Concurrent MU radar, UAV and balloon observations of temperature and moisture finescale structures during the ShUREX2015 campaign

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In a companion study (Luce et al. 2017, this issue), we compared vertical profiles of squared generalized potential refractive index gradient M^2 in the height range ~1.27-4.50 km derived from MU radar data and Unmanned Aerial Vehicles (UAV) instrumented with meteorological sensors. These data were gathered during the ShUREX campaign (Shigaraki UAV Radar Experiment 2015, 1-14 June 2015, Kantha et al., 2017). On 07 June 2015, two UAV flights were conducted at a nearly constant horizontal distance from the MU radar (~1.0 km), almost simultaneously with balloon-borne radiosondes launched from the MU radar site. Due to advection by the wind, the radiosondes drifted up to ~ 3-5 km from the radar site in the altitude range of comparisons. During the observation period, convectively turbulent and cloudy cells developed up to a height of ~1.50 km. In the height range of 1.80-2.15 km, turbulence associated with Kelvin-Helmholtz billows up to ~1.0 km in depth was observed and in the range 2.14-4.0 km, calmer stratified conditions were. Radar-derived M^2 profiles at a vertical sampling of 20 meters and a time average of 1-4 minutes were estimated from echo power at vertical incidence. The UAV- and radiosonde-derived M^2 (and N^2) profiles were estimated from pressure, temperature and relative humidity measurements also at a vertical resolution of 20 m for comparison with the radar data. In stratified conditions above 2.15 km, good agreement was found between the profiles derived from all three sensors, indicating that the same refractive index (temperature/humidity) gradients were detected by all three, down to decameter scales. These gradients extended over a few km at least and persisted for hours without significant changes, indicating weak turbulent diffusion. In the height range 1.80-2.15 km, where turbulence was observed, the three reconstructed M^2 profiles showed substantial differences when KH billows were clearly detected, likely because the horizontal extent of the gradients at the edges of the billows was smaller than the distances between the different instruments. However, remarkable agreements between Richardson number profiles estimated from radar/UAV and Vaisala sondes were found in the measurement range, indicating that all instruments observed the same dynamic conditions. When the morphology of the turbulent layer suggested a later stage of turbulence decay, large differences were found between the M^2 profiles derived from the radar and the *in-situ* sensors.

References

Kantha et al, this issue, 2017
Luce et al. this issue, 2017