

RF propagation measurement in maritime environment off Southern California during Santa Ana winds episode

Luyao Xu⁽¹⁾, Caglar Yardim⁽¹⁾, Swagato Mukherjee⁽¹⁾, Joshua D. Compaleo⁽¹⁾, Qing Wang⁽²⁾

(1) The Ohio State University, Columbus, OH, USA

(2) Naval Postgraduate School, Monterey, CA, USA

During autumn and winter, the coastal area of Southern California is affected by Santa Ana winds, which bring hot and dry air in lower atmosphere. The unusual inversion of vertical temperature and humidity profiles results in ducted environment. Lower Atmospheric Propagation Ultra Wide Band (LATPROP-UWB) system is built to measure the time and range dependent propagation loss over S to Ka band in non-standard maritime atmosphere conditions. This system was initially built and deployed in CASPER east campaign in 2015. Some updates have been done including the GPS synchronization system and the software controlled switches.

LATPROP-UWB system is able to sweep from 2 to 40 GHz and record high resolution propagation loss. During Santa Ana experiment, the transmitter was installed on a research vessel and receiver was installed on the shore. The distance is up to over 100 Km. The transmitter and receiver side are synchronized by a GPS system. GPS antennas were mounted separately on both sides to see the sky directly. Exactly synchronized local time and stable 10 MHz oscillator were provided by the Trimble Thunderbolt E GPS Disciplined Clock modules. Both transmitter and receiver are controlled by software via Ethernet/GPIB/USB cables.

Two types of antennas were used to explore the propagation loss over ducted environment. One covers 2-18 GHz and another covers 18-40 GHz. Purpose-built boxes were utilized to amplify signals and switch antennas. Two antennas were connected to a bidirectional SPDT Electromechanical Switch. The switch connects to either signal generator or signal analyzer through a low noise high gain amplifier and low loss cables. A software controlled circuit was built to select correct port of the switch. According to the different structure, the controlling circuit is powered by either Ethernet or USB cable.

High resolution range dependent propagation loss over S to Ka band were measured and calibrated. The measured results were compared with simulated propagation loss by parabolic wave equation. The time dependent evaporation duct heights during Santa Ana winds were obtained. Wind, temperature, humidity, and pressure were measured and used to calculate duct profile with Monin–Obukhov similarity theory. Estimated duct profiles were also compared with concurrent metrological measurement.