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Fetch effects of forest canopy on flux measurements

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The flux measured above a canopy often deviates from the source strength due to the consequence of limited fetch. Any natural surface is commonly more or less heterogeneous, which violates the assumption of horizontal homogeneity for most micrometeorological measurement methods. This affects methods such as the eddy covariance technique where fluxes are measured in situ from a mast and the source area (or footprint) of the measurements lies upwind from the mast. Hence, in order to understand how the horizontal scale of heterogeneity influences scalar transport as well as the footprint of the measurements, we study the effects of the scale of surface heterogeneity to the measurements conducted at different measurement heights. Numerical simulations of flow over forest canopy with varying scales of heterogeneity were performed using a large eddy simulation (LES) model PALM. LES provides us a means of studying detailed and highly resolved turbulence and understanding the combined effects of forest terrain. The results show that the flow over canopy is sensitive to the size of homogenous fetch and the complexity of terrain. In particular, when the size of fetch is getting smaller and more complex, the local turbulence affects scalar transportation strongly. This has implications for the transport of scalars in the forest canopy. The blending height of scalar in relation to the scale of heterogeneity, measurement height and site location are also discussed. Furthermore, these results show great potential of LES for a wide range of applications in the field of micrometeorology including the determination of placing of instruments and the interpretation of measurements in complex forest terrain.