Challenges in Producing Electromagnetic Propagation-Related Climatology Products

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Developing climatological datasets and products for electromagnetic propagation purposes requires taking into account very specialized considerations as compared to more typical types of climatology products. For climatology products focused on microwave frequency propagation, the proper characterization of atmospheric trapping layers is one of the primary considerations. For climatologies involving near-surface propagation over the ocean, both evaporation ducts and the different types of 'upper-air' ducts must be represented statistically. The foundational database from which the EM climatology is derived must therefore meet special requirements to sufficiently resolve all of these types of trapping layers. Reanalysis datasets are good candidates for producing specialized EM climatologies, but they also have limitations that must be recognized and understood. Vertical resolution is one of the main concerns in resolving upper-air trapping layers. In this presentation different reanalysis products, including the NCEP CFSR and the ECMWF ERA5 reanalyses, will be analyzed and compared with similar products derived from radiosonde data, to determine the relative strengths and limitations of the different data sources.

Other challenging aspects of producing EM-related climatology products include how to properly take into account spatially heterogeneous refractivity conditions, and the highly complex and non-linear nature of EM propagation in relation to varying atmospheric conditions. For example, trying to infer specific propagation metrics from long-term statistics of atmospheric conditions can lead to highly erroneous results due to the non-linear relationships involved. On the other hand, deriving long-term statistics from direct propagation calculations with instantaneous refractivity conditions over a sufficiently long time period to yield climatologically meaningful results will provide higher fidelity products, but such methods also require extensive data storage and computing resources. The trade-offs between these different approaches and different mitigation strategies that can be employed will be examined in this presentation.