BANDED CONVECTION IN MOIST OROGRAPHIC FLOWS

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Abstract: Vertical wind shear can act to organize shallow orographic convection embedded in an unstable cap cloud into convective bands. In this study, the role of topographic roughness in triggering and organizing banded convection is systematically investigated. To this end, three-dimensional simulations of moist flows past a two-dimensional mountain ridge are performed using a cloud-resolving numerical model. Results indicate that small-amplitude roughness elements can enhance the development of embedded convection and anchor convective bands to a fixed location in space. The resulting precipitation patterns exhibit a high variability, since regions receiving heavy rainfall can be only kilometers away from regions receiving little or no rain. First, orographic triggering mechanisms leading to the development of banded convection are investigated by introducing a small-scale bump in the large-scale ridge topography. Roughness elements in the underlying topography are found to force the location and spacing of convective bands over a wide range of scales. Furthermore, a self-sufficient mode of unsteady banded convection is investigated. This mode is not dependent on external perturbations to trigger convection and is able to propagate against the mean flow. Finally, the sensitivity of model simulations of banded convection with respect to horizontal resolution is investigated. Consistent with predictions from a linear stability analysis, convective bands of increasingly smaller scales are favored as the horizontal resolution is increased. However, the control of roughened topography on the triggering of banded convection is found to increase the robustness of numerical simulations with respect to an increase in horizontal resolution.