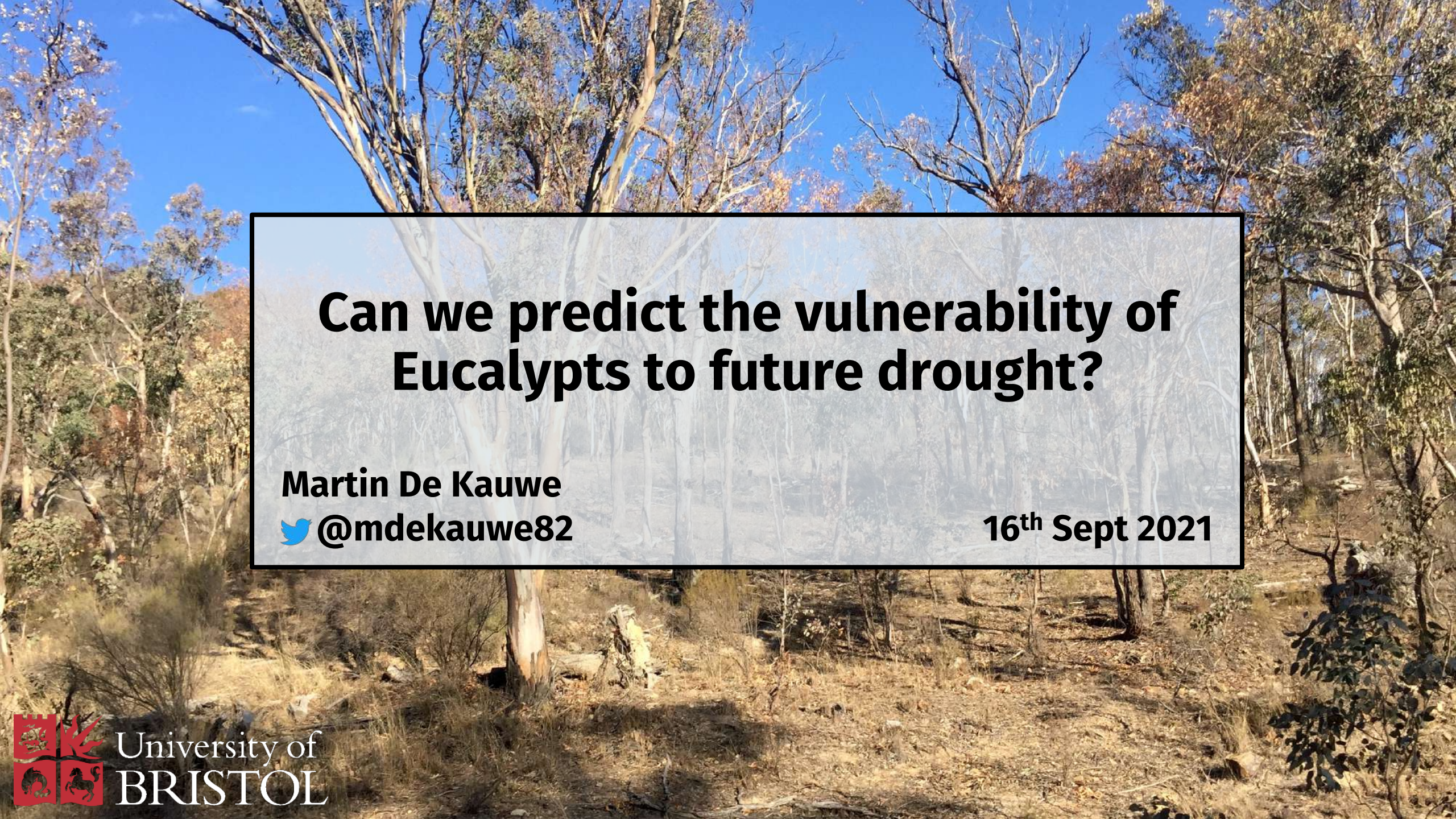


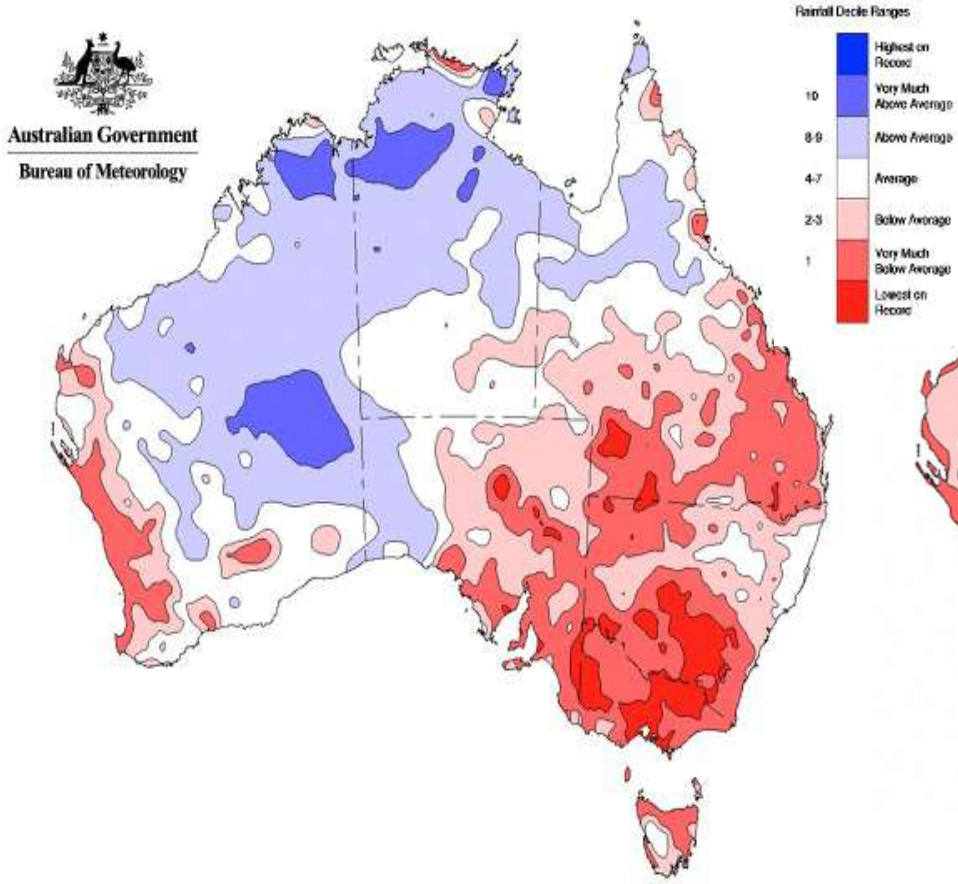
Can we predict the vulnerability of Eucalypts to future drought?

Martin De Kauwe
@mdekauwe82

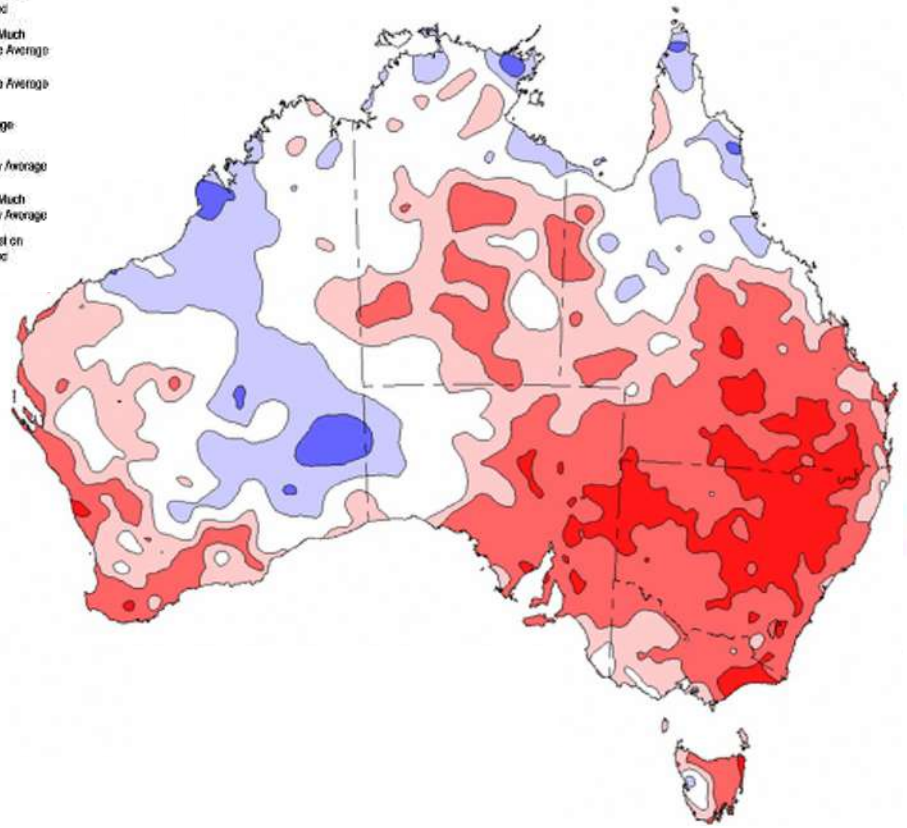
16th Sept 2021

University of BRISTOL

Recent record-breaking droughts



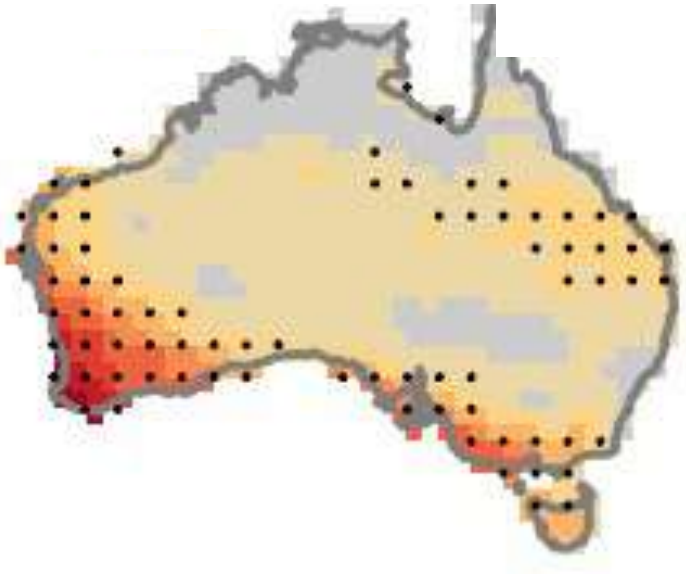
Millennium drought (2000–2009)



Big dry (2017–2019)

CMIP6

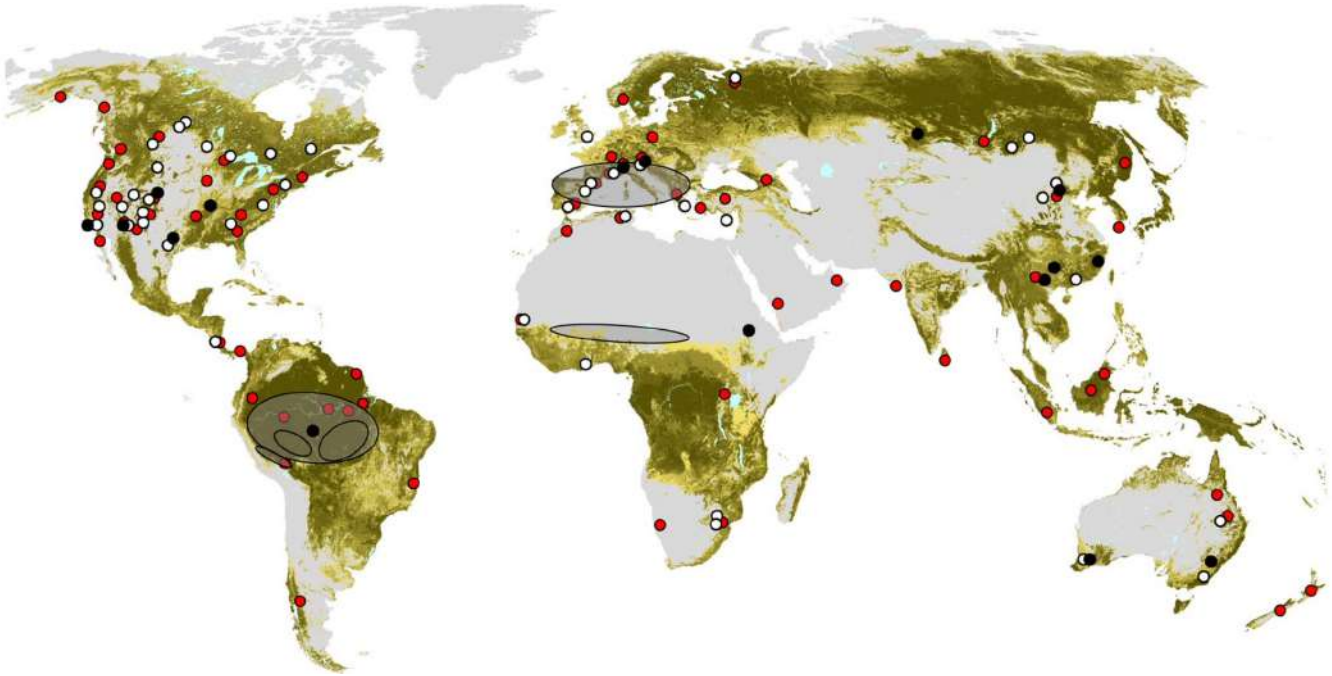
⬆ ~20% in drought duration & frequency



Ukkola et al. (2020) GRL

Widespread drought-induced mortality

Observed mortality events



Allen et al. (2015) Ecosphere

Dieback could have profound consequences for:

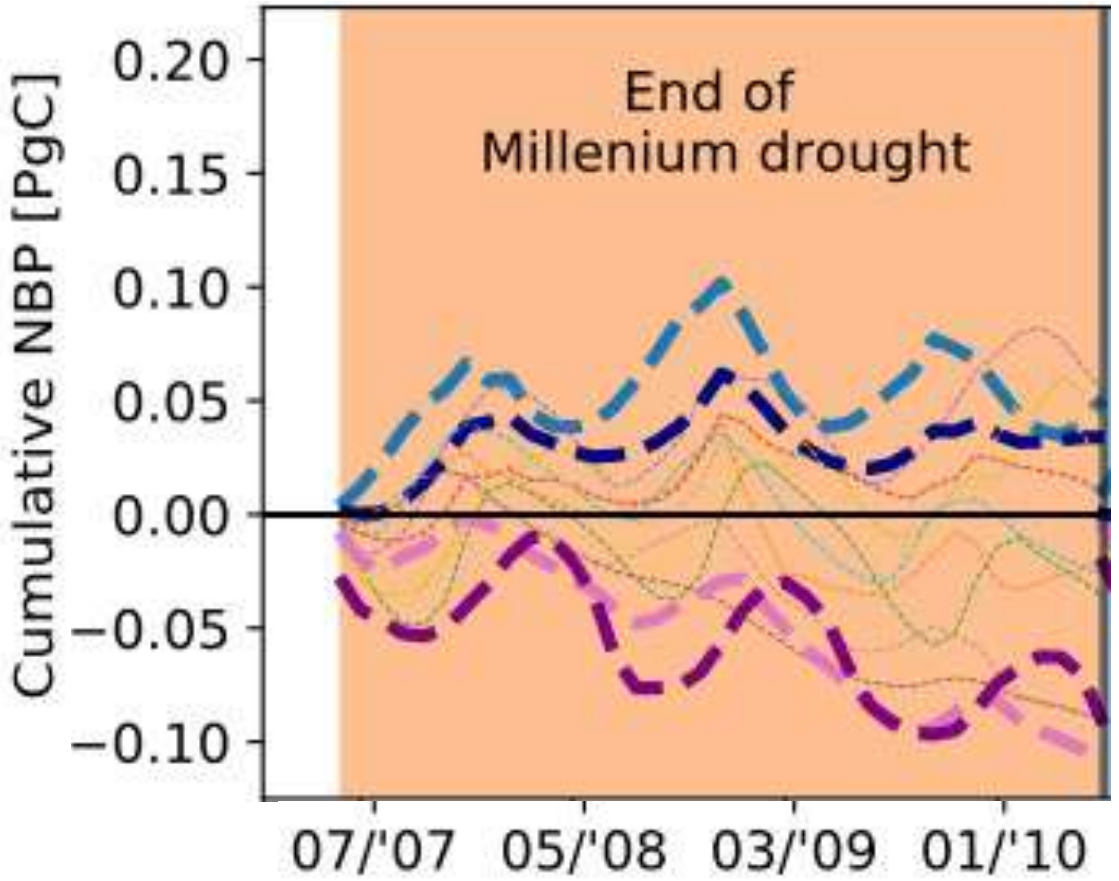
- carbon balance
- land-atmosphere feedbacks
- community composition

Critically…key feedback missing in CMIP models

Q. Can we predict species vulnerability to drought with a model?

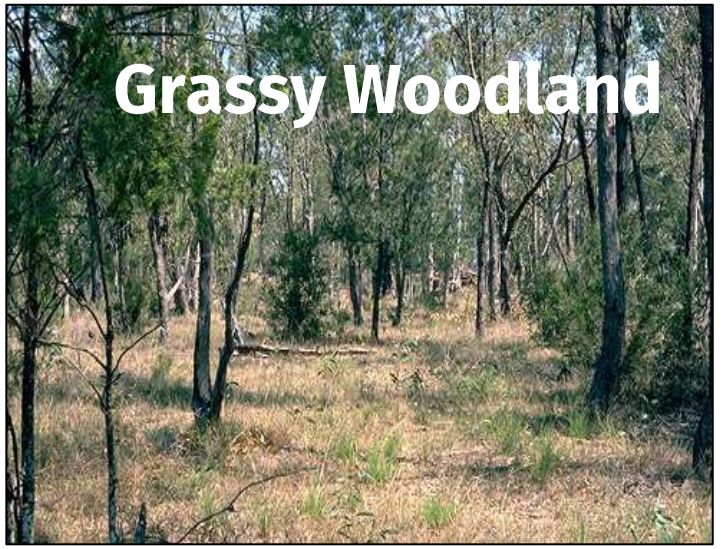
Problem 1: Models diverge when it is dry

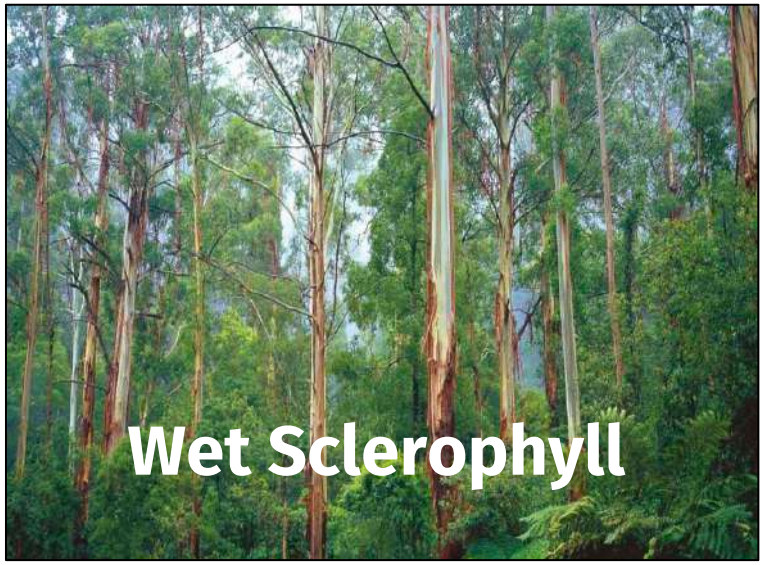
2000-9 NBP sum: 0.15 to -0.22 Pg C (>10 TRENDY DGVMs)



Teckentrup et al. (2021) Biogeosci. *in review*

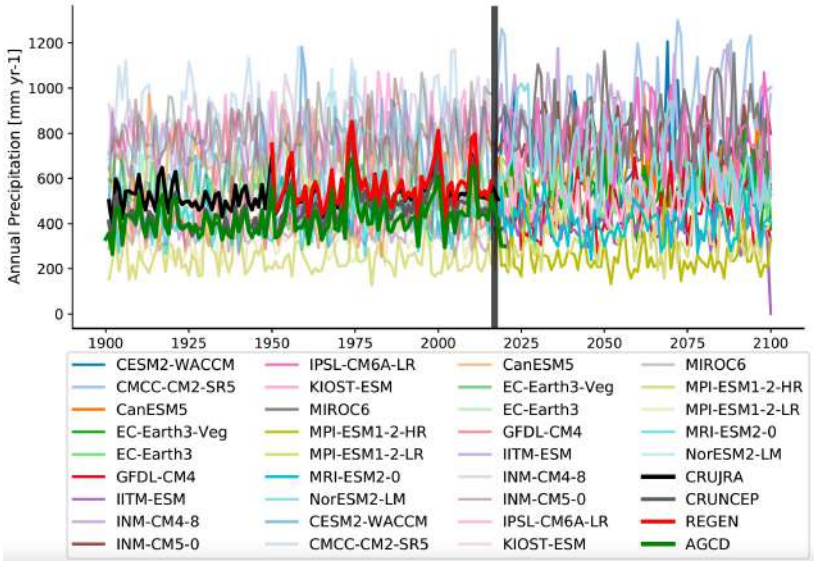
Problem 2: Evergreen broadleaf forest?



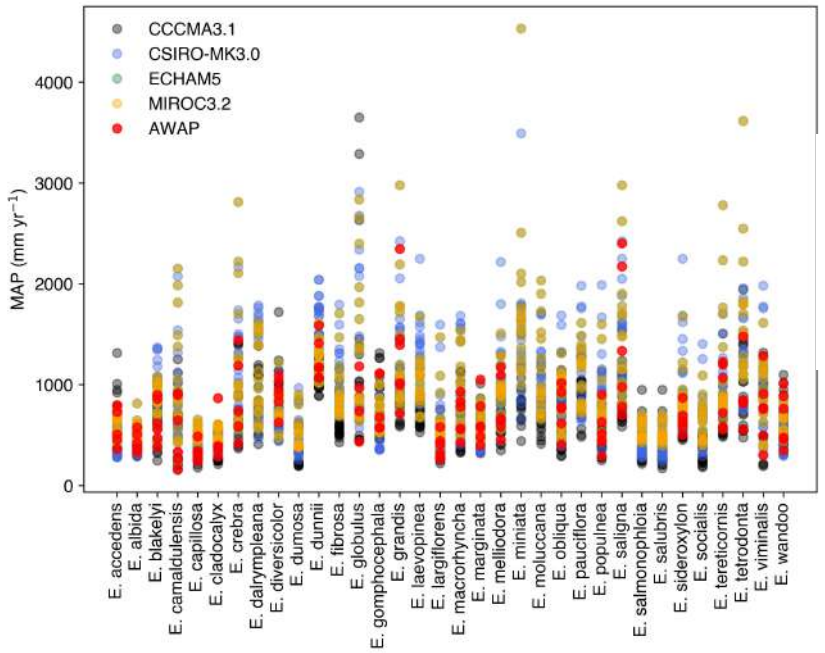


Problem 3: Future climate model forcing

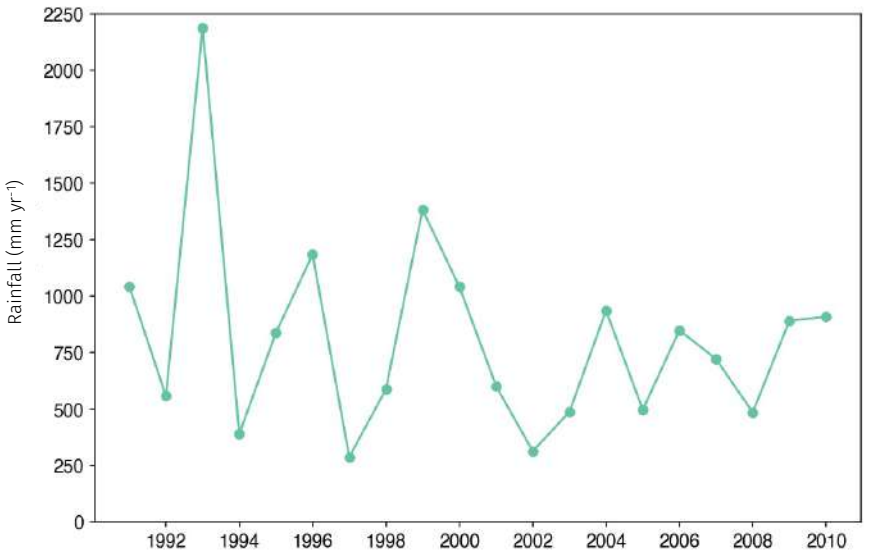
CMIP6 models



“representative” GCMs + RCMs



GCM + RCM … a *random* pixel



Experimental setup

Problem 1 ✓

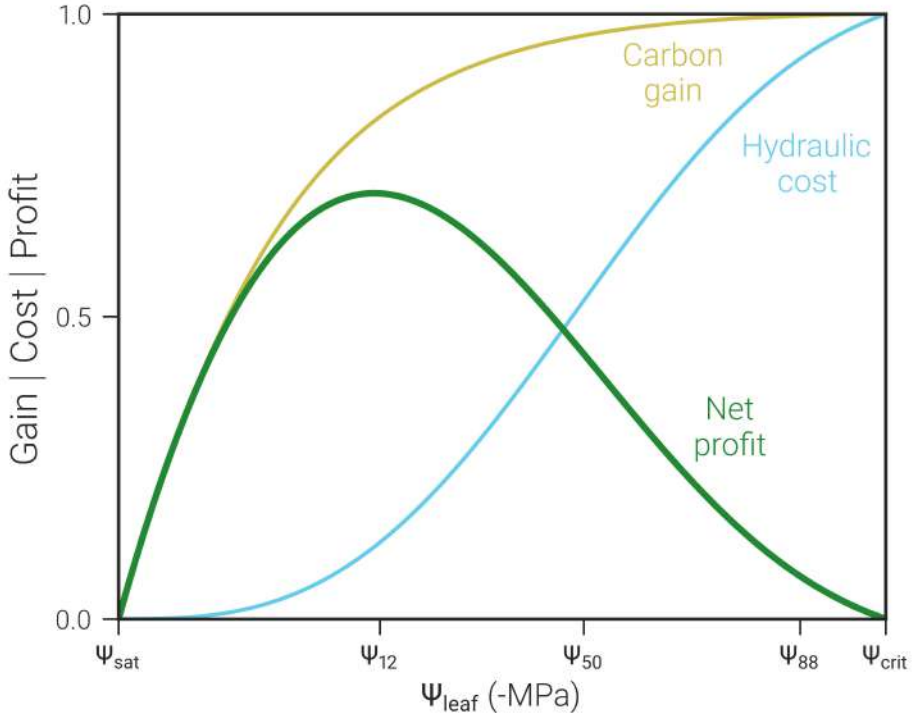
- CABLE LSM + profit maximisation model

Problem 2 ✓

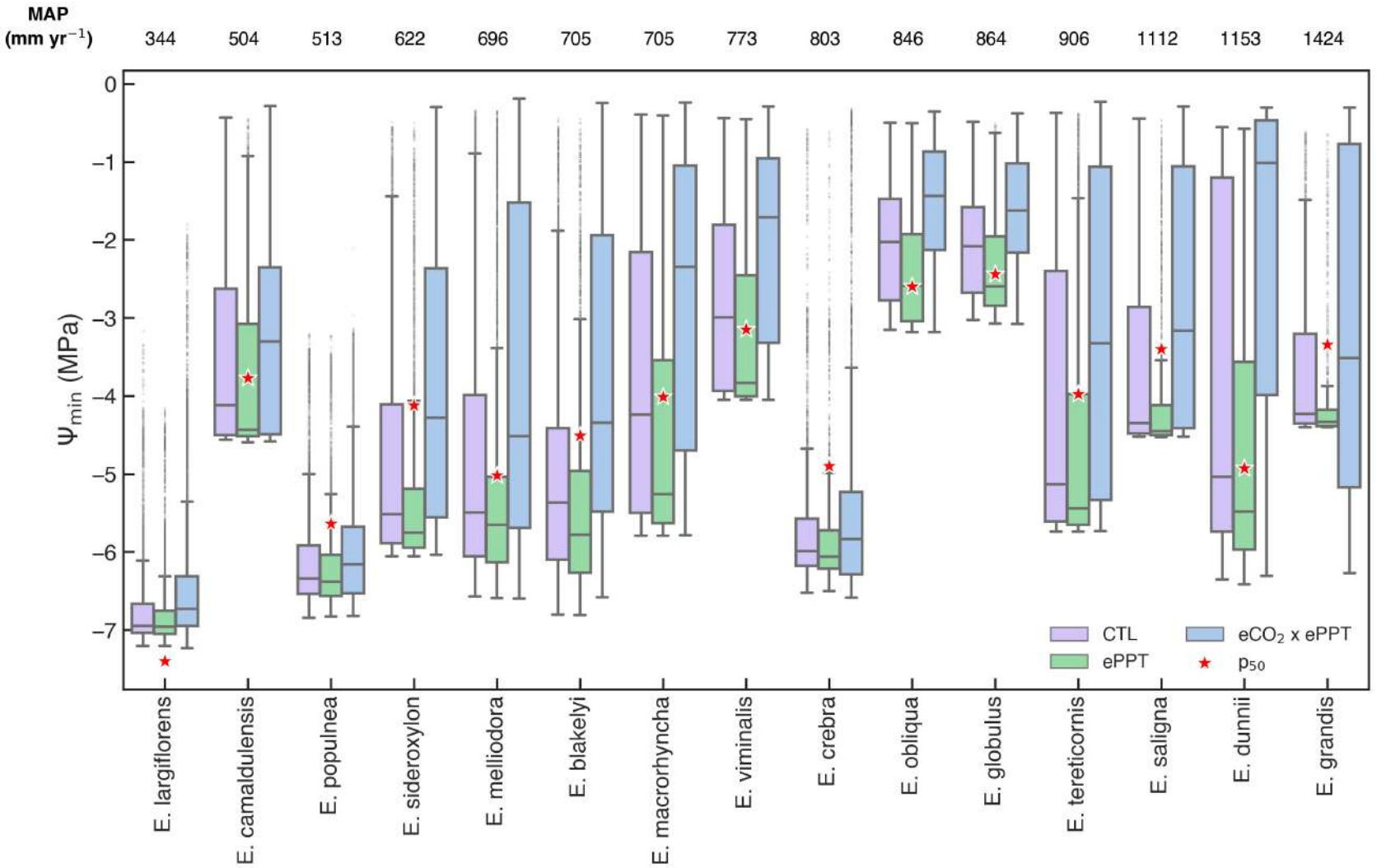
- Hydraulic traits (+V_{cmax}) 15 eucalyptus species

Problem 3 ✓

- Use 5 km AWAP forcing, focus on SE Aus
- Experiments:
  - 2017-2019 drought (CTL)
  - -20% rain (ePPT)
  - -20% rain + double CO_2 (eCO_2 x ePPT)



Minimum leaf water potential (Ψ_{min})

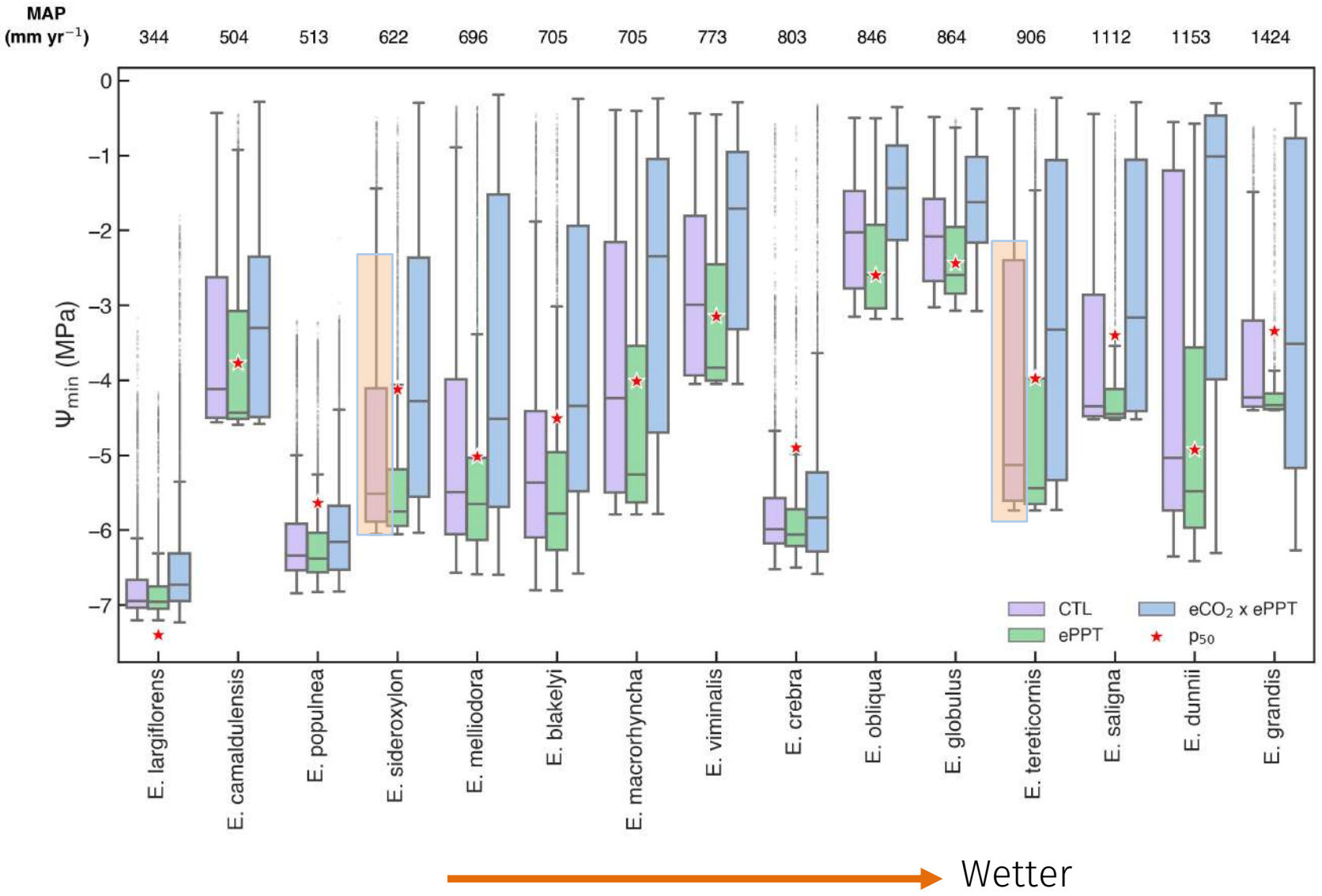


Wetter

Ψ_{min} = an indication of plant water status

i.e., the largest hydraulic tension each species experienced during drought

Minimum leaf water potential (Ψ_{min})

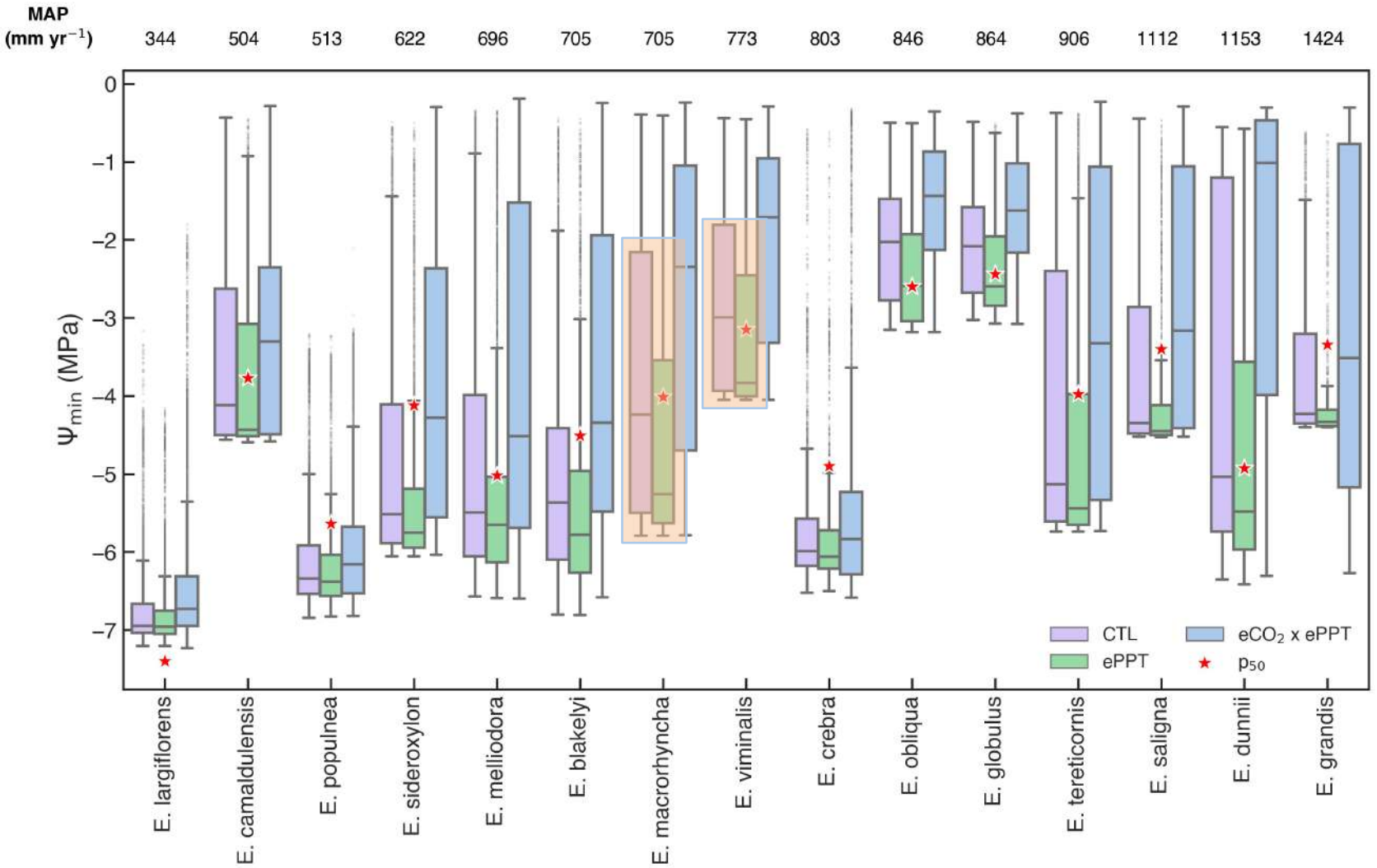


Ψ_{min} = an indication of plant water status

i.e., the largest tension each species experienced during drought

Drought pushed most species ***beyond*** the water potential inducing a 50% loss in hydraulic function (p50)

Minimum leaf water potential (Ψ_{min})

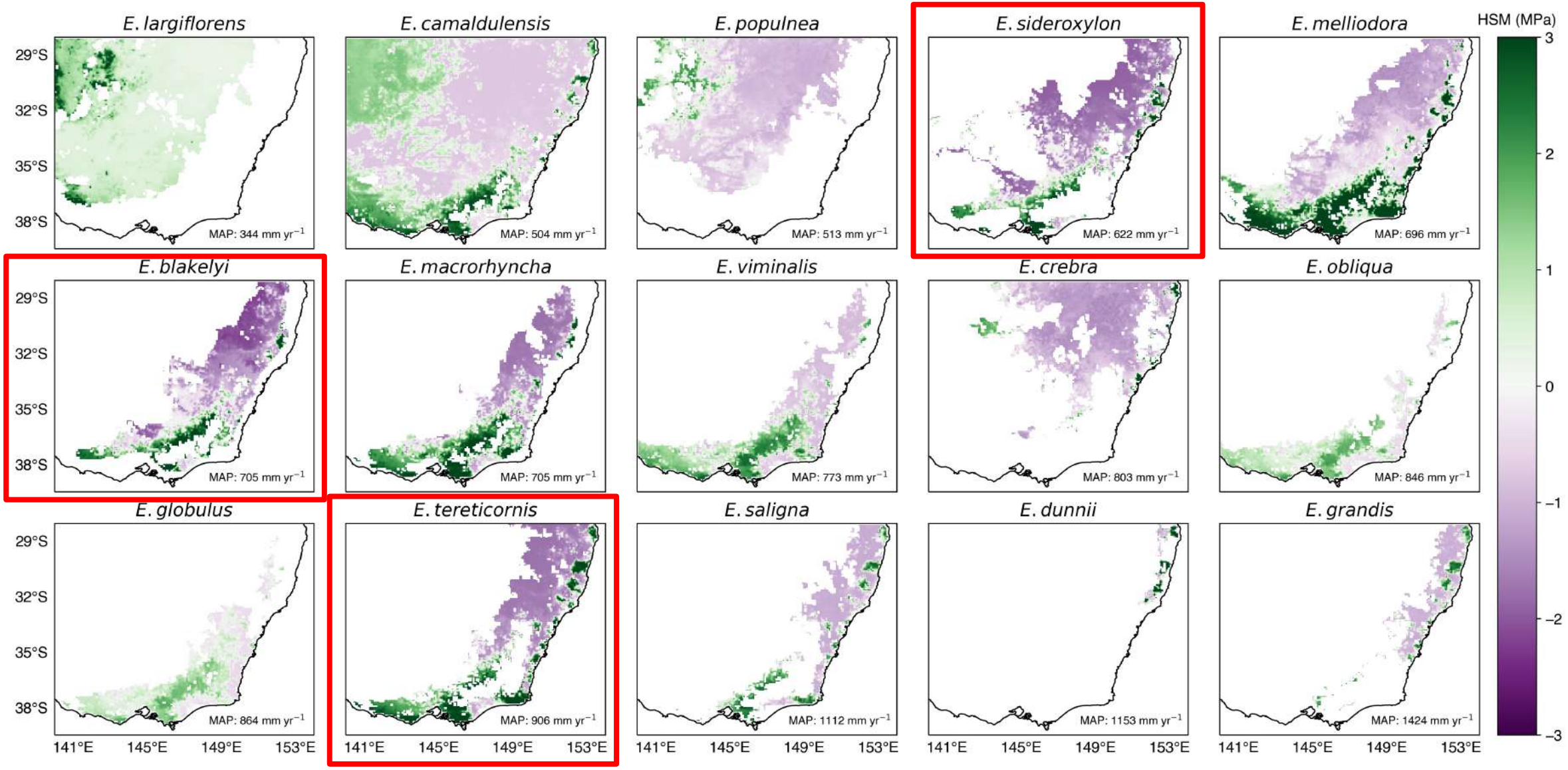


Wetter

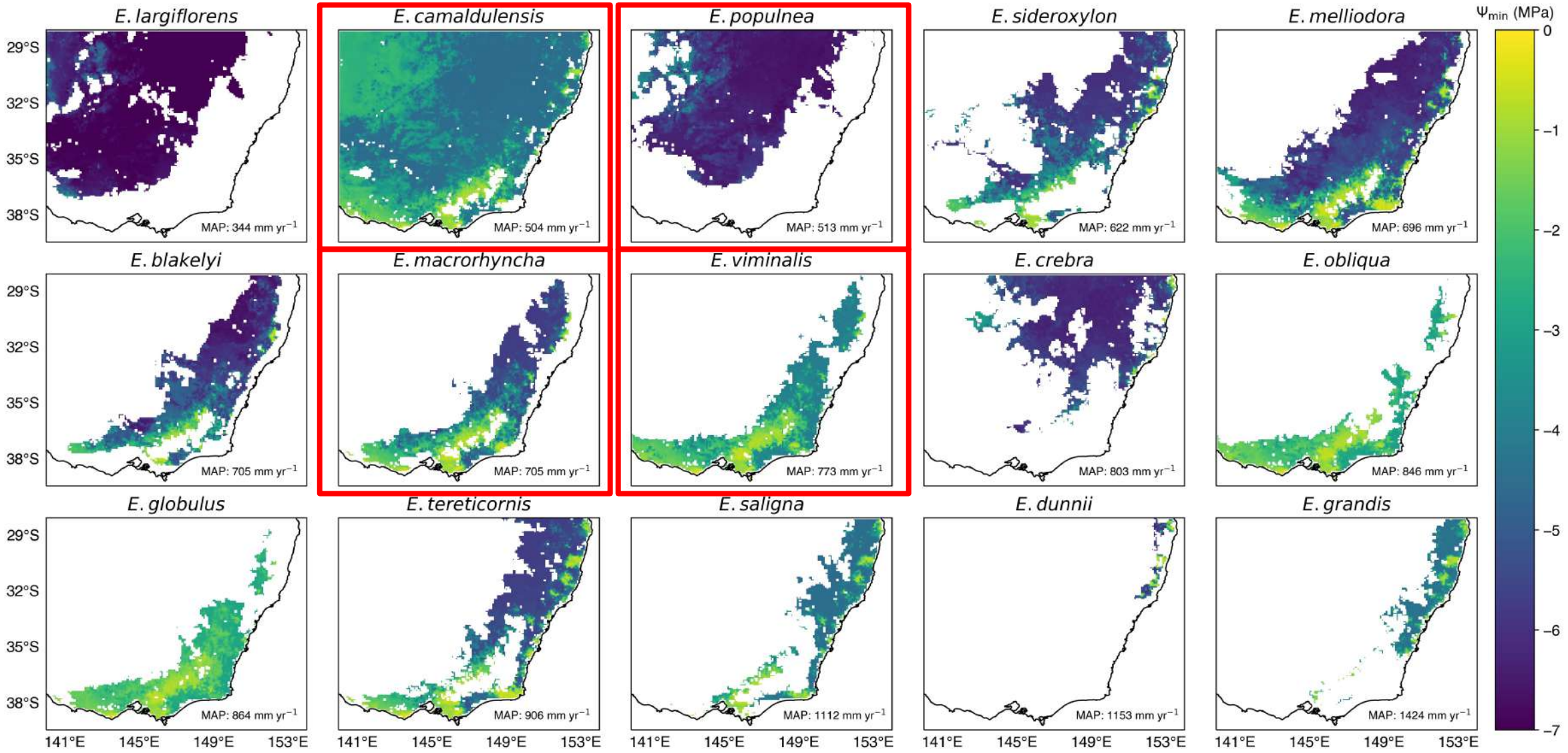
Ψ_{min} = Largest tension species experienced during drought

ePPT impacted species with a southern (wetter) distribution & lower embolism resistance (higher p_{50})

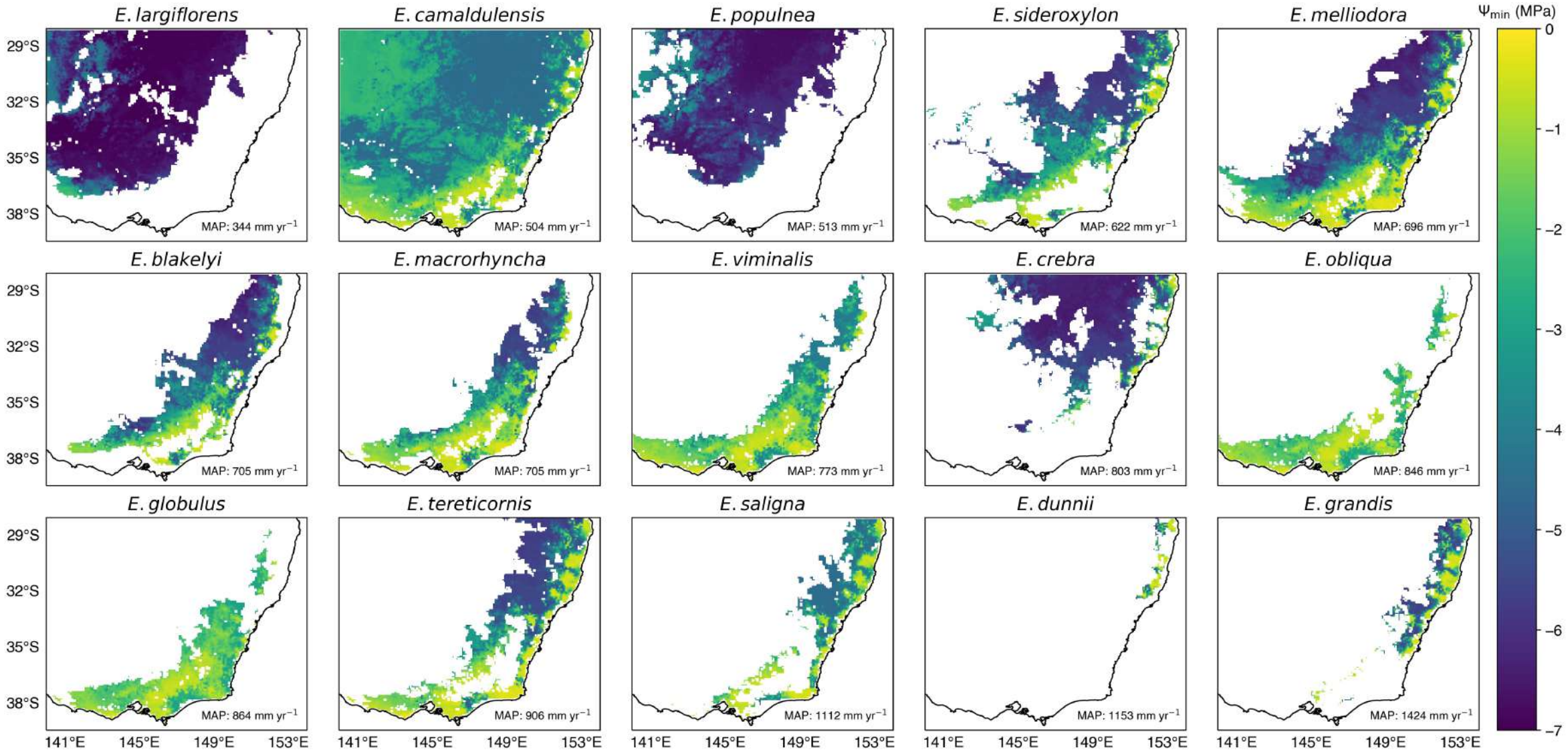
Hydraulic safety margin : $\Psi_{min} - \Psi_{50}$



Minimum leaf water potential (Ψ_{min})



eCO_2 effect on Ψ_{min}



Conclusions

- Identified **where** and **which** species were most at risk

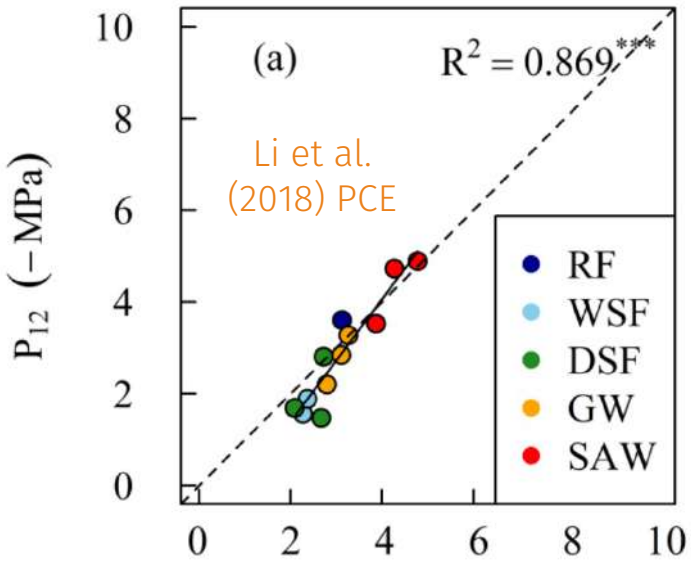
To what extent can rising [CO_2] ameliorate plant drought stress?

New Phytologist (2021) **231**: 2118–2124

- eCO_2 increased Ψ_{min} by ~27% (4%, 54%)
  - Are the effects of eCO_2 too optimistic?
  - no change in LAI (see Rifai et al. 2021 in review *Biogeosci.*)

- Should stomatal close happen before the onset of xylem embolism?
  - = wider HSM -> delay time to Ψ_{50}
  - role of Ψ_{crit} assumption in optimisation…?

- How would GW access change Ψ_{min} sensitivity?
  - See Mu et al. 2021 *Earth Syst. Dyn.* - CABLE drought x HW



Any questions?

Thanks to:

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University of BRISTOL