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

Automatic Whistler Detection using Mask Regional Convolution Neural Network and the Worldwide Archive of Low Frequency Data and Observations

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Lightning induced whistlers, observed on the ground after propagating in the magnetosphere, have a long history as remote sensing tools of the near-Earth space environment. Correct interpretation of these waves by Owen Storey in 1953 led to the discovery of significant plasma density in the magnetosphere [1]. A decade later, through meticulous analysis of whistlers, Don Carpenter discovered the prominent gradient in this plasma density, since then known as the plasmapause or "Carpenter's knee" [2]. The landmark work of Storey and Carpenter, at the dawn of the space age, continues to guide and inspire efforts to use ground based observations to diagnose the space environment.

We leverage the database of observation of the Worldwide Archive of Low Frequency Data and Observations (WALDO) that has recently been compiled by the Georgia Institute of Technology, University of Colorado Denver and Stanford University. This cloud based resource (waldo.world) provides free access to ELF/VLF recordings made at a large number of receiving sites worldwide [3]. Some recordings date back to the 1970s and have been digitized from analog tape. Data recorded at Palmer Station, Antarctica from 2000-2009 feature a large number of whistler observations. We employ an automatic whistler detection algorithm on the data based on a mask regional convolutional neural network (M-RCNN). The algorithm is based on a recently developed technique in computer vision for efficient image segmentation [4] and can provide whistler counts as well as frequency-time dispersion curves. Inversion of the frequency-time signature to identify an L shell of propagation and an equatorial electron density allows for remote mapping of the magnetospheric cold plasma density.

References

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