Further Improvements and Validation for the Navy Atmospheric Vertical Surface Layer Model (NAVSLaM)

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The Navy Atmospheric Vertical Surface Layer Model (NAVSLaM) is the official U.S. Navy model for characterizing near-surface radio-frequency refractivity over the ocean, which is usually dominated by the presence of an evaporation duct. NAVSLaM employs Monin-Obukhov similarity theory (MOST) to describe the air-sea fluxes and the near-surface profiles of temperature and humidity, which in turn are used to compute modified refractivity profiles for input to propagation models. The employment of MOST theory for this purpose is dependent upon the use of empirically determined dimensionless profile functions for temperature and humidity, and also wind speed. The forms of these empirical profile functions have a dramatic impact on the behavior of surface-layer models, such as NAVSLaM, in describing the evaporation duct. Over the last 50 years and more, researchers have presented a multitude of different formulations for these profile functions, based primarily on field experiments conducted over land or ice.

For this presentation, the author examines the impact of the use of different profile functions on the behavior of the NAVSLaM model, and validates the use of different functions against actual propagation measurements. The study will focus primarily on recently formulated and published functions over the last two decades. The choice of the profile functions used has an especially large impact on the behavior of surface-layer models such as NAVSLaM in stable conditions (i.e. $z/L > 0$, where z is the height above the surface and L is the Obukhov length scale). This is due to the fact that surface-layer models tend to be much more sensitive to their input values in stable conditions, and also the forms of the profile functions tend to be more varied in stable conditions, as opposed to unstable conditions ($z/L < 0$). The results of validation studies have shown that some functions perform better over a certain range of stability (defined by z/L), while other functions perform better over a different stability range. For this reason, the author also explores the use of using more than one set of profile functions within NAVSLaM, and then smoothly blending them together to form the best results over a wide range of stability conditions.