Understanding the characteristics of stratosphere to troposphere exchange associated with the synoptic scale disturbances using Advanced Indian MST radar

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Abstract

Very-High Frequency (VHF) radar echoes are known to be aspect sensitive in general, which is the manifestation of either due to thin stable layer providing sharp refractive index gradient or shear driven steep layer structures. Tropopause which acts like a perfect reflector is highly aspect sensitive to the VHF radar echoes. It has been observed that signal strength decreases rapidly up to 10 degree off-zenith angle with an average rate of about 1.2 dB per degree and beyond 10 degree off-zenith angle, it is about 0.6 dB per degree. These aspect sensitive characteristics is attributed to Fresnel reflection/ scattering from sharp gradients in the radio refractive index. There are many studies carried out using Indian MST radar in this aspect but usually one- or two-dimensional characteristics and structures are presented, whereas any atmospheric phenomenon is three-dimensional with time-dependent. With the full azimuthal beam steering capability made available with newly developed Advance Indian MST Radar (AIR) (operates in VHF range), full volume-imaging which can provide full three-dimensional atmospheric dynamics and structure in both clear-air as well in extreme weather conditions. In this study, we present the results obtained from the experiments conducted during clear-air as well as during the passage of tropical cyclone/convection by operating AIR in multi-beam mode with azimuthal steering. The experiments were designed by the optimum selection of zenith and azimuth beams, which will have a full volume imaging scan within ~5.5 min. This shorter scan volume imaging is very useful to study the atmospheric phenomena associated with extreme weather condition. The present configuration of radar can provide better understanding of three-dimensional structures of turbulence, instabilities and exchange of minor constituents between the stratosphere and troposphere, which was not possible when the radar was operated in two orthogonal planes. Both isotropic and anisotropic layers/turbulence are observed at various height levels over the radar volume. Observations shows a high aspect sensitive radar echoes corresponding to the enhance stability and wind shear. Aspect sensitivity (aspect angle and horizontal correlation length) for different zenith and azimuth beam combinations are estimated. Volume imaging of line-of-sight velocity are also shown and horizontal winds are estimated by different combination of zenith and azimuth, which are consistent with in situ radiosonde observation. The detail results will be presented and discussed in the upcoming conference.

[Keywords : MST Radar, aspect sensitivity, VHF radar echoes, turbulence, stratosphere-troposphere interactions]