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Mathematical Methods of Modelling the Morphology of Spruce Trees

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Radiative transfer (RT) models are simulation tools which can be used to quantify relationships between vegetation canopy properties and observed remotely sensed data. This study aims at creating a spruce tree growth model as a key input for use in RT models. The spruce tree model is built on data obtained from terrestrial laser scanning of spruce trees. Each tree model is unique. This uniqueness is achieved by using L-systems which are able to simulate natural randomness while complying with the given tree parameters. L-systems are established on a theory of grammar that enables rewriting a string of symbols according to specified rewriting rules.

In practice, our tree models are generated in Blender visualization software, implementing an algorithm written in Python. The algorithm generates the basic parameters of the whole tree and then creates the parameters of the spruce trunk and initial branches. The parameters are generated randomly within a range that is calculated from measured data. Then each branch is grown on the basis of annual increments defined by field measurements. Tree needles are distributed with respect to the age of individual branches; therefore, the needles have different colors according to their age.

Cones and faces are graphical representations of the spruce model. Branches are represented by cones and needles are represented by faces around the branches. The faces are transparent, thus simulating light transmittance in-between the needles. The whole model is highly computationally demanding, especially with respect to computer memory.