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Validation of WRF single-column model surface layer simulations with the PABLS'15 campaign

Rita Sz Virág (1), Hajnalka Breuer (1), Ágoston Tordai (1), András M Rehák (2), Júlia Göndöcs (1), and Tamás Weidinger (1)

(1) Eötvös Loránd Tudományegyetem, Department of Meteorology, Budapest, Hungary, (2) Budapest University of Technology and Economics, Department of Hydraulic and Water Resources Engineering, Budapest, Hungary

One of the most challenging aspects of numerical weather modelling is the treatment of boundary layer, especially in stable or near neutral stratification conditions. In the absence of intensive turbulent motions, e.g. at night the boundary layer processes are more determined by the surface fluxes than during the day. The coupling between surface fluxes and the boundary layer schemes are treated by schemes of surface layer. The representation of this coupling affects temperature predictions in winter and the daily minimum temperatures throughout the year over continental, landlocked areas. Since our knowledge on the surface layer is limited, and because the numerical weather prediction models cannot afford large-eddy-scale computations, simplification is required in the estimation of exchange processes. The most frequent methods include some form of similarity theory – on the basis of Monin-Obukhov similarity theory.

In 2015 in the scope of the Pannonian Atmospheric Boundary Layer Experiment, a series of multicopter, tethered balloon and flux measurements were taken place in southern Hungary over a period of 5 days, over a flat, homogeneous area in the middle of the Pannonian Plain. The aim of the measurements was to analyse the night-time stable environment of the boundary and surface layer, and if it is possible the transition between stable and unstable regimes. Depending on the instrument, each flight reached 80-200 m height, with a data resolution of 10-30 cm, temperature and relative humidity were available in all cases. The WRF single column model, is used to test different parameterization schemes. Since the surface layer fluxes depend on the surface information, the soil and vegetation parameters have been determined according to the measurement site, soil initial conditions were determined from measurements and simulated fluxes were tested against the continuous flux measurements. The model setup used 61 atmospheric vertical layers, where 22 layers are found in the lowest 200 meters. From the available parameterizations, 26 combinations were chosen and analysed. Initial results show that the vertical gradient of the temperature is captured by simulations, but the moisture flux is not well captured. A cluster analysis on the errors also show that in case of 1st and 1.5 order closure schemes the choice of surface layer scheme results is small variances, but in case of 2nd order closure, the choice of surface layer parameterization is an important factor.