

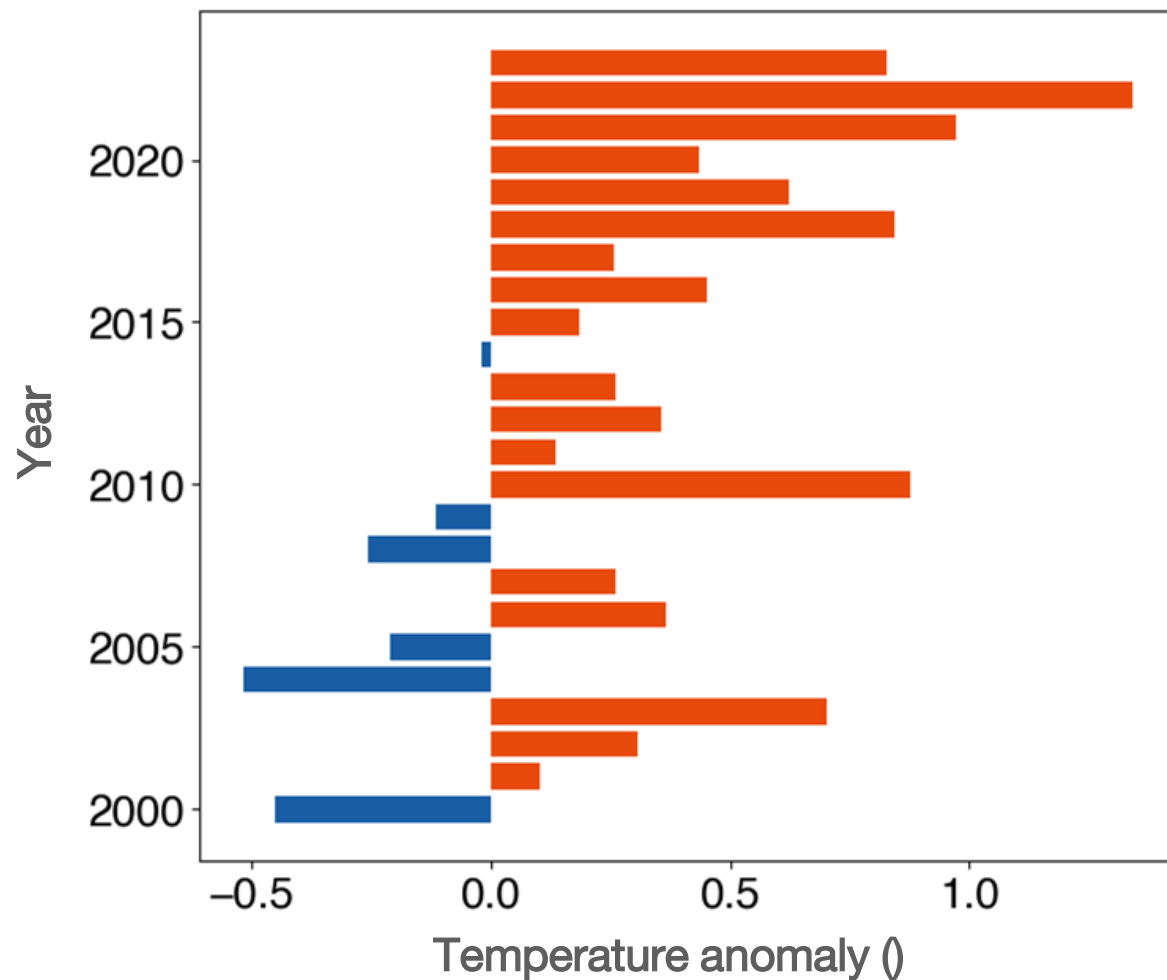
Predicting the Legacy of Extreme Summer Events in UK woodlands

J.Cale Baguley, Martin De Kauwe



Recent extreme European summers

Summer surface air temperature anomalies across Europe



Data source: the Copernicus climate service.

Surface air temperature anomaly, August 2022

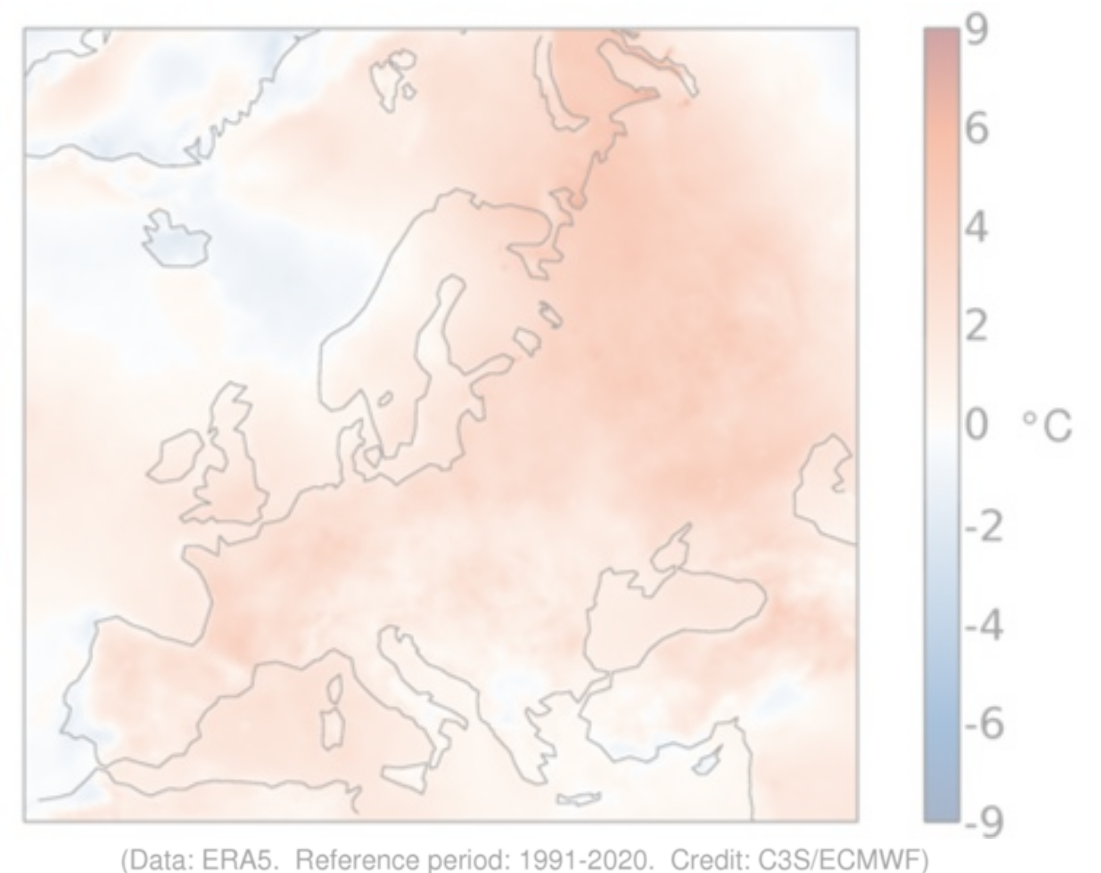
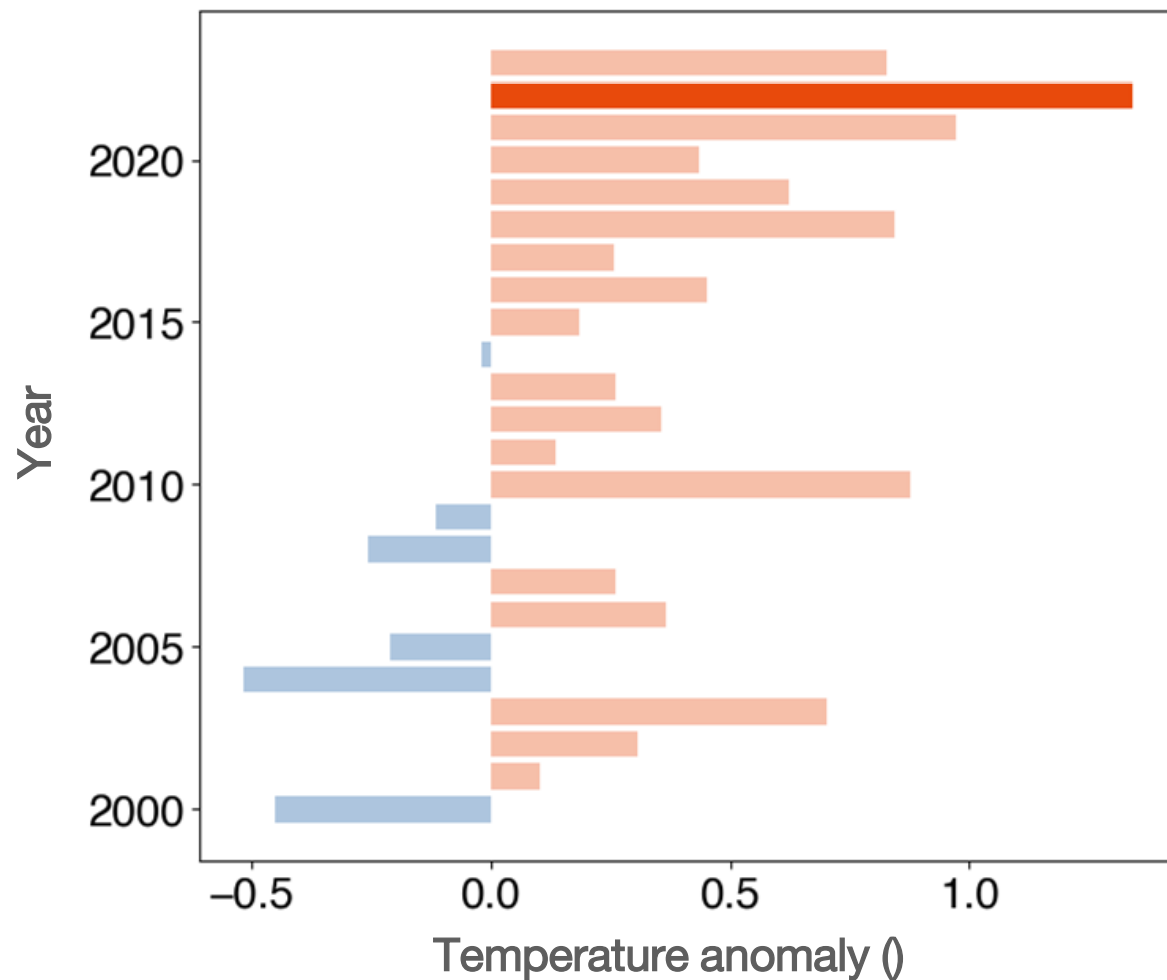


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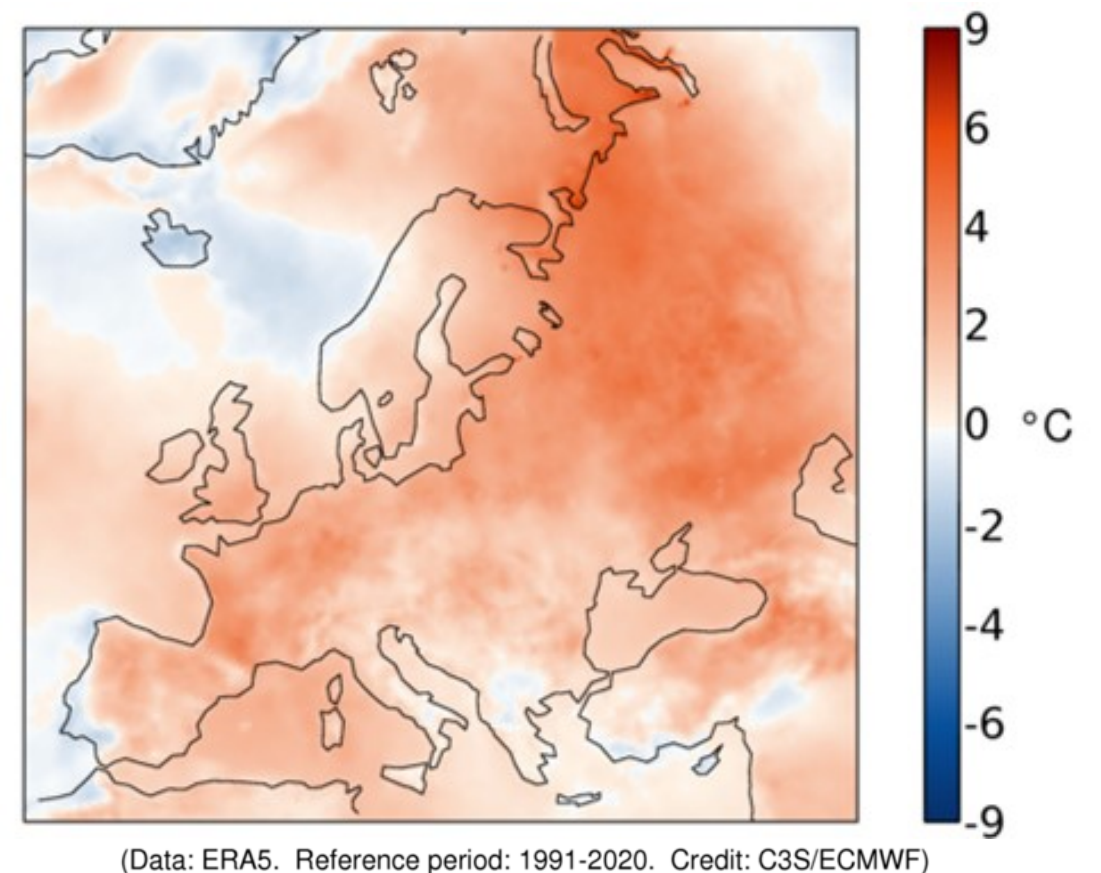
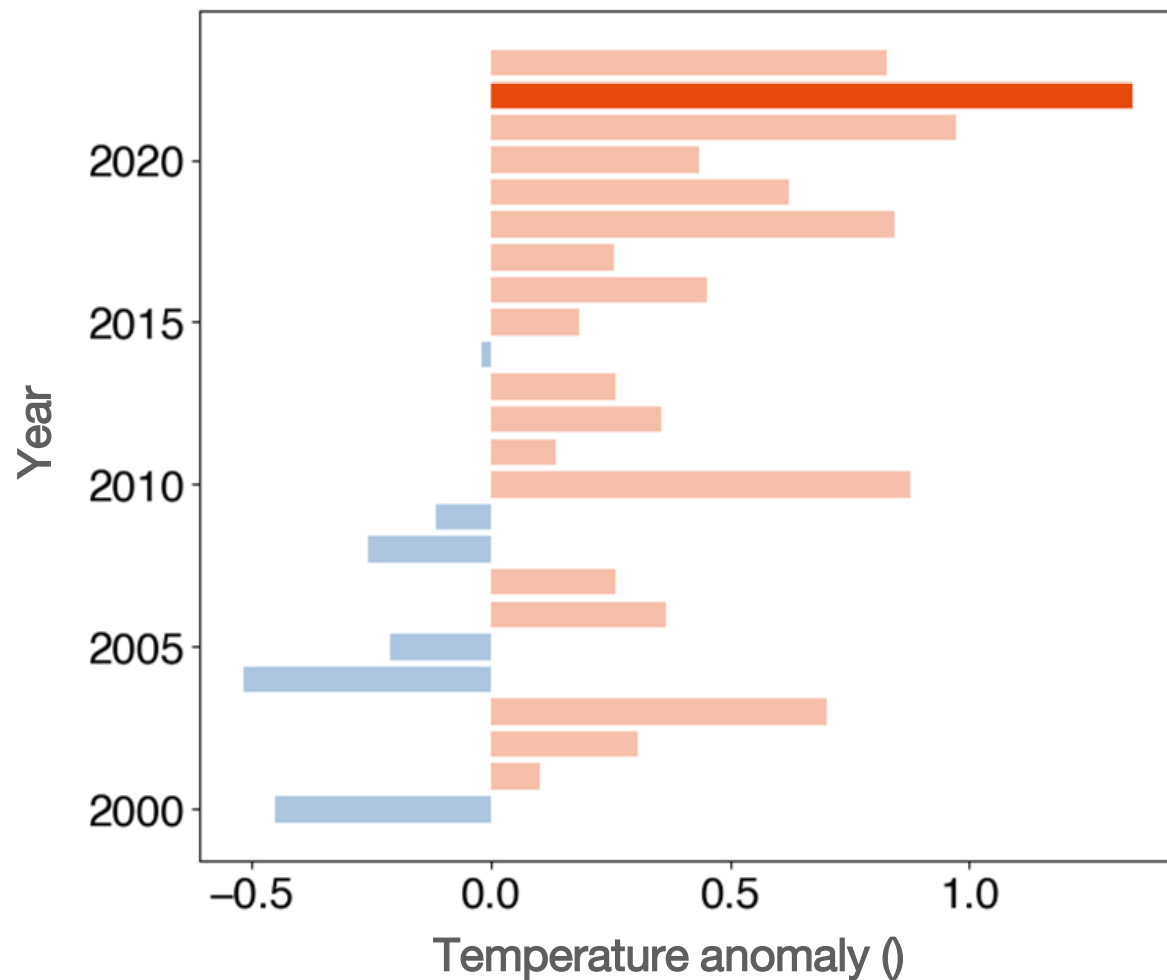


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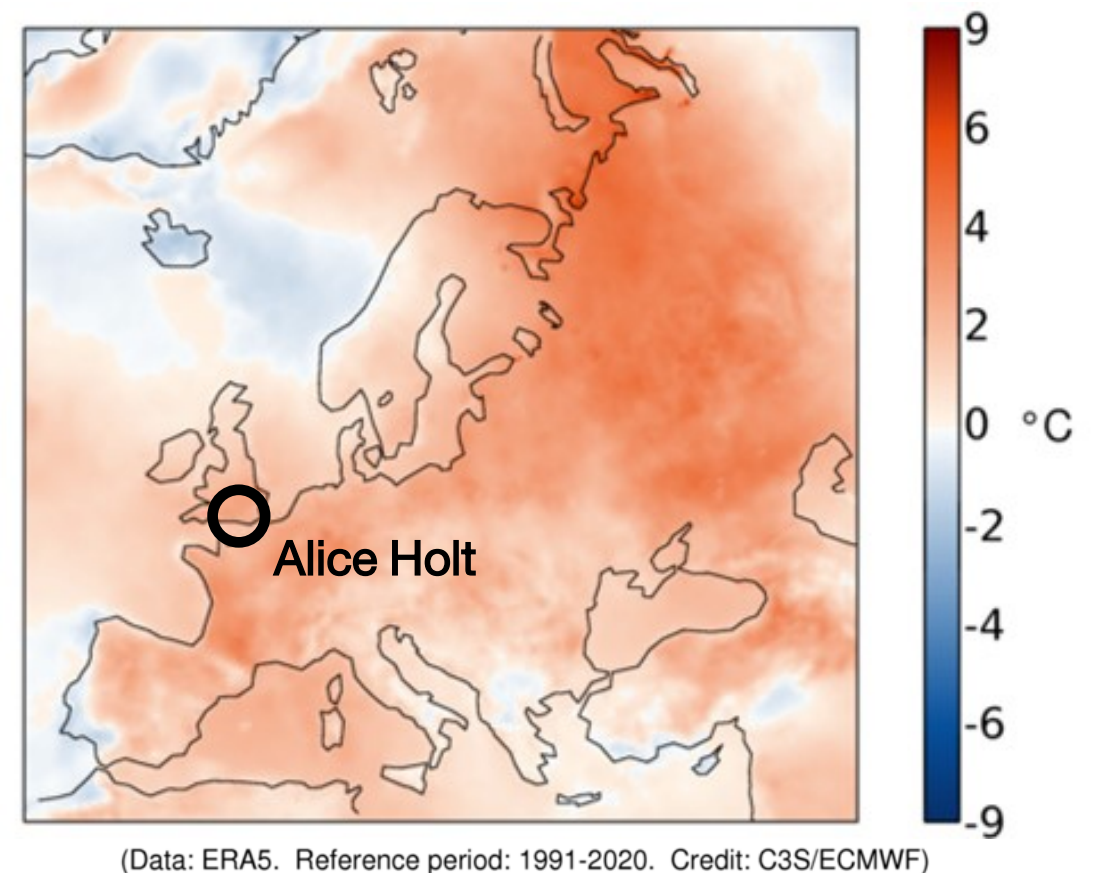
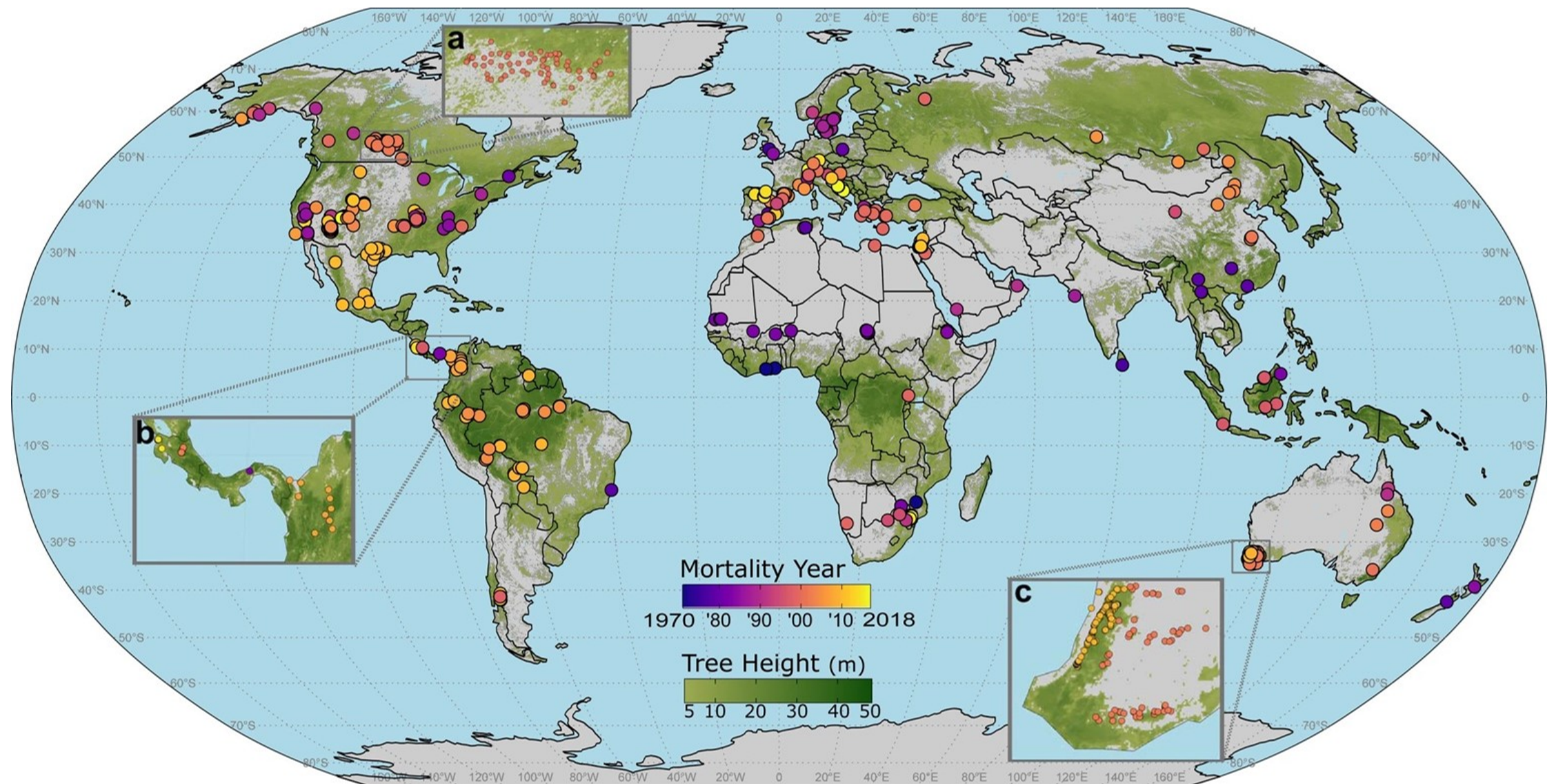


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Drought induced tree mortality



Location of tree mortality plots covering the period 1970 to 2018 catalogued by W.M.Hammond et al 2022.

Key research questions

- Drought stress: What is the impact of summer drought on the water transport system (xylem transport)?
- Drought legacy: How important is the legacy of xylem impairment to future predictions of plant function and drought resilience?

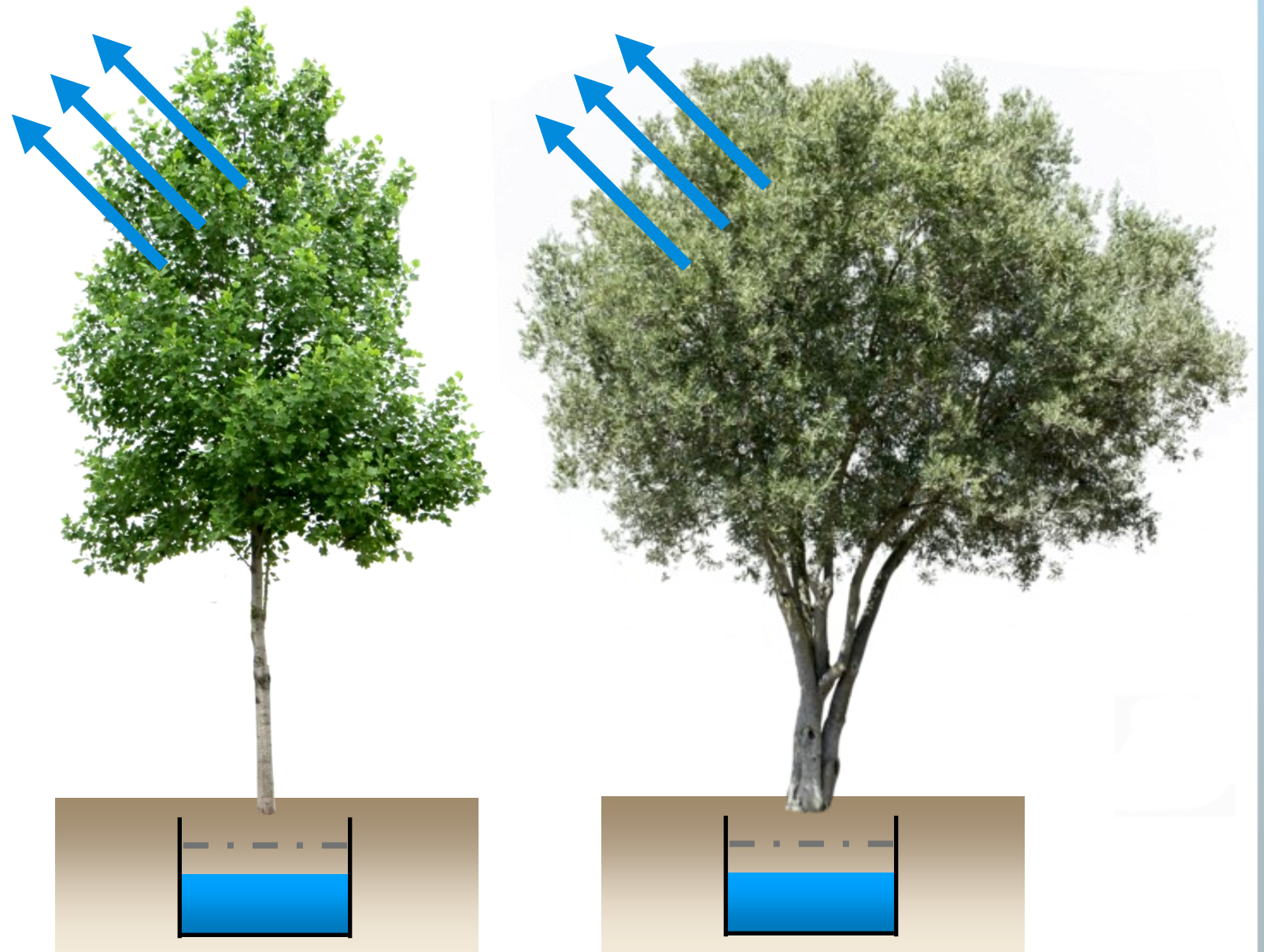
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Modelling water availability in JULES

Transpiration

Is indirectly modulated by FSMC via the down regulation of photosynthesis under reduced water availability.



FSMC

Soil water available to the tree as a fraction of saturated soil water content

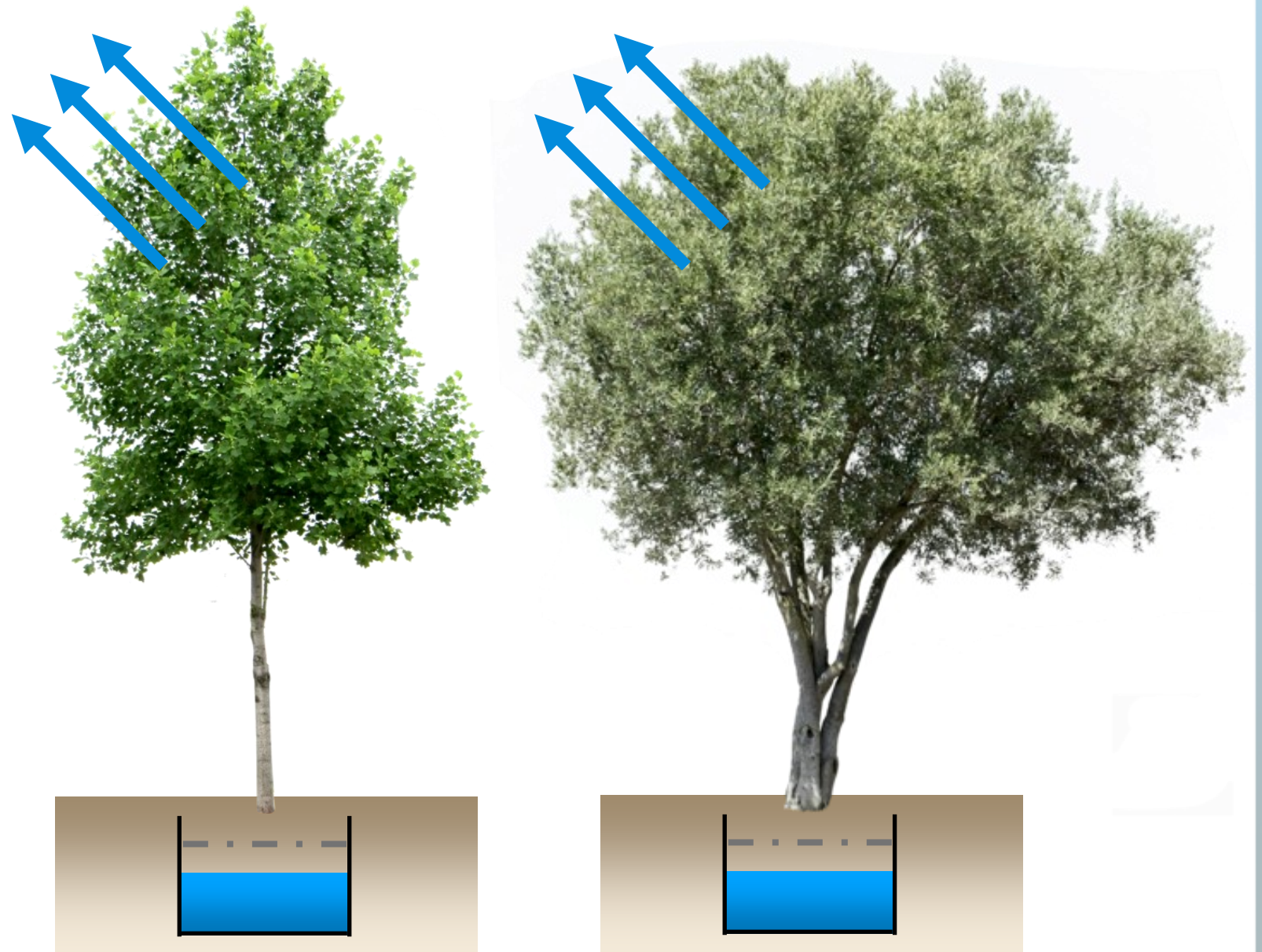
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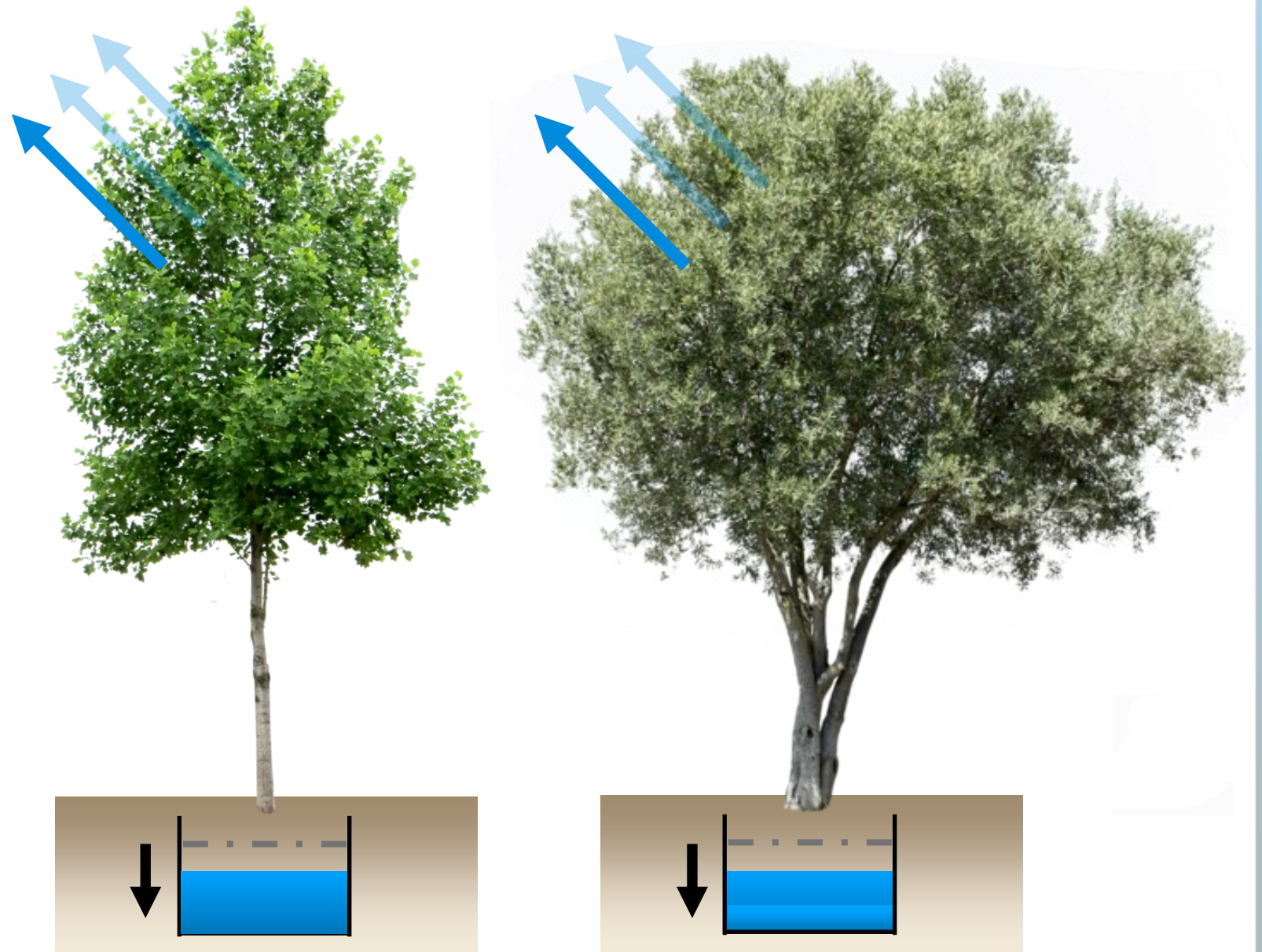
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FSMC ↓

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Modelling water transport by xylem

Water potential

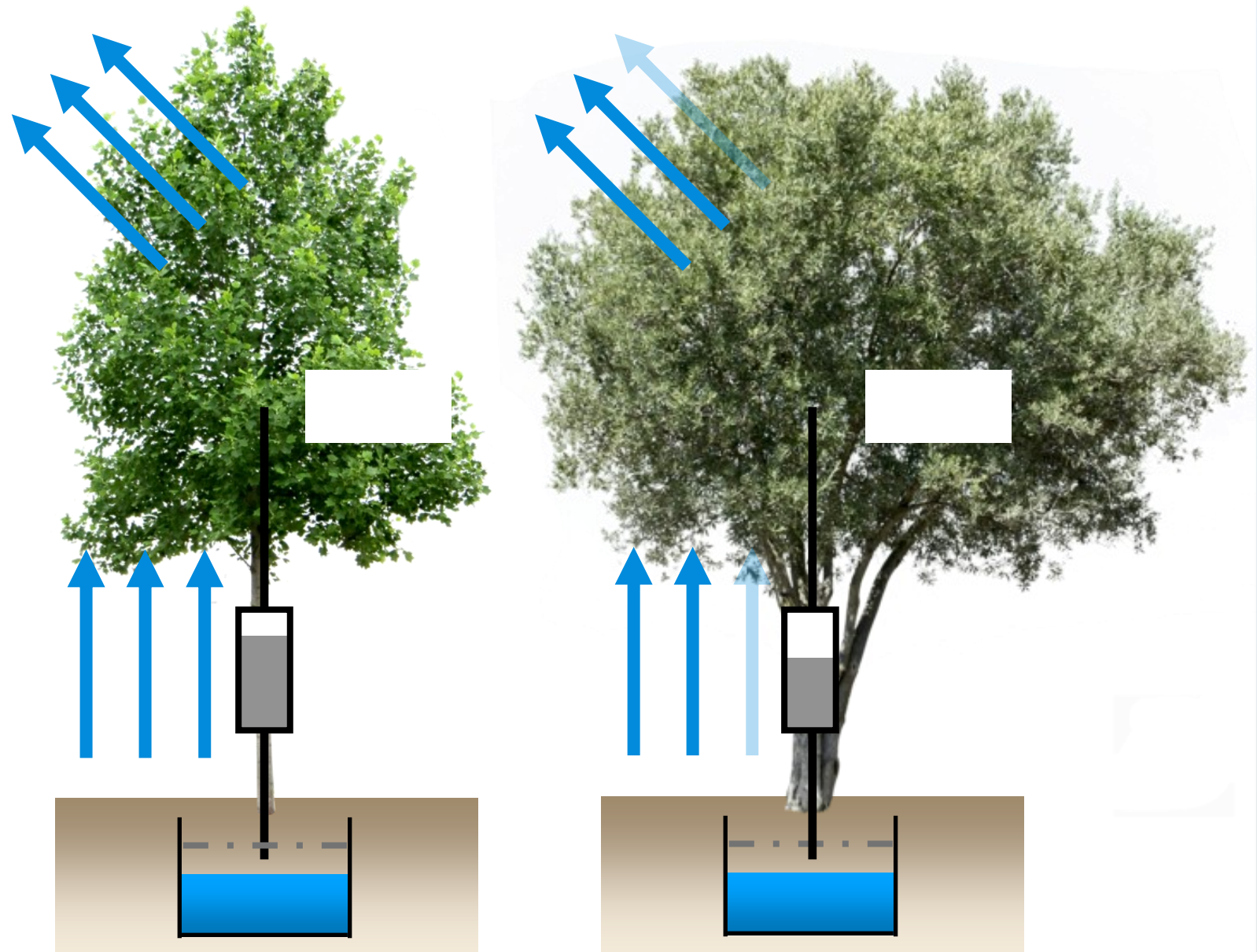
Water moves from higher water potential, ψ , to lower water potential, ψ .

Xylem conductance

Conductance is a measure of the xylem's ability to move water. The higher the conductance the easier the movement of water.

Differing species

Differences in xylem conductance between species result in different behaviour and transpiration rates under the same conditions.



Modelling water transport by xylem

Water potential

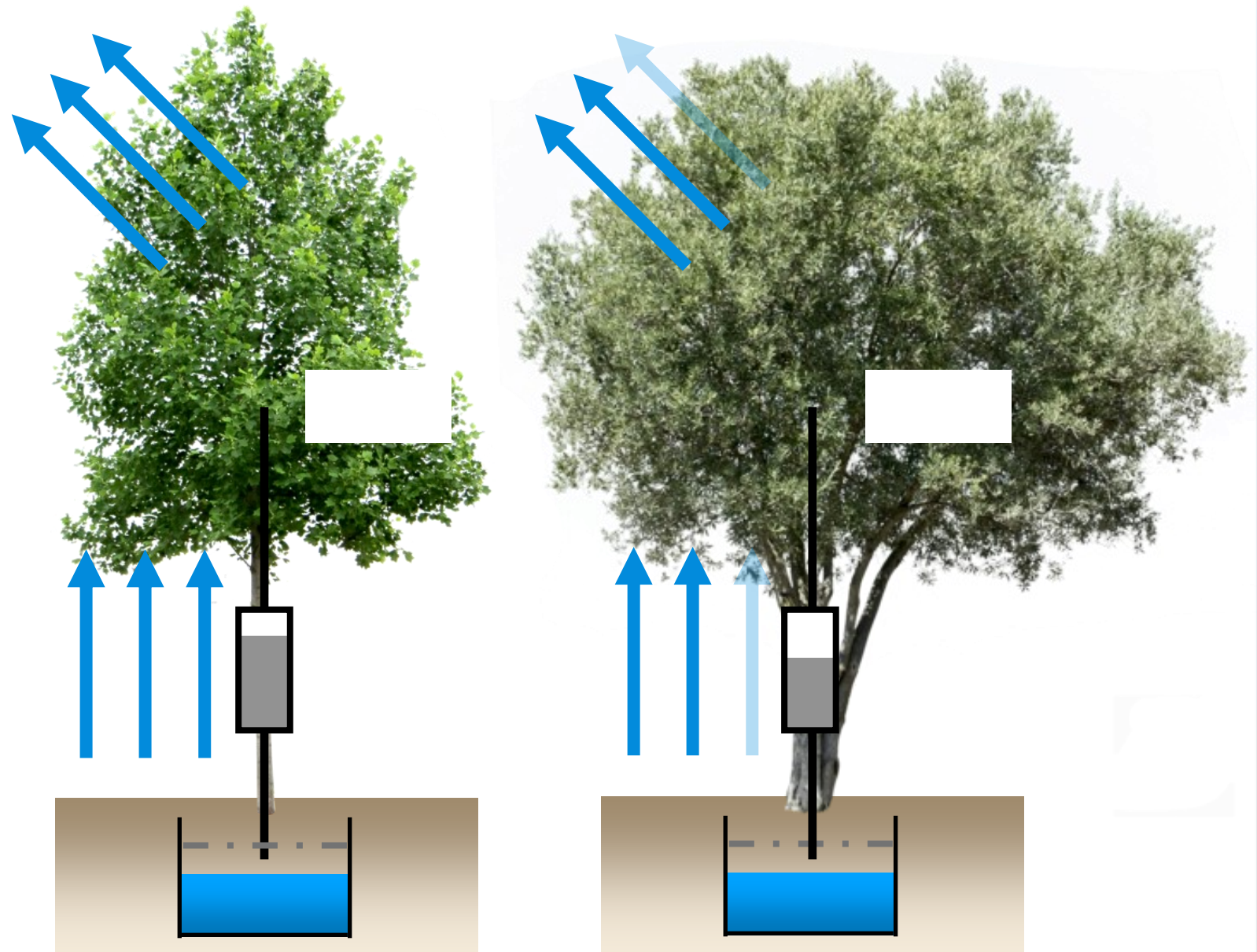
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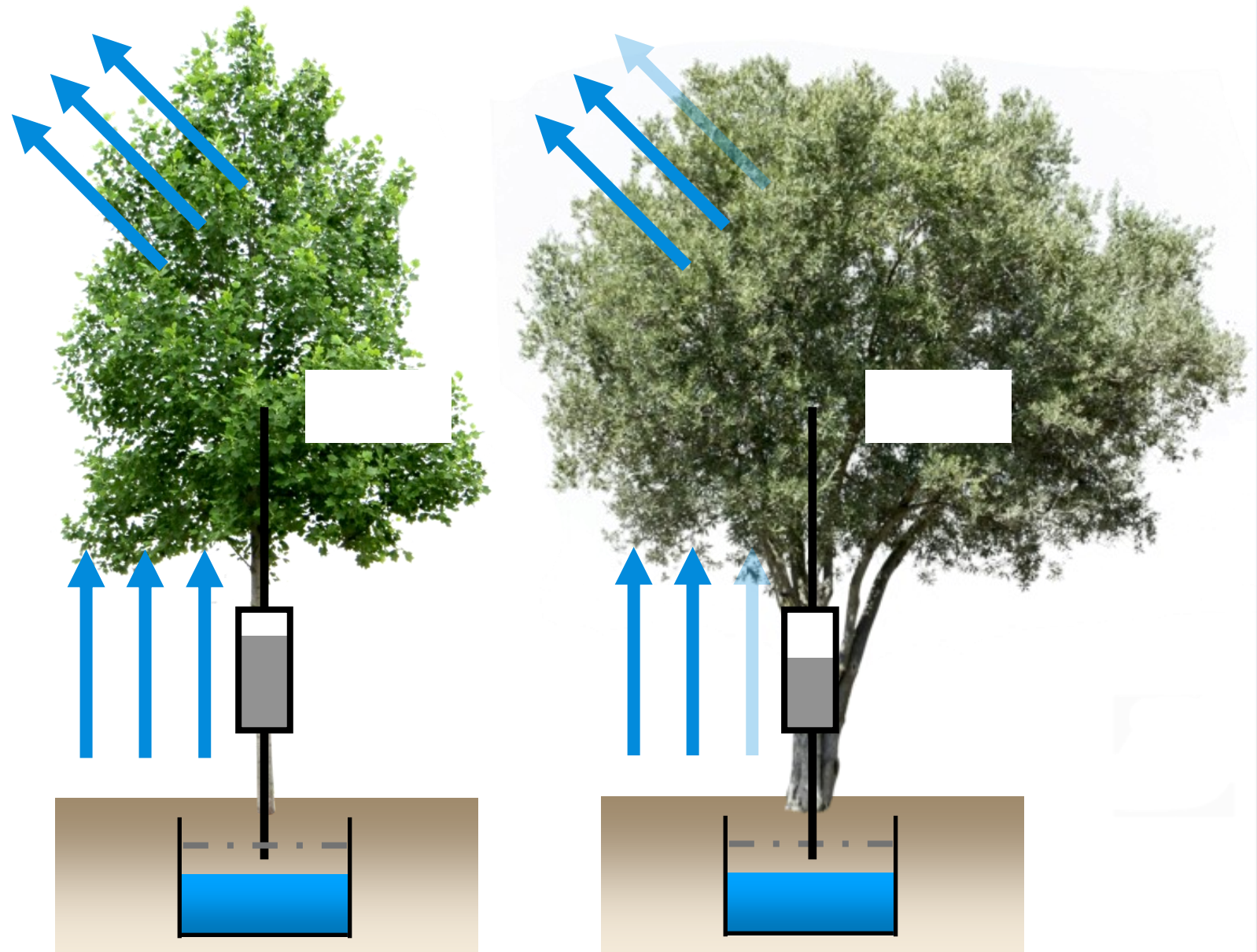
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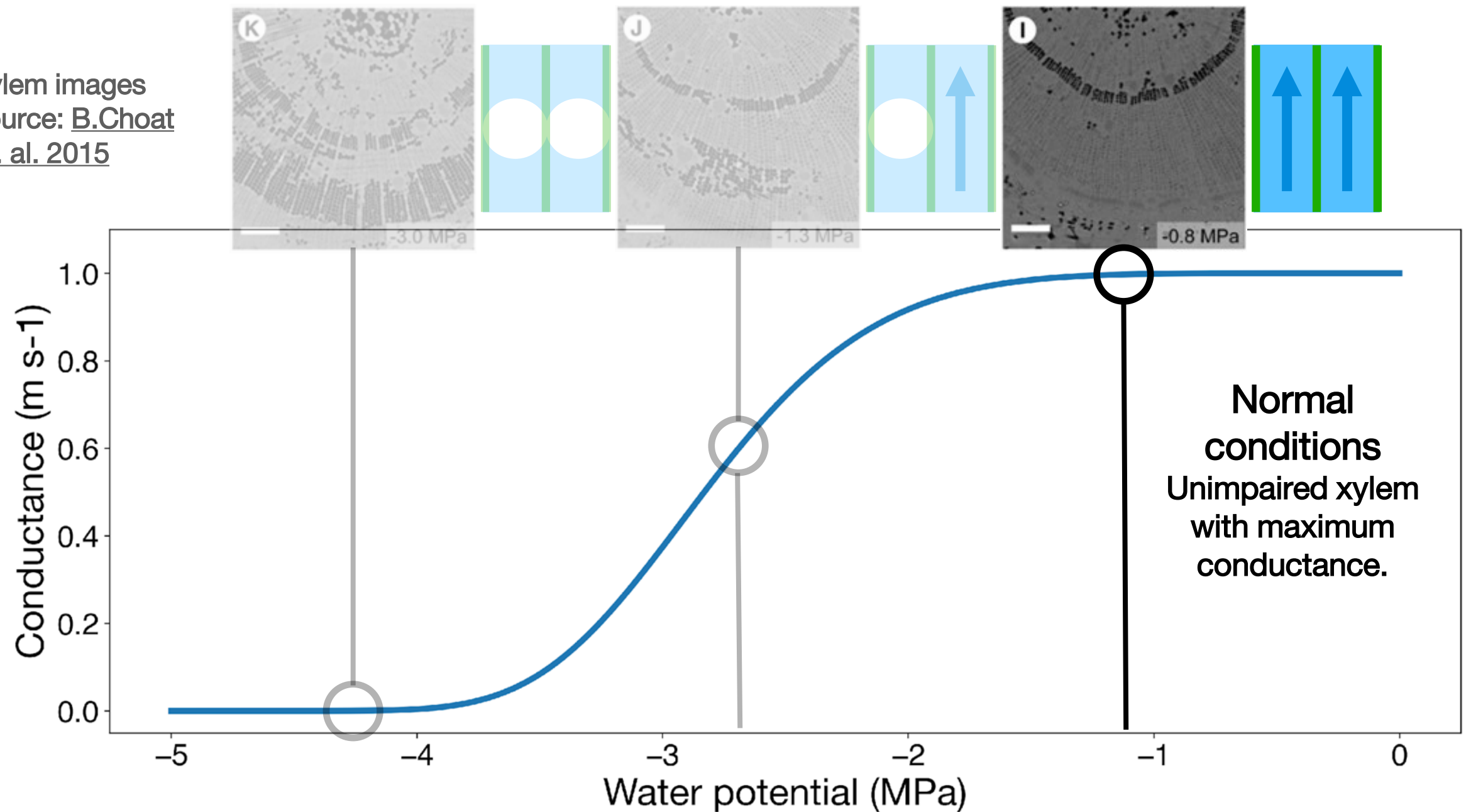
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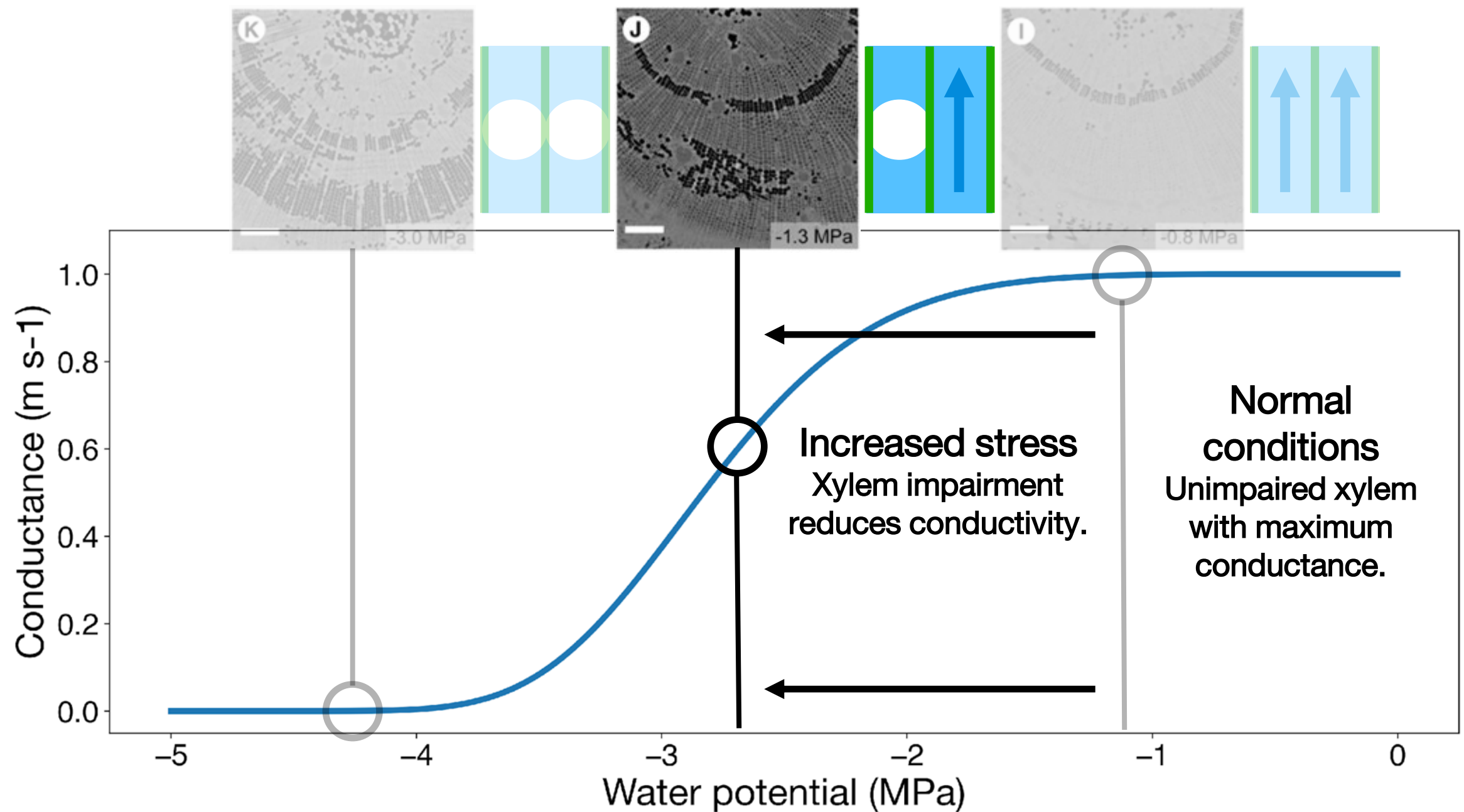


Xylem impairment and conductance

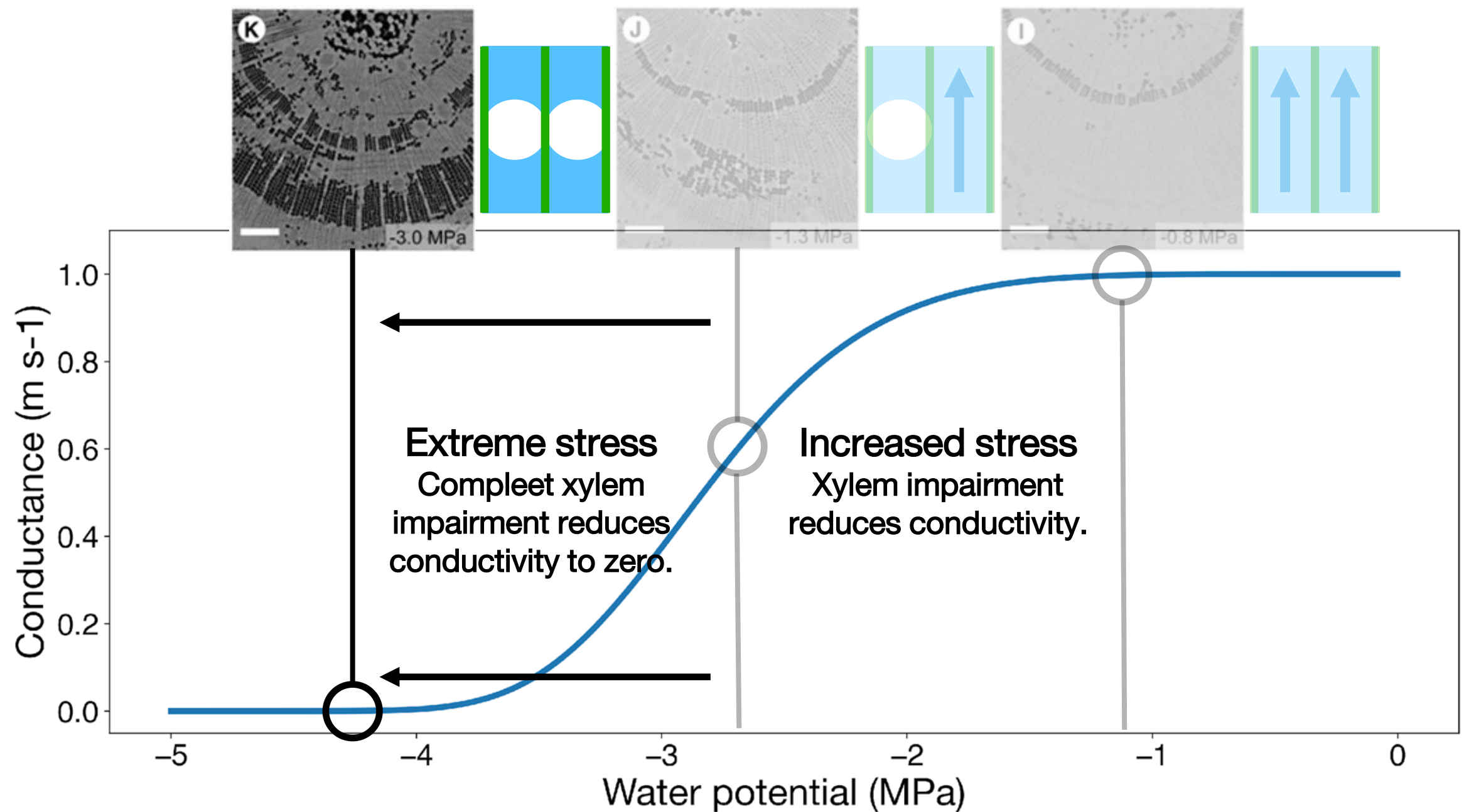
Xylem images
source: [B.Choat
et. al. 2015](#)



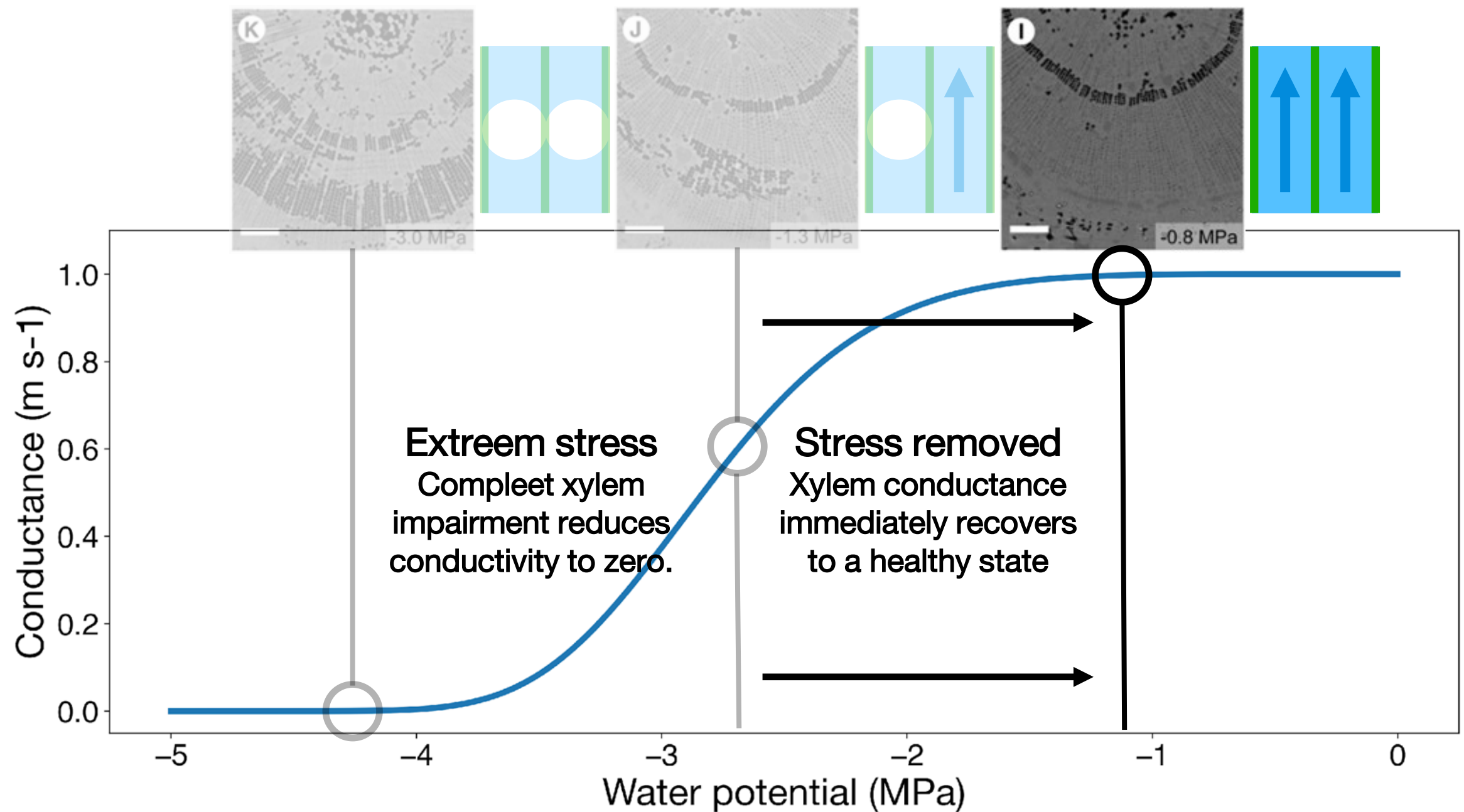
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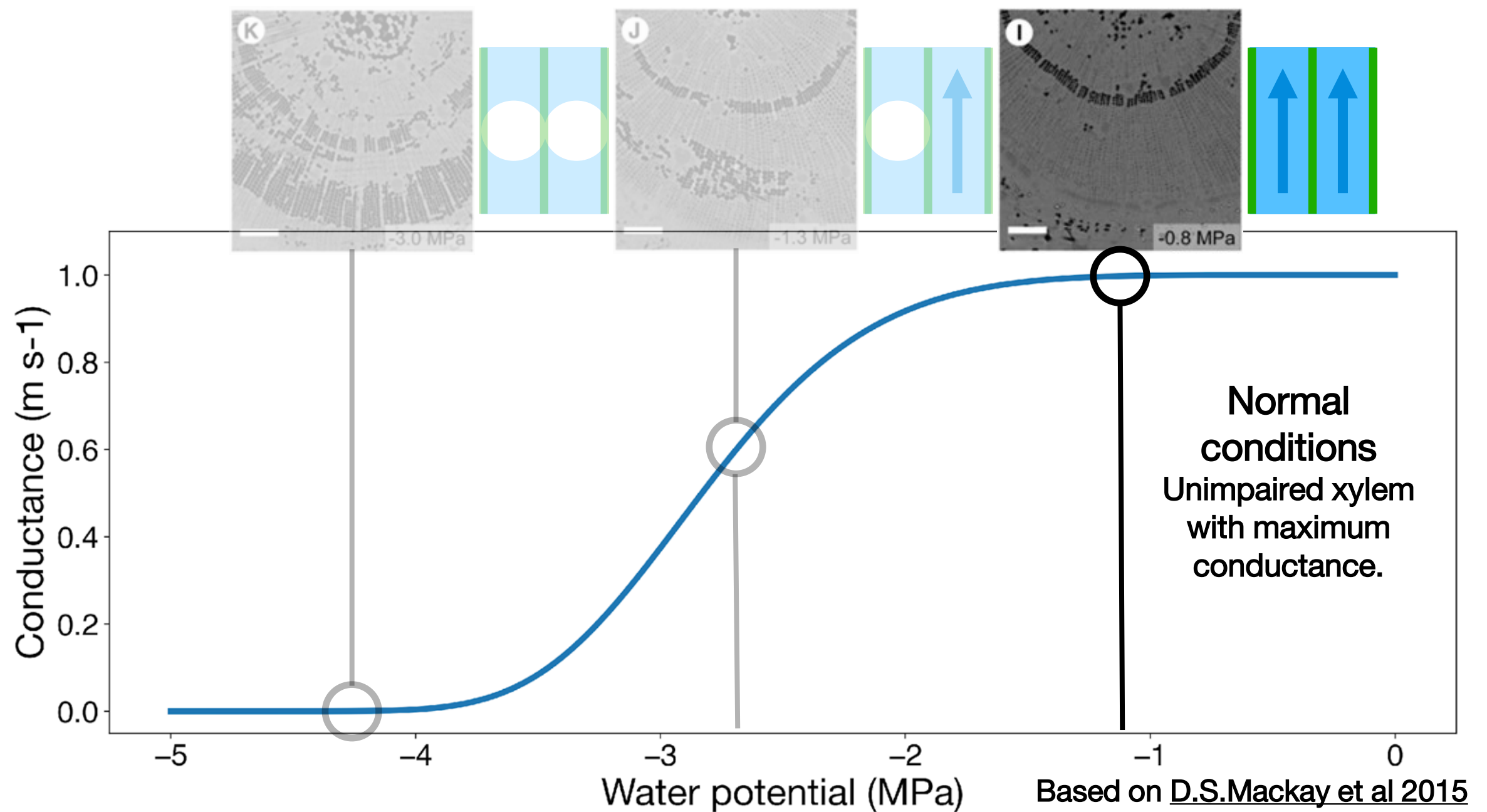
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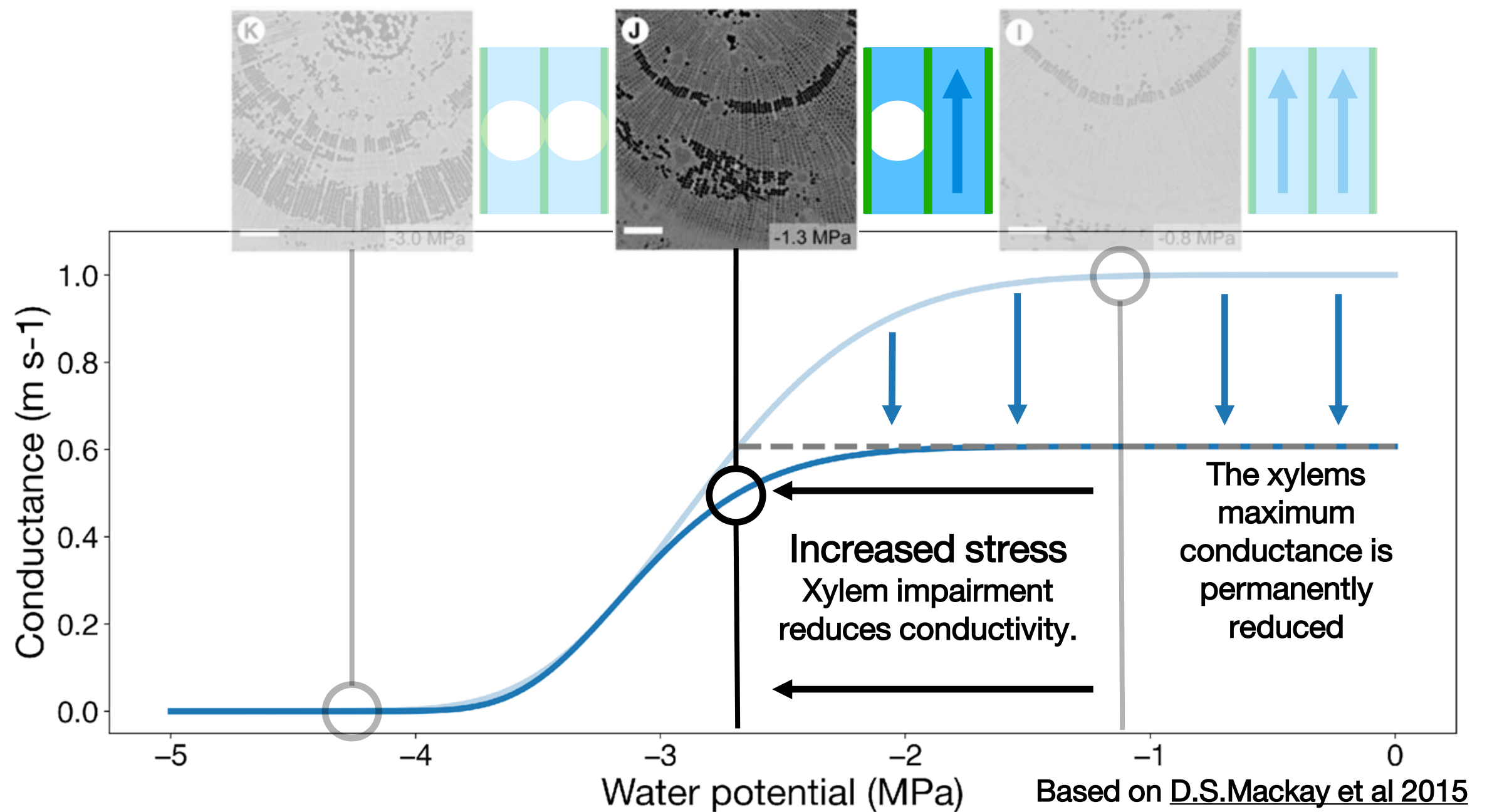
Immediate xylem recovery



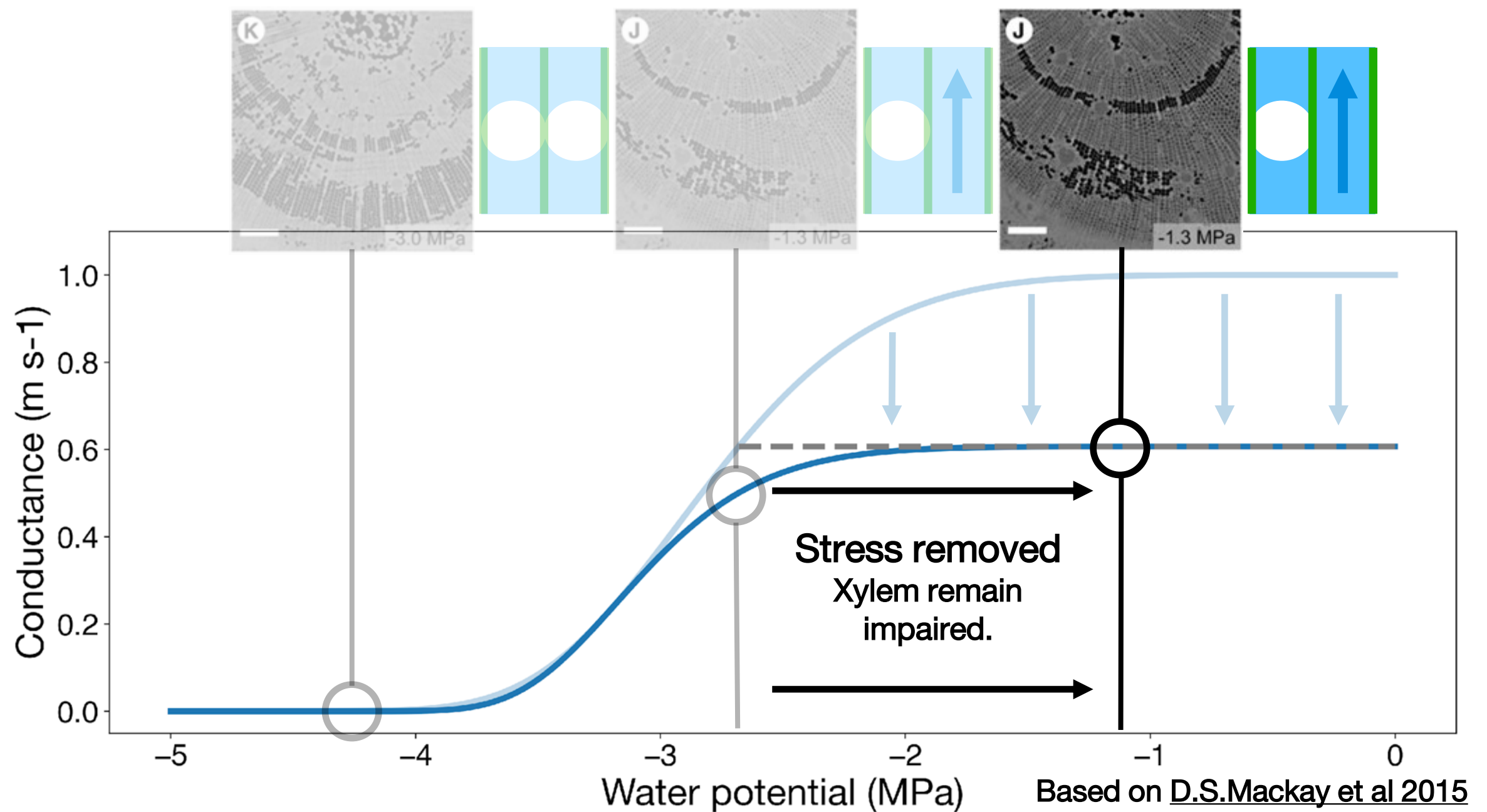
Longterm xylem impairment Kmax model



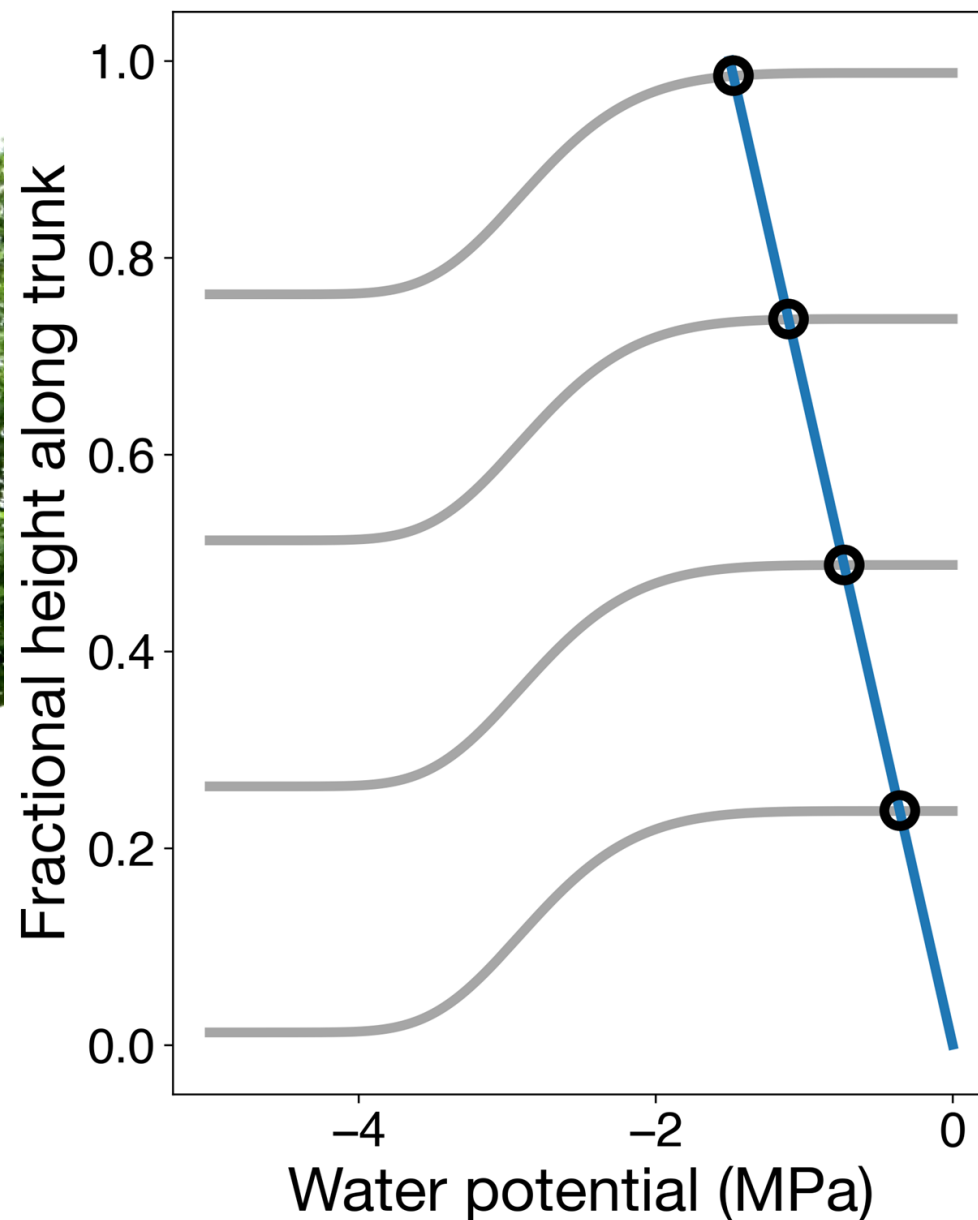
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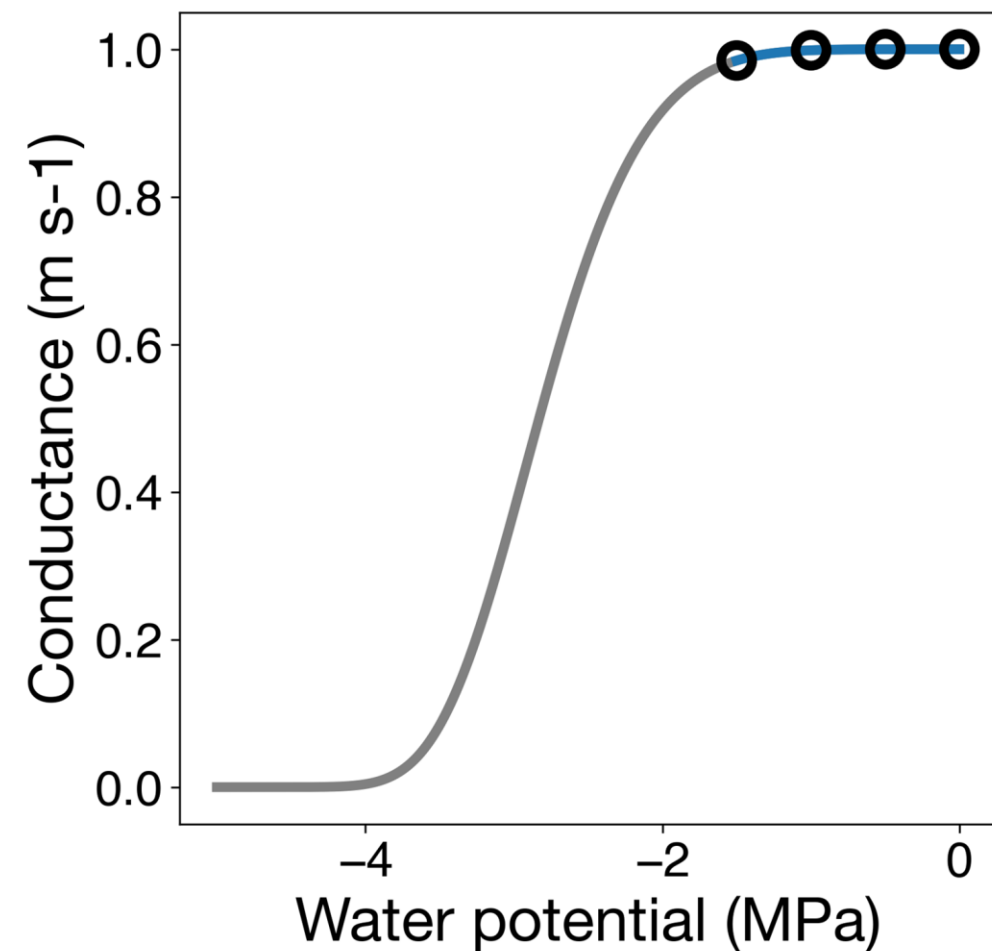
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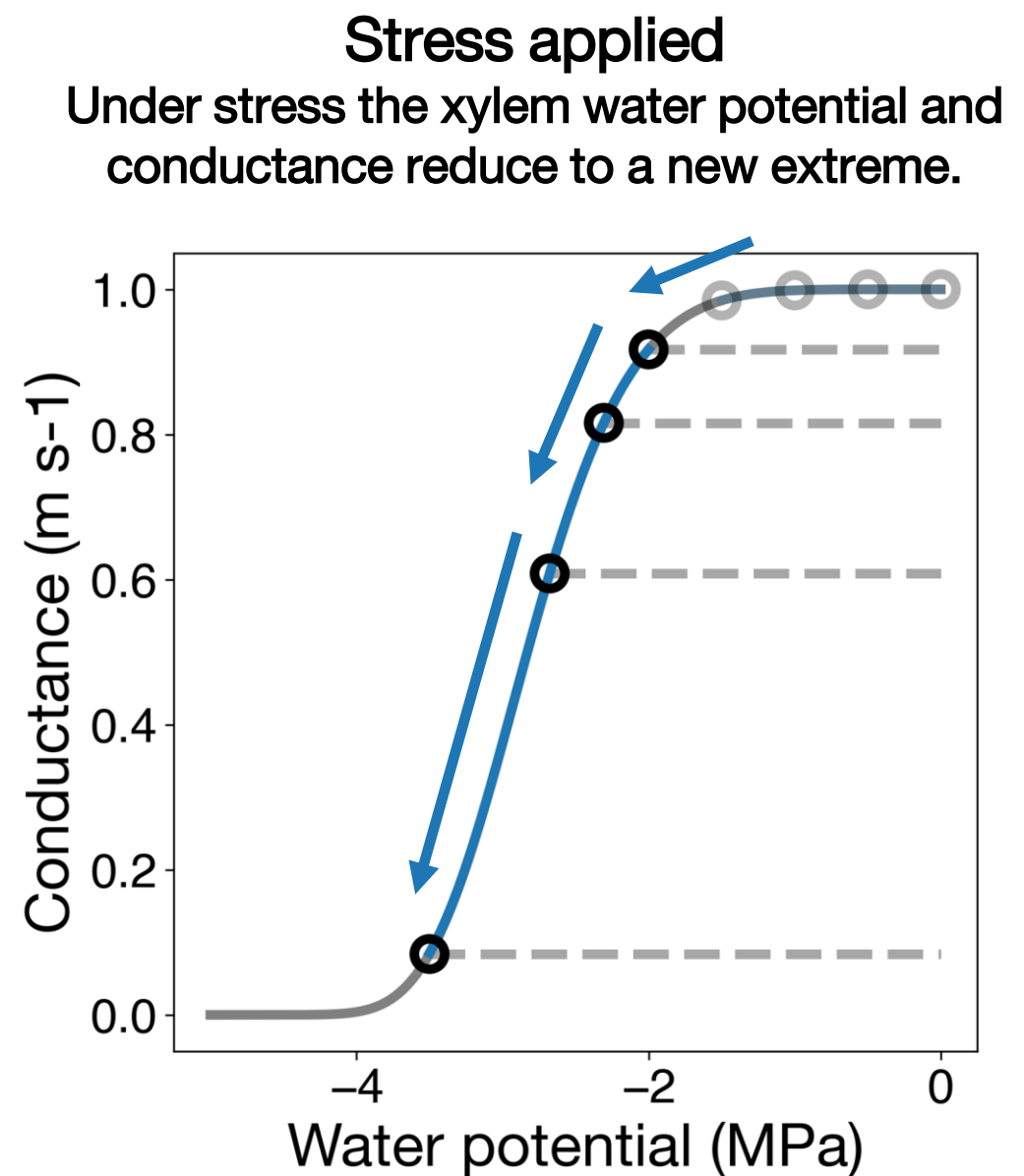
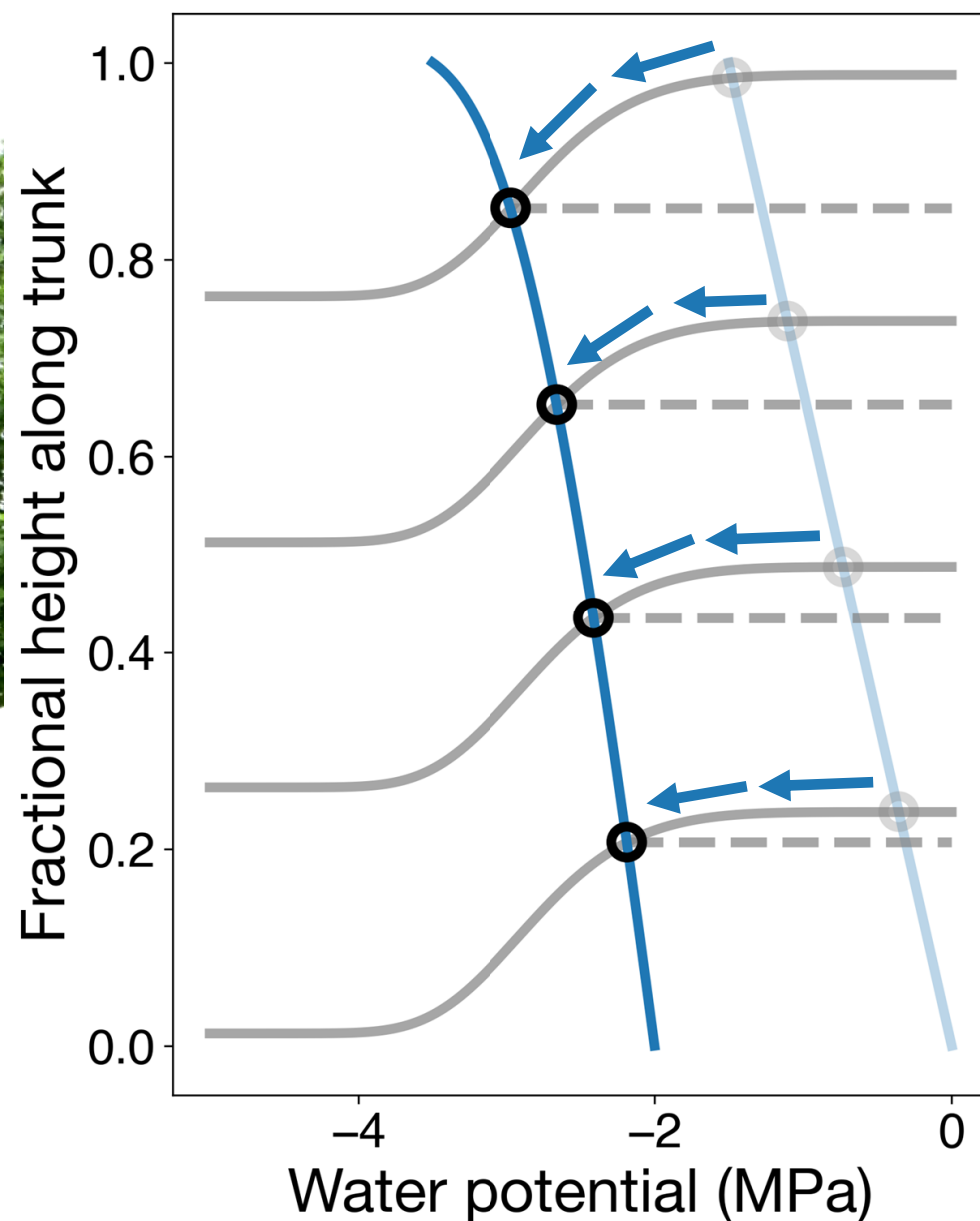
Whole trunk impairment model



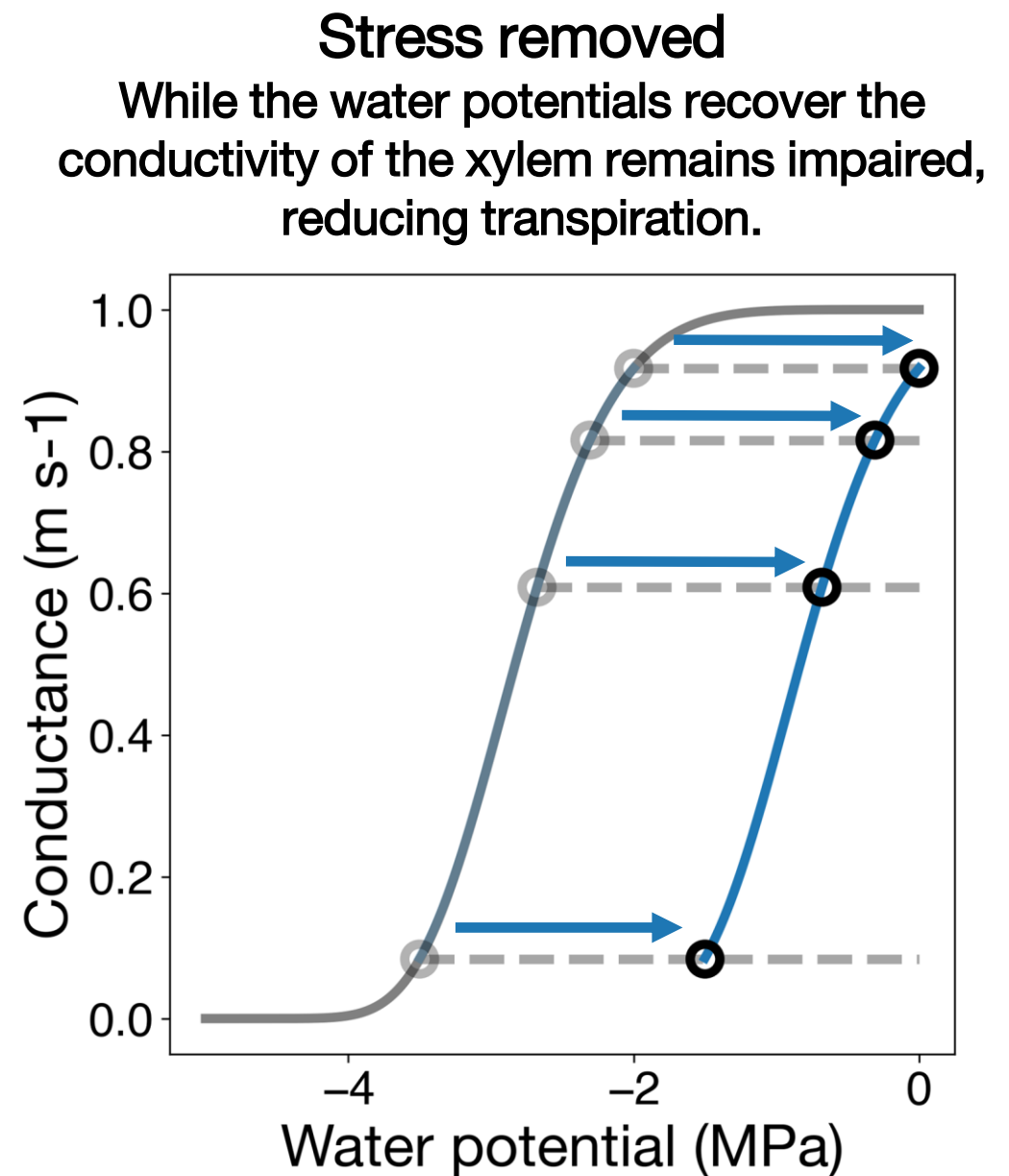
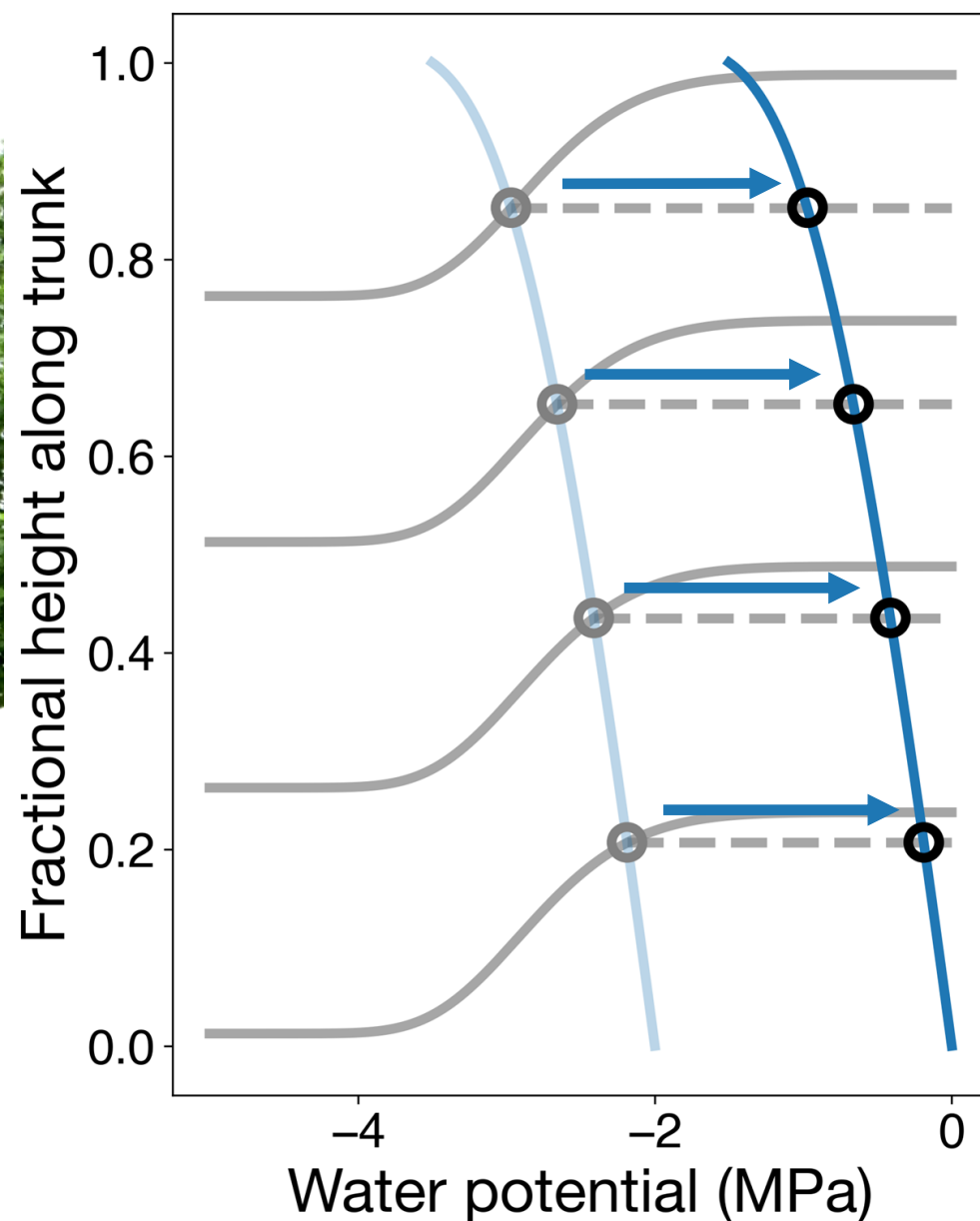
Normal conditions
Both conductance and water potential reduce when moving up a tree.



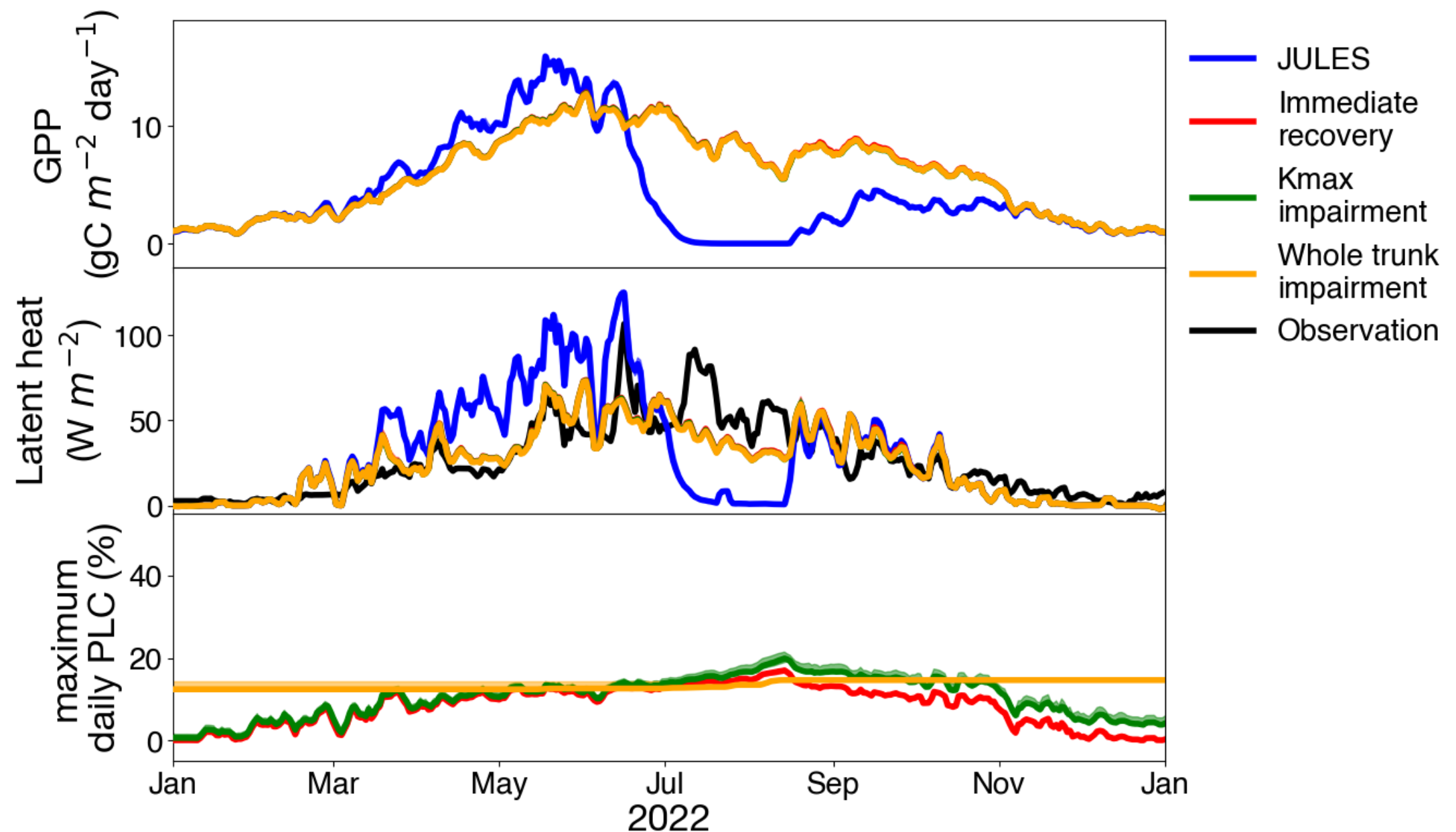
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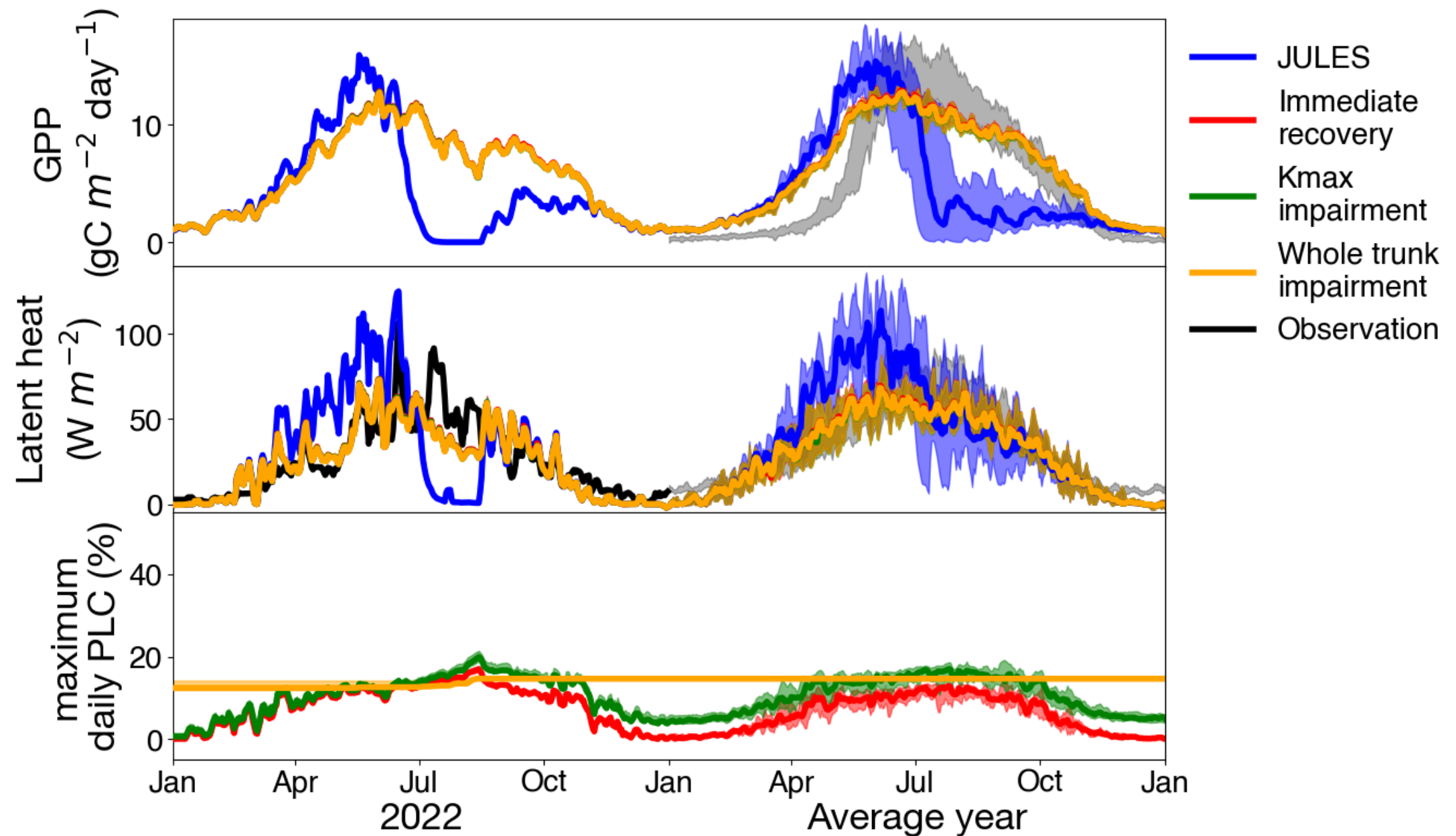
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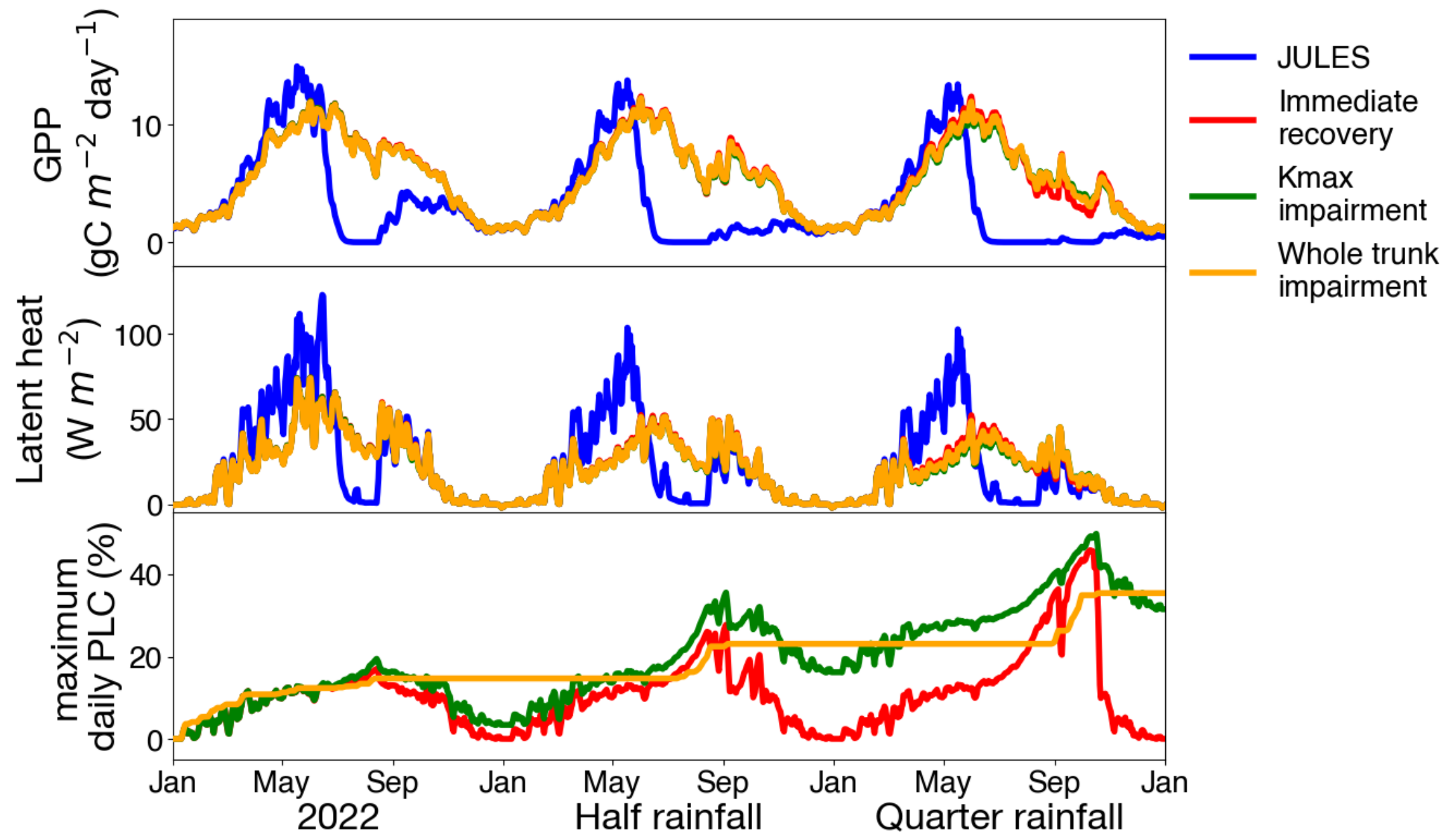
The 2022 drought at Alice Holt



The legacy impact of 2022



Increasing drought stress



Conclusion

- We have shown that simulating legacy effects of extreme summer events in LSMs is feasible
- Interestingly, our approach implies simulated fluxes are unchanged, despite damage to transport system. This is consistent with a lack of legacy signal found in flux evaluation papers.
- Oak species appear robust to recent and worsening droughts. How will heat stress and biotic (pests) worsen these drought impacts?

Future work

- Wider impact: How does xylem impairment impact trees across Europe? Is the response at Alice Holt indicative of trees response to drought more broadly?
- Mitigating drought impact: What methods do trees use to mitigate the impact of droughts, e.g. dropping leaves and the storage of water within the trunk, and can we model these within JULES?
- Xylem Recovery: Following a drought how quickly do trees recover conductivity through xylem refilling and/or growth of new xylem?

Thanks for listening. Any questions?

- Thanks to Tris, Patrick & Lucy



Natural
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Modelling water transport by xylem

Drought vulnerability

Trees more vulnerable to drought stress

