Organic Layer Bulk ^{14}C Dynamics

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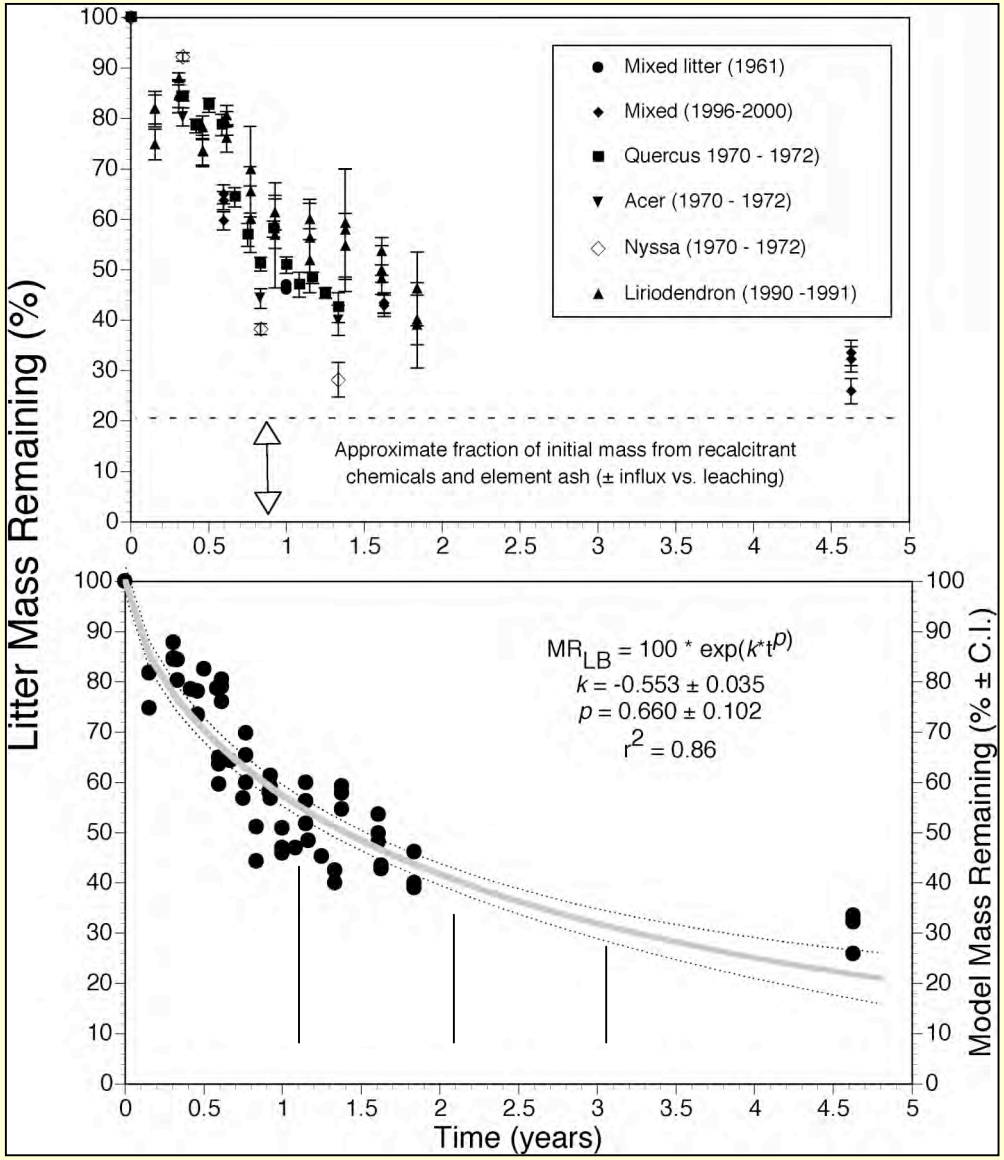
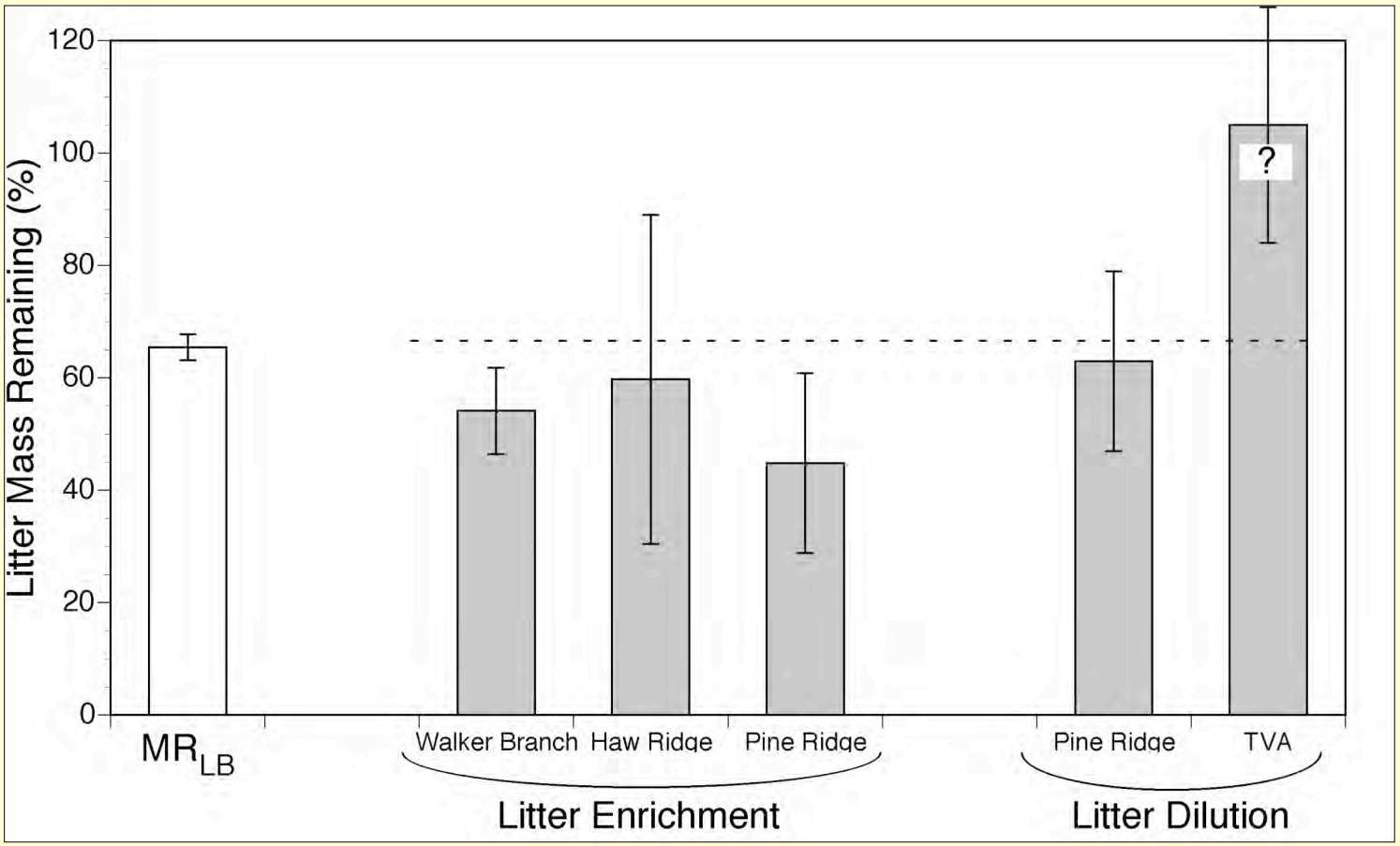
Oi Decomposition from Traditional 'Litter Bags'

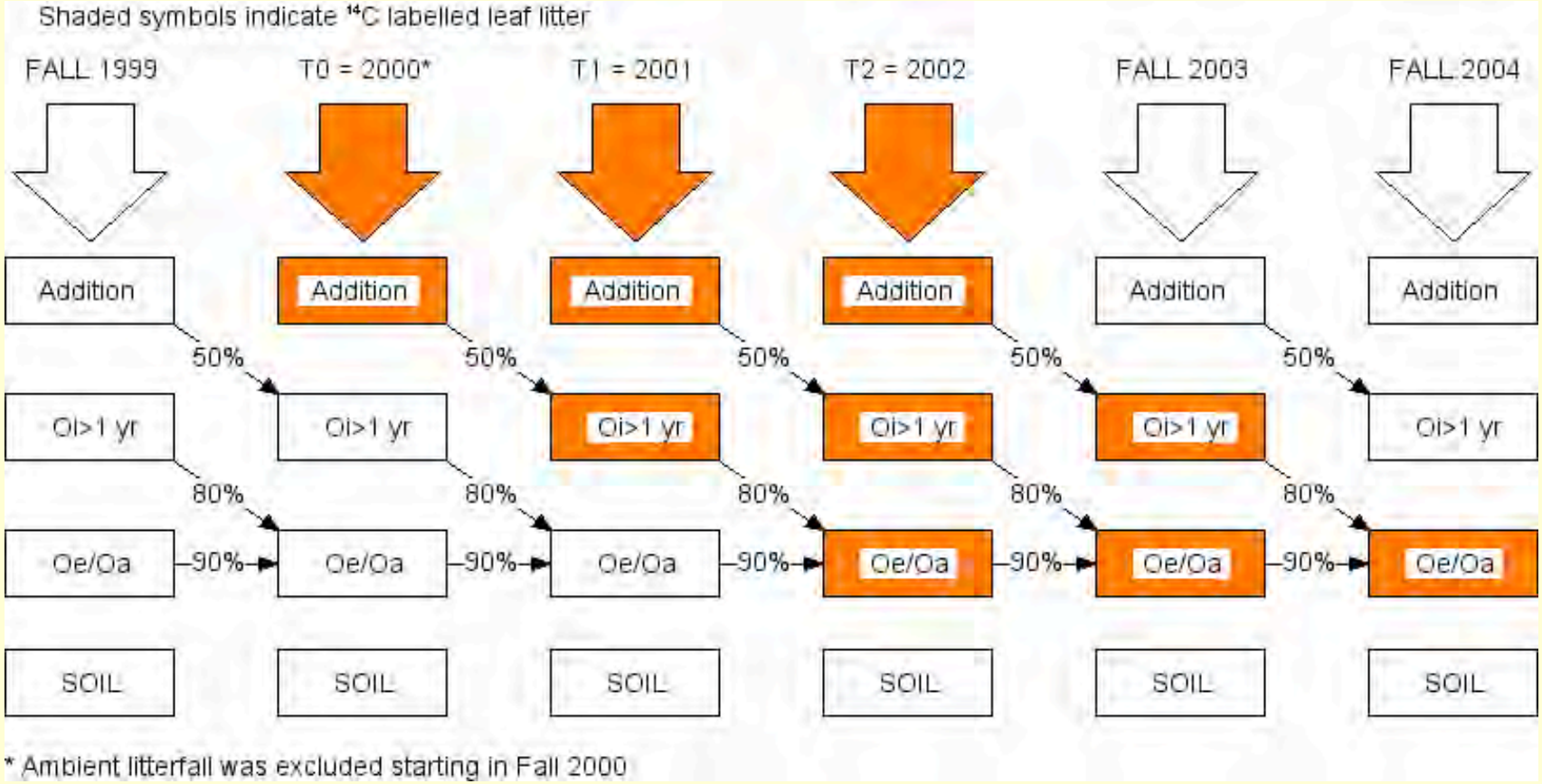
- 1-year litter mass loss is ~50%
- Subsequent decomposition takes place in a buried horizons
- 2-year litter mass loss is ~20%.
- 3rd-year mass loss is ~12% loss and assumed to coincide with the transition from Oi to Oe/Oa litter quality.
- Stable litter cohort mass beyond year-3 suggests a combination of chemically resistant organic material having a low C/N ratio.



Litter Bags vs. ^{14}C-Change

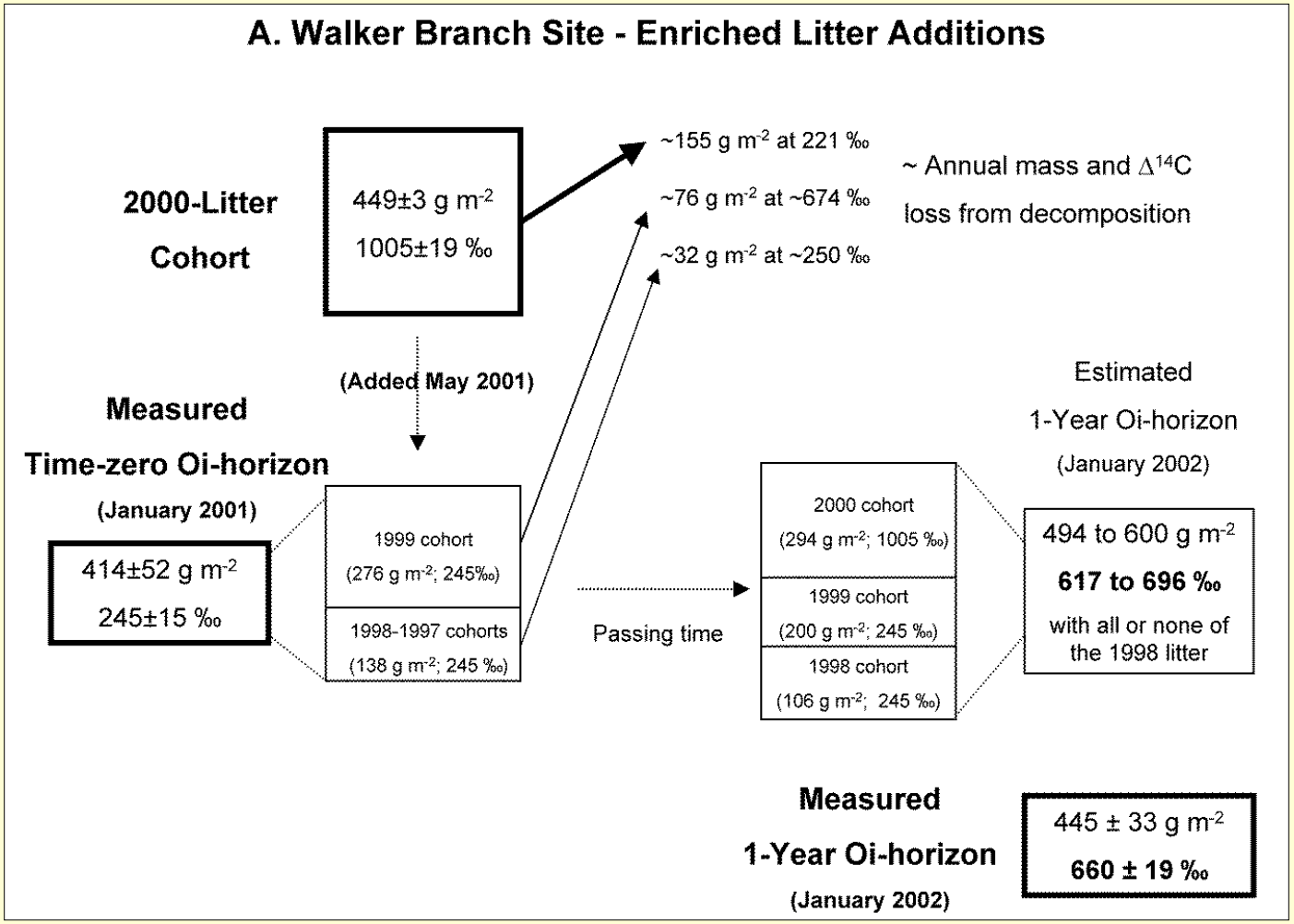


COMPARTMENTS & TIMING



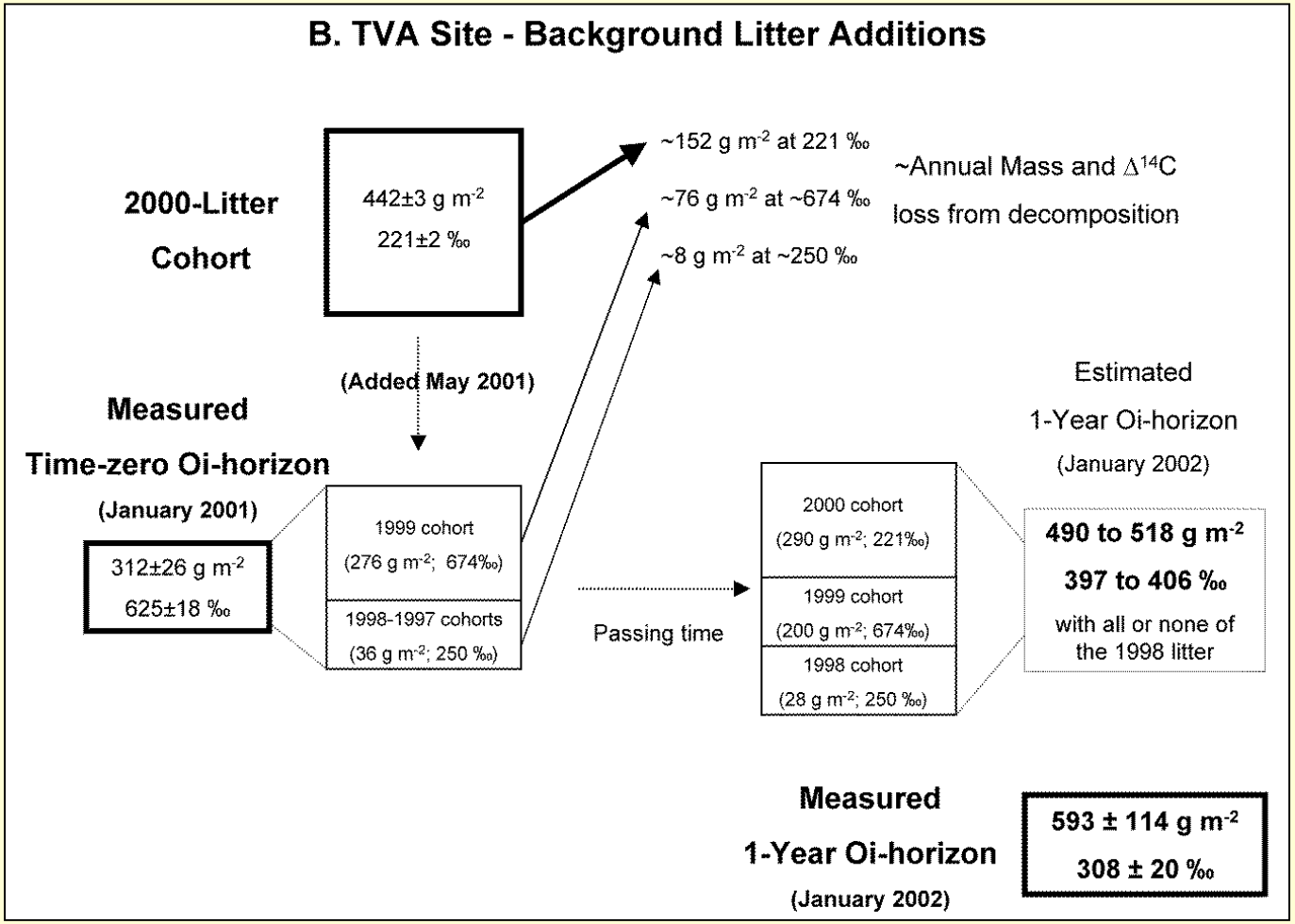
- **Litter additions, Oi > 1 year, Oe/Oa,**
- **Mineral soil (0-15, 15-30, 30-60, 60-90 cm)**

The Apparent 'Well-Behaved' Case



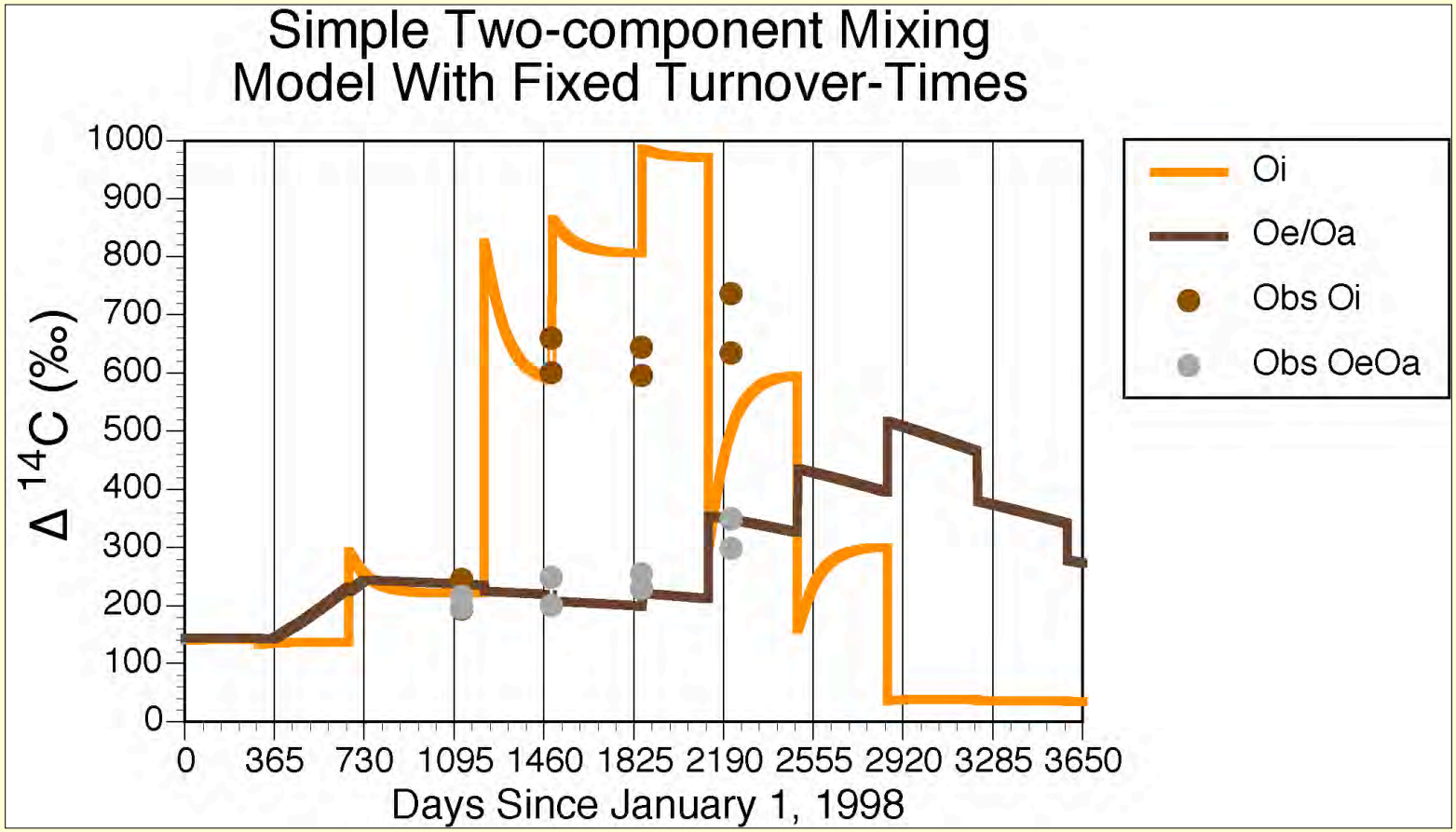
Homogeneous pools mix to yield ~50% change in Oi horizon

The Apparent 'Problem' Case



Non-homogeneous pools mix to yield an apparent ~75% change in the Oi horizon because of preferential loss of material having higher than bulk ^{14}C-signature.

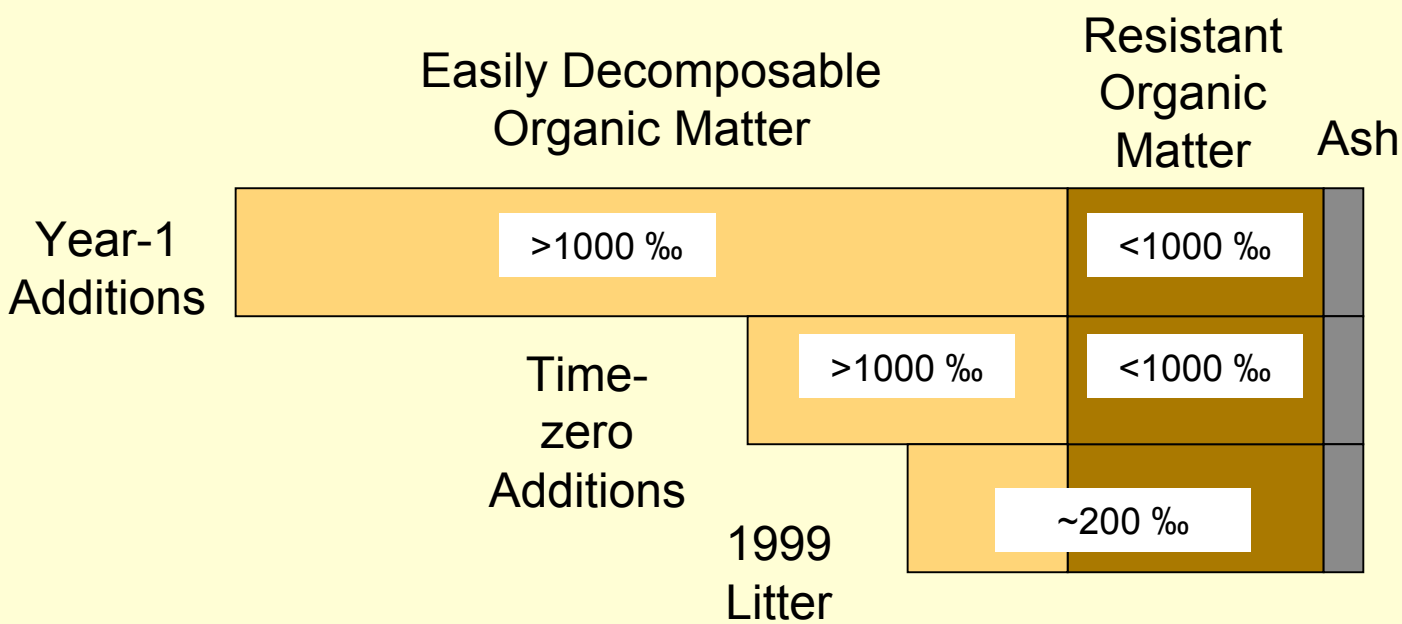
Multi-year Patterns of O-horizon ^{14}C



- **Simple isotopic mixing models did not capture measured ^{14}C values.**
- **Models assuming constant tissue turnover times and uniform tissue composition were inadequate.**

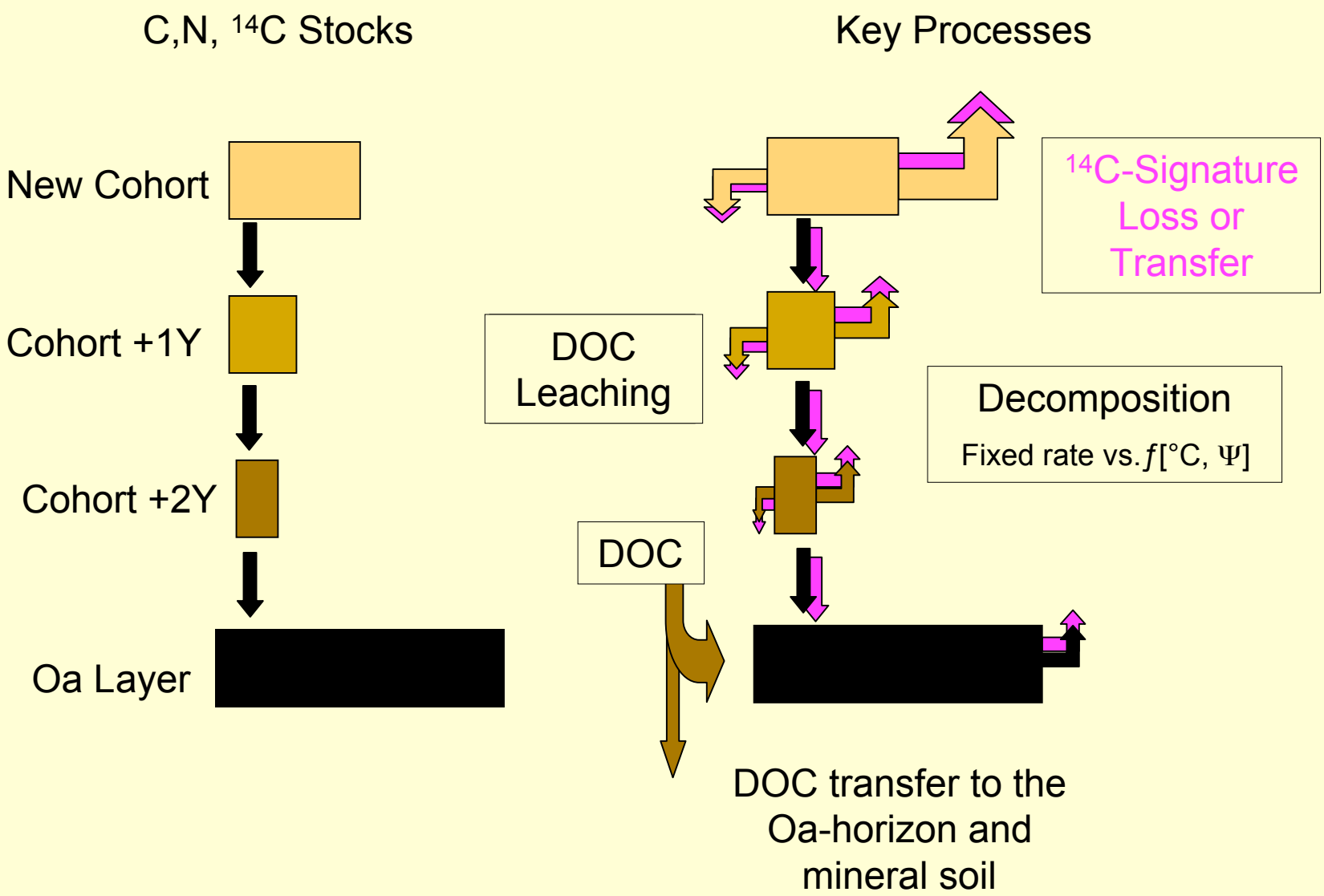
Oi-layer Includes Multiple Cohorts

(Hypothetical Oi>1Y Layer: January 2002)



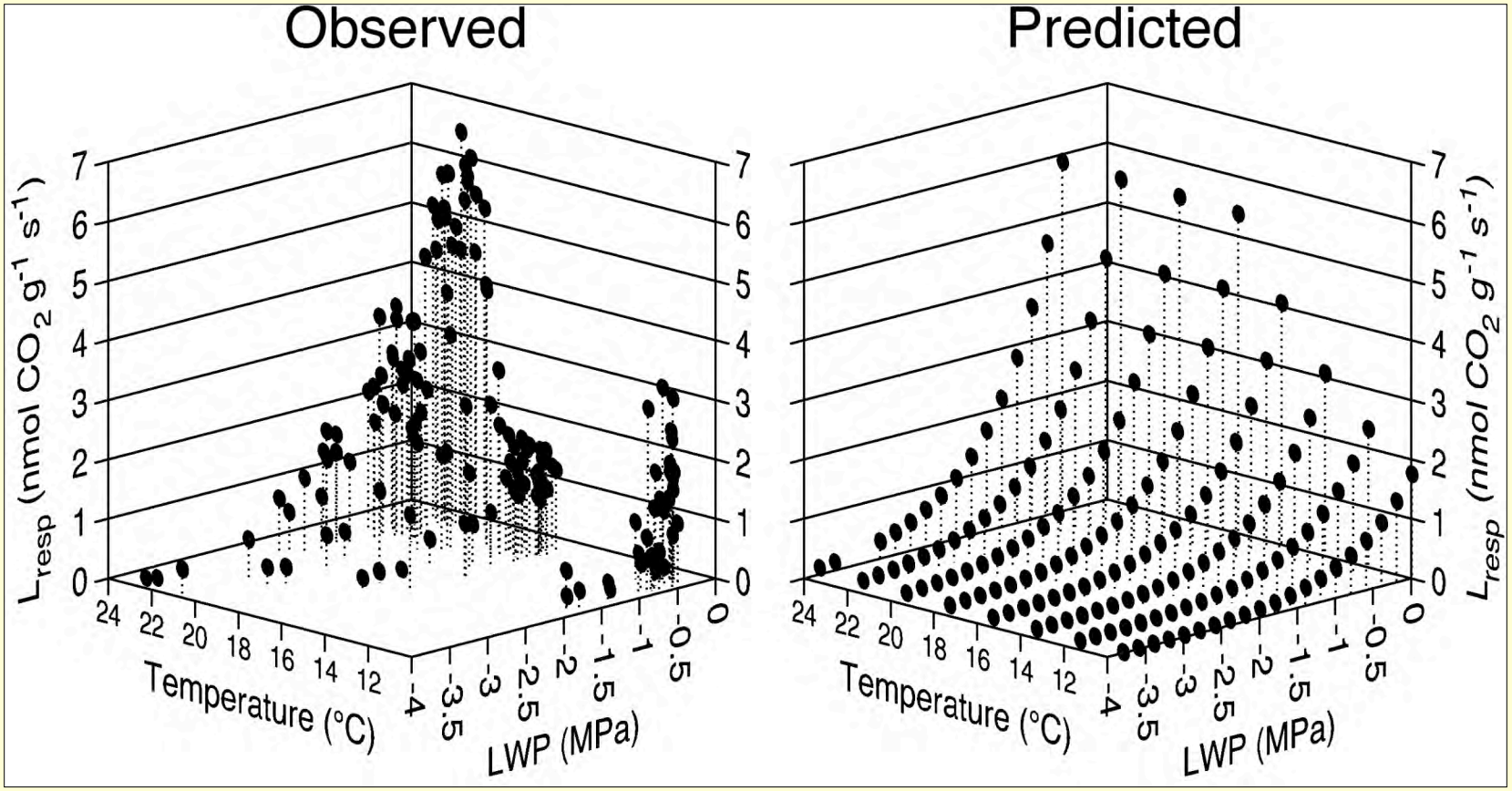
In a stable system all organic components have a similar ^{14}C-signature. In the EBIS experiment, we appear to be analyzing a mixture of materials.

Form of the Litter Cohort Model

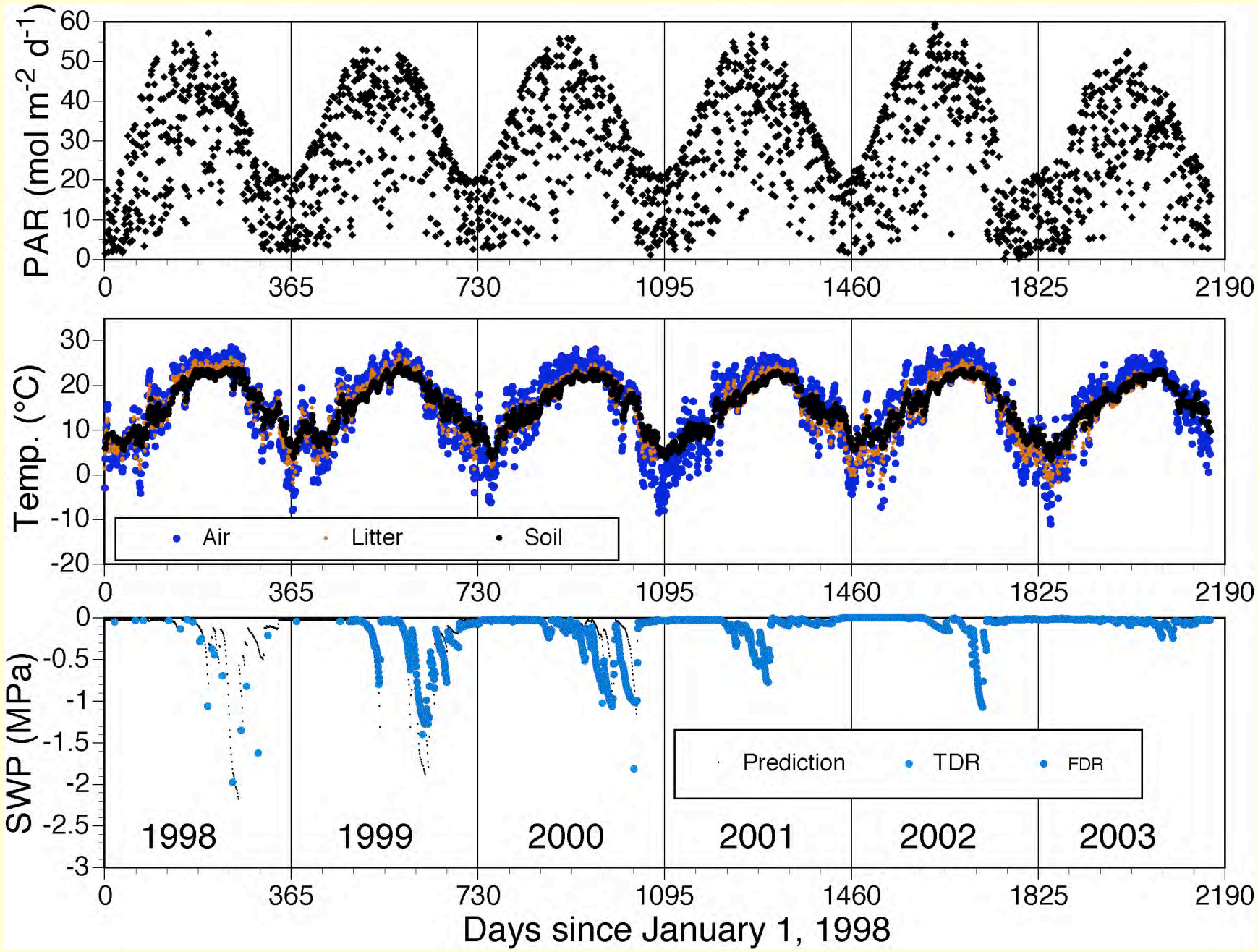


Key Drivers for Decomposition

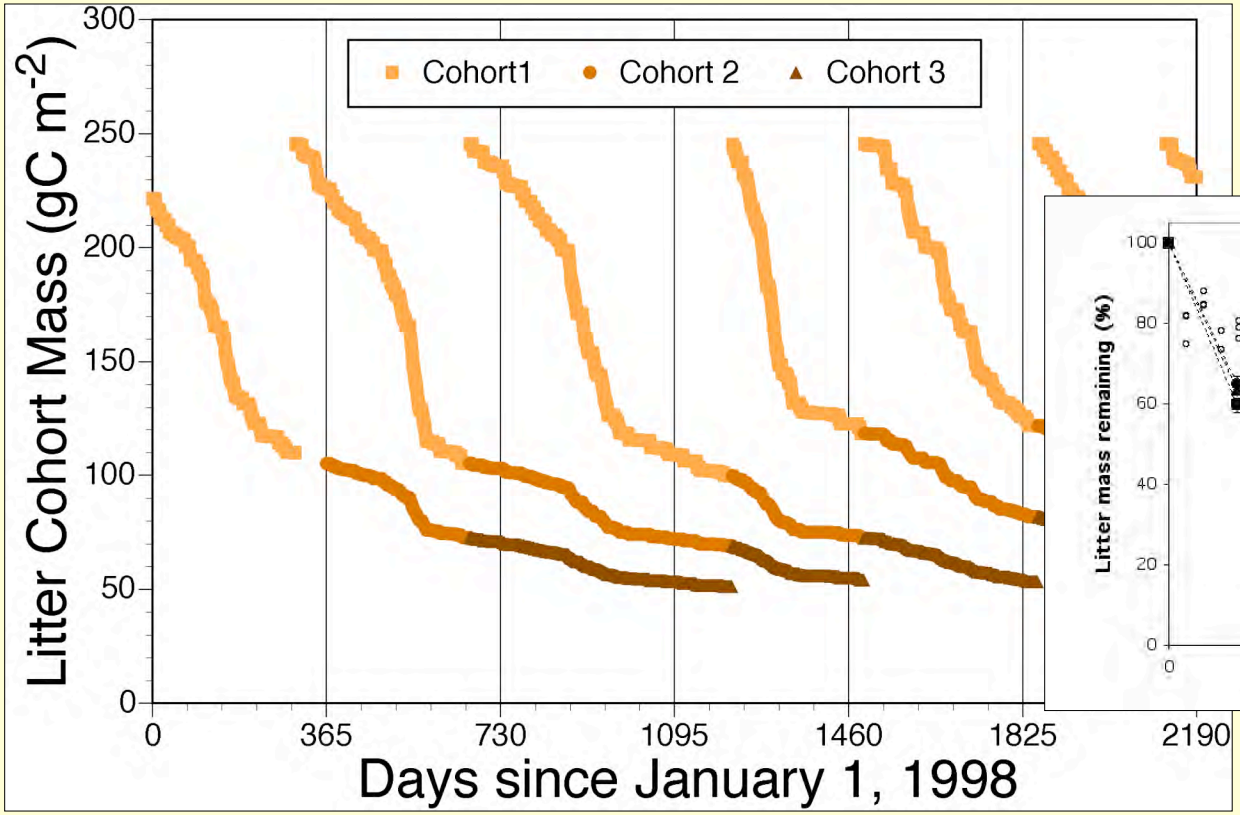
- Temperature
- Litter water potential
- Litter mass
- Organic-layer water potential(s)



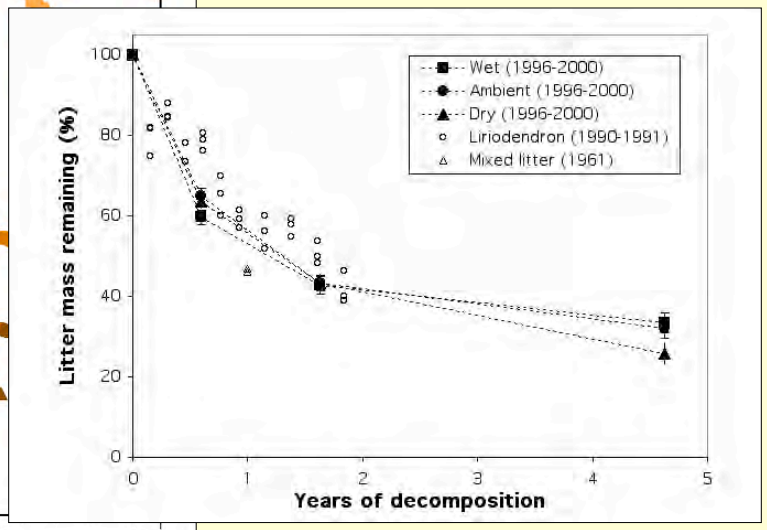
Hanson et al. 2003


PAR (mol m-2 d-1)
60
50
40
30
20
10
0
0
365
730
1095
1460
1825
2190
Temp. (°C)
30
20
10
0
-10
-20
Air
Litter
Soil
SWP (MPa)
0
-0.5
-1
-1.5
-2
-2.5
-3
Prediction
TDR
FDR
1998
1999
2000
2001
2002
2003
Days since January 1, 1998

Simulated Oi-Layer C-Mass

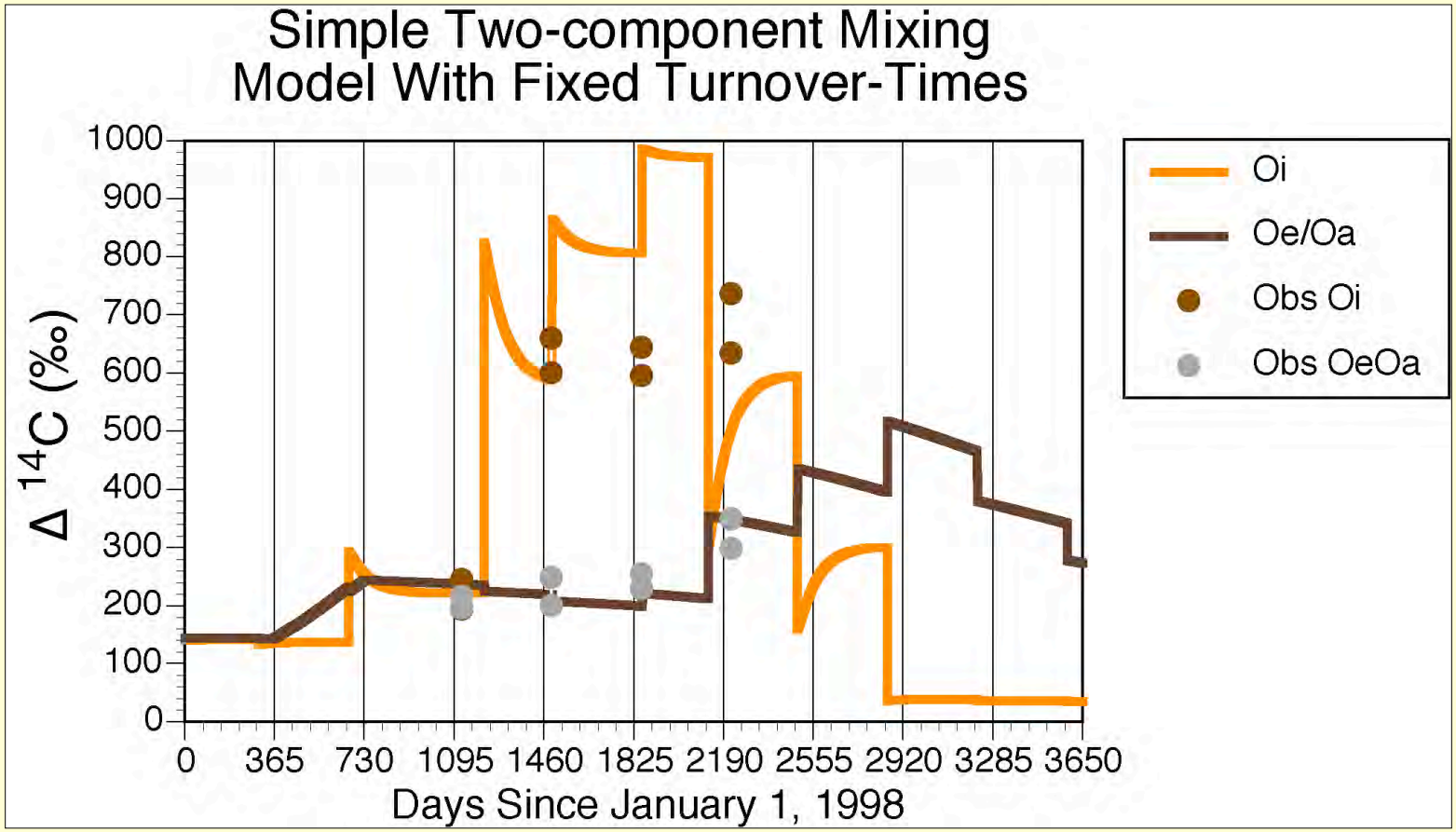


Walker Branch
Litter Mass Loss



- **Simulated Oi-Layer C-mass based on decomposition model can capture mass loss characteristics of Walker Branch litter bags.**
- **Inter-annual differences in weather drive some differences in decomposition and standing C pools.**

Multi-year Patterns of O-horizon ^{14}C



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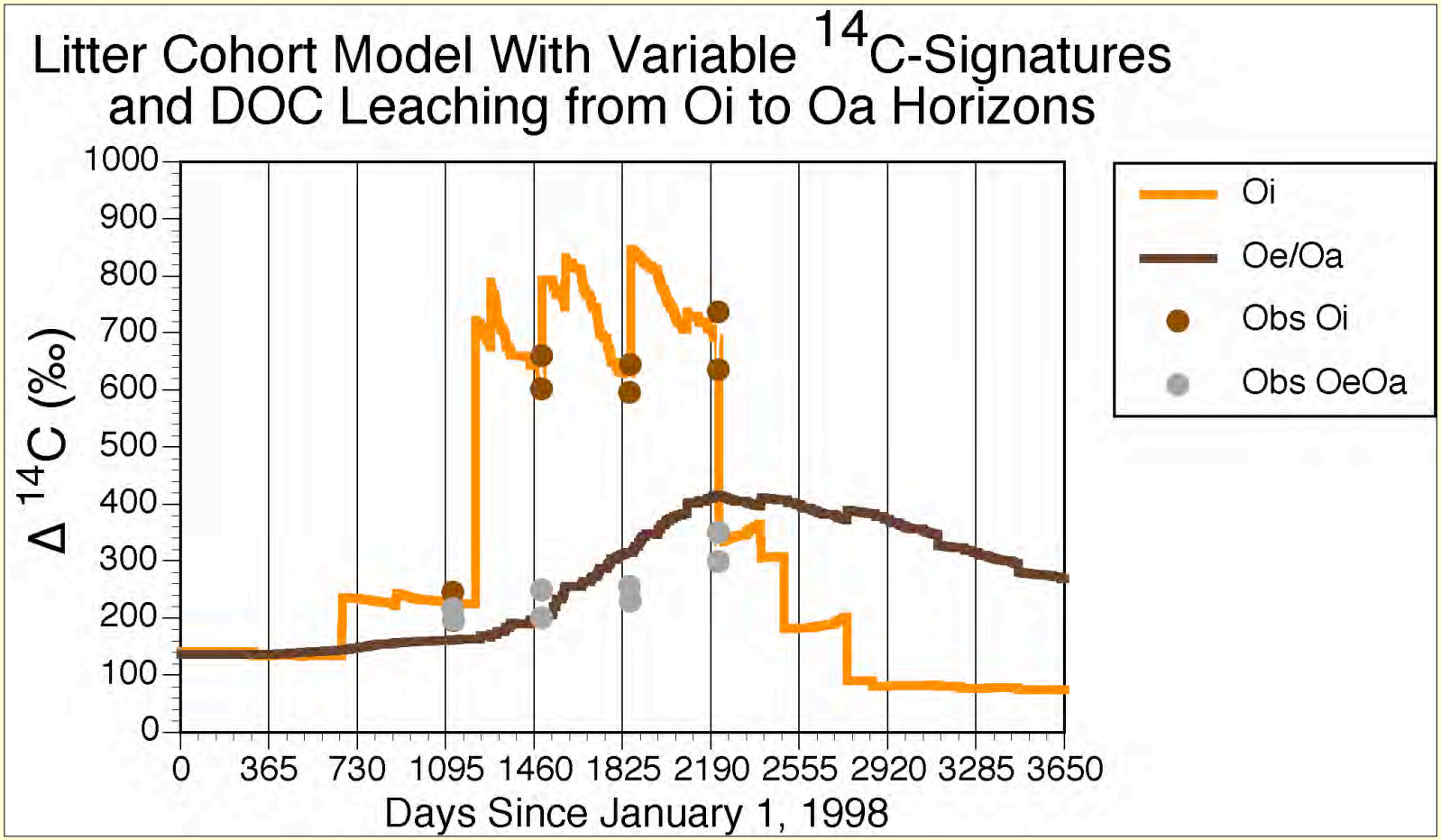
Revised Model/Observations
Multiyear Pattern of O-Horizon ^{14}C



Litter Cohort Model Conclusions

- Oi>1Y samples contain litter contributed by up to 3 litter cohorts.
- Existing decomposition models are appropriate for capturing mass loss with time.
- Differential loss of ^{14}C-signature via decomposition and DOC leaching needs to be further characterized.
  - Does the ^{14}C-signature of leachate C (labile C) agree with ^{14}C-signatures of incubated litter samples?
  - Incubations of recognizable surface litter may contain multiple years of input.
- Movement C into the humus layer and A horizon needs to be resolved
  - Rapid transfers from DOC and earthworm bioturbation
  - Longer term transfers via cohort downward migration?