

INVESTIGATION OF THE SPATIAL VARIABILITY OF THE ATMOSPHERIC BOUNDARY LAYER HEIGHTS OVER AN ISOLATED MOUNTAIN: SELECTED RESULTS FROM THE MATERHORN-2012 EXPERIMENT

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Abstract

Weather forecasting in mountainous regions remains a great challenge for the atmospheric sciences community. The relative importance of the forcing mechanisms leading to multiple and non-linear processes responsible for rapid spatial and temporal variability in the atmospheric boundary layer (ABL) structures over complex terrain is neither well understood nor adequately reproduced by present day weather forecast models. In particular, mesoscale (tens to hundreds of km) variability in the ABL heights is governed by numerous factors such as land-surface processes, underlying topography and prevailing synoptic condition. The Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) program was conducted at Dugway Proving Ground (DPG, Utah, USA) between 25 September and 24 October 2012. A suite of ground-based and airborne instruments were deployed to collect data at high spatio-temporal resolution in and above the atmospheric boundary layer. In particular, a coherent Doppler wind lidar onboard a Navy Twin Otter aircraft was deployed to aid in characterizing turbulence features within the ABL as well as the spatial heterogeneity of the top of the ABL (z_i) over an extended area around and over a steep isolated mountain (Granite Peak) of horizontal and vertical dimensions of about 8 km and 0.9 km, respectively. The Haar-wavelet based approach was applied to the TODWL derived aerosol backscatter signal profiles. The measurements obtained during three selected intensive observation periods (IOPs) that were characterized by quiescent weather conditions provided a data set appropriate for studying spatial variability of z_i in a mesoscale domain, in particular, in the vicinity of the Granite peak, located nearly at the center of the experimental region. The z_i variability was determined from aerosol backscatter profiles across nearly 1200 km of TODWL flight tracks during three IOPs. In general, an east-west gradient in z_i over the region was found for the well-mixed CBL regimes. An intercomparison between z_i obtained with radiosonde measurements over eastern and western site yielded a difference of around 200 m. The TODWL z_i measurements compare well with those from the radiosonde profiles. The near-surface micrometeorological measurements and simultaneous radiosonde profiles of thermodynamic variables over the eastern and the western sites of Granite Peak helped illustrate some of the spatial variability that was generated due to the different surface characteristics and relevant thermodynamic regimes present in the area. The tower-based micrometeorological measurements at the eastern and the western sites confirmed two different surface forcing mechanisms that yielded heterogeneity in the near-surface sensible heat flux during entire diurnal cycle, thus on spatial variability in z_i . Additionally, a precipitation event that occurred between two IOPs helped investigate the impact of two different moisture regimes on the thermodynamic features, thus, on the spatial z_i variability.

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