The scattering characteristics of PMSE at 33 cm with the Poker Flat Incoherent Scatter Radar

Michael J. Nicolls*[1], Michael C. Kelley[2], Roger H. Varney[2], and Craig J. Heinselman[1]

[1] Center for Geospace Studies, SRI International, Menlo Park, CA
[2] School of Electrical and Computer Engineering, Cornell University, Ithaca, NY

We report on multi-beam spectral observations of polar mesospheric summer echoes (PMSE) at 450 MHz (Bragg scattering wavelength of ∼33 cm) carried out with the Poker Flat Incoherent Scatter Radar (PFISR) located near Fairbanks, Alaska. Observations at this high frequency are unique and we argue may provide a more direct indicator of the turbulence energy dissipation region than lower frequency observations, as evidenced by the inferred isotropic nature of the echoes. Many of the observations occurred with auroral particle precipitation, which enhanced the otherwise low D-region ionization. The observations indicate two classes of spectra associated with PMSE at this frequency: "broad" spectra that seem to be particularly turbulent with spectral widths (root mean square velocity fluctuations) of 6-7 m/s, and more common "narrow" spectra, with spectral widths close to 2 m/s. The results are discussed in terms of the turbulence scattering theory of PMSE. Using the theories of *Rapp and Lubken* [2003], we find that neutral turbulence together with enhancement of the Schmidt number by the presence of charged ice can indeed explain the observations, even at these small scales, although some narrow echoes remain unexplained. The echoes are likely associated with large, charged ice particles (a few 10s of nanometers in radius). The narrowest echoes, seemingly resulting from relatively modest neutral turbulence, may acquire long diffusion times which allow them to drift with the background winds for tens of seconds, possibly explaining their predominance. Finally, possible charging mechanisms for the ice particles are discussed and we postulate that whether ice becomes positively or negatively charged depends on the relative importance of photoemission versus electron collection; one would expect impact ionization from the precipitation of auroral particles to charge ice positive, whereas electron collection from an enhanced D-region plasma would charge ice negative.