

Clear-Air Echoes Observed by Ka-Band Scanning Polarimetric Cloud Radars

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In summer of Japan, lower tropospheric atmosphere becomes unstable due to heating from the ground surface that received strong solar radiation, and cumulonimbus clouds are frequently initiated. To observe development of convections from the early stage of the clouds, our institute has installed five scanning cloud radars with operating at 35 GHz (Ka band) in the Kanto region of Japan. In the observations, clear-air echoes (CAEs) appear indistinguishable from the initial stage of the cloud by radar reflectivity (Z) alone. In this study, CAEs observed by the scanning cloud radars are examined, especially using polarimetric function.

CAEs showed a variety of patterns: unorganized, wave-like, honeycomb, and linear. Although some of CAEs developed linear along sea breeze front or gust fronts, most of them appeared in a wide area within the radar observation range. CAEs which appeared on 21 May 2016 also spread widely during the daytime and showed diurnal variation. There was almost no CAEs before sunrise. The Z values increased with time and showed the maximum around noon. Then, Z quickly disappeared from sunset to night. Z was mostly less than -15 dBZ. Range height indicator scanning observations showed that appearance of CAEs was limited below a height of 2 km. Differential reflectivity (ZDR) values of CAEs showed large spatial variations. The ZDR values of CAEs at 1800 LST on 21 May 2016 was considerably larger than that of cloud and weak precipitation echoes observed at the same time. Compared to the cloud and precipitation echoes, correlation coefficient (ρ_{hv}) of CAEs was small (<0.8) and showed larger spatial variations.

The previous studies using S-band (3 GHz) radars showed that Bragg scattering echoes have ZDR near 0 dB and ρ_{hv} about 0.99, which is different from the present case. On the other hand, the features of large ZDR and small ρ_{hv} are consistent with the characteristics of the insect echoes, although spatial variations of ZDR and the maximum ρ_{hv} of CAEs were larger in the present case. The polarimetric parameters of the Ka-band radar can be effective to distinguish between cloud and clear-air echoes.

Keywords: Ka-band radar, clear-air echoes, polarimetric radar