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THE POLAR IONOSPHERE: EDITORIAL

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A major new ground-based facility for the study of the upper atmosphere and magnetosphere at very high geomagnetic latitudes commenced operations in Greenland in early 1983. This facility is the Sondrestrom radar. By transmitting high power pulses of UHF radiation into the atmosphere and collecting the faint incoherent echoes produced through electromagnetic scattering of the incident beam by the ionosphere, a technique with nearly 30 years of development is able to observe the properties of the upper atmosphere for altitudes ranging between the D region and the magnetosphere.

Originally located at Chatanika, Alaska, this instrument was dismantled in March, 1982, and transported to Sondre Stromfjord, Greenland, by ship via the Panama Canal. Hard work saw the radar reassembled and made operational in six months. Observations were resumed with an instrument identical in most respects with the original Chatanika radar, but now located in a new and scientifically exciting location, the polar region.

The most obvious function of the radar is to explore the properties of the polar ionosphere. But, the important coupling interaction of the ionosphere with the magnetosphere and with the neutral atmosphere implies that the real function of this facility is to examine and study the interrelationships among these three regimes of outer space. In this special issue, some of the first scientific results from the Sondrestrom radar are reported. As one would anticipate, there were some surprises but a few expectations were confirmed. The importance of plasma convection to the understanding of the high latitude thermosphere proved to be the most significant finding. It greatly affects the neutral winds, and is closely linked to particle precipitation. However, the configuration of the convection pattern is still far from clear, as is the low-altitude signature of the magnetospheric cusp.

Beyond the immediate scientific goals for the radar, the development of the overall research facility at Sondre Stromfjord, Greenland, is part of a changing emphasis in the conduct of scientific research in the upper atmosphere.

The radar is the focal point for a clustering of instruments. Optical instrumentation featuring the ability to measure in high resolution the Doppler shift of emission lines of aurora or airglow was included from the outset. The existing Greenland magnetometer chain was greatly improved, and micropulsation detectors were installed. Additional radars designed to detect coherently E and F region echoes from drifting ionospheric irregularities were installed in Goose Bay, Labrador, and Great Whale, Quebec. These radars will make bistatic measurements above Greenland.

The radar is the polar anchor of a meridional chain of four incoherent scatter radars stretching a quarter of the way around the world. The chain includes the radars located at Millstone Hill, Massachusetts, Arecibo, Puerto Rico, and Jicamarca, Peru. It is now complemented by optical Doppler instruments at Sondre Stromfjord, Greenland, Laurel Ridge, Pennsylvania, Arecibo, and Arequipa, Peru. The research emphasis of the chain is on global phenomena.

The radar and other instrumentation are part of a network of high-latitude facilities stretching from Scandinavia and Svalbard through Greenland and Canada to Alaska. These include the Sondrestrom, the European Incoherent Scatter (EISCAT), and Millstone Hill radars, the coherent radars designated by acronyms of STARE, SABRE, and BARS located in Europe and Canada, the optical Doppler facilities in Scandinavia, Svalbard, Sondre Stromfjord, Thule, Ann Arbor, Saskatoon, Calgary, and Fairbanks; the magnetometer chains in Greenland and Alaska; and the instruments at the South Pole Station, which is near the magnetic conjugate point of Sondrestrom.

Efforts to conduct the observations on a global scale are being matched by global models, and major efforts are being made to bring the two views together. Concerted efforts are also under way to make the radar data much more available to the scientific community. The focal point of this effort is the incoherent-scatter data base at the National Center for Atmospheric Research that has also just started operations.

It should be appreciated that these goals can only be accomplished by international cooperation. The same spirit that made it possible for the Europeans to build the EISCAT facility fostered the joint cooperation between the governments of Denmark, Greenland, and the United States that supported the choice of the Sondre Stromfjord locaton in Greenland and procured the approvals of the respective governments for installation of the radar at this site. Moreover, the constant encouragement and support of officials in the National Science Foundation, the U.S. Air Force, and the Danish Meteorological Institute proved to be the keystone to the solution of the many problems involving logistics, communications, and site support.

In examining the results in this issue, the reader should be aware of the themes and interrelationships discussed above. The close association of polar cap convection reversals and soft-particle precipitation has been examined with the combined effort of the Sondrestrom radar and the Air Force Geophysics Laboratory airborne ionospheric observatory. The location of the polar cap current (DPY) with respect to magnetospheric boundaries has involved the radar and the Danish magnetometer chain. The discovery of the midnight

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neutral wind abatement required both radar and optical observations. The interpretation involved comparison with model calculations. Early results pertaining to global studies with the radar chain are presented in the articles involving the Millstone Hill radar. The importance of the high-latitude network appears in the work from Svalbard. In addition, most of the radar data used in these papers, and about half of all data acquired since the commencement of observations, will go into the data base at NCAR, where they will be available along with data from the other radars to all interested scientists.

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