Geophysical Research Abstracts
Vol. 19, EGU2017-7206, 2017
EGU General Assembly 2017

Modelling Schumann resonances from ELF measurements using non-linear optimization methods

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Schumann resonances (SR) can be found in planetary atmospheres, inside the cavity formed by the conducting surface of the planet and the lower ionosphere. They are a powerful tool to investigate both the electric processes that occur in the atmosphere and the characteristics of the surface and the lower ionosphere.

In this study, the measurements are obtained in the ELF (Extremely Low Frequency) Juan Antonio Morente station located in the national park of Sierra Nevada. The three first modes, contained in the frequency band between 6 to 25 Hz, will be considered. For each time series recorded by the station, the amplitude spectrum was estimated by using Bartlett averaging. Then, the central frequencies and amplitudes of the SRs were obtained by fitting the spectrum with non-linear functions.

In the poster, a study of nonlinear unconstrained optimization methods applied to the estimation of the Schumann Resonances will be presented. Non-linear fit, also known as optimization process, is the procedure followed in obtaining Schumann Resonances from the natural electromagnetic noise. The optimization methods that have been analysed are: Levenberg-Marquardt, Conjugate Gradient, Gradient, Newton and Quasi-Newton. The functions that the different methods fit to data are three lorentzian curves plus a straight line. Gaussian curves have also been considered.

The conclusions of this study are outlined in the following paragraphs: i) Natural electromagnetic noise is better fitted using Lorentzian functions; ii) the measurement bandwidth can accelerate the convergence of the optimization method; iii) Gradient method has less convergence and has a highest mean squared error (MSE) between measurement and the fitted function, whereas Levenberg-Marquad, Gradient conjugate method and Cuasi-Newton method give similar results (Newton method presents higher MSE); v) There are differences in the MSE between the parameters that define the fit function, and an interval from 1% to 5% has been found.