Implementation of an Optimal Stomatal Control Approach in the Variable Infiltration Capacity (VIC) Model

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Abstract. The VIC model is a widely used macro-scale hydrologic model that allows continuous simulation of the water and energy balances at the land surface-atmosphere interrface. Sub-grid variability allows specification of different plant functional types, each with a suite of parameters used to define the micro-climate and seasonal vegetative response. Transpiration in the VIC model utilizes the Penman-Monteith equation, which includes the specification of a canopy resistance term. The current version of VIC uses a Jarvis approach for canopy resistance, which allows a linear step-wise stomatal resistance response to soil moisture and vapor pressure deficits, and non-linear responses to light and temperature. We implement an improved stomatal resistance formulation based on a set of optimality hypotheses and biophysical models such that water use efficiency is maximized. This improved approach allows for additional responses to changing atmospheric CO_2 and other biochemical controls, and allows for explicit calculation of carbon assimilation. Additionally, the biochemical parameters controlling assimilation and light response also vary with temperature, rather than assuming static response functions. Results with this improved representation accounting for optimal and biophysical stomatal control are compared to simulations using the current VIC model.