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Wind profile in the coastal boundary layer: wind lidar measurements and WRF modelling

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Traditionally it has been difficult to verify meso-scale model wind predictions against observations in the planetary boundary layer (PBL), because of the influence of unresolved microscale features and uncertainty in synoptic scale forcings. In this study we use measurements from a new wind lidar to study the PBL up to 600 m above the surface at a flat coastal site during a one month period in autumn. Because of the large vertical extent of the measurements, it is now possible to study the sensitivity of PBL schemes to both lower and upper boundary conditions. We ran the Weather Research and Forecasting model (WRF-ARW) with two different roughness descriptions over land, two different synoptic forcings and two different PBL schemes at two vertical resolutions.

The surface layer fluxes were found to be largely overestimated by WRF and the wind profile did not have enough vertical shear in the lower part of the PBL. By replacing the roughness for the land surface used with a more representative mesoscale roughness the observed bias in friction velocity and heat flux is reduced and the prediction of the wind speed at 100 m and above slightly improved. In homogeneous upwind conditions, both PBL schemes showed too much mixing during stable conditions and underestimated the amount of low level jets when compared to observations. In all simulations results concerning wind profile shape, magnitude and turbulent fluxes were not improved when a higher vertical resolution was used.