Assessment of Public Domain Forecast Products for Predicting Anomalous RF Propagation

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For low-elevation path geometries, the radio frequency (RF) propagation environment (atmospheric refraction) can vary dramatically as a result of the weather. Vertical gradients of temperature and humidity are the primary driver of variability. Predicting these vertical gradients accurately using numerical weather prediction (NWP) models is challenging, especially when it comes to predicting the more extreme vertical gradients, or "anomalous" propagation conditions.

Anomalous propagation conditions have the ability to drastically change the performance of RF systems from greatly enhancing signal ranges (ducting), to reducing them (subrefraction), for durations ranging from minutes to days. Accurate predictions of anomalous RF propagation conditions can provide improved situational awareness for a variety of applications. For communications system operators, knowing in advance that systems may be more susceptible to long-range interference, or sustained deep fading would be beneficial. In the case of radar operators, knowing the potential for RF ducting, for example, could help prevent wrongly classifying long-range ground/sea clutter as precipitation. For real-time testing of radar or communications systems, knowing the RF propagation conditions can help in assessing potentially irregular system performance, in adapting system configurations/settings, or in rescheduling testing to wait for more favorable conditions.

The forecast accuracy of key ducting parameters (height and strength) as well as near-surface refractivity gradients between different public domain NWP models will be compared to nearby radiosonde observations leading up to and during anomalous propagation events. These models include the US National Oceanic and Atmospheric Administration's (NOAA) Rapid Refresh (RAP) and the US National Centers for Environmental Prediction's (NCEP) North American Mesoscale (NAM) Forecast System. The comparisons will examine how accurately different NWP models with varying horizontal, vertical and temporal resolution can provide RF propagation forecasts as a function of forecast time. These will also be benchmarked against NWP reanalysis data, e.g. the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA-Interim, for an estimate of potential post-test reconstruction accuracy. Computations of RF propagation factor using the JHU/APL-developed Tropospheric Electromagnetic Parabolic Equation Routine (TEMPER) will enable a more quantitative comparison of the impacts of the different data sources. A brief assessment of the potential benefits and limitations of using various NWP models to forecast and assess RF propagation conditions will be discussed.