Project 1513 (new project)

Project title **Ecosystem disturbances in the Earth System**

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Abstract

Ecosystem disturbances regulate land-atmosphere interactions, forest dynamics and structure at time-scales from years to centuries being therefore key components of the Earth System. These range from low-intensity perturbations or destructive events and include natural – abiotic or biotic – as well as human perturbations. Natural disturbances such as wildfires, drought, insects and storms play a key role biophysical and biogeochemical processes and functioning at plant level – e.g., through stomatal regulation, carbon and nutrient allocation to roots, defence and repair mechanisms – and at ecosystem level by controlling mortality, succession and competition.

Key natural disturbances such as fires, droughts, insects and diseases or windthrow, are driven directly or indirectly by climate [1]. A given climatic driver can trigger multiple disturbances or promote interactions between disturbances, resulting in compounding effects between weather and climate extremes, disturbances in space and/or time [2]. With the increase in frequency, intensity or extent of weather and climate extremes in the coming decades, an increasing fraction of global ecosystems is likely to be affected by disturbances recurring faster than recovery periods. Changes in disturbance regimes impact the ecosystems' carbon balance, thus contributing to carbon-climate feedbacks and likely reducing the potential of forests to contribute to nature-based solutions for climate change mitigation [3, 4].

This project aims, on a first step, to develop representations of four major forest disturbance types (fire, bark-beetles, defoliator insects and wind-throw) in ICON-Land. With the new disturbance parameterizations, we aim to conduct numerical simulations to quantify disturbance impacts on land-atmosphere carbon, water and energy exchanges under historical and future climate scenarios. Our work is expected to advance fundamental knowledge about forest dynamics and feedbacks between climate and the carbon-cycle and contribute to resolve long-standing uncertainties about forests' climate change mitigation potential.

This project contributes to two Horizon Europe projects: the ERC Starting Grant "Forest Vulnerability to compound extremes and disturbances under changing climate" (ForExD, G.A. 101039567) and to the project "Next Generation Modelling of Terrestrial Carbon Cycle by assimilation of in-situ campaigns and Earth Observations" (NextGenCarbon, G.A. 101184989). The project further links to work developed in the Breathing Nature Excellence cluster initiative from the University of Leipzig in collaboration with the German Center for Integrative Biodiversity Research (iDiv), the Helmholtz Center for Environmental Research (UFZ) and the Max Planck Institute for Biogeochemistry in Jena.

References

1. Seidl, R. *et al.* Forest disturbances under climate change. *Nature Climate Change* **7,** 395–402. ISSN: 1758-678X (2017).
2. Bastos, A. *et al.* A joint framework for studying compound ecoclimatic events. en. *Nature Reviews Earth & Environment.* Publisher: Nature Publishing Group, 1–18. https://www.nature.com/articles/s43017-023-00410-3 (2023) (Apr. 2023).
3. Bustamante, M. *et al.* Ten new insights in climate science 2023. en. *Global Sustainability* **7,** e19. ISSN: 2059-4798. https://www.cambridge.org/core/journals/global-sustainability/article/ten-new-insights-in-climate-science-2023/F7F1C10C07FD241BFE30ACC4BA555A56 (2024) (Jan. 2023).
4. Bastos, A. & San-Miguel-Ayanz, J. in *European climate risk assessment: EEA Report* 1–38 (2024). ISBN: 92-9480-627-8.