Studies on structure and temporal evolution of atmospheric disturbance under various topography

Abstract

In this thesis, structure and temporal evolution of atmospheric disturbances under various topography are numerically studied in two cases.

The first case examines the Okazaki heavy rainfall event, which occurred at midnight on 28 August 2008 around Okazaki city in the central part of the Japan Islands. A band-shaped precipitation system was produced and remained quasi-stationary for approximately 5 hours over Okazaki city and the surrounding area. This study presents sensitivity experiments to examine the impact of surrounding mountains on this precipitation system. In an experiment without the mountains to the east of Okazaki city, no quasi-stationary precipitation system was reproduced. On the other hand, experiments with mountains to the east side of the Okazaki city reproduced the quasi-stationary precipitation system as observed. When mountains to the east of Okazaki city were present, southeasterly winds from the ocean curved around the mountains to form sustained easterlies, which formed low-level convergence on southside of Okazaki city.

The second case shows the influence of mountains to the intense wind observed over the western part of Aomori Prefecture on 27 - 28 September 1991. The intense wind was brought by the typhoon (T9119) and appeared on the downwind side of the mountains as a downslope wind. While the intense wind lasted, the inversion layer of temperature was detected around the heights of 2 – 3 km and descended with time. The height of the inversion layer lowered with time. The decent of the inversion layer was associated with extratropical transition of T9119 during which a slow decending flow formed on the western side of synoptic-scale cold front. Sensitivity experiments showed that the intensity of downslope wind reduced to 30 m s^{-1} without mountains, while the intensity was 35 m s^{-1} in the control case.

In order to study the role of mountains on the precipitation system, horizontal scales and heights of mountains are compared with those of the precipitation system. As a result, it is suggested that the mountains would give the impact on the precipitation system when the horizontal scale of mountains is greater than 100 km and the height is higher than 1km. However, this is still qualitatative one. Thus, more case studies are required to get quantative results.