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Signatures of strong Langmuir turbulence in the auroral ionosphere: Observations with the EISCAT Svalbard radar during the IPY

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We present the first statistical study of Strong Langmuir Turbulence (SLT) signatures observed in the auroral ionosphere with a incoherent scatter radar. Langmuir turbulence is known to occur in laboratory plasma as well as in space plasmas. In the turbulence regime of SLT Langmuir modes are trapped in dynamic density cavities. Artificially created Langmuir turbulence and SLT were extensively studied with incoherent scatter radars in the ionosphere since the 90s. Recent research shows that SLT occurs also naturally in the ionosphere during aurora in regions of electron precipitation.

Data obtained with the EISCAT Svalbard radar during the international polar year (IPY, 2007-08) were searched for signatures of SLT. In incoherent scatter radar experiments signatures of SLT are observed as enhanced backscattered radar power at the ion line frequencies, plasma line frequencies, and at zero Doppler shift. The power enhancement at zero Doppler shift arises due to Bragg scattering from non-propagating density cavities. In the IPY data set $\sim$ 0.02% of the data comply with our search criteria based on the ion line signature. The event occurrence frequency peaks in the pre-midnight sector and increases with local geomagnetic disturbance. Enhanced backscattered power is often observed with limited altitude extent and the altitude distribution of SLT signatures in the ion line channel has a peak at 220 km. Enhancement of the plasma line is consistently observed with the ion line enhancements. Two classes of enhanced plasma lines occur. The first localized in frequency and altitude occur at altitudes of ion line enhancements. At times these plasma line enhancements show cascade-like structure. The second wide in frequency and range is observed at altitudes further below, 170 km, and at frequencies close to 3 MHz. Optical data available indicate the identified events to occur during auroral breakup with high energetic electrons precipitating.