A Radiosonde-Based Upper-Air Electromagnetic Ducting Climatology

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Climatological databases of electromagnetic (EM) ducting conditions have many important uses, including guidance for planning propagation-related operations and for EM system design and employment studies. This paper focuses on methods for developing a climatology of upper-air ducting conditions, which includes surface, surface-based and elevated ducts. These ducts can have a very strong impact on radar detection ranges, electronic jamming and surveillance and radio-frequency communications. Recently, the Fleet Numerical Meteorology and Oceanography Center (FNMOC) and the Naval Postgraduate School (NPS) have teamed to upgrade the U.S. Navy's upper-air ducting climatology, which is accessed through a web-based, automated interface called the Advanced Climate Analysis and Forecasting (ACAF) system. These new data sets are also being incorporated into the Advanced Refractive Effects Prediction System (AREPS).

The new upper-air ducting climatology is based on the Integrated Global Radiosonde Archive, which includes data for approximately one thousand stations distributed around the globe. For every station, each sounding is examined to identify the presence of ducts and to quantify important attributes, such as duct type, duct top height, modified refractivity deficit, and trapping layer thickness and strength. Monthly ducting statistics are then computed, such as the frequency of occurrence of the different duct types and combinations of the duct types, and duct attribute percentiles. ACAF users will be able to compute and display these ducting statistics for selected regions and time periods of interest, including for composite means and percentiles.

While these statistics provide a useful picture of the expected ducting conditions, they cannot quantify their impact on a specific EM propagation scenario. To provide this information, we also provide climatological modified refractivity profiles for the different duct types, which can be input to propagation models. These are produced by preserving the most important ducting attributes that impact EM propagation, ranked in order of importance: 1) duct top height, 2) modified refractivity deficit, and 3) trapping layer thickness and strength. Representative modified refractivity profiles are produced for the 5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 95^{th} duct top height percentiles. These profiles are produced separately for surface, surface-based, elevated, and combined duct types. ACAF users will be able to produce environment input files for AREPS with the representative modified refractivity profiles for the selected station, month, time of day, duct type, and percentile of interest.