Study of Spatial Structures of Atmospheric Turbulence Echoes based on the MU Radar Multi-beam Experiment

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Zenith and azimuth distribution of atmospheric echoes measured by VHF Stratosphere-Troposphere (ST) radars like the Middle and Upper atmosphere (MU) radar (Shigaraki, Japan, 34.85N, 136.10E) have been analyzed in detail by using different radar beam configurations. It was discovered that the azimuth of maximum echo power was closely related to the direction of the wind shear vector indicating that the wind shear may act to tilt of the scatterers through shear instabilities. Worthington et al.(1999) reported that, from horizontal map of echo power collected in many beams within 40 degrees of zenith angle, the power distribution pattern is often skewed in the troposphere. Multi-beam experiment is a powerful tool to study zenith and azimuth distribution of atmospheric echo intensity. Owing to loss of sensitivity with increasing number of beams, however, we could usually obtain meaningful data to study horizontal distribution of the echo power only in the troposphere.

We conducted first Sequential Multi-beam (SMB) experiment on 11-12, November 2001. SMB is to conduct 16 set of 5-beam (one vertical and differential four oblique beam set) experiment sequentially, which enabled us to obtain horizontal echo power map up to about 20 km. We clearly observed about 10-dB differences of the echo power in the azimuth directions even at 24 degrees off the zenith. The relation between wind shear vectors and the direction of maximum of echo power was seen both in troposphere and lower stratosphere. These results indicate that there are tilted layers that contribute to the reflection echo in the oblique beam even at the large zenith angle (24 degrees off the zenith), and the azimuth dependence is caused by the same mechanism both in the troposphere and the lower stratosphere. Due to the acquisition time of the meaningful data (about two hours), however, it is difficult to show the time variation of the horizontal distribution of echo power.

On 9-10, December 2002, we conducted new SMB experiment with two sets of 21-beams (one vertical and 21 oblique beam set). Although the number of beams was reduced, we could obtain horizontal distribution of echoes with higher time resolution (about 5 miniutes) up to about 10 km altitudes at 20 degrees of zenith angle. We now study much finer structures in the echo power distribution together with their relationship with wind and the wind shear. In the presentation, we will discuss the origin of the azimuthal dependence of the echo intensity more quantitatively.