Multi-event study of ELF/VLF propagation using Kannuslehto and Arase conjunctions

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Extremely Low (ELF) and Very Low Frequency (VLF) plasma waves are naturally occurring magnetospheric waves in the frequency range from 3 Hz to 30 kHz. During their propagation away from their source region they accelerate or scatter electrons through wave-particle interactions. As a consequence, they play a fundamental role in radiation belt dynamics. We used a comprehensive data set of simultaneous and conjugated observations between the ground and space to study the propagation characteristics of these waves, in particular for chorus and quasi-periodical (QP) emissions. On the ground, waves were observed at Kannuslehto (MLAT=64.4N, L=5.46, KAN), Finland while Arase (ERG) was used for inner magnetosphere observations. In the 2017-2018 campaign we have 84 days of possible conjugated observations. There are no previous studies that focus on wave propagation properties using such a large number of simultaneous or conjugated events concurrently. During these events, we calculate the observational electric to magnetic field ratio (E/B_obs) from ERG data. We also calculate the theoretical E/B ratio (E/B_th) from ERG plasma parameters and the cold plasma dispersion relation for a range of wave normal angles. Preliminary results indicate that E/B_obs is usually lower than E/B_th. Comparing both ratios we can discuss wave propagation and compare results to those obtained separately by the Singular Value Decomposition method. Analyzing cases in which the waves reached KAN and those when they did not, combined with one-to-one conjugate emissions between KAN and ERG we discuss wave propagation properties. We combine these results with ray tracing to quantify the proportion of unducted and ducted waves that successfully reached KAN. We also discuss the conditions facilitating wave propagation to the ground. This study will clarify our understanding on the propagation paths of ELF/VLF waves in the magnetosphere.