Transport and Sequestration of Organic C in Contrasting Soils Amended with C-14 Enriched Leaf Litter

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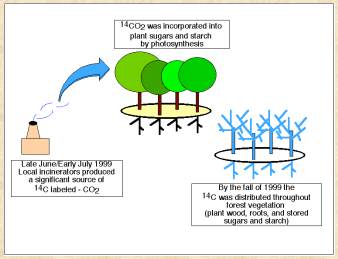
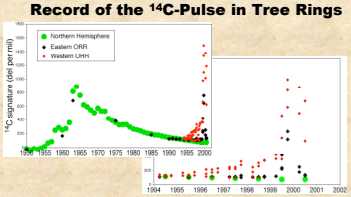
The Event

The 1999 ^{14}C Event



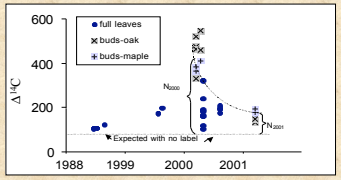
Magnitude of 1999 release to the ORR truly unique

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.

Objectives

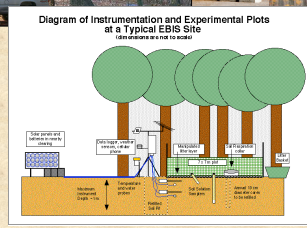
Use enriched litter as a well defined source to quantify organic C flux through soil profiles as a function of storm events.

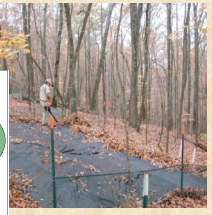
Quantify the impact of coupled hydrological and geochemical processes on the fate and transport of dissolved organic C through contrasting soil profiles being used in the Enriched Background Isotope Study at ORNL.

Quantify the mechanisms that control enhanced carbon accumulation within deep subsoils of forested Ultisols and Inceptisols.

The Approach

Excluding indigenous litter and applying enriched or background litter

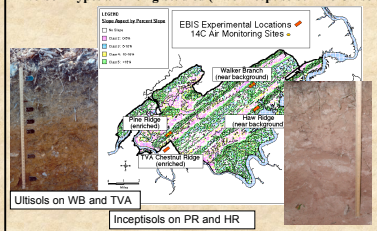




Replicate 7x7 m Plots Were Established at 4 Sites

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).

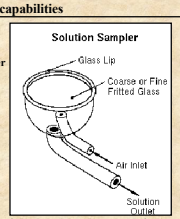
Two Soil Types are Being Studied (Two Inceptisols / Two Ultisols)



Two background and two enriched plots from each of the four EBIS sites (16 plots) were instrumented with four tension lysimeters and four tension-free lysimeters. Two of each type were placed within the A- and B-horizons of the soil profiles.

Multi-porosity sampling capabilities

Zero/low tension solution sampler for monitoring macropore and mesopore domains

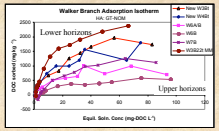


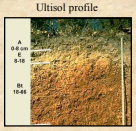
High tension solution sampler for monitoring micropore domains

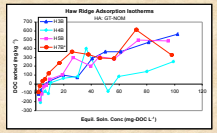
- **Besides the addition of enriched and background litter, an aqueous nonreactive Br tracer was evenly applied over each of the instrumented areas using a backpack sprayer. Non-reactive Br tracer provides useful data for quantifying flow and transport processes at the various sites.**
- **Solution samplers were monitored during all storm events and analyzed for Br, TOC, and inorganic anions. Select samples were analyzed for ^{14}C.**
- **Bulk soil samples from each plot were characterized for select physical and chemical properties and organic C sorption isotherms were quantified for each subsoil.**

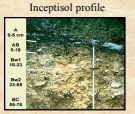
The Results

Carbon sorption isotherms on Ultisol soil profiles



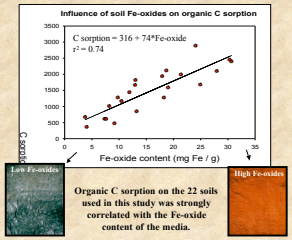






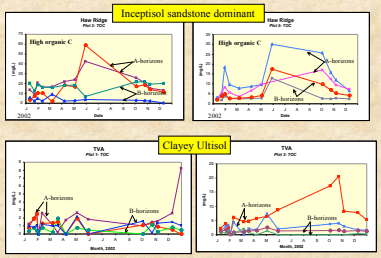
Soil samples from lower B-horizons have significantly larger carbon sorption capacities relative to upper A, E, A/E, and B/E horizons.

Low organic C sorption on sandy inceptisols with low Fe-oxide content.

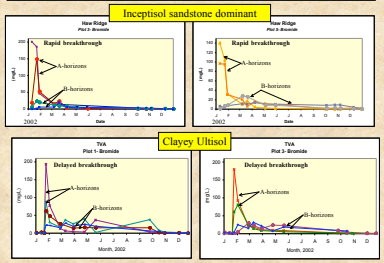


Organic C sorption on the 22 soils used in this study was strongly correlated with the Fe-oxide content of the media.

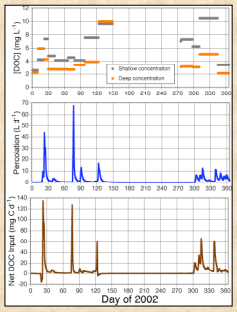
Example storm driven DOC concentrations in soil profiles



Example of storm driven Br breakthrough in soil profiles



- **DOC concentration and flux higher for A-horizons relative to B-horizons.**
- **Haw Ridge (sandy inceptisol) has highest C flux which is consistent with its more rapid flow and transport characteristics and lower organic C retention capacity.**
- **Clayey soils (PR, TVA, WB) have lower organic C fluxes yet greater flux decreases during movement from A- to B-horizons. This may be related to their higher organic C retention capacity.**
- **Organic C fluxes at each site are consistent with the hydrodynamics and geochemical retention capacities of the soils.**



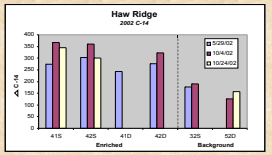
Estimated organic C inputs in the Walker Branch Ultisol B-horizons showing that these lower horizons typically receive more C than they lose.

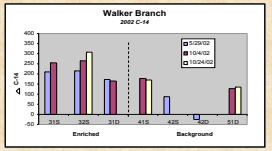
$\Delta^{14}C$ signatures in select pore water from Inceptisol and Ultisol soil profiles

Enriched plots have higher $\Delta^{14}C$ signatures in pore water than background plots.

Pore water from Haw Ridge has a higher $\Delta^{14}C$ signatures relative to Walker Branch which is consistent with the more rapid flow and transport characteristics and lower organic C retention capacity of HR.

Pore water from WB has a lower $\Delta^{14}C$ signature relative to HR with B-horizon samples showing no evidence of enrichment. This may be related to the higher organic C retention capacity of WB.





Conclusions:

- **Non-reactive Br tracer provides useful data for quantifying flow and transport processes at the various sites.**
- **Organic C fluxes at each site are consistent with the hydrodynamics and geochemical retention capacities of the soils.**
- **Organic C sorption is strongly correlated with the soil Fe-oxide content.**
- **Pore water $\Delta^{14}C$ signatures look promising. Enriched plots clearly show higher values than background plots, and the data is consistent with site hydrological and geochemical characteristics.**