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- Recent Final Revised Papers
- Volumes and Issues
- Special Issues
- Library Search
- Title and Author Search

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General Information
Submission
Review
Production
Subscription
Comment on a Paper

Volumes and Issues | Contents of Issue 4

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Towards understanding tree root profiles: simulating hydrologically optimal strategies for root distribution

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Abstract. In this modelling study differences in vertical root distributions measured in four contrasting forest locations in the Netherlands were investigated. Root distributions are seen as a reflection of the plant's optimisation strategy, based on hydrological grounds. The "optimal" root distribution is defined as the one that maximises the water uptake from the root zone over a period of ten years. The optimal root distributions of four forest locations with completely different soil physical characteristics are calculated using the soil hydrological model SWIF. Two different model configurations for root interactions were tested: the standard model configuration in which one single root profile was used (SWIF-NC), and a model configuration in which two root profiles compete for the same available water (SWIF-C). The root profiles were parameterised with genetic algorithms. The fitness of a certain root profile was defined as the amount of water uptake over a simulation period of ten years. The root profiles of SWIF-C were optimised using an evolutionary game. The results showed clear differences in optimal root distributions between the various sites and also between the two model configurations. Optimisation with SWIF-C resulted in root profiles that were easier to interpret in terms of feasible biological strategies. Preferential water uptake in wetter soil regions was an important factor for interpretation of the simulated root distributions. As the optimised root profiles still showed differences with measured profiles, this analysis is presented, not as the final solution for explaining differences in root profiles of vegetation but as a first step using an optimisation theory to increase understanding of the root profiles of trees.

Keywords: forest hydrology, optimisation, roots

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