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Carbon and water balance of a ‘belt and alley’ landscape

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CRC FOR PLANT ~ BASED MANAGEMENT OF DRYLAND SALINITY

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Why put trees in agricultural landscapes?

Pros

- Trees are large
  - Wind erosion control
  - Shelter for livestock
- Trees are deep rooted
  - Intercept lateral water flow
  - Potential dryland salinity control
    - Decrease groundwater recharge
    - Can increase groundwater discharge
- Trees are potentially productive
  - Mallee oil
  - Energy
  - Carbon sequestration

Cons

- Trees are large
  - Get in the way of machinery
  - Hard to move livestock
- Trees are deep rooted
  - Compete with crop
  - Dry soil out prior to crop establishment
- Trees are expensive
  - Establishment cost
  - Crop replacement cost

Quantifying water use and growth

- Leaf level
  - Gas exchange
  - Porometry
- Plant level
  - Sap flow
  - Sampling for growth rate
    - Above-ground
    - Below-ground
  - Scaling difficulty
- Landscape level
  - ?

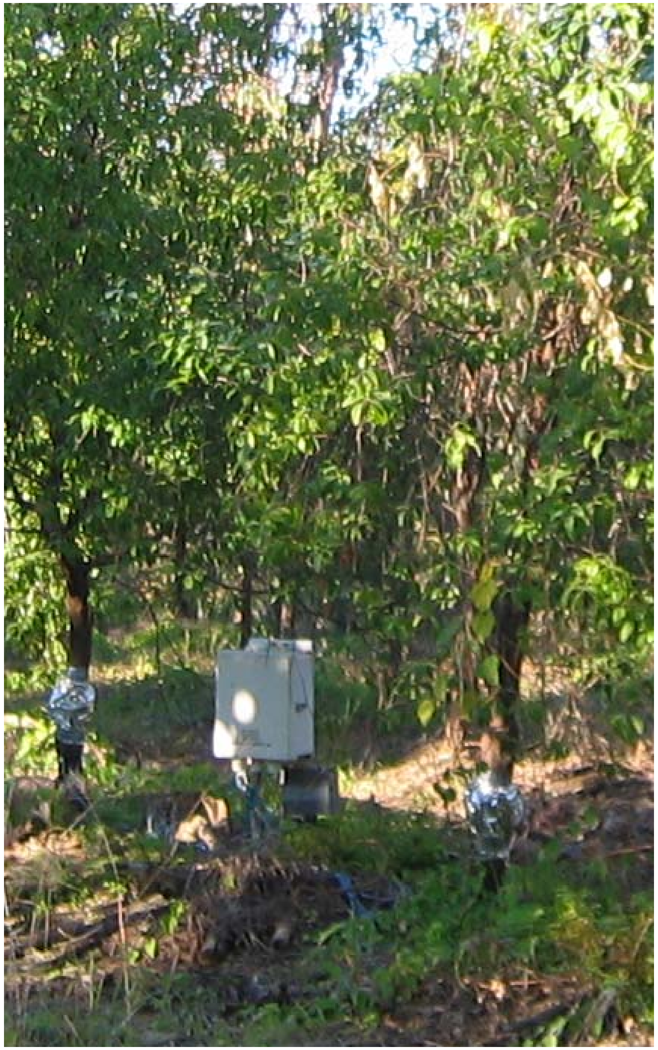
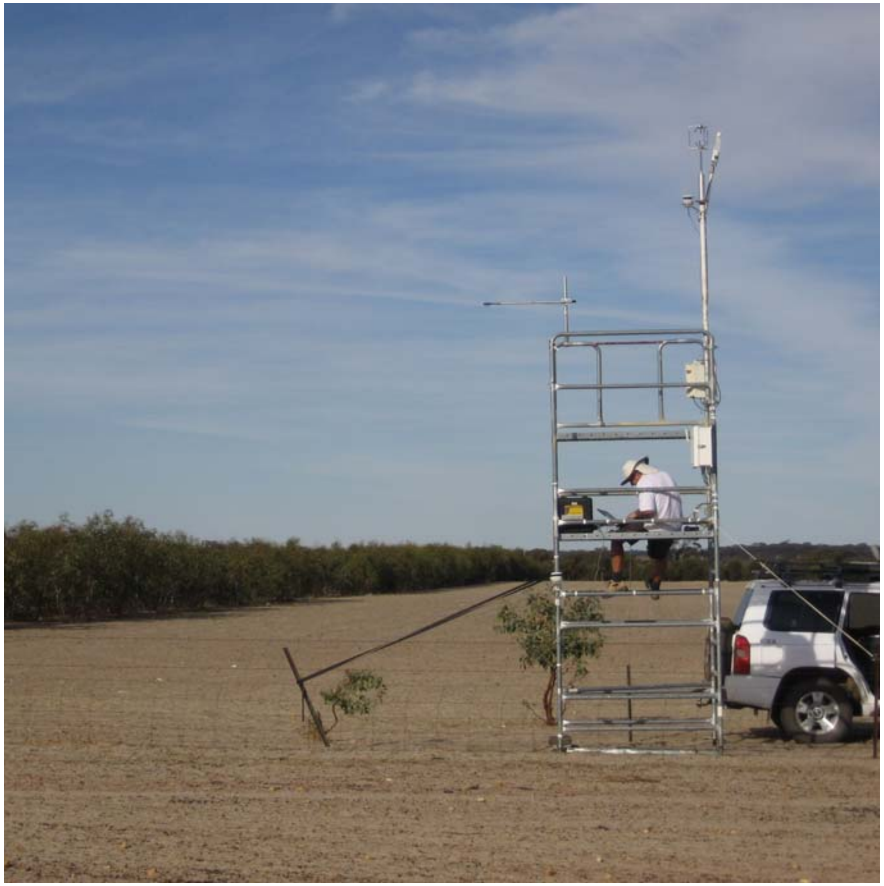


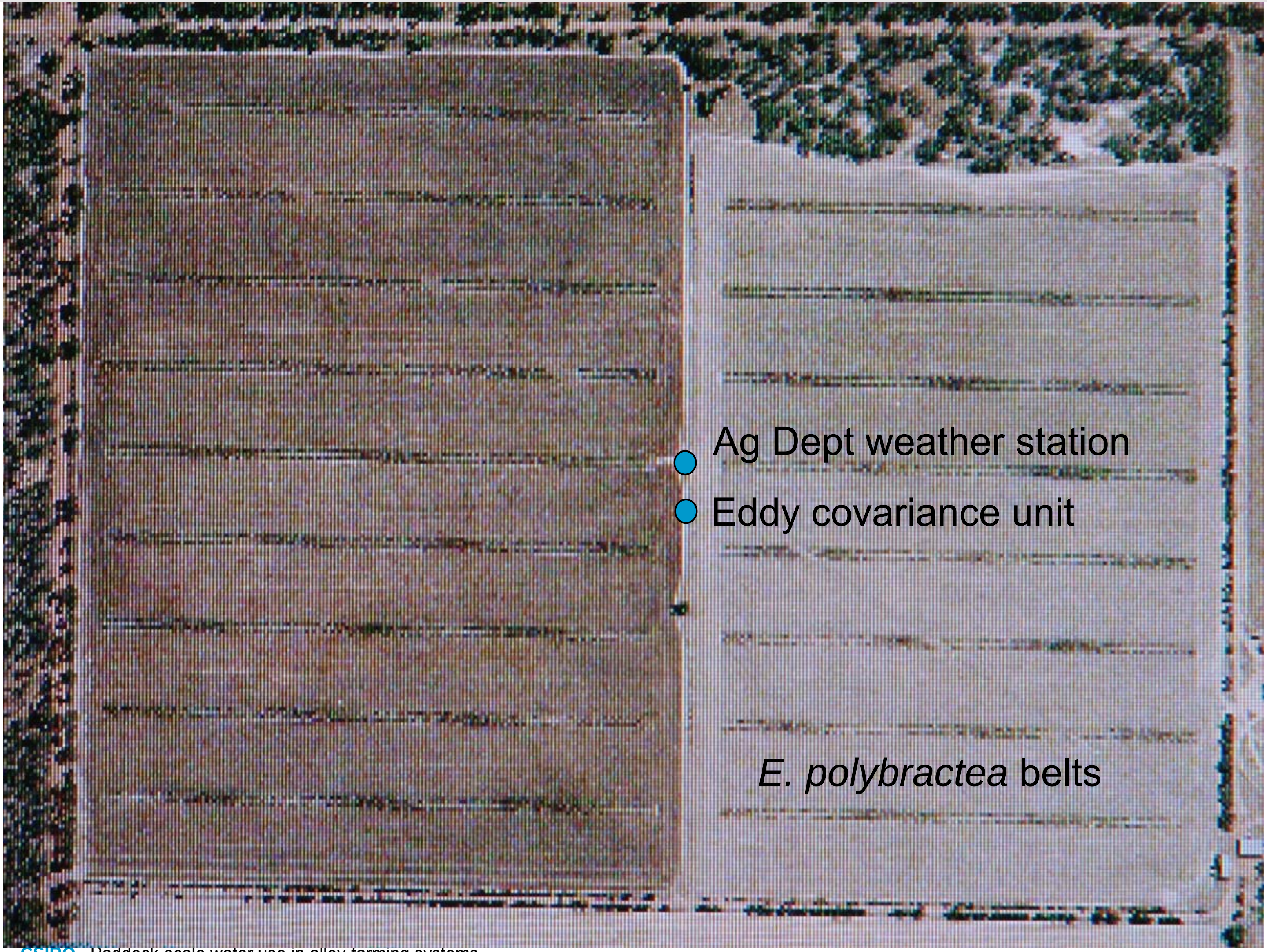
Photo by Jenny Carter

Quantifying water and carbon – paddock scale

- Eddy covariance
  - Water and CO_2
  - 3-D wind speed
  - Both 20 times per second
  - Measure above canopy
- Used extensively for native vegetation, and relatively uniform canopies
- Can we apply this to ‘belt and alley’ landscapes?



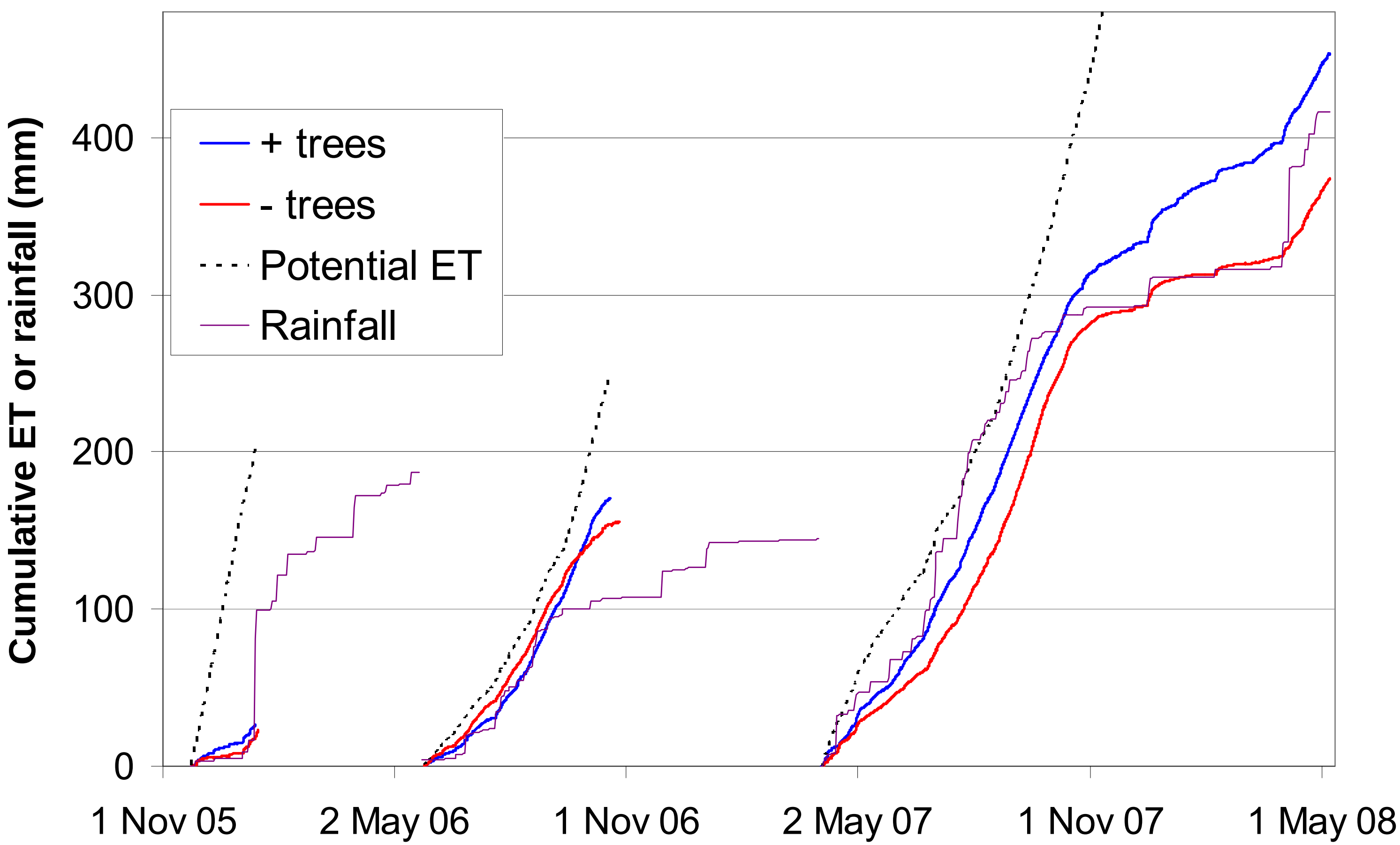
The paddock – 1000 x 750 m



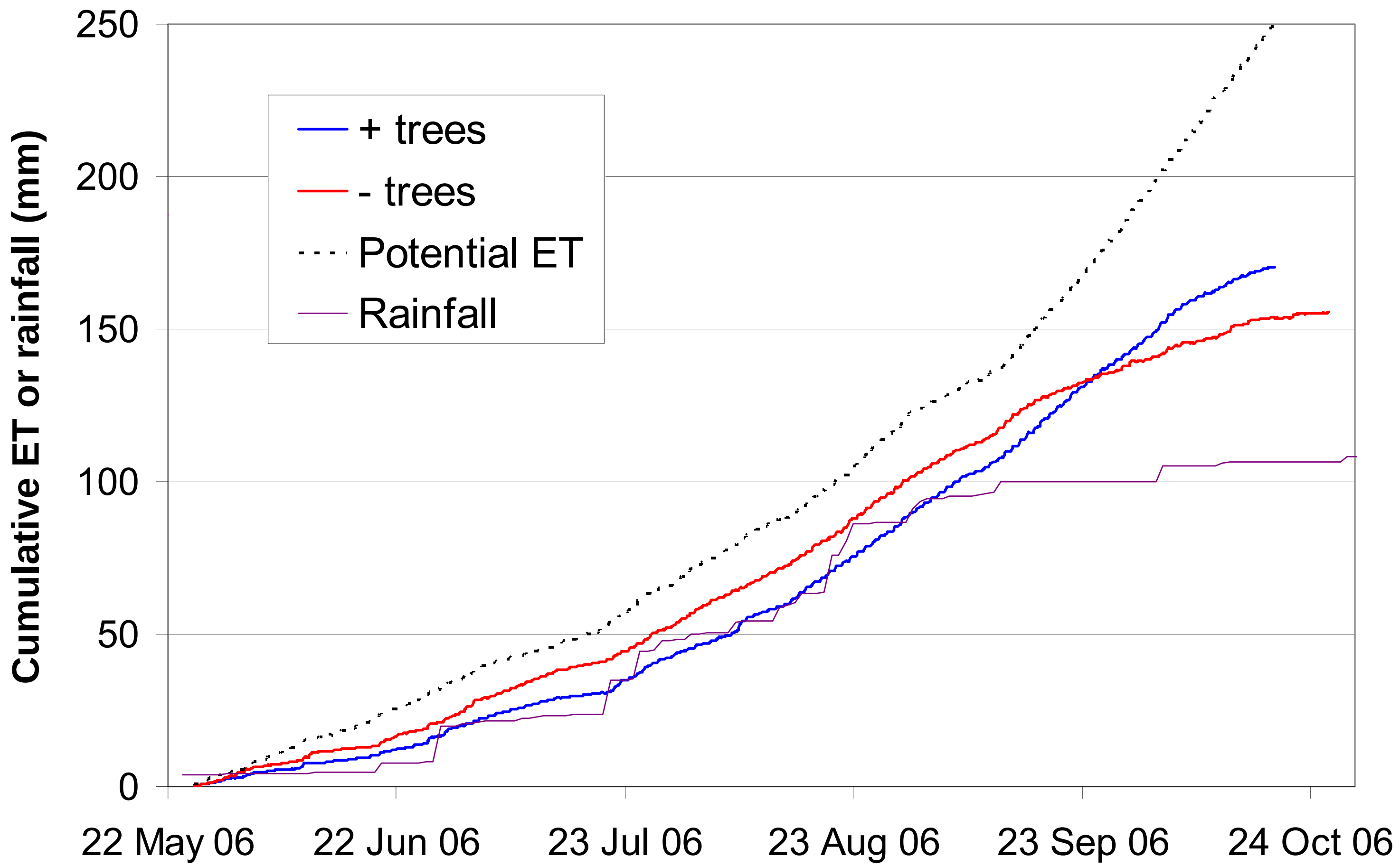
Data Collection in two paddocks ± trees

- Trees
  - ≈ 2 m high in November 2005
  - ≈ 3 m high in October 2006
  - ≈ 4 m high in November 2007
- November 23, 2005 to January 12, 2006, $z_m = 3.7$ m
  - Data for 40 out of 41 days
- May 25, 2006 to October 18, 2006, $z_m = 3.7 – 5.4$ m
  - Data for 127 out of 146 days
- April 4, 2007 to May 7, 2008, $z_m = 6.0$ m
  - Data for 306 out of 390 days

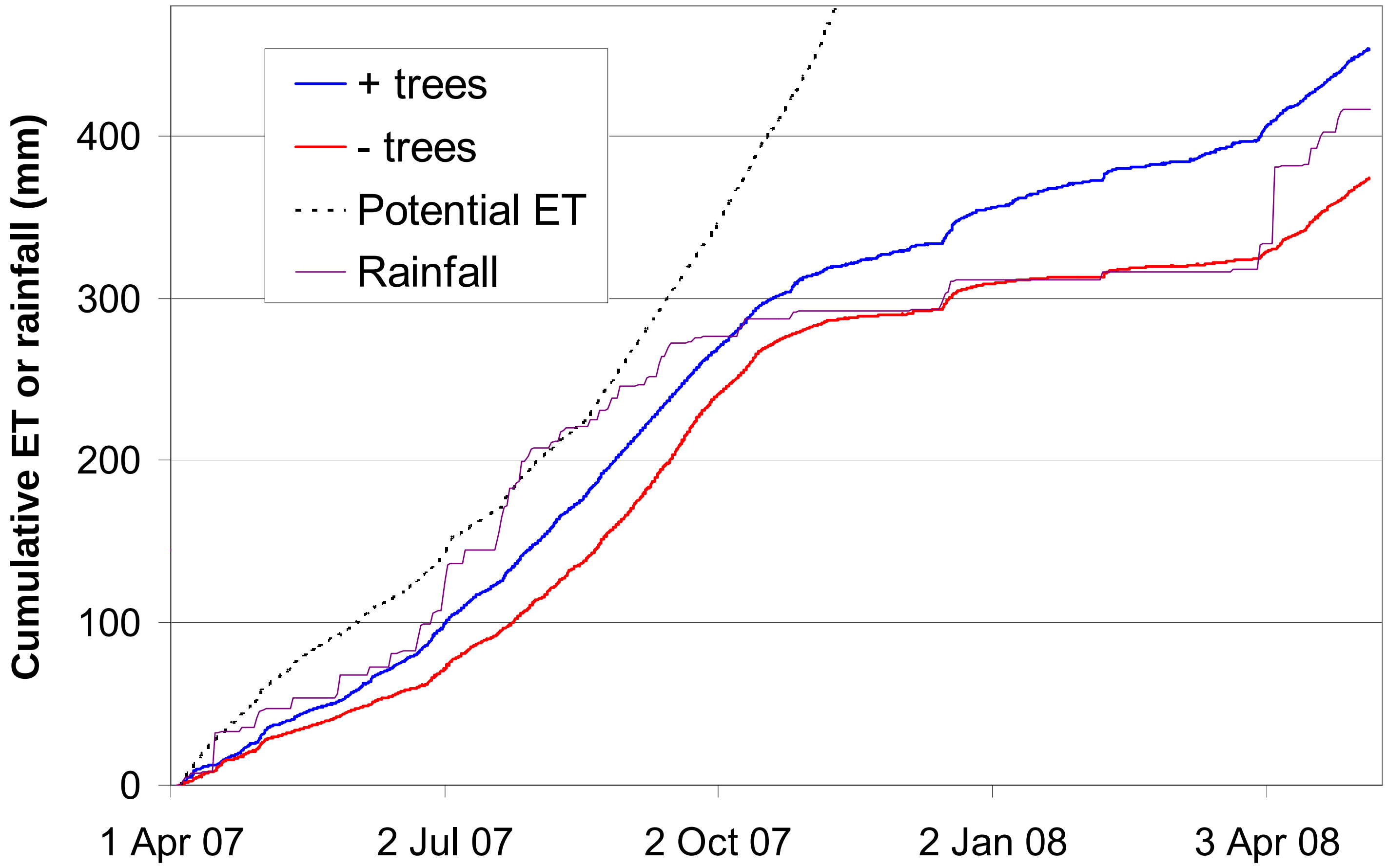
All the ET data



May – October 2006 water use



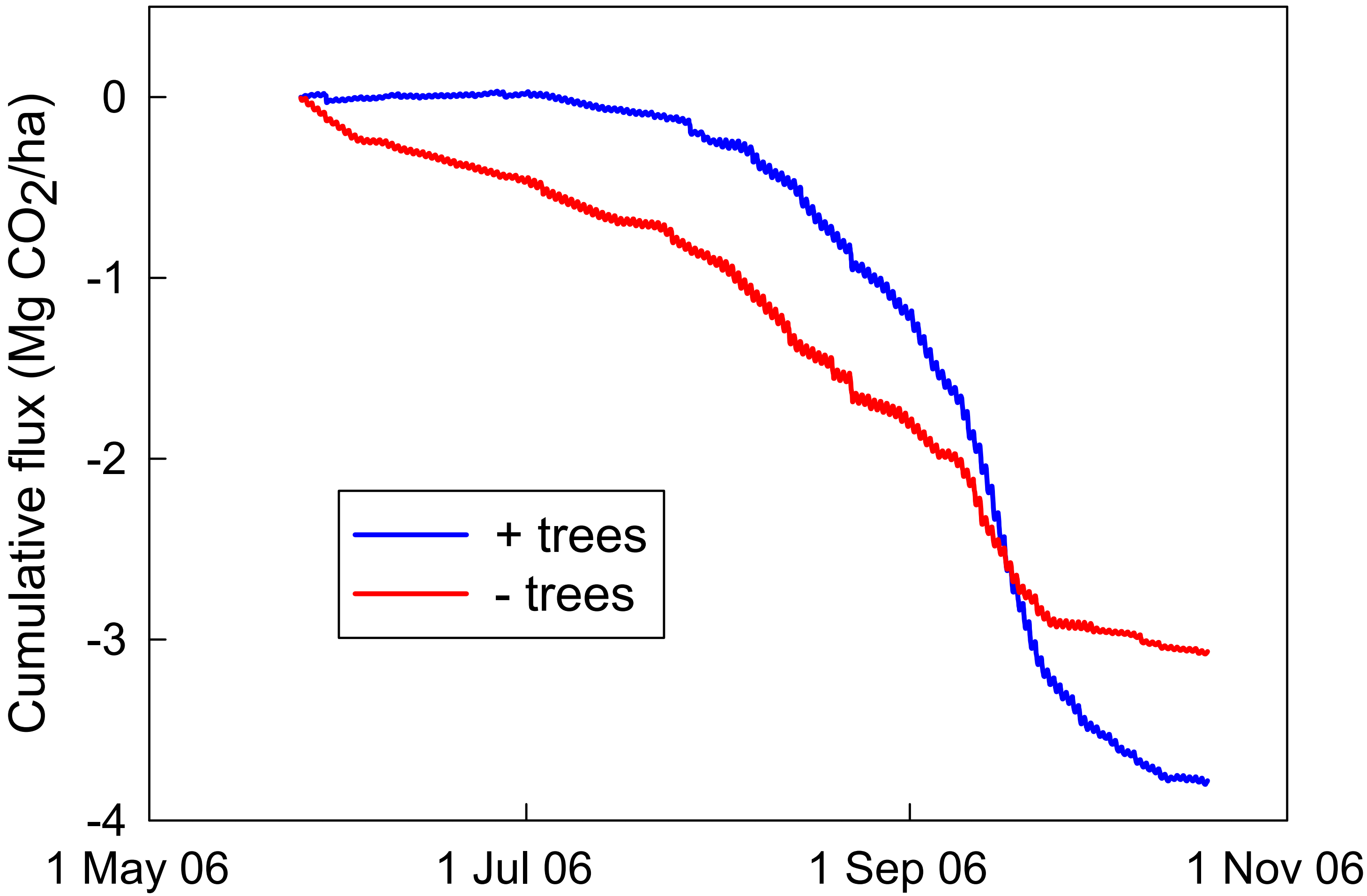
Yearly water use 2007/08



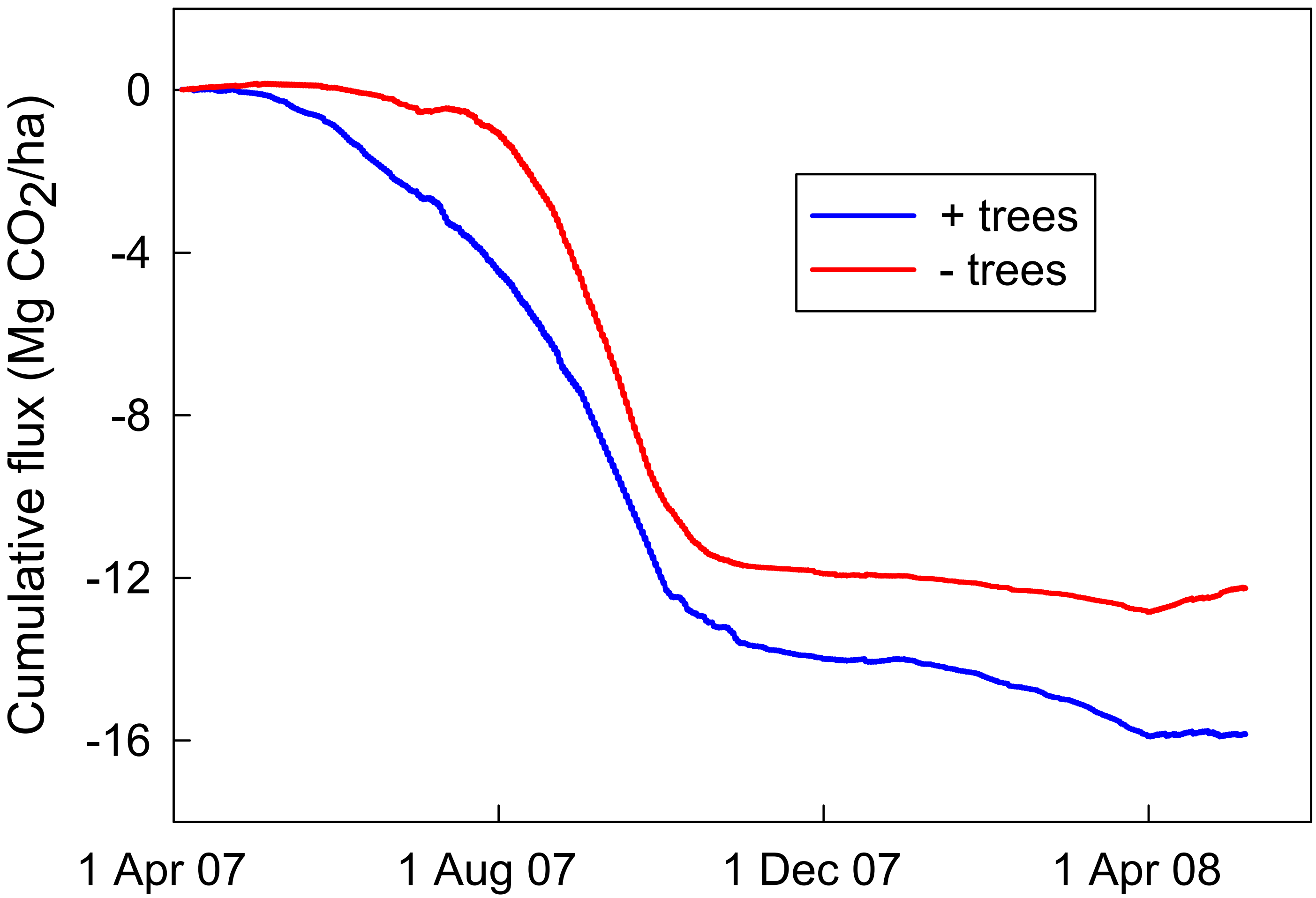
Tree belt water use estimates

Source	Summer water use based on crown area (mm/day)	Notes
White et al. 2002	1.7	Mixed *Eucalyptus*, 12 years old, with access to groundwater.
Wildy et al. 2004	3.3 – 5.8	*E. kochii*, 6-7 yr old, variable access to groundwater.
Carter et al. 2005	2.6 – 6.4	*E. horistes*, 4 yr old, variable access to groundwater.
Current study	0.7	*E. polybractea,* 6-7 yr old, assuming 15% landscape coverage

Growing season carbon uptake



12 months carbon uptake



Carbon uptake

- Total difference over 12 months 4 t CO_2/ha
  - Will vary depending on annual component in alleys
- Summer difference 1.7 t CO_2/ha
  - Attributable to presence of oil mallees
- Few published estimates available for comparison

Conclusions

- Eddy covariance is suitable for paddock-scale water use and carbon uptake measurements
- Lower estimates than those derived from scaling up sap flow.
- Oil mallee trees occupying 15-20% of a paddock used an extra 75 mm in 2007/08 over the whole paddock. This is equivalent to about 375 mm in the area directly under the trees.
- Extra water use at the paddock scale was approximately equal to the expected lucerne performance.
- Extra water was obtained from deep soil stores (water use > rainfall), and these rates of water use cannot be expected to continue indefinitely.
- Oil mallees likely to assist in salinity control, but modelling of impact of heterogeneous patterns of soil water will be necessary

Conclusions (2)

- As expected, oil mallees resulted in greater CO_2 sequestration
- Difference was marginal, but might assist with economics of tree adoption
- Roughly equivalent to increasing soil C by 10% (ie from 0.5% to 0.55%)
- Further research necessary to quantify different arrangements of tree belts.

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Thank you

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