DIRECTION ANGLE MEASURMENTS OF STIMULATED IONOSPHERIC RADIO EMISSIONS USING A THREE-ELEMENT DIGITAL INTERFEROMETRIC RECEIVER

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When the earth's ionosphere is irradiated by a high frequency (HF, 3-30 MHz) radio wave of sufficiently high power density and tuned to match a natural E- or F-region plasma frequency, ionospheric magnetoionic wave modes may be excited and may generate HF electromagnetic sideband waves via nonlinear interactions. These secondary emissions, which may then escape from the ionosphere, have been termed stimulated electromagnetic emission or SEE. The frequency spectrum of this radiation has been studied extensively, and a number of characteristic spectral features have been identified and in some cases related to particular plasma processes.

The separation in frequency between the HF pump and the harmonics of the local electron gyrofrequency is critical in determining the spectral properties of the stimulated sidebands. Evidence of a relationship between pump-induced phenomena and the ambient magnetic field is also apparent in other observations made during HF radiowave pumping experiments. Pump-induced Langmuir turbulence observed by incoherent scatter radar has shown a preference for pointing angles between the Spitze angle and geomagnetic field-aligned, and pump-enhanced electron temperatures and optical emissions have also been shown to have special behavior at similar angles, near to but apparently not quite aligned with the geomagnetic field.

In view of this evidence for angular structure in several HF pump-induced effects, of the dependence of SEE on the geomagnetic field via gyrofrequency harmonics, and of the not-yet-understood relationship between electrostatic fluctuations and SEE, we have begun to investigate experimentally the angular structure present in the various spectral features of the SEE signals and to compare the results with radar and other observations of HF pump-induced effects. During campaigns in late September and early October of 2004 and 2005 at the EISCAT observatory near Tromsø, Norway, we operated a digital radio interferometer designed to measure the angle of arrival of SEE features. Strong SEE signals were observed at a site located 13 km east of the HF pump transmitter and raw voltage samples from three antennas were recorded. Examples will be presented of data periods which include the SEE spectral features known as the broad upshifted maximum (BUM), downshifted maximum (DM), and downshifted peak (DP). Both the direction angle measurements and the high frequency resolution obtainable from the raw digital data are of interest in the results.