Recognizing Pattern in EMIC Waves Spectrograms Using Machine Learning

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The EMFISIS instrument on board the twin Van Allen Probes has been measuring high resolution magnetic field data during the last 6 years. Spectrograms can be obtained from such measurements which can evidence the presence of electromagnetic ion cyclotron (EMIC) waves. Several studies have been showing the relevance of EMIC waves on the pitch angle scattering of energetic particles into the loss cone, hence contributing to the net loss of relativistic electrons from the outer radiation belt to the upper atmosphere. The huge amount of data collected thus far provides us with the opportunity to use a data clustering technique based on a neural network referred to as Self-Organizing Map (SOM). When applied to images of magnetic field spectrograms in the frequency range of EMIC waves, the SOM allows us to distinguish several patterns in these spectrograms expediting their analysis which in turn can be relevant to describe physical aspects of EMIC waves. Specifically, the SOM technique is able to detect and classify distinct patterns in the spectrograms which are identified as signatures of EMIC wave packets. Each spectrogram image provided as input to the SOM corresponds to the windowed Fourier transform of an one hour interval of EMFISIS's magnetic field data. Our dataset spans the September 2012 to December 2016 period, where only in situ data acquired at geocentric distances larger than or equal to 3 Earth radii were selected. Preliminary results revealed that the clustering technique employed here successfully detected, in an automated way, different EMIC wave's signatures like propagation in Hydrogen, Helium and Oxygen bands, as well as, fairly monochromatic mode waves, and further details that will be discussed.

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