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VLF transmissions from Siple Station

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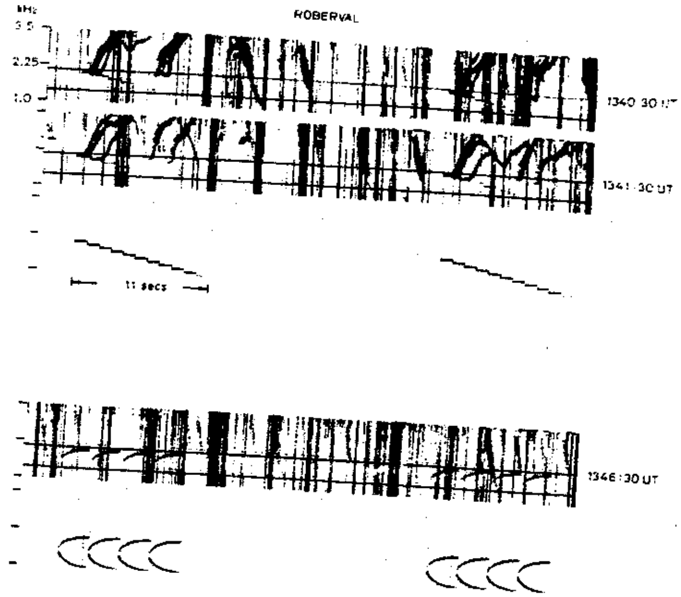
There is increasing interest in transmitting from Siple Station at frequencies as low as 1 kilohertz. Many high-altitude satellites that have wave detectors aboard are especially programed to receive signals below approximately 1.6 kilohertz. There is also interest in transmitting extensively between 1 and 4 kilohertz to enhance the wave interaction with the more energetic electrons and to observe the ionospheric effects associated with the particles scattered in the process.

During 1980, a receiving site that was free of power line interference in the frequency range 10 hertz to 20 kilohertz was established near Roberval (Canada). Transmissions of between 1 and 2 kilohertz were made from Siple and were received at Roberval. An example of the observations of 2 July 1980 are shown in the figure. Two modulations were employed. The upper three panels show a staircase consisting of 1-second pulses transmitted in sequence between 2 and 1 kilohertz at 100-hertz steps. Notice the triggered emissions and echoes at the 2.0- and 1.9-kilohertz frequencies. The lower two panels show a series of pseudo-C letters being transmitted. The upper half of the C's without triggering were observed at Roberval.

Siple Station is now capable of transmission, although at lower power, down to 1 kilohertz. It is hoped that Siple Station will be capable of transmitting at much higher power at these lower frequencies.



A frequency staircase and the letter C being transmitted from Siple Station and received at Roberval. Notice the triggered emissions and echoes associated with the 2.0 and 1.9 kilohertz pulses of the staircase.

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Digital ionosonde studies of the ionosphere from Siple Station and Roberval, Quebec

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In July of 1980 Utah State University began regular operational tests of a revolutionary computer-controlled ionospheric sounder at Roberval, Quebec (Roberval is located at the northern end of the Earth's magnetic field line that passes through Siple Station). Later this year the sounder will be relocated at Siple Station. This instrument, constructed by the Space Environment Laboratory of the National Oceanic and Atmospheric Administration, at Boulder, Colorado, is a greatly advanced version of the traditional ionosonde. Its basic function is to probe the electrons in the ionosphere by the use of reflected radio pulses. The digital sounder, however, can do far more than the traditional ionosonde, which was limited primarily to sweeping through the frequency range of about 1–20 megahertz and recording only the time of flight of the reflected pulse. The new instrument can, in addition, operate at a number of discrete frequencies, with the sampling rate and duration of the sounding under software control by the operator. An even more significant feature of the digital sounder is that it records not only the time of flight of the pulse, but also the amplitude and phase of all echoes at each of four spaced antennas. This permits examination of such attributes as the temporal variations of the amplitude and phase of the signal and the location of the reflecting region. This information is particularly critical at high latitudes, where the ionosphere exhibits strong variations with both short (less than a second) and long (hours) time scales.

Examples of the large quantities of information this machine can provide over greatly different time scales are shown in figures 1 and 2. Both figures show data taken with the sounder operating at a single frequency. The first spans about 4 hours, the second 300 seconds.

Figure 1 shows five parameters derived from the received signal. The top two panels plot the calculated distance (to the north and east of the transmitter) between the transmitter and the ground projection of the ionospheric reflection point. The third panel is the virtual range of the reflected pulse calculated from the time of flight ("virtual" since propagation delays have not been removed). Seen in this panel are both the first echo