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# Flow adjustment inside homogeneous canopies after a leading edge - An analytical approach backed by LES

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A two-dimensional analytical model for describing the mean flow inside a vegetation canopy after a leading edge in neutral conditions was developed and tested by means of large eddy simulations (LES) employing the LES code PALM. The analytical model is able to predict the mean flow in the region directly after the canopy edge, the adjustment region, where one-dimensional canopy models fail due to the sharp change in roughness. The derivation of the adjustment region model is based on an analytic solution of the two-dimensional Reynolds averaged Navier-Stokes equation in neutral conditions for a canopy with constant plant area density (PAD). The main assumptions for solving the governing equations are separability of the velocity components concerning the spatial variables and the neglection of the Reynolds stress tensor gradients. These two assumptions are verified by means of LES. To determine the emerging model parameters, a fitting scheme is simultaneously applied to the velocity and pressure data of a reference LES simulation. Furthermore a sensitivity analysis of the adjustment region model, equipped with the previously calculated parameters, is performed varying the three relevant length scales, the canopy height ($h$), the canopy length and the adjustment length ($L_c$), in additional LES. Even if the model parameters are, in general, functions of $h/L_c$, it was found out that the model is capable of predicting the flow quantities in various cases, while using constant parameters. Finally, the adjustment region model is combined with the one-dimensional model of Massman [*Boundary-Layer Meteorol.*, 83(3):407-421, 1997], which is applicable for the interior of the canopy, to attain an analytical model capable of describing the mean flow for the full canopy domain.