Comparisons between high-resolution profiles of squared refractive index gradient M^2 estimated from MU radar and UAV data collected during the ShUREX 2015 campaign

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Very soon after the development of VHF ST radars, it was noted that the radar echo power (corrected for range attenuation effects) is roughly proportional to the squared generalized potential refractive index gradient M^2 at vertical incidence .This was confirmed many times, at least in a statistical sense, from comparisons between balloon and radar data. Surprisingly, while both Fresnel and turbulent backscatter models predict this proportionality albeit, with coefficients depending on the specific model, good agreements were generally reported independent of aspect sensitivity, for example. It is possible that the conditions under which those previous comparisons have been made, were not fully conducive to revealing more complex relationships. Indeed, most comparisons reported in the literature have been based on the analysis of several profiles at only coarse vertical resolutions (≥150 m) and long time averaging of ~30-60 min. In addition, the horizontal separation between the radars and the radiosondes due to the balloon drift (typically 1-100 km) can make it difficult to interpret the differences between radar- and balloon-derived profiles, especially at tropospheric heights, where the issue of horizontal inhomogeneity and lifespan of atmospheric structures can be more crucial than at stratospheric heights. In the present work, we will describe the results of new comparisons between M^2 profiles estimated from MU radar echo power and from meteorological data collected by unmanned aerial vehicles (UAVs). During the ShUREX (Shigaraki UAV Radar Experiment, 1-14 June 2015) campaign (Kantha et al., 2017, this issue), the light and inexpensive DataHawk UAVs developed at the University of Colorado were used at the Shigaraki MU Observatory site for turbulence studies. The UAV measurements were performed in the close vicinity of the MU radar antenna array (horizontal distance < 1.0 km) from the ground up to ~4.5 km, in order to minimize the horizontal inhomogeneity issues. The vertical ascent rate was ~2 m s^{-1}. The UAV-derived M^2 profiles were calculated from PTU data collected from on board 1-Hz IMET sensors at a vertical resolution of 20 m. The MU radar was operated in range imaging mode at vertical incidence so that radar-derived profiles of M^2 could also be obtained at unprecedented temporal and height resolutions of 1-4 min and ~20 m, respectively, in the altitude range ~1.27-4.5 km. The results will be described for 7 consecutive UAV flights performed on 07 June 2015 from 05:30 LT to 19:00 LT. It was found that: 1) For stratified conditions under which Fresnel scatter mechanism can be expected, the proportionality between the radar echo power and M^2 was also observed at these high time and height resolutions. 2) For turbulent conditions associated with Kelvin-Helmholtz instabilities or convective cloud cells, significant discrepancies between the profiles were observed, depending on the stage of turbulence.

References

Kantha et al, 2017, this issue