EMS Annual Meeting Abstracts
Vol. 11, EMS2014-76-1, 2014
14th EMS / 10th ECAC

Numerical simulations of sheared conditionally unstable flows over a mountain ridge

Mario Marcello Miglietta (1) and Richard Rotunno (2)
(1) ISAC-CNR, Lecce, Italy (m.miglietta@isac.cnr.it), (2) NCAR, Boulder, Colorado, USA

In several recent papers the authors performed numerical simulations with a three-dimensional, cloud-resolving model, for a uniform wind flowing past a bell-shaped ridge and using an idealized unstable (Weisman-Klemp) sounding with prescribed values of the relevant parameters. More recently, some observed cases of orographically forced wind profiles were analyzed, showing that, in order to reproduce larger rainfall rates, it was necessary to initialize the sounding with low-level flow towards the mountain with weak flow aloft (as observed). Additional experiments using the Weisman-Klemp sounding, but with non-uniform wind profiles, are discussed here to identify the conditions in which the presence of a low-level cross-mountain flow together with calm flow aloft may increase the rainrates in conditionally unstable flows over the orography. The sensitivity of the solutions to the wind speed at the bottom and the top of a shear layer, and the effect of different mountain widths and heights, are systematically analyzed herein.

Large rainfall rates are obtained when the cold pool, caused by the evaporative cooling of rain from precipitating convective clouds, remains quasi-stationary upstream of the mountain peak. This condition occurs when the cold-pool propagation is approximately countered by the environmental wind. The large precipitation amounts can be attributed to weak upper-level flow, which favors stronger updrafts and upright convective cells, and to the ground-relative stationarity of the cells. This solution feature is produced with ambient wind shear within a narrow region of the parameter space explored here and does not occur in the numerical solutions obtained in the authors' previous studies with uniform wind profiles. Some preliminary experiments for wind profiles favorable to supercell development over orography will be presented.