

Chebbi W.⁽¹⁾, Jonard M.⁽²⁾, Vincke C.⁽²⁾

⁽¹⁾ National Agronomic Institute of Tunisia, Carthage University, Tunis, 1002, Tunisia; ⁽²⁾ Earth and Life Institute, UCLouvain, Louvain-la-Neuve, 1348, Belgium.

E-Mail: chebbiwafa15@gmail.com

Context

European beech (*Fagus sylvatica* L.), is one of the most socio-economically valuable and widely distributed broadleaved trees in Europe:



- Wood industry
- Biodiversity conservation
- Recreation
- Climate regulation

- Beech requests sufficient moisture in summer and mild temperatures in winter
- Highly competitive and drought-sensitive
- Increasing vulnerability under climate change (e.g. heat waves and droughts)



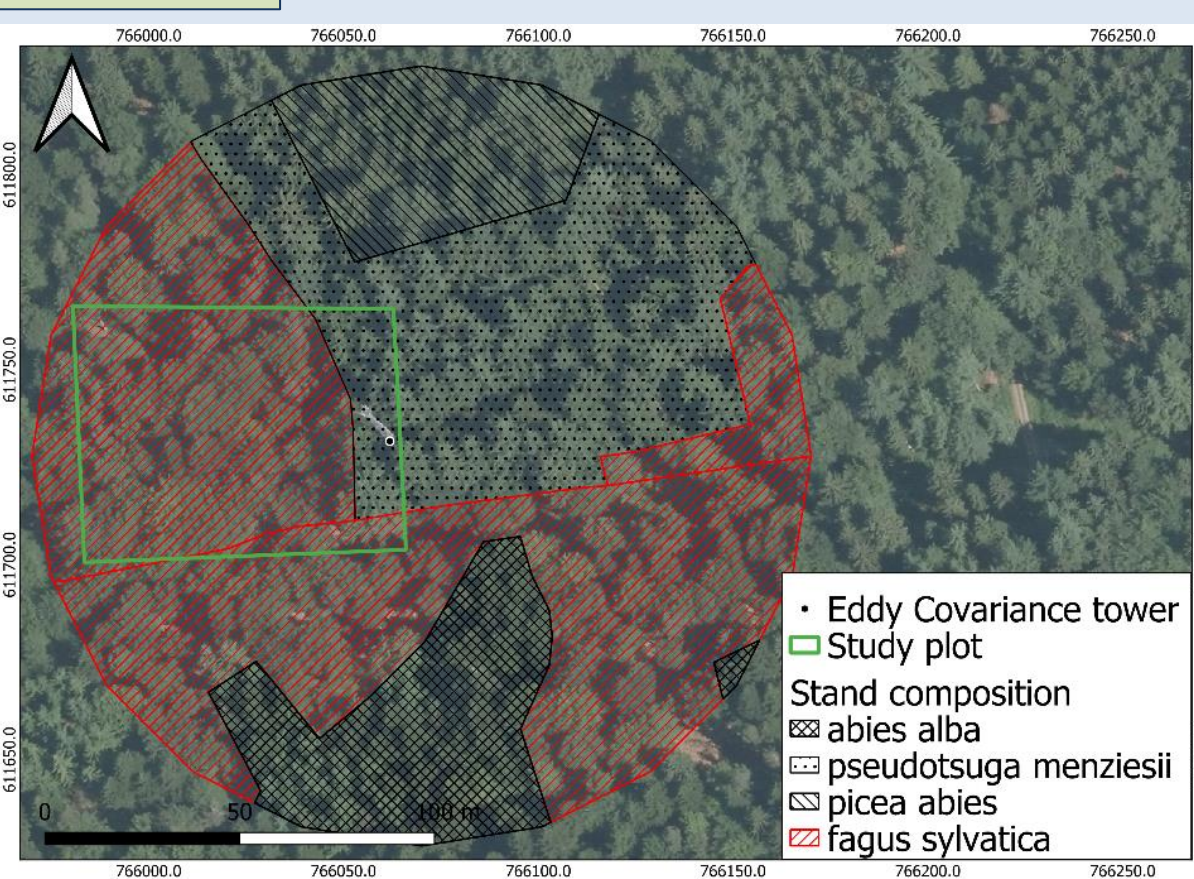
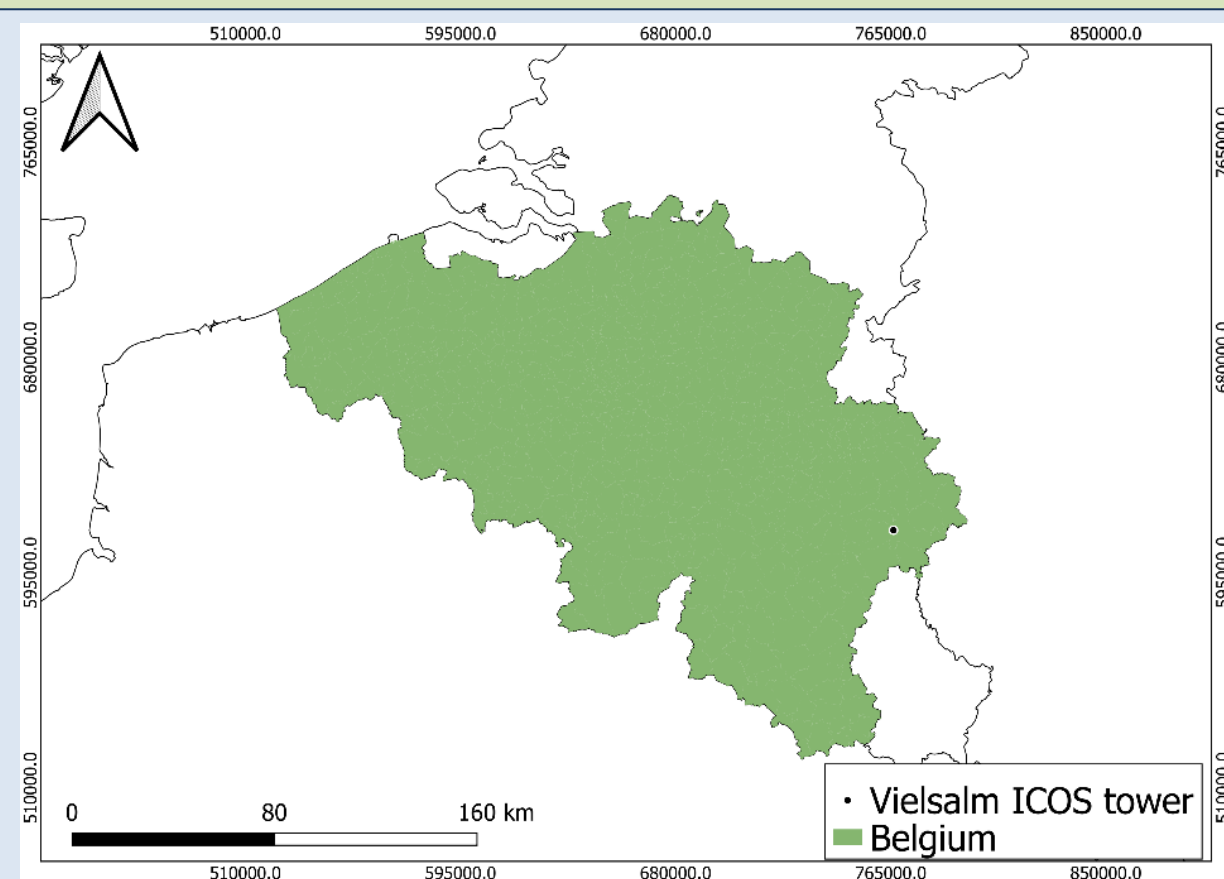
A better understanding of beech response to soil drought is crucial for forest management.

Objective

Reproduce soil water balance dynamics in a beech stand combining field measurements and modeling (1996-2020) to highlight the impact of soil drought on radial growth.

Material and methods

ICOS site: beech sub-plot (Vielsalm, Belgium)



- Temperate maritime climate
- Annual rainfall: 1000 mm
- Dystric Cambisol (1.5 m deep)
- Tree height : 35 m
- Beech tree age: 120 years
- LAI_{max}: 5
- No understory vegetation

Flux measurement (eddy covariance)

Fluxes of CO₂ and H₂O and micrometeorological measurements are performed above the forest by a long-term monitoring eddy-covariance system installed on a 52 m-height tower.



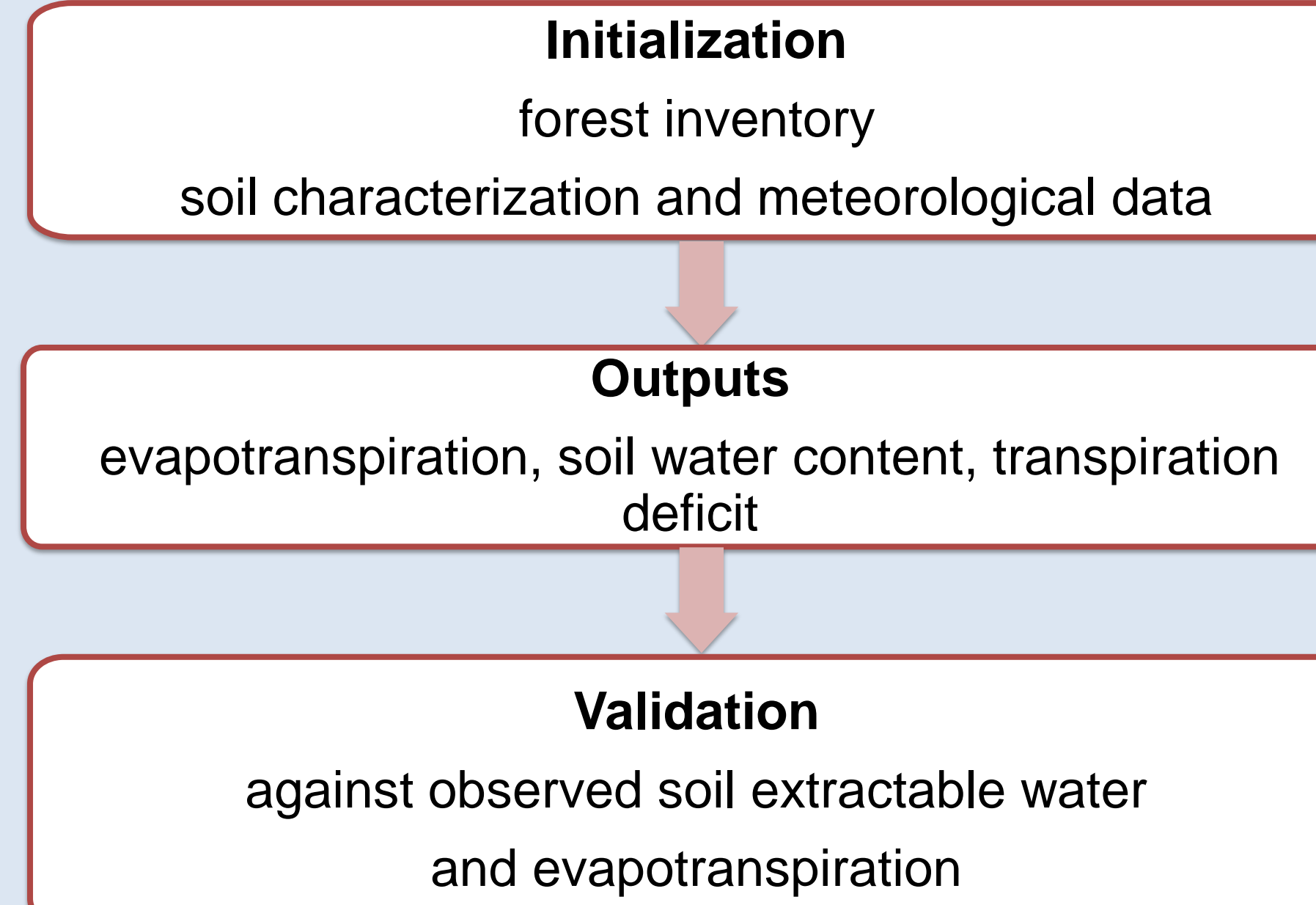
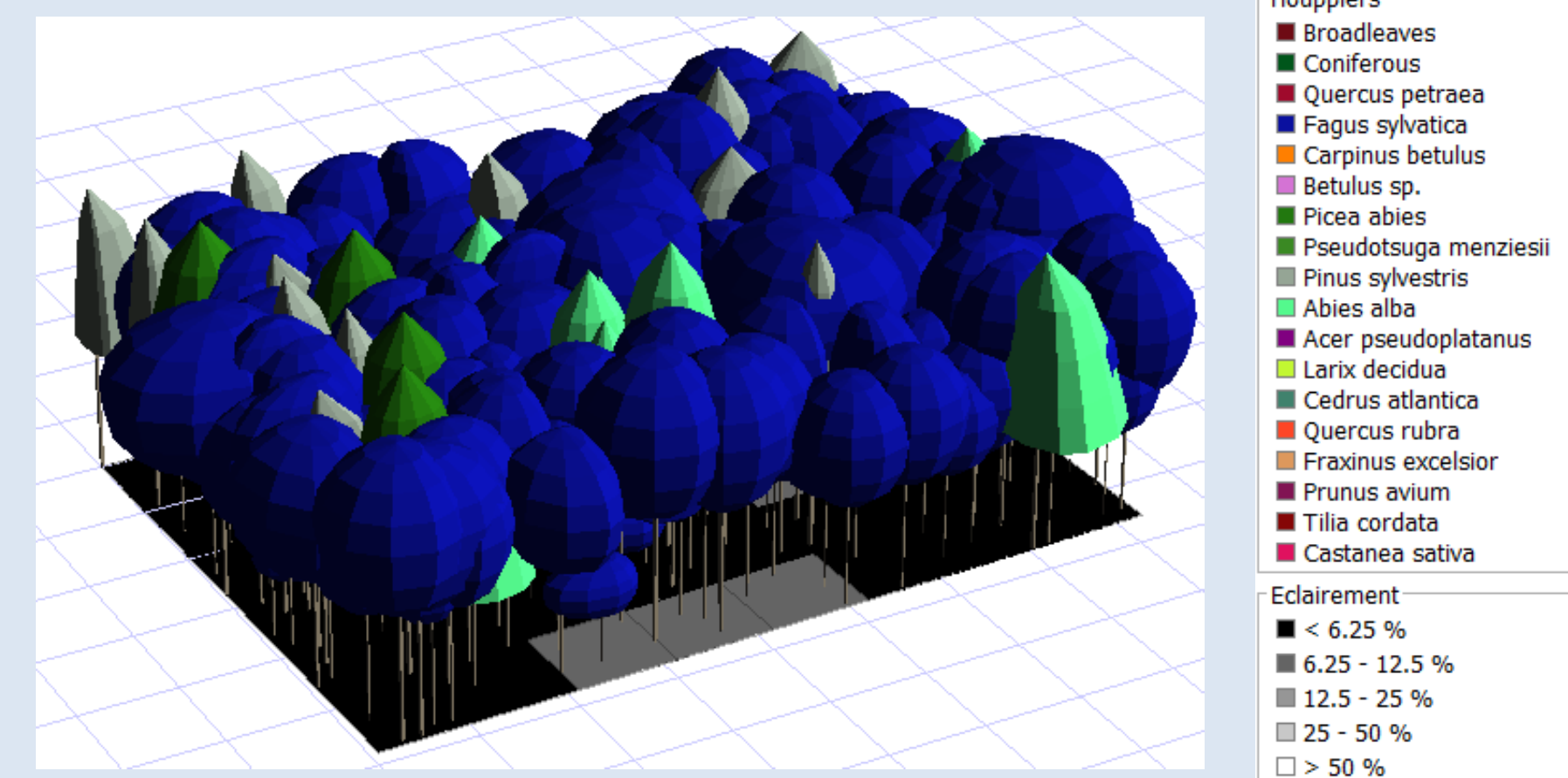
Additional data

- Tree mapping and inventory
- Meteorological variables
- Soil characterization
- Soil water content
- Root density
- Tree ring width series (growth Index) from cores in 24 beeches



Modeling with HETEROFOR

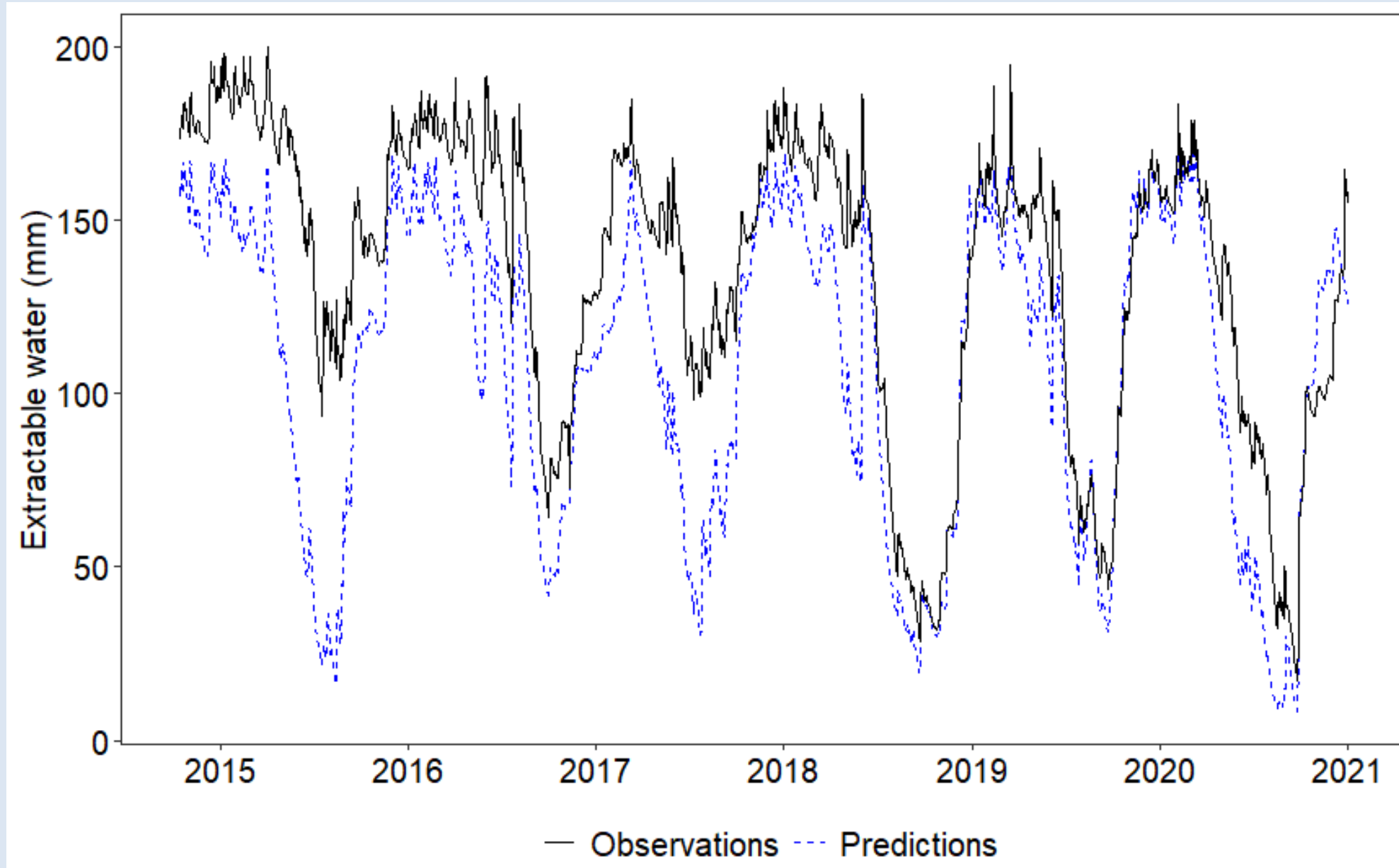
HETEROFOR, a spatially explicit and individual-based model developed to describe the functioning of structurally complex forests (Jonard et al., 2020).



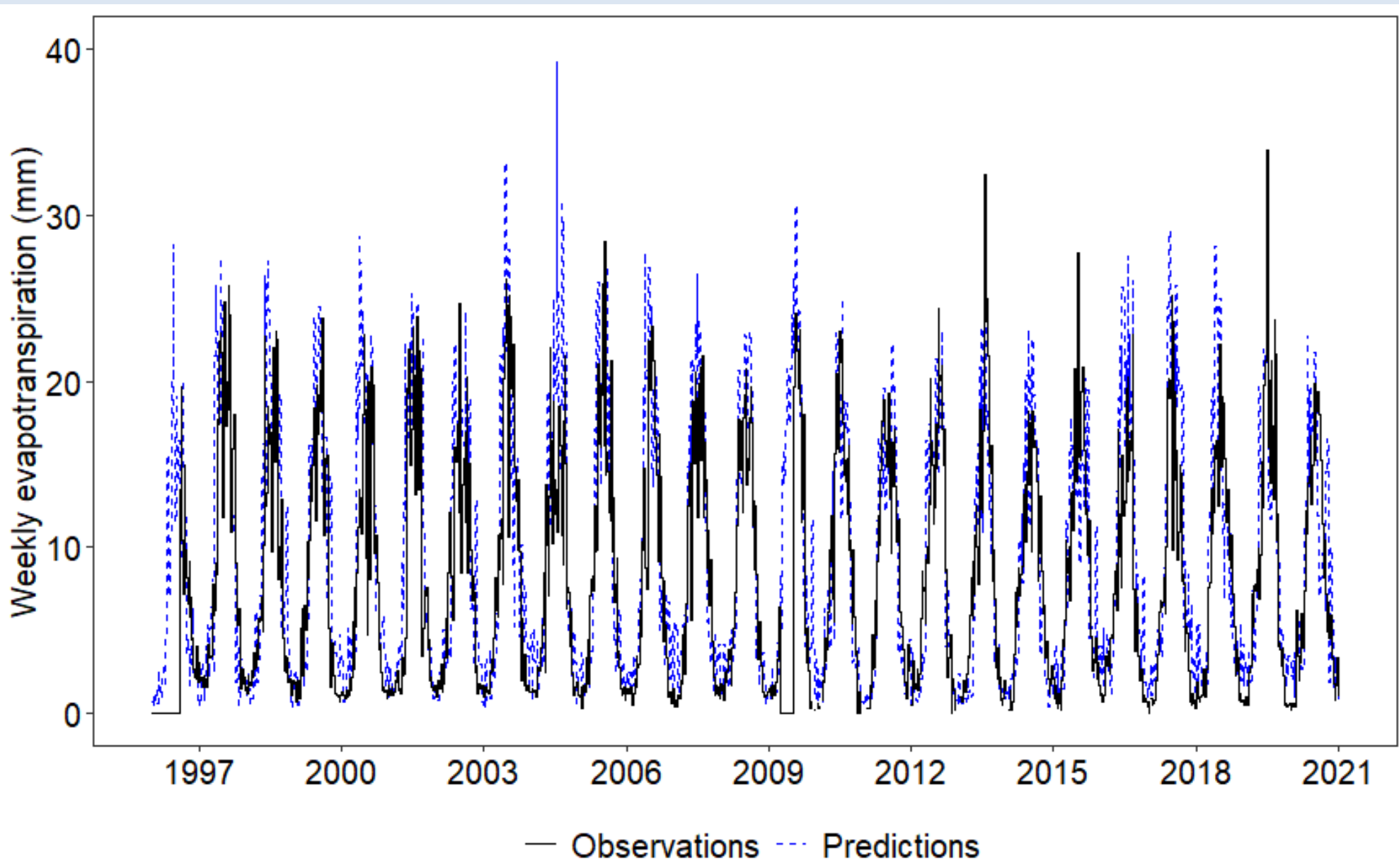
Results

HETEROFOR Model validation

Daily observed and predicted extractable water (mm)



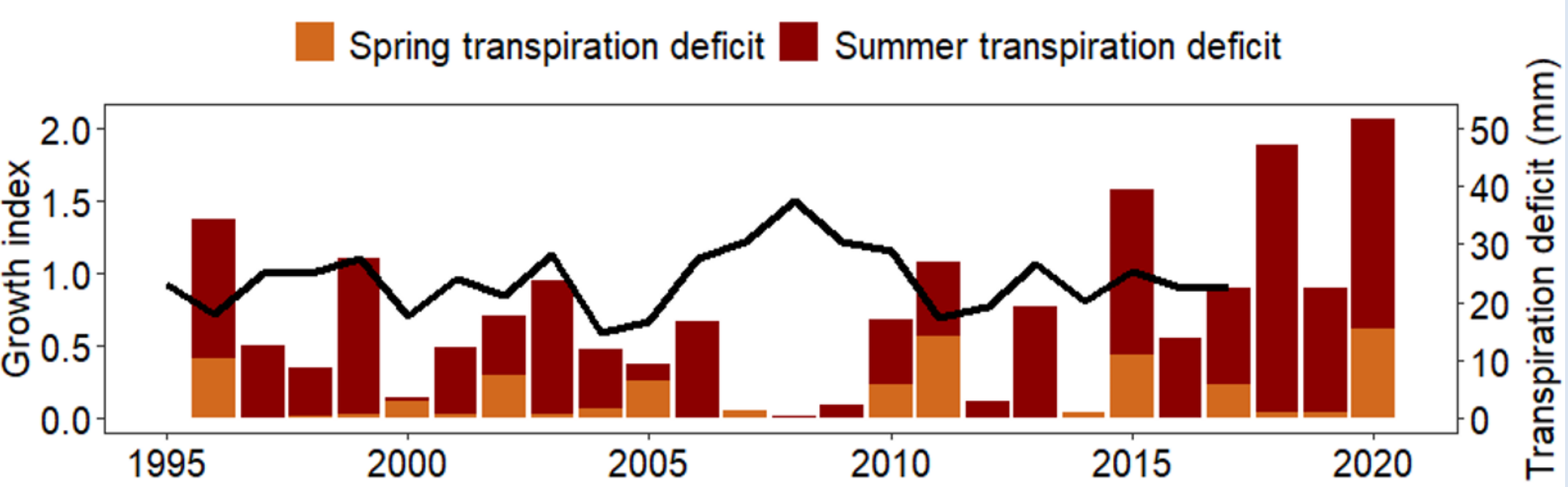
Weekly observed and predicted evapotranspiration (mm)



The good agreement between observations and predictions demonstrates the robustness of the model.

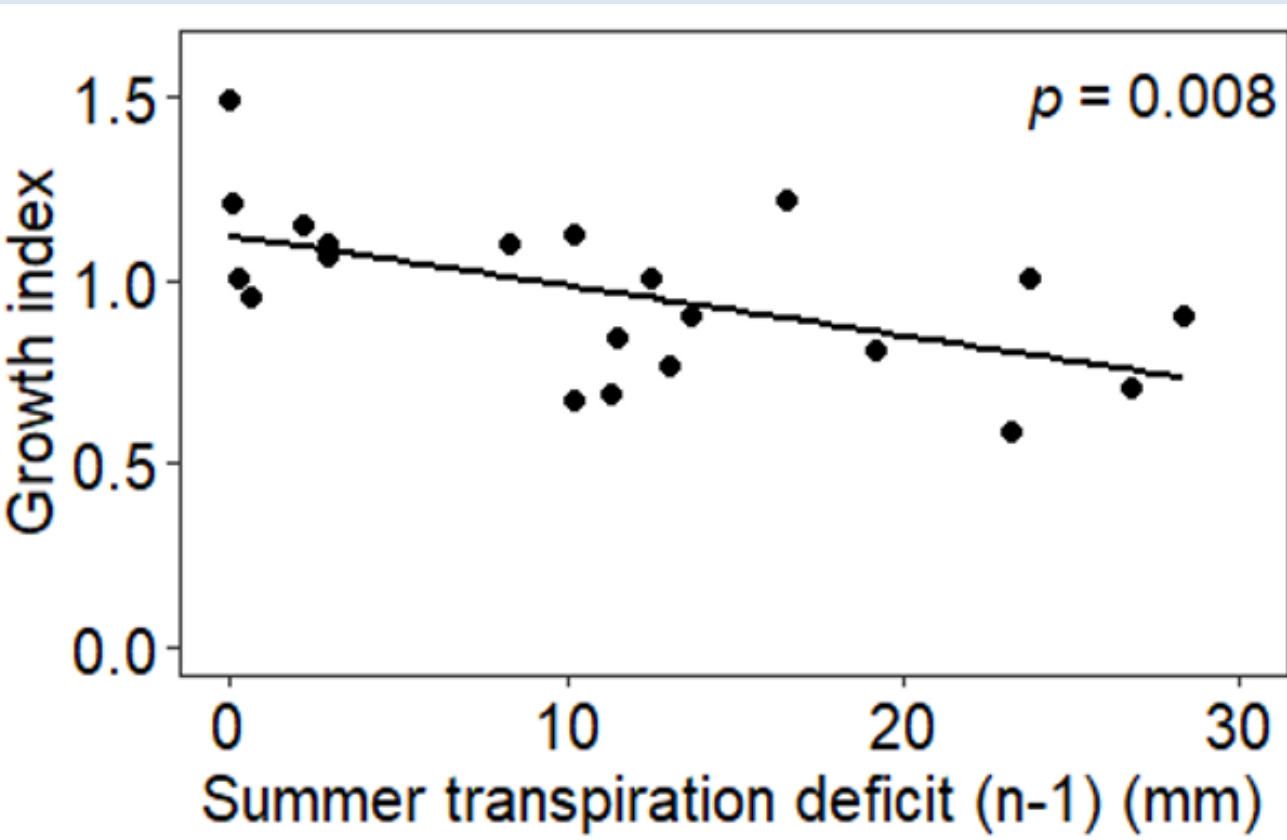
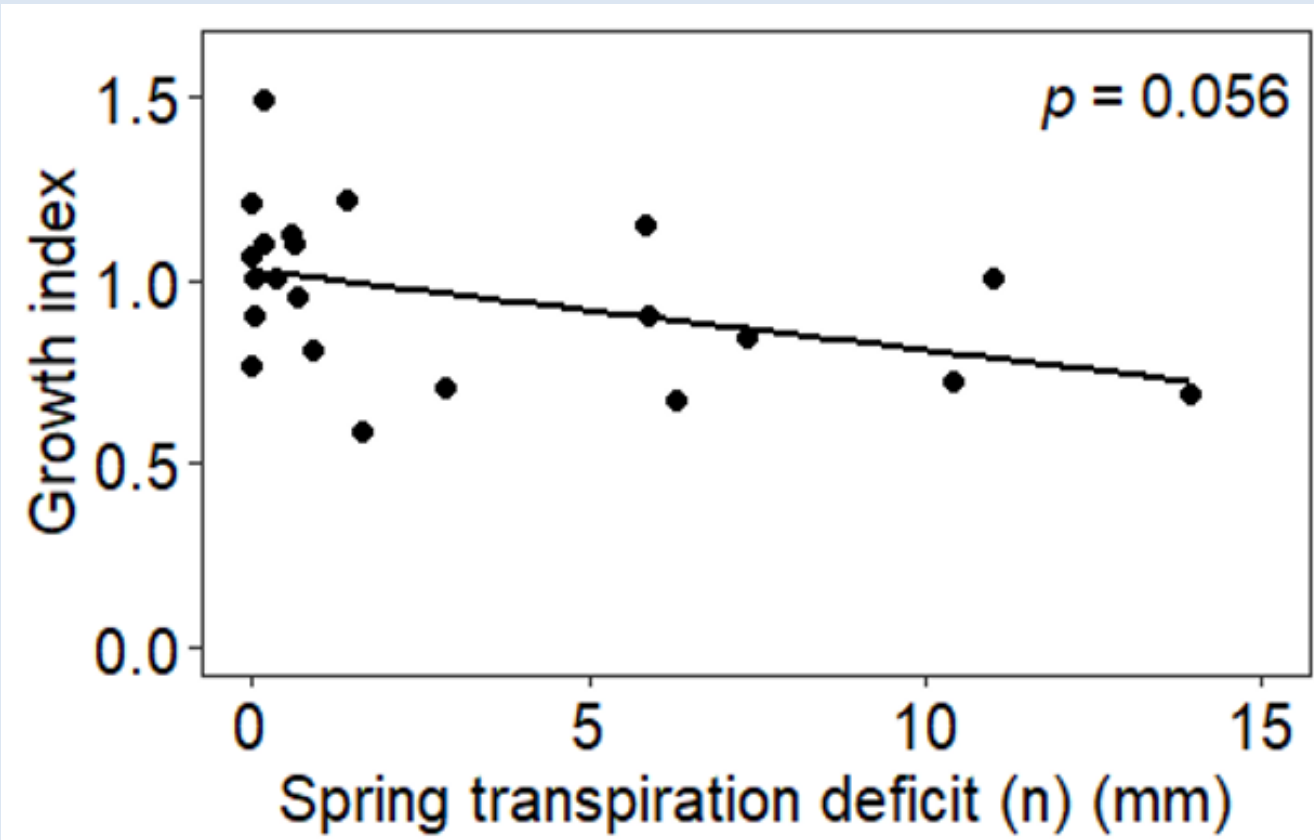
Transpiration deficit effect

Growth index and predicted spring and summer transpiration deficits



Increasing transpiration deficit trend, especially after 2010.

Impact of the previous year (n-1) summer and the current year (n) spring transpiration deficit on the growth index



Negative effect of the spring transpiration deficit (current year) as well as of the summer transpiration deficit (previous year, carryover effect).

Next steps

- Monitoring and modelling of beech tree vitality in order to understand the long-term impact of stress memory
- Better understanding of the fine root distribution and its interaction with soil water availability

Acknowledgments
This research was conducted within the framework of the ICOS Wallonia project, which is supported by the Service Public de Wallonie, Belgium [1217769].

References
- Jonard, M., André, F., De Coligny, F., De Wergifosse, L., Beudez, N., Davi, H., Ligot, G., Ponette, Q., Vincke, C., 2020. HETEROFOR 1.0: A spatially explicit model for exploring the response of structurally complex forests to uncertain future conditions-Part 1: Carbon fluxes and tree dimensional growth. Geosci. Model Dev. 13, 905–935. <https://doi.org/10.5194/GMD-13-905-2020>

