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Valley wind controlled transport of near-ground air into the upper boundary layer – Observations and simulations

Björn Brötz (1), Rafael Eigenmann (2), Volkmar Wirth (2), and Thomas Foken (1)

(1) University of Bayreuth, Department of Micrometeorology, Micrometeorology, Bayreuth, Germany (rafael.eigenmann@uni-bayreuth.de), (2) University of Mainz, Institute for Atmospheric Physics, Mainz, Germany (broetzb@uni-mainz.de)

Surface field observations of energy fluxes during the Convective and Orographically-induced Precipitation Study (COPS) in summer 2007 showed a frequent occurrence of situations of free convection over a maize field at the valley bottom of the Kinzig valley in the Black Forest, southwestern Germany. The free convection was found to be connected to periods of low wind speed during the reversal of a thermally driven valley wind system in the morning hours. Spectral analysis of the turbulence during these situations indicated the presence of large-scale eddy motions close to the ground. Often these near-ground observed turbulence characteristics could be related to enhanced vertical wind speeds measured by boundary layer profiling techniques in the valley atmosphere. Earlier studies in mountainous terrain have reported observations that in similar situations a significant transport of near-ground air up to the boundary layer inversion height took place.
In this study numerical simulations have been made in order to investigate the transport of near-ground air into the upper boundary layer controlled by valley winds. First idealized simulations investigated the isolated process and key parameters were extracted. The influence of this process was quantified and found to be significant for the time of its duration. Then more realistic simulations were made in which multiple observations from the COPS campaign were used to set the initial and boundary conditions. The results of these simulations show less significance than the idealistic case but the effect is still noticeable.