Comparison of aspect sensitivity observed using Doppler Beam Swinging and Spaced Antenna methods with the MU radar

Gernot Hassenpflug[1], Mamoru Yamamoto[2], Shoichiro Fukao[2]

[1] Kyoto University RASC, [2] RASC, Kyoto Univ.

Zenith-angle dependent aspect sensitivity in atmospheric radar echoes at VHF frequency has been observed since 1978, and several qualitative models to explain the causes of the phenomenon have been proposed. The two most extreme models ascribe the anisotropy to anisotropic scattering and specular Fresnel reflectors respectively. More complex models use a combination of the above. Further complications arise through tilting or perturbation of partially reflective sheets or scattering layers. The effect of the aspect sensitivity is to complicate the calculation of parameters such as the vertical velocity, and the effective volume of scatterers in the radar beam.

During the 1980s the mechanisms or sources of scattering of various types was researched intensively, with gravity waves and Kelvin-Helmholtz instabilities the major areas of investigation. However, because of a lack of direct means of accurate measurement of the atmospheric scattering or partially reflecting layer anisotropy, only large-volume methods such as the Doppler Beam Swinging (DBS) method could be used to obtain rough estimates of the azimuth aspect sensitivity functions.

In 1996 and 1997 Doviak and Holloway et al. developed a method of directly measuring turbulent horizontal structure correlation lengths using arbitrary spaced antenna (SA) configurations. It also became apparent that aspect sensitivity was a phenomenon not limited to the zenith dimension, but often prevalent in azimuth as well. This realization led to multiple beam Doppler experiments to determine echo power variation in two dimensions.

It is possible to compare the large-scale (greater than radar beam) aspect sensitivity obtained through DBS experiments with the small-scale (in beam) aspect sensitivity obtained through SA experiments, provided that the aspect sensitivity function is wider than the antenna beam-width. We present results of comparisons of such analyses carried out with the MU radar, discuss whether the radar echo is due to scattering or Fresnel reflection, and hence what processes can most likely account for the generation of the phenomenon.