Abstract:
Observations from an array of five micrometeorological flux towers inside the Arizona’s Meteor Crater, which is a small, enclosed basin, were used to investigate characteristics and structures of slope flows and their interactions with the stratification of the basin. The towers were located along a west and east line with one at the bottom of the crater floor and two on each sidewall. Each tower was equipped with 3-D sonic anemometers at four levels from near surface up to 8.5 m. The month-long observations show frequent development of both upslope and downslope flows on the basin sidewalls on days with undisturbed synoptic conditions.

Keywords: stable boundary layer, slope flows, METCRAX 2006

1. INTRODUCTION

The buildup of cold air pools in enclosed basins has often been associated with the drainage of cold air down the basin sidewalls resulting in the formation of the cold air pool. The METCRAX field campaign (Whiteman et al. 2007, this volume) provides the most comprehensive data set to date for determining the role of slope flows on the evolution of cold pools in an enclosed basin. In this paper, we present preliminary results focused on slope flow structure during the evening transition period during IOP4 on 20 October 2006 using time-lapse photography and corresponding data from the two west slope flux towers. The flux towers were located on the upper and lower west slope of the crater and the camera was located at the west tethersonde site (Fig. 3; Whiteman et al. 2007, this volume).

2. OBSERVATIONS AND PRELIMINARY RESULTS

2.1 Transition period during IOP4

Time-lapse photography was used to record the dispersion of smoke plumes generated by smoke grenades ignited south of the upper west tower. The ignition of the smoke grenades occurred just as the west slope became shaded during which upslope, southeasterly winds were still present. The time-lapse photos were able to capture the flow structure at the time of transition from southeasterly upslope winds to downslope flow. The downslope flows during the transition period were very intermittent changing back to upslope repeatedly until approximately 1530 MST. Very shallow downslope winds developed at 1530 MST and continued through the evening transition. The shallow structure of the flows was well documented in the photo series of Fig. 1. As the smoke was transported downslope, entrainment of ambient air into the downslope flow was observed to occur along the slope at approximately 15:51:52 MST (Fig. 1). This entrainment dispersed the smoke vertically indicating that the flow grew in depth near the lower slope (15:52:12 MST; Fig. 1).
The transition period at the upper west slope site is also clearly indicated in Fig. 2 by a sharp change in wind direction. Winds shifted from southeasterly upslope to west northwesterly downslope at 1530 MST. Wind speeds at 1630 MST are associated with very weak vertical shear at the surface with velocities increasing from 0.5 m s\(^{-1}\) at 0.5 m AGL to approximately 1 m s\(^{-1}\) at 5 m AGL (Fig. 2). Temperatures for both towers on the west sidewall are shown in Fig. 3. The beginning of the transition period is shown in the temperature structure at the upper west slope site when the 0.5 m AGL temperature became colder than the temperatures at the 3 and 5 m levels (~1500 MST). This local cooling of the surface also occurs at the lower west tower at 1545 MST (Fig. 3).

Winds during the course of the night were light and variable with wind speeds less than 1 m s\(^{-1}\) at the upper west tower. Winds at the lower west tower (Fig. 4) however, are more variable. At approximately 0300 MST winds increased to 3-4 m s\(^{-1}\) at both sites which indicates a larger scale intrusion of background northwesterly winds into the crater. This increase in wind was associated with an approximate temperature jump of 2 ºC as shown in Fig. 3. Cooling began to occur again at about 0430 MST and the winds while still from northwest, decreased in magnitude.

SUMMARY

Preliminary analyses of slope flows during the evening transition period of METCRAX IOP4 show that the slope flows are shallow and less than about 1 m s\(^{-1}\) with a very intermittent character. Further analyses are planned that will investigate the turbulence structure of both the downslope and upslope flows for each IOP.

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REFERENCES

Figure 1. Time lapse photography during the transition period of IOP 4 on 20 October 2006. Times listed in each photo are MST. Photos were taken at 5 s intervals using a Canon Rebel XT digital SLR camera equipped with an 18-55 mm lens.

Figure 2. Time series of 5 min averaged winds at the Upper West tower during IOP 4 (20-21 October 2006).
Figure 3. Time series of 5 min averaged temperatures at the Upper and Lower West towers during IOP4 (20-21 October 2006).

Figure 4. Time series of 5 min averaged winds at the Lower West tower during IOP 4 (20-21 October 2006).