Soil moisture stress on vegetation in JULES

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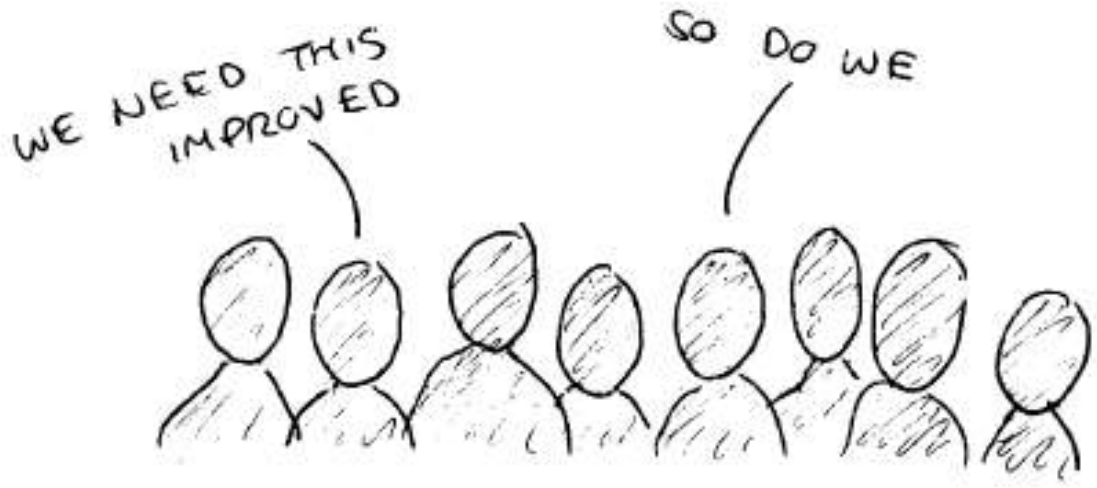
JULES annual meeting 2018

Soil moisture stress on vegetation JPEG

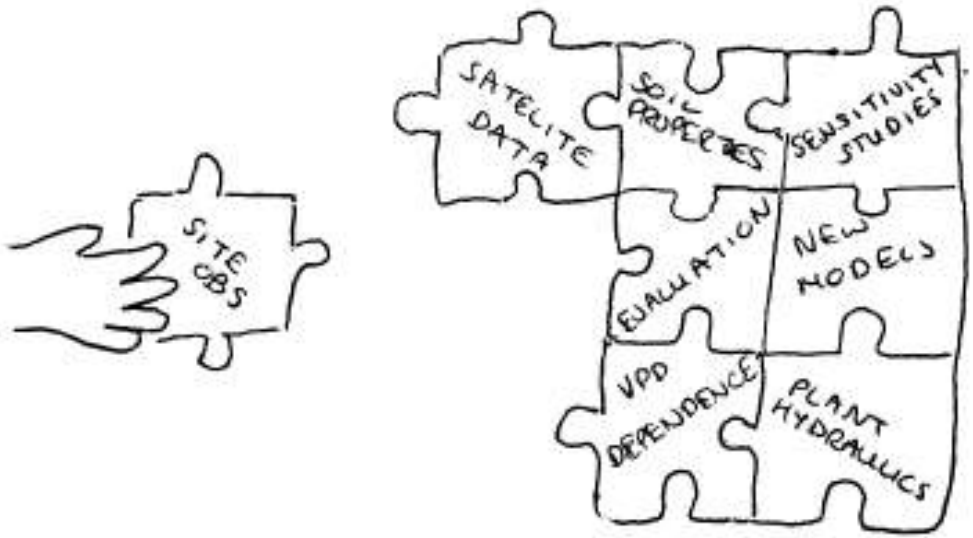
- Two years ago, at the JULES 2016 meeting, a cross-community group was set up to discuss and evaluate this process within JULES.

- There were many groups within the community already working on this process, so made sense to combine efforts.



Soil moisture stress on vegetation JPEG

- Currently 40+ members on the mailing list.
- 3 face-to-face meetings and 14 teleconference meetings so far (minutes available on the JULES wiki).
- This group has benefited from the involvement of experts in other parts of JULES, flux tower and satellite observations, plant physiology, other models.



Progress so far

- Documenting and evaluating the current representation using site observations - paper in progress.
- Rose suite shared across the group, including evaluation software
- Sensitivity studies (global and regional).
- Investigating and evaluating model extensions.
- New options introduced to JULES.

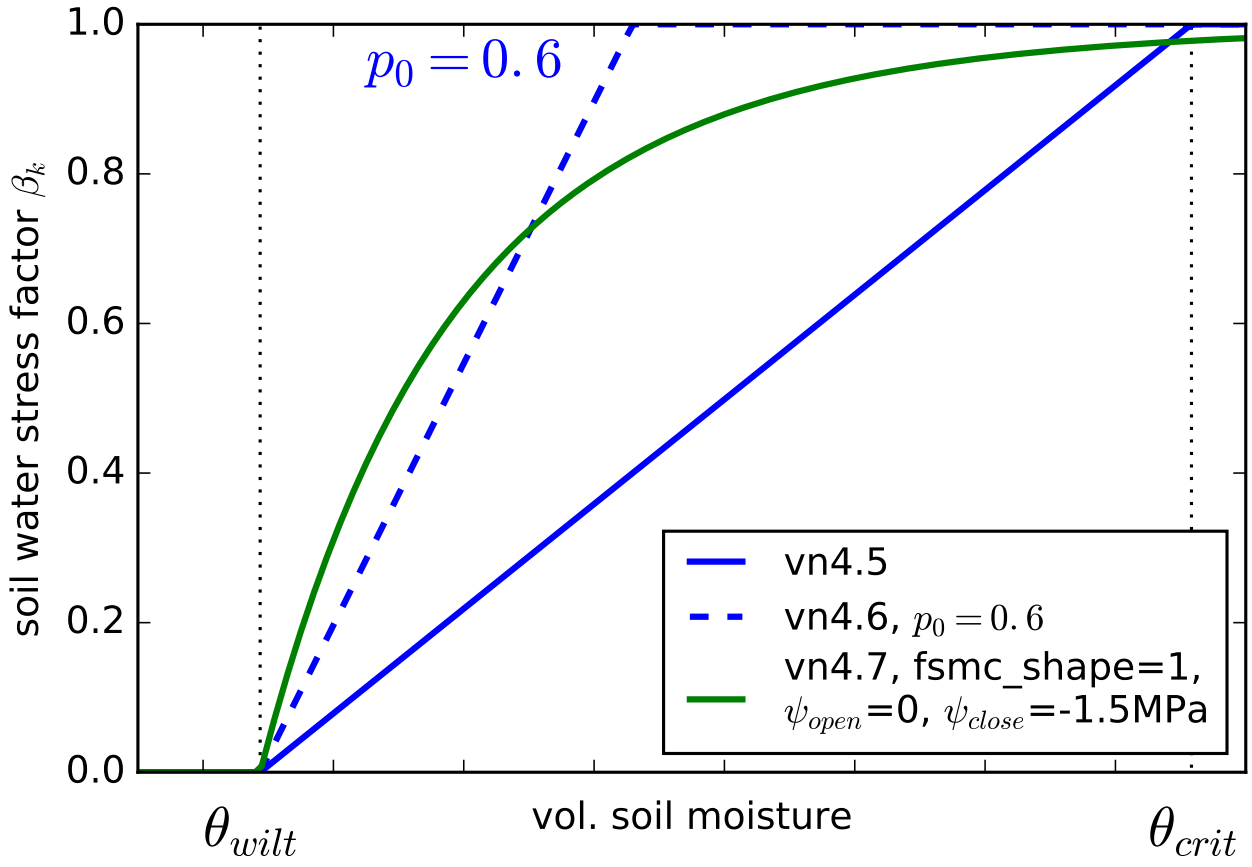
Soil moisture stress factor β

- Soil moisture stress in JULES is parameterised by β, which is 0 (completely stressed) to 1 (completely unstressed).
- β is used to convert between the potential net leaf photosynthesis A_P and the water-limited net leaf photosynthesis A:

$$A = A_P \beta$$

- Stem and root maintenance respiration can also be scaled by β.

Options for shape of stress factor β



Overall stress factor β

Overall stress factor β is either

- calculated for each layer and weighted by the fraction of roots in that soil layer r_k

$$\beta = \sum_k r_k \beta_k$$

or

- based on the average soil properties in the root zone.

Site-based evaluation runs

- 32 FLUXNET2015 sites
- 8 Large-Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) sites (see Cleiton's talk in this session)
- 15 year crop dataset, Avignon (see Camilla's slides from yesterday)
- Irrigated versus non-irrigated maize and soybean, Nebraska
- Tallgrass prairie, FIFE, Kansas (see KW slides from yesterday)
- The Agricultural Model Intercomparison and Improvement Project (AgMIP) maize evapotranspiration study, Ames, Iowa, US.

FLUXNET2015/LBA suite was designed for MONSooN but has been extended to JASMIN and Exeter University (Patrick McGuire - see slides from yesterday, Carolina Rojas).

Sensitivity studies

- Drought in WFDEI-forced runs over Europe, using JULES, CHTESSEL/CTESSEL, Sinclair, different soil hydraulic schemes (Reading University).
- Global WFDEI runs, comparing JULES default to the newer options ($p_0 = 0.5$, Sinclair, CLM).
- Offline and online UKESM1 runs (UKESM team), GL configuration development runs (Martin Best)
- IMOGEN runs in progress (Anna Harper).

Adding more explicit plant hydraulics

- Dewar/Tardieu/Davies hydraulic model - stomatal conductance has explicit dependence on leaf water potential and ABA concentration.
- SOX model - see Cleiton's slides in this session.

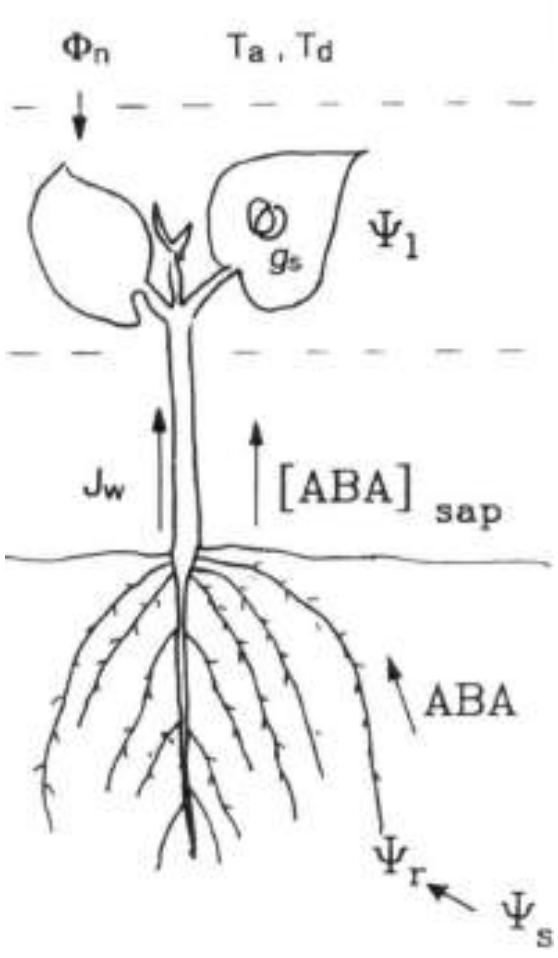


Image: Tardieu and Davies 1993

Additional work in the JPEG

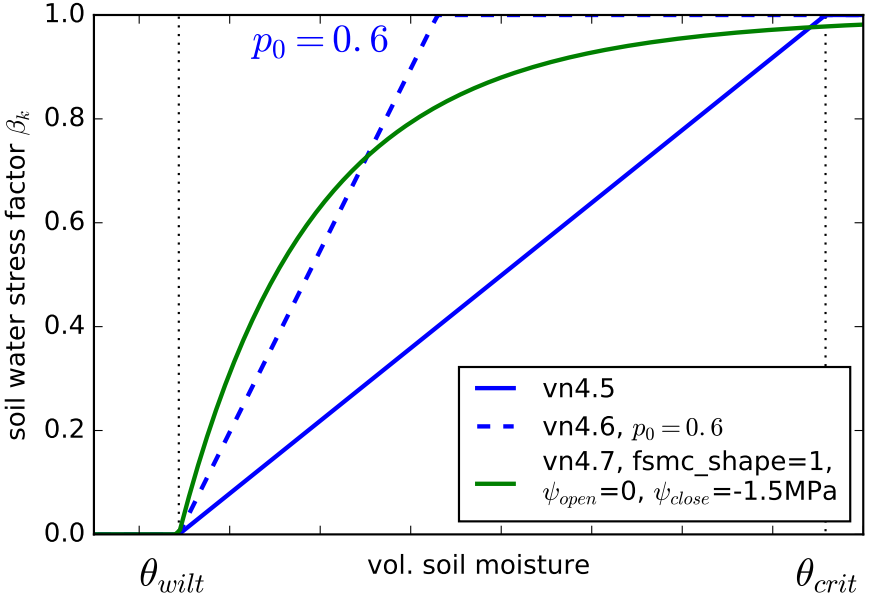
- Review of methods in other models.
- Changing soil depth and root distribution at the Amazon sites.
- Diagnosing stress from satellite obs: LST, Tair relations (Rob King - see slides from yesterday, Phil Harris), sign of correlation between LST and ET (Gill Kaye)
- Where to apply the stress - stomatal, biochemical, mesophyll (Pier Luigi Vidale).
- Impact of uncertainties in soil moisture, LAI and precip measurements
- Impact of different methods for calculating soil properties.
- Reduction in observed LUE at flux sites as a function of soil moisture (Stocker et al 2018 - see Colin's talk in this session).

Summary

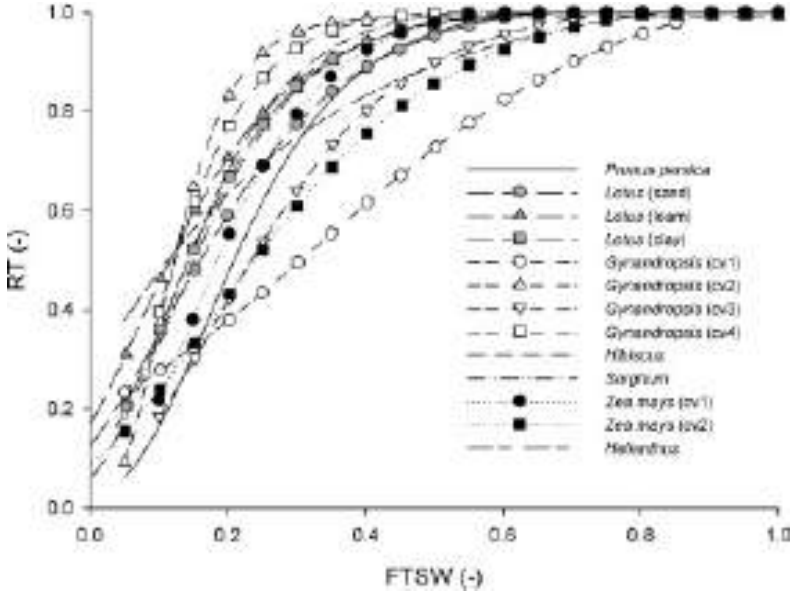
- Documenting and evaluating the current representation using site observations - paper in progress.
- New options included in JULES.
- Configurations can be reused by the JULES community.
- Lots of work across group looking at model improvements.

Additional slides

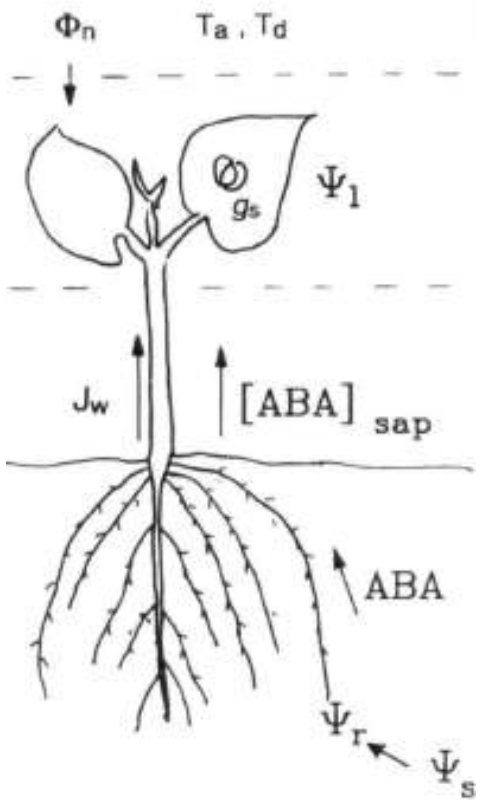
New in JULES 4.9



Obs: Relative Transpiration (RT) against Fraction of Transpirable Soil Water (FTSW), Verhoef and Egea 2014.



Dewar/Tardieu/Davies hydraulic model



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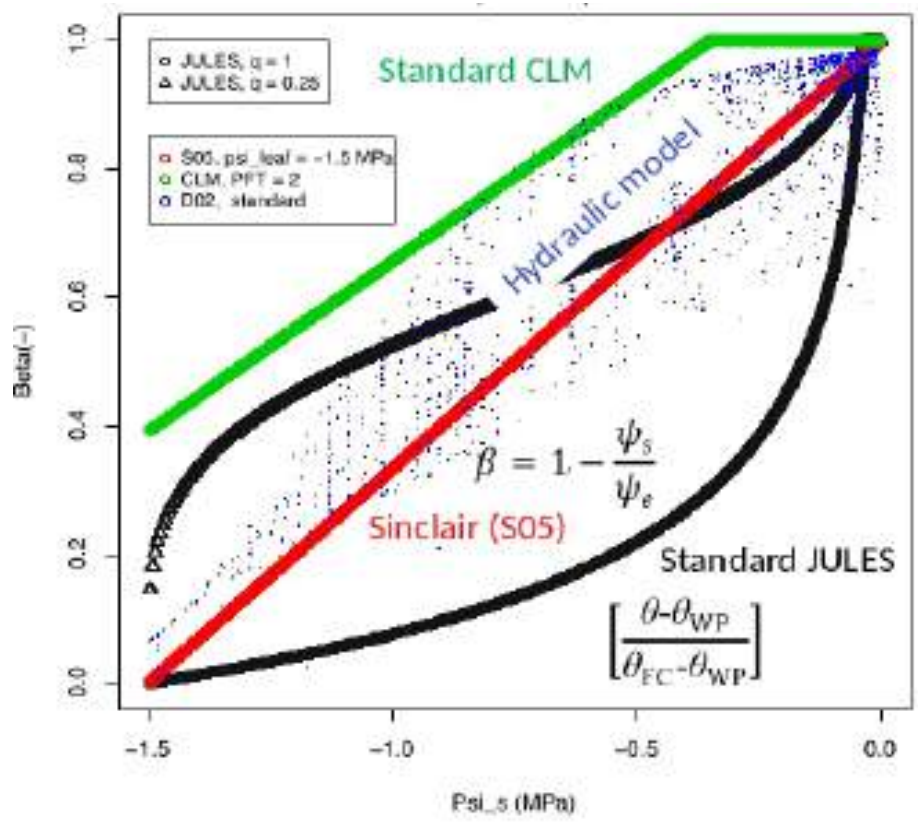
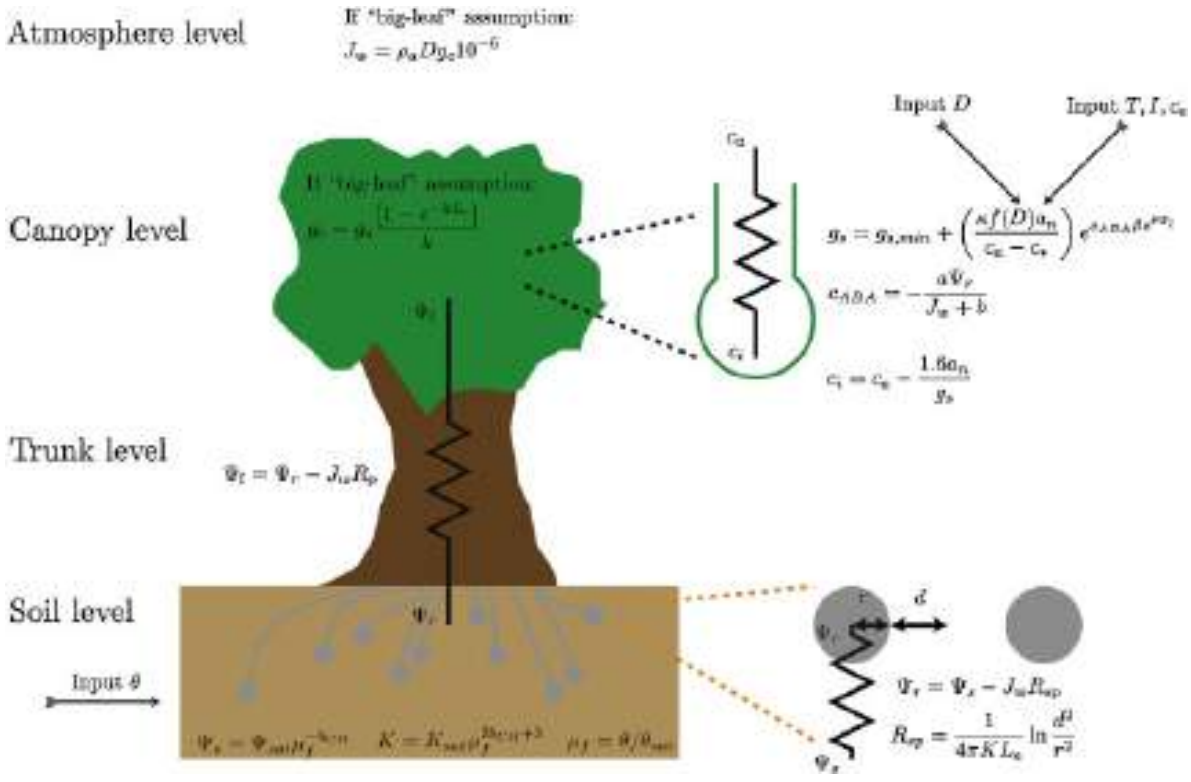


Plot: Verhoef, Egea, Garrigues, Vidale, Balan Sarojini, in prep.

Huntingford et al, 2015



SOX model

- Stomatal Optimization based on Xylem hydraulics.
- Being developed at Exeter University as part of CSSP Brazil.
- Has a drought factor which represents xylem loss of conductance as leaf water potential decreases.
- Internal CO_2 is set where (net assimilation) x (drought factor) is at a maximum.
- In a branch of JULES in a rough format - can be tested in the JPEG suites.