ESTIMATING THE FIELD-PARALLEL SCALE LENGTH OF ARTIFICIAL F-REGION STRIATIONS BY MEANS OF HF RADAR BACKSCATTER

A. Senior[(1)], M. J. Kosch[(1)], N. D. Borisov[(2)], T. K. Yeoman[(3)], M. T. Rietveld[(4)] and F. Honary[(1)]

(1) Dept. of Communication Systems, InfoLab21, Lancaster University, Lancaster, LA1 4WA, U.K. (a.senior@lancaster.ac.uk)
(2) IZMIRAN, 142190 Troitsk, Moscow Region, Russia (borisov@lpi.ru)
(3) Dept. of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, U.K. (tim.yeoman@ion.le.ac.uk)
(4) EISCAT Scientific Association, Ramfjordmoen, 9027 Ramfjordbotn, Norway. (mike@eiscat.uit.no)

ABSTRACT

We used the HF coherent scatter radar at Hankasalmi, Finland to observe striations generated by the EISCAT HF facility near Tromsø, Norway. By sweeping the radar frequency we can estimate the field-parallel scale length of the irregularities, since ionospheric refraction brings rays at higher frequencies to orthogonality with the geomagnetic field (necessary to receive backscatter) at higher altitudes. In daytime conditions, the scale length was ~20 km. This approach assumes highly aspect-sensitive irregularities. Recent observations of radar backscatter from striations in an ionosphere perturbed by travelling disturbances may indicate evidence of lower aspect-sensitivity.

INTRODUCTION

One of the most important phenomena resulting from the interaction of a high-power O-mode radio wave with the ionospheric plasma is the generation of geomagnetic field-aligned plasma density irregularities with small scale sizes (a few metres) perpendicular to the magnetic field. These "striations" are excited by the heating of the plasma by upper-hybrid (UH) waves generated by conversion of the O-mode wave on the plasma density perturbations [1,2].

OBSERVATIONS AND CONCLUSIONS

We have conducted experiments using the HF coherent scatter radar at Hankasalmi, Finland to observe striations generated by the EISCAT HF facility near Tromsø, Norway. Ionospheric refraction means that rays at higher radar frequencies reach orthogonality to the geomagnetic field in the heated volume (a necessary requirement to receive backscatter) at higher altitudes. Thus, by sweeping the radar frequency we can estimate the field-parallel scale length of the irregularities to compare with the theoretical predictions of [3]. We found that in daytime conditions, the scale length was ~20 km, which compares well to previous estimates at Tromsø [2]. The method and results are described in more detail in [4]. Our analysis assumes that the backscattering from the striations requires the radar beam to be exactly orthogonal to the geomagnetic field.

In a more recent experiment, undertaken with the aim of addressing some of the shortcomings of the experiment described in [4], the ionosphere was found to be modulated by travelling ionospheric disturbances (TIDs). These TIDs caused variations in the power and elevation angle-of-arrival of the HF radar backscatter from the striations. A raytracing model shows that some of the effects result from the access of the pump wave to UH resonance being modified by the TIDs. The elevation angle variations suggest that the radar is detecting the variation in the height of the striations associated with the TIDs. This is not what would be expected if exact orthogonality is required for backscattering and may suggest that off-orthogonal scattering is important. This has implications for our previous results.

REFERENCES

[1] A. V. Gurevich, "Nonlinear phenomena in the ionosphere", Springer-Verlag, 1978.
[2] T. R. Robinson, "The heating of the high latitude ionosphere by high power radio waves", Phys. Rep., 179, 79-209, 1989.
[3]. N. Borisov, A. Senior and F. Honary, "Stationary state and relaxation of artificial irregularites excited in ionospheric heating experiments", J. Plasma Phys., 71, 315-334, 2005.
[4]. A. Senior et al., "Multi-frequency HF radar measurements of artificial F-region field-aligned irregularities", Ann. Geophys., 22, 3503-3511, 2004.