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## SHORT NOTE

### THE OCCURRENCE AND THE MOVEMENT OF THE SOURCES OF ATMOSPHERICS ACCOMPANIED WITH THE COLD FRONTS IN WINTER 1973

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#### 1. Introduction

It was reported by Kimpara et al. (1953) that when cold fronts were activated by landing on the Japan Islands after passing over the Japan Sea or by passing across the central mountain-ranges of Japan, the violent atmospheric had been observed. The author reported previously the good correlation between the movements of the directional records of atmospheric at 60 KHz and of the cold fronts in winter. And the sources of atmospheric were fixed by using two direction finders tuned to 50 KHz setting up at the Kagoshima Station and the Sakushima Station. Thereafter, in order to fix the sources of atmospheric within about 2000 Km more accurately, the third direction finder was set up at Moshiri in Hokkaido. In this paper, the author reports some results obtained in January and February 1973, and describes the occurrence and the movement of atmospheric which were accompanied with the cold fronts.

#### 2. Some results obtained in winter 1973

##### (1) January 10, 1973

Fig. 1 shows the results of the fixed sources of atmospheric at 12h, 15h, 18h and 21h JST, respectively. The period of each observation was 8 minutes. The symbol (+) indicates the fixed sources of atmospheric obtained from the pair of the Kago-

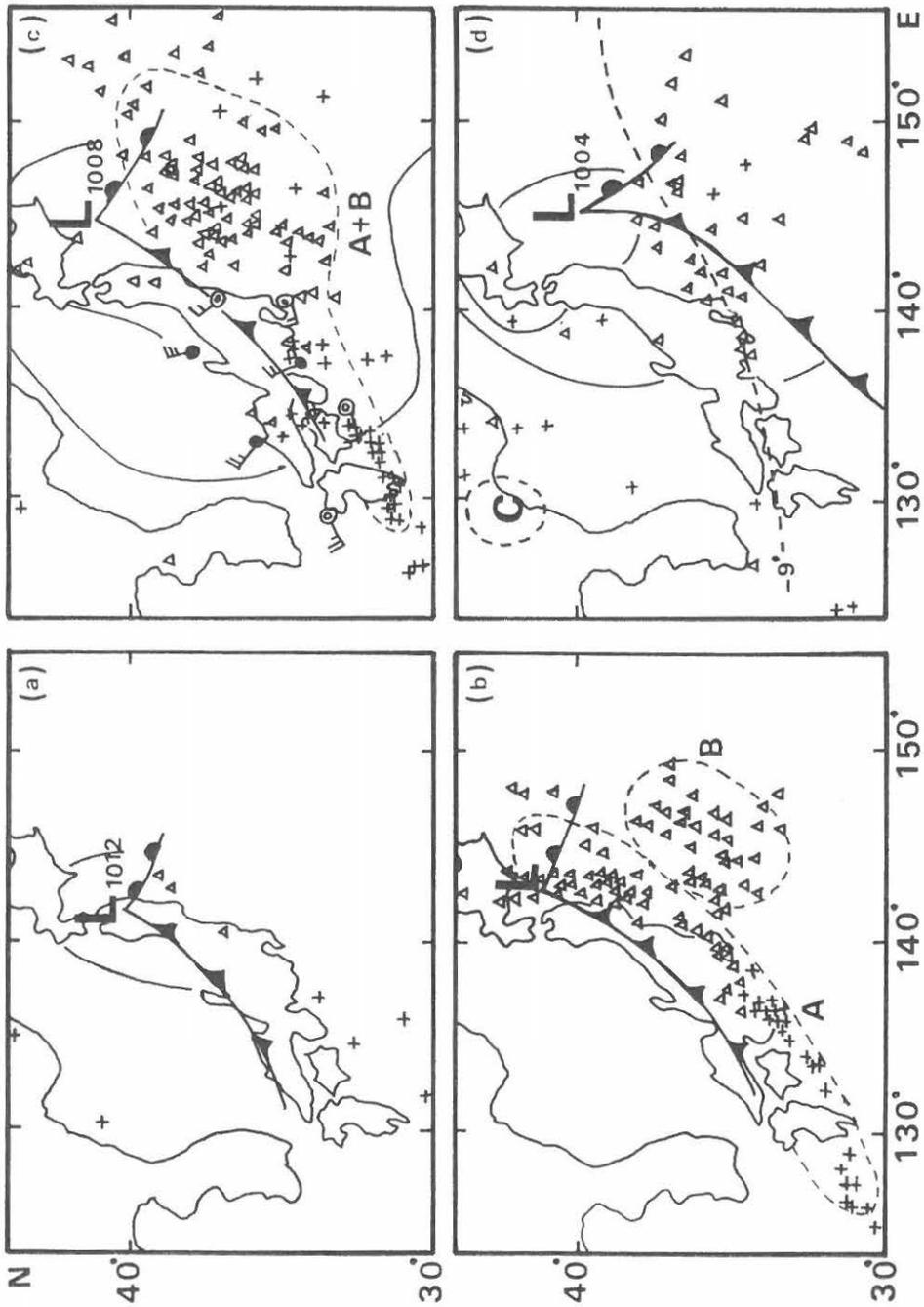


Fig. 1 The sources of atmospherics obtained on Jan. 10, 1973.

(a) 1150–1158 (b) 1450–1458 (c) 1750–1758 (d) 2050–2058 JST

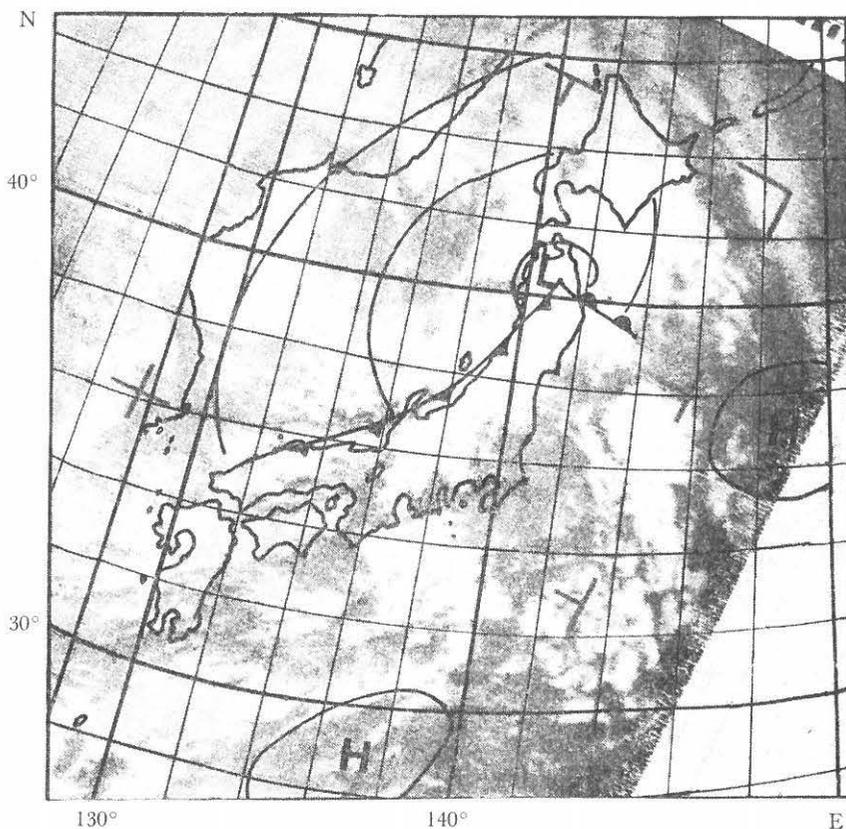


Fig. 2 The facsimile picture of cloud from the ESSA-8 on Jan. 10, 1973.

shima and the Sakushima DF stations, and the symbol ( $\Delta$ ) the one from the pair of the Sakushima and the Moshiri DF stations.

At 9h JST, the only one source was fixed which was accompanied with the local thunderstorm at the Hokuriku district in Japan during the observation of 8 minutes. But at 12h JST, as shown in Fig. 1 (a), several sources of atmospheric were fixed along the coast-line of the Pacific side of Japan. And at 15h JST, the occurrence number of the sources of atmospheric along the coast-line increased considerably, as shown in Fig. 1 (b). The other group of the sources of atmospheric was also obtained in the neighborhood of lat.  $36^{\circ}\text{N}$  and long.  $145^{\circ}\text{E}$  on the Pacific Ocean. Now it is classified into the former as group A, and the latter as group B. At 15h JST, there was a sharp distinction between the group A and group B, but at 18h JST, no distinction between the both groups because of the moving of group A. At that time, the occurrence number of atmospheric reached the maximum during the observation time of 8 minutes. Thereafter, the occurrence number of this mixed group decreased

gradually, and at 21h JST, the sources of atmospheric scattered.

As the occurrence and the movement of the sources of atmospheric described above were considered to have a good correlation with the movement of cold fronts, the author examined the movement of the cold fronts from the weather map on Jan. 10.

A cold front which was accompanied with the low pressure with 1012 mb on the Japan Sea arrived at the main land of Japan at about 12h JST, passed through the central mountain-ranges of Japan at about 15h JST, and passed over the main land at about 20h JST. The low pressure developed more and more with the movement of the cold front. From Fig. 1 the group A was clearly accompanied with the cold front. The occurrence number of the group A reached the maximum when the cold front passed through the central mountain-ranges of the main land, and the maximum continued till the time when it passed over the main land. And the group B was occurred by the cumulus around the high pressure at lat.  $37^{\circ}$  N and long.  $148^{\circ}$  E. The existence of this cold front and this cumulus are found from the facsimile picture of the clouds received from the Meteorological Satellite ESSA-8\*, as shown in Fig. 2. The position of the cold front at 11h in Fig. 2 is interpolated from the position of the cold front on the weather maps at 9h and 18h JST. The cloud having a narrow width along the coast-line of the Japan Sea side correspond to the cold front, and the bended cloud off the coast of the San-in district show the direction of the wind from the cold air mass in the upper atmosphere. This cold wind in the upper atmosphere made rapid growth of the low pressure, as described above.

(2) February 6 and 7, 1973

As seen from the observational results in January, it was found that the occurrence and the movement of the sources of the atmospheric were related well with the cold front. In February, in order to monitor the occurrence of atmospheric accompanied with the cold fronts, the author observed continuously the occurrence number of atmospheric together with the fixing of the sources. The occurrence number was obtained by the lightning counter with the vertical antenna at the same frequency of 50 KHz. Fig. 3 shows the variation of the occurrence number for each one hour from Feb. 6 to Feb. 9. The upward arrow indicates the sunrise time, and the downward arrow the sunset time. The occurrence number was less than about 30 in the daytime, and the one was less than about 100 at night under the condition of the meteorological quiet state. The remarkable increases of the occurrence number were seen clearly on Feb. 6. That is, the occurrence number reached the first peak at

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\* This facsimile picture of the cloud was received at the Sakushima Station.

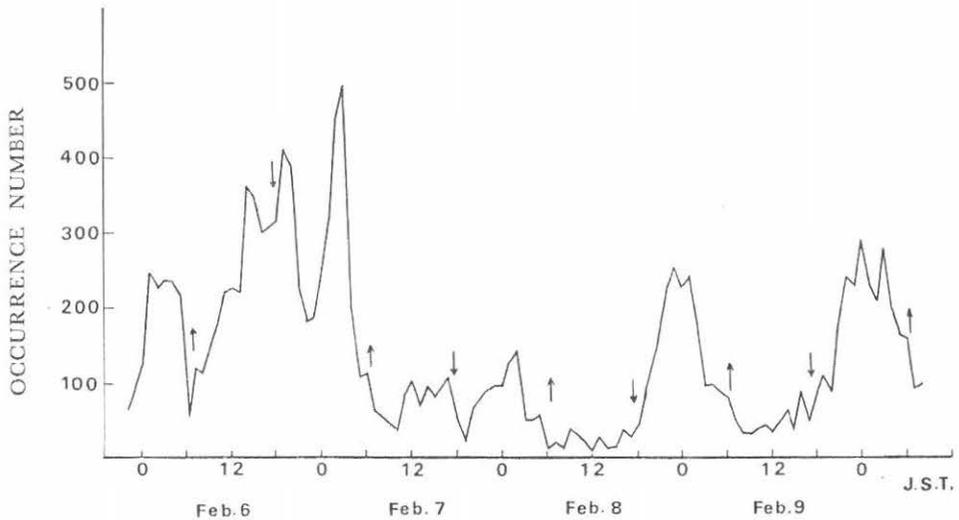


Fig. 3 The variation of the occurrence number of atmospheric.

about 15h JST, the second peak at about 19h JST, and the third peak at about 3h JST on Feb. 7, but again it increased a little in the afternoon on Feb. 7.

On Feb. 8 and 9, the variation of the occurrence number represented almost the quiet state, although the occurrence number at night increased a little. The remarkable increases of the occurrence number in the afternoon on Feb. 6 are thought to be due to the appearance of the meteorological disturbance.

In order to interpret the variation of the occurrence number shown in Fig. 3, the sources of atmospheric were fixed on Feb. 6 and 7. The individual source of atmospheric (+) was obtained by means of the triangulation of the three DE stations. The symbol ( $\oplus$ ) represents the accurate fixed point obtained by the triangulation method. The accurate fixed point means that the value of DAN\*\* at each station is less than  $9^\circ$ . The period of the observation was also 8 minutes. At 12h JST on Feb. 6, the sources of atmospheric were characterized by two groups, as shown in Fig. 4-1(a). At 15h JST, the southern group of the two groups moved to north-eastward progressively, and were mixed with the another group. Then, the occurrence number of the sources of atmospheric reached the maximum, as shown in Fig. 4-1(b). At 18h JST, the mixed group moved to eastward slowly keeping the occurrence number of 15h JST, as shown in Fig. 4-1(c). At 21h JST, the sources of atmospheric were scattered to the longitudinal direction decreasing the occurrence number, as shown in Fig. 4-1(d).

\*\* See the Fig. 11 in the paper of Proc. Res. Inst. Atmospheric, Nagoya Univ. 19 (1969).

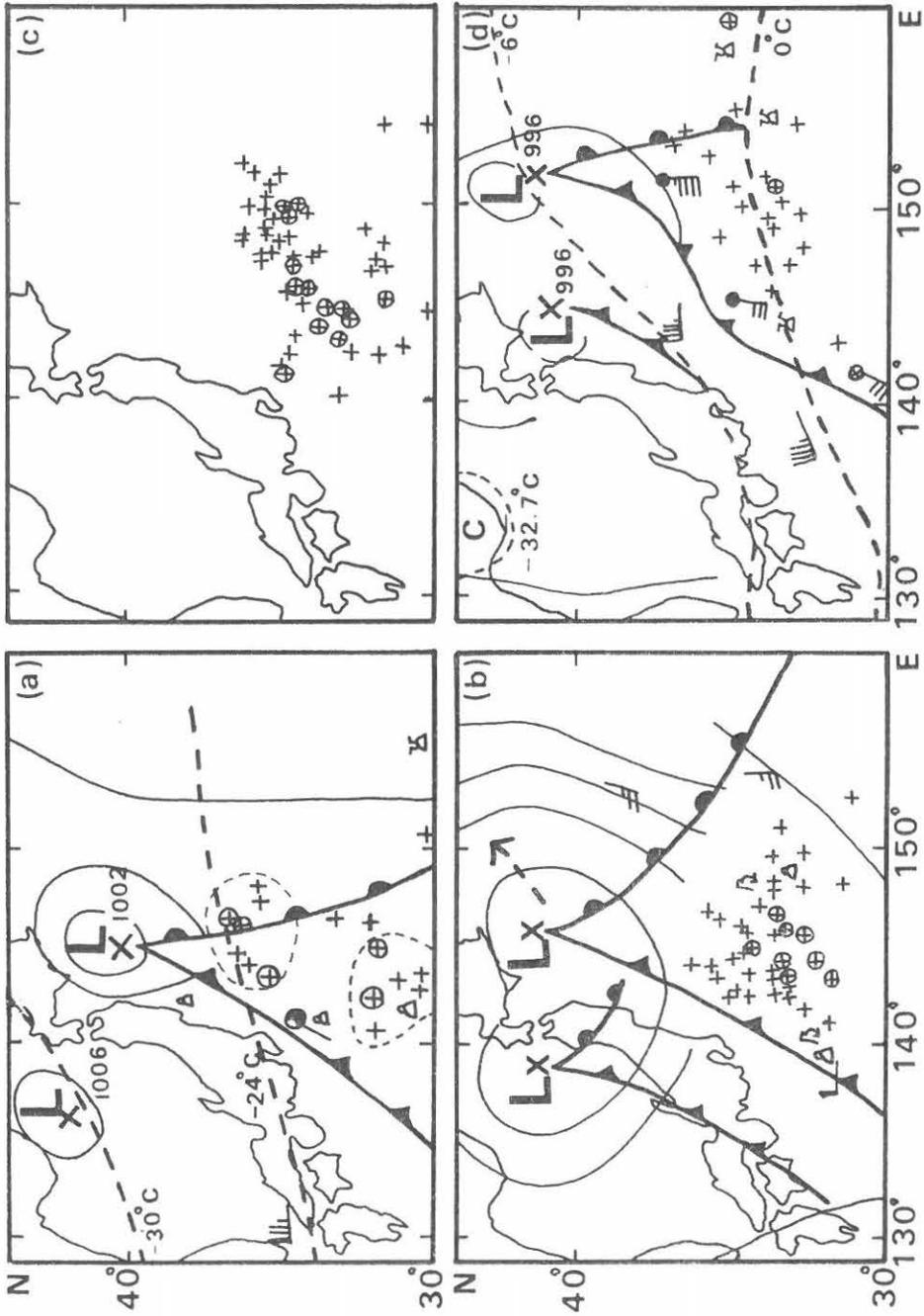


Fig. 4-1. The sources of atmospherics obtained on Feb. 6, 1973.

(a) 1150-1158 (b) 1450-1458 (c) 1750-1758 (d) 2050-2058 JST

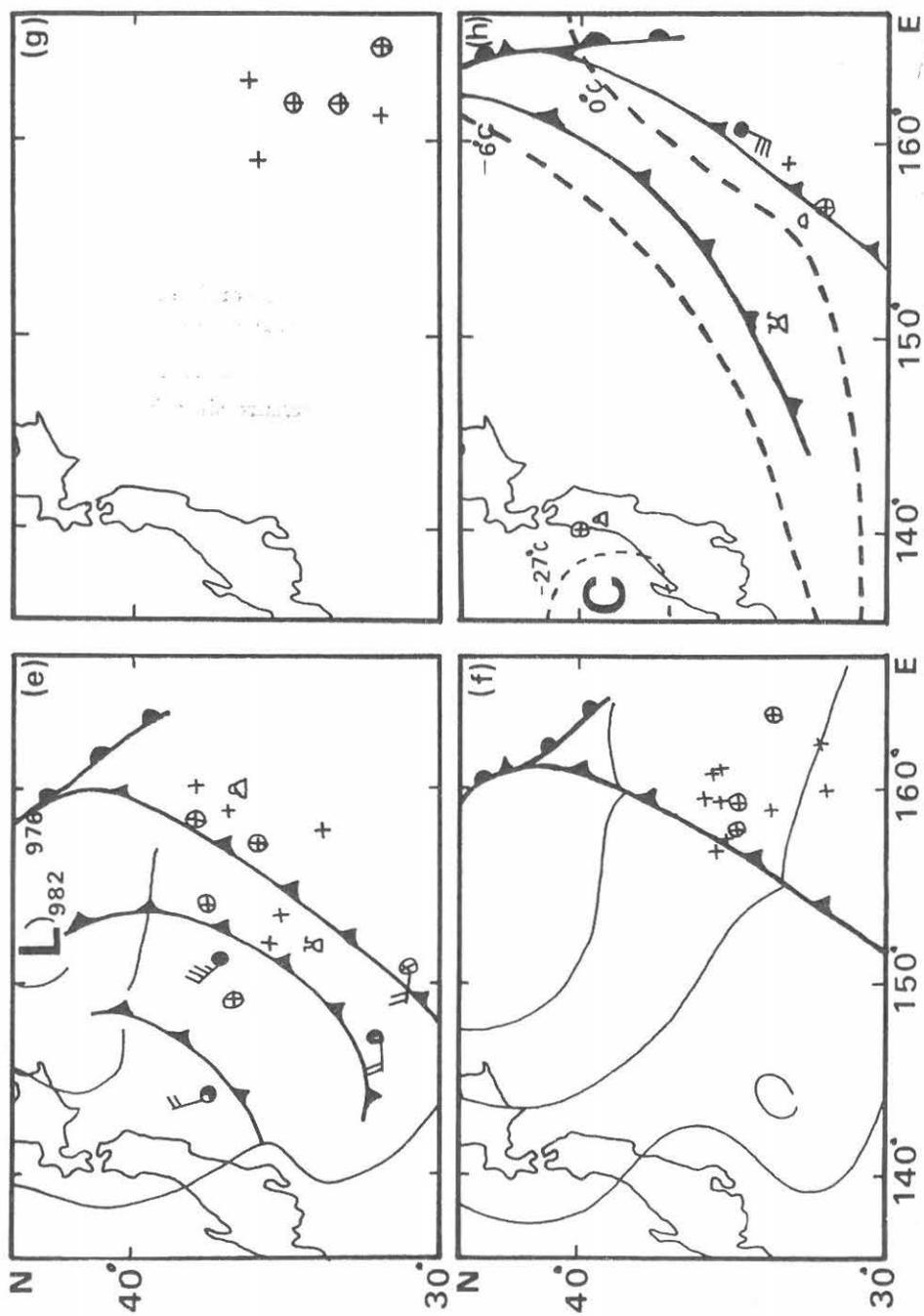


Fig. 4-2 The sources of atmospherics obtained on Feb. 7, 1973.

(e) 0850-0858 (f) 1150-1158 (g) 1450-1458 (h) 2058-2058 JST.

Unfortunately, no fixed data was obtained for the third peak of the occurrence number in the early morning on Feb. 7. At 9h JST on Feb. 7, the scattered sources of atmospheric moved to eastward fastly. And at 12h JST, the sources of atmospheric arrived at the position of about 2000 Km far from the main land, as shown in Fig. 4-2(f). At 15h JST, the sources of atmospheric moved to eastward more than 2000 Km far from the main land, as shown in Fig. 4-2(g), and at 21h JST, the sources of atmospheric almost disappeared, as shown in Fig. 4-2(h).

Next, the author describes the relation of the sources of atmospheric with the cold front. The low pressure with 1006 mb situating at the south of Japan on Feb. 5 moved fastly to northward along the coast-line of the Pacific side, and at 9h JST on Feb. 6, the low pressure which accompanied with the cold front arrived at off the coast of the Sanriku. On the other hand, the low pressure situating on the Japan Sea developed, and moved toward the Japan Islands. At the time, the cumulus occurred in front of the cold front situating on the Pacific Ocean, as shown in Fig. 4-1(a). And then, the low pressure on the Japan Sea passed over the Japan Islands accompanying with the new cold front, as shown in Fig. 4-1(b). When the new cold front, situating in parallel with the old cold front, the occurrence number of atmospheric reached the maximum, as shown in Fig. 3 and Fig. 4-1(b). Thereafter, the two cold fronts moved to eastward slowly, and at 21h JST, the old cold front began to occlude. Then, the occurrence number of atmospheric decreased gradually. As seen from Fig. 4-1(d), the sources of atmospheric dispersed along the isotherm (written by the broken lines) on the constant-pressure chart of 500 mb. At 9h JST on Feb. 7, the third cold front passed over the Japan Islands, and at 12h JST, the three cold fronts were mixed, as shown in Fig. 4-2(e). At the time, the occurrence number of atmospheric increased a little, as shown in Fig. 3. Thereafter, these cold fronts moved to eastward, and at 21h JST, the cold fronts occluded.

### 3. Conclusion

The occurrence number of the atmospheric on Jan. 10 increased when the cold front passed over the central mountain-ranges on the main land in Japan, and the sources of atmospheric moved to eastward according to the eastward moving of the cold front.

The occurrence number of the atmospheric on Feb. 6 increased when the cold front situating on the Japan Islands approached to the other cold front on the Pacific Ocean, and the sources of atmospheric moved to eastward according to the eastward moving of the cold front.

From the observational results obtained at 50 KHz in winter, it may be confirmed that the occurrence and the movement of the sources of atmospherics have a good correlation with the movement of the well developed cold front.

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