Radio Frequency Propagation Measurements and Modeling during TAPS 2013 Field Campaign

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Over a two week period in Nov/Dec 2013, the Australian Defence Science and Technology Group (DSTG) sponsored a field campaign near the northeastern coast of Australia out to the Great Barrier Reef (GBR) to collect atmospheric meteorological measurement concurrent with radio frequency (RF) propagation data at several frequencies ranging from 9 to 90 GHz. The objective of the campaign was to investigate sensitivity of the propagation to atmospheric variation in a warm tropical environment and to determine the Navy's capability for predicting the performance of various RF sensors from high resolution forecasts obtained from a numerical weather prediction (NWP) model. In this study we consider the U.S. Navy's linked modeling system comprised of the Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS), the Navy Surface Layer Model (NAVSLaM), and the Advanced Propagation Model (APM). These models were run in real-time during the campaign for weather guidance and daily operational planning. Here we have reanalyzed the 11-day trial after introducing into the COAMPS model, a land-surface model, and land-surface data initialization, which were unavailable for TAPS real-time forecasting.

We find remarkable differences in the propagation path loss associated with environmental changes in the evaporation duct, a feature commonly found over the world's oceans due to the sharp drop in moisture at the sea surface. The evaporation duct height (EDH) is strongly correlated to signal strength for frequencies near and below 3 GHz. The higher frequencies transmitted from DSTG's MIMO (multi-in, multi-out) system located on the Lucinda shore tend to have more complicated behavior owning to interference patterns and multipath lobes. The receivers were placed at various heights (between 3.5 and 11.7 meters above mean sea level) on the decks and mast of a research vessel, the R/V Cape Ferguson that tracked daily from the Lucinda shore toward the GBR. We document the change in signal strength when the MIMO system was within the evaporation duct, which ranged in height from 5 to 18 m, verses when it was above the EDH. In the presentation we show the daily trends in Ka-band propagation both modeled and measured, and the path loss correlations to characteristics of the evaporation duct.