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Automated tool for estimating field line resonance frequencies using ground-based magnetometer measurements

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Ground-based magnetometer stations offer a valuable and easy-to-access tool for sounding the Earth's magnetic field disturbances in the inner magnetosphere with a multi-viewpoint system. Using Ultra-Low Frequency (ULF) measurements recorded from meridional aligned stations, it is possible to infer the Field Line Resonance (FLR) frequencies, using a well-established technique, namely the gradient method (Baransky et al. 1985 and Waters et al. 1991). Based on this technique, several authors developed (semi-)automated tools for estimating FLR from ground-based magnetometer measurements. Recently it has been observed (Foldes et al., 2021) that the Machine Learning (ML) approach represents a valuable tool to estimate FLRs from Fourier cross-phase spectra. However, it is commonly known that detecting FLRs using cross-phase spectra may often be unfeasible due to data gaps, noisy signals and/or quiescent ULF wave periods. To handle these situations, we implement an ML classification algorithm to detect periods in which resonance frequencies are clearly observable and thus can be easily estimated. Our algorithm can distinguish between periods with observed frequency from the others; moreover, it can determine if the considered field line is crossing the plasma boundary layer (PBL) at a given time. The results of our method are validated for a particular pair of stations (at L=2.9), along the Equatorial quasi-Meridional Magnetometer Array (EMMA), which provides an extensive data set with several different geomagnetic conditions. This kind of approach in the analysis of ground-based magnetic field measurements, combined in a two-stage ML pipeline with a regression algorithm (as in Foldes et al., 2021), may provide a prominent tool for monitoring the plasmasphere dynamics using a completely automated system.