Radio Frequency Near Surface Anomalous Propagation In the Presence of Diurnal Coastal Air/Sea/Land Interactions

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Near surface radio frequency propagation is imposed by the thermodynamic structure of the atmospheric boundary layer (ABL). Modified refractivity (M) is determined by the vertical gradients of the parcel conserved atmospheric boundary layer variables of potential temperature (θ) and water vapor mixing ratio (w).

$$dM/dz \approx 0.128 + c_1\, dw/dz - c_2\, d\theta/dz \qquad (1)$$

If the ABL is thermally stable with drier air aloft, dθ/dz is positive and dw/dz is potentially negative resulting in a negative gradient in M leading to a surface duct.

Over the water and near the coast, the diurnal temperature contrast between the land and water potentially produce corresponding diurnal wind circulations that reverse the transport of thermodynamic characteristics in the Marine Atmospheric Boundary Layer (MABL). During clear days, the temperature at the surface on land may increase on the order of ten degrees above that of the adjacent water. This land surface heating produces strong vertical transport of momentum and heat fed by mass flow from the sea. This often results in dry warm air from the land re-circulating offshore at the top of the MABL. This re-distribution of heat and humidity produces strong vertical thermodynamic gradients that lead to anomalous radio frequency propagation.

This paper will present the results of a case study during three days of measured anomalous propagation near the mouth of the Gulf of California and Baja California Sur. During the daylight hours, the initial offshore flow of relatively warm and dry air at the surface reversed to a cooler and more humid onshore flow. This produced a well-mixed MABL from the surface up to approximately 200m ASL capped by a thermally stable entrainment layer with a negative vertical gradient in water vapor mixing ratio. The resulting surface based RF ducts were at a height of 200 meters ASL with a corresponding M deficit of 82.

Data from the 40km Eta Data Assimilation System (EDAS) clearly indicate a linear surface convergence zone parallel to the coastline delineating the landward extent of the diurnal coastal circulation. The case study is supported in four dimensions by 2km horizontal resolution Regional Atmospheric Modeling System vertical meteorological profiles over the ocean and adjoining land.