Mesoscale Structure and Along-Front Variation of a Meiyu Front and Associated Precipitation Observed in the Downstream Region of the Yangtze River

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Abstract

A Meiyu front evolved on 21 June, 2002 in the downstream region of the Yangtze River has been observed by five Doppler radars. The front was much deeper and precipitation systems were much stronger in the western parts of the observational area than those in the eastern parts. It seems that the different frontal structure would be important in the formation of different types of precipitation along the Meiyu front.

Keywords: Meiyu front, Precipitation systems, Doppler radar

1. Introduction

Since 2001, the Institute of Observational Research for Global Change (IORGC) of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) has conducted a project study on Meiyu fronts and associated precipitation systems in the downstream region of the Yangtze River. Intensive observations have been taken during the Meiyu season of each year. The main purpose of this project is to elucidate processes of mesoscale precipitation systems associated with Meiyu fronts. The results of the observations and analyses will contribute to the development and improvement of numerical models of global atmosphere.

On 21 June, 2002, a Meiyu front and associated precipitation system were observed by five Doppler radars in the downstream region of the Yangtze River. This study will describe the structure of the Meiyu front and precipitation system. We will emphasize the along-front variation of the front and precipitation system.

2. Structure of Meiyu front and precipitation system

The Meiyu front evolved in the observational area in the morning on 21 June 2002 (Fig. 1). The surface front was well defined by the intense horizontal gradient of the equivalent potential temperature and there was nearly a 180-degree shift in wind direction across the front. A linear mesoscale convective system

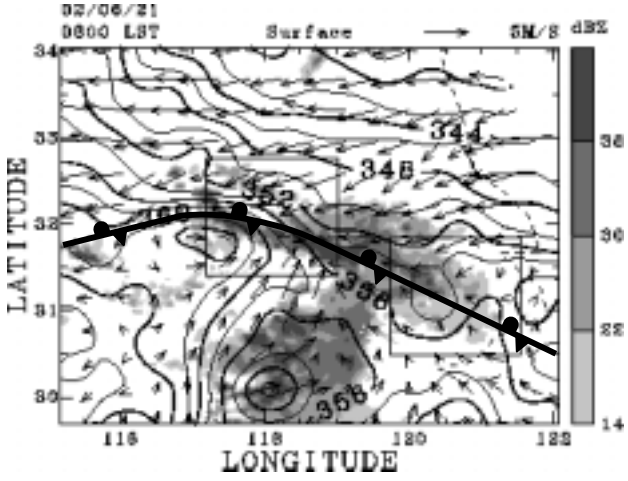

Fig. 1. Horizontal distribution of surface winds (arrows) and surface equivalent potential temperature (contoured every 2 K) for 0800 LST 21 June 2002. The reflectivity of low elevation PPI (shaded) and the position of the surface Meiyu front obtained from weather map are superimposed. Two boxes indicate two areas suitable for multiple-Doppler radar analysis.

had developed along the Meiyu front. Along the front, the contour of equivalent potential temperature was more crowded in the western portion than that in the eastern portion, suggesting that the front was stronger in the western portion. The variation of the intensity for the convective system along the front also has the same tendency.

There are two areas suitable for multiple-Doppler

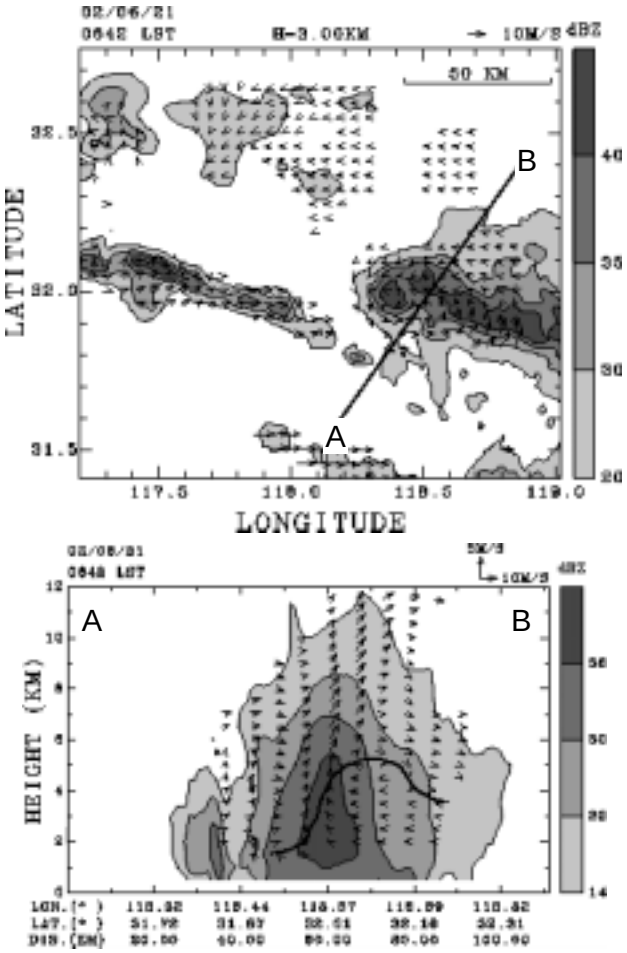

Fig. 2. Top panel: horizontal section of radar reflectivity (shaded) and ground-relative winds (arrows) at the 3-km level for 0642 LST 21 June 2002 in the area shown by the western box in Fig. 1. Bottom panel: vertical section of radar reflectivity (shaded) and ground-relative winds (arrows) along the line shown in the top panel. The bold solid line marks the interface of winds from both sides.

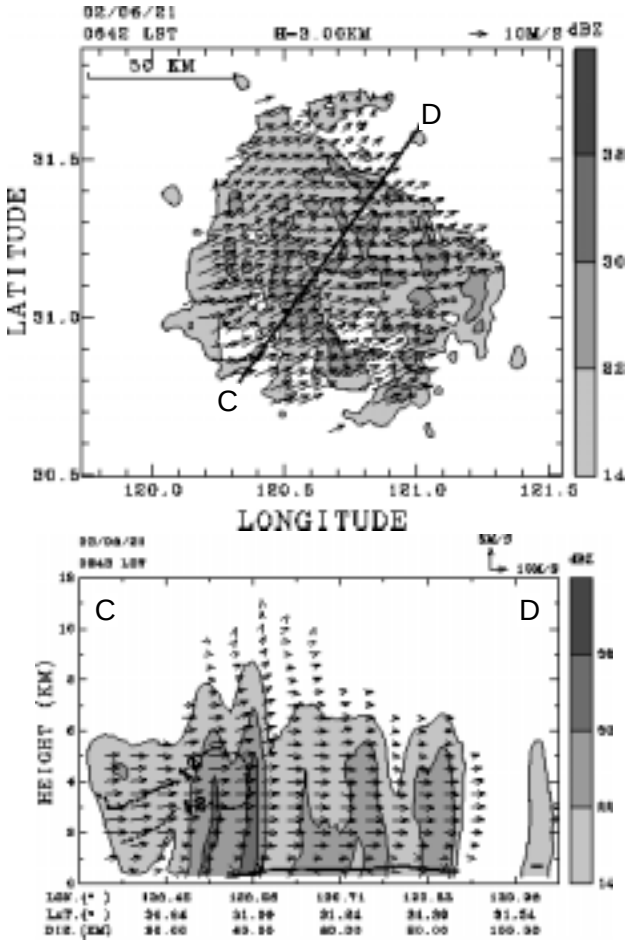

Fig. 3. Top panel: same as that of Fig. 2, only in the area shown by the eastern box in Fig. 1. Bottom panel: same as that of Fig. 2, only along the line shown in the top panel of Fig. 3. The bold dashed line is the isotach of horizontal winds with the speed of 12 m s^{-1}.

analysis, as shown by two boxes in Fig. 1. The western box covered region where the front and precipitation were stronger, while the eastern box covered the region where the front and precipitation were weaker.

The results of Doppler radar analysis in two areas are shown in Figs. 2 and 3, respectively. The western segment of the front was characterized by a deep layer of east-northeasterly flow behind the front (Fig. 2). The frontal surface reached as high as 6 km. No prefrontal low-level jet was found in this region. Strong convection evolved in a narrow belt and close to the leading edge of the front. Little stratiform precipitation was found behind the front.

In contrast, the eastern segment of the front was shallow, less than 1 km in depth (Fig. 3). A southwesterly low-level jet was identified ahead of the front. Precipitation system in this region was organized with new convection successively developing south of the front, moving across the front toward the north, and becoming stratiform precipitation behind the front. Convective updrafts and cells were much weaker than those in the western region

3. Conclusions

Data from intensified observation taken in the downstream region of the Yangtze River were used to analyze the detailed mesoscale structure of a Meiyu front and associated precipitation system. The front was observed on 21 June 2002. The east-west oriented front could be divided into two parts which have been observed by Doppler radars very well. The western segment of the front was characterized by a deeper frontal surface and strong narrow convective line. In contrast, the eastern segment of the front was shallow. Although a southwesterly low-level jet was identified ahead of the front in this region, only weaker convective cells and stratiform precipitation were found in a broader area across the front.

It seems that the different frontal structure would be important in the formation of different types of precipitation along the Meiyu front.