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Satellite ORBIS Experiment

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Signals transmitted by satellite ORBIS at 10.004 Mc/s were received at Haringhata Field Station (geomagnetic lat. 12°15′ N, geomagnetic long. 32° W). Long-distance propagation paths could be established between the station and the satellite in some passes, while a few overhead passes could not be received. Absence of signals from a few overhead passes is explained in terms of blanketing-type sporadic *E*. It is concluded that long-distance propagation paths may be sustained either by hop modes in the presence of irregularities in the ionosphere or by ionospheric ducting.

1. Introduction

Signals from the satellite ORBIS, transmitting at 10.004 Mc/s, were received at the Haringhata Ionospheric Field Station (12°15′ N geomagnetic lat.) from November 19 to December 2, 1964. ORBIS, the mnemonic for Orbiting Radio Beacon Ionospheric Satellite, was launched primarily to study transhorizon propagation. The orbital parameters of the satellite were given as inclination 70.02°, apogee 368 km, and perigee 188 km. The height of the satellite when it was close to the station was about 220 km. Usable data could be obtained only during nighttime hours, since heavy interference was present during the day and the early evening passes. About 30 passes within the time interval 2000–0500 IST were used for this study.

2. Receiver

A unipole antenna above artificial ground was used to receive the satellite signals in conjunction with a SX–28 receiver. The detected output after d-c amplification was integrated with a network having a time constant of 0.1 sec. The integrated output was recorded on a recording milliammeter having a chart speed of 12 in./hr.

3. Data

The useful data that could be recorded were between 2100 and 0500 hr. Daytime or early evening records were doubtful due to interference.

The characteristics of the received signal intensity from the satellite ORBIS may be summarized as follows:

(1) very long propagation paths,
(2) total absence of signals from a few passes, including two near-overhead passes,
(3) fast fading of signals,
(4) clear sinusoidal type of fading,
(5) burst-type signals.

Signals could be received over very long distances and from almost any position of the satellite during the period of time under review. Signals in all cases except one exhibited a slow increase at the start and a slow decrease at the end.

The typical range of reception is exhibited in figure 1 for the set of revolutions 157 to 162. It shows that signals could be received from almost any position of the satellite.

It was observed that signals could not be received from certain satellite passes, although these were favorably placed. Revolutions 159 and 160 were symmetrically situated to the east and the west of the station. However, signals could not be received at all from revolution 160, while revolution 159, although short, could be received well. Such missing passes are also reported for revolutions 15 and 16.

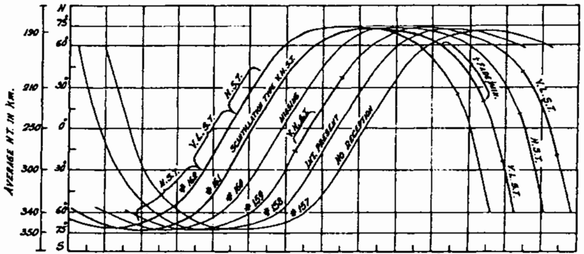

FIGURE 1. *Zone of reception from ORBIS (in thick lines) as a function of subsatellite latitude and longitude and satellite height.*

Figure 2 shows a record exhibiting the normal scintillating type of signal with a fading period lying between 10 to 20 per minute. Fading records were limited primarily by the slow chart speed of the available recorder.

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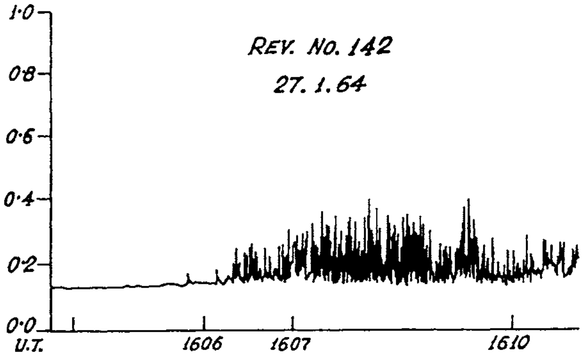

FIGURE 2. *Normal scintillating type of signal.*

Slow sinusoidal fading without any superimposed high-frequency fluctuations was recorded in some parts of revolutions 14, 161, and 144. Slow fading rates could be classified into two groups as 1 fade/min and 4–6 fades/min. Such slow fading occurred after the sudden cessation of high-frequency fluctuations. The subsatellite positions in the two cases of 1 fade/min were 160° W and 40° N for revolution 161 and 70° W and 15° S for revolution 13. Such a record is exhibited in figure 3. The only case of 4–6 fades/min obtained in revolution 144 corresponded to subsatellite position range 350° W, 60° S to 285° W, 30° N. The fading record for this case is shown in figure 4.

One case of sudden signal burst was obtained for revolution 13. It consisted of two bursts of signal when the subsatellite position was 280° W, 68° S and 270° W, 45° S. The record exhibiting such a signal burst is shown in figure 4.

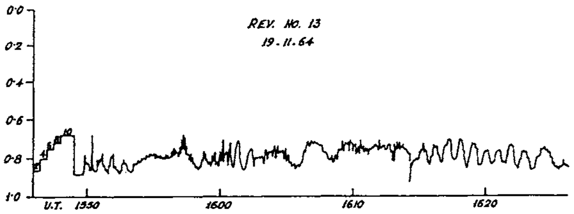

FIGURE 3. *Slow fading rate of 1 fade/min.*

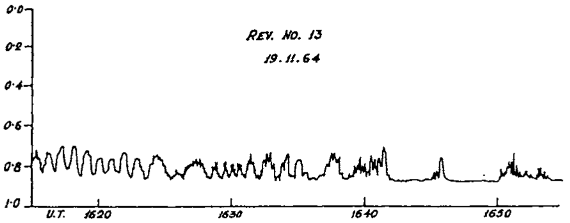

FIGURE 4. *Signal bursts received from long distance.*

4. Discussion

The case of no signal reception from the satellite was found to be interesting, particularly for the near-overhead revolution 143, since the preceding and the following passes could be received. This problem has to be considered from the point of view of ionospheric changes over an interval of 1½ hr, as the aspect angle of the satellite antenna relative to the vertical receiving antenna offered no solution. It is believed that blanketing-type sporadic *E* prevalent at this station was responsible for such a blackout.

The case of slow sinusoidal fading exhibited in some of the records can be explained by assuming clouds of irregularities with a scale of about 400 km. The faster fading due to the small-scale irregularities embedded in such clouds might have been too fast for the 0.1-sec recorder time constant. Such fading may also be attributed to an oscillatory type of change in the irregularity itself.

The burst-type signal is attributed to ionospheric ducting, as has been treated by Mullen et al.[2] Ray-tracing technique utilizing the position of the satellite and the orientation of the magnetic field relative to the satellite track will decide if such ducting could be present in the present case.

5. Conclusion

It is indeed very interesting from the propagation point of view to note that the ionosphere can sustain long-distance propagation modes. However, with the present experiment it is extremely difficult to conclude whether such modes of propagation are due to the formation of ionospheric ducts or the usual hop modes with suitable disposition of ionospheric irregularities. The question may be settled if the angle-of-arrival measurements are carried out with satellites transmitting sweep-frequency signals.

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[2] Mullen, J. P., C. Daniels, and R. S. Allen (1964), Investigating ionospheric ducting with the ORBIS beacon, AF Cambridge Res. Labs., Rept. No. 64–29.

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