Further Studies of the X-Band Beacon-Receiver Phased Array and Evaporation Duct Height Estimation

Jonathan M. Pozderac[1], Joel T. Johnson[1], Caglar Yardim[1], Craig F. Merrill[2], Tom Cook[3], Tony de Paolo[3], Eric Terrill[3], Frank J. Ryan[4], and Paul Frederickson[5]

[1] Dept. of Electrical and Computer Engineering, The Ohio State University, Electroscience Laboratory, Columbus, OH 43212, USA.
[2] NSWC, Carderock Division, West Bethesda, MD, USA.
[3] Scripps Institution of Oceanography, UC San Diego, CA, USA.
[4] Applied Technology, Inc., San Diego, CA, USA.
[5] Dept. of Meteorology, Naval Postgraduate School, Monterey, CA, USA.

Variations in the refractive properties of the marine atmospheric boundary layer (MABL) can effect the phase and amplitude of radiowave propagation in coastal and marine environments. The ability to assess the refractive effects of the atmosphere on shipboard surveillance and communication systems is required to avoid unwanted extended signal transmissions as well as poor functionality of these systems. Atmospheric refractive properties are highly dependent on atmospheric conditions; experiments that combine complex propagation measurements with atmospheric characterization can offer opportunities for improved modeling and increased radiowave propagation awareness.

A novel transmit-receive array system called the X-band Beacon-Receiver array (XBBR) is demonstrated for determining MABL evaporation duct height (EDH) values; a large contributing factor to non-standard radiowave propagation. A recent campaign provided an opportunity to deploy a multichannel X-band receive array system and corresponding beacon transmitters to investigate their use in characterizing properties of the MABL utilizing both amplitude and phase of recorded signals. The experiment reported here deployed the XBBR receive array at the Scripps Institution of Oceanography pier in La Jolla, CA, and the transmitting beacons on a moored buoy 15 km offshore. Long Term measurement began on May 13th, 2015 and concluded in October, 2015.

The method proposed compares propagation loss and phase values given by the Variable Terrain Radio Parabolic Equation (VTRPE, Ryan, 1991) modeling software for various propagation environments with complex signals obtained with the XBBR array. The method uses a normalized measurement of the received power to reduce uncertainties caused by variations in the power transmitted by the transmit array, and relative phase values to negate the need for synchronized transmission. Meteorological data was also recorded to act as input to the Navy Atmospheric Vertical Surface Layer Model (NAVSLaM); this allows for determination of the evaporation duct height from in-situ meteorological data to serve as the ground truth for comparison with our evaporation duct height estimation.

An in depth study of the measurements and results will be presented, along with a discussion of the propagation effects observed and methods developed to improve future measurements and results.