Clustering Analysis of Refractive Index Profiles: Toward a Ducting Climatology

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In order for radio propagation analysts to understand ducting behavior, it is essential to be able to characterize the atmosphere's vertical refractive structure. Much recent work has focused on the proper determination of the structure using meteorological measurements and mesoscale weather models. On the other hand climatological descriptions of radio meteorology have largely been fulfilled by the DCS and HEPC databases, which describe duct heights, refractive index slopes and other determined properties of the refractive profiles.

A problem arising from these methods is that atmospheric properties are reassembled in ways that may never arise naturally, failing to give any characterization of a "typical day". The various characteristics of the profiles were taken in isolation from one another, and when re-combined do not describe a typical atmospheric profile. The standard approach also lacks information about variations from the mean. Knowing the variations in each of the chosen quantities does not give a sense of the variation of the whole. The different quantities may affect one another and cannot be treated independently.

This paper diverges from previous methods by using clustering techniques to create representative refractive profiles directly from data, not by synthesizing various averaged and statistical parameters. This technique keeps intact the refractive profiles – insuring a physically realistic view of the atmosphere, and it identifies typical outcomes and their respective probabilities. For a given location, time, date and set of years, historical data is examined and grouped into clusters of similar profiles. The median profile and the frequency of occurrence are calculated for each cluster. The cluster medians maintain the basic characteristics of the original profiles (e.g. multiple, strong, or weak ducts), and can be used to see how the propagation is affected. Additionally the variability of the profiles is evident in each cluster while retaining a resemblance to one another. This allows best and worst case analyses to be performed within a cluster and between clusters.

With an established method to cluster atmospheric profiles for any given location, date and time, ducting climatology can be generated. The basis for climatologically generated ducting conditions can be the NCEP reanalysis forecasts, archived weather forecasts, or archived weather data. Using solid data as a basis for the climatology has the potential to provide high vertical and horizontal resolution profiles for radio propagation analysts to understand radio meteorology behavior.