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# Plant adaptation in saline environments and effects on root water uptake

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This work extends a well-known model of plant carbon uptake limited by water loss to account for salt-induced stress. Understanding how plant adapt to different stress sources, such as droughts, hypoxic or hyper-saline conditions, is, in fact, important to gain a deeper comprehension of how plants react to a changing climate, to changes in edaphic conditions, e.g. induced by excessive irrigation, and to better understand the physiological adaptations controlling plant competition both in the terrestrial and the aquatic environment.

In this overall framework we particularly focus here on the effect of salinity on plant transpiration and photosynthesis.

First, we developed a model based on the stomatal optimization principle, which assumes that plants attempt to maximize carbon gain while limiting water loss. We extend the classic formulation which only includes limitation by water loss by accounting for the effect of salinity. Salinity, in fact, directly influences leaf physiological attributes, such as mesophyll conductance and photosynthetic parameters, thereby influencing the overall 'cost' of water to the plant. We calibrate and validate the model with published datasets for different types of plants artificially subjected to salinity stress. We explored a linearized model and we compared the results with the original model ones. The results of the model are consistent with the datasets analyzed, and we found that the cost parameter (which sets the tradeoffs between carbon gain and water loss) increases with salinity as it does in water stress conditions.

Using the results obtained at the leaf scale, we then modeled the root water uptake using a coupled model of subsurface flow based on a modified Richards' equation that accounts for the effects of increasing salinity, anaerobic conditions, water stress and compensation factors. Plant water uptake is considered as a soil moisture sink term with a potential rate dictated by the carbon demands of the leaves, and an actual rate that accounts for both - hydraulic and salinity limitations. The soil-plant-atmosphere continuum formulation adopted allows local and global constraints on root water uptake, as well as water redistribution processes, to emerge naturally with no need of ad hoc assumptions.

We aim to further use the model to explore the mechanism selecting for the root biomass distribution with depth, as a function of soil properties and forcing characteristics.