Nitrification, Denitrification and Nitrous Oxide (N$_2$O) Fluxes in CLM5

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Ozone Depletion

Global Warming

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N$_2$O Flux in CLM5

Denitrification accounts for 98% of N$_2$O flux.
CLM N$_2$O flux does not capture tropical source maximum
Fate of $\text{NH}_4^+$ and $\text{NO}_3^-$ in productive grid cells

Almost no $\text{NH}_4^+$ is nitrified, but then almost all the resulting $\text{NO}_3^-$ is denitrified.
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Why is nitrification the big loser in the competition for $\text{NH}_4^+$, especially in productive grid cells?

Potential Immobilization = $F($soil decomposition rate$)$

Potential Plant Uptake = $F($primary production rate$)$

Potential Nitrification = $F($$\text{NH}_4^+$ concentration$)$
CLM nitrification rate is based on truncated interpretation of original Parton equation

CLM follows CENTURY nitrification scheme (Parton et al., 2001, 1996)

But the actual Parton et al. equation includes terms for both NH$_4^+$ pool size and soil N turnover rate

\[
\text{Nitrification} = 0.2 \times \text{Netmin} + K_{\text{max}} \times \text{NH}_4 \times F(\text{Temp}) \times F(\text{WFPS}) \times F(\text{pH})
\]

(N turnover rate + Excess NH$_4^+$ concentration)
Standard CLM4.5

Add N turnover term to nitrification equation

CLM4.5 results
Standard CLM4.5

Add N turnover term to nitrification equation

CLM4.5 results
Effect of adding N turnover term to nitrification equation at Amazon grid cell

Nitrification and Denitrification

Vegetation and Soil Carbon

SOC
Vegetation C

Standard CLM4.5
Add N turnover term to nitrification equation
Carbon cycle

- Atm CO₂
- Plant
- Litter
- Soil Organic Matter

Nitrogen cycle

- Atm N₂O
- Atm N₂
- Soils NH₄⁺
- Soils NO₃⁻

Processes:
- Biological N₂ Fixation
- Synthetic Fertilizer
- Fossil fuel NOx

Other processes:
- Denitrification
- Recycled N

External input/output

Leaching

Respiration
Parton et al. 2001 equation assumes nitrification is 20% of net mineralization, but CLM suggests more spatial heterogeneity