



## Soil moisture stress on vegetation JPEG

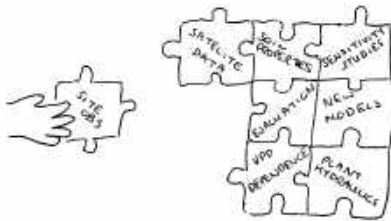
Kirsti Ashworth, Beena Balan Sarojini, Cleiton Breder Eller, Eleanor Blyth, Penny Boorman, Patrick B ker, Manoel Cardoso, Aline Castro, Christina Charlton-Perez, Peter Cox, Andrew Cunliffe, Martin De Kauwe, Chetan Deva, Imtiaz Dharssi, Pete Falloon, Pierre Friedlingstein, Sebastien Garrigues, David Galbraith, Nicola Gedney, Breogan Gomez, Kate Halladay, Anna Harper, Phil Harris, Garry Hayman, Debbie Hemming, Chris Huntingford, Chris Jones, Jaideep Joshi, Gillian Kay, Doug Kelley, Rob King, Timothy Lam, Alinor Lavergne, Daijun Liu, Camilla Mathison, Toby Marthews, Patrick McGuire, Lina Mercado, Catherine Morfopoulos, Rodolfo Nobrega, Frederick Otu-Larbi, Divya Pandey, Ewan Pinnington, Colin Prentice, Tristan Quaife, Eddy Robertson, Rafael Rosolem, Lucy Rowland, Heather Rumbold, Alistair Sellar, Darren Slevin, Mei Sun Yee, Anne Verhoef, Pier Luigi Vidale, Karina Williams, Andy Wiltshire, Stephanie Woodward, Azin Wright, Yangang Xing

JULES annual meeting 2020



## SM-stress JULES Process Evaluation Group

- ▶ We are a cross-community group working to evaluate and improve soil moisture stress on vegetation within JULES.
- ▶ Group members are attacking the problem from different angles: different vegetation types, timescales, geographic regions, applications, observations.
- ▶ The group has benefited from the involvement of experts in other parts of JULES, flux tower and satellite observations, soil hydrology, plant physiology, developers from other land-surface models.





Just submitted!

## **Improvement of modelling plant responses to low soil moisture in JULESvn4.9 and evaluation against flux tower measurements**

Anna B. Harper, Karina E. Williams, Patrick C. McGuire, Maria Carolina Duran Rojas, Debbie Hemming, Anne Verhoef, Chris Huntingford, Lucy Rowland, Toby Marthews, Cleiton Breder Eller, Camilla Mathison, Rodolfo L.B. Nobrega, Nicola Gedney, Pier Luigi Vidale, Fred Otu-Larbi, Divya Pandey, Sebastien Garrigues, Azin Wright, Darren Slevin, Martin G. De Kauwe, Eleanor Blyth, Jonas rdo, Damien Bonal, Nina Buchmann, Benoit Burban, Kathrin Fuchs, Agns de Grandcourt, Ivan Mammarella, Lutz Merbold, Leonardo Montagnani, Yann Nouvellon, Natalia Restrepo-Coupe, and Georg Wohlfahrt

submitted to GMD August 2020





## SM-stress JPEG recommendations

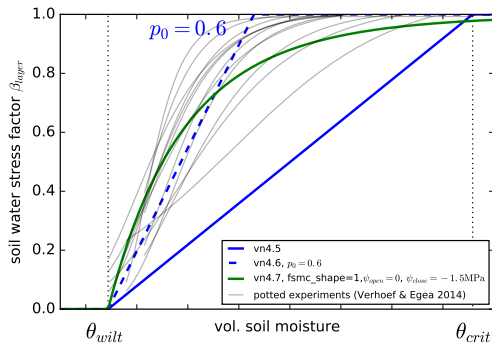
1. Stress should not really start to kick in until lower soil moistures.
2. The soil column needs to be deeper.
3. New modelling strategy in the longer term e.g. explicit soil-plant hydraulics





# 1. Change when the SM-stress kicks in

- ▶ Stress in JULES should be delayed until lower soil moistures.
- ▶ Group has explored many ways to achieve this (offline & online).
- ▶ Recommends a change to shape of JULES SM-stress function  $\beta_k$   
(e.g. Verhoef & Egea 2014, Williams et al 2019, Harper et al submitted, Wright et al in prep)



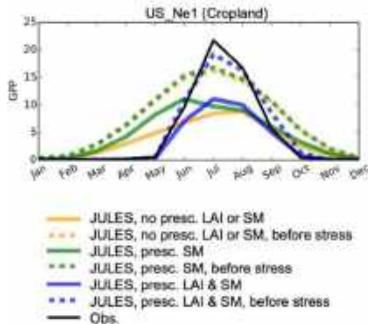
GMED ticket 521 (John Edwards):  $p_0 = 0.6$  accepted for GL9.



## Examples from JULES Golden sites

**Mead:** irrigated maize.

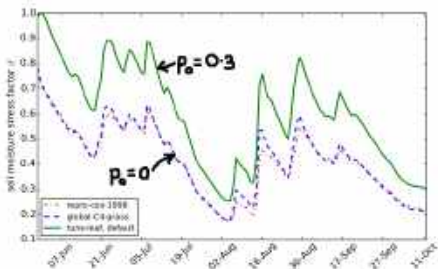
- ▶ Site met. data, 'rainfall' includes irrigation.
- ▶ Should not be significantly water stressed.



Harper et al, submitted.

**FIFE:** tallgrass prairie.

- ▶ Site met. data, forced with LAI and SM.
- ▶ Leaf potential observations show grass is mostly unstressed in June.



Williams et al, 2019.



## 2. Deeper soil column

'There is ample justification for having deeper soils and roots in JULES'.

Harper et al (submitted)

Report: **Case for new GL soil column configuration** (in prep) for GMED ticket 550, with Eleanor Burke and John Edwards.

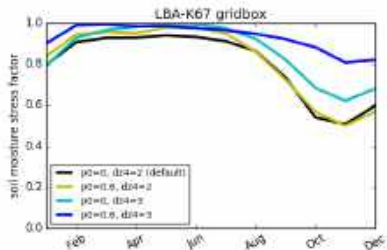
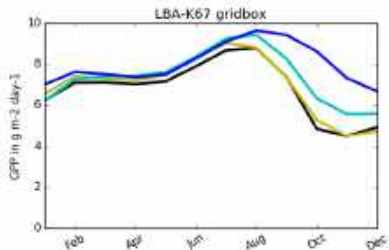
Shows that changing soil column improves representation of

- ▶ SM-stress on vegetation
- ▶ permafrost



## Example: dry season in eastern Amazon

Water stress is not observed at the LBA km-67 site in the Tapajós National Forest, Brazil (e.g. Restrepo-Coupe et al, 2013).



Default: GA7 AMIP model development suite at UM11.4





### 3. Beyond the empirical $\beta$ function

- ▶ Investigating more explicit representations of plant hydraulics and water-use strategies e.g. SOX.

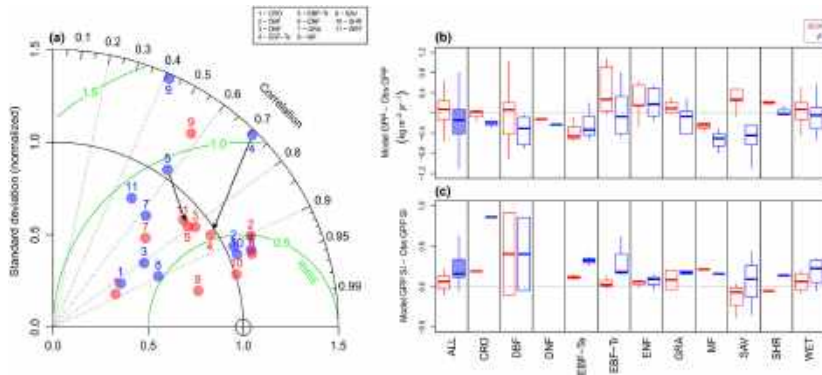
## **Stomatal optimisation based on xylem hydraulics (SOX) improves land surface model simulation of vegetation responses to climate**

Eller CB, Rowland L, Mencuccini M, Rosas T, Williams K, Harper A, Medlyn BE, Wagner Y, Klein T, Teodoro GS, Oliveira RS, Matos IS, Rosado BHP, Fuchs K, Wohlfahrt G, Montagnani L, Sitch S, Cox P,

New Phytologist, January 2020



# JULES-SOx performance across biomes



- (a) Taylor diagram, monthly GPP
- (b) Anomaly boxplots, annual GPP
- (c) Anomaly boxplots, Seasonality Index of GPP

Fig. 5, Eller et al. (2020)



## Group Future

- ▶ We are continuing to work on these identified priorities, using different scales and vegetation types, different evaluation datasets and techniques, sensitivity studies, MIPs, vegetation types, applications (e.g. TRENDY, GL, UKESM).
- ▶ Tools and resources developed by the group can continue to be used across the JULES community
  - ▶ suite to run LBA and selected FLUXNET sites, including evaluation software, supported on a range of platforms (see `FluxnetandLbaSites` on JULES wiki)
  - ▶ Shared configurations for 2 JULES golden sites (see `JulesGoldenSites` on JULES wiki).
  - ▶ 5000+ lines shared python.
- ▶ Regular meetings, including talks from invited speakers
  - ▶ Next: **“Towards a unified theory of plant photosynthesis and hydraulics”**, Jaideep Joshi, 24th September



Additional slides



## FLUXNET/LBA suite

A. Harper, K. Williams, P. McGuire, C. Duran Rojas and F. Otu-Larbi

<https://code.metoffice.gov.uk/trac/jules/wiki/FluxnetandLbaSites>

- ▶ Suite compiles JULES, runs at each site, and plots the output against obs.
- ▶ Supported on a range of platforms.
- ▶ Tutorial for running suite on JASMIN.
- ▶ Emphasis is on building up a body of knowledge about individual site characteristics and the JULES performance at that site from suite users.