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Interaction of inner belt electrons with human-made VLF waves: inner belt energy structuring

J.-A. Sauvaud (1), T. Moreau (1), R. Maggiolo (1), C. Jacquey (1), M. Parrot (2), J.-J. Berthelier (3)

(1) CESR, Toulouse, France, (2) LPCE Orléans, France, (3) CETP, Saint-Maur, France

We show that the electron component of the low-altitude (700 km) inner radiation belt (1.1$<$ L $<$1.35) consists in the superposition of many quasi mono-energetic peaks (E$<$1.5 MeV) as expected from the interaction of electrons with a large number of Earth-based VLF emitters (20-100 kHz) distributed along the particle drift around the Earth. This energy-layered structure is clear in low B field regions where particles can reach the satellite altitude. This happens just West of America and inside the South Atlantic Anomaly itself, but the structures begin to be measured over Asia. The wave instruments onboard Demeter indeed displays the strong emissions of human-made monochromatic waves in the frequency range 20-100 kHz. We show that they are able to destabilize the low energy component of the inner radiation belt at the recorded energy peaks. At larger L values (1.4 - 2) a strong electron energy dispersed structure characterizes the inner radiation belt at 700 km in 2005, starting to be detected after October 2004. Calculations of the electron resonant energy indicate that the structure is caused by a mirror point lowering/precipitation due to the electron interactions with transmitters in the 20 kHz range. We attribute the main electron structure to the NWC Australian VLF emitter (19.8 kHz) which appear to be working mainly after October 15, 2004, i.e. when the electron structure begin to be detected. This VLF emission occupies the L range of the detected electron structure. The variation of the electron energy peak as a function of the McIlwain parameter can thus be used to estimate the equatorial thermal electron content at altitudes corresponding to the transition between the upper ionosphere and the plasmasphere.