URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Evolution of the Overall VLF Wave Intensity Measured by a Ground-Based Station Analyzed Using Principal Component Analysis

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Intensity of electromagnetic waves measured in the very low frequency range (VLF) in the Earth's inner magnetosphere is affected by many factors, such as geomagnetic activity, season of the year, solar activity or interplanetary shock occurrence. The present analysis shows how this can be analyzed by using the Principal Component Analysis (PCA) which allows to substantially reduce the dimensionality of the original data set. Measurements performed by a ground-based station Kannuslehto in Finland (67.74° N 26.27° E, L≈5.42) are used. Due to the high frequency and time resolutions, the data set is analyzed in detail in both domains and effects of the investigated factors are studied. This study is performed in terms of the principal component coefficients which characterize individual frequency-local time spectrograms. We study their variations related to the season of the year, geomagnetic activity, interplanetary shock occurrence, and solar cycle. The analysis demonstrates how a relatively small number of parameters can effectively describe the VLF wave intensity measured over a long time period in a wide frequency range.