11A.2 EVOLUTION OF ADVECTION FOG OBSERVED BY KA-BAND RADARS

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1. Introduction

Ka-band radar is a new research tool capable of observing the movement and structure of fog. Ka-band radar has been mainly used for cloud observation and few researches for fog. Two Ka-band radars were used in the field experiment of marine advection fog conducted in summer of 2000. One is a mobile 35 GHz Doppler radar which is designed and constructed by Mitsubishi Electric Corporation and Radio Science Center for Space and Atmosphere (RASC), Kyoto University for experimental observations of clouds and fog (see specifications in 11A.1 in this volume and Ohmori et al., 1999). The other is an airport Ka-band radar. The main specifications of this radar are similar to the mobile one except that anatena diameter is 3m and only reflectivity data are measurable.

These radars were used at the field operation for marine fog at Kushiro, northeastern part of Japan. Kushiro is famous for its marine fog in summer times and fog occurs more than 100 days in a year. Marine fog is formed over the cold ocean and advected into land.

2. Data

Field operation was conducted from July 24 to August 10 in 2000 at around the Kushiro airport, about 7 km inland from seashore. The mobile radar was located 5 km south of the airport, 2 km inland from sea. Various surface observation data including visibility taken by local airport observatory were also available. In this paper, we mainly use the data of mobile radar taken from the evening on 31 July to the morning on 1 August.

3. Evolution of fog echo

Figure 1 shows the time change of visibility taken at the airport. Visibility decreased rapidly after 1700 JST (Japan Standard Time), 31 July. Visibility was below 1000 m after 1730 JST through night and recovered temporarily around 0700 JST, 1 August. Fog completely cleared after 0900 JST. Surface wind was almost southerly and wind speed is 2 - 4 m/s throughout the event except between 2200 and 0130 JST in which wind was calm.

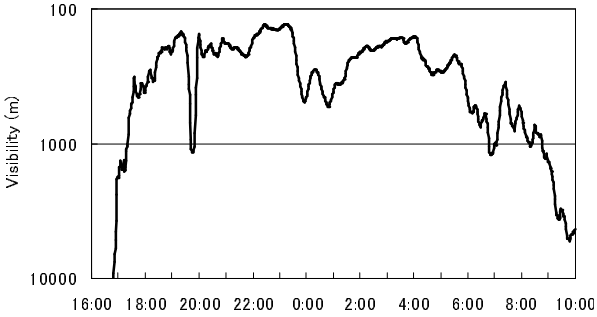

Fig.1 Time change of visibility at Kushiro airport from 16 JST 31 July to 10 JST 1 Aug.

Mobile radar data were derived from 1830 JST, 31 to 0900 JST, 1. Figure 2 shows time-range cross section of reflectivity along Az=0 and 180 degree. Based on echo area and echo movement, we subdivide the whole period into 6 stages.

Stage I (from 1830 to 2330 JST)

Fog echo existed within 5km from radar which corresponded to coastal region. Northward movement of fog were seen in two period from 2100 to 2130 JST, and 2230 to 2330 JST. Besides these periods fog echoes were almost stationary along the coast line. Reflectivity was below -20 dBZ when echo was stationary, but reached -14 dBZ when echo moved northward.

Stage II (from 2330 to 0100 JST)

Fog echo was detected more than 10 km to the south of radar. Echo did not move northward to land and almost stayed over the ocean. Reflectivity reached its maximum value of -14 dBZ between 0000 JST and 0030 JST. At this stage, echo structure was stratiform and no roll nor open cell structure were seen inside.

Stage III (from 0100 to 0400 JST)

The characteristics of this stage is its northward movement of fog echo. Fog echo first appeared 10 km south of radar and move northward with average

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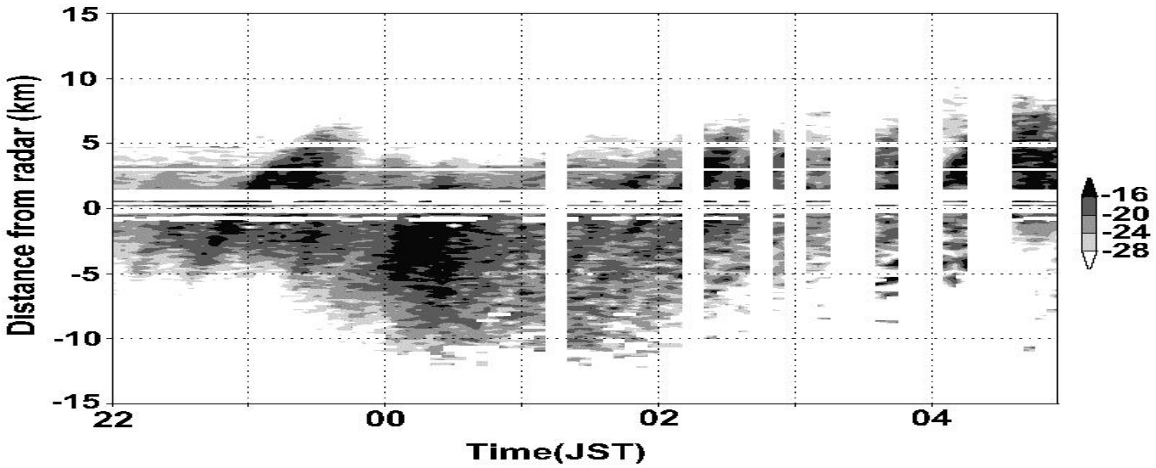

Fig.2 Time-range cross section along north-south direction from 22 JST, 31 to 05 JST 1.

speed of 3 m/s. Echo intensified especially after crossing the coastline. Figure 3 shows reflectivity distribution at 0211 JST. Roll structure is prominent. The distance between each roll is about one kilometer.

Stage IV (from 0400 to 0500 JST)

Fog echo was mainly detected over the land in this stage. Figure 4 shows reflectivity distribution at 0435 JST. Open cell structure was seen in this stage.

Stage V (from 0500 to 0730 JST): Similar to Stage III

Stage VI (from 0730 to 0900 JST): Similar to Stage I

4. Summary

Ka-band (35 GHz) radar was used to study distribution and motion of marine advection fog. This radar was able to detect fog echo within about 10 km from radar. Echo intensity varied from -30dBZ to -10 dBZ. In the early stage and dissipating stage of fog, fog was formed mainly in coastal region. In the mature stage, fog was formed not only coastal region but further offshore and further inland. Fog echo has three typical patterns of its internal structure, stratiform, roll, and open cell. Roll type appeared mainly over the ocean when echo moved northward. Open cell type appeared over the land. These results indicate the existence of convective activities in advection fog.

5. References

Ohmori, Y., T. Kirimoto, T. Wakayama, S. Watanabe, T. Matsuda, H. Hashiguchi, and S. Fukao, 1999: 35 GHz fog and cloud detection radar using an incoherent transmitter. AMS 29th Inter. Conf. Radar Meteor., Montreal, Canada, 440-441.

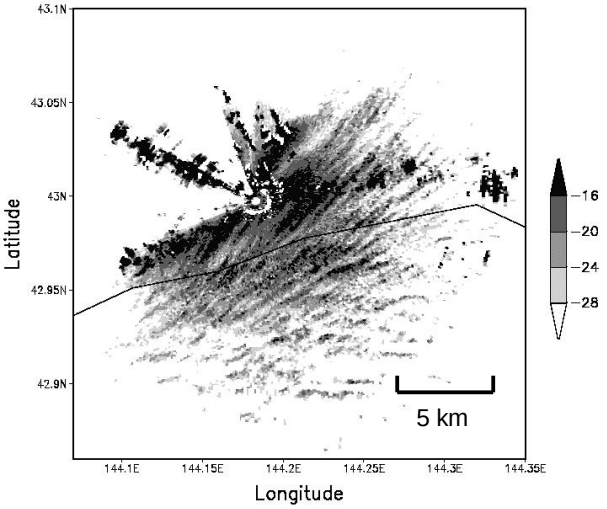

Fig.3 Reflectivity (dBZ) at 0211 JST

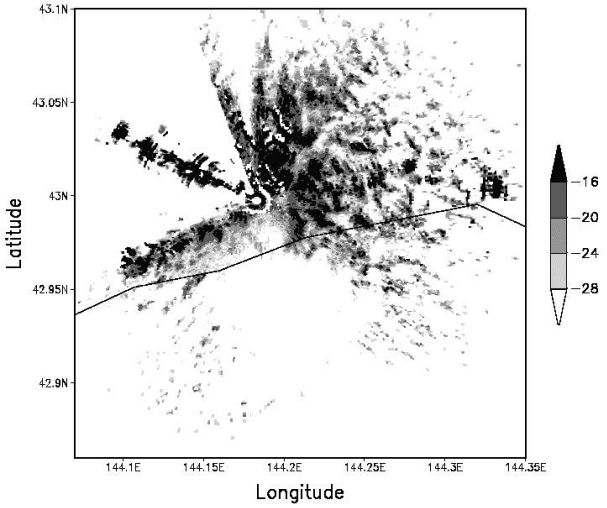

Fig.4 Reflectivity (dBZ) at 0435 JST