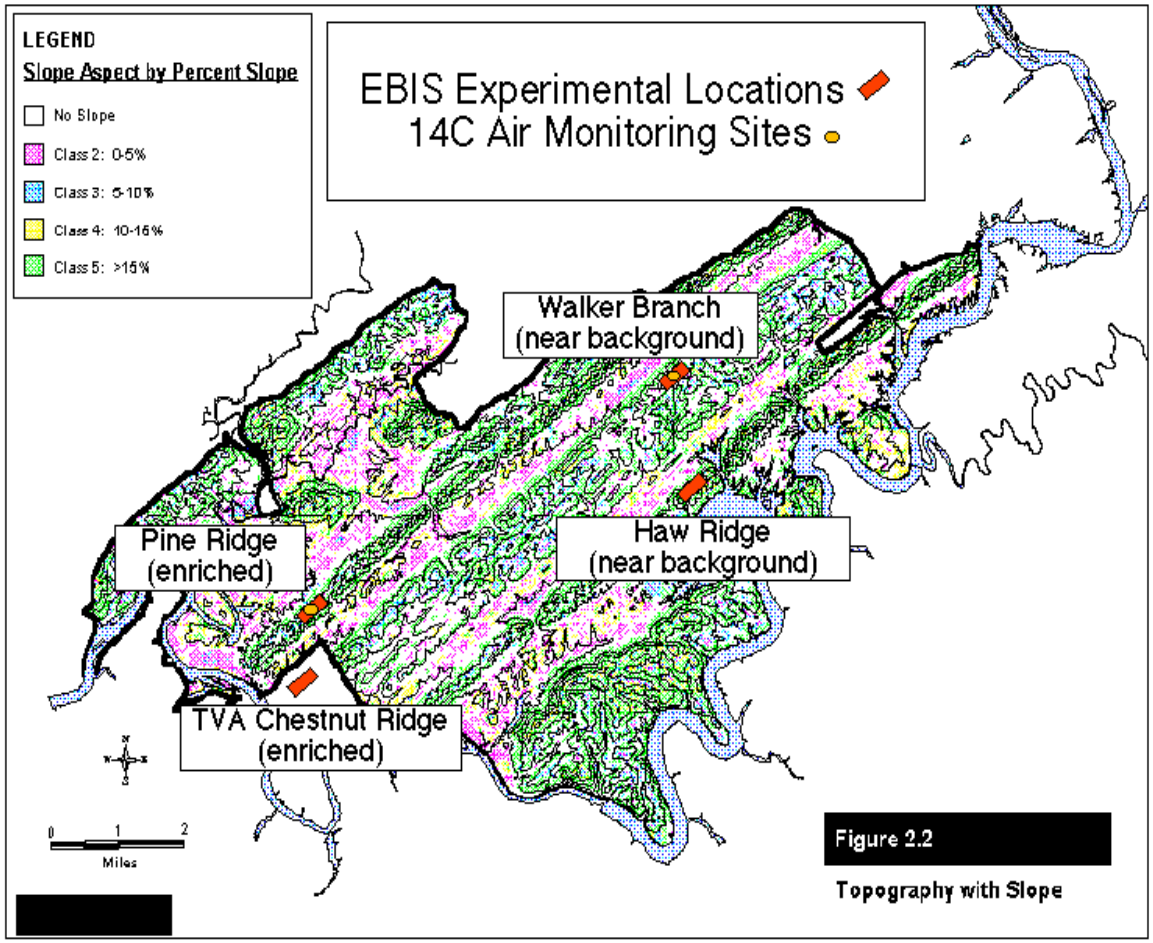
Soil Respiration Measurements and Quantification of Sources

EBIS Project Meeting

January 27 and 28, 2003

University of California, Irvine

Sites monitored



- Results shown here will include data from:

1) TVA in August 2001 and

2) Walker Branch and TVA in May, July and September 2002

- 6 plots total at each site (3 of each treatment)

Field measurements

- Rates of soil respiration (total) using a closed dynamic chamber and a licor

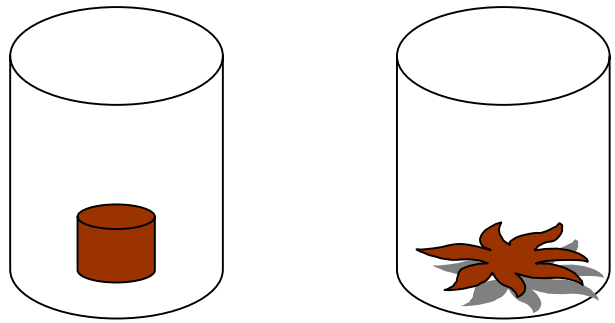
- Leaf litter and soil samples (first 5 cm)

- Collection of CO_2 for ^{14}C analysis from root and total soil respiration using molecular sieve traps

Laboratory work

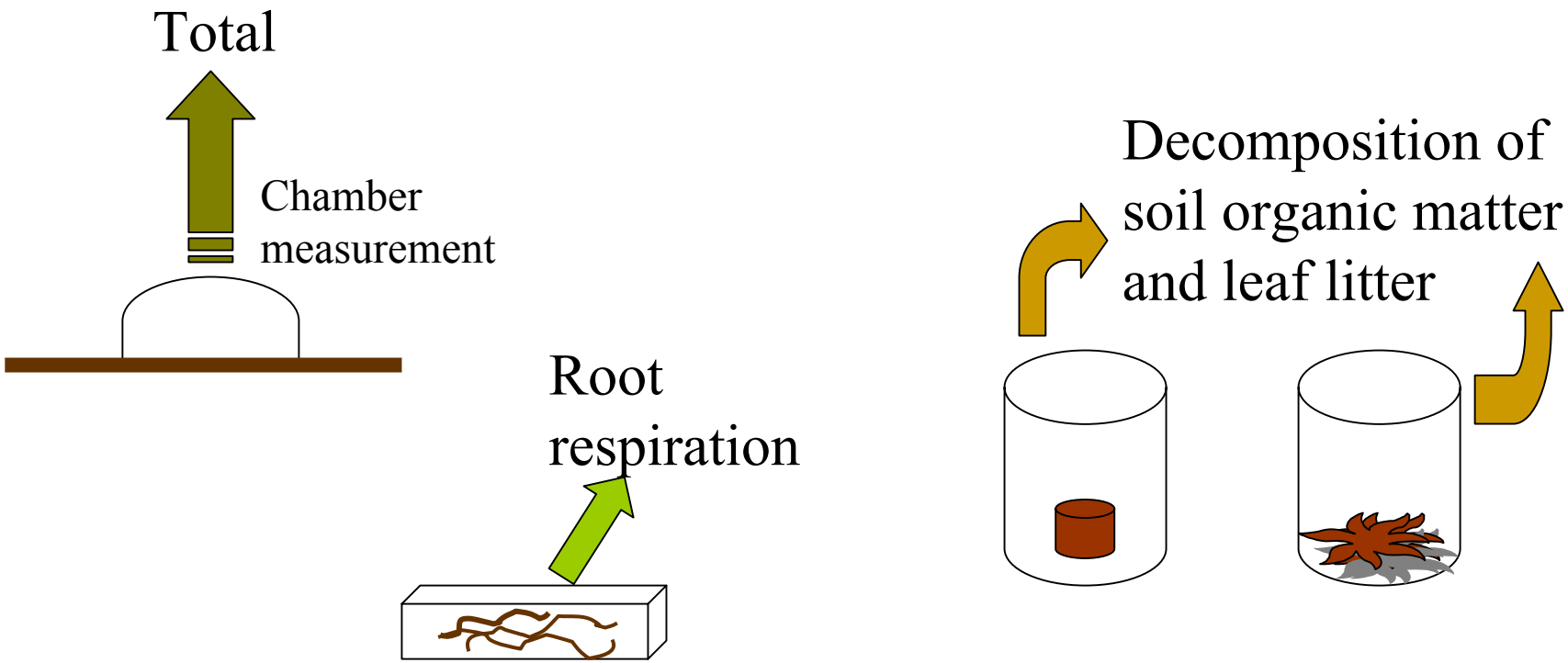
- Incubation of soil and leaf litter for 1 week approximately in 1 L jars to measure respiration rates and collect CO_2

- CO_2 from incubations and field collections is purified cryogenically and reduced to graphite for ^{14}C analysis at LLNL



Estimation of autotrophic and heterotrophic sources

$$\Delta^{14}C_{Total} = (FRR)\Delta^{14}C_{Autotrophic} + (1\text{-}FRR)\Delta^{14}C_{Heterotrophic}$$

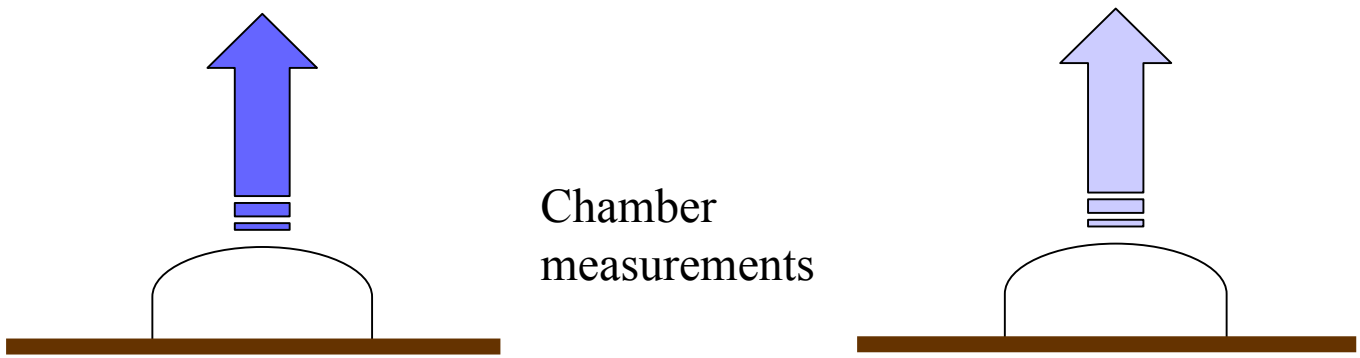


Estimation of the contribution of leaf litter decomposition

$$\Delta^{14}C_{total} = \Delta^{14}C_{\text{leaf litter}} * FLD + (\Delta^{14}C_{\text{root and soil decomposition}} + \Delta^{14}C_{\text{root respiration}}) * (1-FLD)$$

Difference between treatment plots ~ FLD

$\Delta^{14}C_{Total}\Big]_{enriched}$ >> $\Delta^{14}C_{Total}\Big]_{background}$



Enriched leaf litter
($\Delta^{14}C$= +1000‰)

Background leaf litter
($\Delta^{14}C$= +220‰)

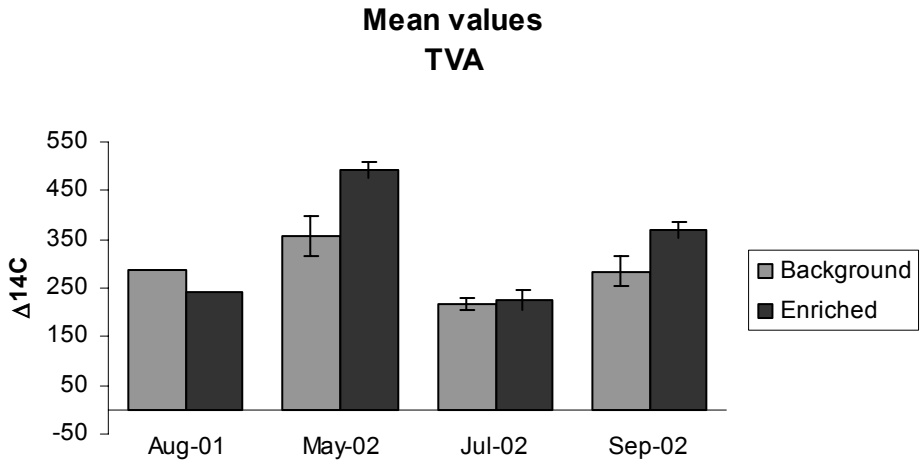
Contribution of root decomposition to heterotrophic respiration (frd)

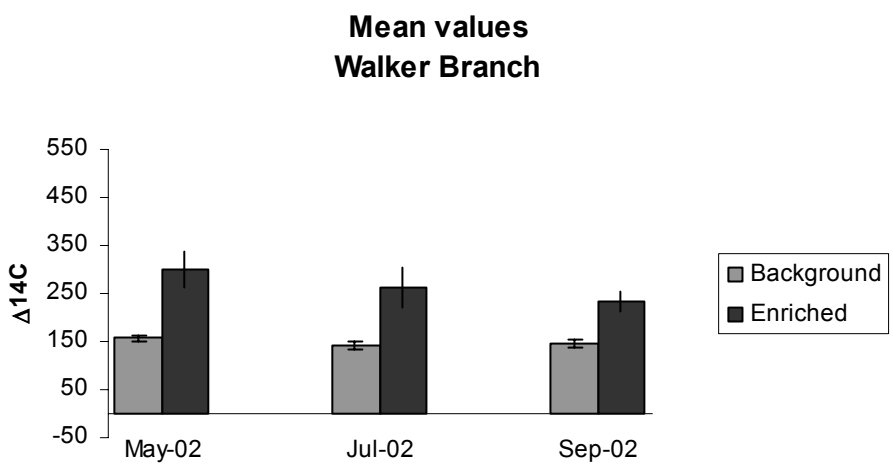
- Use of $\Delta^{14}C_{Heterotrophic}$ across sites and within any given treatment
- Use of the ^{14}C signature of roots

$$\Delta^{14}C_{heterotrophic} = \Delta^{14}C_{roots} * \text{frd} + (\Delta^{14}C_{\text{soil and leaf litter decomposition}}) * (1\text{-frd})$$

- "frd" is proportional to the difference across sites

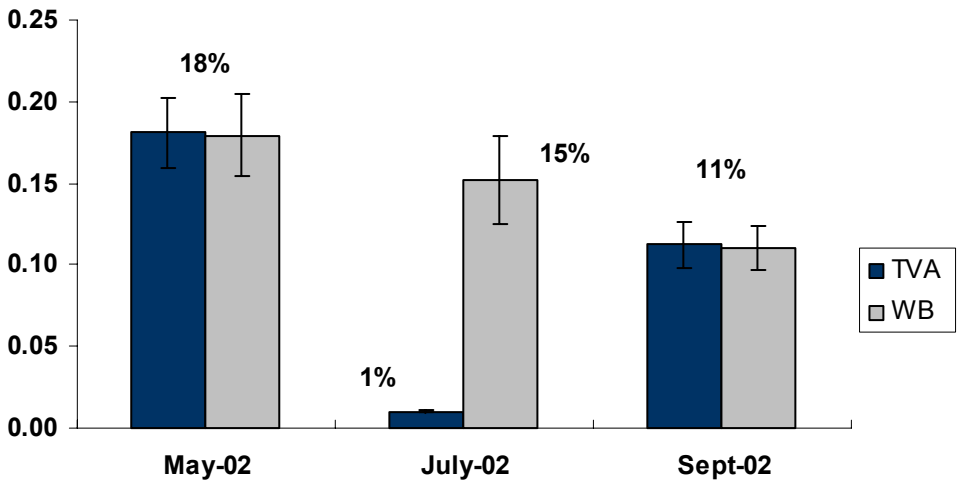
$\Delta^{14}C$ of total soil respiration





- A difference in the isotopic signature between treatments is observed as expected
- The overall signature is more enriched at the TVA site
- No difference was observed between treatments in August 2001 and July 2002 at the TVA site

Fraction from leaf litter decomposition (FLD)

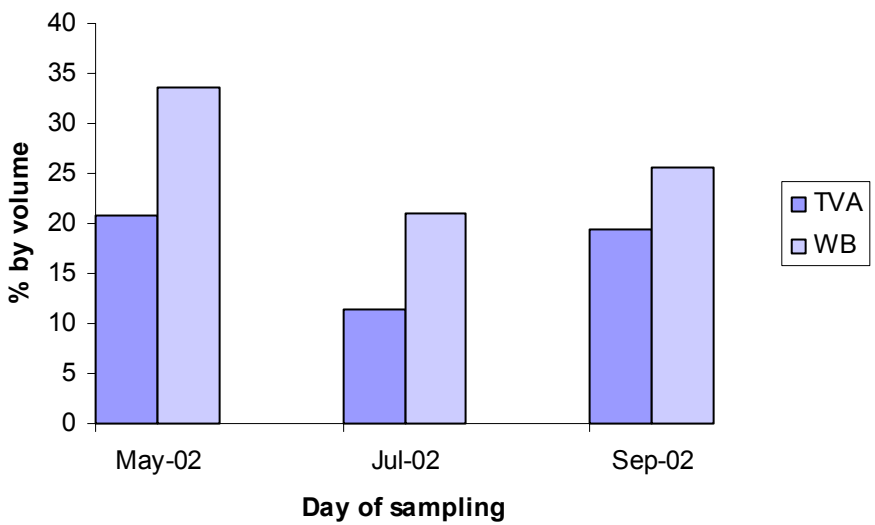


- The contribution from leaf litter decomposition decreased with time at both sites

- There was almost no contribution in July 2002 at TVA

- The value of FLD for August 2001 could not be estimated given the small (and negative) difference between treatments

Average soil moisture (upper 10 cm)



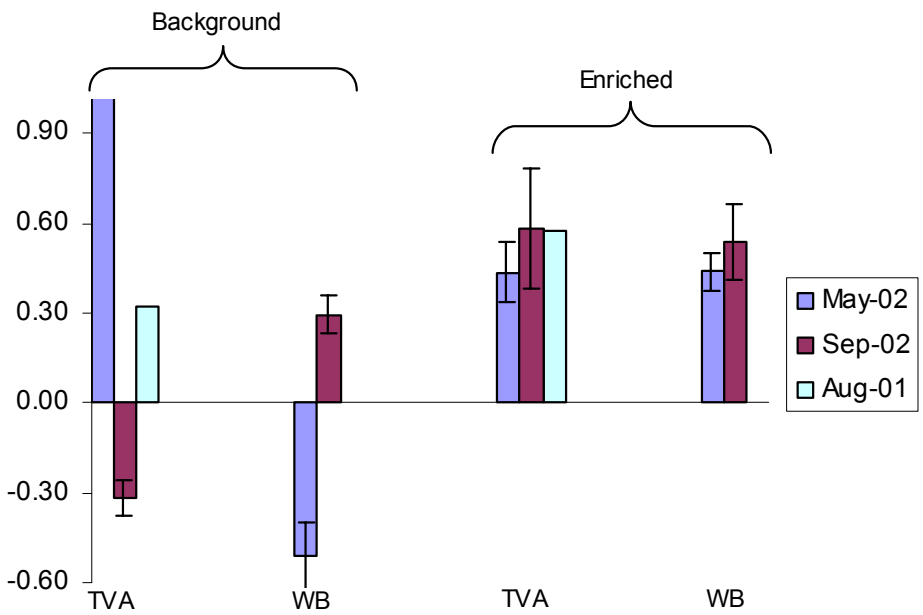
- Overall, higher soil moisture content in Walker Branch than in TVA

- The lowest soil moisture content at TVA (11%) coincided with the lowest FLD (1%) at the site

- There was no similar effect at Walker Branch where FLD continued to decrease steadily

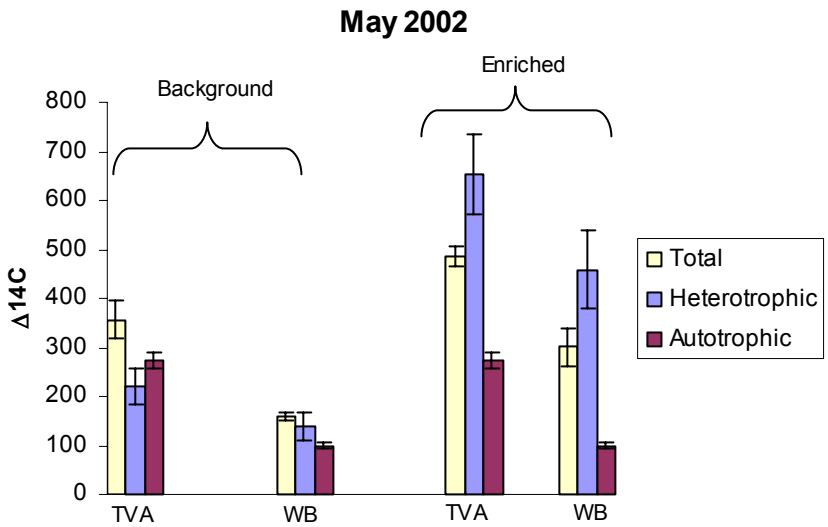
- There must be a threshold value of moisture content over which FLD is affected significantly

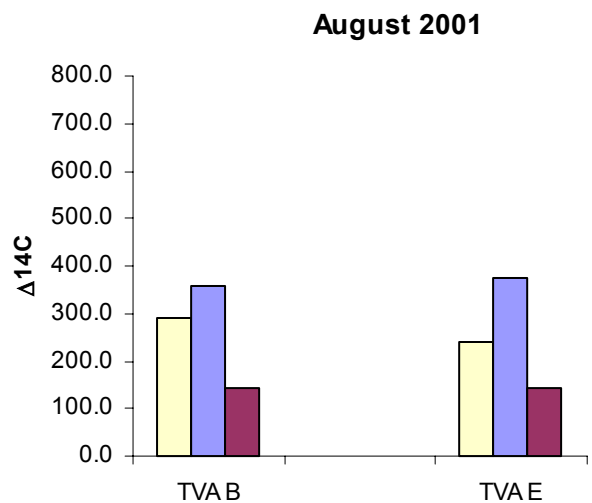
Fraction from root respiration

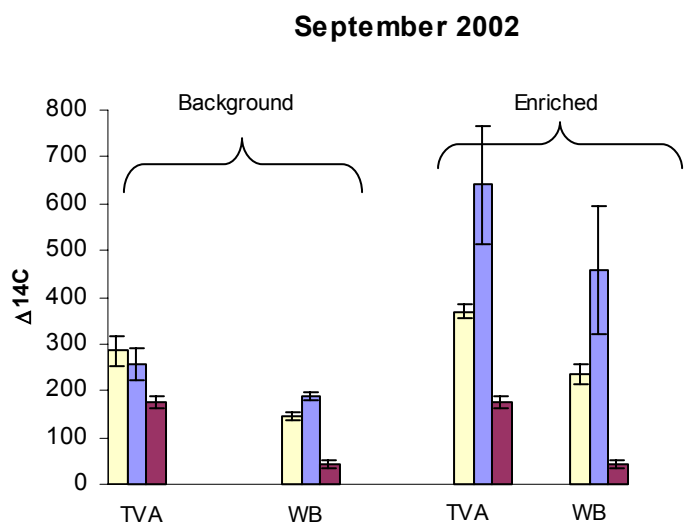


- Mass balance approach seems to work better with enriched plots
- FRR ranged from 0.44 to 0.58 from May to September respectively
- There were no incubations carried out in July

$\Delta^{14}C$ of sources vs total







- For the background plots, the difference in the isotopic signature between sources and total respiration is less significant

Conclusions

- A mass balance approach for ^{14}C was used to estimate the fraction from root respiration (FRR) and the fraction from leaf litter decomposition (FLD)

- FRR was estimated to vary from 0.44 to 0.58 from May through September

- FLD was estimated to vary from 18 to 11% for the same period, but was strongly limited when soil moisture content reached a value of 11% by volume

- The mass balance approach works better when the isotopic signatures of sources and total respiration differ significantly (case of the enriched plots)

Proposed future work

1) To better establish a pattern of response of FLD to soil moisture content,

- A manipulation experiment to control soil moisture and monitor leaf litter moisture
- Continue to measure both treatments

2) To identify seasonal variations in the ^{14}C of root respiration

- Measurement of ^{14}C of ambient air on the same day of root sampling and measurement of ^{14}C and ^{13}C of carbohydrates in roots

3) To identify correlations between climate variables and sources of soil respiration

- Use of weather data (such as RH, air temperature) available at each site