

Inherent expression of water relation traits in eucalypts are strongly influenced by the environment



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Increases in tree and forest drought mortality worldwide
→ forest ecosystems impacted in many areas

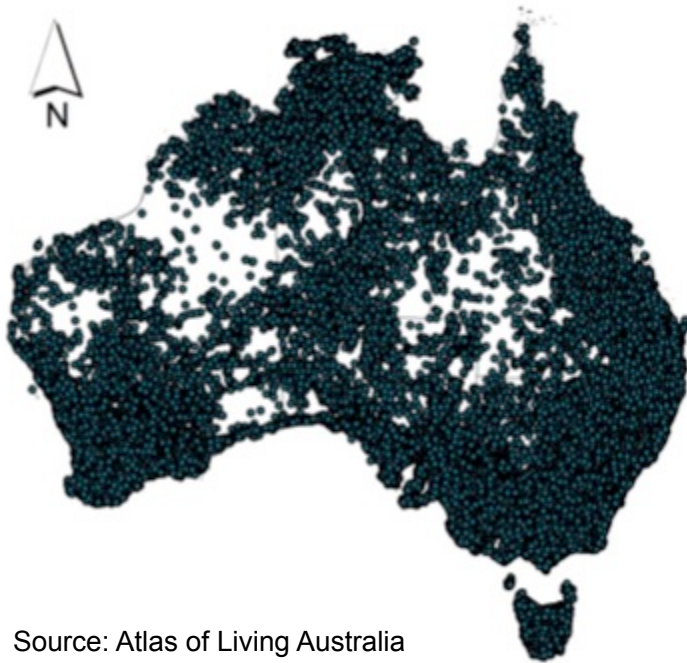
Drought events are predicted to increase due to climatic changes

Need to understand how trees adapt to drought, why and when they are vulnerable

Need to understand the relevance of key functional traits

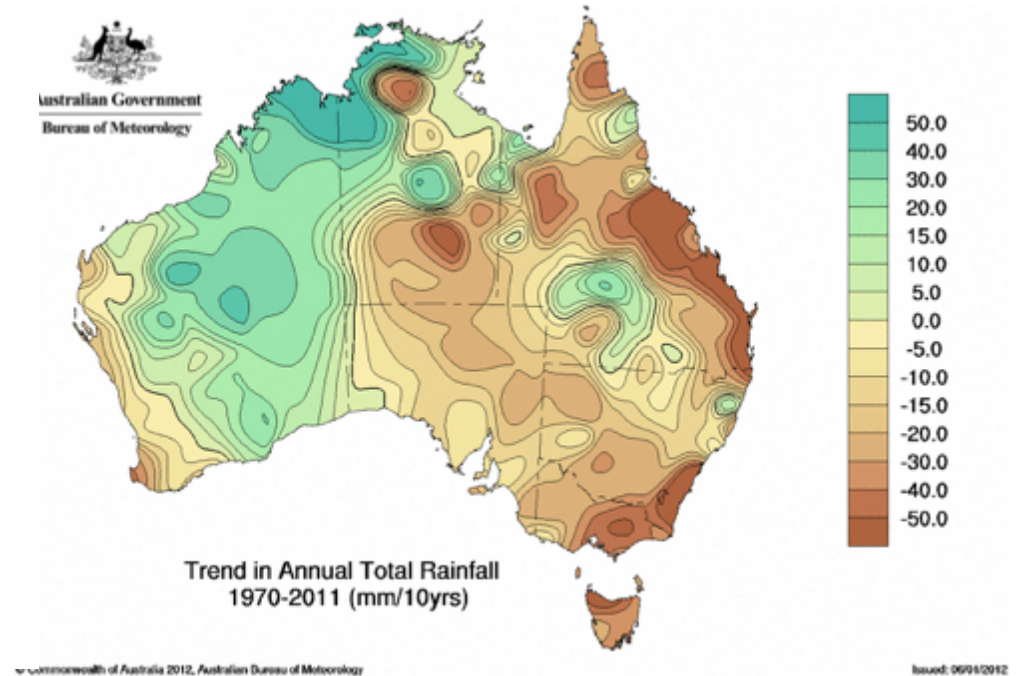
Traits linked to hydraulic vulnerability are linked to tree mortality

Eucalypt distribution



Source: Atlas of Living Australia

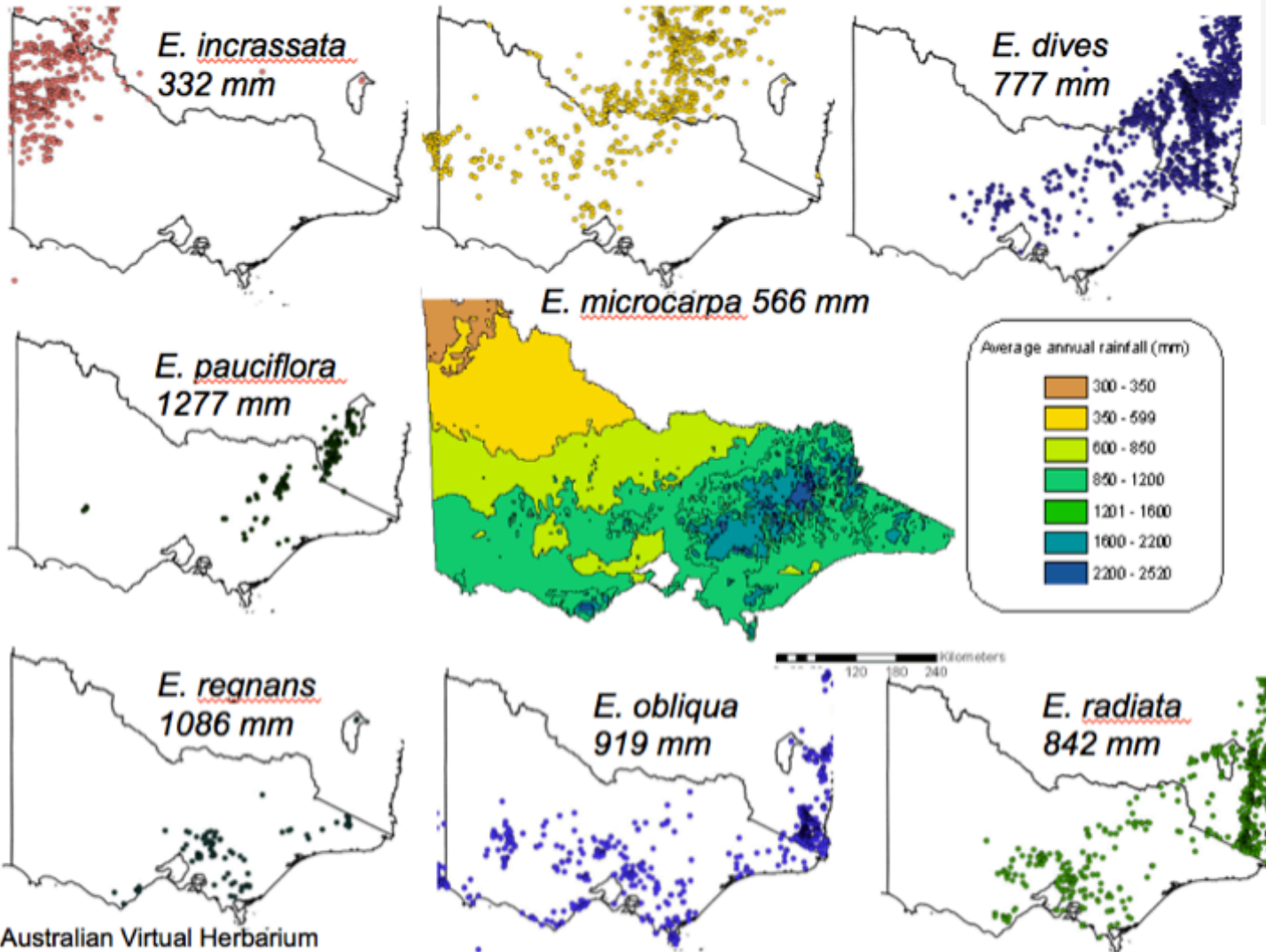
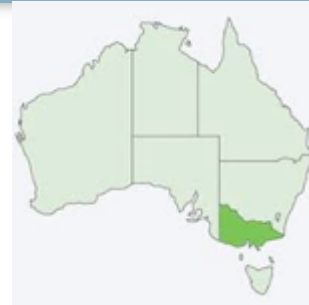
Trend in rainfall



Eucalypts are a widely distributed genus
>900 different species
Occurs in almost every ecosystem in
Australia

Eucalypts and climate

Many eucalypts have very *narrow* climatic ranges
Over 140 eucalypt species in Victoria (SE Australia)



Meta-analyses indicate → drought tolerant water relation traits mainly in arid landscapes

More *arid* climate:

- Lower turgor loss point
- Lower minimum water potentials
- Lower vulnerability to cavitation
- More anisohydric behaviour (tolerance of low Ψ , weaker control of g_s)
(Bartlett et al 2012, Choat et al 2012, Klein 2014)

BUT

Trait vs climate relationships investigated mainly in distantly related species

How is this expressed within ONE genus that grows everywhere???

What are the water relation strategies within one genus (*Eucalyptus*)?

Does expression of water relation traits depend on climate?

- How important are water relation traits for the distribution of eucalypts?
- Are these traits expressed inherently?
- How plastic are these traits?
- Do we observe adjustment of traits?

Semi arid



Ironbark woodlands



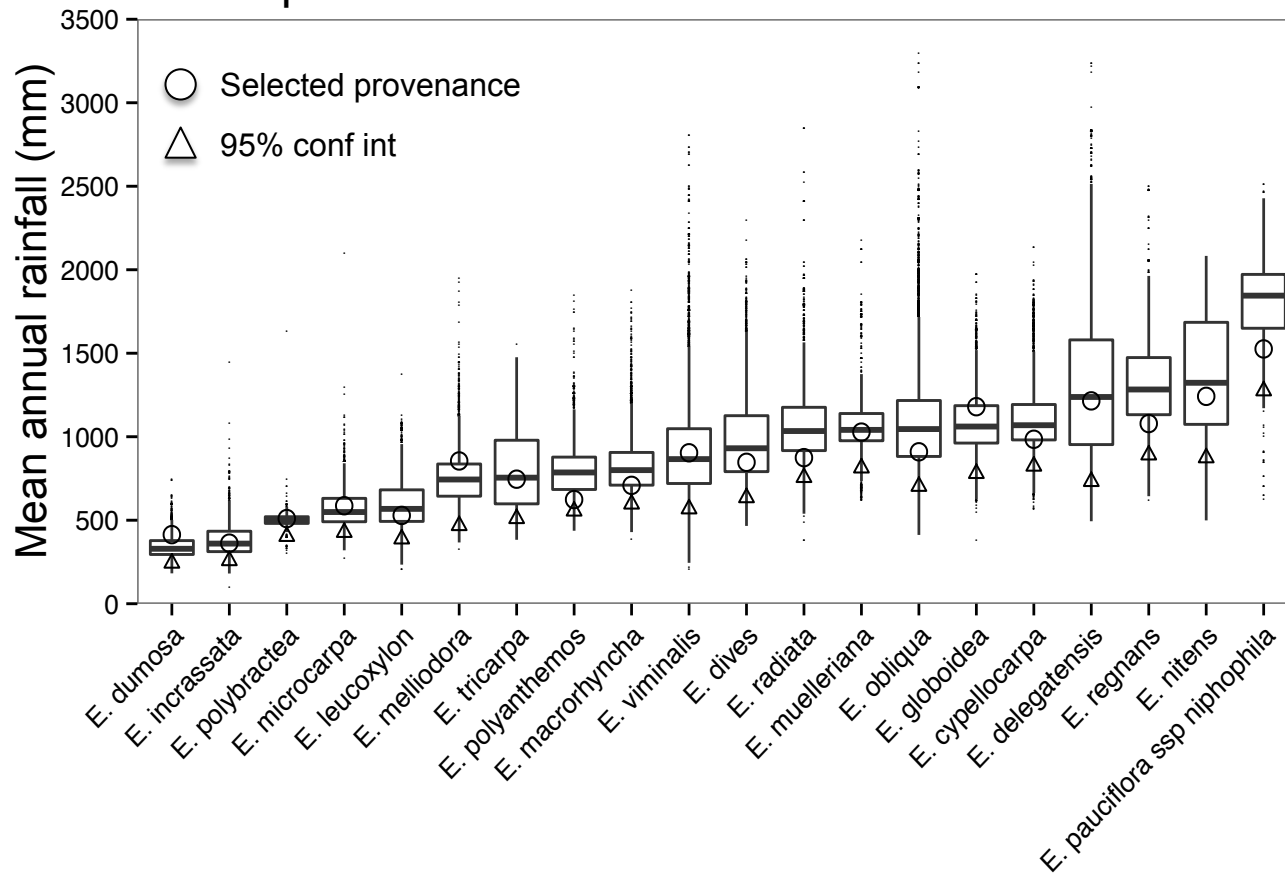
Dry sclerophyll



Temp rainforest

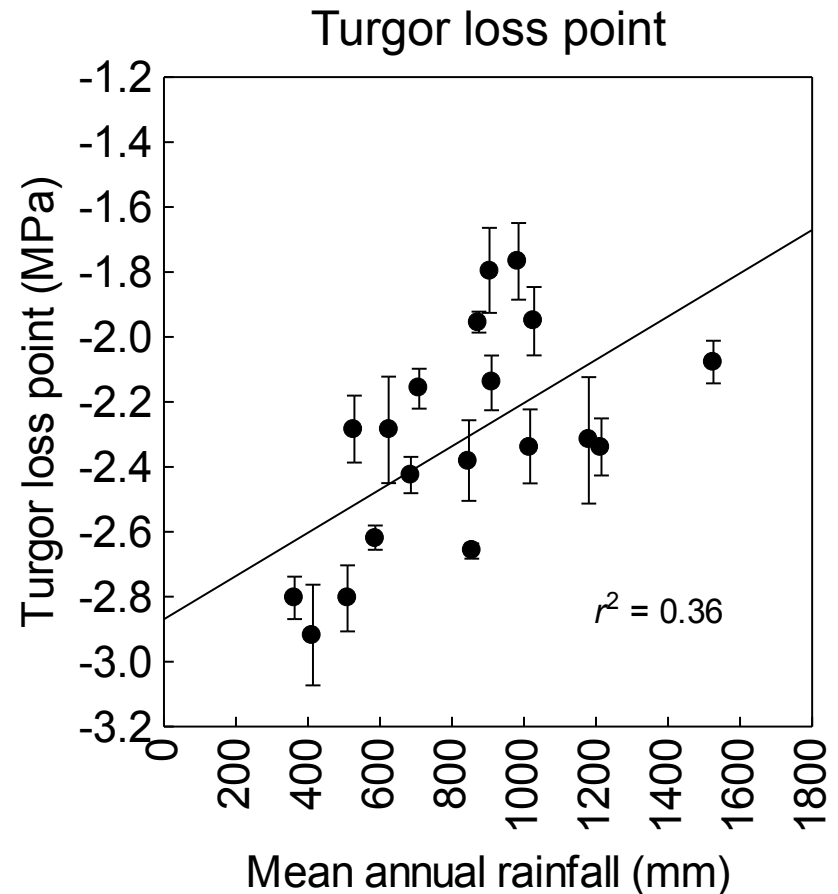
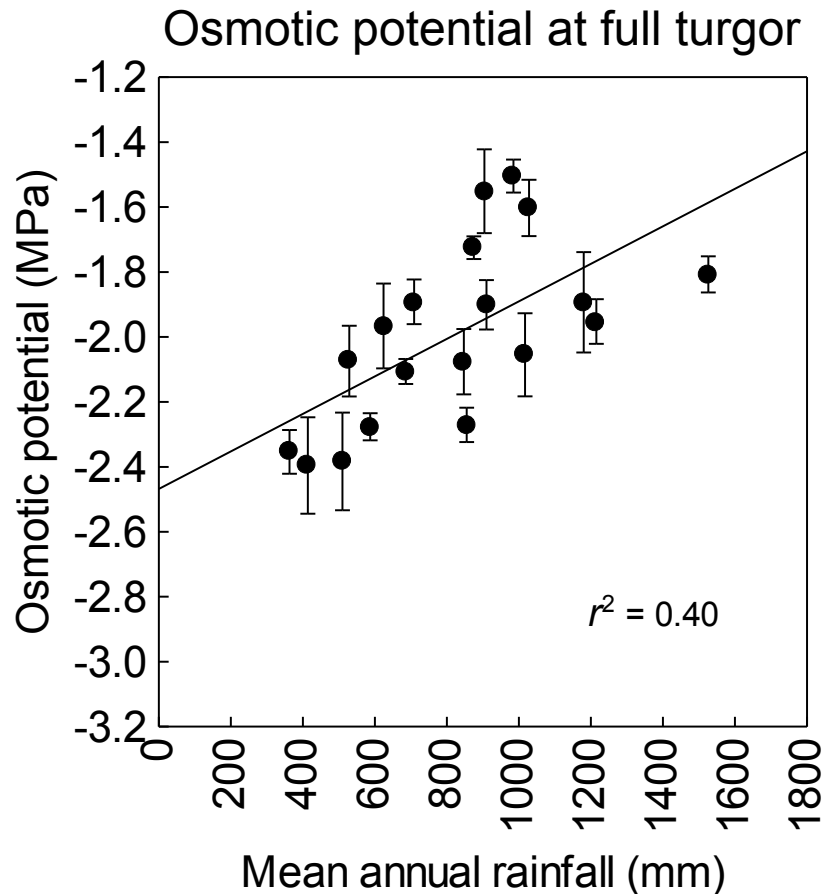


- Common garden in Melbourne,
- 20 eucalyptus species from contrasting environments, grown from seed
- 2 yo trees, well watered at time of measurement
- 6-10 replicate trees



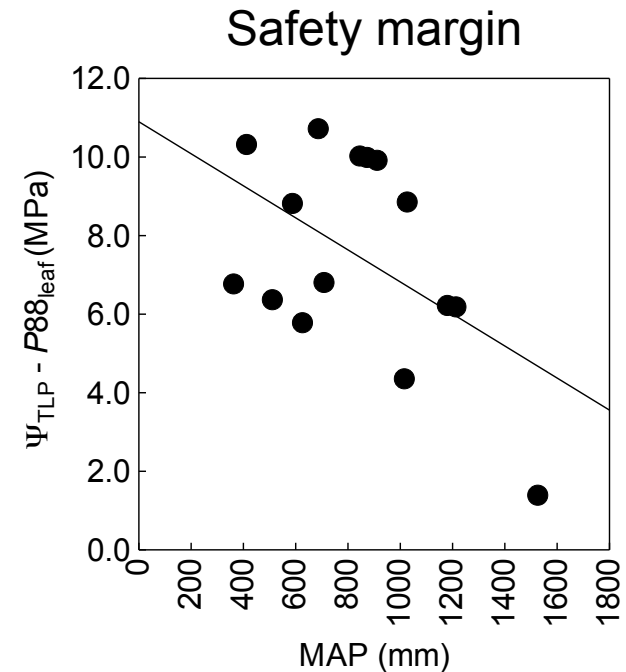
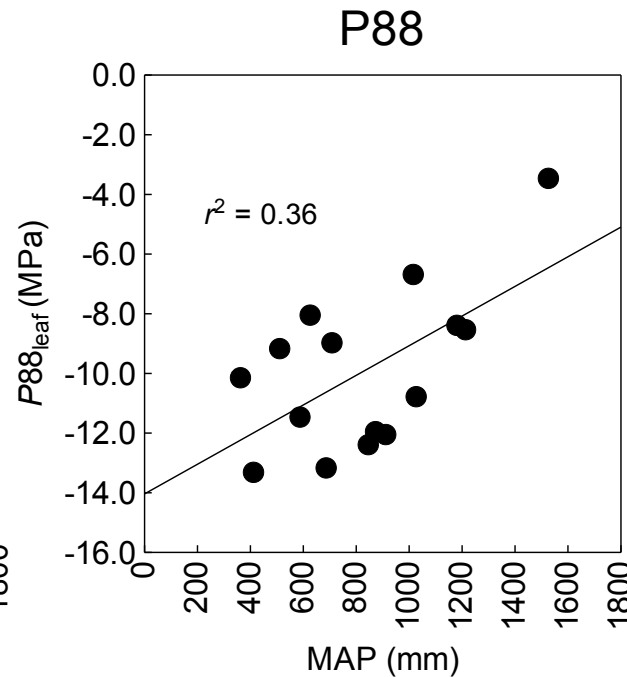
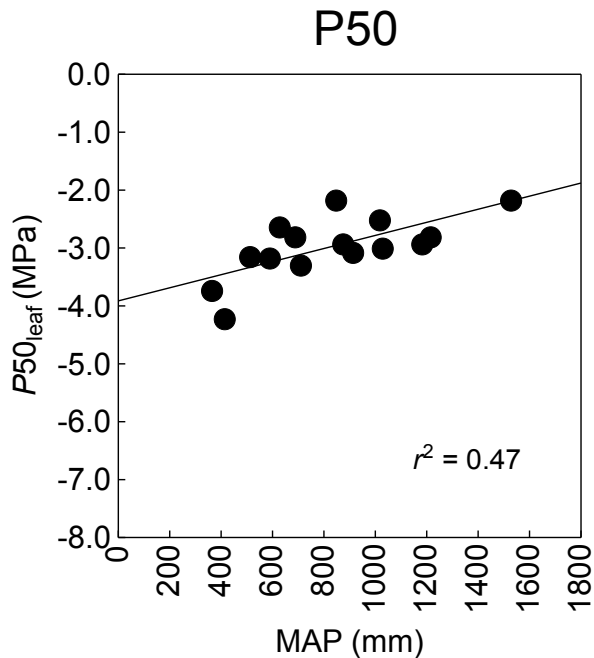
- **pV curve** traits by bench-drying method
<http://landflux.org/Tools.php>
- **P_{50} leaf** according to Brodribb & Holbrook 2003

TLP & osmotic potential are correlated to mean annual rainfall



Significant correlations btw TLP & OP and mean annual rainfall
Species from more arid environments have lower TLP and more solutes
→ Inherent expression of traits, strong genetic control over trait expression

Vulnerability to cavitation is correlated to mean annual rainfall

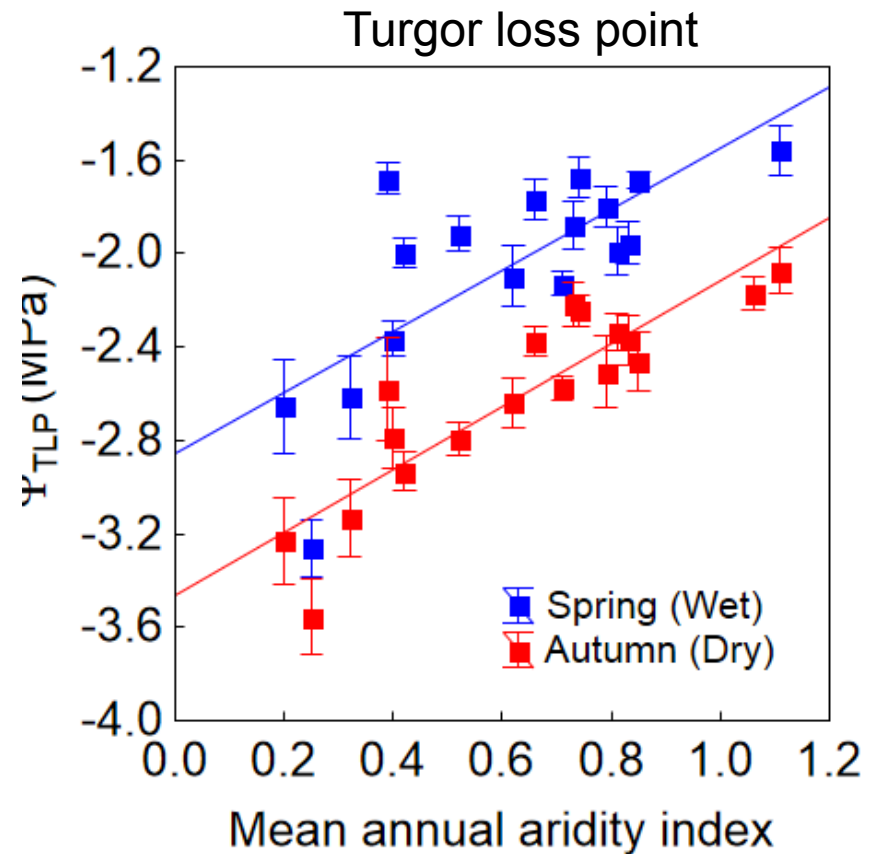
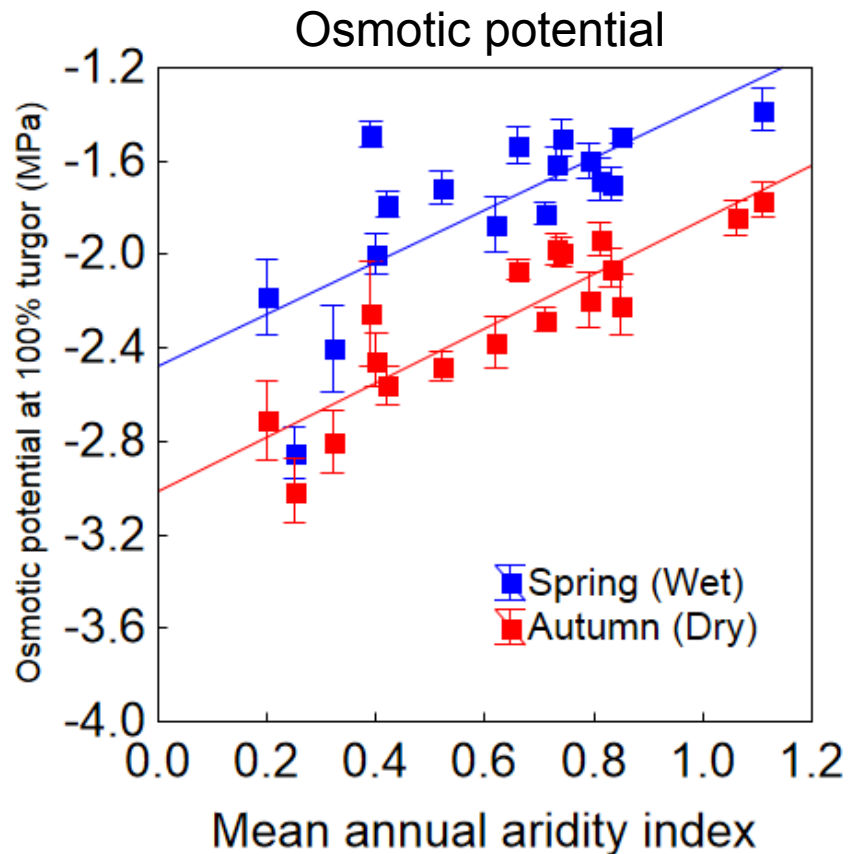


Eucalypts from more arid environments:

- Less vulnerable to cavitation
- Lower P50
- Much lower P88
- Have a greater hydraulic safety margin (difference btw TLP and P88)

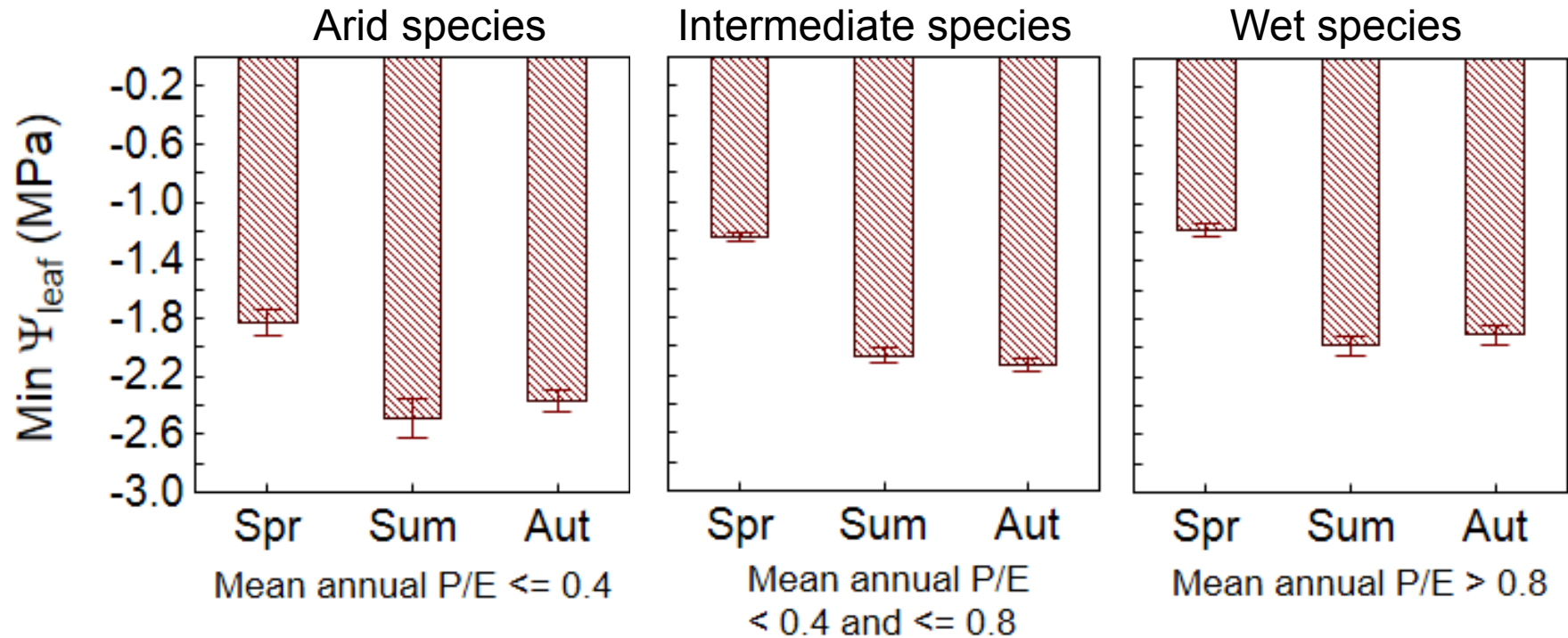


Adjustment of osmotic potential and turgor loss point?



- PV curves in spring (wet) and in autumn (dry)
- Similar adjustment for osmotic potential & TLP (relationship holds in drought)
- Equal shift of osmotic potential & TLP (~ 0.6 MPa), similar adjustment regardless of origin
→ similar response to similar stress?

Are wet eucalypts isohydric and arid ones anisohydric?

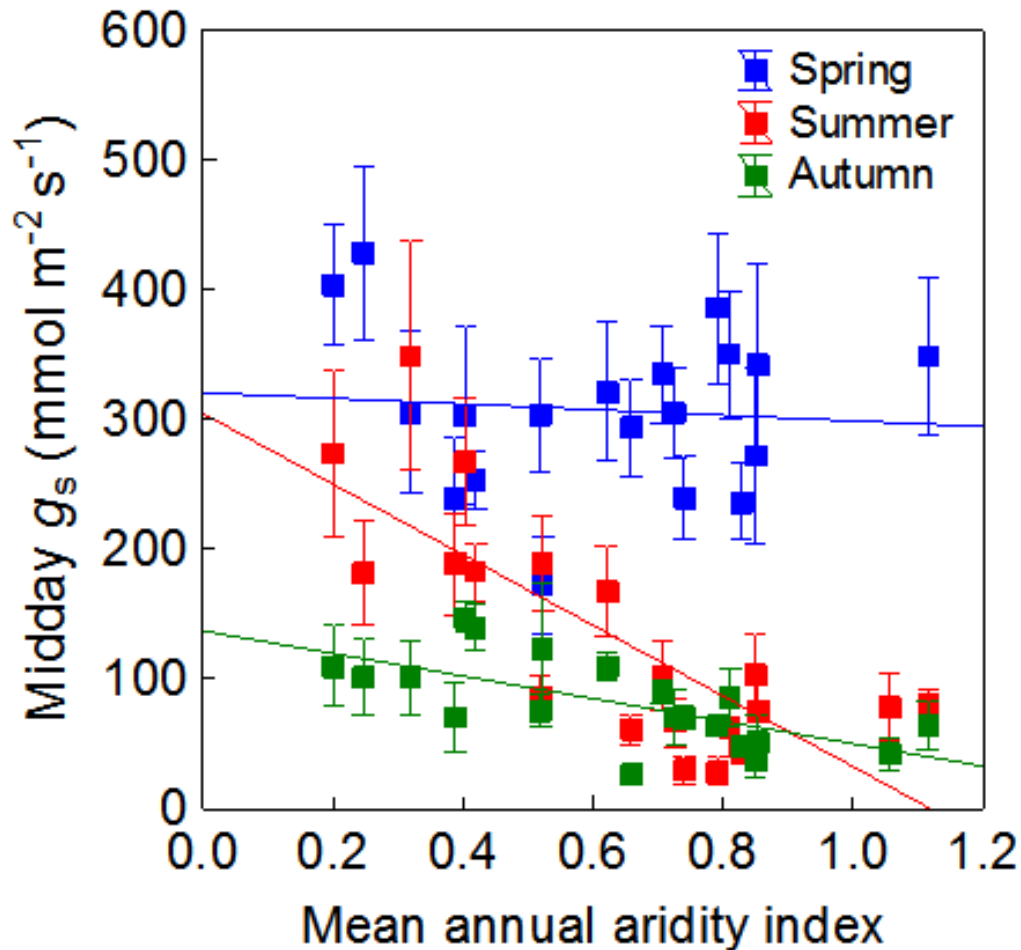


Midday water potential (Ψ_{leaf}) was more negative in summer & autumn than in spring

Species from drier and wetter climates showed similar change from wet to dry seasons

→ all species are anisohydric

Stomatal control of water loss



High conductance in all species in spring (wettest season)

Stomatal conductance reduced in all species in summer and autumn

Arid species maintained higher conductance in the summer (dry season) compared to mesic species

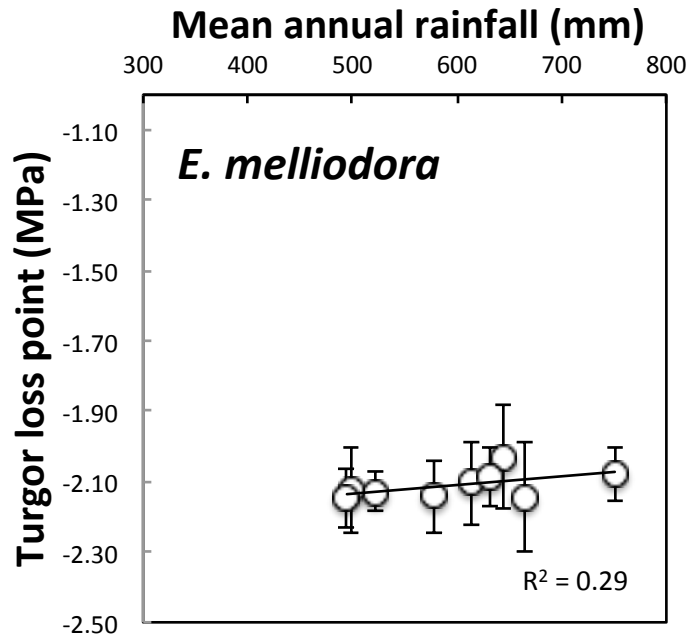


Trait variation within a species?

Two species with broad climate range, 9 provenances each, glasshouse.

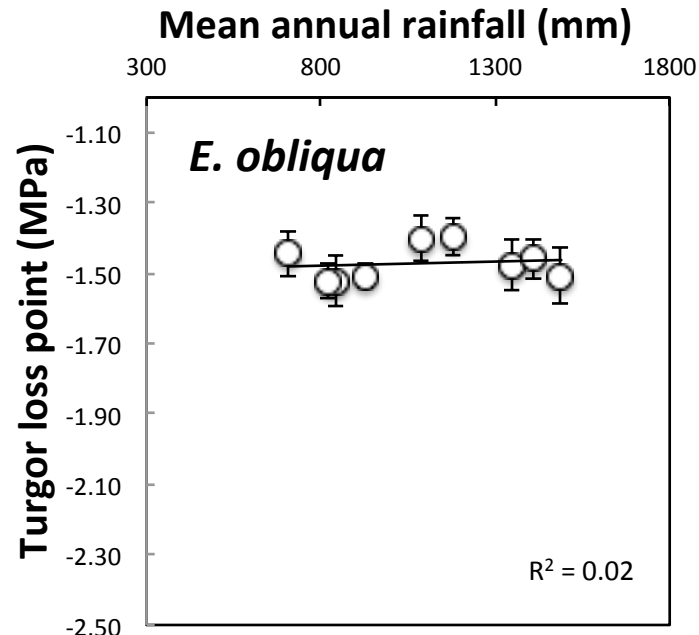
More arid species

495 – 750 mm



More mesic species

710 – 1500 mm

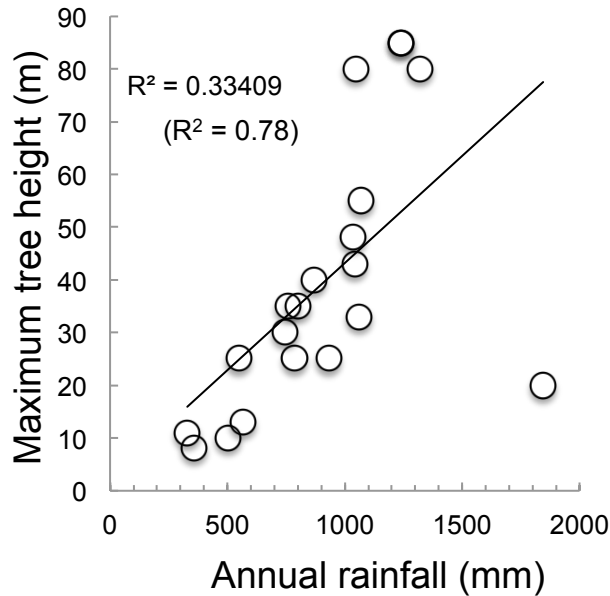


More arid species has lower TLP
→ consistent with species differences

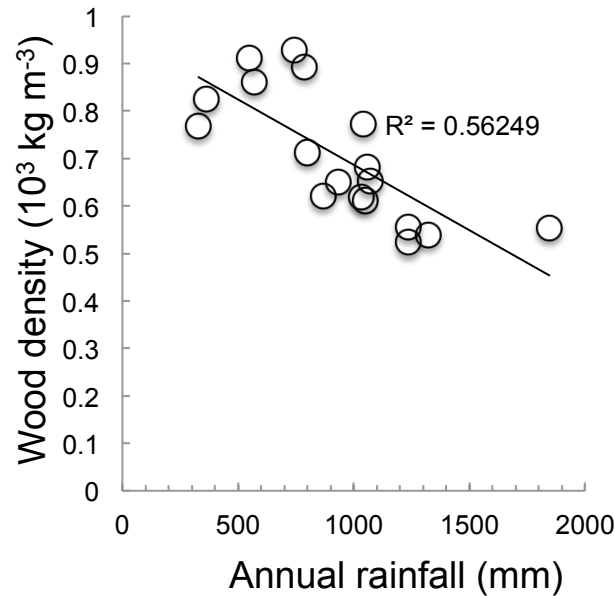
No relationship between climate of origin and TLP **within** a species
→ Need to assess plasticity of traits in the field

Tree traits and climate

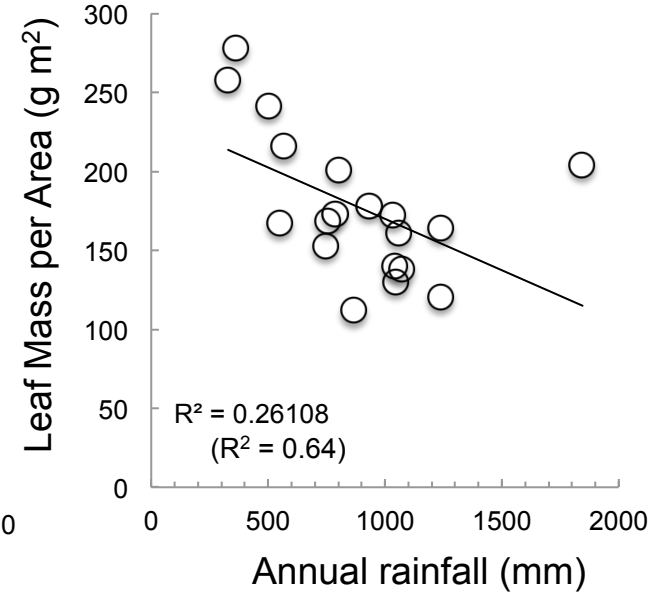
Tree height



Wood density



LMA



Strong correlations between tree traits and rainfall in SE AUS eucalypts

Greater aridity →

- smaller trees
- denser wood
- smaller and thicker leaves



What are the water relation strategies within one genus?

All species show a degree of anisohydrie

Does expression of water relation traits depend on climate?

Yes, more negative water relations traits in more arid species BUT not populations

- How important are water relation traits for the distribution of eucalypts?
Probably important, inherently expressed, chronic vs transient drought

- Are these traits expressed inherently?
Yes, expressed also under non-stressed conditions

- How plastic are these traits? Do we observe adjustment of traits?
Similar degree of plasticity, experimental design? Field?

