Observations and numerical simulations on cumulus topped boundary layer over the Loess Plateau, China

Masanori Nishikawa[1]; # Tetsuya Hiyama[2]; Hatsuki Fujinami[2]; Atsuhiro Takahashi[3]; Atsushi Higuchi[4]

[1] Environ. Studies, Nagoya Univ.; [2] HyARC, Nagoya Univ.; [3] NIES; [4] CEReS, Chiba University, Japan

This study firstly investigated the day-to-day variation in diurnal maximum atmospheric boundary layer (ABL) height over the Loess Plateau in China from April to July 2005 to understand the seasonal progression of the ABL. The hourly ABL height was determined using vertical profiles of turbulent intensity observed by a Wind Profiler Radar (WPR). The maximum ABL height showed large day-to-day variation. Interestingly, during the afternoon of clear days, cumulus clouds frequently generated and the cumulus topped boundary layer developed up to a higher height. The diurnal maximum ABL height reached around 3 km above the surface, which was much higher than that estimated using a slab model with surface heat fluxes. When the ABL developed up to a higher height and the cumulus topped boundary layer appeared, the vertical gradient of potential temperature between 600 hPa and 700 hPa was smaller. This indicated that the capping inversion was so weak that cumulus clouds generated very easily. Thus, it could be suggested that generation of cumulus clouds over the Loess Plateau is related to not only surface heat fluxes but also the atmospheric stability within the middle troposphere.

The Loess Plateau consists of dissected flat tablelands with steep gullies. To consider and evaluate the effect of topography on cumulus generation over the Loess Plateau, numerical simulations of the ABL development were conducted using a cloud-resolving non-hydrostatic model. Two kinds of numerical simulation were carried out under two sets of bottom boundary conditions: real terrain and flat terrain. Here, we describe differences in ABL development and cumulus generation between the flat- and real-terrain conditions and illustrate the local circulation structures induced by the ABL development. More cumulus clouds were generated over the real terrain than over the flat terrain. In the real-terrain case, large amounts of cumulus cloud were generated on the windward slopes and edges of the tableland with updrafts caused by thermal generation and local circulations developing with horizontal and vertical scales of several kilometers. Because local circulations lifted water vapor on the windward slopes and edges of the tableland non-uniformly, cumulus clouds clearly developed at the ABL top. Thus, the topography of the Loess Plateau also plays an important role in cumulus generation.