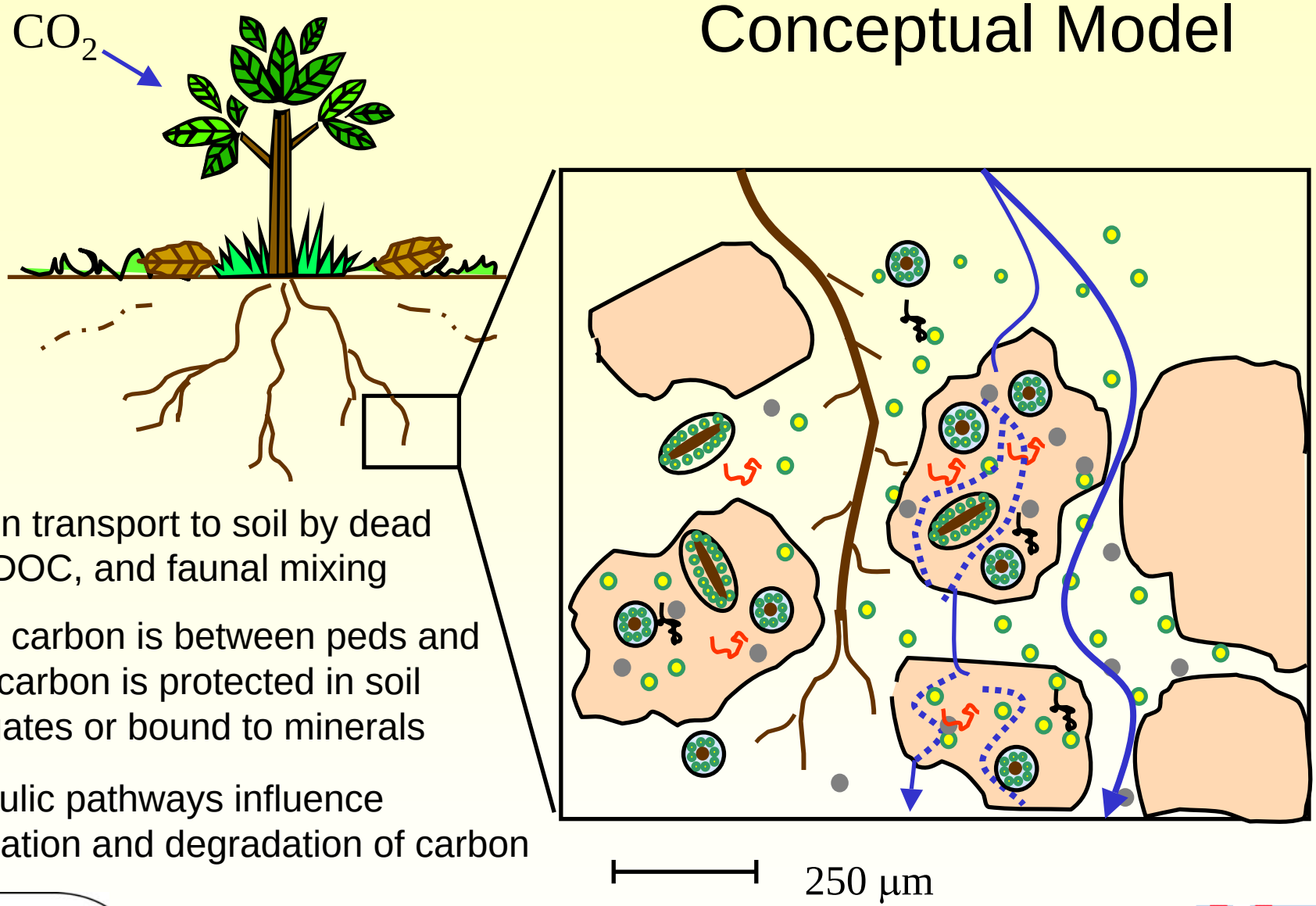
Forms and Fate of Carbon in Soils

Density-based method

EBIS 2-Year Project Meeting
January 7 and 8, 2004

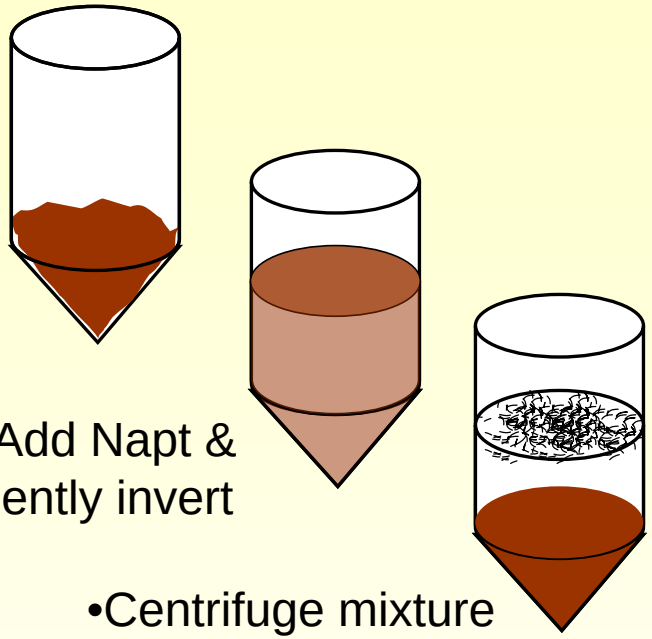
Chris Swanston
Margaret Torn
Paul Hanson
Erin Hanlon

Conceptual Model



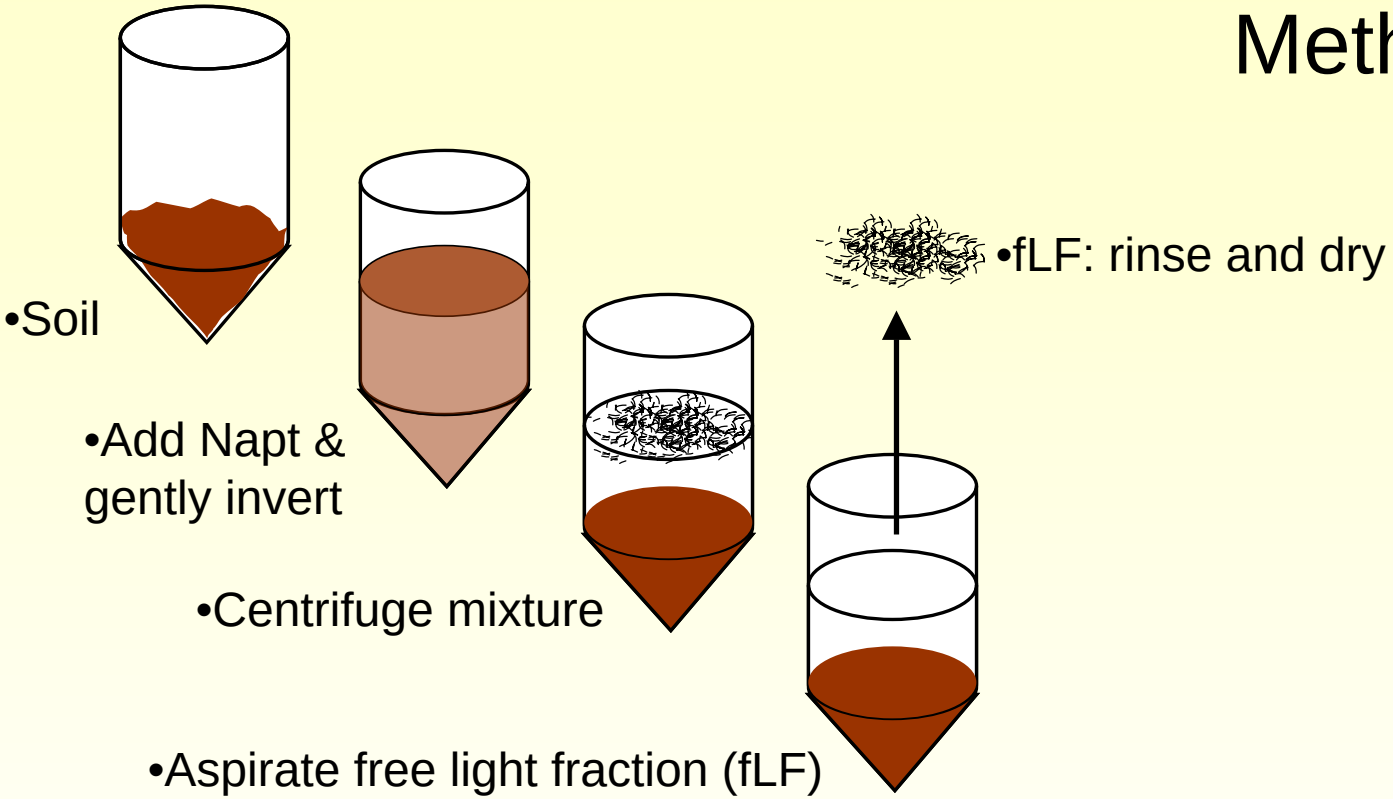
- Carbon transport to soil by dead roots, DOC, and faunal mixing
- Active carbon is between peds and stable carbon is protected in soil aggregates or bound to minerals
- Hydraulic pathways influence stabilization and degradation of carbon

Density Fractionation Methodology

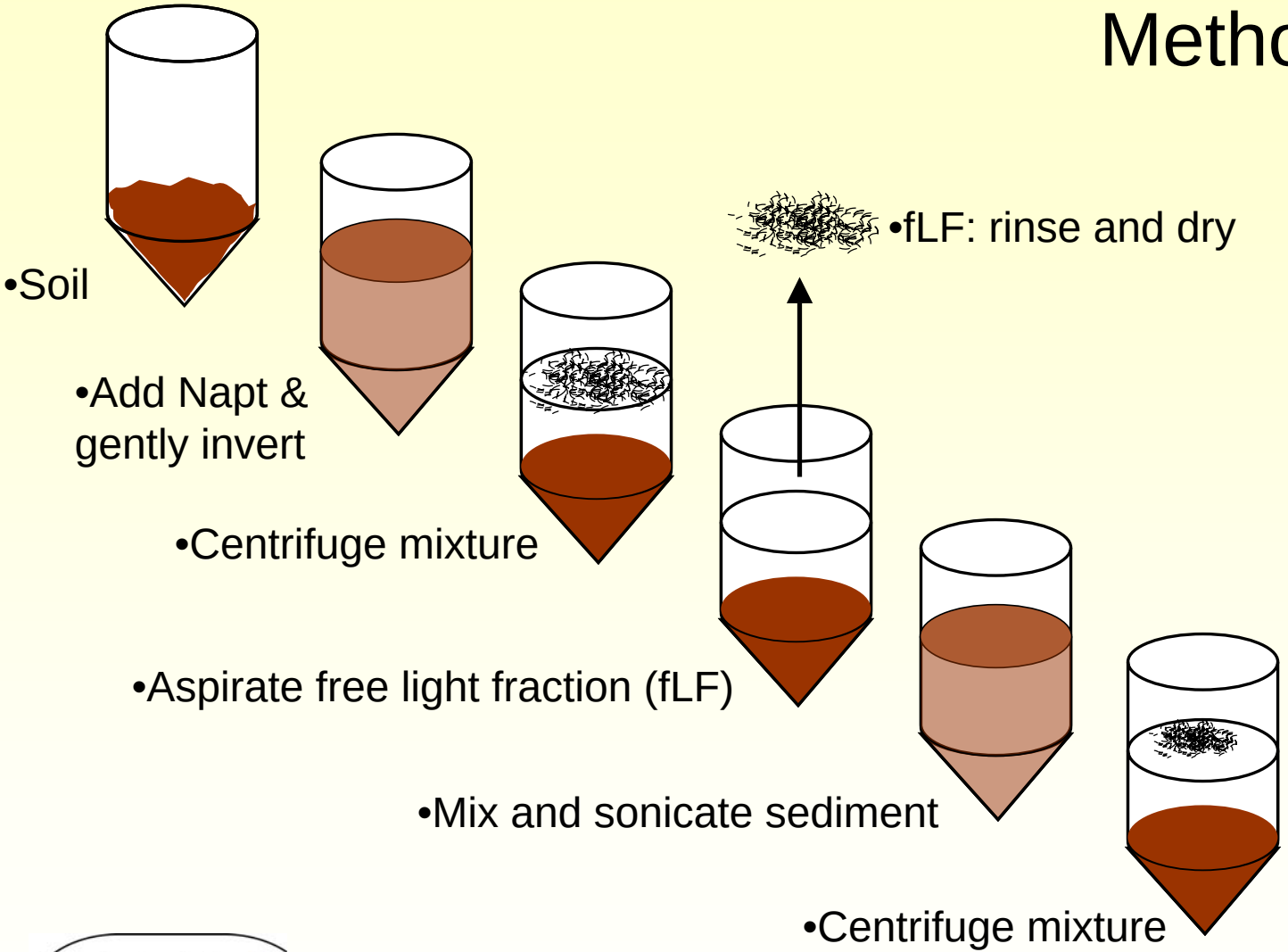


- Soil
- Add Napt & gently invert
- Centrifuge mixture

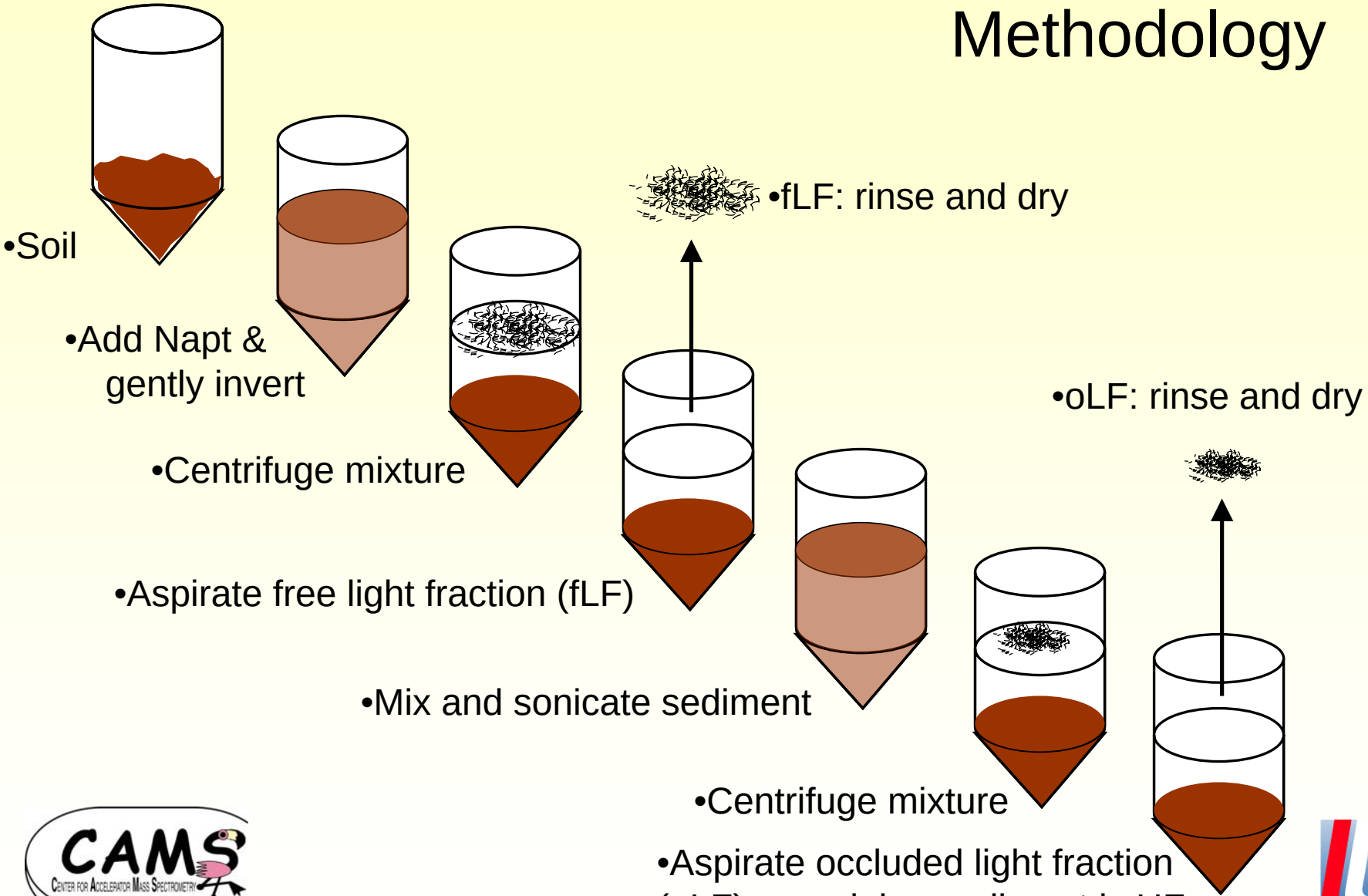
Density Fractionation Methodology



Density Fractionation Methodology



Density Fractionation Methodology



0-year Ultisols
(Walker Branch and TVA Chestnut Ridge)

- Considered WB and TVA separately
- Split plot ANOVA's
  - main plots: depth (0-15, 15-30 cm)
  - subplots: fraction (fLF, oLF, HF)
- Tested: Fm ^{14}C, %C, %N, C:N, and %Soil C_{DF}

0-year Ultisols

Walker Branch

	Mass % of bulk soil	C -g kg^{-1}-	N -g kg^{-1}-	C :N	% Soil C_{CF}
0-15 cm					
Bulk soil	NA	24.88 (5.89)	0.97 (0.04)	25.5 (1.5)	NA
Free LF	2.17 (0.37)	299.79 (7.94)	8.85 (0.20)	34.1 (1.7)	25.52 (2.44)
Occl LF	1.08 (0.11)	388.57 (9.31)	9.31 (0.40)	42.3 (2.0)	16.74 (0.80)
HF	96.74 (0.47)	12.46 (0.54)	0.72 (0.03)	17.3 (0.6)	49.69 (2.47)
15-30 cm					
Bulk soil	NA	5.88 (0.51)	0.17 (0.02)	35.6 (2.6)	NA
Free LF	0.44 (0.05)	326.31 (8.57)	6.91 (0.42)	45.5 (2.1)	23.84 (1.86)
Occl LF	0.24 (0.02)	360.93 (2.38)	6.53 (0.63)	57.2 (3.7)	14.93 (1.19)
HF	99.31 (0.08)	2.89 (0.25)	0.24 (0.02)	12.4 (0.8)	51.93 (4.93)

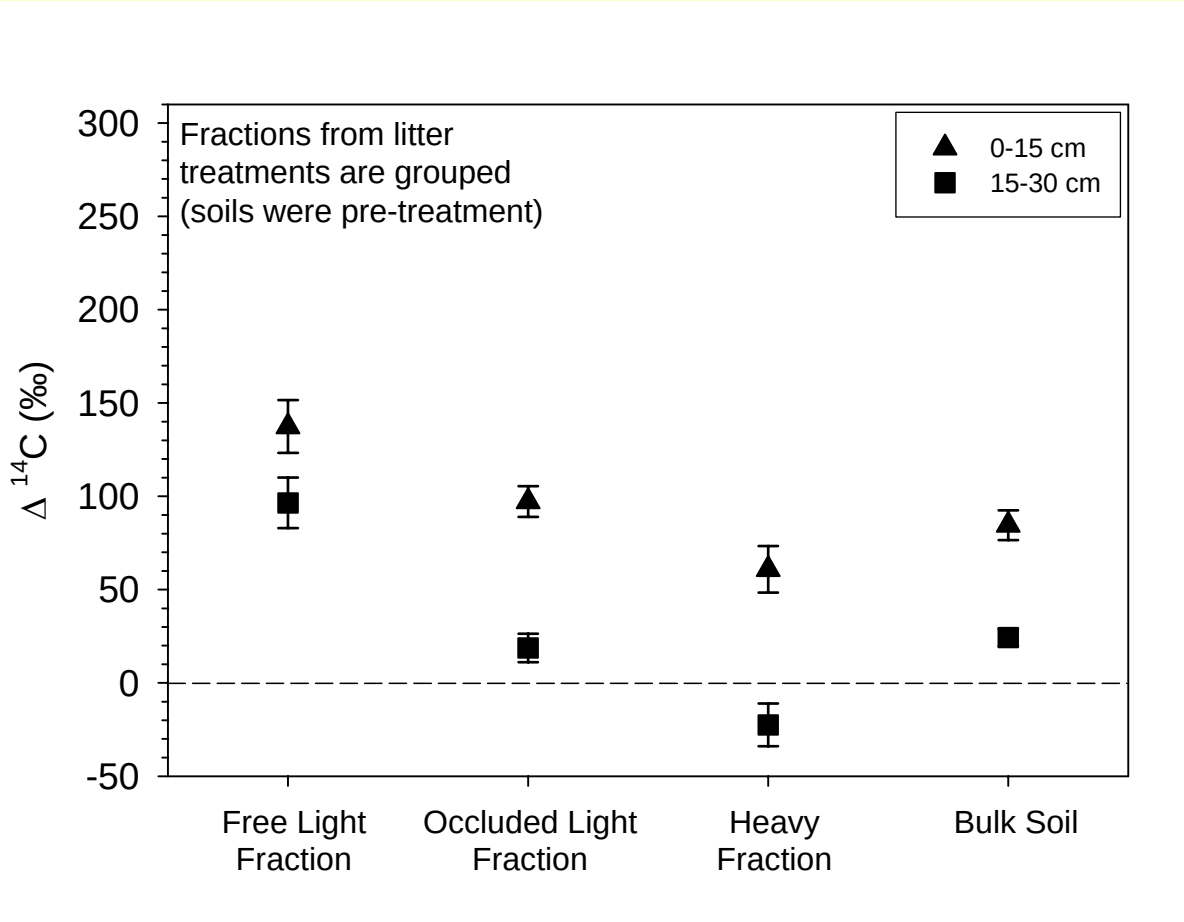
0-year Ultisols

TVA Chestnut Ridge

	Mass % of bulk soil	C[1] -g kg^{-1}-	N[1] -g kg^{-1}-	C :N	% Soil C_{DF}
0-15 cm					
Bulk soil	NA	24.87 (2.16)	1.18 (0.05)	21.2 (0.6)	NA
Free LF	2.16 (0.10)	295.64 (5.03)	10.29 (0.36)	28.9 (0.8)	25.58 (0.82)
Occl LF	0.88 (0.06)	376.18 (11.14)	8.54 (0.44)	44.6 (2.0)	13.33 (1.03)
HF	96.96 (0.08)	13.33 (0.45)	0.88 (0.04)	15.2 (0.3)	51.92 (1.10)
15-30 cm					
Bulk soil	NA	8.50 (0.55)	0.42 (0.03)	20.4 (1.1)	NA
Free LF	0.50 (0.04)	318.27 (2.68)	8.63 (0.30)	37.1 (1.3)	19.27 (0.87)
Occl LF	0.32 (0.03)	410.42 (12.85)	7.60 (0.35)	54.4 (1.8)	15.59 (0.76)
HF	99.18 (0.06)	4.58 (0.35)	0.40 (0.02)	11.4 (0.5)	54.71 (1.03)

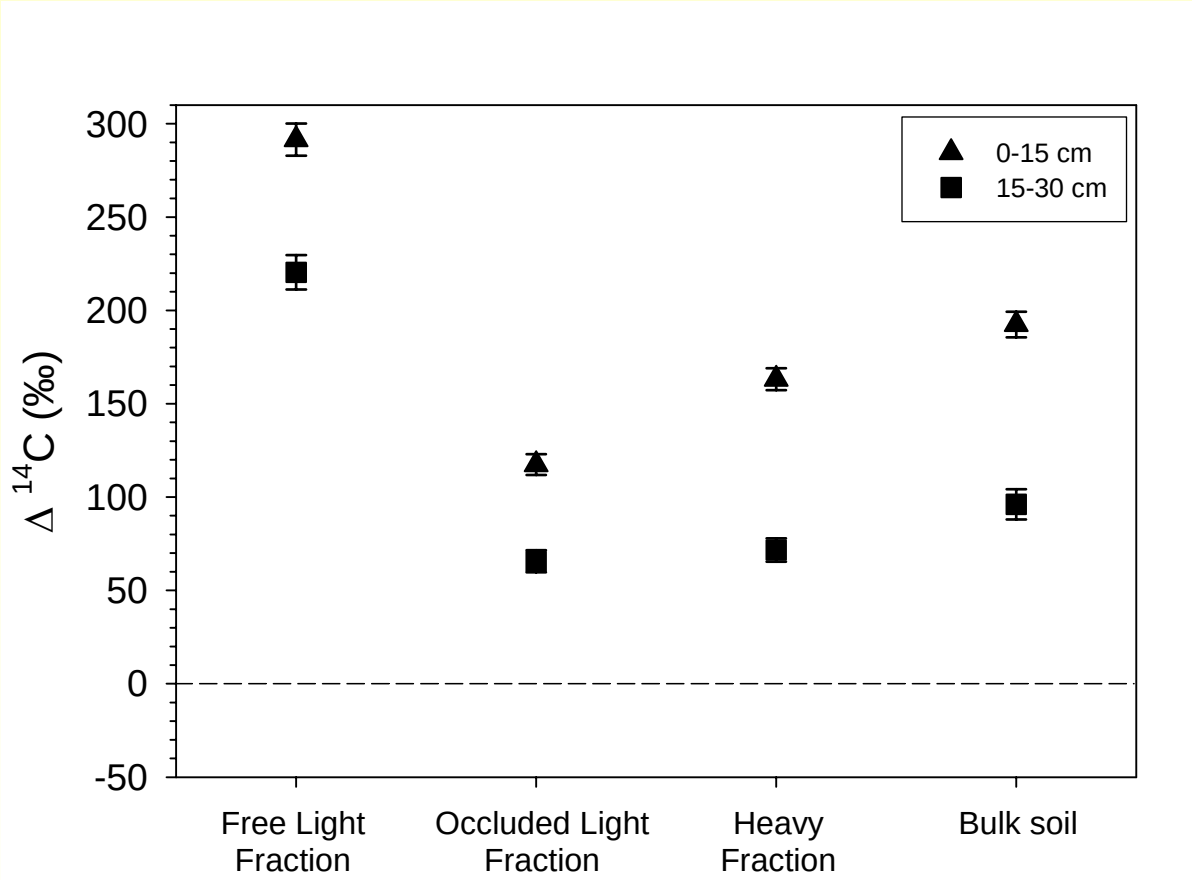
0-year Ultisols

Walker Branch



0-year Ultisols

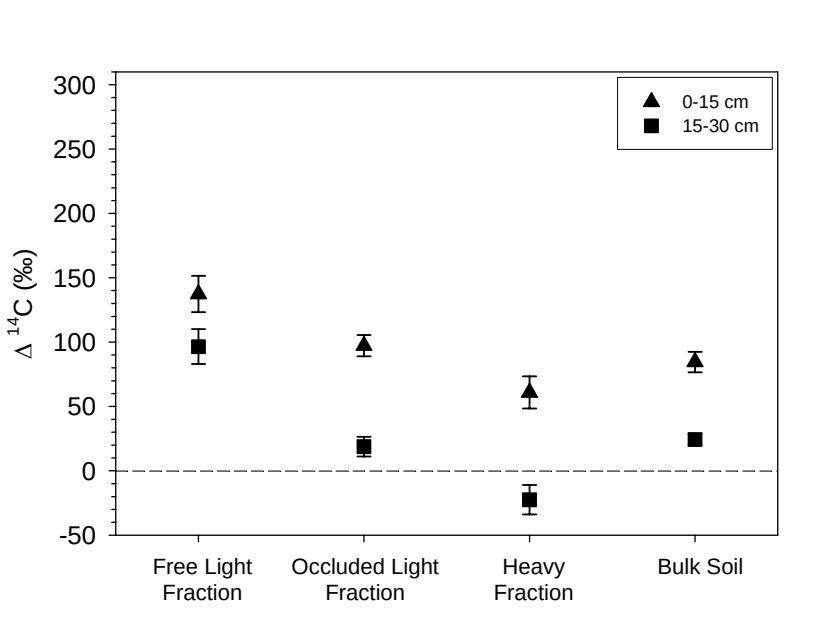
Walker Branch

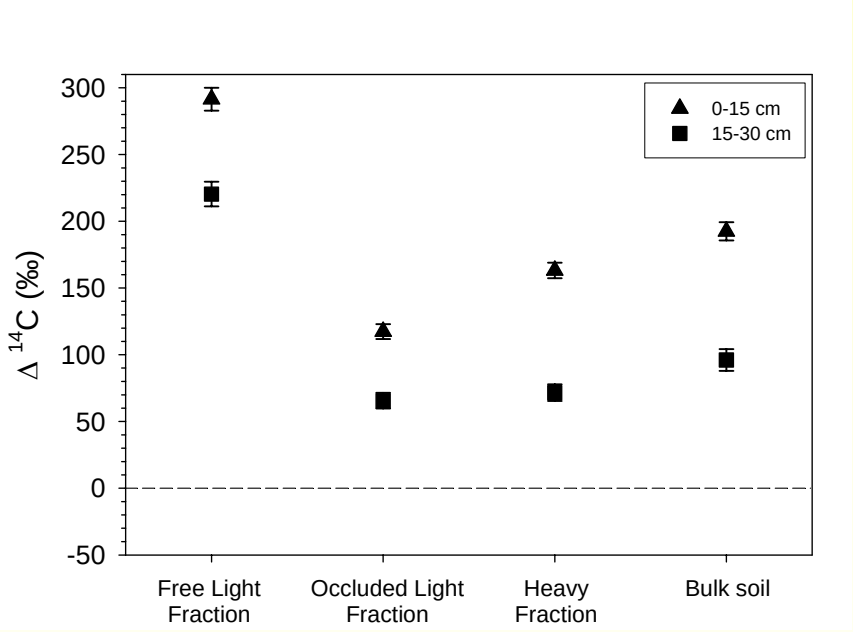


Fractions from litter treatments are grouped (soils were pre-treatment)

0-year Ultisols

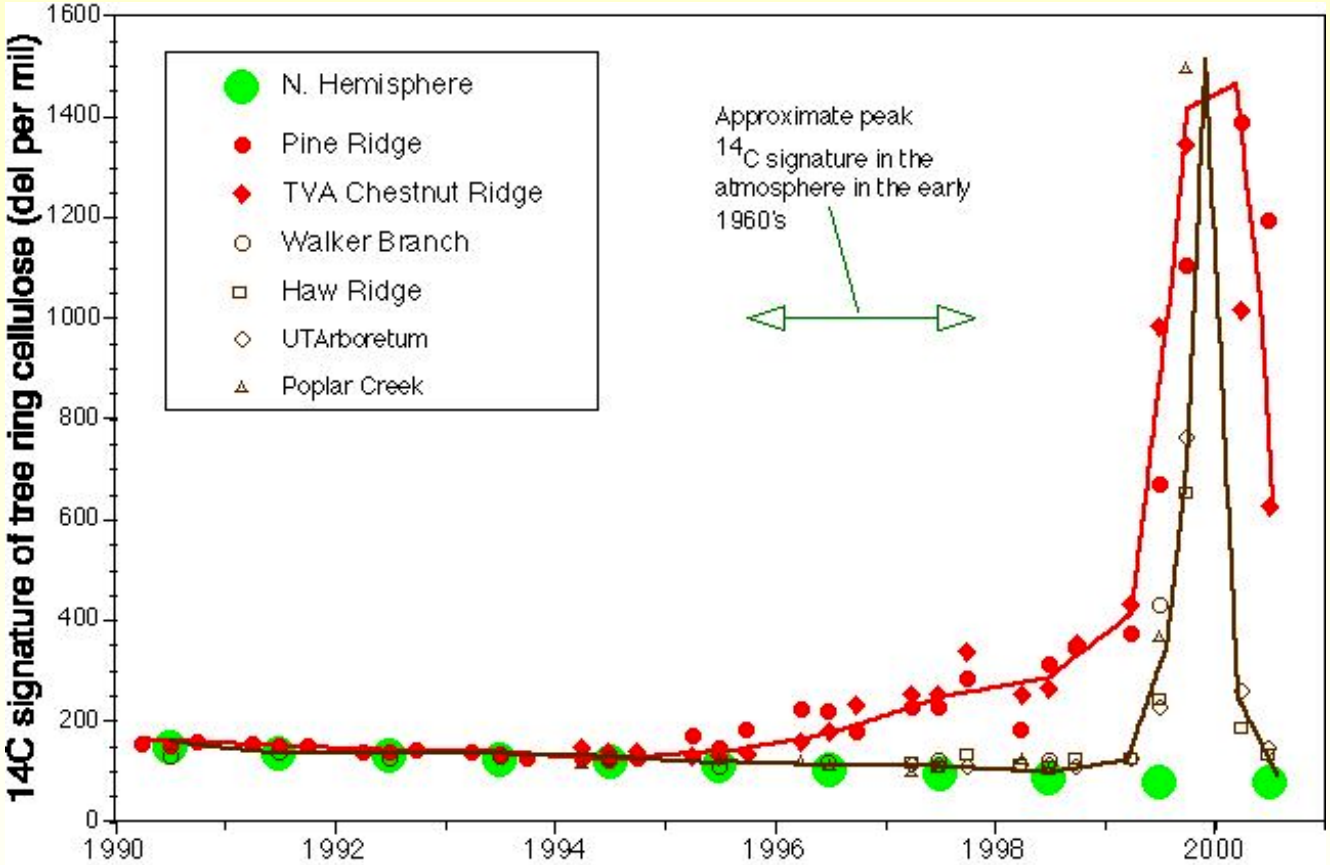
Walker Branch and TVA Chestnut Ridge





- fLF and HF clearly elevated at TVA
- oLF not clearly elevated at TVA

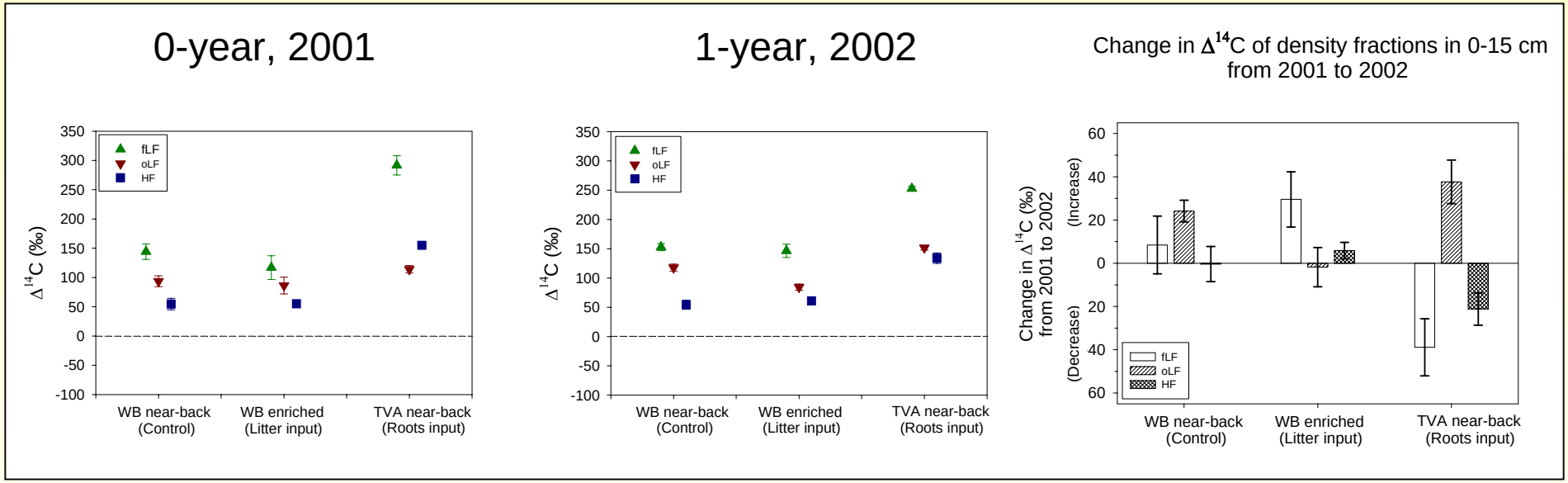
^{14}C concentrations in cellulose of trees in Oak Ridge Reservation and surrounding areas.



- The western ORR has been elevated for longer….

Preliminary 1-year 'Trends'

0-15 cm

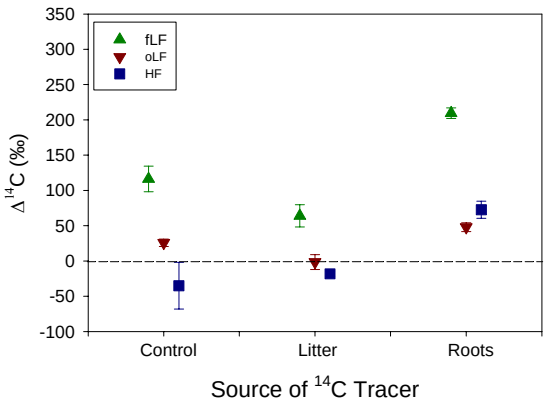


- Walker Branch, enriched litter
  - Enrichment of ^{14}C in fLF, probably from mixing and DOC
- TVA Chestnut Ridge, near-background litter
  - Depletion of ^{14}C in fLF and HF, likely from recent root input and mixing of near-background litter
  - Enrichment of oLF, likely from older root input

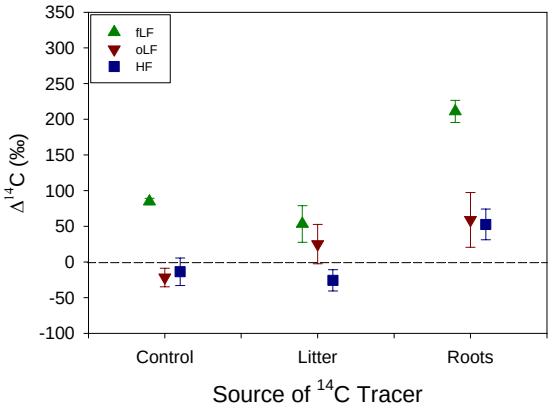
Preliminary 1-year 'Trends'

15-30 cm

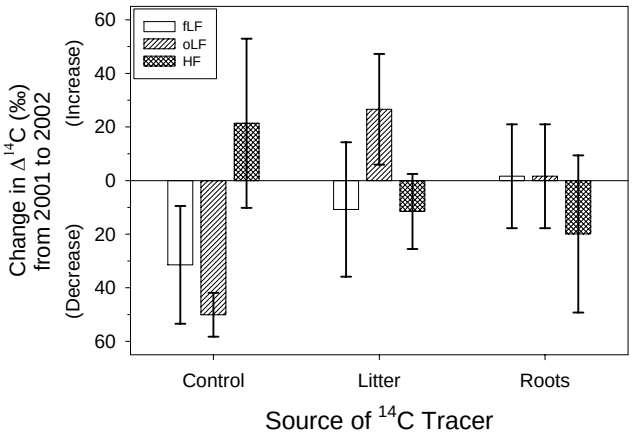
0-Year, 2001



1-Year, 2002



Change in $\Delta^{14}C$ of density fractions in 15-30 cm from 2001 to 2002



- Nothing really solid – WB near-background oLF dropping (?)

Concluding Remarks

- Current results
  - This method separates fractions with different chemistry and cycling rates.
  - These density fractions are sensitive to ^{14}C inputs/fluctuations.
  - They are comparable in mass proportion in WB and TVA 0-15 cm depth class, but differ in the 15-30 cm class.
  - A pre-1999 enriched-^{14}C pulse appears to be moving through the fLF and HF at TVA, and possibly into the oLF.

- On-going and future work
  - Near-term: Submission of a manuscript on 0-year Ultisol results for a special issue of Geoderma
  - Separate Inceptisols 0-30 cm.
  - Refine method for 30-60 and 60-90 cm soils, and continue separating those.
  - Add to tree ring database; create separate pulse curve for each site.