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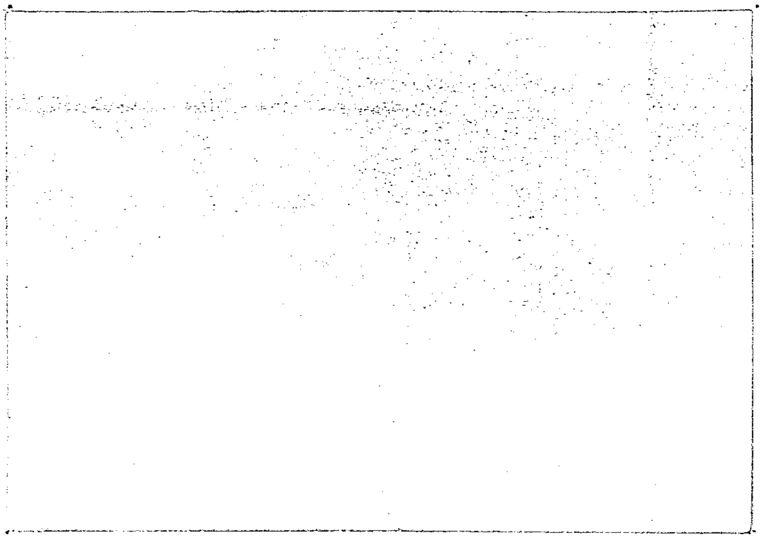

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ATTENUATION OF MEDIUM FREQUENCY SKY-WAVE SIGNALS IN AUSTRALIA FOLLOWING THE MID-PACIFIC HIGH ALTITUDE NUCLEAR EXPLOSIONS IN AUGUST 1958

AUSTRALIAN BROADCASTING CONTROL BOARD

Report No. 23

Title: Attenuation of Medium Frequency Sky-Wave Signals in Australia following the Mid-Pacific High Altitude Nuclear Explosions in August 1958.

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Attenuation of Medium Frequency Sky-Wave Signals in Australia following the Mid-Pacific High-Altitude Nuclear Explosions in August 1958

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Abstract - Similar attenuation patterns are found in quasi maximum medium frequency sky-wave field strength values following each of the high altitude nuclear explosions at Johnston Island. The pattern is formed by periods of severe attenuation lasting one or two days and extends from the second to the tenth day after each explosion.

Introduction

High altitude nuclear tests were conducted during August 1958 above Johnston Island which is located in the mid-Pacific. Reports indicate that megaton H-Bomb explosions called Teak and Orange took place; Teak on August 1st at 10:50 G.M.T., altitude 60 Km., Orange on August 12th at 10:30 G.M.T., altitude 30 K.m. Geophysical effects caused by these explosions have been described by several authors and theories advanced to explain the observations. Matsushita (1959) studied geomagnetic and ionspheric data collected, Cullington (1958), Fowler and Waddington (1958) and Malville (1959) discussed the artificial auroras produced, Steiger and Matsushita (1960) reported on photographs of the spectacle following the first explosion, Obayashi, Coroniti and Pierce (1958) described the effect on long distance short wave transmissions to Japan, while Crain and Tamarkin (1961) sought to explain changes in V.L.F. propagation characteristics on propagation paths remote from the explosion point or its magnetic conjugate.

Features which appeared in Australian medium frequency sky-wave field strength recordings after each explosion are described in this paper.

Medium Frequency Sky-Wave Field Strength Recordings

Regular observations of clear channel * medium frequency sky-wave field strength levels over distances of 400 miles and 800 miles have been conducted in eastern Australia since 1953 (Dixon 1960). During most of this period weekly samples of the field strength received from three broadcasting stations were obtained by recording the level of each station for a period of 1½ hours centred on the second hour after sunset. These tests were conducted to determine signal level characteristics, particularly variations over the sunspot cycle. By 1957 it became apparent that the signal variation attributable to sunspot activity, as indicated by the Wolf sunspot number, accounted for only a small part of the total variation in quasi maximum values. Apart from significant correlations between field strength and vertical incidence E layer critical frequency values at noon during the period of high sunspot activity, no other measured phenomenon appeared to be related to the results.

In order to test certain hypotheses based on the E layer correlation, and to determine the influence of distance and frequency, the number of clear channel stations observed each week was increased to twelve and the period of each recording reduced to one hour from June 1958 to June 1959, no more than two stations being recorded each night. On completion of this recording programme, sufficient results had been obtained to reveal a definite yearly variation of signal levels in general, with a more pronounced and somewhat different variation appearing in the occurrence of low level recordings. This led to the conclusion that for certain short periods throughout the year a few low signal level recordings may be expected, although high level signal levels are not necessarily precluded during these periods. The coincidence of these periods with shower meteor activity has been noticed and will be discussed in a later paper describing medium frequency sky-wave signal characteristics.

Results during August 1958

The Johnston Island high altitude nuclear tests were conducted during one of these periods (late July to early August) and although some low signal level recordings would normally be expected at this time, there are a number of abnormal features associated with the quasi maximum values which indicate that these explosions caused severe attenuation in sky-wave radio propagation at delayed intervals not previously reported.

The first indication of any abnormality was noticed in the number of very low signal level recordings, which was considerably greater than in any other period. More than 50% of all very low signal level recordings made since 1953 occurred during August 1958, but no greater significance was attached to this fact as the recording programmes of 1958-1959 provided as many recordings as had been obtained in the preceding programme.

However the following points of coincidence in the train of events following each explosion are considered to be highly significant for a recording property which in itself is fairly rare.

(1) Very low signal levels were recorded on the second night following each explosion - recordings at this time of the year being run from 9:30 G.M.T. to 10:30 G.M.T.

(2) Low to very low signal levels were recorded on the 3rd, 6th, 10th and 11th nights following the first explosion and on the 6th, 9th and 10th nights following the second explosion (table 1).

(3) A characteristic of medium frequency sky-wave recordings is that measurements made on the same night are only poorly correlated, so that in general it is not uncommon for both high and low signal level recordings to be made on the same night from different stations over adjacent paths. This characteristic is evident in table 1 but it is perhaps too much of a coincidence that similar results were obtained on both occasions in the first attenuation period following each explosion when two recordings were available.

The relative coincidence of these attenuation periods suggests that the effect took more than one but less than two days to arrive and reappeared on two occasions with an interval of four days between appearances. As the quasi maximum field strength extracted from recordings represents a sampling rate of once per day, it is convenient to assume that such a measurement is representative of the signal level for the whole night. On this basis these attenuation periods lasted one or two days.

Matsushita (1959) reported severe D region absorption at two ionospheric stations in the Pacific, the delay in onset being much shorter after the first explosion than after the second, due presumably to the higher altitude of the explosion on August 1st. These results are compared with those from eastern Australia in table 2, indicating a general trend of increasing delay in onset and increasing duration of absorption with increase in distance. Particularly severe absorption occurred at Maui while at Rarotonga absorption forced f_{min} to 7-8Mc/s, but no similar influence appears in published hourly values from the ionospheric stations at Canberra and Brisbane. Delays shown in table 2 are consistent with a spread of ionizing material away from the explosion, thereby producing a much longer effective persistance of ionization than that occurring naturally in the ionosphere as a result of ultra-violet radiation from the sun or from meteor impact. The Australian case could be considered as a somewhat diluted or spent residue with insufficient D region ionization to have any apparent influence on vertical incidence soundings but sufficient to cause pronounced attenuation of oblique incidence signals.

Not all the features in table 2 appear to fit this interpretation. The delay in onset of absorption after both explosions was similar for the Australian recordings whereas dissimilar delays were observed at Maui and Rarotonga. Of particular interest in the recurrent feature displayed in sample recordings after each explosion. This orderly aspect suggests a fixed pattern of events which is difficult to explain without corroborative data from other regions of the Pacific.

Conclusion

Similarity in the abnormal train of events observed in medium frequency sky-wave field strength recordings made in eastern Australia following the high altitude nuclear explosions at Johnston Island leaves very little doubt that these explosions influenced medium frequency sky-wave propagation in the region from the 2nd to the 10th day after each explosion. The area of influence could have been fairly extensive as very low signal levels were recorded simultaneously on propagation paths with centres separated by up to 500 miles.

Table 1

Field strength exceeded for 10% of the time in each recording relative to the inverse distance value. Twelve stations were recorded each week, one or two stations being recorded each night.

July August 1958

31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
.46	.80	.86	.06	.08	.22	.49	.22	.23	.80	.49	.10	.04	1.04	.08
.71	1.23			.06	.48	.33		.72			.22	.36	..71	.12

ıgust 1958

15	16	17	18	19	220	21	22	23	24	25	26	27	28	29	30
.36	.45	.82	.26	.36	.61	.52	.10	.56	.52	.62	.29	.45	.72	.31	.53
.56			.06	.48	1.05	.09	.00			.19	.53	.52	.12	.37	

Location	Distance from Johnston Island miles	Delay in onset of absorption after explosion: 1st August	Delay in onset of absorption after explosion: 12th August
Maui	800	22 min.	4 hours 30 mins.
Rarotonga Is.	2800	1 hour 10 mins.	6 hours 30 mins.
Eastern Australia	4400	1 day 2 days	1 day 2 days

Location	Duration of absorption period: 1st August	Duration of absorption period: 12th August	Comments: 1st August	Comments: 12th August
Maui	2 hours 10 mins.	14 hours	blackout occurs	blackout occurs
Rarotonga Is.	5 hours	1 day 12 hours		f_{min} 7-8Mc/s
Eastern Australia	1 day (probably 2 days)	probably one day	f_{min} 1.6 Mc/s	f_{min} 1.6Mc/s

Table 2 Comparison of Australian results for the first attenuation period after each explosion with those given by Matsushita (1959).

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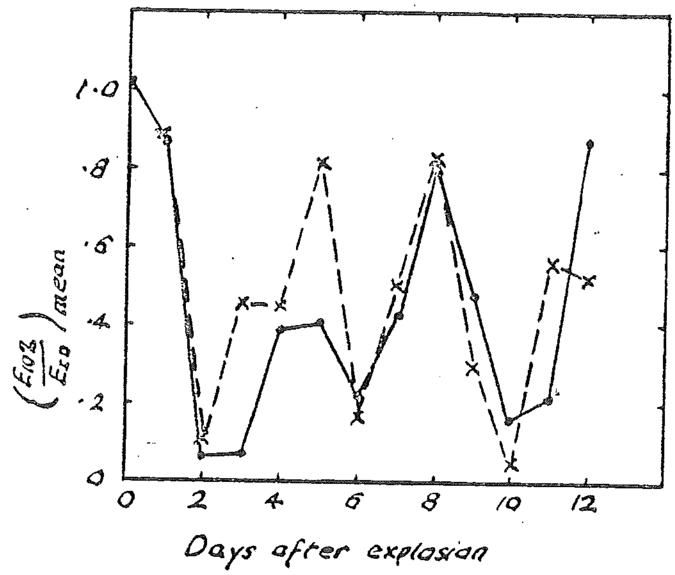

Figure 1. Mean 10% sky wave field strength relative to the inverse distance value.

•————• Teak August 1st 1958

x————x Orange August 12th 1958