Fine structures of clouds and precipitations observed with W-band Radars FALCON-I and FALCON-A

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Abstract

Cloud is one of the most significant items in climate system and would have important role on global warming. Especially in the arctic region, investigations of characteristics and behavior of clouds are important because arctic warming is accelerated in recent years. Observation of clouds with radars in millimeter wave range is one of the most powerful methods to derive information on interior of clouds. We have developed and operated cloud profiling FMCW (Frequency Modulated Continuous Wave) Doppler radars named FALCONs in W-band 95 GHz. FALCON-I is operated mainly in Chiba, Japan, and FALCON-A (Fig.1), which has almost same performance as FALCON-I, is operated at the Arctic Station in Ny-Alesund Svalbard, Norway, as a part of a project cooperated with National Institute of Polar Research, Japan. Each facility consists of two 1m-diameter antennas and has high temporal and spatial resolutions. These have enough sensitivities to observe thin clouds and have high resolution in Doppler measurements. Performances of FALCON-A are summarized in Table 1.

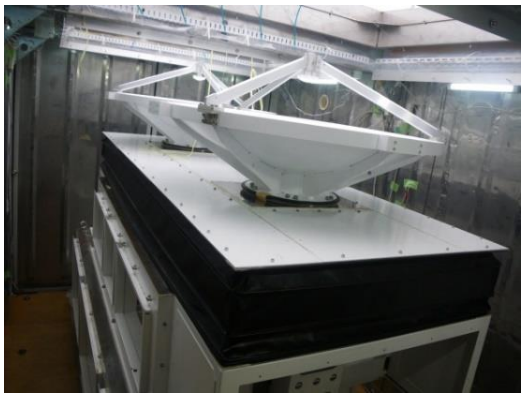

Fig.1. Cloud Profiling Doppler Radar FALCON-A at Ny-Alesund, Svalbard, at N79°in Arctic region..

Antenna Diameter	1 m × 2
Frequency	94.84 GHz
Output Power	1W (+30 dBm)
Beam Width	0.18 deg.(FWHM) = 15m at h=5km
Range Resolution	48 m (Typ.)
Direction of Antennas	Zenith
Polarization	1 Linear
Doppler Velocity Range	±3.2 m/sec (Typ.)
Time Resolution	10 sec (Typ.)

Table 1. Parameters and Performances of FALCON-A

Fig.2. shows observation results with FALCON-I in Chiba prefecture. Left panel shows radar reflectivity dBZ and Right panel shows Doppler profile map at 6:42 UT, which corresponds to very beginning of precipitation. We realized that precipitation begins at the bottom of the cloud and is accelerated in few hundred meters by reaching to terminal velocities of droplets.

Fig.3. shows an example of Doppler observations of Clouds with FALCON-A at Ny-Alesund. Precise interior motions of clouds can be seen with Doppler maps. These results are quite useful to investigate characteristics of clouds in various cases.

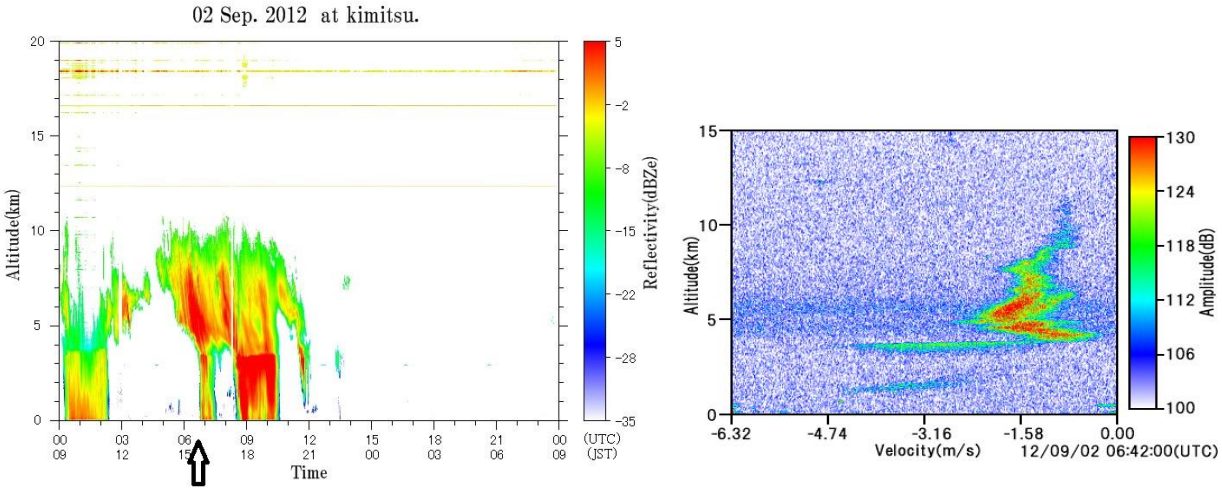

Fig.2. Radar reflectivity (Left panel) observed at Kimitsu Chiba with FALCON-I and Doppler profile map at 6:42 (Right panel), which corresponds to very beginning of precipitation as shown with an arrow in Left panel.

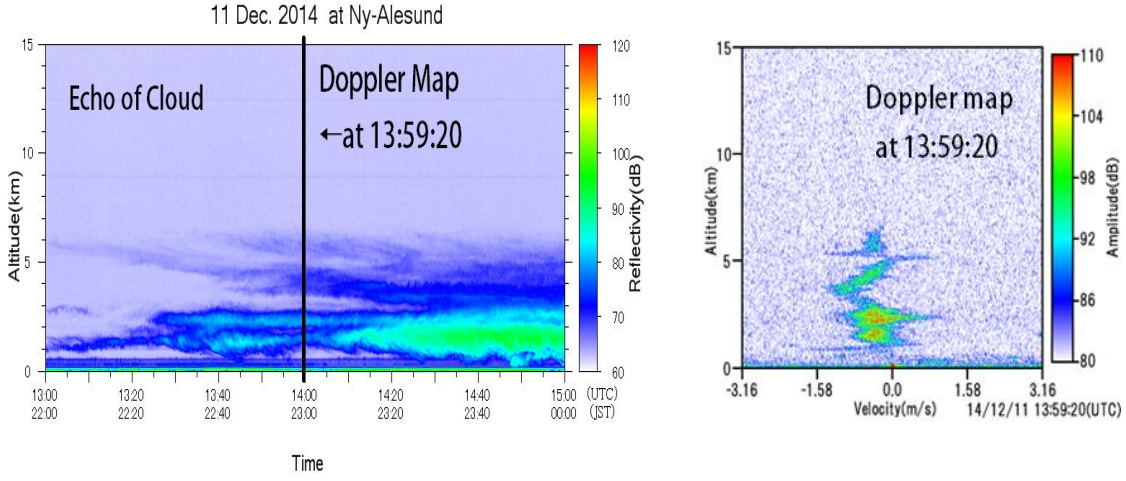

Fig.3. Time-Height map of echo of cloud (Left panel) and Doppler map (Right panel) at 13:59:20 on 2014 Dec. 11 th There are three layer of clouds; lower cloud at h=1-3 km, middle layer around 4-5 km, and upper layer at 5-6 km. Between the upper and the middle layer cloud around the height of 5 km, strong up/down motions are seen with the Doppler velocity of ±1. m/s.