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Observations and modeling of the wind profile and wind turning in the atmospheric boundary layer

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We illustrate observations of the variation of both horizontal wind components with height from combined sonic and wind lidar measurements from 10 m up to 1200 m. The observations were carried out within a one-year campaign at Høvsøre, a flat coastal farmland area in western Denmark. The observations are analyzed over a wind sector, in which the upstream topographical conditions are nearly homogeneous, and a number of cases representing a variety of forcing, stability, turbulence and wind conditions are presented. For the turbulence and stability conditions we use the sonics located on booms along a 116 m meteorological mast. A pulsed wind lidar, located besides the mast, complements the sonic measurements of both horizontal wind components from 100 m up to 1200 m. For the forcing conditions, we perform numerical simulations as we do not have observations of the horizontal pressure and temperature gradients.

The simulations are done using the WRF mesoscale model and the outputs of variables such as pressure and geopotential are used to derive the surface geostrophic wind, gradient wind (the surface geostrophic wind accounting for centrifugal forces) and the thermal wind, and therefore the total geostrophic wind (adding the thermal to the gradient wind). Such geostrophic winds are helpful for understanding the behavior of the wind profile and wind turning particularly close to the boundary-layer height as the observed wind approaches them far from the surface and thus can be used to analyze the wind shear and wind turning.

The observed wind profiles nicely approach the simulated geostrophic wind close to the boundary-layer height under both barotropic and baroclinic conditions. The largest deviations (the wind is highly ageostrophic) are found under a period where a low-level jet is observed. The simulated wind from WRF is generally underpredicted, particularly higher up, as well as the wind turning.