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Simultaneous observations of the 557.7 nm airglow and stimulated electromagnetic emission during HF pumping of the ionosphere with diagnostic schedule: first results

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Abstract

The first results on simultaneous observation for artificial airglow emission at 557.7 nm (green line) and stimulated electromagnetic emission (SEE) during HF pumping of the ionosphere with specially designed HF pulsing sequence are reported. Ionospheric radio pumping was performed at the "Sura" radio facility situated near Niznhny Novgord, Russia. The measurements of airglow were handled at the Astronomical Observatory of Kazan State University (220 km to the east of "Sura" facility) by the astronomical telescope AZT-14 connected with the electric photometer. During several "Sura" runs enhancements of the airglow intensity in time with pump wave pulses were observed after the pump wave switch from continuous transmission to low duty cycle pulse transmission. The airglow and SEE intensities and SEE decay rates were correlated.

Keywords: HF pumping of the ionosphere; Artificial 557.7 nm airglow; Simulated electromagnetic emission

1. Introduction

A powerful O-polarized HF pump radio wave transmitted vertically into the ionospheric *F*-region from the ground excites a wide range of plasma processes, particularly the pondermotive parametric instability (PPI) (Perkins et al., 1974; Al'ber et al., 1974) and thermal (TPI) (Grach et al., 1977; Vas'kov and Gurevich, 1977) parametric instabilities. The pondermotive instabilities develop primarily near the pump wave reflection point $z_R \sim 200$–300 km, where $f_p = f_0$ (f_p is the local plasma frequency, f_0 the pump wave frequency) during first few milliseconds of the pump–plasma interaction. PPI lead to excitation of HF Langmuir waves propagating mainly along the geomagnetic field. The thermal instabilities occur near the upper hybrid (UH) height 2–5 km below z_R, where $f_p = (f_0^2 - f_{ce}^2)^{1/2}$. Here f_{ce} is the electron cyclotron frequency. TPI cause an excitation of HF upper hybrid waves propagating mainly across the magnetic field, and field aligned small scale irregularities of plasma density (striations). The characteristic times of the thermal instability excitation, as well as characteristic times of the striation decay after pump wave turn off are of 0.5–10 s. In their turn, the HF plasma waves generate the HF stimulated electromagnetic emissions (SEE) (Thide et al., 1982). occurring as

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