Using Climatology to Support EM Propagation Modeling

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The propagation of electromagnetic (EM) waves in the atmosphere is affected by refraction, attenuation and scattering. Of particular interest is a refractive effect called “ducting” that leads to over-the-horizon propagation.

Several models exist that account for these factors, most notably 2-D Parabolic Equation (PE) models. These phenomena vary with location, season and time of day. When designing EM systems to reliably operate in specific locations or managing radio spectrum usage to mitigating interference, it becomes necessary to include site-specific information on the various phenomena that occur in those locations. This is often done using climatological data, typically historical weather station or radiosonde data from a nearby location. It is difficult, however, to find *in situ* data that provide sufficient sampling of all the desired quantities. Numerical Weather Prediction (NWP) models are an attractive option for filling these temporal and spatial gaps.

The long time-series datasets generated by NWP reanalysis efforts are particularly attractive because they can provide statistically significant sampling on a global scale. These large datasets, often several to tens of terabytes (TB) in size, provide a powerful means for running site-specific propagation calculations. A unique feature of climatology from reanalysis is the ability to maintain correlations between environmental variables of interest. This is a stark contrast to historical databases which typically do not provide correlated statistics.

This presentation will provide an overview of the strengths and weaknesses of various NWP models and datasets for climatology and detail recent advances in this area. Particular attention will be paid to ducting statistics, and the importance of planetary boundary layer (PBL) and surface layer (SL) parameterizations. PBL and SL parameterizations are a crucial component of any attempt to reconstruct (or forecast) the atmosphere because they represent the unresolved scales associated with the transfer of energy between the surface and the atmosphere. Over the marine atmospheric boundary layer (MABL), the characteristics of the PBL are determined by the interaction between the large scale, synoptic environment (usually well captured by NWP models or reanalysis techniques) and the exchange of energy across the air-sea interface. Each model represents these processes differently and thus there can be significant differences in the way the lower atmosphere is represented in any given data product. Given the sensitivity of RF propagation models to PBL processes, these differences can have a significant impact on the climatological statistics generated by a given reanalysis.