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Estimation of turbulence parameters in the lower atmosphere using the high resolution ARIES ST Radar (ASTRAD) Observations: First results from Central Himalayan region

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Turbulence in the atmosphere play vital role in controlling the surface, lower as well as upper tropospheric dynamics both during day and nighttime and also depicting both spatial and vertical inhomogenities over a complex terrains like Himalayan region. Turbulence mostly occurs due to degeneration of mountain induced gravity waves and acts a potential source of vertical mixing in the atmosphere (Dornback, 1998). Inaccurate estimation of turbulence parameters will also have immense effect on the aviation sector in the complex mountainous regions. Another important application of the estimation of turbulence parameters is for astronomical observations since it determines the key parameters of adaptive optics systems and precision of astrometric measurements. Characterisation of turbulence in mountainous region is also vital to understand the dynamics of mountain waves and other mesoscale phenomenon which has crucial role in modulating the general circulation wind patterns (Palmer,1987). The flow conditions associated with the turbulence includes high vertical velocities, wind shear and low Richardson number which can be well measured with high vertical and temporal resolutions of wind fields (Horizontal and Vertical) by Stratosphere–Troposphere Radars. In this context, Estimation of Turbulence parameters like Turbulent kinetic energy dissipation rate, ε and eddy diffusion coefficient, K_m will be determined by using standard Wind Variance method. This method utilizes the temporal spectrum of vertical wind in the inertial sub range demarcated by Brunt-Vaisala frequency and Nyquist frequency. Incorporating this method these parameters were earlier reported for tropical site of Gadanki using MST radar observations by Satheesan and Krishna Murthy [1,2]. The validity of these methods will be tested with the conventional methods using (i) Doppler spectral width and (ii) backscatter signal power .

For the estimation of Turbulence parameters, we utilize the high resolution observations by using newly installed ARIES ST radar facility in the high altitude subtropical site of Manora Peak, Nainital (29.4^0N, 79.5^0E, 1799m amsl) . The radar system has total 588 Yagi-Uda antenna elements as an active aperture phased array arranged in 12 sub-clusters with each clusters having 49 elements each in a hexagon shape. From the high spatial and temporal resolution of vertical wind over this turbulence parameters have been achieved for this region. However, in the process of the integration of sub-clusters a test observations during 2017 were conducted and the results presented here are with the partial operation of radar (7-10 clusters) with the maximum altitude range of 12-14 km with vertical wind measurements upto 9-10 km. Although the results are preliminary but still holds significance since it is the first ever attempt to parameterize the turbulence over a complex Himalayan terrain.

1. K.Satheesan and B.V.Krishna Murthy, "Estimation of turbulence parameters in the lower atmosphere from MST radar observations," *Q.J.R.Meteorol.Soc.*, **130**, 2004, pp. 1235-1249, doi:10.1256/qj.03.86.

2. K.Satheesan and B.V. Krishna Murthy, "Turbulence parameters in the tropical troposphere and lower stratosphere," *Journal of Geophysical Research*, **107**:D1, 1, January 2002, doi: 10.1029/2000JD000146.