Sensitivity of EM Propagation to Blending the Surface Layer with the Upper Air Environment

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Propagation modeling takes into account the variability in the environment by providing vertical profiles of modified refractive index M along the path between sensor and target. For surface and ship-board sensors, temperature and moisture gradients to within about 100m above the underlying land or water surface are sufficient to describe the shape of the M profile and the strength of surface refractivity features such as ducting or subrefraction. Most of the early solutions relied upon a highly resolved single column surface layer (SL) model to parameterize the environment at these lowest layers. The SL model uses similarity theory, referred to as MOST, to define a log-linear, stability dependent profile given a value for pressure, temperature, moisture at the surface and another at some height (~5m) within the atmosphere.

Limitations of MOST arise from the assumptions and simplifications: the atmosphere approximated as stationary, homogeneous and solely forced by the surface, rather than upper air dynamics, or local advection for example. This additional environmental complexity frequently occurs within about 100 km of coasts, around mountainous topography or over SST gradient features and is captured by vertical variations of pressure, temperature and moisture within and above the atmospheric boundary layer up to ~2km. To obtain these upper air profiles, and their variability along the propagation path, mesoscale models of the atmosphere provide such information down to the lowest model level, about 5-10 m above the surface. In many previous studies when characterizing the environment for propagation models, either mesoscale model profiles alone were used, ignoring surface effects, or surface layer profiles alone were used, ignoring any upper air effects.

In order to provide propagation codes with a more complete description of the environment, methods for merging the surface layer with the mesoscale model profiles have been designed and tested by determining an appropriate blend heights. This research examines various techniques and the resulting impact on propagation path loss. The sensitivity with respect to EM propagation for the blended profiles will be compared to that using either the mesoscale or SL profiles alone for sensors within and above the SL. We also explore a simplification for extending the mesoscale model profiles to the surface by using the model's internal surface layer parameterization, a process that eliminates the need for a separate SL model or determination of blend heights.