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Short note
The Southern Hemisphere Auroral Radar Experiment (SHARE)

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Introduction

The near Earth space environment (known as Geospace) is dominated by the interaction between the solar wind and the geomagnetic field, which creates the magnetosphere. Considerable energy flows from the solar wind into the magnetosphere and ends up in the Earth's upper atmosphere (the thermosphere and ionosphere). The coupling of the geomagnetic field with that of the solar wind (known as the interplanetary magnetic field, or IMF) produces a variety of electro-dynamic responses with signatures such as electric fields and currents in the polar ionospheres. These produce, *inter alia*, motion of the ionospheric plasma (at altitudes between 100 and 1000kms) which can be monitored from the ground using radar techniques. Analysis of such plasma motion provides a very powerful means of investigating the nature of the interactions taking place at the boundaries between the magnetosphere and the solar wind. To do this effectively requires simultaneous measurements over as large an area (in latitude and longitude) as possible.

The Southern Hemisphere Auroral Radar Experiment (SHARE) aims to establish a dual HF backscatter radar system in Antarctica by deploying a new radar at Sanae Station (71.67°S, 2.85°W) to operate in tandem with the pre-existing radar at Halley Station (75.52° S, 26.63°W) in studies of the dynamics of geospace. It is planned that the Sanae radar will be installed and commence operation in early 1995.

The radars

The HF backscatter radar operates on a fixed frequency selected between 8 and 20 MHz, and is therefore sensitive to decametre-scale ionospheric irregularities. It is designed to form a narrow (in azimuth) beam which is stepped through 16 adjacent beam positions to provide an azimuth scan of 52°. For each beam the backscatter return from the ionosphere is averaged for each of (normally) 70 separate range gates, typically 45 km each, giving a maximum radar range of over 3000km. The complete field of view is scanned in 2 minutes, and for each range/beam cell, the radial Doppler spectrum of the backscattered signal is deduced, giving the line of sight velocity, and a measure of shear and turbulence in the plasma flow. Technical details are provided by Greenwald *et al.* (1985).

The backscatter observed arises from small-scale ionospheric density irregularities in the E and F regions. These are normally present over large regions of the auroral oval and polar cap, and the F-region irregularities move with the background plasma flow (Ruohoniemi *et al.* 1987). They thus act as scattering targets from which to determine high latitude plasma convection. Statistical studies (Leonard 1991) of the backscatter returns observed using the Halley radar show that irregularities are normally present throughout the high latitude ionosphere for all magnetic local times. The radars are thus highly effective tools for studying plasma motions at ionospheric altitudes.

Ruohoniemi *et al.* (1989) have demonstrated that it is possible to convert the maps of the radial component of velocity from a single radar into maps of horizontal velocity. However, the technique assumes spatial and temporal uniformity, and even then, Freeman *et al.* (1991) and Yeoman *et al.* (1992) have shown that significant errors can occur in some circumstances. Studies using the Halley radar and its northern hemisphere companion at Goose Bay, Labrador have demonstrated that plasma motion in the polar ionosphere is often highly non-uniform both in space and time. Furthermore, these non-uniformities appear to be crucial signatures of the coupling processes at the magnetopause (see Pinnock *et al.* 1993, Rodger *et al.* 1994), and their velocity signatures cannot be determined from a single radar. Unambiguous determination of the spatial and temporal variation in horizontal plasma flow requires two radars sharing a common field of view, which is what SHARE is designed to do.

SHARE field of view

The envelope of the fields of view of the two radars comprising SHARE (Fig. 1a) indicates a region of overlap between the two radars of several million km^2, spanning from *c.* 66–84° geomagnetic latitude. This range covers the mean locations of the geophysically interesting polar regions (the auroral oval, the dayside footprint of the cusp and polar cap). Over much of this latitude range the coverage is in excess of 45° of geomagnetic longitude (equivalent to 3 h of magnetic local time). This field of view also includes a wide range of current and planned complementary experiments located at manned observatories (South Pole is of special importance because of its unique

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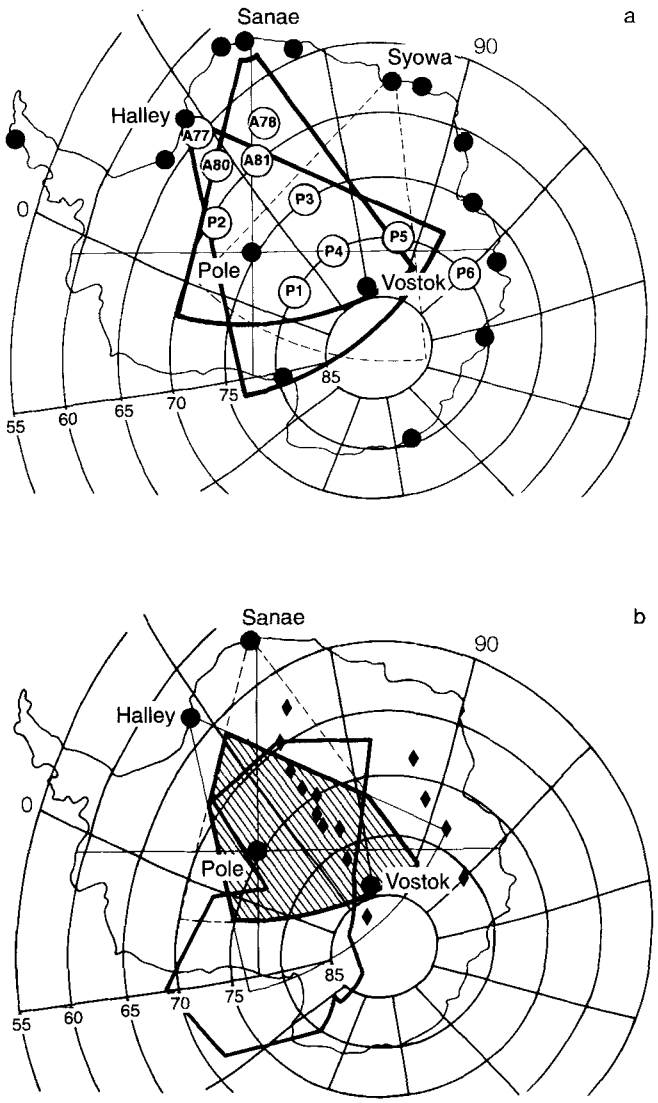


Fig. 1. Maps showing the fields of view of the SHARE radars superimposed on a geomagnetic coordinate grid. **a.** full field of view of the two radars. (●) locations of current manned observatories and (○) planned Automatic Geophysical Observatories (AGOs). "A" prefix indicate UK and "P" USA (A77 and P2) are already deployed. (dotted) = the field of view of a radar planned for Syowa station. **b.** geographical region where dual coverage occurs with SHARE, together with the region of dual coverage of four radars in the Arctic mapped along the geomagnetic field into the Antarctic. (◆) are the geomagnetically mapped locations of magnetometer stations located in Greenland.

location and extensive experiment suite), and Automated Geophysical Observatories (AGOs). Taken together, these facilities offer an unparalleled view of the southern polar ionosphere.

Disturbances in the solar wind produce global scale responses in the magnetosphere, resulting in effects in both polar ionospheres. Inter-hemispherical comparisons for individual cases reveal differential behaviour dependent upon the orientation of the IMF and on season. The importance of such studies was brought into focus by the success of PACE (Baker *et al.* 1990). As a result, an international consortium (known as the Super Dual Auroral Radar Network or SuperDARN) has been formed to establish a network of six HF radars in the Arctic stretching from Finland westwards to Saskatoon in Canada. SHARE forms the southern hemisphere portion of SuperDARN, together with a radar to be sited at Syowa station by Japan. Fig. 1b shows that SuperDARN will be able to determine plasma flow simultaneously in both polar regions with spatial coverage and resolution impossible hitherto. SHARE, as part of SuperDARN, will be a crucial element of the International Solar Terrestrial Physics (ISTP) study, which brings together spacecraft missions, ground-based observations and theory in an attempt to quantify the energy flow and dissipation through the coupled solar wind, magnetosphere, ionosphere system.

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