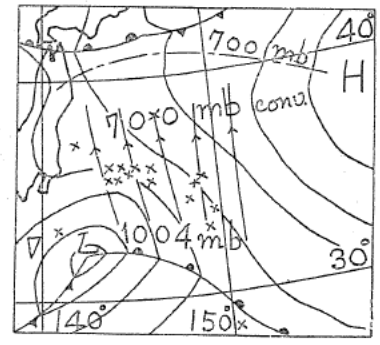
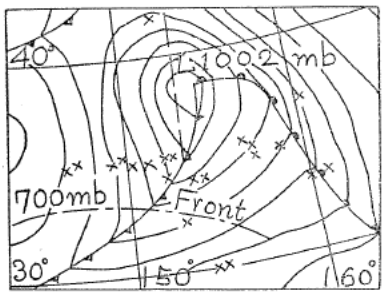


FIG. 1 (*left*). Distribution of origins of atmospherics (×) at 20.50 JMT, Oct. 11, 1951.
FIG. 2 (*right*). Distribution of origins of atmospherics (×) at 17.50 JMT, Oct. 9, 1951.

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



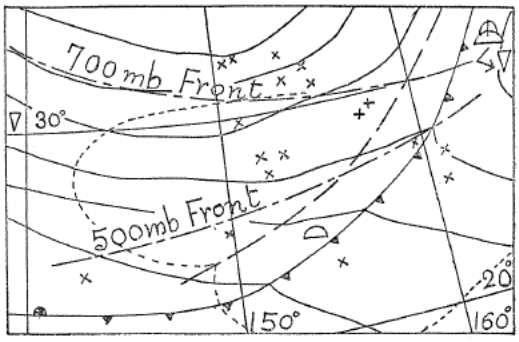


FIG. 3 (*left*). Distribution of origins of atmospherics (×) at 20.50 JMT, Oct. 10, 1951.
FIG. 4 (*right*). Distribution of origins of atmospherics (×) at 02.50 JMT, Oct. 8, 1951.

Fig. 4 shows a distribution of atmospherics at 02.50 JMT, 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.

By observing these examples we may conclude that in the neighbourhood of Japan, where we have abundant meteorological informations of the upper atmosphere as well as of the earth surface, the zonal distribution of atmospherics off the coast of Japan Islands are located 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, 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, Feb. 1 in the neighbourhood of Japan a strong westerly air current (110–140 knots) in the upper atmosphere below 500 mb passed 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 northward, 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 northward again, and the westerlies too at 12.00 JMT, Jan. 31, and return to the south at 00.00 JMT, Feb. 1. On Feb. 2 and 3 the movements of westerlies are quite irregular which seems to ascertain the branch-

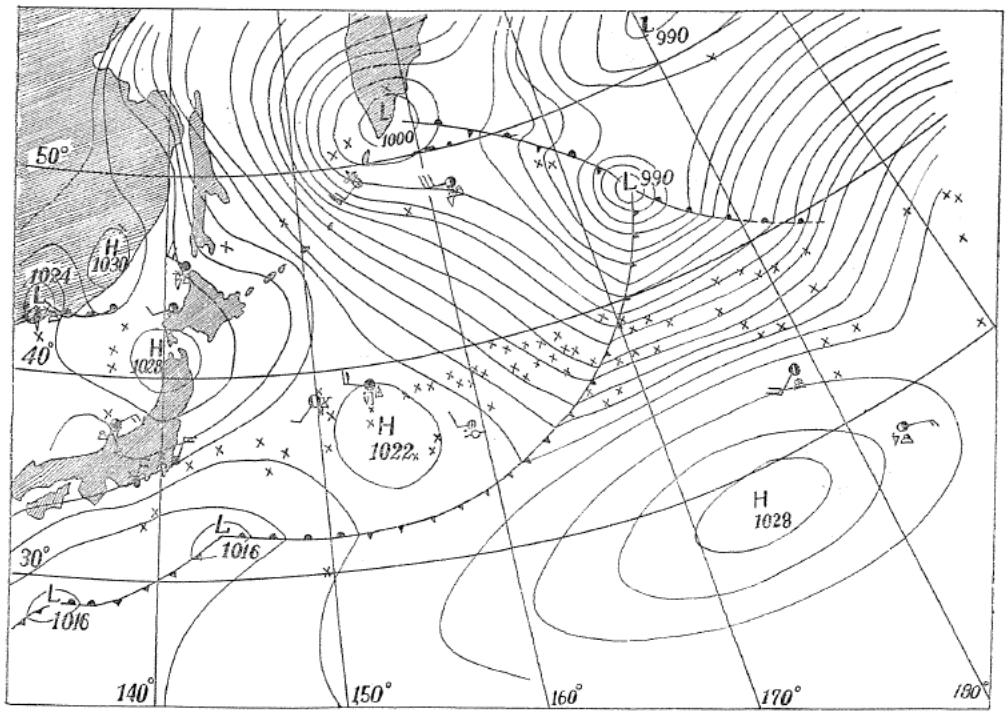
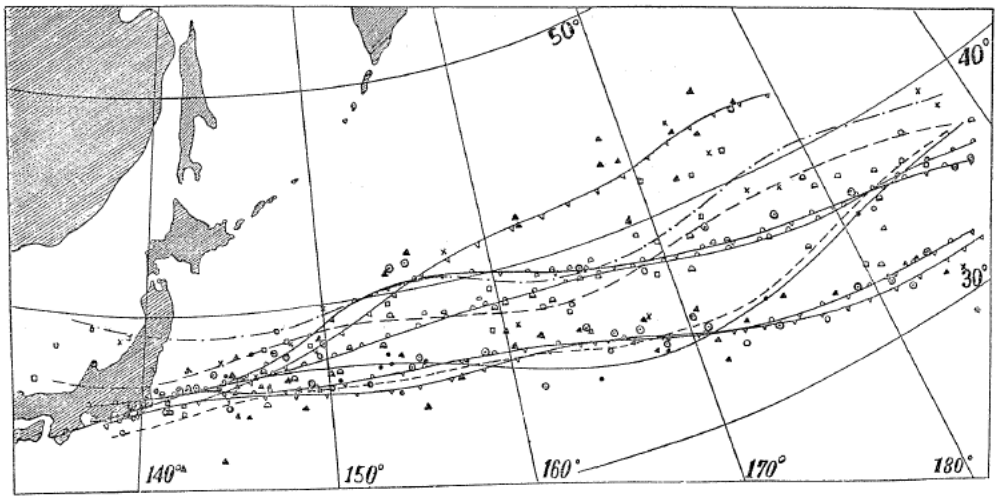


FIG. 5. Distribution of origins of atmospherics (×) at 02.50 JMT, Feb. 1, 1952.

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	95-125
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

ing 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.



Jan. 28	0850	———	○
Jan. 29	1450	– – –	□
Jan. 30	1450	—·—	×
Jan. 31	0850	-------	○
Feb. 1	0250	○—○—○	△
Feb. 2	0840	▽—▽—▽	▲
Feb. 3	0850	○—▽—○	◎

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 their active seasons such as autumn and winter, and investigated their correlation with meteorological phenomena by consulting the informations of the upper atmosphere as well as of the earth surface furnished by the Central Meteorological Observatory.

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

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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 C.M.O. Japan, Vol. **37**, No. 1 and 2, 1952.