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Impacts of the Westerlies on Planetary Boundary Layer Growth Over a Valley on the North Side of the Central Himalayas

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The spatial-temporal structure of the Planetary Boundary Layer (PBL) over mountainous areas can be strongly modified by topography. The PBL over the mountainous terrain of the Tibetan Plateau (TP) is more complex than that observed over its flat areas. To date, there have been no detailed analyses which have taken into account the topography effects exerted on PBL growth over the Tibetan Plateau (TP). A clear understanding of the processes involved in the PBL growth and depth over the TP's mountainous areas is therefore long overdue.The PBL in the Himalayan region of the Tibetan Plateau (TP) is important to the study of interaction between the area's topography and synoptic circulation.

This study used radiosonde, *in-situ* measurements, ERA5 reanalysis dataset and numerical model to investigate the vertical structure of the PBL and the land surface energy balance in the Rongbuk Valley on the north of the central Himalaya, and their association with the Westerlies, which control the climate of the Himalaya in winters. Two sunny November days in 2014 with different synoptic conditions in terms of large-scale wind direction and speed were selected to investigate the ways in which large-scale synoptic forcing affected the vertical structure of the PBL, atmospheric stability, surface wind field, and land surface energy fluxes. The results revealed that the valley winds and PBL growth were strongly influenced by the variations of the westerlies. When the synoptic wind direction at the height of the mountain ridges was parallel to the axis of the valley, the downward transmission of the westerlies to the valley floor (DTWTV) was strong and cause high near-surface wind speeds and sensible heat flux value, then produced an extremely deep PBL (9 km above sea level) in the early afternoon of November 23. When the synoptic wind direction at the ridge height intersected the axis of the valley and was weak, the DTWTV was weak, and the PBL became relatively low on November 28. These results demonstrate that the interaction between the topography and synoptic circulation plays a critical role in PBL growth.