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RESEARCH REPORT

ON THE PRELIMINARY INVESTIGATION OF ATMOSPHERICS IN SOUTH-EAST ASIA

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Abstract

In order to improve our understanding of the propagation mechanism of atmospherics, the test observations were carried out simultaneously at Bangkok in Thailand and at Toyokawa in Japan from 27 September to 16 October, 1979. The distance between the both observing points is about 4340 km.

The result of the preliminary investigation has shown that it is possible to identify the coincidence of some atmospherics received at the both stations by using the NWC signal as a time reference.

1. Introduction

Since 1968, the direction finding (DF) observations of atmospherics have been made by the Research Institute of Atmospherics to study the propagation mechanism (Iwai et al., 1969, 1979). As described in the previous papers concerning the fixing of atmospheric sources by means of the DF network, the fixing rate in the region along the base lines of the DF stations is lower than that in other regions, in spite of the high thunderstorm activity in the former region. This less fixing rate is due to the geographical position of the DF stations in Japan Islands (Nishino et al.,1976).

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The simultaneous observations of atmospherics in both South-East Asia and Japan had been planned to solve the above-mentioned problem.

The cooperative research program concerning the simultaneous observations of atmospherics was started at Bangkok (13°44'N, 100°30'E), Thailand and at Toyokawa (34°50'N, 137°22'E), Japan. The preliminary investigation was carried out in 1979, and then the subsequent investigation will be made in the summer season in 1980.

2. The Preliminary Investigation

The items of the investigation were as follows.

a) Investigation of interference of radio noises in ELF and VLF ranges in and around Bangkok.

b) Test measurements to examine the time difference within about 1 milli-second, required to identify the same atmospherics received at Bangkok and Toyokawa by means of the reception of the NWC signal transmitted at 22.3 kHz in Australia.

c) Preliminary observations of the power and phase spectra of atmospherics at Bangkok.

The following items were carried out simultaneously in Japan, in cooperation with Thailand.

a) Recordings of waveform of atmospherics and of the NWC signal.

b) Group delay time difference (GDD) measurments for atmospherics at VLF and ELF.

c) Triangulation fixing of the sources of atmospherics by using the DF network.

From the viewpoints of the installation of equipment and of the maintenance of observing apparatus, the cam-

Fig.1 The exterior of the building of the Department of Electrical Engineering, Chulalongkorn University.

pus of Chulalongkorn University was suitable for the observations, where the level of interfering electric noises was, fortunately, lower than that of the expected observing signals. And so the observing apparatus with a power line harmonic eraser could operate normally. The detailed description of the eraser will be made in future. The electrical antenna (5 m high) was installed on the top of the building of the Department of Electrical Engineering. Fig. 2 shows the observing apparatus operated in an air-conditioned room of the building.

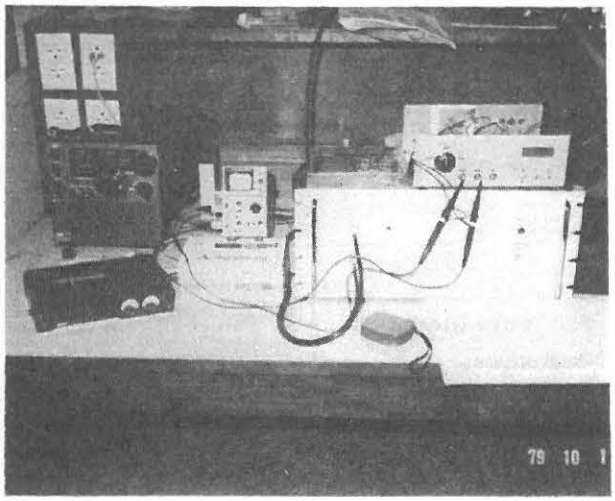

Fig.2 Observing apparatus at Bangkok.

The block diagram of the apparatus is shown in Fig. 3. In addition to the simultaneous observations at Bangkok and Toyokawa, the DF observations were made from 27 September to 17 October, 1979 at Kagoshima (31°29'N, 130°43'E), Sakushima (34°43.6'N, 137°02'E) and Moshiri (44°22'N, 142°16'E). The observations were made in following schedule; 07^h20^m-07^h25^m (UT), 0740-0745, 0820-0825, 0920-0925, 0940-0945, 1220-1225 and 1240-1245 on week days except Sunday and Saturday, and Wednesday (NWC signal stopped on Wednesday).

During the observing period, lightning discharges occurred in Bangkok at 1220-1225 (UT), 1240-1245, on 1 October and at 0720-0725, 0740-0745, on 5 October, 1979.

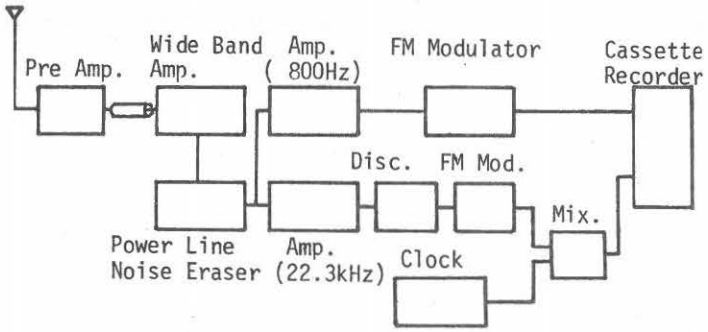

Fig.3 Block diagram of the observing equipment.

In the next section we describe briefly some results obtained in the preliminary investigation.

3. Observing Results

Fig. 4 shows an example of the obtained data at Bangkok and Toyokawa, for which the NWC signals were received with the expected coincidence of the time. It was found from the figure that the atmospherics were recorded with a time lag at the both stations. Fig. 5 shows the relationship among the positions of Bangkok, Toyokawa and the NWC transmission station. The difference between the distances of NWC-Bangkok and NWC-Toyokawa is about 2500 km, which is equivarent to the propagation time difference of 8.4 milli-seconds.

Referring to this propagation time difference, it is possible to decide the arrival time difference between atmospherics received at the both stations. Fig. 6 shows an expansion of Fig. 4.

It is found from Fig. 6 that the arrival time difference of atmospherics is 13 milli-seconds, which corresponds to the path difference (about 3800 km) of the atmospherics propagated at the light velocity from a consequent origin to the both stations. Referring to the distance of about 4340 km between Toyokawa and Bangkok and

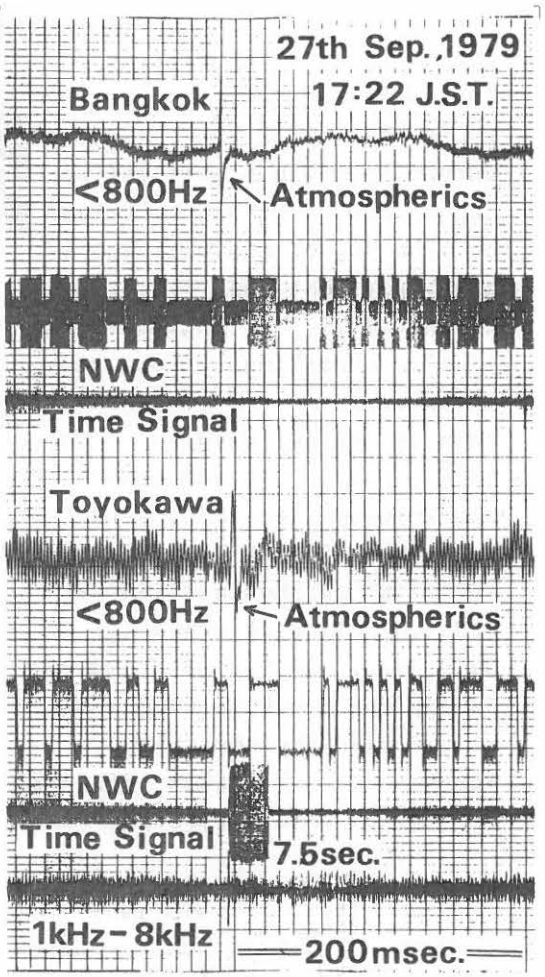

Fig.4 Observing result at $17^h22^m7.5^s$JST (JST=UT+9^h). The demodulated NWC signal is displayed for Toyokawa. The FM signal through a low pass filter is displayed for Bangkok.

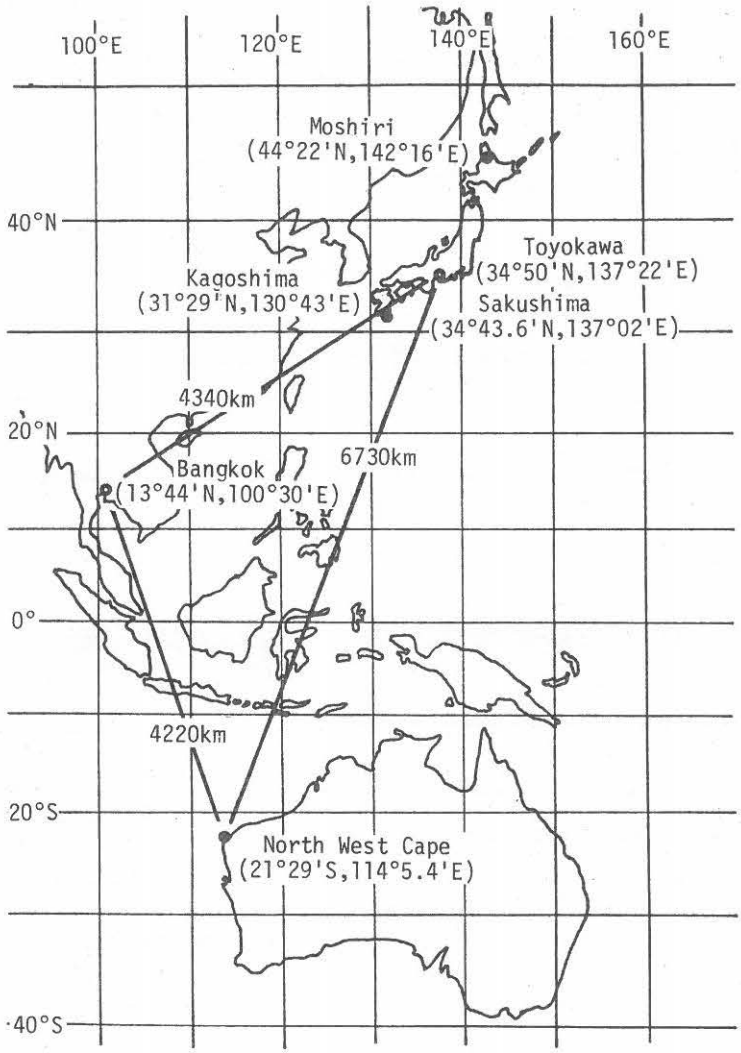

Fig. 5 Relationship among the positions of Bangkok, Toyokawa and the NWC transmission station.

to the preceding arrival time at Bangkok, the position of the atmospheric origin seems to be close to Bangkok.

The position of atmospherics origin can be decided by means of the atmosphric arrival time difference measured exactly for the both stations in combination with the bearing angle of the atmospherics at one of the stations.

Moreover, these atmospherics were also observed by the DF network.

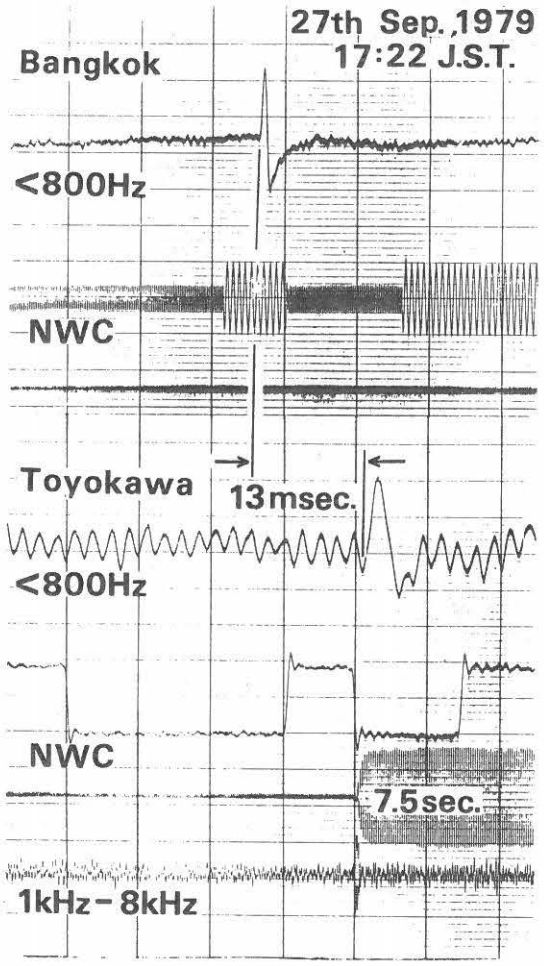

Fig.6 Expansion of Figure 4.

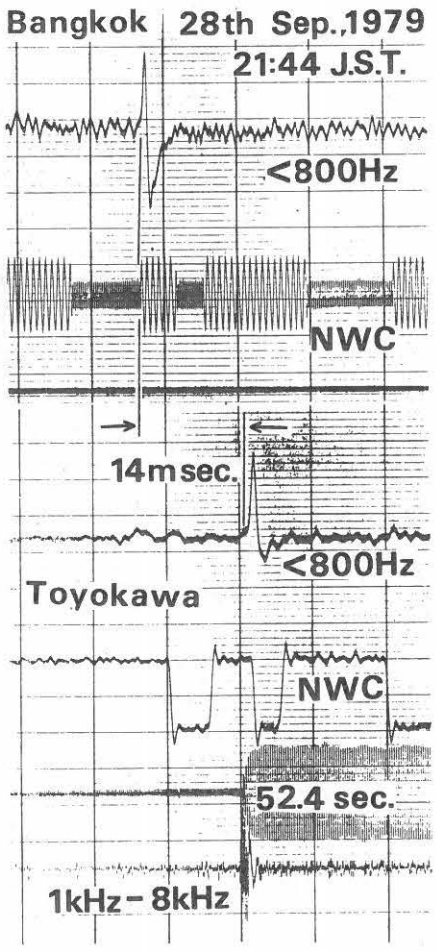

Fig.7 Observing result at $21^{h}44^{m}52.4^{s}$JST on 28 September, 1979.

The bearing angles measured clockwise from the geographical north were 246°, 250° and 245° at Kagoshima, Sakushima and Moshiri, respectively. In this case, the intersecting point could not be obtained from the direction lines at Kagoshima and Sakushima, because of a very small differnce between the bearing angles. The intersecting point obtained from the bearing angles at Sakushima and Moshiri is 17.3°N, 100.6°E and the distances from intersecting point to Bangkok and Toyokawa are 397 km and 4092 km, respectively. So the difference between the distances to Bangkok and Toyokawa is 3695 km, which is nearly equal to the value of 3800 km obtained from the simultanious observation at Bangkok and Toyokawa. The bearing angle at Kagoshima is 250 for this intersecting point, and the difference between this value and observed value of 246° is 4°, which may be the measuring error at Kagoshima station. Fig. 6 shows an example of the data observed in the day time, while Fig. 7 shows one at night, which is received at 2144 JST (JST=UT+9h) on 28 September, 1979. In Fig. 7, the arrival time difference between the

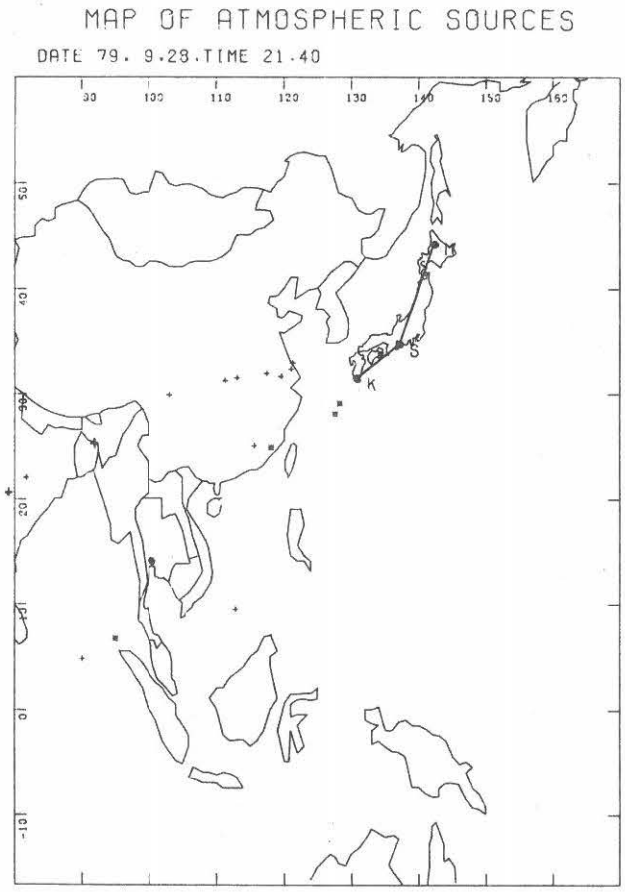

Fig. 8 The distribution of the sources of atmospherics received simultaneously at Bangkok and Toyokawa by using the DF network during 12^h40^m- 12^h45^mUT on 28 September, 1979.

atmospherics received at the both stations is 14 milli-seconds, which corresponds to the difference of the distances of about 4200 km. The position of the origin seems to be near Bangkok. The bearing angles are 244°, 246° and 245° at Kagoshima, Sakushima and Moshiri, respectively. And the intersecting point are 21.3°N,111.4°E by the DF at Kagoshima and Sakushima, 3.1°N, 88.6°E for Sakushima and Moshiri and 6.3°N, 91.4°E for Moshiri and Kagoshima. The differences of the distances from the three intersecting points to Bangkok and Toyokawa are 1484 km, 4339 km and 4340 km, respectively. In this case, the triangle made by the direction lines for the three DF stations is in a large flat shape of cocked-hat. Therefore, the fixed point of the center of gravity of the large cocked-hat includes a large error. If the arrival angle at Kagoshima were subtracted by 1° from the observed angle of 244° considering the measuring accuracy of the direction finder within $\pm 1°$, the intersecting points for Kagoshima-Moshiri, Kagoshima-Sakushima and Sakushima-Moshiri could concentrate in a very narrow area. The difference of the distances from the resultant fixed point to Bangkok and Toyokawa becomes about 4300 km.

As mentioned above, the fixing of atmospheric sources by using the DF network is usually difficult in the region along the base lines. Therefore, the time difference method using an additional station in South-Earst Asia is believed to be very useful for the fixing of the sources of atmospherics along the base lines. Fig. 8 shows the distribution of the sources of atmospherics received simultaneously during the observation period mentioned above at Bangkok and Toyokawa by using the DF network.

4. Conclusion

From the results of the preliminaly investigation, it is concluded that it is possible to observe simultaneously the atmospherics in Thailand and Japan. And it has become clear that the NWC signal is useful and convenient as a time reference.

Moreover, it is found that the measurment of the propagation time difference between Bangkok and Toyokawa is useful for the fixing of the sources of atmospherics in South-East Asia, which can not be usually made exactly by the DF network of the Research Institute of

Atmospherics. It seems to be more powerful to use an additional direction finder at Bangkok together with the propagation time difference method. Therefore, the direction finder is being prepared for the investigation in this year.

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References

Iwai A., J. Ohtsu, M.Nishino and M.Kashiwagi; A New Direction Finding Network for Locating the Sources of Atmospherics, Proc. Res. Inst. Atmospherics,Nagoya Univ., vol. 16, 17 (1969).

Nishino. M and M. Kashiwagi; The Characteristics of the Distribution of Atmospheric sources and the Consideration of the Fixing Error, Proc. Res. Inst. Atmospherics, Nagoya Univ., vol 23, 1, (1976).

Iwai A., M. Kashiwagi, M. Nishino and M. Satoh; Triangulation Direction Finding Network for Fixing the Sources of Atmospherics, Proc. Res. Inst. Atmospherics, Nagoya Univ., vol. 26, 1, (1979).