

Climatic signals registered as C isotopic  
values in *Metasequoia* leaf tissues:  
A statistical analysis

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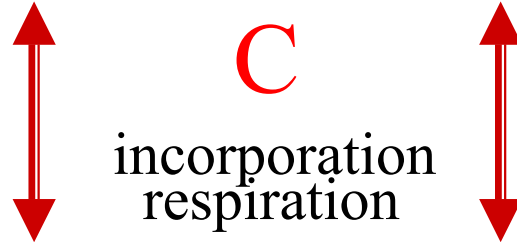
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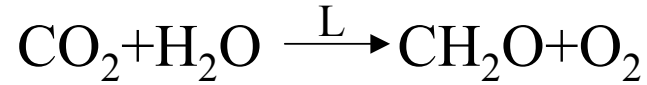
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Atmospheric CO<sub>2</sub>  
(1.1% <sup>13</sup>C, δ<sup>13</sup>C = -7‰)



## Photosynthesis



Biological factors

C<sub>3</sub>, C<sub>4</sub>, CAM options

Plant organs

Taxonomy

Environmental factors

Light condition

Temperature

Precipitation

Salinity/humidity

Metabolism and Biosynthesis

$$\delta^{13}\text{C}_p \text{ (‰ or per mil)} = 1000 \times [(\text{}^{13}\text{C}/\text{}^{12}\text{C}_{\text{sample}})/(\text{}^{13}\text{C}/\text{}^{12}\text{C}_{\text{VPDB}}) - 1]$$

# Leave Tissue and Isotopic Data

Leave Tissue Source:

40 sites across the United States (29 N – 57 N)

Randomly collected and well defined sun (south) and shade (north) leaves

Measurements:

Amount of C and N (%)

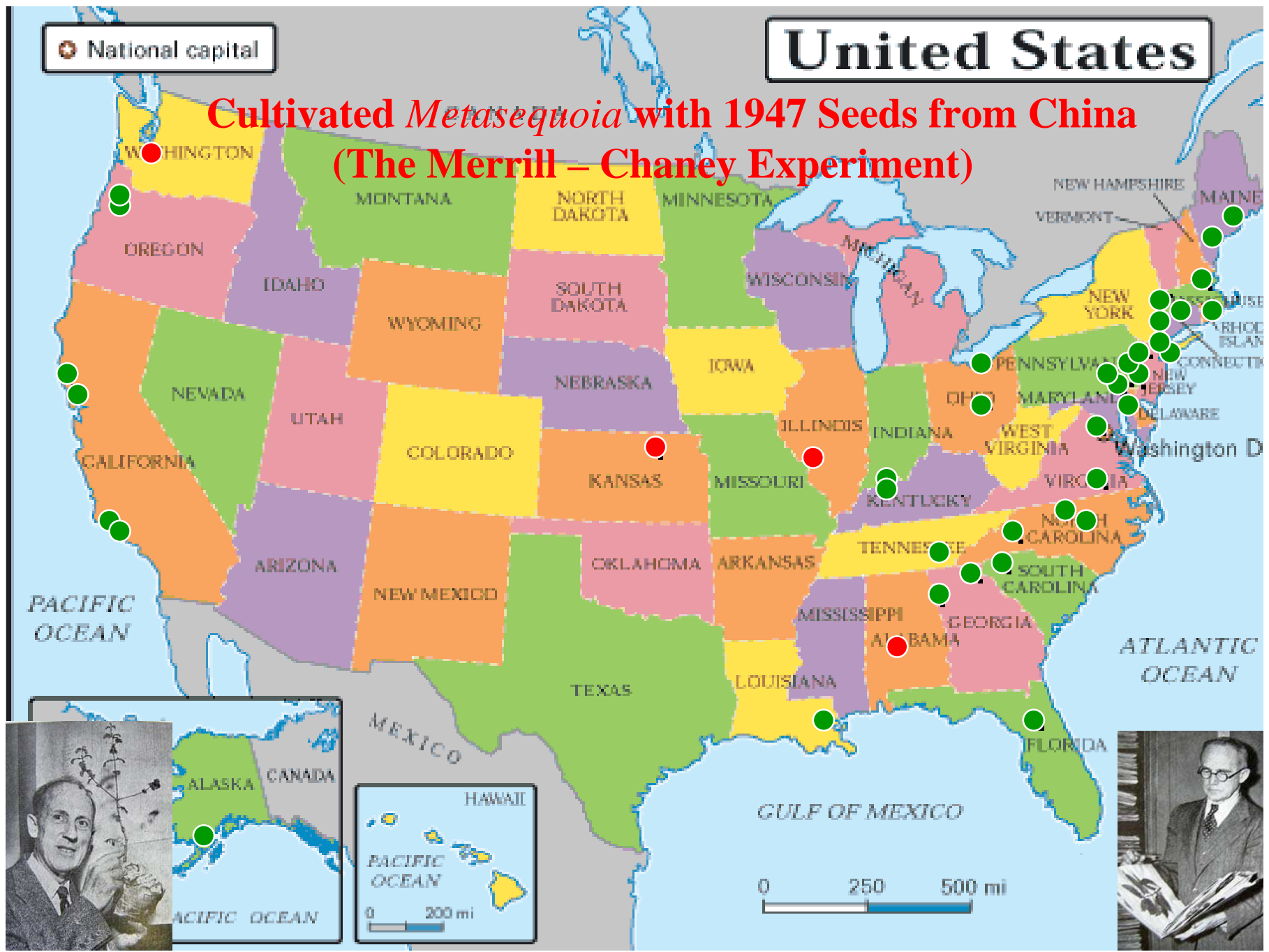
Lipid free bulk C and N isotopic values

C isotopic offset between northern and southern leaves (same tree)

# United States

● National capital

## Cultivated *Metasequoia* with 1947 Seeds from China (The Merrill – Chaney Experiment)





Connecticut College, CT

Princeton University, NJ



Longwood Gardens, PA



# Climate Data

## Sources:

- NOAA dataset (1971-2000)
- Public source: [www.weather.com](http://www.weather.com) (2003 and 2004)



## Parameters:

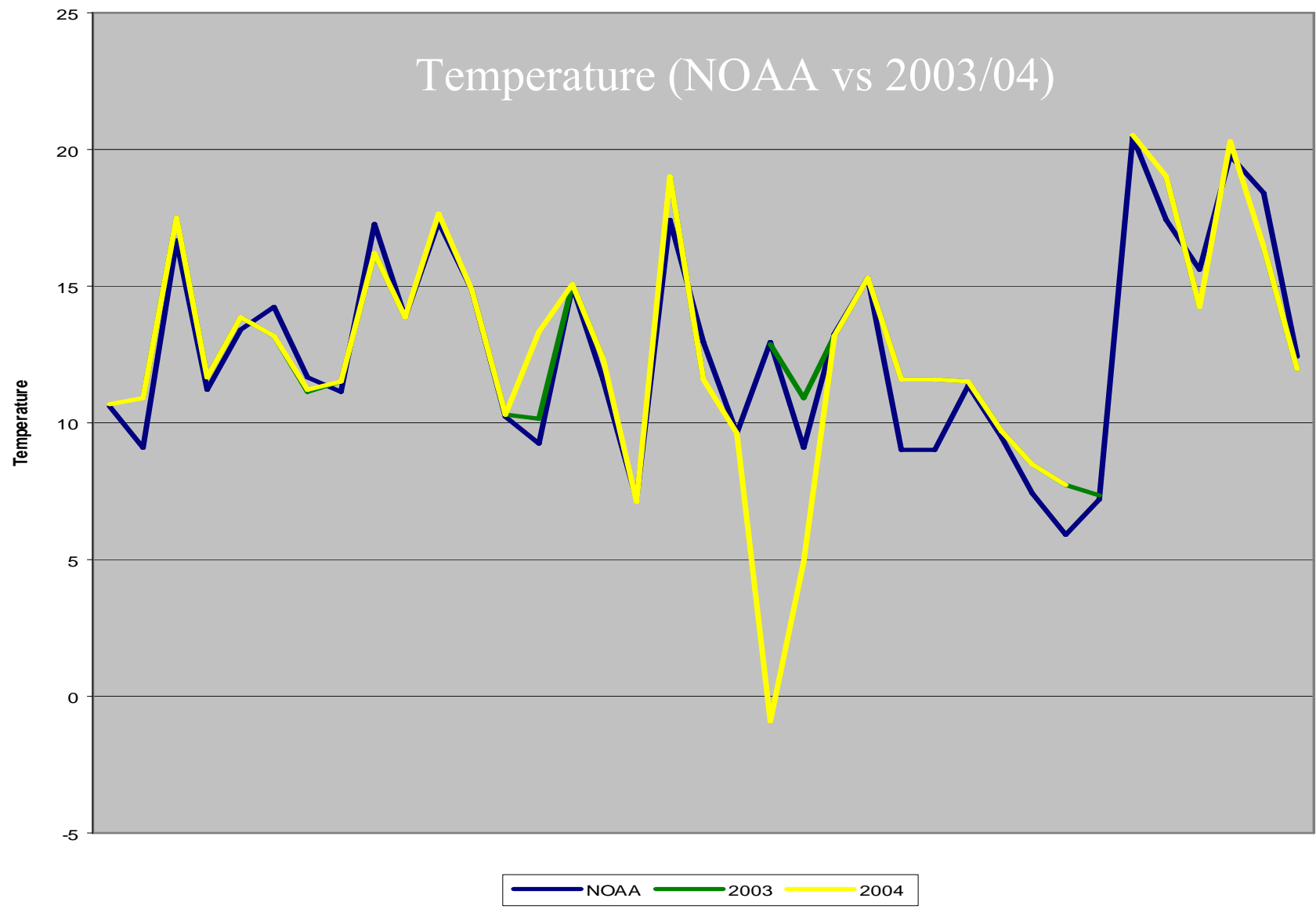
Mean Annual Temperature (MAT)

Average Mean Summer Temperature (AMST) (June-August)

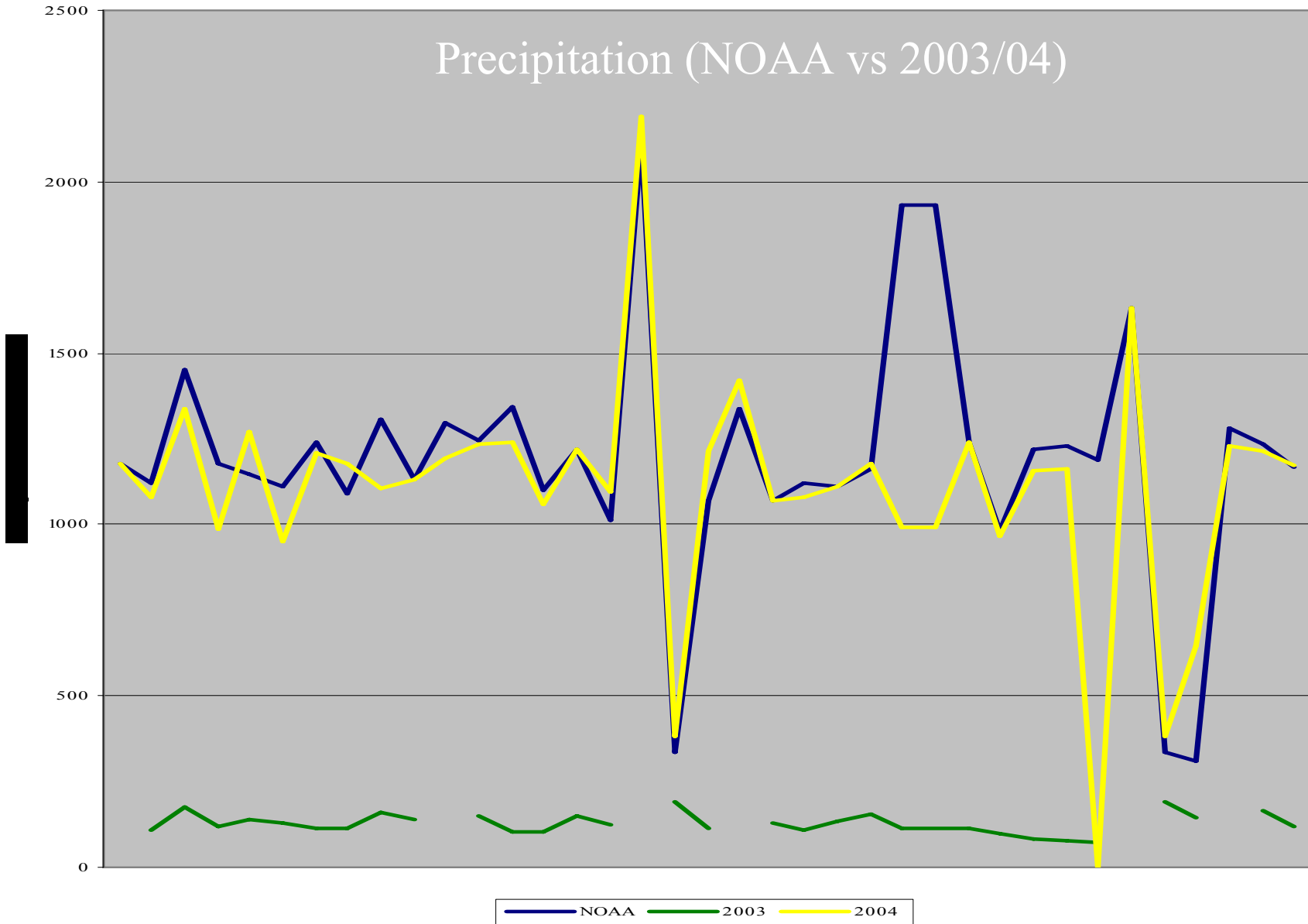
Mean Annual Precipitation (MAP)

Average Mean Summer Precipitation (AMSP) (June-August)

# Mean Annual Temperature



# Mean Annual Precipitation



# Multiple Regression Model

$$\begin{aligned} \text{Climate Property} = & \beta_0 + \\ & \beta_1 \cdot \text{Carbon Isotope}_{\text{South}} + \\ & \beta_2 \cdot \text{Carbon Isotope}_{\text{North}} \end{aligned}$$

Climate properties tested (NOAA 1971-2000 Ave)

- Annual Mean Temperature
- Summer Mean Temperature \*
- Annual Mean Precipitation \*
- Annual Summer Precipitation

# South Versus Unidentified South

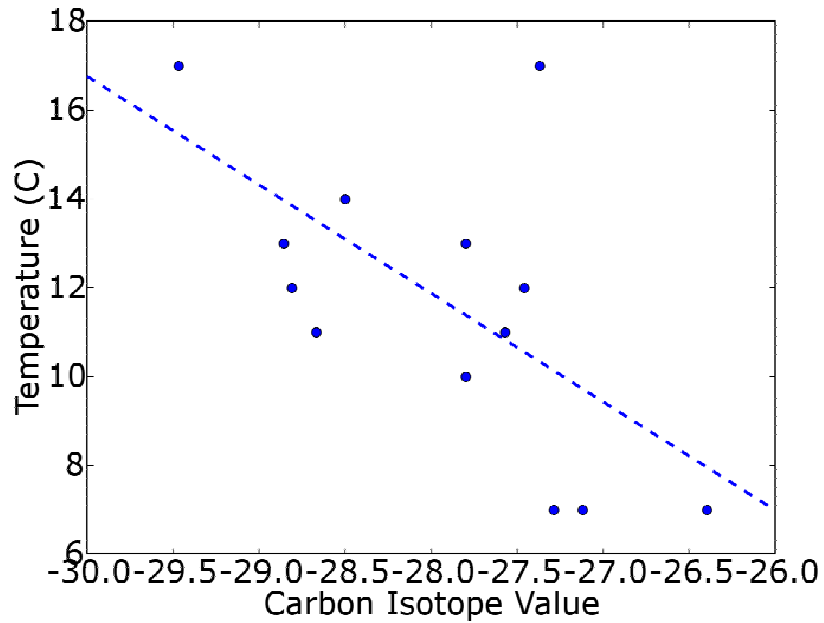
- Significant effect only for carefully collected south-facing samples

	Coefficient	Standard Error	p-value
Intercept	-56.6	25.6	<b>0.049*</b>
Carbon Isotope - South	-2.44	0.916	<b>0.022*</b>

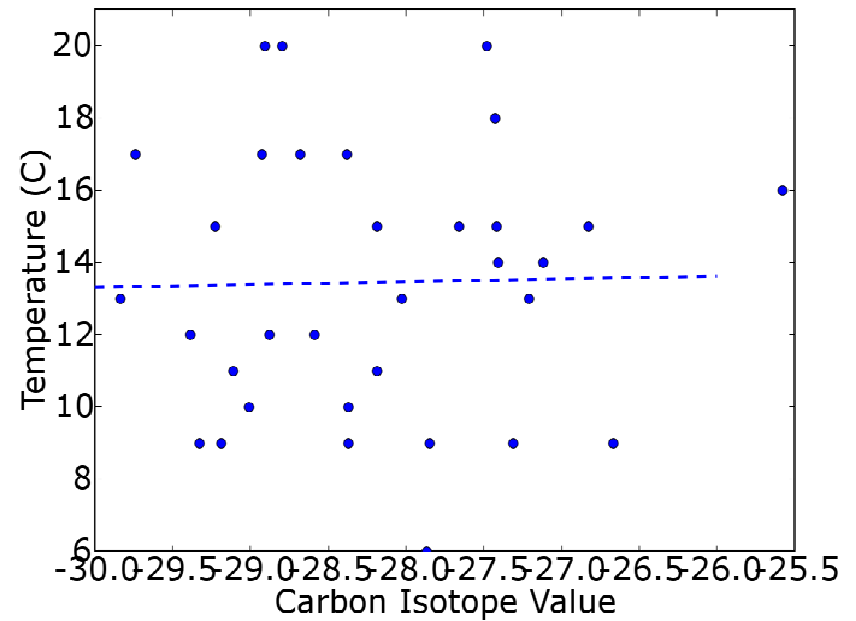
	Coefficient	Standard Error	p-value
Intercept	-15.6	19.4	0.42
Carbon Isotope – Unidentified South	-0.078	0.686	0.91

# South Versus Unidentified South

South



Unidentified South



# Temperature

<b>Annual Temperature</b>	Coefficient	Standard Error	p-value
Intercept	-78.6	38.3	0.067
Carbon Isotope - North	-1.30	1.66	0.449
Carbon Isotope - South	-1.91	1.16	0.130

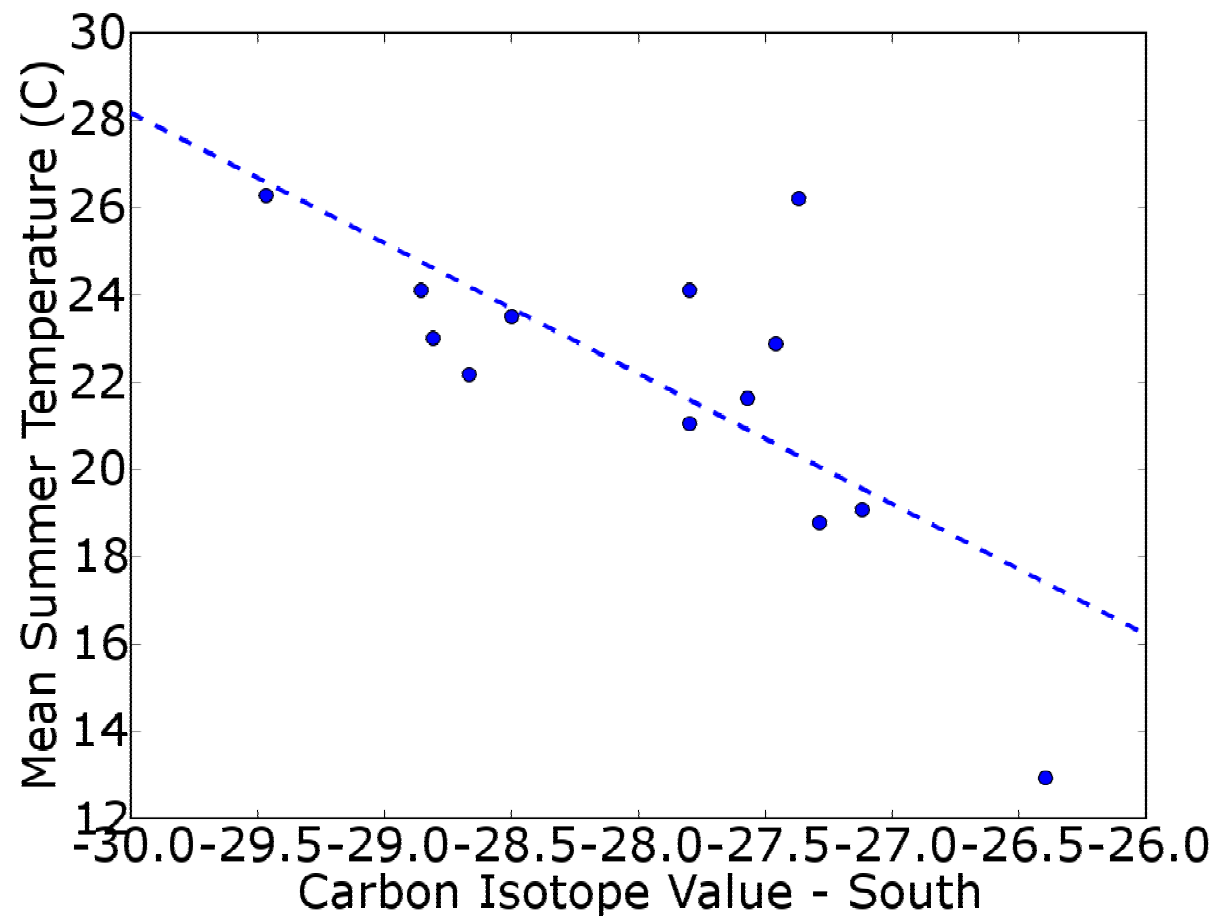
F significance = 0.061

<b>Summer Temperature</b>	Coefficient	Standard Error	p-value
Intercept	-54.5	37.7	0.179
Carbon Isotope - North	0.246	1.63	0.887
Carbon Isotope - South	-2.98	1.14	<b>0.025*</b>

F significance = **0.032\***

# Temperature

Summer Temperature	Coefficient	Standard Error	p-value
Carbon Isotope - South	-2.98	1.14	<b>0.025*</b>



# Precipitation

<b>Annual Precipitation</b>	Coefficient	Standard Error	p-value
Intercept	1760	2820	0.546
Carbon Isotope - North	-249	122	<b>0.068</b>
Carbon Isotope - South	272	85.2	<b>0.0096**</b>

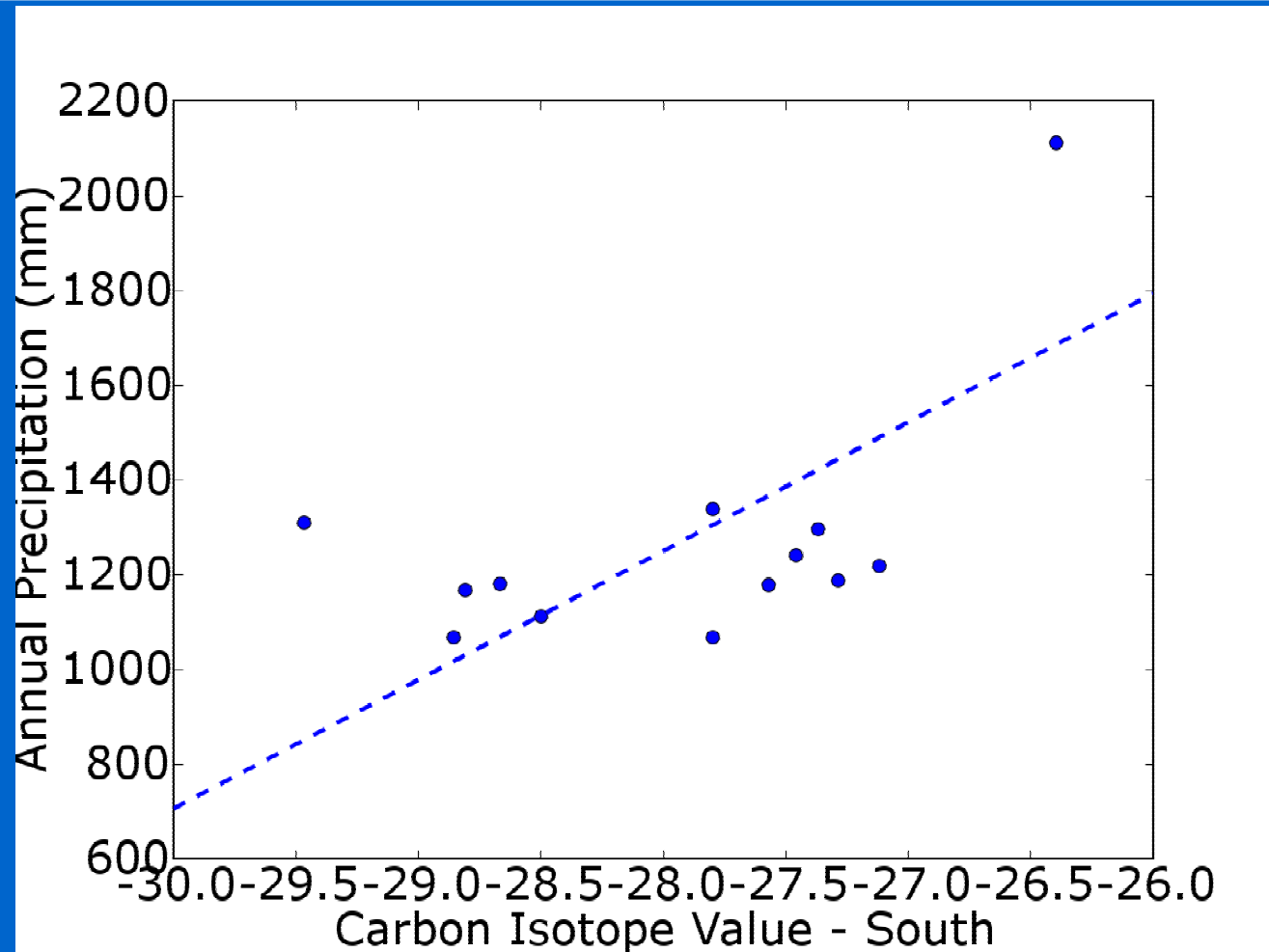
F significance = **0.0294\***

<b>Summer Precipitation</b>	Coefficient	Standard Error	p-value
Intercept	-238	183	0.223
Carbon Isotope - North	-15.8	7.94	0.074
Carbon Isotope - South	3.83	5.54	0.505

F significance = 0.165

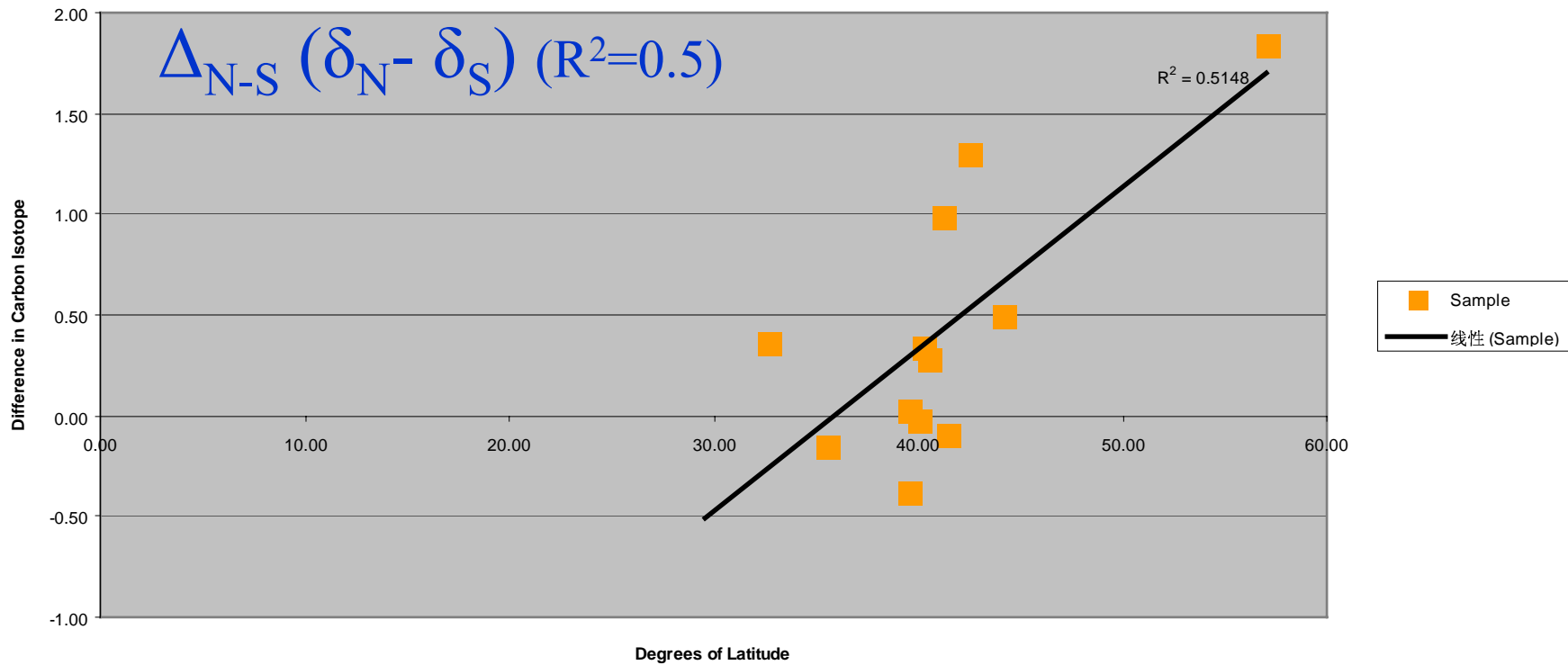
# Precipitation

Annual Precipitation	Coefficient	Standard Error	p-value
Carbon Isotope - South	272	85.2	<b>0.0096**</b>



# C Isotope offset between N-S Facing Leaves vs Latitudes

Difference in North/South Isotopes According to Latitude



# Conclusions

- Statistically significant correlations are found only between C isotope values of carefully collected sun leaves and mean annual temperature (MAT) and mean annual precipitation (MAP)
- A simple correlation is found between isotopic offset between northern and southern leaves of the same tree and the latitudes
- The results indicate well averaged C isotope signal throughout the year and have implications to interpretation of fossil C isotopic record

## Further Work:

Further test using additional samples with well defined leaf aspects

# Acknowledgement

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