Grassland Restoration Modeling

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Background and Objectives

- Background
  - Conversion of marginal agricultural land to native vegetation can lead to significant increases in soil organic C
- Objectives
  - Use a simulation modeling approach to describe soil organic C dynamics in a 25 y prairie restoration experiment at Fermilab (Batavia, IL)
  - Use model results to provide insights as to the mechanisms regulating C accrual when converting agricultural land to native vegetation

Aerial view of prairie restoration plots at Fermilab (Photo courtesy T West)

Simulating soil C after conversion of agricultural land to native prairie at Fermilab

Big bluestem
(Andropogon gerardii)

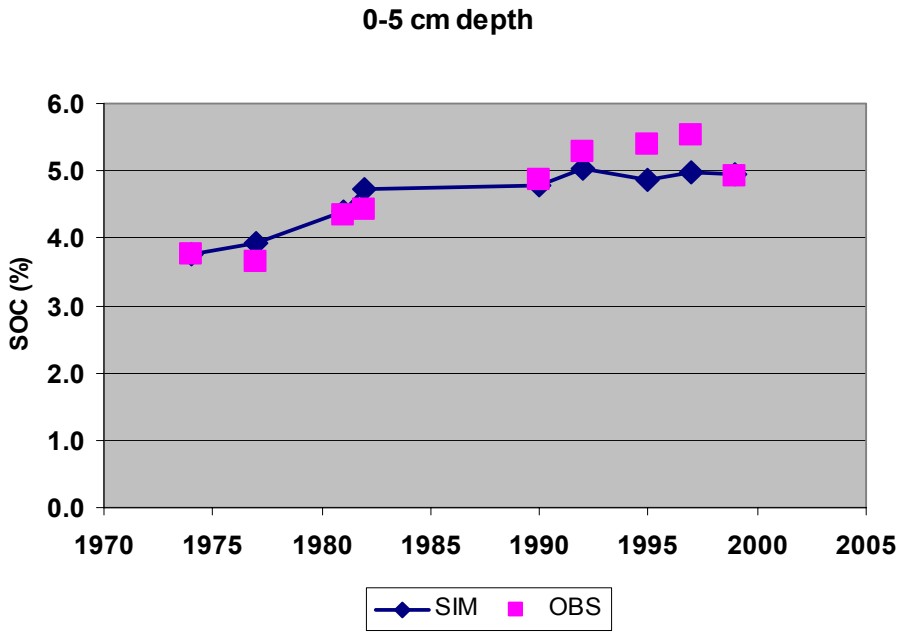
- A 25-y weather record was assembled from Aurora, IL
- Crop parameters were adapted for modeling big bluestem growth
- Soil layer properties for the Drummer soil were obtained from STATSGO database and complemented with site information
- A 25-y run (1975 – 1999) simulated the conversion of an agricultural field to a pure stand of big bluestem
- N deposition was simulated at a rate of 2.1 mg L^{-1} (NADP)

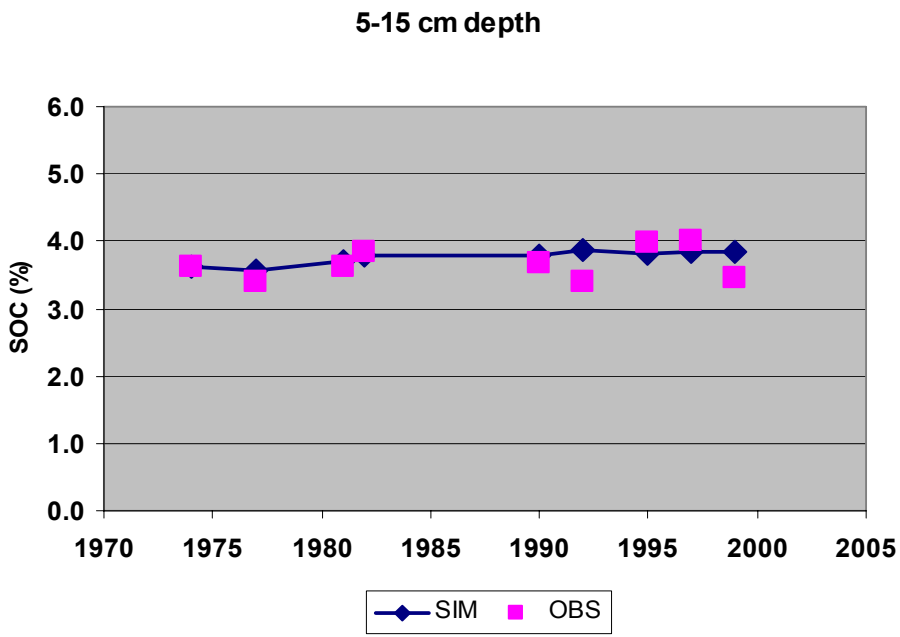
Simulated (SIM) vs. observed (OBS) big bluestem biomass (Mg ha^{-1})

	Above ground biomass	Roots 0-5 cm	Roots 5-15 cm	Roots 15-25 cm
SIM	8.5	6.9	3.7	1.1
OBS	8.3	9.0	3.1	1.8

Simulated and observed soil C under big bluestem vegetation

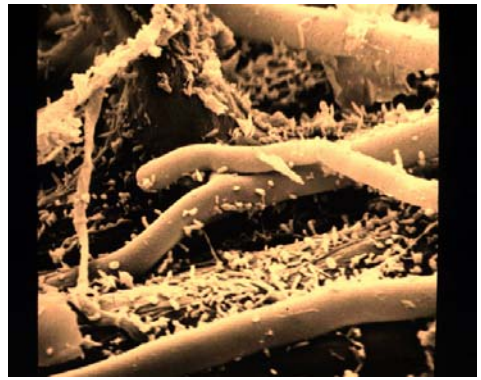
- Overall, EPIC captured the soil organic C dynamics observed during 25 years in the Fermilab chronosequence experiment
- Most of the observed increase in soil C occurred in the top 5 cm soil depth
- The simulated annual rate of soil C accrual to 15 cm depth was lower than the observed rate:
  - Simulated: 0.34 Mg/ha
  - Observed: 0.67 Mg/ha
- The under prediction of soil C by the model may be related to the under prediction of root and rhizome biomass in the top 5 cm soil depth





Initial and final soil microbial biomass C (%) in Fermilab chronosequence

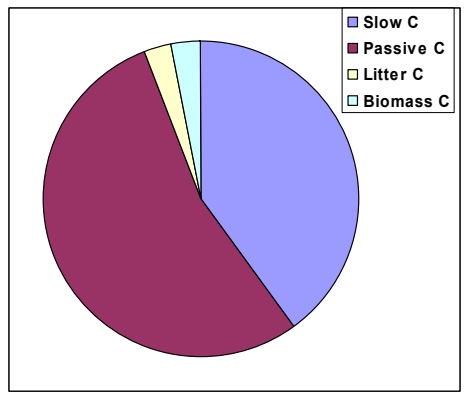
	0-5 cm	5-15 cm	15-25 cm
Initial (1974)	1.0	1.0	1.0
Final (1999) Simulated	3.2	2.7	2.6
Final (1999) Observed	3.1	2.7	2.5



Credit: R. Campbell. 1985. Plant Microbiology. Edward Arnold, London. p. 149.

Distribution of C within soil C pools

- Passive C represented ~54% of the total
- Most of the C accrual occurred in the slow C pool



Summary

- In diagnostic mode, EPIC
  - Reproduced aboveground NPP of bigbluestem
  - Underpredicted root mass accumulation in the top 5-cm soil layer by 23% but predicted it well in deeper soil layers
  - Soil C dynamics were reproduced well by the model in the top two soil layers but C accrual in the top 5 cm soil layer was only 51% that of the observed
  - Captured well the evolution of microbial biomass C over a 25 y period
  - Suggested most of the soil C accrual occurs in the slow pool