Studies on Biogeochemistry
Model Spin-up in CLM-CN

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The Definition of Model Spin-up

- Model spin-up refers to the process by which a steady-state solution is estimated.
- Terrestrial biogeochemistry models usually spin-up from the bare ground to "equilibrium" vegetation to establish realistic steady-state values for their various “pools” (carbon pools, nitrogen pools, etc).

Motivation

- Testing methods which can reduce the computational cost, and retain or improve the simulated results.
Data and Methodologies

- **Model:** Community Land Model with explicit consideration of carbon and nitrogen processes (CLM-CN).
- **Spin-up methods included:**

1) Native dynamic (ND): the system of coupled plant, litter, and soil carbon and nitrogen pools develops on a “monotonic” path from the null state to the stable steady state \((\text{Thornton and Rosenbloom 2005})\).

2) Accelerated decomposition (AD): 600 years AD-spinup which gives nitrogen decomposition rate a factor of 20; 1 year exit-spinup which skips C and N balance checking; at least 50 years run in normal mode \((\text{Thornton and Rosenbloom 2005})\);
3) Soil initialization (SI) of carbon and nitrogen pools: Initialize the soil carbon pools by reading in organic matter at soil levels; it is assumed that per kilogram organic matter contains 0.58 kilogram carbon, and soil nitrogen pools depend on the C:N ratio.

✓ Global Soil Data Task soil organic matter content, has been gridded onto CLM.

✓ Soil carbon has its vertical distribution.

Results

Spin-up time (years needed to reduce the differences between each 30-year forcing cycle less than 1%) by using these methods.

\[ \Delta C_{\text{tot}}(\%) = \frac{100 \times (C_{\text{tot}(i)} - C_{\text{tot}(i-1)})}{C_{\text{tot}(i-1)}} \leq 1.0\% \]
Results
Comparison of spin-up time of three methods at three regions.
The position of Reserva_Jaru (RJA) site: latitude -10.08, longitude -61.93, and it is a LBA site. The surface vegetation here is tropical rain forest.
Conclusion

1) The spin-up time shows a great spatial variability, and this variability strongly depends on the initial conditions of the model.

2) Comparing with the ND-spinup method, the AD-Spinup method can significantly reduce the computational time (up to 70%), and this result is similar to Thornton’s result based on the model Biome-BGC (Thornton and Rosenbloom 2005).

3) The SI-spinup method is also an efficient spin-up method; in the tropical rainforest, the simulated variables can quickly reach to the levels which are close to the steady-state.
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References:


Thank you for your attention!

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