The coupled carbon-water cycle in the terrestrial biosphere

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Topic 2: Eco-physiology of leaf transpiration and photosynthesis.

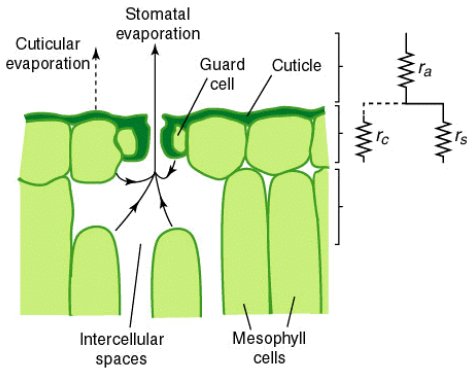

Figure 7.1 Pathways for water loss from one surface of a leaf, showing the boundary layer (r_a), cuticular (r_c) and stomatal (r_s) resistances. The leaf resistance is in parallel sums of two resistances, one representing r_s and the other plus r_c (Freely adapted from Jones, 1983; p. 110)

Jan Baptist van Helmont is credited with coining the word ‘gas’ in the 17th century and noting that ‘gas sylvestre’ (carbon dioxide) is given off by burning charcoal. He also investigated water uptake by a willow tree in 1648, in effect performing one of the earliest recorded experiments on stomatal conductance to gas transfer. Centuries later, both of van Helmont’s activities converged in a modern-day story: Atmospheric CO2 is rising largely because of the combustion of fossil fuel, and the ability of terrestrial plants to uptake CO2 is currently a leading mitigation strategy to offset this rise. Because the role of stomata in regulating the exchange of CO2 for water is central to many plant and ecosystem processes, services and products, variations in stomatal conductance and in their responses to environmental variables have been subjected to intense research for decades, though no complete satisfactory theory emerged.

In this session, the basics of photosynthesis, leaf transpiration, and the economics of gas exchange in the context of optimality theories are covered.

References:

Katul, G.G., S. Palmroth, and R. Oren, 2009, Leaf stomatal responses to vapour pressure deficit under current and CO2-enriched atmosphere explained by the economics of gas exchange, *Plant, Cell, and Environment*, 32, 968-979

Katul, G.G., S. Manzoni, S. Palmroth, and R. Oren, 2010, A stomatal optimization theory to describe the effects of atmospheric CO2 on leaf photosynthesis and transpiration, *Annals of Botany*, 105(3):431-442

Group Project: Comparisons between optimality theory predictions and numerous empirical and semi-empirical formulations will be conduced using a wealth of gas exchange measurements.

Extra Material: Matlab Code of the models in Katul et al. (2010) will be supplied as a starting point.