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Calculating the turbulent fluxes in the atmospheric surface layer using feedforward networks

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Artificial neural networks (ANNs) are common to solve non-linear relationships between input and output variables as universal approximators. Functional relations can often be expressed by shallow and quite simple feedforward networks, also known as multi-layer perceptrons (MLPs). This kind of networks was utilised to estimate the turbulent fluxes of momentum and heat in the atmospheric surface layer to enhance the modelling of atmosphere and surface interactions. During the training and validation procedure about 390,000 data tuples were processed. For each data tuple, measurements of temperature and wind speed in two different heights above ground and for validation the scales of wind and temperature u_* and T_* were required. This data originates from hourly multi-year time series from seven different measurement sites covering three various land usage types namely grassland, forest and wetland.
Different network set-ups and combinations of input variables were investigated. All results were compared to a conventional iterative calculation method following the Monin-Obukhov similarity theory (MOST). Results of best ANNs are comparable to those calculated with the classical MOST. These results and the effects of input data quality, data preprocessing and network architecture will be presented for selected MLPs. For example, experiments showed that the use of MPLs with only one single hidden layer is mostly sufficient to describe the variations of the turbulent fluxes.