Evaporation duct height estimation from UWB Lower Atmospheric Propagation (LATPROP) Measurement System

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Coupled Air-Sea Processes and EM Ducting Research (CASPER) is a multi-university research initiative (MURI) project that aims to improve prediction and exploration of EM propagation in coastal marine atmospheric boundary layers (MABL). The East Coast Intensive Operations Period (IOP) is a large field experiment that was conducted off coast of Duck, NC, during October-November 2015. We deployed the ultra-wide band lower atmospheric measurement (UWB-LATPROP) system with transmitter placed at the end of the Field Research Facility (FRF) pier in Duck, and receiver installed on the research vessel (R/V Atlantic Explorer-AE), which moved westward towards the pier 2-3 times every day. The variation of propagation loss in 64 frequencies points sweeping 2-40 GHz under ducting conditions was recorded as a function of distance.

The ground-truth propagation loss along each track was extracted by subtracting antennas gains, cable losses, and LNA gains and transmitted powers from received powers. Effects of relative bearing from receiver to transmitter on antenna gains and temperature variations on LNA gains were considered for corrections. Libraries of propagation loss as a function of distance for each frequency at evaporation ducting heights from 0-40 m for each run was generated by a parabolic equation wave model: ADVANCED PROPAGATION MODEL (APM). Tide height changes on transmitter height, rough seas effects due to wind speed and loss of troposcatter were included. Evaporation duct height inversion is performed by minimizing the error between the measured propagation loss and the losses of library across all frequencies.

Wind speed, temperature and relative humidity were measured both with sensors on bow mast and also by radiosondes and tethered balloons. NAVY ATMOSPHERIC VERTICAL SURFACE LAYER MODEL (NAVSLaM) converted metrological measurement to evaporation duct profiles. The inverted evaporation duct refractivity profiles from UWB-LATPROP were compared to the profiles inferred from concurrent meteorological and oceanographic measurements and COAMPS predictions. Errors of different models based on ground-truth propagation loss are given.