A data-based cross-site evaluation of (optimal) carbon gain and water use strategies as expressed in FLUXNET eddy covariance data.

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Introduction

The concept of some form of optimisation of the exchange of carbon for water by plants has attracted limited interest following the seminal publications of Cowan and Troughten (1972); Cowan and Farquhar (1977) and Cowan (1982). One of the reasons why the take-up of these concepts has been rather limited is the requirement for the specification and differentiation of the 'transpiration function' (Cowan 1982). Given specification of this function is model dependent, it is difficult to claim objectivity for the results from such an analysis. Also, because the transpiration function is highly non-stationary, its specification and differentiation is often not possible when analysing data collected under the very conditions of interest i.e. plants and plant canopies operating in their natural adapted state.

The FLUXNET data-base provides an ideal opportunity to, for the first time, evaluate these theories at the canopy scale under natural conditions providing an alternative data-based framework for analysing carbon gain and water use strategies can be identified. Jarvis (in prep) has suggested that the estimation of the objective functions associated with strategies such as optimisation (of any carbon gain strategy) can be done using model-free, data-based methods such as repeat randomised rescaling of flux data (see Figure 1). This opens up the opportunity to rigorously evaluate carbon gain and water use strategies in flux data where previously the classic approach of say Cowan and Farquhar (1977) was not possible in any meaningful way.

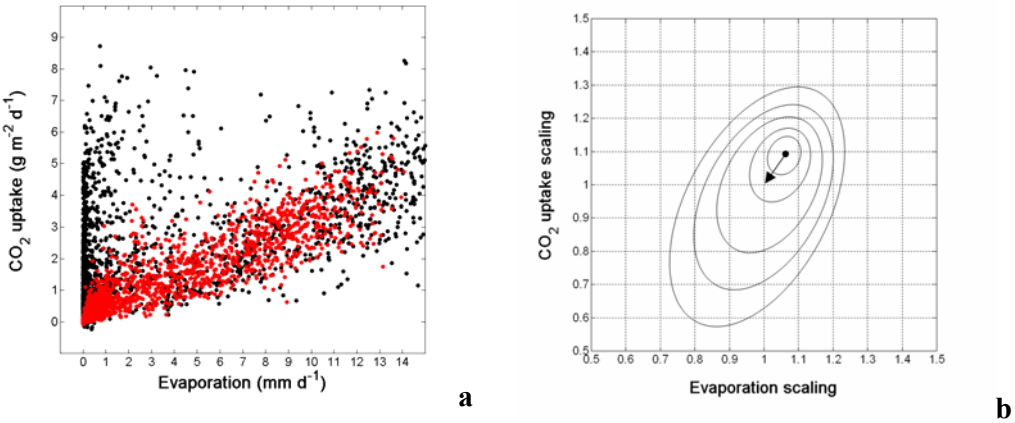

Figure 1. a. The relationship between evaporation and gross CO_2 uptake for the Harvard Forest flux site 1996-2001. The black dots are potential rates and the red dots are the observed rates derived from daily aggregated EC data. b. The response surface of the cost function $J = f\{A,T\}$ as a function of scaling of the data shown in 1a. The contours are equipotentials and the black dot marks the minimum which is plotted in relation the observed case 1:1. The difference between the optimal scaling and 1:1 is a measure of sub-optimality for this site in relation to the selected objective function J.

Aims and objectives

This proposal will assess two aspects of eddy covariance observations of CO_2 and H_2O flux within the FLUXNET synthesis data-base. Firstly, it will assess the degree of sub-optimality within site (see Figure 1b) and compare this between sites to assess what factors cause sub-optimal behaviour. Issues of robustness in relation to environmental predictability will be a primary consideration here. Secondly, the value of the cost function(s) will be compared between sites to assess what factors affect optimal strategies of different sites. Issues of resource (light, temperature, nutrients and water) availability will be a primary consideration here.

Data requirements

For both of the analyses identified above it is critical to access to the broadest possible range of biome types and climatic regimes in order to sample the fullest possible range of the resource availability and environmental predictability space. The analysis will require forest, grassland, tundra and mixed canopy sites.

References

Cowan IR and Farquhar GD (1977) in. Jennings DH (ed) Cambridge UP, pp471-505
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Co-authorship rules

The proposer is prepared to abide by proposed co-authorship guidlines, namely:

- All the data providers will be invited to give additional intellectual input.
- Additional intellectual input (like discussion of methodology and results, writing of part of the papers, etc.) should lead to co-authorship and pure data contribution to group co-authorship if possible with journal.
- The contributor is suggested by the PI (can be himself, one of his/her group or also one from another group), and the PI should forward the initial email to the respective colleague for further interaction.
- Final decision is with lead author.
- PIs have to send the references of the papers they want to be cited with their data, same for the data processing methods and spatial data.