

Lidar description of the evaporative duct in ocean environments

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ABSTRACT

The description of radar propagation in the presence of the evaporation duct has proven to be a difficult problem in both littoral and open ocean environments. To properly characterize the propagation of a radar beam at low elevation angles, the evaporation duct must be located and scattering properties quantified. The two key elements defining an evaporation duct are the gradients in density and specific humidity. The gradients of the neutral density are determined from the rotational Raman temperature profile. The profile of water vapor is measured directly from the vibrational Raman scattered returns. High spatial resolution and high temporal resolution measurements of water vapor and temperature are required to accurately describe the evaporation duct. Raman lidar techniques can provide these measurements continuously with high accuracy and high resolution so the development of the evaporation duct can be studied. A detailed simulation of a Raman lidar has been developed and applied to a near horizontal path, to examine the expected accuracy for high vertical resolution profiles. The simulation also allows various atmospheric scenarios to be investigated and analyzed. The evaporation duct is an atmospheric phenomenon that causes radar propagation to remain trapped in the surface layer. The duct can be thought of as a waveguide that bends and reflects the radar beam along a path effectively trapping it and guiding it over long distances. This is a major problem for radar propagation paths in both littoral and open ocean environments. Moreover, ducting skews details of radar returns such that radar objects are hidden, or are detected at unexpected distances, or may appear with apparent cross-sections and speeds much different than their actual values.

Keywords: Lidar, refractivity, ducting, evaporation