CO2 and Hydraulic Conductivity

Plant hydraulic architecture influences transpiration through its effect on g_s (Meinzer et al. 1997). Yet the interaction between g_s and plant hydraulic architecture within an elevated C_a context has been largely neglected (Phillips et al. 2011). The dependency of transpiration on plant hydraulic architecture is formulated via a simple one-dimensional flow model (Tyree and Zimmerman 2002):

$$E = k_L(\Psi_s - \Psi_L) \quad (1)$$

where E is leaf-level transpiration rate (mmol m^{-2}(leaf) s^{-1}), k_L is leaf-specific hydraulic conductance (mmol m^{-2} s^{-1} MPa^{-1}), is soil water potential (MPa), and is leaf water potential (MPa). The leaf-specific hydraulic conductance can be further divided as:

$$k_L = \frac{H_V K_S}{h} \quad (2)$$

where H_V is the Huber value (sapwood area divided by leaf area, m^2 m^{-2}), K_S sapwood specific hydraulic conductivity (mmol $s^{-1}m^{-1}MPa^{-1}$)and h tree height (m) (representing the path length for water transport). If this framework is correct, a decrease in E_L can be expected to be accompanied by an increase in, or a decrease in k_L. If k_L changes with elevated C_a, it can be the result of a decrease in H_V or K_S, or opposite changes in both these components might compensate (assuming h is constant). Reports from the literature on each of these components are mixed. For example, it is commonly observed that is unaffected by elevated C_a (Phillips et al. 2011), or even decreases (Bunce 1995, 1996). Some studies have reported a decrease in k_L with elevated C_a, while did not change (Bunce and Ziska 2002; Eamus et al. 1995). Other studies found that and k_L did not change but the H_V increased in response to elevated C_a (Phillips et al. 2011), re-calculated from their Table 1). These contrasting results, and lack of critical data, emphasise the scarcity of studies relating the decrease in transpiration at elevated C_a with plant hydraulic architecture.