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LES modeling of surface-induced free convection in a complex valley driven by turbulent flux measurements

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During the COPS (Convective and Orographically-induced Precipitation Study) experiment 2007, eddy-covariance flux data combined with Sodar/RASS measurements in the Kinzig valley (Black forest, southwest Germany) have been used to investigate the generation of near-ground free convection events. The measured high-quality turbulent flux data revealed free convection to be induced in situations of high buoyancy fluxes and a simultaneously occurring wind speed collapse. The minimum in wind speed – observable by the Sodar measurements through the whole vertical extension of the valley atmosphere – is the consequence of a thermally-induced valley wind system, which changes its wind direction from down to up-valley winds in the morning hours. Buoyant forces then dominate over shear forces within turbulence production. These situations can be detected with the help of the stability parameter z/L (z: height, L: Obukhov length) which can be calculated from directly measured turbulent fluxes. Free convection can be assumed for values of z/L below -1.

Large-Eddy Simulations of the boundary layer were carried through in order to understand whether the above mentioned mechanism is responsible for the observed free convection. First, idealized simulations will be presented to show the principle ability of the model to simulate a suppression of convection by wind in a valley. Second, model runs are set up with more realistic initial and boundary conditions and topography. These simulations are driven by the data of the flux measurements which are assimilated to the model grid in a prior step.