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STOMATAL OPTIMIZATION MODELLING IN JSBACH

An in-depth case study on a boreal forest measurement site

1 WHAT DID WE DO?

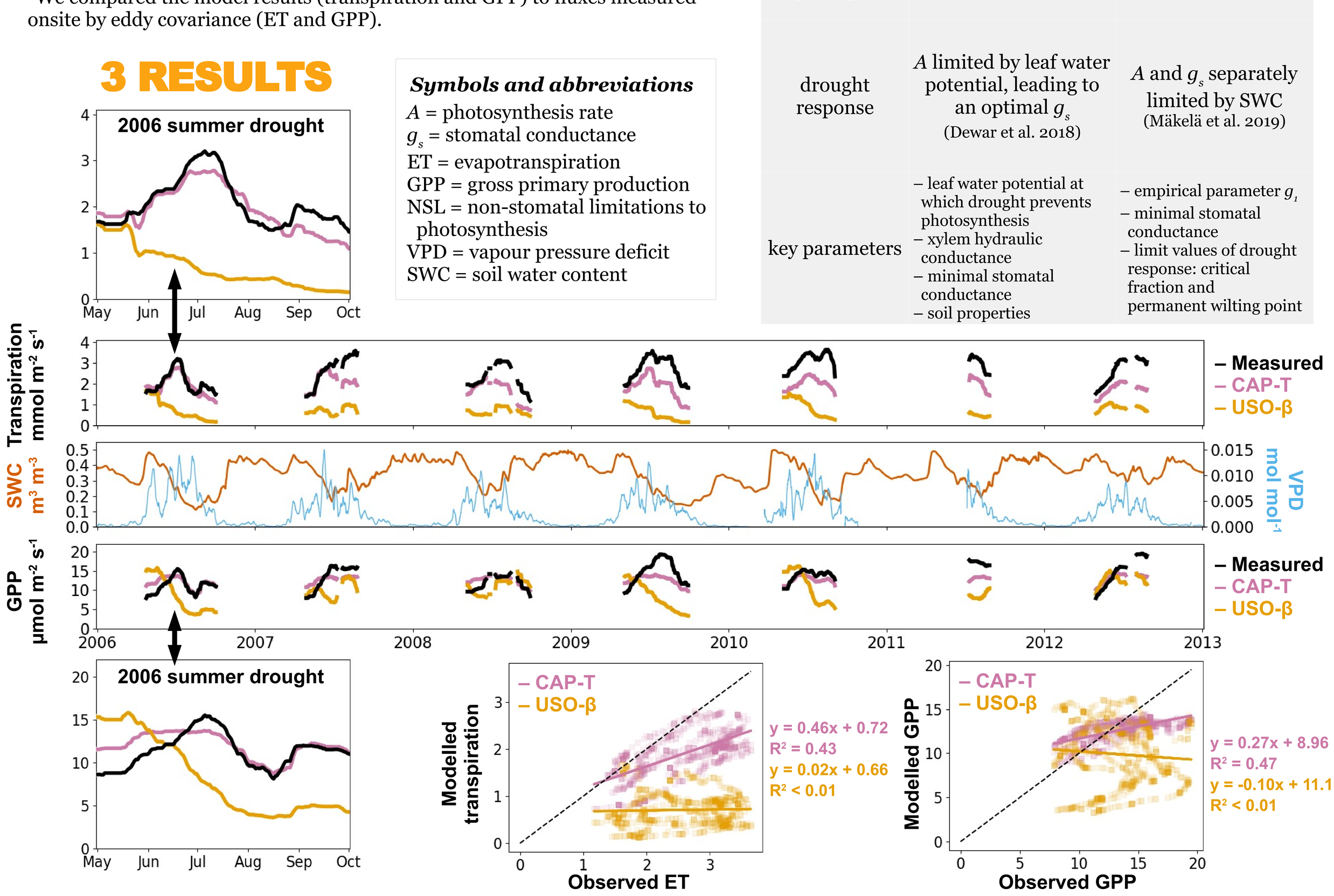
– We modified the stomatal and photosynthesis models in the land surface model **JSBACH**, replacing the BETHY model with **CAP-T** and **USO-β (see table)**.
– We used either measured or literature-based values for as many parameters as we could (rather than JSBACH defaults, soil type maps etc.).
– We used measurement data for forcing, introducing **soil water content measured from the horizon B1** (14–26 cm).
– We ran JSBACH for a single site: the Scots pine forest around the **SMEAR II** measurement station in Hyytiälä, Southern Finland.
– We filtered the data so that transpiration would make up almost all of the evaporation flux: dry days in the growing season, excluding early morning hours.
– We compared the model results (transpiration and GPP) to fluxes measured onsite by eddy covariance (ET and GPP).

2 THE MODELS

	CAP-T	USO-β
photosynthesis model	single-regime "bi-substrate" model (Thornley & Johnson 1991)	two-regime "biochemical" model (Farquhar & von Caemmerer 1980)
stomatal optimization principle	maximize A while subject to NSL (Dewar et al. 2018)	Unified Stomatal Optimization (Medlyn et al. 2011)
drought response	A limited by leaf water potential, leading to an optimal g_s (Dewar et al. 2018)	A and g_s separately limited by SWC (Mäkelä et al. 2019)
key parameters	– leaf water potential at which drought prevents photosynthesis – xylem hydraulic conductance – minimal stomatal conductance – soil properties	– empirical parameter g_1 – minimal stomatal conductance – limit values of drought response: critical fraction and permanent wilting point

3 RESULTS

Symbols and abbreviations
A = photosynthesis rate
g_s = stomatal conductance
ET = evapotranspiration
GPP = gross primary production
NSL = non-stomatal limitations to photosynthesis
VPD = vapour pressure deficit
SWC = soil water content



4 SO...?

– CAP-T doesn't look too bad, all things considered.
– USO-β is performing very poorly. Why is that?
– We still have to find out which effect is due to which choice.
– Measured SWC seems to work better than calculated SWC.

Dewar RC *et al.* 2018. *New Phytol.* **217**: 571–585.
Farquhar GD *et al.* 1980. *Planta* **149**: 78–90.
Medlyn BE *et al.* 2011. *Glob. Change Biol.* **17**: 2134–2144 (corrigendum **18**: 3476).
Mäkelä J *et al.* 2019. *Geosci. Model Dev.* **12**: 4075–4098.
Thornley JMH & Johnson IR. 1990. Plant and Crop Modelling. Clarendon Press.