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A Machine Learning technique for ULF wave classification in Swarm magnetic field measurements

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Ultra-low frequency (ULF) magnetospheric plasma waves play a key role in the dynamics of the Earth's magnetosphere and, therefore, their importance in Space Weather studies is indisputable. Magnetic field measurements from recent multi-satellite missions are currently advancing our knowledge on the physics of ULF waves. In particular, Swarm satellites have contributed to the expansion of data availability in the topside ionosphere, stimulating much recent progress in this area. Coupled with the new successful developments in artificial intelligence, we are now able to use more robust approaches for automated ULF wave identification and classification. The goal of this effort is to use a machine learning technique to classify ULF wave events using magnetic field data from Swarm. We construct a Convolutional Neural Network that takes as input the wavelet power spectra of the Earth's magnetic field variations per track, as measured by each one of the three Swarm satellites, aiming to classify ULF wave events in four categories: Pc3 wave events, background noise, false positives, and plasma instabilities. Our primary experiments show promising results, yielding successful identification of 90% accuracy. We are currently working on producing larger datasets, by analyzing Swarm data from mid-2014 onwards, when the final constellation was formed.