

# Significant drought legacy effects on gross primary productivity detected in terrestrial ecosystems across the globe

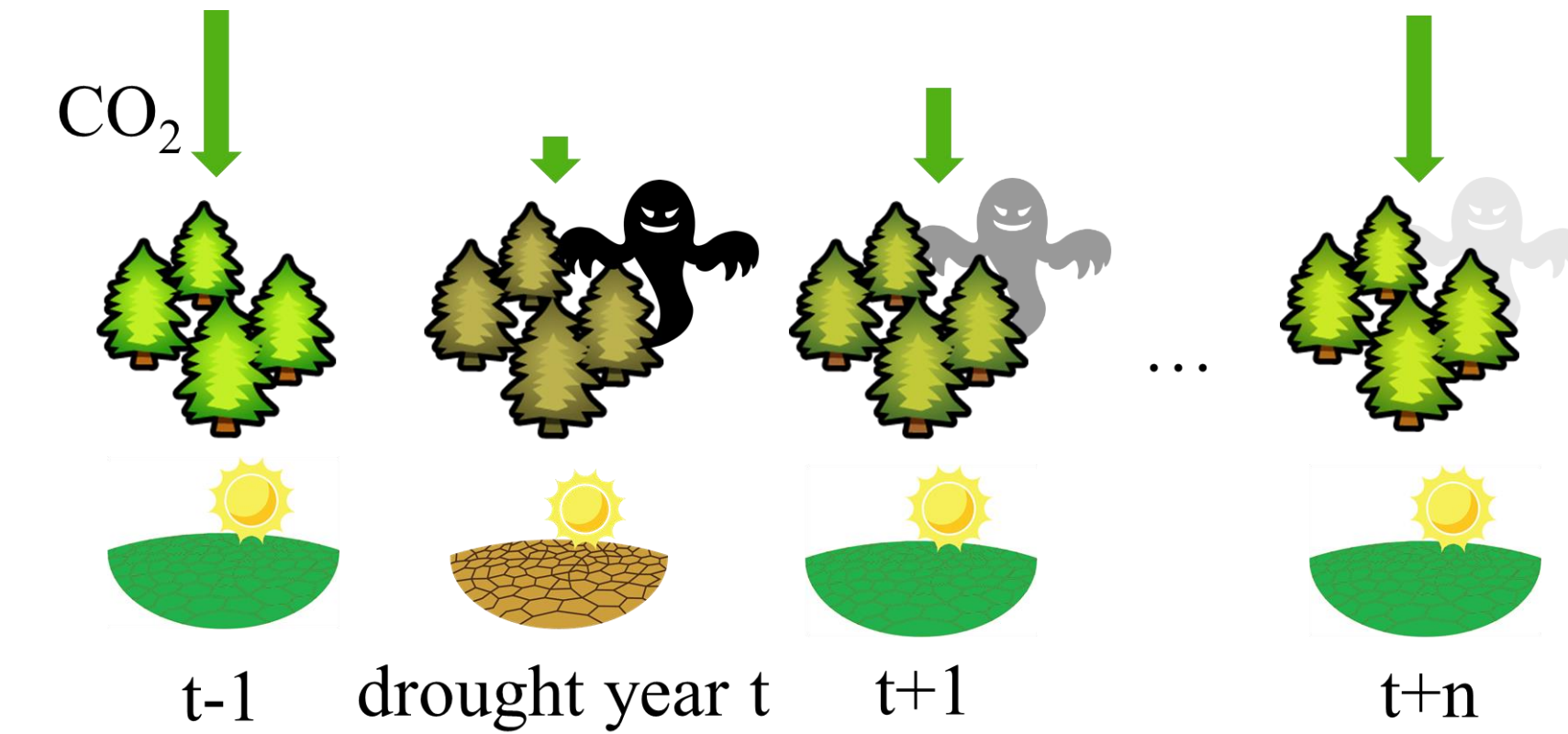
Xin Yu<sup>1,2\*</sup>, René Orth<sup>1</sup>, Markus Reichstein<sup>1</sup>, Michael Bahn<sup>2</sup>, Ulisse Gomasca<sup>1</sup>, Mirco Migliavacca<sup>3</sup>, Dario Papale<sup>4</sup>, Christian Reimers<sup>1</sup> and Ana Bastos<sup>1</sup>

[1] Max Planck Institute for Biogeochemistry, Dept. of Biogeochemical Integration, 07745 Jena, Germany [2] University of Innsbruck, Department of Ecology, A-6020 Innsbruck, Austria [3] Joint Research Centre, European Commission, 21027 Ispra (VA), Italy [4] Department for Innovation in Biological, Agro-food and Forest systems (DIBAF), University of Tuscia, Viterbo, Italy

\*Correspondence: xyu@bgc-jena.mpg.de

## Introduction

- Drought **concurrently** causes direct impacts on ecosystems in the drought year, but also can result in **legacy effects** during the following seasons and years
- Drought legacy effects on **ecosystem carbon cycling** are still poorly understood



## Take home messages

- **Widespread** drought legacy effects on GPP in terrestrial ecosystems across the globe
- Drought legacies are in the **same order of magnitude** of concurrent effects
- **Aridity** is the most direct driver modulating legacy effects in forests

## ① How to quantify drought legacy effects?

- Legacy effects = **actual GPP** – **potential GPP** (Yu et al., 2022)

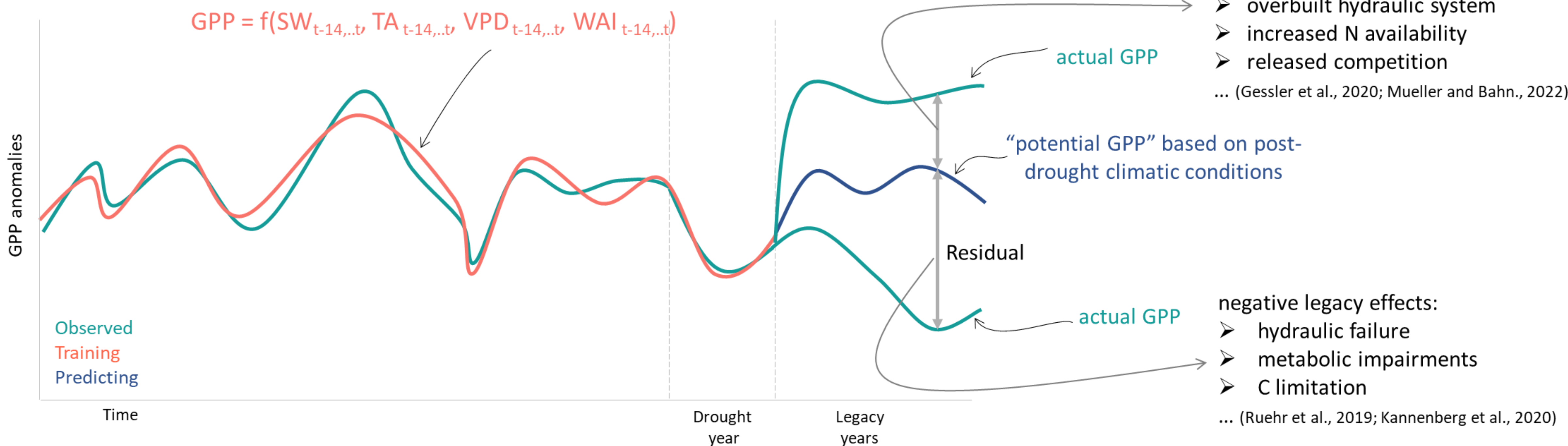


Figure 1. Diagram of drought legacy effects quantification. Drought legacy effects on GPP are quantified as the difference between potential and actual GPP in the post-drought years. Potential GPP is estimated by a trained random forest model with climate variables as predictors of GPP. Model uncertainties are estimated by leave-one-out approach. The strongest drought year is defined as the year when the strongest GPP reduction is associated with low water availability index (WAI).  $WAI_t = \min(WAI_{max}, WAI_{t-1} + P_t - ET_t)$ .

## ② Investigated EC sites, legacy effects sign and size

- **Widespread** drought legacy effects on GPP are either **positive** or **negative**

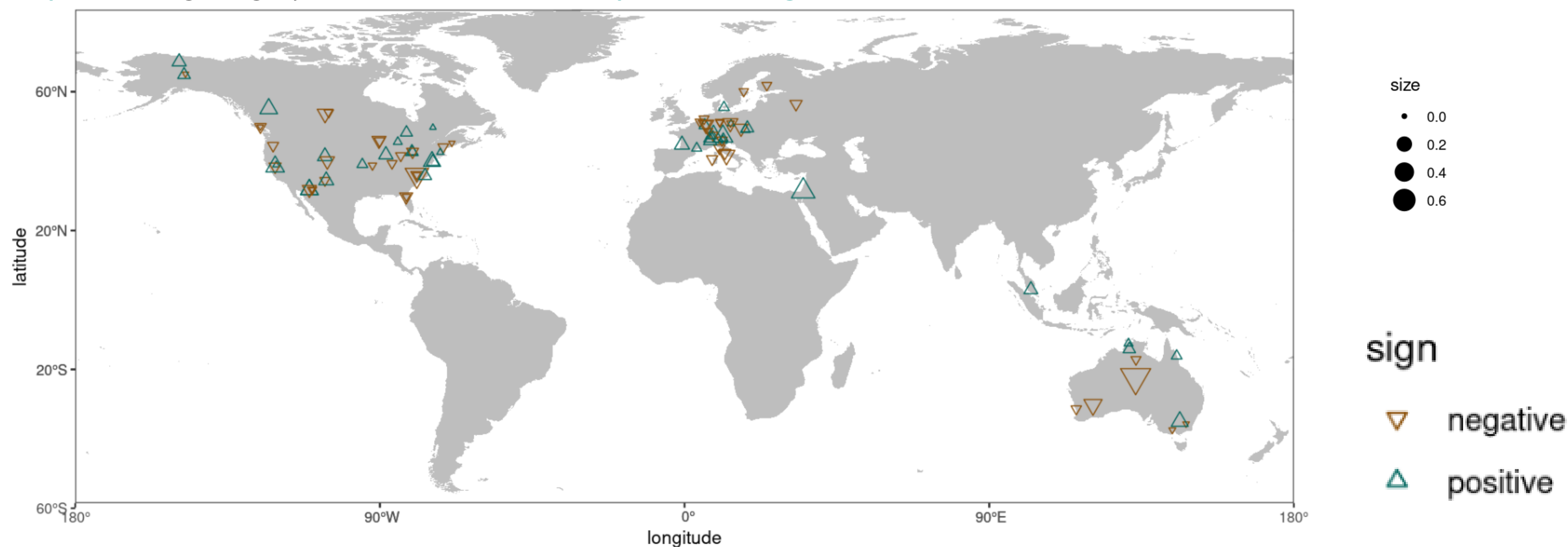


Figure 2. Investigated eddy covariance sites, drought legacy effects sign and size. Eddy covariance sites ( $\geq 7$  years) are from La Thuile 2007, FLUXNET2015, AmeriFLUX, ICOS warm winter 2020, and OzFLUX. Sites from Lathuile 2007 and AmeriFLUX are processed using REdyProc in R (Wutzler et al., 2018) including ustar filtering, gap-filing, and partitioning.

## ③ Concurrent vs legacy effects

- Legacy effects are **comparable** with concurrent effects

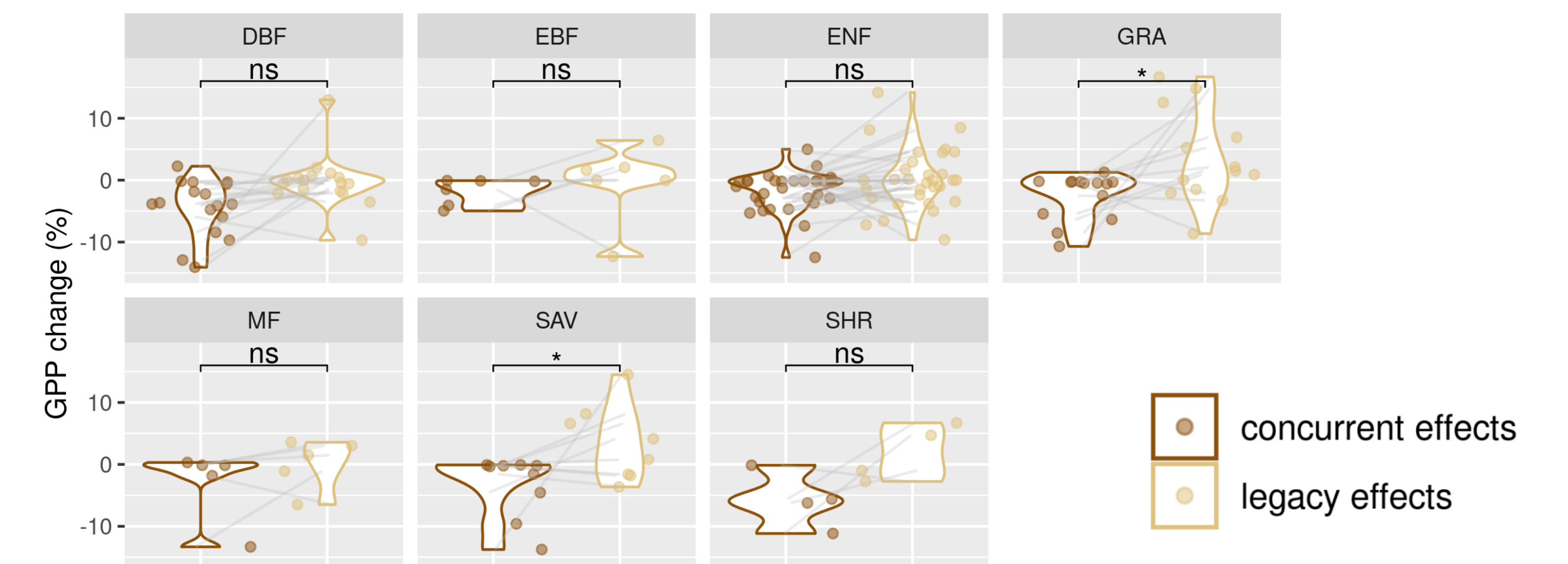


Figure 3. Concurrent effects in the drought year and legacy effects in the first 2 years after drought across biomes. The significance labels between each two groups show the significant (\*) or non-significant (ns) difference of order of magnitude based on paired two-samples T-test (\* $p < 0.05$ , ns  $p > 0.05$ ).

## ④ Causal structure of legacies in forests

- **Aridity** (P/Rn) is the most direct driver modulating legacy effects in forests

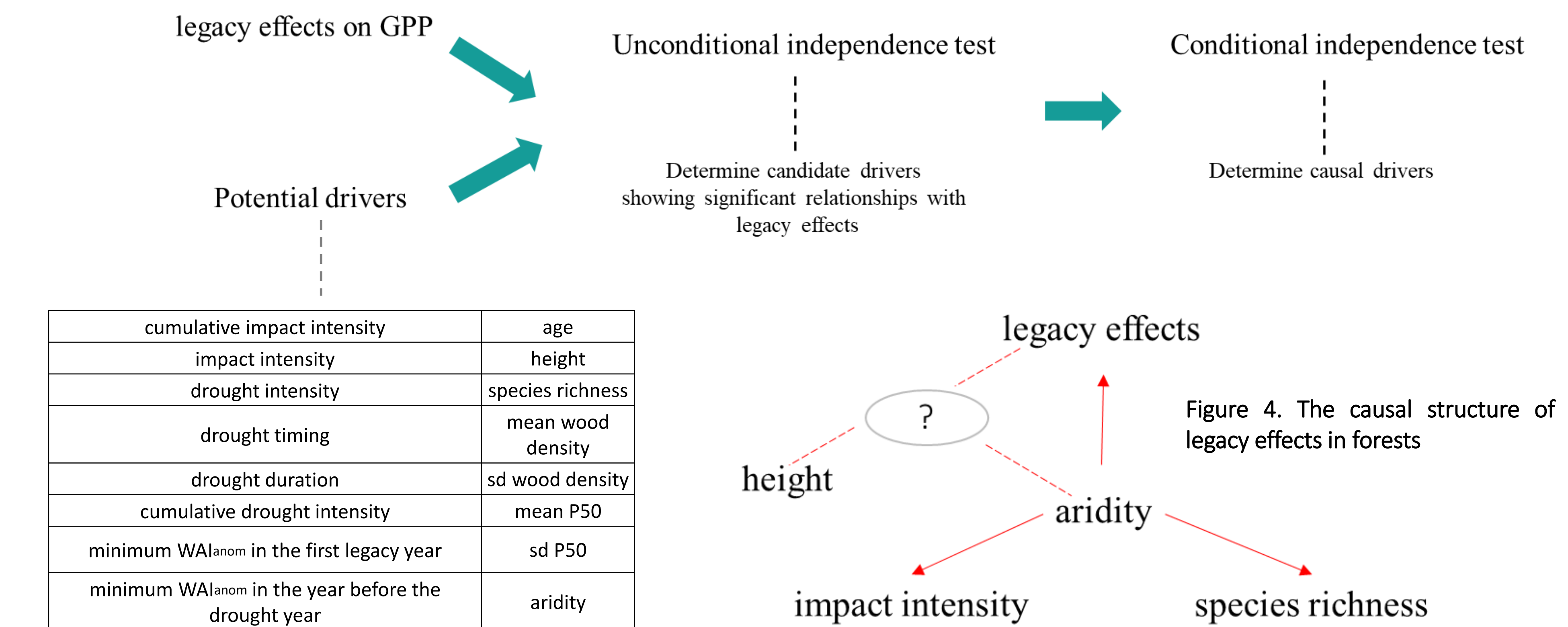


Figure 4. The causal structure of legacy effects in forests

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