Fixed-Link and Range-Dependent X-Band EM Propagation Measurements in the Marine Atmospheric Boundary Layer for Testing Numerical Weather Prediction of Refractivity

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Forecasting of atmospheric refractivity is essential for predicting electromagnetic (EM) propagation conditions affecting shipboard radars and radio communication in the maritime environment. Especially at low altitudes, refractivity can vary considerably with both height and range, so characterizing marine atmospheric boundary layer properties, ducting in particular, is thus crucial for propagation analysis. 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 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 West Coast Intensive Operations Period (IOP) conducted off the coast of Point Mugu, CA, during September-October of 2017. A key part of the EM measurements is the reception of X-band continuous wave (CW) signals via a vertical array of receiving antennas. The antennas at different heights provide data for refractivity profile inversion algorithms.

The CASPER West IOP system consists of a number of 11 GHz beacons emitting CW signals placed on various fixed and mobile platforms. These include forward- and backward-facing transmitters on the research vessel (R/V Sally Ride), a beacon on a controlled towed vehicle (CTV) deployed from a Twin Otter airplane, a beacon on the Twin Otter, and a shore based transmitter at Pt. Mugu, California. The CW signals from all transmitters are spaced at least 10 MHz so that they may transmit simultaneously. The receiving system is an array of four vertically spaced antennas from 5 to 12 m above mean sea level deployed on the starboard boom of the research platform R/P FLIP, which was moored 30 nm south of Pt. Mugu.

The X-band system allows for the measurement of the fixed point-to-point propagation loss between the shore based transmitter and FLIP, and the one-way propagation loss between the other mobile emitters and FLIP as a function of range as the platforms move towards and away from FLIP. The measured signals are used to invert for evaporation duct and surface based duct refractivity profiles, and compare to the profile inferred from concurrent meteorological and oceanographic measurements, and numerical weather prediction. Range-dependent and time-dependent inversion results estimated from the collected data during the CASPER West IOP will be presented.