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Extremely intense ELF magnetosonic waves: a survey of Polar observations

Bruce Tsurutani (1), Barbara Falkowski (1,2), Jolene Pickett (3), Olga Verkhoglyadova (1,4), Ondrej Santolik (5,6), and Gurbax Lakhina (7)

(1) California Institute of Technology, Jet Propulsion Laboratory MS169-506, Space Plasma Processes, Pasadena, United States (bruce.tsurutani@jpl.nasa.gov, +1-(0)818-3548895), (2) Glendale Community City College, Glendale Calif USA (bfalkowski@glendale.edu), (3) University of Iowa, Iowa City, IA, USA (pickett@uiowa.edu), (4) CSPAR, University of Alabama, Huntsville, AL, USA (olga.verkhoglyadova@jpl.nasa.gov), (5) Institute of Atmospheric Physics, Prague, Czech Republic (os@ufa.cas.cz), (6) Charles University, Prague, Czech Republic (os@ufa.cas.cz), (7) Indian Institute of Geomagnetism, Navi Mumbai, India (gslakhina@gmail.com)

From a survey of Polar plasma waves conducted over the interval 1 April, 1996 to 4 April, 1997 (during solar minimum) at and inside the plasmasphere, magnetosonic waves were detected at all local times with a slight preference of occurrence in the midnight-postmidnight sector at L= 3 to 4. The waves occurred primarily during heightened geomagnetic (AE) activity. Wave occurrence (and intensities) peaked at $\sim\pm5°$ of the magnetic equator, with half-maxima at $\sim\pm10°$. An extreme magnetosonic wave intensity event of amplitude Bw = $\sim\pm$ 1 nT and Ew = $\sim\pm$ 25 mV/m was detected during the survey period. The event occurred near local midnight (0022 MLT), at the magnetic equator (MLAT = -0.5°), at the plasmapause (L = 3.5), and during a substorm/convection event (AE = 624 nT; SYM-H = -33 nT). If more stringent requirements ($|$ MLAT$|$ $\leq$ 5° and AE > 300 nT) are imposed, the wave occurrence rate approaches $\sim$50% for the 23 to 00 MLT bin at L = 3 to 4. A strong local time anisotropy in the location of magnetosonic wave occurrence rate supports the idea of generation by protons injected from the plasmasheet into the midnight sector magnetosphere. The authors speculate that intense magnetosonic waves are always present somewhere in the magnetosphere during strong substorm/convection events. For other wave events, magnetosonic waves were also detected as far from the equator as +20° and -60° MLAT, but at lower intensities. The wave magnetic component oscillations are aligned along B0, the ambient magnetic field direction, and the electric component oscillations are orthogonal to B0, indicating linear polarization. The magnetosonic wave amplitudes decreased at locations further from the magnetic equator, while transverse whistler mode wave amplitudes increased. The authors speculate that either charged particle interactions with the magnetosonic waves or direct mode conversion is leading to the generation of the transverse whistler mode waves. Thus this mechanism, if correct, may be a new source for the low frequency component of plasmaspheric hiss, adding to other sources, previously discussed in the literature. As a final comment, we argue that modelers should use dynamic particle tracing codes and the maximum (rather than average) wave amplitudes to simulate wave-particle interactions.