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Evaluation of the atmospheric boundary layer schemes in the mesoscale models WRF and RAMS using scintillometry and in situ observations at Cabauw

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Limited area models are widely used for high resolution weather forecasting and atmospheric research. These models also provide the meteorological input for air quality forecasting and for inverse modeling studies, e.g. for identification of CO_2 sources and sinks. The success of these applications depends on the accuracy of the provided meteorology, especially in the atmospheric boundary layer and close to the surface.

We evaluate the atmospheric boundary layer schemes in the mesoscale models WRF and RAMS for two contrasting apparent golden days (i.e. calm and windy) in The Netherlands, for both grassland and forest sites. The windy case is exclusive because of a large humidity jump between the boundary layer and the free atmosphere, and is therefore particularly interesting to study the representation of entrainment. Also, the influence of different boundary conditions will be assessed.

The model intercomparison reveals that radiation components are estimated reasonably well by both models. Both models forecast the latent heat flux correctly, but relatively large differences occur for sensible heat flux and boundary layer height. Observations of the PBL potential temperature and humidity suggest other optimal settings for the energy flux model than the surface flux observations. Standard RAMS energy fluxes return a cold bias in the PBL. WRF and RAMS with increased Bowen ratios, capture the atmospheric temperature correctly but overestimate the Bowen ratio. The uncertainty in the surface energy fluxes is reflected in height of the PBL, which also differs substantially between the two models. Note that our model results appear insensitive to the choice of the initial and boundary conditions (ECMWF or NCEP).

Thus, we find that the observed surface sensible heat flux cannot explain the boundary layer growth and energy content during the day. Therefore, a further discussion of both the observed and modeled terms of the heat budget equation is required to understand the found discrepancy.