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FROM PLANT TO FIELD: A NOVEL MECHANISTIC APPROACH TO MODELING SOIL-PLANT-ATMOSPHERE INTERACTIONS AT THE WATERSHED SCALE

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SUMMARY

A numerical model of soil moisture dynamics is coupled with plant transpiration, photosynthesis and growth. Soil moisture dynamics is modeled by the 3-D Richards equation and plant uptake is described by an Ohm's law type model accounting for water potential gradients and root, xylem and stomatal conductances. The transpiration flux from soil to the atmosphere is driven by the leaf water potential which is controlled by both local soil moisture and atmospheric forcing. The hydraulic model is linked to the atmosphere by the calculation of the stomatal conductance which is optimized for maximum carbon gain considering Fickian mass transfer of CO_2 *and* H_2O *through stomata and a biochemical model of photosynthesis. Dry matter accumulation is calculated from daily* CO_2 *assimilation accounting for respiration costs and allocation of carbohydrates to the different plant organs. The toxicity of salt concentration in the topsoil is addressed by considering osmotic stress and inhibition of the photosynthetic efficiency. The model is applied to a 25 ha basin cultivated with maize crop on the Venice coastland to investigate the ecohydrological processes and feedbacks occurring at the site. The model is applied at the basin scale to understand the impact of land elevation, soil heterogeneities, and seawater contamination on crop dynamics. To our knowledge, this is the first time that a fully 3-D hydrologic model is coupled with the stomatal optimization theory and applied at the field scale to simulate vegetation-hydrology interactions. Limitation and perspectives of eco-hydrological modeling for farmland and ecosystems management are discussed.*