

Statistics of upper cloud vertical velocity measured by JMA wind profiler network (WINDAS) for calibration of EarthCARE cloud profiling radar

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Wind profilers normally measure wind profile using atmospheric turbulent echo as a target. However, echoes from hydrometeor such as rain, snow, cloud ice are frequently detected by wind profilers, especially in case of higher frequency radars. WINDAS is Japanese wind profiler network constructed by the Japan Meteorological Agency (JMA). Thirty-one wind profilers have been operated from the north to the south of Japan since 2001 and two wind profilers were added in 2013. Horizontal and vertical wind velocities are measured every 10 minutes. Radio frequency of WINDAS profiler is 1.357 GHz, so WINDAS profilers have high sensitivity not only for rain, but also for upper ice cloud, although water cloud is hard to detect. Distinction between ice cloud echo and atmospheric echo is not so easy in case of one profile of WINDAS data, but vertical velocity of ice cloud echo and atmospheric echo can be statistically separated, since ice cloud echoes have falling velocity. In this study, using appearance of WINDAS echo with vertical Doppler velocity at each height in each month, we pick out ice cloud echoes and decided the representative vertical velocity of those data. Comparing with vertical velocity appearance of upper ice cloud measured by a W-band cloud radar 50 km apart, vertical velocity appearance of the nearest WINDAS profiler shows good agreement in those mean and those deviation.

EarthCARE (Earth Clouds, Aerosols and Radiation Explorer) carries a W-band Cloud Profiling Radar (CPR) with vertical Doppler measurement function. It is important to calibrate its vertical velocity using various ground radars because the satellite velocity contamination due to small off-nadir pointing causes large errors in vertical velocity measurement. Comparing with ground based W-band cloud radar is planned for EarthCARE/CPR calibration. However, chance of simultaneous measurement during the EarthCARE satellite pass above the ground cloud radar site is limited. If vertical velocity of ice cloud measured by the WINDAS profilers can be available for EarthCARE/CPR calibration, many calibration data are available, and accuracy of vertical velocity will be improved.

In order to check the statistical feature of the ice cloud echo vertical velocity, seasonal variation of ice cloud echo are investigated using WINDAS profiler data. Figure is the 9-year average of mode of ice cloud Doppler velocities at each height in each month using Kumagaya WINDAS profiler. The right profiles are monthly profiles of vertical velocities with height from the ground and the left profiles are the same with height from the 0 degree height. In the right figure, seasonal change of upper cloud fall velocities is clearly seen, faster in summer and slower in winter. In the left figure, monthly variation of falling velocities in upper cloud is shrunk and seasonal change disappeared. It means that statistically vertical falling velocities of ice cloud are well depended on the atmospheric temperature. We will show the all WINDAS profiler data and show the similarity and difference of the ice cloud vertical velocity with each site.

Keywords: wind profiler, cloud radar, EarthCARE, ice cloud

Seasonal change of vertical velocity of hydrometeor echo
WINDAS Kumagaya 2003-2011

