ACTIVITY REPORT

Section 1 Propagation of atmospherics and ELF radio noise

Much progress has been made during the passed year in the First Section. Firstly, apparatus and related topics at Tottori Observatory are discussed. A new prefab (approximately $10 m^2$) has been built near the original one for the purpose of holding discussions. (refer to Fig. 1) During the observational period of U.S.-Japan cooperative work staff may stay here for the night observations. The apparatus and aerial which will be described below were constructed in order to improve the techniques of slow tail observation. Since the measurement of precise time of arrival is required in the cooperative observations to identify the slow tail waveforms between the two countries, an electronic clock was built capable of keeping time within an error of 9ms a day. Another device which is necessary for the observation of slow tails is a uni-directional VLF direction finder which a photo-cell mounted on the surface of a cathode ray tube. A VLF spike which shows the reception of slow tails coming from the particular direction is drawn on the recording paper. Initially the vertical rod aerial (15 m) was employed for the measurement of the slow tail, however, another aerial (crossed vertical loop) whose dimension is $5 m \times 25 m$ has been built in addition, because it enables the measurement to be possible even under disturbed weather conditions. This loop aerial, buried partly under the ground, has 100 turns, and is shown in Fig. 2. Since the attenuation of propagation is, as is well known, rather large in this frequency band, a highly sensitive aerial is necessary so that waveform can be well received even in the daytime.

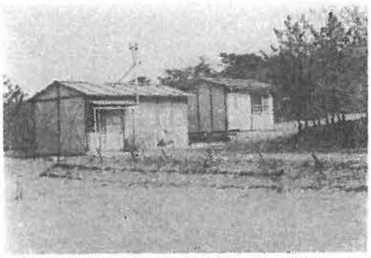

Fig. 1 Tottori Observatory

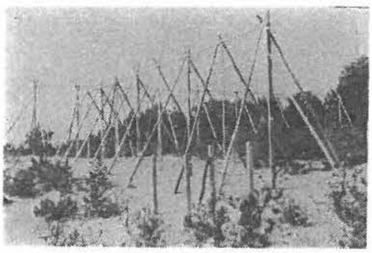

Fig. 2 Vertical crossed loop aerials built in Tottori Observatory

Secondly, the observations of the U.S.-Japan cooperative research programme started last February. The counterpart of this research is Dr. W. L. Taylor, E. S. S. A., Boulder. As to the slow tail programme, simultaneous observations were made on four days in February and March respectively according to the resolution made at the Gamagori Conference. The programme of the subsequent measurements was decided upon by mutual agreement on each occasion, and observations were made in May and September. The outline of these observations is shown in the Table 1. The most important aim of these simultaneous obsrvations is the identification of waveforms observed simultaneously at the two respective sites, because the distance from the source is very large. Although the February and March observations were thought to be tentative, the March observation was fortunately quite encouraging, and several pairs of waveforms could be identified originating from an area in the South Pacific Ocean. Fig. 3 shows a sample of the indetified slow tails which propagated over the distances from 6000km to 8000km. A result of the frequency analysis of the slow tail observed is shown in Fig. 4. The peak value in amplitude is at a frequency of approximately 30 Hz. As a result of the May observations, slow tails

Table 1 Schedule for cooperative observations of slow tails

Year Month	Date (UT)	Hour (UT)	Start min. (duration)	Aerial used	Additional record	Sources under consideration
Feb. 1967	15 17 20 22	20 JST 04MST 11 UT	00min (10min) 20min, 30min, 40min, 50min (30sec)	15m vertical rod	VLF spike time signal	South-East Asia (propagation at night)
Mar. 1967	16 18 21 23	08 JST 16MST 23 UT	00min (10min) 20min, 30min, 40min, 50min (30sec)	do	VLF spike time signal	South-East Asia (propagation in the daytime)
May 1967	15 17 20 22	11 JST 19MST 02 UT	00min, 10min, 20min, 30min, 40min, 50min (30sec)	15m vertical rod	VLF spike time signal signal showing the particular direction	Tahiti (South Pacific Ocean) (propagation in the daytime)
Sept. 1967	13 15 18 20	21 JST 03MST 12 UT	00min, 10min, 20min, 30min, 40min, 50min (30sec)	15m vertical rod vertical loop ($5m \times 20m$, 100 turns)	VLF spike time signal uni-directional signal	South-East Asia & South Pacific Ocean (propagation at night)

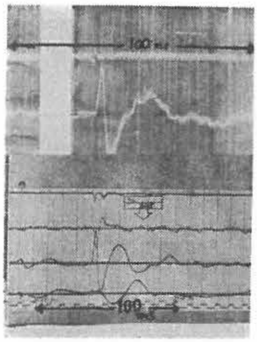

Fig. 3 A pair of slow tails obesrved simultaneously at Lafayette and Tottori

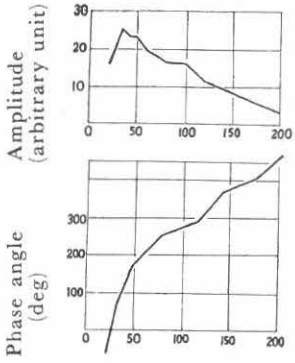

Fig. 4 A sample of the frequency spectrum of slow tails

originating from Tahiti and its neighbourhood are recommended for observation. Slow tails propagating from that direction could be easily tabulated owing to the additional technique on the cathode ray tube as described above. Any way, it can be said that we have taken a first step forward in observing slow tails traversing a great distance.

The cooperative observation of Schumann resonance have been made since February this year for one week a month. The counterpart of this research is Professor C. Polk of the University of Rhoed Island, R. I.. The basic work of these cooperative observations is the recording of waveforms for ten minutes in every hour during the predetermined period. In addition to this, quasi-amplitude-frequency spectra are also observed with a Y-Y recorder during the cooperative period. The variation of the resonance frequency of the first order mode with time is investigated from the records obtained. It is also interesting to know how the diurnal variation of the integrated field intensity varies with the order of the mode, and for this purpose, integrated field intensity at frequencies of 8, 14, 20 and 30 Hz are recorded continuously.

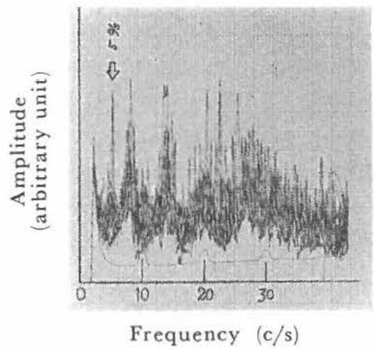

Fig. 5 A particular oscillation at a frequency of 4-5c/s seen in the frequency spectrum of Schumann band (19 April 1967, 1900-1930 JST)

Thirdly, as regards VLF atmospherics research, two kinds of routine observation are made, one is the integrated field intensity at frequencies of 2, 4, 6, 10, 21 and 27 KHz, the other the amplitude-frequency spectra ranging 0.5 to 60 KHz. These observations are to be moved to Saku Island which is situated 32 km south west of our Institute owing to the increased noise now experienced in our Institute. Data are distributed to twenty-five stations in the world every month and also published. (refer to Reference (1))

Finally, the chief interests of our present researches are as follows.

1) Electromagnetic oscillations having a peak at a ferquency of 4 to 5 Hz are sometimes found in records of the amplitude-frequency spectra of the cavity resonance. A sample of this oscillation is shown in Fig. 5.

2) It is interesting to know what parameters of the ionosphere can account for the SEA effect in the ELF band. Attempts are currently being made to determine propagation characteristics taking into consideration a two layered model superimposed by the Earth's magnetic field.

3) As regards sferic fixes in Japan it is evident that fixing is not possible for sources distributed in the SW direction because Japan mainly lies in that direction. However, in the SW direction from Japan, there exists the most intense storm centre in Asia. To overcome this difficulty, an automatic method of determining the range of each sferic is now being developed. If this technique is successful, the long dream of locating atmospherics by only one station might come true.

4) An approach to the study of the propagation of slow tails is the study of the frequency spectra deduced from the integrated field intensity at various frequencies. Four additional frequencies (800, 400, 170 and 45 Hz) have been added to the frequencies of 570, 260, 100 and 30 Hz.

5) Efforts have been made to interpret the SEA effect in the VLF band. As is well known, various SEA ratio's are produced by solar flares, so these are investigated in terms of the distance from the origin and the depression of the ionospheric height by the use of $(n-\frac{1}{2})$ order mode of wave guide mode theory.

6) Another interest is the VLF radio wave propagation, and the plasma physics both in ionosphere and exosphere to be explored by sounding rocket measurements in the Kagoshima Space Centre, University of Tokyo. In the case of a rocket observation of radio noise another apparatus similar to that installed in the rocket is also in operation on the ground at Kagoshima Observatory (31° 31′ N, 130° 46′ E), of our Institute. in order to compare both results. Early observations by rocket sounding resulted the detection of a form of radio noise in the ionospheric plasma, further measurements is, therefore, considered to be necessary and will be made by the Radio Exploration Satellite (REXS-1) which is being designed.

7) In addition, the investigation of the latitude effect of the intensity of VLF atmospherics on board the Fuji dedicated to the Antarctic Research Expedition of Japan is again being carried out.

Reference

(1) IQSY date on atmospherics, whistlers, VLF emissions and solar radio emissions, Science Council of Japan

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