THE IONOSPHERIC TOP-SIDE SOUNDER

THE *Alouette* satellite, containing an ionosonde capable of sounding the ionosphere from above, was launched on September 29, 1962. It was designed and built by the Canadian Defence Research Telecommunications Establishment and the satellite was put into orbit by the U.S. National Aeronautics and Space Administration. Other co-operating institutions include the U.K. Radio Research Station and the U.S. Central Radio Propagation Laboratory. The following three articles present some early results from the three co-operating institutions.

SOME PRELIMINARY RESULTS OF SOUNDING OF THE TOP SIDE OF THE IONOSPHERE BY RADIO PULSES FROM A SATELLITE

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MOST of the present knowledge of the ionized upper atmosphere, the ionosphere, has been obtained by examination of radio waves reflected from the bottom of the ionization layer. Except by the incoherent scatter technique the top side of this layer is inaccessible for examination by radio waves from the ground, since the waves which penetrate to these heights are not reflected but continue outward into space. The concept of sounding the top side of the ionosphere using a sounder in a satellite was an obvious consequence of the ability to launch artificial earth satellites. As long as four years ago the idea was current among ionospheric research groups in the United States, United Kingdom, Germany and Canada. Because radio sounders, using vacuum tubes, are heavy and consume kilowatts of power, it was necessary to use solid-state devices in order to produce a sounder suitable for use in a satellite. The first top-side sounder to operate in orbit was launched at 0605 G.M.T. on September 29, 1962, as part of the *Alouette* satellite, 1962 $\beta\alpha 1$.

The *Alouette* satellite contains, in addition to the sounder, apparatus for counting cosmic-ray particles (National Research Council, Ottawa), for observing the very-low-frequency radio spectrum, and for monitoring the engineering performance. A measure of the cosmic noise-level as a function of frequency is provided by the automatic gain control voltage of the sounder receiver. The sounder data only will be discussed here.

The top-side sounder consists of a transmitter, receiver, timing circuits, antennæ, and antenna matching networks[1]. The power radiated during a pulse is of the order of 10 W. Two orthogonal antennæ are used, a 150-ft. dipole, operating at frequencies below 4·5 Mc/s, and a 75-ft. dipole for the range 4·5–11·5 Mc/s. The sounder is operated on command. Once started, it functions for 10 min, generating thirty transmissions in which the radio frequency changes linearly with time over the frequency-band 0·4–11·5 Mc/s. It then shuts off automatically until commanded on again. Nickel–cadmium batteries, recharged by solar cells, permit about 5 h of operation per day.

The *Alouette* orbital parameters as of October 17, 1962, provided by the National Aeronautics and Space Administration Computation Centre, are:

Anomalistic period		105·4137 min
Inclination		80·463 deg.
Argument of perigee		2·5649 deg.
motion	minus	49·531 deg./day
Right ascension of ascending node		158·899 deg.
motion	minus	0·984 deg./day
Semi-major axis		1·15892 Earth radii
Eccentricity		0·00235
Perigee		996·38 km
Apogee		1031·05 km
Velocity at perigee		26,498 km/h
Velocity at apogee		26,374 km/h

The height of the orbit was chosen by compromise. The lower the height, the smaller is the region explored. The greater the height, the smaller is the signal-to-noise ratio of the signals reflected near the height of the maximum ionization density. The inclination of the orbital

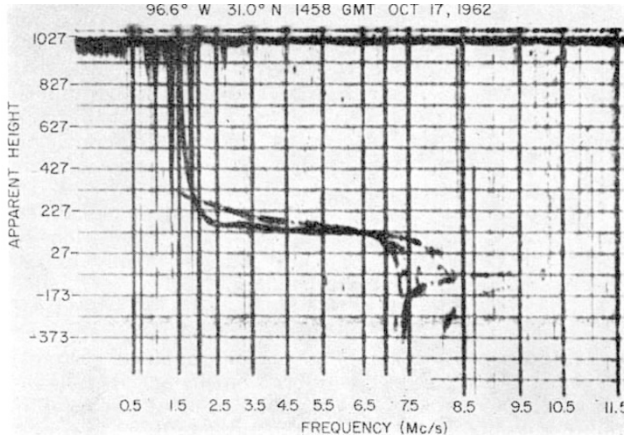

Fig. 1. A typical top-side ionogram

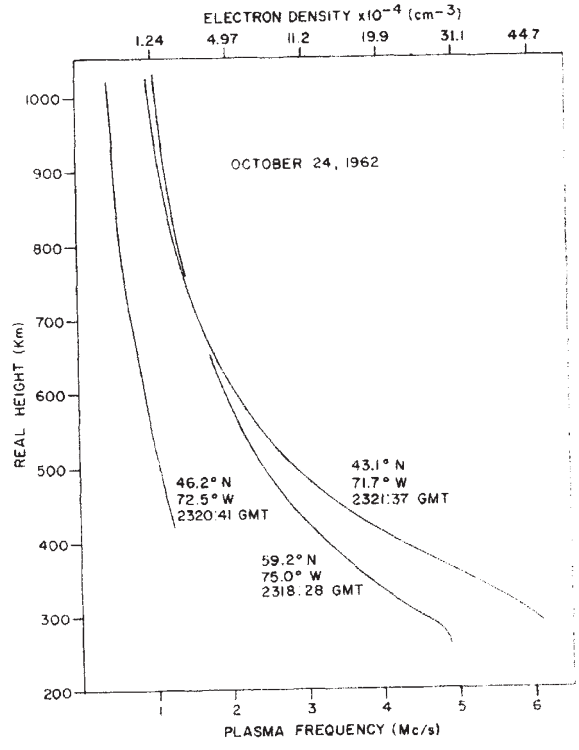

Fig. 2a. Distributions in height of free electrons showing depression of density at Ottawa latitudes