Quantifying soil moisture impacts on light use efficiency across biomes

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including unpublished contributions by:

Trevor Keenan (*LBNL* and *UC Berkeley*)

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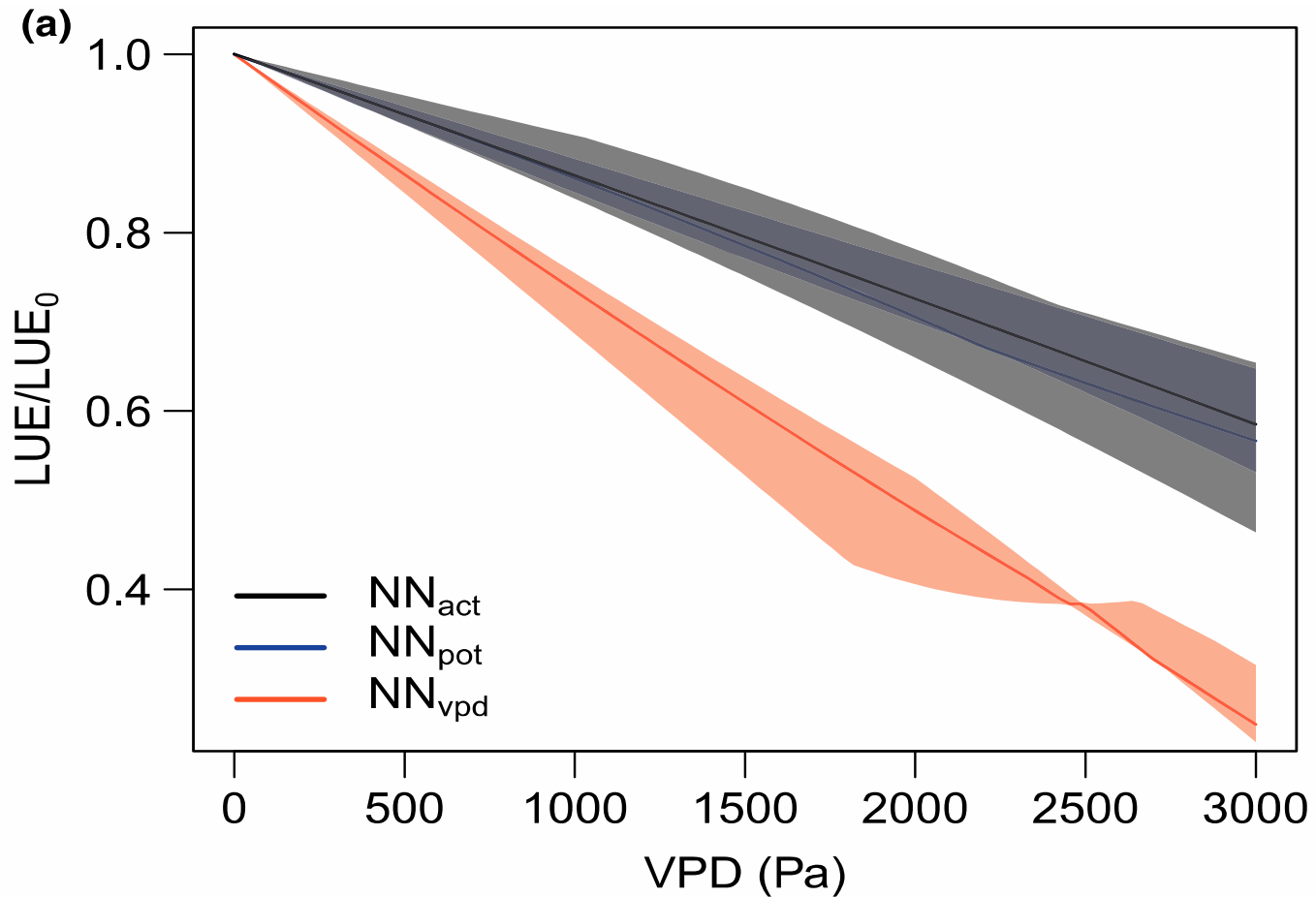**Iain Colin Prentice** (*Imperial College)*

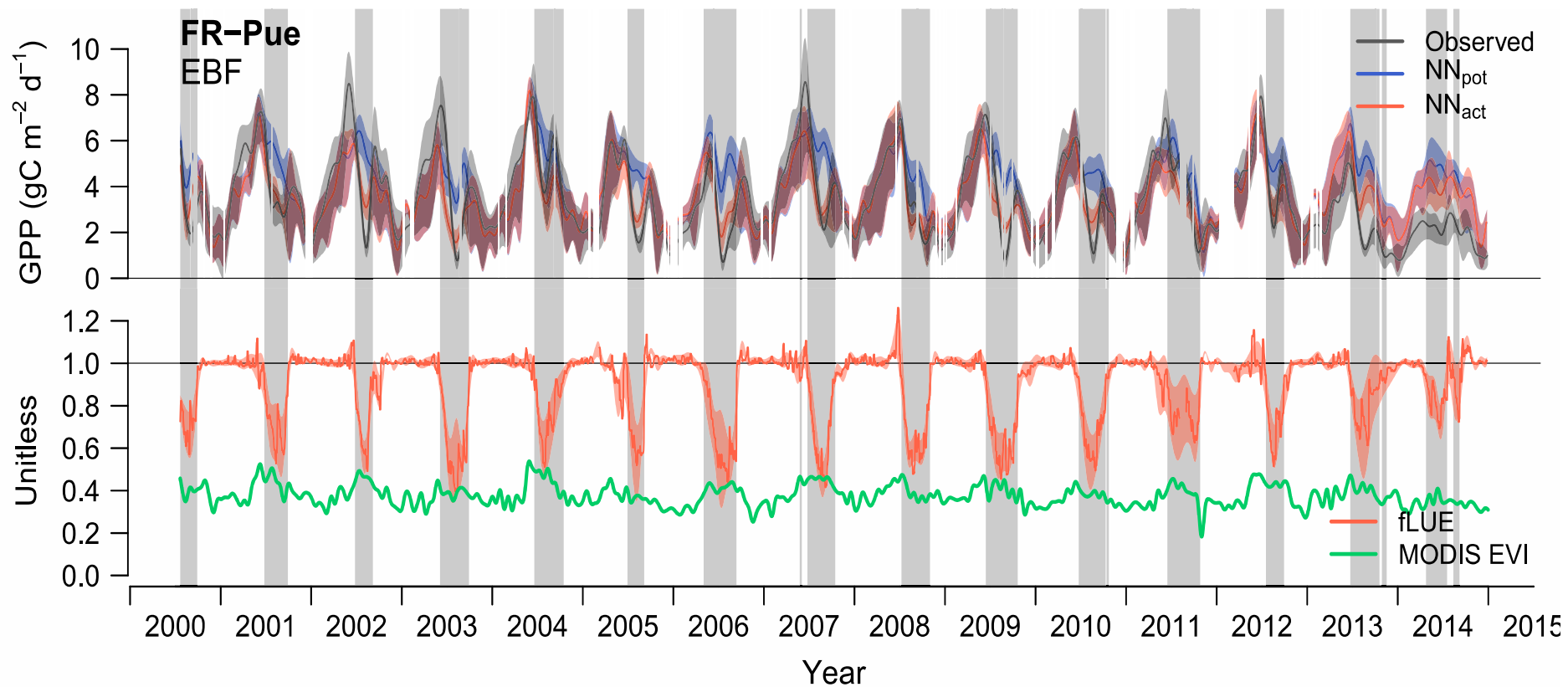**Sonia Seneviratne** (*ETH*)

Jacob Zscheischler (*ETH*)

Empirical analysis of drought effects on LUE

- GPP = LUE x IPAR x fAPAR
- Neural network approach to determine LUE-environment relationships on "good days"
- Empirical analysis of ratios of LUE to "good day" LU.
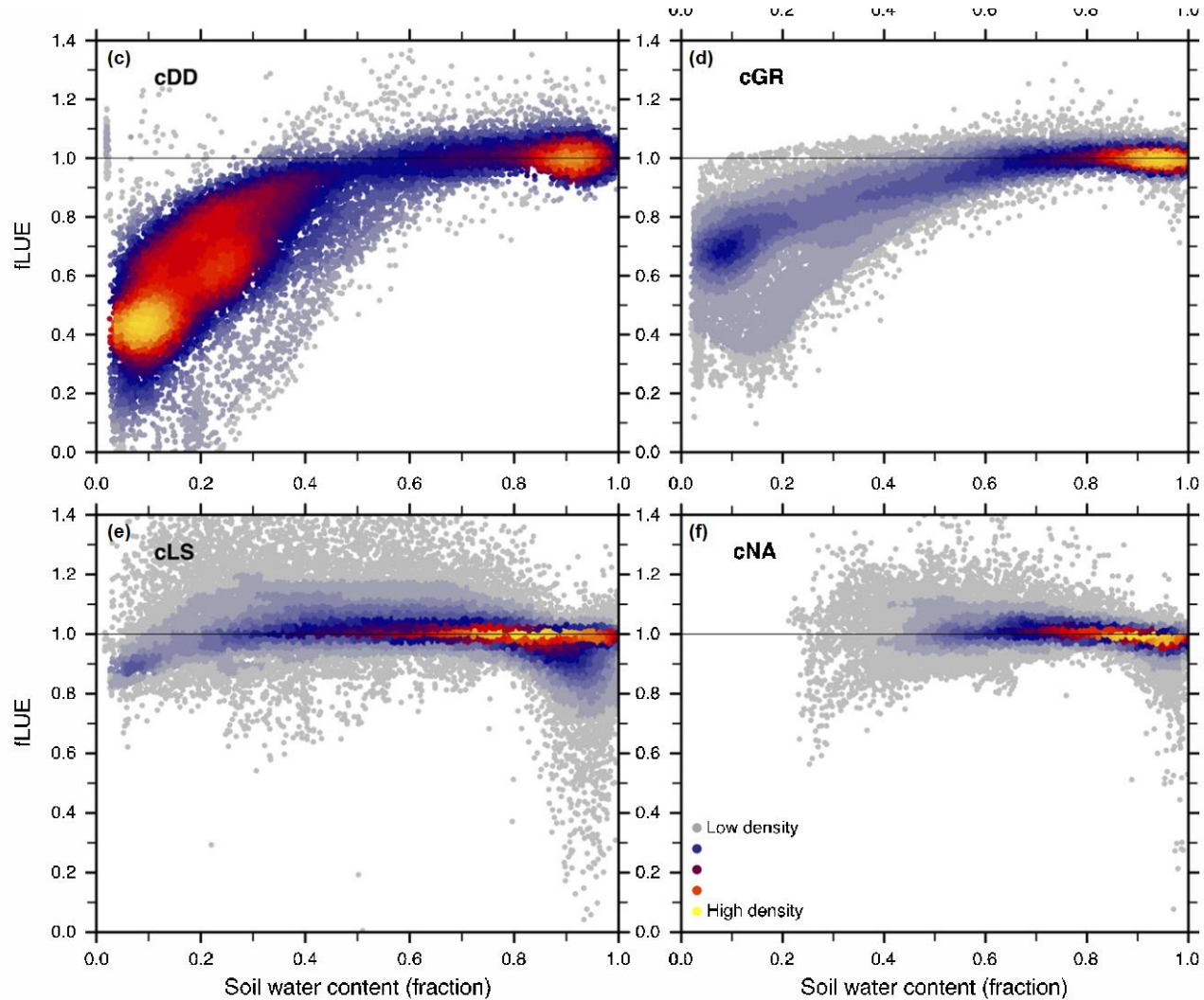- Independent of any specific model of light use efficiency (but could be used with any such model...)

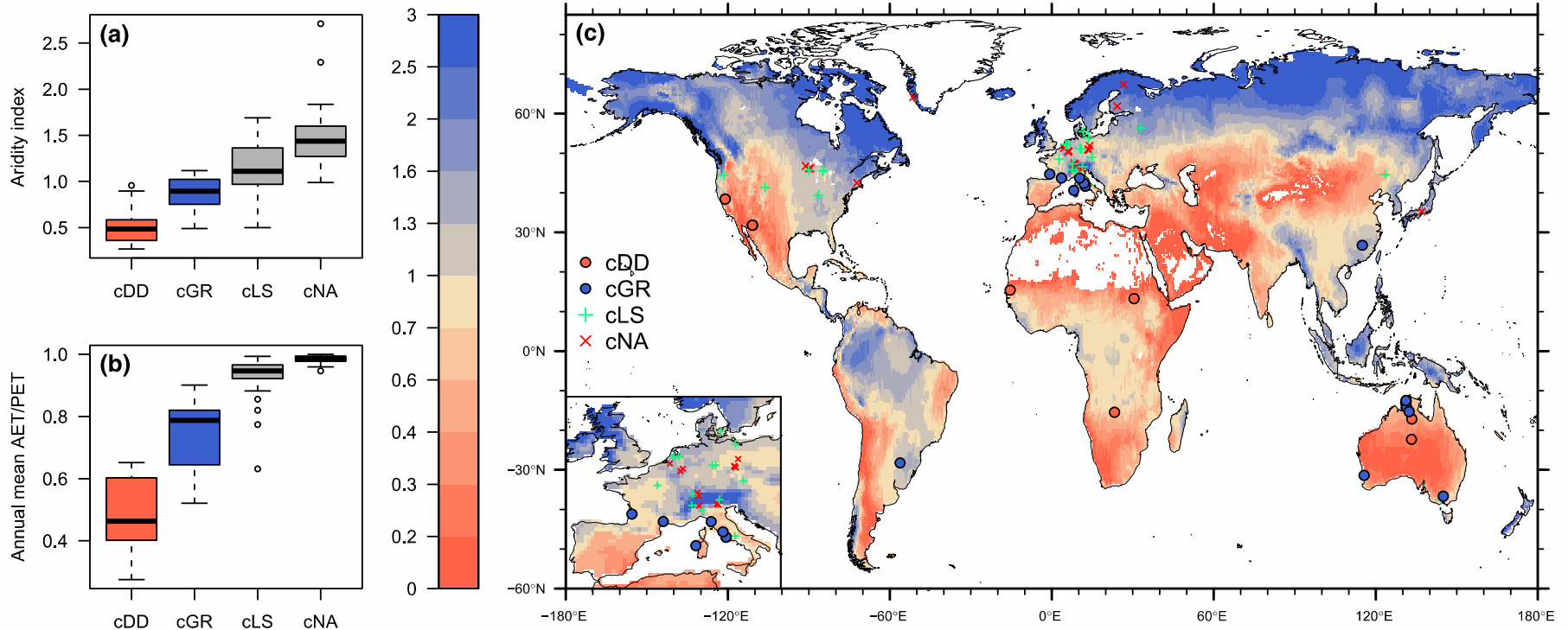# The neural network includes effects of VPD

Drought every summer!

Stocker *et al.* 2018 *New Phytologist*

Four response modes (clusters)

Stocker *et al.* 2018 *New Phytologist*

Vegetation in dry climates is most sensitive to drought!

Stocker *et al.* 2018 *New Phytologist*

Empirical reduction factor

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

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

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

θ is relative soil moisture
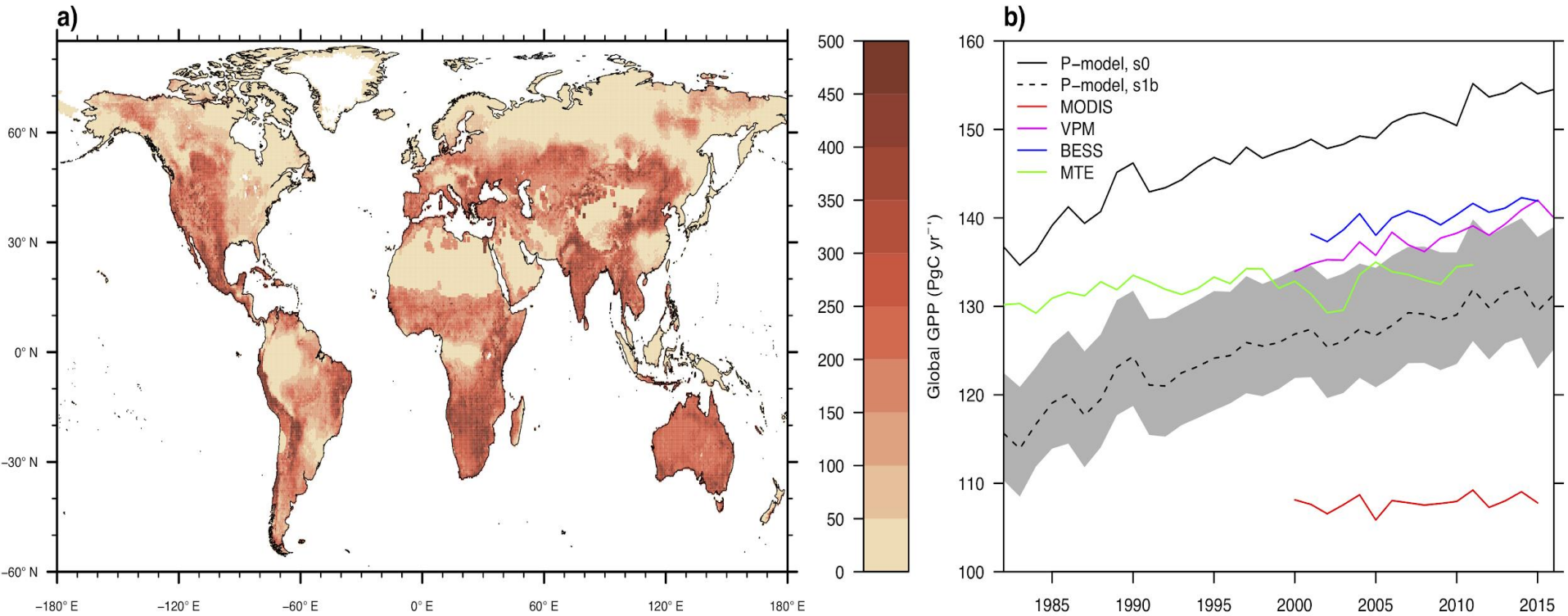θ* = 0.9
α is (climatological) AET/PET, from SPLASH
(Davis *et al.* 2017 *GMD*)
a, b are parameters – different for grasses and woody plants

GPP reduction due to soil moisture effect
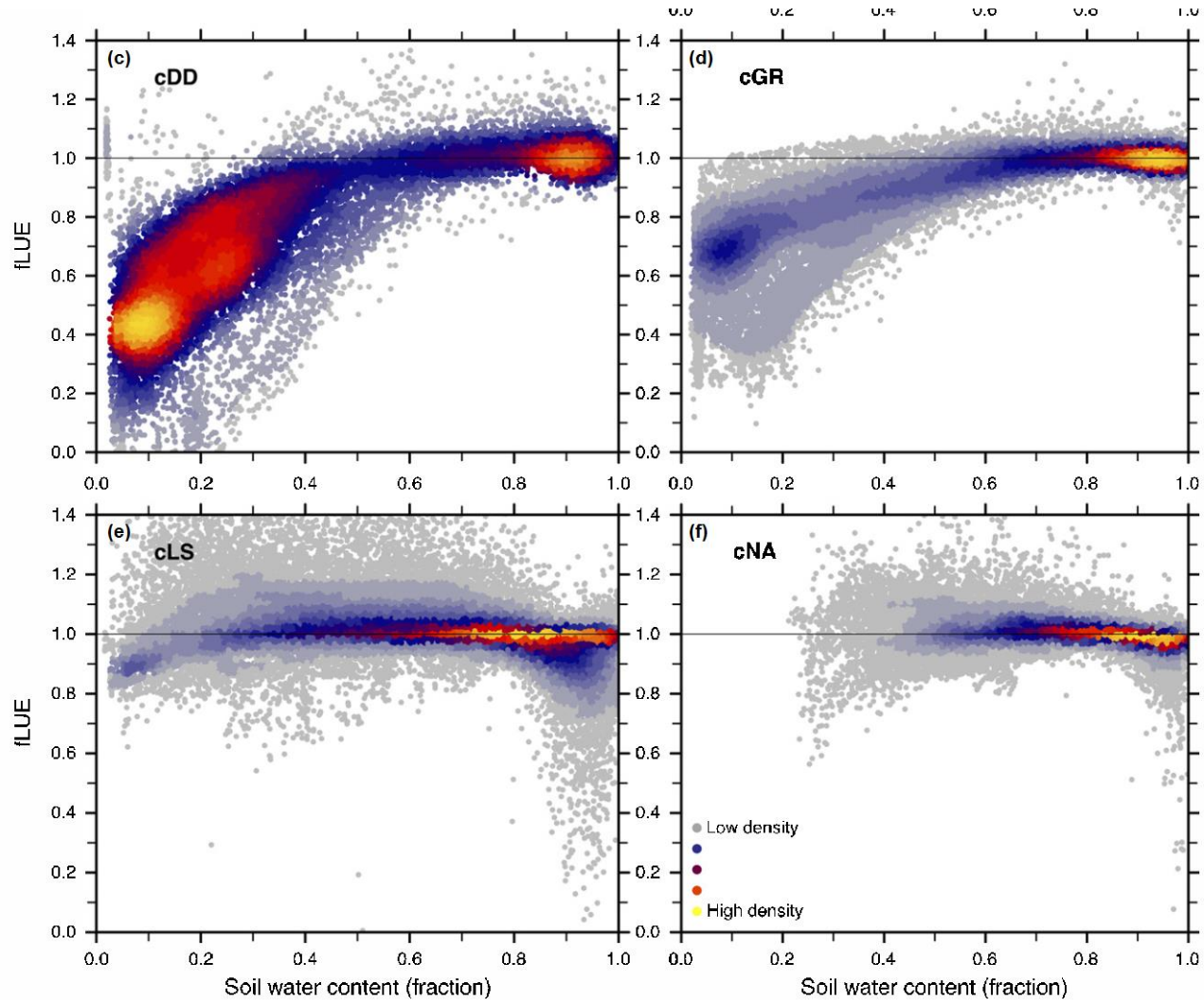

Stocker *et al.* 2018 in review

A question

- Can this behaviour be represented (more accurately) by an extension of the (optimality-based) P model?

Four response modes (clusters)

Stocker *et al.* 2018 *New Phytologist*

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 θ is small:

    - Water transport costs are increased =>

    - Stomatal sensitivity to VPD is increased =>

    - χ is reduced =>

    - GPP is reduced.