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- towards climate change services

Orographic precipitation enhancement by boundary-layer turbulence: evidence from vertically pointing airborne cloud radar data

B. Geerts and Q. Miao
University of Wyoming, Atmospheric Science, Laramie, WY, United States (geerts@uwyo.edu)

The University of Wyoming King Air, with multi-antenna 3 mm Doppler radar (the Wyoming Cloud Radar, or WCR), is used to examine shallow orographic precipitation growth. The key question regards how boundary-layer turbulence affects orographic precipitation growth in cold clouds. Houze and Medina and (2005) speculate that BL turbulence is important in snow growth, mainly though riming in turbulent eddies whose updraft speed far exceeds the average ascent rate over the terrain. Flight-level cloud microphysics data and WCR data were collected in flights across the Snowy range in Wyoming. The WCR Doppler velocity transects across the mountain clearly indicate intense turbulence, not in a stable shear layer intersecting the terrain (the mechanism proposed by Houze and Medina (2005)), but rather in the boundary-layer, roughly in the lowest 1 km above the undulating ground, especially on the windier days. This turbulence enhances the hydrometeor growth rate by riming, and thus more precipitation reaching the ground before the crest. Also, ice nucleation may occur along rimed surfaces on the ground, such as trees, or by snow on the ground lofted by turbulent wind gusts. The resulting ice crystals are readily mixed by BL turbuelnce, and thus the Bergeron process too may enhance the growth rate of snow. Specifically, BL turbulence co-locates supercooled liquid water and near-surface ice crystals in updrafts, where rapid growth is likely. This work addresses both the significance of BL turbulence, surface-induced nucleation, and possible interaction between the turbulence and upper level processes. This work is based on evidence from a single mountain range. It remains unclear how common the observed conditions are