A Study on the Structures of Turbulence Echo Layers in the Mesosphere Observed with the MU Radar

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In the mesosphere, dynamics of the atmosphere is complicated and affected by various factors such as the solar activity and the atmospheric

disturbances near the earth's surface. As for the latter case, the amplitudes of atmospheric waves become larger with increasing altitude,

and the waves break in the mesosphere, where the surrounding atmosphere is accelerated by the momentum transported by the waves. The details of variability of the mesosphere is, however, still unknown and clarification of such variations are of great interest in recent years, because the mesosphere is a region sensitive to the earth's environmental changes. Therefore, observations with radars, lidars, satellites, etc. have extensively been carried out.

In this study, we analyzed time-height structure of turbulence echo layers in the mesosphere using the data-base archived from routine observations with the MU radar which were carried out for 4-5 successive days each month for more than 18 years since March 1986. Several observations longer than two weeks were also analyzed. Earlier studies clarified that the structure of the mesospheric turbulence echo layers are affected by atmospheric gravity waves, showing a downward phase progression within duration of several hours. However, day-to-day variations of the echo layer height have not been studied yet.

We first developed an algorithm of sampling of archived observation data. The SNR is calculated with a time and height resolution of 30 minutes and 300 meters, and then, a significant echo region exceeding the threshold level in order to extract 5% of total time-height bins was selected. In addition, meteor echoes are carefully removed considering its sporadic behavior in order not to influence on this sampling. We extracted the echoing region using such algoruthm and then finally selected a single time-height spot (the center of gravity) for one or more seperated time-height regions for a single day.

We have investigated all of these monthly results between March 1986 and December 1994, and found that in most cases echo regions move

downward during the several day observation periods. The average downward velocity was larger in summer (-0.89km/day) and smaller in winter (-0.39km/day). However, in both summer and winter the range of velocity was similar. The variance of velocities was large in winter (1.8 km^2/day^2) and summer (1.7km^2/day^2). In winter several large velocities (-4.1 km/day and -3.7 km/day) and corresponding large variances were found. In spring and autumn downward velocity was between those in the mid summer and winter (-0.52km/day), and the velocity variance was relatively small (spring: 1.5 km^2/day^2, autumn: 1.6 km^2/day^2).

From long-duration observations (19, 20 days), we found that the center height of the echo regions oscillate upward and downward. Moreover, a similar periodicity was also detected in the horizontal wind velocity, especially for the meridional component. It could be due to the periodical variation of atmospheric stability caused by the atmospheric waves seen in the wind velocity variations, but in order to clarify this senario, we need temperature profile information in the mesosphere. Comparison with the satellite derived temperature profiles by TIMED/SABER etc. could be useful for discussing more in detail in future.