THE GEOMETRICAL CHARACTERISTICS OF HF-INDUCED PLASMA WAVE PHENOMENA.

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ABSTRACT

Plasma waves excited by powerful HF radio waves of O-mode polarization are usually of two types: Langmuir waves which are excited near the HF reflection height and propagate preferentially along the magnetic field, and upper-hybrid waves which are excited typically several kilometres lower and propagate near perpendicular to the magnetic field. It was often assumed that for HF launch angles not too far from the zenith, the source of the plasma waves, usually in the F region of the ionosphere, was determined largely by the antenna radiation pattern of the HF transmitter which typically has a full width of 14 degrees. Since the advent in 1997of radar Langmuir turbulence measurements using fine scanning of the European Incoherent Scatter Scientific Association (EISCAT) 931 MHz antenna through and beyond the heated region, it has become clear that the phenomena do not behave as expected. The excitation of enhanced ion lines, topside enhancements, outshifted plasma lines, maximises for a zenith angle of about 9 degrees south, between the Spitze (6.1 degrees) and field-aligned direction (12.9 degrees) at Tromso.

Since then other phenomena have also been shown to maximise near the field-aligned direction in what is now commonly called the magnetic zenith effect. These are the HF-excitation of airglow caused by energetic electrons as observed by imaging systems, the production of small scale (< 1 km) electron density irregularities (striations) as observed by coherent HF radars and by amplitude scintillations of satellite signals, and the increase of electron temperature as measured by incoherent scatter radar. All these phenomena are thought to be caused by upper-hybrid processes although the excitation of airglow may also be through Langmuir turbulence. Most recently, measurements have been made near the EISCAT facilities of the angular dependence of Stimulated Electromagnetic radio Emissions (SEE) which has various components which may be related to either upper-hybrid or Langmuir wave processes. These complex measurements are still being analysed but preliminary results show that some features do appear to come from south of the zenith direction.

On-going work continues with finer radar meridional scans and azimuthal scans to better localize the regions of plasma wave enhancement. A summary of the observations, their relation to theory, and ideas for future work will be presented.