Use of the LIDET litter decomposition study to test soil carbon and nitrogen biogeochemistry in CLM

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Long-Term Intersite Decomposition Experiment (LIDET)

Observations

10-year study of litter dynamics for a variety of litter types placed in numerous different environments

- 20 sites: 2 tundra, 2 boreal forest, 5 conifer forest, 3 deciduous forest, 3 tropical forest, 2 humid grassland, 3 arid grassland
- 9 litter types (6 species of leaves, 3 species of root) that vary in chemistry

Litter bags sampled once a year for C and N

Model simulations

- CLM-cn, CLM-cent, DAYCENT
- Follow a cohort of litter (100 g C m^{-2}) deposited on October 1
- Specified climatic decomposition index (CDI), to account for temperature and moisture
- Soil mineral nitrogen

  DAYCENT

  SOM C:N ratios vary with mineral N. Use low and high C:N ratios

  CLM-cn, CLM-lbnl

  Configure simulations so that N does not limit decomposition & immobilization (fpi=1) and so that N is rate limiting (fpi<1)

The models

CLM-cn

3 litter pools

- Turnover = 20 h – 71 d

4 SOM pools

- Turnover = 14 d – 27 y
- C:N = 10-12

Rapid decomposition rates
Low SOM C:N ratios (high immobilization)

CLM-cent

3 litter pools

- Turnover = 20 d – 74 d

3 SOM pools

- Turnover = 50 d – 222 y
- C:N = 8-11

Slow decomposition rates
Low SOM C:N ratios (high immobilization)

DAYCENT

Surface

2 litter pools

- Turnover = 46 d – 182 d

2 SOM pools

- Turnover = 61 d – 12 y
- C:N = 10-20

Belowground

2 litter pools

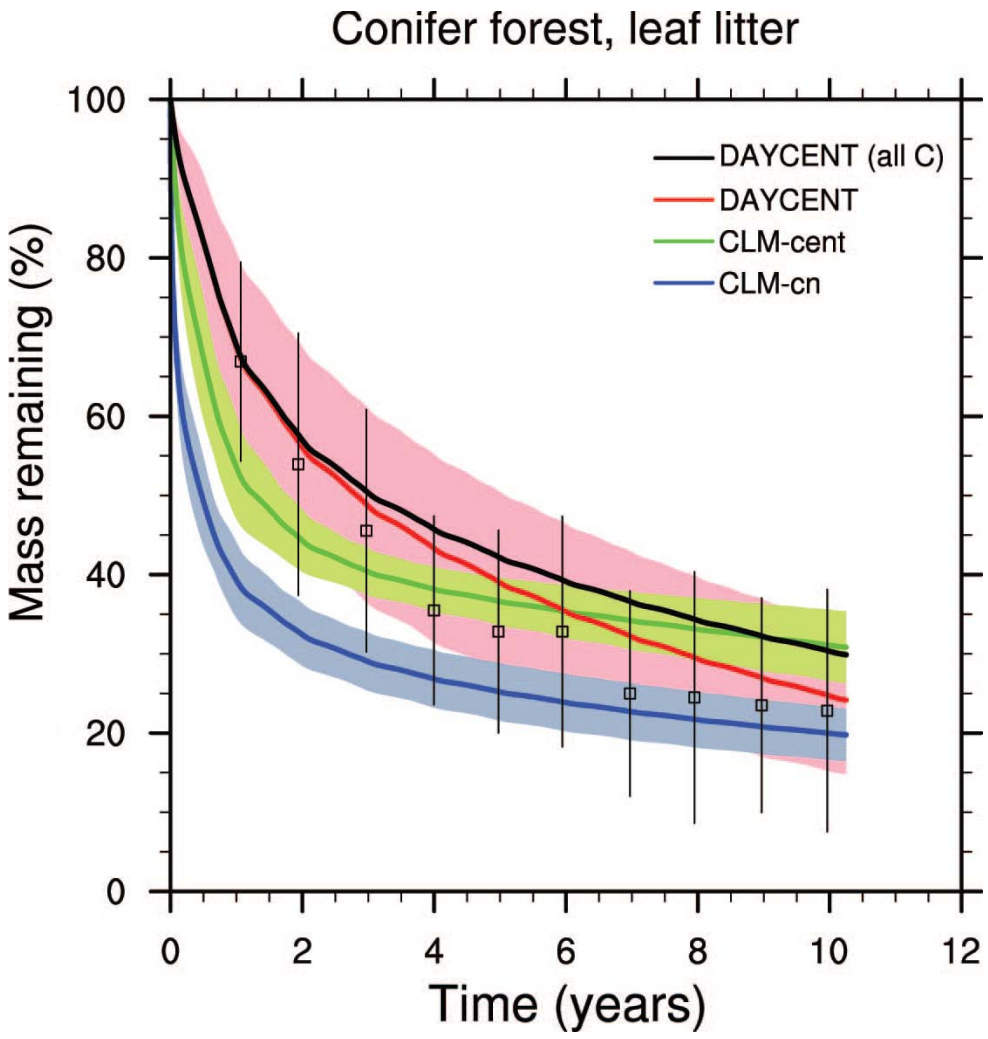
- Turnover = 20 d – 74 d

3 SOM pools

- Turnover = 33 d – 303 y
- C:N = 6-40

Slow decomposition rates
High SOM C:N ratios (low immobilization)

Carbon dynamics



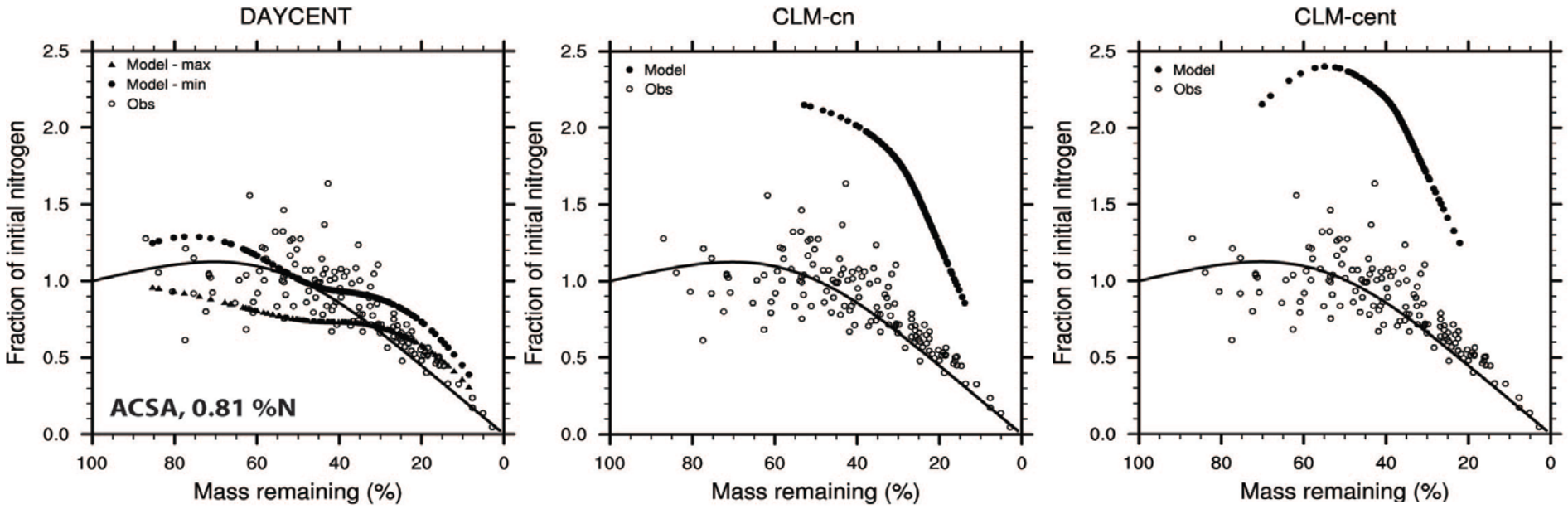
5 sites
6 leaf litter types
Shown are the site x litter mean and ± 1 SD

DAYCENT simulations show surface C and all C (surface and soil)

Similar behavior in other biomes

Nitrogen dynamics

Maple, 0.81 %N

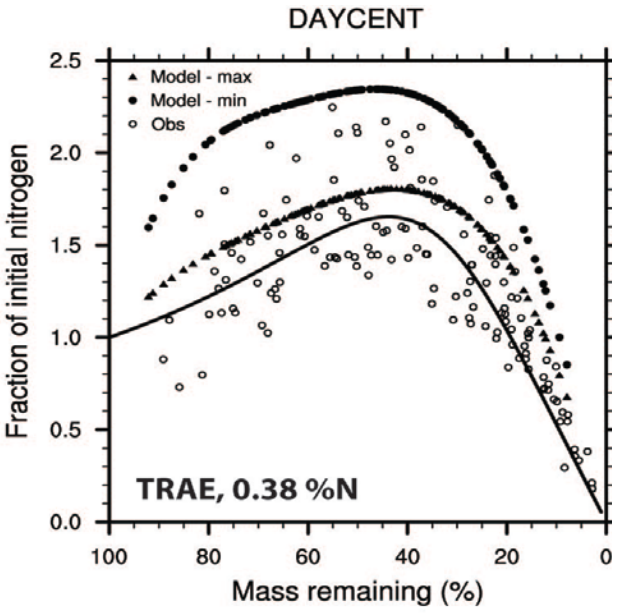


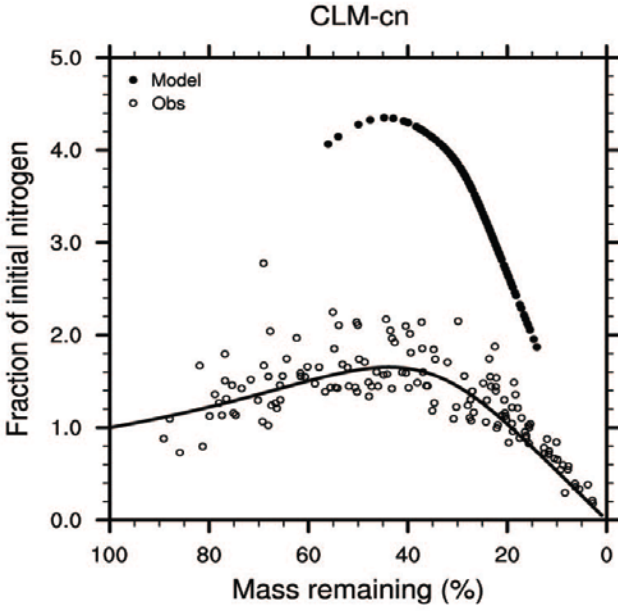
Observations are sampled once per year. Shown are data for maple leaf litter at all biomes except arid grassland. Model data are sampled similar to the observations.

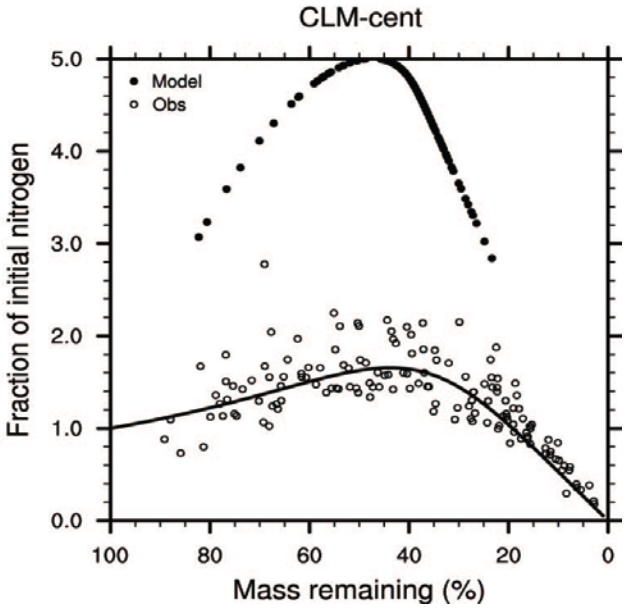
Similar behavior for other leaf litter types

Nitrogen dynamics

Wheat, 0.38 %N

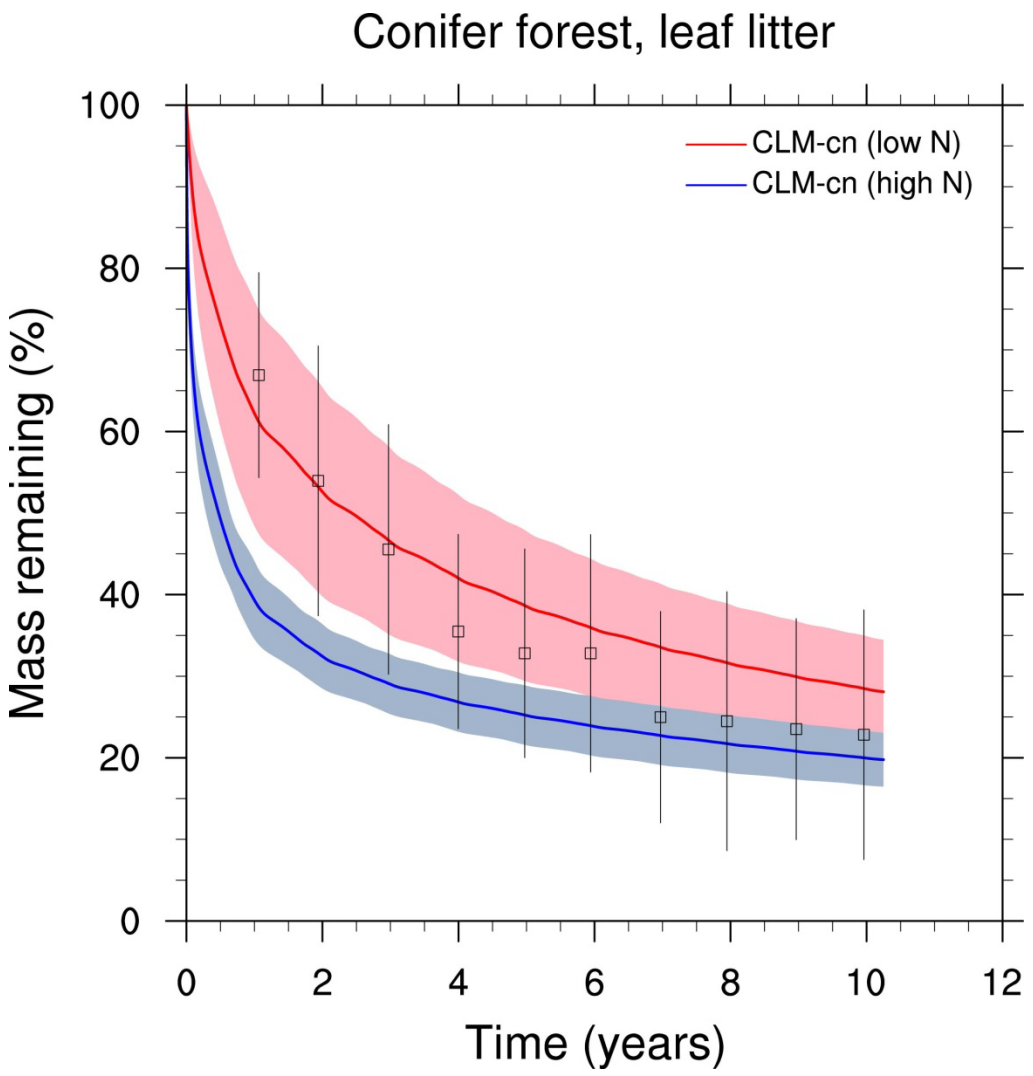






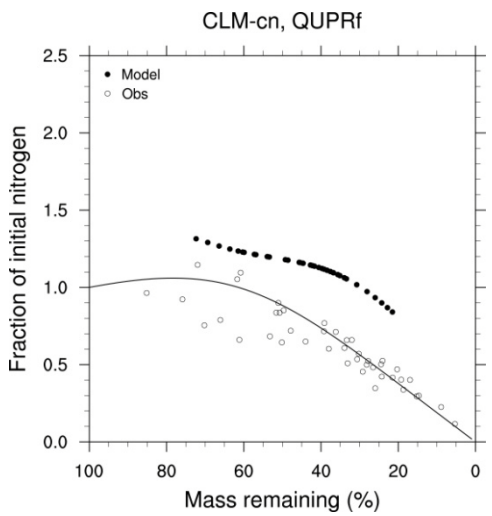
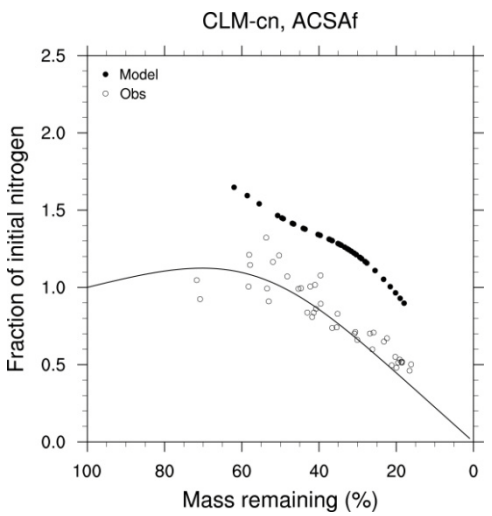
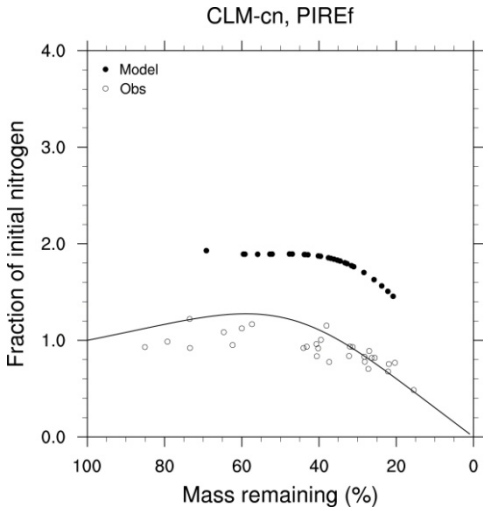
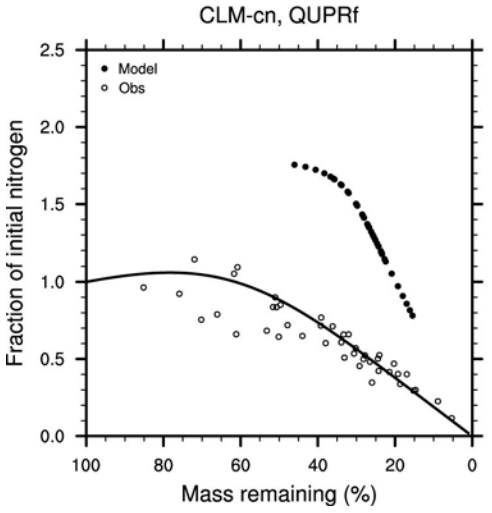
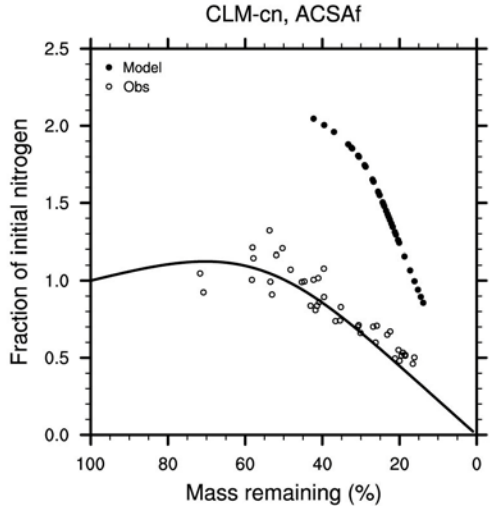
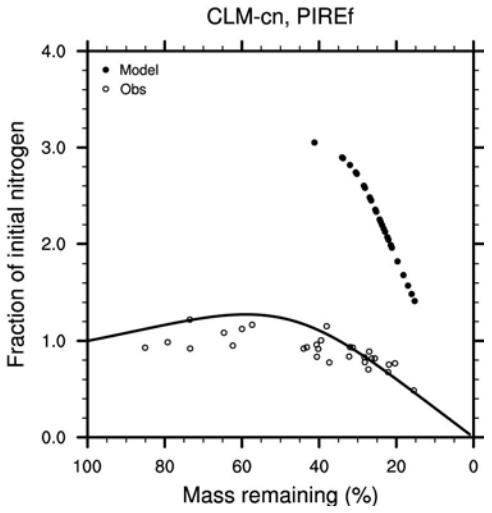
CLM-cn nitrogen limitation

N limitation reduces decomposition rates in CLM-cn and improves carbon dynamics. Here we use fpi = 0.05



CLM-cn nitrogen limitation

Conifer forest only

	Oak, 1.03 % N	Maple, 0.81 % N	Pine, 0.59 % N
N limiting			
N not limiting			

N limitation reduces immobilization

Conclusions

The models differ in C and N dynamics

- CLM-cn overestimates C loss and overestimates N immobilization
  - N limitation reduces decomposition rates, but restricts N mineralization
- DAYCENT represents C and N dynamics reasonably well
  - N limitation incrementally improves N dynamics
- CLM-cent is somewhere in between (better C dynamics than CLM-cn, but overestimates immobilization)

General thoughts

- "Century-like" is not necessarily like Century
- Details of soil BGC models matter
- CLM-cn and DAYCENT represent quite different views of C-N interactions