P13A.9

High resolution observations of terrain modified storms using the MRI portable X-band Doppler radar (X-POD)

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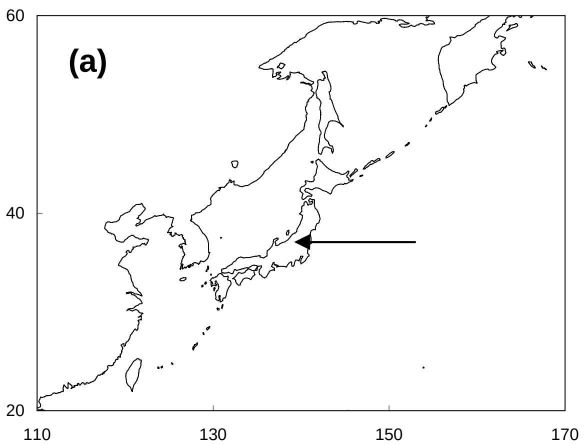
1. INTRODUCTION

An understanding of flows and precipitation over orography is important for a number of purposes. In mountainous regions, however, radar observations are usually affected by beam blockage, which makes it nearly impossible to examine modified processes in a region of complex terrain. The purpose of this paper is to present the preliminary results of the first field observations by using the MRI portable X-band Doppler radar (X-POD). An important aspect of this radar is its portability. The X-POD can deploy close to mountains, therefore, the fine-scale data obtained with the X-POD are important as they provide unique reflectivity and Doppler velocity information, which can be used to help to understand modification of the airflow and precipitation pattern by the topography. The first experiment of X-POD over mountain region was conducted at the Gunma University in the Numata basin (the Kanto region, Japan) during September to October 2006.

In this paper, we discuss close range and high resolution observations of terrain modified storms in a variety of synoptic situations such as front, cyclone, and thunderstorm during the experiment.

2. THE LOCAL TERRAIN OF THE STUDY AREA

Figure 1 shows the location of the X-POD radar and the surrounding terrain. The area consists of mountains and a basin, and the elevation varies from about 120m to 2500m. The radar was installed on the roof of the Gunma university building with five floors, 20 m above ground.



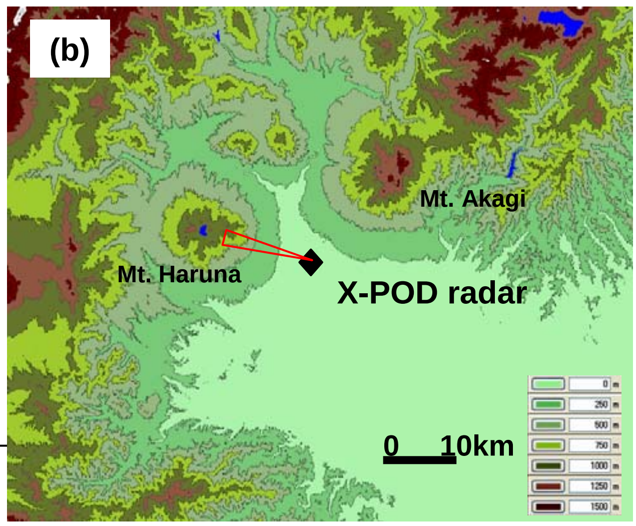


Fig. 1 (a) Map showing the location of the study area (the tip of the black arrow). (b) Enlarged map around the study area including terrain contours every 250m. Direction of photograph presented in section *3.a* is indicated by a red triangle.

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3. PRELIMINARY RESULTS

a. Rapidly decaying thunderstorm over the leeward slope on 10 September 2006

This case study is representative of summertime conditions over the central mountain range. Convergence of moisture-rich air led to isolated intense thunderstorm activity. One of the thunderstorms passed over the X-POD radar range, allowing high resolution observation of the structure and evolution of thunderstorm over the Mt. Haruna. Time series of reflectivity PPI scans (Fig. 3) show that the thunderstorm rapidly decayed as it moved down over the leeward slope. The vertical structures of the thunderstorm changed considerably for bewteen 18:57 and 1906 (Fig. 4).

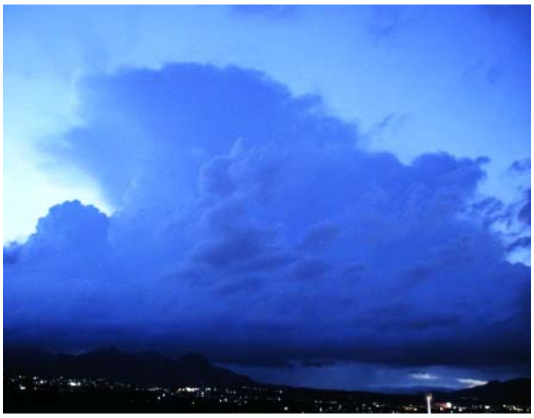

Fig. 2 The thunderstorm on 10 September 2006 at 1823JST. The view is to the west-northwest from the location of the X-POD radar.

b. Windward orographic enhancement of rainfall on 26 September 2006

On the afternoon of 26 September 2006, an extratropical cyclone was located near the southern coast of Honshu island, Japan, over the Pacific Ocean. GMS Satellite imagery indicated an extensive cloud system associated with the cyclone moved northeastward over the Pacific Ocean and the eastern Japan (not shown). Over the X-POD radar site, echoes associated with the cyclone continuously passed and moved northeastward. Fig. 5 shows the time series of reflectivity RHI scans of 40-. and 220-deg azimuth, as the direction along the direction of the echo motions. Fig. 5 highlights the orographic enhancement of rainfall on the windward slope over the Mt. Akagi.

c. Stratiform precipitation and quasi-stationary embedded convective cells on 01 October 2006

During the afternoon of 01 October 2006, a stationary front at the surface was aligned approximately east-west over the Pacific Ocean, near the southern coast of Honshu Island, Japan (not shown). Wind directions are southeasterly at the surface, veering to southerly to southwesterly at 500 hPa according to the aerological data at Tateno over the central Japan. Over the X-POD radar site, echoes moved northeastward. Fig. 6 shows the time series of reflectivity RHI scans of 40- and 220-deg azimuth, as the direction along the direction of the echo motions.

A distinct bright band is found at 4-km altitude in the stratiform precipitation. In contrast, there were quasi-stationary embedded convective cells extended vertically, which meight be produced by convergence strengthened by downslope wind.

4. CONCLUDING COMMENTS

The feasibility of the X-POD observations in mountainous regions has been demonstrated. The preliminary results of this study suggest that the X-POD would be useful for documenting sub-km-scale radar fields with fine special and temporal resolution.

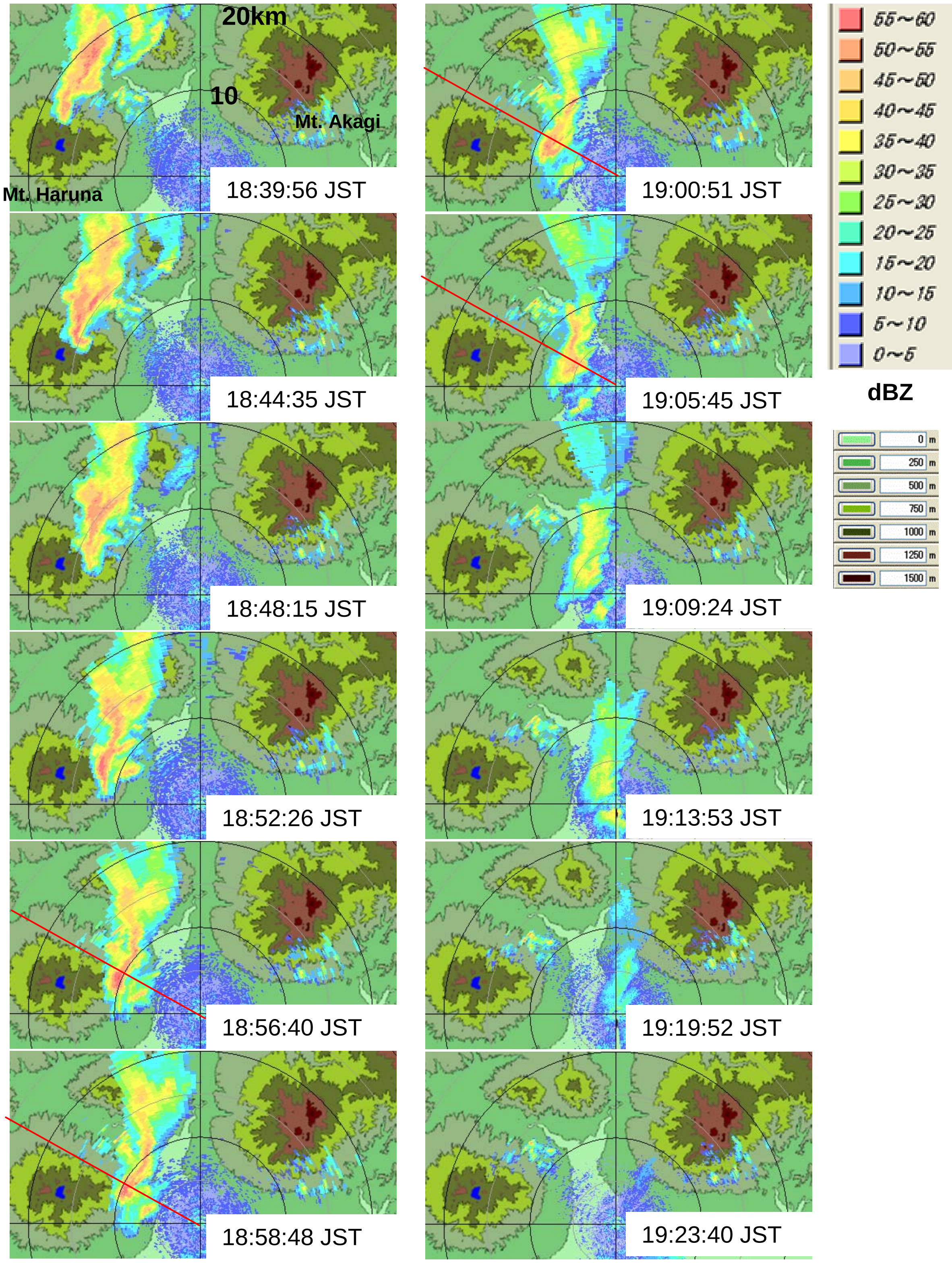

Fig. 3 Time series of reflectivity PPI scan at elevation angle 5.0 on 10 September 2006 . Terrain contours (intervals of 250 m) are superimposed. The RHI scan beams are indicated by red lines (see Fig. 4).

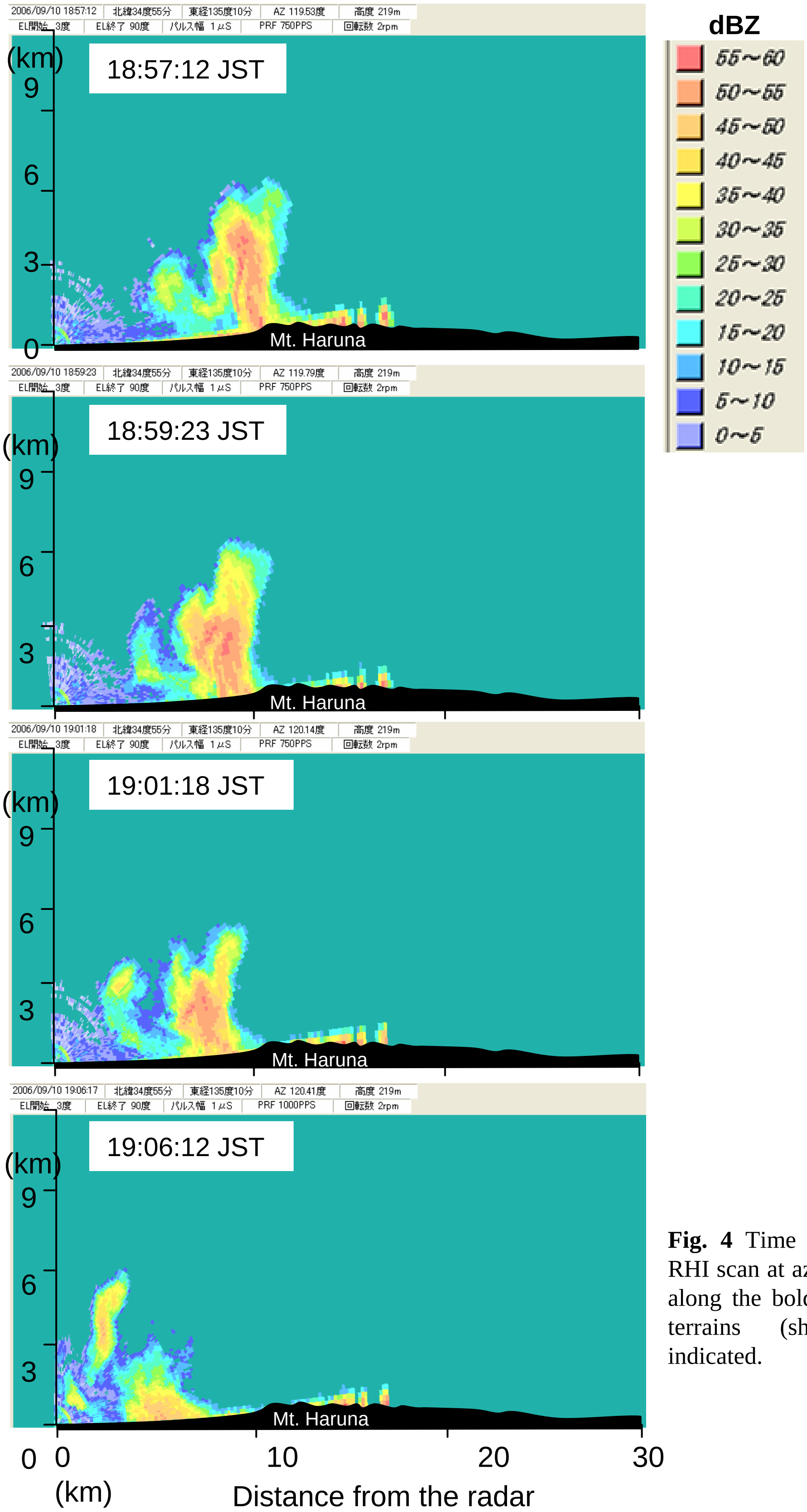

Fig. 4 Time series of reflectivity RHI scan at azimuth angle 300-deg along the bold line in Fig. 3. The terrains (shadow) are also indicated.

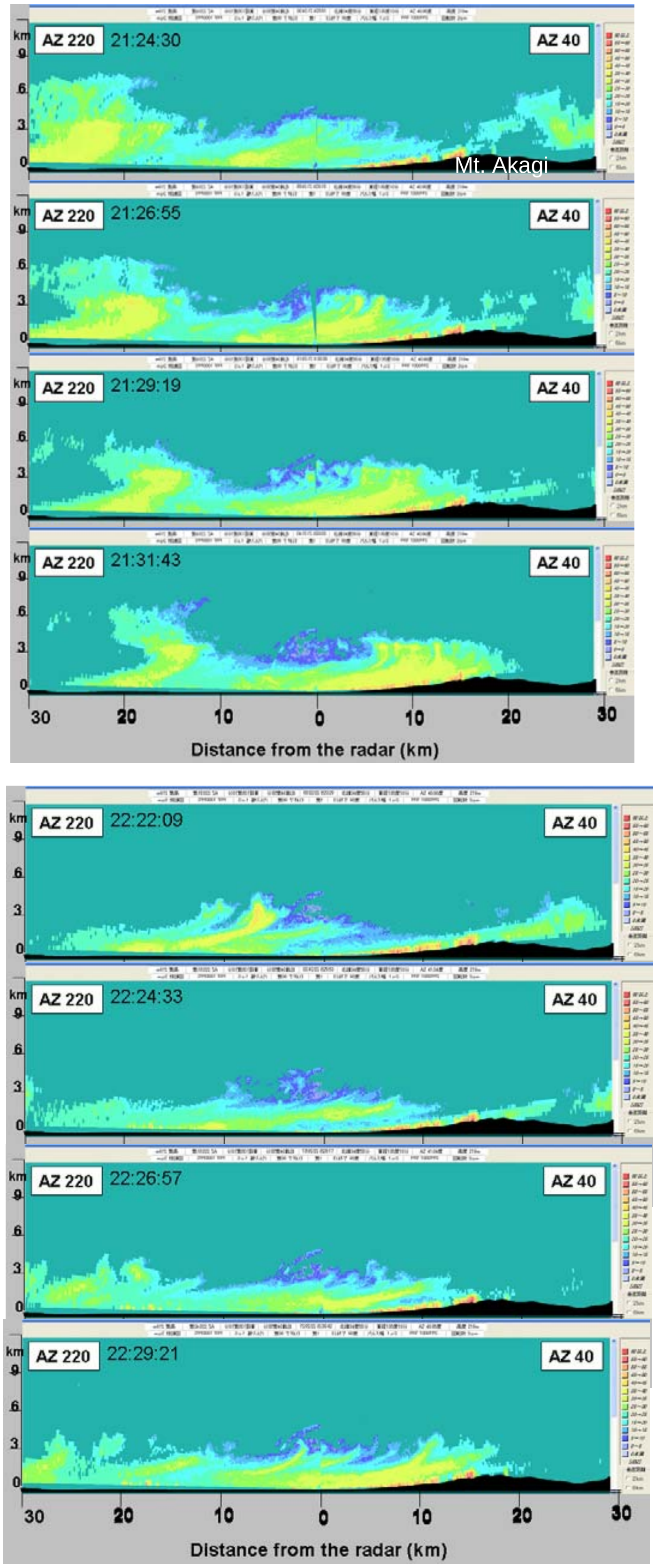

Fig. 5 Time series of reflectivity RHI scans of 40- and 220-deg azimuth on 26 September 2006. The terrains (shadow) are also indicated.

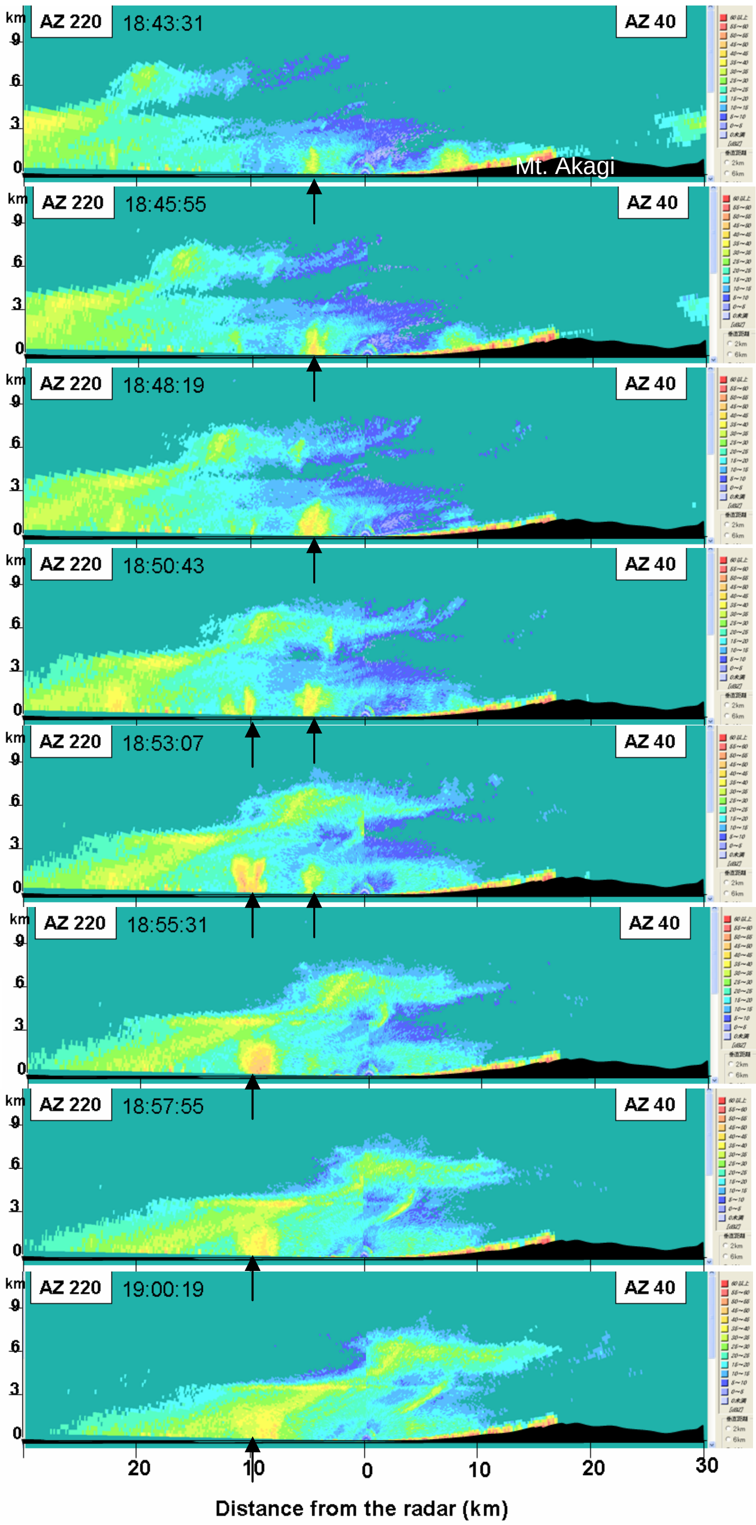

Fig. 6 Time series of reflectivity RHI scans of 40- and 220-deg azimuth on 01 October 2006. The arrows indicate the quasi-stationary embedded convective cells
The terrains (shadow) are also indicated.