

Influence of rising CO₂ on water and carbon fluxes in maturing *Eucalyptus* trees: Lessons from the Hawkesbury Forest Experiment

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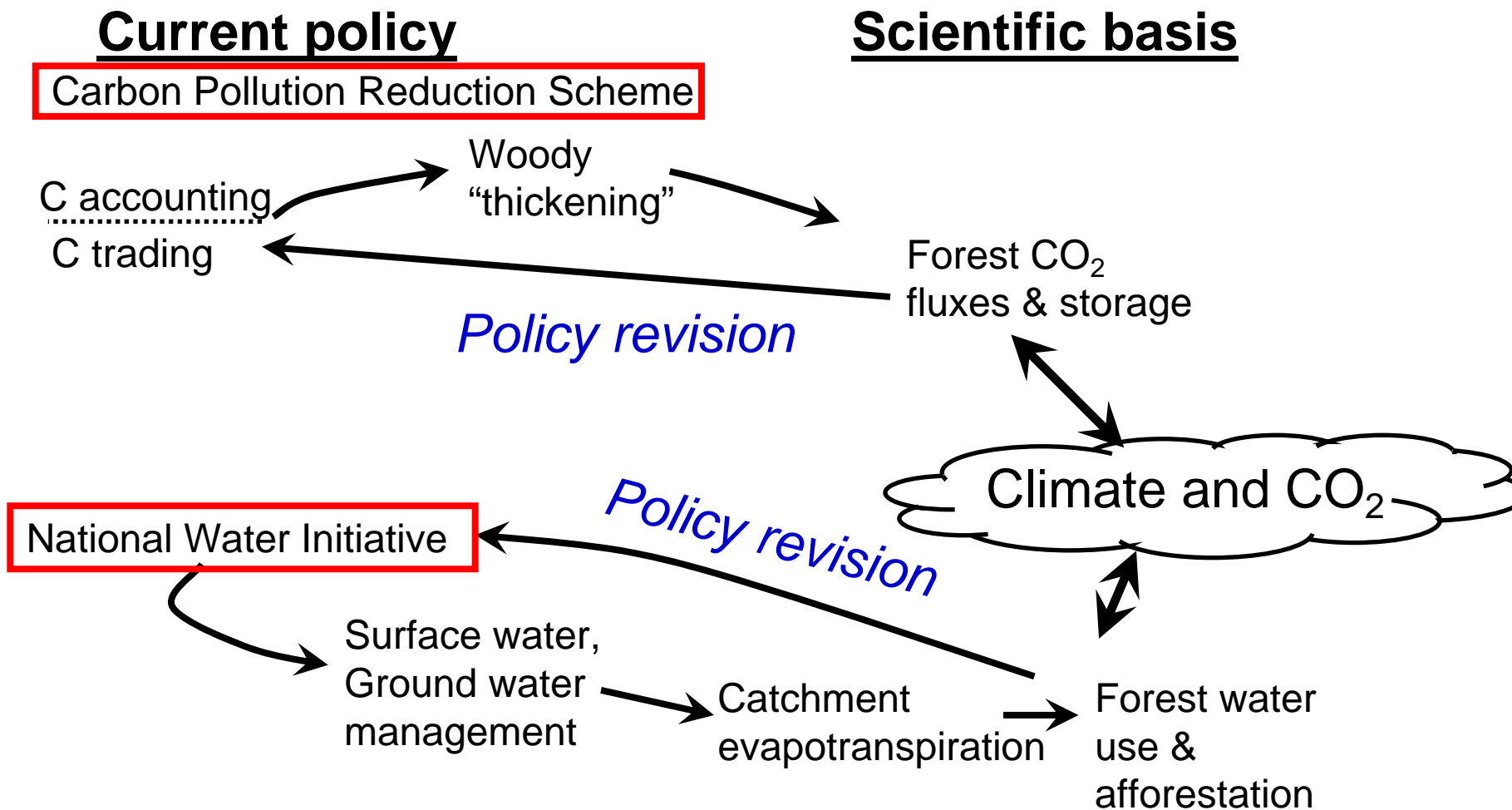


Australian forests provide valuable amenities for our communities

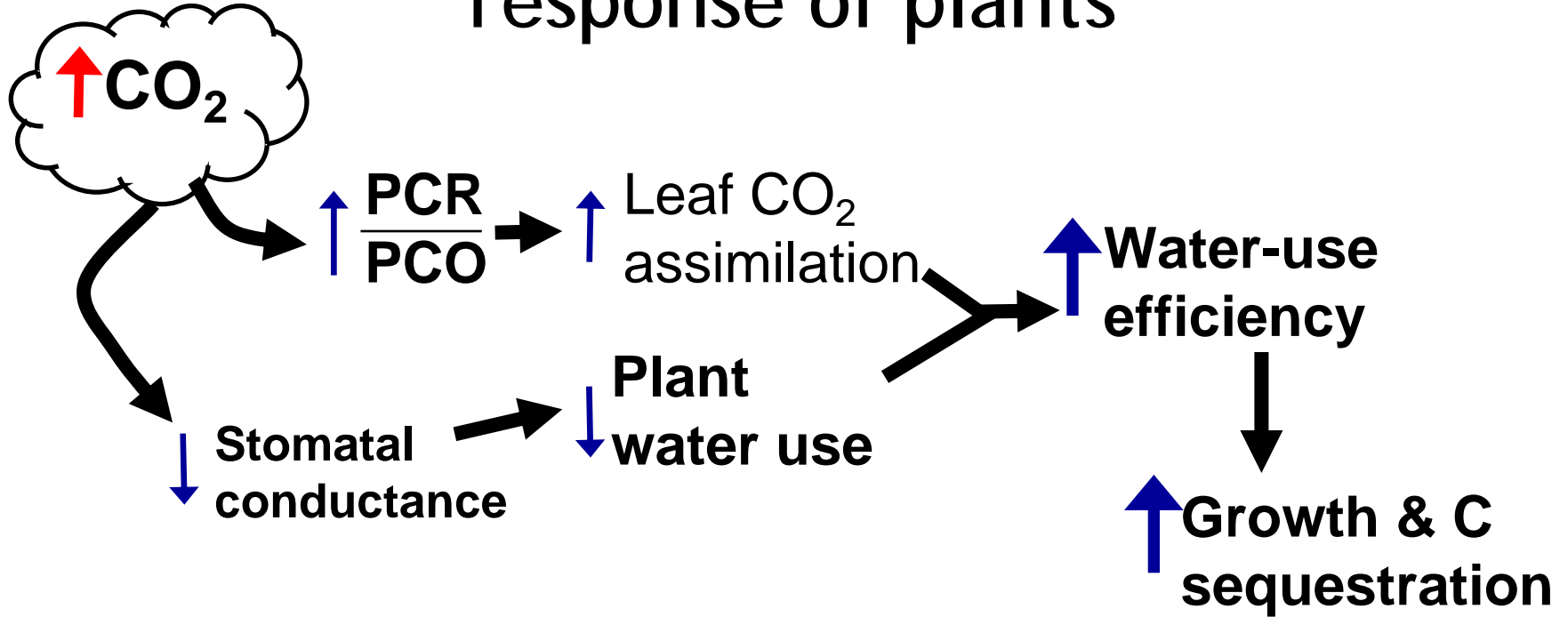
- Materials (timber, paper), biodiversity/habitat, recreation, and climate amelioration



Role of forest ecosystem services in climate change policy development

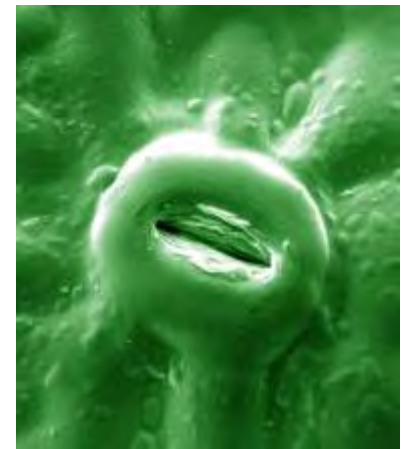
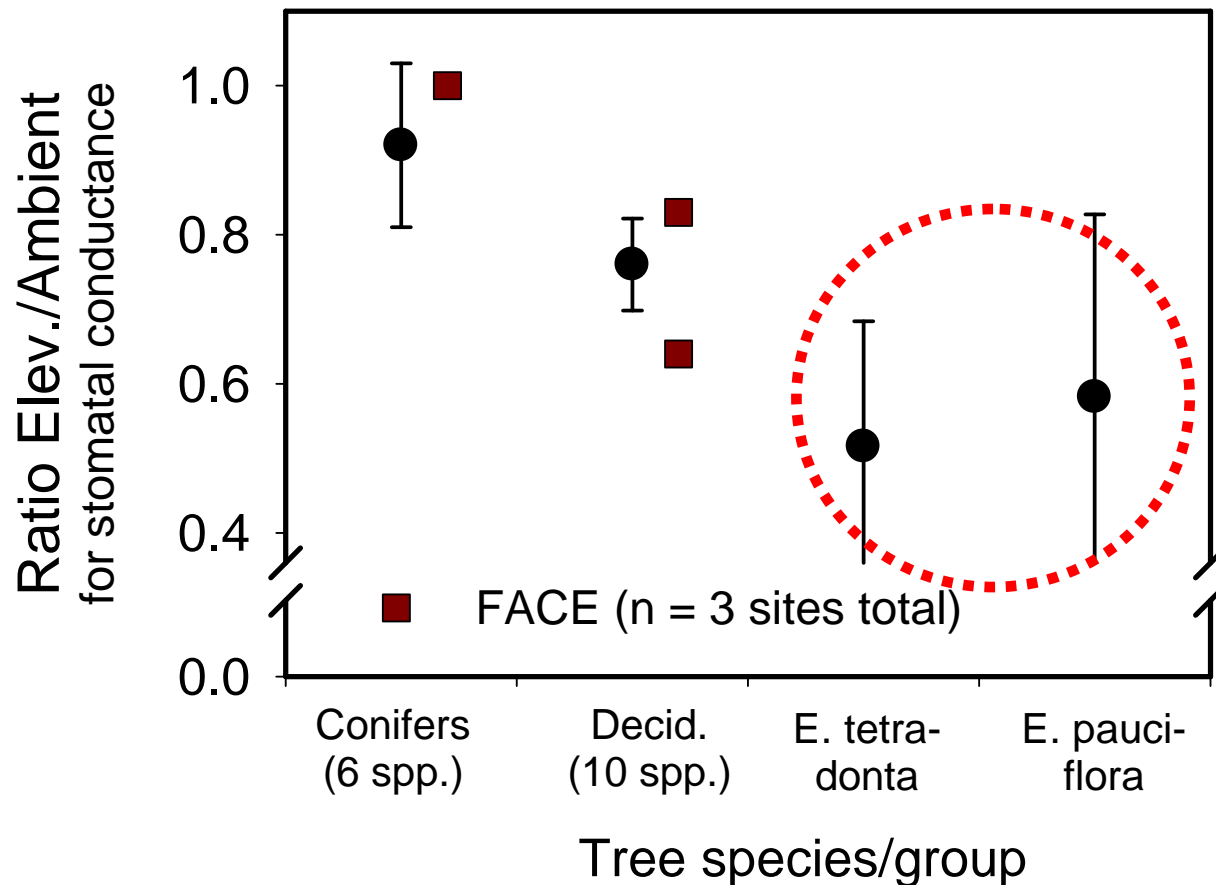


General model of the atmospheric CO₂ response of plants



*Do tree plantations respond in this manner?
What about Australian trees?*

Do stomata of trees adapt similarly to high CO₂? Summary of [CO₂] responses of N. Hemisphere trees & Eucalypts



Data from: Medlyn et al. (2000), Ellsworth et al. (2004), Tissue et al. (1997, 1999), Gunderson et al. (2002), Roden and Ball (1996), Eamus et al. (1995)

Here we ask: Are these general atmospheric CO₂ responses for trees in Europe and America applicable to *Eucalyptus* in future, higher atmospheric CO₂?

Can this help define the soil moisture range for growing tree plantations, and does this potential growing-range increase in elevated CO₂?



THE Hawkesbury Forest Experiment



NSW DEPARTMENT OF
PRIMARY INDUSTRIES



Research Partners



HFE - *Treatments*

CO₂

Ambient

Amb + 240 ppm

X

Water

Ambient

Water-withheld

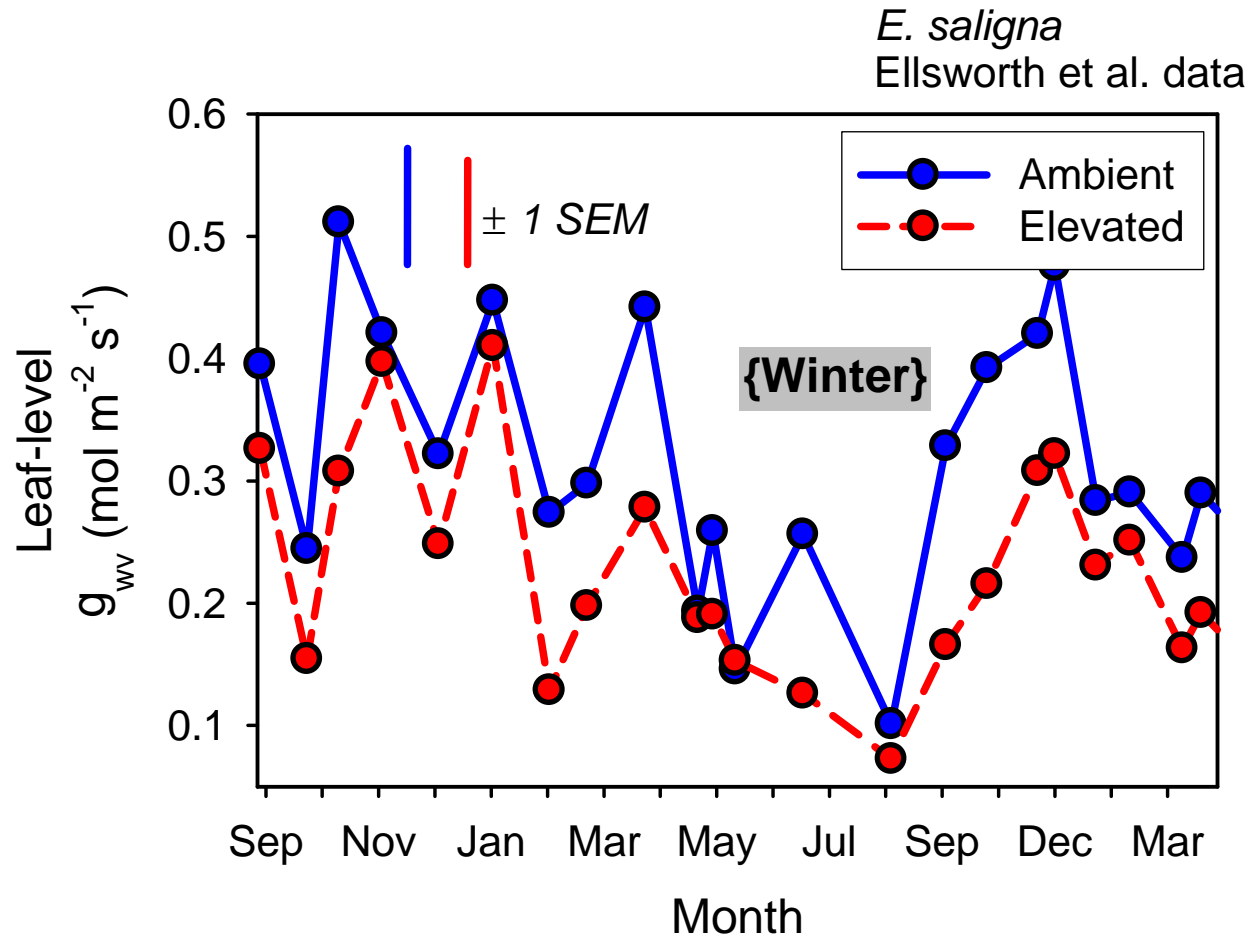
supply

The Hawkesbury Forest Experiment: chambers for CO₂ exposure of trees

- Regulate environment to track ambient conditions (with CO₂ enrichment)
- Measure tree-scale CO₂ & H₂O fluxes

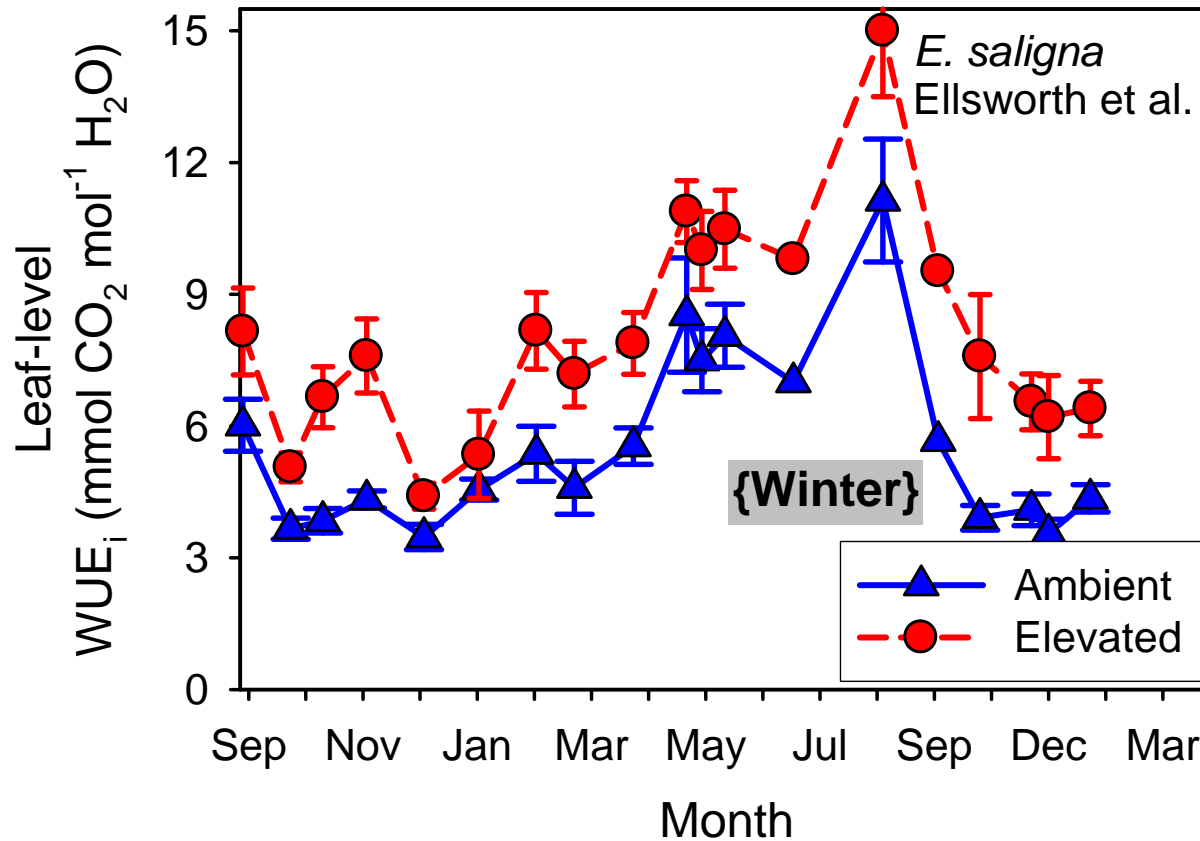


Stomatal closure in plantation *Eucalyptus*



**~ 26% Reduced stomatal conductance in elevated $[\text{CO}_2]$
Compared to -20% for Northern Hemisphere deciduous trees**

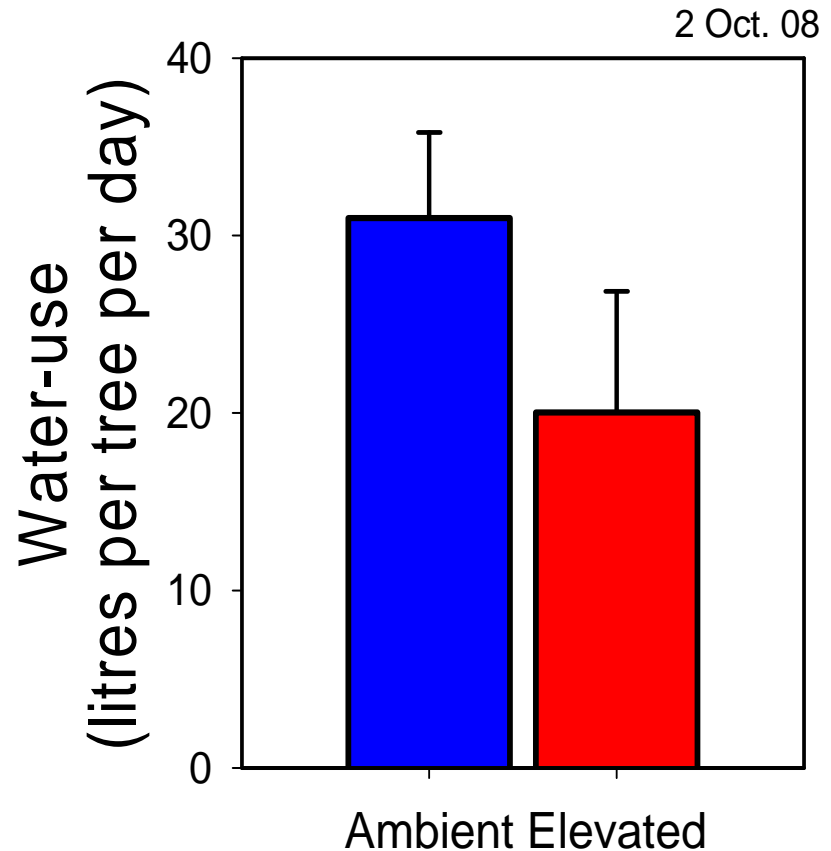
Leaf scale water use-efficiency response of plantation *Eucalyptus*



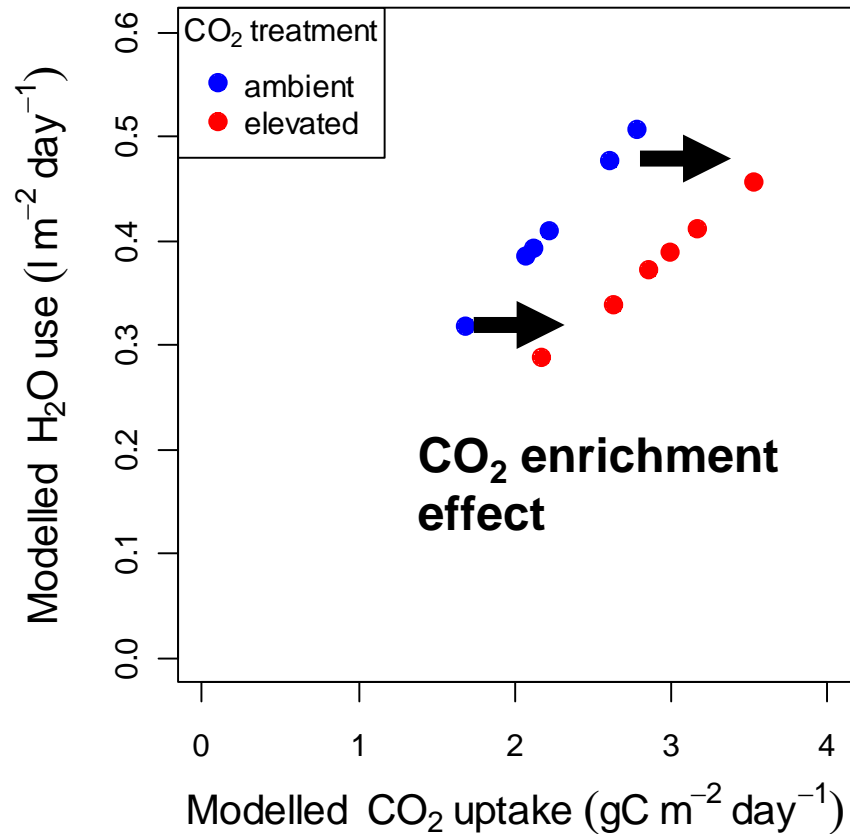
~ 30% increased WUE in elevated [CO₂]

Eucalyptus tree water-use example

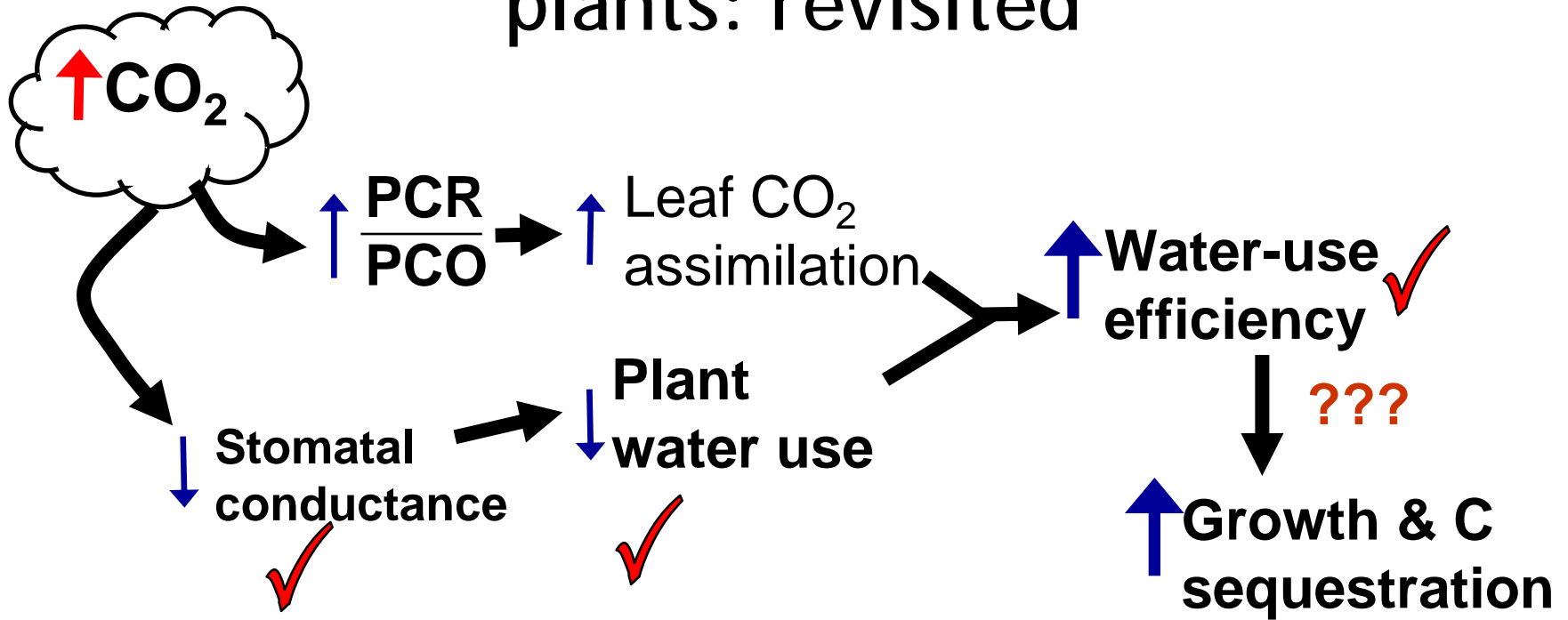
- Ex.: 5m tall trees on a warm spring day (34°C)
- 30% reduction in tree water-use (corrected for tree size effect)
- Equivalent water savings $\sim 0.5 \text{ mm d}^{-1}$



Increased whole-tree water-use efficiency



General atmospheric CO₂ response of plants: revisited



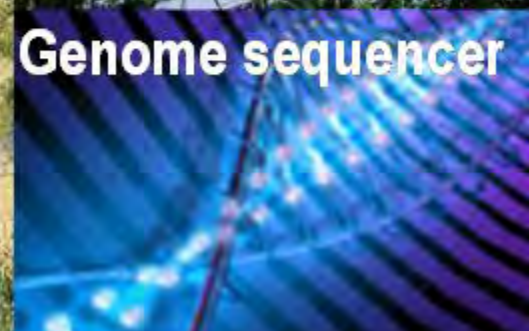
How much water is required for C sequestration by tree plantations?



Next steps

- Continued experimentation: forest FACE, and CO₂ x warming at HFE
- Physiological modelling to help understand if these mechanisms will increase growth with CO₂ x drought, and also affect species growing range.

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Questions?



