DETERMINATIN OF AURORAL REGION COLD AND HOT PLASMA DENSITIES FROM THE GROUND OBSERVATONS OF AURORAL HISS

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ABSTRACT

We propose a new remote sensing method to determine auroral region cold and hot plasma densities from the ground observations of impulsive auroral hiss (IAH). The technique is illustrated using IAH observations from South Pole Station, Antarctica.

METHOD AND RESULTS

This method is based on a new model of IAH propagation to ground [1]. In this model, IAH is generated at large wave normal angles along auroral field lines by ~1-10 keV electrons via Cerenkov mechanism. IAH propagates from the source region to the ground along field aligned density cavities and enhancements (ducted mode) up to ~3000-5000 km altitude and then scatters from meter-scale irregularities to the ground. Using this new understanding of IAH propagation to the ground, we propose a method to determine the AH source region, energetic electron parallel resonance energy, and cold plasma electron concentrations and depletions along auroral field lines. We begin with tentative density models of the auroral magnetosphere that match with past experimental and theoretical work. We then perform raytracing calculations to match the observed dispersion with the dispersion calculated from our raytracing simulations. In general, this match requires that IAH source altitude is a function of frequency as well as cold plasma density, thus giving us a method to determine both the source location and the cold plasma density. The initial wave normal at the source location along with local cold plasma density (determined from the dispersion) and local gyrofrequency (from a model), leads to calculation of electron parallel energy required to generate the hiss via Cerenkov mechanism. To explain our technique, we analyzed an IAH spectra recorded at South Pole, Antarctica, on July 09, 1996 0005 UT to show that, for the sample spectrogram, the AH source region for frequencies 7-9 kHz should be >16,000 km while for frequencies 12-20 kHz it should be <8000 km. We also show that the parallel resonance energy of the energetic electrons generating the frequencies should be <1 keV, and the cold plasma electron concentration along the 79-deg invariant latitude field line should be ~ 100 el/cc at 12,740 km, showing a $1/R^5$ dependence.

CONCLUSIONS

The new technique provides for the first time measurement of auroral cold plasma density and density depletions at altitudes not accessible to ionosondes and could only be measured in situ on satellites. When VLF measurements are combined with optical measurements, we believe that method provides improved estimates of electron energies responsible for generating IAH. When combined with radar measurements, the method provides estimates of lower hybrid waves excited by IAH. LH waves are important because they couple both to electrons and ions, providing additional channel to thermal plasma. It is believed that LH waves are the most efficient in heating suprathermal ions in the auroral region.

REFERENCES

[1] V. Sonwalkar and J. Harikumar, An Explanation of Ground Observations of Auroral Hiss: Role of Density Depletions and Meter-Scale Irregularities Vikas S. Sonwalkar and Jayashree Harikumar, *J. Geophys. Res.*, 105, 18,867-18,883, August 2000.