Quantifying soil moisture impacts on light use efficiency across biomes

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Empirical analysis of drought effects on LUE

- $\text{GPP} = \text{LUE} \times \text{IPAR} \times \text{fAPAR}$
- Neural network approach to determine LUE-environment relationships on “good days”
- Empirical analysis of ratios of LUE to “good day” LU.
- Independent of any specific model of light use efficiency (but could be used with any such model...)

The neural network includes effects of VPD
Drought every summer!

Stocker et al. 2018 New Phytologist
Four response modes (clusters)
Vegetation in dry climates is most sensitive to drought!
Empirical reduction factor

$$\beta = \begin{cases} 
q(\theta - \theta^*)^2 + 1, & \theta \leq \theta^* \\
1, & \theta > \theta^* 
\end{cases}$$

where

$$q = (\beta_0 - 1)/(\theta^* - \theta_0)^2$$

and

$$\beta_0 = a + b\alpha$$

$\theta$ is relative soil moisture

$\theta^* = 0.9$

$\alpha$ is (climatological) AET/PET, from SPLASH

(Davis et al. 2017 GMD)

$a, b$ are parameters – different for grasses and woody plants

Stocker et al. 2018 in review
GPP reduction due to soil moisture effect

Stocker et al. 2018 in review
A question

• Can this behaviour be represented (more accurately) by an extension of the (optimality-based) P model?
Four response modes (clusters)
A working hypothesis

- The differences in soil moisture response reflect differences in root zone depth.
- Optimal root zone depth is determined in part by GPP.
- When $\theta$ is small:
  - Water transport costs are increased $\Rightarrow$
  - Stomatal sensitivity to VPD is increased $\Rightarrow$
  - $\chi$ is reduced $\Rightarrow$
  - GPP is reduced.