Refractivity estimation using multiple elevation angles

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Estimation of the atmospheric refractivity is important for the prediction of radar performance. Surface or elevated trapping layers formed by the outflow of relatively dry and warm air over a cooler body of water often results in the refractive structure supporting convergence-zone like behavior and multi-modal effects. The propagation under such conditions can be very sensitive to even small changes in the vertical and horizontal structure of refractivity. Obtaining *in situ* measurements of sufficient fidelity to estimate where intensifications in the EM field will occur is difficult.

The authors previously have demonstrated the ability to infer refractivity parameters from grazing-incidence radar sea clutter data. The radar system was the 2.8 GHz Space Range Radar that overlooks the Atlantic Ocean in the vicinity of Wallops Island, VA. The forward modeling consisted of the mapping of an 11-parameter environmental model via an electromagnetic propagation model into the space of the radar clutter observations. A genetic algorithm was employed to optimize the objective function. Ground truth data were atmospheric soundings obtained by a helicopter flying a saw-tooth pattern. The overall result was that the ability to estimate the propagation within the duct itself was comparable to that of in situ measurements, however, the ability to characterize the region above the duct was quite poor.

Modern 3-D radars, however, have relatively narrow beams. Using these narrow beams at multiple elevations might resolve the ambiguity leading to the poor characterization in the region above the duct. Using radar data from the SPANDAR radar it is demonstrated that such an approach is feasible and more robust estimates can be obtained by using two elevation angles and/or by constraining the solution to contain realistic refractivity profiles.