# Sub-project 3: Soils vs Climate Change

## Paul Nelson (JCU)

- Soil pit was installed in mid 2007
- 3 Depths 0.1m, 0.75m, 1.5m
- Sensors:

  Temperature (thermocouple)

  Water content (TDR probes)

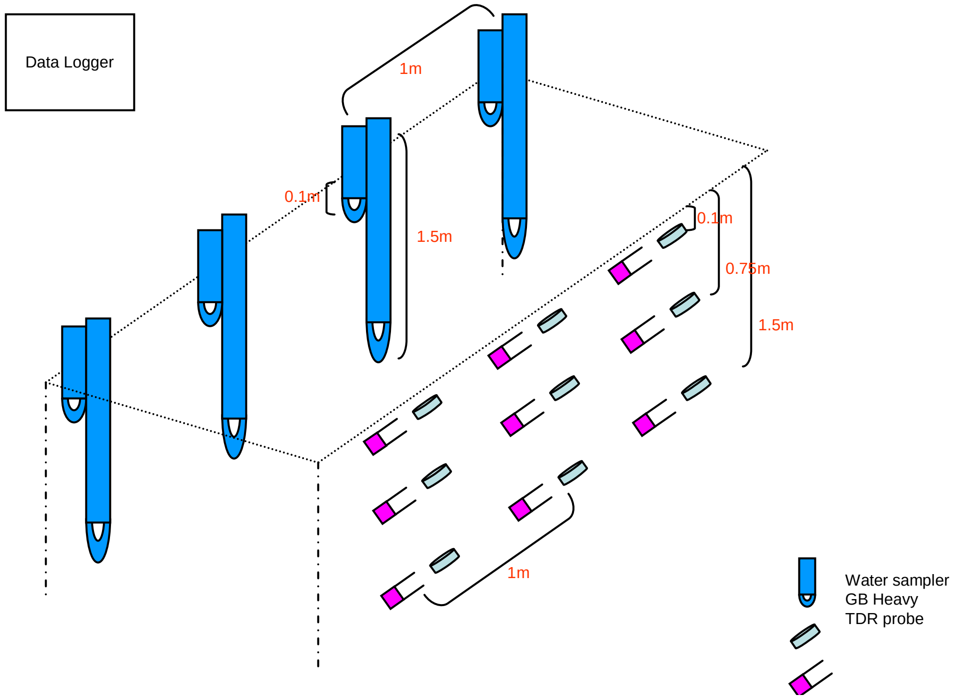
  Water potential (Gypsum blocks)
- Vacuum system

  Used to collect water infiltrating through the profile for measuring DOC movement

# SOIL CHARACTERISTICS

❖ Cape Tribulation: water availability is likely then to be the key driver of productivity in these seasonally dry rainforests. A sensor pit was dug, initially by hand!

❖ Rock : Soil ratio : around 40%

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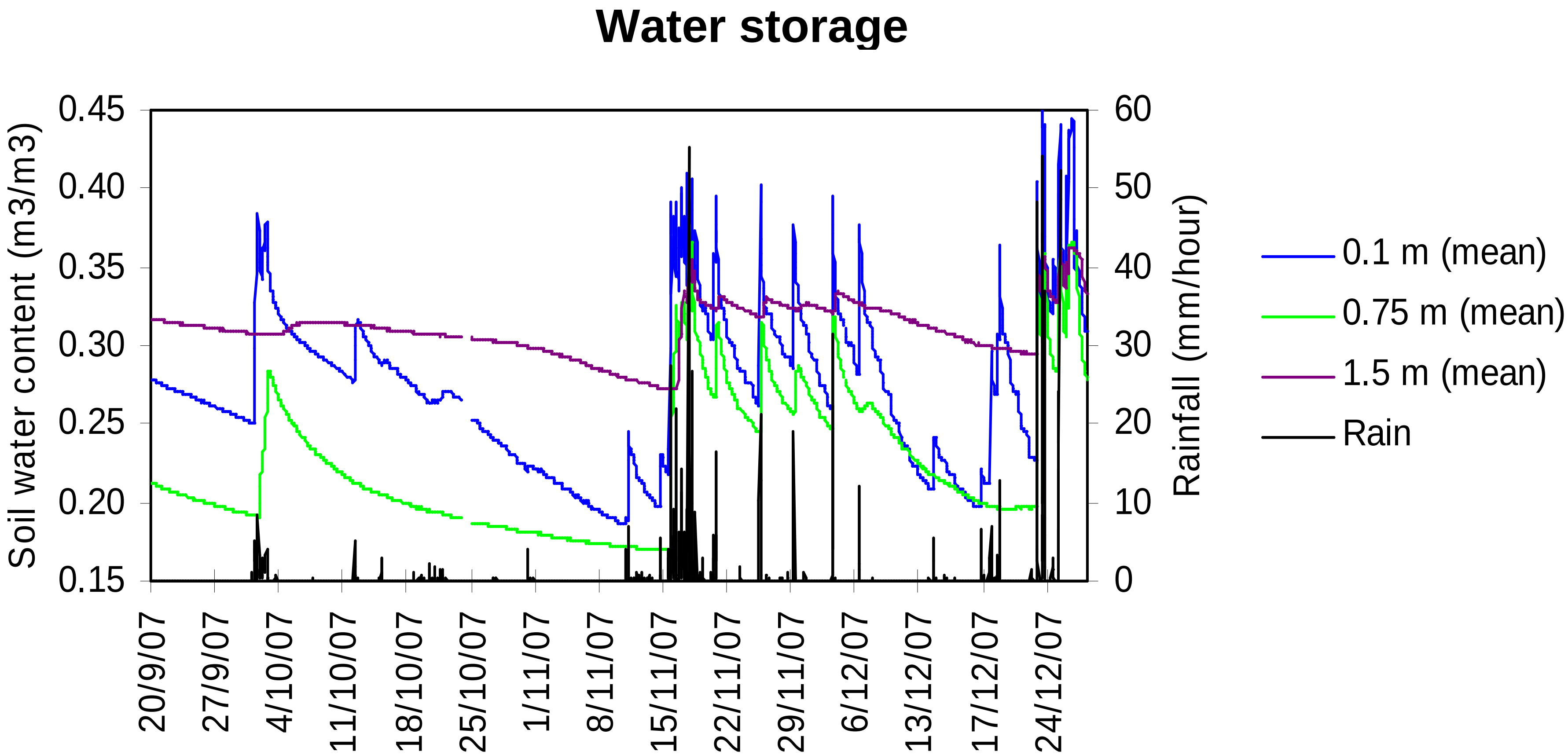
# SUB-SURFACE STORAGE



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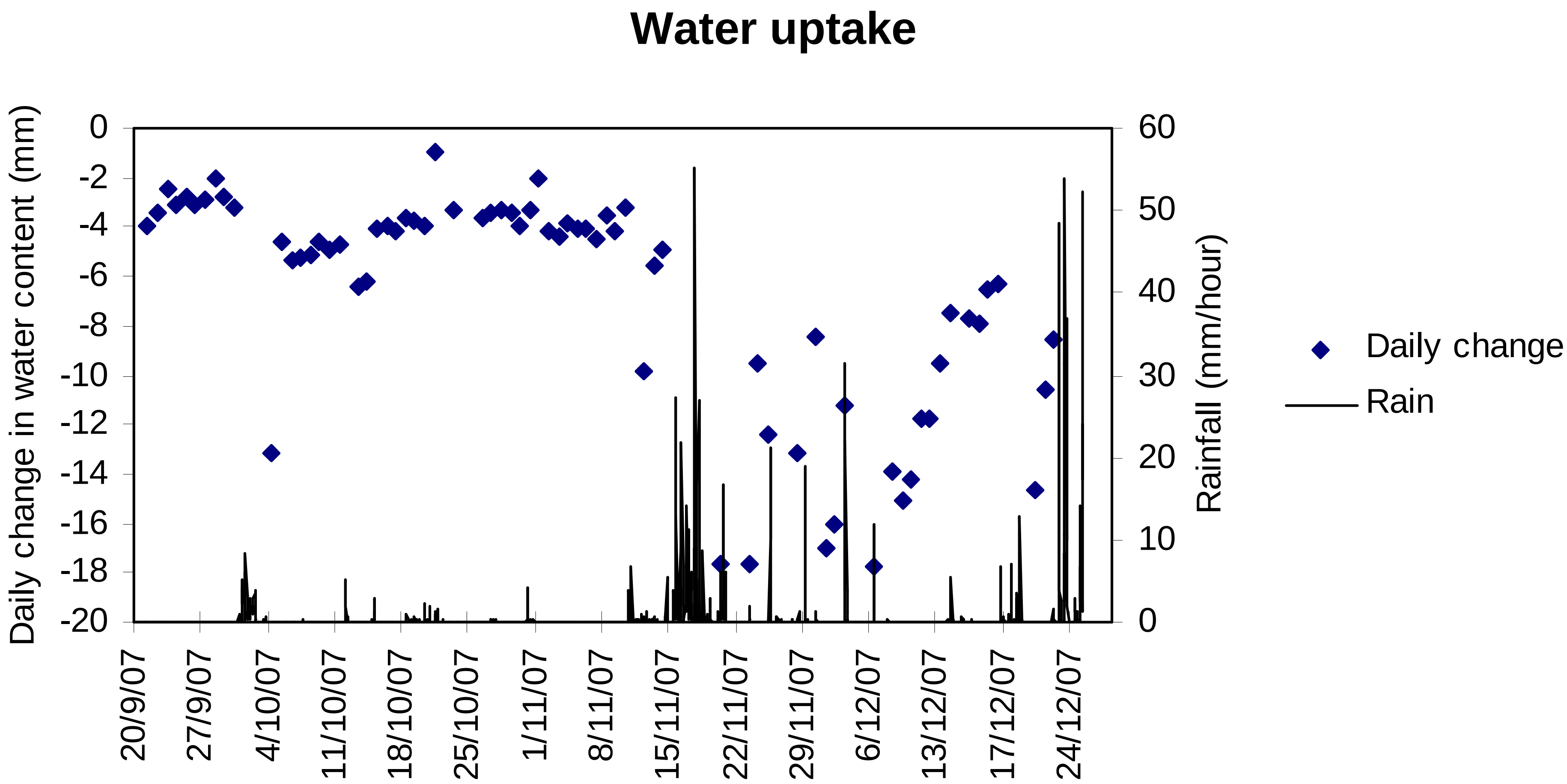
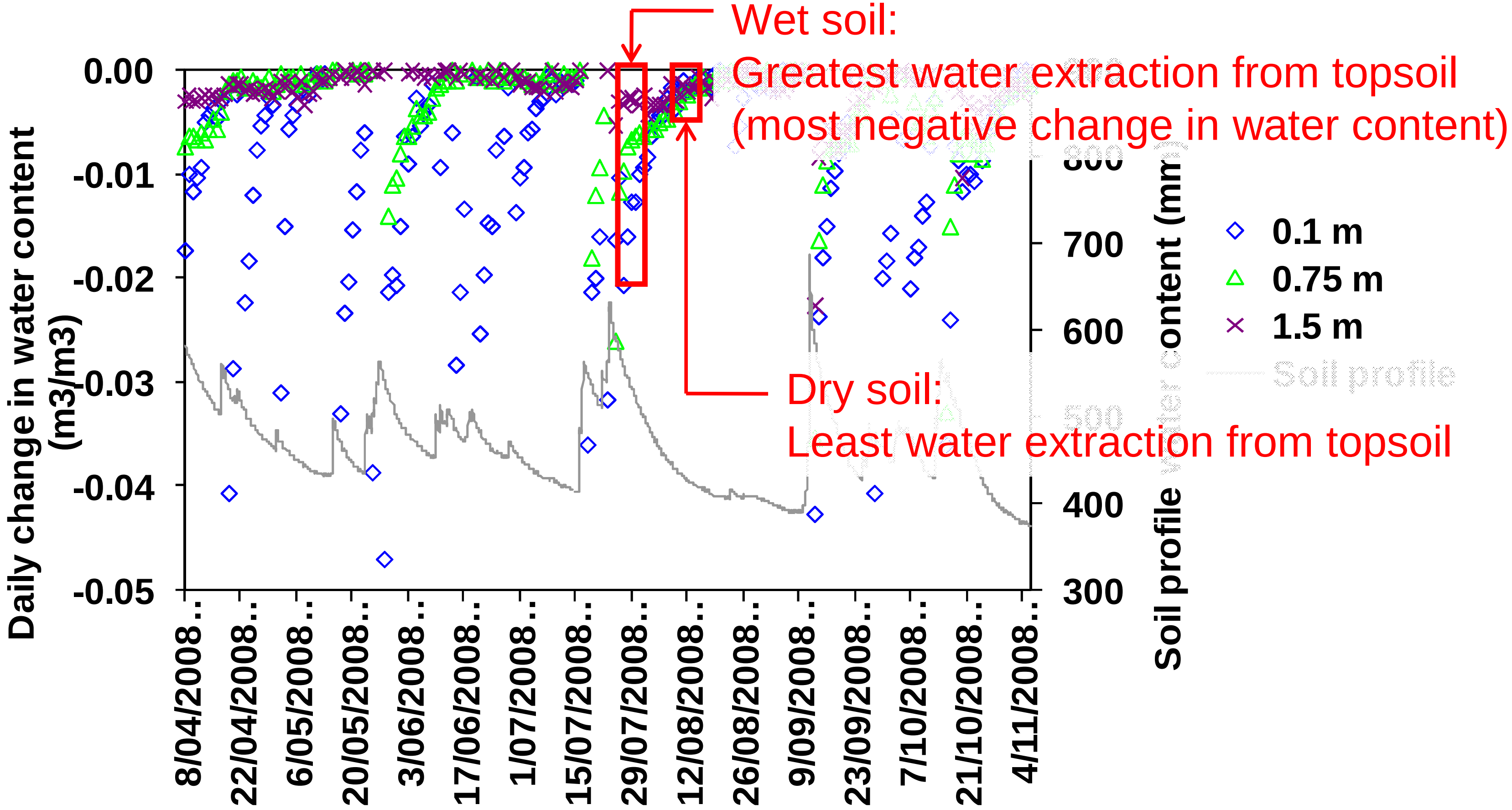
# SUB-SURFACE FLUXES



# WATER UPTAKE VS DEPTH



# WATER UPTAKE GROUNDWATER

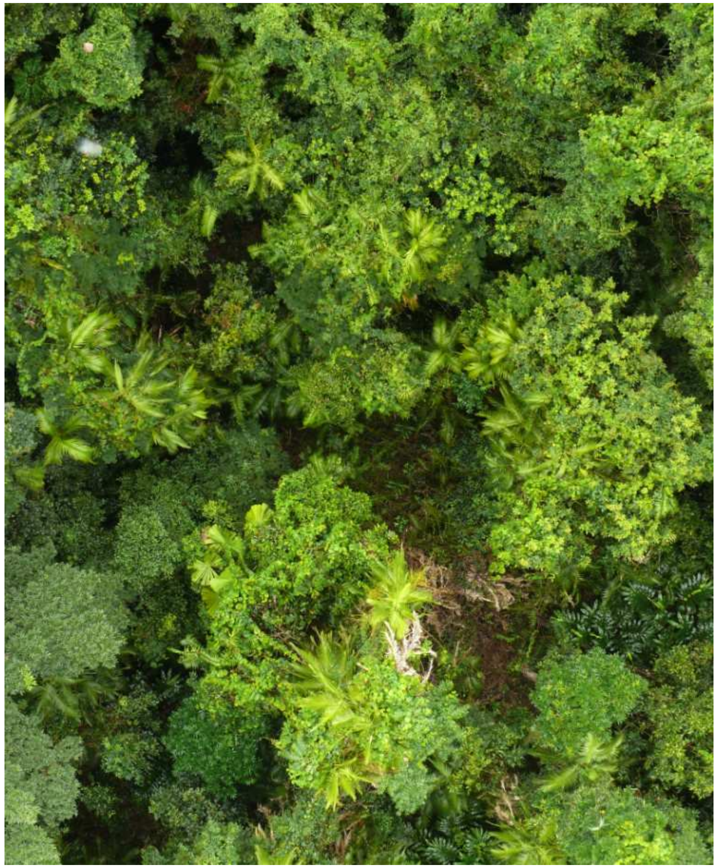
- Installed 3 bores to measure uptake from groundwater
- Bedrock at 12-33 m depth
- Watertable at 10-13 m depth (July 2008- April 2008)
- Marc Le Blanc (JCU) is in charge of this part of the sub-project.

# PHENOLOGY CRANE

❖Phenological events are recorded monthly using the crane which began in Jan 2009

❖Budding, flowering and fruiting events are recorded as presence or absence.

❖ Phenocam is being installed in 2 months time.



# PHENOCAM (T23-24)

Jan 09

Feb 09

Mar 09

Apr 09

Sony DSLR α-700 tried Sony video

# FOREST PRODUCTIVITY

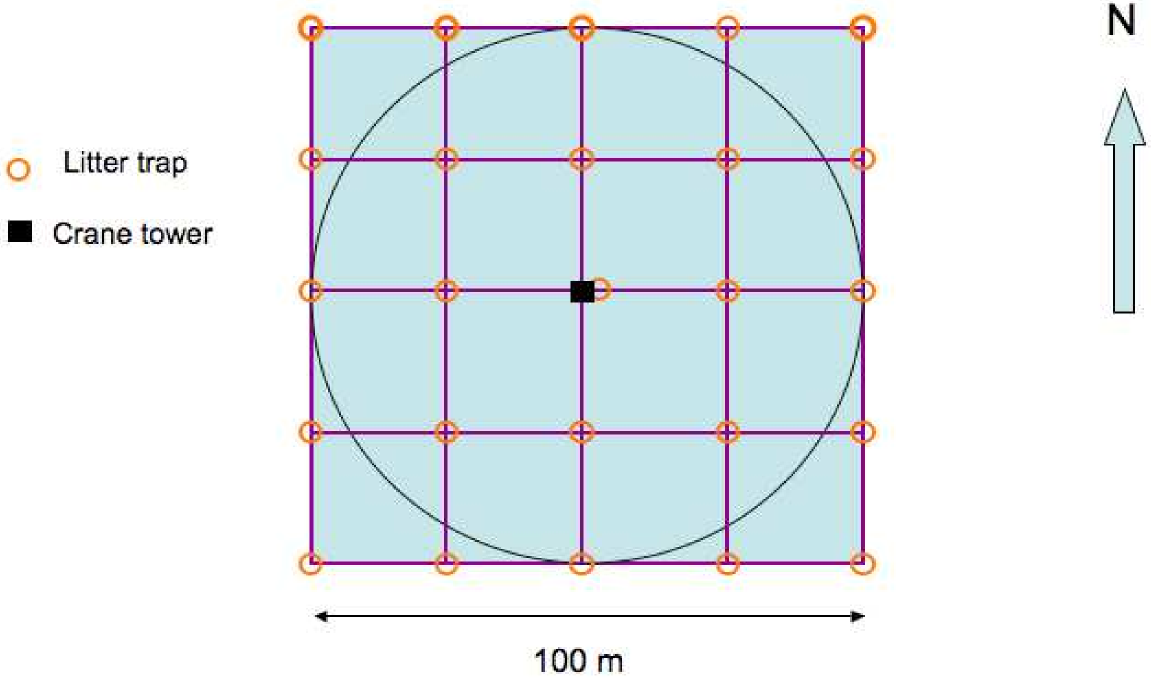
## Cape Tribulation above ground productivity

- **Dendrometry:** 171 trees have been banded.
- **Litter:** 25 traps have been monitored fortnightly.

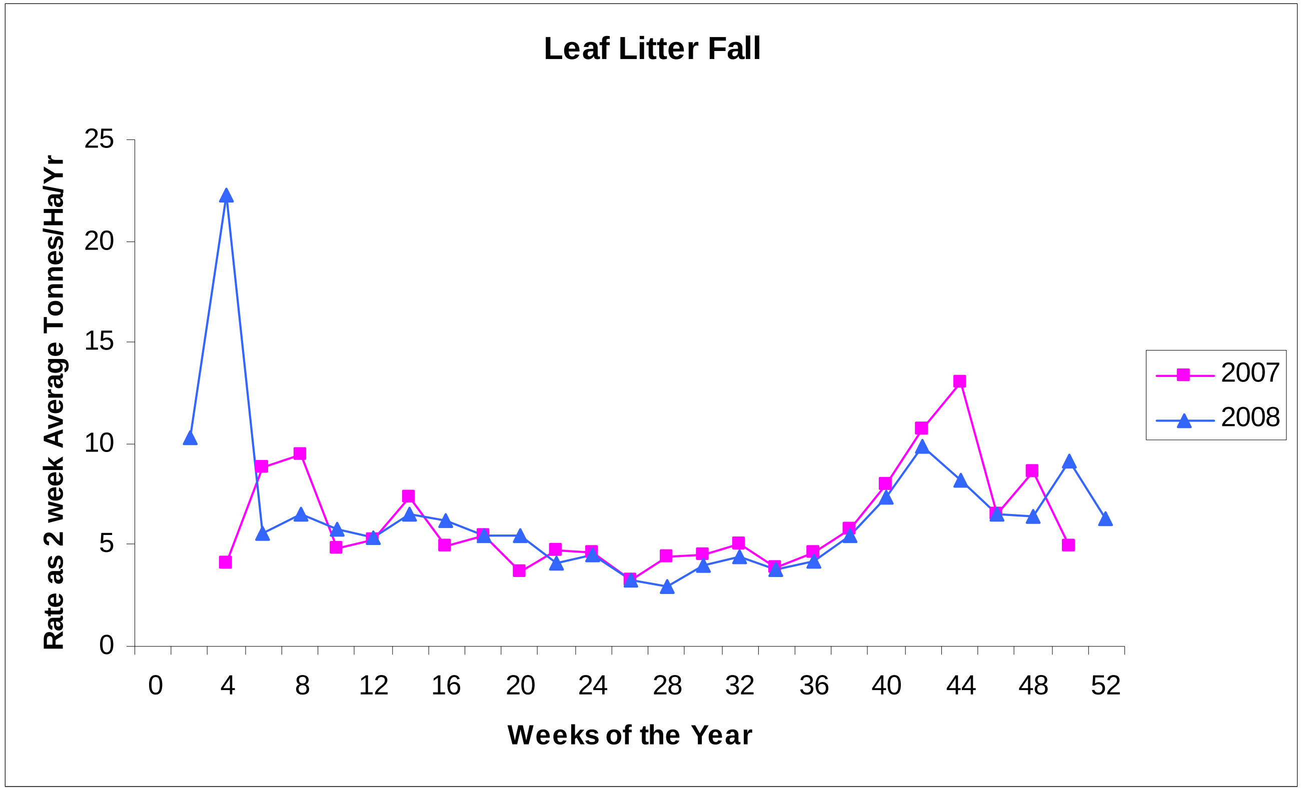
# LEAF LITTER-FALL

## 25 permanent litter traps on one hectare grid

One hectare sampling grid for litter traps, soil and LAI
at the Cape Tribulation Canopy Crane study site.




# Leaf Litter Fall




**Average for 2007**
**6.1 t/ha/yr**

**Average for 2008**
**6.5 t/ha/yr**

# Total Litter Fall

*Fine litter: fall, average amount, and disappearance in*

| Forest formation and place | (a) Fine litterfall (t ha$^{-1}$ year$^{-1}$) |
|---|---|
| **Lowland evergreen rain forest:** | |
| Mulu, Sarawak: ridge | 7.7 |
| valley alluvium | 9.4 |
| Pasoh, Malaya | 10.6 |
| Penang, Malaya | 7.5 |
| Manaus, Brazil | 7.6 |
| **Lowland semi-evergreen rain forest:** | |
| Barro Colorado, Panama | 13.3 |
| Kade, Ghana | 9.7 |

Mainly from Whitmore (1984*a*, Table 10.8); Anderson and Swift in Sutton *et al.* (1983, Table 1)
† Heaney and Proctor (1989)

**Total Litter Fall 2007**

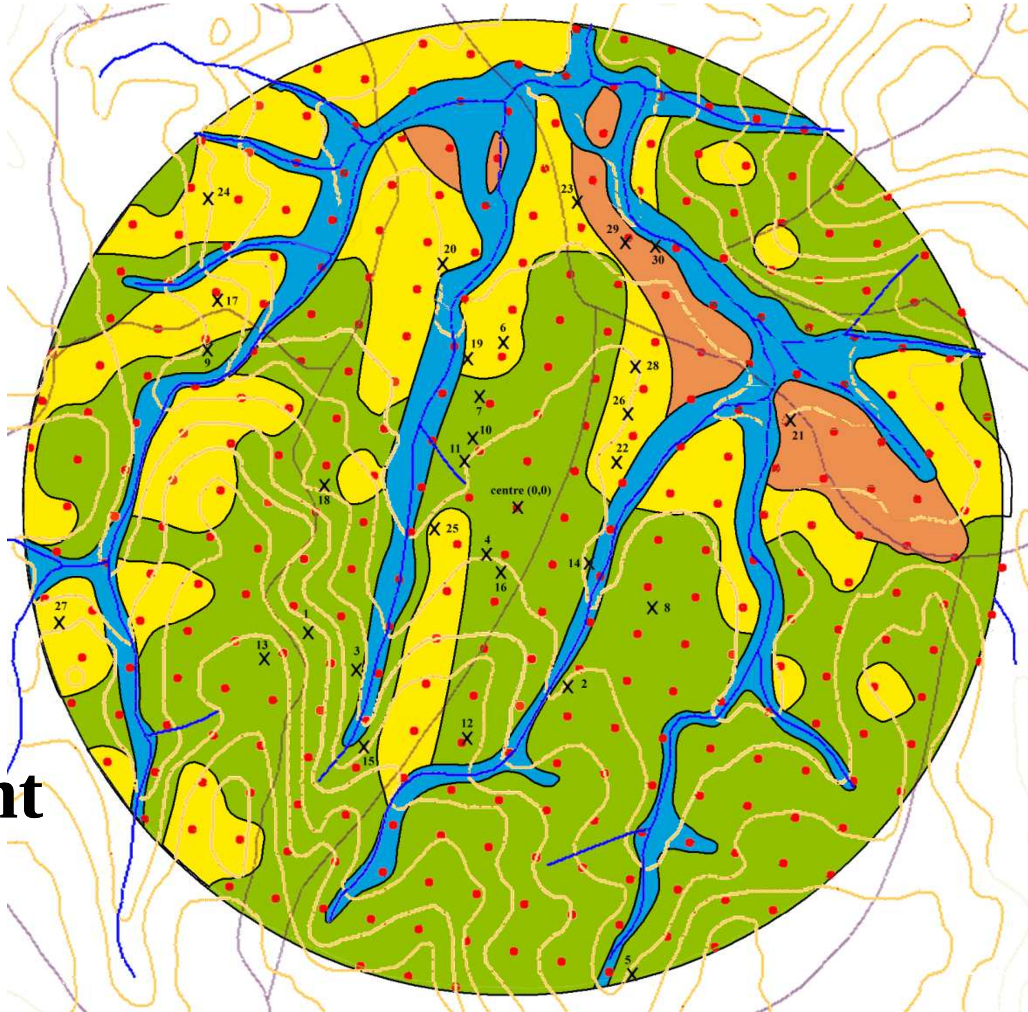
**12.35 tonne/ha/yr**

**Total Litter Fall 2008**

**10.97 tonne/ha/yr**

Woody material 35% 2007   21% 2008

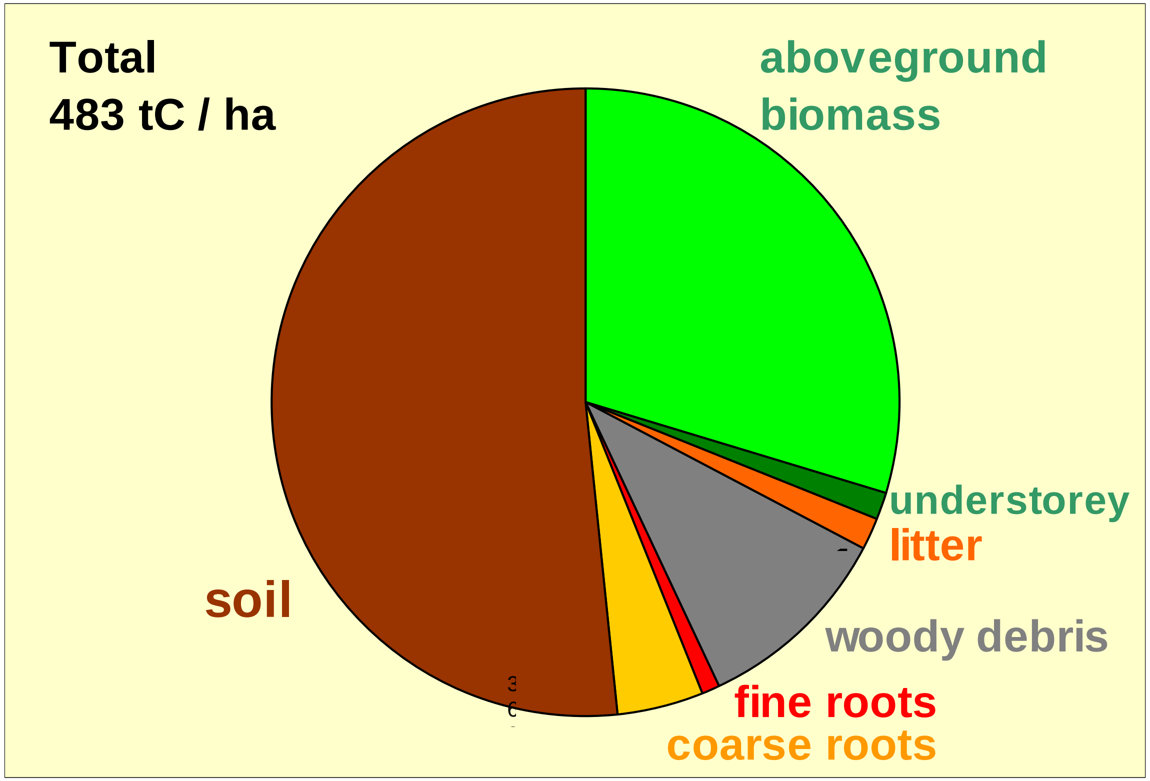
# SPATIAL SAMPLING OF C POOLS



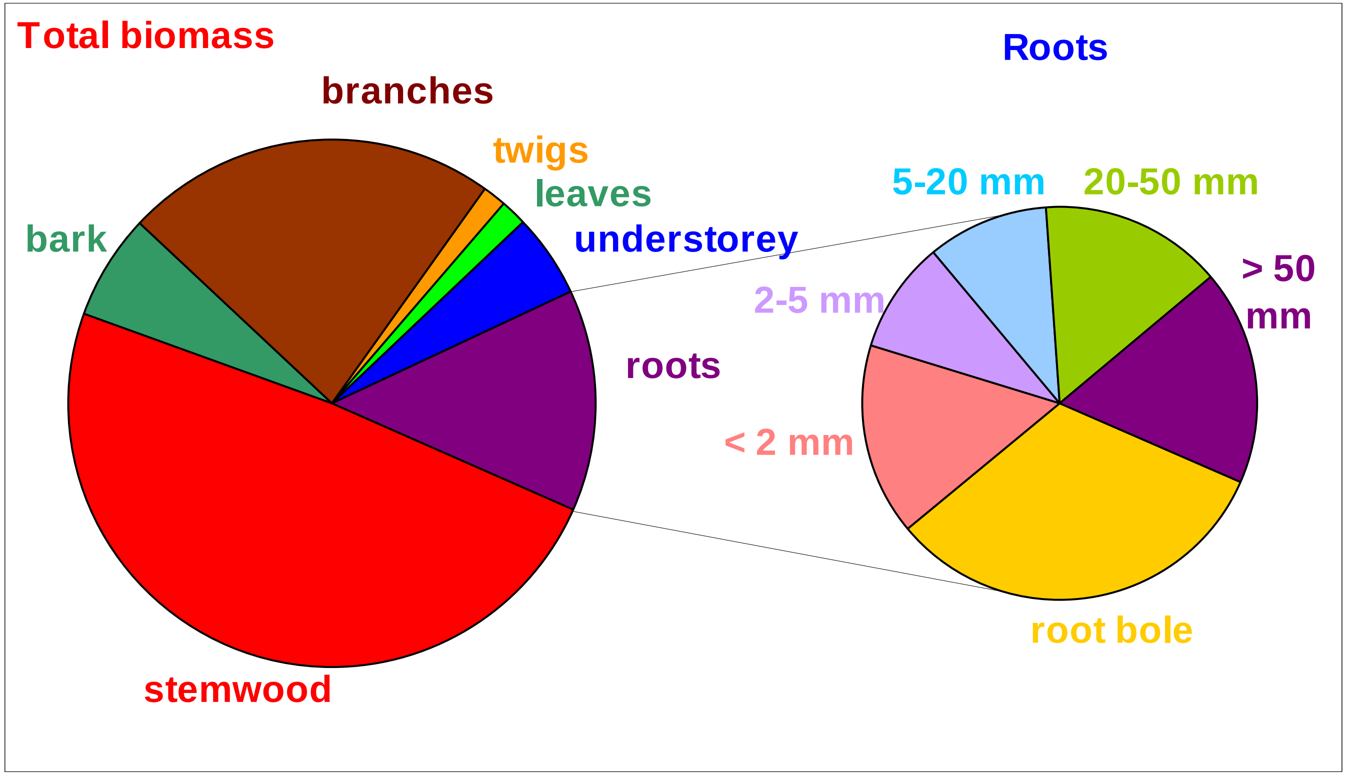

- ❖ **Spatial sampling design at Tumb. Ensured measurements are comparable with the source area of the flux tower.**
- ❖ **Stratified, random distance weighted from tower with 30 permanent plots.**

# BUDGET OF C POOLS

- Total C budget for this forest ecosystem is quite high at nearly 500 tC/ha.
- But nothing like the forest of Jason’s!



# BIOMASS C BUDGET

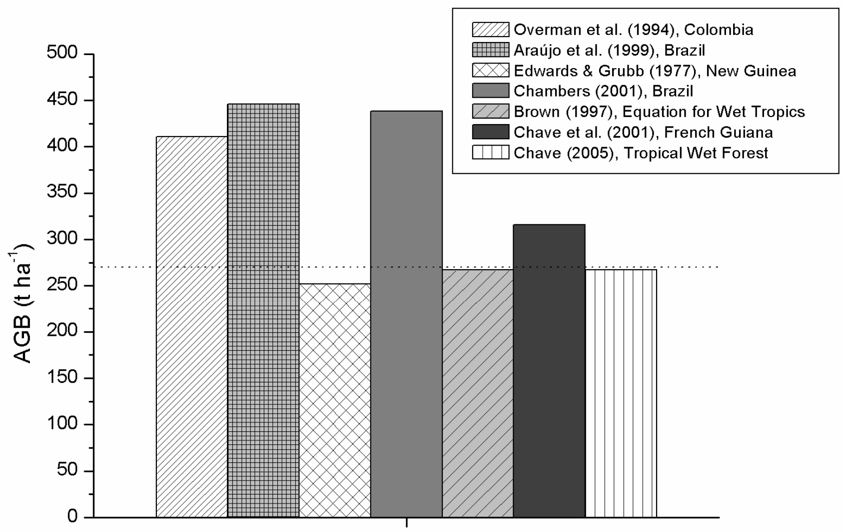



❖ Proportion of roots is small which follows for a forest on deep fertile soils and high rainfall.

# ALLOMETRY

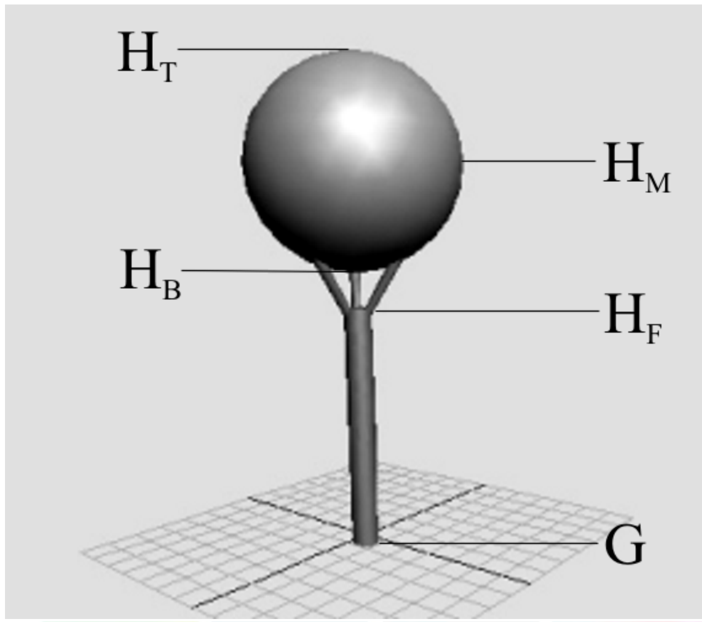
- Allometric equations are used to expand from readily measureable quantities (dbh, height, density) to the above ground biomass for the plot. Hypsometers seem to be the best for height.
- This can then be converted to tC/Ha.


- The difficulty in developing allometric equations is that it requires harvesting of whole trees – or a canopy crane.



# THE CRANE

- **Measurements were made of each component of the AGB, these were then summed to provide an estimate for the tree and then replicated to provide data used to develop a species equation.**




| **Species (kg)** | **Stem biomass (%)** | **Crown biomass (%)** | **Tree biomass (σ)** |
|---|---|---|---|
| *Alstonia scholaris* | 90 | 10 | 246 (215) |
| *Cleistanthus myrianthus* | 69 | 31 | 244 (118) |
| *Myristica insipida* | 80 | 20 | 226 (138) |
| *Acmena graveolens* | 83 | 17 | 1161 (1168) |
| *Endiandra microneura* | 64 | 36 | 791 (708) |
| *Normanbya normanbyi* | 96 | 4 | 145 (46) |

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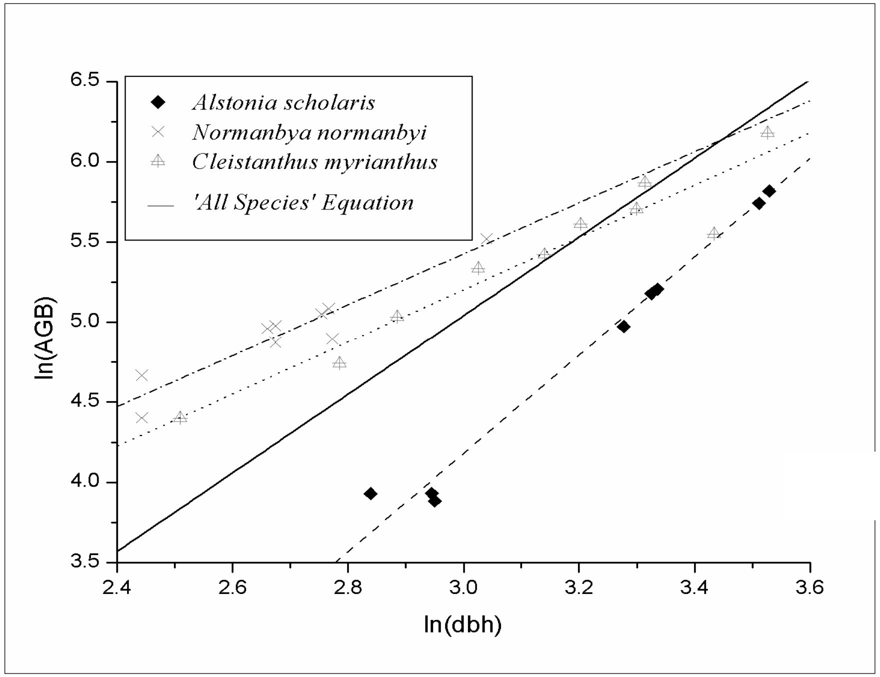
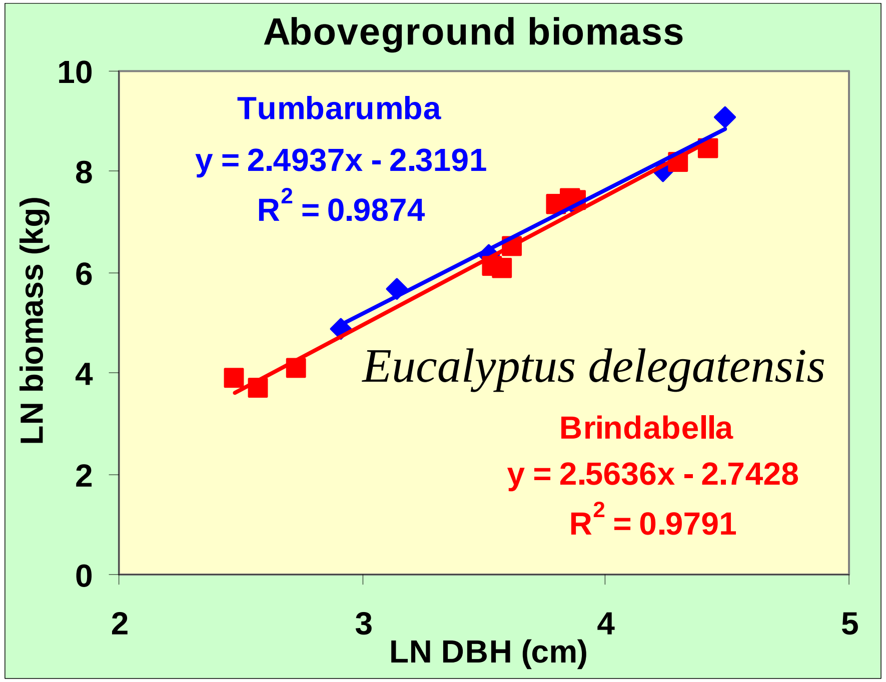
# ALLOMETRY II

- Species specific allometric equations along with general species equations allowed calculation of site AGB = 270 t $ha^{-1}$



# DENDROMETRY

- Dendrometer bands were placed on 171 trees with DBH >25cm in March 2007
- DBH = at 1.30m above forest floor.
- Growth rates in year 2007/8 ranged from 0 to 8cm increase in circumference.
- Census interval on dbh plot is every 5 years.

# LAI HIGHLY VARIABLE

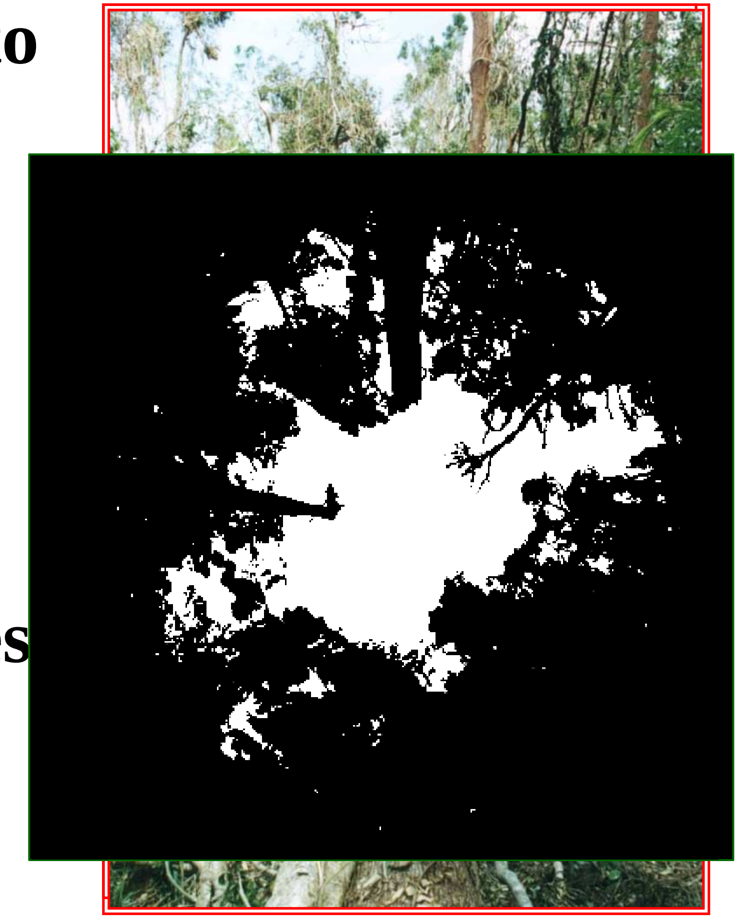
**Highly variable crown cover and LAI over one hectare plot**

(Three of the 25 canopy fish-eye images taken at litter trap sites in April 2008)

# AFTER CYCLONE RONA

**Significant damage occurred to the canopy structure.**

- **in particular the vines towers were knocked to the ground.**
- **large amounts of debris trees were carried to the fores floor.**
- **Light penetration changed considerably.**



# GRANIER: SAP FLOW SYSTEM
## (THERMAL DISSIPATION)

- **The constant current power supply heats the top needle electrode.** UP GmbH System Germany **12-14 V DC supply.**
- **$\Delta T$ measured between top and bottom electrodes.**
- **Sap velocity inversely proportional to $\Delta T$**

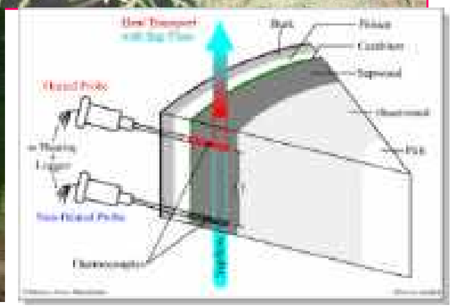
**$\Rightarrow$ calculate the sap flux density $U_v$**

- **$\Delta T_o$ measured when no sap flux.**

$$U_v = 0.000119 * Z^{1.231} \qquad [m^3\ m^{-2}\ s^{-1}]$$

$$Z = \frac{(\Delta T_o - \Delta T)}{\Delta T}$$

$$Q = \rho_s * u_v * A_{sw} \qquad [kg\ s^{-1}]$$

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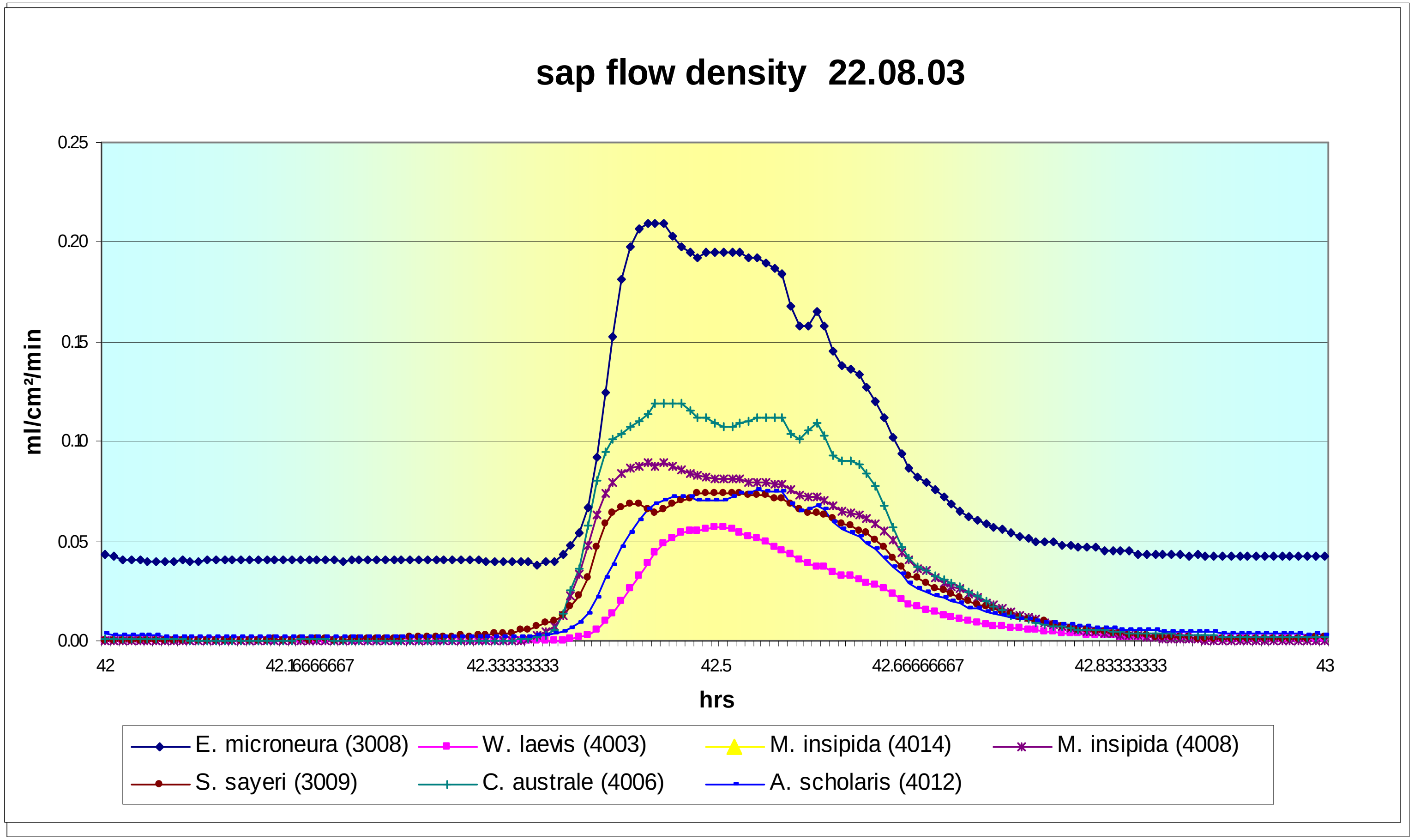
# GRANIER: SAP FLOW SYSTEM DATA



# TRUNK HEAT BALANCE: SAP FLOW SYSTEM

EMS-51 System, Czech Republic

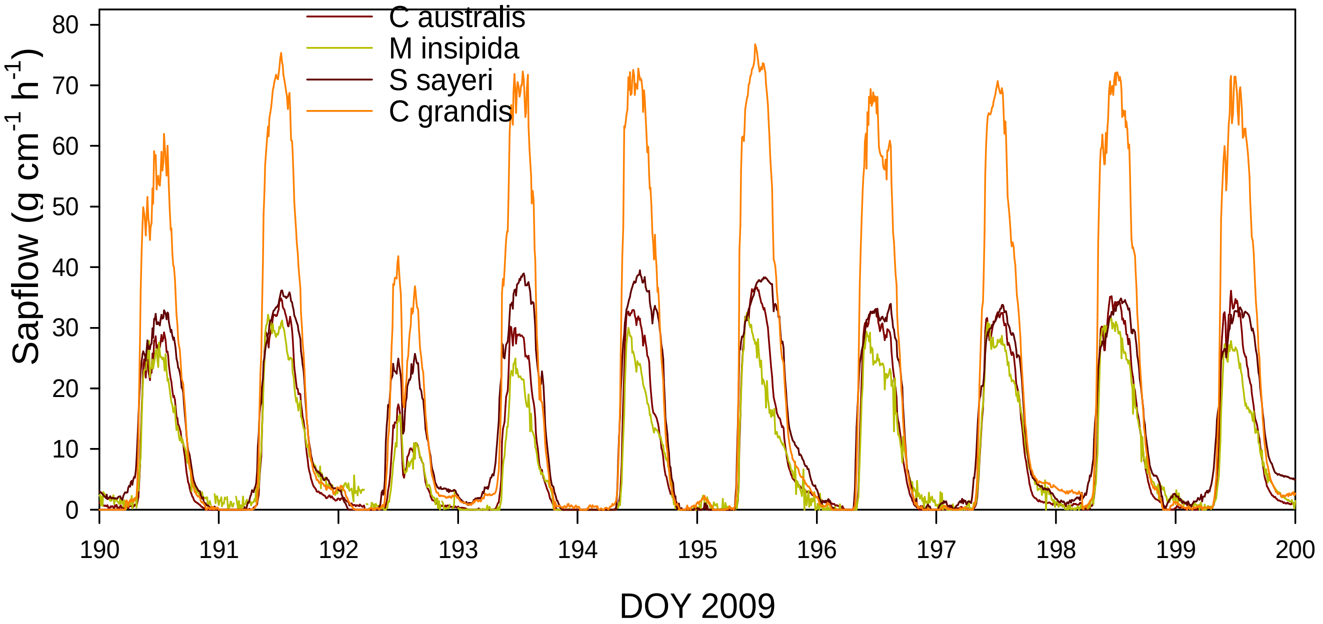
- **The power supply current is proportional to the sap flow ( 40 - 200 mA)**
- **12-14 V DC supply is converted to 1kHz AC which is supplied at constant power (0.6W) by top 3 electrodes.**
- **T on 3 electrodes measured relative to T on bottom electrode.**

$$Q_{cm} = \frac{P}{c_w * d * dT} - \frac{z}{c_w} \quad [\text{kg s}^{-1}\text{ cm}^{-1}]$$

$$= 0.000125 * U_{sig}[\text{mV}] - Q_{idle} \quad [\text{kg h}^{-1}\text{ cm}^{-1}]$$

$$Q_{tree} = Q_{cm}*(A - 6.28*B) \quad [\text{kg/hr}]$$

# TRUNK HEAT BALANCE: DATA



# PHOTOSYNTHETIC PARAMETERS

Peter Franks
*Plant, Cell and Environment*
*(2006) 29, 584–592*

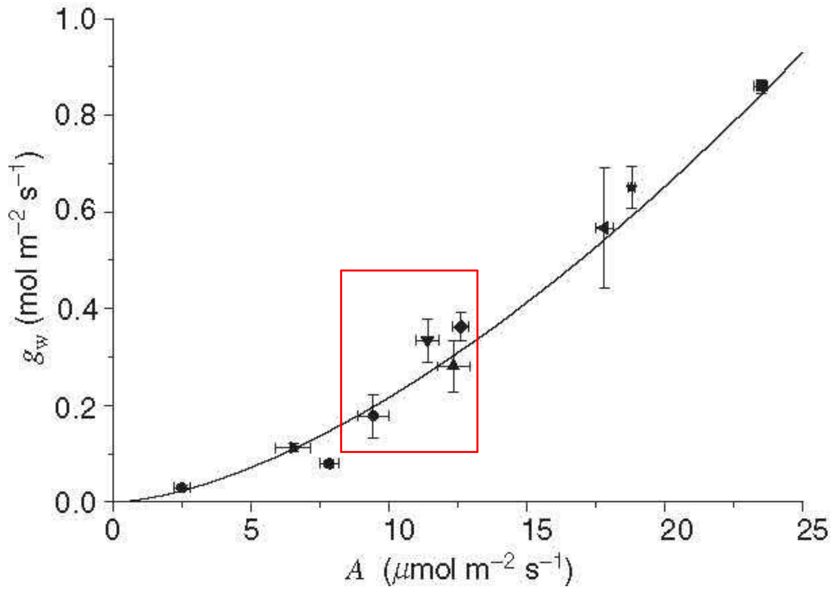
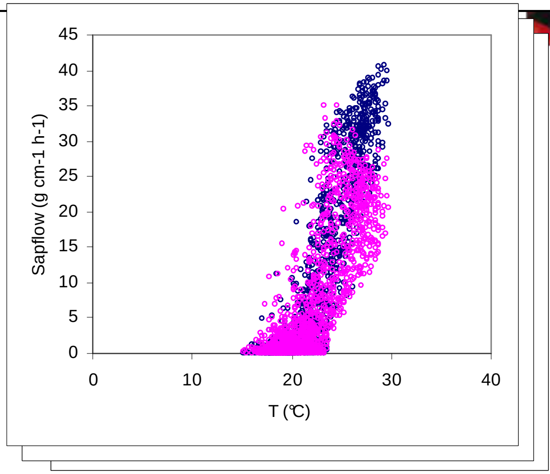


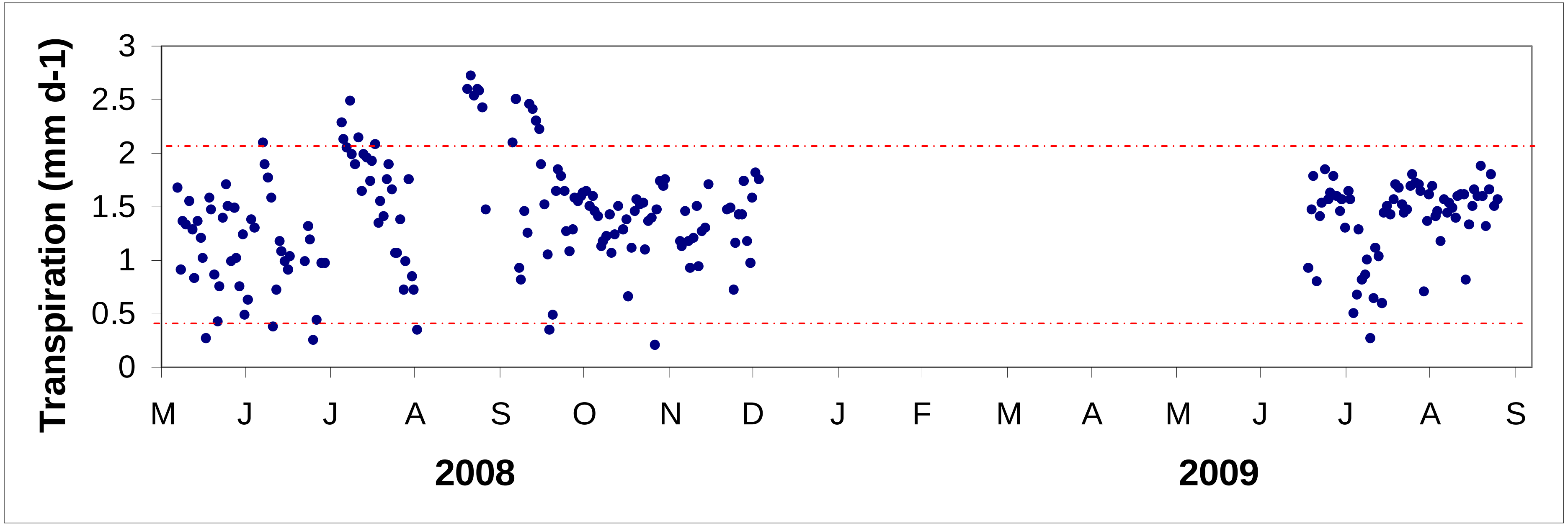

**Figure 5.** Steady-state stomatal conductance to water vapour ($g_w$) versus $CO_2$ assimilation rate ($A$) across the 10 species. The relationship is well described by a power function (solid line, $g_w = 0.0056A^{1.6}$). ▼, *Acmena graveolens*; ▲, *Argyrodendron peralatum*; ◆, *Dysoxylum pettigrewianum*; ★, *Eucalyptus ptychocarpa*; ▶, *Idiospermum australiense*; ⬢, *Nephrolepis exaltata*; ⬟, *Psilotum nudum*; ●, *Syzygium sayeri*; ■, *Triticum aestivum*; ◀, *Vicia faba*. Conditions as for Fig. 2.

# TRUNK HEAT BALANCE: DATA II

**Sapflow can be analysed in terms of environmental drivers.**

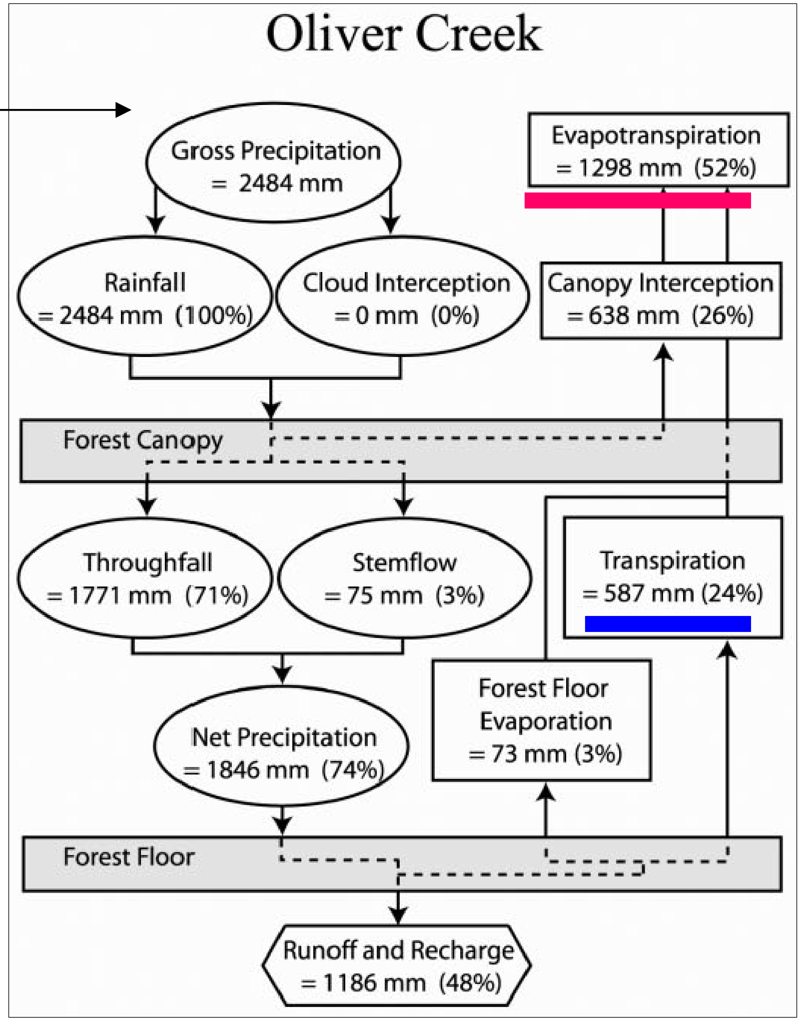
- **Scaled from tree to stand.**



# TRUNK HEAT BALANCE: DATA III

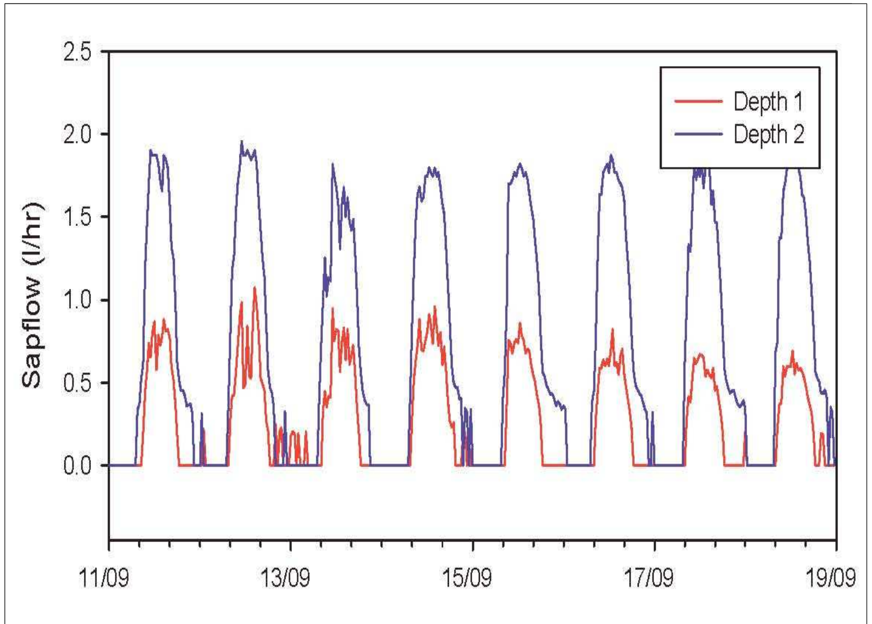
- **D. McJannet et al.** ***Hydrol. Process.*** **21 (2007) 3473.**
- **Trunk Heat Balance : Annual transpiration around 540mm**
- **Eddy flux LE 4.8mm d$^{-1}$. evapotransp. 1752mm y$^{-1}$**
- **Extended dry period from July through to October precipitation input < 4mm day.**
- **Mean water uptake from the soil was between 2 - 4 mm d$^{-1}$.**



# HEAT PULSE: SAP FLOW SYSTEM

**D. McJannet & P. Fitch**
***CSIRO Land and Water***
***Technical Report No. 39/04***

- **sap flow is measured by determining the velocity of a short pulse of heat carried by the moving sap stream.**



. Heat pulse thermistors and heater installed in sapwood of a tree.

- **Sap flow velocities are calculated and converted to volumetric sap flow.**
- **A commercial example is Greenspan Technology (Qld): Lindsay Hutley, Derek Eamus**