MIDLATITUDE RADAR OBSERVATIONS OF THE JULY 2004 GEOMAGNETIC STORM

Melissa G. Meyer and John D. Sahr
University of Washington Electrical Engineering
Box 352500, Seattle, WA, 98195, USA
Corresponding Email: mgmeyer@ee.washington.edu

We operate a coherent scatter radar at sub-auroral latitude in the northwest United States. Our "passive radar" takes advantage of existing illumination by commercial FM transmitters to observe plasma density irregularities in the E region ionosphere. During the geomagnetic storms occurring from 17 July until 27 July 2004, we observed many of these irregularities for continuous periods (up to 2.5 minutes) every 4 minutes, thus sampling the sub-auroral "storm evolution" completely on both long time scales (several hours) as well as short ones (seconds). Our radar is also capable of fine spatial resolution: 1.5 km in range and approximately 2 km in transverse resolution at a distance of 1000 km (achieved with interferometry). We are able to form rudimentary images and discern velocity shears within scattering volumes with interferometric techniques; we can use antenna pattern, range, and the magnetic aspect angle criterion to roughly locate scatterers in our field of view.

We have found many interesting features in our July 2004 data, including irregularities whose speed sharply increases over a few kilometers in range, and the filamentation of irregularity Doppler spectral structure from broad, flat peaks into sharply-defined periodic structures, over time scales of minutes. In several instances during our July 2004 observations we see a large-scale wavelike structure (in latitude and/or time) that propagates through our field of view. The characteristics (amplitude and period) of these equatorward-moving oscillations in backscatter intensity closely resemble those reported by the Millstone Hill group in their studies of spatial and temporal variations in the sub-auroral polarization stream (SAPS) electric field. The SAPS phenomenon, characterized by a region of poleward electric field and sunward-drifting plasma, is thought to be an important part of magnetosphere-ionosphere coupling at midlatitudes, and it is influenced by magnetic storms and susceptible to a feedback instability arising from field-aligned currents closing in low-conductivity regions of the ionosphere. By treating individual backscattering irregularities (present due to ionospheric two-stream instabilities) as tracers for electric field structure within the larger, and longer-lived, SAPS channel, we find quasi-periodic oscillations in the field structure within the channel as well as an equatorward motion of the entire SAPS structure. We also roughly estimate electric field strength by making assumptions about irregularity phase velocities and the radar flow angle.

We will present many of our observations from this storm, as well as relevant Doppler statistics derived from the data, and discuss these observations with respect to storm evolution at midlatitude, storm-time magnetosphere-ionosphere coupling, and in particular, electric field structure in the sub-auroral polarization stream. We will compare our SAPS observations with those of the Millstone Hill group. Finally, we will comment on the passive radar instrument and the geophysical conditions under which our observations were made.