Effects on the simulated hydraulic stress of different representations of a mixed forest in Luxembourg

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Different tree ages, different needs

Missing a PFT representation of a mixed forests

Same phenology, different traits

Expousure to frequent stress damage the trees

Our hypothesis suggests that a more detailed characterization of PHTs in mixed forest ecosystems will better represent observed water fluxes and stress compared to the generic PFT generic parameterization.

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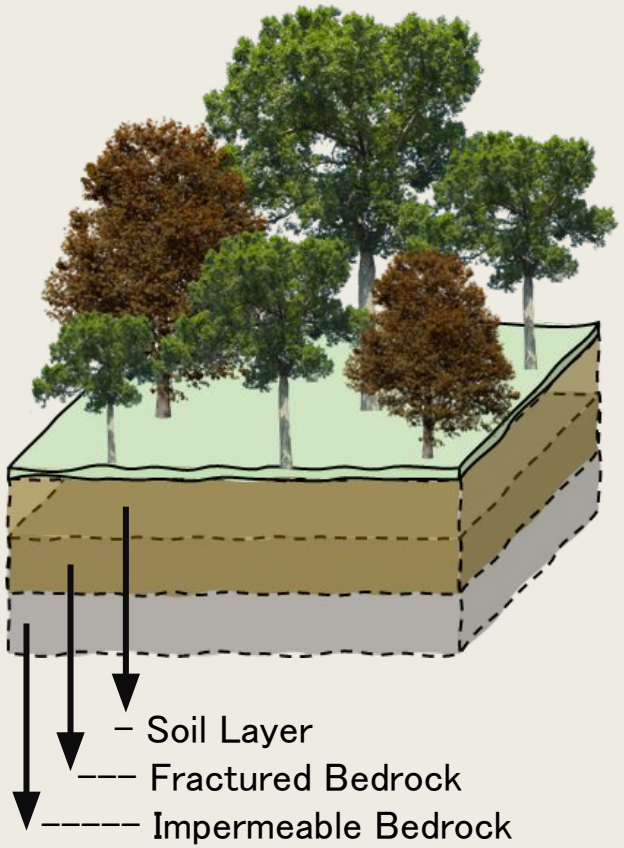
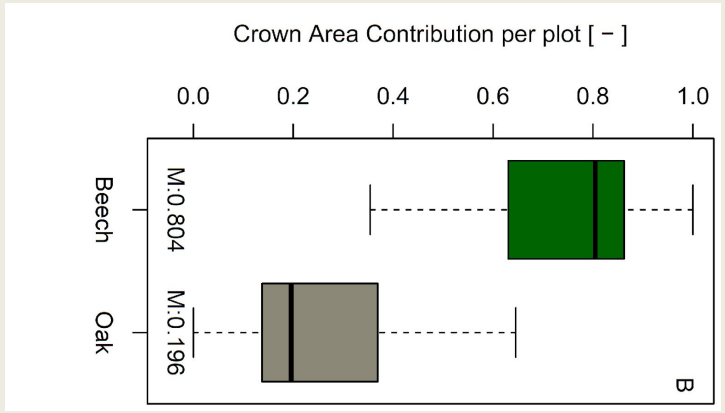
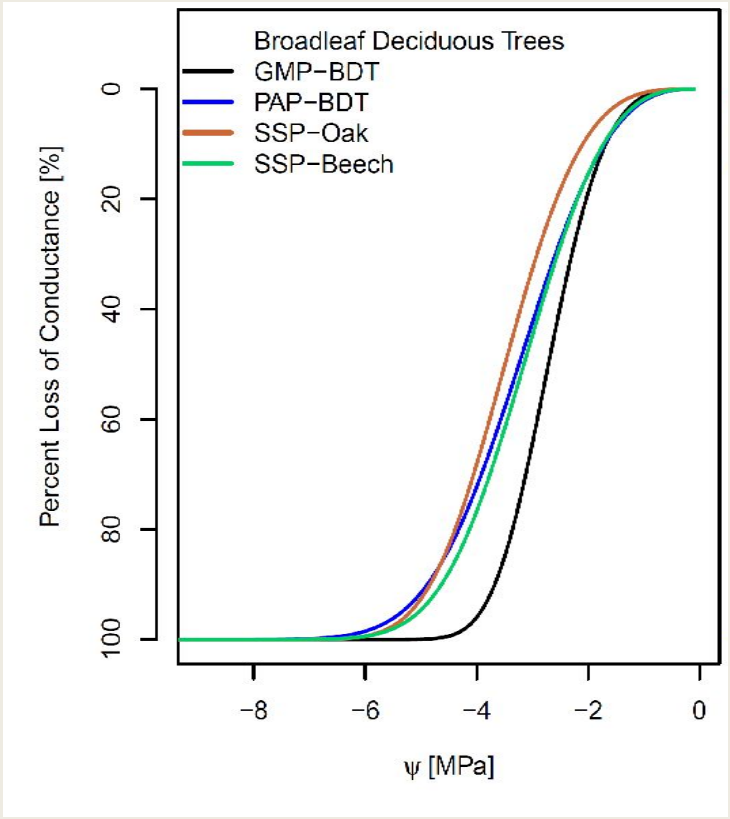
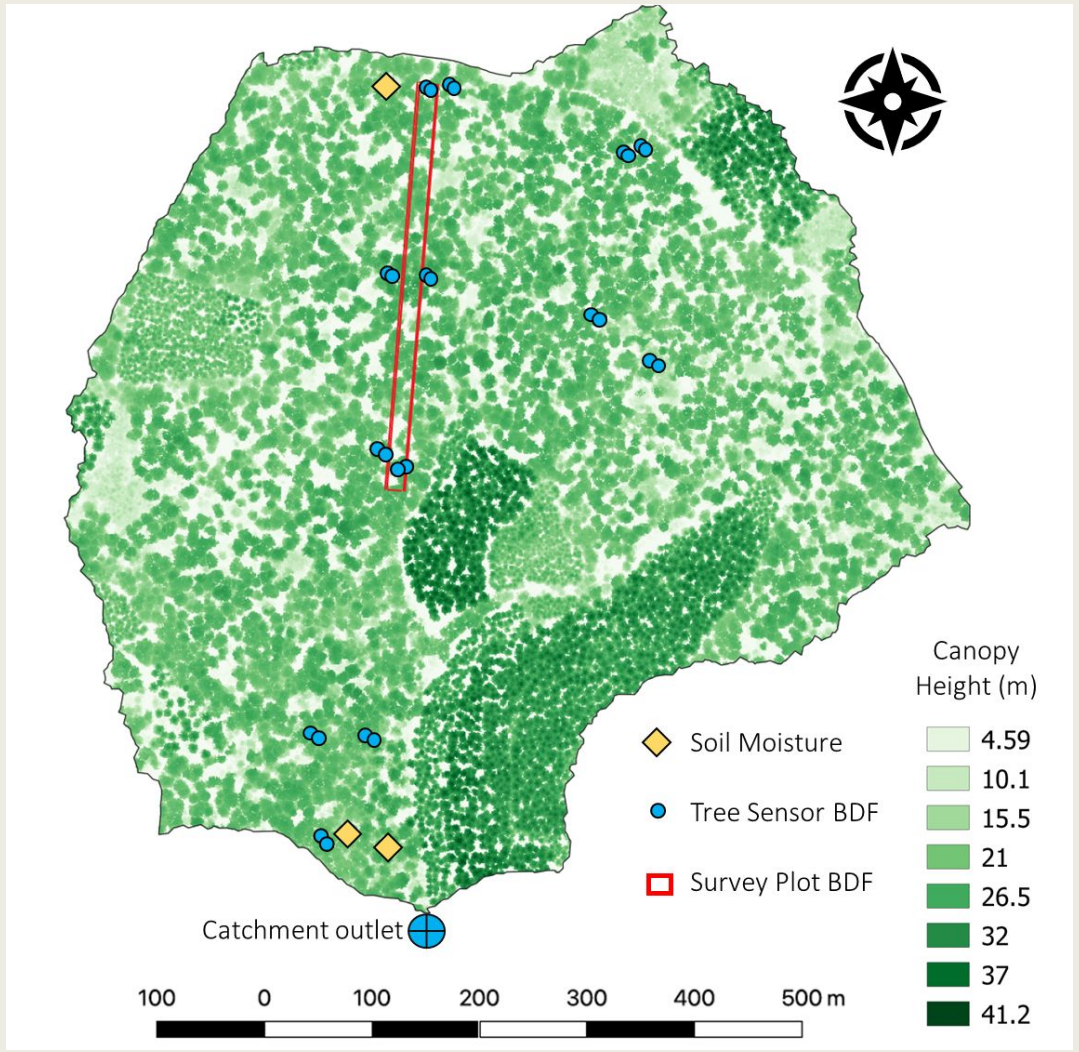
How did we do it?

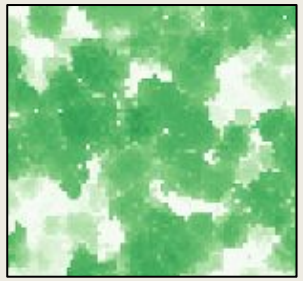
Atmospheric forcing based on Roodt station (~ 5km)











Broadleaf Deciduous Forest (BDF)

Area: 35.3 ha

Tree Density: 302 tree ha^{-1}

Species:

Fagus sylvatica
Quercus petraea
Quercus robur

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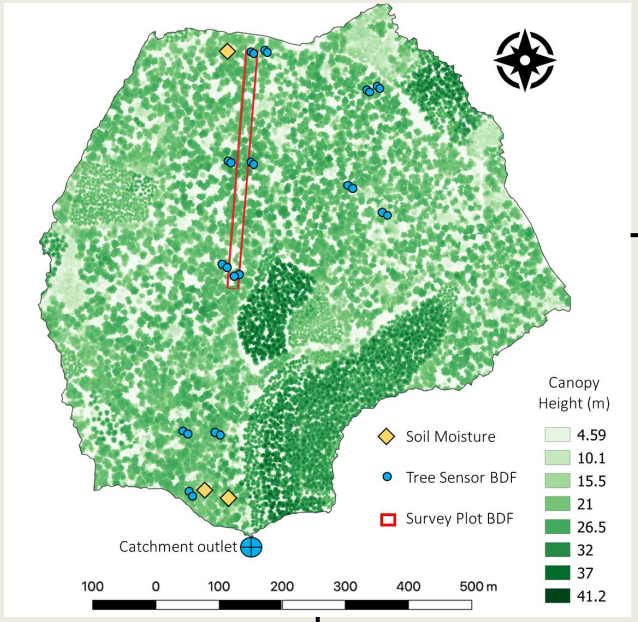
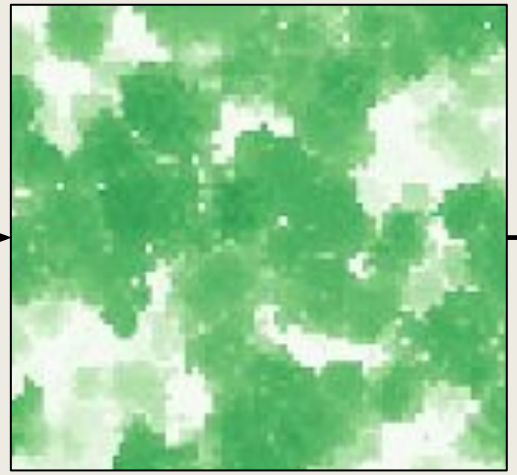
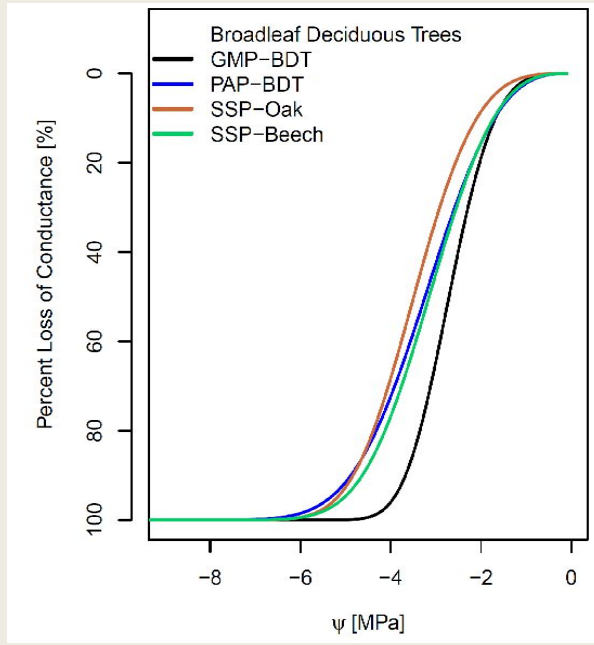
Numerical experiments



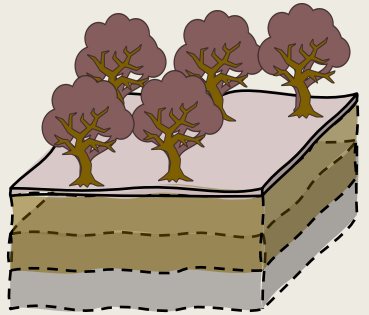


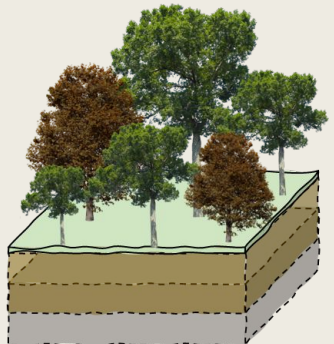
Point Scale Experiment
CLM 5.0

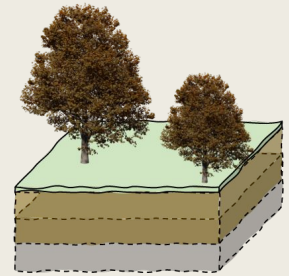
- Generic Parameterization
- PFT Adjusted Parameterization
- Species Specific Parameterization

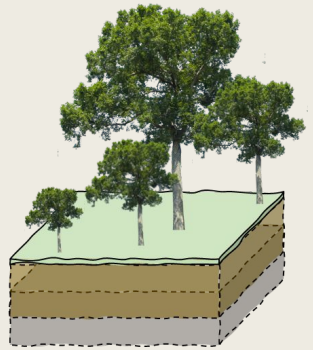


- Transpiration
- Water Potentials
- Canopy Stress Factor









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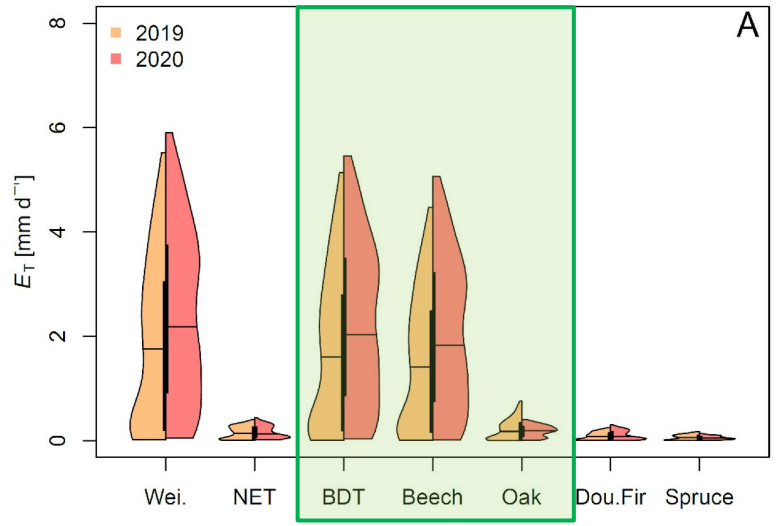
Forest Response to Environmental Conditions

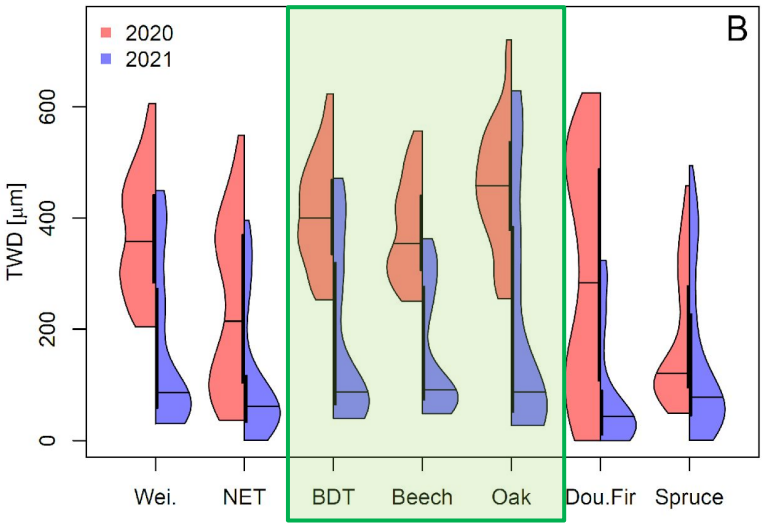
- Transpiration (E_T) in Weierbach was strongly influence by solar radiation (R_s) and relative humidity (RH).

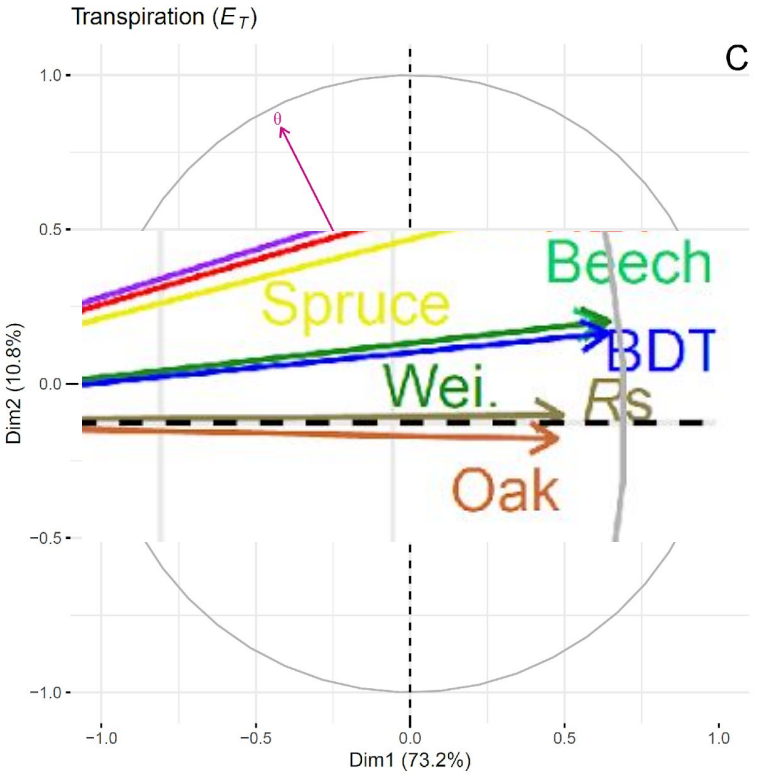
- The estimations of tree water deficit (TWD) showed a strong difference between years.

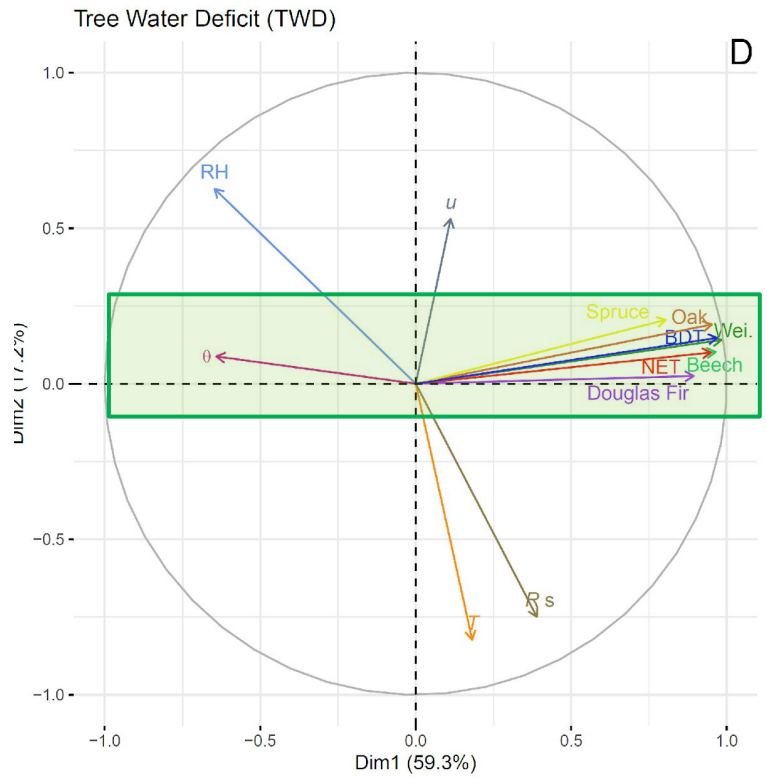
- The interannual differences of TWD were primarily affected by the soil water content (θ).

- Soil drought rather than atmospheric drought was the primary driver for vegetation stress.









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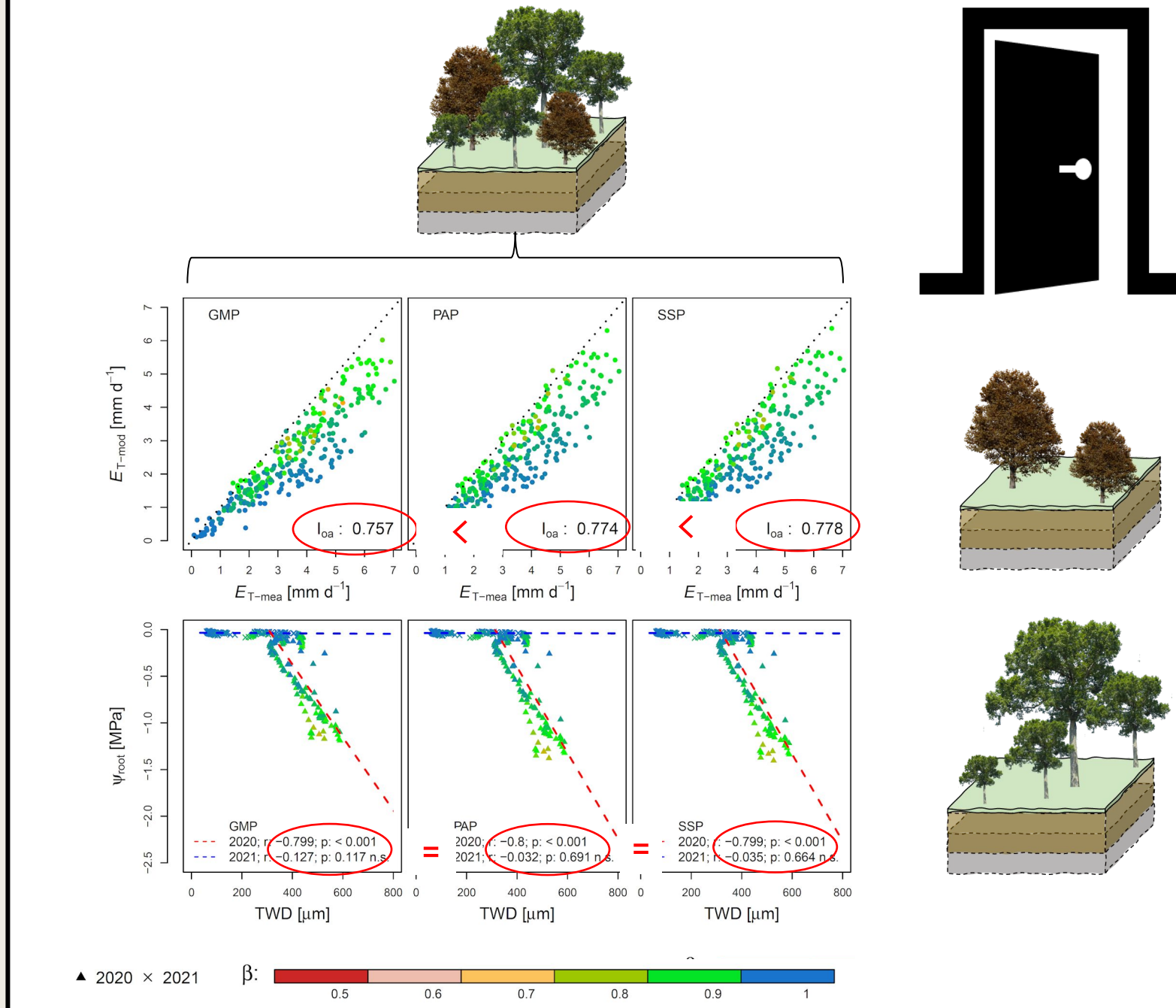
Response at lumped level

- Modelled transpiration rates improved slightly.

- No interannual differences on the TWD response to soil water potential (Ψ_{soil}).

- No indication of canopy stress from β factor.



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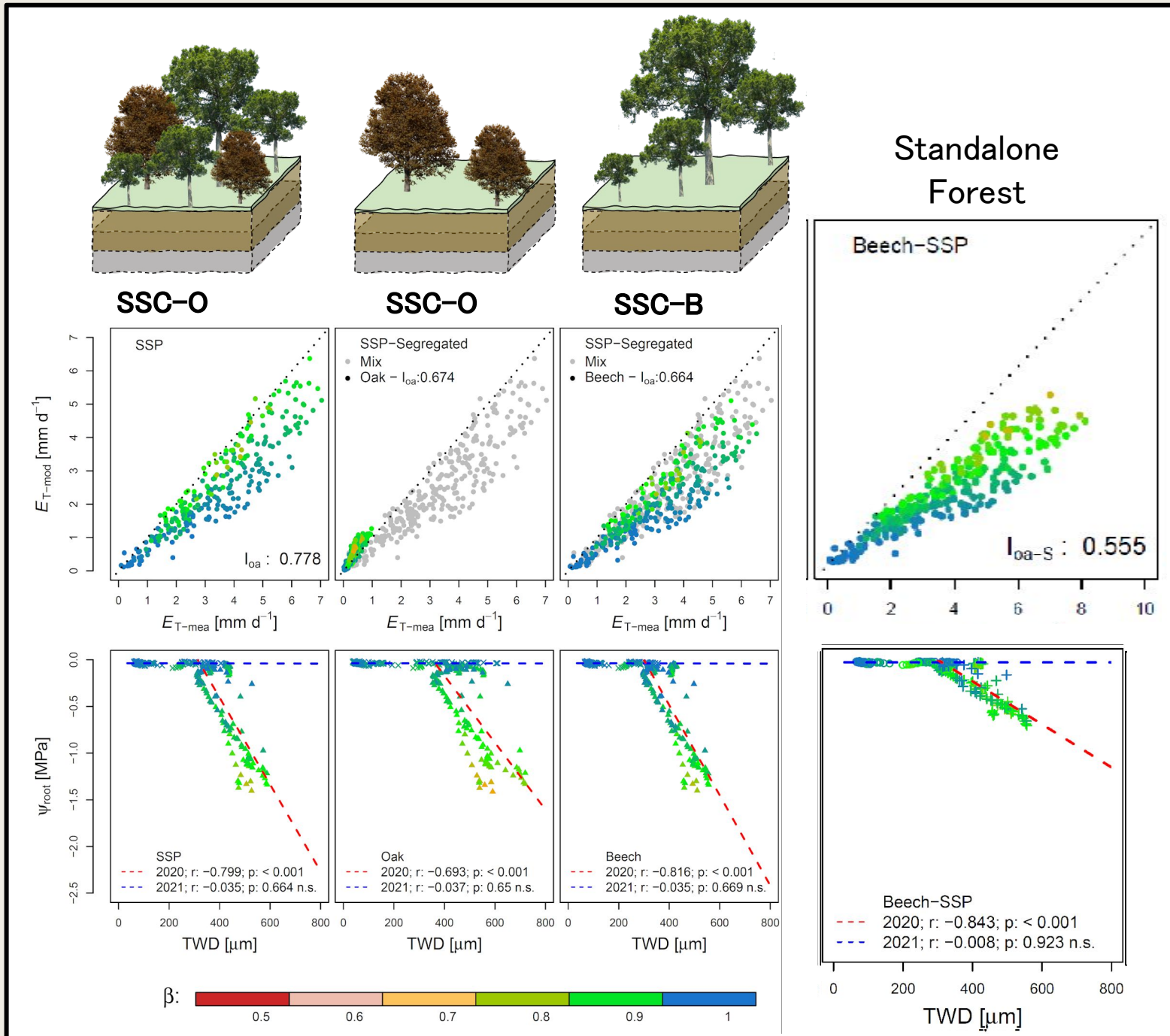
Close up to the response of individual forest fractions

- When Oak shares the soil water with Beech, the Oak fraction depicts more negative Ψ_{root}.

- The SSP parameterization enhances modeled ET for individual species when compared with the standalone condition.

- The model's dominant fraction of a mixed forest masks the water status of smaller fractions within a grid cell.



Standalone Forest

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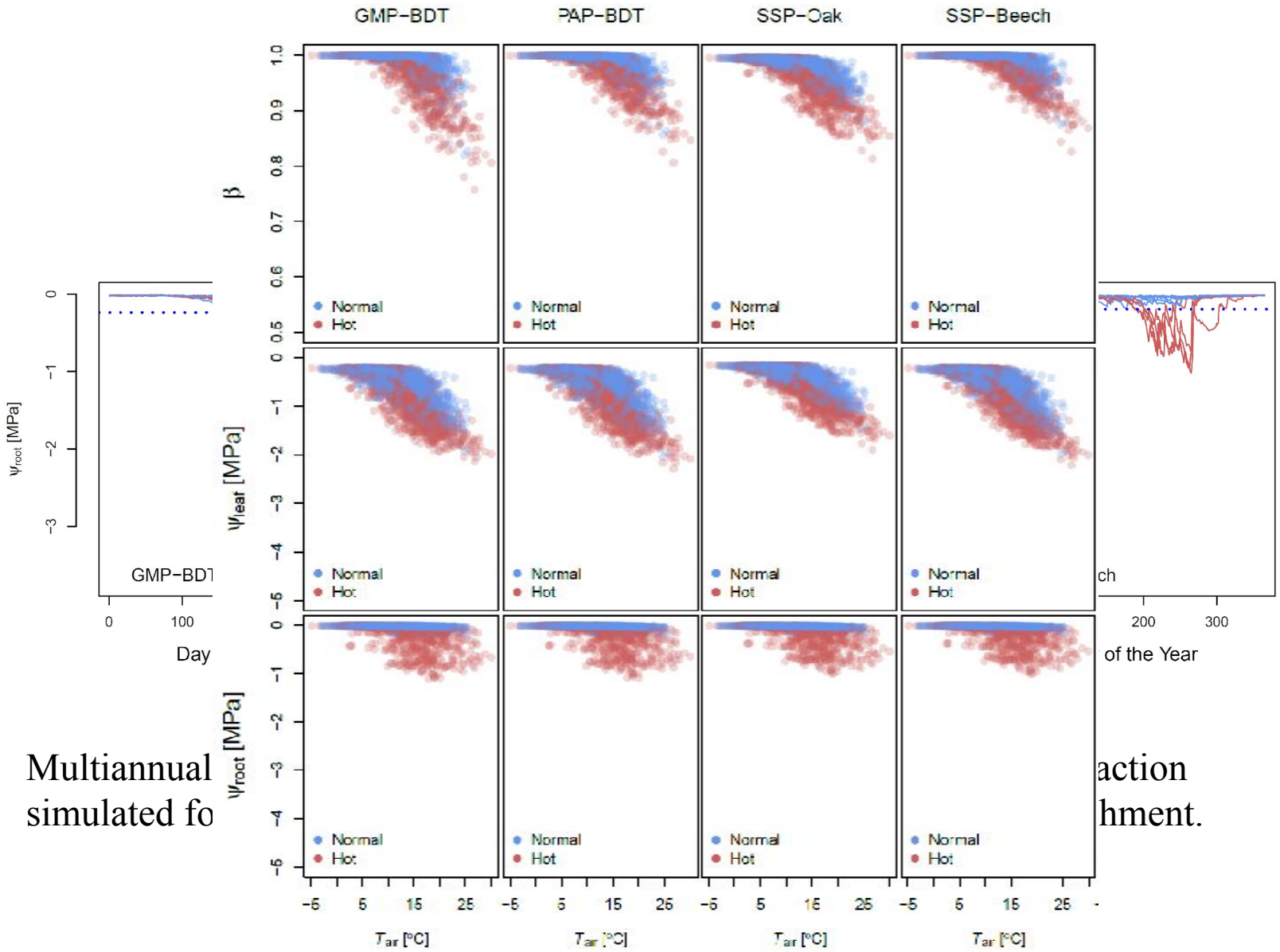
Identifying the stress periods at Weierbach

- The response of the canopy stress factor (β) and leaf water potential (Ψ_{leaf}) to high air temperatures is similar between normal and hot years.

- The root water potential (Ψ_{root}) provides a good differentiation between hot and normal years for broadleaf forest types.

- By selecting the minimum Ψ_{root} value of normal years as an assumed limit for stress conditions, it is possible to identify the periods were the vegetation experiences more stress in the broadleaf forest at Weierbach.



Multiannual action
simulated fo hment.

Multiannual variability of the canopy stress factor (β), leaf (Ψ_{leaf}) and root (Ψ_{root} matric potentials of the patched mixed forest with respect to the air temperature for the period between 2011 and 2021 at Weierbach.

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- The use of a refined parameterization improved the capability of the model in reproducing the vegetation water stress at both coarse (i.e., PFT) and fine (i.e., species) levels for the broadleaf stands.

- Representing fully-mixed forests as individual species showed limitations on the E_T estimates as even though the grid-cell level do not differ among parameterizations.

- These results highlight the importance of refining the characterization of the PHT assigned to conventional PFT, where the improvement should consider the spatial distribution of the species present in a region.

- The performance of Ψ_{root} in broadleaf covers highlighted its utility to identify such periods of hydraulic stress.

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