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WRF-LES simulations of real episodes in complex terrain and comparison with height-resolving ground-based remote sensing data

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To quantify the land-surface-atmosphere interactions in a regional climate model, the simulation first has to plausibly represent the properties of the atmosphere, especially in the atmospheric boundary layer. As turbulence is the most important driving factor for exchange processes between surface and atmosphere, the model has to be turbulence resolving, if small scale fluxes are of interest.
To achieve this, we use high resolution WRF-LES to simulate two 48 hour periods over complex terrain in Southern Germany in a non-nested approach. The model resolution is at $30m$ horizontally and $\backsim 11m$ vertically up to $\backsim 2000m$ a.s.l., then stretching. Realistic boundary conditions are achieved by using a digital elevation model, land use, land cover and vegetation maps and meteorological boundary conditions from reanalysis data. The model domain covers $225km^2$ within the TERENO (Terrestrial Environmental Observatories) pre-Alpine area.
The simulations are compared to data from height-resolving ground-based remote sensing instruments (Doppler LIDAR, RASS, SODAR) employed during the ScaleX measurement campaigns in July 2015 and 2016. Comparisons of modeled vs. measured data generally show a good agreement in the observed variables (temperature, humidity, wind speed, wind direction).
The model is able to represent the characteristic atmospheric properties of the area like the formation and disappearing of daytime and nocturnal boundary layers, low level jets over the nocturnal boundary layer and local topographical modifications to wind directions. Simulated wind speeds are $\backsim 1.5ms^{-1}$ higher than measured on average, but the maxima are underestimated by up to $2ms^{-1}$ in the low level jet. Due to the low temporal resolution of the atmospheric boundary conditions the timings of boundary layer formations or the onset of the low level jet are, on some instances, misjudged.
The simulated high resolution data allows for a four dimensional view on heat and moisture fluxes that cannot be achieved through measurements.