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Simulation of momentum transfer by vegetation using 3-D non-hydrostatic meso-scale Model

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A 3-D non-hydrostatic meso-scale model is applied to the simulation of wind and turbulence in a plant canopy with a focus on the estimation of vegetation roughness length (z0) and displace height (d). Model vegetation is characterized according to vegetation type by using leaf area density, vegetation height, and leaf area index. The model predicts 3-D wind circulation and turbulence structure within and above the canopy from which z0 and d are estimated. Sensitivity of z0 and d to the canopy architecture and the unknowns in the model parameters controlling momentum transfer by vegetation are examined. For the purpose, the model is first applied to the simulation of wind fields in the spatially homogeneous canopy for which field measurements are available from the literature. Contributions of other forcing terms to wind profile in canopy, which are not considered in the 1-D models are examined. Next, the model is applied to spatially heterogeneous forest in Germany using high-resolution vegetation data. Sensitivity of the predicted z0 and d to the spatial resolution of vegetation is examined. The results can be used to improve the parameterization of z0 and d for regional- and global-scale atmospheric models in which small-scale canopy architecture is not resolved.