Reduced turbulent mixing in a mesoscale NWP model for radar propagation forecasting

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The effect of the atmosphere on radar coverage in complex coastal environments is of great importance in many naval applications. Variations in atmospheric refractivity driven by vertical gradients of temperature and moisture can significantly enhance or reduce the range at which a particular target may be detected. Mesoscale Numerical Weather Prediction (NWP) models can be used to predict the spatial and temporal variation of atmospheric refractivity fields, which form the basis for forecasting radar coverage patterns.

Previous work (e.g. Wang et al., Journal of Applied Meteorology and Climatology 51:115-132, 2012) has suggested that in stable marine boundary layers the gradients of temperature and humidity predicted by the Met Office Unified Model (MetUM) can be insufficiently strong, leading to an under-prediction of radar duct frequency and strength. In stable boundary layers the MetUM uses a one-dimensional mixing-length parametrisation for the turbulent fluxes of heat, moisture and momentum based on a local Richardson number. We investigate the impact of reducing the turbulent mixing in stable boundary layers, and compare the results of mesoscale model runs with observations collected during the Wallops-2000 Microwave Propagation Measurement Experiment. As expected, reducing the turbulent mixing allows sharper gradients of temperature and humidity to develop. This leads to a greater incidence of predicted ducting with thinner, stronger ducts, which gives a closer match to the observed profiles. We also compare the spatial radar coverage calculated by the AREPS tactical decision aid using both the model-predicted refractivity fields and the observed vertical atmospheric profiles. For the cases studied, the reduced mixing generally leads to qualitatively better coverage predictions.