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Evaluation of the three dimensional mesoscale model WRF for the GABLS3 intercomparison case study, and model improvement for the low-level jet

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Correct forecasting of the diurnal cycle of the atmospheric boundary layer (ABL) is of key importance for many applications in wind energy engineering, weather forecasting, agriculture, and air quality prediction. Previous research has shown models are very sensitive to the selected boundary-layer parameterization. Each model has a different method for ABL height estimation and turbulent diffusion. In this contribution we extend the GABLS3 column model intercomparison (Bosveld et al., 2011; http://www.knmi.nl/samenw/gabls/), by evaluating the WRF three dimensional model (version 3.2.1) for the same case. Preliminary results show satisfactory model behaviour for net radiation with comparison to Cabauw observations (Netherlands). It is worth mentioning that a 20 [W/m-2] positive bias in long wave downward radiation as in earlier studies has been confirmed. Two meter temperatures are slightly underestimated during daytime, and substantially underestimated at night. Concerning, vertical profiles, the YSU ABL scheme in WRF overestimates the ABL depth and low level jet (LLJ) altitude. The modelled LLJ speed also is too low according to the validating radio-sounding measurements in de Bilt (Netherlands, KNMI measurement site) and at Cabauw. To circumvent the relatively poor skill of the YSU scheme for the LLJ, the YSU scheme has been modified by implementation of the ABL height definition in Vogelezang and Holtslag (1996). The latter accounts for the fact that the ABL depth is related to both boundary layer wind shear and near surface mechanical shear production. The modification results in an improvement of LLJ shape, i.e. the LLJ speed increases and the LLJ altitude is lowered and both become in closer agreement with the observations.