D-Region and PMSE studies with PFISR

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We report here the first combined measurements of the D-region ionosphere and the polar summer mesosphere and lower thermosphere with the 450 MHz Poker Flat Advanced Modular Incoherent Scatter Radar (PFISR) under active auroral conditions. Observations were performed for a 24-hr interval on 9 June 2007 with PFISR configured to define four beams at nominal 10° zenith angles pointing approximately North, South, East, and West. Observations during the first 7 hours occurred at nighttime and revealed strong temporal correlations between auroral precipitation, the occurrence of Polar Mesosphere Summer Echoes (PMSE), and enhanced electron densities and radar echoes extending to much lower altitudes (~64-80 km). Specifically, PMSE, enhanced electron densities, and lower D-region echoes only occurred during enhanced auroral precipitation. PMSE and lower D-region echoes most often occurred together, but on occasion in isolation, and PMSE were more often visible to PFISR because of their much higher S/N at this frequency. The enhanced D-region backscatter with PFISR also enabled definition of horizontal winds with high precision extending to altitudes as low as ~ 64 km, which has previously been possible only at much lower frequencies (MF and HF), with the Arecibo 430 MHz ISR having a much larger power-aperture product, or during polar cap absorption events. These results show that PFISR promises to be a powerful tool to diagnose the neutral and electro-dynamics of the environment where Noctilucent Clouds are formed.