

Recent advances in plasma-line observation techniques

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We present recent hardware and signal processing advances, which enable observations of the full incoherent scatter radar spectrum without expensive receivers or computing hardware. This allows recording of not only the ion-line, but also the full profile of plasma-lines for incoherent scatter radar experiments. The measurement of plasma-resonance frequency from plasma-lines is a more accurate measurement of ionospheric electron density. The measurement is also independent of the ion-line, providing additional information that can be used to constrain plasma-parameter fitting. We show recent full Doppler bandwidth incoherent scatter radar observations from the Millstone Hill, Sondrestrom, and Arecibo radars. The Millstone Hill observations unexpectedly provide plasma-line returns from substantially off-zenith elevation angles (affording regional mid-latitude electron density information) and show that, even in harsh radio interference conditions, the full plasma-line profile can often be recovered. Observations from the Sondrestrom radar are used to demonstrate that plasma-lines can be used to improve the temporal resolution of measurements of electron density, enabling improved estimates of precipitation energy spectra and recombination rates. Recent observations from Arecibo are shown, which demonstrate the utility of the plasma-line observations for studies of ionospheric waves, with applications to the study of gravity waves, and magnetosphere-ionosphere coupling processes. Finally, Arecibo observations are also used to show that a full profile of thermal plasma-lines, without the presence of suprathermal enhancements, can be observed – the observations are shown to be in agreement with the classical theory for incoherent scattering from thermal plasma.