Integration of Refractivity from Clutter and Numerical Weather Prediction

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The problem of fusing the atmospheric information obtained from radar measurements (refractivity from clutter – RFC) and numerical weather prediction models – NWP (e.g. COAMPS) is addressed here. RFC is an inversion approach for estimation of the atmospheric refractivity profile from radar clutter, and RFC-ED refers to its implementation for the case of evaporation ducts. A Bayesian formulation is used for RFC providing probability density function (PDF) of the atmospheric parameters. Similarly, an ensemble NWP model used here that provides both the estimates and the uncertainties in these estimates. Navy Atmospheric Vertical Surface Layer Model (NAVSLaM) is used to convert atmospheric variables to evaporation duct refractivity profiles. Air temperature and relative humidity at a reference height are identified as state variables where probability densities of RFC-ED inversions and NWP ensembles appear complementary to one another. A joint cost function that depends on both the mean estimates and the associated uncertainties in both methods is used for optimization. Ensembles from the surface layer around the Hawaii Islands are used. It is demonstrated that the PDFs obtained from the two methods have very different shapes and parameter correlations. This means characterization of the near surface atmosphere using both RFC-ED and NWP reduces the variance of air temperature and relative humidity estimation in an evaporation duct. The joint inversion method is successfully tested for unstable, neutral, and stable atmospheric conditions. This improved atmospheric parameter/refractivity estimation resulted in a reduction in the parameters-of-interest such as the propagation factor which subsequently could be used in radar performance analysis.