Recent Results from RAX: High-latitude Ionospheric Irregularity Experiments

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The second Radio Aurora Explorer (RAX) satellite completed nearly two dozen experiments with the incoherent scatter radars in Gakona and Poker Flat, Alaska and Resolute Bay, Canada. E region coherent echoes occurred during four of the passes including one with artificial irregularities generated by HAARP. Two of the PFISR passes occurred during very large (1500 m/s) and moderate (700 m/s) F region ion drift velocities. Microsecond-resolution raw data were downloaded for high-resolution range-time-intensity and Doppler velocity estimates on the ground. After mapping the intensity data in the magnetic geometry, we obtained the echo distribution in altitude with 3 km resolution, and in magnetic aspect angle to a fraction of a degree.

First, we find that the echoes are mostly confined to the altitude range of 100-110 km. The highest signal-to-noise ratio of 18 dB occurred near 105 km. Second, the slow spacecraft motion across the loci-of-perpendicularity allowed us to resolve the magnetic aspect dependence of the echo intensity with good statistics. The magnetic aspect angle distribution narrows down with increasing altitude and approaches to the half of the radar beam-width near the altitude of 110 km. De-convolving the radar beam factor from the measurements shows extremely fine magnetic field alignment ($\sim 0.1^\circ$). Third, the measured Doppler velocity shows variation with altitude, indicative of wind shears. The overall velocity magnitude is near the saturated speed of meter-scale plasma waves generated by the Farley-Buneman instability. For the altitude of 105 km, the measured Doppler velocity is in excellent agreement with the empirical formula ($C_s \cos\theta$) that the irregularities propagate at the ion acoustic speed times the cosine of the flow angle. Finally, despite the strong F region ion drift velocities, we did not find any evidence of F region sub-meter scale irregularities that are predicted to be generated through the Post-Rosenbluth