Geophysical Research Abstracts
Vol. 14, EGU2012-13999, 2012
EGU General Assembly 2012

Has the plant genetic variability any role in models of water transfer in the soil-plant-atmosphere continuum ?

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Water transfer in the SPAC is essentially linked to environmental conditions such as evaporative demand or soil water potential, and physical parameters such as soil hydraulic capacity or hydraulic conductivity. Models used in soil science most often represent the plant via a small number of variables such as the water flux that crosses the base of the stem or the root length (or area) in each soil layer. Because there is an increasing demand for computer simulations of plants that would perform better under water deficit, models of SPA water transfer are needed that could better take into account the genetic variability of traits involved in plant hydraulics. (i) The water flux through the plant is essentially limited by stomata, which present a much higher resistance to water flow than those in the soil – root continuum. This can lead to unexpected relations between flux, leaf water potential and root hydraulic conductance. (ii) A large genetic variability exists within and between species for stomatal control, with important consequences for the minimum soil water potential that is accessible to the plant. In particular, isohydric plants that maintain leaf water potential in a narrow range via stomatal control have a higher (nearer to 0) 'wilting point' than anisohydric plants that allow leaf water potential to reach very low values. (iii) The conductivity for water transfer in roots and shoots is controlled by plants via aquaporins. It largely varies with time of the day, water and nutrient status, in particular via plant hormones and circadian rhythms. Models of SPA water transfer with a time definition of minutes to hour should probably not ignore this, while those with longer time steps are probably less sensitive to changes in plant hydraulic conductivity. (iv) The "dogma" that dense root systems provide tolerance to water deficit is profoundly affected when the balance "H_2O gain vs C investment" is taken into account. At least three programmes of recurrent selection for drought tolerance have resulted in a decrease in root biomass. Overall, it is now crucial to take into account the rapid progress in plant hydraulics in SPA models of water transfer. Several projects aim at this objective, in particular the EU project DROPS that gathers geneticists, plant modellers and soil modellers.