Calculation of surface fluxes – a proposed formulation for EULAG

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Near-logarithmic vertical variability of temperature and wind speed in the atmospheric surface layer can hardly be resolved explicitly in meteorological models with vertical resolution of an order of 10 m or coarser. Hence, either some sort of a subgrid transport parameterization, or a proper specification of the lower boundary condition should be used. A standard treatment of this issue in meteorological models relies upon the Monin-Obukhov similarity; usually, this is done by using no-slip conditions together with a specified value of the ground surface temperature, calculated from the surface heat budget equation. Using wind speed and temperature calculated at the lowest atmospheric model level, and employing either empirical functions or functions derived from a RANS-model, it is then possible to calculate surface layer stability parameters, surface fluxes, and integral (effective) transfer coefficients for the lowest model layer. In the EULAG, another option is used: the surface heat flux is specified externally, and the momentum flux results from a no-slip or a partial-slip lower boundary condition. Nevertheless, there remains an issue of the subgrid varibility of velocity near the ground, and its dependence on the static equilibrium, which should be handled adequately.

During an attempt to construct a proper formulation, we found an interesting duality of solutions in the stable range. It turns out that given the 'geometry' (height of the model level where wind speed and temperature values are available, aerodynamical and thermal roughness heights), and the value of surface heat flux, we obtain two different values of surface drag. Is this effect physical? If so, what is the meaning of these solutions, and are there corresponding different scenarios in the nature? An investigation of these questions using a simple 1-D ABL model will be presented.