

Water relations in the soil-plant system: what can we learn from functional-structural plant models

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Water movement in the plant is driven by water potential differences between the atmosphere, the shoot, the roots and the surrounding soil. At the shoot level, the plant tightly regulates the total water demand through the regulation of stomata. At the root system level, continuous interactions between heterogeneous (in time and space) soil and root hydraulic properties influence the amount of water entering the plant.

At the root scale, hydraulic properties are defined by anatomical (e.g. presence of endodermis, number of xylem poles) and functional features (e.g. expression of aquaporins). At the plant scale, these features are combined into a root hydraulic architecture, that ultimately defines the intrinsic capacity of a plant to uptake water.

This uptake capacity is subordinate to the amount of available water in the surrounding soil. In dry soil portions, low soil water potential and hydraulic conductivity, both directly linked to the soil water content, restrict local water flows and can have a strong effect on the overall uptake process.

Using two functional-structural plant models (PlaNet-Maize and R-SWMS) we will show that regulatory processes, both at the plant or the soil level, must be explicitly considered when exploring water uptake mechanisms. We will show how these processes interact and influence with each other and why functional-structural plant models are essential tools to their study.