EBIS Workshop

January 27 and 28, 2003

University of California-Irvine

- Goals
  - Project history (1999 to date)
  - Research progress
  - Discuss hypotheses and modeling
  - Evaluate problem areas (??)
  - Discuss potential publications (??)
  - Discuss plans beyond FY2004

Sponsor: U.S. Department of Energy, Office of Science, Biological and Environmental Research Program

Why we're here today.

Date: Mon, 20 Sep 1999 16:53:53 -0800
From: Julia Gaudinski <gaudinsk@uci.edu>
Subject: Hot Data
X-Sender: gaudinsk@ea-pop.oac.uci.edu
To: hansonpj@ornl.gov
Cc: setrumbo@uci.edu

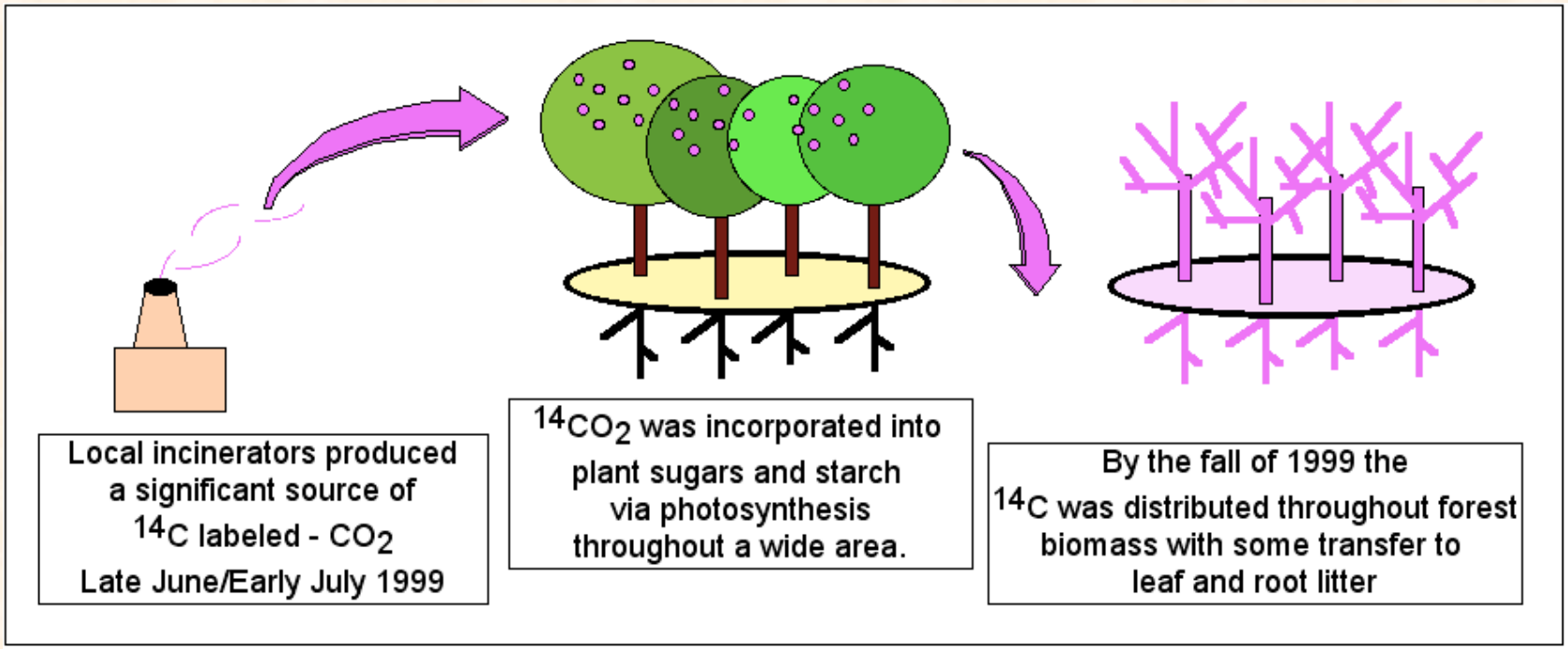
Hi Paul,

……..” I have attched an excel file with my most recent data from July and August plotted up. All the data are seriously contaminated with 14C!!…….So I think we definitely have something NOT natural going on here……. this is potentially disastrous for a lot of the work I have already done……However, there may be a silver lining to this dark cloud…”

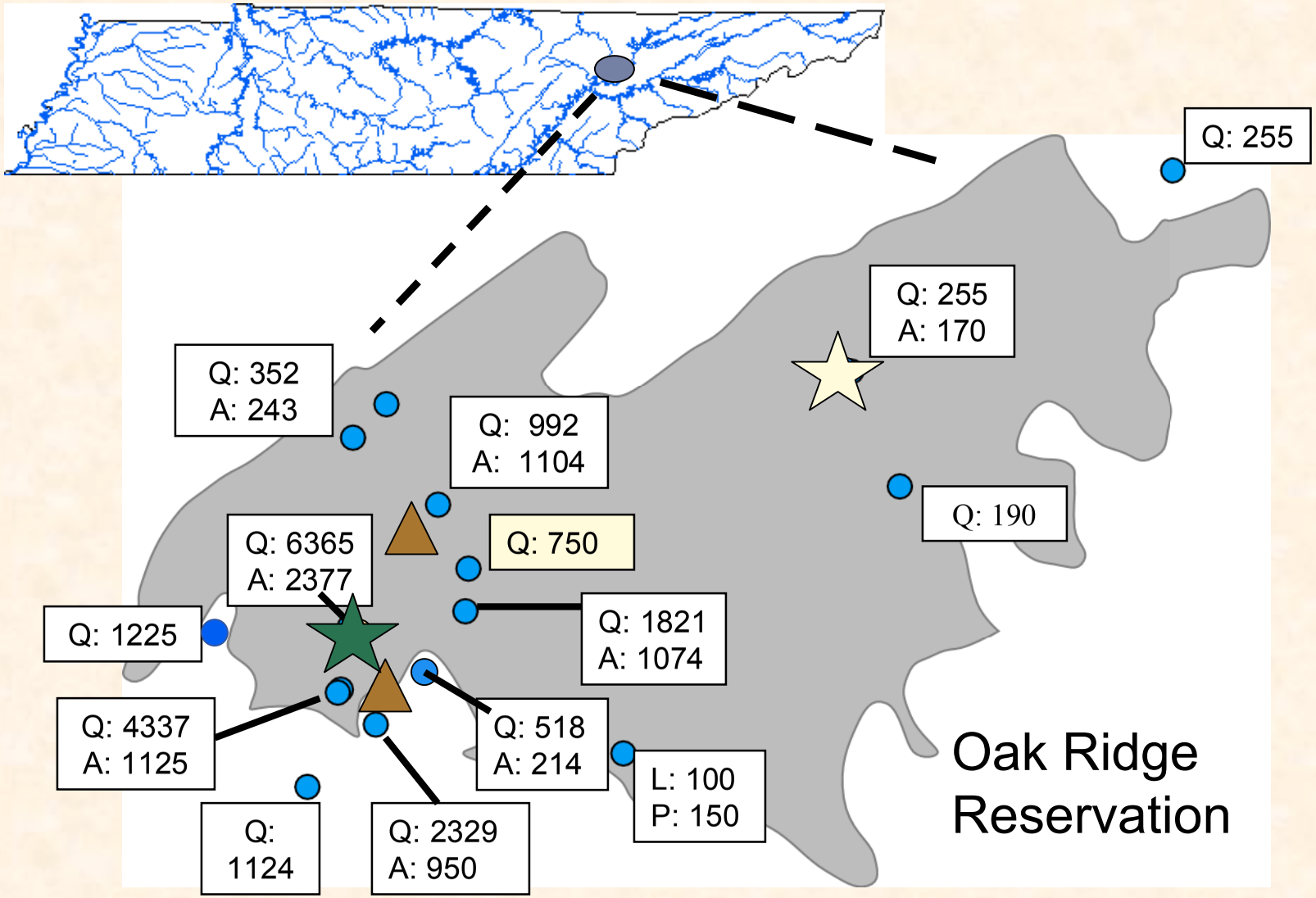
EBIS Project Timeline

- **Summer of 1999:**
  - **Julia's 'discovery'**
- **1999 to late summer 2000:**
  - **What happened?**
  - **Reservation sampling and analysis**
  - **Safety issues and local oversight meetings**

The 1999 ^{14}C Event

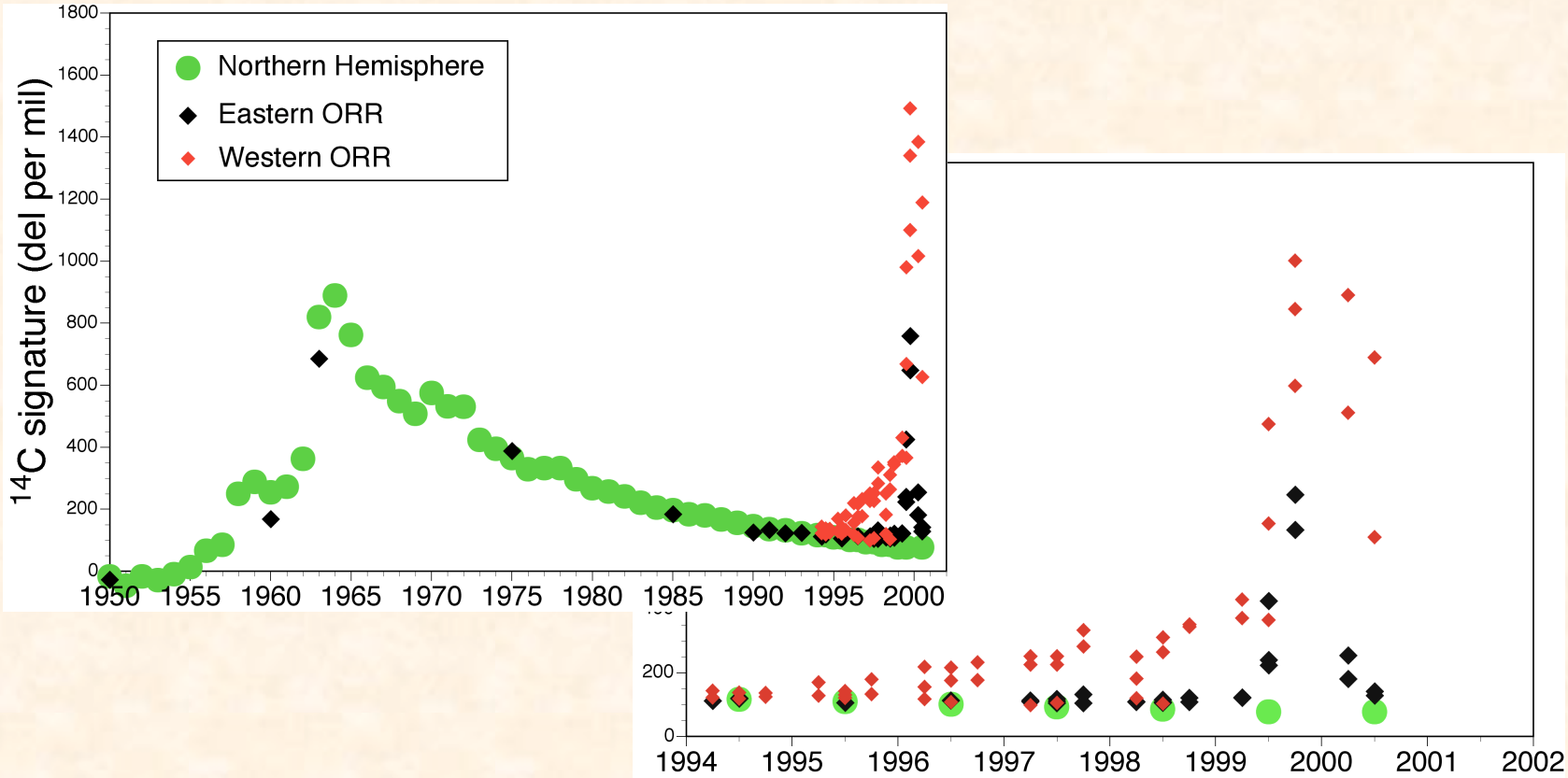


We initially thought that the 1999 litter fall would not have an enriched ^{14}C-label because the leaves were constructed prior to the pulse. We were wrong.



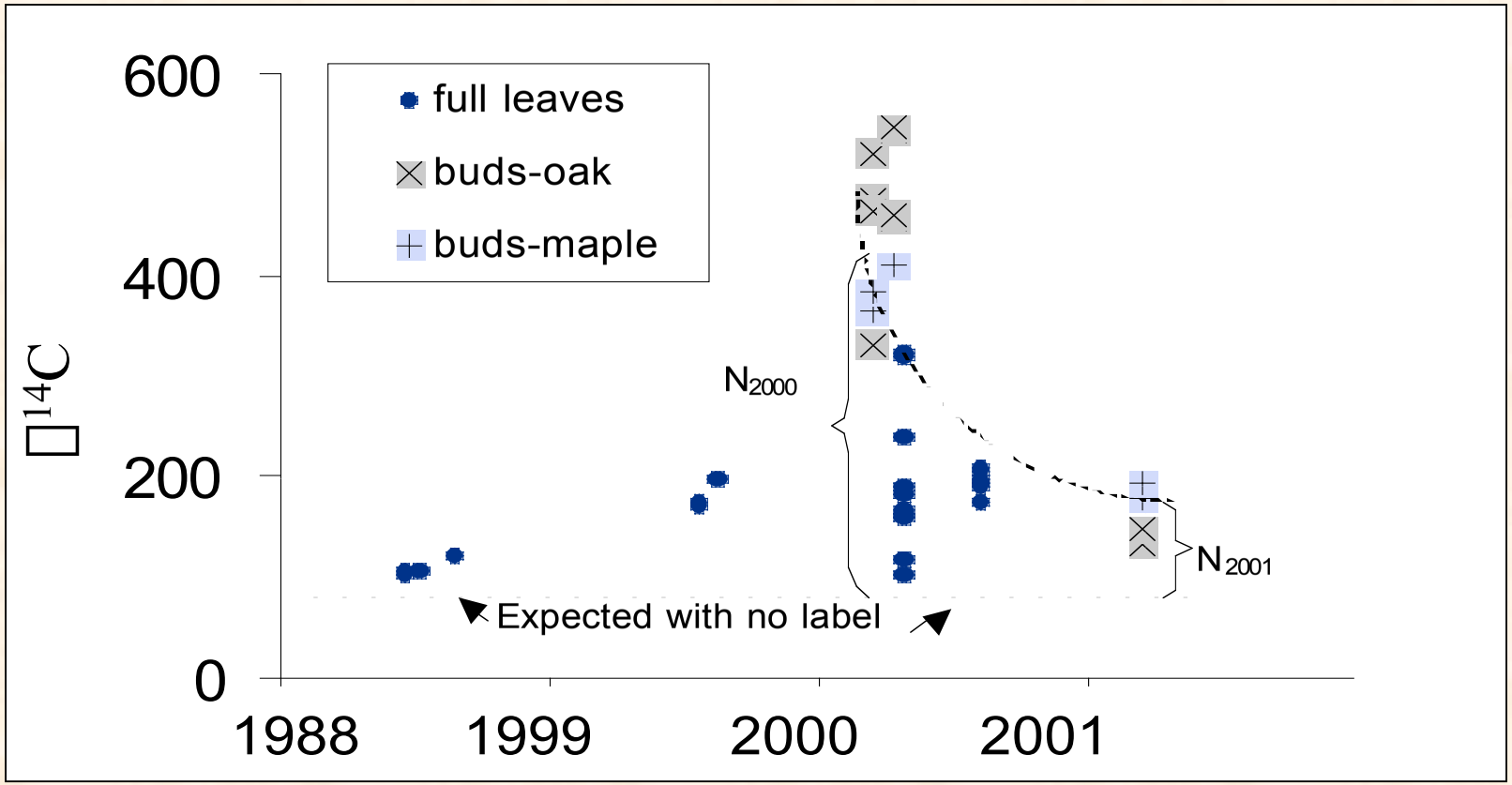
Hazardous waste incinerators

Record of the ^{14}C-Pulse in Tree Rings



- **The ^{14}C signature in the local tree ring record demonstrates the unique and unprecedented nature of the 1999 event.**

^{14}C in 2000 Vegetation Samples



- **^{14}C in 2000 foliage suggested that the ecosystem signature could be exploited for carbon cycle studies.**

Concerns about Collected-Litter Radioactivity - Summer 2000

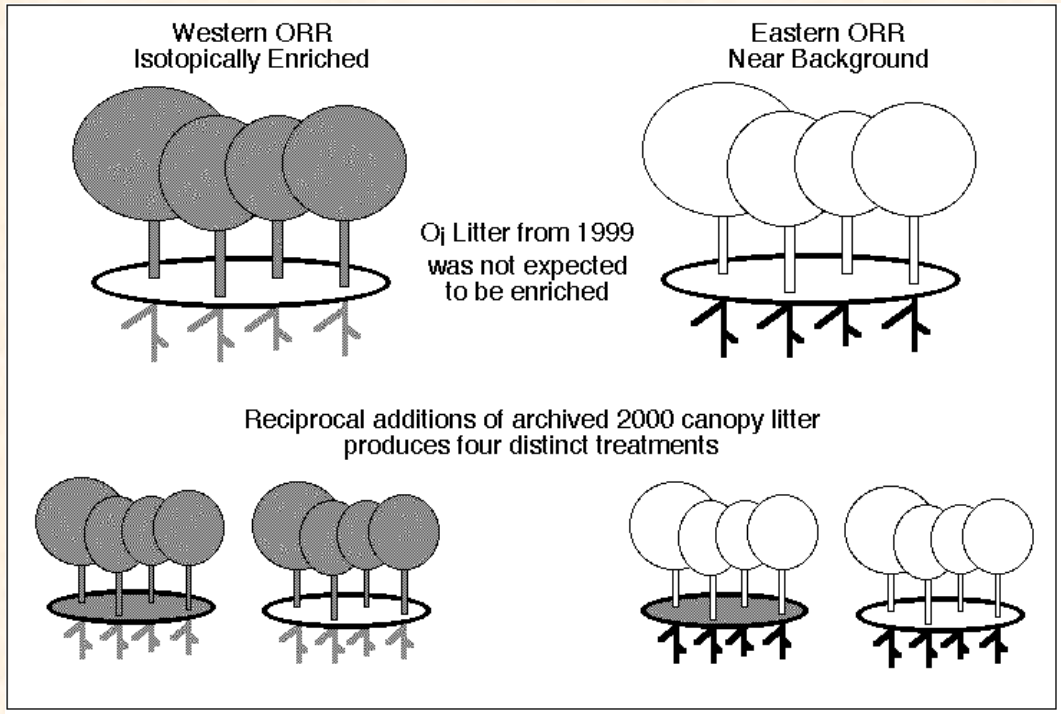
- I wrote:
  - "We hope and anticipate that once we collect large quantities of enriched leaf litter (2 hectares worth or ~15 metric tons) it won't subsequently be declared contaminated waste. Can anyone provide assurance that this won't happen? Thanks."
- The final ORNL/DOE reply:
  - "Based on what Don has told me, this is not radioactive material added by DOE, and thus would fall under DOE's "no rad added" policy. That determination would put the material under the "green tag" surface contamination rules since leaves by their very nature are primarily surface. By those rules, we are well under any limits for release to the public."

EBIS Project Timeline (continued)

- **August 2000**
  - Scoping Workshop
  - Prep $$$ obtained
- **August 2000**
  - Startup funds from DOE for FY2000 and FY2001
- **September 2000**
  - Experimental plots laid out
- **October-December 2000**
  - Enriched- and background-litter collected
- **October 2000**
  - EBIS proposal submitted to DOE

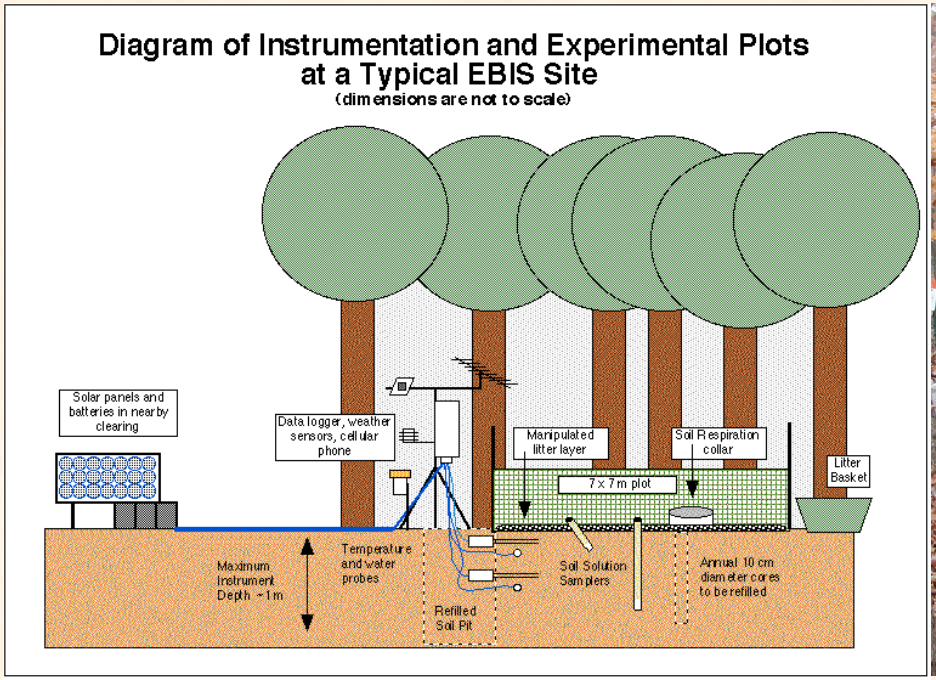
Archiving ^{14}C Enriched Litter - 2000

‘Factorial’ Design was Suggested by Data

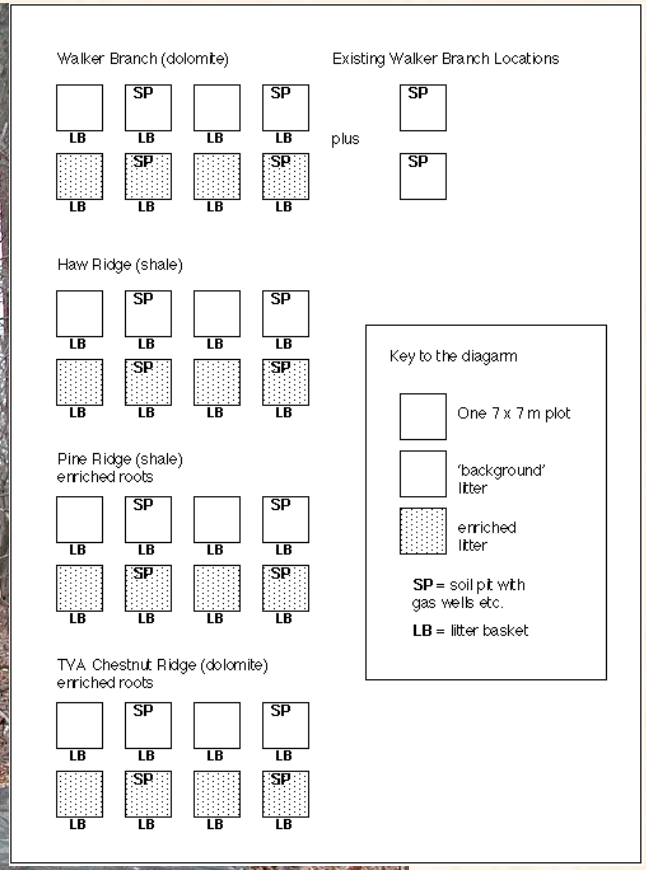


- **The 1999-canopy-litter was enriched -- not expected because the leaves were constructed prior to the pulse.**
- **Root ^{14}C-signatures were too remain high over time in this design.**

Replicate 7x7 m Plots Were Established at 4 Sites



- **Eight plots were established at each site. Half receive enriched litter each year and the other half receive background litter. Ambient litterfall is excluded from all plots (see photo).**


Walker Branch (dolomite)
Existing Walker Branch Locations
plus
Haw Ridge (shale)
Pine Ridge (shale)
enriched roots
TVA Chestnut Ridge (dolomite)
enriched roots
SP
LB
Key to the diagarm
One 7 x 7 m plot
'background' litter
enriched litter
SP = soil pit with gas wells etc.
LB = litter basket

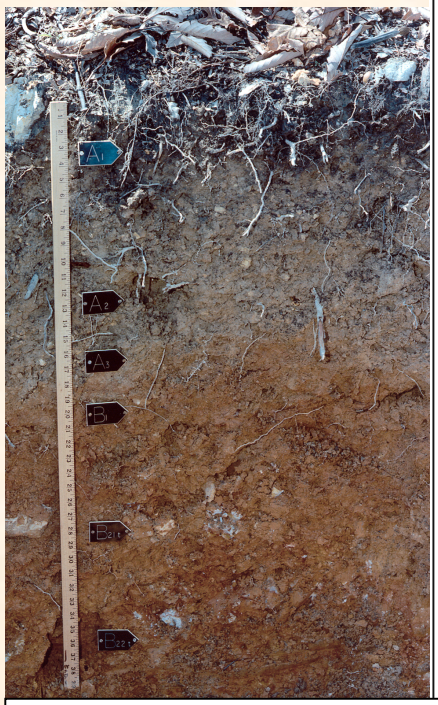
Project Timeline (continued)

- Feb/Mar 2001
  - Time-zero samples
  - 1st litter cohort added to plots (ambient litter excluded)
- October 2001
  - Full EBIS funding
- Jan/Feb 2002
  - 1-year sampling
  - 2nd litter cohort added (ambient litter excluded)
- June 2002
  - Initial publication
  - Trumbore et al. 2002 EOS 84:265,267-8.
- Jan/Feb 2003
  - 2-year sampling
  - 3rd litter cohort added (ambient litter excluded)

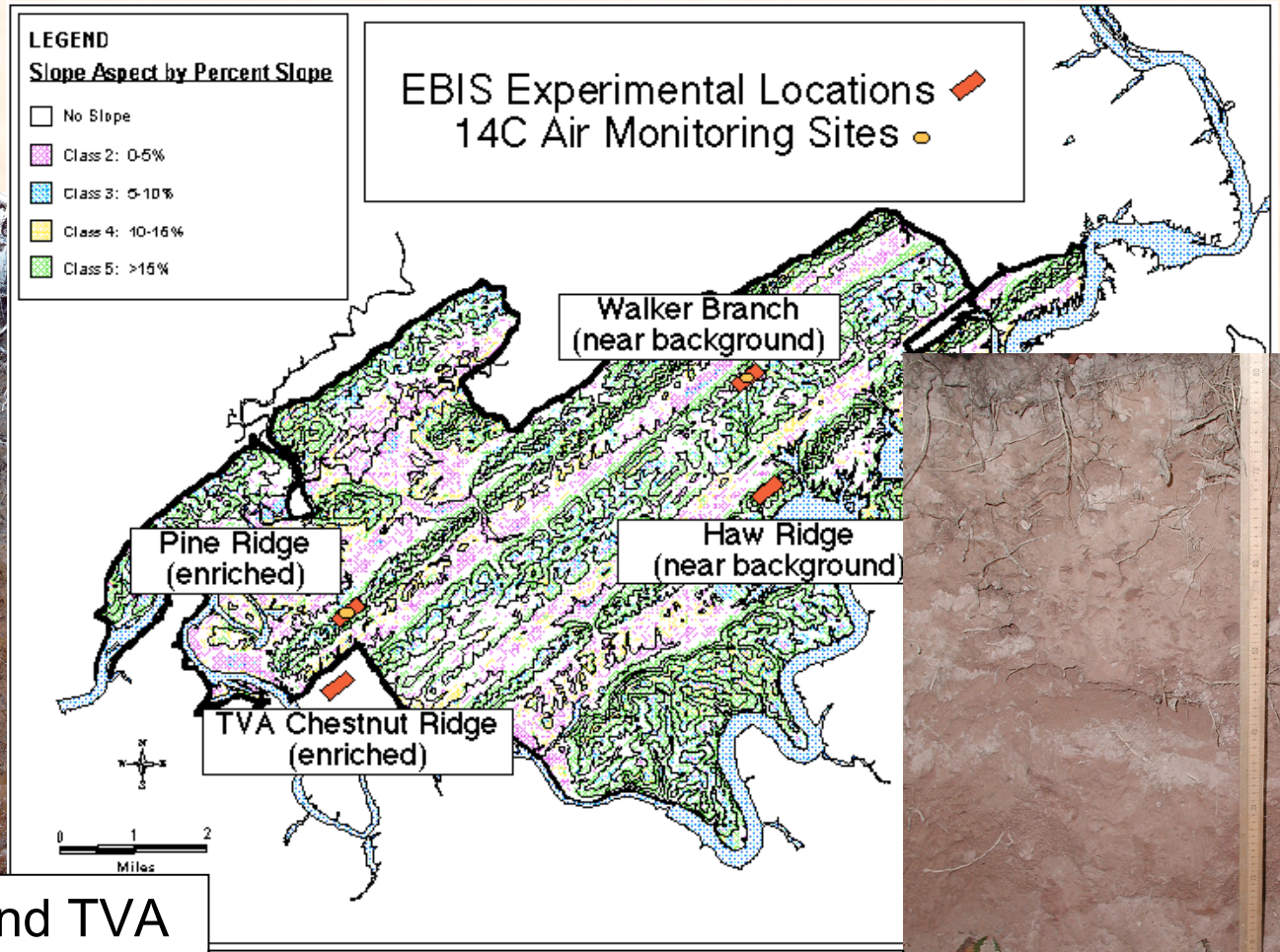
Experiment Design Questions

- How comparable are the 4 sites?
  - Soils and vegetation
- Is there any environmental bias?
  - Temperature and water
- Sampling issues
  - Horizon designations

Two Soil Types are Being Studied

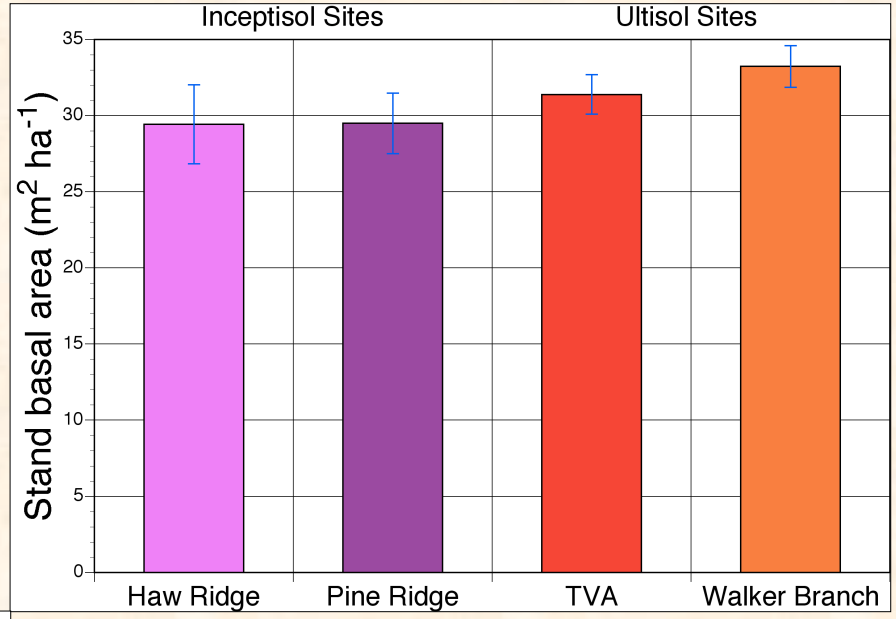


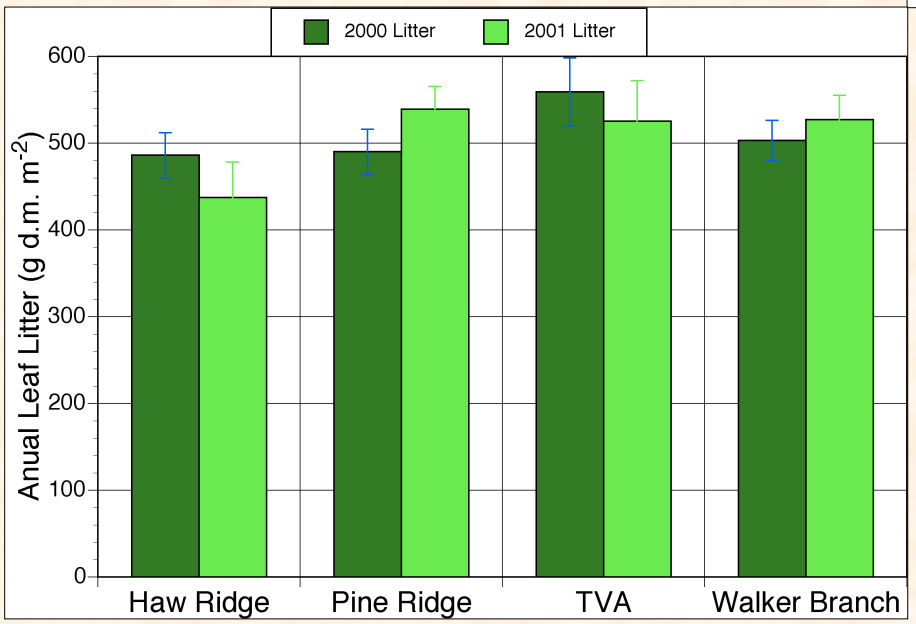
Ultisols on WB and TVA



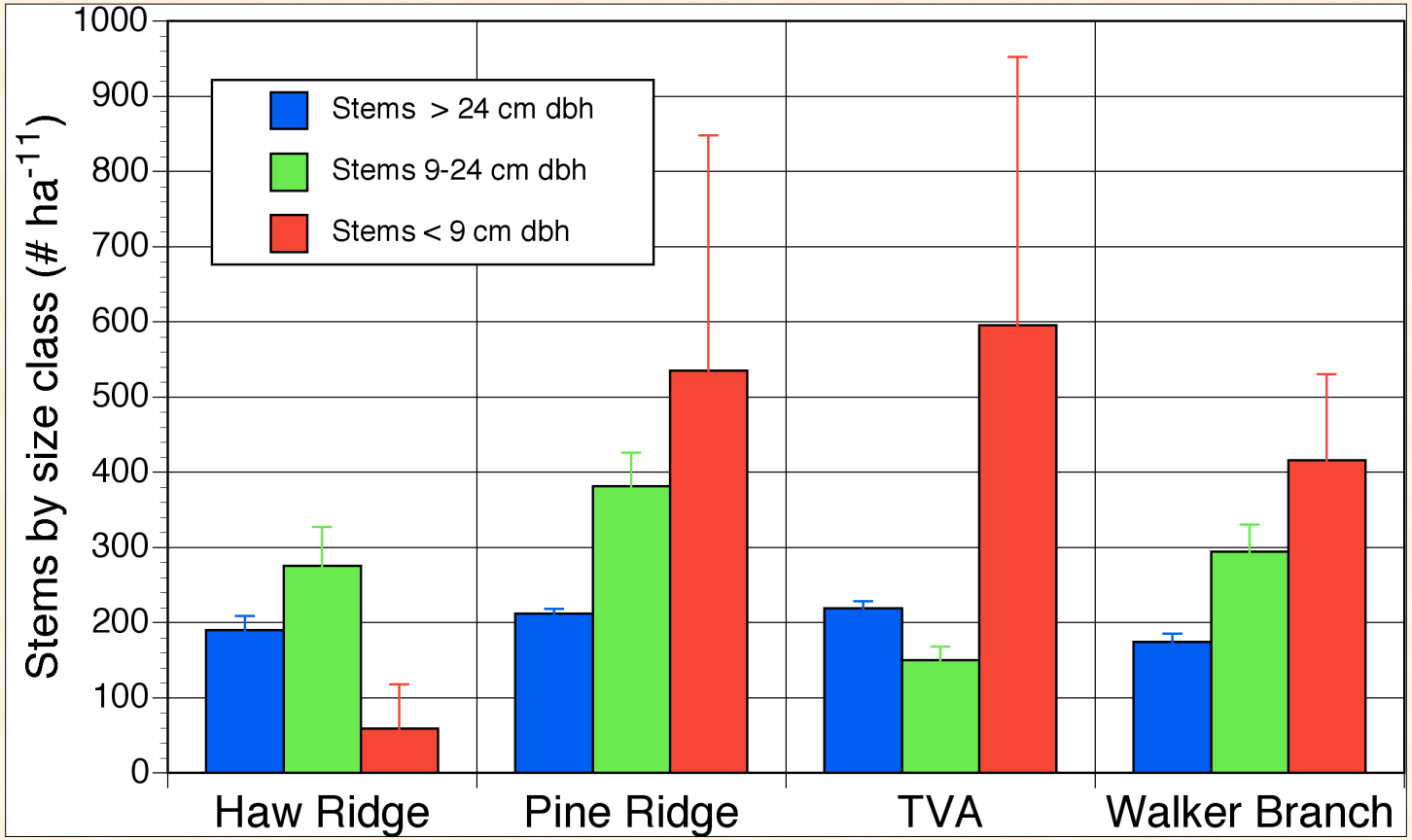
Inceptisols on PR and HR

Basal areas of all 4 sites covered a limited range from 28 to 34 $m^2\ ha^{-1}$





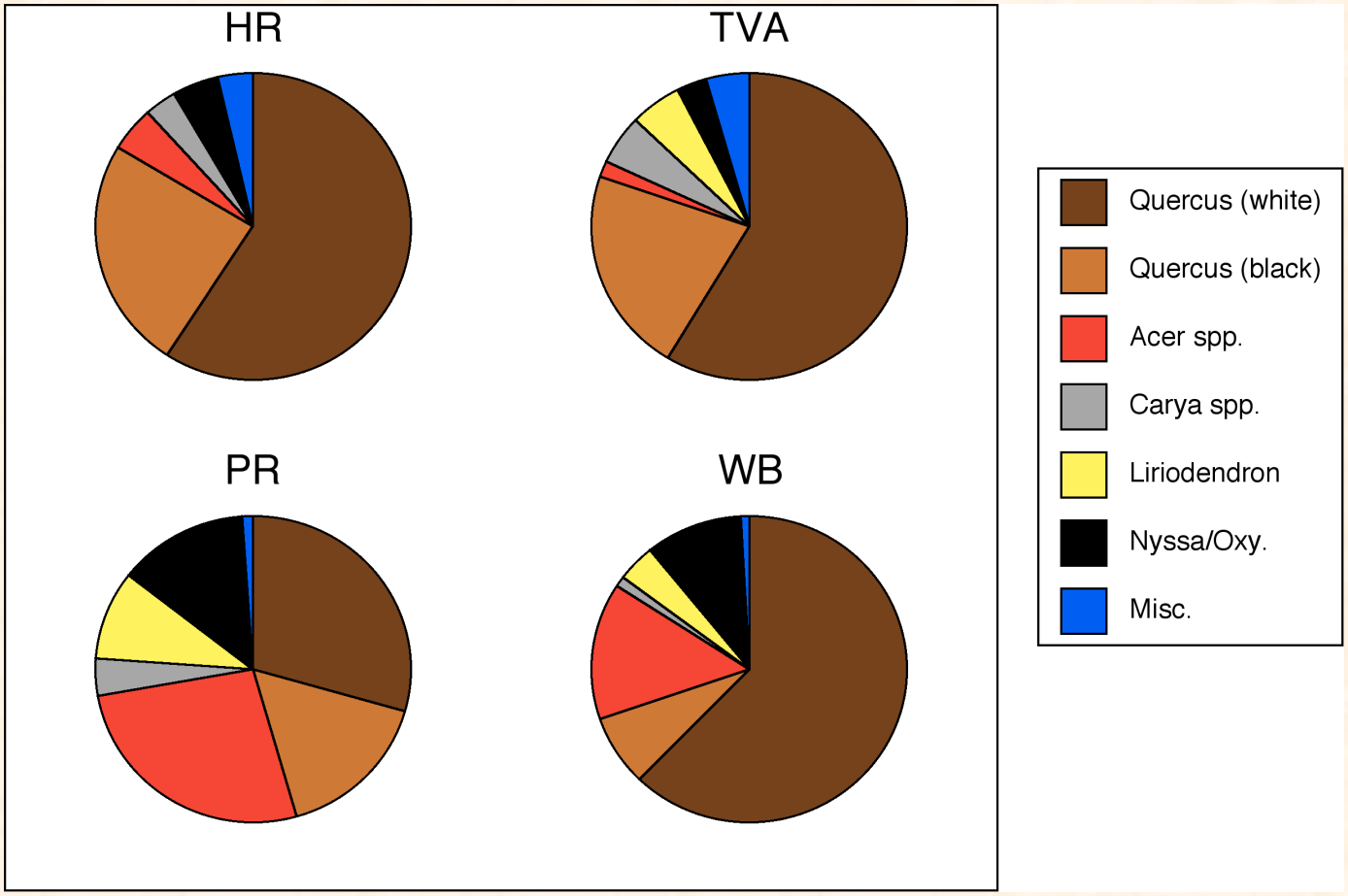
Foliar litter production at all sites is ~500 g m^{-2} annually.



Reduced numbers of small (or young) stems at Haw Ridge may indicate an older forest.

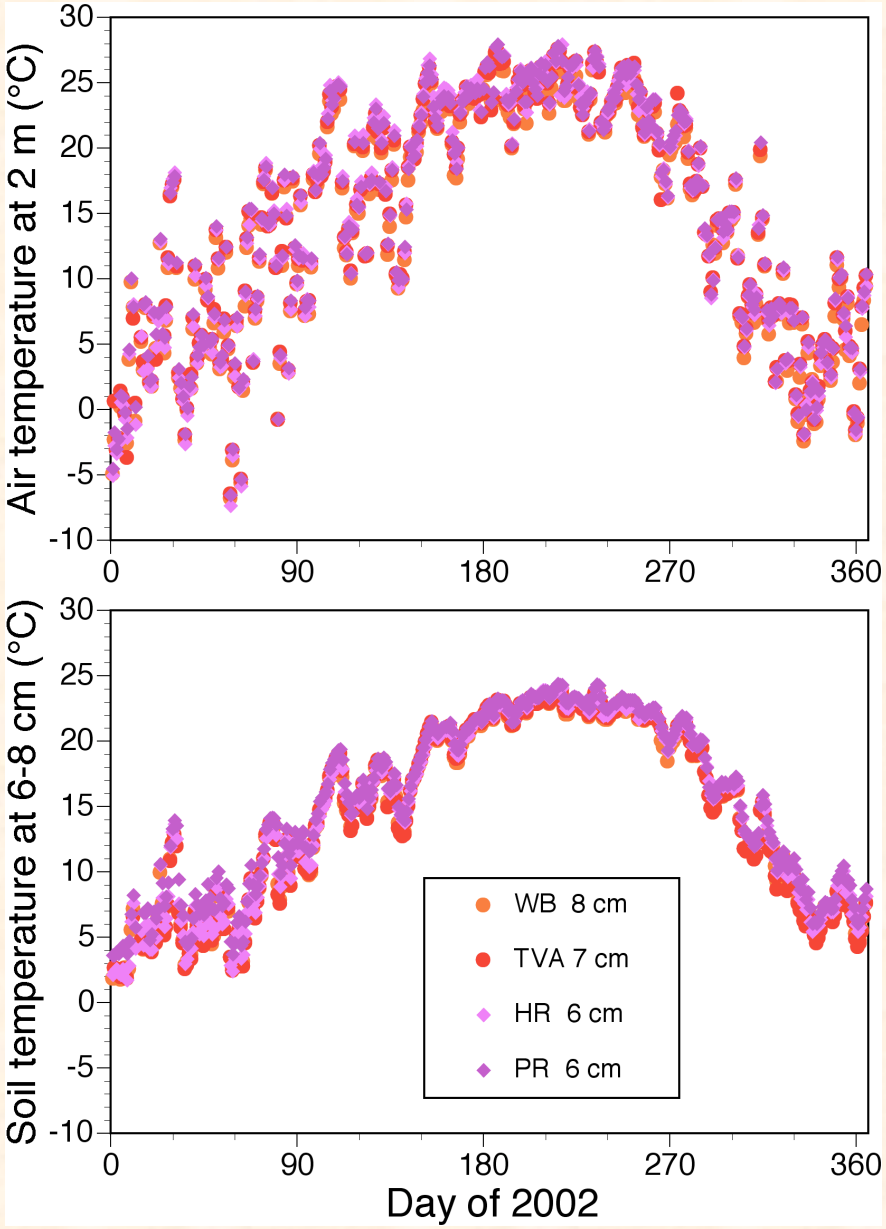
Quercus (oak) Dominated Forests

[*Acer* litter contributions on Pine Ridge could impact decomposition]

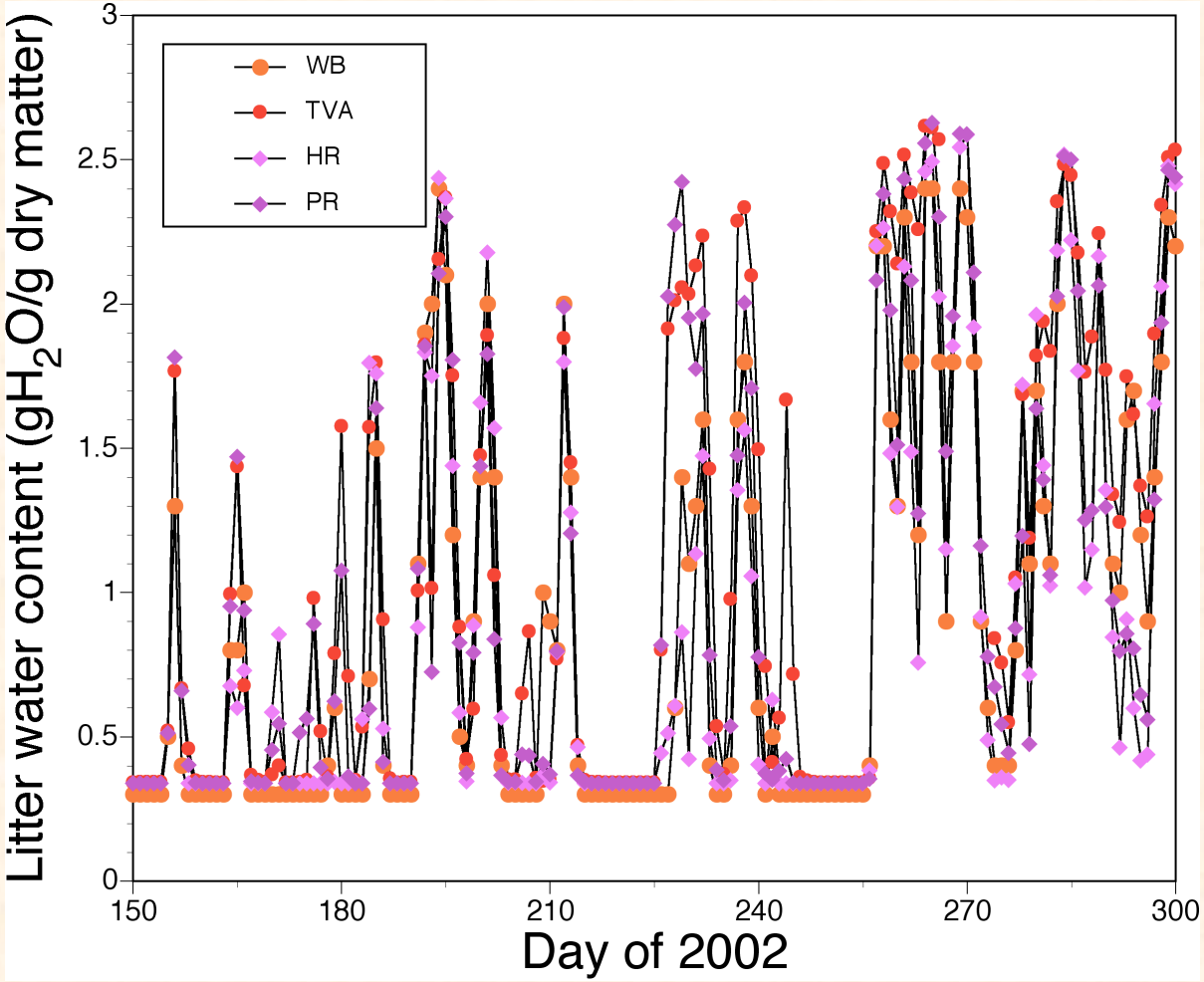


Temperatures

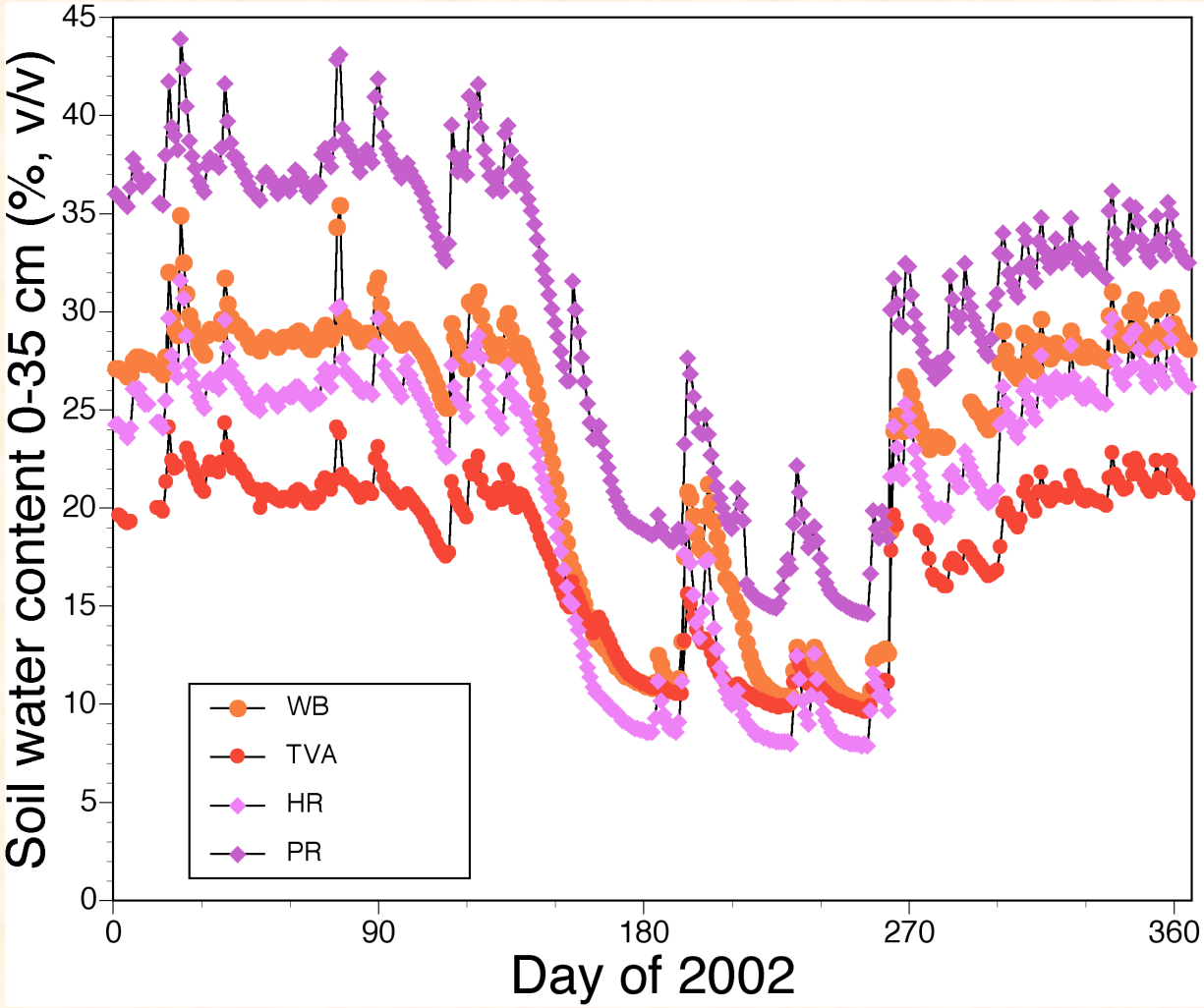
- Similar air, litter and soil temperatures were found at all 4 sites.
- Slightly warmer soil temperatures at HR and PR may reflect shallow placement of temperature probes.



Litter-layer Water Content

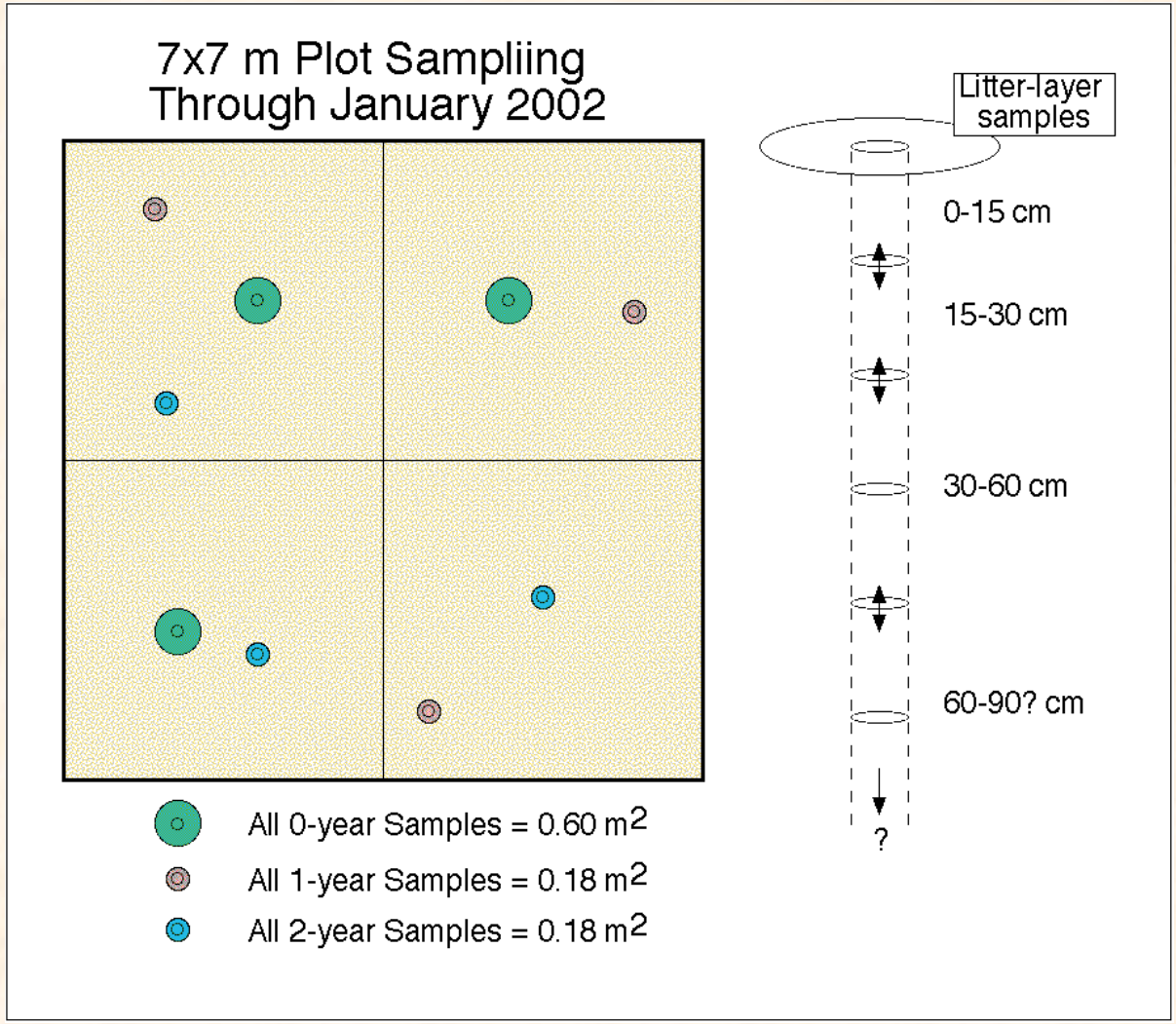


2002: Soil water Content



Pretreatment (0-year) Plot Sampling

Organic Layers: O_i>1Y and O_e/O_a



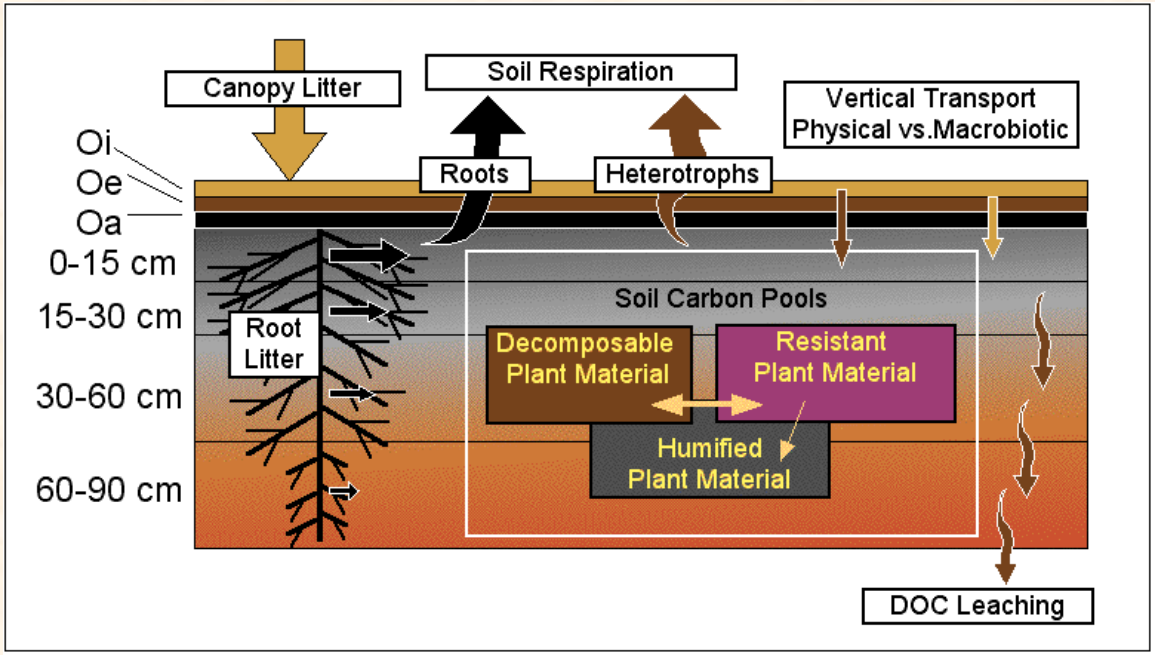
O_e horizon is minimal

0-15 cm is >A horizon

Depth of B horizon is highly variable

- **Sampling the 7x7 m plots will consume the study area. When?**
- **Mineral soil sampling depths are approximate ±2 cm.**

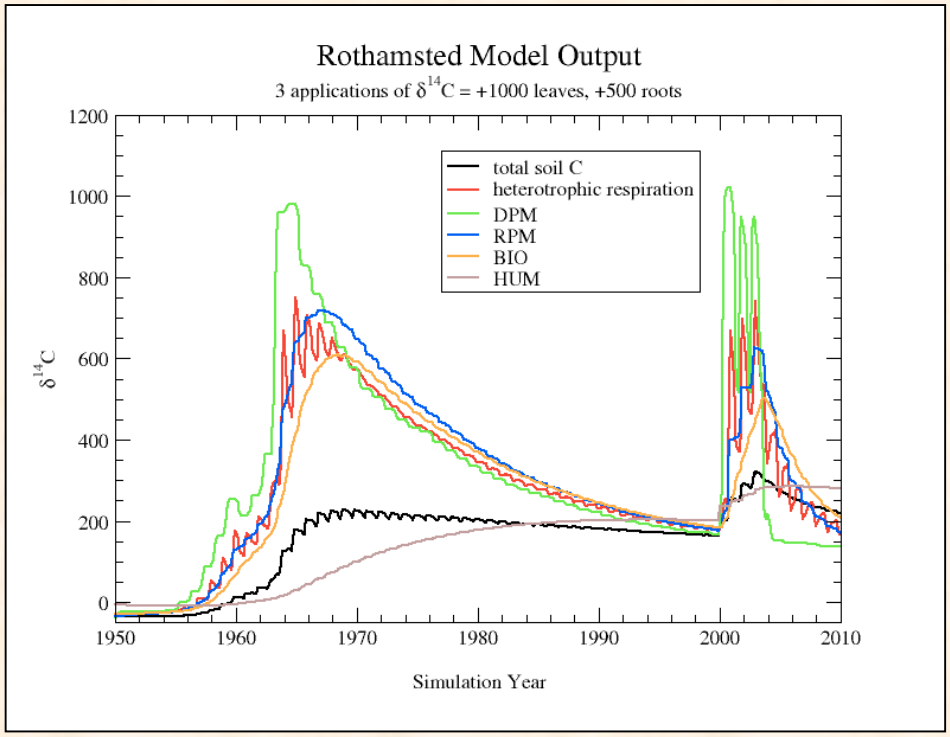
Issues to be Addressed

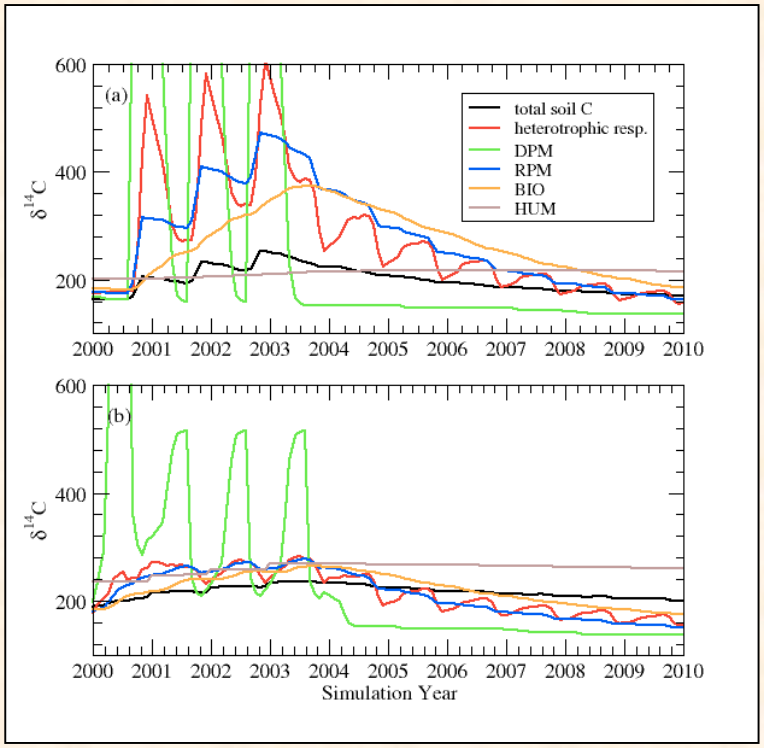


- Partitioning of soil respiration between autotrophic and heterotrophic sources
- Partitioning of heterotrophic soil respiration between above-ground and below-ground decomposition sources
- Quantifying pathways from carbon sources to stable forms in soils
- Quantifying the role of dissolved organic carbon in vertical transport
- Evaluating the longevity and turnover time of fine roots

Ultimate Goal

Improved Soil C-cycling Models





- **A priori predictions from the Rothamsted Model showing the influence of 3 years of enriched litter additions.**

Using ^{14}C to Understand Ecosystem C-cycling & Storage

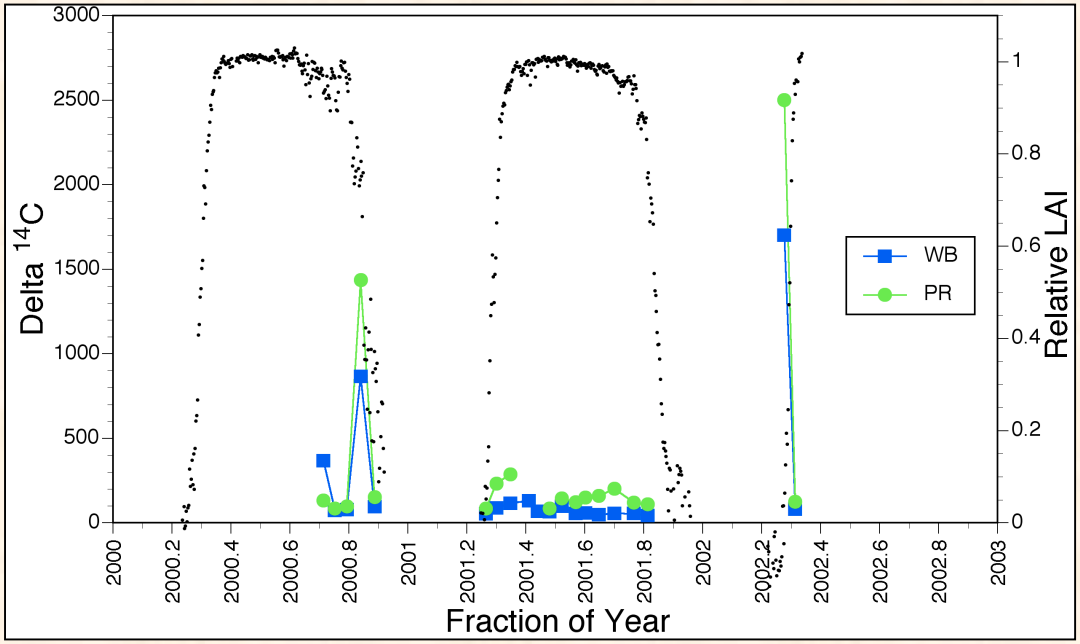
- **Natural radiocarbon (Carbon dating)**
  - produced by cosmic rays interacting with the upper atmosphere
  - Use ^{14}C dating to determine turnover times for long-lived carbon pools (T1/2 = 5730 yr)
- **'Bomb' radiocarbon (Reincorporation)**
  - Using ^{14}C to determine age of fractionated soil organic matter (model bomb ^{14}C incorporation)
  - New discoveries about roots - a complication
  - Determining sources of soil respiration
- **Experimental additions (Pulse label)**
  - Usually done at small spatial and temporal scales
  - Magnitude of 1999 release to the ORR truly unique

^{14}C Analysis: ~$300 to $400/sample

$$\Delta^{14}C = \left(\frac{\left(\frac{^{14}C}{^{12}C} \right)_{sample}}{\left(\frac{^{14}C}{^{12}C} \right)_{standard}} - 1 \right) 1000$$

Samples are corrected to a common ^{13}C value and therefore the ^{14}C values do not reflect mass dependent fractionation of isotopes. The standard is 1895 wood. Measurements accurate to +/- 5 per mil.

Measurements of ^{14}C in Air



- **^{14}C in ambient air is being monitored throughout the study to allow for corrections to our analysis in the event of future ^{14}C additions via photosynthesis.**