Could electromagnetic wave pumping in the L mode be of importance for the magnetic zenith effect?

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It is well-known that electromagnetic high frequency (HF) pumping of the F-region ionosphere from ground-based transmitters results in the strongest plasma response when the HF beam is directed in geomagnetic zenith. Experiments at both EISCAT in northern Scandinavia and HAARP in Alaska, USA, have shown that HF-induced optical emissions and self-focusing of the HF beam are the strongest in magnetic zenith. Electron heating and geomagnetic field-aligned density striations too are the most intense in magnetic zenith. Experimental results will be presented that indicate transionospheric propagation of the HF pump wave in magnetic zenith during conditions when the maximum electron plasma frequency in the overhead ionosphere was several 100 kHz above the pump frequency. The HF pump wave transmitted by the EISCAT-Heating facility was observed in the topside ionosphere with the Radio Receiver Instrument (RRI) in the e-POP (enhanced Polar Outflow Probe) package on the Canadian CASSIOPE satellite. The conditions in the plasma were diagnosed with the EISCAT UHF incoherent scatter radar and the EISCAT Dynasonde. The experimental results are consistent with theoretical predictions of HF pump wave guiding in the L mode by geomagnetic field-aligned density irregularities. L-mode propagation facilitates significantly stronger pumping of the plasma compared to the usually considered O mode, which cannot propagate at plasma frequencies above the wave frequency. The results are suggested to be of importance to understand the magnetic zenith effect.