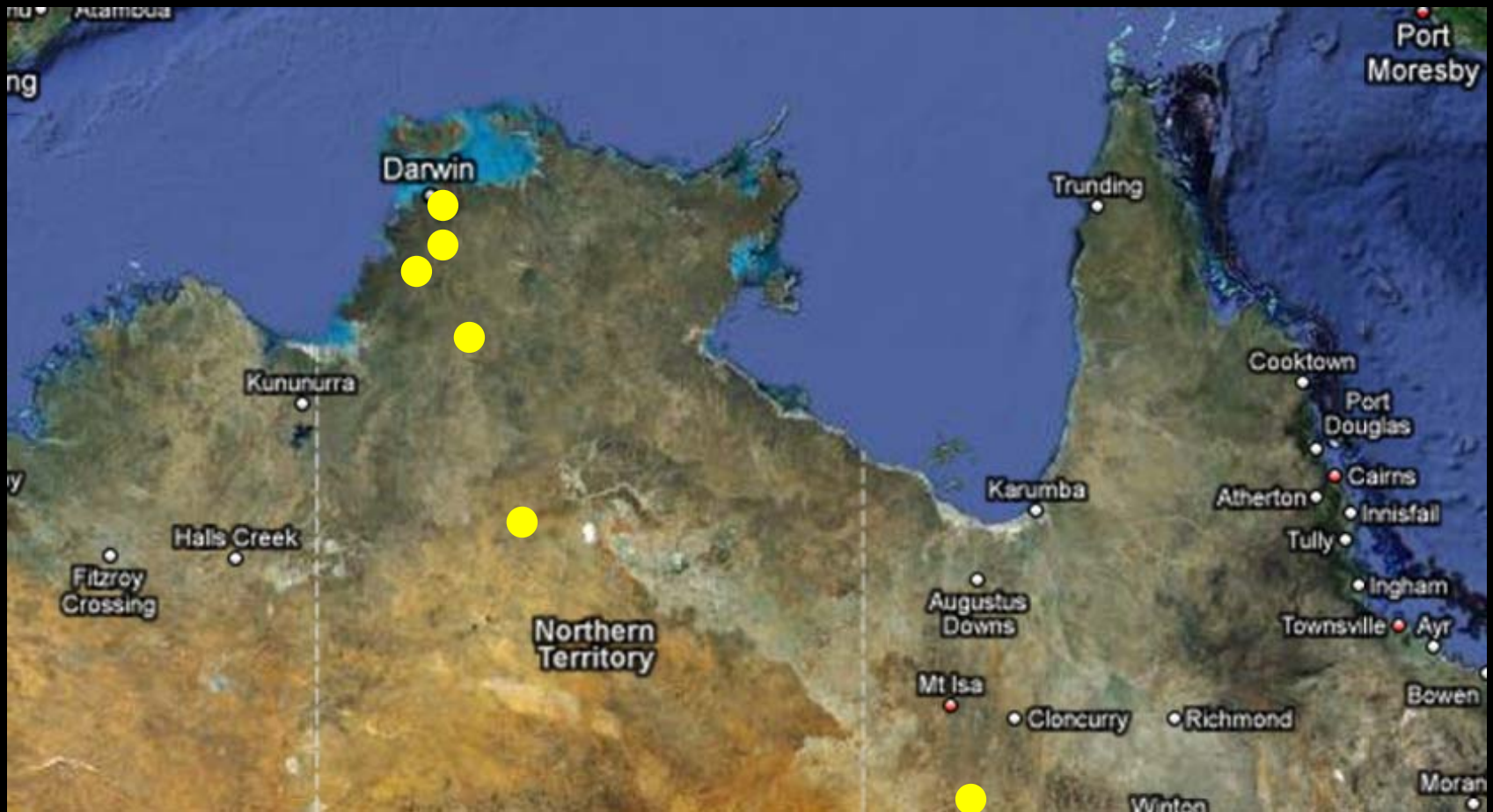


Patterns of leaf gas exchange along a continental-scale rainfall gradient in north Australia

Lucas Cernusak
Charles Darwin University



Sampling sites



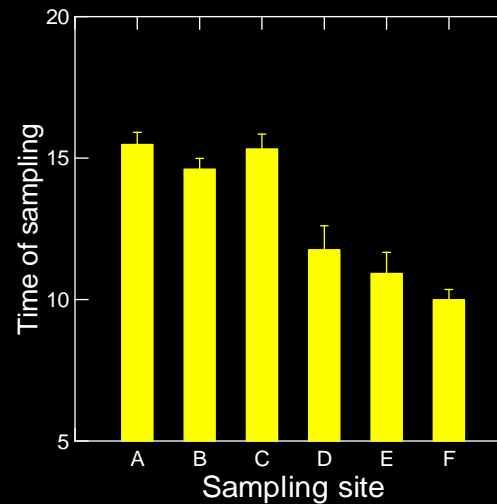
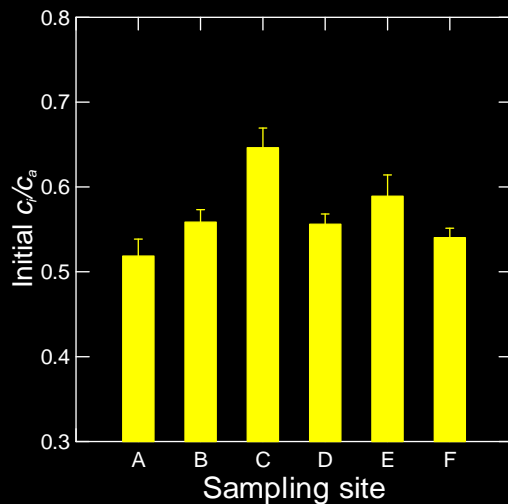
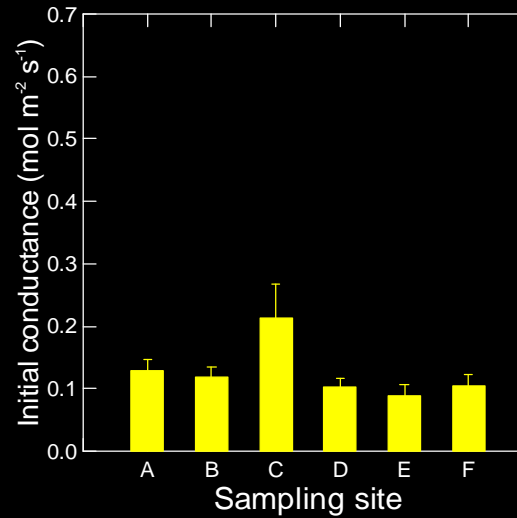
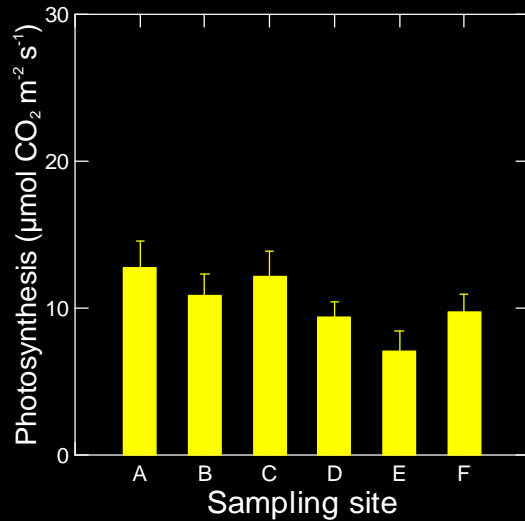
Leaf gas exchange measurements



Leaf gas exchange measurements- Boulia

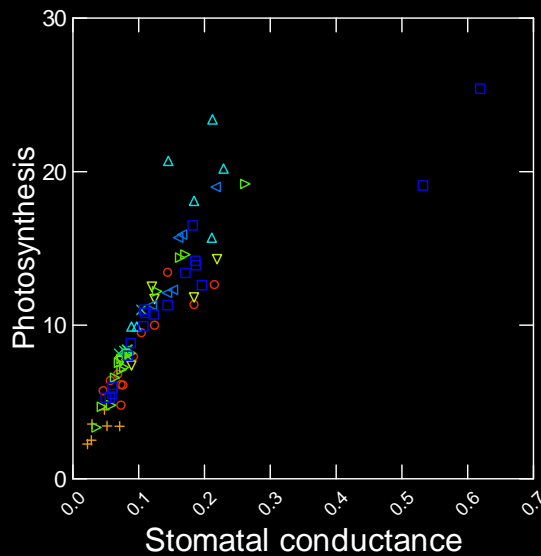
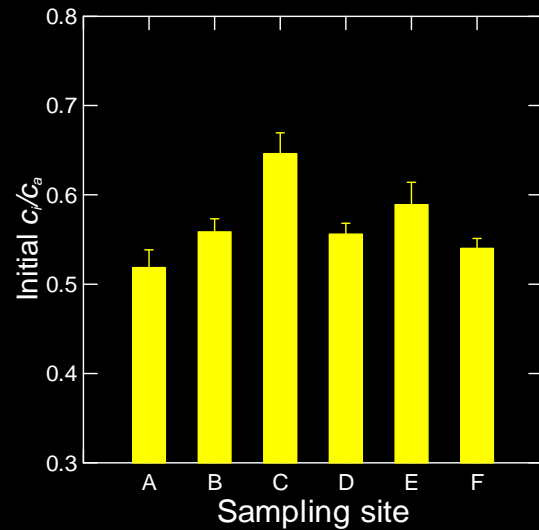


Leaf gas exchange summary by site



Sampling sites
A- Howard Springs
B- Adelaide River
C- Daly River
D- Dry Creek
E- Sturt Plains
F- Boulia

c_i/c_a relatively constant among sites



Species

- *C. latifolia*
- × *E. aparrerinja*
- + *E. coolibah*
- △ *E. miniata*
- ▽ *E. pruinosa*
- △ *E. tectifera*
- ▽ *E. terminalis*
- *E. tetrodonta*

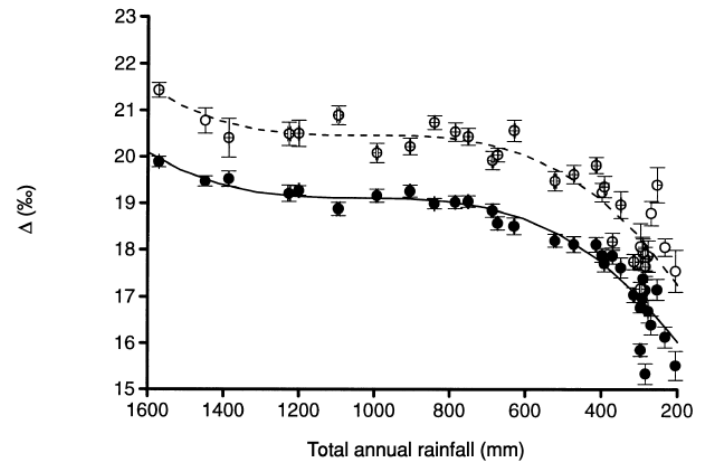
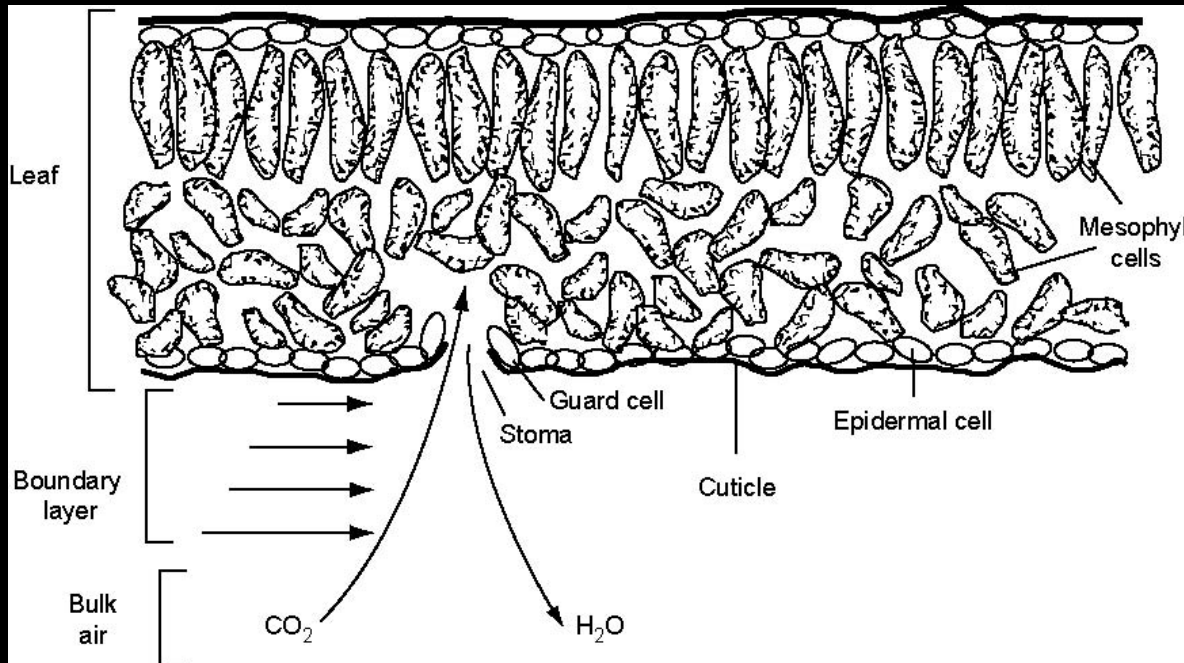


Fig. 5. Response of the zone mean ($\bar{x} \pm \text{SE}$) leaf and wood Δ values to decreasing total annual rainfall. Regression lines from the full set of values ($n = 645$) are: leaf $\Delta = 14.29 + 18.15 \times \text{PPT}_m - 17.74 \times \text{PPT}_m^2 + 5.76 \times \text{PPT}_m^3$ ($r^2 = 0.45$); wood $\Delta = 13.26 + 16.88 \times \text{PPT}_m - 16.28 \times \text{PPT}_m^2 + 5.24 \times \text{PPT}_m^3$ ($r^2 = 0.59$) where rainfall is expressed in m (PPT_m). ○, Leaf Δ ; ●, wood Δ .

Water-use efficiency partly controlled by c_i/c_a



$$\frac{A}{E} = \frac{c_a \left(1 - \frac{c_i}{c_a} \right)}{1.6v}$$

Excel utility for fitting A-C_i curves (Sharkey et al. 2007)

Microsoft Excel - sm001.xls

File Edit View Insert Format Tools Data Window Help

Type a question for help

D50

Please enter your values

T leaf 32 °C
P_{atm} 101 kPa
O₂ 21 kPa

2. Estimate limiting factors (1= rubisco, 2= RuBP regeneration, 3= TPU)
(assign at least one point to limitation 3, enter 0 to exclude points)
3. Press the "Solve" button
4. Adjust limiting factor if needed (use 0 to disregard a data pair)
5. Press the "Save" button to save to your computer and or-
6. Cut and paste outputs if desired

Make no changes here

Estimated Limiting	Enter A	Enter either C _i ppm or C _i Pa	Calculated C _e	Limitations A _e A _i A _t	Error terms
0	11.7	210	2121	20.82 13.54 16.03 25.40	0.163 4.302 0.000
1	8.27	150	15.15	14.87 8.31 12.21 25.40	0.002
1	6.57	130	13.13	12.31 6.48 10.50 25.40	0.009
1	3.38	98.6	10.06	9.95 3.80 7.25 25.40	0.050
1	0.185	64.5	6.51	6.51 0.09 1.93 25.40	0.008
1	-1.08	50.3	5.08	5.12 -1.38 -0.86 25.40	0.091
1	7.82	144	14.54	14.28 7.76 11.73 25.40	0.003
2	15.5	232	23.43	22.92 15.28 17.05 25.40	2.391
2	22.9	376	37.98	37.21 25.86 21.52 25.40	1.899
2	25.3	665	67.17	66.32 42.28 25.41 25.40	0.012
3	25.4	814	82.21	81.37 48.87 26.44 25.40	0.000

*If you enter C_i will be calculated, do not delete equations in the C_i column

Use solver to minimize this sum of squares

Solve

4.465

Save

Outputs

	@ T leaf	@ 25 °C
V _{cm} max	131	71 mmol m ⁻² s ⁻¹
J	134	89 mmol m ⁻² s ⁻¹
TPU	9.1	6.7 mmol m ⁻² s ⁻¹
R _{id}	1.84	120 mmol m ⁻² s ⁻¹
g _m	30.00	19.29 mmol m ⁻² s ⁻¹ Pa ⁻¹

*R_{id} is constrained to be >0 and
g_m is constrained to be 30 or less

To cite this estimating utility:
Sharkey, T.D., Bernacchi, C.J., Farquhar, G.D.,
Singsaas, E.L. (2007) In Practice: Fitting
photosynthetic carbon dioxide response curves for
C₃ leaves. *Plant Cell & Environment* 30:100-103
Version 2007.1
[Link to paper](#)

To refresh your copy and for updates to this application please visit www.blackwellpublishing.com/plantsci/pcecalculation/

Calculations Hints, advice and advanced use

Ready

NUM

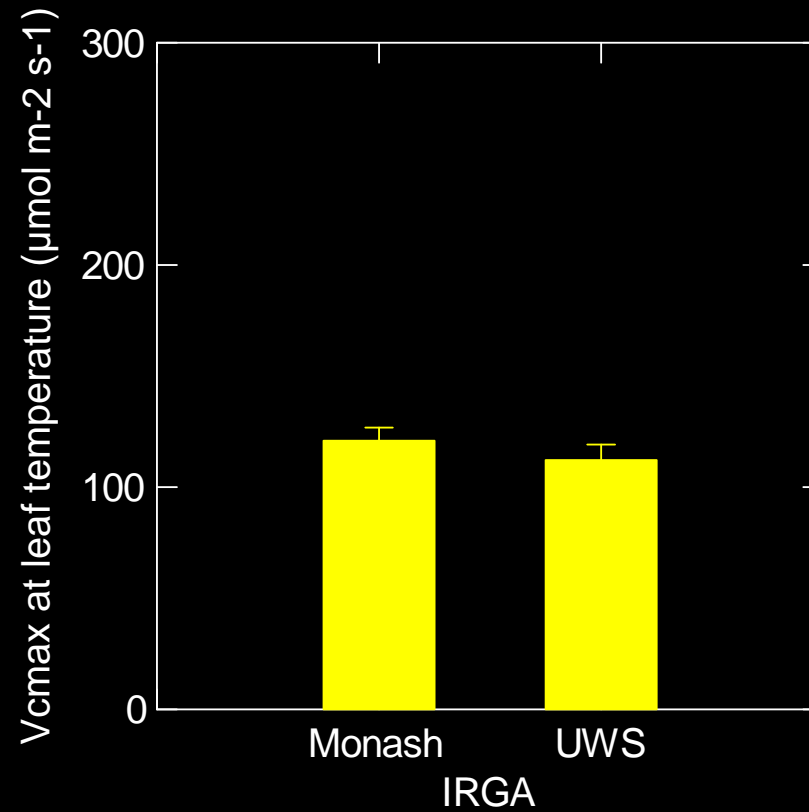
3:55 PM

sm001.xls SIOP Vcmx.xls REDUCED SIOP Leaf gas...

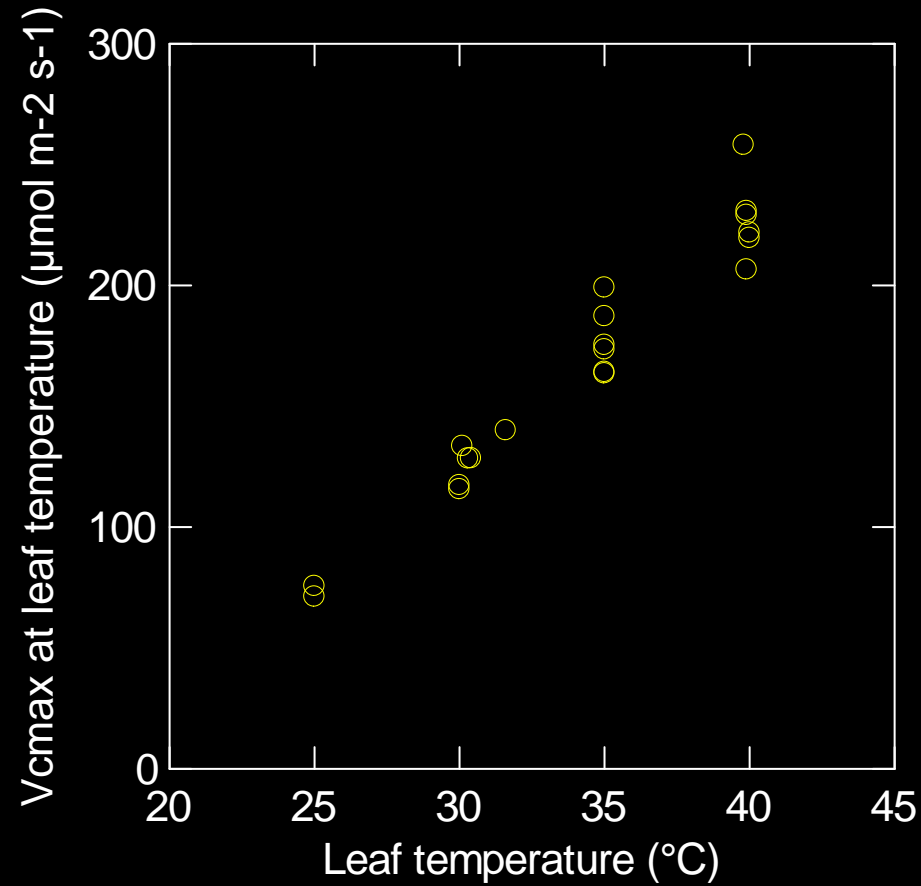
A/C_i curve

Legend: Aobs (blue diamonds), Rubisco (red line), RuBP_regen (green line), TPU (yellow line)

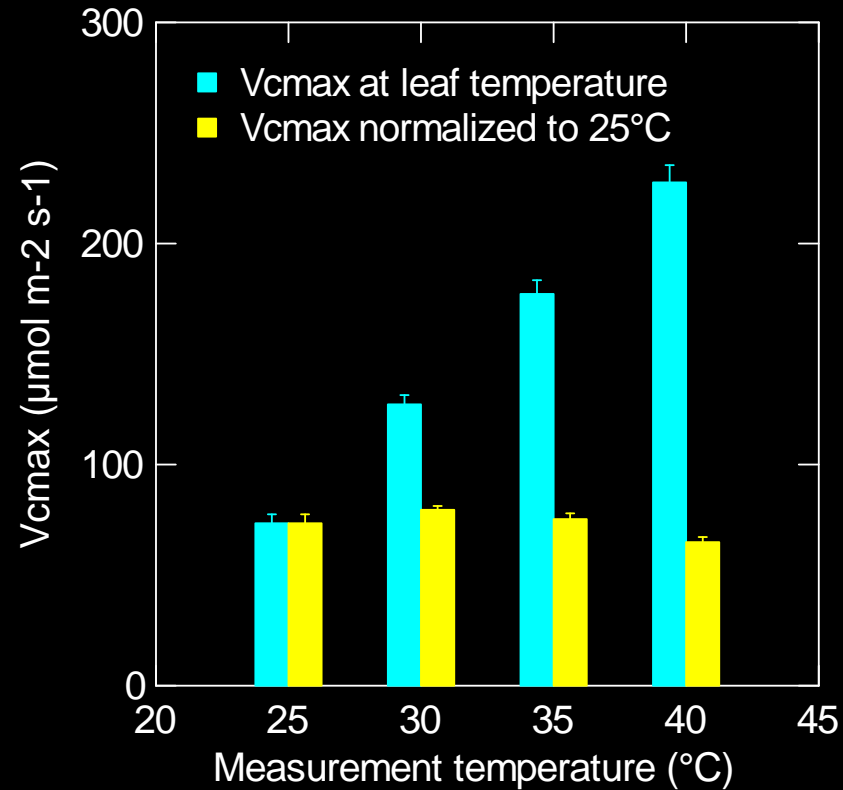
No apparent bias depending on which IRGA was used



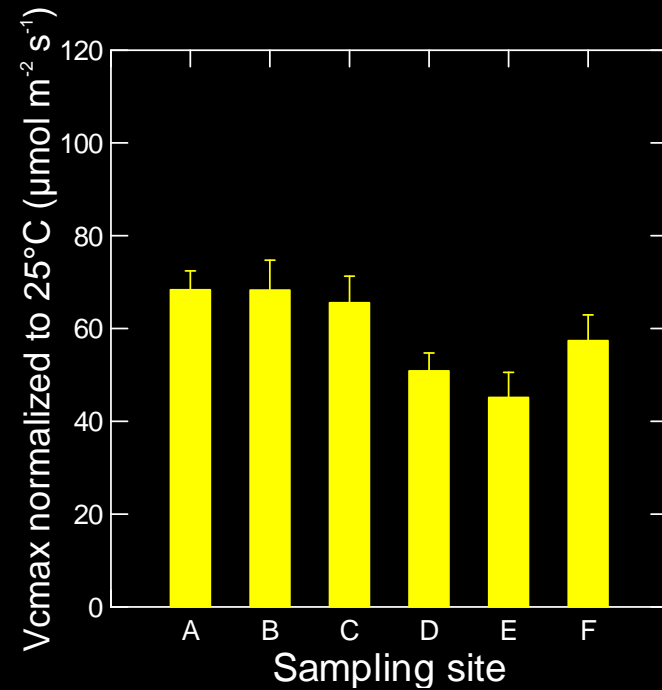
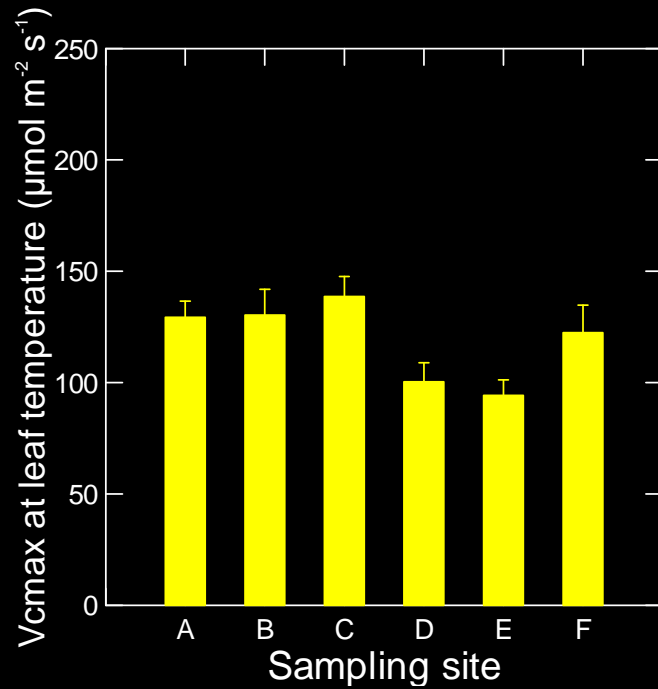
Eucalyptus tetrodonta temperature response (Daly River)



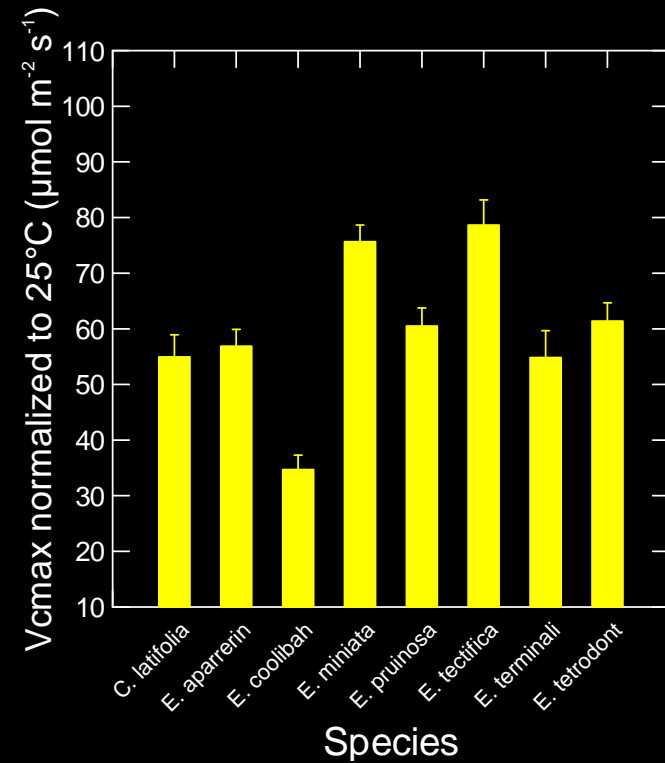
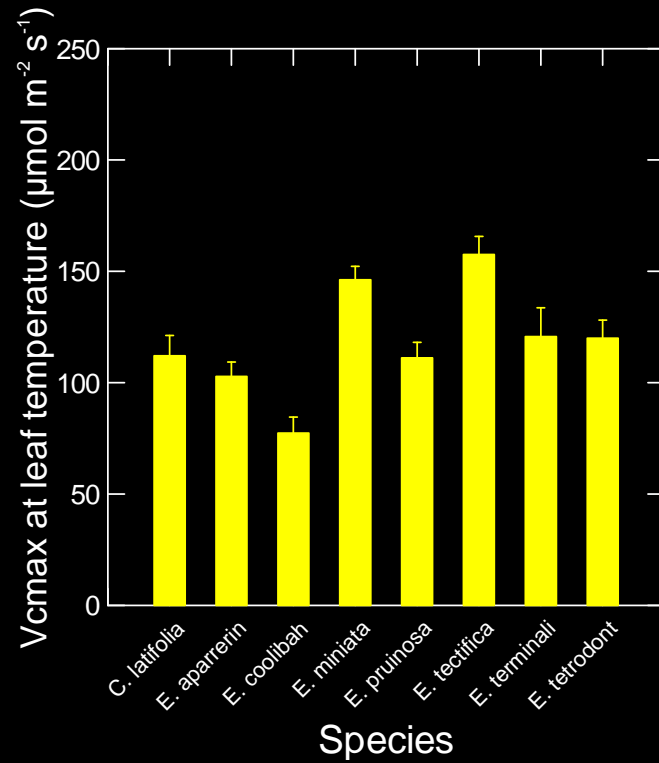
Eucalyptus tetrodonta temperature response (Daly River)



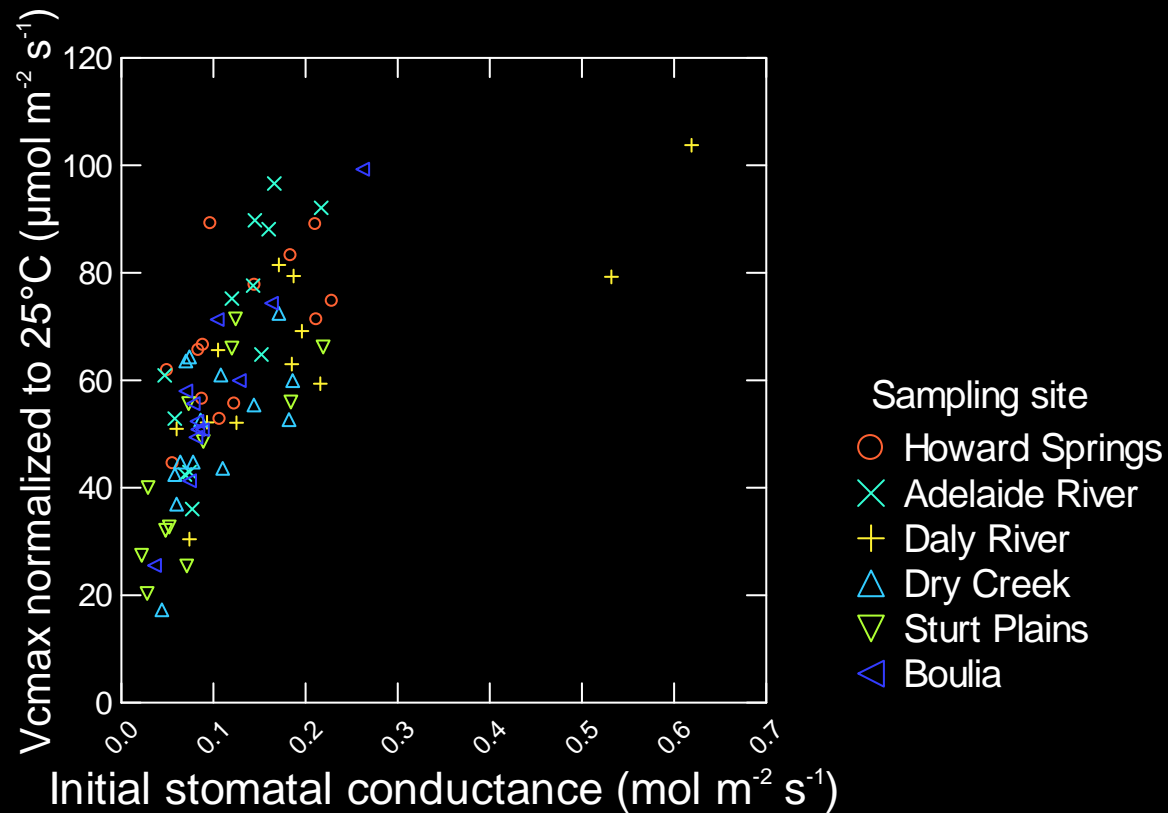
Variation among sites in V_{cmax}



Variation among species in V_{cmax}



V_cmax showed a strong dependence on initial stomatal conductance



Initial stomatal conductance was the strongest term in ANOVA for Vcmax, but site and species were also significant

Categorical values encountered during processing are:

SITE\$ (6 levels)

Adelaide Riv, Boulia, Daly River, Dry Creek, Howard Sprin, Sturt Plains

SPECIES\$ (8 levels)

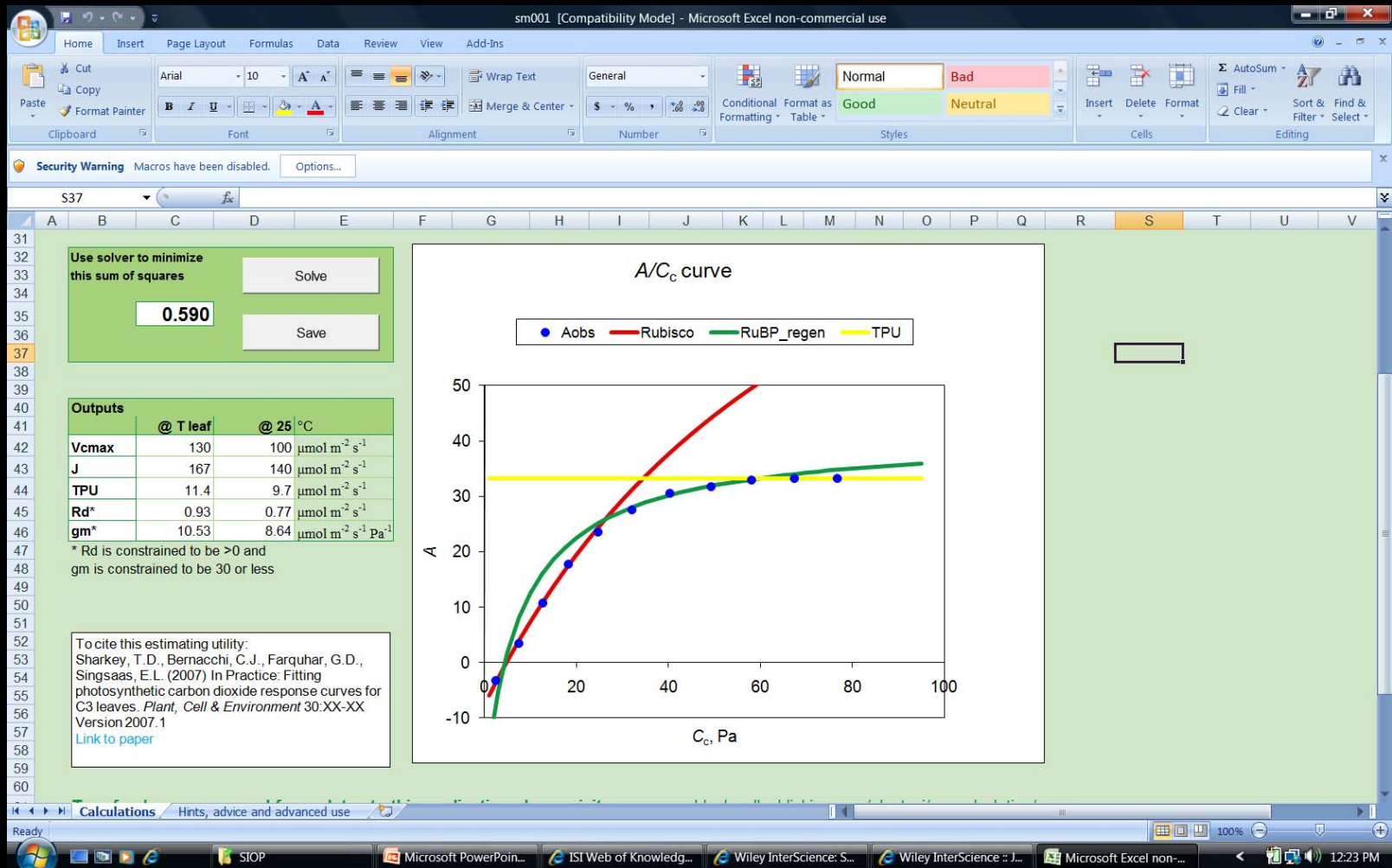
C. latifolia, E. aparrerin, E. coolibah, E. miniata, E. pruinosa,
E. tectifera, E. terminali, E. tetradont

Dep Var: VCM_25 N: 75 Multiple R: 0.88820 Squared multiple R: 0.78891

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
SITE\$	2403.78371	5	480.75674	4.80614	0.00098
CONDUCTANCE	3570.33391	1	3570.33391	35.69276	0.00000
SITE\$*CONDUCTANCE	3032.64716	5	606.52943	6.06350	0.00014
SPECIES\$(SITE\$)	2619.54663	6	436.59111	4.36462	0.00108
Error	5701.68929	57	100.02964		

Excel utility for fitting A-C_i curves (Sharkey et al. 2007)



Conclusions and future directions

- Photosynthesis, conductance and c_i/c_a did not show large variation among sites along the rainfall gradient
- These gas exchange data are consistent with previous measurements of ^{13}C discrimination (Miller et al. 2001)
- V_{cmax} , estimated assuming constant mesophyll conductance of $3 \text{ mol m}^{-2} \text{ s}^{-1} \text{ bar}^{-1}$, showed strong dependence initial stomatal conductance
- Mesophyll conductance and stomatal conductance likely co-vary
- Leaf samples currently being processed for nitrogen concentration and $\delta^{13}\text{C}$