

Ectomycorrhizal functionality after 5 years of summer drought in a mature forest

Fabian Weigl, Jasmin Danzberger, Hans Pretzsch, Thorsten Grams, Karin Pritsch

FORECOMON 2021-06-09

[back-up version as of 2021-06-02]

fabian.weigl@tum.de



The Kranzberg roof experiment (Kroof)

Mature Forest in Southern Germany

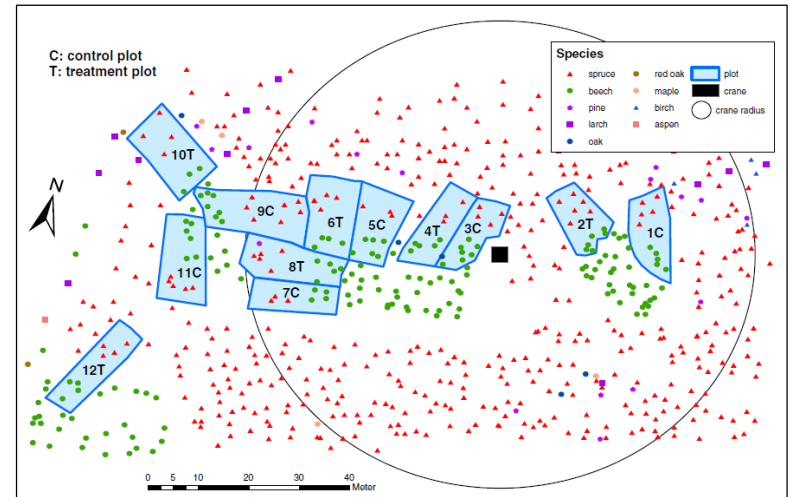
12 plots [beech, mixture, spruce]

Phase 1: drought

- 2014-2018
- Throughfall exclusion during vegetation period

Phase 2: recovery

- June 2019: rewatering + $^2\text{H}_2\text{O}$ + ^{13}C depleted CO_2
- Until 2023: recovery



Overview “summer drought”




Almost no water available down to 70 cm depth during growth period

Stem diameter growth -30 % (beech), -70 % (spruce)


Fine roots -57 % (beech), -73 % (spruce)

10 spruce died (bark beetles) in 2015

→ Trees at the edge of survival

Article |  Open Access |  

The Kroof experiment: realization and efficacy of a recurrent drought experiment plus recovery in a beech/spruce forest

Thorsten E. E. Grams , Benjamin D. Hesse, Timo Gebhardt, Fabian Weigl, Thomas Rötzer, Benedikt Kovacs, Kyohsuke Hikino, Benjamin D. Hafner, Melanie Brunn, Taryn Bauerle, Karl-Heinz Häberle, Hans Pretzsch, Karin Pritsch ... [See fewer authors](#) ^

First published: 05 March 2021 | <https://doi.org/10.1002/ecs2.3399>

Phase 1: Ectomycorrhiza Project

Karin Pritsch, Fabian Weigl, Jasmin Danzberger, Franz Buegger,

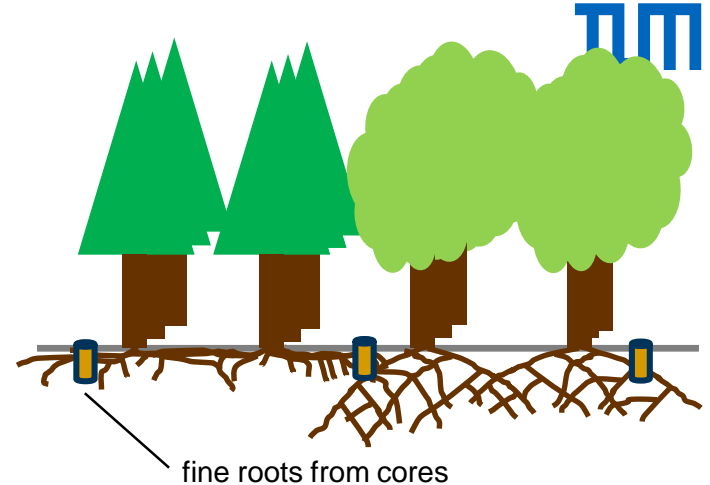
Uwe Nickel, Rene Kerner, Ramona Werner

Rationale

- Increasing frequency and intensity of drought periods
- Spruce and beech under risk

Initial hypotheses, e.g.:

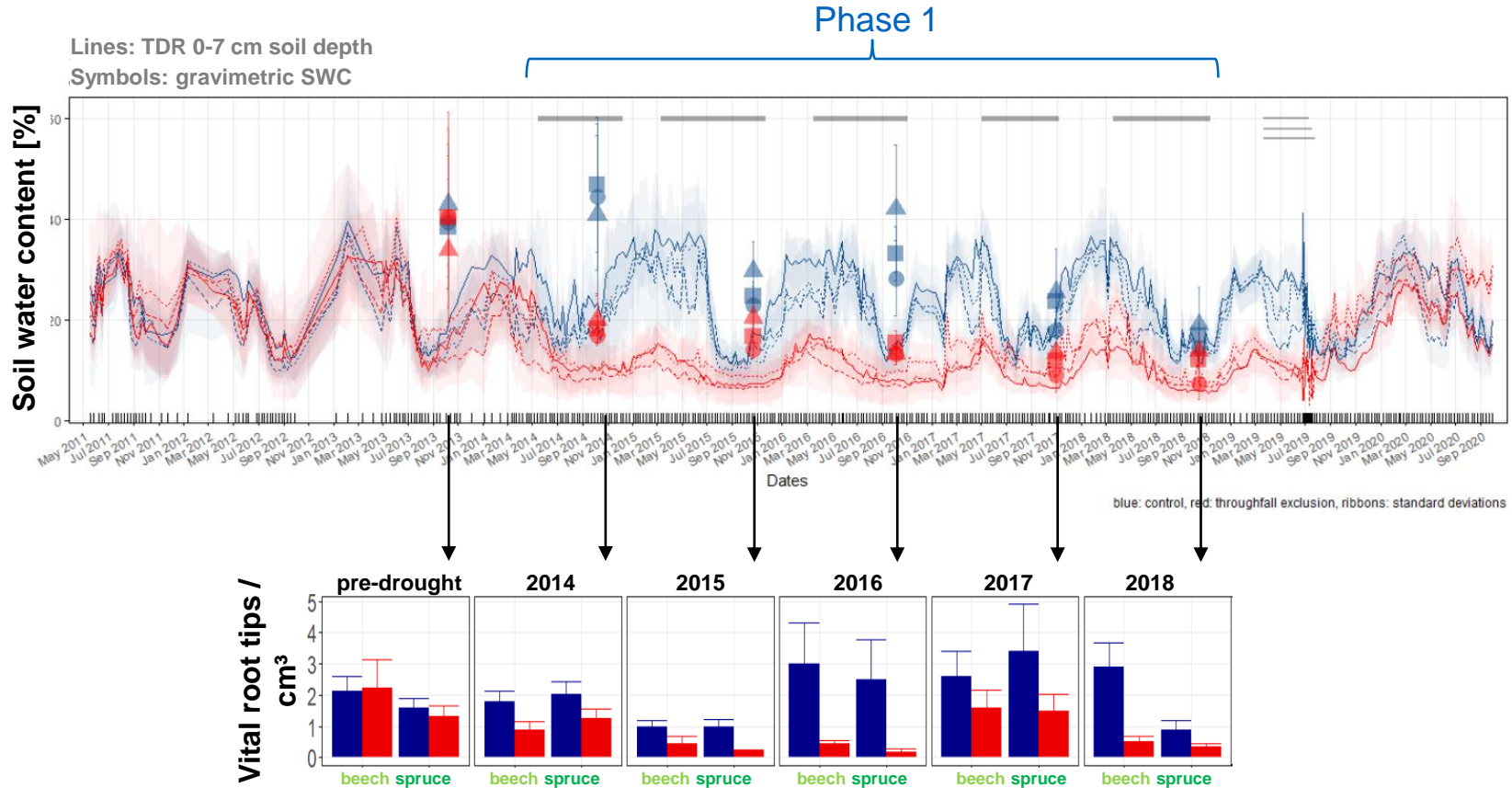
- Spruce more affected by drought than beech (e.g., isohydric vs. anisohydric)
- Tree mixture attenuates drought effects (complementarity of traits)
- **Ectomycorrhizal (ECM) fungal community composition and functions reflect tree responses**



Annual samplings:

- ECM and fungal community
 - morphotypes & abundance counting
 - NGS ($> 60 \cdot 10^6$ ITS2 sequences)
- ECM functions
 - > 60000 extracellular enzyme activities

Success of “summer drought” belowground



ECM relations on a larger scale

Quantity: 5 y. extreme drought strongly impacted ecosystem level due to loss of 90 % root tips

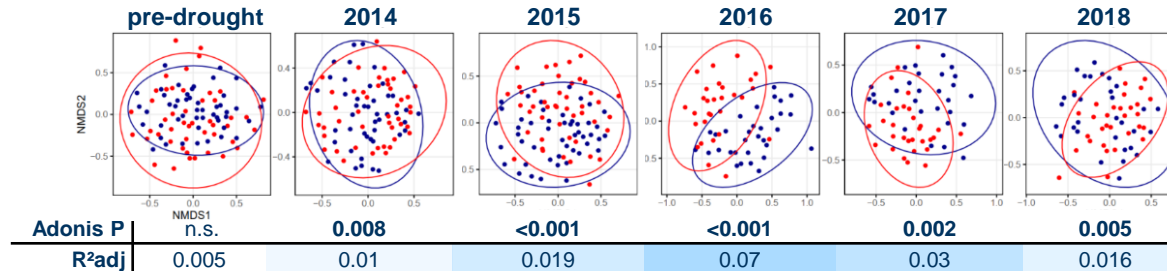
Quality: no progressive change during time-course: ECM fungal communities and EA stable

		3 years*	5 years
Quantitative:	vital fine roots	↘ ↘ ↘	↘ ↘
Quantitative:	EA / cm ³	↘ ↘ ↘	↘ ↘
Qualitative:	EA/ root tip	↔	↔
Qualitative:	ECMf diversity	↘	↔
Qualitative:	ECMf communities	progressive change?	minor change

*Nickel et al. 2018

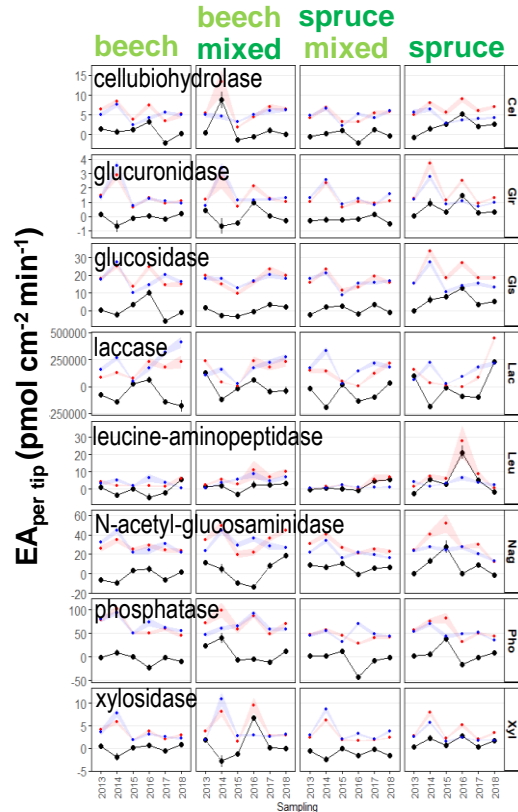
<https://doi.org/10.1111/gcb.13957>

ECMf communities (community dissimilarity NMDS)

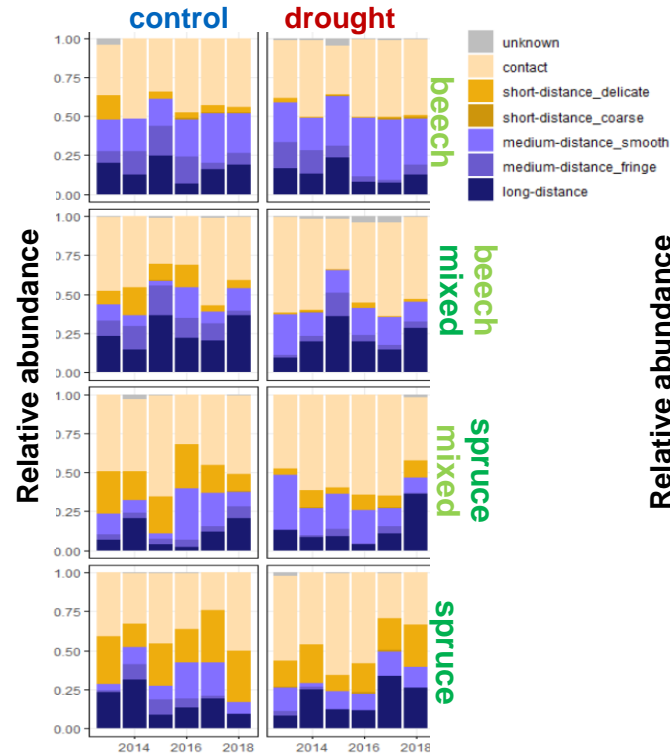


ECM results on a finer scale

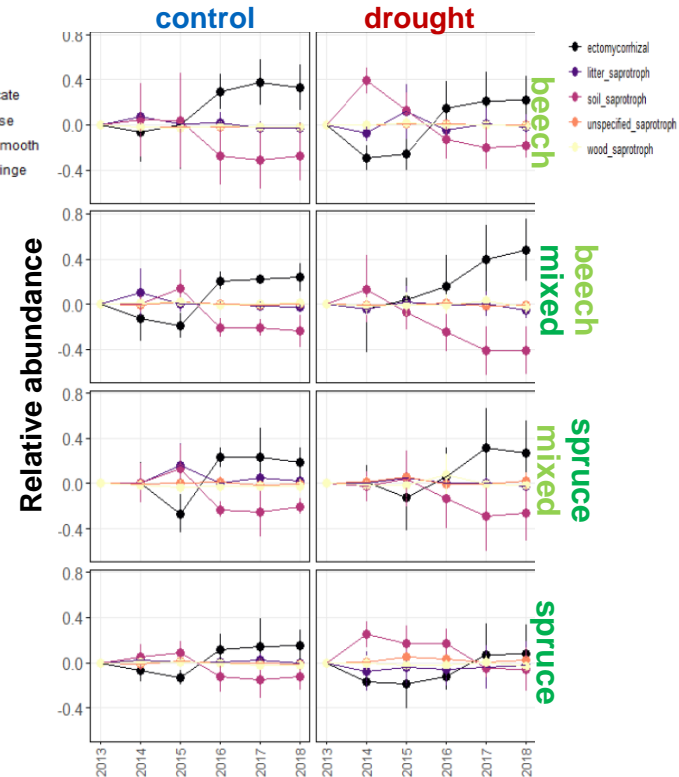
1) EA per ECM tip



2) ECMf Exploration Types



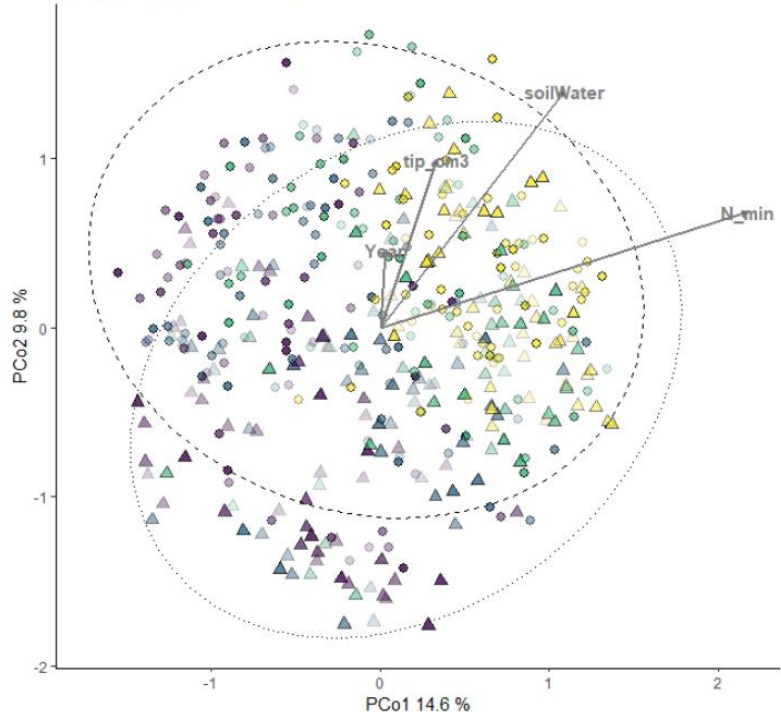
3) Fungi Functional Traits



ECMf temporal stability vs. Saprotrophic progression

Ectomycorrhizal fungi

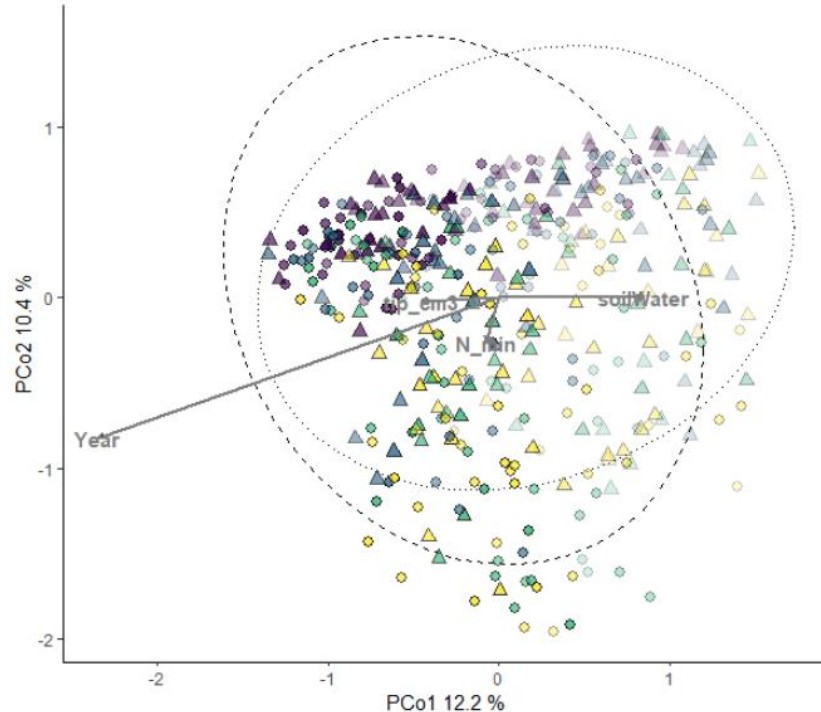
2014-2018 PCoA kroof drought Ectomycorrhizal fungi (FUNguild)
with fitted supplementary vectors



hellinger transformed, bray, n= 414

Saprotrophs

2014-2018 PCoA kroof drought defined SAPROTROPHS
with fitted supplementary vectors



hellinger transformed, bray, n= 414

Conclusions on ECM and 5 years drought

- 1) Quantitative: Fine root system severely diminished at ecosystem level
- 2) Qualitative (ECM-tip level): No progressive loss of function, changes limited
plus:
 - + no selection towards long distance exploration types
 - + relative amounts of saprotrophs continuously declining

ECM-fungi: supported with tree-water?



➡ **In our summer drought scenario,
surviving ECM may pose mostly unperturbed insulae.**

Thank you!



Fabian Weikl

Now active for *HoliSoils*

- *Climate smart forestry*
- *Soil green house gases*
- *Biodiversity*



Karin Pritsch

Kroof Pls:

Karin Pritsch (Helmholtz Center Munich)

Thorsten Grams (TUM Ecophysiology of Plants)

Hans Pretzsch (TUM Forest Growth)

Many helpful hands:

group members, esp. Franz Buegger, Uwe Nickel, trainees, and ecology volunteers

DFG Deutsche
Forschungsgemeinschaft
MU 831-23-1 German Research Foundation

fundet by
Bavarian State Ministry of the
Environment and Consumer Protection
and by
Bavarian State Ministry of
Health and Care

**BAYERISCHE
STAATSFÖRSTEN**
Nachhaltig Wirtschaften.

HelmholtzZentrum münchen
German Research Center for Environmental Health

DES
Department of
Environmental Sciences