University of Washington Research Program in Antarctica, 1965-1966

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During 1965-1966, a permanent building was constructed at the long-wire site, about 12 miles from Byrd Station, and a second dipole antenna, 10 miles in length, was laid perpendicularly to the 21-mile antenna. A diagram of the layout of these antennas is shown in fig. 1. Research was carried out by the University of Washington group on five different problems, viz.:

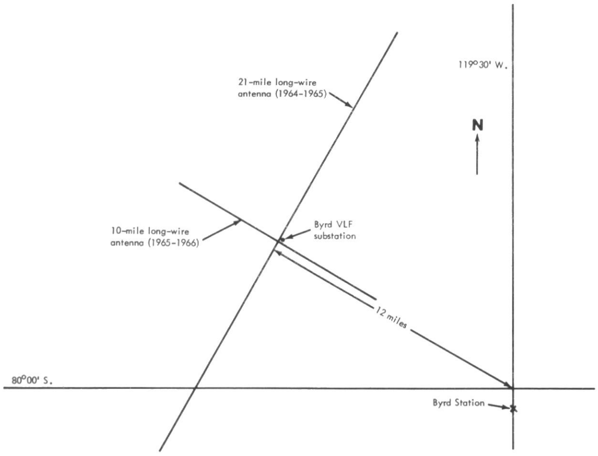

Fig. 1. Diagram of Long-Wire Antennas

VLF ionospheric studies. The *D*-region, located in the height range 50 to 100 kilometers above the surface of the Earth, is the interface between the relatively un-ionized lower atmosphere and the ionosphere. This is a complex and rapidly varying region, especially at auroral latitudes, and is characterized by very low electron densities, high collision frequencies, and rapid motions. The electron density varies rapidly at times of magnetic disturbance and may increase enormously to cause the so-called polar-cap absorption events.

Experimental study of the *D*-region by reflection of electromagnetic waves has not been successful in the past owing to limitations in antennas. The long-wire antennas at Byrd Station have removed these experimental restrictions. Unlike the extremely narrow band vertical antennas used with conventional VLF stations, the horizontal antennas near Byrd Station have very broad bandwidths and produce maximum radiation in the vertical direction.

A VLF *D*-region sounding system was installed and put into operation at Byrd Station during the 1965-1966 season, and has been in daily operation during the 1966 winter. The system consists of a keyer unit and transmitter at the long-wire antenna site, and a receiver at the Stanford VLF site. The keyer unit generates a sequence of pulses at a succession of frequencies between 3 and 30 kc./s., which are amplified to peak power levels of about 10 kilowatts and applied to the 10-mile antenna. The envelopes of the pulses are approximately Gaussian, which reduces to a minimum the spectral width of the signal at each operating frequency. Oscilloscopic photographs of the current wave form fed to the antenna at 5 and 30 kc./s., respectively, are shown in fig. 2. Reflected signals from the ionosphere are picked up in a loop antenna at Byrd Station and transmitted back to the long-wire site via a 450 mc./s. telemetry link, where a phase-comparison system is used to measure the propagation delay between transmitted and received signals. The records are currently on film; however, a digital tape system is planned for next year.

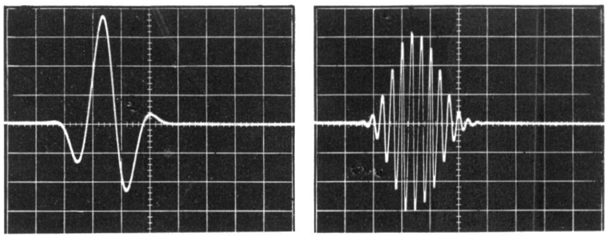

Fig. 2. Current Wave Forms. Left, 5 kc./s.; Right, 30 kc./s.

Results to date from the *D*-region sounding system are very encouraging. Ionospheric reflections are being received consistently, and a more accurate picture of the physics of the *D*-region is emerging.

Continued antenna research. The input impedance of the 21-mile dipole has been measured periodically to determine the effects of temperature and depth of burial under the snow. During January and February 1966, the second dipole antenna, 10 miles in total length, was laid down perpendicularly to the 21-mile antenna. Like the longer antenna, the new one is made from the core of RG 17/U cable, consisting of a polyethylene-covered, solid copper wire. The new antenna increases considerably the capabilities of the site, making possible either separate operation of the two antennas, or the combination into a single antenna system of controllable polarization.

Airborne field-strength measurements. An attempt was made during February 1966 to measure from an aircraft the radiated fields from the 21-mile antenna. While the aircraft was to have flown to a maximum distance of 500 miles from the center of the antenna and measured field strengths at a succession of frequencies in the 1 to 30 kc./s. range, high noise levels in the airborne receiving equipment prevented all but local measurements from being made. The experiment was not a complete failure, however, as good data were obtained on the current distribution along the antenna.

Earth-ionosphere cavity resonances. There has been considerable interest in recent years in the resonances of electromagnetic waves in the Earth-ionosphere cavity. The lowest resonant frequencies have been calculated to occur at 8.0, 14.1, 20.3, and 26.4 cps. In the past, experimental studies of these resonances have depended entirely on the natural radiations resulting from lightning activity throughout the world. The feasibility of exciting and detecting these resonances, using man-made signals from the 21-mile antenna, is being studied by the University of Washington group.

Exospheric electron density program. The objective of this program is to measure the propagation time of signals transmitted at a series of VLF frequencies between Byrd Station and the Seattle, Washington, area via exospheric paths. From the propagation delay vs. frequency, electron densities in the exosphere can be calculated. Since the strength of the signals received in the Northern Hemisphere is expected to be very low, a special binary, coded sequence and correlation-detection scheme is being employed. Equipment to key the 100-kilowatt solid-state transmitter at the long-wire site was shipped to Antarctica for the 1965-1966 summer program; however, problems with the transmitter prevented the keyer from being used, and field modifications were initiated to adapt the keyer to the lower-powered transmitter used in the *D*-region sounder program.

Receiving equipment will be installed during 1966 at an electrically quiet location in the San Juan Islands, about 70 miles north of Seattle, Washington. It is hoped that the field modifications at the long-wire site will be successful and that data can be obtained during 1966.

Ionospheric Forward-Scatter Program in the Antarctic

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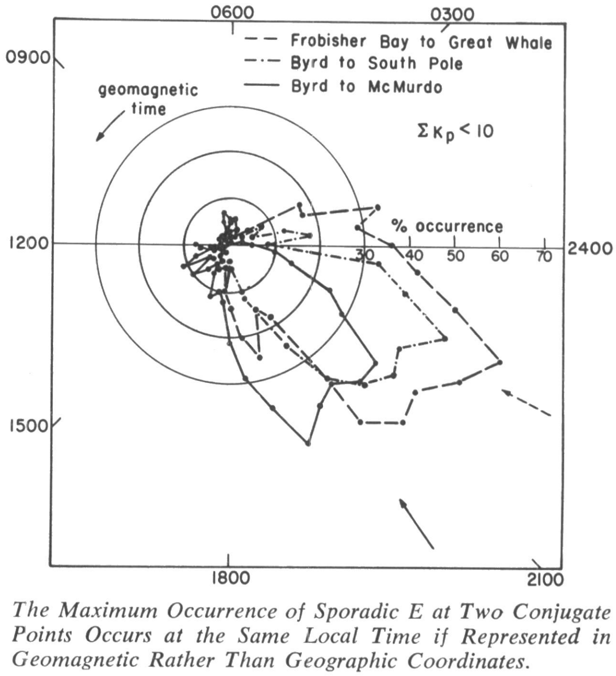
The three ionospheric forward-scatter circuits: Byrd-Pole, Byrd-McMurdo, and McMurdo-Vostok, operated satisfactorily during the past year. Only one polar cap absorption (PCA) event, indicating the arrival of solar protons with energies exceeding 10 MeV., was observed during the one-year period. The solar particle influx was detected on March 24 following the importance 3 solar flare that commenced at 0233 UT. The records, which displayed unusual characteristics, are being studied in detail.

More than 70 relativistic electron precipitation (REP) events have now been identified in the records of the Alaskan forward-scatter paths. Their characteristics have been established, and generalized conclusions concerning the spectra of precipitated electrons have been deduced. It is noteworthy that this phenomenon has never been observed on the antarctic paths, a fact that is of prime importance in confirming our hypothesis concerning the mechanism responsible for this new type of radio-wave absorption event. Elaborate calculations now in progress should make it possible to determine the electron flux and energy spectrum for any specific event from the observed radio-wave absorption.

Analysis of recordings of the occurrence of the sporadic *E* mode of signal propagation has yielded



The Maximum Occurrence of Sporadic E at Two Conjugate Points Occurs at the Same Local Time if Represented in Geomagnetic Rather Than Geographic Coordinates.