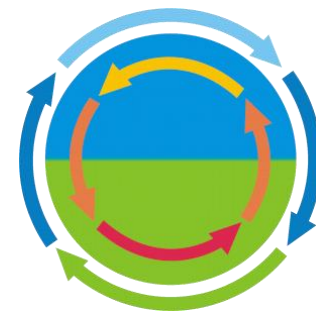


The significance of plant hydraulic parameters for modeling carbon and water fluxes across European climate zones and PFTs

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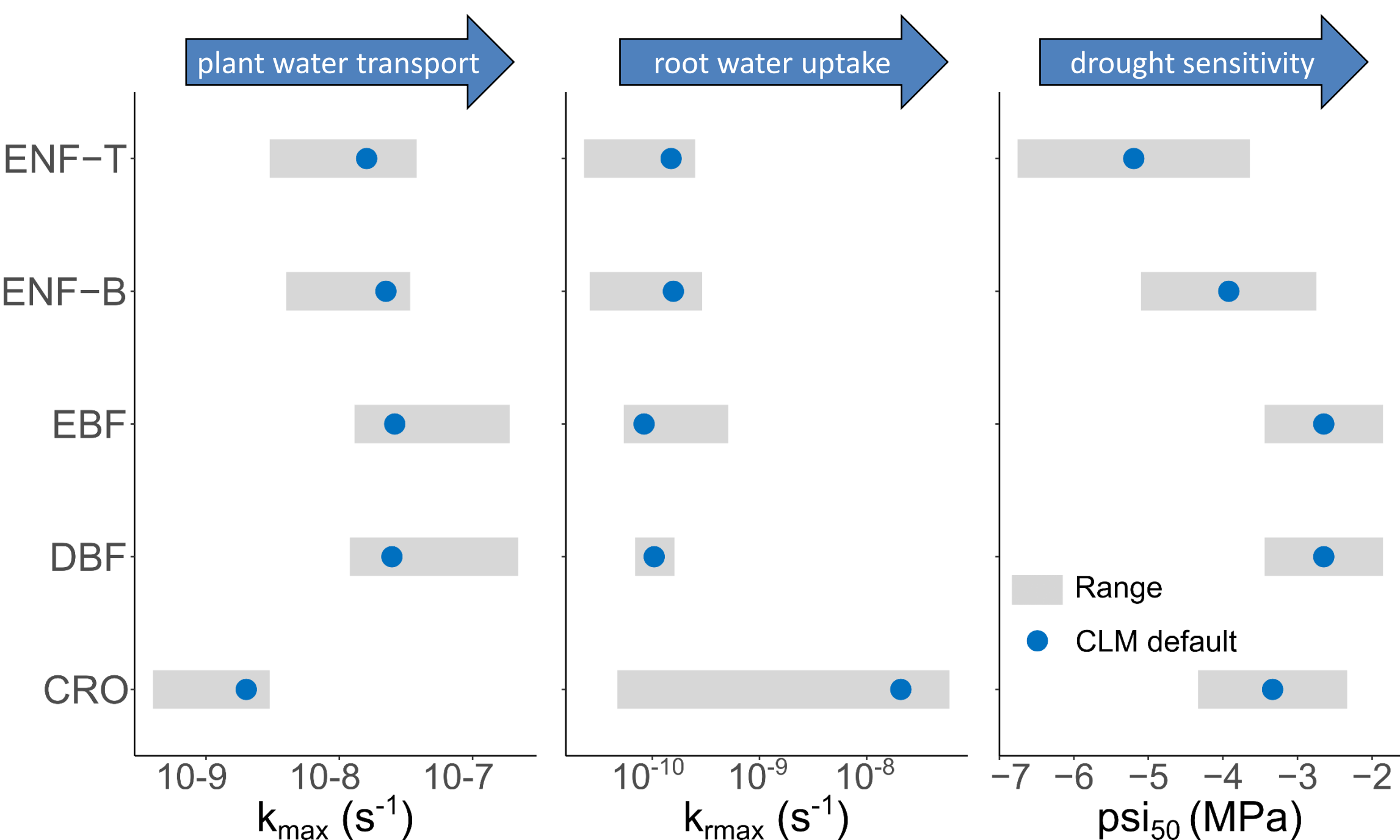
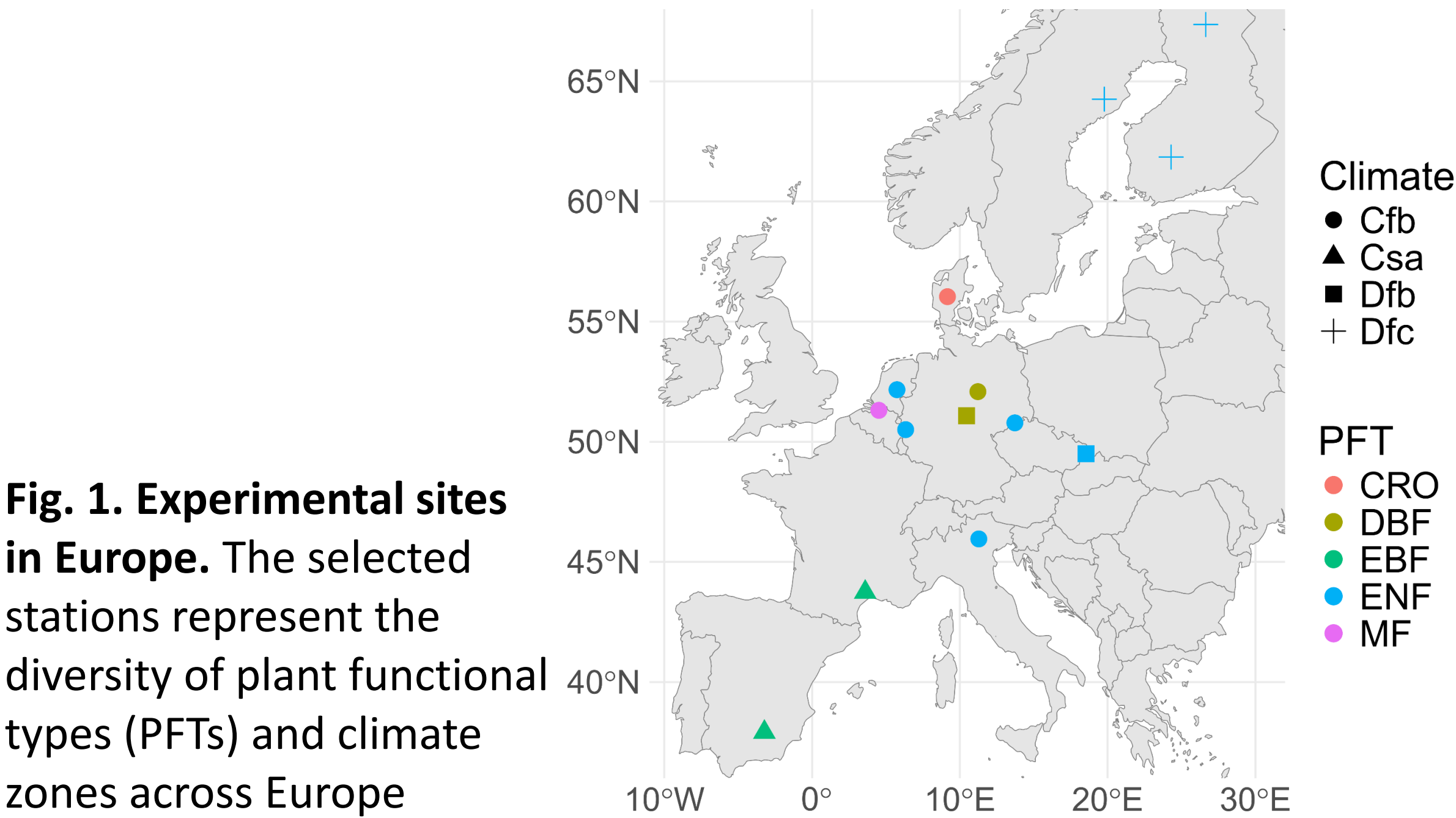


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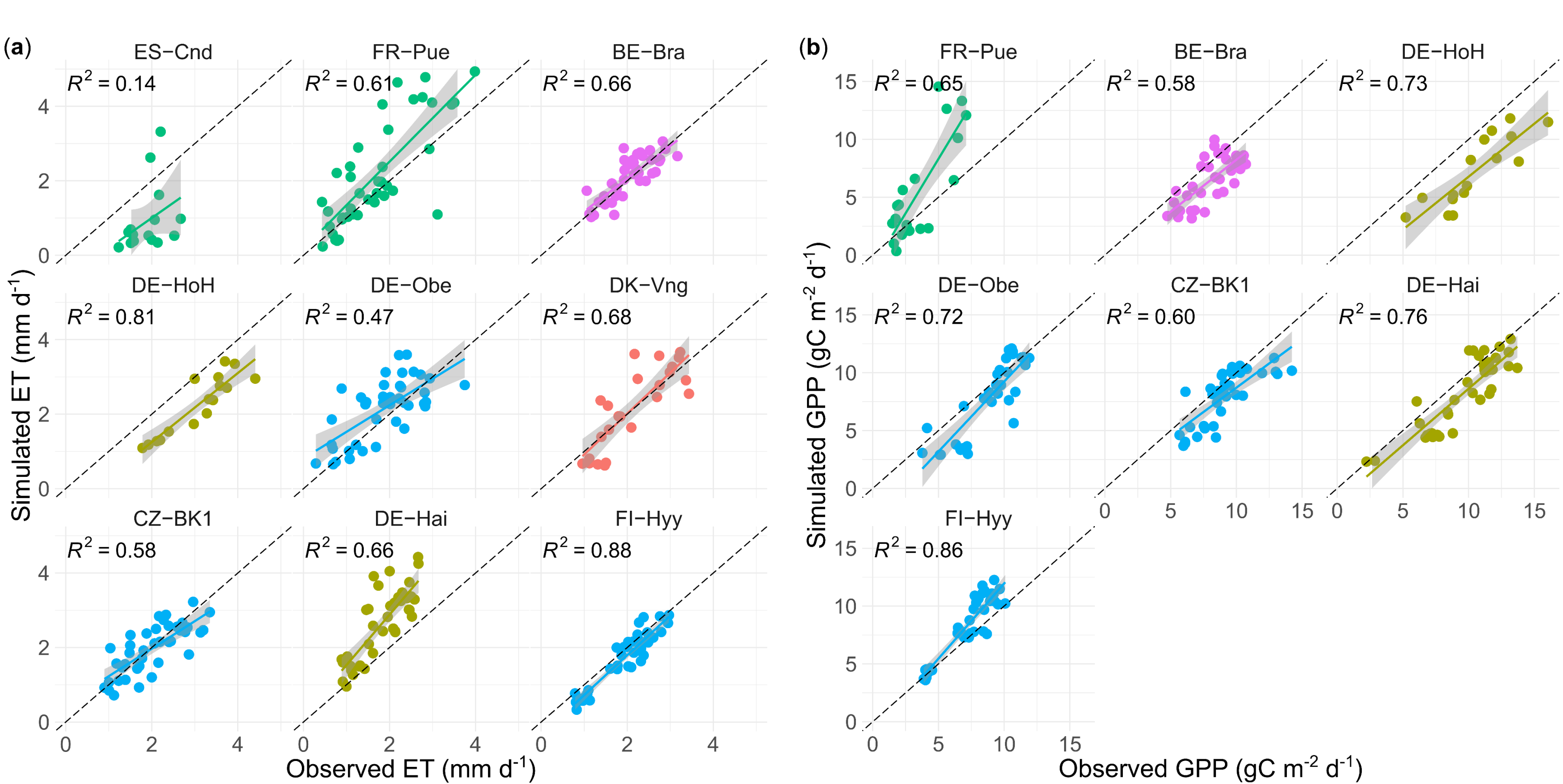
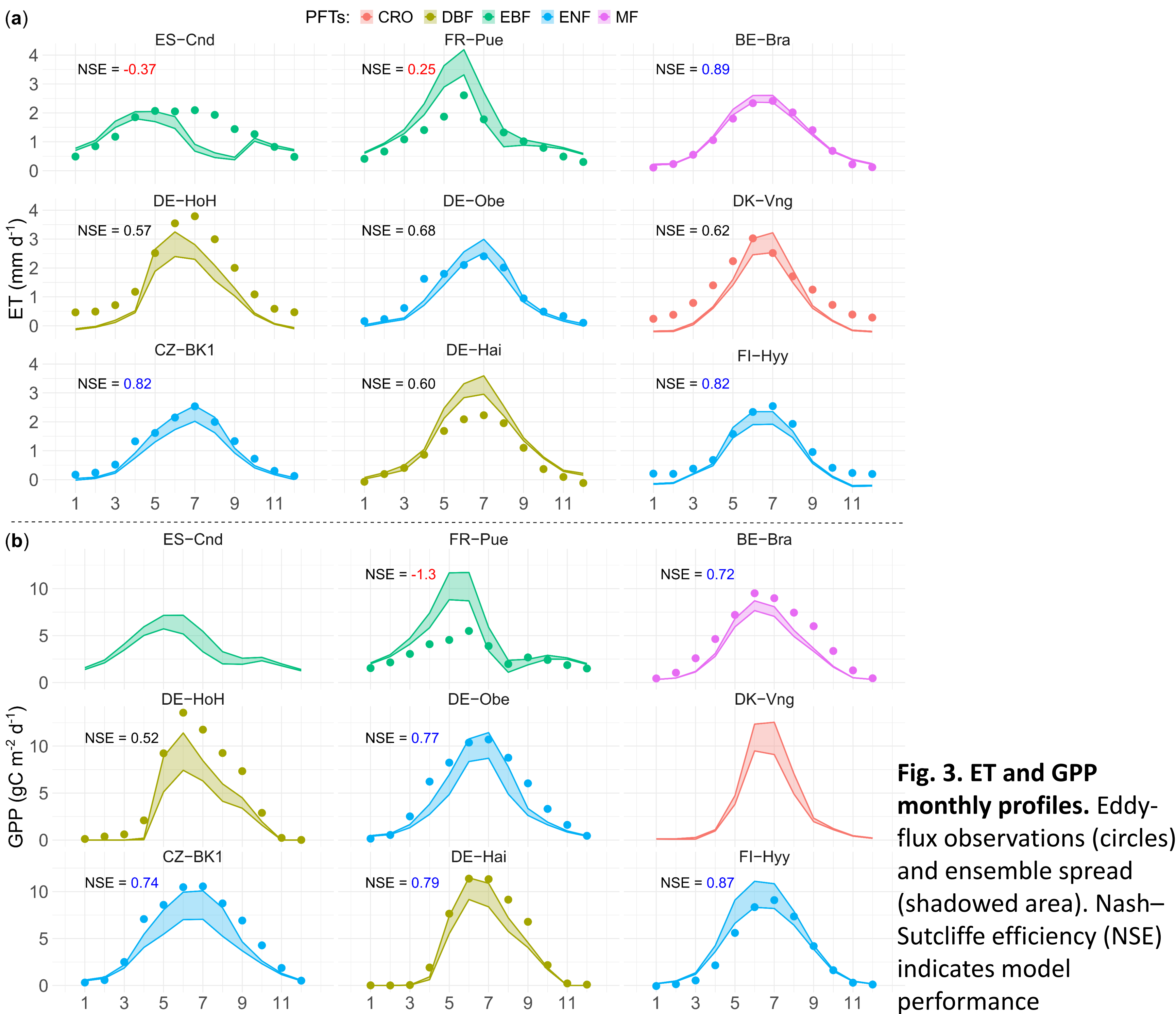
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Motivation and Methods

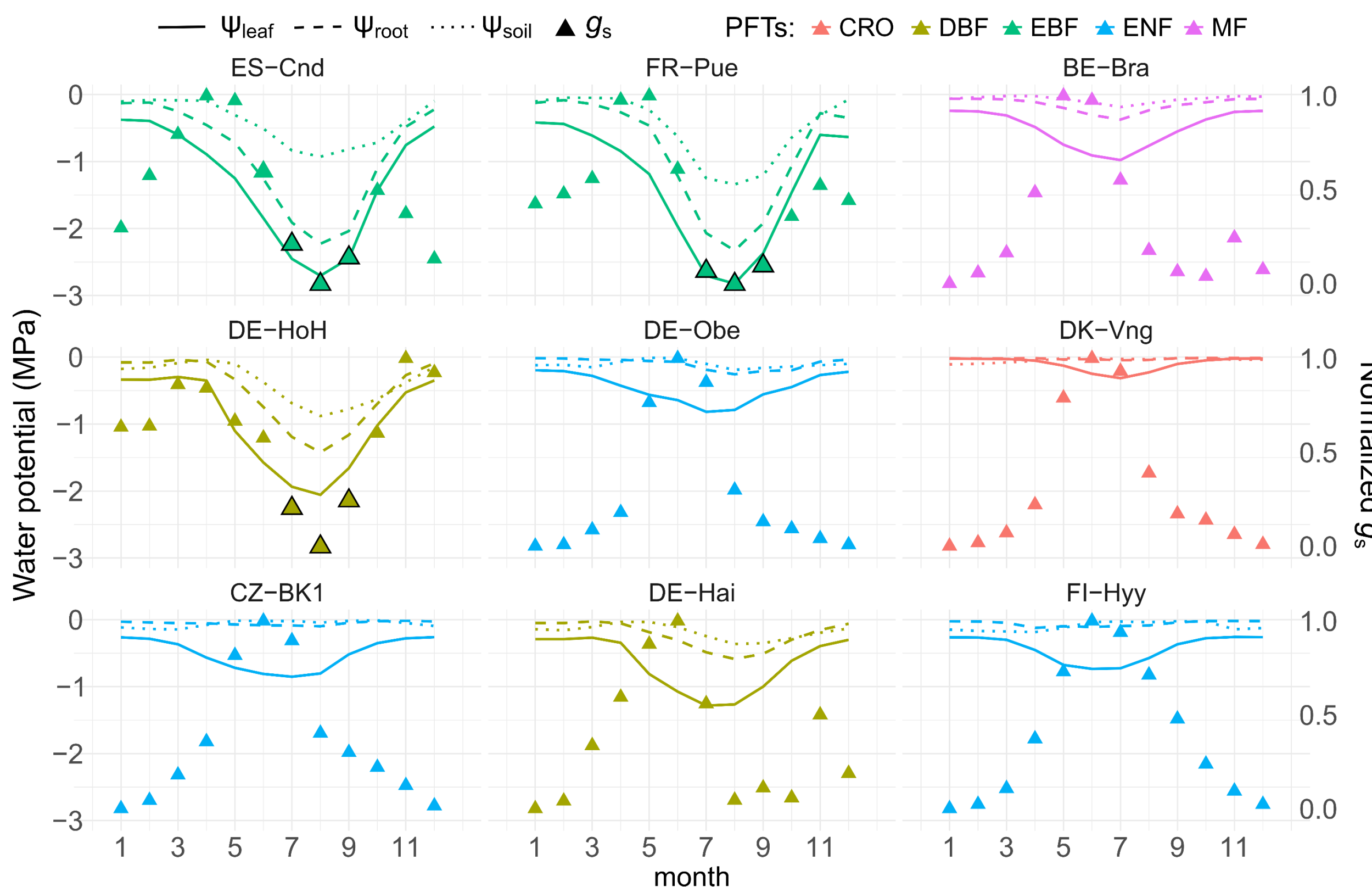
- Climate change increases plant water stress, challenging simulations of vegetation water (W) and carbon (C) fluxes
- Land surface models commonly use empirical soil moisture stress functions, without representing vegetation water status
- CLM5 includes a new plant hydraulic stress routine, improving simulations of water potential, root uptake, and water stress¹
- Key hydraulic parameters remain uncertain and significantly impact modelled fluxes²
- We investigated model behaviour with new routine: W and C fluxes, vegetation water status and stomatal conductance (g_s)
- Perturbation experiment: 128 ensemble members, variation of plant/root segment maximum conductance (k_{max} , k_{rmax}) and water potential at 50% conductance loss (ψ_{50})
- Perturbation ranges were based on prior CLM5 studies^{2,3} and hydraulic trait databases^{4,5} (Fig. 2)



Ensemble spread and model performance



Effect of vegetation water status on g_s



Conclusions and outlook

- Model captures both seasonal dynamics (Fig. 3) and interannual variability (Fig. 4)
- Model performance varies strongly across stations; largest mismatches in Mediterranean sites
- High ensemble spread, especially for GPP → plant hydraulic trait uncertainty remains a key issue
- Simulated water potential gradients from soil to leaf reflect soil–plant–atmosphere temporal dynamics (Fig. 5)
- Stomatal closure under plant hydraulic stress captured in high-activity vegetation during summer (EBF, DBF), when ψ_{leaf} drops below parameterized thresholds (Fig. 5)
- Very pronounced plant hydraulic stress in Mediterranean sites according to the model → potential overestimation?
- Next steps**
 - Variance decomposition → quantify individual contribution of hydraulic parameters driving uncertainty and error
 - Shift from PFT to site-specific parameterization → better reflect vegetation-climate interactions

References

- Kennedy et al. 2019. <https://doi.org/10.1029/2018MS001500>
- Kennedy et al. 2024. <https://doi.org/10.22541/essoar.172745082.24089296/v1>
- Eloundou et al. 2024. <https://doi.org/10.5194/equsphere-equ24-16086>
- Baca Cabrera et al. 2024. <https://doi.org/10.1002/pld3.582>
- Choat et al., 2012. <https://doi.org/10.1038/nature11688>