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Plant area density extraction from aerial LiDAR scans for CFD applications over forests

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In CFD-Reynolds-averaged Navier-Stokes (RANS) applications over complex terrain, the forest architecture is often a critical information needed in order to properly conduct a wind flow analysis. In this work, a numerical treatment built around a local binning algorithm was developed in order to generate a 3D grid of plant area density (PAD) using aerial LiDAR scans. These LiDAR-based datasets consist in a set of xyz coordinates providing valuable information on the spatial heterogeneity, both concerning the forest height and density as well as the terrain elevation. In CFD-RANS, the effect of the forest is often parametrized through effective source terms in the momentum and turbulence model equations. The PAD then emerges as an explicit variable to be determined and is defined here as the static one-sided frontal area of solid plant parts per unit volume. A discrete analogy of the Beer-Lambert law, which relates the light attenuation in forest canopies to an exponential decay, was applied to compute the needed PAD estimates. A first sensitivity analysis using the developed framework regarding key wind flow field parameters such as the velocity, the turbulent kinetic energy and the wind direction is presented. Resolution issues about the forest and CFD grids are furthermore discussed.