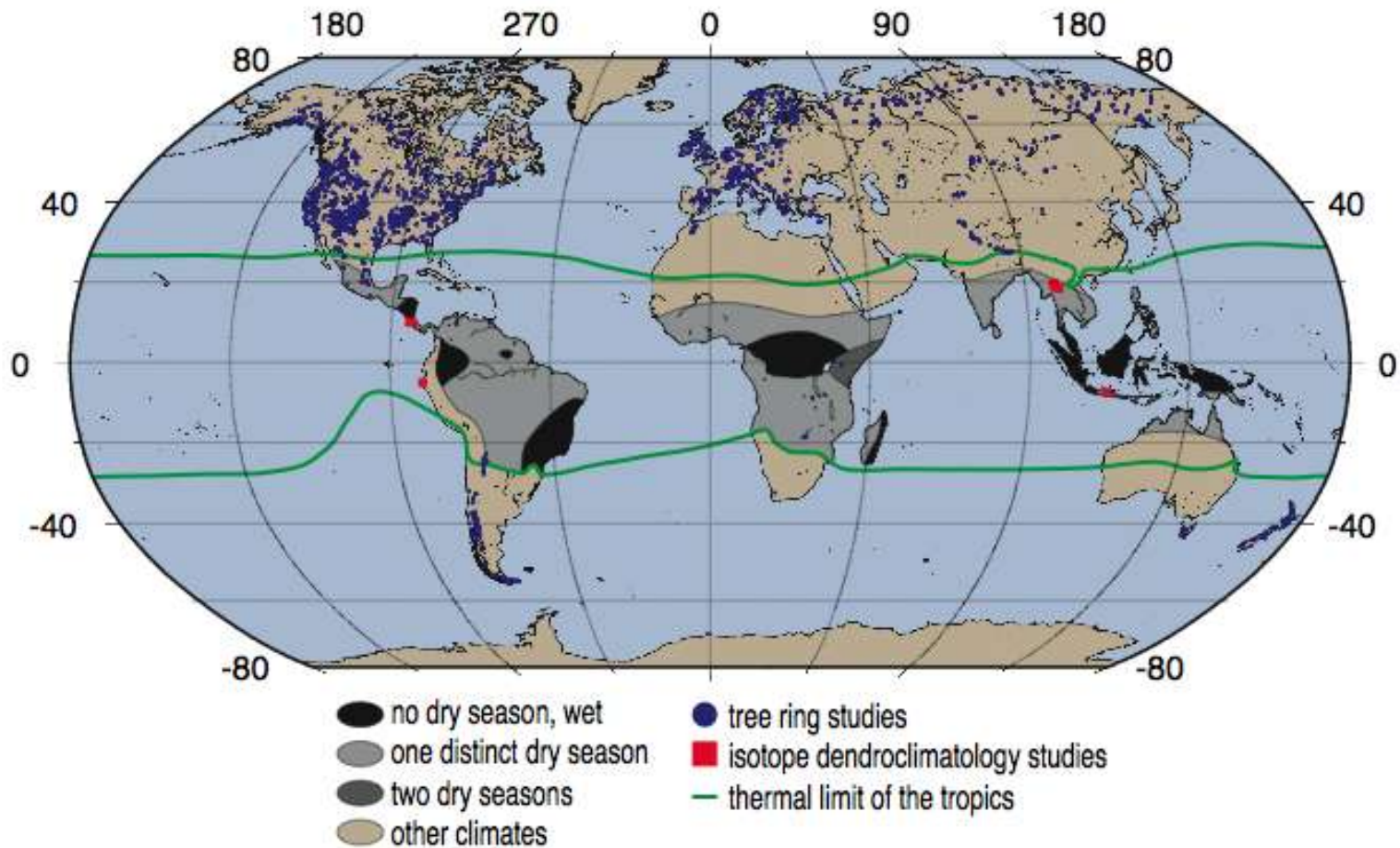


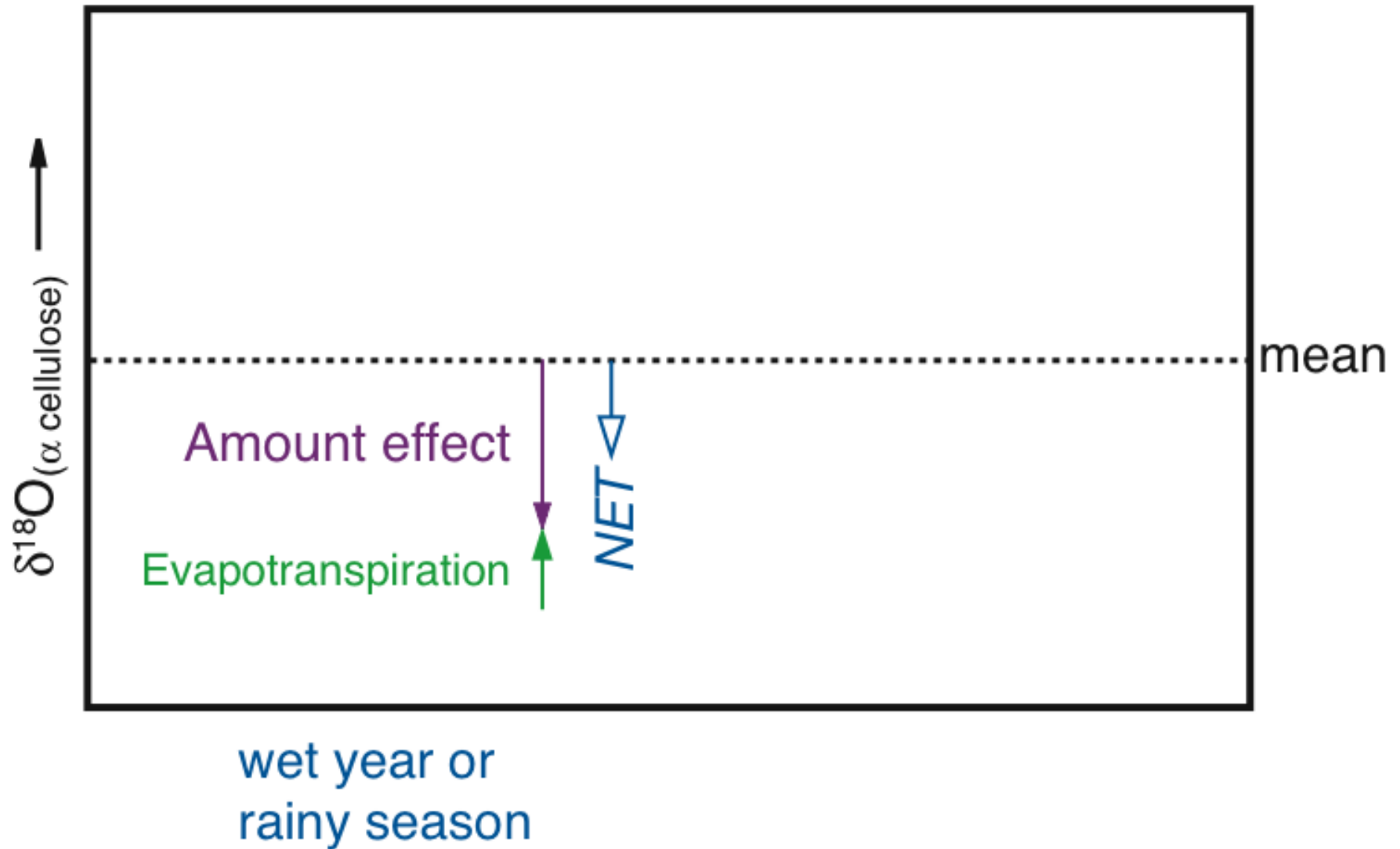
On the development of dendro-geochemical techniques for the study of the terrestrial tropics

Pascale Poussart

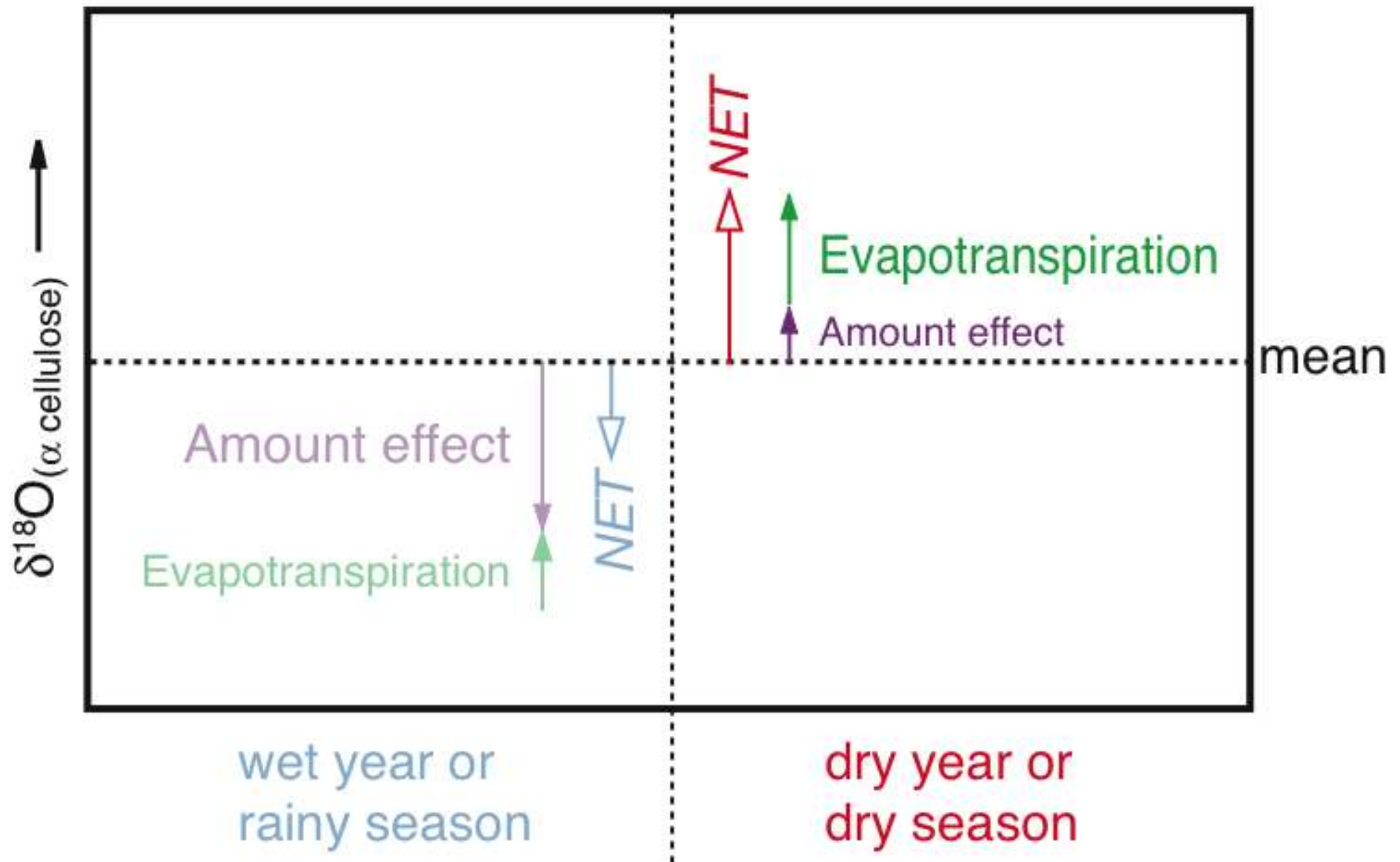


Much of the tropics have seasonal rainfall patterns

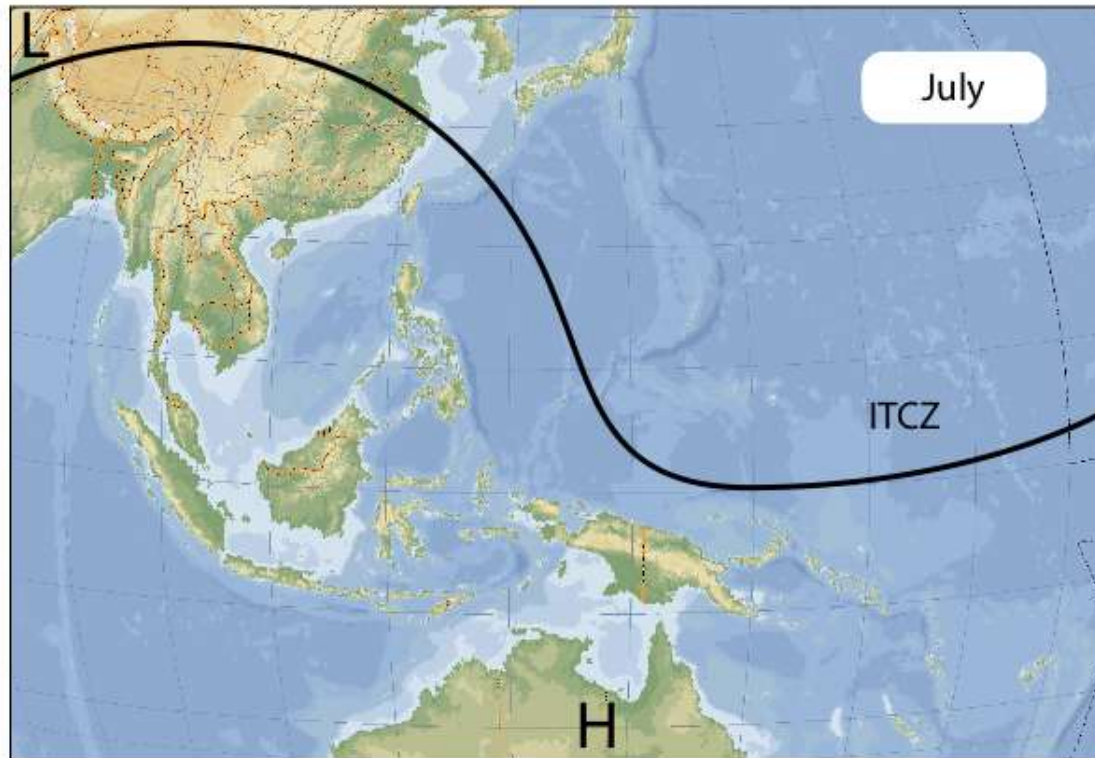
Annual or seasonal $\delta^{18}\text{O}$ signal recorded in tree cellulose



Annual or seasonal $\delta^{18}\text{O}$ signal recorded in tree cellulose



Climate of Southeast Asia



Climate of Southeast Asia

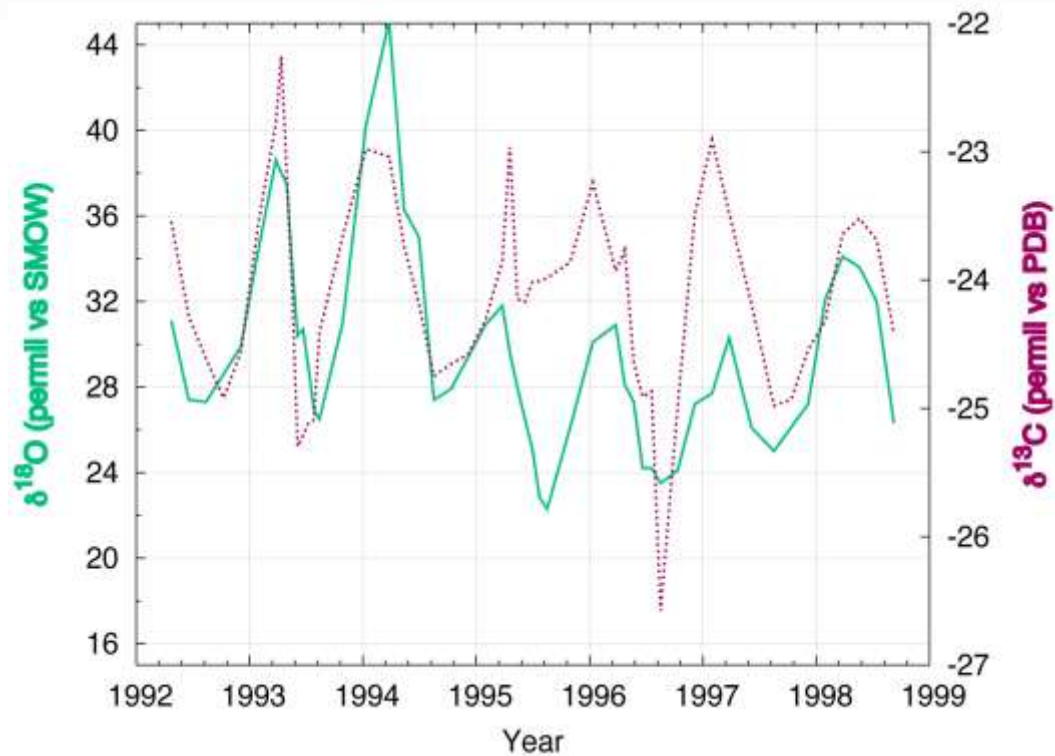


Isotopic chronometer

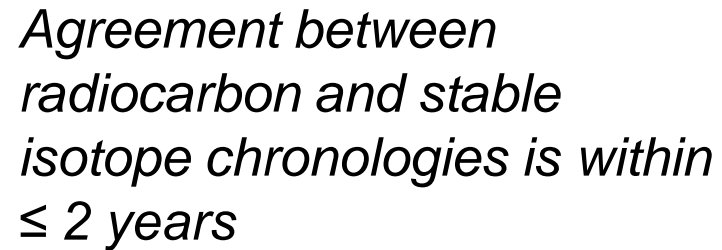


DIN99south - Podocarpus herriifolius
Scar from end of October 1992
Tree cut in February 1999

Isotopic chronometer



Poussart et al. (2004)

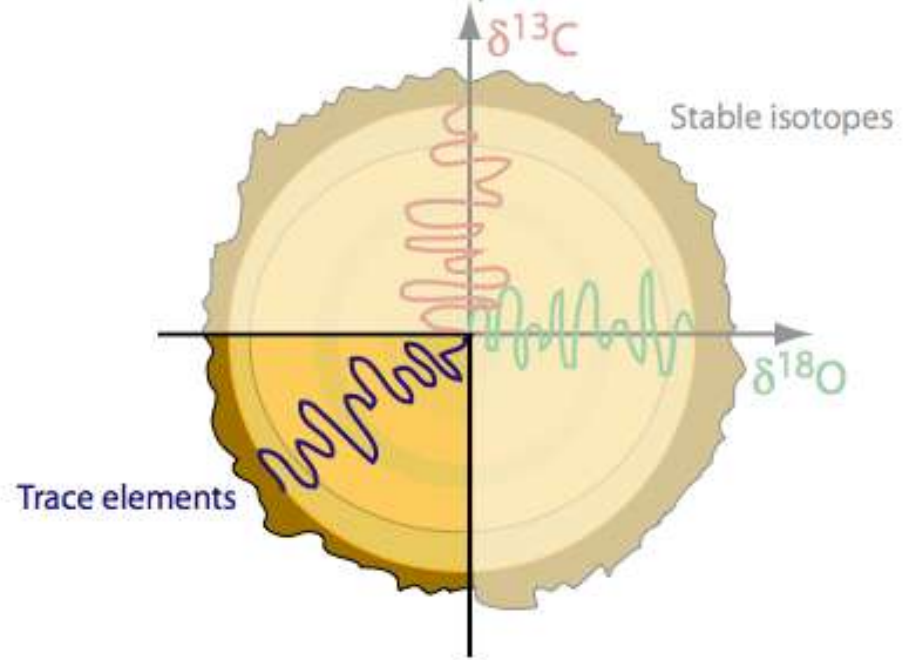


Poussart and Schrag (2005)

Dendrochronology



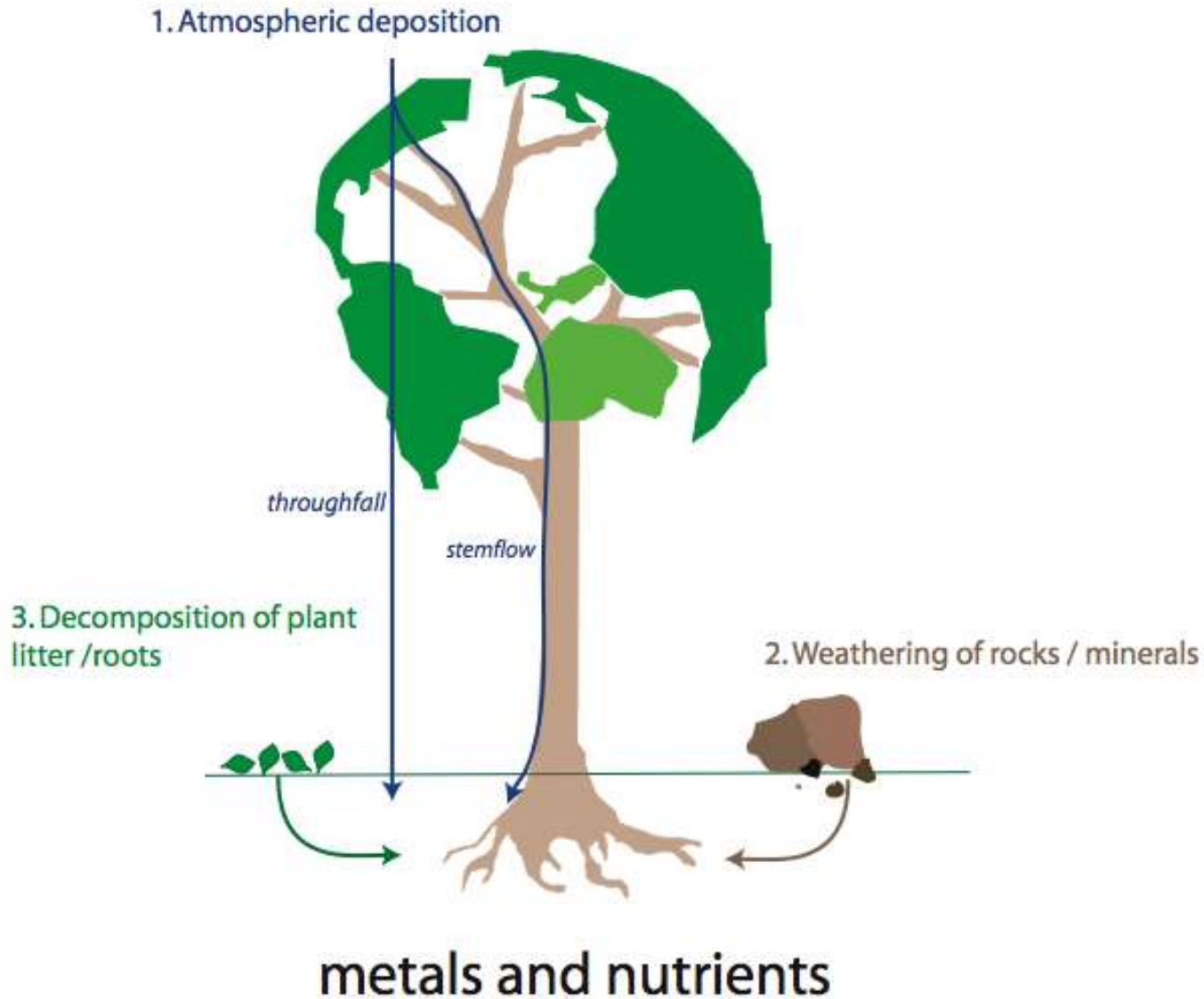
Tools for tropical trees



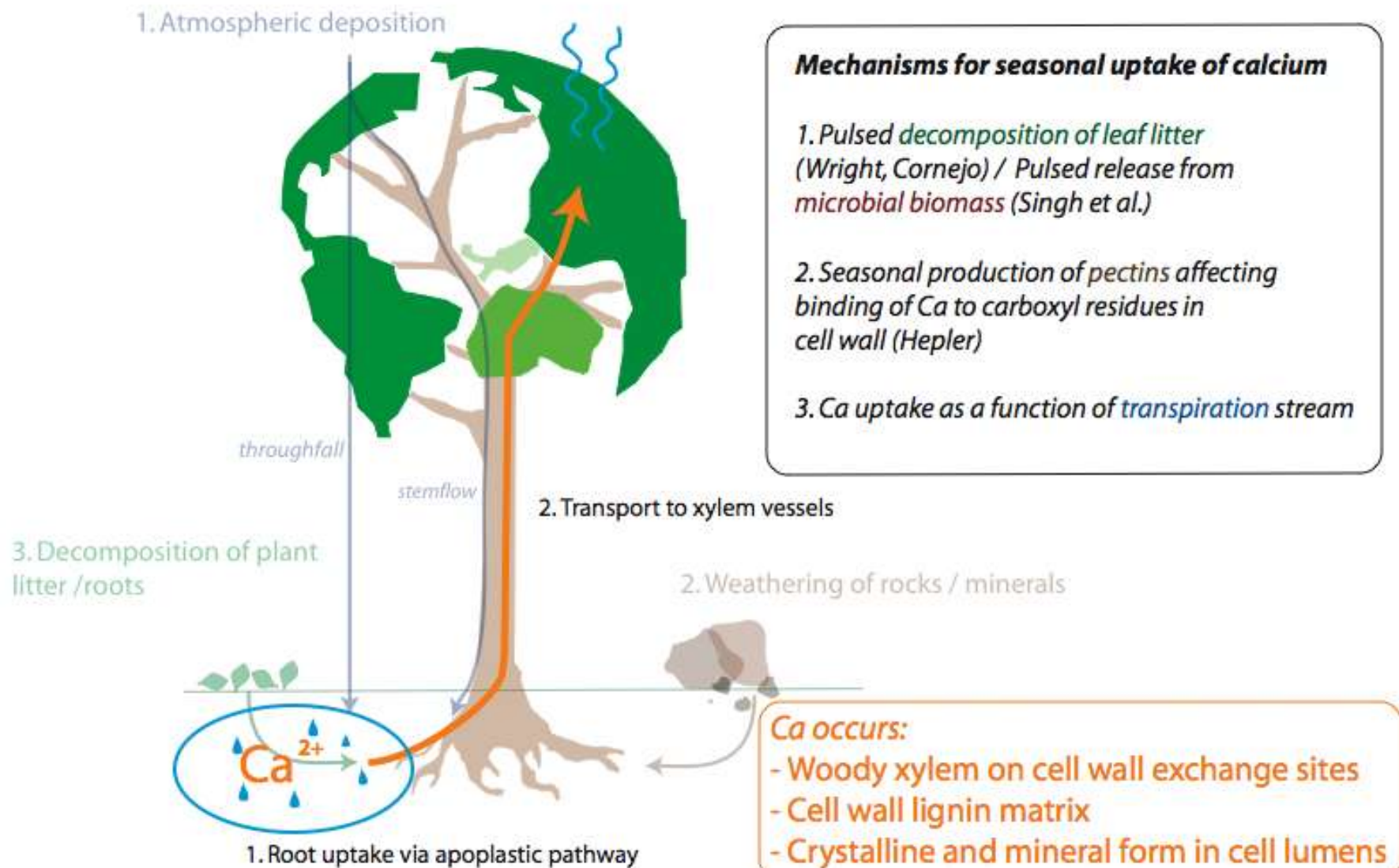
Tree age
Growth rate history
Climate history

Additional tools: Radioisotopes, dendrometry, cambium wounding methods

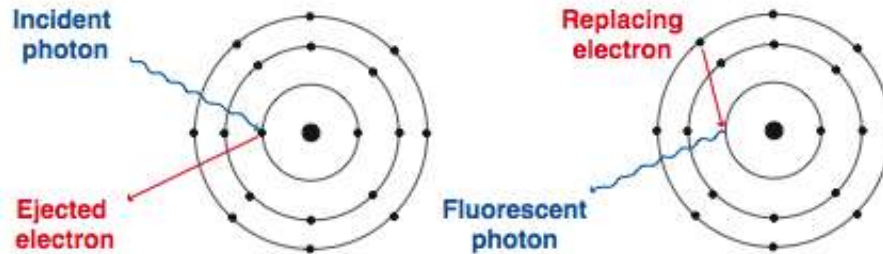
Tropical dendrochemistry



Tropical dendrochemistry



X-Ray Fluorescence



Periodic table (Mo)

Periodic table (Mo)																					
1 H																	2 He				
3 Li	4 Be															5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg															13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr				
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe				
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn				
87 Fr	88 Ra	89 Ac																			
Sensitivity																					

Sensitivity



low

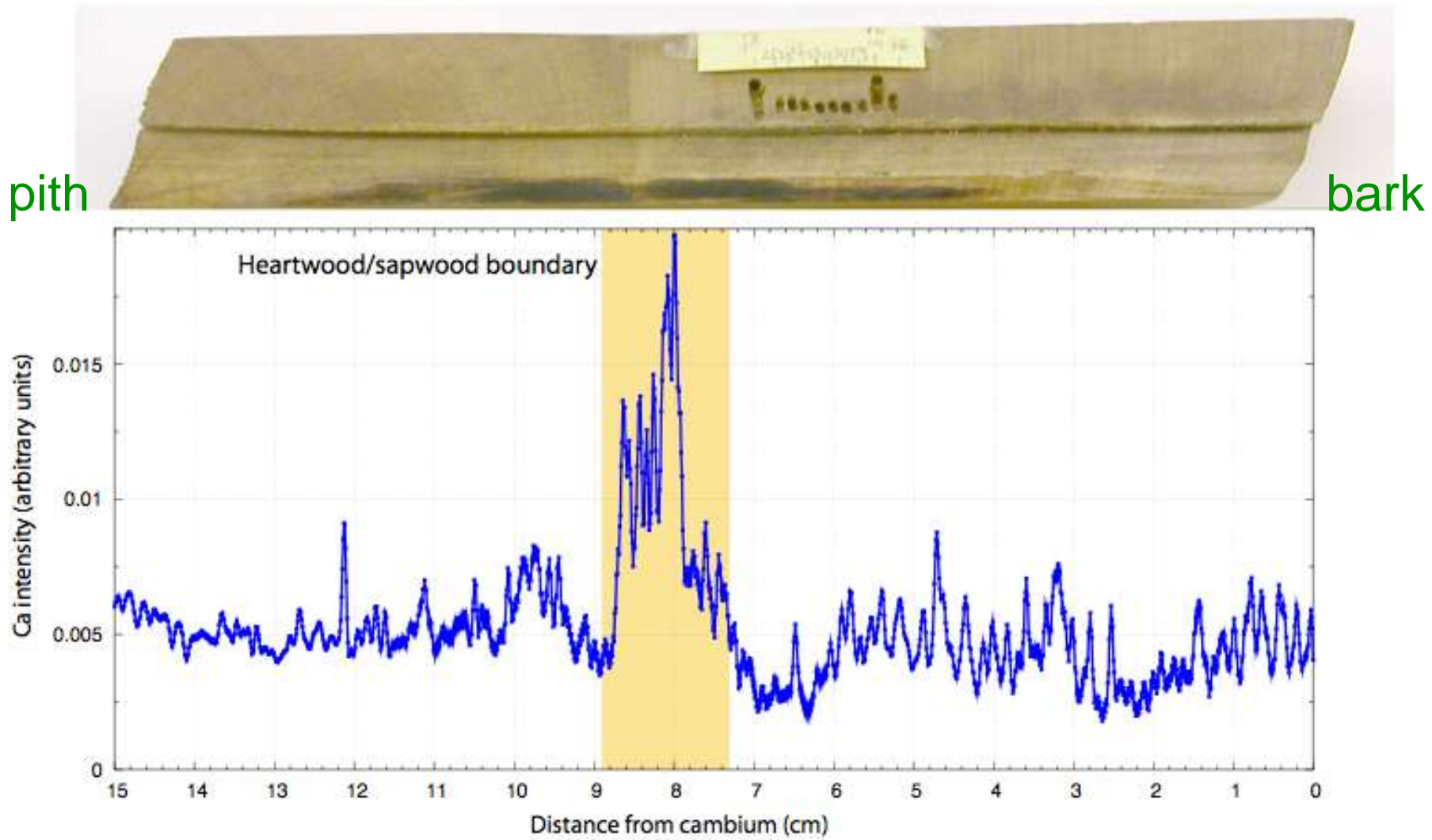


medium

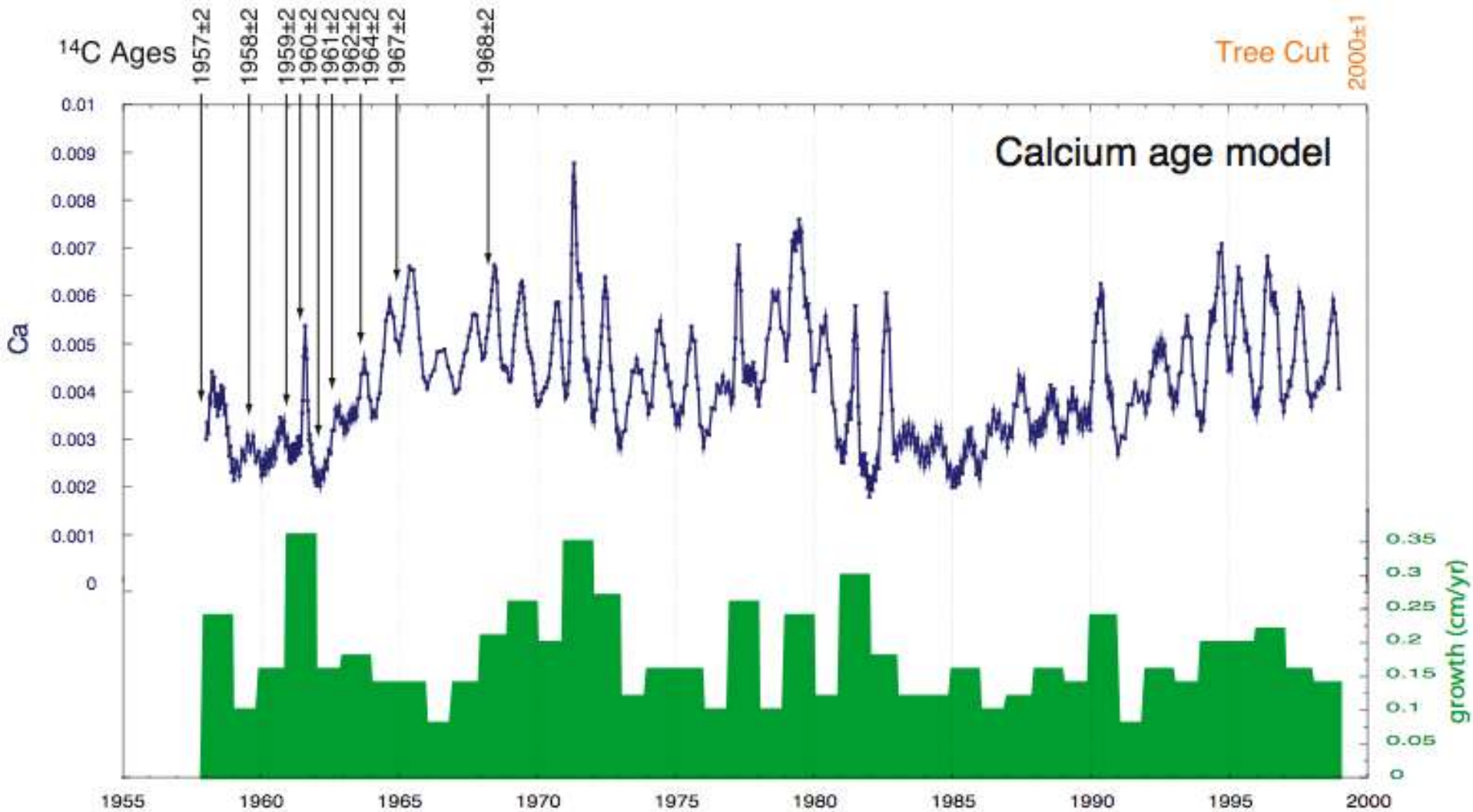


high

PK1 Miliusa Velutina

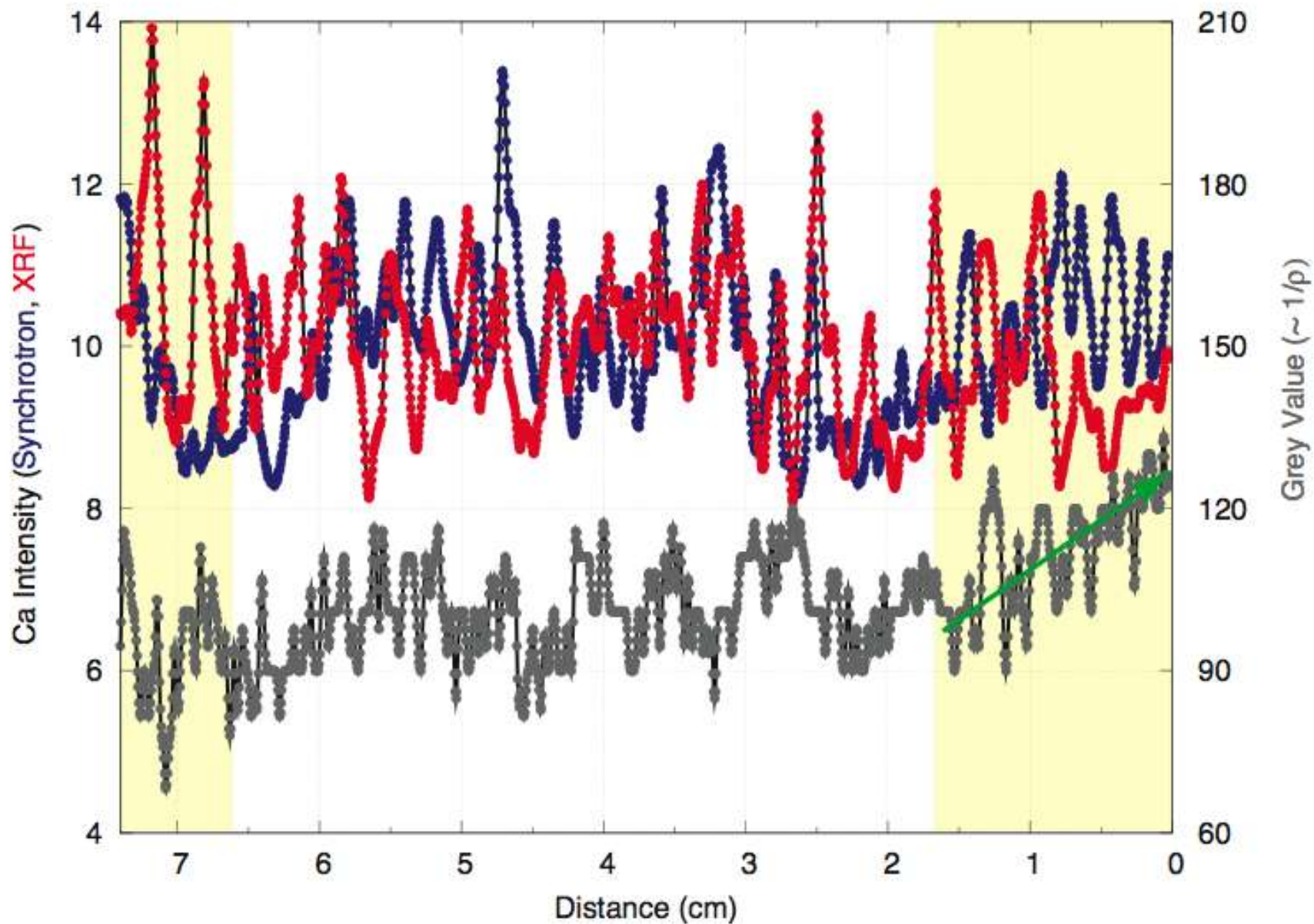


Poussart et al. (2006)

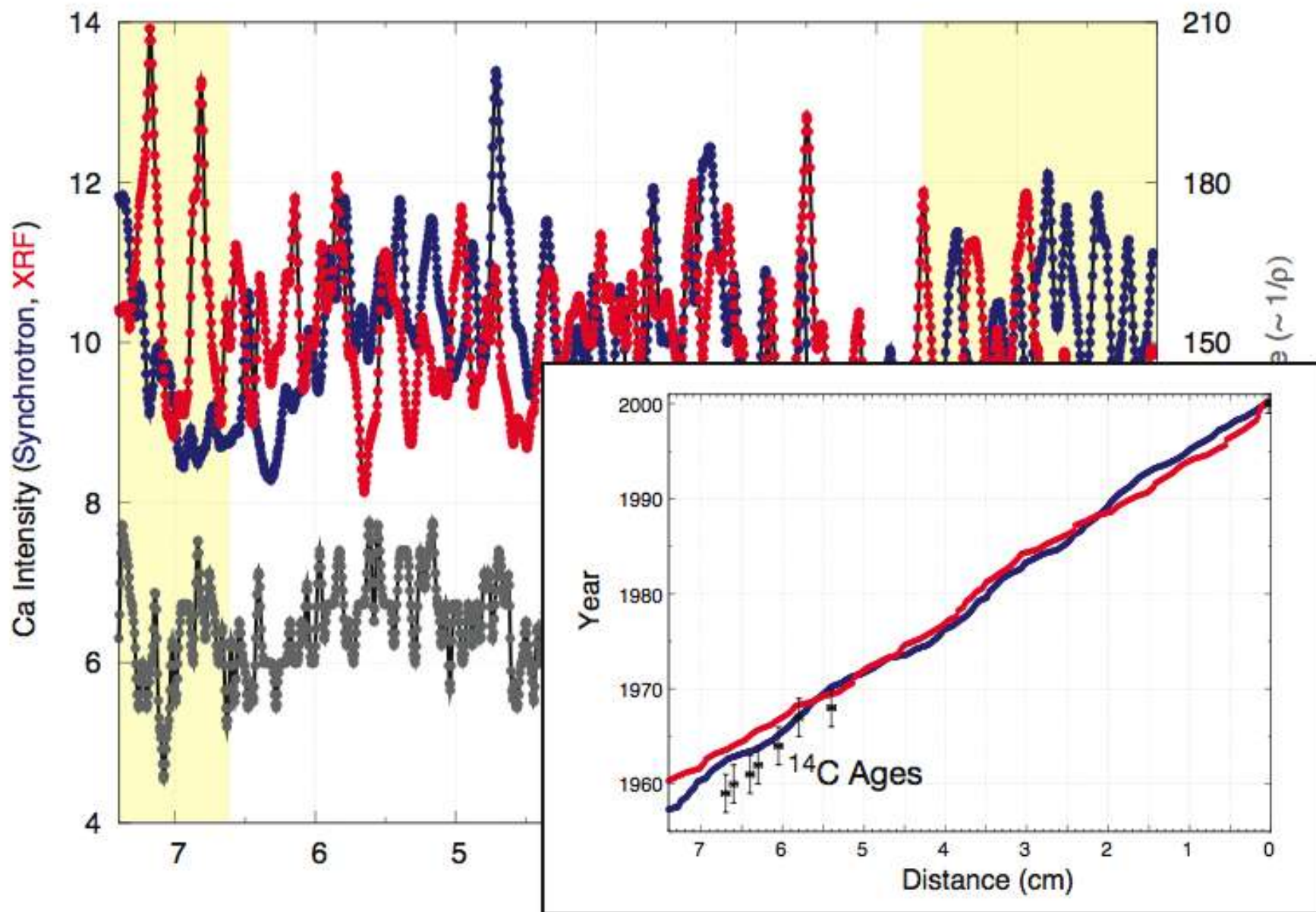


Annual Ca maximum intensities are significantly correlated with March rainfall in Mae Sariang (end of dry season)
($r = 0.47$ $p < 0.01$)

SYNCHROTRON VERSUS XRF



SYNCHROTRON VERSUS XRF



Results

Ringless tropical trees record seasonal cycles

These cycles are observed using $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and Ca. ($\Delta^{14}\text{C}$)

Isotopic and elemental age models all agree within ± 2 years

One tree sample shows correlation with rainfall.

For statistically robust climate records, we will need to make use of the fast XRF collection to generate large numbers of replicated records.



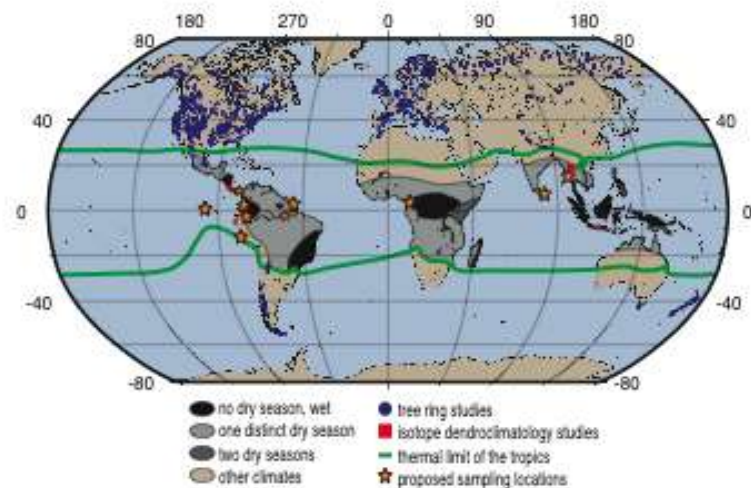
Future work

Sampling in **Brazil, French Guiana, Indonesia, Panama and Thailand.**

Use Forest Dynamics Plots from STRI.

Use of data sets in ecology, soil chemistry, climatology and dendrometry to study nutrient cycling.

This will help **fill the gap in paleoclimate archives from the terrestrial tropics.**

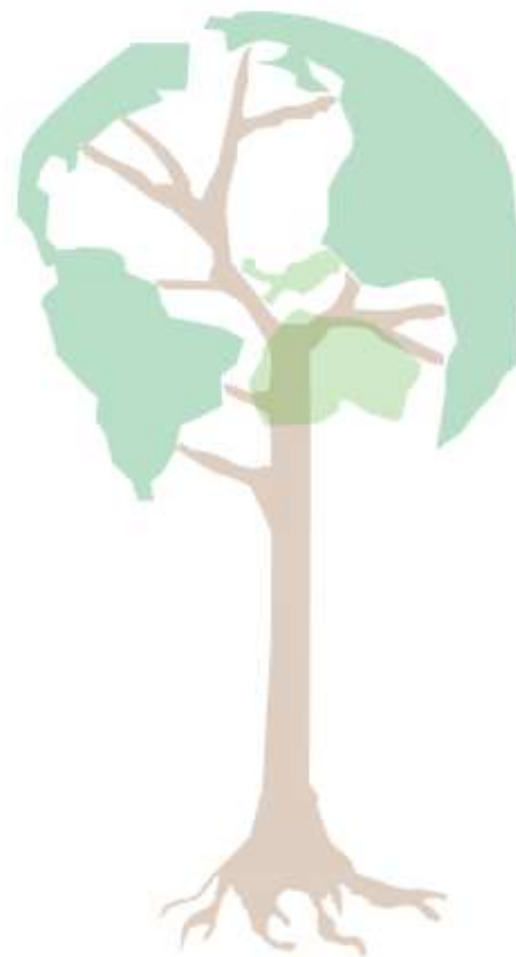


Acknowledgements

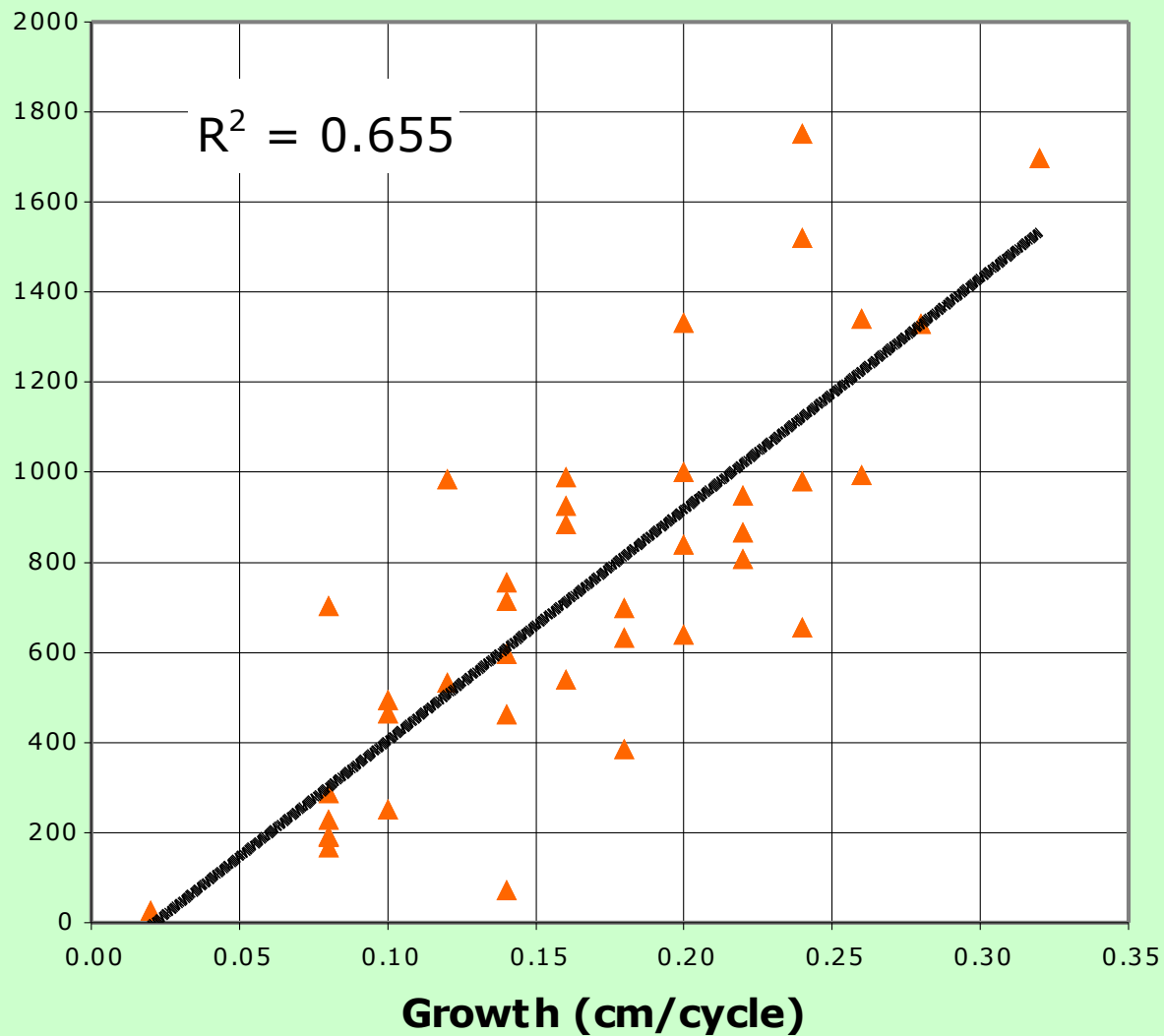
Satish Myneni (Princeton Geosciences)
Tony Lanzirotti (Brookhaven National Lab)
Jess Tierney (WHOI)
Dan Schrag (Harvard)
Mike Evans (University of Arizona)
Tom Guilderson (Lawrence Livermore National Lab)
Brendan Buckley (Lamont)

Funding

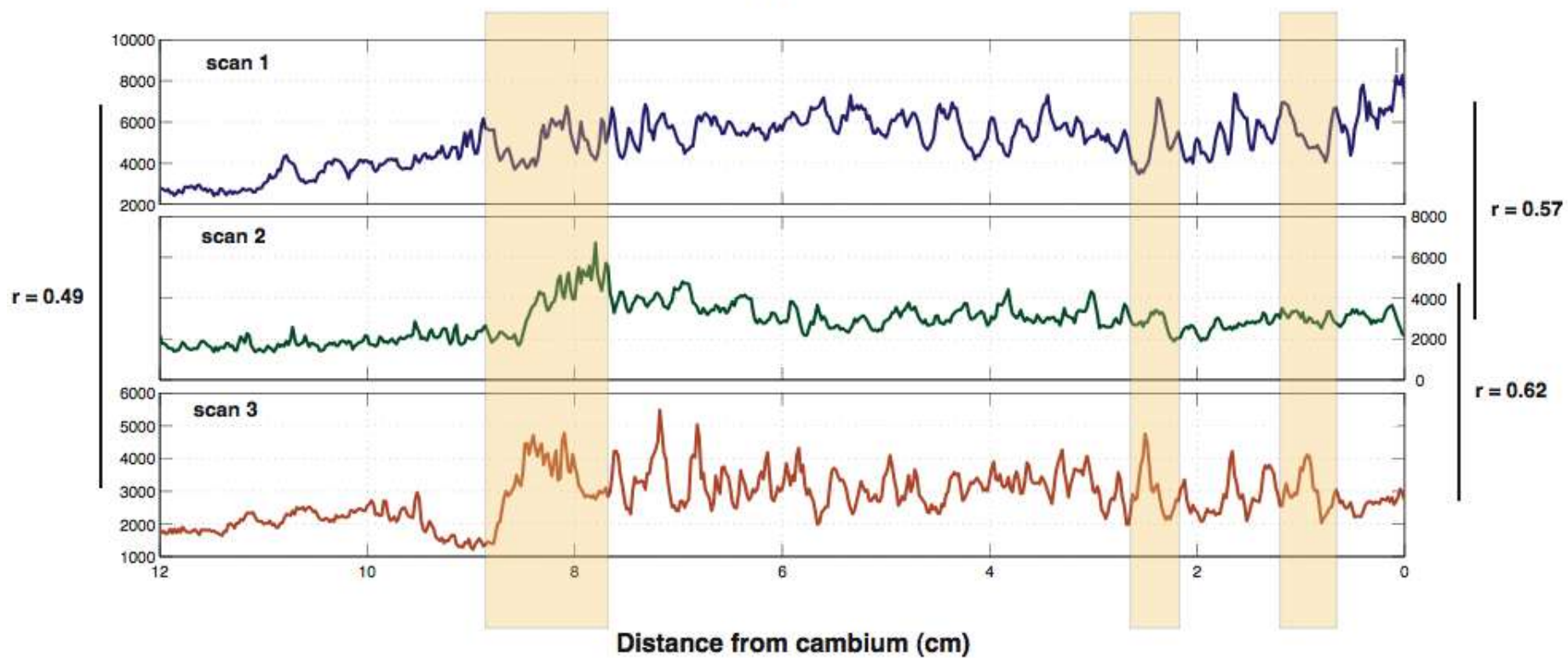
FCAR, NSERC, NSF, CTFS
Teresa Heinz Foundation for Environmental Research



Ca - Average Peak to Trough



PK1: WHOI scanning XRF Ca intensity



Doi Inthanon

Podocarpus neriifolius



Pangmapa

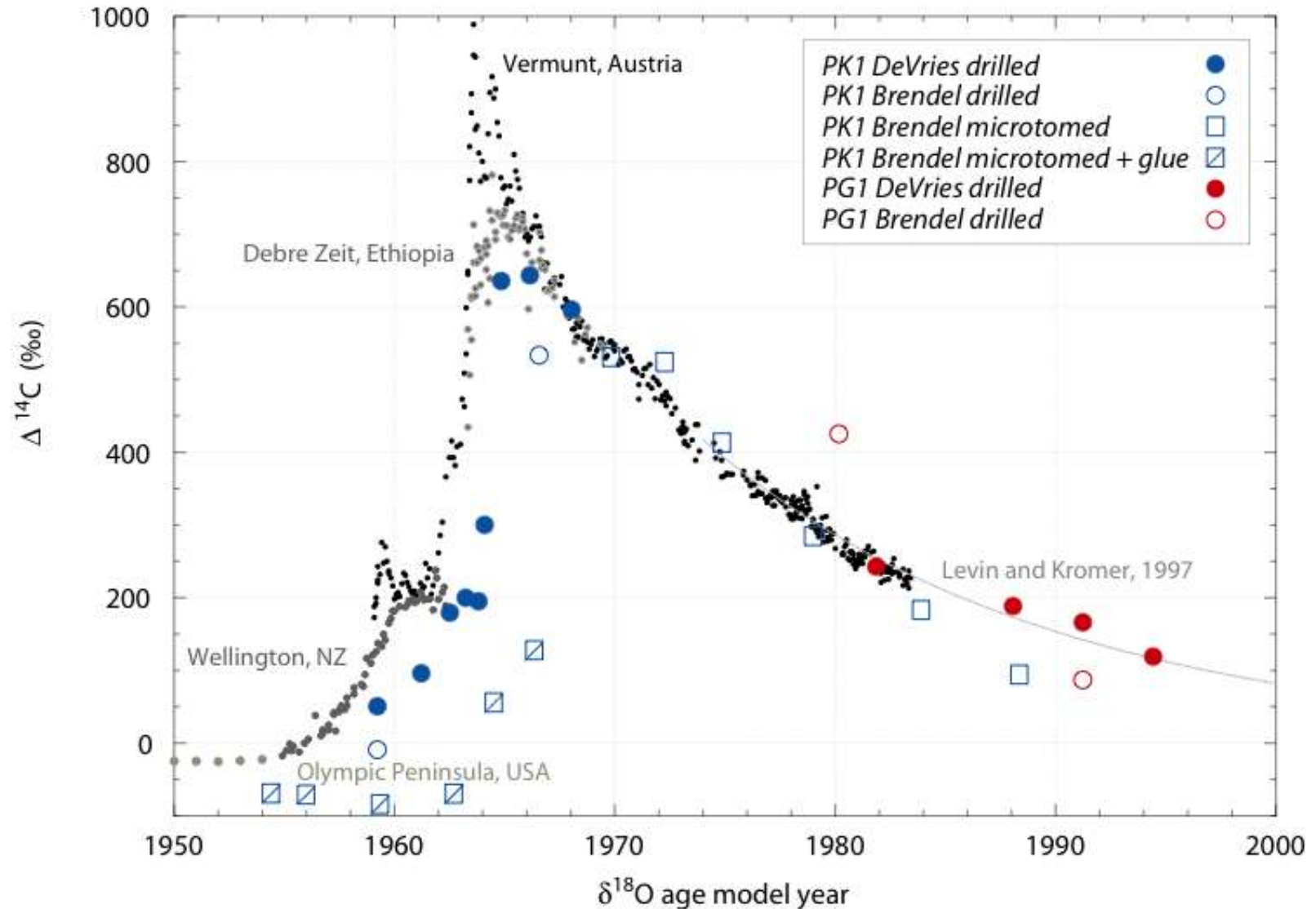
Quercus kerrii (PG1)



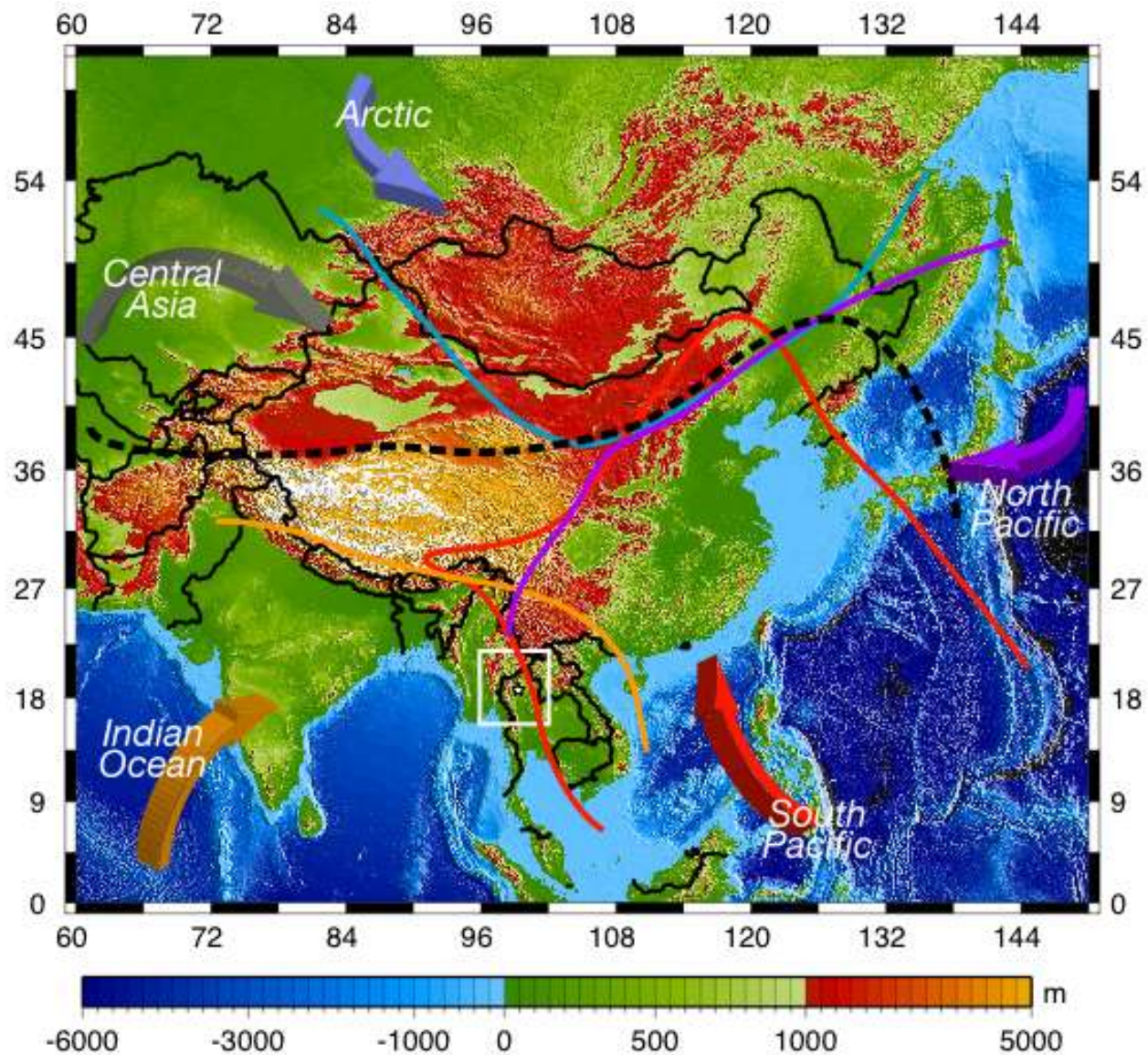
Miliusa velutina (PK1)



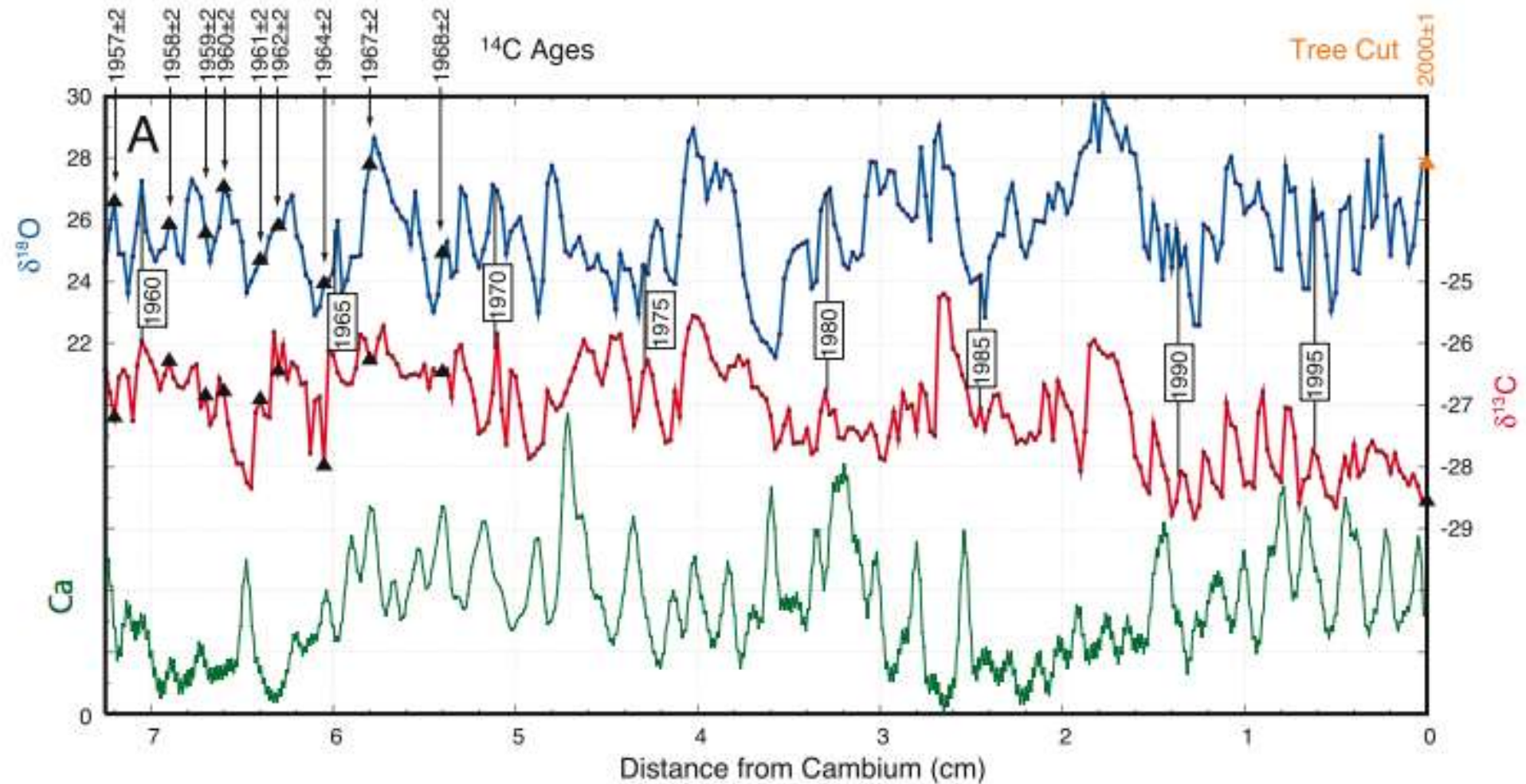
$\Delta^{14}\text{C}$ vs. $\delta^{18}\text{O}$ age model years of PK1 and PG1



Major air masses over southeast Asia

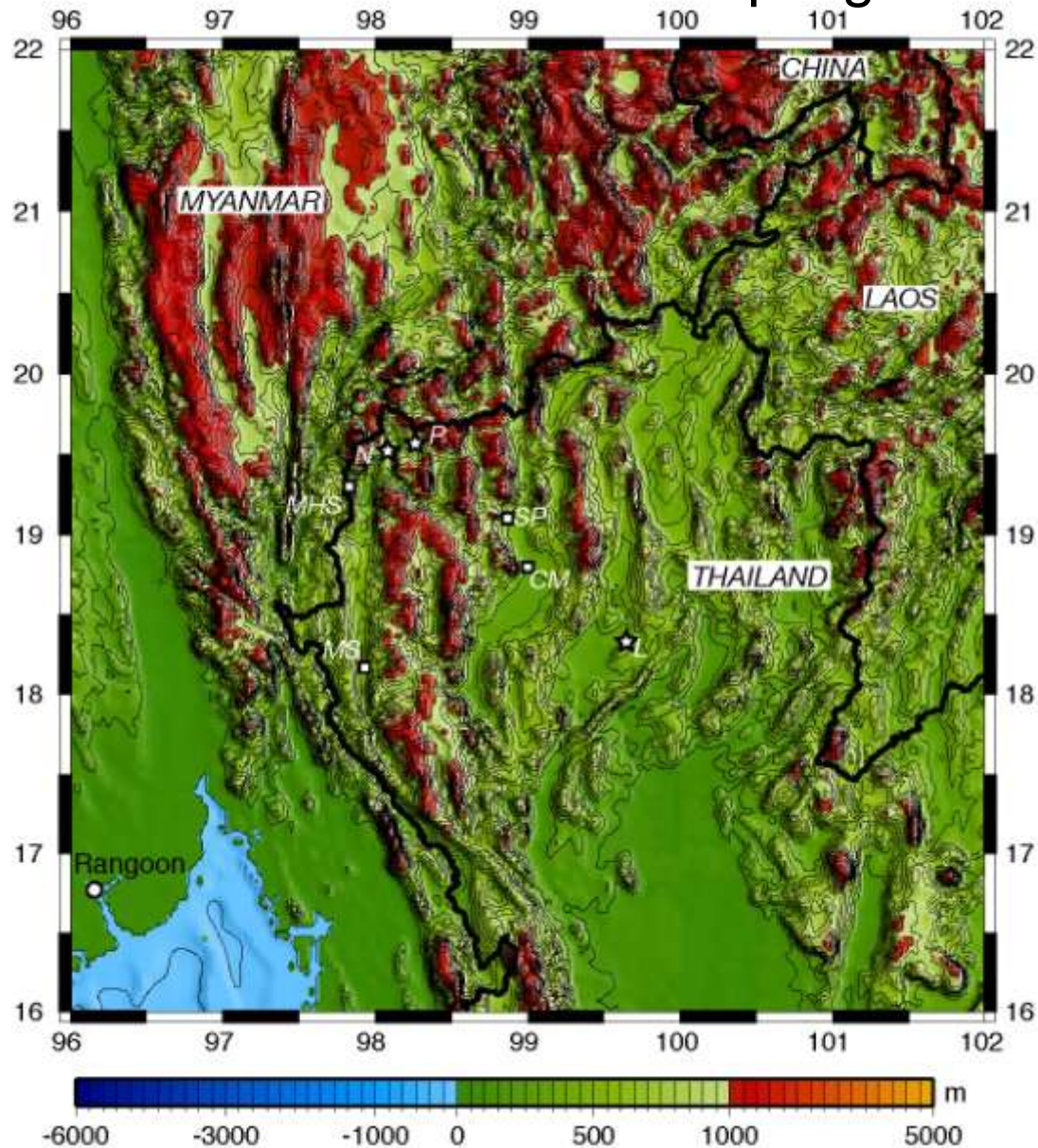


PK1 Miliusa Velutina -



Isotopic data: *Poussart and Schrag, EPSL, 2005, C*

Northern Thailand sampling



Stars: Sampling locations

Squares: Stations with measurements since > 1950

PK1: WHOI scanning XRF elemental distributions

$r = -0.50$

S



$r = -0.44$

Ca

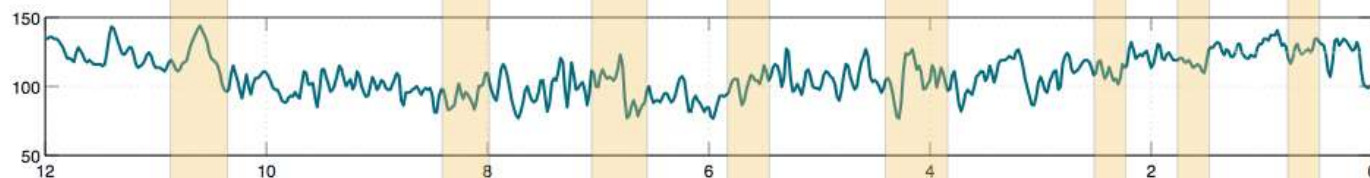


$r = -0.67$

Sr



**X-radiograph
gray values**



Distance from cambium (cm)

*data smoothed with 3 pt running mean
(Scan 1)*

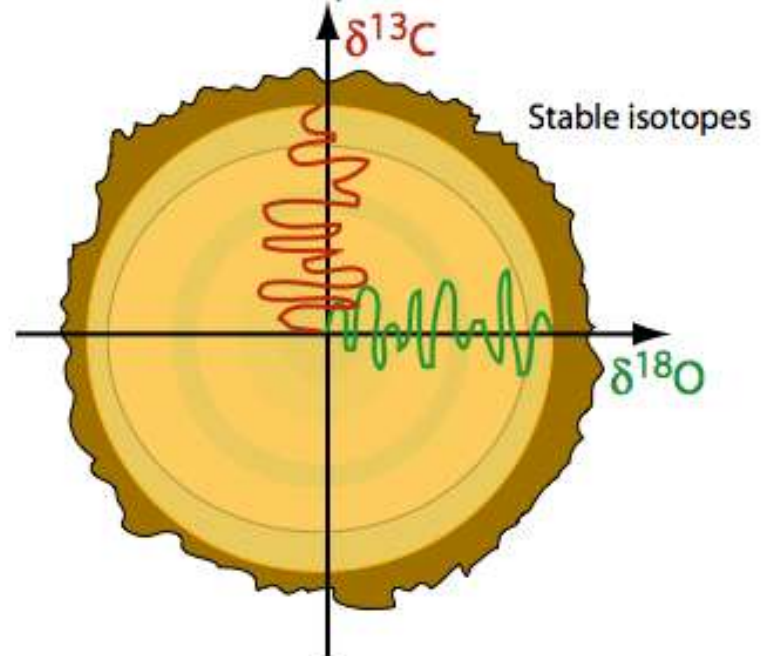
$r = 0.81$

$r = 0.78$

Dendrochronology



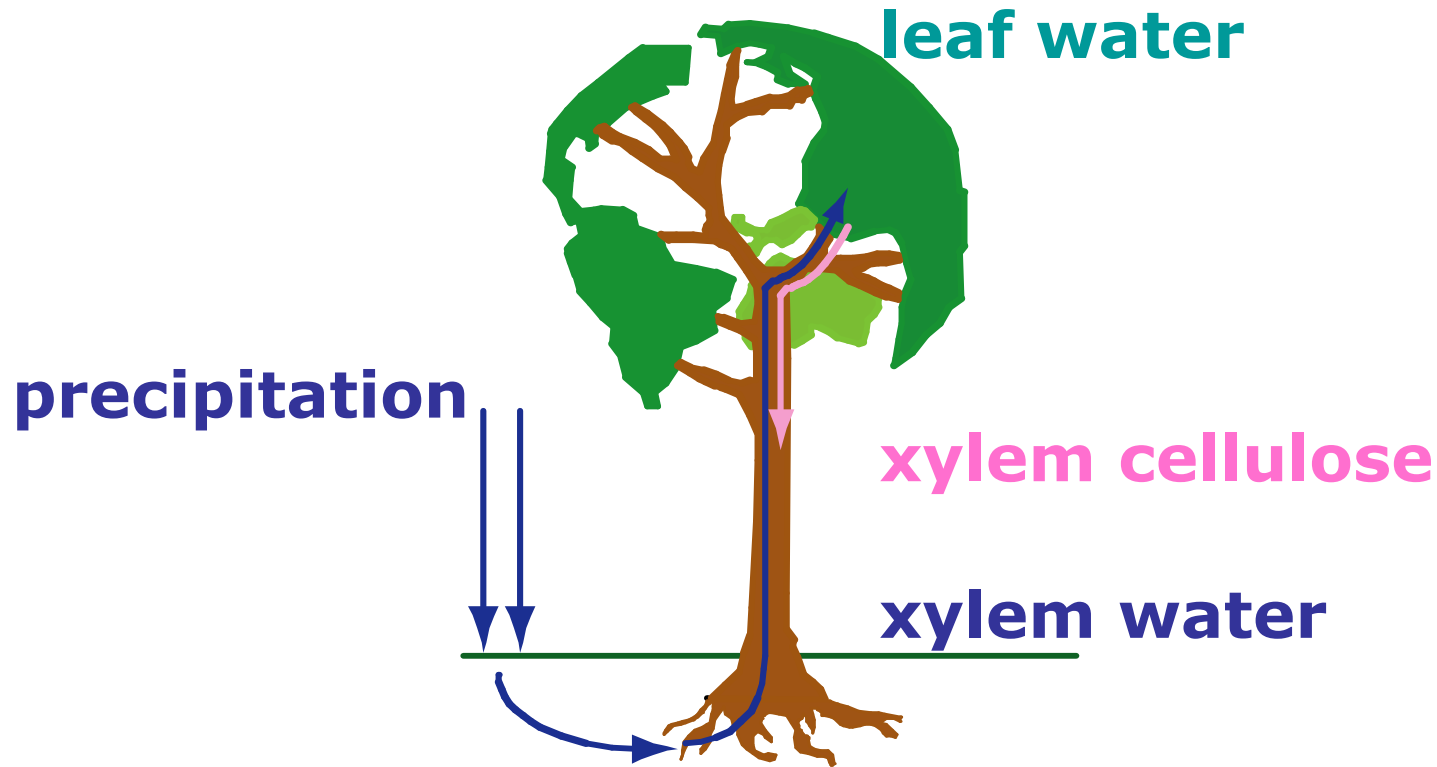
Tools for tropical trees



Tree age
Growth rate history
Climate history

Additional tools: Radioisotopes, dendrometry, cambium wounding methods

Tropical isotope dendroclimatology

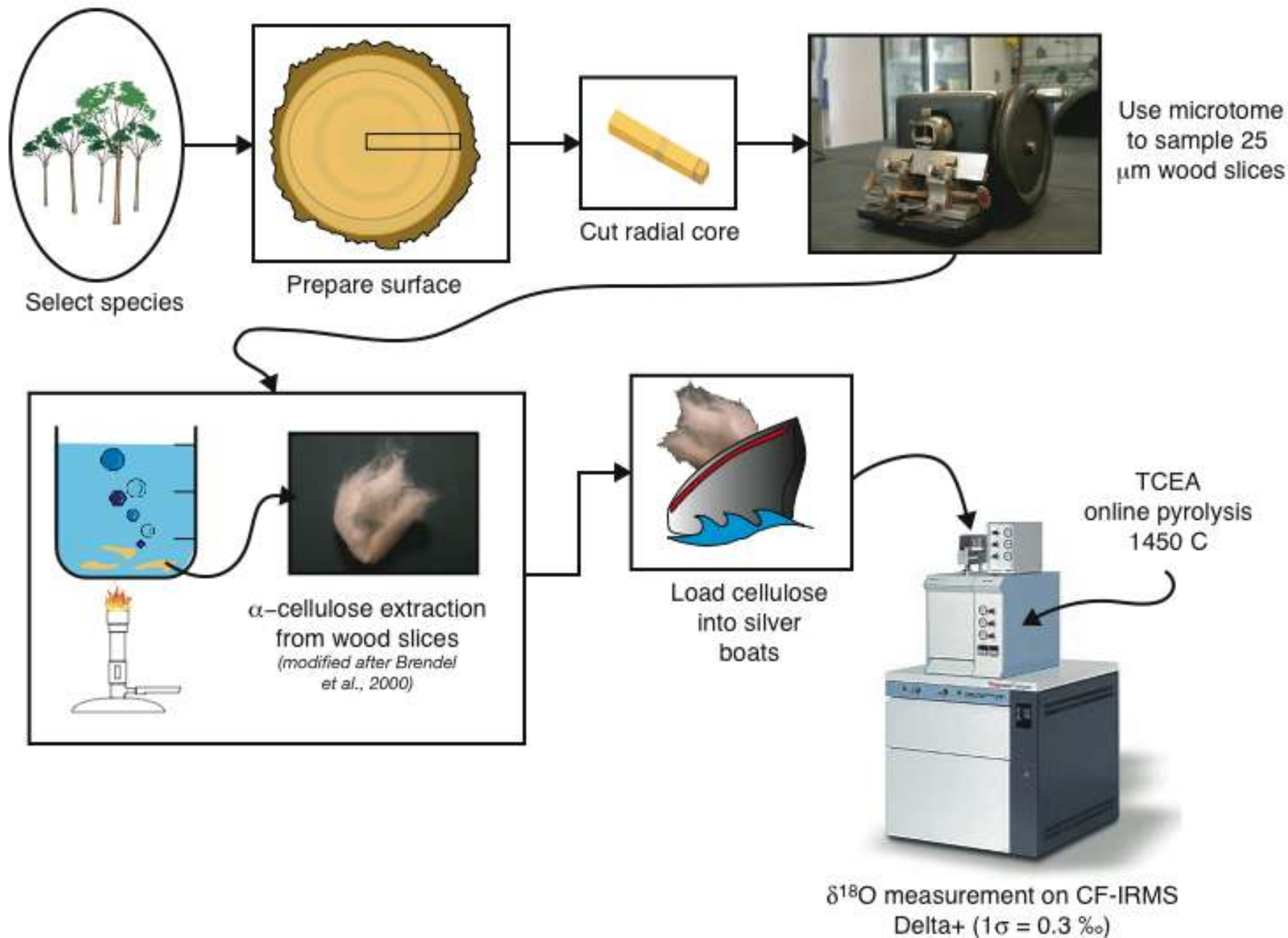


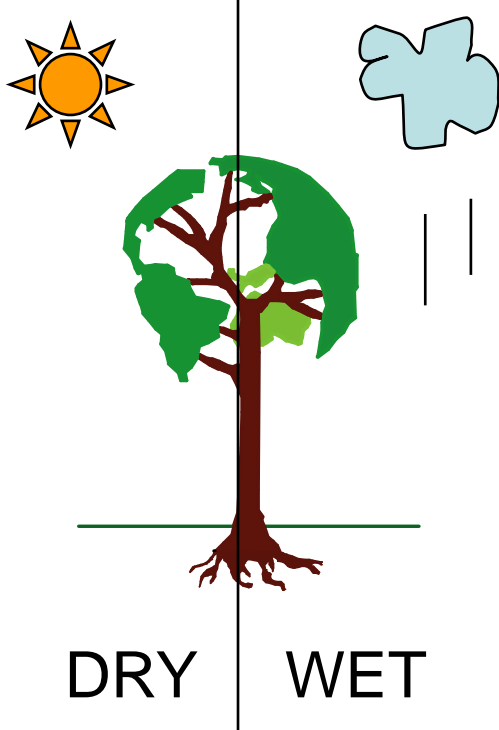
$$\delta^{18}\text{O}_{\text{cx}} = f_o \times (\delta^{18}\text{O}_{\text{wx}} + \epsilon_o) + (1 - f_o) \times (\delta^{18}\text{O}_{\text{wl}} + \epsilon_o)$$

-
- f_o : fraction of carbon-bound oxygen that exchanges with medium water (0.42)
 ϵ_o : isotope fractionation factor for enzyme-mediated exchange or addition of oxygen (+27‰)
 $\delta^{18}\text{O}_{\text{cx}}$: xylem cellulose isotope ratio
 $\delta^{18}\text{O}_{\text{wx}}$: xylem water isotope ratio
 $\delta^{18}\text{O}_{\text{wl}}$: leaf water at the site of evaporation

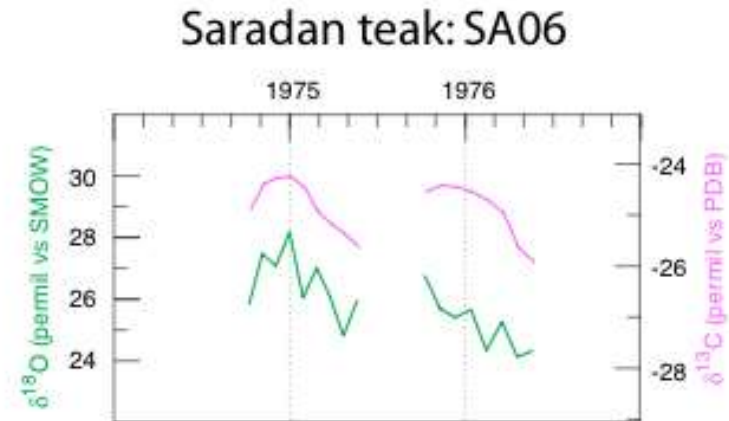
Roden *et al.*, 2000

METHODS





Carbon isotope model



$$\delta^{13}C_{cx} = \delta^{13}C_a - a - (b - a)c_i / c_a + \varepsilon_b$$

$$c_i = c_a - A / g_s$$

a: Fractionation effect related to diffusion of CO₂ through stomatal pores (4.4 ‰).

b: Isotopic discrimination by the Rubisco enzyme during carbon fixation (27 ‰).

c_i, c_a: CO₂ concentration inside and outside of leaf

ε_b: Biochemical fractionation factor - post-photosynthetic effects (2-5 ‰)

A: Rates of CO₂ fixation

g_s: Stomatal conductance

Farquhar *et al.* 1989

Ca (XRF - WHOI)

