

PhD: European forests responses to drought

Climate change is threatening forests through increasing drought events and heat waves. These stresses increase evaporative demand and reduce soil water availability, leading to decreased carbon assimilation and higher tree mortality^{1,2}. Current land surface models, embedded within Earth system models, poorly capture forest responses to drought³, resulting in a large spread of responses between models to estimate the future of forests and their carbon sink capacity.

This PhD project aims to address two key challenges of modelling drought impacts on forests: 1. exploring trees' ability to reach deep water sources in soils and 2. revisit the effects that water stress has on different parts of the vegetation in land surface models. The PhD will assess the sensitivity of forest functioning and vulnerability under future climate conditions.

The ISBA-CTRIP land surface model will be evaluated at local and regional scales using various observational and remote sensing datasets⁴. The PhD is part of the ANR project TAW-Tree and will involve close collaboration with other researchers of the project, providing observations and comparing model sensitivity to various estimates of Total Available Water (TAW) at local and regional scales. ISBA-CTRIP uses a simple function to link soil moisture deficit with carbon and water fluxes. This PHD aims at exploring and implementing process-based approaches of root water uptake⁵, as well as drought impacts on carbon and water fluxes using, for example, an explicit hydraulic architecture of trees. The goal is to enhance the ISBA-CTRIP model for a more accurate description of drought impacts on European forests.

This PhD project is a close collaboration between [INRAE](#) and [CNRM](#), supervised by [Emilie Joetzjer](#) (INRAE), [Christine Delire](#) (CNRM), and [Matthias Cuntz](#) (INRAE). The student will be based at UMR Silva of INRAE Nancy with extended visits to CNRM in Toulouse.

We are looking for an enthusiastic student with a strong interest in eco-physiology, land surface interactions, as well as good coding skills. The student will work in a highly collaborative environment.

How to apply

Send a motivation letter and a resume to emilie.joetzjer@inrae.fr and christine.delire@meteo.fr
Do not hesitate to contact us for further information.

References

¹ Saintonge F-X et al., 2021, Situation et gestion de la crise liée aux scolytes de l'Épicéa commun fin 2021 dans l'est de la France, en Suisse et en Wallonie, la revue forestière française (2021) <https://doi.org/10.20870/revforfr.2021.7201>

² Van Der Woude, Auke M., et al. "Temperature extremes of 2022 reduced carbon uptake by forests in Europe." *nature communications* 14.1 (2023) <https://www.nature.com/articles/s41467-023-41851-0>

³ Bastos, Ana, et al. "Impacts of extreme summers on European ecosystems: a comparative analysis of 2003, 2010 and 2018." *Philosophical Transactions of the Royal Society B* 375.1810 (2020) <https://doi.org/10.5194/esd-12-1015-2021>

⁴ Delire, Christine, et al. "The global land carbon cycle simulated with ISBA-CTRIP: Improvements over the

last decade." *Journal of Advances in Modeling Earth Systems* 12.9(2020) <https://doi.org/10.1029/2019MS001886>

⁵Joetzjer, Emilie, et al. "Effect of tree demography and flexible root water uptake for modeling the carbon and water cycles of Amazonia." *Ecological modelling* 469 (2022) <https://doi.org/10.1016/j.ecolmodel.2022.109969>

⁶Yao, Yitong, et al. "Forest fluxes and mortality response to drought: model description (ORCHIDEE-CAN-NHA, r7236) and evaluation at the Caxiuanã drought experiment." *Geoscientific Model Development Discussions* (2021): 1-38 <https://doi.org/10.5194/gmd-15-7809-2022>

⁷Paschalis, Athanasios, et al. "When do plant hydraulics matter in terrestrial biosphere modelling? " *Global Change Biology* 30.1 (2024) <https://doi.org/10.1111/gcb.17022>