German Centre for Integrative Biodiversity Research (iDiv)
Halle-Jena-Leipzig

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

Impacts of the 2018–2019 drought

Cumulative growth and stress responses in a floodplain forest ecosystem

Florian Schnabel, *Sarah Purrucker, Lara Schmitt, Rolf A. Engelmann, Anja Kahl, Tom Künne, Ronny Richter, Carolin Seele-Dilbat, Georgios Skiadaresis, Christian Wirth*

TreeDi

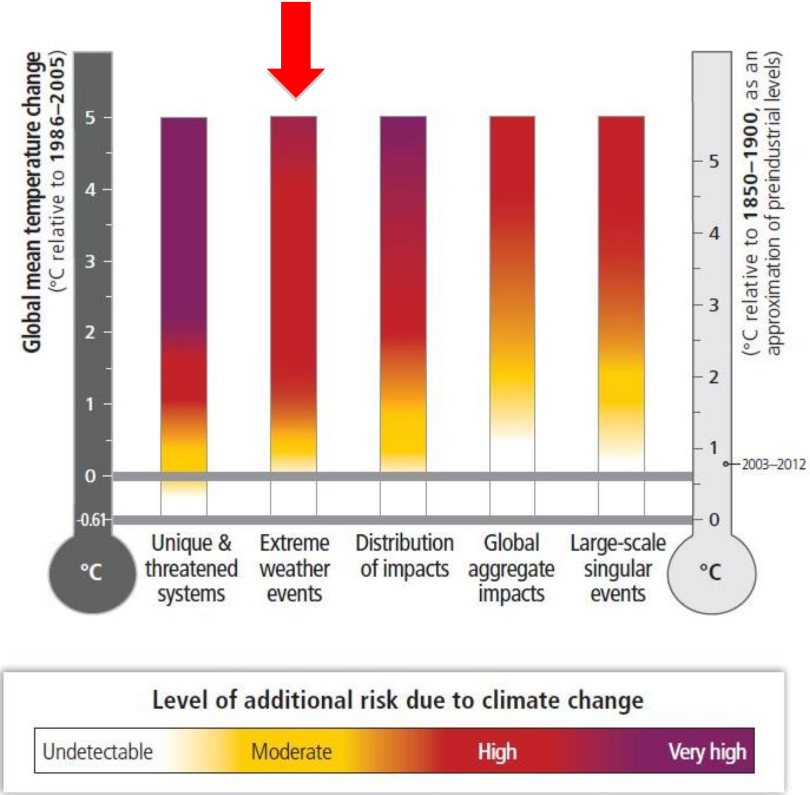
@MixedForests

iDiv is a research centre of the DFG Deutsche Forschungsgemeinschaft

Increasing frequency and intensity of climate extremes

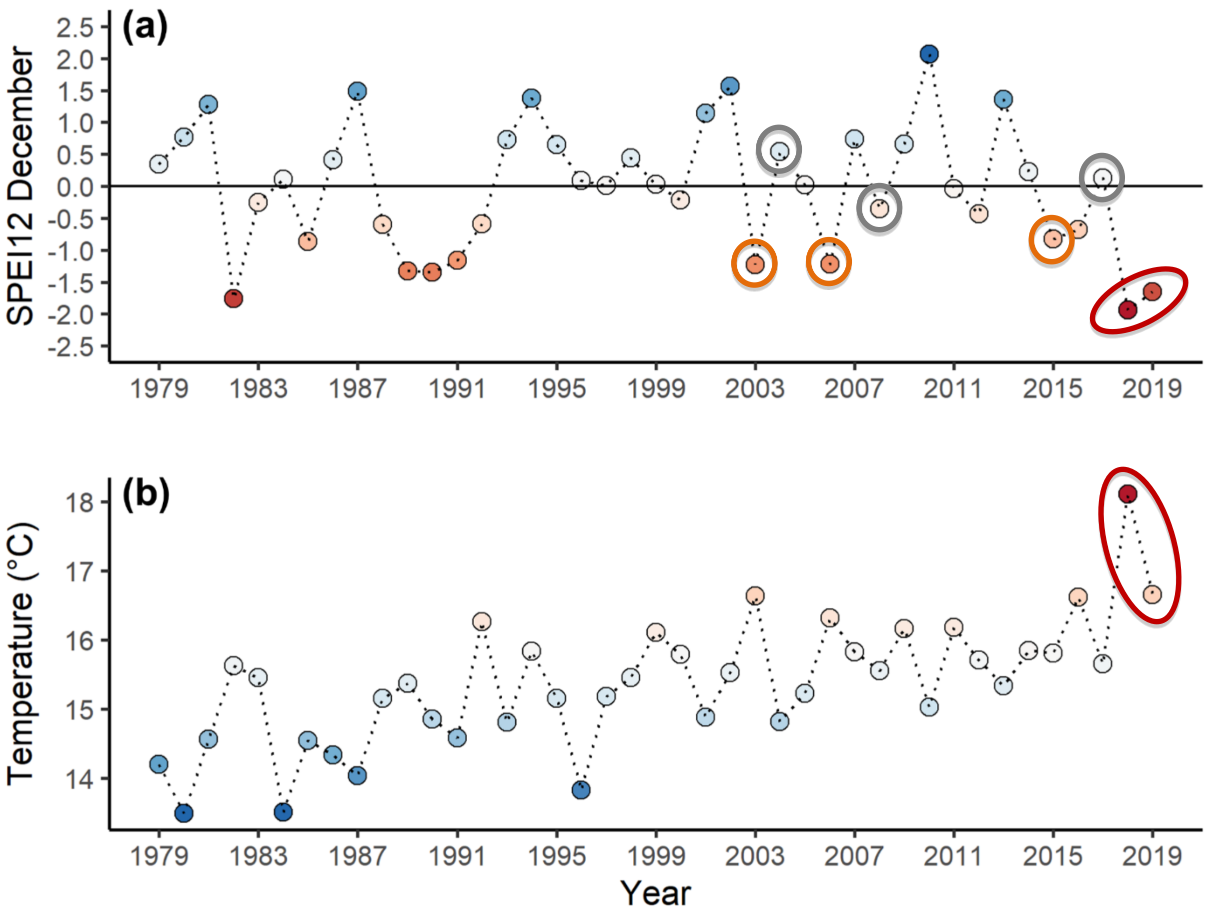
The 2018-2019 drought in Central Europe

Science, 2021



IPCC, 2014

The hotter drought 2018-2019



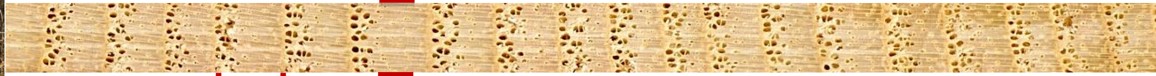
Years for analysis

- Reference years
- Single drought years
- Consecutive hotter drought years

Drought year selection following Schwarz et al. 2020

Retrospective analysis of drought effects using tree rings

Growth response: $\frac{Dr_{growth}}{PreDr_{growth}} - 1$ (0 = ‚normal‘)



1 year

Core of *F. excelsior*

Δδ¹³C: $\Delta\delta^{13}C = Dr_{\delta^{13}C} - PreDr_{\delta^{13}C}$ (0 = ‚normal‘)

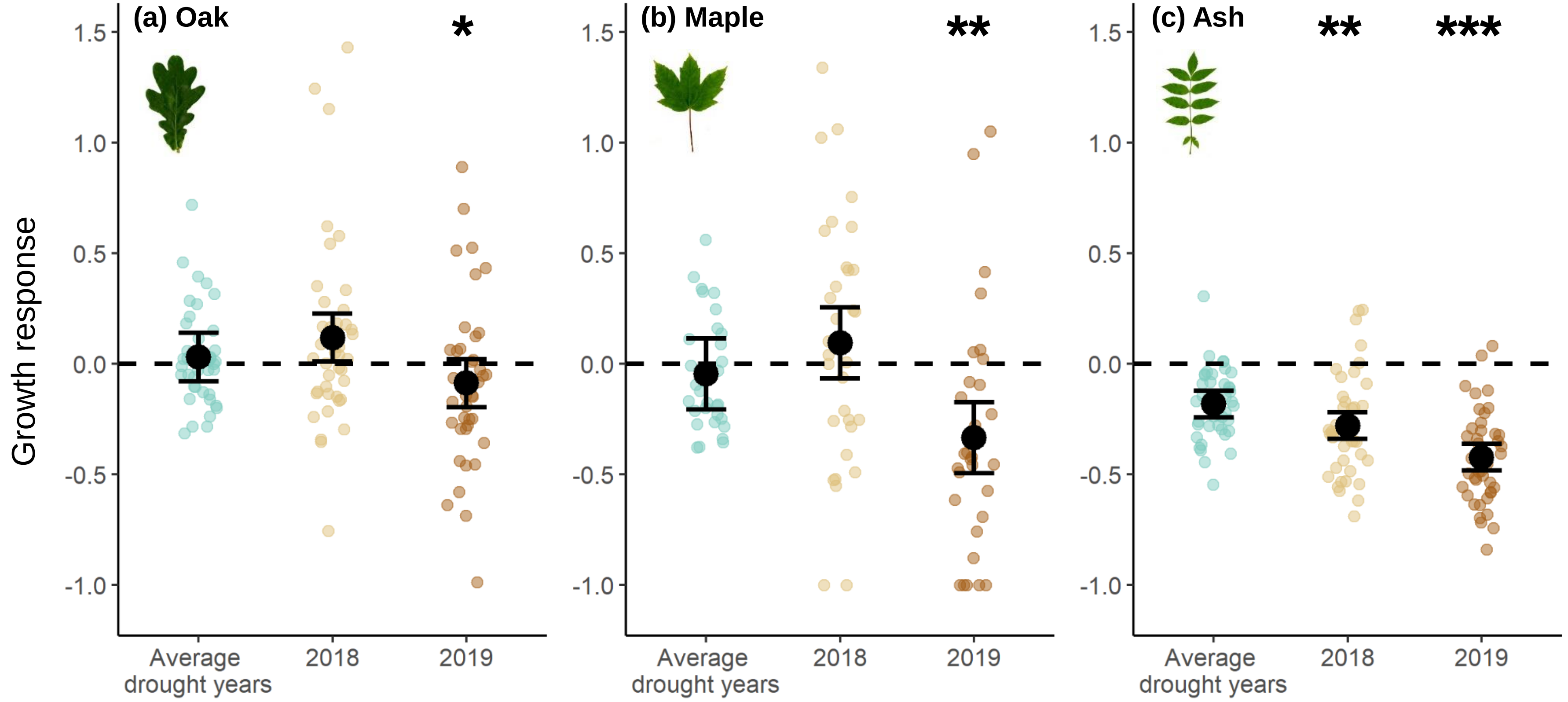
(proxy for physiological water stress)

Oak
(*Q. robur*)

Maple
(*A. pseudoplatanus*)

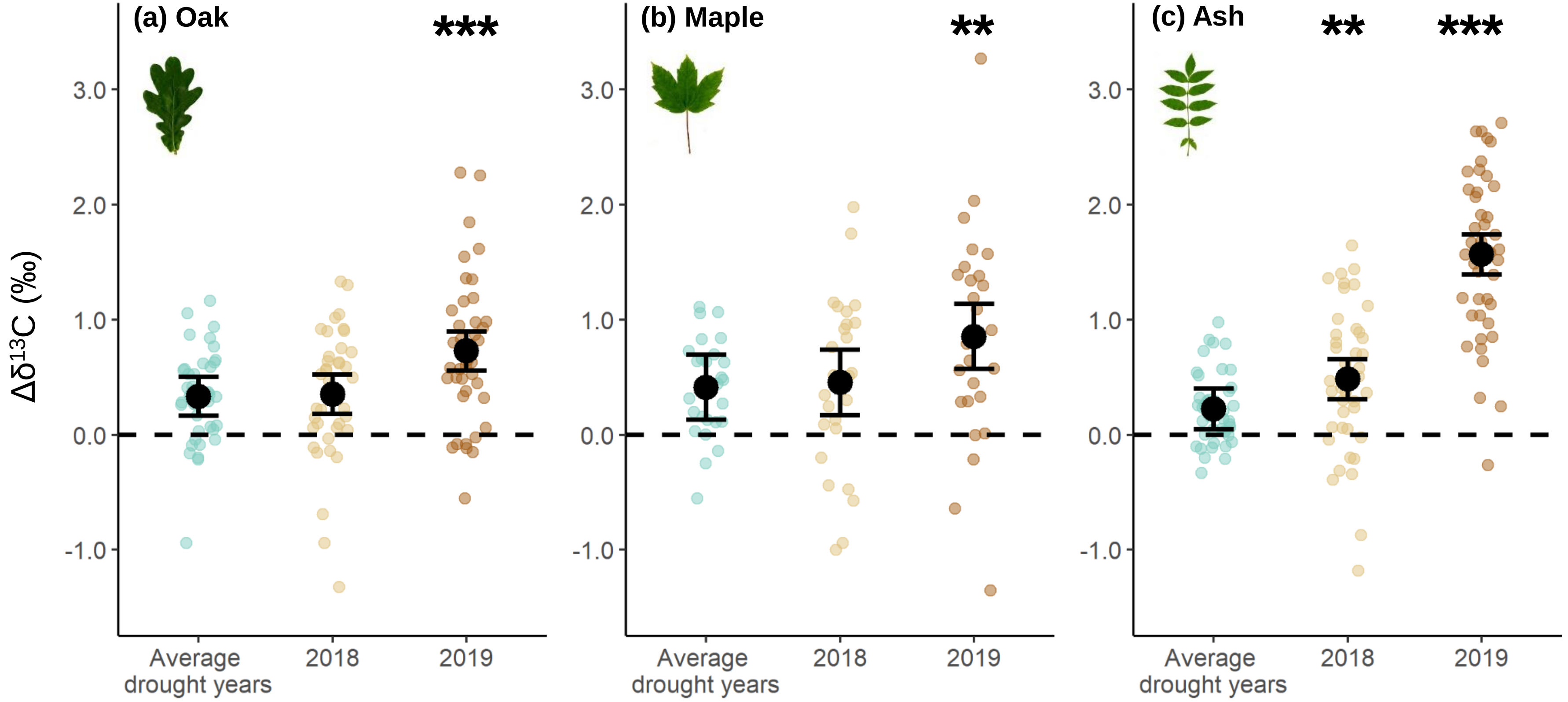
Ash
(*F. excelsior*)

iDiv

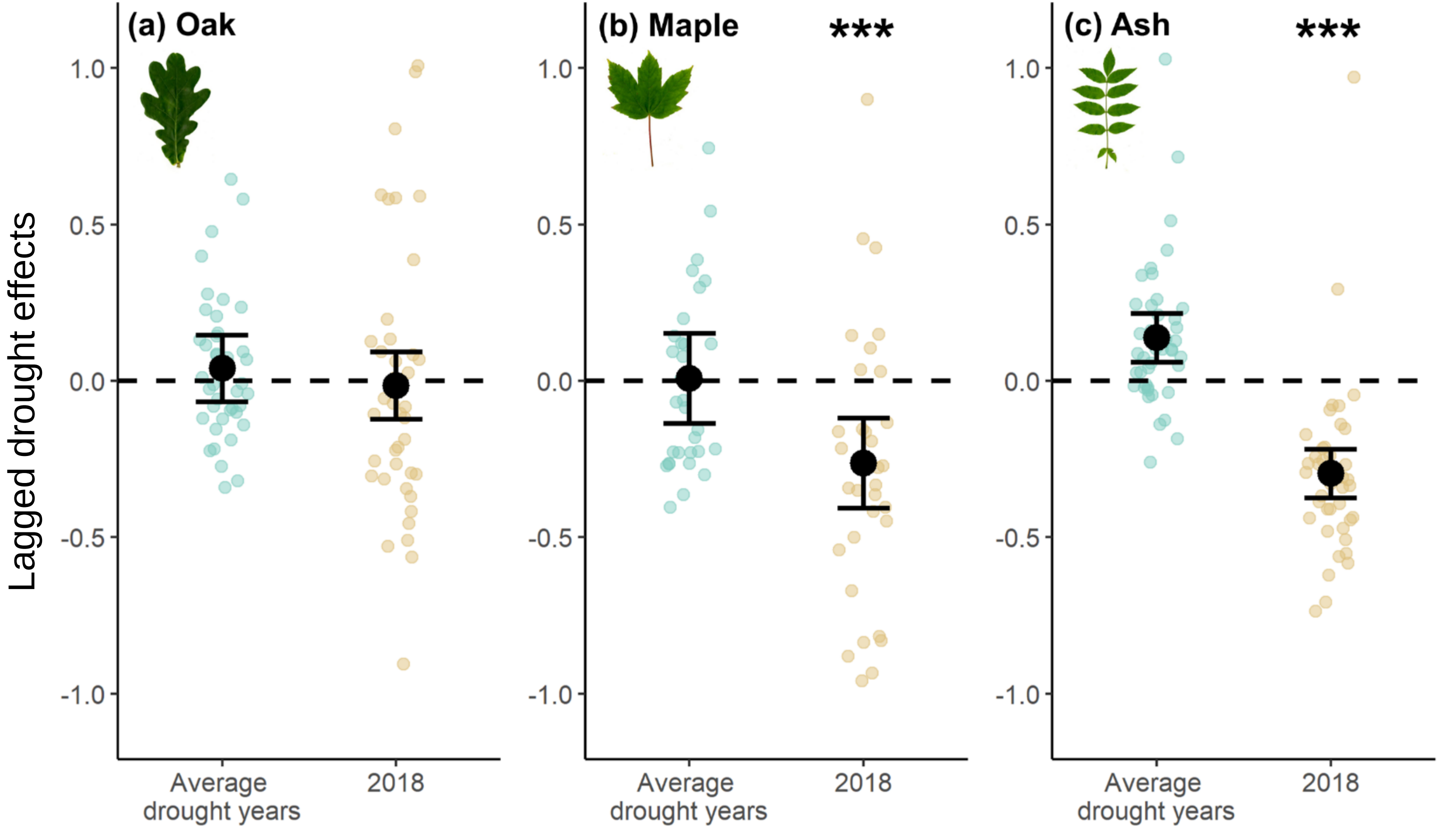


Schnabel et al. 2022, GCB

2018 and 2019 are compared against the average of single drought years



Schnabel et al. 2022, GCB



Legacy effect:
Observed growth - predicted growth

(based on climatic water balance)
Anderegg et al. 2015

Schnabel et al. 2022, GCB

The cumulative effect of consecutive hotter drought years caused unprecedented stress responses.

Consecutive hotter drought years pose a novel threat!

Received: 24 March 2021 | Revised: 6 July 2021 | Accepted: 23 November 2021

DOI: 10.1111/gcb.16028

Global Change Biology WILEY

PRIMARY RESEARCH ARTICLE

Cumulative growth and stress responses to the 2018–2019 drought in a European floodplain forest

Florian Schnabel[1,2] | Sarah Purrucker[2] | Lara Schmitt[2] | Rolf A. Engelmann[1,2] | Anja Kahl[2] | Ronny Richter[1,2,3] | Carolin Seele-Dilbat[2,4] | Georgios Skiadaresis[5] | Christian Wirth[1,2,6]

https://onlinelibrary.wiley.com/doi/10.1111/gcb.16028

iDiv

This presentation participates in OSPP

EGU

Outstanding Student & PhD candidate Presentation contest

Vote here:

https://doi.org/10.5194/egusphere-egu22-6271

This work woud not have been possible without the work of many others!

Thank you ☺

Sarah Purrucker, Lara Schmitt, Rolf A. Engelmann, Anja Kahl, Ronny Richter, Carolin Seele-Dilbat, Georgios Skiadaresis & Christian Wirth

Contacts & Literature

florian.schnabel@idiv.de

@MixedForests

TreeDi : https://www.idiv.de/en/treedi.html

IPCC (2014). Climate change 2014. Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. New York, NY: Cambridge University Press.

Popkin, G. (2021) Forest fight, *Science*, 375

Schwarz, J. A., Skiadaresis, G., Kohler, M., Kunz, J., Schnabel, F., Vitali, V., & Bauhus, J. (2020). Quantifying Growth Responses of Trees to Drought—a Critique of Commonly Used Resilience Indices and Recommendations for Future Studies. *Current Forestry Reports*, 6, 185–200. https://doi.org/10.1007/s40725-020-00119-2

Schnabel, F., Purrucker, S., Schmitt, L., Engelmann, R. A., Kahl, A., Richter, R., . . . Wirth, C. (2022). Cumulative growth and stress responses to the 2018-2019 drought in a European floodplain forest. *Global Change Biology*, 28(5), 1870–1883. https://doi.org/10.1111/gcb.16028

Anderegg, W. R. L., Schwalm, C., Biondi, F., Camarero, J. J., Koch, G., Litvak, M., . . . Pacala, S. (2015). Pervasive drought legacies in forest ecosystems and their implications for carbon cycle models. Science, 349(6247), 528–532. https://doi.org/10.1126/science.aab1833

Choat, B., Jansen, S., Brodribb, T. J., Cochard, H., Delzon, S., Bhaskar, R., . . . Zanne, A. E. (2012). Global convergence in the vulnerability of forests to drought. *Nature*, 491(7426), 752–755. https://doi.org/10.1038/nature11688

McDowell, N., Pockman, W. T., Allen, C. D., Breshears, D. D., Cobb, N., Kolb, T., . . . Yepez, E. A. (2008). Mechanisms of plant survival and mortality during drought: Why do some plants survive while others succumb to drought? *New Phytologist*, 178(4), 719–739. https://doi.org/10.1111/j.1469-8137.2008.02436.x

Extended Materials

Drought-tolerance traits might explain tree responses to drought

Stomatal control

Water saver – Water spender

Oak

Ash

Saver: J_S ↓ **Spender**: J_S →

Based on sap flux regulation during drought (J_s)

Cavitation resistance (Ψ_{50})

Resistent - Sensitive

Oak

Ash

-2.8 MPa **-2.8 MPa**

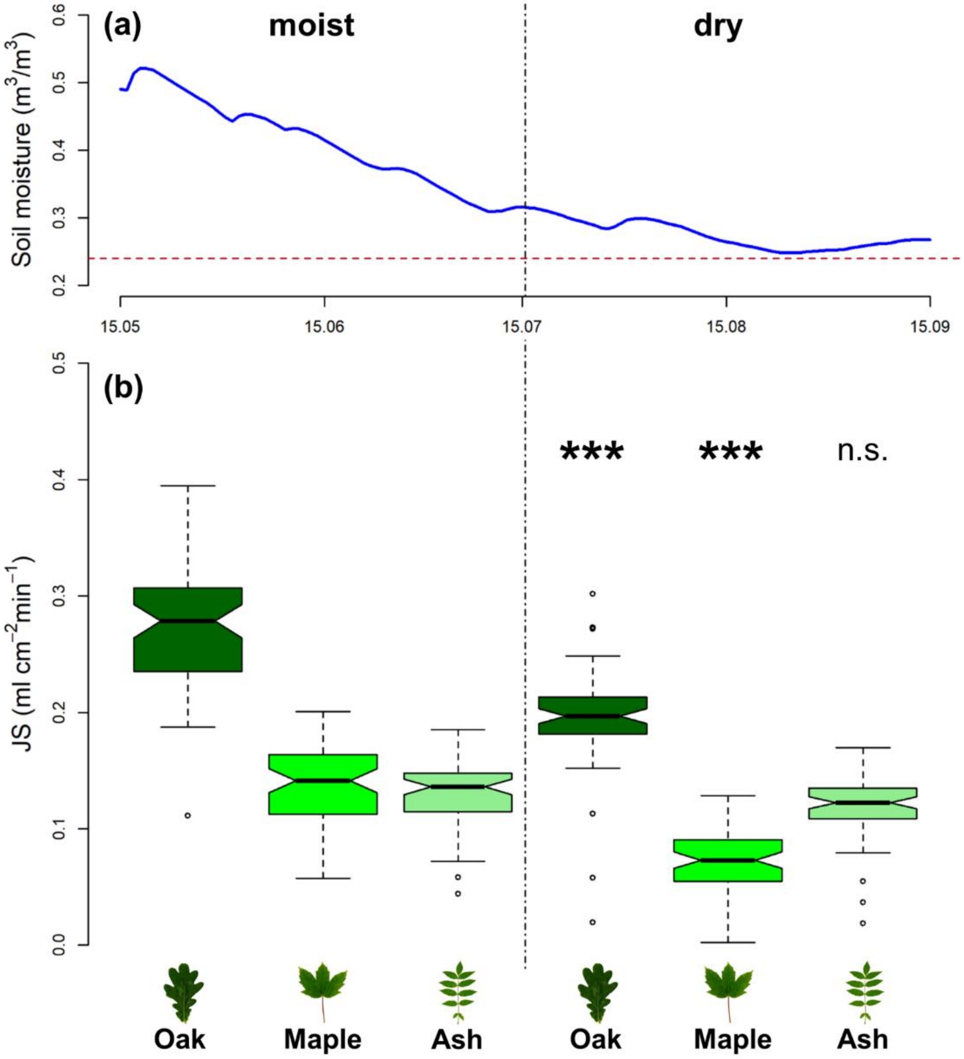
Choat et al. 2012

Stronger drought response of ash compared to oak is potentially related to its water spending behaviour…

(see McDowell et al. 2008 for details on species stomatal control and cavitation resistance)

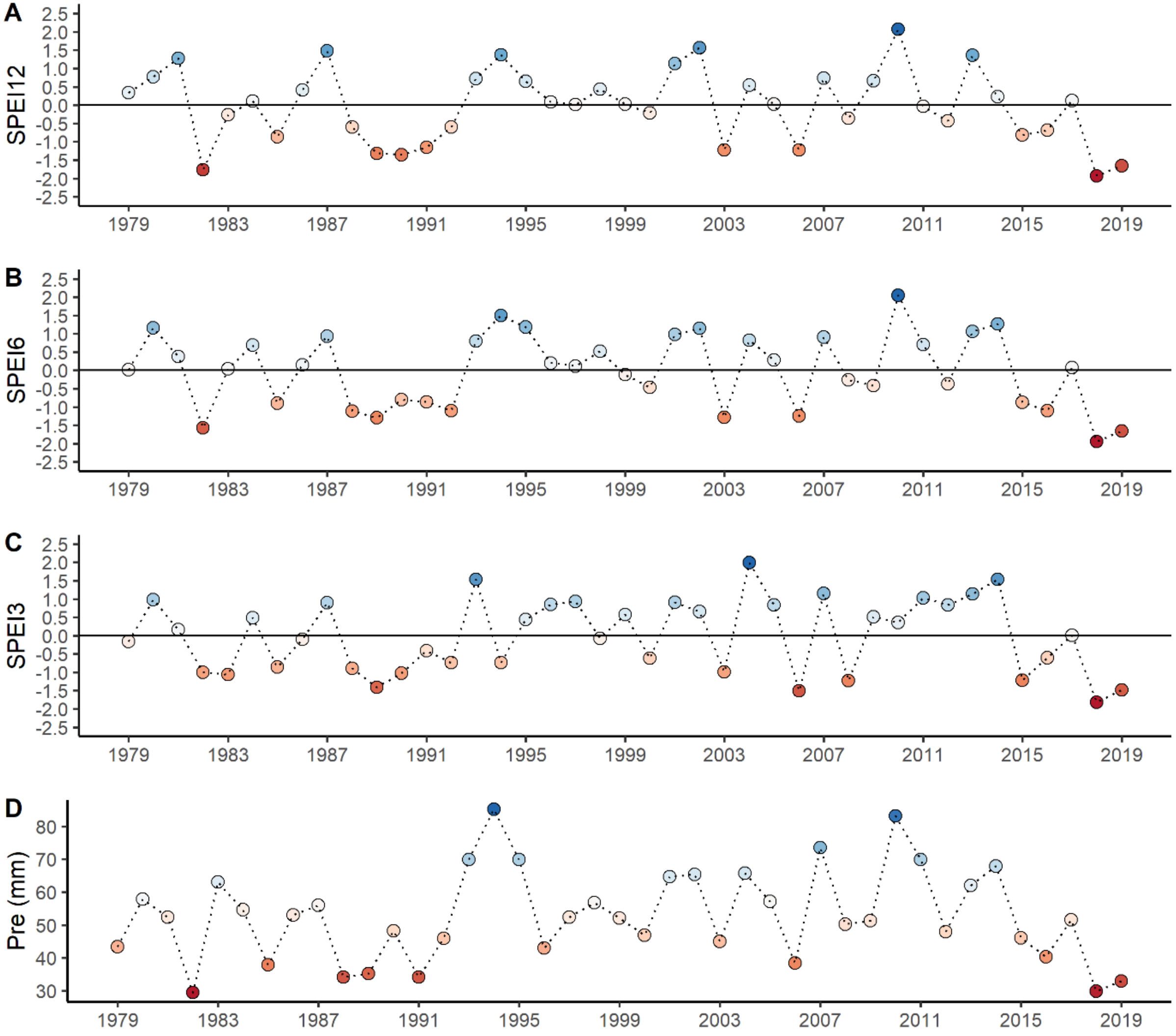
iDiv

Sap flux regulation during the 2018 drought



Schnabel et al. 2022, GCB

Additional climate variables



iDiv