The influence of Water Vapor Vertical Profiles on Multi-wavelength Radar Propagation Factor in the Nocturnal Boundary Layer

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At night over land under calm conditions, radiational cooling creates a temperature inversion at the surface. This is referred to as the nocturnal boundary layer (NBL) that is typically 100m or less deep. This temperature inversion has the potential to create a surface radio frequency (RF) duct. This potential RF duct can be strengthened if water vapor decreases with height. In a recent presentation (North American Radio Science Meeting, FR-UF.1P.7, July 2020), it was shown using high resolution radiosonde data, that water vapor vertical profiles in the NBL can appear to be random within the nocturnal boundary layer. This is thought to be the result of intermittent turbulence in the NBL. It is not unusual to see water vapor in a fraction of the NBL being well mixed and not supportive of RF duct strengthening. In some cases, water vapor will increase in a fraction of the depth of the NBL more supportive of sub-refraction.

High resolution radiosonde data from the Cooperative Atmospheric Surface Exchange Study conducted in October of 1999 (CASES 99) provide a 3 to 5m vertical resolution in the NBL. Vertical thermodynamic profiles from these data will be used to calculate vertical profiles of potential temperature, water vapor mixing ratio and modified refractivity in the NBL. Emphasis will be placed on examples where water vapor mixing ratio appears random.

S, C and X band radars will be modeled using the Advanced Refractive Effects Prediction System (AREPS) and placed in the emphasized NBLs. Propagation factor plots for each NBL case will be displayed and analyzed.