Simultaneous observation of vertical wind and hydrometeor fall velocity in stratiform precipitation by the Equatorial Atmosphere Radar and a polarization lidar

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Precipitation has two types; stratiform and convective. In the upper part of stratiform precipitation, ice particles grow up into snowflakes through depositional growth, riming growth, and aggregation. Latent heat released by deposition generates upward air motion, which supports a growth of large-sized snowflakes [1]. Therefore simultaneous measurement of vertical wind (W) and hydrometeors is a key for understanding processes in stratiform precipitation.

The Equatorial Atmosphere Radar (EAR) is a clear-air radar operated at 47-MHz frequency [2]. The EAR has an excellent capability of measuring echoes from clear-air turbulence and hydrometeors simultaneously. Linear deoplaization ration (LDR) measured by polarazation lidar is useful for knowing phase (ice, water, or mixed phase) and nonsphericity of hydrometeors. 1.3-GHz Doppler radar, which has higher sensitivity for hydrometeors than the EAR, was used to measure hydrometeor fall velocity (V_h). The experiment was done as "Cloud observation campaign using Lidar and Equatorial Atmosphere Radar (CLEAR)" carried out during December 2008.

Figure shows altitude profiles of W, hydrometeor fall velocity (V_h), lidar scattered power ($P_{||}$) and LDR observed during the stratiform precipitation event on 8 December 2008. Owing to hydrometeor melting, V_h rapidly increased with decreasing altitude at 4.6-5.0 km (Figure b). W was upward (about 0.1 m s^{-1}) above 6.2 km and downward below 4.0 km due to latent heating and hydrometeor evaporation, respectively (Figure a). LDR increase in the altitude range 4.8-7.0 km with decreasing altitude suggests an increase of the degree of nonsphericity caused by aggregation (Figure d). These results indicate that simultaneous observation by the EAR and polarization lidar is useful for comprehensive understanding of the processes in stratiform precipitation region.

References

[1] Houze, R. A., "Nimbostratus", *Cloud dynamics*, Academic Press, pp. 196-220, 1993.

[2] Fukao, S., H. Hashiguchi, M. Yamamoto, T. Tsuda, T. Nakamura, M. K. Yamamoto, T. Sato, M. Hagio, and Y Yabugaki, "Equatorial Atmosphere Radar (EAR): System description and first Results", *Radio Sci.*, vol. 38, no. 3, 1053, doi:10.1029/2002RS002767, 2003.

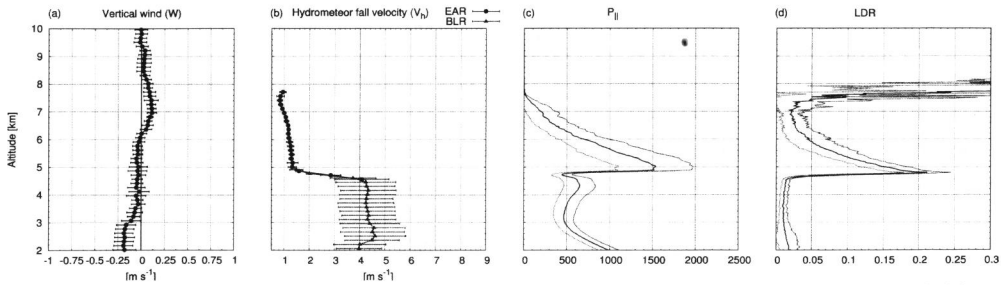

Figure. Altitude profiles of (a) W, (b) V_h, (c) $P_{||}$, and (d) LDR. Error bars in (a) and (b) and thin curves in (c) and (d) show standard deviation.