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Interactive comment on "Spatial and temporal variations in plant Water Use Efficiency inferred from tree-ring, eddy covariance and atmospheric observations" *by* Margriet Groenendijk et al.

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This discussion paper cites Prentice et al. (2014), but overlooks its significance for water use efficiency (WUE).

The new theory introduced by Prentice et al. (2014) replaces the Cowan-Farquhar stomatal optimization principle with a more explicit and comprehensive hypothesis: that plants minimize the sum of the costs (per unit assimilation) of maintaining both the biochemical capacity for photosynthesis and the physical capacity for transpiration. We showed how this minimum is obtained by maintaining a 'set point' of the ratio χ of leaf-internal to ambient CO2, whose value is almost independent of ambient CO2, but dependent on vapour pressure deficit (D) and temperature. See also

http://dx.doi.org/10.1101/040246 where the theory is further tested with leaf δ13C measurements, and extended to include the additional effects of atmospheric pressure.

The exact form of these dependencies (equation 8 in Prentice et al., 2014) can be used to obtain the derivatives of ln (WUE) with respect to different predictors. For ln CO2, the derivative is always > 1. For example, at 400 μmol mol–1 CO2 and 10C, the derivative is 1.05 and at 30C it is 1.16. For ln D, the derivative is < –0.5 and depends primarily on the value of χ. It is approximately –0.62 for χ = 0.8 (a typical value for cold, wet climates) and –0.73 for χ = 0.6 (a typical value for warm, dry climates).

Therefore, the values obtained for these dependencies seem to be more in line with new theory than old. The data would repay a more penetrating statistical analysis that would allow the emegence of dependencies that are explicitly predicted by the new theory.

Prentice, I.C., N. Dong, S.M. Gleason, V. Maire and I.J. Wright (2014) Balancing the costs of carbon gain and water loss: testing a new quantitative framework for plant functional ecology. Ecology Letters 17: 82-91.

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