The D-region ionospheric electron density profile plays an important role in many applications, including long-range and transionospheric communications, improving our understanding with coupling between the lower atmosphere and the upper ionosphere occurs, and is required for estimation of very low frequency (VLF) wave propagation within the earth-ionosphere waveguide. However, measuring the D-region ionospheric density profile has been a challenge. The D-region is about 60 to 90 [km] in altitude, which is higher than planes and balloons can fly but lower than satellites can orbit. Researchers have previously used VLF remote sensing techniques, from either narrowband transmitters or sferics, to estimate the density profile, but these estimations are typically during a short time frame and over a single propagation path.

We report on an effort to construct estimates of the D-region ionospheric electron density profile over multiple narrowband transmission paths for long periods of time. Measurements from multiple transmitters at multiple receivers are analyzed concurrently to minimize false solutions and improve accuracy. Likewise, time averaging is used to remove short transient noise at the receivers. The cornerstone of the algorithm is an artificial neural network (ANN), where input values are the received amplitude and phase for the narrowband transmitters and the outputs are the commonly known h’ and beta two parameter exponential electron density profile. Training data for the ANN is generated using the Navy's Long-Wavelength Propagation Capability (LWPC) model. Results show the algorithm performs well under smooth ionospheric conditions and when proper geometries for the transmitters and receivers are used.