Versatile X-band Receiving Array for EM Propagation Measurements in the Marine Atmospheric Boundary Layer

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Coupled Air-Sea Processes and Electromagnetic-ducting Research (CASPER) is a multi-university research initiative (MURI) project that explores the effects of environmental conditions in the marine-atmospheric boundary layer (MABL) on low altitude EM propagation, ducting in particular, for naval applications. The Ohio State University group is responsible for EM measurements during the CASPER at-sea experimental campaigns. The most recent is the East Coast Intensive Operations Period (IOP) conducted off the coast of Duck, NC, during October-November of 2015. A key part of the EM measurements is the reception of X-band continuous wave (CW) signals via a receiving array with multiple antennas at prescribed heights.

The CASPER East IOP system consists of a number of 11 GHz beacons emitting CW signals placed on various mobile platforms. These include a research vessel (R/V Sharp), a controlled towed vehicle (CTV) towed from a Twin-Otter airplane, and a RHIB (rigid hull inflatable boat). The CW signals are spaced about 10 MHz so that all beacons may transmit simultaneously. The receiving system is an array of 4 vertically spaced antennas from 3 to 15 m above mean sea level deployed on another research vessel (R/V Atlantic Explorer). The 4 antennas are connected through an RF switch to a low-noise amplifier (LNA) that goes into a small Signal Hound® spectrum analyzer. The Signal Hound is powered by and controlled through a USB computer connection. Both the RF switch and the spectrum analyzer are controlled by software on the remote computer. Data from each antenna is recorded sequentially as the RF switch cycles through the whole array. This system is low-cost (less than $10K total), dependable, expandable, and easy to implement.

The X-band system allows for the measurement of the one-way propagation loss between the emitters and receiver as a function of range as the mobile platforms move towards and away from the Atlantic Explorer. The measured signal will be used to invert for the evaporation duct refractivity profile and compare to the profile inferred from concurrent meteorological and oceanographic measurements and COAMPS predictions. Processed data collected during the CASPER East IOP in October-November of 2015 will be presented.