Surface and elevated ducts and implications on the modeling of mesoscale NWP refractivity and radio-wave propagation

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Atmospheric processes that involve subsiding or advecting air masses in either littoral environments or large scale subsidence at the top of the boundary layer are often associated with temperature inversions and corresponding decreases in atmospheric moisture content, resulting in the formation of ducts. This paper discusses aircraft measurements carried out in Australia of ducting events caused by various atmospheric processes.

From the measurements it is evident that ducting structure results from large changes in atmospheric temperature and water vapour content which are associated with small changes in height. These sharp changes in temperature and humidity produce either elevated or surface ducts with large M-deficits. The situation is rather complicated as the ducting layers can occur at a wide range of altitudes and are usually horizontally inhomogeneous.

Recent research has focused attention on the use of meso-scale numerical weather prediction (NWP) models in forecasting the refractive index structure in littoral environments as a means of providing the necessary refractive index input for the computation of radio-wave propagation effects. Investigations show that there is sufficient mesh resolution to effectively calculate the horizontal variations in refractivity over the sea surface, which are due to changing sea surface conditions and unique land features nearby. However the typical mesh size may be too coarse vertically, to adequately predict the refractive index gradients that are often observed.

Several propagation scenarios are considered for the observed ducting events and a comparison is made between propagation coverage predictions based upon the actual measured profiles and “under-sampled” versions that may occur in the case of NWP generated refractivity profiles. In some cases, the comparisons are quite different.

Simply increasing the vertical grid resolution in the NWP model may not be the best solution to this issue, although a better resolution would no doubt produce more accurate refractive index profiles. However, the use of an adaptive vertical grid in a series of nested model runs, may be worth considering.