Statistical occurrence and distribution of the electric and magnetic field peaks of high amplitude whistler-mode waves in the outer radiation belt

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We present a statistical analysis with 100% duty cycle and non-averaged amplitudes of the prevalence and distribution of high-amplitude ($>$ 5 mV/m and $>$ 50 pT) whistler-mode waves in the outer radiation belt using 5 years of Van Allen Probes data. Our study makes use of a novel interpolation technique which improves the frequency resolution and amplitude accuracy of the Van Allen Probes Electric Fields and Waves instrument filterbank peak detector. We apply this technique to both the electric and magnetic field peaks to investigate their statistical occurrence, spatial distribution, and dependence on geomagnetic activity.

Whistler-mode waves with high electric field amplitudes are most common above L=3.5 and between MLT of 0-7 where they are present 1-4% of the time. During high geomagnetic activity, high-amplitude whistler-mode wave occurrence rises above 30% in some regions. The largest of these electric field peaks (those greater than 50 mV/m) occur most commonly at low L in the pre-dawn sector during times when the plasmapause at this location is highly eroded. We propose that this may indicate that the high magnetic field and relatively low density left in this region after plasmasphere erosion may optimize the amplification of whistler-mode waves through non-linear processes. We also compare and contrast the occurrence pattern of high-amplitude electric field peaks and magnetic field peaks to quantify whether high-amplitude waves are more often electromagnetic or quasi-electrostatic and, by proxy, whether large-amplitude waves are more commonly parallel propagating or obliquely propagating with respect to the magnetic field.

These results have important implications for modeling radiation belt particle interactions with chorus, as large-amplitude waves interact non-linearly with electrons, resulting in rapid energization, de-energization, or scattering. This also may provide clues regarding the mechanisms which can cause significant whistler-mode wave growth up to more than 100x the average wave amplitude.