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Conference Abstract

VPDrought – a novel approach to disentangle atmospheric and soil drought in a natural Scots pine forest

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Abstract

In recent years, an increasing number of studies have reported on forest declines and shifts in species composition in response to changing climatic conditions (Rigling et al. 2012). The intensification of droughts through rising evaporative demand (i.e., vapor pressure deficit or VPD) is a considerable concern because of their disastrous impacts on natural systems (Grossiord et al. 2020; Trotsiuk et al. 2021). For forests, ecosystem services such as wood provisioning and carbon sequestration are severely jeopardized by these changes, leading to significant uncertainties regarding climate regulation. Climate-vegetation models are not only in need of data on atmospheric and soil drought sensing mechanisms but are also critically challenged by insufficient understanding of the processes driving forest vulnerability to climate change. Only by deciphering the single *vs*. combined VPD and soil moisture effects will we be able to improve global predictions.

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We apply a scale spanning approach to disentangle the processes affected by atmospheric (i.e., VPD) and soil droughts from the tissue to the tree and the ecosystem level. We set up the first atmospheric humidity and soil moisture manipulative experiment in a mature natural forest. We combine air humidity (and thus VPD) manipulation using a humidification system in the canopy of adult Scots pine trees exposed naturally to high summer VPD and a below canopy through-fall exclusion system (Schaub 2023). The system is installed at the long-term Pfynwald irrigation experiment, which is since 2003 a pivotal WSL long-term experimental monitoring site anticipated to be near its tipping point with respect to climate change (Bose et al. 2022).

This experiment helps us understand how the soil moisture responses of trees, shrubs, and microbial communities are altered by atmospheric dryness from the tissue- to the ecosystem-level. This novel manipulative VPD and soil moisture experiment provides an empirical research platform to address the most critical questions in the context of climate impacts in temperate forests. The data will ultimately allow the development of novel predictive methods to assess climate change impacts on forests. Preliminary data will show the effects of altered atmospheric and soil drought on adult Scots pine trees.

Keywords

Climate change, drought, heat, vapor pressure deficit, forests

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Conflicts of interest

The authors have declared that no competing interests exist.

References

- Bose A, Rigling A, Gessler A, Hagedorn F, Brunner I, Feichtinger L, Bigler C, Egli S, Etzold S, Gossner M, Guidi C, Lévesque M, Meusburger K, Peter M, Saurer M, Scherrer

D, Schleppi P, Schönbeck L, Vogel M, von Arx G, Wermelinger B, Wohlgemuth T, Zweifel R, Schaub M (2022) Lessons learned from a long-term irrigation experiment in a dry Scots pine forest: Impacts on traits and functioning. Ecological Monographs 92 (2). https://doi.org/10.1002/ecm.1507

- Grossiord C, Buckley T, Cernusak L, Novick K, Poulter B, Siegwolf RW, Sperry J, McDowell N (2020) Plant responses to rising vapor pressure deficit. New Phytologist 226 (6): 1550-1566. https://doi.org/10.1111/nph.16485
- Rigling A, Bigler C, Eilmann B, Feldmeyer-Christe E, Gimmi U, Ginzler C, Graf U, Mayer P, Vacchiano G, Weber P, Wohlgemuth T, Zweifel R, Dobbertin M (2012) Driving factors of a vegetation shift from Scots pine to pubescent oak in dry Alpine forests. Global Change Biology 19 (1): 229-240. https://doi.org/10.1111/gcb.12038
- Schaub M (2023) VPDrought - A novel approach to disentangle air dryness and soil drought. https://vpdrought.wsl.ch/en/. Accessed on: 2025-1-16.
- Trotsiuk V, Babst F, Grossiord C, Gessler A, Forrester D, Buchmann N, Schaub M, Eugster W (2021) Tree growth in Switzerland is increasingly constrained by rising evaporative demand. Journal of Ecology 109 (8): 2981-2990. https://doi.org/10.1111/1365-2745.13712