Comparisons between turbulent kinetic energy dissipation rates estimated from MU radar data and UAV-borne Pitot sensors during ShUREX 2016 campaign.

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During the ShUREX campaigns (Kantha et al., 2017, this issue), unmanned aerial vehicles (UAVs) developed at the University of Colorado, Boulder, were flown in the vicinity of the MU radar (~1 km or less) to obtain in situ measurements of atmospheric parameters from the ground up to the altitude of ~4-5 km. In particular, high frequency (sampling: 800 Hz) response cold wire and Pitot tube sensors were used to estimate turbulence parameters. Turbulent kinetic energy (TKE) dissipation rate ε_{UAV} and temperature structure constant C_T^2 were estimated from high-resolution relative wind and temperature data, respectively. Time series and vertical profiles of ε_{UAV} were compared with MU radar-derived ε_{radar} estimates that made use of the Doppler spectral width. The present work is devoted to describe the methods used for estimating e from both datasets and the results of comparisons from 15 UAV flights of ShUREX 2016. Almost all the deepest turbulent events (> 10^2 m) were detected by both instruments. In addition, by assuming a constant outer scale of turbulence ($L_{out} = 170\, m$), most estimates of ε_{radar} and ε_{UAV} exceeding $10^{-5}\ m^2 s^{-3}$ agreed within a factor 3 or less. Therefore, it is proposed that MU radar data, such as those obtained during the ShUREX campaigns, can be used for not only detecting all significant turbulent events in the lower troposphere but also for estimating TKE dissipation rates (consistent with those provided by the UAV sensors) *from radar data alone* (i.e. without any additional in situ data) within a good confidence interval. The high quality of the comparisons suggests that the method described here would be enough for climatological studies of turbulence occurrence and quantitative estimates of TKE dissipation rates from VHF radar data alone. The theoretical models relating C_T^2 and ε are also discussed in light of the present datasets.

References

Kantha et al, this issue, 2017